MOODY MARINE LTD

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Final Report for

ANTARCTIC KRILL PELAGIC TRAWL FISHERY

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1. INTRODUCTION

This report sets out the results of the assessment of the Aker BioMarine Antarctic krill pelagic trawl Fishery against the Marine Stewardship Council (MSC) Principles and Criteria for Sustainable Fishing.

1.1 The fishery proposed for certification

The MSC Guidelines to Certifiers specify that the unit of certification is "The fishery or fish stock (=biologically distinct unit) combined with the fishing method/gear and practice (=vessel(s) pursuing the fish of that stock) and management framework." The fishery proposed for certification is therefore defined as:

Species:	Antarctic Krill (*Euphausia superba*)
Geographical Area:	Southern Ocean, CCAMLR Area 48 (see Figure 1below)
Method of Capture:	Pelagic Trawl (continuous fishing system)
Management System:	CCAMLR Framework
Client Group:	Aker BioMarine nominated vessels

In the course of the certification it is possible that further companies/vessels may join the client group. This would be in accordance with the MSC's stated desire to allow fair and equitable access to the certification.

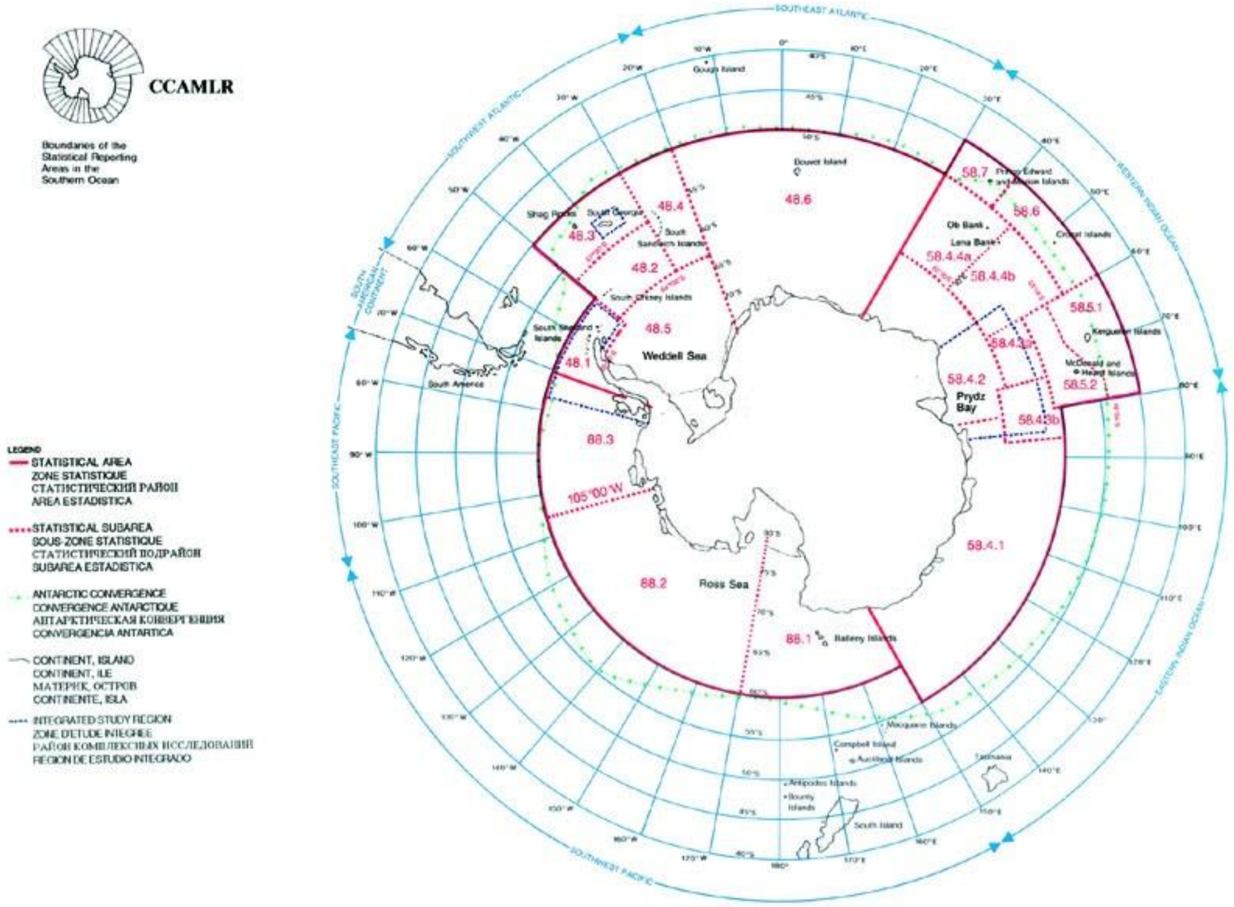

Figure 1: Map of the CCAMLR Convention Area boundaries of the statistical reporting areas within the Southern Ocean. source: http://www.ccamlr.org/Pu/e/conv/map.htm

1.2 Report Structure and Assessment Process

The aims of the assessment are to determine the degree of compliance of the fishery with the MSC Principles and Criteria for Sustainable Fishing, as set out in Section 8.

This report sets out:

- the background to the fishery under assessment and the context within which it operates in relation to the other areas where krill are fished
- the qualifications and experience of the team undertaking the assessment
- the standard used (MSC Principles and Criteria)
- stakeholder consultation carried out. Stakeholders include all those parties with an interest in the management of the fishery and include fishers, management bodies, scientists and environmental Non-Governmental Organisations (ENGO's)
- the methodology used to assess ('score') the fishery against the MSC Standard.
- a scoring table with the Scoring Indicators adopted by the assessment team and Scoring Guidelines which aid the assessment team in allocating scores to the fishery. The commentary in this table then sets out the position of the fishery in relation to these Scoring Indicators.

The intention of the earlier sections of the report is to provide the reader with background information to interpret the scoring commentary in context.

Finally, as a result of the scoring, the Certification Recommendation of the assessment team is presented, together with any conditions attached to certification.

In draft form, this report is subject to critical review by appropriate, independent, scientists ('peer review'). The comments of these scientists are appended to this report. Responses are given in the peer review texts and, where amendments are made to the report on the basis of peer review comments; these are also noted in the peer review text. Following peer review, the report is then released for public scrutiny on the MSC website.

The report, containing the recommendation of the assessment team, any further stakeholder comments and the peer review comments is then considered by the Moody Marine Governing Board (a body independent of the assessment team). The Governing Board then make the final certification determination on behalf of Moody Marine Ltd.

It should be noted that, in response to comments by peer reviewers, stakeholders and the Moody Marine Governing Board, some points of clarification may be added to the final report.

Finally, the complete report, containing the Moody Marine Ltd Determination and all amendments, will be released for further stakeholder scrutiny.

1.3 Stakeholder meetings attended

Information used in the main assessment has been obtained from interviews and correspondence with stakeholders in the fishery, notably:

I1.	Aker BioMarine	Simon Wadsworth
I2.	WWF-Norway	Nina Jensen
I3.	Norwegian Ministry of Foreign Affairs	Karsten Klepsvik
I4.	Fiskeridirektorate	Aksel Ekemor
I5.	Institute of Marine Research	Svein Iversen
I6.	MRAG	John Pearce
I7.	Greenpeace	Richard Page
I8.	WWF	Sian Prior
I9.	Seafood Choices Council	Emily Howgate

1.4 Other information sources

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2 GLOSSARY OF ACRONYMS USED IN THE REPORT

ASOC	Antarctic and Southern Ocean Coalition
B0	Pre-exploitation Biomass
BAS	British Antarctic Survey
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CEMP	CCAMLR Ecosystem Monitoring Programme
CITES	Convention on International Trade in Endangered Species
CPUE	Catch per Unit Effort
EPOC	Ecosystem Productivity Ocean Climate model
ETP	Endangered, Threatened, Protected Species
F	Fishing Mortality
FAO	Food and Agriculture Organisation of the United Nations
FOOSA	Krill-Predator-Fishery Model (previously known as KPFM2)
GSGSSI	Government of South Georgia and South Sandwich Islands
GYM	Generalised Yield Model
IUU	Illegal, Unregulated and Unreported Fishing
IWC	International Whaling Commission
LTER	Long Term Ecological Research Network
M	Natural Mortality
MSC	Marine Stewardship Council
OCCAM	Ocean Circulation and Climate Advanced Modelling Project
PUCL	Precautionary Upper Catch Limit
RFMO	Regional Fisheries Management Organisation
SGSSI	South Georgia and South Sandwich Islands
SMOM	Spatial Multi-Species Operating Model
SSMU	Small-scale Management Unit
TAC	Total Allowable Catch
US AMLR	US Antarctic Marine Living Resources Program
VME	Vulnerable Marine Ecosystem
VMS	Vessel Monitoring System
WG-EMM	Working Group on Ecosystem Monitoring and Management
WWF	World Wildlife Fund
Y	Yield

3 BACKGROUND TO THE FISHERY

3.1 Introduction

Aker BioMarine is a Norwegian company which began krill test fishing in 2003. The following year they began to harvest krill for use as fish meal and oil for human consumption. Krill are harvested using a continuous mid-water/pelagic trawl system which was specifically developed by Aker BioMarine. This system is guarded by a fine mesh which prevents anything larger than krill from entering the system and is monitored by underwater cameras.

The following section discusses the Antarctic krill and the development and status of the fishery which targets this species within the Southern Ocean.

3.2 Biology of the Target Species

For detailed reviews of the research on Antarctic krill biology and ecology see Miller (2003), Miller and Hampton (1989), Everson (2000d) and Nichol (2006). The following provides a brief overview of the species and draws attention to some issues relevant to the fisheries management. References are made to additional scientific articles where appropriate.

Spatial Distribution
The pattern of post-larval krill distribution has been relatively well studied, via circumpolar plankton net surveys during the Discovery Investigations (1935-1939), through sightings and commercial activities between 1929 – 1983, and through FIBEX acoustic studies (see Miller and Hampton, 1989) and both synoptic and *ad hoc* surveys (see Iverson, 2000d; WGEMM 2000; Nicol 2006). For example, the Norwegian research vessel *G.O. Sars* recently performed an ecosystem survey that operated around South Georgia and Bouvet Islands (Iversen et al., 2008). Data from this survey are expected to be presented to CCAMLR in 2009.

The summer distribution of Antarctic krill, *Euphausia superba* (Dana, 1852) is circumpolar, bounded to the north by the Antarctic polar front and by the pack ice in the south. However, the southern limits of the distribution are not known exactly, as a significant proportion of the krill population extends under pack ice where it cannot be detected. Nevertheless, biomass estimates of this species suggest that it is the most abundant on Earth.

Movement around the pole is strongly influenced by the main water flow fields. The general circulation of the Southern Ocean has been well described (see Miller and Hampton, 1989), and this Antarctic Circumpolar Current has been modeled.

Most interest in krill fishing is likely in Area 48. Survey results have suggested that krill density is approximately 2.5 times greater in the West Atlantic than the Indian Ocean and commercial catches, plankton net samples and whaling records show that krill abundance in the Pacific Ocean is substantially less than in the other sectors. The southwest Atlantic sector contains more than 50% of Southern Ocean krill stocks (Atkinson *et al.* 2004). Also, krill extends further north in the Western Atlantic Sector (as far as 53^{o}S) compared to the Indian or Pacific sector (as far as 65^{o}S).

Krill densities in the West Atlantic are usually associated with bottom topography (i.e. shallow shelves or close to islands) and with oceanographic features such as the Weddell-Scotia Confluence, where Scotia Sea waters merge with those flowing out of the western end of the Weddell Sea. Specific areas of high krill concentration include the Scotia Sea (Subarea 48.1), areas adjacent to the Antarctic Peninsula (Subarea 48.1), and the northern reaches of the Weddell Sea close to the South Orkneys (Subarea 48.2). Krill are also abundant in the vicinity of South Georgia (Subarea 48.3).

Modelling of the impacts of currents on krill distribution (and hence potential sources and sinks) has shown that krill from Elephant Island can be carried across the Scotia Sea by these currents, arriving off South Georgia several months later (Hoffmann et al., 1998). The pattern of ocean circulation across the Scotia Sea also affects the distribution of krill within CCAMLR Area 48; proximity to each other and location within the circumpolar current means that links between the South Shetlands (Subarea 48.1) and South Orkneys (Subarea 48.2) are likely strong. The location of South Georgia (Subarea 48.3) on the north side of the current means local krill abundance will be affected by latitudinal variations in the flow through the Drake Passage (Sushin and Shulgovsky, 1999). In turn, import advection of krill from breeding and nursery grounds upstream around the western Antarctic Peninsula, due to the Antarctic Circumpolar Current's flow toward South Georgia, may contribute to interannual changes in krill abundance, and hence the biological communities at South Georgia (Meredith et al., 2008). Evidence has also been found for a compensating southwards migration, with an increasing proportion of krill found south of the Antarctic Circumpolar Current as the season progresses. The retention of krill in moderately productive oceanic habitats is a key factor in their high total production (Atkinson et al., 2008).

While krill have been viewed as being relatively passive particles in the ocean currents, post-larval krill are efficient swimmers, able to sustain forward motion against currents for long periods. Therefore krill distribution may be influenced by adults seeking to remain in favourable habitats (Miller and Hampton, 1989).

While there is some evidence for patterns in the vertical distribution of krill, these may differ among areas. In the West Atlantic, with some exceptions, krill show a diurnal vertical migration pattern, with krill aggregations tending to be shallower at night than by day. In contrast, other studies (usually in oceanic areas) indicate no specific patterns in krill vertical distribution.

Krill forms patches, shoals, schools, swarms or superswarms. Although krill is commonly found in dense aggregations, some part of the population still occurs in a solitary or dispersed stage, but this may vary with season. Krill in aggregations are the main target of the fishery. Swarms extend in space from a few square metres to more than 100 km^2, with densities ranging from 0.5 to several kg/m^3, may be located at various depth ranges, and either migrate vertically or remain stationary within the upper 100 m water layer. These groups may last a matter of hours, days or weeks and their components vary considerably in shape, size and gonad development. Swarming and schooling behaviour of krill has been explained as an adaptive strategy to avoid selective predators (fishes, birds, etc.), and to increase efficiency in food-searching and food-patch utilization. Abrupt disruption of a school can trigger mass molting, and molts may act as decoys. The swarms are usually associated with islands, continental shelves and slopes, or zones of water mixing.

The identification of separate krill stocks (by genetic or any other means) has not been achieved and the separation and identification of discrete krill stocks therefore remains uncertain.

Mating and Spawning

Gravid females are usually found close to the continental slope, and in waters above the Circumpolar Deep Water. Less developed females are found over the inner shelf or closer to the ice-edge while females producing eggs and actually spawning are predominantly found in open waters. Aggregations may, among other things, be associated with mating success, as positive associations have been observed between mature male and female krill with developing ovaries.

Spawning lasts from late November to late March, although the onset of spawning varies geographically and year to year. The extent of winter sea-ice and the duration of ice cover act together to influence the onset of the spawning season, with overall lower spawning success following mild winters.

Spawning biomass is a reasonable indicator of egg production which is a major factor affecting regional recruitment. Egg production is a product of female abundance, the percentage of females reproducing in a season, the number of spawning episodes and the number of eggs released per spawning episode. Females lay 6,000–10,000 eggs at one time. Not all females are likely to reproduce every season, with the proportion of subadult and adult females reproducing within a season varying from less than 20% to nearly 100%.

Krill spawns in batches, where the number of batches within a season will depend upon the interbrood period. The krill interbrood period varies with location and year from a minimum of 6 days to a maximum of 50 days in mid-summer, probably depending on food availability and environmental conditions. The number of spawning episodes per season ranges from 3 to 9. While there is significant uncertainty over the relationship, it is likely that the sum of eggs released is correlated with body size.

Life History

Nicol (2006) proposed a conceptual model of krill with emphasis on the way they make use of currents and sea ice to produce a successful life history strategy. The model is qualitative, but highlights areas requiring more information, notably on the forces that control recruitment into the adult population.

Female krill usually spawn in the surface layers, the eggs then sinking and hatching at depth, probably between 800 and 2500m. After hatching, krill larvae develop through three stages as they ascend the water column. Feeding commences after 21-30 days at depths 30 to 100m in the fourth development stage. The total development for egg to final larval stage takes about 130 days. Female krill mature and spawn first at about age 2, whereas males mature a year later at 3 years old.

While longevity was found to be higher than originally expected, the krill of age 5 years or above constitutes less than 1% of the stock. Therefore older age groups are unlikely to contribute substantially to population structure, or strongly influence population dynamics. A number of techniques have been used to estimate krill age and longevity, but remain under development.

Most krill demographic studies continue to rely on length-frequency analyses to provide estimates of age and growth as there is no standard or reliable method to age crustaceans. Modes in length frequencies can be used to identify and follow cohorts over time to estimate the proportions of individual length-size components (de la Mare 1994a; 1994b). Krill have not only been shown to shrink in response to sub-optimal food conditions by molting to a smaller body size, their sexual characteristics have also been shown to regress. Despite these potential inaccuracies, length data forms the basis for monitoring rates at which krill grow, mature and die.

Growth

Krill growth rates have been determined using various methods, including modal progression in length-frequency data and experimental studies.

Growth is seasonal in the Antarctic Peninsula region occurring mainly between the end of January to early February. The seasonal growth is probably dependent on food availability rather than temperature. Krill reaches a maximum total length of 62 mm.

Given low food availability during winter and a limited capacity to store lipids, it has been assumed that the species does not feed during winter and therefore shrinks in size as a result. In the laboratory, krill have been observed to survive extended periods (as much as 211 days) without food while demonstrating associated body shrinkage. A reduced metabolic rate could also allow krill to overwinter without feeding. However, krill have been observed feeding on ice-algae as well as on zooplankton or protozoa. While body shrinkage is therefore possible, its frequency and its potential effect on length frequency data are unknown.

Natural Mortality (M)
The most realistic estimates of natural mortality (M) rates for krill lie in the range 0.66 to 1.35 year^{-1}. Based on the method of Hoenig (1984) longevity between 7 and 5 years would be consistent with natural mortality approximately between 0.62 to 0.87 year^{-1} respectively.

Recruitment
Estimates of recruitment and recruitment indices have been obtained from survey data. There is no clear stock-recruitment relationship for krill in the Antarctic Peninsula region, although strong year classes have been observed for some years (1980-81, 1981-82, 1987-88 and 1994-95).

The single most likely factor explaining the variability in krill recruitment has been sea-ice state. For example, in the case of poor winter sea-ice conditions, salps develop rapidly in the early austral spring and may compete directly with krill for phytoplankton (Loeb *et al*. 1997).

Geographical variation in krill recruitment is large. The 1980-81 and 1985-86 year classes were successful in the Atlantic while recruitment in the Indian Ocean failed during these years, which could be attributed to differences in the periodicity of ice conditions for different areas so necessitating separate estimation and interpretation, of krill recruitment patterns. It is also possible that some of the symptoms of global climate change such as increased incident UV-B resulting from ozone depletion or the effects of rising sea temperature on ice conditions, may affect recruitment directly, as well as indirectly through associated impacts on such factors as food production.

Trophic Relationships
Krill are primarily herbivorous, especially during the austral spring and autumn when large phytoplankton blooms occur. Krill feed predominantly on phytoplankton in summer, but appear able to use other food if available and possess physiological mechanisms to enable them to survive when food is scarce. Krill search for food, using various rapid feeding behaviours to exploit local high food concentrations. They feed on algae associated with pack ice during winter.

Krill is considered a key species of the Antarctic ecosystem. As a dominant herbivore, it links the organic matter produced by phytoplankton to a great variety of other Antarctic species. Baleen whales, seals, fishes, birds and cephalopods are among the largest krill predators. It has been suggested that krill compete with pelagic tunicates (salps) for food, niche separation possibly being based upon water temperature (Atkinson *et al*. 2004). 152–313 million tonnes of krill are thought to be consumed by its various predators each year (Miller and Hampton 1989).

The Antarctic food web, and the role of krill as a food source for a variety of predators, is discussed in detail within Section 7.4.

3.3 History of the Fishery

Exploratory fishing for krill began in the early 1960s. Catch levels were initially low and the build-up of catches was slow. It was not until the 1973/74 season that the fishery assumed commercial significance. CCAMLR has used catch statistics to indicate areas where the fishery has been most active and from where the largest catches have been taken. Miller (2003) provides an outline of the developments in the fishery.

94% of the catches from 1973 to 2008 were taken in depths between 0 and 200 m, with most taken around 50 m (Naganobu et al. 2008). The best fishing grounds were related to the steep mean water temperature gradient from the surface to 200 m. In the main fishing regions off East Antarctica, the Scotia Sea and the north of South Georgia, large fishing catches were concentrated in waters colder than –0.5°, 0.0° and 1.0°C respectively (Naganobu et al. 2008). These patterns corresponded with each oceanic front in the Southern Ocean (WGEMM 2008 Para. 4.19).

The former Soviet Union was responsible for the bulk of catches before 1991/92. Thereafter, the former Soviet Union catches were split between the Russian Federation (a CCAMLR Member) and Ukraine (non-CCAMLR Member prior to 1995).

From the first commercial take in the early 1970s, krill catches rose steadily from 19 785 tonnes in 1973/74 to a peak of 528 201 tonnes in 1981/82. Catches then declined sharply until 1983/84 due to marketing and processing problems, possibly associated with the discovery of high levels of fluoride in the exoskeleton of krill. Following the solution of these technical problems by rapid processing and the development of improved peeling machines, catches increased again, levelling off at around 300 000 to 400 000 tonnes. The next major impact on the krill fishery was triggered by the breakup of the Soviet Union in 1991 with the subsequent removal of fuel subsidies for Russian and Ukrainian vessels.

Other nations, mainly Poland, Chile and Korea, have accounted for about 4% of the total catch. Korea entered the fishery in 1978/79, fishing sporadically in Subarea 58.4 from 1978/79 to 1983/84 and took about 9 000 tonnes during that time. It re-entered the fishery in 1986/87, moving its operations to Subareas 48.1 and 48.2, and taking about 1 500 tonnes annually until 1991/92. Both Chile and Poland undertook exploratory fishing for krill between 1976 and 1977, but did not enter the fishery in earnest until 1982/83 and 1985/86 respectively. Chile built up to annual catches of about 5 000 tonnes throughout the 1980s, leaving the fishery after the 1993/94 season. Poland has taken variable catches between 2 000 and 20 000 tonnes to date. Recently there has been a resurgence of interest in fishing for krill from new countries such as the UK, Argentina, USA and Norway.

Krill catches have been reported mostly from CCAMLR Subareas 48.1. 48.2, and 48.3, and to a lesser extent Areas 58 and 88. Initially, the Krill fishery was distributed in all three CCAMLR Statistical Areas (48, 58 and 88). Japan started fishing in Division 58.4.2 which was logistically convenient. However, following comprehensive exploration of most areas around the Antarctic continent, the fishery became concentrated in the Atlantic sector (Area 48) where the most predictable concentrations of krill are to be found. Catches have been concentrated on shelf breaks in all areas. In Area 48, catches occur to the north and west of the South Shetland Islands, in a more diffuse area north of the South Orkney Islands and to the north of South Georgia.

The potential for catches outside the convention area are thought to be low (Miller 2003). There has been one reported catch of krill outside the CCAMLR Convention Area in 1992/93 by Poland immediately north of Subarea 48.1 (FAO Statistical Division 41.3.2).

The seasonal pattern of krill catches is linked to seasonal sea-ice distribution. In areas adjacent to the Antarctic Continent, fishing generally commences in the early austral spring as the ice edge moves southwards exposing the shelf break, and ends in May with krill remaining over the shelf break under the ice during the winter. In the more oceanic Subarea 48.2, fishing commences at a similar time but fishing continues over a longer period. In contrast, the waters around South Georgia (Subarea 48.3) remain ice-free in winter, and so constitute the only waters which contain fishable krill concentrations during the austral winter (May-September). Since 2001, the CCAMLR fishing season has been defined as the period between 1 December one year to 30 November of the next (Conservation Measure [CM] 32-01).

Nine countries submitted notifications for 23 vessels for the 2008/09 season (S-CAMLR 2008b), with

12 new vessels intending to enter the fishery. All notifications included an intent to fish in Area 48 and Norway to carry out an exploratory fishery for krill in Subareas 48.6. The notifications were for fisheries using four different gear types including beam trawls. The total notified catch was 879 000 tonnes of krill (excluding the Norwegian exploratory fishery notification) which exceeds the trigger level for Area 48 (Subareas 48.1, 48.2, 48.3 and 48.4) for the second consecutive year.

Despite the increase notifications recently, there has been no overall increasing trend in fishing for krill (Figure 2). Reported for the 2007/2008 season (S-CAMLR 2008a), six vessels from five Member countries fished for krill, exclusively in Area 48, with a total of 84 110 tonnes caught by the end of May. Projections based on these catches suggest that the total catch for the season would be approximately 108 000 tonnes or less. This estimate is below the recent (2004/05) and long-term (1986/87) maximum annual catches for Area 48 (129 026 and 400 835 tonnes respectively), and within 4% of catch totals in the previous two seasons.

Market limitations continue to be the main constraint on the development of this fishery (Nichol and Foster 2003). However, there is high interest in developing the fishery through research on making the fishery work economically. The Russian and US intend to fish in Subarea 48.3 during the austral summer, which appears to be a new practice. Catches taken by Norway have increased significantly (WGEMM 2008), partly to the development of improved fishing methods. The Russians intend to try out beam trawls for midwater fishing, in combination with a pumping method (WGEMM 2008 Para 4.8).

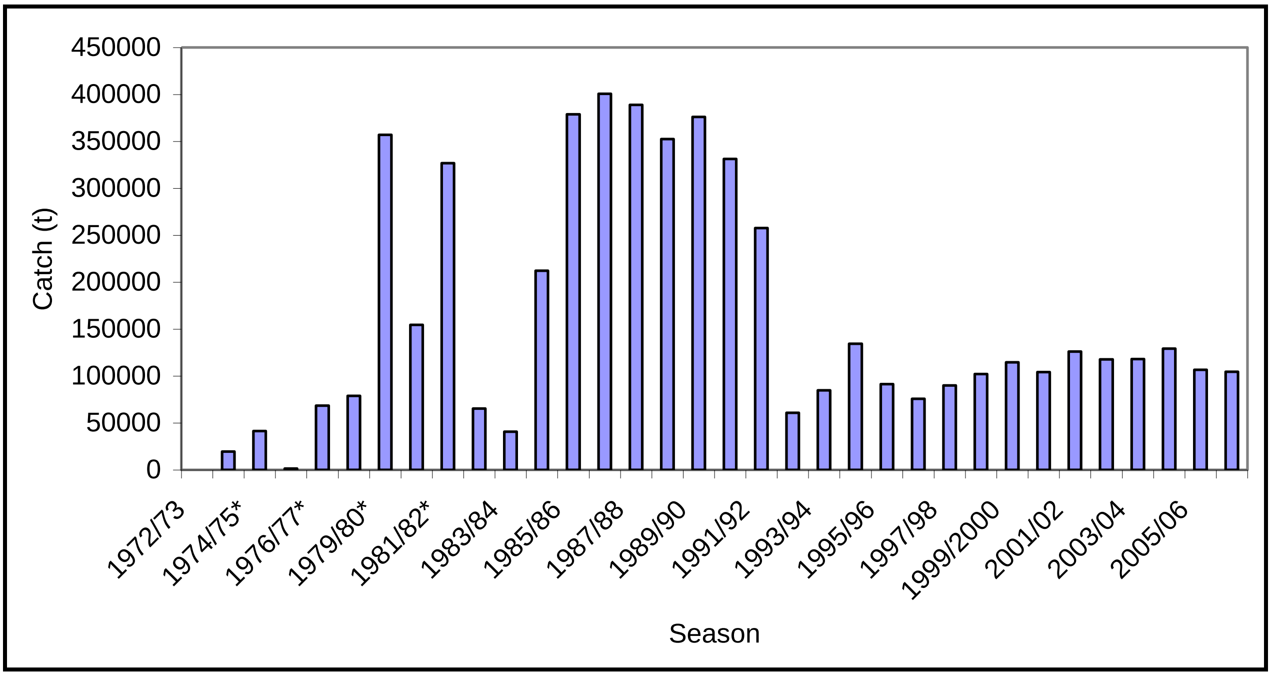


Figure 2: Annual Antarctic krill catches 1972-2006 in Area 48 (from S-CAMLR 2008a). The catch was sustained above 200 000 t during 1984-1992 only, reaching a peak in 1986/87 of around 400 000t. The total Antarctic catch peaked in 1981/82 at 528 201 t.

3.4 Fleet and Gear Description

Echo-sounders are used to locate krill aggregations, as well as determine shape and orientation of the swarm. Hauls are made through swarms, not only with regard to catch rate, but also quality and in the case of the continuous fishing system, to avoid blockages. Various areas have been favoured by the fishery, which are located close to clearly identifiable geographic features (such as oceanic islands) or areas exhibiting particular hydrographic properties.

Fishing vessels search for krill at about 10 knots and fish at about 2 knots which involves repeated trawling on the same krill swarm.

During the early part of the fishing season - at least in the West Atlantic until late December - krill swarms tend to be small and catch rates low. In the high season (late December to the end of February when daylight is almost continuous), the number of swarms and their sizes increase so providing high catch rates. In March, encroachment of ice in the southernmost fishing grounds (i.e. Subarea 48.1) accompanies a shortening day length as autumn progresses into winter. Swarms then tend to rise to the surface after sunset and disperse with a consequent large drop in catch rates. Fishing usually continues around the clock until the later part of the season when it ceases during periods of darkness and as a result of ice.

Density and distribution of the krill aggregation is important to the fishery. Very large, dispersed layers of krill are likely to be quite common (less so in the Scotia Sea), but the density of animals so contained is generally too low to render fishing an economic proposition. In one survey of the West Atlantic, some 96% of the krill aggregations detected were of a biomass less than 1 tonne (Miller 2003).

Krill are caught using fine mesh pelagic trawls. However, there are three approaches to getting the krill from the net to onboard the vessel. Bringing the net aboard each haul, pumping out the net after it is brought back to the vessel, but while it remains in the water, and a continuous fishing system where the krill are continuously pumped from the cod end directly aboard.

A wide variety of trawl net configurations are used (S-CAMLR 2008a), which is likely to have a strong influence on gear selectivity. Information on the type of krill trawl nets used is recorded by observers in their logbook and cruise report, with some observers including net designs, but the level of detail recorded varies greatly and the observer coverage has been low.

In general the major limitation imposed on catches is processing capacity and attendant quality concerns. Hauling of the net on board the vessel severely limits fishing time, as the catch in each haul (i.e. each time the trawl is deployed) is limited to prevent the product being crushed, and to allow processing while the catch is fresh - generally within 2-3 hours for fresh-frozen product. Towing times (i.e. the time in which the trawl is actually fishing) are therefore relatively short (30 minutes to an hour). This problem has been eliminated through the continuous fishing method.

Currently, the krill fishery's three major products are boiled-and-frozen krill (for human consumption), fresh-frozen animals (used as fishing bait and aquaculture fish food, though part is used to produce a seasoning liquid for human consumption) and meal. Processing constraints differ for the various products. Fresh-frozen krill are processed within 2-3 hours of capture, whereas peeled or boiled-and-frozen animals can be stored for 3-4 hours before processing.

Some effort has been made to avoid krill with phytoplankton in their guts if the final product is for human consumption. Not only is this “green” product considered less desirable by consumers, processing time needs to be shorter to avoid an unacceptable decline in quality.

However, recent increased product demand has been primarily observed for peeled krill for meal production, or for whole animals for bait or biochemical processing (Everson 2000). Fish meal production is increasing and, in particular, interest is growing in the supply of whole animals to the aquaculture market. Bycatch in human consumption and bait fisheries is discarded, whereas it is retained and used in the meal fishery. Dried and boiled-and-peeled krill are now rare - with the latter only having been produced on an exploratory basis.

The size of individual krill taken by the fishery is usually categorised into three length classes:- LL (>45 mm), L (35-45 mm), and M (<35 mm). The largest size class has been targeted throughout because it is easier to peel, and larger sizes are preferred for both human consumption and as bait.

Kawaguchi (2008) provided information on the behaviour of the krill fishery using CCAMLR data from the most recent 10 years by analysing distances travelled by vessels in relation to catch level. Mean travel distances tend to be longer after the least catch levels with some exceptions. Limited evidence suggests that efficiency and size of the operations have increased since the 1980s. Fishery behaviour depends on product type, the local distribution of krill and logistics (e.g. sea conditions), all of which may affect both selectivity and catch rates.

4 STOCK ASSESSMENT

4.1 Management Unit

There has been no unequivocal identification of separate krill stocks by genetic or any other means. More work is required before any of the approaches (e.g. allozymic frequency, mitochondrial DNA) attempted to date can be rejected or accepted with confidence (Siegel 2000a).

The krill under this certification is found in the Atlantic sector (Area 48), which is treated as a single management unit. The physical oceanography and topography make this a reasonable choice even if recruitment is shared with other areas (the Pacific in area 88 and Indian Ocean in area 58). Given the low exploitation of any areas outside Area 48 and likely development of the fishery primarily within Area 48, managing Area 48 as a single separate stock is precautionary.

It is possible that populations might be best managed on a smaller scale as self-recruiting single stocks. For example, there has been some debate on whether krill populations around South Georgia are self sustaining. Despite adult abundance being high however, a lack of eggs or young larvae in the region may be evidence that the population relies on seasonal immigration (Miller 2003).

Based on surveys and identification of persistent oceanographic areas of higher density, has led to speculation on the existence of separate "Enderby" (Indian Ocean) and "Kerguelen-Gaussberg" (Pacific) stocks respectively (Miller 2003). Large concentrations of whales feeding on krill in the vicinity of the Kerguelen-Gaussberg Ridge add credence to the existence of a separate aggregation in that area. Similar levels of aggregation have been tentatively identified in survey and catch data, but no generally accepted definition of management units exist.

Management of smaller areas depends critically on movement (“flux”) of krill between various localities. Krill flux (either passively as a result of water movement or actively through migration) affects yield primarily as a consequence of impacts on estimated B0 values (SC-CAMLR 1993). A circulatory system may link krill populations around the South Shetlands, South Orkneys and South Georgia (SC-CAMLR 1994, Annex 5, Appendix D). The extent to which krill are exchanged between areas or remain resident in highly productive areas remains largely unknown. The major uncertainty about flux concerning CCAMLR's development of a krill management paradigm was especially prominent in the setting of precautionary limits for subareas within Area 48 - effectively the management areas used by CCAMLR.

The synoptic survey avoided this problem by surveying areas (nearly) simultaneously; otherwise residence in an area has to be assumed. Where necessary, CCAMLR has assumed that flux is negligible, which they believe results in a more conservative yield estimate (SC-CAMLR 1994, Annex 5, Appendix D). Rates of immigration and emigration are most likely to have a significant impact on small scale management units (SSMU) rather than on Area 48 overall. For example “up stream” fishing may still deplete areas where fishing is reduced or prevented altogether.

Concern has been more orientated towards concern over local depletion and ensuring catches leave adequate biomass to support local predator populations. This is leading to an overall TAC divided among small scale management units to ensure control over depletion by area. CCAMLR is attempting to define krill "management regions" (SSMU) to complement or replace Statistical Areas/Subareas (CCAMLR 1992). SSMUs need to account for the potential effects of localised krill fishing on land-based predators, and are being identified on the basis of information concerning krill distribution, predator foraging areas and fishing grounds (SC-CAMLR-XXI 2000, paragraphs 3.16-3.22), but have not been implemented yet.

4.2 Assessments and stock status

Stock Assessment

Regular integrated stock assessments are not undertaken on krill. Catches are recorded, but the lack of age data and of regular and complete abundance indices makes a reliable assessment impossible. Instead, a precautionary low catch limit has been set based on the potential yield of the stock, while management and monitoring systems are being put in place.

In the absence of empirical information on the response of the krill stock to harvesting, CCAMLR has set an initial limit to yield based on an estimate of potential yield. The model software used to estimate the potential yield, Generalized Yield Model (GYM; see Constable and de la Mare 1996), uses standard population model equations, but allows the population dynamics to represent particular stocks by setting appropriate parameter values for growth, natural mortality and recruitment. The model has been used for various toothfish fisheries in CCAMLR.

Miller (2003) outlines the relevant life history information and parameterisation used in the GYM for krill. Growth and mortality estimates mainly depend on length frequency data (de la Mare 1994a; 1994b). The GYM is used primarily to account for the expected population production and random effects around this through the variation in recruitment. The projection is used to calculate the appropriate total allowable catch as a proportion (γ) of the unexploited biomass (B_0) based on the harvest control rule. The unexploited biomass is estimated independently from a survey.

The WGEMM expressed the intention to develop integrated assessments which would allow more frequent and less costly estimates of krill population status rather than the current reliance on synoptic surveys (WGEMM 2007 Para. 2.52 and 2.53), of which only one so far has been completed. Integrated assessments and accurate abundance indices, such as regular surveys, will be increasingly important should the krill fishery develop and the krill population departs significantly from its unexploited state.

Management strategy evaluation has been suggested as a tool to test SSMU quota allocations, develop integrated assessments and identify suitable indicators (WGSAM 2007 Para. 3.12(iv)(f), 5.33; 6.15 and 6.16), but has not yet been used. Simulation models are being developed for allocating quotas to SSMUs. Catch reporting is currently not frequent enough to implement a system (WGEMM 2007 Para. 2.58, 2.59, 2.60).

Biomass Estimates and Abundance Indices

An initial biomass estimate is required in the harvest control rule and in setting the precautionary catch. In early 2000, CCAMLR conducted a multi-ship acoustic survey of Area 48 (CCAMLR-2000 Survey). Later that year, WG-EMM conducted a ‘B_0 Workshop’ to estimate the pre-exploitation biomass of krill and its associated variance in Area 48 (WGEMM 2000, Appendix G). The workshop estimated the krill standing stock (B_0) which was used as a proxy for krill pre-exploitation biomass in the Generalised Yield Model (GYM). This proxy was used with the GYM to estimate krill sustainable yield based on the decision rule.

The CCAMLR-2000 Survey design was agreed by WG-EMM in 1999 and consisted of a large-scale survey to cover much of Subareas 48.1, 48.2, 48.3 and 48.4 with randomly spaced transects. The survey rationale and design is described in CCAMLR Science, Vol. 8(2001):1-23. This large-scale survey was divided into three strata. Within the large-scale area there were four mesoscale regions that were considered to have a high abundance of krill and therefore to be of importance to commercial fishing fleets. These regions lie to the north of South Georgia, north of the South Orkney Islands, and north of the South Shetland Islands, and around the South Sandwich Islands. Additional mesoscale strata were designated for these regions to improve estimates of their biomass.

Krill biomass is difficult to estimate using acoustic technology as it does not have a swimbladder and is difficult to distinguish from other acoustic targets. Four vessels participated in the survey, and each vessel was equipped with Simrad EK500 echosounders operating at 38, 120 and 200 kHz. Echosounders were set according to agreed protocols, and acoustic data were logged using the SonarData echolog_EK Version 1.50 software. Net samples and CTD data were also collected in accordance with agreed protocols. The 120 kHz data were used for the estimation of krill standing stock. Data at 38 and 200 kHz were used along with those at 120 kHz to aid with target delineation and also provide information to incorporate into the estimate of uncertainty of the standing stock estimate. At the B_0 Workshop in 2000, the krill standing stock was estimated to be 44.29 million tonnes (coefficient of variation = 11.38%). At the time, it was noted that it had only been possible to provide an estimate of the sampling variance of the survey. However, it was recognised that there are other components of uncertainty which should be identified so that they could be incorporated into the estimation of the TAC.

In 2007, WG-SAM advised that previous precautionary catch limits set using the Greene *et al.*(1991) target-strength model should be revised using the SDWBA model. As a result, the CCAMLR-2000 survey data was re-analized and the B_0 estimate was revised to 37.29 million tones with a CV estimate of 21.20% (Demer *et al*. 2007). Using these values and the γ arising from the use of the GYM (0.093), the precautionary catch limit for Area 48 was reduced to 3.47 million tonnes and Conservation Measure 51-01 was amended in 2007.

Besides the estimate currently used in the decision rule, biomass estimates have been made using alternative methods on the same data. Demer and Conti (2005) estimated the krill biomass as 109.4 million tonnes (SD 11.38 million tonnes) using an alternative model of acoustic target strength. Heywood *et al.* (2006) estimated a density map, which might be more useful for SSMU quotas, but which resulted in an overall estimate of biomass as 207.98 million tonnes (SD 10.08 million tonnes). The significant difference between the various estimates raises uncertainty (Everson 2008; Brierley *et al*. 2008), although a lower estimate is still used for the potential yield.

Biomass also changes during the season as well as from year to year. Saunders and Brierley (2007) found significant seasonal change in South Georgia krill biomass from monitoring throughout the year 2002-2005, with biomass estimates substantially higher during the summer. This was found to explain some year-to-year variation of previous surveys depending on the time of year the survey was carried out. Years in South Georgia that stand out for markedly low krill density (i.e. densities below the range expected due to intra-annual variation) were 1993/94, 1998/99 and 1999/2000. South Georgia may depend more on krill seasonal immigration than other areas.

Catch-per-Unit-Effort (CPUE) has not yet provided a good index of abundance for monitoring. CPUE is largely a measure of the local krill aggregation densities being fished, but also may reflect operational differences with the nationality of the fishery concerned. For example, catch and effort data from the continuous fishing system is very different to that recorded on standard trawls (WGEMM 2007 Para. 4.18).

Catch and Bycatch Monitoring

Total catch of live weight is estimated from the processed product, which actually weighed. These may be subject to significant error due to inappropriate conversion factors being applied (WG-EMM-08/46) and no account being taken of discards (WGEMM 2000; see also SC-CAMLR-XVIII, paragraph 2.5). WGEMM (2008 Para 4.39) expressed concerned over the inconsistency in recording of the amount of krill removed from the ecosystem, which increases uncertainties in the catch estimates. Problems with the reporting of data on appropriate spatial and temporal scales from the continuous fishing system (SC-CAMLR-XXV, Para. 4.16; WG-EMM-07/5), have been eliminated for the 2008 season (WGEMM 2008 Para 4.38). The 2006 Scientific Committee highlighted selectivity of different gears, bycatch of fish larvae, seabird warp strikes and incidental seal mortality as key areas of concern (SC-CAMLR-XXV, Para. 2.15). Incidental mortality of krill from trawling (krill which pass through the net but may be damaged) has not been estimated.

Conservation Measure 23-06 for the data reporting system for the krill fishery does not require collection of biological information (sex and size information). Data are collected by observers on board vessels (Bibik and Zhuk, 2008; WG-EMM-08/5; Iwami and Naganobu, 2008), although, unlike the toothfish fisheries, vessels are not required to carry international observers outside the South Georgia Subarea 48.3. Siegel (2007) has presented information on selectivity and vulnerability of krill in conventional trawling, by comparing length-frequency data of krill from different fishing gears.

Conversion factors, used to convert the measured catch processed weight to live (“green”) weight, are considered uncertain (WG-EMM-08/46; Leape *et al*. 2009). Observers have experienced difficulties in obtaining accurate data or gaining access to the processing factory (SC-CAMLR-XXVII/BG/6 Para. 3.14). WG-EMM-08/46 found that conversion factors ranged between 1 and 26 across product types and therefore a nominal reported catch of 600 000 tonnes could represent a catch of 2.5 million tonnes in an extreme case, assuming all the catch was boiled product. However, dried and boiled-and-peeled krill are rare, with the latter only having been produced on an exploratory basis, but meal production is increasing (Miller 2003). Also that the Norwegian continuous fishing method producing meal reports unprocessed product weight (WGEMM 2008 Para. 4.38), and that this represents the largest proportion of the total catch (approx. 40% of the 2006/7 catch; WG-EMM-08/5). Therefore the “extreme case” does not seem currently possible, but this issue remains important for other fishing methods and clearly requires monitoring.

The Scientific Committee and WG-EMM have commented extensively on the implications of new technologies in the krill fishery (SC-CAMLR-XXIV, paragraphs 4.4 to 4.10; SC-CAMLR-XXV, Annex 4, Para. 3.28 to 3.31 and 3.48 to 3.61). In particular, concerns have been expressed that the new continuous fishing system may capture different components of the krill population and may have a higher ecosystem impact than conventional trawls. However, even for the conventional trawl, very limited information is available on catchability or selectivity.

The CCAMLR database holds scientific observer data from 35 trips/deployments between 1999/2000 and 2005/06 in Subareas 48.1, 48.2 and 48.3, most of which were from Subarea 48.3 (WG-EMM-07/5, Appendix 1). Two CCAMLR scientific observers were deployed in the 2006/07 season, both of them on the *Saga Sea* which is employing the continuous fishing system (WG-EMM-07/5). Only 12.8% (7 234 hauls) of the total hauls in the krill fishery were observed for by-catch between 1999/2000 and 2005/06. The dominant by-catch species differed between SSMU groups, showing *Pleuragramma antarcticum* dominant in the Antarctic Peninsula region, *Champsocephalus gunnari* at South Georgia, and *Lycodapus* spp. at the South Orkney Islands. *Electrona* spp. were abundant in catches in both the South Georgia and South Orkney Island regions (WG-EMM-07/5).

Bycatch is generally low, consisting mainly of juvenile fish (WG-EMM-08/5; Bibik and Zhuk, 2008;

Iwami and Naganobu, 2008). The fishery employs bycatch reduction measures and bycatch of larger mammals and birds is low, with no seabird or seal by-catch observed by scientific observers in 2006/07 (WG-EMM-08/5). There has only been one occurrence of incidental mortality of seabirds reported by observers in the krill fishery, which was in the 2004/05 season. A total of 260 seal mortalities have been recorded by observers in the krill fishery, with 258 of these mortalities identified as Antarctic fur seals and 2 unidentified seals. Seventy-six percent of these observed mortalities occurred on two vessels during the 2003/04 season, both of which were not using mitigation measures at the time.

CEMP

While the number of CEMP parameters and Members submitting data had remained relatively constant, the number of sites from which data had been submitted had declined over the past five years. This change may not simply be related to funding, but to a combination of issues including shifting scientific priorities (WGEMM 2007 Para 5.4). The CEMP database is substantial resource with which to study the Antarctic marine ecosystem and its application in the identification of Small Scale Management Units (SSMUs) for krill has proved invaluable (SC-CAMLR 2002) (see also Section 7.5.2).

Environmental Effects

Climate change may reduce krill abundance directly through reducing winter sea ice extent and by favouring competitors reducing food availability (Gloss 2005). Pelagic tunicates (salps; mainly *Salpa thompsoni*), which are not a major dietary item for Antarctic vertebrate predators, are competitors with krill. Salps occupy the extensive lower-productivity regions of the Southern Ocean and tolerate warmer water than krill, and can form blooms which affect adult krill reproduction and survival of krill larvae (Loeb *et al*. 1997). Summer food and the extent of winter sea ice are key factors in the high krill densities observed in the southwest Atlantic Ocean, where lower sea ice extent has an adverse affect on krill abundance. The southwest Atlantic sector krill density has declined since the 1970s, whereas salps appear to have increased in the southern part of their range (Atkinson at al. 2004).

4.3 Management advice

Harvest Strategy

Article II of the CAMLR Convention lays the foundation for the "ecosystem approach", requiring that harvested populations be monitored and assessed, significant ecological interactions between harvested and other species should be defined and quantified, and levels of depletion should be estimated in order to monitor their restoration if necessary. Management will need to take account of krill’s low and pivotal position in the Antarctic trophic structure and therefore sustainable exploitation will need to account of krill’s interactions with other species (Miller 2003).

WG-EMM's terms of reference have been prioritized, and cover requirements to provide scientific advice and account for major uncertainties. These have largely been followed with emphasis being given to ecosystem assessment and status. While CCAMLR’s role has been limited to conservation, it has also been tasked with allowing development of the fishery. Therefore while adequate protection should be afforded to krill-dependent predators at critical times and in specific areas, such protection should not exert unnecessary, or unreasonable, restrictions on the fishery (SC-CAMLR 1993).

Delineation of krill stock boundaries has not been possible, particularly given that krill are resident in various areas for different periods of time, or move between areas in a manner which largely unknown and likely to be quite variable. For practical purposes, management units are based on areas where the most fishing occurs (i.e. Statistical Subareas 48.1, 48.2, 48.3, and to a lesser degree 58.4). These areas, particularly 48.1 and 48.3, contain sites where large colonies of land-based, krill predators breed, or are located.

CCAMLR is developing a strategy to manage an anticipated expansion in the krill fishery in accordance with the fundamental management objectives set out in Article II (WGEMM 2008). The decision process is complex covering monitoring procedures for both the krill itself and predator populations (Figure 3). The primary controls are catch limits set at an overall level, and at some future date, will be set for each SSMU. CCAMLR has accepted that it is not appropriate to use MSY as a target in the krill fishery, since sustainable harvesting was likely to be substantially below the single species MSY. To be precautionary, CCAMLR is attempting to be proactive (CCAMLR 1991 Para. 6.13) and apply precautionary limits to exploitation commensurate with available information on stock dynamics. CCAMLR has the policy that while adequate protection should be afforded to krill-dependent predators at critical times and in specific areas, such protection should not exert unnecessary or unreasonable restrictions on the fishery (SC-CAMLR 1993).

In setting krill precautionary catch limits, CCAMLR has used a potential yield estimate. While the potential yield estimate does not take account of the potential effects of harvesting on dependent predators, the decision rule does. In addition, krill predator populations are being monitored, catch reports are being made and there are periodic, fisheries-independent surveys of local biomass. Monitoring includes a long time series of krill density and recruitment indices collected as part of the BAS, US AMLR and LTER programs (WGEMM 2007 Para 2.75 and 5.43). Whether these are sufficient to detect impacts of fishing in a timely manner has not yet been tested.

The fishery overlaps with areas where foraging, land-base predators, especially penguins, captured krill to feed their young during rearing. Mangel and Switzer (1998) used modelling approaches to examine the potential impacts of fishing on krill on penguin breeding success. They suggested that, based upon models and assumptions of krill biomass, fishing extractions, the required level of krill by penguin offspring, and adult foraging behaviour, relative local reproductive success could be inversely correlated with the fraction of the total krill biomass caught by the fishery. Three levels of krill fishery-predator overlap have been defined to identify the localities and times during which fishery-predator interactions are likely to be most significant (Everson 2000b). This indicator is being used to develop spatial catch quotas.

As noted in Trathan and Hill (2008): "*Conservation measure CM 51-01 (2002) requires that CCAMLR set individual catch limits for the SSMUs if the total catch for Statistical Area 48 exceeds 620 000 tonnes in any fishing season. Such catch limits should reduce the potential impact of the fishery on colonies of land-based krill-dependent predators (SC-CCAMLR-XXI Para. 3.17). Current catches are at about 20% of this level (the average annual catch for the period 1999/2000 to 2005/2006 was 116 000 tonnes: CCAMLR Statistical Bulletin Vol. 19).*" The total catch within Area 48 is therefore effectively limited to 620 000t until a system of quota allocation among Small Scale Management Units (SSMUs) is in place. In theory, up to 620 000t could currently be taken in any small area, although in practice this with the current fishing capacity would not be possible and unlikely in future given logistical issues such as ice cover. If total catches are allowed to rise above the 620 000t level, local catches would not be able to rise above area-specific quotas within each SSMU in order to protect local availability of food to predators. SSMU quotas are being developed using the overall potential yield and the harvest control rule, and divided among areas based on ecosystem system model simulations, that explicitly take predator demands into account, and agreed performance indicators (see section 7.4). Catches have remained well below the trigger level, so the strategy remains untested.

In developing precautionary catch limits for krill, CCAMLR has also considered a number of approaches (including open/closed areas) on which management of the krill fishery might be based

(SC-CAMLR 1991-1993; Hewitt and Linen Low 2000).

Conservation Measure 51-01 (2008) sets two precautionary catch limitations on krill in Statistical Subareas 48.1, 48.2, 48.3 and 48.4 (see also Section 6.5):

- The precautionary krill catch limit of 3.47 million tonnes for Area 48 has been set based on the potential yield estimate. This is well above the current catch and will allow expansion of the fishery.
- A "catch trigger" (620 000 tonnes) is set which will not be exceeded until a procedure for division of the overall catch limit into smaller management units has been established, based on advice from the Scientific Committee. The objective of this division is to avoid possible unacceptable concentration of catch within the foraging areas of vulnerable predators. While the trigger level is close to the highest overall annual catch to date, it is significantly higher than the highest catch in Area 48.

Additional provisions within the various measures deal with monthly data reporting procedures, including on-going requests to provide haul-by-haul data from the fishery and carry scientific observers on krill vessels.

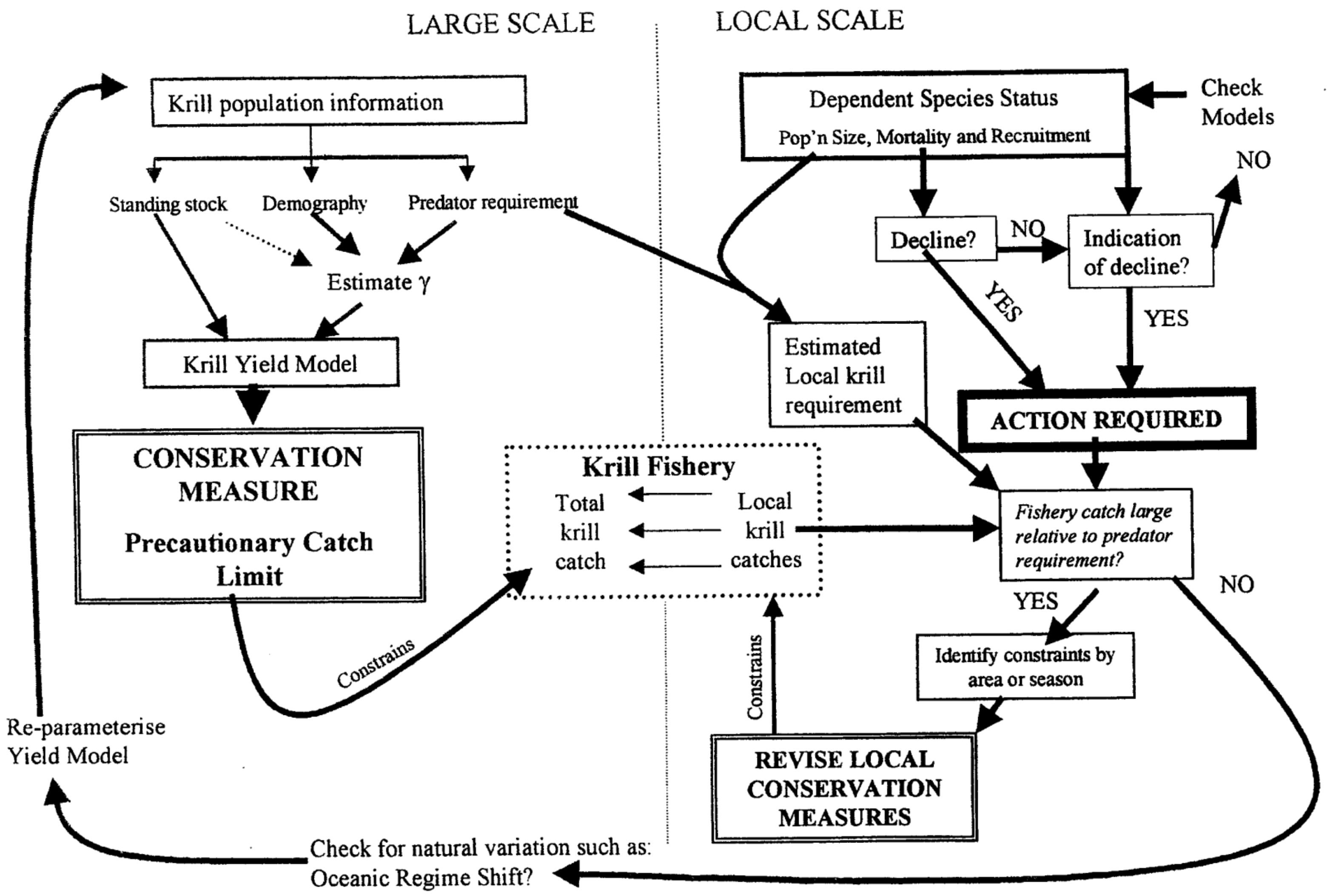


Figure 3: Decision process outlined from WGEMM 2000 for the large scale overall TAC and local quotas.

Notifications

There are currently no controls to prevent excess capacity in this fishery, although such controls are not urgently needed. Potential increase in capacity is monitored through notification procedure.

There is a large discrepancy between notified and actual catches, despite WGEMM's request to improve the accuracy of notifications. The vessels notified to fish for krill in the 2008/09 season indicate that sufficient vessel capacity exists to exceed the trigger level (WGEMM 2008 Para. 4.14). As a result, the Scientific Committee has recommended taking action through revising Conservation Measure 21-03 to discourage frivolous notifications.

The large discrepancy between notifications for krill fishing and actual fishing effort (WGEMM 2007 Para. 4.17; SC-CAMLR 2007 Para. 3.45) makes the notification system useless for any short term planning and may be misleading. There was also a substantial increase in the number of notifications of intention to participate in the krill fishery in 2008/09, suggesting a potential catch in excess of 700 000 tonnes (WGEMM 2007 Para. 4.14). Problems with the system include a large number of notifications by non-Members (e.g. WGEMM 2007 Para 4.17), the total notified catch (764 000 t) was greater than the trigger level in Area 48 (620 000t) in 2007, but actual catches have remained at the medium term average of 100000t, the poor quality of some notifications which were incomplete on submission, revised after the deadline for submission and/or lacked the necessary information.

Harvest Control Rule

The current harvest control rule is a precautionary catch limit which has the objective of constraining exploitation to a safe level. The catch limit is based upon the krill potential yield, which is estimated using the Generalised Yield Model (GYM) and is a proportion of pre-exploitation biomass (B_0). Estimates of krill recruitment variability, growth and natural mortality are used in a stochastic simulation to determine the likely effects of various levels of harvesting on the population. For each level of harvesting, the parameter γ in the equation $Y=\gamma B_0$ is calculated and the stock is tracked over a 20 year period (where Y = yield and B_0 = unexploited biomass). The γ parameter is used for convenience. It can be determined independently of the B_0 estimate. The B_0 estimate can be updated or estimated separately for different areas without affecting γ.

The GYM was used to estimate the probability density of possible krill population sizes at various fishing mortality (F) levels, including in the absence of fishing. This is done by running the simulation was run a large number of times with different random input values in the model. The random variability incorporated into the GYM in this case is the set of recruitment values over the time period. The set of outcomes from these simulations are used in the decision rules.

There are two rules for selecting values of γ that meet their criteria (see Figure 4). The rules for the calculation of parameter γ are (WGEMM 2000 Para. 2.100):

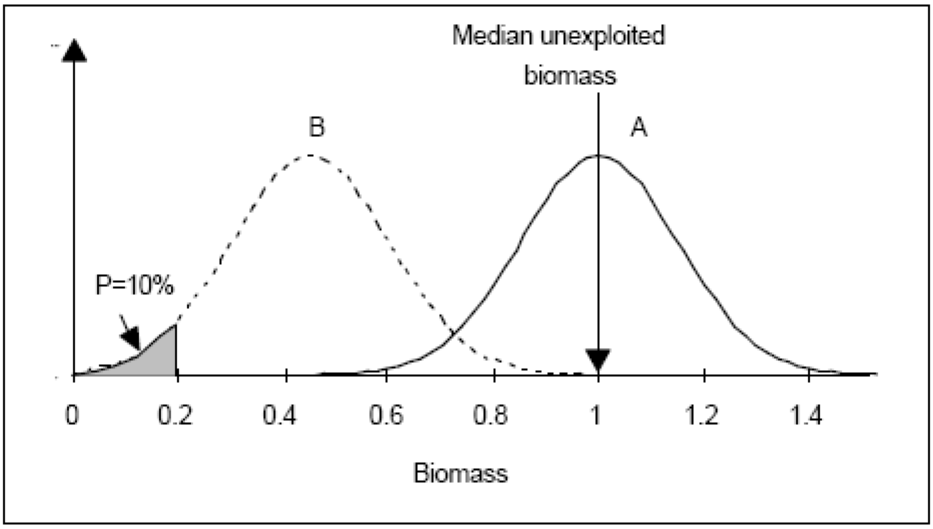
- recruitment criterion – 'that the probability that the spawning biomass falls below 20% of the median pre-exploitation spawning biomass after 20 years should not exceed 10%' – $\gamma_1 = 0.118$;

- predator criterion – 'that the median spawning biomass should not fall below 75% of the pre-exploitation spawning biomass after 20 years' – $\gamma_2 = 0.091$.

According to these rules, the lowest γ (γ_2 = 0.091) would be used for the catch limit. Hence the potential yield catch limit for krill in Area 48 was set to 4.0 million tonnes (γ= 0.091, B_0 = 44.29 million tonnes) in 2000. The B_0 estimate was updated in 2007 to 37.3 million tonnes (Demer *et al.*, 2007) leading to the current Area 48 catch limit of 3.47 million tonnes.

The "recruitment criterion" addresses Article II objective 3(a). It includes a limit reference point of

20% of the unexploited spawning biomass and risk factor of 10% after 20 years. The limit reference point and risk factors have no strong theoretical base except SPR 20% has been suggested as a generic recruitment overfishing threshold (Mace and Sissenwine 1993).



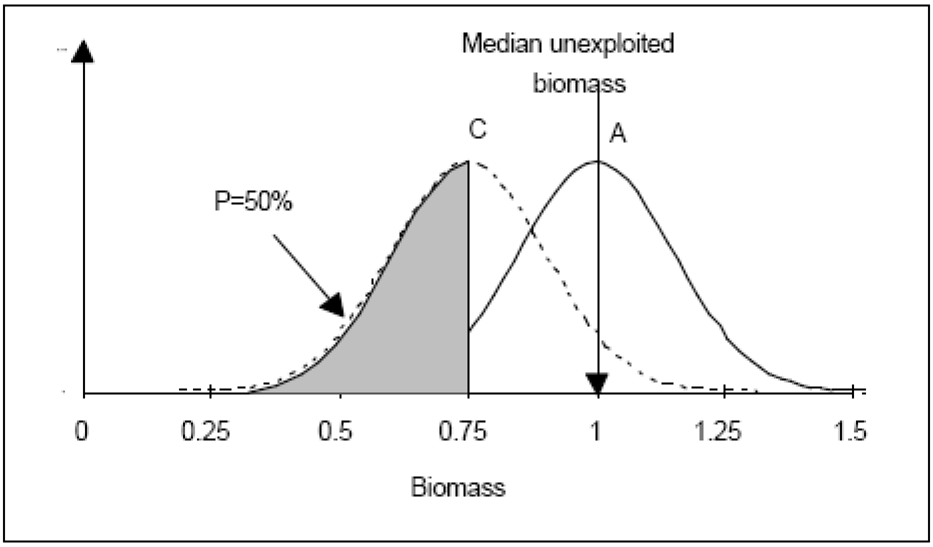


Figure 4 Distribution of biomass of krill under different management regimes (SC-CAMLR, 1994) . A is the statistical distribution of biomass in any year for a population which has not been exploited. B in the top graph is the statistical distribution of lowest spawning stock biomass over 20 years with catches = $\gamma_1 B_0$. C in the lower graph is the statistical distribution of spawning stock biomass after 20 years of exploitation with annual catches $\gamma_2 B_0$.

The "predator criterion" addresses Article II objective 3(b). It includes what is effectively a target reference point of 75% of the unexploited spawning biomass and risk factor of 50% after 20 years. The 75% level is an arbitrary, interim value, being the midpoint between 50% and 100% of the krill pre-exploitation stock level (SC-CAMLR-XIII Para. 7.22; CCAMLR-XIII Para. 3.10). The 50% is, presumably, an MSY proxy based on Schaefer (1954) and probably the target for the single species approach, whereas the 100% refers to no fishing, providing complete protection for the ecosystem role of krill.

The projected time period (20 yrs) relates to objective Convention Article 3(c). It is used to allow integration of exploitation with sustainability and precaution and is good practice. 20 years is adequate to cover several generations of the species. The 20 years is part of the decision rule only, and should not be interpreted as a requirement that the catch limit is fixed for 20 years.

However, a catch trigger level prevents the decision rule described above having any practical effect until smaller scale area quotas are developed and applied. The Commission has agreed that krill catches should not exceed a “trigger” level in Area 48 until a procedure for division of the overall catch limit into smaller management units (SSMU) had been established (CCAMLR-XIX Para 10.11, 10.12). The Conservation Measure 51-01 sets the trigger level at 620 000 tonnes, which is above the historical maximum annual catch in Area 48 (400 835 t; WGEMM 08/05). Although this choice was based loosely on historical catches, it was arbitrary, but below alternative proposals made at the time.

Structuring quotas to apply in SSMUs is still under development. It is seen as necessary to make the management procedure consistent with ecosystem requirements (Article II of the Convention), and in 2000 the Commission estimated development would take 5-10 years. As well as dealing with the issue of developing a good theoretical basis for quota allocation among the SSMUs, there are practical issues which need to be dealt with. Catch reporting is currently not frequent enough (WGEMM 2007 Para. 2.58, 2.59, 2.60). Some vessels lack international observer coverage and VMS. However, with the current total catch so low compared to the potential yield, there is resistance to further management controls.

Three models (EPOC, FOOSA and SMOM) have been used to examine six possible principles for subdividing the precautionary catch limit among the SSMUs. These are based on spatial distribution of: 1) historical catches 2) predator demand 3) krill biomass 4) krill biomass minus predator demand 5) krill availability indices that would be updated on a regular basis 6) fishing strategies rotating catches within and between SSMUs.

There are a series of essential scenarios suggested for evaluating the different SSMU candidate options (SC-CAMLR-XXVI, Annex 7, Para. 5.37 and 5.38), which will be applied to the ecosystem models to evaluate the performance of the principles for allocating quota among the SSMUs. WG-SAM recommended that performance measures should be derived for the status of krill, predator populations and the fishery over relevant time scales (SC-CAMLR-XXVI, Annex 7, Para. 5.39 to 5.47).

Main Uncertainties and the Precautionary Approach

The current assessment process incorporates parameter (fishery and ecosystem) uncertainty, and structural (model) uncertainty to the extent that there are multiple models being developed (WGEMM 2007, 2008). Robustness of the decision rule to wider uncertainties has not yet been explored. It is not clear the degree to which long-term changes to parameters, particularly those caused by changes in krill/predator distribution and climate/environment, would be incorporated into the current harvest strategy. Another uncertainty that is not currently incorporated in the assessment and decision rules is that of implementation uncertainty. Implementation uncertainty, caused by IUU fishing for krill or inaccurate reporting, may become important in the future, and may be either minimised by putting appropriate management measures in place or explicitly represented in models (WGEMM 2007 Para. 2.64, 2.80).

Given the various significant uncertainties associated with this fishery (Leape *et al*. 2009; Johnston *et al*. 2009; Nicoll and Jensen 2009), the issue remains whether the current catch limits are sufficiently precautionary to have a low risk of unacceptable impact to the ecosystem. This MSC assessment was carried out based on an average current catch of 113 000t and a management control of the trigger level catch of 620 000t. For this catch limit to be precautionary, it must meet two conditions:

1. The catch limit must be set at a level that is precautionary.
2. There needs to be sufficient confidence that the catches in practice will not significantly exceed this level.

The trigger level catch is justified as precautionary primarily on the basis of the potential yield estimate. The current average annual catch, which has been steady since 2000, is 18% of the trigger level which itself is 18% of the potential yield (catch limit) estimate. It should be noted that the trigger level is significantly higher than the maximum annual historical catch in Area 48 of approximately 400 000t and there is no real justification for this particular value, except that it lies well below the potential yield estimate. Therefore whether it is precautionary or not depends on the yield estimated from the Generalised Yield Model.

The harvest control rule used to calculate the potential yield is probabilistic, but does not take account of all uncertainties. The main source of uncertainty accounted for is recruitment variability. Other causes of biomass reduction (e.g. seasonal shrinkage), natural fluctuations of krill abundance and potential long term changes in productivity (e.g. climate change) are not accounted for.

The reference points and risk parameters are generic despite the considerable research activity undertaken on this species. The predator criterion refers to the simulation median after 20 years and is set half way between $SSB_{50\%}$, which is a B_{MSY} proxy, and the unexploited stock size. This is conservative compared to a single species criterion and does reserve additional biomass for predators. The recruitment criterion refers to 10% of simulations after 20 years falling below 20% of the spawning stock. Again, there is no real justification for 10%, 20% or the 20 years used in this rule.

The twenty years is approximately three times the longevity and eight times the generation time. The decision rule will decrease the exploitation rate the longer this interval is, so considering the natural mortality of the species, 20 years appears precautionary. Also, if this TAC is applied, the criteria mean that the reference points will likely be approached over a twenty year period, which should allow ample time to monitor the performance of the rule.

The resulting level of exploitation from this rule appears precautionary. The final exploitation proportion is set relatively low at approximately 0.12 $year^{-1}$ compared to the natural mortality which is > 0.6 $year^{-1}$, and would be considered very precautionary in a single species context.

Of perhaps greater concern is the estimated unexploited stock, B_0, which is proportional to the catch limit. The unexploited biomass was estimated from a synoptic survey conducted in 2000.

Fishing had taken place before the 2000 survey. However, treating the 2000 survey as a survey of the unexploited stock should produce a lower biomass than the true unexploited biomass, and therefore should set a more precautionary catch limit.

Various methods have been applied to estimate the Area 48 biomass from the same survey data. Estimates have varied from 37 to 208 million tonnes:

- The most recent, CCAMLR-approved biomass estimate for the 2 million km^2 area of the CCAMLR Synoptic Survey is 37.3 million tonnes (Demer *et al*., 2007).
- The original biomass estimate was 44.3 million tonnes (WGEMM 2000). The current estimate is a 16% reduction of this original value.
- Demer and Conti (2005) estimated the krill biomass as 109.4 million tonnes based on a revised target strength model and the original acoustics data.
- Using an alternative estimation model, Heywood *et al*. (2006) estimated the overall biomass as 208.0 million tonnes, much higher than the current value (see also Everson 2008; Brierley

et al. 2008).

- For the same CCAMLR 2000 Synoptic Survey area, Atkinson *et al*. (2008) estimated the biomass to be 106 million tonnes using all available data from the KRILLBASE database similar to Demer and Conti (2005). It is proposed that these estimated levels of abundance and productivity are consistent with the level required to support predator consumption of 128 to 470 million tonnes per year. In addition, Atkinson *et al*. (2008) suggested that the Atlantic krill population is more abundant over large areas previously assumed to contain a small part of the stock, notably between 30^{o}W and 30^{o}E. Thus the CCAMLR 2000 Survey would have sampled only 40% of the main Atlantic population from 0^{o}-90^{o}W.

In most cases, the differences in estimates exceed the sampling standard errors or confidence ranges, suggesting that these standard errors underestimate the overall uncertainty. However, the CCAMLR-approved biomass estimate, which is used for the catch limit, uses the lowest estimate from the range of values available.

The current catch and trigger level catch remain well below the catch limit estimate, which itself incorporates a significant degree of precaution. Although it might be theoretically possible for the whole trigger level catch to be taken in a single SSMU, this would be very unlikely given the vessel operation behaviour and logistics (Kawaguchi *et al*. 2006; Kawaguchi 2008).

Concern has been expressed as to the accuracy of the catch estimate (WGEMM 2008 Para. 4.39; WG-EMM-08/46). Inaccuracies are introduced by unrecorded discards and poor estimates of factors converting the measured processed weight to unprocessed “green” weight of the catch. Current concern has mostly been with the latter due to difficulties with obtaining information to estimate conversion factors accurately, and sensitivity of the estimate of catch weight to this factors (WG-EMM-08/46). Although there is a clear problem with conversion factors, raised by SC-CAMLR itself, it will not be as bad as the worst case indicated in WG-EMM-08/46, and the Saga Sea vessel, subject to this certification, is making no contribution to this potential problem. While it is unclear how accurate the catch estimates are, the current catch is sufficiently low that catches beyond the trigger level appears implausible. However, this problem remains significant and will need to be addressed, particularly if catches increase.

The monitoring system appears adequate to detect basic problems in the fishery, such as the conversion factors issue above. Catch data are reported by vessels. Many vessels carry observers, although only Norwegian vessels and vessels fishing in area 48.3 carry international observers and CCAMLR has otherwise received few observer reports Data are collected by observers on board vessels and these data are reported in the articles, analyses and assessments (e.g. Bibik and Zhuk, 2008; WG-EMM-08/5; Iwami and Naganobu, 2008). Using all the available data, various problems have been raised and reported at WGEMM meetings (e.g. WG-EMM-08/46) suggesting that such problems will be detected as they arise.

5 FISHERY MANAGEMENT FRAMEWORK

5.1 CCAMLR General Management, Consultation and Review

CCAMLR, the Commission for the Conservation of Antarctic Marine Living Resources, provides specific management objectives through its conservation measures and the text of its Convention. The aim of the Commission is the conservation of marine life. Conservation itself is defined as including rational use, although there is no activity directed at management of seals and whales as harvestable resources, those being covered by other Conventions.

The primary framework for the operation of the krill fishery is the Convention that came into force in 1982 as part of the Antarctic Treaty System. The agreement is currently recognized by 25 Member States and is the sole management organization for fish and krill harvesting within international waters encompassing all Antarctic fisheries. The CCAMLR management system has three objectives:

(a) prevention of decrease in the size of any harvested population to levels below those which ensure its stable recruitment. For this purpose its size should not be allowed to fall below a level close to that which ensures the greatest net annual increment;
(b) maintenance of the ecological relationships between harvested, dependent and related populations of Antarctic marine living resources and the restoration of depleted populations to the levels defined in sub-paragraph (a) above;
(c) prevention of changes or minimization of 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 of the effects of environmental changes, with the aim of making possible the sustained conservation of Antarctic marine living resources.

The aims of these three objectives are consistent with the aims of MSC Principles 1 and 2. CCAMLR's strategy for achieving its objectives is reflected in quantitative annual TACs [as defined in Conservation Measure 51-01 (2008) and annually reviewed]. These TACs are set to ensure that each fishery complies with the long-term objectives above. The Environmental Charter for South Georgia (adopted in 2001) contains clear and specific long-term goals for fisheries there, and for the protection of its ecosystem.

Although it is part of the Antarctic Treaty System, CCAMLR has many of the characteristics of a Regional Fisheries Management Organisation (RFMO) with respect to its management of fisheries. The organisation has specific responsibility for Antarctic waters and as such its operations are transparent to scrutiny, and its aims are in line with the delivery of MSC Principles 1 and 2. The Commission delivers clear and effective management of the fisheries under its management remit, fisheries regulated in accordance with its Convention and therefore consistent with international agreements. Fisheries have been evaluated at a number of meetings of the Standing Committee on Operations and Inspection. There are currently no licensed and regulated Antarctic fisheries operating under any controversial exemption to an international fisheries or environment-related agreement. With respect to the management undertaken by the South Georgia Government, fisheries are managed under GSGSSI (Government of South Georgia and South Sandwich Islands) ordinances, which are aligned with CCAMLR requirements. There is an ongoing dispute between the UK and Argentina with respect to the sovereignty of South Georgia, but this has no material impact on the implementation of CCAMLR requirements within Subarea 48.3.

Control methods implemented regionally by CCAMLR and locally by GSGSSI for combating IUU, such as enhanced monitoring, arrest of illegal vessels, and legal penalties, are consistent with international conventions and agreements.

There are no indigenous people dependent upon fishing for krill in waters managed by CCAMLR, and no indigenous inhabitants of SGSSI. Moreover, none have been historically dependent on the krill fishery, because Falkland Islanders were traditionally only associated with the whaling stations on South Georgia (Agnew, 2004). The legal rights of fishers are observed by the system, although they are not legally codified.

The annual review of CCAMLR-managed fisheries by WG-FSA and SC-CAMLR assesses the status of each fishery using as base criteria the principles set out in the Convention. In addition to representation by all members, a number of other organizations, such as environmental NGOs, e.g.

ASOC, fishing industry groups and other interested parties are invited as observers to the annual meetings of the CCAMLR Scientific Committee and Commission. The CCAMLR Convention sets out the terms under which such observers can attend and participate in its statutory meetings, and records of these meetings are documented and are available for scrutiny after each annual meeting.

The overall TACs in the areas of interest here are set by CCAMLR, which has a proven ability to close fisheries in real time based upon scientific evidence, and a reporting system in place to gather the evidence necessary to trigger that action (see section 6.5 below). Member States must comply with all regulations and requirements set (as Conservation Measures) and licence their own-flag vessels. All decisions such as Conservation Measures and other resolutions are made by consensus, taking a precautionary and ecosystem approach. GSGSSI may impose additional requirements or controls in addition to the CCAMLR requirements for the krill fishery when it operates inside the South Georgia Maritime Zone. The levels of fishing (quotas and number of vessels), the types of vessels licensed, and the locations of fishing to be allowed are reviewed annually internally by GSGSSI and their scientific advisors as part of their licensing policy review.

All fishing companies operating in the fishery and particularly the client group are aware that they need to ensure compliance and operation consistent with the regulations and principles of CCAMLR, GSGSSI and the flag state.

The WWF – Aker BioMarine partnership has existed since 2006, with the common goals of ensuring sustainable management of fish and krill and combating illegal harvesting. In the period 2009 through 2011, joint activities between Aker BioMarine and WWF Norway include promoting environmental labelling and ensuring traceability throughout the fisheries value chain, from harvesting through to products purchased by consumers. WWF Norway will play a role in bringing critical external stakeholder input into the management process for the fishery under assessment.

The science and management of any CCAMLR fishery is subject to review. Internal reviews provide evaluations of major elements of the management system, and stock assessment methods are reviewed and modified annually if possible, but depending on the fishery, though regularly in any case. Other Conservation Measures are reviewed less frequently, so any improvements cannot be tested and implemented rapidly.

All fishery divisions managed under CCAMLR responsibility undergo annual review as required under Article 2, Paragraph (c) of the Convention. The Commission makes decisions based on annual advice from multinational and multidisciplinary scientific and technical working groups, which is reviewed by the CCAMLR Scientific Committee (SC-CAMLR). All decisions on Conservation Measures and other resolutions are made by Member consensus, taking a precautionary and ecosystem approach.

5.2 Fishing Rights, Licensing, and Subsidies

The fishery proposed for certification is being prosecuted currently by a single vessel, although under the Olympic system currently operative in the krill fishery generally, Norway has given notice that it could exercise an option to operate up to four licenses. Within its official notifications of intent (see below), Norway has granted a second license nationally to Aker BioMarine to operate another vessel with similar gear and extraction processes in the same area, but for market and simple economic reasons, that license is highly unlikely to be activated for another three years. Of the other two licenses Norway has proposed invoking, one may be activated in 2009, though not necessarily only with the same gear and processes or even in the same area, but with the 2009 season already well under way, the vessel has not yet given clear indication that it will take up its option.

Norway is a country that takes its formal fishing rights and allocations seriously, so it is unlikely to allow any existing or future national operation to jeopardise its credibility. That statement applies as much to vessels licensed to operate, such as Aker BioMarine in this instance, as it does to those that might wish to be licensed but are not currently licensed formally. Possibilities of national and international blacklisting exist, and would almost certainly be invoked by Norway on Norwegian interests, along with formal litigation, if the need arose. The fishery would be closed formally if stock sustainability or administrative/bureaucratic processes dictate that it be halted. Although Aker BioMarine does not have a long or broad tradition of involvement in fishing generally, being a relatively new entrant to the industry, it shows in its communications (with this assessment team and administratively) and prospectus that it takes all its responsibilities and commitments associated with its license(s) very seriously.

The license to catch Antarctic krill was granted to Aker BioMarine after a competitive, transparent, consultative process within Norway itself, within which all information relating to the proposed fishery was provided despite the obvious commercial sensitivity of the innovative gear design, at least.

Neither the CCAMLR system nor GSGSSI has capacity to provide subsidies of any sort. Costs related to the operation and management of the Commission are fully recovered from Member States through their membership fees. CCAMLR has no policy on whether Member States should subsidise their vessels. GSGSSI recovers its costs of fisheries management from the licensing of vessels to operate in the waters under its jurisdiction. However, the krill fishery in area 48 is made up of vessels from a number of nations. Direct and indirect subsidies almost certainly exist to varying degrees in some individual states, but currently no subsidies exist in Norwegian fisheries for krill, for fishing in general or for sustainable fishing.

There is an implicit incentive to meet national (Norway), CCAMLR and GSGSSI requirements in terms of licensing, observer requirements and data reporting, to ensure that the vessels are in a good position to ensure future licensing in the fishery.

5.3 Fishing Locations

The fishery seeking certification operates in the Southern Ocean in waters close to the Antarctic Peninsula and around South Georgia, Sub-areas 48.1, 48.2 and 48.3. Early in the season at the height of the austral summer, fishing is in the south of the target fishing area, but as winter approaches accompanied by a north-expanding ice field, krill aggregations also seemingly move north towards South Georgia, and the operator follows those aggregations until the season ends in September. The target fishing area falls within the region identified in previous stock surveys as holding a large part of the global population of Antarctic krill, and it is considered generally by most interested parties, including scientists operating under the CCAMLR umbrella, to be capable of supporting a long-term and sustainable fishery provided precautionary management practice is followed. Other areas around the Southern Ocean are known to contain large and perhaps potentially exploitable stocks of krill, but those areas are not yet targeted intensively by any fishery, and some have not yet been opened formally to exploitation by CCAMLR.

The depths of operation vary depending on time of day, meteorological condition and season, but are generally in around 50–350 m of water. Fishing is within the water column, and there is never any bottom contact by the gear, so there are no potentially deleterious habitat consequences arising from interactions between the gear and the substratum.

5.4 Administrative Arrangements and Boundaries

As stated above, the Norwegian fishery receives no national subsidy so is managed through market forces. The operator is subject to both national and international legislation, and although the main administrative control is through CCAMLR (see section 6.1 above), Norwegian legislation and requirements, if more stringent than those of CCAMLR, are always applied on top of CCAMLR directives. Formal reporting is to the standards and norms required by CCAMLR, and copies are retained also in Norway under the control of the Norwegian Ministry of Fisheries, which together with its Ministry of Foreign Affairs comprises the Norwegian delegation to CCAMLR. Catch and effort statistics are therefore available through both Norwegian sources, at which rigorous quality control is applied, and CCAMLR.

Currently, Norway and the operating fishery only seek certification for the small sector of the Southern Ocean contained within Area 48, as stipulated above.

5.5 Legislation, Regulation and Precautionary Management

A summary of Conservation Measures and recommendations in force is provided in Appendix G. These should be read in knowledge of the area and fishing information provided in Figure 6, Figure 7 and Figure 8 of section 6.5 below.

Conservation Measure 51-01 (2008) sets two precautionary catch limits on krill in Statistical Sub-areas 48.1, 48.2, 48.3 and 48.4:

- The precautionary krill catch limit of 3.47 million tonnes for Area 48, based on the potential yield estimate. This is well above the current catch and will allow for expansion of the fishery.
- A "catch trigger" (620 000 t) not to be exceeded until a procedure for division of the overall catch limit into smaller management units has been established, based on advice from the Scientific Committee. The objective of this division is to avoid possible unacceptable concentration of catch within the foraging areas of vulnerable predators. Although the trigger level is close to the highest global annual catch to date, it is significantly more than the largest annual catch to date in Area 48.

Additional provisions within the various measures deal with monthly data-reporting procedures through implicit cross-reference to other Conservation Measures, and there are ongoing requests to continue to provide validated haul-by-haul data from the fishery and to carry (independent, where possible) scientific observers on krill vessels in order to improve and verify the information forthcoming from the fishery.

In terms of notifications, there are currently no controls to prevent excess capacity in the Antarctic krill fishery, although such controls are seemingly not needed urgently at current catch levels. Potential increases in capacity are monitored through the notification procedure. There is a large discrepancy between notified and actual catches, despite WGEMM’s request to improve the accuracy of notifications. The vessels notified to fish for krill in the 2008/09 season indicated that sufficient vessel capacity existed to exceed the trigger level (WGEMM 2008 Para. 4.14). As a result, the Scientific Committee recommended taking action through revising Conservation Measure 21-03 to discourage frivolous notifications.

The large discrepancy between notifications for krill fishing and actual fishing effort (WGEMM 2007 Para. 4.17; SC-CAMLR 2007 Para. 3.45) limits the utility of the notification system for short-term planning, and it may be misleading. There was also a substantial increase in the number of notifications of intention to participate in the krill fishery in 2008/09, suggesting a potential catch in excess of 700 000 t (WGEMM 2007 Para. 4.14). Problematic issues with the system include a large number of notifications by non-Members (e.g. WGEMM 2007 Para 4.17), the fact that the total notified catch (764 000 t) exceeded the trigger level in Area 48 (620 000 t) in 2007, the reality that actual catches have remained at the medium-term average of 100 000 t, and the poor quality of some notifications, which were incomplete on submission, revised after the deadline for submission and/or lacked the necessary information.

As noted above, CCAMLR has proven ability to close fisheries in real time based upon scientific evidence, and a reporting system in place to gather the evidence necessary to trigger that action. That reporting system becomes increasingly frequent and rigorous as the level of krill catch increases towards the trigger level, moving from monthly to ten-day reporting (at 80% of the trigger level), and haul-by-haul reporting (two-hourly for the continual fishing operation under certification) is taking place throughout and submitted to CCAMLR on return to port (CCAMLR CM 23-06). The trigger for reporting is reduced in the subsequent year. In addition, the Norwegian fisheries management system, which itself has proven capability to close fisheries in real time, would control the Aker activities. Therefore, if the level is considered sufficiently precautionary, the system is in place to manage it.

Guidelines on bycatch and legislation on discarding are in place internationally, and Norwegian legislation in any case precludes the discarding of any material taken during fishing operations. Therefore, the Aker BioMarine fishing operation, which adheres to Norwegian standards and hence generates virtually no organic material to be discarded back to sea, meets the highest standards of legislated clean use of a resource. CCAMLR regulation of the fishery is adhered to fully, and the operator moreover expresses its willingness to maintain its compliance with legislation even if further requirements are introduced in line with a developing fishery on a resource about which much still remains unknown, necessitating continued precautionary management.

All CCAMLR decision-making on allocation of quotas is based on the precautionary approach and on the best available information by national experts working closely together in the Working Groups, Scientific Committee and Commission. The principle of precautionary management is enshrined in the FAO’s Code of Conduct for Responsible Fisheries (FAO 1995), and a number of “tools” have been suggested by those who helped develop that code to assist managers and decision-makers in applying the precautionary principle to the management of national and international fisheries. Those tools have been outlined by Garcia (1994), and it is illustrative here to list them as a means of briefly evaluating whether, in the opinion of this certification team, the Antarctic krill fishery is following the precautionary approach by utilizing those tools. The full list of tools is:

- adopt the sustainable development principle;
- adopt the principle of precautionary management;
- use the best scientific evidence available;
- adopt a broad range of management benchmarks and reference points;
- develop criteria for use when assessing the impacts of development;
- take a risk-averse stand;
- agree acceptable levels of impacts and risk;
- take a holistic view of resources within their environment;
- speed up management response time;
- allow for greater participation by non-fishery users in management bodies;
- improve decision-making procedures;
- introduce prior consulting procedures
- strengthen monitoring, control and surveillance.

Noteworthy in the above list are the use of the terms “sustainability”, “risk-aversion”, “holistic view” (= an ecosystem approach to management), and “reference points”, key terms used nowadays to underpin best practice fisheries management worldwide. Many of the tools are, of course, clearly taken up in a CCAMLR context, but a few are also taken up even more rigorously in Norway’s national fisheries policy. However, while acknowledging that future climate change impacts are largely unpredictable and perhaps also that knowledge of krill biology and ecology should be enhanced (Johnston *et al*., 2009; but see Everson, 2000d, for a review of current knowledge), it is our view that the Antarctic krill fishery seeking certification is well covered by most of these tools, so adheres closely to the principle of precautionary management. Given that the trigger level above is currently not even being approached, we are confident that for the foreseeable future at least, there is no concern that precautionary management principles will be breached in this fishery. Future certification reviews will, of course and if certification is granted, address this issue carefully.

5.6 Harvest Controls

The 2009 TAC for Antarctic krill applied through the trigger level, which we interpret as a precautionary upper catch limit (PUCL), is, as stated above, 620 000 t, out of a stock size of many millions of tonnes, some 40 million tonnes of which seemingly falls within the target area, according to latest survey estimates. However, the previous full survey of biomass was about eight years ago, and the ecosystem is changing (Johnston *et al*., 2009); regrettably, there are no plans for a comprehensive re-survey of the stocks in the near future. Given that the biomass of nearly all marine resource populations fluctuates naturally, however, and that Antarctic krill may be on a natural downward trend not necessarily linked to its exploitation, a new survey of biomass is needed to shed light on the population dynamics of a species that can live to just seven years, although the proportion of animals that attain that age is likely low. Current declared annual catches fall well short of the PUCL of 620 000 t (see section 6.5 above), at some 150 000 t by just six countries (Russia, Japan, Korea, Ukraine, Poland and Norway). The operations-limited maximum catch of Aker BioMarine operating a single vessel is 50 000 t. As stated above, anticipated annual catch notifications seemingly serve little purpose other than to demonstrate a capacity to exceed the PUCL, and accelerated rates of catch reporting as the trigger level is approached, as stipulated in CCAMLR Conservation Measures, have not yet been activated.

Other CCAMLR-directed controls, such as limits on bycatch, are seemingly not applicable to the Aker BioMarine operation currently, because the catching process entirely precludes the capture of predators (seabirds, seals, fish), and the currently determined catch rate of fish larvae in the continuous fishing operation is low at present levels (see section 6.2. below). This issue will, however, need to remain subject to strict, ongoing monitoring to ensure that the bycatch rates do not vacillate seasonally or spatially into unwanted territory (e.g. to become notable catch rates of fish species of conservation or biodiversity concern, or a large bycatch of larvae of commercially important fish species).

5.7 Monitoring, Control and Surveillance

CCAMLR provides a clear comprehensive monitoring system and control framework for Antarctic fisheries. Surveillance of CCAMLR fisheries is undertaken by Member States and incorporates the CCAMLR system of inspection. There is little IUU pressure on the krill fishery and no significant IUU activity has ever been recorded in the krill fishery in Area 48. In other CCAMLR fisheries where IUU has been a problem, the Commission has demonstrated a clear commitment to enforce relevant conservation and management measures, IUU reduction strategies and management rules through the provision of inspection protocols both at sea and in port, and through observer programmes.

The implementation of sanctions to deal with non-compliance is an issue for Member States, either through flag-state control, or, in the case of South Georgia, through GSGSSI coastal state jurisdiction over the Maritime Zone. Sanctions within the South Georgia Maritime Zone are applied at a level appropriate for deterring IUU fishing.

Fishers, specifically those applying for certification here, comply with the management system, providing information on the fishery prior to (Notification of Intent) and during fishing (C1 and observer data) at levels defined by CCAMLR and GSGSSI to provide effective management of the overall fishery.

As stated above, all Norwegian fisheries are subject to rigorous and strict control systems, and in the current case, the Norwegian authorities enforce total adherence to both the CCAMLR requirements mentioned above and to their own often more rigorous controls. VMS (satellite) data are provided continuously during the fishing operations of Aker BioMarine, and in the rare cases where the signal from the vessel is temporarily lost, the information can subsequently be recovered because all data are stored automatically on board. Aker BioMarine adheres fully to the principle of allowing non-national observers on its vessel at all times (currently, the observer coverage is provided by the UK). Its observer database and coverage is impressive by current world standards.

5.8 Consultation and Dispute Resolution

Norway participates actively in CCAMLR, and has shown itself very willing to adhere to the principles of that Convention, and also actively promotes even more rigour in the system. Its own regulations on fishing are so strict that there is no doubt in the mind of the certification panel that should dispute arise and Aker BioMarine shown to be at fault, the vessel would be withdrawn immediately. Future participation in the Antarctic krill fishery is considered in Norway to be a high priority, and the country's responsible ministries take their commitments to CCAMLR and GSGSSI very seriously.

6 ECOSYSTEM CHARACTERISTICS

The ecosystem within CCAMLR area 48 and around South Georgia and South Sandwich Islands has been well studied during research by CCAMLR members through co-ordinated research cruises and observer programmes, and specific research and fisheries management organisations such as BAS and MRAG in the UK, and is a subject of ongoing research (e.g. Agnew, 1997). Besides supporting management and conservation within the area, this research supports the work that CCAMLR and its Scientific Committee have performed developing an ecosystem approach to the regulation of fisheries (e.g. within WG-EMM, as described in more detail below). This includes management approaches that assess the status of the ecosystem and its health.

In this section, we summarise information relevant to research on the ecosystem component of the fishery under certification, relevant to the MSC criteria.

6.1 Retained species

Retained species are described as those parts of the retained catch that are not covered under Principle 1 because they are not included in the Unit of Certification.

The nature of the *Saga Sea* fishing process means that a notable retained component of the catch consists of fish larvae. While less than 5% of the total catch by weight, this can be considered a 'main' retained species due to the potential vulnerability of this component. This retained group has been the subject of a recent report on data and research on this aspect of the *Saga Sea* operation (MRAG, 2009). Bycatch of larval fish taken has been observed in krill catches by 'conventional' gears (e.g. Iwami and Naganobu, 2008). CCAMLR has requested Members who fish for krill in the Convention Area to provide information on the by-catch of juvenile fish in the krill fishery, and has developed a standard protocol for scientific observations on board krill trawlers. A recent analysis of the bycatch of small fish and squid from krill fisheries around South Georgia in 2006 and 2007 (Ross et al 2007, Orr et al. 2007), showed that many hauls contained small fish and the composition varied greatly. Large fish appear to aggregate outside of krill swarms (Kaartvedt et al., 2005), but with the fishing gear employed by the *Saga Sea*, for example, these fish are excluded from the cod-end of the net where the extraction of the krill occurs.

While the number of larvae caught using the continuous fishing method may be perceived as greater than conventional trawl methods, the method of fishing by the *Saga Sea* means that fish larvae are more easily identifiable within the continuous fishing trawl when compared to crushed samples that may be unidentifiable as larvae when a conventional krill trawl catch is examined. Therefore the overall impact of the two approaches may be no different (MRAG, 2009). However, the low numbers of observations in the conventional krill trawl catch in particular, and restricted sampling across seasons and areas of operation means strong conclusions cannot be drawn.

In the period 2006-2008, combined catch rates of larvae per tonne of krill were ~43 individuals per tonne in Subareas 48.1 and 48.2 in the summer, and 1.1 to 99.5 individuals per tonne in Subareas 48.2 and 48.3 in the winter, respectively. While identification of larvae to genera and species level continues, current data indicates that species specific catch rates were highest for Icefish *Champsocephalus gunnari*: maximum catch rates being 58.83 individuals per tonne in winter (Subarea 48.3) and 38.3 'other icefish' individuals per tonne in summer (Subarea 48.2). Within 48.3, the key area for *C. gunnari* larval catch, this species is considered within biological limits and harvested sustainably. Lanternfish, the second most common species in 48.3 in the winter, is no longer the subject of a directed fishery where it is abundant (Subarea 48.3), on the basis of its likely importance as prey (forage) species in the food web (see regulation 32-17). There is no formal assessment of the status of the stock, but this management measure and the low by-catch levels that are recorded make it very likely that fishing has resulted in minimal and insignificant reduction in stock size. Rockcod larvae were also identified within the catch. Directed fishing for the Antarctic rockcod (*Notothenia rossii*) has been prohibited since 1985 (see regulations 32-05 to 32-07), and the recovery is being monitored for stocks which were overfished in the late 1960s and early 1970s. Prohibitions are also in place to protect other rockcod and icefish species (other than *C. gunnari*, this being the most common genus in 48.2 in the summer; see regulation 32-07) in Area 48.3.

While season appears to affect the level of larval catch, and localised spatial differences were also noted, spatial and temporal data were limited due to the movement of the fishing vessel. BAS are to start a pilot programme to study larval bycatch further in mid 2009. It should be noted that fish larvae will have a high natural mortality rate, and hence the impact of fishing on overall larval survival may be low. However, this is the subject of further study. In turn, larval occurrence is likely related to adult population abundance.

At the trigger level of 620 000 tonnes of krill, a maximal catch of 99.5 larvae per tonne equates to 61 700 000 fish larvae caught, a worst-case situation given current information, and ignoring species-specific and area-specific catch rates. Based upon a conservative evaluation assuming either the current total catch level of krill or the current catch trigger level is taken from one place, and in light of the high rate of natural mortality in younger fish, impacts would be expected to be no more than background variability, and hence undetectable at these levels. However, the number is not insignificant, and hence continued monitoring of larval bycatch is warranted, particularly to identify approaches to reduce catches of species. Therefore continued monitoring of larval bycatch is warranted, particularly to identify approaches to reduce catches of these species (e.g. through spatial or temporal approaches) and the spawning seasons of the different stocks.

6.2 By-catch, discarding, and ETP species

An observer monitors the *Saga Sea* (the unit of certification) during all fishing activities, which is a voluntary addition to activities required by CCAMLR regulations, and funded by ASOC (the Atlantic Southern Ocean Coalition). This 100% observer coverage collects information not only on the fisheries operations, but also any bycatch, discards and incidental mortalities that occur within the fishery. The observer covered between 20 and 86% of 'trawls' during the fishing season in 2006/07 (CCAMLR 2008d).

Given the nature of the fishery and fishing gear, and the intended product (fish meal, fish oil) discarding does not occur in this fishery. All catch is brought on board through the suction system, onto a conveyor belt and into the hold. Sorting of krill does not occur on board, and hence all individuals captured are retained on board. There are no size limits that would lead to discarding.

Unobserved mortalities from animals escaping through the cod end or other net mesh are highly limited by the small mesh size of the cod end. This has been observed through underwater camera observations performed during gear trials. However, the level of mortalities within the few individuals passing through the mesh has not been studied. Given the size of the mesh the mortality is expected to be high, but the overall impact limited due to the limited number of escapees.

No gear losses have been recorded. Indeed, the gear is over-engineered to prevent losses occurring. In the highly unlikely event that a gear was lost, an incident report would be filed by the vessel (and observer) and reported to CCAMLR and the Norwegian Fiskeridirektoratet. Attempts to recover the gear would occur if losses occurred at depths in which recovery would be feasible.

MSC guidelines suggest that ETP species can be based upon those on the CITES listing. Using South

Georgia and South Sandwich Islands entries as a basis, those of concern that may relate to krill fisheries are:

- Commerson's Dolphin/Piebald Dolphin (*Cephalorhynchus commersonii*)
- Spectacled Porpoise (*Phocoena dioptrica*)
- Common Rorqual/Fin Whale (*Balaenoptera physalus*)
- Southern Right Whale (*Eubalaena australis*)
- Antarctic Fur Seal (*Arctocephalus gazella*)
- Subantarctic Fur Seal (*Arctocephalus tropicalis*)
- Southern Elephant Seal (*Mirounga leonina*)

As the trawl is pelagic, and successful efforts are made to prevent the expensive gear from being damaged on the sea bed (as confirmed through the observer coverage), any interactions between ETP cnidarians and hydrozoans and the trawl gear are considered extremely rare.

The direct interaction of the fishing operation with marine mammals (seals and whales) and marine birds is reduced by the nature of the fishing operation. The net opening is covered by a fine excluder mesh net which actively excludes marine mammals and diving birds such as penguins from entering the net and becoming trapped (as required by CCAMLR regulation CM 25-03). In turn, the slow towing speed of less than 2 knots allows these animals to move around the outside of the net with minimal danger. Seals were observed inspecting the net opening during underwater camera monitoring of the net opening during trials to ensure the net fished appropriately. No entanglements or other detrimental interactions were observed during that period. In turn, the net design means that the net opening closes on hauling further reducing entanglement possibilities.

The layout of the trawl warps, which enter the water very close to the stern of the vessel, reduces the potential for birds to strike these warps during fishing operations. Furthermore, the fact that the vessel can fish for up to 25 days continuously reduces the number of setting and hauling events, which reduces the time during which birds could interact with the net on the surface. In turn, CCAMLR regulations for deploying cleaned nets, the fact that the trawl sinks rapidly on deployment (and hence bird scaring lines are not required), that trawling often takes place during the winter months (particularly at South Georgia) when birds are not feeding chicks and hence food foraging is reduced, and that discharges from the operation are only water (krill being stored whole) appears to have eliminated interactions. No bird or marine mammal mortalities have been observed by the CCAMLR observer during the operations (MRAG, 2009), as acknowledged by CCAMLR (Report of the twenty-sixth meeting of the Scientific Committee (2007), item 4). Even in the ‘normal’ krill trawl fishery, in contrast to the historical pattern in longline fisheries, seabirds are seldom killed in CCAMLR waters (Kock et al., 2007) and none have been observed in the krill fishery around South Georgia (Varty et al., 2008). Therefore, the nature of the fishery under certification, with very infrequent hauling, means that the likelihood of bird mortalities is much reduced. Therefore, Varty et al. (2008) noted “Consequently, there seems no justification for a NPOA-Seabirds for the krill fishery in Subarea 48.3 at the present time.” Measures in place to mitigate incidental bird mortalities are detailed in CCAMLR CM 25-03.

There is therefore a high degree of confidence that there are no significant direct detrimental effects (indirect effects being considered under section 6.5) of the fishery on ETP species.

6.3 Habitats

The fishery operates using a midwater/pelagic trawl. The key habitat of concern is therefore the pelagic system. With relevance to this ecosystem, a number of oceanographic models have been developed, including OCCAM (Ocean Circulation and Climate Advanced Modelling project) and a BAS-specific oceanography model for the South Georgia region (SGSSI; CCAMLR Area 48.3), which is closely associated with the OCCAM model. The BAS model has been developed based on topography to predict on a fine scale ocean currents, and hence larval movement and retention, as a method to underpin considerations of population genetics. As noted, these models have been used to study the circumpolar distribution of krill.

As detailed above for ETP species, the mid-water nature of the fishery means the fishing gear would very rarely impact sensitive benthic habitats, and this interaction is in practice actively avoided (as confirmed through the observer coverage, which indicates no interactions) due to the potential to damage the net and in particular the associated pumping tube gear (which is expensive and difficult to repair at sea). Key areas of sensitive habitat in Area 48 have been identified through swath bathymetry mapping studies performed during a number of surveys, including those by the James Clark Ross and Endurance research vessels. This has been supplemented by echo-sounder records from commercial vessels, and related to observations by observer programmes of benthic species brought up in fisheries operating in Area 48 and around SGSSI. This programme is supplemented by the activities of the Zoological Society. Observers collect information on any bycatch species, including benthos should contact with the bottom occur during trawling. CCAMLR has gathered these and other information sources together during their Report of the Workshop on Bioregionalisation of the Southern Ocean (2007), which built upon the broad-scale pelagic regionalisation from the 2006 Hobart Workshop, and has continued to develop the analyses.

Due to the pelagic nature of the gear, and avoidance of the seabed by fishers due to the likelihood of damaging the net, there is little potential for damage to the benthic ecosystem. Impacts on the pelagic system are expected to be negligible and transient.

6.4 Ecosystem impacts

Krill plays a central role in the Southern Ocean food web, forming a key food source for a number of species (Everson, 2000b). As a result, the feeding of predators on this group has been extensively studied.

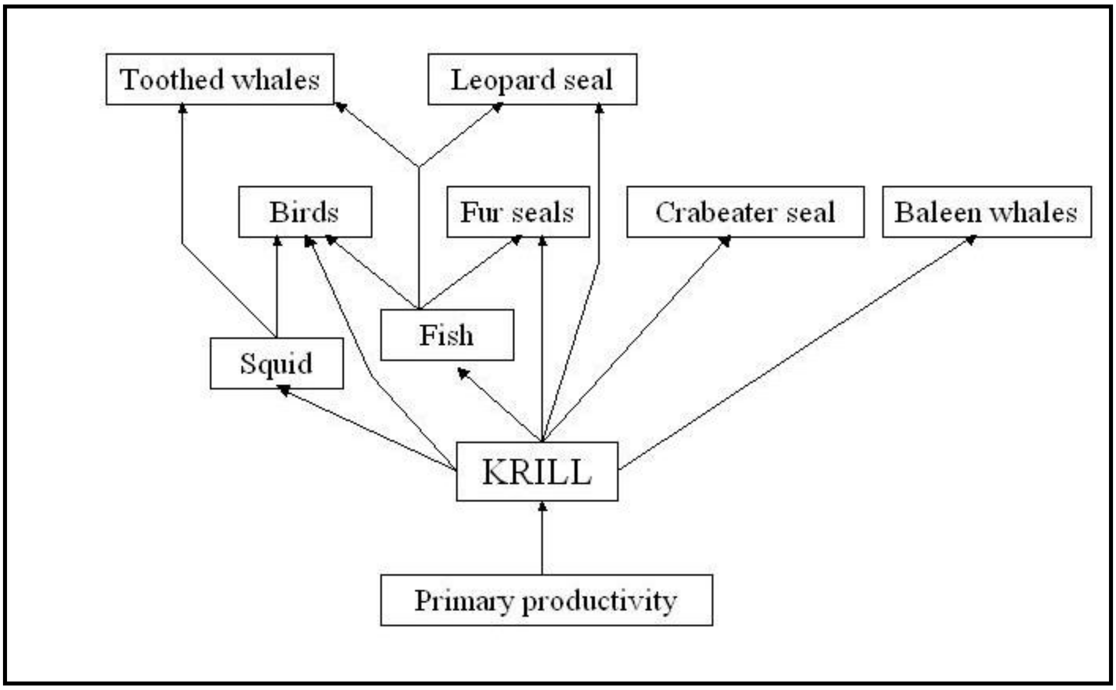


Figure 5: Simplified Southern Ocean food web, centred around krill. From Everson (2000).

While a number of fish species consume krill (e.g. mackerel icefish, *Champsocephalus gunnari*, and myctophids, at South Georgia and in the Scotia Sea), and fluctuations in local krill abundance might affect fish populations in that area, overall consumption of krill by fish is thought to be lower than that of marine mammals and birds, although estimates of 10-20 million tonnes in the southern Ocean have been suggested. Some squid species also feed on krill, but only rough estimates of consumption (in the tens of millions of tonnes) are available, due to the uncertainties in the overlap between squid and krill in high Antarctic waters. However, estimates as high as 30-40 million tonnes per annum have been suggested (Everson, 1984).

Croxall (1984) noted that Adelie (*Pygoscelis adelie*), chinstrap (*P. antarctica*), macaroni (*Eudyptes chrysolophus*) and gentoo (*P. papua*) penguins feed extensively on Antarctic krill (*E. superba*), and gentoo and macaroni penguins also feed on *E. frigida*, and both this species and *E. triacantha*, respectively when around South Georgia. Gentoo penguins have also been shown to have considerable plasticity in their diet, diving and foraging behaviours among colonies. This strategy allows continued chick-rearing success remained in the face of differences in prey availability. Chinstrap penguins have also shown prey switching to myctophid fish around South Shetland Islands (Miller and Trivelpiece, 2008). Black-browed (*Diomedea melanphris*), light-mantled sooty (*Phoebretia palpebrata*) and grey-headed (*D. chrysostoma*) albatrosses also feed on krill, although only up to 40% of their diet (first two species) and 16% for grey-headed, and around 20% of giant petrel (*Macronectes* spp) diets is composed of krill, while other petrels may have a varied component of crustacea, including krill, in their diets. The bulk of krill consumption is attributable to relatively few species, being macaroni penguins and prions at South Georgia (Croxall and Prince, 1987). These two species have been estimated to consume around 3.8 million and 1.3 million tonnes per annum, respectively. Krill forms an important food at key stages of the life history of birds. For example, studies have found that krill dominated the diet of Adelie penguins during the incubation and crèche periods, and the mortality of young is governed by the success of this provisioning (Tierney et al., 2008).

All Antarctic seals feed to some extent on krill, with the exception of the elephant seal (Laws, 1984) and the Weddell seal. It forms a major food source for crabeater seals (*Lobodon carcinophagus*), with consumption estimates based on 1990s population estimates being between 50 and 134 million tonnes of krill a year, and around half the food eaten by leopard seals (*Hydrurga leptonyx*). Fur seals (*Arctocephalus gazella*) can feed extensively on krill, but can readily shift to fish and squid. Where they are common, such as around South Georgia, fur seals have been estimated to consume 5-6 million tonnes of krill each year (based on late 1990s population estimates). The population size of fur seals has increased notably in recent years.

Baleen whales in the southern Ocean, including minke *Balaenoptera acutorostrata*, blue *B. musculus*, fin *B. physalus*, Sei *B. borealis* and humpback *Megaptera novaeangliae*, feed extensively on krill, and were estimated to consume ~85 million tonnes per annum (Everson, 2000b). Estimates of consumption levels at pre-whale-exploitation levels is over 200 million tonnes per annum.

As Everson (2000) notes, a relatively low number of species therefore have a large impact on krill stocks. In turn, if the estimated amount of krill consumed by predators is used as an indicator, the annual production of krill must be in the order of hundreds of millions of tonnes. For example, estimates of total predator consumption range in the Southern Ocean range from 128-470 Mt y^{-1} (Atkinson et al., 2008), while Mori and Butterworth (2006) estimated consumption levels of around 155 Mt y^{-1} for seals and whales alone. For the area around South Georgia alone, Everson and de la Mer (1996) estimated 9.76 million t of krill were taken by predators each year.

Further consideration must be given to the timing and spatial extent of feeding activities. Studies have looked at the seasonality, spatial and vertical variation in feeding on krill between species. For example, Everson (1983) examined the foraging activity of two penguin species during the breeding season; gentoo penguins have much shorter foraging distances from nesting sited compared to macaroni penguins, and hence there may be differential availability of krill for these species dependent upon the distribution of krill. Foraging patterns have also been monitored in fur seals and penguins through electronic tagging studies. Indeed, vertical migrations of krill have been studied not only through acoustic surveys, but also the diving patterns of krill predators. Although there is no simple pattern in krill vertical migrations, they tend to be deep by day, and at or near the surface after dark (Everson, 2000), again affecting their availability to different predators.

Given the position of krill within the Southern Ocean food web, the abundance of krill, and potential food chain impacts of krill fishing, is of key importance when considering the certification of this fishery.

Impacts of changes in krill abundance on predators

As a result of the key role of krill within the food web, CCAMLR uses an ecosystem approach to management of exploited stocks. To examine the potential impacts of fishing on the food chain, and to support CCAMLR's aim for an ecosystem approach, a number of ecosystem models have been developed for the Southern Ocean and areas within it. These have ranged from predator-prey models through to energy flow models and mass-balance models using ECOPATH. Cornejo-Donosoa and Antezana (2008) developed a mass-balance model for CCAMLR sub area 48.1, giving a description of the food web dominated by the phytoplankton–krill–top predators chain, and complemented with alternative food pathways (e.g. through *Electrona antarctica*), which together gives an enhanced complexity to the system. Model limitations exist, and data gaps include patterns during the winter season, grouping of functional groups, and steady state assumptions. An ECOPATH model for the Scotia Sea/South Georgia shelf has also been developed under the BAS Discovery 2010 programme. This research programme is also using fatty acid and stable isotope analysis to improve both food web structure and model performance. Further ecosystem dynamics models have been specifically developed within CCAMLR to aid ecosystem management decisions. These have been used to examine the impact of future decisions on krill abundance and predator responses to krill densities as well as associated uncertainties, and to assist the movement toward small-scale management units within the fishery (e.g. Hill et al., 2007; Plagányi and Butterworth, 2008). These include the models FOOSA, SMOM and EPOC (WGEMM, 2007).

While the CCAMLR Ecosystem Monitoring Programme (CEMP; below) does not monitor whale predators of krill, due to its land-based nature, these animals are included in the ecosystem models, and international cooperation through CCAMLR will improve the models further, with the joint IWC/CCAMLR workshop aiming to include whales within ecosystem models, including that for the Scotia Sea, by sharing consumption/provisioning rates (Constable, 2008). This workshop included the examination of methods that can incorporate the impacts of future climate change within ecosystem models.

To monitor directly the impacts of fishing and ecosystem fluctuations on predators, and in accordance with the approach set out in Article II, 3 of the CCAMLR Convention, an Ecosystem Monitoring Programme (CEMP) was established (SC-CAMLR, 1985; Agnew, 1997), with a Working Group on Ecosystem Monitoring and Management. CEMP data are collected following a set of standard methods and submitted by members on a voluntary basis. The programme monitors a number of bird species, Antarctic fur seals, and krill populations for a number of parameters. For example, with respect to penguins, parameters to be measured, which operated at various time and space scales, include: adult arrival weight; duration of first incubation shift; breeding population size; age-specific survival; foraging trip duration; breeding success; chick fledgling weight; and chick diet. Breeding population size, breeding success and age-specific survival are measured in black-browed albatross and foraging trip duration and pup growth in fur seals (Everson 2002). Main sites for CEMP were Bird Island (South Georgia), the islands of the southern Scotia Arc, the Antarctic Peninsula and the Prydz Bay. However, data on some key species (e.g. crabeater seal) is limited due to the species biology and funding constraints.

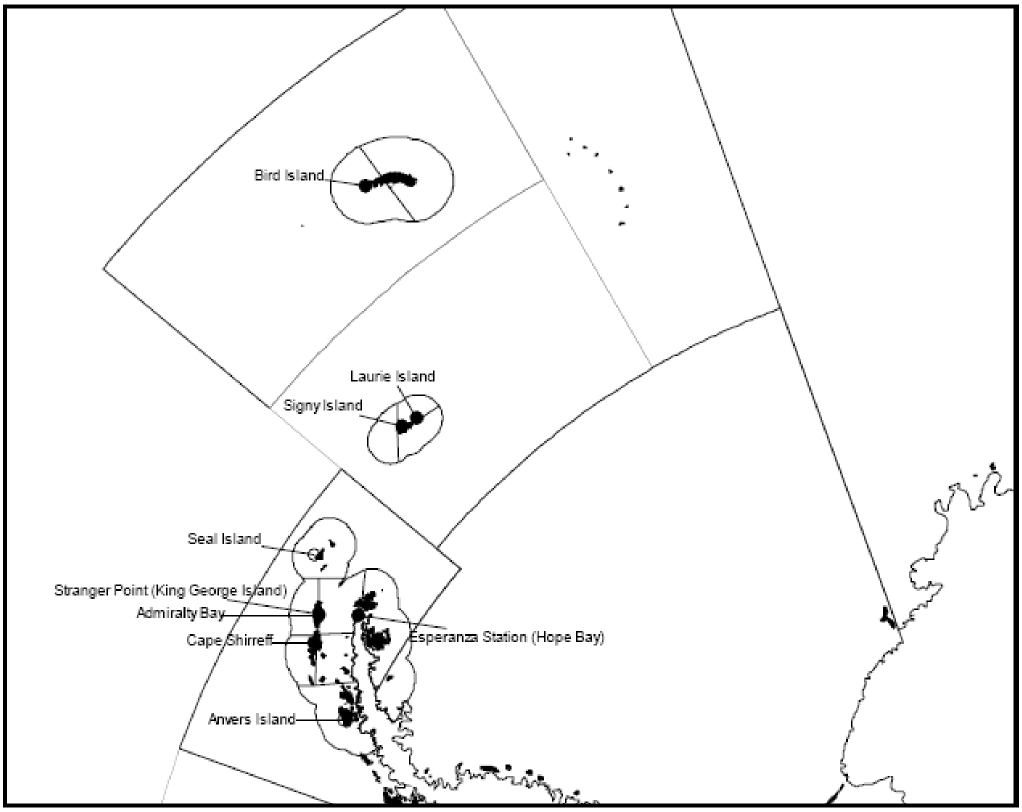


Figure 6: CEMP sites for predator monitoring within Area 48 (WG-EMM-08-04)

Sampling levels between these sites vary widely, with data collection in some locations having stopped in the last 20 years. However, there are key sites in each of the CCAMLR sub-areas of 48, which have high and consistent time series, being Bird Island, Signy Island, and Admiralty Bay (CCAMLR WG-EMM-08/4), which appears to provide a basis to monitor the impact of krill fishing on predators and their breeding success. However, some more localised impacts may not be identified due to the shortfalls in data collections from some sampling sites. Furthermore, the ability to distinguish the effects of fishing from environmental variability may be limited. Data are examined regularly, for example through specific workshops (E.g. WG-EMM Predator Survey Workshop, as reported in CCAMLR, 2008a). Independent review of the methods and statistical approaches noted that the quality of statistical methodology presented was ‘impressive’, and no substantive criticisms of the methods adopted were noted (CCAMLR 2008b).

The behavioural tendency for krill to aggregate is a key reason for fishery viability, but also represents a key potential area for fishery impact on the ecosystem. The krill fishery has consistently operated in the same areas in the South Orkney Islands, the South Shetland Islands and South Georgia which are feeding grounds for land-breeding krill-eating penguins, other birds and seals. Therefore, the possibility that excessive quantities of krill could be removed from local areas is clearly a significant risk (Croxall and Nicol, 2004), and could locally impact predator populations given their limited foraging distances (e.g. nesting gentoo penguins, given they are constrained in foraging range by the need to return to feed the chick). Icefish are also somewhat constrained to the continental shelf region. This is particularly relevant in Subareas 48.1 and 48.3, where large colonies of land-based krill predators breed or are located. Modelling has progressed to examine these localised interactions further (Mangel and Switzer, 1998), demonstrating the potential for fishery/predator interactions to occur.

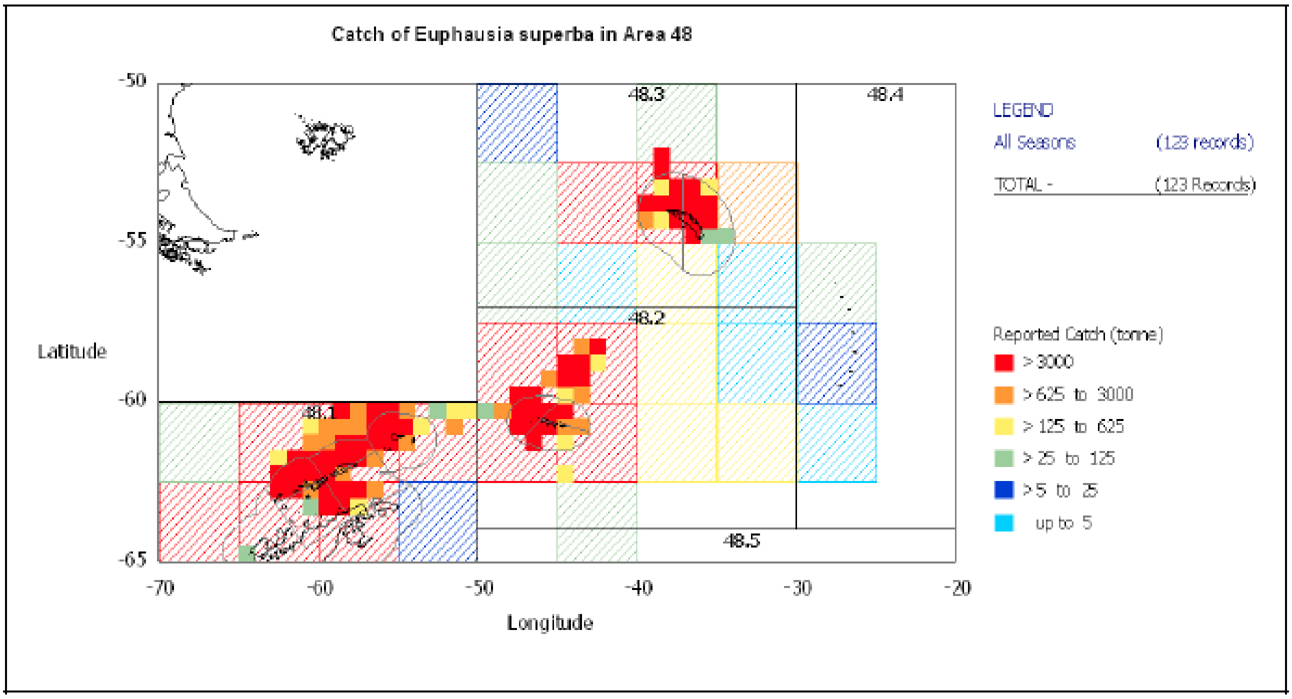


Figure 7: Localisation of krill catches (t) in Area 48 in all seasons, from CCAMLR EMM-08-05

Impacts of fluctuations in krill abundance on predators has been identified. Time series of Antarctic fur seals, black-browed albatrosses, gentoo penguins and macaroni penguins populations at South Georgia showed declines from 1980 to 2000 and an increase in the frequency of years with low reproductive success. Abundance of krill was apparently large enough to support predator demand in the 1980s, during which extensive fishing for the species occurred, but not in the 1990s (Reid & Croxall, 2001). The krill biomass index from the Antarctic Peninsula–South Shetland Islands region showed a decreased abundance, with consistent negative values, during the period 1988–1995 (Siegel et al. 1998), with concordant patterns of inter-annual changes in krill biomass at South Georgia and the Antarctic Peninsula–South Shetland Islands (Brierley et al., 1999). The increase in the frequency of negative predator-breeding performance over the predator time-series suggests an increase in the frequency of periods of low krill biomass (Reid & Croxall, 2001). While these changes show the impact of krill fluctuations on predator abundance, they cannot be explained by the impact of fishing alone (Koch et al., 2007). This is particularly true for South Georgia, where krill inter-annual variability may be greater due to the influences of water currents.

Studies have also linked periods of low krill abundance to lower fish condition and delays in gonadal maturation (e.g. in icefish; Everson, 2000). Mackerel icefish is both a predator of krill and an important prey component for predators, such as Antarctic fur seals and gentoo penguins (see Kock et al., 2007). The species shows highly variable recruitment, compounded by sporadic years with apparently higher natural mortality than normal, such as in 1990/1991, possibly due to poor feeding conditions and increased predation by Antarctic fur seals and other predators when the abundance of their preferred diet (krill) is low (Constable et al., 2000).

As noted in section 5.3, CCAMLR has begun the process of managing krill fisheries at the more localised scales of environment–prey–predator interactions. In 2001, CCAMLR agreed that the fishery for Antarctic krill in the southwest Atlantic should be managed through small scale management units (SSMU) that allowed for the spatial subdivision of the precautionary catch limit for krill in Area 48 (SC-CAMLR-XX). Subsequently, in 2002 a series of 15 SSMUs were described which were then endorsed by CCAMLR (SC-CAMLR-XXI; Constable 2002).

SSMUs were delineated using datasets that complemented each other (SC-CAMLR-XXI paragraphs

3.18), including an estimate of krill biomass derived from the CCAMLR 2000 Synoptic Survey (Hewitt et al. 2004), the distribution of krill harvesting effort, the spatial distribution of land-based predator colonies, estimates of land-based predator foraging ranges, and the spatial distribution of pelagic predators, particularly whales and fish. SSMUs were delineated for Subareas 48.1, 48.2 and 48.3; these comprised 12 shelf-based SSMUs and 3 pelagic SSMUs (see Figure 8). Work has continued on this development (e.g. Trathan et al., 2008; Trathan and Hill, 2008; Hill and Agnew, 2008) including initial proposals for allocating precautionary catch limits amongst the SSMUs of Area 48 (Hill et al., 2007; Trathan and Hill, 2008), using predator demand or krill standing stock (considered the primary approach) as the likely basis. They concluded that "WG-EMM cannot delay the subdivision of the precautionary catch limit without incurring some risk." CCAMLR Conservation Measure 51-01 (2008) states that 'the krill catches in Statistical Subareas 48.1, 48.2, 48.3 and 48.4 shall not exceed a set level, defined herein as a trigger level, until a procedure for division of the overall catch limit into smaller management units has been established, and that the Scientific Committee has been directed to provide advice on such a subdivision' SSMU-specific TAC levels would not be implemented until the trigger level of catches is achieved, and despite notifications to fish, recent catch levels have been far below that level.

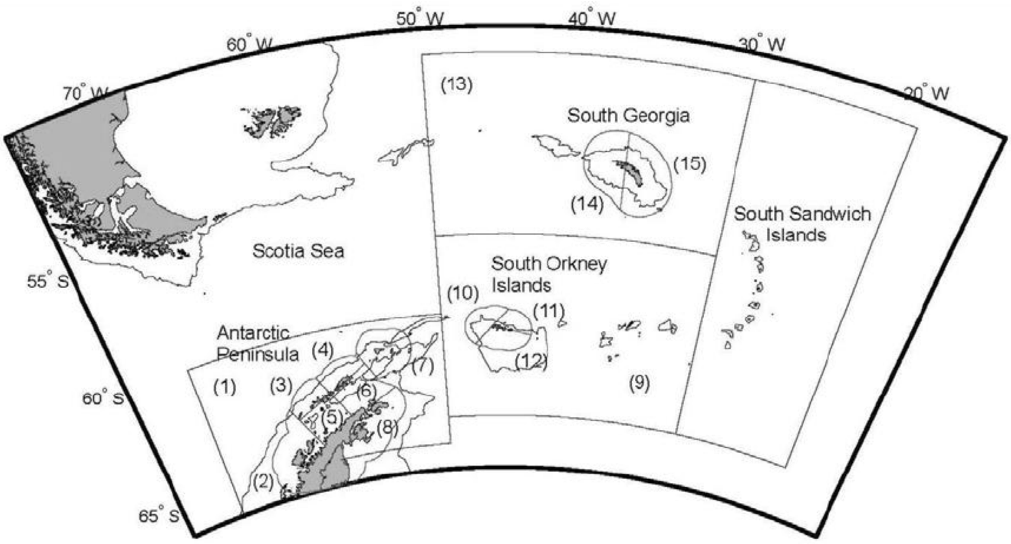


Figure 8: Small-scale management units (SSMUs) in subareas 48.1, 48.2 and 48.3 (Trathan et al., 2008)

Small-scale management units (SSMUs) in Subareas 48.1, 48.2 and 48.3 are displayed in Figure 8. Proposed SSMUs are: (1) Antarctic Peninsula Pelagic Area (APPA); (2) Antarctic Peninsula West (APW); (3) Drake Passage West (APDPW); (4) Drake Passage East (APDPE); (5) Bransfield Strait West (APBSW); (6) Bransfield Strait East (APBSE); (7) Elephant Island (APEI); (8) Antarctic Peninsula East (APE); (9) South Orkney Pelagic Area (SOPA); (10) South Orkney West (SOW); (11) South Orkney North East (SONE); (12) South Orkney South East (SOSE); (13) South Georgia Pelagic Area (SGPA); (14) South Georgia West (SGW); (15) South Georgia East (SGE). Note that SSRU APE extends partly into Subarea 48.5.

Management using SSMUs will require the localised mapping of krill catch and abundance, and the monitoring of impacts on predators from any localised depletions. Data on krill catches is collected at sufficient spatial detail to allow catches to be broken down by proposed SSMUs, as presented in CCAMLR (2008d) (see also Figure 8).

To meet CCAMLR Article II requirements, in order to maintain sound ecological relationships between krill and its predators, an operational understanding of different issues is needed. These include the effect of regional krill distribution and recruitment on availability, the impact of fishing on localised predator populations, etc. As noted above, site-specific information from the CEMP can be limited at specific sites within Area 48, in particular within subarea 48.1 (which it should be noted has a much higher density of sampling sites than the other two subareas of consideration within this certification). However, it should also be noted that the South Shetland Islands area is surveyed each austral summer by the US Antarctic Marine Living Resources Program, and the acoustic data are used to examine trends in krill biomass and to assess the potential impact of fishing to the reproductive success of land-based predators (seals and penguins) (Reiss et al., 2008).

Examining the potential impacts of krill fisheries on ecosystems

While the fishery under certification comprises only one vessel and fishing method, the overall impact of krill removals within Area 48 must be considered from an ecosystem perspective. In this sense, the current management trigger points for the krill fishery as a whole within Area 48 must be examined. CCAMLR has set precautionary levels for krill exploitation which as noted above, triggers management at SSMU level if breached. As noted under principle 1, the 2000 combined survey noted a krill biomass level across the Scotia Sea of 44.3 million tonnes, which was revised due to increased knowledge on krill acoustic target strength to 37 million tonnes (Hewitt et al., 2004; SC-CCAMLR, 2007). Using the GYM model, this gave a precautionary catch limit of ~3.45 million tonnes. However, a trigger level was put in place at 620,000 tonnes, which if breached requires the implementation of SSMU-specific TACs (CCAMLR CM 51-01(2008) para 3). This explicitly aims to take into account the requirements of krill predator species at regional and local geographic level. Given the well documented uncertainties within the ecosystem and krill food web, this trigger level must be sufficiently precautionary to sustain predator requirements at the global scale. The assumption here is that if this level was breached, the approach detailed in Trathan and Hill (2008) would also be applied in a sufficiently precautionary way to ensure impacts on local predator populations are avoided, and that plans were put in place to ensure that the reporting/observer system is sufficiently robust to enable the process to operate.

As noted by Trathan and Hill (2008), estimating predator requirements for krill results in highly variable values, given the potential for prey switching, variable coverage of species and areas, and abundance estimates. The estimate of total predation requirements derived by Hill et al. (2007) was 4 times that estimated by Hewitt et al. (2004), and even that estimate did not capture all predators within the system. The predator requirement estimate of 3,466,157 tonnes is approximately 10% of the biomass estimate from the combined krill survey in 2000. The trigger level for krill fishing is 18% of this predator requirement value, so total extractions are ~11% of the 2000 total biomass survey level (predator + fishery extractions at the precautionary trigger level).

There is no doubt that fluctuations in krill biomass can affect predator populations, as seen in the 1990s, which resulted from inter-annual fluctuations in recruitment. However, at noted under Principle 1, macro-level extractions appear to be at precautionary levels compared to the current anticipated levels of krill biomass. As noted above, future issues resulting from climate change must be considered, and would benefit from further surveys and research.

The issue of localised depletions is being addressed through the development of SSMUs and associated local-scale TACs. Hill et al. (2008) developed spatially-resolved reference points for the density of krill, and the abundance of “generic” seals, penguins and whales using the ecosystem models developed within CCAMLR, in order to tune the operating models.

Watters et al. (2008a) used this tuned FOOSA model to examine the impact of changes in krill abundance on their predators in the Scotia Sea. This model aimed to capture the key life history and predator-prey relationships, and was conditioned based upon the parameterisations developed in Hill et al. (2008). Four plausible parameterizations were developed, which implied ongoing trends in predator populations, and, in forward simulations, changes in abundance predicted from these ongoing trends will likely need to be separated from changes caused by krill fishing. This model was used to assess the risks and tradeoffs associated with various management strategies for subdividing the precautionary krill catch limit among SSMUs in Area 48 (Watters et al., 2008b). They noted that their results and conclusions were conditioned on the use of FOOSA and the set of four parameterizations developed by Watters et al. (2008a). Using the FOOSA model, Watters et al. examined a range of levels of krill extraction relative to the precautionary harvest rate (γ = ~3.45 million tonnes). The current trigger level for SSMUs would therefore be 0.15 of this level.

Consequences for predators depended upon the strategy taken to define SSMU-specific TAC levels, which are yet to be determined:

- Under **option 2** (precautionary catch limit subdivided on the basis of the spatial distribution of predator demand), the fishery must mostly operate in pelagic SSMUs, and predator populations were unlikely to be reduced by 75% of levels in the absence of fishing, when krill was fished at levels of 50% of the precautionary level (i.e. ~1.7 million tonnes); the risks of such depletion were, however, likely to increase as harvest rates increase beyond that level.
- Under **option 3** (precautionary catch limit subdivided on the basis of the spatial distribution of krill biomass), harvest rates up to those defined by the current trigger level (i.e., 0.15 x γ), implementation of Fishing Option 3 is unlikely to reduce predator populations to 75% or less of the abundances that might occur in the absence of fishing. As harvest rates are increased past that defining the current trigger level, the risks of depleting penguin and fish populations increase in some SSMUs.
- Fishing **option 4** (precautionary catch limit subdivided on the basis of the spatial distribution of krill biomass minus predator demand) would concentrate fishing in a few coastal SSMUs (particularly those in Subarea 48.2), resulting in increased risks of predator populations being reduced to 75% or less of abundances in the absence of fishing. In a few SSMUs, such risks occurred at harvest rates near (but greater than) that level defining the current trigger level.

They noted that some predator populations, in particular penguins, might struggle to recover if depleted, even in the absence of fishing for 20 years. This risk often increased rapidly as harvest rates increased past the rate defining the current trigger level.

Therefore, the simulations suggest that while the current trigger level for division of krill TACs into SSMUs appears ‘highly likely’ to result in the ecosystem remaining within biologically based limits, and that current fishing levels (being 0.03 γ) further minimised those risks, further study is needed to appropriately define SSMU-scale TAC levels and overall TAC limits. As noted by Leape et al. (2009), Option 1, which assumes the current distribution of catches continues at the higher level, resulted in impacts on the predator population in earlier ecosystem simulation runs, and was hence abandoned for further analysis. This represents an implicit acknowledgement that action on SSMU specific quotas must occur once the precautionary trigger level is reached. While the current certification has taken the position that the fishery can be considered for certification up to the trigger level, it is clear that an agreed approach to devising SSMU-level quotas is needed before moving beyond that point.

7 OTHER FISHERIES AFFECTING TARGET STOCK

There are up to ten vessels which may target the krill stock within Area 48. Only one of these, the Saga Sea, is an Aker BioMarine vessel. Other krill fishery vessels are from countries such as Poland, Chile, Ukraine, Russia and Chile and all are subject to CCAMLR controls and are not included within this certification assessment.

Other trawl fisheries operating within CCAMLR Area 48 which may affect krill include the South Georgia mackerel icefish and the South Georgia toothfish fisheries. The latter of these two fisheries has already been MSC certified and is currently undergoing a re-assessment. The Mackerel icefish fishery is presently undergoing a main assessment for MSC certification.

8 STANDARD USED

The MSC Principles and Criteria for Sustainable Fisheries form the standard against which the fishery is assessed and are organised in terms of three principles. Principle 1 addresses the need to maintain the target stock at a sustainable level; Principle 2 addresses the need to maintain the ecosystem in which the target stock exists, and Principle 3 addresses the need for an effective fishery management system to fulfil Principles 1 and 2 and ensure compliance with national and international regulations. The Principles and their supporting Criteria are presented below.

Principle 1
A fishery must be conducted in a manner that does not lead to over-fishing or depletion of the exploited populations and, for those populations that are depleted, the fishery must be conducted in a manner that demonstrably leads to their recovery. [1]**:**

The intent of this principle is to ensure that the productive capacities of resources are maintained at high levels and are not sacrificed in favour of short term interests. Thus, exploited populations would be maintained at high levels of abundance designed to retain their productivity, provide margins of safety for error and uncertainty, and restore and retain their capacities for yields over the long term.

Criteria:

1. The fishery shall be conducted at catch levels that continually maintain the high productivity of the target population(s) and associated ecological community relative to its potential productivity.
2. Where the exploited populations are depleted, the fishery will be executed such that recovery and rebuilding is allowed to occur to a specified level consistent with the precautionary approach and the ability of the populations to produce long-term potential yields within a specified time frame.
3. Fishing is conducted in a manner that does not alter the age or genetic structure or sex composition to a degree that impairs reproductive capacity.

Principle 2
Fishing operations should allow for the maintenance of the structure, productivity, function and diversity of the ecosystem (including habitat and associated dependent and ecologically related species) on which the fishery depends.

The intent of this principle is to encourage the management of fisheries from an ecosystem perspective under a system designed to assess and restrain the impacts of the fishery on the ecosystem.

Criteria:

[1] The sequence in which the Principles and Criteria appear does not represent a ranking of their significance, but is rather intended to provide a logical guide to certifiers when assessing a fishery. The criteria by which the MSC Principles will be implemented will be reviewed and revised as appropriate in light of relevant new information, technologies and additional consultations

1. The fishery is conducted in a way that maintains natural functional relationships among species and should not lead to trophic cascades or ecosystem state changes.

2. The fishery is conducted in a manner that does not threaten biological diversity at the genetic, species or population levels and avoids or minimises mortality of, or injuries to endangered, threatened or protected species.

3. Where exploited populations are depleted, the fishery will be executed such that recovery and rebuilding is allowed to occur to a specified level within specified time frames, consistent with the precautionary approach and considering the ability of the population to produce long-term potential yields.

Principle 3
The fishery is subject to an effective management system that respects local, national and international laws and standards and incorporates institutional and operational frameworks that require use of the resource to be responsible and sustainable.

The intent of this principle is to ensure that there is an institutional and operational framework for implementing Principles 1 and 2, appropriate to the size and scale of the fishery.

A. Management System Criteria:

1. The fishery shall not be conducted under a controversial unilateral exemption to an international agreement.

The management system shall:

2. Demonstrate clear long-term objectives consistent with MSC Principles and Criteria and contain a consultative process that is transparent and involves all interested and affected parties so as to consider all relevant information, including local knowledge. The impact of fishery management decisions on all those who depend on the fishery for their livelihoods, including, but not confined to subsistence, artisanal, and fishing-dependent communities shall be addressed as part of this process.

3. Be appropriate to the cultural context, scale and intensity of the fishery – reflecting specific objectives, incorporating operational criteria, containing procedures for implementation and a process for monitoring and evaluating performance and acting on findings.

4. Observe the legal and customary rights and long term interests of people dependent on fishing for food and livelihood, in a manner consistent with ecological sustainability.

5. Incorporates an appropriate mechanism for the resolution of disputes arising within the system[2].

6. Provide economic and social incentives that contribute to sustainable fishing and shall not operate with subsidies that contribute to unsustainable fishing.

7. Act in a timely and adaptive fashion on the basis of the best available information using a precautionary approach particularly when dealing with scientific uncertainty.

[2] Outstanding disputes of substantial magnitude involving a significant number of interests will normally disqualify a fishery from certification.

8. Incorporate a research plan – appropriate to the scale and intensity of the fishery – that addresses the information needs of management and provides for the dissemination of research results to all interested parties in a timely fashion.

9. Require that assessments of the biological status of the resource and impacts of the fishery have been and are periodically conducted.

10. Specify measures and strategies that demonstrably control the degree of exploitation of the resource, including, but not limited to:

    a) setting catch levels that will maintain the target population and ecological community's high productivity relative to its potential productivity, and account for the non-target species (or size, age, sex) captured and landed in association with, or as a consequence of, fishing for target species;
    b) identifying appropriate fishing methods that minimise adverse impacts on habitat, especially in critical or sensitive zones such as spawning and nursery areas;
    c) providing for the recovery and rebuilding of depleted fish populations to specified levels within specified time frames;
    d) mechanisms in place to limit or close fisheries when designated catch limits are reached;
    e) establishing no-take zones where appropriate.
11. Contains appropriate procedures for effective compliance, monitoring, control, surveillance and enforcement which ensure that established limits to exploitation are not exceeded and specifies corrective actions to be taken in the event that they are.

B. Operational Criteria

Fishing operation shall:

12. Make use of fishing gear and practices designed to avoid the capture of non-target species (and non-target size, age, and/or sex of the target species); minimise mortality of this catch where it cannot be avoided, and reduce discards of what cannot be released alive.

13. Implement appropriate fishing methods designed to minimise adverse impacts on habitat, especially in critical or sensitive zones such as spawning and nursery areas.

14. Not use destructive fishing practices such as fishing with poisons or explosives;

15. Minimise operational waste such as lost fishing gear, oil spills, on-board spoilage of catch etc.

16. Be conducted in compliance with the fishery management system and all legal and administrative requirements.

17. Assist and co-operate with management authorities in the collection of catch, discard, and other information of importance to effective management of the resources and the fishery.

9 BACKGROUND TO THE EVALUATION

9.1 Evaluation Team

Lead Assessor: Andrew Hough: Moody Marine Limited. Dr Hough has a PhD in marine ecology from the University of Wales, Bangor and fourteen years post-doctoral experience in commercial marine and coastal environmental management projects. He is manager of Moody Marine operations within Moody International Certification with particular responsibility for the implementation of MSC Certification procedures and development of MSC methodologies. Dr. Hough has acted as lead assessor on the majority of Moody Marine MSC pre assessments and main assessments.

Project Coordinator: Seran Davies: Moody Marine Limited. Seran is a qualified marine biologist with eight years direct experience of marine environmental management and assessment, including fishery evaluations and EIA of developments in marine and freshwater environments.

Expert advisor: Paul Medley. Paul is an independent fisheries consultant, based in the UK. His expertise includes mathematical modelling of fisheries and ecological systems, techniques for multispecies stock assessment and external review of stock assessment methodologies. He has been an invited expert for a number of stock assessment working group meetings. He has a wide practical experience in marine biology, including design and implementation of surveys and fisheries experiments. This includes addressing wider environmental issues of ecological management, including maintenance of marine biodiversity. He has also taken part in the MSC assessment of the South Georgia Patagonian Toothfish fishery and has worked with MSC on new methodology developments.

Expert advisor: Graham Pilling. Graham is a Fisheries Biologist & Advisor and Head of the Seas and Oceans Group with the Centre for Environment, Fisheries and Aquaculture Science (Cefas), UK. His experience includes working in tropical, temperate and polar marine and freshwater ecosystems, gaining in depth experience in the practical assessment and management of pelagic and demersal fisheries through a wide range of methodologies. He has chaired FAO GFCM and EU STECF SGMED stock assessment meetings on demersal species in the Mediterranean, and has been an expert reviewer for a number of US stock assessments. He has developed and implemented models to simulate the long-term impacts of uncertainty in stock biology and assessments on fisheries management, and methods to assess and manage data poor fisheries. He has also taken part in the MSC assessment of a wide range of fisheries, concentrating on Principle 2 (environment and ecosystem) issues.

Expert Advisor: Andy Payne. Andy is currently employed by Cefas as an international fisheries consultant, but for a few years at Cefas he was also Science Area Head: Fisheries Management. Previously (to 2000) he was Director of the Sea Fisheries Research Institute in South Africa (now Marine & Coastal Management). Although his primary research interest there was groundfish, more specifically hake, he was involved in management advice for all stocks and species at a high level. He has much experience in fishery-independent surveying, and scientific stock assessment and management advice. From 1982 to 1989, he attended the International Commission for the SE Atlantic Fisheries as South African representative and for several years was chairman of that organisation’s Standing Committee on Stock Assessment. Over the years too, he has provided review input to the Argentine hake fishery, to several US stock assessment and review panels (various species and stocks), and has advised SADSTIA, Cape Town, on issues relating to management of their MSC-accredited hake fishery in line with a specific condition of certification. He is also an internationally respected scientific editor, currently Editor-in-Chief of the ICES Journal of Marine Science, and has written/edited several technical and coffee-table books on marine resources.

9.2 Previous certification evaluations

The fishery has not been previously assessed against the MSC standard.

9.3 Inspections of the Fishery

Inspection of the fishery focused on the practicalities of fishing operations, the mechanisms and effectiveness of management agencies and the scientific assessment of the fisheries.

Meetings were held as follows (some of the key issues discussed have been identified for each meeting):

Name	Affiliation	Date	Key Issues
Simon Wadsworth Webjorn Eikrem Sigve Nordrum	Aker BioMarine	19/01/09	Fishing operations
Nina Jensen	WWF Norway	19/01/09	Ecosystem Interactions
Karsten Klepsvik	Norwegian Ministry of Foreign Affairs (CCAMLR Representative)	19/01/09	CCAMLR management
Aksel Ekemor Havard Holder Terje Lobach Svein Iversen	Fiskeridirektorate (Norway) Institute of Marine Research (Norway)	20/01/09	Scientific assessment of fishery Ecosystem interactions and management effectiveness
John Pearce	MRAG	12/02/09	Fishery science and research. Management effectiveness
Richard Page, Paul Johnstone Sian Prior Emily Howgate	Greenpeace WWF Seafood choices council	12/02/09	Ecosystem interactions and management effectiveness

10 STAKEHOLDER CONSULTATION

10.1 Stakeholder Consultation

A total of 38 stakeholders were identified and consulted specifically by Moody Marine. Information was also made publicly available at the following stages of the assessment:

Date	Purpose	Media
10/10/08	Announcement of assessment	Direct E-mail/letter Notification on MSC website Advertisement in press
22/10/08	Notification of Assessment Team nominees	Direct E-mail Notification on MSC website
4/11/08	Notification of intent to use MSC FAM Standard Assessment Tree	Direct E-mail Notification on MSC website
19/12/08	Notification of assessment visit and call for meeting requests	Direct E-mail Notification on MSC website
19/01/09	Assessment visit	Meetings
10/06/09	Notification of Proposed Peer Reviewers	Direct E-mail Notification on MSC website

Date	Purpose	Media
6/08/09	Notification of Public Draft Report	Direct E-mail Notification on MSC website
November 2009	Notification of Final Report	Direct E-mail Notification on MSC website

10.2 Stakeholder Issues

In addition to the meetings listed above, several written submissions were also received by the assessment team. Substantive submissions have been appended to this report within Appendix D and can be summarised as follows:

Appendix D.1 Johnston, P., Santillo, D., Page, R. and Dorey, C. (2009). Gambling with Krill Fisheries in the Antarctic: Large uncertainties equate with high risks. Greenpeace Research Laboratories Technical Note 01/2009. 12th February 2009. School of Biological Sciences, University of Exeter.

Appendix D.2 Leape, G., Gascon, V., Werner, R., Pearl, A. Fischer, M. (2009) Analysis on the Eligibility of Aker BioMarine's Krill Fishery Operations for MSC Certification Rationale in Regards to a Number of Performance Indicators that are not Achieving the Minimum SG 60 Necessary for MSC Certification. Antarctic Krill Conservation Project (AKCP) The Pew Environment Group Washington, DC - USA March, 19, 2009. Unpublished Document.

Appendix D.3 WWF. February 2009. MSC Fisheries Assessment: Antarctic krill Fishery. WWF Position Paper. February 2009. Contacts: Rob Nicoll (Antarctic & Southern Ocean initiative Manager) and Nina Jensen (Head of Conservation department, WWF-Norway).

Specific points arising from these submissions, which have been expressly considered by the assessment team, are reproduced below:

Catch limits
(WWF) There is support for the interim catch level for Area 48 of 620,000 tonnes and this must remain in place until CCAMLR has adopted an adaptive feedback management system that not only divides the catch limit into SSMU's but is flexible enough to respond to ongoing monitoring.
(PEW) CCAMLRs harvest strategy for krrill is based upon biomass estimates that are subject to an enormous degree of uncertainty.
There is also uncertainty as to the amount of krill actually being removed from the ecosystem. Uncertainty as to the krill caught in different areas hinders CCAMLRs ability to limit catches as the catch limit is approached.

Ecosystem fragility/impacts
(Greenpeace) There are massive uncertainties with regard to krill biology, krill population dynamics and its role within the wider ecosystem.
(PEW) The fishery targets the core of the Antarctic food web; consequently the fishery has the potential to undermine the key role of krill in the ecosystem structure and function, thus causing irreversible harm. Krill fishing catches are concentrated in areas of high krill productivity and availability, which are key for maintaining the balance of the ecosystem.

Bycatch
(WWF) There are concerns about the unknown impacts of the Aker BioMarine technology on the Antarctic marine ecosystem, especially in relation to the bycatch of marine larvae.
(PEW) The impact of bycatch of marine fish larvae by the krill fishery is unknown and no mitigation measures are in place. Sampling by research vessels in South Georgia identified bycatch of finfish species occurring in large numbers in krill trawls. At the CCAMLR 2008 meeting, the Scientific Committee noted that there is still uncertainty over the level of bycatch of juveniles and larval fish in the krill catch over all seasons and areas in which the krill fishery operates.

Predator conflict
(WWF) For the fishery to be certified it must demonstrate that there is no significant localised impact on predator populations and ensure that fishing effort is well-dispersed to avoid conflict and competition with krill predators at a local scale.

(Greenpeace) The management of krill is effected using a model which has a limited capacity to respond to variables and this has not been fully developed in relation to krill dependent predators to any meaningful degree.

(PEW) For many marine mammals and sea birds, krill is the most abundant food source. Areas of highest krill concentration are often close to land based breeding colonies of krill-eating birds and seals. It is precisely these areas where the krill fishery is currently targeted. Recent studies have shown significant relationships between the relative abundance of humpback and minke whales, increasing krill abundance, and certain physical features which may aid in prey aggregation off the Antarctic Peninsula. Changes in predator populations concurrent to observed decreases in krill biomass have been documented such as extreme variation in reproductive output for krill-dependent top predators breeding at South Georgia in relation to annual krill availability.

Management
(WWF) It is essential that Aker BioMarine krill fishery contributes with information related to how the fishing effort is distributed according to the proposed SSMUs and in relation to predator distribution to be able to conclude on potential localised impacts of the krill fishery.

(Greenpeace) CCAMLRS's existing management plan cannot be considered precautionary.

(PEW) There is still a considerable degree of uncertainty in relation to krill fisheries management. CCAMLR need to address these uncertainties as a matter of priority in order to make the allocation of catch limits amongst SSMUs a key component to prevent irreversible harm to the ecosystem.

Climate Change
(PEW) The Antarctic ecosystem is already being impacted by climate change. The Antarctic Peninsula, where major krill spawning and nursery areas are located (and also an area where fishing is concentrated), is one of the world's fastest warming areas. Consequences on krill populations that are not yet well understood, nonetheless, there is already evidence of direct consequences for krill stocks through the loss of sea ice.

(WWF) Krill management must be flexible and adaptive in order to allow rapid adjustments as new information on the impacts of climate change becomes available. Failure to do so could mean that the current management may prove to be inadequate as changes in seasonality, food availability and migration result in changes in krill stocks that could not have been foreseen under non-climate change scenarios. The fishery must have in place mechanisms to cope and respond to these matters.

(Greenpeace) Climate change impacts are not specifically accommodated by the management model.

MPAs
(WWF) All fisheries within Area 48 must be cognizant of the likelihood of the establishment of a network of MPAs within the area in the near future. These fisheries must be supportive of the need to include networks of MPAs in the delivery of ecosystem-based management in the region.

These issues raised by the stakeholders have been considered throughout the assessment and have all been specifically addressed in the report and considered in the scoring commentary.

Following the MSC procedure of stakeholder consultation; on completion of the peer review, the Public Draft assessment report was submitted for stakeholder review. The review period was from July to August 2009 with a further extension granted until September 20th 2009 in response to stakeholder request. On completion of this period comments on the Antarctic krill certification assessment report were received from the following:

- The Monterey Bay Aquarium and New England Aquarium. Comments submitted by Edward Cassano- Senior Director, Department of Conservation Outreach, Monterey Bay Aquarium.

- Norwegian College of Fishery Science, University of Tromsø, Norway. Comments submitted by Professor Ola Flaaten- Department of Economics and Management.

- Antarctic and Southern Ocean Coalition (ASOC). Comments submitted by James Barnes-Executive Director, ASOC.

- Pew Environmental Group's Antarctic Krill Conservation Project (AKCP). Comments submitted by Gerald Leape, Rodolfo Werner, Virginia Gascon, Micaela Fischer and Andi Pearl.

- Pew Coordinated Response. Comments were also received from a coalition of scientists (referred to from here on in as Pew Coordinated Response). The individual scientists providing input were as follows:

Name	Association
Dr. Pablo G. Borboroglu	Researcher, National Research Council of Argentina (CONCIET), Argentina. Visiting Scientist, University of Washington, USA.
Dr. Villy Christensen	Associate Professor, University of British Columbia Fisheries Science Centre, Canada.
Dr. Phaedra Doukakis	Senior Research Scientist, Institute for Ocean Conservation Science, Stony Brook University, USA.
Dr. James Estes	Professor of Ecology and Evolutionary Biology, Director, STEPS Institute, University of California, Santa Cruz, USA.
Dr. Exequiel Ezcurra	Director, University of California Institute for Mexico and the United States (UC MEXUS). Professor of Ecology, University of California, Riverside, USA.
Dr. Les Kaufman	Professor of Biology, Boston University. Associate Director, Boston University Marine Program, USA.
Dr. Patricia Majluf	Director of the Centre for Environmental Sustainability (CSA), Cayetano Heredia University, Peru.
Dr. Enric Sala	Spanish National Council for Scientific Research (CSIC), Spain.
Dr. Jarrod Santora	Researcher, Farallon Institute for Advanced Ecosystem Research, USA.

Dr. Enriqueta Velarde	Researcher, Labatorio de Ecologi-a de Aves Marinas, Unidad de Investigacion de Ecologia y Pesquerias, Universidad Veracruzana, Mexico

The five sets of comments received from the above are presented within Appendix E. Moody Marine's responses to these comments are also presented within Appendix E.

11 OBSERVATIONS AND SCORING

11.1 Introduction to scoring methodology

The MSC Principles and Criteria set out the requirements of certified fishery. These Principles and Criteria have been developed into a standard (Fishery Assessment Methodology) assessment tree - Performance Indicators and Scoring Guideposts - by the MSC, which is used in this assessment.

The Performance Indicators (PIs) have been released on the MSC website. In order to make the assessment process as clear and transparent as possible, each PI has three associated Scoring Guideposts (SGs) which identify the level of performance necessary to achieve 100, 80 (a pass score), and 60 scores for each Performance Indicator; 100 represents a theoretically ideal level of performance and 60 a measurable shortfall.

For each Performance Indicators, the performance of the fishery is assessed as a 'score'. In order for the fishery to achieve certification, an overall weighted average score of 80 is necessary for each of the three Principles and no Indicator should score less than 60. As it is not considered possible to allocate precise scores, a scoring interval of five is used in evaluations. As this represents a relatively crude level of scoring, average scores for each Principle are rounded to the nearest whole number.

Weights and scores for the Fishery are presented in the scoring table (Appendix A).

12 LIMIT OF IDENTIFICATION OF LANDINGS FROM THE FISHERY

Traceability

The Saga Sea is a 100% krill vessel only participating in the Antarctic Krill fishery in CCAMLR, area 48 including South Georgia. The vessels do not participate in any other fisheries. Traceability provisions are considered as being excellent with VMS (satellite) data provided continuously during the fishing operations of Aker BioMarine to the Norwegian authorities and CCAMLR. In the rare cases where the signal from the vessel is temporarily lost, the information can subsequently be recovered because all data are stored automatically on board. Aker BioMarine also adheres fully to the principle of allowing non-national observers on its vessel at all times. Catch reporting of amount and location is provided to the Norwegian authorities and CCAMLR and all products from the fishery display the coordinates of catch, catch date and the vessel (Saga Sea) license number.

At-Sea processing
On board the vessel the krill catch is processed to a krill meal or a frozen krill paste. It is bagged in sacks which clearly state that they contain krill from the vessel Saga Sea and also display the license number of the vessel. All krill products are marketed as 100% krill products and no other products, are produced by the vessel with all products being labelled accordingly.

Once landed further processing for products for human consumption may occur with krill oil being produced by extraction from the krill meal as well as the production of a krill high omega 3 powder from the drying of the krill paste.

All products from the fishery are labelled with an identification key which is traceable all the way to the end user. This identification key includes the catch coordinates of the krill, vessel license number (Saga Sea), catch date and production date.

Points of Landing
An Aker BioMarine owned and controlled tramper vessel transloads the krill products from the Saga Sea (no other vessels) and transports the products from the fishing grounds to Aker BioMarine's facility in Nueva Palmira close to Montevideo, Uruguay. Products from here are transported directly to the processing plant (to be further processed into human Omega 3 products) or to the end customer (meal to feed customers). Products are then transported from Uruguay to Norwegian customers using conventional shipping lines. At the end of the krill season the Saga Sea will land its last trip in Uruguay.

Eligibility to enter Chain of Custody
As stated above, all products from the fishery are easily identifiable back to the catch date, location, vessel and production date (through the identification key) making it easy to accurately differentiate catches which have been determined as being eligible for entering the chain of custody from the certified fishery. The Target Eligibility date for this fishery is 31st May 2009.

13 ASSESSMENT RESULTS

The Performance of the Fishery in relation to MSC Principles 1, 2 and 3 is summarised below:

MSC Principle	Fishery Performance
Principle 1: Sustainability of Exploited Stock	Overall : **84 PASS**
Principle 2: Maintenance of Ecosystem	Overall : **90 PASS**
Principle 3: Effective Management System	Overall : **93 PASS**

The fishery attained a score of 80 or more against each of the MSC Principles and did not score less than 60 against any Indicators. It is therefore recommended that the Aker BioMarine Antarctic Krill Pelagic Trawl Fishery be certified according to the Marine Stewardship Council Principles and Criteria for Sustainable Fisheries.

Following this Recommendation of the assessment team, and review by stakeholders and peer reviewers, a determination is hereby made by the Moody Marine Governing Board to certify this fishery.

The scoring was carried out on the basis of the catch trigger level (as set by CCAMLR) of 620 000 t not being exceeded. Thus current performance of the fishery meets the requirements of the MSC standard. However, should catches approach and reach this trigger level it is recommended that an audit should be generated in order to review the fishery's performance against the MSC standard at this level of exploitation. This audit would be additional to the required annual surveillance audits and would necessitate a close review of the performance indicators, including an assessment to ensure that the actual management responses expected at such a level of exploitation are commensurate with intentions and that the identified Principle 2 impacts at a higher level of exploitation are within defined limits.

13.1 Conditions

As a standard requirement of the MSC certification methodology, the fishery shall be subject to (as a minimum) annual surveillance audits. These audits shall be publicised and reports made publicly available.

The fishery attained a score of below 80 against 3 Performance Indicators. The assessment team has therefore set conditions for continuing certification that the client for certification is required to address. The conditions are applied to improve performance to at least the 80 level within a period set by the certification body but no longer than the term of the certification.

As a standard condition of certification, the client shall develop an 'Action Plan' for Meeting the Conditions for Continued Certification', to be approved by Moody Marine.

The conditions are associated with 2 key areas of performance of the fishery. The Conditions, associated timescales and relevant Scoring Indicator are set out below.

Condition 1. Limit and Target Reference Points

Although there are limit and target reference points, there are no reference points consistent with the more precautionary Harvest Control Rule catch trigger level (interpreted here as the Precautionary Upper Catch Level (PUCL)) of 620 000t.

Action required:
Estimate the precautionary fishing mortality and biomass levels consistent with the catch trigger level of 620 000t and (as this is a low trophic level species) assess the associated risk of over fishing according to the predator and recruitment criteria.

Timescale: Within one year of certification.

Relevant Scoring Indicators: 1.1.2

Condition 2. Larval fish catch

Larval fish catch within all fisheries for Antarctic krill is expected, although the Aker BioMarine fishing method allows this amount to be measured. At the current level of catch, the rate of larval fish capture is not likely to place species beyond biologically based limits or hinder recovery and rebuilding of depleted species. However, this has not been demonstrated with appropriate scientific rigour.

Action required: Assess the risk that the main retained species are beyond biologically based limits as a result of larval fish catch at current and trigger levels; concentrating on *C.gunnari* and *N.rossii* but with consideration for other species which may be of concern.

If the risk is unacceptable a strategy should be tested and then implemented which would be expected to maintain the fish species at levels which are highly likely to be within biologically based limits or to ensure the krill fishery does not hinder their recovery and rebuilding.

Timescale: The risk assessment must be completed within 2 years from certification. If required, the strategy must be implemented within 4 years from certification.

Relevant Scoring Indicators: 2.1.1, 2.1.2

In addition to the above two conditions set by the assessment team for the fishery, the client has agreed with a stakeholder for an additional voluntary condition to be put in place for the fishery.

Condition 3. Additional Voluntary Condition – SSMUs and Krill-Predator Interactions

SSMUs. If the fishery expands beyond current catch trigger levels (620 000 mt) then SSMUs, as defined by CCAMLR, must be introduced within two years of expansion beyond the trigger levels or (in the absence of other relevant and compelling information) the certification will be voluntarily withdrawn.

Krill-Predator Interactions. Within 12 months of certification, the Aker BioMarine krill fishery will develop a comprehensive research programme to map their fishing operations in relation to information on predator distribution and abundance to help to address the key uncertainties associated with the relationship between krill biomass and predator populations.

Relevant Scoring Indicator: N/A

13.2 Recommendations

The following recommendations have been made by the Assessment team associated with the Antarctic krill fishery certification:

Recommendation 1

To ensure consistency with the practice of other CCAMLR fisheries, it is recommended by the expert team that the following be implemented within the krill fishery:

- Reporting rate should be increased from 10 days to 5 days as the 80% level is approached.
- VMS should be mandatory on all vessels
- International observers should be mandatory on all vessels

Recommendation 2

In its current form, it is considered by the assessment team that the notification system fails to serve any fishery management purpose. It is recommended that this be sufficiently improved so as to provide a beneficial fishery management tool.

Recommendation 3

The scoring was carried out on the basis of the catch trigger level of 620 000 t not being exceeded. Thus current performance of the fishery meets the requirements of the MSC standard, but the following points are considered by the assessment team as areas where performance could be further improved:

- Should allowed catches exceed 620 000 t then appropriate reference points, harvest control rules, ecosystem evaluations and monitoring information to support them should be implemented.

- With respect to ecosystem impacts of fishing there should be an evaluation of SSMU specific harvest control rules using the CEMP monitoring data.

APPENDICES

Appendix A: Scoring Tables

SCORING CRITERIA	SCORING GUIDEPOST 60	SCORING GUIDEPOST 80	SCORING GUIDEPOST 100

Principle 1	A fishery must be conducted in a manner that does not lead to over-fishing or depletion of the exploited populations and, for those populations that are depleted, the fishery must be conducted in a manner that demonstrably leads to their recovery.

1.1	Management Outcomes:

1.1.1	**Stock Status**: The stock is at a level which maintains high productivity and has a low probability of recruitment overfishing	It is likely that the stock is above the point where recruitment would be impaired.	It is highly likely that the stock is above the point where recruitment would be impaired. The stock is at or fluctuating around its target reference point.	There is a high degree of certainty that the stock is above the point where recruitment would be impaired. There is a high degree of certainty that the stock has been fluctuating around its target reference point, or has been above its target reference point, over recent years.

Scoring Comments
There is a high degree of certainty that the stock is above the point where recruitment would be impaired. There is a high degree of certainty that the stock is above the point where recruitment would be impaired. The catch is considered well below the designated trigger level which is set at the point where potentially catches would begin to have an impact on the stock. **There is a high degree of certainty that the stock has been fluctuating around its target reference point, or has been above its target reference point, over recent years.** There is a high degree of certainty that the stock has been above its target reference point over recent years. The current catches are lower than they were 10-20 years ago, and have never exceeded the current trigger level. Catches have been low enough that there is a high degree of certainty that the stock is well above target and limit reference points. Given the current low market value of krill and difficulties of processing, IUU fishing is considered negligible. While there is some uncertainty associated with the way catches are measured and reported, these do not threaten the current stock status.
Score: 100
Audit Trace References
WGEMM, 2000; WGEMM, 2007; WGEMM, 2008; WG-EMM-08/5; WG-EMM-07/5

SCORING CRITERIA		SCORING GUIDEPOST 60	SCORING GUIDEPOST 80	SCORING GUIDEPOST 100
1.1.2	**Reference Points:** Limit and target reference points are appropriate for the stock.	Generic limit and target reference points are based on justifiable and reasonable practice appropriate for the species category.	Reference points are appropriate for the stock and can be estimated. The limit reference point is set above the level at which there is an appreciable risk of impairing reproductive capacity. The target reference point is such that the stock is maintained at a level consistent with B_{MSY} or some measure or surrogate with similar intent or outcome. For low trophic level species, the target reference point takes into account the ecological role of the stock.	Reference points are appropriate for the stock and can be estimated. The limit reference point is set above the level at which there is an appreciable risk of impairing reproductive capacity following consideration of relevant precautionary issues. The target reference point is such that the stock is maintained at a level consistent with B_{MSY} or some measure or surrogate with similar intent or outcome, or a higher level, and takes into account relevant precautionary issues such as the ecological role of the stock with a high degree of certainty.

Scoring Comments

Generic limit and target reference points are based on justifiable and reasonable practice appropriate for the species category.

Generic limit and target reference points are based on justifiable and reasonable practice appropriate for the species category. For the purposes of this assessment, the reference points are those used in the harvest control rule to set the catch limit. The reference points are used in a probabilistic decision rule and, within this context, are precautionary. The reference points have not been estimated due to the lack of relevant information, but are based on standard definitions of reference points and should be appropriate for a relatively fast growing species like krill.

The limit reference point is set above the level at which there is an appreciable risk of impairing reproductive capacity.

The limit reference point is set above the level at which there is an appreciable risk of impairing reproductive capacity. The biomass limit reference point is 20% of the unexploited spawning stock biomass, which is a generic reference point, but appropriate considering the stock is lightly fished and there is an on-going research programme. Without a specific stock recruitment relationship, reference points of this type are good practice. Although 20% of the unexploited SSB is not necessarily a very precautionary limit reference point, the risk-based decision rule uses this value in a precautionary way. The harvesting rate (i.e. fishing mortality) is limited to a level ensuring that there is a low risk the stock will fall below the limit point.

The target reference point is such that the stock is maintained at a level consistent with B_{MSY} or some measure or surrogate with similar intent or outcome The target reference point is such that the stock is maintained at a level consistent with B_{MSY}. The target reference point is set at a precautionary level in relation to a proxy B_{MSY}. The overriding concern for this stock is its ecological role; additional biomass above the MSY point is reserved for predation. **For low trophic level species, the target reference point takes into account the ecological role of the stock.** The target reference point takes into account the ecological role of the stock. Krill is a low trophic level species, and is the main prey for a large number of species in the Antarctic. The reference point to protect the biomass available for krill predators is based upon maintaining spawning biomass at or above 75% of the spawning level. This is treated like a target reference point in the decision rule. The 75% level is not based on the species biology, and may be updated based new research and ecosystem models being developed. The TAC trigger point for the catch is considered as part of the harvest control rule (see 1.2.2).
Score: 70
A score of 70 means that a condition has been raised- refer Condition 1.
Audit Trace References
WGEMM, 2000; WGEMM, 2007; WGEMM, 2008; Miller, 2003; WG-EMM-08/5

SCORING CRITERIA		SCORING GUIDEPOST 60	SCORING GUIDEPOST 80	SCORING GUIDEPOST 100
1.1.3	**Stock Rebuilding:** Where the stock is depleted, there is evidence of stock rebuilding.	Where stocks are depleted rebuilding strategies which have a reasonable expectation of success are in place. Monitoring is in place to determine whether they are effective in rebuilding the stock within a specified timeframe.	Where stocks are depleted rebuilding strategies are in place. There is evidence that they are rebuilding stocks, or it is highly likely based on simulation modelling or previous performance that they will be able to rebuild the stock within a specified timeframe.	Where stocks are depleted, strategies are demonstrated to be rebuilding stocks continuously and there is strong evidence that rebuilding will be complete within the shortest practicable timeframe.

Scoring Comments
Not applicable as the krill stock in Area 48 is not depleted. CCAMLR has predefined rules for recovery of depleted stocks so that if the stock was ever deemed to be depleted a rebuilding plan would be developed and implemented within the CCAMLR framework.
Score: N/A
N/A
Audit Trace References
WGEMM, 2000; WGEMM, 2007; WGEMM, 2008

SCORING CRITERIA	SCORING GUIDEPOST 60	SCORING GUIDEPOST 80	SCORING GUIDEPOST 100

1.2	**Harvest Strategy (management)**

1.2.1	Harvest Strategy: There is a robust and precautionary harvest strategy in place	The harvest strategy is expected to achieve stock management objectives reflected in the target and limit reference points. The harvest strategy is likely to work based on prior experience or plausible argument. Monitoring is in place that is expected to determine whether the harvest strategy is working.	The harvest strategy is responsive to the state of the stock and the elements of the harvest strategy work together towards achieving management objectives reflected in the target and limit reference points. The harvest strategy may not have been fully tested but monitoring is in place and evidence exists that it is achieving its objectives.	The harvest strategy is responsive to the state of the stock and is designed to achieve stock management objectives reflected in the target and limit reference points. The performance of the harvest strategy has been fully evaluated and evidence exists to show that it is achieving its objectives including being clearly able to maintain stocks at target levels. The harvest strategy is periodically reviewed and improved as necessary.

Scoring Comments

The harvest strategy is responsive to the state of the stock and is designed to achieve stock management objectives reflected in the target and limit reference points.
The harvest strategy is responsive to the state of the stock and is designed to achieve stock management objectives reflected in the target and limit reference points. While the harvest strategy has not yet matured, there is clear evidence of ongoing development of the strategy and interim controls on fishing that are precautionary and appropriate for the current level of development.

The stock is currently only lightly exploited, so the harvest strategy remains untested. If catches and stock productivity remain at the current level, the stock will not be at risk. Monitoring of the stock, based on biomass surveys, has been patchy since the last synoptic survey, so the state of the stock is surmised based on the low levels of catch relative to the potential yield. The primary objective of the strategy is to maintain the stock at a level to protect its role in the ecosystem as the main prey species to a large number of predators. This is to be achieved, in the first instance, by limiting the exploitation in areas important to predators to levels which will not put those predator populations at risk.

The harvest strategy is reasonably precautionary with a TAC (620 000 t) interim "trigger" being set well below the estimated potential yield, but 50% higher than the highest annual catch reported in 1986/87 of 400 835 t. Once this trigger level is reached, quota management must be implemented on small scale management units (SSMU). The objective of SSMU quotas would be to prevent local depletion depriving dependent predator populations of adequate opportunities to obtain their prey. Quotas based on SSMU have not yet been developed, but have been subject to considerable research and development.

There is no specific justification for this catch trigger level, except that it is only 18% of the catch limit. The catch limit (potential yield) for Area 48 has been set according to the lowest level between the "recruitment" and "predator" precautionary criteria in the harvest control rule. In the last assessment, lowest yield was produced by the predator based rule. However, this catch limit will not apply until the SSMU quotas have been achieved.

The harvest strategy may not have been fully tested but monitoring is in place and evidence exists that it is achieving its objectives.
The harvest strategy has not been fully tested, but monitoring is in place and evidence exists that it is achieving its objectives. The stock, catches and predator populations are being monitored, and there is no evidence that they are being affected by harvesting. The current catches are too low to have a significant impact on the overall stock size. However, catches remain low largely because of market constraints rather than through management control. There is currently no incentive for IUU fishing or to misreport catches. Unless catches significantly increase, the current strategy is clearly adequate by default and direct evidence that the strategy is able to achieve its objectives would only become available as exploitation increases.

Monitoring is extensive both with on-board observer coverage for biological sampling of the catch, and CEMP for monitoring the abundance of predator species. Concern has been expressed over reductions of CEMP monitoring, but it is adequate for the current level of catch. The international observer coverage, which is generally considered reliable, is less than 100% in this fishery. There has been no complete biomass survey of Area 48 since 2000, although surveys have been conducted since then covering smaller areas. Assuming complete biomass surveys occur every 10 years (the next would be no sooner than 2010), it is not clear that this would be frequent enough to monitor stock status. CPUE is not used as it is not thought likely to have a simple relationship with stock size.

The harvest strategy is periodically reviewed and improved as necessary
The harvest strategy is periodically reviewed and improved as necessary. There are documented annual meetings of the working group (WGEMM) and of CCAMLR to discuss the harvest strategy, outcomes and problems. There is clear evidence of responses to management issues as they arise. Catch limits are defined in Conservation Measure 51-01 (2008) and are reviewed annually.

Score: 95

Audit Trace References

WGEMM, 2000; WGEMM, 2007; WGEMM, 2008; SC-CAMLR. 1993; SC-CAMLR. 1994; Trathan and Hill, 2008; CCAMLR Conservation Measure 51-01 (2008)

1.2.2	Harvest control rules and tools: There are well defined and effective harvest control rules in place	Generally understood harvest control rules are in place that are consistent with the harvest strategy and which act to reduce the exploitation rate as limit reference points are approached. There is some evidence that tools used to implement harvest control rules are appropriate and effective in controlling exploitation.	Well defined harvest control rules are in place that are consistent with the harvest strategy and ensure that the exploitation rate is reduced as limit reference points are approached. The selection of the harvest control rules takes into account the main uncertainties. Available evidence indicates that the tools in use are appropriate and effective in achieving the exploitation levels required under the harvest control rules	Well defined harvest control rules are in place that are consistent with the harvest strategy and ensure that the exploitation rate is reduced as limit reference points are approached. The design of the harvest control rules take into account a wide range of uncertainties. Evidence clearly shows that the tools in use are effective in achieving the exploitation levels required under the harvest control rules.

Scoring Comments

Well defined harvest control rules are in place that are consistent with the harvest strategy and ensure that the exploitation rate is reduced as limit reference points are approached.
There is a well defined harvest control rule in place that is consistent with the harvest strategy and ensures that the exploitation rate is low enough that there is little or no risk that the spawning stock biomass will be reduced bellow the limit reference point. The harvest rule is interpreted as the total catch being limited to the trigger level of 620 000t. This limitation ensures that the exploitation rates never approaches the target.

The potential yield calculation uses B_0 rather than the current biomass and will not reduce the exploitation rate as reference points are approached (i.e. there is no feedback). This calculation however is not yet actually applied as a decision rule, but does demonstrate that the current and trigger level catches are highly precautionary. The stated aim of CCAMLR is to allow the fishery to be developed towards taking the catch indicated by the HCR, which would include further research and monitoring. The exploitation rate is constrained so that limit reference points are not exceeded.

The selection of the harvest control rules takes into account the main uncertainties.
The selection of the harvest control rules takes into account the main uncertainties. The main uncertainties have been considered, and explain the low value of the trigger catch relative to the surveys of krill abundance. However, the harvest control rule is commensurate the level of fishery development, and does not explicitly cover a wide range of uncertainties (e.g. climate change), which would require monitoring and adjustment of the controls in response.

The potential yield estimate is generated from a probabilistic harvest control rule, based on a stochastic simulation taking into account recruitment uncertainty and biomass survey error. The lowest biomass estimate of the various methods is used as the B_0 estimate, and has been adjusted downwards based on a re-evaluation in 2007. As the stock is currently considered only lightly fished, a precautionary level of catch at this stage should be sufficient.

Available evidence indicates that the tools in use are appropriate and effective in achieving the exploitation levels required under the harvest control rules.
Available evidence indicates that the tools in use are appropriate and effective in achieving the exploitation levels required under the harvest control rules. The tool used to control the harvest is the landings reported by the fishing vessels. The tools have not yet been invoked in this fishery, but the same system applies as used in the toothfish fishery, which, for the legal fishery, has been highly effective. There is some concern as to the accuracy of catch estimates, but the recording is adequate for the current level of catch.

The model uses the most up-to-date parameter estimates for the life history as well as a synoptic survey which combined trawl and acoustic methods to estimate the biomass in 2000. This estimate is treated as the unexploited biomass, although some fishing has occurred before 2000. The decision rule uses a proxy for biomass at MSY, and includes an arbitrary adjustment to allow for additional biomass to support predation.

Score: 80

Audit Trace References

WGEMM, 2000; WGEMM, 2007; WGEMM, 2008; Demer *et al.*, 2007;

1.2.3	**Information / monitoring:** Relevant information is collected to support the harvest strategy	Some relevant information related to stock structure, stock productivity and fleet composition is available to support the harvest strategy. Stock abundance and fishery removals are monitored and at least one indicator is available and monitored with sufficient frequency to support the harvest control rule.	Sufficient relevant information related to stock structure, stock productivity, fleet composition and other data is available to support the harvest strategy. Stock abundance and fishery removals are regularly monitored at a level of accuracy and coverage consistent with the harvest control rule, and one or more indicators are available and monitored with sufficient frequency to support the harvest control rule. There is good information on all other fishery removals from the stock.	A comprehensive range of information (on stock structure, stock productivity, fleet composition, stock abundance, fishery removals and other information such as environmental information), including some that may not be directly relevant to the current harvest strategy, is available. All information required by the harvest control rule is monitored with high frequency and a high degree of certainty, and there is a good understanding of the inherent uncertainties in the information [data] and the robustness of assessment and management to this uncertainty.

Scoring Comments

Sufficient relevant information related to stock structure, stock productivity, fleet composition and other data is available to support the harvest strategy.

Sufficient relevant information related to stock structure, stock productivity, fleet composition and other data is available to support the harvest strategy. The harvest strategy is primarily based on the 2000 synoptic survey. Other biomass surveys have been conducted since 2000, but have not covered the whole of area 48 and some attempt has been made to reconstruct the time series of biomass. The surveys provide the majority of the information on stock abundance and structure. How frequently synoptic surveys will be conducted in future is not clear. The spatial distribution of biomass, which is even more uncertain, will become more important when SSMU quotas are implemented. However, the potential yield (catch limit) is based on estimates of the unexploited stock size, so in theory a single synoptic survey is adequate.

Fleet composition is monitored by CCAMLR and information is exact.

Catch composition, potentially providing information on selectivity and stock structure, is monitored through the observer coverage. These data are not currently used in the harvest strategy, partly because of the low level of exploitation. CCAMLR international observer coverage is less than 100%. The Saga Sea has an international observer on board, and within the South Georgia zone (48.3), all vessels must carry international observers. Otherwise vessels use national observers, a scheme which is not considered as reliable by all States.

Some of the more comprehensive range of information has now been obtained preparing for a higher level of exploitation. There has been research on survey methods and biomass estimation, improvements in catch sampling and the way catches are measured and reported. More accurate data will be necessary if exploitation increases. As the harvest strategy is focused on the role of the species in the ecosystem, part of the monitoring procedure includes CEMP, which estimates the abundance of the predator populations. This is being used with abundance estimates of krill to construct models which can be used to allocated quotas among the SSMUs.

Stock abundance and fishery removals are regularly monitored at a level of accuracy and coverage consistent with the harvest control rule, and one or more indicators are available and monitored with sufficient frequency to support the harvest control rule.
The harvest control rule is based on catch monitoring. Catch reports are obtained monthly from all vessels and there is no incentive to under-report. Although not an issue for the Aker fishery, discarding is legal in this fishery and some discarding may occur where the size of the krill is important, such as that used for human consumption or bait, but is not likely where catches are used for fish meal. Conversion factors from the processed weight, which is actually measured, to the live weight are highly uncertain for some products. However, for the current low exploitation rate, these are not likely to be important enough to affect stock status.

The harvest control rule requires a good understanding of the basic life history parameters. The life history remains uncertain, although there has been clear progress in understanding with results suggesting that krill is relatively long-lived for a small shrimp species. Like all crustaceans, krill cannot be aged reliably so that growth and mortality cannot be estimated easily. The information is sufficient enough to support the current harvest control rule.

There is good information on all other fishery removals from the stock.
There is good information on all other fishery removals from the stock. Fishing only occurs within the CCAMLR area with few if any opportunities for fishing outside. IUU catches are negligible. There is no incentive to misreport.

Score: 80

Audit Trace References

WGEMM, 2000; WGEMM, 2007; WGEMM, 2008; Demer and Conti, 2005; Demer *et al*., 2007; Heywood *et al*. 2006; Atkinson *et al*. 2008; WG-EMM-08/46
Foster et al. 2007; Japanese Delegation 2008; WG-EMM-08/5; WG-EMM-07/5; Saunders and Brierley 2007

1.2.4	**Assessment of stock status:** There is an adequate assessment of the stock status	The assessment estimates stock status relative to reference points.	The assessment is appropriate for the stock and for the harvest control rule, and is evaluating stock status relative to reference points.	The assessment is appropriate for the stock and for the harvest control rule and takes into account the major features relevant to the biology of the species and the nature of the fishery.
		The major sources of uncertainty are identified.	The assessment takes uncertainty into account.	The assessment takes into account uncertainty and is evaluating stock status relative to reference points in a probabilistic way. The assessment has been tested and shown to be robust. Alternative hypotheses and assessment approaches have been rigorously explored.
			The stock assessment is subject to peer review.	The assessment has been internally and externally peer reviewed.

Scoring Comments
The assessment is appropriate for the stock and for the harvest control rule, and is evaluating stock status relative to reference points. The assessment is appropriate for the stock and for the harvest control rule, and is evaluating the stock status relative to reference points. A traditional stock assessment, in the sense of fitting a dynamic model to catch and abundance index information, has not been done due to the lack of information and limited development of the fishery. The potential yield has been estimated using a standard CCAMLR approach, the Generalized Yield Model. The sustainable catch estimate obtained from the model is currently not used directly, but is well above a lower interim precautionary limit (trigger level) which appears to have no theoretical basis beyond being low compared to the potential yield. **The assessment takes uncertainty into account.** The GYM simulation is stochastic and used to apply a probabilistic decision rule. However, various structural uncertainties are not taken into account, particularly in the interpretation of the survey data. Where possible, more precautionary values are used; most importantly, the lowest value of the few B_0 estimates available is being used. Taking uncertainty further into account, the catch trigger level is even lower than this potential yield estimate. **The stock assessment is subject to peer review.** The stock assessment is subject to peer review through the working group system. No external review has been conducted, although various aspects of the modelling and assessment have been reviewed through the normal scientific publication.
Score: 80

Audit Trace References

WGEMM, 2000; WGEMM, 2007; WGEMM, 2008; de la Mare 1994a; de la Mare 1994b; Constable and de la Mare 1996; WGSAM 2007; WG-EMM-08/5
Jolly and Hampton 1990

Principle 2	Fishing operations should allow for the maintenance of the structure, productivity, function and diversity of the ecosystem (including habitat and associated dependent and ecologically related species) on which the fishery depends

2.1	Retained non-target species

2.1.1	***Status:*** The fishery does not pose a risk of serious or irreversible harm to the retained species and does not hinder recovery of depleted retained species.	Main retained species are likely to be within biologically based limits or if outside the limits there are measures in place that are expected to ensure that the fishery does not hinder recovery and rebuilding of the depleted species. If the status is poorly known there are measures or practices in place that are expected to result in the fishery not causing the retained species to be outside biologically based limits or hindering recovery.	Main retained species are highly likely to be within biologically based limits, or if outside the limits there is a partial strategy of demonstrably effective management measures in place such that the fishery does not hinder recovery and rebuilding.	There is a high degree of certainty that retained species are within biologically based limits. Target reference points are defined and retained species are at or fluctuating around their target reference points.

Scoring Comments

As this PI considers the status of the retained non-target species, it is judged against the current catch level within the krill fishery as a whole – i.e. on average 113,000 t p.a.

Catches of adult fish during krill fishing are absent due to the fishing gear and methods employed, and the mono-specific swarming behaviour of krill. However, the nature of the *Saga Sea* fishing process means that the normal fish larval bycatch that occurs during krill fishing using all gears will be preserved and is therefore measurable. As a result, an identifiable retained component of the catch consists of larvae of several fish species. The CCAMLR observer on board Saga Sea monitors catches of fish larvae, and analyses of resulting data have been performed. The total larval catch is less than 5% of the total catch by weight; this can be considered a 'main' retained species due to the potential vulnerability of this component and the fact that there is a vulnerable species present in this catch.

Main retained species are likely to be within biologically based limits or if outside the limits there are measures in place that are expected to ensure that the fishery does not hinder recovery and rebuilding of the depleted species.

Observer analysis reports have stated that overall catches of larval fish is much lower in more southerly areas 48.1 and 48.2 than in Subarea 48.3. While identification of larvae to genera and species level continues, current data indicates that species-specific catch rates were highest for Icefish *Champsocephalus gunnari*: maximum catch rates being 58.83 individuals per tonne in winter (Subarea 48.3), and for 'other icefish' with 38.3 individuals per tonne in summer (Subarea 48.2). Within 48.3, the key area for *C. gunnari* larval catch, this species is considered within biological limits and harvested sustainably. Larval stages of this species are not present year round, and consequently are only likely to be at risk for a limited period. The most important concentrations of these larval fish will be present in locations where the water circulation will lead to their retention on the shelf. These are not necessarily the same localities as those of the fishable krill aggregations because those concentrations occur in the localities where they have been brought to the region on the Antarctic Circumpolar Current.

Lanternfish, the second most common species in 48.3 in the winter, is no longer the subject of a directed fishery where it is abundant (Subarea 48.3), on the basis of its likely importance as a prey (forage) species in the food web. There is no formal assessment of the status of the stock, but this management measure and the low by-catch levels recorded make it very likely that krill fishing has resulted in a minimal and insignificant reduction in stock size. Rockcod larvae (*Notothenia* spp.) were also identified within the catch. Although these larvae have not been identified down to the species level, it is precautionary to assume these include larvae of the species *N. rossii*. Directed fishing for the Antarctic rockcod (*N. rossii*) specifically has been prohibited since 1985, and recovery is being monitored for stocks which were overfished in the late 1960s and early 1970s. Prohibitions are also in place to protect other rockcod and icefish species (other than *C. gunna*ri, this being the most common genus in 48.2 in the summer) in Area 48. Rockcod appear to remain at low population levels.

Measures are in place within the fishery as a result of the currently low catch level of krill (well below the precautionary trigger level), and the restriction of fishing around CEMP management sites, which will provide some localised protection. However, there is no current strategy or partial strategy to react to further findings on the level of fish larval catch within the fishery.

If the status is poorly known there are measures or practices in place that are expected to result in the fishery not causing the retained species to be outside biologically based limits or hindering recovery.
The highest catch rates are for *C. gunnari*, which is considered within safe biological limits. While catch rates appear low based upon current information, the Nototheniid and other icefish larval catches are of note, given the prohibitions on directed fisheries for these species (in Area 48 and Area 48.3 respectively).

Measures in place for the krill fishery as a whole are at present the precautionary trigger level of 620 000t of krill, while practices in place to minimise impact include the current lower level of krill catches. At that trigger level, a maximal catch of 99.5 larvae per tonne equates to 61 700 000 fish larvae caught, a worst-case situation given current information, and ignoring species-specific and area-specific catch rates. This number is not insignificant, and therefore continued monitoring of larval bycatch is warranted, particularly to identify approaches to reduce catches of species (e.g. through spatial or temporal approaches) and the spawning seasons of the different stocks. However, based upon a conservative evaluation assuming either the current total catch level of krill or the current catch trigger level is taken from one place, and in light of the high rate of natural mortality in younger fish, impacts would be expected to be no more than background variability and hence undetectable at these levels.

At a species-specific level, while catch levels of species such as Nototheniidae are relatively low (<4 individuals per tonne of krill), that bycatch limits of adults in other adult fish fisheries in the area are (for example) 300t, and the impact at current low catch levels on the viability of adult populations is likely to be slight, there remains a need to reduce bycatch of this and other species to ensure that the fishery does not hinder recovery and rebuilding.

Score: 65

A score of 65 means that a condition has been generated- Refer Condition 2.

Audit Trace References

MRAG (2009); CCAMLR CMs 34-04, 34-05, 34-06, 32-07, 33-01, 51-01, 91-01; Iwamu and Naganobu (2008); Client interview; CCAMLR (2008c)

SCORING CRITERIA		SCORING GUIDEPOST 60	SCORING GUIDEPOST 80	SCORING GUIDEPOST 100
2.1.2	***Management strategy:*** There is a strategy in place for managing retained species that is designed to ensure the fishery does not pose a risk of serious or irreversible harm to retained species.	There are measures in place, if necessary, that are expected to maintain the main retained species at levels which are highly likely to be within biologically based limits, or to ensure the fishery does not hinder their recovery and rebuilding. The measures are considered likely to work, based on plausible argument (e.g., general experience, theory or comparison with similar fisheries/species).	There is a partial strategy in place, if necessary that is expected to maintain the main retained species at levels which are highly likely to be within biologically based limits, or to ensure the fishery does not hinder their recovery and rebuilding. There is some objective basis for confidence that the partial strategy will work, based on some information directly about the fishery and/or species involved. There is some evidence that the partial strategy is being implemented successfully.	There is a strategy in place for managing retained species. The strategy is mainly based on information directly about the fishery and/or species involved, and testing supports high confidence that the strategy will work. There is clear evidence that the strategy is being implemented successfully, and intended changes are occurring. There is some evidence that the strategy is achieving its overall objective.

Scoring Comments

This PI is scored on the basis of the current catch trigger level of 620 000t.

There are measures in place, if necessary, that are expected to maintain the main retained species at levels which are highly likely to be within biologically based limits, or to ensure the fishery does not hinder their recovery and rebuilding.

The current low catch levels of krill represent a measure that reduces the impact of krill fishing on fish larvae, while the precautionary catch trigger level represents a further measure. However, these cannot be viewed as specific (partial) strategies aimed at ensuring fish larval catches are unlikely to affect adult fish population levels; they represent partial strategies directed for krill population management, and their effectiveness for minimising the impact of krill fishing on fish populations has not been formally evaluated.

There is a strategy in place for collection of information directly from the fishery about other retained species. This allows the impact of future strategies to be monitored. At this stage the level of risk to the adult stocks has been regarded as low (see 2.1.1) but ongoing research is being conducted to quantify the level of bycatch down to the species level. Work on identification of these species of bycatch and analysis of bycatch rates in the krill fishery is currently ongoing through the observer programme.

C. gunnari is subject to stock assessment, while status of other species are based upon the results of scientific surveys. There is no directed fishery for lanternfish in Subarea

48.3, due to its likely importance as a prey (forage) species in the food web. There is no formal assessment of the status of the stock, but this management measure and the low by-catch levels that are recorded make it very likely that fishing has resulted in minimal and insignificant reduction in stock size.

Rockcod (Nototheniidae) and other icefish species larvae have also been identified within the catch. Directed fishing for the Antarctic rockcod (*Notothenia rossii*) has been prohibited since 1985, and recovery is being monitored for historically overfished stocks, while prohibitions on directed fishing are also in place for other icefish species. Limits on the bycatch of adult fish are also in place.

The measures are considered likely to work, based on plausible argument (e.g., general experience, theory or comparison with similar fisheries/species).
Based upon low catch levels dictated by the current catch trigger level (620 000t), the measure can be expected to result in relatively minimal impacts on adult fish biomass, based upon plausible argument. There is some evidence that this is likely to work due to those low catch levels. However, there is no objective basis for this confidence without additional study.

Score: 60

A score of 60 means that a condition has been generated- Refer Condition 2.

Audit Trace References

CCAMLR CM 33-01, 34-04, 34-05, 34-06, 32-07, 51-01, 91-01; CCAMLR (2008c); MRAG (2009)

SCORING CRITERIA		SCORING GUIDEPOST 60	SCORING GUIDEPOST 80	SCORING GUIDEPOST 100
2.1.3	***Information / monitoring:*** Information on the nature and extent of retained species is adequate to determine the risk posed by the fishery and the effectiveness of the strategy to manage retained species.	Qualitative information is available on the amount of main retained species taken by the fishery. Information is adequate to qualitatively assess outcome status with respect to biologically based limits. Information is adequate to support measures to manage main retained species.	Qualitative information and some quantitative information are available on the amount of main retained species taken by the fishery. Information is sufficient to estimate outcome status with respect to biologically based limits. Information is adequate to support a partial strategy to manage main retained species. Sufficient data continue to be collected to detect any increase in risk level (e.g. due to changes in the outcome indicator scores or the operation of the fishery or the effectiveness of the strategy).	Accurate and verifiable information is available on the catch of all retained species and the consequences for the status of affected populations. Information is sufficient to quantitatively estimate outcome status with a high degree of certainty. Information is adequate to support a comprehensive strategy to manage retained species, and evaluate with a high degree of certainty whether the strategy is achieving its objective. Monitoring of retained species is conducted in sufficient detail to assess ongoing mortalities to all retained species.

Scoring Comments

Qualitative information and some quantitative information are available on the amount of main retained species taken by the fishery.
CCAMLR has asked Members to intensify their investigations into the by-catch of juvenile fish and to extend them to other seasons so that CCAMLR can assess more precisely where and when fish are most vulnerable to the krill fishery, and take appropriate action (http://www.ccamlr.org/pu/e/e_pubs/am/p6.htm#(ii)Midwater). An observer is present onboard *Saga Sea* while fishing for krill in Area 48. An appropriate scientific protocol has been developed for sampling fish larvae within the catch, which has been analysed and reported to CCAMLR.

Identification of fish larvae sampled from the catch is ongoing. Species identification has been achieved for most species, but some have so far only been identified to genus level. Quantitative information is therefore available at the species level for specific species, and at the genus level for others.

Modelling of factors which influence larval bycatch are ongoing, based on the years of data collected so far, and will help develop any further mitigation measures required for the fishery. Due to the nature of the fishery, these data are constrained in time and space, and hence a full analysis of the variability resulting from these factors has not yet been performed.
(This achieves SG80 for the first paragraph)
Information is sufficient to estimate outcome status with respect to biologically based limits.

Given available information on fish larval catch rates by area and season (if partial in cases), biological information of adult growth and mortality estimates, available approaches for estimating –at-age natural mortality, and biomass estimates for many species, there is sufficient information to develop estimates of outcome status with respect to adult biologically based limits. However, this has not yet been performed (see 2.1.1.)
(This achieves SG80 for the second paragraph)

Information is adequate to support a partial strategy to manage main retained species.
Information on the spatial and temporal pattern of larval catch is being developed through the ongoing international observer coverage onboard the *Saga Sea*. This information is adequate to support the development of partial strategies to manage the main retained species, as necessary, and will be expanded with continual coverage of the vessel in future years. Available information could support strategies such as move-on rules.
(This achieves SG80 for the third paragraph)

Sufficient data continue to be collected to detect any increase in risk level (e.g. due to changes in the outcome indicator scores or the operation of the fishery or the effectiveness of the strategy).
An international observer monitors the *Saga Sea* during all fishing activities. This 100% observer coverage collects information not only on the fisheries operations, but also any bycatch, discards and incidental mortalities that occur within the fishery. The observer covered between 20 and 86% of 'trawls' during the fishing season in 2006/07. Using the scientific protocol developed, the sampling of larval retained species is sufficient to detect any increase in risk level. While the lack of full identification of all species means that the ongoing mortalities of *all* retained species cannot be noted (some are currently only identified to genus level) further studies are underway to improve this.
(This achieves SG95 for the fourth paragraph)

Score: 90

Audit Trace References

MRAG (2009); CCAMLR (2008d); client interview

SCORING CRITERIA		SCORING GUIDEPOST 60	SCORING GUIDEPOST 80	SCORING GUIDEPOST 100
2.2	**Discarded species (also known as "bycatch" or "discards")**			
2.2.1	***Status*** The fishery does not pose a risk of serious or irreversible harm to the bycatch species or species groups and does not hinder recovery of depleted bycatch species or species groups.	Main bycatch species are likely to be within biologically based limits, or if outside such limits there are mitigation measures in place that are expected to ensure that the fishery does not hinder recovery and rebuilding. If the status is poorly known there are measures or practices in place that are expected result in the fishery not causing the bycatch species to be biologically based limits or hindering recovery.	Main bycatch species are highly likely to be within biologically based limits or if outside such limits there is a partial strategy of demonstrably effective mitigation measures in place such that the fishery does not hinder recovery and rebuilding.	There is a high degree of certainty that bycatch species are within biologically based limits.

Scoring Comments
There is a high degree of certainty that bycatch species are within biologically based limits. Bycatch species are defined as those species not retained and are discarded (the nature of fishing means that larval fish are primarily considered under 2.1.1., as retained species). Under this definition there is no discarding in the Aker krill fishery due to the fishing method and intended use of the catch. All catch is brought on board through the suction system, onto a conveyor belt and into the hold. Sorting of krill does not occur on board, and hence all individuals captured are retained. There are no size limits that would lead to discarding (and this has not been observed). Bycatch would also include those species not on the CITES list, which would include non-CITES listed birds, whales and seals. No bycatch or incidental mortality of these species has been observed. Limited 'unobserved' mortalities have been observed through underwater camera observations, and the overall impact is limited due to the small number of escapees (a result of the mesh size). No gear losses have been recorded.
Score: 100
Audit Trace References
Client interview; MRAG (2009); CCAMLR (2008d); observer reports

SCORING CRITERIA		SCORING GUIDEPOST 60	SCORING GUIDEPOST 80	SCORING GUIDEPOST 100
2.2.2	***Management strategy:*** There is a strategy in place for managing bycatch that is designed to ensure the fishery does not pose a risk of serious or irreversible harm to bycatch populations.	There are measures in place, if necessary, which are expected to maintain main bycatch species at levels which are highly likely to be within biologically based limits or to ensure that the fishery does not hinder their recovery. The measures are considered likely to work, based on plausible argument (e.g general experience, theory or comparison with similar fisheries/species).	There is a partial strategy in place, if necessary, for managing bycatch that is expected to maintain main bycatch species at levels which are highly likely to be within biologically based limits or to ensure that the fishery does not hinder their recovery. There is some objective basis for confidence that the partial strategy will work, based on some information directly about the fishery and/or the species involved. There is some evidence that the partial strategy is being implemented successfully.	There is a strategy in place for managing and minimising bycatch. The strategy is mainly based on information directly about the fishery and/or species involved, and testing supports high confidence that the strategy will work. There is clear evidence that the strategy is being implemented successfully, and intended changes are occurring. There is some evidence that the strategy is achieving its objective.

Scoring Comments

There is a strategy in place for managing and minimising bycatch.

The methods in place represent a strategy, rather than a partial strategy, for managing and minimising bycatch. These methods include:

a. the 100% international observer coverage, which monitors *Saga Sea* activities, including for bycatch, discards and incidental mortalities.
b. The net opening covered by a fine excluder mesh net which actively excludes marine mammals and diving birds such as penguins from entering the net and becoming trapped.
c. The slow towing speed of less than 2 knots allows these animals to move around the outside of the net with minimal danger.
d. The net design means that the net opening closes on hauling further reducing entanglement possibilities.
e. The layout of the trawl warps, which enter the water very close to the stern of the vessel, reduces the potential for birds to strike these warps during fishing operations.
f. The fact that the vessel can fish for up to 25 days continuously reduces the number of setting and hauling events, which reduces the time during which birds could interact with the net on the surface.
g. CCAMLR regulations for deploying cleaned nets.
h. The fact that the trawl sinks rapidly on deployment (and hence bird scaring lines are not required).
i. That trawling often takes place during the winter months (particularly at South Georgia) when birds are not feeding chicks and hence food foraging is reduced
j. That discharges from the operation are only water (krill being stored whole) appears to have eliminated interactions.

Unobserved mortalities from animals escaping through the cod end or other net mesh are highly limited by the small mesh size of the cod end. The gear is over-engineered to prevent losses occurring, and indeed, no losses have been recorded. In the highly unlikely event that a gear was lost, an incident report would be filed by the vessel (and observer) and reported to CCAMLR and the Norwegian Fiskeridirektoratet. Attempts to recover the gear would occur if losses occurred at depths in which recovery would be feasible.

The strategy is mainly based on information directly about the fishery and/or species involved, and testing supports high confidence that the strategy will work.
The information collected through the international observer programme, and through the use of underwater cameras during the development of the gear (i.e. through observation of the strategy *in situ*), indicates the strategy to eliminate bycatch within the fishing method has been implemented successfully, and there is therefore high confidence that the strategy is working.

There is clear evidence that the strategy is being implemented successfully, and intended changes are occurring. There is some evidence that the strategy is achieving its objective.
No bird or marine mammal mortalities have been observed by the CCAMLR observer during the operations. There is therefore clear evidence that the strategy is being implemented successfully, and intended changes are occurring. There is evidence that the strategy is achieving its objective.

Score: 100

Audit Trace References

CCAMLR CMs 25-03, 26-01, 31-01; MRAG (2009); CCAMLR (2008c, CCAMLR 2008d); Varty et al.(2008); CCAMLR (2008d); interview with client; interview with Fiskeridirektoratet; CCAMLR Resolution 22/XXV

SCORING CRITERIA		SCORING GUIDEPOST 60	SCORING GUIDEPOST 80	SCORING GUIDEPOST 100
2.2.3	***Information / monitoring*** Information on the nature and amount of bycatch is adequate to determine the risk posed by the fishery and the effectiveness of the strategy to manage bycatch.	Qualitative information is available on the amount of main bycatch species affected by the fishery. Information is adequate to broadly understand outcome status with respect to biologically based limits. Information is adequate to support measures to manage bycatch.	Qualitative information and some quantitative information are available on the amount of main bycatch species affected by the fishery. Information is sufficient to estimate outcome status with respect to biologically based limits. Information is adequate to support a partial strategy to manage main bycatch species. Sufficient data continue to be collected to detect any increase in risk to main bycatch species (e.g. due to changes in the outcome indicator scores or the operation of the fishery or the effectiveness of the strategy).	Accurate and verifiable information is available on the amount of all bycatch and the consequences for the status of affected populations. Information is sufficient to quantitatively estimate outcome status with respect to biologically based limits with a high degree of certainty. Information is adequate to support a comprehensive strategy to manage bycatch, and evaluate with a high degree of certainty whether a strategy is achieving its objective. Monitoring of bycatch data is conducted in sufficient detail to assess ongoing mortalities to all bycatch species.

Scoring Comments

Accurate and verifiable information is available on the amount of all bycatch and the consequences for the status of affected populations.
Information collected through the CCAMLR international observer programme provides accurate and verifiable information on the amount of all bycatch. Details of the sampling process are described in detail in Section 11 of the Observer Manual "Observation of By-catch of Fish Larvae in Krill Catches" with a supplementary protocol for observation implemented in 2006/07. The sampling process on the client group vessel is a non-destructive sampling mechanism ensuring that the bycatch observed is representative of the catch. Sampling processes and data collection are defined in the CCAMLR Scientific Observer Manual. Observers would record any incidental bycatch.

During the stages of gear development and commercial use, underwater cameras were deployed both at the trawl opening and cod end, which provided further quantitative information on potential and actual (i.e. zero) bycatch levels.

Information is sufficient to quantitatively estimate outcome status with respect to biologically based limits with a high degree of certainty.
The information collected by the CCAMLR international scientific observers is sufficient to quantitatively estimate outcome status with respect to biologically based limits with a high degree of certainty.

Information is adequate to support a comprehensive strategy to manage bycatch, and evaluate with a high degree of certainty whether a strategy is achieving its objective. The information available from the CCAMLR international observer programme is adequate to support a comprehensive strategy to manage bycatch, and evaluate with a high degree of certainty whether a strategy is achieving its objective. At present, due to the elimination of bycatch through the approaches listed in 2.2.2, no additional strategies have been required. **Monitoring of bycatch data is conducted in sufficient detail to assess ongoing mortalities to all bycatch species.** The CCAMLR scientific observer programme on the Saga Sea has run for 3 years, and is intended to continue in future years. Monitoring through the agreed protocols provides sufficient detail to assess any potential ongoing mortalities to all bycatch species.
Score: 100
Audit Trace References
MRAG (2009); CCAMLR observer manual; interview with client; CCAMLR (2008d)

SCORING CRITERIA	SCORING GUIDEPOST 60	SCORING GUIDEPOST 80	SCORING GUIDEPOST 100

2.3	**Endangered, Threatened and Protected (ETP) species**

2.3.1	***Status:*** The fishery meets national and international requirements for protection of ETP species. The fishery does not pose a risk of serious or irreversible harm to ETP species and does not hinder recovery of ETP species.	Known effects of the fishery are likely to be within limits of national and international requirements for protection of ETP species. Known direct effects are unlikely to create unacceptable impacts to ETP species.	The effects of the fishery are known and are highly likely to be within limits of national and international requirements for protection of ETP species. Direct effects are highly unlikely to create unacceptable impacts to ETP species. Indirect effects have been considered and are thought to be unlikely to create unacceptable impacts.	There is a high degree of certainty that the effects of the fishery are within limits of national and international requirements for protection of ETP species. There is a high degree of confidence that there are no significant detrimental effects (direct and indirect) of the fishery on ETP species.

Scoring Comments

There is a high degree of certainty that the effects of the fishery are within limits of national and international requirements for protection of ETP species.
As the trawl is pelagic, and successful efforts are made to prevent the expensive gear from being damaged on the sea bed (as confirmed through the observer coverage), interactions between ETP cnidarians and hydrozoans and the trawl gear do not occur.

No fatal ‘interactions’ have been noted between the gear and ETP marine mammals. While seals have been seen inspecting the net during the use of underwater cameras mounted at the mouth of the trawl, the use of excluder mesh at the trawl mouth prevents marine mammals and birds from becoming entangled in the gear, and is further helped by the slow speed of trawling.

The gear design allows the net to remain at depth for long periods, thereby reducing the time on surface when marine mammals (and birds) might interact. No reports of seabird mortality or entanglements were reported in the krill fishery. In turn, CCAMLR regulations for deploying cleaned nets, the fact that trawling in particular areas (e.g. South Georgia) takes place during months when birds are not nesting and hence food foraging is reduced, and the layout of the gear at the stern of the vessel appears to have eliminated interactions.

As a result, there is a high degree of certainty that the effects of the fishery are within limits of national and international requirements for protection of ETP species.

There is a high degree of confidence that there are no significant detrimental effects (direct and indirect) of the fishery on ETP species.
No mortalities of ETP species have been noted during observer monitoring or underwater camera monitoring. As a result, there is a high degree of confidence that there are no

significant detrimental direct effects of the fishery on ETP species.

With respect to indirect effects, the effects of fishing on the krill and predator populations at the 15 Small Scale Management Units have been modelled. The model defines the probabilities at given levels of krill yield at each SSMU of a reduction in the various predator populations compared to that in the absence of fishing. The results of these models show that at current levels of fishing (below the precautionary trigger level) there is a low probability of fishing affecting predators adversely. However, these populations will need to be accounted for when allocating quotas by SSMU if the overall levels of krill catch increase towards the trigger level. Both the FOOSA (KPFM2) and SMOM models include whales within their formulations. The simulations of Watters et al. (2008b) "predicted almost no risk of depleting whale populations across all three fishing options and all harvest rates".

As a result, there is a high degree of confidence that there are no significant detrimental indirect effects of the fishery on ETP species at current fishing levels.

Score: 100

Audit Trace References

CCAMLR (2008a, 2008c, 2008d); Varty et al. (2008); interview with client; Watters et al. (2008a, 2008b), Hill et al. (2008); Orr et al. (2007); observer reports; Plagányi and Butterworth (2008)

2.3.2	***Management strategy*** The fishery has in place precautionary management strategies designed to: - meet national and international requirements; - ensure the fishery does not pose a risk of serious or irreversible harm to ETP species; - ensure the fishery does not hinder recovery of ETP species; and - minimise mortality of ETP species.	There are measures in place that minimise mortality, and are expected to be highly likely to achieve national and international requirements for the protection of ETP species. The measures are considered likely to work, based on plausible argument (eg general experience, theory or comparison with similar fisheries/species).	There is a strategy in place for managing the fishery's impact on ETP species, including measures to minimise mortality, that is designed to be highly likely to achieve national and international requirements for the protection of ETP species. There is an objective basis for confidence that the strategy will work, based on some information directly about the fishery and/or the species involved. There is evidence that the strategy is being implemented successfully.	There is a comprehensive strategy in place for managing the fishery's impact on ETP species, including measures to minimise mortality, that is designed to achieve above national and international requirements for the protection of ETP species. The strategy is mainly based on information directly about the fishery and/or species involved, and a quantitative analysis supports high confidence that the strategy will work. There is clear evidence that the strategy is being implemented successfully, and intended changes are occurring. There is evidence that the strategy is achieving its objective.

Scoring Comments

There is a comprehensive strategy in place for managing the fishery's impact on ETP species, including measures to minimise mortality, that is designed to achieve above national and international requirements for the protection of ETP species.

The two groups of ETP species that may feasibly interact or compete with the krill fishery are seabirds and marine mammals. All krill vessels operating in Area 48 must apply Conservation Measure 25-03 to minimise the incidental mortality of seabirds and marine mammals, and there is a high degree of confidence that there are no significant detrimental effects (direct and indirect) of the fishery on ETP species (see also Conservation Measure 26-01 (2008)).

Mortality to ETP species is minimised through strategies in place to minimise interactions with the gear:

a. the use of mesh to prevent ETP marine mammal species entering the net and getting entangled
b. the speed of trawling (around2 knots) which reduces the likelihood of ETP marine mammal interactions
c. the reduced period of trawls present on the surface due to the continuous trawling method (when compared to other pelagic trawls)
d. the minimal number of warps, which enter the water very close to the stern of the vessel, thereby reducing the chance of bird strikes, and prohibition of net monitoring cables
e. CCAMLR regulations to deploy cleaned nets on setting

All krill vessels operating in Area 48 must have a marine mammal exclusion device fitted as defined in Conservation Measure 51-01 (2008) para 7. The "eco-harvesting" gear employed on the *Saga Sea* minimises the bycatch of seals / penguins through filtering nets at the gear mouth, and minimises incidental mortality on the surface as a result of the long fishing period, compared to 'conventional methods' which regularly set and haul the gear, the periods where the highest incidence of incidental mortality occurs.

There is therefore a comprehensive strategy in place for managing the fishery's impact on ETP species, including measures to minimise mortality, which is designed to achieve above national and international requirements for the protection of ETP species.

The strategy is mainly based on information directly about the fishery and/or species involved, and a quantitative analysis supports high confidence that the strategy will work.
Information from the CCAMLR international observer onboard *Saga Sea*, and information from the use of underwater cameras to monitor gear performance, have shown no significant or fatal interactions between the fishing method and ETP species. Modelling work of the indirect effects of fishing also suggest that fishing strategies will not have a significant negative impact on ETP populations up to the trigger level (see 2.3.1).

The strategy is therefore mainly based on information directly about the fishery and/or species involved, and quantitative analysis supports high confidence that the strategy will work.

There is clear evidence that the strategy is being implemented successfully, and intended changes are occurring. There is evidence that the strategy is achieving its objective.
Evidence has been gathered through the CCAMLR international observer programme, underwater camera studies, and through the EMM CEMP monitoring programme. The evidence of effectiveness is documented through the annual observer and fishery reports to CCAMLR, and EMM reports.

There is therefore clear evidence that the strategy is being implemented successfully, and intended changes are occurring. There is evidence that the strategy is achieving its objective.

Score: 100

Audit Trace References

MRAG (2009), Watters et al. (2008a, 2008b), CCAMLR (2008d, 2008e); client interview; CCAMLR CMs 25-03 (2003), 26-01 (2008); Orr et al. (2007); observer reports; Kock et al. (2007)

2.3.3	***Information / monitoring*** Relevant information is collected to support the management of fishery impacts on ETP species, including: - information for the development of the management strategy; - information to assess the effectiveness of the management strategy; and - information to determine the outcome status of ETP species.	Information is adequate to broadly understand the impact of the fishery on ETP species. Information is adequate to support measures to manage the impacts on ETP species Information is sufficient to qualitatively estimate the fishery related mortality of ETP species.	Information is sufficient to determine whether the fishery may be a threat to protection and recovery of the ETP species, and if so, to measure trends and support a full strategy to manage impacts. Sufficient data are available to allow fishery related mortality and the impact of fishing to be quantitatively estimated for ETP species.	Information is sufficient to quantitatively estimate outcome status with a high degree of certainty. Information is adequate to support a comprehensive strategy to manage impacts, minimize mortality and injury of ETP species, and evaluate with a high degree of certainty whether a strategy is achieving its objectives. Accurate and verifiable information is available on the magnitude of all impacts, mortalities and injuries and the consequences for the status of ETP species

Scoring Comments

Information is sufficient to quantitatively estimate outcome status with a high degree of certainty.

ETP species can be based upon those on the CITES listing. Using South Georgia and South Sandwich Islands entries as a basis, those of concern that may relate to the fishery under certification therefore include:

Commerson's Dolphin/Piebald Dolphin (*Cephalorhynchus commersonii*)
Spectacled Porpoise (*Phocoena dioptrica*)
Common Rorqual/Fin Whale (*Balaenoptera physalus*)
Southern Right Whale (*Eubalaena australis*)
Antarctic Fur Seal (*Arctocephalus gazella*)
Subantarctic Fur Seal (*Arctocephalus tropicalis*)
Southern Elephant Seal (*Mirounga leonina*)

CCAMLR international scientific observers record information key to the assessment of compliance with CCAMLR Conservation Measures. Under these observer protocols, detailed observer records are maintained on the presence of ETP species around the vessel during fish activity and any mortality and injury events relating to ETP species are recorded by the observers, with samples being retained for assessment by Member States. The magnitude of all impacts, mortalities and injuries and the consequences for the status of ETP species are therefore well known. The observer information obtained is sufficient to quantitatively estimate the status of ETP species interactions with a high degree of certainty. Further monitoring of ETP species (e.g. albatross) occurs through the CEMP monitoring programme.

Information is adequate to support a comprehensive strategy to manage impacts, minimize mortality and injury of ETP species, and evaluate with a high degree of certainty whether a strategy is achieving its objectives.
The CEMP and observer programme provide considerable data to support the ETP injury and mortality mitigation strategies developed and employed by CCAMLR over the past twenty years. Information from these sources and the resulting strategies has reduced the levels of interaction and subsequent injury and mortality of ETP species greatly, identified as monitoring continues. Where needed, the strategy can continue to develop to manage impacts, and minimise mortality and injury of ETP species. While the CEMP programme (given its land-based nature) does not include whale species – in particular baleen whales – CCAMLR have initiated joint programmes with IWC in an attempt to improve the ecosystem modelling and understanding of those krill dependent species, which should improve this information into the future.

Accurate and verifiable information is available on the magnitude of all impacts, mortalities and injuries and the consequences for the status of ETP species.
The *Saga Sea* has a very good observer coverage rate, at 100% of fishing days covered. The CEMP data provides a time series of key predator population characteristics. Although the degree of data collection under this programme has varied over time, a key site in each sub-area of Area 48 continues to be monitored with high coverage. *Ad hoc* monitoring has also been performed using underwater camera gear, during gear development and during the early period of commercial use. This allowed direct observation of the efficacy of mitigation measures while fishing. Continued evaluation will continue through the scientific observer programme and there is a high degree of certainty that this strategy is achieving its objectives.

Information is therefore sufficient to quantitatively estimate outcome status **for the unit of certification** with a high degree of certainty. Information **from the *Saga Sea*** is adequate to support a comprehensive strategy to manage impacts, minimize mortality and injury of ETP species (although some limitations with respect to whale species are noted), and evaluate with a high degree of certainty whether a strategy is achieving its objectives. Accurate and verifiable information is available on the magnitude of all impacts, mortalities and injuries and the consequences for the status of ETP species.

Score: 95

Audit Trace References

MRAG (2009); Watters et al. (2008a, 2008b); CCAMLR (2008d, 2008e); client interview; CCAMLR CMs 25-03 (2003), 26-01 (2008); Orr et al. (2007); observer reports; CCAMLR observer manual; interview with Greenpeace, interview with WWF; Constable (2008)

SCORING CRITERIA	SCORING GUIDEPOST 60	SCORING GUIDEPOST 80	SCORING GUIDEPOST 100

2.4	Strategies have been developed within the fisheries management system to address and restrain any significant negative impacts of the fishery on the ecosystem

2.4.1	***Status*** The fishery does not cause serious or irreversible harm to habitat structure, considered on a regional or bioregional basis, and function.	The fishery is unlikely to reduce habitat structure and function to a point where there would be serious or irreversible harm.	The fishery is highly unlikely to reduce habitat structure and function to a point where there would be serious or irreversible harm.	There is evidence that the fishery is highly unlikely to reduce habitat structure and function to a point where there would be serious or irreversible harm.

Scoring Comments
There is evidence that the fishery is highly unlikely to reduce habitat structure and function to a point where there would be serious or irreversible harm. The fishery operates using a midwater/pelagic trawl. The key habitat of concern is therefore the pelagic system. Due to the pelagic nature of the gear, and avoidance of the seabed by fishers due to the likelihood of damaging the net, there is little potential for damage to the benthic ecosystem. Impacts on the pelagic system are expected to be negligible and transient, further reduced by the slow speed of trawling. No interactions with the seabed have been noted by the international observer.
Score: 100
Audit Trace References
Interview with client; observer reports; CCAMLR (2008d); Orr et al. (2007)

2.4.2	***Management strategy*** There is a strategy in place that is designed to ensure the fishery does not pose a risk of serious or irreversible harm to habitat types.	There are measures in place, if necessary, that are expected to achieve the Habitat Outcome 80 level of performance. The measures are considered likely to work, based on plausible argument (e.g general experience, theory or comparison with similar fisheries/habitats).	There is a partial strategy in place, if necessary, that is expected to achieve the Habitat Outcome 80 level of performance or above. There is some objective basis for confidence that the partial strategy will work, based on some information directly about the fishery and/or habitats involved. There is some evidence that the partial strategy is being implemented successfully.	There is a strategy in place for managing the impact of the fishery on habitat types. The strategy is mainly based on information directly about the fishery and/or habitats involved, and testing supports high confidence that the strategy will work. There is clear evidence that the strategy is being implemented successfully, and intended changes are occurring. There is some evidence that the strategy is achieving its objective.

Scoring Comments

There is a strategy in place for managing the impact of the fishery on habitat types.
Only pelagic trawling for krill is allowed under CCAMLR Conservation Measures 51-01 (2008) and 21-03 (2008). CCAMLR fisheries for krill in Area 48 limit the impact of the fishery on all benthic habitats by restricting the gear that can be used. In this way interactions with the potentially vulnerable benthic habitats are avoided. The restrictions work well with the fishery operating in areas of deep water with relatively shallow sets.

CCAMLR conservation measures also restrict fishing around CEMP management sites, which will provide some localised protection. Furthermore, there are controls on trawling around South Georgia, such that trawling is not allowed within 12 nautical miles of the shore.

The strategy is mainly based on information directly about the fishery and/or habitats involved, and testing supports high confidence that the strategy will work.
These strategies have been developed based on the understanding of the fishery and key important habitats within Area 48, as well as the desire to protect breeding colonies of key species onshore. Information from the CEMP programme, continued international observer monitoring, and ecosystem simulation studies, provide a high degree of confidence that these strategies are working.

There is clear evidence that the strategy is being implemented successfully, and intended changes are occurring. There is some evidence that the strategy is achieving its objective.
The implementation of the strategy is supported by the logbook and observer data on fishing depths and fishing locations. The absence of benthic species observed in the catch taken (C1 logbooks and supporting observer data) supports the non-interaction with benthic habitats.

There is a strategy in place for managing the impact of the fishery on habitat types. The strategy is mainly based on information directly about the fishery and/or habitats

involved, and testing supports high confidence that the strategy will work. There is clear evidence that the strategy is being implemented successfully, and intended changes are occurring. There is evidence that the strategy is achieving its objective.
Score: 100
Audit Trace References
CCAMLR CMs 51-01, 21-03, 91-01; observer reports; CCAMLR (2008a, 2008d, 2008e); interview with client; Orr et al. (2007)

2.4.3	***Information / monitoring*** Information is adequate to determine the risk posed to habitat types by the fishery and the effectiveness of the strategy to manage impacts on habitat types.	There is a basic understanding of the types and distribution of main habitats in the area of the fishery. Information is adequate to broadly understand the main impacts of gear use on the main habitats, including spatial extent of interaction.	The nature, distribution and vulnerability of all main habitat types in the fishery area are known at a level of detail relevant to the scale and intensity of the fishery. Sufficient data are available to allow the nature of the impacts of the fishery on habitat types to be identified and there is reliable information on the spatial extent, timing and location of use of the fishing gear. Sufficient data continue to be collected to detect any increase in risk to habitat (e.g. due to changes in the outcome indicator scores or the operation of the fishery or the effectiveness of the measures).	The distribution of habitat types is known over their range, with particular attention to the occurrence of vulnerable habitat types. Changes in habitat distributions over time are measured. The physical impacts of the gear on the habitat types have been quantified fully.

Scoring Comments

The distribution of habitat types is known over their range, with particular attention to the occurrence of vulnerable habitat types.
Some areas of known vulnerable benthic marine ecosystems are known within the geographic range of the fishery and fisheries that may interact with these ecosystems are excluded from the immediate area. The pelagic trawl fishery for krill does not interact with any of these habitat areas due to the depth at which krill are found.

Data on benthic habitats are collected through 100% observer coverage of other fisheries in Subareas 48.3 and 48.4 that potentially interact with VMEs, as well as through specific surveys and the work of CCAMLR in the Bioregionalisation of the Southern Ocean (2007), which includes both benthic and pelagic habitats. C1 data on vessel position and depth of fishing (along with bottom depth, allows fishing locations to be determined in 3-dimensions and confirm the lack of interaction with habitats. Habitat locations of potential VMEs are determined from other fisheries' C1 (trawl) and C2 (longline) logbook data and associated observer data.

For the pelagic habitat, a number of oceanographic models have been developed, including OCCAM (Ocean Circulation and Climate Advanced Modelling project) and a BAS-specific oceanography model for the South Georgia region (SGSSI; CCAMLR Area 48.3), which is closely associated with the OCCAM model.

Changes in habitat distributions over time are measured.
The key habitat of interaction is the pelagic system. This habitat is regularly monitored during research surveys undertaken by CCAMLR counties within Area 48, and using remote sensing, localised sensor arrays, Argo floats, and other sensors. The findings are incorporated within ecosystem and current models (e.g. OCCAM and more localised models).

The physical impacts of the gear on the habitat types have been quantified fully.
Due to the pelagic nature of the gear, and avoidance of the seabed by fishers due to the likelihood of damaging the net, there is little potential for damage to the benthic ecosystem. Impacts on the pelagic system are expected to be negligible and transient, further reduced by the slow speed of trawling.

The distribution of habitat types is therefore known over their range, with particular attention to the occurrence of vulnerable habitat types. Changes in habitat distributions over time are measured. Sufficient data continue to be collected to detect any increase in risk to habitat (e.g. due to changes in the outcome indicator scores or the operation of the fishery or the effectiveness of the measures).

Score: 100

Audit Trace References

Atkinson et al. (2008); observer reports, CCAMLR bioregionalisation workshop (2007); www.antarctica.ac.uk/; Everson (2000); Hill et al. (2008); Hill et al. (2007); Orr et al. (2007); www.noc.soton.ac.uk/JRD/OCCAM/;

2.5	Ecosystem

2.5.1	***Status*** The fishery does not cause serious or irreversible harm to the key elements of ecosystem structure and function.	The fishery is unlikely to disrupt the key elements underlying ecosystem structure and function to a point where there would be a serious or irreversible harm.	The fishery is highly unlikely to disrupt the key elements underlying ecosystem structure and function to a point where there would be a serious or irreversible harm.	There is evidence that the fishery is highly unlikely to disrupt the key elements underlying ecosystem structure and function to a point where there would be a serious or irreversible harm.

Scoring Comments

The Aker BioMarine fishery is part of the larger CCAMLR managed fishery, which contributes part of the total extraction, and so this PI considers the total levels of current extraction. This status PI is therefore judged against the current catch level of krill within the fishery, of on average 113 000t.

The fishery is highly unlikely to disrupt the key elements underlying ecosystem structure and function to a point where there would be a serious or irreversible harm.

Given the pivotal role of krill within the Antarctic ecosystem, a large amount of effort has been invested in assessing the likely impacts of krill biomass fluctuations and removals on ecosystem status and performance.

Current levels of krill extraction are at low levels compared to the precautionary biomass trigger level, which is based upon the biomass estimated from the 2000 krill survey (see 2.5.2). This precautionary level was selected on a precautionary basis using ecosystem considerations as an underlying driver, taking account uncertainty in signal strength, krill inter-annual biomass fluctuations and a risk-based simulation approach.

The predator requirement estimate of 3,466,157 tonnes is approximately 10% of the biomass estimate from the combined krill survey in 2000. Current extraction levels represent 3% of the 2000 total biomass level. At the macro-geographic scale, therefore, expert judgement expects that this level of extraction will not result in disruption to the key elements of the ecosystem structure.

This is supported by some observational and simulation evidence. The CEMP programme, supported by other site-specific monitoring studies (e.g. as performed by BAS), provides a time series of data monitoring breeding success and krill predator population numbers. While declines in particular species have been seen (e.g. Macaroni penguins), the data do not provide a link between these declines and the extraction of krill through fishing at current levels.

The data have assisted in the parameterisation of complex ecosystem models to investigate the impacts of krill fishing on predator populations. Using the FOOSA model, Watters et al. examined a range of levels of krill extraction relative to the precautionary harvest rate and trigger level for SSMUs. Their simulations suggest that the current trigger level for division of krill TACs into SSMUs appears ‘highly likely’ to result in the ecosystem remaining within biologically based limits. As a result, current extraction levels, as considered within this PI, are unlikely to result in impacts to local predator populations. However, further study is needed to appropriately define SSMU-scale TAC levels and overall TAC limits. Their simulations take into account a number – but not all – areas of uncertainty. In turn, studies have indicated that localised effects of krill fishing on predators might occur. Therefore this PI is scored at 80.

Within the current trigger level, the fishery is highly unlikely to disrupt the key elements underlying ecosystem structure and function to a point where there would be a serious or irreversible harm.

Score: 80

Audit Trace References

Watters et al. (2008 a, 2008b); CCAMLR (2008a, 2008e); Mangel and Switzer (1998); CCAMLR (2008e)

SCORING CRITERIA		SCORING GUIDEPOST 60	SCORING GUIDEPOST 80	SCORING GUIDEPOST 100
2.5.2	***Management strategy*** There are measures in place to ensure the fishery does not pose a risk of serious or irreversible harm to ecosystem structure and function.	There are measures in place, if necessary, that take into account potential impacts of the fishery on key elements of the ecosystem. The measures are considered likely to work, based on plausible argument (eg, general experience, theory or comparison with similar fisheries/ ecosystems).	There is a partial strategy in place, if necessary, that takes into account available information and is expected to restrain impacts of the fishery on the ecosystem so as to achieve the Ecosystem Outcome 80 level of performance. The partial strategy is considered likely to work, based on plausible argument (eg, general experience, theory or comparison with similar fisheries/ ecosystems). There is some evidence that the measures comprising the partial strategy are being implemented successfully.	There is a strategy that consists of a plan, containing measures to address all main impacts of the fishery on the ecosystem, and at least some of these measures are in place. The plan and measures are based on well-understood functional relationships between the fishery and the Components and elements of the ecosystem. This plan provides for development of a full strategy that restrains impacts on the ecosystem to ensure the fishery does not cause serious or irreversible harm. The measures are considered likely to work based on prior experience, plausible argument or information directly from the fishery/ecosystems involved. There is evidence that the measures are being implemented successfully.

Scoring Comments
There is a strategy that consists of a plan, containing measures to address all main impacts of the fishery on the ecosystem, and at least some of these measures are in place. The plan and measures are based on well-understood functional relationships between the fishery and the Components and elements of the ecosystem. As noted in 1.1.1 and 1.1.2, the strategy for krill management has been developed in recognition of the role of krill within the ecosystem. The implicit strategy is based upon the precautionary trigger level, which cannot be breached until small-scale management units (SSMUs) are put in place, with SSMU-specific quotas. This strategy of catch limitation is operational, although fishing levels have not been nearly high enough to test the application of this plan. Therefore, the plan is implicitly used to demonstrate that the current catch is much lower than the planned catch and therefore highly precautionary. Modelling has recently been performed to assess the effectiveness of the plan (i.e. the precautionary trigger level) for maintaining ecosystem elements. However, it cannot be said that the functional relationships between the fishery and the components and elements of the ecosystem are well understood. There are well documented uncertainties within the ecosystem and krill food web, although understanding is adequate to develop and test reasonably robust strategies and the trigger level appears sufficiently precautionary to sustain predator requirements at the global scale. **This plan provides for development of a full strategy that restrains impacts on the ecosystem to ensure the fishery does not cause serious or irreversible harm.** The current strategy of the precautionary trigger level is implemented at the Area 48-wide scale. However, the plan is already being further developed to explicitly to take into

account the requirements of krill predator species at regional and local geographic level. This extension to a more complete strategy involves the designation of SSMUs (based upon predator population structures) and local-scale quotas, to minimise the chances of localised depletions and thereby restrain impacts on the ecosystem to ensure the fishery does not cause serious or irreversible harm. This plan would require a sufficiently robust reporting/observer system to ensure the process will operate as anticipated. It should be noted that this level of catch is beyond the level of fishing currently being certified. It should also be noted that previous ecosystem modelling showed that division of the precautionary trigger level quota at the SSMU level based on historical fishing patterns (option 1) has been discarded as an approach, as it would have "have relatively greater negative impacts on the ecosystem compared to the other fishing options". Therefore, the division of SSMU-level quotas has been based upon alternative options. While the strategy is a progression beyond the current approach, the need to define and agree the basis for quota divisions means it cannot therefore be called 'full'.

The measures are considered likely to work based on prior experience, plausible argument or information directly from the fishery/ecosystems involved.
The performance of the current plan, based upon the precautionary trigger level, is considered likely to work based upon prior experience, where historical catches were much greater but appeared to have minimal impacts on the ecosystem. More reassuringly, the plan has been tested within ecosystem simulation models. These studies have shown that the current trigger level for division of krill TACs into SSMUs is 'highly likely' to result in the ecosystem remaining within biologically based limits. It is noted that fishing extractions greater than this level (which are not part of this certification process) may lead to impacts on predator populations, dependent upon how SSMU-level quotas are derived. It is also noted that their simulations take into account a number – but not all – areas of uncertainty. Further support for current measures comes from the CEMP programme.

There is some evidence that the measures comprising the partial strategy are being implemented successfully.
While modelling has been performed to assess the performance of the strategy, the full evidence for implementation is not yet available, partly due to the current low-levels of krill fishing in comparison to the precautionary trigger level. In turn, the strategy has not yet been tested for the impacts on the other retained species (see 2.2.2).

Score: 80

Audit Trace References

Watters et al. (2008a, 2008b); CCAMLR CMs 51-01, 91-01; Trathan and Hill (2008); CCAMLR (2008e); Trathan et al. (2008); Leape et al. (2009)

2.5.3	***Information / monitoring*** There is adequate knowledge of the impacts of the fishery on the ecosystem.	Information is adequate to identify the key elements of the ecosystem (e.g. trophic structure and function, community composition, productivity pattern and biodiversity). Main impacts of the fishery on these key ecosystem elements can be inferred from existing information, but have not been investigated in detail.	Information is adequate to broadly understand the functions of the key elements of the ecosystem. Main impacts of the fishery on these key ecosystem elements can be inferred from existing information, but may not have been investigated in detail. The main functions of the Components (i.e. target, Bycatch, Retained and ETP species and Habitats) in the ecosystem are known. Sufficient information is available on the impacts of the fishery on these Components to allow some of the main consequences for the ecosystem to be inferred. Sufficient data continue to be collected to detect any increase in risk level (e.g. due to changes in the outcome indicator scores or the operation of the fishery or the effectiveness of the measures).	Information is adequate to broadly understand the key elements of the ecosystem. Main interactions between the fishery and these ecosystem elements can be inferred from existing information, and have been investigated. The impacts of the fishery on target, Bycatch, Retained and ETP species and Habitats are identified and the main functions of these Components in the ecosystem are understood. Sufficient information is available on the impacts of the fishery on the Components and elements to allow the main consequences for the ecosystem to be inferred. Information is sufficient to support the development of strategies to manage ecosystem impacts.

Scoring Comments

Information is adequate to broadly understand the key elements of the ecosystem

Information collected through the observer programme, CEMP studies, fisheries logbooks, and in particular ecosystem studies that feed into and support the activities of CCAMLR within the Ecosystem Monitoring and Management group provides sufficient information to broadly understand the elements of the ecosystem. Krill form the basis of the Antarctic food chain, as well as representing the equivalent of the 'small pelagic' fish species in the region. As such, maintaining the abundance of krill to underpin the food chain above it is seen as imperative to maintaining a healthy marine ecosystem. As a result, the main interactions between krill and the rest of the ecosystem elements (including fishing) have been investigated. The food web of the Southern Ocean is very well studied, while prey requirements of predators has been the subject of considerable research, along with behavioural and spatial considerations of predator/prey interactions. Krill are known to affect predators such as seabirds and fish when krill population levels are low (e.g. due to low krill recruitments).

CCAMLR monitors the effects of fishing and other ecosystem effects on the species in the Antarctic ecosystem that are either preyed upon by krill or prey on krill, the latter through the CCAMLR Ecosystem Monitoring Program (CEMP) and links with IWC. The Information collected through CEMP has two main functions in order to identify and understand the key elements of the Antarctic ecosystem:(1) Detect and record significant changes in critical components of the marine ecosystem within the Convention Area, to serve as a basis for the conservation of Antarctic marine living resources; and (2) Distinguish between changes due to harvesting of commercial species and changes due to environmental variability, both physical and biological.

CCAMLR states that CEMP's major function is to monitor the key life-history parameters of selected dependent species ('indicator species', which are likely to respond to changes in the availability of the harvested species i.e. krill). The following species have been set as the CEMP indicator species:
Harvested species: *Euphausia superba*
Dependent Species: *Pygoscelis adeliae* (Adélie penguin), *Pygoscelis antarctica* (Chinstrap penguin), *Pygoscelis papua* (Gentoo penguin), *Eudyptes chrysolophus* (Macaroni penguin), *Diomedea melanophrys* (Black-browed albatross), *Thalassoica antarctica* Antarctic petrel, *Daption capense* (Cape petrel), *Arctocephalus gazella* (Antarctic fur seal), *Lobodon carcinophagus* (Crabeater seal).

CCAMLR has developed CEMP standard methods and established sampling sites. The 'CEMP Standard Methods' include data collection methods and procedures for data analysis aimed at yielding standardised information for comparisons across species and sites. CEMP sites are located in three Integrated Study Regions (ISR) and in a network of additional sites. Sampling levels between CEMP sites vary widely, with data collection in some locations having stopped in the last 20 years. However, there are key sites in each of the CCAMLR sub-areas of 48, which have high and consistent time series, being Bird Island, Signy Island, and Admiralty Bay, which provides a basis to monitor the impact of fishing of all types on predators and their breeding success. However, some more localised impacts may not be identified due to the shortfalls in data collections from some sampling sites. In turn, while information on the relationships between predators and krill are expanding, they are reliant on available information, which can be limited spatially and temporally. However, available information has proved sufficiently robust for ecosystem modelling approaches.

Main interactions between the fishery and these ecosystem elements can be inferred from existing information, and have been investigated.
CCAMLR regularly reviews the analyses of CEMP data, and conducts annual assessments that attempt to document ecosystem 'health'. Trends in CEMP parameters and the occurrence of anomalous years in the monitored parameters are identified by species and site. Changes which reflect natural environmental variation and those which may reflect the effects of harvesting are examined. Procedures are being developed to take account of both environmental variation and harvesting effects in the formulation of conservation measures governing commercial harvesting in the Convention Area.

Data are examined regularly, for example through specific workshops (E.g. WG-EMM Predator Survey Workshop) and through the annual CCAMLR-EMM process. Independent review of the methods and statistical approaches noted that the quality of statistical methodology presented was 'impressive', and no substantive criticisms of the methods adopted were noted.

However, information is currently limited on the interactions between the fishery and retained larval fish stages. While this is being investigated, the preliminary nature of the study means it has not – yet – been investigated in detail, although the observer plan means that it can be in future years.

The impacts of the fishery on target, Bycatch, Retained and ETP species and Habitats are identified and the main functions of these Components in the ecosystem are understood.
Sources of fishery impact are identified and measured. There is evidence that the Saga Sea method of fishing results in no direct impacts on bycatch species, ETP species or habitats. As noted above, the impacts on retained larval fish are being investigated.

The understanding of the functionality of components underpins a number of ecosystem models that have been developed for the Southern Ocean and areas within it. These have ranged from predator-prey models through to energy flow models and mass-balance models using ECOPATH. A mass-balance model has been developed for CCAMLR sub area 48.1, giving a description of the food web dominated by the phytoplankton–krill–top predators chain, and complemented with alternative food pathways (e.g. through *Electrona antarctica*), which together gives an enhanced complexity to the system. Model limitations exist, and data gaps include patterns during the winter season, grouping of functional groups, and steady state assumptions. An ECOPATH model for the Scotia Sea/South Georgia shelf has also been developed under the BAS Discovery 2010 programme. This research programme is also using fatty acid and stable isotope analysis to improve both food web structure and model performance. In turn, international cooperation through CCAMLR will improve the model further, with the joint IWC/CCAMLR workshop aiming to include whales within ecosystem models, including that for the Scotia Sea, by sharing consumption/provisioning rates. This workshop included the examination of methods that can incorporate the impacts of future climate change within ecosystem models. Further models have been specifically developed within CCAMLR to aid ecosystem management decisions, the impact of future decisions on krill abundance and hence predator status, and the movement toward small-scale management units within the fishery. These include the models FOOSA, SMOM and EPOC.

Sufficient information is available on the impacts of the fishery on the Components and elements to allow the main consequences for the ecosystem to be inferred.
The information collected through observers, ecosystem studies and the CEMP provides sufficient information to parameterise the ecosystem models described above. These have been used to examine the main consequences for the ecosystem as a result of fishing at different levels.

Some limits of the CEMP data collection are noted and will be monitored during future annual audits. The disjoint between the ecosystem requirements resulting from krill fishing activity and the methods of funding the collection of the CEMP data are recognised.

Information is sufficient to support the development of strategies to manage ecosystem impacts.
The information available from the different sources, which provide Area 48 scale and smaller-scale catch data, predator numbers and trends, ecosystem interactions, and the potential impact of fishing on krill on the ecosystem, is sufficient to support the development of the strategies detailed above, in order to manage ecosystem impacts and detect any increase in risk level.

Score: 85

Audit Trace References

Agnew (1997); observer reports, Orr et al. (2007); CCAMLR (2008a, 2008b, 2008e); Cornejo-Donosoa and Antezana (2008); Constable (2008); Hill et al. (2007); Plagányi and Butterworth (2008), Watters et al. (2008a, 2008b); Everson (2000); interview with Greenpeace; interview with WWF; Leape et al. (2009)

SCORING CRITERIA	SCORING GUIDEPOST 60	SCORING GUIDEPOST 80	SCORING GUIDEPOST 100

Principle 3	**The fishery is subject to an effective management system that respects local, national and international laws and standards and incorporates institutional and operational frameworks that require use of the resource to be responsible and sustainable**

3.1	**Governance and Policy**

3.1.1	**Legal and/or customary framework** The management system exists within an appropriate and effective legal and/or customary framework which ensures that it: - Is capable of delivering sustainable fisheries in accordance with MSC Principles 1 and 2; - Observes the legal rights created explicitly or established by custom of people dependent on fishing for food or livelihood; and - Incorporates an appropriate dispute resolution framework.	The management system is generally consistent with local, national or international laws or standards that are aimed at achieving sustainable fisheries in accordance with MSC Principles 1 and 2. The management system incorporates or is subject by law to a mechanism for the resolution of legal disputes arising within the system. Although the management authority or fishery may be subject to continuing court challenges, it is not indicating a disrespect or defiance of the law by repeatedly violating the same law or regulation necessary for the sustainability for the fishery. The management system has a mechanism to generally respect the legal rights created explicitly or established by custom of people dependent on fishing for food or livelihood in a manner consistent with the objectives of MSC Principles 1 and 2.	The management system is generally consistent with local, national or international laws or standards that are aimed at achieving sustainable fisheries in accordance with MSC Principles 1 and 2. The management system incorporates or is subject by law to a transparent mechanism for the resolution of legal disputes which is considered to be effective in dealing with most issues and that is appropriate to the context of the fishery. The management system or fishery is attempting to comply in a timely fashion with binding judicial decisions arising from any legal challenges. The management system has a mechanism to observe the legal rights created explicitly or established by custom of people dependent on fishing for food or livelihood in a manner consistent with the objectives of MSC Principles 1 and 2.	The management system is generally consistent with local, national or international laws or standards that are aimed at achieving sustainable fisheries in accordance with MSC Principles 1 and 2. The management system incorporates or is subject by law to a transparent mechanism for the resolution of legal disputes that is appropriate to the context of the fishery and has been tested and proven to be effective. The management system or fishery acts proactively to avoid legal disputes or rapidly implements binding judicial decisions arising from legal challenges. The management system has a mechanism to formally commit to the legal rights created explicitly or established by custom on people dependent on fishing for food and livelihood in a manner consistent with the objectives of MSC Principles 1 and 2.

Scoring Comments
The management system is generally consistent with local, national or international laws or standards that are aimed at achieving sustainable fisheries in accordance with MSC Principles 1 and 2.

The primary framework for the operation of the krill fishery is the Convention on the Conservation of Antarctic Marine Living Resources that came into force in 1982 as part of the Antarctic Treaty. The Antarctic Treaty and the FAO's Code of Conduct underpin all of CCAMLR's activities, and the agreement is recognized by 25 Member States and is the sole management organization for fish and krill harvesting within international waters encompassing Antarctic fisheries. Although it is part of the Antarctic Treaty System, CCAMLR has many of the characteristics of a Regional Fisheries Management Organization (RFMO) in terms of the management of fisheries and its transparency to scrutiny by all its Members.

The management system incorporates or is subject by law to a transparent mechanism for the resolution of legal disputes which is considered to be effective in dealing with most issues and that is appropriate to the context of the fishery. CCAMLR delivers clear and effective management of the fisheries under its remit. Those fisheries are regulated in accordance with the CCAMLR Convention, and are therefore consistent with international agreements. Fisheries have been evaluated at a number of meetings of the Standing Committee on operations and inspection. There are currently no licensed and regulated Antarctic fisheries operating under any controversial exemption to an international fisheries or environment-related agreement. With respect to the management undertaken by the South Georgia Government, fisheries are managed under GSGSSI ordinances, which are aligned with CCAMLR requirements. There is an ongoing dispute between the UK and Argentina with respect to the sovereignty of South Georgia, but it has no material impact on the implementation of CCAMLR requirements within Sub-area 48.3.

The management system or fishery acts proactively to avoid legal disputes or rapidly implements binding judicial decisions arising from legal challenges. Control methods implemented regionally by CCAMLR and locally by GSGSSI for combating IUU, such as enhanced monitoring, arrest of illegal vessels and legal penalties are consistent with international conventions and agreements.

Within the fishery there are no indigenous people dependent upon fishing in waters managed by CCAMLR, and no indigenous inhabitants of SGSSI, so paragraph 4 does not apply here. No settlers were historically dependent on the krill fishery, because Falkland Islanders historically only associated with the whaling stations on South Georgia. The legal rights of fishers are observed by the system, although they are not legally codified.

Score: 95

Audit Trace References

Convention on the Conservation of Antarctic Marine Living Resources. 1982.
Annual Reports from SCOI to the Commission. Annex V, CCAMLR Report of the Eighteenth Meeting of the Commission - CCAMLR XVIII
GSGSSI: South Georgia and South Sandwich Islands Fisheries (Conservation and Management) Ordinance 2002 (as amended)
CCAMLR Observer reports from the krill fishery and other fisheries with regard to compliance of the legal fishery and presence of illegal vessels.
Agnew, D. J. 2004. Fishing South. 128 pp.

3.1.2	**Consultation, roles and responsibilities** The management system has effective consultation processes that are open to interested and affected parties. The roles and responsibilities of organisations and individuals who are involved in the management process are clear and understood by all relevant parties.	Organisations and individuals involved in the management process have been identified. Functions, roles and responsibilities are generally understood. The management system includes consultation processes that obtain relevant information from the main affected parties, including local knowledge, to inform the management system.	Organisations and individuals involved in the management process have been identified. Functions, roles and responsibilities are explicitly defined and well understood for key areas of responsibility and interaction. The management system includes consultation processes that regularly seek and accept relevant information, including local knowledge. The management system demonstrates consideration of the information obtained. The consultation process provides opportunity for all interested and affected parties to be involved.	Organisations and individuals involved in the management process have been identified. Functions, roles and responsibilities are explicitly defined and well understood for all areas of responsibility and interaction. The management system includes consultation processes that regularly seek and accept relevant information, including local knowledge. The management system demonstrates consideration of the information and explains how it is used or not used. The consultation process provides opportunity and encouragement for all interested and affected parties to be involved, and facilitates their effective engagement.

Scoring Comments

Organisations and individuals involved in the management process have been identified. Functions, roles and responsibilities are explicitly defined and well understood for all areas of responsibility and interaction. Overall management lines and the responsibilities of different management bodies are clear. The main responsibility for developing and promulgating the management plan for the fishery within Area 48 lies with CCAMLR, within the framework of the Antarctic Treaty. Article XVII of the Convention details the role of the Executive Secretary of CCAMLR and any other staff that they may need to appoint. Scientists appointed by CCAMLR members meet annually in Working Groups to undertake stock assessments and prepare scientific advice for the Commission. This scientific advice is reviewed annually by the CCAMLR Scientific Committee (SC-CCAMLR), which provides management advice to the Commission. Management policies and procedures are implemented through Conservation Measures and Resolutions. The CCAMLR Convention sets out the terms under which observers can attend and participate in its statutory meetings. Within the CCAMLR Secretariat, the roles for the management of the different aspects of the fishery (compliance, data, observers, etc) are well defined and operate in a clear and efficient manner.

The management system includes consultation processes that regularly seek and accept relevant information, including local knowledge. The management system demonstrates consideration of the information and explains how it is used or not used. The overall TACs within Sub-areas of Area 48 are set by CCAMLR. Member States must comply with all regulations and requirements set (as Conservation Measures) and subsequently license their own flagged vessels. All decisions on Conservation Measures and other resolutions are made by consensus, taking a precautionary and ecosystem approach in line with established international norms. In addition, the portion of the fishery operating within the South Georgia Maritime Zone operates under the jurisdiction of the Government of South Georgia and South Sandwich Islands (GSGSSI). The Management Plan (Ordinance of 2000) specifies clearly the authorities and responsibilities of the Commissioner, Director of Fisheries, and Officers. The Director of

Fisheries is responsible for the conservation and assessment of fish stocks, the development and management of fisheries, the monitoring, control and surveillance of fishing, and fishing-related operations. The South Georgia Management Plan is well defined. GSGSSI may impose additional requirements or controls in addition to the CCAMLR requirements for the krill fishery when it operates inside the South Georgia Maritime Zone. The levels of fishing (quotas and number of vessels), the types of vessels licensed and the allowed locations of fishing are reviewed annually internally by GSGSSI and their scientific advisors as part of their review of licensing policy.

The consultation process provides opportunity and encouragement for all interested and affected parties to be involved, and facilitates their effective engagement. The process followed includes an open forum for dialogue, and encourages transparency wherever possible. All fishing companies operating in the fishery and particularly the client group are fully aware that they must ensure compliance and operation consistent with the regulations and principles of CCAMLR, GSGSSI and the flag state. The WWF – Aker BioMarine partnership has existed since 2006 with the common goal of sustainable management of fish and krill, and combating illegal harvesting. In the period 2009 through 2011, the joint activities of Aker BioMarine and WWF-Norway will include promoting environmental labelling and ensuring traceability throughout the fisheries value chain, from harvesting through to products purchased by consumers. WWF-Norway will play a key role too of bringing critical external stakeholder input into the management process for the fishery under assessment.

Score: 100

Audit Trace References

Convention on the Conservation of Antarctic Marine Living Resources. 1982.
GSGSSI: GSGSSI Fisheries (Conservation and Management) Ordinance 2000 (along with the 2002 and 2004 Amendments)
http://www.akerbiomarine.com/text.cfm?path=200&id=3-1599

SCORING CRITERIA		SCORING GUIDEPOST 60	SCORING GUIDEPOST 80	SCORING GUIDEPOST 100
3.1.3	**Long term objectives** The management policy has clear long-term objectives to guide decision-making that are consistent with MSC Principles and Criteria, and incorporates the precautionary approach.	Long-term objectives to guide decision-making, consistent with MSC Principles and Criteria and the precautionary approach, are implicit within management policy.	Clear long-term objectives that guide decision-making, consistent with MSC Principles and Criteria and the precautionary approach, are explicit within management policy.	Clear long-term objectives that guide decision-making, consistent with MSC Principles and Criteria and the precautionary approach, are explicit within and required by management policy.

Scoring Comments

Clear long-term objectives that guide decision-making, consistent with MSC Principles and Criteria and the precautionary approach, are explicit within and required by management policy. The CCAMLR krill fishery in area 48 is managed as an "assessed" fishery. Data, research plans and regulations are tailored to meeting the management needs of each of these designations (Conservation Measure 23-06 (2007)). All CCAMLR fisheries are managed within a precautionary approach, as defined by the FAO in its Code of Conduct for Responsible Fisheries (FAO, 1995) and are consistent with MSC Principles and Criteria.

Score: 100

Audit Trace References

CCAMLR Conservation Measure 23-06 (2007) "Data reporting system for *Euphausia superba* fisheries "

3.1.4	**Incentives for sustainable fishing** The management system provides economic and social incentives for sustainable fishing and does not operate with subsidies that contribute to unsustainable fishing.	The management system provides for incentives that are consistent with achieving the outcomes expressed by MSC Principles 1 and 2.	The management system provides for incentives that are consistent with achieving the outcomes expressed by MSC Principles 1 and 2, and seeks to ensure that negative incentives do not arise.	The management system provides for incentives that are consistent with achieving the outcomes expressed by MSC Principles 1 and 2, and explicitly considers incentives in a regular review of management policy or procedures to ensure that they do not contribute to unsustainable fishing practices.

Scoring Comments

The management system provides for incentives that are consistent with achieving the outcomes expressed by MSC Principles 1 and 2, and seeks to ensure that negative incentives do not arise. There is clear evidence in the Articles that the management system in place is seeking to ensure that negative incentives do not arise. Notable too is that the Aker BioMarine operation receives no national subsidy, and moreover the CCAMLR system has no capacity to provide subsidies of any sort. Costs related to the operation and management of the Commission are fully recovered from Member States through their membership fees. CCAMLR has no policy on whether Member States should subsidise their vessels. The GSGSSI does not provide subsidies of any sort (pers. comm., Harriet Hall, CEO GSGSSI), recovering their fisheries management operational costs from licensed vessels through the charging of licence fees. Direct and indirect subsidies almost certainly exist to varying degrees in some of those states. There are definitely no subsidies in Norwegian fisheries for krill, for fishing in general or for sustainable fishing. There is, however, an implicit incentive to meet national (Norway), CCAMLR and GSGSSI requirements in terms of licensing, observer requirements and data reporting, to ensure that Norwegian fishing operations are well placed to ensure future licensing in the fishery.

The krill fishery in Area 48 is nevertheless made up of vessels from a number of different nations, and the notification system operative leaves a lot to be desired; indeed it is currently virtually meaningless.

Score: 80

Audit Trace References

Obligations on the Commission and Members as set out in Article 2 of the Convention.

SCORING CRITERIA	SCORING GUIDEPOST 60	SCORING GUIDEPOST 80	SCORING GUIDEPOST 100

3.2	Fishery- specific management system

3.2.1	**Fishery- specific objectives** The fishery has clear, specific objectives designed to achieve the outcomes expressed by MSC's Principles 1 and 2.	Objectives, which are broadly consistent with achieving the outcomes expressed by MSC's Principles 1 and 2, are implicit within the fishery's management system.	Short and long term objectives, which are consistent with achieving the outcomes expressed by MSC's Principles 1 and 2, are explicit within the fishery's management system.	Well defined and measurable short and long term objectives, which are demonstrably consistent with achieving the outcomes expressed by MSC's Principles 1 and 2, are explicit within the fishery's management system.

Scoring Comments

Short and long term objectives, which are consistent with achieving the outcomes expressed by MSC's Principles 1 and 2, are explicit within the fishery's management system. The CCAMLR management system is encapsulated in Article 2 of its Convention and provides well-defined, measurable short- and long-term objectives. The management system has the following three objectives:

(a) prevention of decrease in the size of any harvested population to levels below those which ensure its stable recruitment. For this purpose its size should not be allowed to fall below a level close to that which ensures the greatest net annual increment;

(b) maintenance of the ecological relationships between harvested, dependent and related populations of Antarctic marine living resources and the restoration of depleted populations to the levels defined in sub-paragraph (a) above;

(c) prevention of changes or minimization of 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 of the effects of environmental changes, with the aim of making possible the sustained conservation of Antarctic marine living resources.

The aims of these three objectives mirror and preceded the establishment of the aims of MSC Principles 1 and 2. CCAMLR's strategy for achieving these objectives is reflected in quantitative annual TACs (e.g. as defined in Conservation Measure 51-01 (2008) and annually reviewed), set to ensure that each fishery complies with the long-term objectives above. A precautionary krill catch limit of 3.47 million tonnes is set for Area 48, based on the potential yield estimate. This is well above the current catch and will allow for expansion. However, a "catch trigger" (620 000 t) is set not to be exceeded until a procedure for division of the overall catch limit into smaller management units has been established, based on advice from the Scientific Committee. The objective of this division is to avoid possible unacceptable concentration of catch within the foraging areas of vulnerable predators. Although the trigger level is close to the highest global annual catch to date, it is significantly more than the largest annual catch to date in Area 48.

The Environmental Charter for South Georgia (adopted in 2001) contains clear and specific long-term goals for fisheries in the area, and for the protection of the ecosystem; short-term goals for the fisheries in the SGMZ are implicit, not explicit. Research objectives in other fisheries in the area have included bycatch reduction, resulting in the implementation of closed areas to fishing to reduce bycatch of benthos, linked to the implementation of plans put in place to meet conditions of MSC certification.

Overall, although the fishery-specific objectives are stated, they are not particularly well-defined in all cases, especially in terms of larval bycatch issues. We note, though, that they are well-defined in terms of acceptable stock and trophic impacts

Score: 85

Audit Trace References

Convention on the Conservation of Antarctic Marine Living Resources. 1982.
GSGSSI: Environmental Charter for South Georgia and The South Georgia Plan for Progress: Environmental Management Plan http://www.sgisland.gs/index.php/(g)charter?useskin=gov
CCAMLR Conservation Measure 51-01 (2008) "Precautionary catch limitations on *Euphausia superba* in Statistical Subareas 48.1, 48.2, 48.3 and 48.4."

SCORING CRITERIA		SCORING GUIDEPOST 60	SCORING GUIDEPOST 80	SCORING GUIDEPOST 100
3.2.2	**Decision-making processes** The fishery-specific management system includes effective decision-making processes that result in measures and strategies to achieve the objectives.	There are informal decision-making processes that result in measures and strategies to achieve the fishery-specific objectives. Decision-making processes respond to serious issues identified in relevant research, monitoring, evaluation and consultation, in a transparent, timely and adaptive manner and take some account of the wider implications of decisions.	There are established decision-making processes that result in measures and strategies to achieve the fishery-specific objectives. Decision-making processes respond to serious and other important issues identified in relevant research, monitoring, evaluation and consultation, in a transparent, timely and adaptive manner and take account of the wider implications of decisions. Decision-making processes use the precautionary approach and are based on best available information. Explanations are provided for any actions or lack of action associated with findings and relevant recommendations emerging from research, monitoring, evaluation and review activity.	There are established decision-making processes that result in measures and strategies to achieve the fishery-specific objectives. Decision-making processes respond to all issues identified in relevant research, monitoring, evaluation and consultation, in a transparent, timely and adaptive manner and take account of the wider implications of decisions. Decision-making processes use the precautionary approach and are based on best available information. Formal reporting to all interested stakeholders describes how the management system responded to findings and relevant recommendations emerging from research, monitoring, evaluation and review activity.

Scoring Comments

There are established decision-making processes that result in measures and strategies to achieve the fishery-specific objectives. CCAMLR has well established, transparent and effective decision-making processes. They allow for stakeholder input and clear scientific analysis of the data available within the Working Groups and Scientific Committee, and they result in conservation measures and fisheries strategies designed to achieve their short- and long-term fishery-specific objectives.

Decision-making processes respond to serious and other important issues identified in relevant research, monitoring, evaluation and consultation, in a transparent, timely and adaptive manner and take account of the wider implications of decisions. Generally, fisheries-specific issues identified in relevant research are included in the decision-making processes within the Working Groups and Scientific Committee as appropriate. Where and when necessary, modifications are made to the monitoring and evaluation of the fisheries (through modifications to the complex data-recording systems and observer logbooks). However, we note that there has not yet been adherence to all relevant management issues, notably the need to employ independent international observers to monitor the fishery.

Decision-making processes use the precautionary approach and are based on best available information. The CCAMLR decision-making processes operate on a well-publicized schedule and include stakeholder involvement, including observers from different NGOs and stakeholder and interested bodies. CCAMLR has shown, for example through the reduction of seabird mortality and measures to identify and protect VMEs that it is proactive in meeting newly identified management issues. All CCAMLR decision-making on catch limits is based on the precautionary approach (see documentation in section 6 above) and the best available information by national experts working closely together in Working Groups, the Scientific Committee and the Commission.

Formal reporting to all interested stakeholders describes how the management system responded to findings and relevant recommendations emerging from research, monitoring, evaluation and review activity The whole CCAMLR process is based on dialogue and formal reporting.

Score: 90

Audit Trace References

CCAMLR Commission Reports. www.ccamlr.org

3.2.3	**Compliance and enforcement** Monitoring, control and surveillance mechanisms ensure the fishery's management measures are enforced and complied with.	Monitoring, control and surveillance mechanisms exist, are implemented in the fishery under assessment and there is a reasonable expectation that they are effective. Sanctions to deal with non-compliance exist and there is some evidence that they are applied. Fishers are generally thought to comply with the management system for the fishery under assessment, including, when required, providing information of importance to the effective management of the fishery.	A monitoring, control and surveillance system has been implemented in the fishery under assessment and has demonstrated an ability to enforce relevant management measures, strategies and/or rules. Sanctions to deal with non-compliance exist, are consistently applied and thought to provide effective deterrence. Some evidence exists to demonstrate fishers comply with the management system under assessment, including, when required, providing information of importance to the effective management of the fishery. There is no evidence of systematic non-compliance.	A comprehensive monitoring, control and surveillance system has been implemented in the fishery under assessment and has demonstrated a consistent ability to enforce relevant management measures, strategies and/or rules. Sanctions to deal with non-compliance exist, are consistently applied and demonstrably provide effective deterrence. There is a high degree of confidence that fishers comply with the management system under assessment, including, providing information of importance to the effective management of the fishery. There is no evidence of systematic non-compliance.

Scoring Comments

Evaluation of this performance indicator takes into consideration the operation of Aker BioMarine vessels and the Norwegian national system for reporting and compliance.

A comprehensive monitoring, control and surveillance system has been implemented in the fishery under assessment and has demonstrated a consistent ability to enforce relevant management measures, strategies and/or rules. CCAMLR provides a clear and comprehensive monitoring system and control framework for Antarctic fisheries. Surveillance of CCAMLR fisheries is undertaken by Member States and incorporates the CCAMLR system of inspection. There is little IUU pressure on the krill fishery and no significant IUU activity has ever been recorded in the krill fishery in Area 48. In other CCAMLR fisheries where IUU has been a problem, the Commission has demonstrated a commitment to enforce relevant conservation and management measures, IUU reduction strategies and management rules through the provision of inspection protocols at sea and in port, and through observer programmes. Norway and Aker BioMarine, comply completely, and even beyond, the CCAMLR requirement for compliance and reporting.

Sanctions to deal with non-compliance exist, are consistently applied and demonstrably provide effective deterrence. The implementation of sanctions to deal with non-compliance is an issue for Member States, either through flag state control, or, in the case of South Georgia through GSGSSI coastal state jurisdiction over the Maritime Zone.

Sanctions within the South Georgia Maritime Zone are applied at a level appropriate for deterring IUU fishing. Norwegian interest in the future of the Antarctic krill fishery ensures that, as for all other Norwegian fisheries interests, all regulations on the fishery now, and almost certainly all that may be applied in future, are closely monitored and adhered to.

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There is a high degree of confidence that fishers comply with the management system under assessment, including, providing information of importance to the effective management of the fishery. Fishers seeking certification comply with the management system, providing information on the fishery prior to (Notification of Intent) and during fishing (C1 and observer data), at the levels defined by CCAMLR and GSGSSI to provide effective management of the fishery. There is no evidence of systematic, indeed any, non compliance.

Score: 100

Audit Trace References

CCAMLR Observer Scheme.
CCAMLR Observer Reports
CCAMLR Conservation Measure 23-06 (2007) "Data reporting system for *Euphausia superba* fisheries "
CCAMLR C1 trawl logbook. http://www.ccamlr.org/pu/e/sc/fish/C1v2008trawlE.xls
CCAMLR scientific observer data

3.2.4	**Research plan** The fishery has a research plan that addresses the information needs of management.	Research is undertaken, as required, to achieve the objectives consistent with MSC's Principles 1 and 2. Research results are available to interested parties.	A research plan provides the management system with a strategic approach to research and reliable and timely information sufficient to achieve the objectives consistent with MSC's Principles 1 and 2. Research results are disseminated to all interested parties in a timely fashion.	A comprehensive research plan provides the management system with a coherent and strategic approach to research across P1, P2 and P3, and reliable and timely information sufficient to achieve the objectives consistent with MSC's Principles 1 and 2. Research plan and results are disseminated to all interested parties in a timely fashion and are widely and publicly available.

Scoring Comments

A comprehensive research plan provides the management system with a coherent and strategic approach to research across P1, P2 and P3, and reliable and timely information sufficient to achieve the objectives consistent with MSC's Principles 1 and 2. A comprehensive research plan by CCAMLR exists for krill fisheries, focusing on the monitoring of krill catches, scientific observation and environment monitoring. The research plan and its results are disseminated to all interested parties in a timely fashion and are widely and publicly available. The CCAMLR Ecosystem Monitoring Programme (CEMP; Agnew 1997) provides cross-cutting data on environment and predator abundance to link into fisheries data and targets research at an ecosystem approach to management of the krill fishery.

An additional research programme for the client group vessels has been developed between Aker BioMarine and British Antarctic Survey and utilising CCAMLR Scientific Observers supplied by MRAG Ltd for 2009. Data requirements above and beyond the standard set of CCAMLR observer data have been defined and will be implemented.

The research plan and results are disseminated to all interested parties in a timely fashion and are widely and publicly available

Score: 100

Audit Trace References

Agnew, D. J. 1997. The CCAMLR Ecosystem Monitoring Programme. Antarctic Science, 9: 235-242.
CCAMLR website – CCAMLR Ecosystem Monitoring Programme http://www.ccamlr.org/pu/e/sc/cemp/intro.htm.
CEMP Standard Methods http://www.ccamlr.org/pu/e/e_pubs/std-meth04.pdf

SCORING CRITERIA		SCORING GUIDEPOST 60	SCORING GUIDEPOST 80	SCORING GUIDEPOST 100
3.2.5	**Monitoring and management performance evaluation** There is a system for monitoring and evaluating the performance of the fishery-specific management system against its objectives. There is effective and timely review of the fishery-specific management system.	The fishery has in place mechanisms to evaluate some parts of the management system and is subject to occasional internal review.	The fishery has in place mechanisms to evaluate key parts of the management system and is subject to regular internal and occasional external review.	The fishery has in place mechanisms to evaluate all parts of the management system and is subject to regular internal and external review.

Scoring Comments

The fishery has in place mechanisms to evaluate all parts of the management system and is subject to regular internal and sometimes external review. CCAMLR conducts ongoing internal reviews of its processes and the performance of its Member States to meet the fishery-specific management requirements outlined. These requirements are reviewed annually (to fit in with the annual fisheries cycle) by the appropriate CCAMLR Working Groups (e.g. seabird mortality will be analysed by the Working Group on Incidental Mortality of Associated Fauna). Any vessels or Member States not meeting the required levels may not be allowed to fish in those specific fisheries.

CCAMLR was subject to a comprehensive external performance review during 2008, but such external review is not regular. The review was carried out by a panel appointed by the Commission composed of nine persons (see http://www.ccamlr.org/pu/E/revpanrep.htm. The purpose of the performance review was to evaluate the Commission's performance against comprehensive criteria and specifically against the objectives and principles set out in Article II of the Convention. The review states that the stock status and trends are broadly consistent with Article II of the Convention and international best practice. With particular reference to krill fisheries, it identified the need for ongoing research into predator–prey linkages in ecosystem modelling and adequate monitoring and management within krill fisheries.

Score: 90

Audit Trace References

CCAMLR Performance Review http://www.ccamlr.org/pu/E/00-Prfrm-Review-for-public-webpage.pdf .

Appendix B: Peer Review Reports

1. Peer Reviewer Biographies
2. Peer Review Report A
3. Peer Review Report B

APPENDIX B1: Peer Reviewer Biographies

The assessment report was peer reviewed by the following (presented in alphabetical order):

Dr. Inigo Everson. Inigo is an Honorary Visiting Professor at Anglia Ruskin University, Cambridge undertaking research into fisheries issues. Whilst at FAO in 1976, he was a key scientific contributor to the negotiation of CCAMLR, an organisation in which he has chaired the Scientific Committee, along with the Working Groups on Fish Stock Assessment and Ecosystem Monitoring and Management. He was a member of the UK delegation to CCAMLR for 20 years. He has experienced Southern Ocean fisheries at first hand, having led a number of trawl and acoustic surveys as well as being an International CCAMLR Fisheries Inspector. His research, spanning over 40 years has resulted in over 100 peer reviewed papers mainly on Antarctic fish, krill and ecosystem interactions. More recently he has been involved in assessment of the fishery resources of Lake Victoria, East Africa.

Dr. Stephen Nicol BSc.(Hons.) Zoology, Aberdeen, MSc. Oceanography, Southampton PhD. Biology, Dalhousie.Born: Dublin, Ireland, educated in: Ireland, England, U.S.A., Scotland and Canada. My PhD thesis was on North Atlantic krill and I have continued to work on krill ever since in Canada, South Africa and Australia. Joined the krill research team at the Australian Antarctic Division in 1987 and have participated in eight Antarctic cruises, four of which I have organized and led. I have been Program Leader of one of the AAD’s science programs on and off since 1992. Research interests include all aspects of the biology and ecology of krill, Antarctic fisheries, and the dynamics of Southern Ocean ecosystems. Have been on Australia's Delegation to the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) since 1987 and have served as office holder in CCAMLR as well as in a number of international scientific organizations. I’m on the Steering Group of the Southern Ocean Global Ecosystem Dynamics (GLOBEC) and the Integrated Circumpolar Climate Interactions and Ecosystem Dynamics (ICED) Programs.

APPENDIX B2: Peer Review Report A

MSC Assessment: AKER BioMarine Antarctic krill fishery

1. The accuracy of the Information quoted in the report:

Section 4.2 Spatial Distribution.
Final paragraph of the section: Throughout this section the authors use a number of terms to describe the spatial distribution of krill. Paragraphs 5, 6 and 7 outline a pattern of krill moving with the main circulation pattern. This is in conflict with the conclusions in the final paragraph which is implying the expectation of minimal inter-mixing.

The situation is difficult to describe succinctly and I would delete the first part of the final paragraph and only retain the final sentence.
Moody Marine Comment: Agreed and the confusing text has been deleted.

Section 4.4. Fleet and gear description.
Second paragraph. If trawling is limited to a wind speed of less than 10 knots then I suggest that not much fishing is likely to be undertaken. I suggest that figure is incorrect or else the fishing method is optimistic in its ability to operate in the Southern Ocean.
Moody Marine Comment: Agreed and the text has been deleted.

Section 5.2. Catch and Bycatch monitoring
The question of Conversion factors is important. The extreme values quoted do not take full account of how the information is used to determine the amount of 'removals'. The situation clearly requires monitoring as is stated and this appears to be covered adequately by the current management system.
Moody Marine Comment: Agreed.

Section 5.3. Harvest Control Rule
The text in this section appears to be composed largely of parts of different explanations of the story. In order to make clear the distinction between the two values of gamma I suggest the inclusion of an explanatory diagram such as Figure 1 of SC-CAMLR (1994) paragraphs 5.18 to 5.26.
Moody Marine Comment: Diagram has been added to the report (see Figure 4)

Section 6.1.
Paragraph 3 contains the sentence starting 'The aims of these three objectives mirror the aims of MSC Principles 1 and 2.' I suggest this be reworded to record the fact that the MSC Principles are very much in line with those of CCAMLR which preceded it by a quarter of century. NB The orientation of the image seen in a mirror is the opposite of the object!
Moody Marine Comment: Good point, though the subject is mentioned elsewhere. Text has been changed to be more neutral.

Section 6.2.
The first paragraph may be accurate but it is a little difficult to follow. It might benefit from setting the different components out as 'bullet points'
Moody Marine Comment: We can understand that the reviewer finds this issue complicated, but the MSC evaluation panel did so too, and deliberations on license take-up are happening at this very moment, and were doing so while the evaluation was underway. The danger with bullet points is that they become fact, so here we would prefer to leave the paragraph as is; perhaps open to difficulties in understanding, but at least there is acknowledgement that the situation is changing all the time. Therefore, no change preferred.

Section 7.4.
In the paragraph on seals it would be worth mentioning Weddell seals as non-krill feeders.

Moody Marine Comment: Agreed, Weddell seals have been noted at the end of the first sentence of that paragraph. "with the exception of the elephant seal (Laws, 1984) and Weddell seal."

MSC Assessment: AKER BioMarine Antarctic krill fishery
2. Whether this information has been applied appropriately to the scoring indicators used in the table.

1.1.1. I agree with the comments raised

1.1.2. The comment states that the aim is to maintain the spawning biomass at or above 75% of the spawning level. I understand from the source papers, particularly SC-CAMLR (1994) paragraphs 5.18 to 5.26, that, in simple terms, the model is aiming to indicate a level of harvest that would not reduce the median SSB below 75% of the 'unexploited' value. The 20% value relates the modelled SSB falling below that value no more than twice during the 20 year simulated period. In Section 6.5 it is noted that the Precautionary Catch Limit, based on the model, is 3.47 million tonnes. At the time of the adoption of that value it was agreed that further controls would be appropriate to take account of the impact of localised fishing. It is not clear whether the Condition relates to Area 48, Subarea 48.3 or the SSMU. Arising from this it is not clear what is to be expected from Condition 1. Some clarification can be achieved by reference to Figure 3 (Everson 2000 Fig 8.9) and the Condition made more specific. In my view the main requirements of this Condition are explained in Scoring Criterion 1.2.1. and further developed in 2.5.2. which, if true, makes the Condition superfluous.
Moody Marine Comment: Condition 1 is required to identify reference points consistent with the de facto harvest control rule and cross referencing the monitoring indices with the rule which is based on catch alone. This is partly the result of the interpretation of the MSC assessment team which, despite the many uncertainties, recognise that the fishery is currently at low risk based on the 620 000t catch limit. It is important, and a requirement under the MSC principles, to be able to interpret the monitoring indices relative to what might be expected to be associated with the harvest level. The condition relates to the entire stock for which the catch limit applies (Area 48).

1.1.3. Even in the context of 'Olympic' fishing CCAMLR has a record of closing fisheries when a TAC has been reached. Consequently the 620,000t, should it be approached in any season, will initiate closure. Allowing the fishery to go beyond the 620,000 t level necessitates agreement on the SSMU breakdown which means that this lower value effectively remains the TAC until there is consensus on the application of SSMUs.
Moody Marine Comment: Agreed; no change is necessary.

1.2.1. CCAMLR has a record of instituting a process for providing information to clarify such a situation. This occurred in the Subarea 48.3 toothfish fishery in 1994. It should be noted however that the arrangement was set up in the form of a designed experiment that was manageable with a TAC of a few thousand tonnes. It would present much greater difficulties in this context but could be organised.
Moody Marine Comment: Agreed; no change is necessary.

1.2.2. I agree with the comments raised.

1.2.3. I agree with the comments raised.

1.2.4. I agree with the comments raised.

2.1.1. There are a number of issues raised in this section.
Myctophids are widespread and present in the region although in Subarea 48.3 they tend to be distributed further offshore than the main, fishable, krill aggregations. This has been covered adequately in the scoring points.

The following additional points should be considered with respect to *Champsocephalus gunnari*. Larval stages are not present year round and consequently are only likely to be at risk for a limited period. The most important concentrations of these larval fish will be present in locations where the water circulation will lead to their retention on the shelf. These are not necessarily the same localities as those of the fishable krill aggregations because those concentrations occur in the localities where they have been brought to the region on the Antarctic Circumpolar Current. Consequently the associated Risk Assessment should take account of water circulation with respect to the krill fishery, krill distribution and larval fish distribution as well as the annual cycle of larval fish production

Moody Marine Comment: Text has been added to this effect.

2.1.2. The comments in 2.1.1. apply in this context. I agree with the conclusions but would encourage the study to take account of water circulation patterns and seasonal effects on larval fish presence.
Moody Marine Comment: Text has been added to this effect.

2.1.3. I agree with the comments raised on this topic.

2.2.1. This topic is normally considered in two parts. One related to birds, seals and whales, a consideration covered fully by the submission. The second relates to larval fish.

Moody Marine Comment: Given that evidence suggests that the vast majority of larval fish are retained due to the method of fishing, larval fish are here fully considered under 'retained species' in Section 2.1. Those larval fish that are not retained – i.e. that escape through the cod end – are limited. The text has been clarified to reflect this.

2.2.2. I agree with the comments raised on this topic.

2.2.3. I agree with the comments raised on this topic

2.3.1. I agree with the comments raised on this topic

2.3.2. I agree with the comments raised on this topic.

2.3.3. I agree with the comments raised on this topic.

2.4.1. I agree with the comments raised on this topic.

2.4.2. I agree with the comments raised on this topic.

2.4.3. I agree with the comments raised on this topic

2.5.1. I agree with the comments raised on this topic.

2.5.2. The comments in this section demonstrate that the fishery regime is structured to take account fully of the requirements of Article II of CCAMLR. This is an evolving situation that relies on the best scientific advice as was hoped in the negotiation of that Convention. In that respect the system is working as originally planned.

2.5.3. All key points are covered in the submission.

3.1.1. I agree with the comments raised on this topic.

3.1.2. I agree with the comments raised on this topic.

3.1.3. I agree with the comments raised on this topic.

3.1.4. The current 'trigger' level for the fishery is substantially lower than the estimated precautionary TAC from the GYM. Seen in that light there is, at least in theory, spare capacity that cannot be used until such time as the scientific study on the evaluation of the SSMUs has been completed and agreed by Members. In the event that there is pressure to increase the krill fishery beyond the current trigger level there is the added incentive that such an expansion is predicated on the application of the SSMU system.

The point about Notifications is well taken. A large number of speculative notifications adds significantly to the workload associated with administering the fishery. CCAMLR is aware of this and is taking steps to make

notifications more realistic. Within the area controlled by GSGSSI the number of vessels is likely to be controlled such that the PUCL is not reached.
Moody Marine Comment: Noted

3.2.1. The MSC Principles are in agreement with the aims of CCAMLR rather than the opposite. That apart I agree with the other points raised.
Moody Marine Comment: text has been altered.

3.2.2. I agree the comments raised on this topic. I would note however that generally speaking CCAMLR does not allocate quotas but rather sets catch limits. The only exception is outlined in section 1.2.1. of these notes.
Moody Marine Comment: The reviewer is correct and the text has been altered to reflect this.

3.2.3. I agree with the comments raised on this topic.

3.2.4. Mention has been made of the time delay between large-scale estimates of krill abundance in Area 48. Addressing this either directly or through smaller scale surveys that are integrated into an overall plan to detect changes in krill abundance is part of the plan.

The small scale surveys are designed to take account of variation in local krill demand by dependent species and the evidence provided indicates that this is probably covered adequately. Large scale surveys, currently at approximately decadal intervals should take account of longer term variation, such as due to climate change. Although it would useful to increase the frequency of such surveys the current timescale is probably adequate to determine such large scale effects. In this respect the SSMU controls provide a further buffer to exercise greater control and hence avoid the chance of excessive catches.

Note that CEMP is the 'CCAMLR Ecosystem Monitoring Programme'.
Moody Marine Comment: Again the reviewer is correct about the aims and likely outputs and achievements of the various surveys, but no change is wording is necessitated because his explanation should be viewed as a knowledgeable supplement to what is written already. However, the error in the full name of CEMP does need correction to "CCAMLR Ecosystem Monitoring Programme". The error is regretted.

3.2.5. I agree with the comments raised on this topic.

Comments raised in Appendix D1.

> *Comment (1) Standing stock estimates of krill are subject to wide confidence limits on a regional and local basis. These estimates are based on relatively old survey data and the aggregate data do not comprise a sufficient time series to resolve key questions attached to long term krill population trends and potential impacts upon krill dependent predators.*

The main concerns raised are addressed in sections 1.1.2., 1.1.3. and 1.2.1. In addition the following points need to be taken into account:

the 'trigger level' is set much lower than the estimated precautionary TAC
there are safeguards whereby the trigger level is reviewed in the light of studies on the SSMUs
the potential yield is a very small proportion of krill production as estimated from predator demand.

Accordingly, whilst these are reasonable concerns they do not constitute a reason for downgrading the Performance Indicators.

> *Comment (2) Management of krill is on the basis of a single species model which cannot accommodate fully uncertainties and indeterminacies in the data. Impacts of climate change on krill have been poorly characterised but may be substantial. Currently the models used to manage the species do not account for long term environmental change. Factors associated with success of krill recruitment have not been well characterised.*

The uncertainties mentioned by the authors have been included in the assessment model which although a single species model as stated is moderated by a discount factor to take account of predator demand. This does not mean that there is no need for further improvement and refinement along the lines stated.

The timescale of effects resulting from climate change have been addressed in Scoring table section 3.2.4.

> *Comment (3) Determinants and drivers of the population structure are incompletely understood and the causes of inter- and intra-annual variation in krill populations are poorly understood.*

These points have been adequately dealt with in the Scoring Points.

> *Comment (4) Predator-prey dynamics are incompletely understood and, therefore, management feedback systems are difficult to devise to assure full protection.*

The main concerns appear to have been covered by the establishment of the SSMUs as management units.

MSC Certification of the Krill Fishery

The points raised under the three sections have been adequately considered in the submission and adequate comment made in the Scoring Points.

I do not see new information being brought forward in this report that would lead to the conclusions made in Appendix D.1.

Appendix D.2.
Analysis on the eligibility of Aker Biomarine's Krill Fishery Operations for MSC Certification.

Principle 1
1.2.1. There is a robust and precautionary harvest strategy in place.

The key points raised have been addressed in the Scoring Tables. In addition it should be noted that the PUCL, which is set at around 18% of the estimated Precautionary Catch Limit, provides a further buffer in the event of rapid change.

1.2.2. Harvest control rules and tools

Whilst the arithmetic indicates that *in extremis* the actual removals may vastly exceed the recorded amounts, in reality this is an unlikely scenario. The key topic for action is that standardisation of reporting such that reliable estimates of total removals can be made is important. The management regime is aware of this and action is in progress.

1.2.3. Information/Monitoring

For a number of years SC-CAMLR has been seeking consistent Observer coverage on all krill fishing vessels. This has been continually under review and progress has been made in the past year.

Principle 2.

2.2.1. The fishery does not pose a risk of serious or irreversible harm to the bycatch species or species groups and does not hinder recovery of depleted bycatch species or species groups.
And
2.2.2. There is a strategy in place for managing by catch that is designed to ensure the fishery does not pose a risk of serious or irreversible harm to bycatch populations.
And
2.2.3. Information/Monitoring on bycatch

This is a potential problem but is one that is being addressed through the implementation and strengthening of the Observer programme. Questions related to birds, seals and whales have been fully considered. Questions related to larval and juvenile fish are covered within 2.1.3.

2.3.1. Endangered, Threatened or Protected Species.
2.3.2. Management strategy
2.3.3. Information/Monitoring

The criticism here is centred on the uncertainties over the baleen whale recovery. Bearing in mind that the estimated krill consumption by baleen whales at their peak was of the order of 100 million tonnes it seems inconceivable that a catch of around 0.5% of that figure will adversely impact their recovery.
Whales are not considered explicitely within CCAMLR as they remain the prerogative of the IWC as is stated in the CCAMLR Convention.

Ecosystem considerations
2.5.1. The fishery does not cause serious or irreversible harm to the key elements of the ecosystem structure and function.
2.5.2. There are measures in place to ensure the fishery does not pose a risk of serious or irreversible harm to ecosystem structure and function.
2.5.3. There is adequate knowledge of the impacts of the fishery on the ecosystem.

All of the points made in this criticism have been adequately dealt with in the assessment.

Principle 3.

3.2.2. The fishery-specific management system includes effective decision-making processes that result in measures and strategies to achieve the objectives.

The main criticism centres around the CCAMLR International Observer Programme and it is noted that 100% Observer coverage starting in December 2009. With that scheme in place the key issues will have been met.

3.2.3. The fishery has a research plan that addresses the information needs of management.
The supporting information provided in the submission and the descriptions of current and planned actions provides a management plan in all but name. The evidence brought forward indicates a high level of scientific commitment and integration coupled with a strong desire to ensure a sustainable long-term krill fishery.

The information brought forward in this submission does not support the view that this fishery submission fails to achieve SG60.

Appendix D.3. WWF

Comments on Catch limit, SSMUs and Technology.

The statements made are supportive of the mechanism that is in place or are being established. No further comment is necessary.

Comments on Scientific Observers.

The comments are in line with planned actions. In addition the point is made that full Observer Coverage on the Aker Biomarine project will allow valid comparisons with other fishing methods. Such a comparison will be improved by 100% Observer coverage on all krill fishing vessels, an added incentive to ensure implementation of this process.

Comments on Research and Monitoring

A valid concern is raised over the extent of support for the CEMP and its integration into the management process. The difficulty with this system is that the CEMP programme is being largely supported by institutions not engaged directly in the fishery. It is valid to highlight this issue although in the present situation this does not detract from the main submission.

Comments on the impacts of Climate Change

This a valid point that is receiving consideration, however, with the current level of harvesting climate change is likely to affect the fishery and dependent species before the fishery begins to impact krill predators.

MSC Assessment: AKER BioMarine Antarctic krill fishery

3. Whether the interpretation of this information justifies the decision made on whether to certify the fishery

The information in the original submission has been interpreted correctly in arriving at the decision on the main performance indicators leading to fishery certification.

MSC Assessment: AKER BioMarine Antarctic krill fishery

4. The suitability of the conditions attached to certification.

Consideration should be given to providing a clearer specification to the requirements of Condition 1 paying attention to the time and space scales of the proposed work.
Moody Marine Comment: The condition is fairly clear, in our opinion, in requiring reference points consistent with the de facto harvest control rule (i.e. the 620 000 t) catch limit. It should be noted that as a Certification Body, we cannot prescribe to clients what should be done in meeting conditions – we concentrate on the outcome of the actions taken.

Regarding Condition 2 consideration should be given to including a component to assess the season, localities and residence times on the shelf of larval fish as compared to fishable krill aggregations.
Moody Marine Comment: This point could be considered by the client.

APPENDIX B3: Peer Review Report B

General points.
It is very encouraging to see that a krill fishing company is going through the MSC process openly and transparently. For much of the period of operation of the krill fishery it has proved extremely difficult to obtain even basic information about fishing operations and plans with the result that the conservation management approach adopted by CCAMLR has not made as much progress as it could have.

Throughout the document there is a reliance on the collecting of scientific information (either through formal channels such as CEMP or through national Antarctic Programs) to support the concept of a well managed fishery. Unfortunately with most of the data collected, there is no established link to management and no decision rules about what to do if an indicator suggests that the fishery is not operating in a sustainable fashion. In a political organisation such as CCAMLR which operates by consensus this is a serious problem and can lead to inaction even when a problem may have been identified.

Specific comments on individual sections and paragraphs.
I have made comments on sections of text which are highlighted in italics. Where no comment is recorded I generally agree with the tenor of the comments made.

P3. section 2.3 Stakeholder meetings attended
It is worth noting that there is very little evidence of meetings or interactions with experts involved in the management of the krill fishery through CCAMLR or of those who have an intimate knowledge of krill biology and ecology. This lack of direct input is reflected in some areas of the report where somewhat naïve statements are made. These will be highlighted under the various sections. Although it must have been difficult to attract experts to participate in the process, the lack of a formal interaction with CCAMLR is a notable omission.
Moody Marine Comment: The assessment team has met with representatives of the Norwegian delegation to CCAMLR and with scientists active in the CCAMLR process. In combination with our other meetings and information gathering, we feel that this has provided more than sufficient information for us to make an evaluation of the fishery against the MSC standard. Of course, we also have the peer reviewers' expertise to call upon.

p.11. 4. BACKGROUND TO THE FISHERY
The discussion on distribution of krill relies quite heavily on older information. There have been three large scale acoustic biomass surveys conducted for CCAMLR which have been used to establish precautionary catch limits on the krill fishery. Additionally there are reanalyses of historical net data that have been recently published which describe the range and distribution of krill.
Moody Marine Comment: The outline on krill distribution was drawn primarily from the species profile. It is not intended to be an up-to-date review of the academic literature, but should provide some general background pertinent to the scoring. Some more recent additional references have been added.

p. 11. Krill are also abundant in the vicinity of South Georgia (Subarea 48.3) especially during the austral winter

Although the fishery operates mostly around South Georgia in winter this is for operational reasons, not because densities are more abundant in winter. There is no evidence that krill abundance in winter at South Georgia is higher than in other seasons.
Moody Marine Comment: Text has been amended by deleting "especially…".

4.3 History of the Fishery
p. 15. Recently there has been a resurgence of interest in fishing for krill from new countries such as the UK, Argentina, USA and Canada.

The most significant new entrant into the krill fishery in recent years has actually been Norway with Aker Biomarine being followed by at least two other Norwegian companies. The recent history of the fishery is characterised by the decline in interest by Japan and a rise in interest by new entrants. Canada has not fished for krill.
Moody Marine Comment: The reference is to an expressed interest, but given the weaknesses noted in the notification scheme, we accept the limitations involved. Norway has been added to the list, Canada has been removed.

p. 16. A wide variety of trawl net configurations are used (S-CAMLR 2008a), which is likely to have a strong influence on gear selectivity. Information on the type of krill trawl nets used is recorded by observers in their logbook and cruise report, with some observers including net designs, but the level of detail recorded varies greatly.

This variability may be a serious problem for CCAMLR because it affects efforts to establish measures of effort and also makes it extremely difficult to examine general issues such as incidentally mortality of krill caused by the fishing operation. The allusion to the observers reports fails to note that there have been very few observers reports ever submitted to CCAMLR (35 at last count in the 27 years of CCAMLR's operation) so it is even more difficult to assess whether different gear types represent a problem that needs to be addressed.
Moody Marine Comment: Text added "… and the observer coverage has been low."

p. 20. Biomass Estimates and Abundance Indices
The significant difference between the various estimates raises uncertainty (Everson 2008; Brierley et al. 2008), although the lowest estimate is still used for the potential yield.

The uncertainty caused by the different estimates of biomass produced by alternative methods of analysing the acoustic data has not been resolved within CCAMLR. There is approximately an order of magnitude difference in the biomass estimates that arise from different methods (including nets). Although CCAMLR currently uses the lowest acoustic estimate for the calculation of potential yield, this is not a policy decision – the value used is that produced on the basis of advice from ASAM on the most appropriate method to use and this is a technical rather than a management decision. There are other, even lower, estimates of biomass that have been produced from the same dataset.
Moody Marine Comment: This is the lowest estimate of those we have seen, and while the decision may be based on technical issues, the lower the estimate the lower the risk of overfishing as this is used to set the catch limits. Text has been change from "lowest" to "a lower".

p. 20. Catch and Bycatch Monitoring
In the 1998/99 season, 103 318 tonnes of krill were caught entirely from the Atlantic sector (WGEMM 2000). The catch came from Subareas 48.1 (38%), 48.2 (49%) and 48.3 (13%). Most of the winter krill catch was taken from Subarea 48.2 in contrast to previous seasons when the winter fishery had concentrated in Subarea 48.3.

I am unclear why there is a discussion of this season; these data are available for most seasons.
Moody Marine Comment: The paragraph has been deleted as it contains non-essential detail.

It appears that the total catch was estimated from product weights and that these may be subject to significant error due to inappropriate conversion factors being applied (WG-EMM-08/46) and no account being taken of discards (WGEMM 2000; see also SC-CAMLR-XVIII, paragraph 2.5).WGEMM (2008 Para 4.39) expressed concerned over the inconsistency in recording of the amount of krill removed from the ecosystem, which increases uncertainties in the catch estimates.

There is a recent trend for the winter fishery to operate further South and the effects of this shift are unknown.
The issue of conversion factors may well be serious but because there is so little information available it is not possible to even begin to estimate the magnitude of the problem. Additionally, the mortality of krill associated with trawling has been raised as an issue several times within CCAMLR, particularly by Russian scientists, yet there has been no recent attempt to investigate this issue, which also may be highly significant.
Moody Marine Comment: Product weights are the result of processing, so it is unclear why a change in fishing location might affect this in a dramatic way.
We are very concerned with this issue, but it is interpreted within the current harvest strategy. WG-EMM-08/46 has

attempted to estimate examined uncertainties in krill catch arising from the use of product conversion factors from scientific observer data. A significant proportion of the catch is now taken with international observer coverage, so presumably the error and uncertainty will rapidly decrease. The current catch would have to under estimated by a factor of 8 (approximately 13%) for the true catch to pass the limit of 3 million tonnes. The current vessel capacity actually fishing krill would preclude this possibility. Text has been added “Incidental mortality of krill from trawling (krill which pass through the net but may be damaged) has not been estimated.”

p. 21. Data are collected by observers on board vessels (Bibik and Zhuk, 2008; WG-EMM-08/5; Iwami and Naganobu, 2008), although, unlike the toothfish fisheries, vessels are not required to carry international observers outside the South Georgia Subarea 48.3.

This is a critical point. Observers are carried on some vessels, in some areas for some of the time, and there is no systematic data collection effort. Although international observers are required around South Georgia this is a national regulation by the UK rather than a regulation imposed by CCAMLR.

As mentioned before the issue of processing conversion factors may impact the fishery because it could result in considerable under-reporting of catch. This may not occur in the case of the continuous fishing method but it makes it extremely difficult to determine total extractions from the fishing area and this could lead to catches that exceed the precautionary catch limits, even if operator believe they are operating responsibly and within the limits. This is an issue that needs quantification as a matter of urgency.
Moody Marine Comment: This is true and one of the reasons why the assessment team felt it necessary to apply a precautionary catch limit at the trigger level to the certification.

p. 21. In particular, concerns have been expressed that the new continuous fishing system may capture different components of the krill population and may have a higher ecosystem impact than conventional trawls. However, even for the conventional trawl, very limited information is available on catchability or selectivity.

This section highlights a key concern – there is a serious lack of information on the operation of the fishery and of its gear. The fact that there is little information on trawl fisheries does not excuse there being little information on the continuous fishing method. A real concern is that the continuous fishing method has only been in commercial use since 2004 and much of that time its use has been developmental. There is only a small amount of information on the use of this technique and none on its use in full blown commercial operations of the nature envisaged by AKER (e.g. 50,000 tonnes a year).
Moody Marine Comment: With observer coverage of this vessel, including sampling the catch before processing, such information should be forthcoming. The existing regime is considered sufficiently precautionary.

p. 21.Bycatch
It is almost impossible to make generalisations about the levels of bycatch because of the lack of systematic observer coverage. With so few observer’s reports being submitted to CCAMLR with such limited spatial and temporal coverage it is not possible to make robust statements about the effects of the krill fishery (however prosecuted) on other elements of the pelagic ecosystem.
Moody Marine Comment: This issue applies (as a Principle 2 issue) to the unit of certification for which international observer coverage and higher levels of sampling are available.

p. 22. CEMP
The report does not deal with the CCAMLR Ecosystem Monitoring Program adequately. In later sections the existence of CEMP is proposed as a method of assessing the effects of the krill catch on land based vertebrates but there is no analysis of whether CEMP is capable of doing this. There are a number of problems with CEMP that preclude its use in assessing the effects of the fishery:

1. There are very few sites and they are not strategically located, particularly for the SSMUs
2. There has been no serious attempt to investigate whether the predator parameters measured actually respond to changes in fishing pressure

3. There is no mechanism for incorporating CEMP information into management advice, so even if a significant change in a parameter is observed, there is no agreed way of altering fishing practices as a result – even if it were possible to directly link it to the fishery.

Moody Marine Comment: These issues have been considered in this assessment combination with all other monitoring and management applied to the fishery. The points above must also, of course, be considered in light of what is achievable and what is required by the MSC standard. Our conclusions here are unchanged.

p.23 In addition, krill predator populations are being monitored, catch reports are being made and there are periodic, fisheries-independent surveys of local biomass. Monitoring includes a long time series of krill density and recruitment indices collected as part of the BAS, US AMLR and LTER programs (WGEMM 2007 Para 2.75 and 5.43). Whether these are
sufficient to detect impacts of fishing in a timely manner has not yet been tested.

It is worth pointing out that krill predator populations are being monitored at a very limited number of sites. There have been only 2 fishery independent surveys of local biomass and the results of one of these (FIBEX) is viewed with considerable suspicion. The krill time series data is not used by CCAMLR to manage the fishery (although the recruitment time series is fed into the GYM). There is little doubt that the data being collect are insufficient to detect impacts of fishing – and there is no mechanism to alter the krill management approach even if impacts were detected.

Moody Marine Comment: The reviewer is correct, but his concerns do not render the harvest strategy ineffective, in our opinion.

p. 23 In theory, up to 620 000t could currently be taken in any small area, although in practice this with the current fishing capacity would not be possible and unlikely in future given logistical issues such as ice cover.

This is not strictly correct. Notifications for the krill fishery have indicated that there is sufficient fleet capacity to exceed the trigger level. The entire 620,000 tonnes could be taken in a very restricted area and this is a major concern, but what is more of a concern is that a substantial portion of the trigger limit could be taken out of a small area and this could affect predator populations. Individual krill swarms have been reported to have a biomass of over a million tonnes so intensive harvesting in small areas is highly likely.

Moody Marine Comment: The current capacity referred to here are the vessels actually fishing. The notifications are dealt with elsewhere but hardly provide a good indication of capacity in this fishery. While 620 000 t could be taken in a small area, it seems to be an extreme worst case scenario and highly unlikely to happen. We have heard no plausible reason why vessels would do this.

p. 23. If total catches are allowed to rise above the 620 000t level, local catches would not be able to rise above area-specific quotas within each SSMU in order to protect local availability of food to predators. SSMU quotas are being developed using the overall potential yield and the harvest control rule, and divided among areas based on ecosystem system model simulations, that explicitly take predator demands into account, and agreed performance indicators (see section 7.4). Catches have remained well below the trigger level, so the strategy remains untested.

The SSMUs will be used once the trigger level has been reached but there has never been a krill catch higher than 528,000 tonnes and this was spread around the Antarctic. The effects of taking large amounts of krill out of a small area are unknown and the adoption of the SSMUs will probably result in catch limits that ensure that localised catches are far smaller than this. Waiting until the trigger level has been reached before adopting a subdivision scheme for the catch could easily result in significant localised effects.

Moody Marine Comment: See comment above. This is a management issue for CCAMLR, not for the fishery under evaluation, which we believe does not pose a problem of sustainability

p. 26. The large discrepancy between notifications for krill fishing and actual fishing effort (WGEMM 2007 Para. 4.17; SC-CAMLR 2007 Para. 3.45) makes the notification system useless for any short term planning and may be misleading.

This statement fails to grasp the usefulness of the notification system. It was brought in to try and gauge interest in the krill fishery – not to be an accurate predictor – and it has been very successful in drawing out information from

existing and new entrants about their future fishing plans. It has also been very useful for obtaining information on the plans of non-Member nations and this has allowed discussion of these plans at CCAMLR resulting in these fishing efforts being discouraged. Prior to the notification scheme there was no formal requirement to inform CCAMLR about future fishing plans thus there was no avenue for discussing future plans in the meetings of the Scientific Committee and Commission. Since the formalisation of the notification there has been informed debate in CCAMLR about future development in the krill fishery.
Moody Marine Comment: This maybe the intention within CCAMLR, but to outsiders the scheme appears to have been misleading and seems a bizarre way to get a debate going.

p. 29 *The monitoring system appears adequate to detect basic problems in the fishery, such as the conversion factors issue above. Catch data are reported by vessels. All vessels carry observers, although only Norwegian vessels and vessels fishing in area 48.3 carry international observers.*

This is actually incorrect – not all vessels carry observers and those that do rarely report their findings to CCAMLR. The observer coverage is <u>not</u> sufficient to detect basic problems in the fishery – this has been pointed out repeatedly by WG-EMM.
Moody Marine Comment: The monitoring system does not rely on observers only. We were informed that the vessels do carry observers, but in many cases these are national observers and do not report to CCAMLR. There is a clear lack of transparency. The text has been changed "*Many vessels carry observers, although only Norwegian vessels and vessels fishing in area 48.3 carry international observers and CCAMLR has otherwise received few observer reports*"

p.29. Data are collected by observers on board vessels and these data are reported in the articles, analyses and assessments (e.g. Bibik and Zhuk, 2008; WG-EMM-08/5; Iwami and Naganobu, 2008). Using the available data, various problems have been raised and reported at WGEMM meetings (e.g. WGEMM-08/46) suggesting that such problems will be detected as they arise.

The results of these discussions are that WG-EMM has repeatedly indicated that there are not enough observer reports to be able to make any generalisations about the important aspects of the fishery and that 100% observer coverage is the only way to obtain sufficient information. It is highly unlikely that problems will be detected as they arise, and even if they were, the level of observer coverage is so low that it would be impossible to convince CCAMLR of a cause and effect relationship. Even if that were possible, there is no stipulated management action in response to a reported change.
Moody Marine Comment: We disagree that "It is highly unlikely that problems will be detected as they arise". Certainly the monitoring may not detect more subtle problems on selectivity and incidental mortality on the krill and rarer events, but the more significant the problem and its impact, even quite low amounts of sampling will detect it. Many problems in many fisheries have been detected without observer coverage at all. To suggest that "the level of observer coverage is so low that it would be impossible to convince CCAMLR of a cause and effect relationship." assumes that CCAMLR would not apply the precautionary approach. Data being referred to here is not just observer data. Vessels report their catches and location, which should rapidly indicate, for example, if all vessels are catching all their krill in a small area.

p. 32. The fishery seeking certification operates in the Southern Ocean in waters close to the Antarctic Peninsula and around South Georgia, Sub-areas 48.1, 48.2 and 48.3. Early in the season at the height of the austral summer, fishing is in the south of the target fishing area, but as winter approaches accompanied by a north-expanding ice field, krill aggregations also seemingly move north towards South Georgia, and the operator follows those aggregations until the season ends in September.

The fishery has actually been remaining in the south of the area because of reduced ice cover in recent years. There is no suggestion that krill aggregations actually move north at the end of summer – quite the opposite in fact.
Moody Marine Comment: This represents fishing practices and information as provided. Possible changes in detail would not affect our conclusions.

P 37. While the number of larvae caught using the continuous fishing method may be perceived as greater than conventional trawl methods, the method of fishing by the Saga Sea means that fish larvae are more easily identifiable within the continuous fishing trawl when compared to crushed samples that may be unidentifiable as larvae when a *conventional krill trawl catch is examined. Therefore the overall impact of the two approaches may be no different (MRAG, 2009).*

It is very difficult to make any conclusions about the larval fish bycatch by either method of harvesting because the number of observations is so low and they do not cover all seasons and areas of operation.
Moody Marine Comment: While this paragraph was quoting the observations made in MRAG (2009), the issue raised here has been added to the text. "Therefore the overall impact of the two approaches may be no different (MRAG, 2009). However, the low numbers of observations in the conventional krill trawl catch in particular, and restricted sampling across seasons and areas of operation means strong conclusions cannot be drawn."

P 43. However, there are key sites in each of the CCAMLR sub-areas of 48, which have high and consistent time series, being Bird Island, Signy Island, and Admiralty Bay, which provides a basis to monitor the impact of fishing of all types on predators and their breeding success (CCAMLR WG-EMM-08/4).

It is highly unlikely that these 3 sites are sufficient to monitor the impacts of fishing of all types and their breeding success, and I would be very surprised if WG-EMM had agreed that this was so. There has been considerable discussion within WG-EMM about the lack of spatial coverage of CEMP, particularly with regard to the establishment of SSMUs and WG-EMM have even admitted that they would be unable to separate out the effects of fishing from environmental variability.
Moody Marine Comment: This was not a direct quote from WG-EMM, and this has been clarified in the text. The issue of sub-area vs local impacts of krill fishing is also already noted in the subsequent paragraph. The fact that environmental variability is as great, or greater, than the direct impacts of fishing is noteworthy. Text has been altered to:
"However, there are key sites in each of the CCAMLR sub-areas of 48, which have high and consistent time series, being Bird Island, Signy Island, and Admiralty Bay (CCAMLR WG-EMM-08/4), which appears to provide a basis to monitor the impact of krill fishing on predators and their breeding success. However, some more localised impacts may not be identified due to the shortfalls in data collections from some sampling sites. Furthermore, the ability to distinguish the effects of fishing from environmental variability may be limited."

p. 45. Currently movement toward SSMU-specific TAC levels would not be implemented until the trigger level of catches is achieved, and despite notifications to fish, recent catch levels have been far below that level.

There has been agreement amongst most CCAMLR nations that SSMU-level TACs should be implements as soon as possible – the delay is the result of the lack of agreement on a mechanism for catch limit subdivision, or in some instances, of the need for such a subdivision.
Moody Marine Comment: CCAMLR Conservation Measure 51-01 (2008) states that 'the krill catches in Statistical Subareas 48.1, 48.2, 48.3 and 48.4 shall not exceed a set level, defined herein as a trigger level, until a procedure for division of the overall catch limit into smaller management units has been established, and that the Scientific Committee has been directed to provide advice on such a subdivision'. This has been added to clarify the point made.
"CCAMLR Conservation Measure 51-01 (2008) states that 'the krill catches in Statistical Subareas 48.1, 48.2, 48.3 and 48.4 shall not exceed a set level, defined herein as a trigger level, until a procedure for division of the overall catch limit into smaller management units has been established, and that the Scientific Committee has been directed to provide advice on such a subdivision' SSMU-specific TAC levels would not be implemented until the trigger level of catches is achieved, and despite notifications to fish, recent catch levels have been far below that level."

p. 45 While the fishery under certification comprises only one vessel and fishing method, the overall impact of krill removals within Area 48 must be considered from an ecosystem perspective. In this sense, the current management trigger points for the krill fishery as a whole within Area 48 must be examined.

This is a critical point that will be alluded to later. Would it be sensible to certify the only vessel operating in a sustainable fashion in a multi vessel fishery? It could be argued that almost by definition, a fishery acting under CCAMLR's rules and regulations would meet the criteria for MSC certification, however, this ignores the problems inherent in implementing CCAMLR's ecosystem approach.

Moody Marine Comment: When considering retained, bycatch, ETP and habitats, the 'Unit of Certification' (i.e. the continuous trawl method in Area 48) is examined specifically as its impacts will be unique. At the ecosystem level, however, we examined the potential impact of the trigger level, which was identified as the 'limit' of catch within the current certification assessment. This approach was considered essential in this fishery and reflects the observations made by the reviewer.

p. 47. While the current certification has taken the position that the fishery can be considered for certification up to the trigger level, it is clear that an agreed approach to devising SSMU-level quotas is needed before moving beyond that point.

As pointed out above the fishery has never operated at the trigger level so it would be difficult to predict how the population (and its dependent species) might respond to fishing at this level, particularly if the entire catch was taken out of restricted areas. The requirement to move to SSMUs is urgent and CCAMLR cannot be seen to be acting in a truly precautionary fashion until they have implemented TACs by SSMUs – and have an adequate way of monitoring the effects of the catch.
Moody Marine Comment: The authors generally agree, and any certification would not apply if overall catches from the fishery (rather than just the unit of certification) increased above the trigger level.

Comments on scoring tables
1.2.1 *Monitoring is in place that is expected to determine whether the harvest strategy is working.*
This is not correct therefore the scores in this section need to be revised downwards (see below).
Moody Marine Comment: See below

The harvest strategy has not been fully tested, but monitoring is in place and evidence exists that it is achieving its objectives. The stock, catches and predator populations are being monitored, and there is no evidence that they are being affected by harvesting.
This is not strictly correct – I am unaware of any evidence that exists that the strategy is effective other than the absence of an obvious stock collapse.
Moody Marine Comment: The level of monitoring here is assessed in the context of the decision rule (i.e. limit the catch at or below the trigger level). Catches are monitored and, as indicated by the reviewer, there have been many biomass surveys since the synoptic survey which should have reported a decline in biomass had there been one. For the level of catch compared to any estimate of the total biomass, this appears sufficient.

Monitoring is extensive both with on-board observer coverage for biological sampling of the catch, and CEMP for monitoring the abundance of predator species. Concern has been expressed over reductions of CEMP monitoring, but it is adequate for the current level of catch. The international observer coverage, which is generally considered reliable, is less than 100% in this fishery.

This comment overstates the level of monitoring quite considerably. By what standard is the level of CEMP monitoring adequate? The less than 100% international observer coverage is actually <u>considerably</u> less with most vessels operating without them.
Moody Marine Comment: It is the judgement of the assessment team that, given the relatively low level of catch, the level of monitoring was adequate. This is consistent with the application of the MSC standard across all fisheries. Krill, with its important trophic role in the Southern Ocean ecosystem, clearly requires greater risk aversion, which is taken into account. The basis for risk management is either to gather more and better information to verify a low negative impact, or reduce risk by management action, usually reduced harvesting. In this case, risk is reduced by keeping catches to a low level. Catches at or below the current trigger level compared to estimates of the total biomass appear low enough to give an acceptable risk. Should the harvest rate increase, the level of monitoring may well become inadequate. Many of the monitoring systems being developed and discussed are preparing for the expansion in the fishery. While we support the development of the improved monitoring system, the certification assessment must apply to the fishery as it is now.

1.2.3
There is good information on all other fishery removals from the stock.

This is not correct because of uncertainty in conversion factors and incidental mortality of krill therefore this criterion should be revised downwards.
Moody Marine Comment: See comments above.

2.1.1 Because of the uncertainties over bycatch of larval fish (some of which are highly depleted species) it is difficult to see how this fishery can meet a minimum scoring criterion.
Moody Marine Comment: The uncertainty over larval fish bycatch is noted within the SG text. However, the majority of larvae taken are from *C. gunnari*, which is considered sustainably exploited around South Georgia. For potentially over-exploited species, even when the 'worst case' scenario was taken within a rough calculation of the maximal larval mortality at trigger level catches, given the biology of the species the impact was considered to be negligible compared to background variability. However, a condition (condition 2) was raised to address this more fully
2.1.2 The current catch level cannot be viewed as a measure that maintains retained species at a high level. As the catch is allowed to rise to 620,000 tonnes and can be locally concentrated it could significantly affect retained species. The last line of the comments put the case succinctly "However, there is no objective basis for this confidence without further study." Consequently it is difficult to see how a minimum score can be given on this criterion until this further study has been completed.
Moody Marine Comment: As per the scoring guidepost text, and as noted above, plausible argument in the worst case scenario suggested that the impact would be lost within background variability. The lack of an 'objective basis' for this means the fishery did not meet the level of the SG80 text, but a score of 60 was considered appropriate

2.1.3 It is difficult to see how the scoring of this criterion was arrived at given the overall lack of data and analyses.
Moody Marine Comment: 2.1.3 scores against the information available and monitoring in position, for the unit of certification. The Saga Sea has an observer present during 100% of its time at sea. The observer provides quantitative information that has been examined scientifically. This is reflected in the SG80 score of the first section ('qualitative and some quantitative information'). This provides sufficient information, combined with known biological parameters for the species, to develop outcome status with regard to biologically based limits for the species (as was rapidly performed to answer 2.1.1 and 2.1.2, but as noted has not been 'officially' performed, and is the subject of the condition arising from 2.1.1. and 2.1.2) and therefore again meets SG80 text. Information is sufficient to support a partial strategy as noted, again meeting the SG80 text. Given the continued 100% observer coverage on the unit of certification, data are collected in sufficient detail to assess ongoing mortalities of retained species, which would score at the SG100 level, but as noted not all have been identified to this level. A score of 95 was therefore given for this paragraph, which under MSC guidelines provides an overall score of 90. Additional text has been added to clarify this scoring (scores have been added to the text to show how the overall score of 90 was obtained).

2.2.3 *The information available from the CCAMLR international observer programme is adequate to support a comprehensive strategy to manage bycatch, and evaluate with a high degree of certainty whether a strategy is achieving its objective. At present, due to the elimination of bycatch through the approaches listed in 2.2.2, no additional strategies have been required.*

Given that the scheme of Scientific Observation has resulted in so few reports from the krill fishery it is difficult to see how in its current form it is adequate to support a comprehensive strategy. Therefore this criterion should be scored downwards.
Moody Marine Comment: The reviewer must again be aware that this PI is scored based upon the information available for the unit of certification – i.e. the Saga Sea fishing with the continuous trawl method. The PI is scored based upon the available data that demonstrates bycatch is negligible due to the method of fishing used by the unit of certification. This supports the observation that the approaches listed in 2.2.2 are adequate to eliminate bycatch and that no additional strategies are required. Information is therefore 'adequate to support a comprehensive strategy to manage bycatch, and evaluate with a high degree of certainty whether a strategy is achieving its objective', consistent with the SG100 text. It does not, in the opinion of the assessment team, merely represent a 'partial strategy', which would require a lower score.

2.3.3 This score is based on information from CEMP and from scientific observers. Because of the lack of systematic data collection by either of these processes, information is only <u>adequate</u> for this scoring criterion thus the score should be revised downwards.
Moody Marine Comment: There seems to be confusion here, since 2.3 scores the direct impact *of the unit of*

certification on ETP species, rather than ecosystem impacts *of the krill fishery as a whole*, which are considered under 2.5. As noted in 2.3.1, direct observation through observers and underwater camera studies has shown no fatal interactions with ETP species. In light of this, there is sufficient information to quantitatively estimate outcome status with a high degree of certainty *for the unit of certification*, through the mechanisms noted. To clarify this further, the following changes have been made to the final paragraph:
"Information is therefore sufficient to quantitatively estimate outcome status **for the unit of certification** with a high degree of certainty. Information **from the *Saga Sea*** is adequate to support a comprehensive strategy to manage impacts, minimize mortality and injury of ETP species (although some limitations with respect to whale species are noted), and evaluate with a high degree of certainty whether a strategy is achieving its objectives. Accurate and verifiable information is available on the magnitude of all impacts, mortalities and injuries and the consequences for the status of ETP species."

2.5.1 Given the uncertainties surrounding the ecology of krill, the lack of observation of the fishery (and its uncertainties) and the immature nature of the CEMP this criterion can be scored at best as: *The fishery is unlikely to disrupt the key elements underlying ecosystem structure and function to a point where there would be a serious or irreversible harm.* The discussion on the risks associated with subdivision of the catch limits does not deal with the risks posed if the catch up to the trigger level is taken in a small area. It is a very bold and brave statement to assert that *Within the current trigger level, the fishery is highly unlikely to disrupt the key elements underlying ecosystem structure and function to a point where there would be a serious or irreversible harm.* I am not sure that many scientists working in the CCAMLR community would be prepared to agree with this. Consequently the score for this criterion should be revised downwards.
Moody Marine Comment: The view expressed by the reviewer is highly precautionary, and appears contrary to both the historical pattern of the fishery and the information available from current simulation studies. It is recognised that simulation results are predicated upon the assumptions made during their development. However, a range of assumptions appear to have been used and results at the trigger point were (generally) robust to those assumptions. Changes in the pattern and level of the fishery, and new evidence arising, would be identified during the annual surveillance audits, and the score could be re-evaluated on that basis. Based upon current information, however, the score appears justified.

2.5.2 *The measures are considered likely to work based on prior experience, plausible argument or information directly from the fishery/ecosystems involved.*
The performance of the current plan, based upon the precautionary trigger level, is considered likely to work based upon prior experience, where historical catches were much greater but appeared to have minimal impacts on the ecosystem. As there was no systematic monitoring of the ecosystem in the early 1980s it is not possible to make this statement.

The discussion on SSMUs ignores the issue that there is no agreed plan to divide the catch and that there is still a considerable risk at a level of 620,000 tonnes.

As the measures have not been adequately tested this criterion needs to be adjusted downwards.
Moody Marine Comment: the lack of a <u>complete</u> ecosystem strategy is noted within the text, and the score was reduced as a result. Simulation results suggest the strategy is likely to work based on current information. However, if further information comes to light during the annual surveillance audits, the score could be re-evaluated on that basis (e.g. rapid increase in quota uptake, decision to sub-divide quota based upon approaches indicated to be non-precautionary through simulation). In acceptance of some of the observations raised by the reviewer, however, the score has been reduced to 80.

2.5.3 *Information / monitoring. There is adequate knowledge of the impacts of the fishery on the ecosystem.*
Because of the lack of a mandatory observer scheme, the shortfalls of the CEMP program and the uncertainties over bycatch it is difficult to see how information/monitoring can be considered adequate. WG-EMM has on numerous occasions pointed out the inadequacy of this sort of data collection. This criterion is scored far too highly.
Moody Marine Comment: While the Saga Sea has 100% international observer coverage, other vessels fishing with alternative gears within the fishery may have local observer coverage. The discussion on observer coverage within CCAMLR is noted, as pointed out by the reviewer. In turn, the issue on the shortfalls in CEMP data coverage noted

earlier are valid.
The first SG text scores between 80 and 100, given that knowledge of the key elements of the system is good and key elements are broadly understood.
The second SG text scores between 80 and 100, given that the main interactions have been investigated, although as noted there are gaps in the information.
The third SG text scores between 80 and 100, as available information does allow the main functions of the ecosystem components to be known, and in some cases well understood.
The fourth SG text scores 80, noting the issues with the CEMP data.
The fifth SG text also scores 80, for the same reason.
Therefore, the overall score for this PI has been reduced to 85.

3.2.2 *Decision-making processes The fishery-specific management system includes effective decision-making processes that result in measures and strategies to achieve the objective.*

Although CCAMLR does have a formalised procedure for making decisions, there have been notable problems with reaching consensus on key issues such as the mandatory carriage of scientific observers in the krill fishery. Consequently, this criterion is probably scored too highly.
Moody Marine Comment: From an international performance perspective, we do not agree with the reviewer. The CCAMLR procedure is not perfect by any means, but it is far better than in many other areas or commissions, so from a purely comparative position, the score is probably correct at 90. Decision-making is responsive on many important issues; of course, not everyone will be happy with the direction that response takes!

3.2.4 *Research plan The fishery has a research plan that addresses the information needs of management*.
This may be true but it has proved extremely difficult to ensure that the work deemed important by WG-EMM is actually carried out. Because of the difficulty of actioning the plan this criterion ought to be scored lower.
Moody Marine Comment: The score is based on the existence of a comprehensive research plan, so the score is in our opinion correct. The effectiveness of that research plan are not addressed in this sub principal, only its existence and communicability.

Concluding comments

Overall, the assessment probably falls somewhat short of what I might hope given the MSC principles. There are two reasons for this. Firstly the operator has a very short history in the krill fishery and has not yet had a chance to establish its credentials or to fully examine the impacts of its new technology. This suggests to me that this proposal is slightly premature. Secondly, the proposal assumes that the procedures implemented by CCAMLR in pursuit of its ecosystem approach to management are sufficiently robust to enable the krill fishery to meet the MSC criteria. Whilst I agree, on paper, many of the initiatives that CCAMLR has implemented are in support of genuine ecosystem based management, in practice they fall far short of this. In particular, the Scheme of Scientific Observation ought to be providing information that is essential to managing the krill fishery, yet in practice it is ineffective because CCAMLR has been unable to achieve consensus on an appropriate level of observer coverage. The CCAMLR Ecosystem Monitoring Program is another example of an initiative that should be of great use in managing the krill fishery, but again a lack of a systematic approach has limited its usefulness and there is no agreement on how to link observations from CEMP to management decisions. As the krill fishery begins to expand it will be essential that CCAMLR is receiving appropriate information from the fishery that allows some assessment of the effects of a growing fishery on the krill stock, and also on the dependent and related species. Currently there is no system which allows this information to be systematically collected and relayed to the decision makers. There are a large number of uncertainties surrounding the biology of krill and its ecosystem interactions and the models that have been developed to manage the fishery are based on a number of assumptions, which may well be shown to be incorrect when fishing pressure is increased. CCAMLR needs both the ability to monitor the system and the capacity to act quickly to change management practices to adapt to changing circumstances. In the past, uncertainty has been used within CCAMLR as a reason for inaction and unless formal processes are implemented to assist management action, a similar approach could be used in future and this could have disastrous consequences. Many of these issues are beyond the control of the proponent, however, the krill fishing industry is currently small and a willingness of krill fishing companies to co-operate to ensure that CCAMLR lives up to its potential could be to the benefit of all involved.

This proposal for MSC certification of the krill fishery should not be seen as an assessment of the adequacy of CCAMLR's approaches to management of the krill fishery. Many of the issues raised above are subject to active efforts within CCAMLR and its working groups and initiatives are in place to address topics such as observer coverage and application of TACs to SSMUs. CCAMLR has made great progress in developing an ecosystem approach to management of all fisheries in its jurisdiction, however, the task is considerable and progress is understandably slow. It is imperative that progress matches the pace of the development of the fishery.

Appendix C: Client Action Plan

Client Action Plan

Condition 1. Limit and Target Reference Points

Although there are limit and target reference points, there are no reference points consistent with the more precautionary Harvest Control Rule catch trigger level (interpreted here as the Precautionary Upper Catch Level (PUCL)) of 620 000t.

Action required:
Estimate the precautionary fishing mortality and biomass levels consistent with the catch trigger level of 620 000t and (as this is a low trophic level species) assess the associated risk of over fishing according to the predator and recruitment criteria.

Timescale: Within one year of certification.

Relevant Scoring Indicators: 1.1.2

Client Action
During the first year of certification Aker Biomarine Antarctic AS agrees to provide an estimate on the precautionary fishing mortality and biomass levels consistent with the catch trigger level of 620 000t and assess the associated risk of over fishing according to the predator and recruitment criteria. A working group consisting of independent scientists from the international community will be established to provide the updated data and modelling required for the estimate. This will include personnel from the Norwegian Institute of Marine Research as well as the British Antarctic Survey. Aker Biomarine will work closely within the framework and management requirements of CCAMLR and CEMP. Key stakeholders will be involved in the programme, including WWF Norway to validate the process, outputs and final reporting. Final reports will be independently peer reviewed.

Condition 2. Larval fish catch

Larval fish catch within all fisheries for Antarctic krill is expected, although the Aker BioMarine fishing method allows this amount to be measured. At the current level of catch, the rate of larval fish capture is not likely to place species beyond biologically based limits or hinder recovery and rebuilding of depleted species. However, this has not been demonstrated with appropriate scientific rigour.

Action required: Assess the risk that the main retained species are beyond biologically based limits as a result of larval fish catch at current and trigger levels; concentrating on *C.gunnari* and *N.rossii* but with consideration for other species which may be of concern.

If the risk is unacceptable a strategy should be tested and then implemented which would be expected to maintain the fish species at levels which are highly likely to be within biologically based limits or to ensure the krill fishery does not hinder their recovery and rebuilding.

Timescale: The risk assessment must be completed within 2 years from certification. If required, the strategy must be implemented within 4 years from certification.

Relevant Scoring Indicators: 2.1.1, 2.1.2

Client Action

Within 2 years of certification Aker Biomarine will assess the associated risks that the main retained marine fish species are beyond biologically based limits, at current and trigger levels. The assessment programme will focus on *C.gunnari* and *N.rossii* whilst still monitoring all retained marine larvae.

Independent scientific observers will be employed during all krill fishing operations to assess marine larvae by catch. Data will be made available to stakeholders. Standard sampling protocols will be employed (described in the CCAMLR *Interim protocol for Fish/Fish Larvae by-catch observation in Krill fishery*). Methods and results will be independently verified by experts in the field of Antarctic marine larvae from British Antarctic Survey and other relevant organisations.

Potential influences on by-catch will be recorded for each trawl and included in the analyses. These include trawl type, CCAMLR Area (48.1,48.2 and 48.3), season (‘Summer’ from October to March and ‘winter’ from April to September), Time of Day (‘Day’ from 0600hrs to 1800hrs and ‘Night’ from 1800hrs to 0600hrs), sea state (recorded on a categorical scale from 1 to 8), sea-surface temperature (SST), bottom depth, fishing depth and the krill catch for that particular trawl.

With the use of advanced statistical modelling, seasonal and geographic influences can be determined on the frequency and species of marine larvae by-catch. From this any key factors can be identified that increase the risk of marine larvae by catch. Aker Biomarine has been monitoring marine larvae by catch, as described above, for all its operations since 2006. This information can be made available to increase the data and reliability of the modelling. Once risk factors have been identified then management programmes can be established within 4 years to avoid vulnerable populations and reduce impact.

As with condition 1, Aker Biomarine will work closely within the framework and management requirements of CCAMLR and CEMP. Key stakeholders will be involved in the programme, including WWF Norway to validate the process, outputs and final reporting. Final reports will be independently peer reviewed.

Appendix D: Stakeholder Comments

Appendix D.1

Gambling with Krill Fisheries in the Antarctic: Large uncertainties equate with high risks.

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Introduction

This briefing paper outlines the large uncertainties and indeterminacies attached to current scientific knowledge of krill ecology in the Antarctic. The uncertainties relate firstly to the depth of knowledge of krill standing stocks, life history and reproductive strategies and secondly to the ways in which krill ecology may be driven by ongoing climate change in the Antarctic. The Antarctic Peninsula is warming at a rate well above the global average and this will impact on seasonal sea ice which is linked to krill reproductive success.

These issues are of considerable importance since Antarctic krill is a keystone species which supports an expanding fishery sector. The management regime applied to this fishery does not adequately accommodate these uncertainties and indeterminacies. Accordingly, the pursuit of an industrial scale fishery targeting krill in the Southern Ocean is associated with high risks of unsustainability which could have major consequences for the wider ecosystem.

What are Krill?

"Krill" is a term which refers to around 85 species of euphausid crustaceans which are mostly planktonic. They are found in all oceans of the world and their large size coupled with a tendency of some species to form dense "swarms" means that they are highly important in some marine ecosystems. In addition, some species are commercially harvested in directed fisheries which appear likely to be subject to increasing effort in coming years (Everson 2000). This is particularly true of the Antarctic region. Here, of the seven krill species commonly reported, the principal swarming species *Euphausia superba* is targeted by large scale commercial fisheries particularly in the Atlantic sector, with the Indian and Pacific Ocean sectors attracting less interest. Henceforth, the term krill is used in this document to refer to this species alone.

The distribution of krill in the waters around Antarctica is shown in Figure 1 below. It has a circumpolar distribution as far north as the Antarctic Polar Front Zone, and the distribution of the species helped define the management area defined by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) as shown in Figure 2.

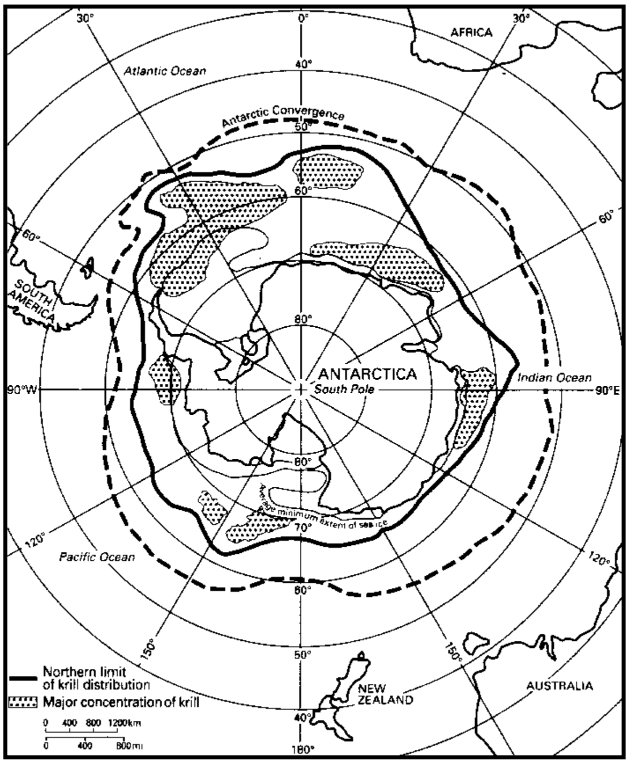

Figure 1. Map of Antarctica showing the Antarctic Convergence, major concentrations of krill and the northern-most limit of their distribution. The species is predominantly found in areas covered seasonally or permanently by sea-ice.
From University of the United Nations website at: http://www.unu.edu/unupress/unupbooks/uu15oe/uu15oe06.gif

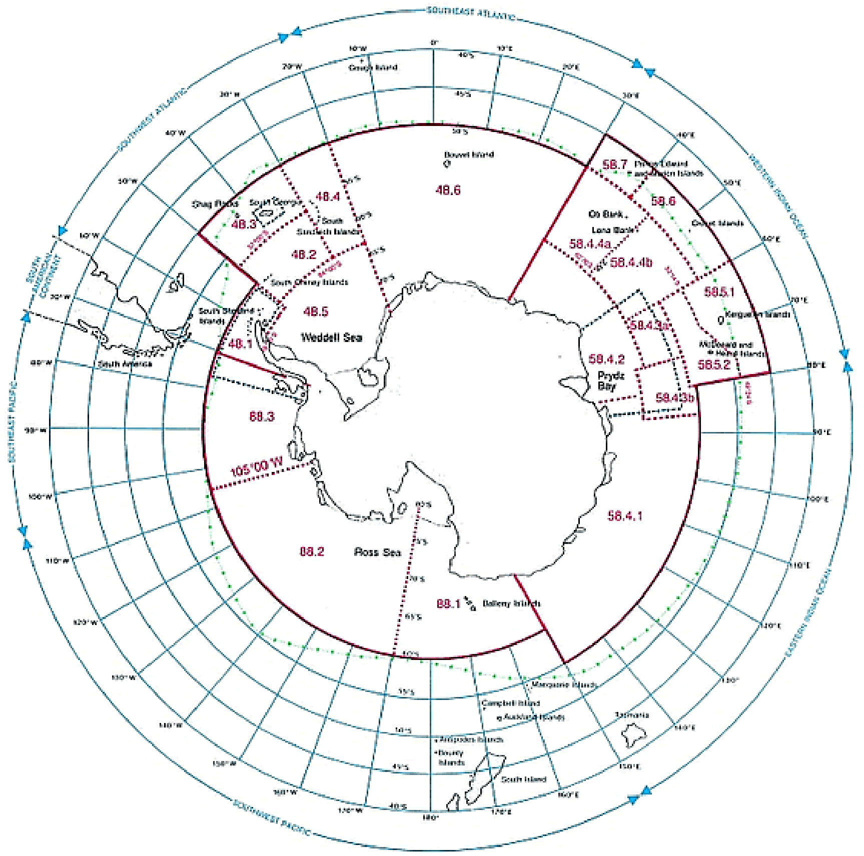

Figure 2. Map of the CCAMLR Area showing statistical sub-areas for reporting.
From: http://www.mfat.govt.nz/Foreign-Relations/1-Global-Issues/Antarctica/Ross-Sea-Strategy/0-ccamlrmap.php

Relevance of Krill to Antarctic Ecosystems

Krill effectively underpin Southern Ocean food webs as illustrated by Figure 3. Food webs in this ocean realm are simpler than those found in many other ecosystems. Although there are fewer species, however, they are present in large numbers. Hence, it has been estimated that the crabeater seal is the second most abundant large mammal on the planet after humans (Siniff 1991). Although precise numbers are currently the subject of some debate, estimates of krill consumption by this species range from 50 to 130 million tonnes annually. In addition to the seal species, a variety of seabirds including Adélie, chinstrap, macaroni and gentoo penguins feed extensively on krill. The seven species of baleen whale present in the Southern Ocean all feed on krill. Finally, krill are an important component of the diet of various fish species.

Euphausia superba is arguably one of the best studied of all pelagic animals, and there is considerable insight into the ecological connections which have evolved in response to the cold and highly seasonal environment in which it is found. Nonetheless, there are large uncertainties about key elements of its biology and the precise drivers of its abundance and distribution (Nicol 2006). The detailed relationship between sea ice extent and krill abundance has emerged following acoustic survey work in the 1980s. This shows that the abundance of Antarctic krill is positively correlated to the extent of sea ice in the previous winter, a relationship which can also be retrospectively identified. It is thought that communities of micro-algae and other micro-organisms provide food for over-wintering adult krill and larvae, and that these same communities act as "seed-stock" for the open water areas which appear in the austral spring. Hence, larger areas of sea ice create good feeding conditions in both winter and spring. This very logical hypothesis has, however, not been absolutely verified, illustrating the key information gaps which still exist. It is likely that the more robust adults have different over-wintering strategies to the larvae, which are more vulnerable to food deprivation.

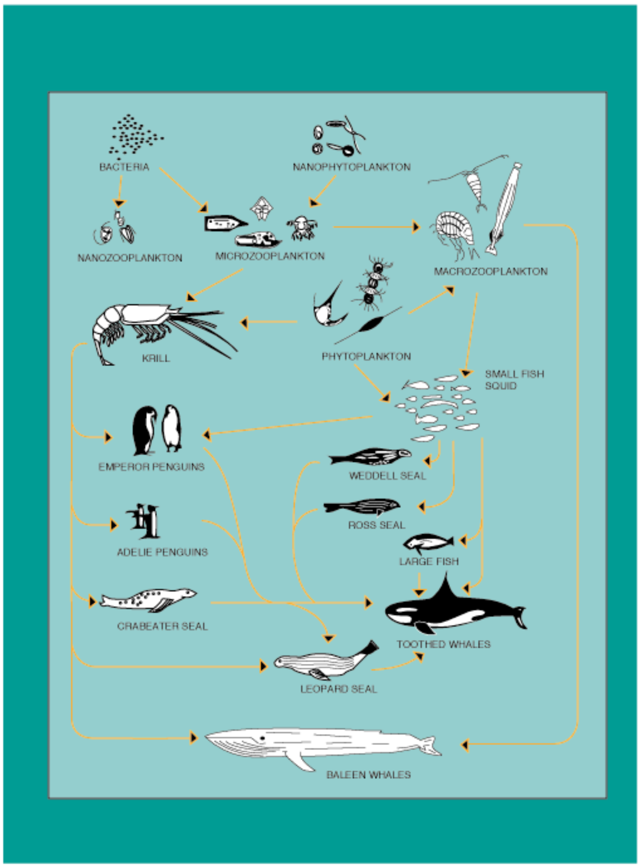

Figure 3. Diagram of the Antarctic food web showing the central role of krill.
From Hader *et al.* 1991.

Water and ice movements also figure in the life history. Sea ice movements are complex and larvae associated with ice also move with it, though this is not the complete story. The Antarctic Circumpolar Current may, for example, explain the high abundance of krill in the waters around South Georgia which are free of sea-ice. Population densities have been linked to gyral circulation patterns. However, overall, this is another area where substantial uncertainties exist. The scientific literature acknowledges the fact that there is an incomplete understanding of the forces which determine the distribution of krill at all scales, local, regional or continental. Significantly, the elucidation of the population dynamics at a single location is held hostage to the fact that key processes relevant to the population (growth and recruitment) are happening in areas remote from these populations (Nicol 2006).

Recently, it has been suggested that the huge numbers of krill present in the Southern Ocean coupled with behavioural patterns which see them undertake significant daily migrations through the water column may play an important role on global carbon cycling. On this basis, it has been further suggested that krill waste products introduced below the mixed layer would effectively move carbon into deep waters where it would be retained over long time periods (Tarling & Johnson 2006; Swadling 2006).

A thorough knowledge of the population dynamics of krill and the factors driving these dynamics is essential to understanding the way in which the populations of these organisms are likely to respond to pressures of human activities. Two major impacts with the potential to interact significantly in driving overall population impacts are currently of relevance: (a) impacts of anthropogenically-forced climate change and (b) impacts of fishing activities directed at krill. The effects of these pressures working individually and in combination are at the present time a completely unknown quantity.

Climate Change and the Antarctic

The recent IPPC Assessment Report (see: Anisimov *et al.* 2007; Lemke *et al* .2007) documents what appear to be somewhat contradictory trends in impacts of climate change over the Antarctic as a whole with some areas warming and others apparently cooling. A recent evaluation, however, has shown that despite these apparent inconsistencies, the continent as a whole appears to be warming at a rate comparable to the entire Southern Hemisphere (Steig *et al.* 2009).

The Antarctic Peninsula, where major krill spawning and nursery areas are located, has been undergoing a dramatic warming in recent decades and is considered to be one of the most rapidly warming areas on the planet with rates several times the global mean. The temperature rise has exceeded 2.5°C over the last 50 years and although the rate is seasonally variable, the number of days when temperatures reach above 0°C has risen by 74%.

The drivers of this rapid temperature rise are not understood with complete certainty but it is thought that they are linked with anthropogenically driven changes in atmospheric circulation patterns. The climate models do not seem to simulate this warming and so it is not known to what extent it may continue into the future. The temperature changes have driven changes both in biological systems and in the physical environment in the region as a whole. Despite the complexity and the difficulty in establishing causal relationships, the British Antarctic Survey (BAS 2007) outlines observed impacts, many of which relate to the Antarctic Peninsula and the sub-Antarctic islands. While temperature is a primary driver of Antarctic ecology, moisture and nutrient availability may also be changed (Walther *et al.* 2002). Hence, a study of the ecology of lakes on Signy Island which has a maritime Antarctic climate and on which permanent ice cover has receded by some 45% since the early 1950s, has shown some profound changes. The lake open water period increased by around 63 days in 1993 as compared to 1980, reflecting a 0.5°C rise in summer air temperatures (Quayle *et al.* 2002).

In the terrestrial environment striking changes have been observed in the populations and distributions of Antarctica's only two species of flowering plants: Antarctic hair grass *(Deschampsia antarctica*) and Antarctic pearlwort (*Colobanthus quitensis*). At sites along the Antarctic Peninsula these changes have been linked to warming and to local snow recession. Larger areas are now surviving winter and reproducing in the summer months. The ranges of these plants, however, have remained largely unchanged, these being defined by the lack of suitable ice-free ground south of the Terra Firma Islands. Rapid increases in bryophytes and micro-organisms have also been observed at sites in the maritime Antarctic. Although less visible, it is expected that this change in flora will be accompanied by increases in the associated invertebrate fauna (Convey 2003).

A trend towards warmer conditions also raises the possibility that alien species of plants and animals could become established in the Antarctic and sub-Antarctic, while those already present could expand their range and numbers. Many species have the potential to establish themselves in the region, and humans are likely to be the pivotal vector (Frenot *et al.* (2005).

The general warming trend in the Antarctic has recently been powerfully confirmed by conducting a retrospective review of glaciers in the peninsula. This has convincingly shown that over the last 61 years 87% of glaciers have retreated and that the demarcation between those retreating and those advancing has moved progressively southwards (Cook *et al.* 2005). These trends seem set to continue through the rest of the 21st century. Recent modelling exercises (Bracegirdle *et al.* 2008) suggest that the intensity of near surface winds is likely to increase by some 20%. Averaged surface warming over the continent as a whole is projected to be 0.34°C per decade while sea ice area will continue to decline by around 3% (250,000 sq kilometres) per decade. Paradoxically, snowfall in the interior may increase by 20%.

A reduction in sea ice is likely to have important biological impacts. There has been a reduction in duration and extent of winter sea ice formation to the west of the Peninsula (although increases have been observed in other parts of the Antarctic). The reduction in sea ice has potentially severe implications for the distribution of *inter alia* various penguin species dependent upon sea-ice and already it appears that ice-adapted Adélie penguins are being replaced by open-water species such as chinstrap penguins. Recent work based on IPCC climate projections suggests that emperor penguins which depend on sea ice for breeding, foraging and moulting have a 36% chance of losing 95% of their population by 2100, a loss which equates with virtual extinction of the island population studied (Jenouvrier *et al.* 2009).

The most spectacular physical changes in the Antarctic environment relate to the ice shelves of the Antarctic Peninsula. These are floating extensions of a grounded ice-sheet and globally most of them are located in embayments around the Antarctic continent (including the Antarctic Peninsula.) The size of ice shelves is essentially determined by the amount of snow falling on their surface and the amount of glacial ice delivered to them These inputs are counterbalanced by ice lost through melting and the formation (calving) of icebergs. Changes in these parameters will be reflected in changes in the size of the ice shelves. According to work cited by Anasimov *et al.* (2007) some 14,000 square kilometres of have been lost from ten floating ice shelves over the last 50 years. Marine sediment core data suggest that these ice shelves have probably not been at such a minimum for 10,000 years and definitely have not been as reduced in extent at any time in the last 1000 years.

The British Antarctic Survey lists seven ice shelves which have been seriously impacted by warming on the Antarctic Peninsula (BAS 2008). With some of these, the loss of ice has been progressive, lasting several decades, while in other cases dramatic collapses have taken place. The various mechanisms of ice loss are an area of active research. The best known example of collapse was the Larsen A ice shelf collapse in 1995. This occurred in a matter of weeks. The Prince Gustav ice shelf also finally collapsed in 1995 having retreated progressively during the late 20th century. A similar retreat, followed by collapse in 2002, took place with the Larsen B ice shelf. After these collapses, links were made with climate change (BAS 2008). If the current rate of warming on the Peninsula is maintained, then further retreats and collapses can be anticipated.

The Wilkins ice shelf is likely to be next. Its collapse has been predicted since it lost around 1000 square kilometres in 1998. Ten years later, in March 2008, a further 400 square kilometres was lost. Although the ice shelves are floating and therefore will not contribute to sea level rise as they retreat or collapse, their loss may well lead to an increase in the “flow” rates of glaciers and increases in meltwater. These will both add to sea level rise.

In late November 2008, new rifts developed on the ice shelf. Currently, a small strip of ice connects the main body of the ice shelf with the adjacent Charcot Island. Much speculation exists as to when this ice bridge will disintegrate. This could, in turn, put the entire ice shelf at further risk of disintegration. It is not clear when the ice bridge will disintegrate, but the 2008 event continued to progress even after the onset of the austral winter. (Daily images from the area are being uploaded by the European Space Agency at: www.esa.int/esaEO/SEMWZS5DHNF_index_0.html).

Climate Change Impacts on Krill and the Wider Antarctic Ecosystem

One serious potential impact of reduced sea ice (though not of ice shelf loss *per se*) is failure of krill populations to reproduce and a subsequent failure to recruit into the population over a much wider area. Recruitment failure of krill has already been linked to reproductive failure in a range of seal, and bird species (Convey *et al.* 2003). In the Southwest Atlantic sector which is thought to support >50% of krill stocks, there has been a decline of around 80% in krill numbers since the mid 1970s (Atkinson *et al.* 2004). At the same time, another group of filter feeders, the salps, which prefer warmer and nutrient poorer water, have increased in number. The krill which are generated along the ice edge provide a food resource over a wide area. Analysis of four species dependent on krill at South Georgia showed that all four declined during the 1990s after a period of stability or increase during the 1980s. This was attributed to reduced prey availability and corresponded with changes in krill population structure. Effectively there was a move to a situation where predation on a very large population of krill was superceded by predation on a population less able to support predator demand (Reid & Croxall 2001). Similar impacts have been observed in Adélie penguin populations near Palmer Station in the Western Antarctic peninsula implying that these impacts are already detectable over a very wide area (Fraser & Hofmann 2003). In the South Atlantic, failure of Antarctic krill recruitment and population decline will inevitably foreshadow recruitment failures in a range of higher trophic level marine organisms (Trathan *et al.* (2007).

The krill issue is also seen as of concern in relation to the potential recovery of whale populations from commercial whaling operations. It is not known whether the fast rate of warming in the Peninsula region and West Antarctic will continue. The potential, however, for far reaching changes in krill ecology seems to be high, if also relatively poorly characterised. At present, it is not known if changes in krill populations as reflected in changes in key predator populations represent an element of high inter-annual variability or the beginning of a systematic downward trend.

Resolution of this conundrum is hampered by lack of a long-term data series (Kock *et al.*2007).

Antarctic Krill Fisheries

The krill fishery began in the 1970s and reached a peak in the early 1980s when around 500,000 tonnes were taken. It stabilized at around 400,000 tonnes from 1986/87 through to 1990/91 and then declined further to 87,000 tonnes in the 1992/93 season rising again to around 100,000 tonnes in 1999. Catches reached around 126,000 tonnes in 2001/2002, falling slightly to 104,000 tonnes in the 2006/2007 season (CCAMLR 2008). However, the industry looks set to expand rapidly in the coming years with totalled report notifications for the 2007/2008 season of over 750,000 tonnes with 620,000 tonnes projected for area 48 and the balance for Area 58.4 (South Indian Ocean) (ASOC 2007 a & b). Another significant trend in the fishery is that the historic domination of the industry by Russia and Japan is being broken by the entry of vessels from other nations into the industry. In particular Norway has become a key player, accounting for around 40% of the 2007 recorded catch (CCAMLR 2008a).

It is likely that intensity of fishing for krill will increase in the future in the Antarctic Region. It is currently the largest fishery in the Southern Ocean (Everson 2000). The market for krill is expected to grow in line with increasing demand globally for aquaculture feed (Nicol & Foster 2003). Previous difficulties related to rapid spoiling of the catch and high levels of fluoride leaching from the shells into the meat have largely been overcome by improved and more rapid on-board processing techniques. Some facilities exist aboard vessels to manufacture bio-diesel from krill. The decline in sea ice in the south-western Atlantic has enabled the krill fishery to operate year round (Smetacek & Nicol 2005). This and the improved processing methods have effectively removed the last constraints that were limiting growth of this fishery. In addition, the development of new products is taking place, including the production of krill oil rich in omega-3 fatty acids as a human dietary supplement.

Management of the krill fishery is conducted under the auspices of Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR). CCAMLR, under the Antarctic Treaty, arguably owes its existence to international efforts to forestall a “free for all” in fisheries in the region. In 1991, the first ‘precautionary’ catch limit for Area 48 was established at 1.5 million tonnes (ASOC 2007c). Following the CCAMLR 2000 Krill Synoptic Survey in Area 48 (Watkins *et al.* 2004), the total biomass of krill was estimated at 44.3 million tonnes (Hewitt *et al.* 2004). This was used to set a revised precautionary limit of 4 million tonnes (see also: Hewitt *et al.* 2002, ASOC 2007c) for Area 48. Subsequently, in Conservation Measure 51-01 (CCAMLR 2008b; ASOC 2007d) catches were limited to 3.47 million tonnes from Statistical Areas 48.1, 48.2, 48.3 and 48.4 in any one season, with an added proviso that, until this total catch limit could be allocated between smaller management units , then the combined catch should not exceed the trigger level of 620,000 tonnes. This, therefore, is an effective catch limit until such management units are actually defined according to the working principles outlined by Constable and Nicol (2002). Stricter conditions were also imposed on the operation of the fishery. Conservation Measure 51-02 set limits for division 58.4.1 of 440,000 tonnes subdivided across the area, and 51-03 a limit for 58.4.2 of 2.645 million tonnes again subdivided into two. No trigger level was set for 51-02, but with 51-03, trigger levels of 260,000 tonnes and 192,000 tonnes for the two subdivisions were set.

The new limits clearly allow for considerable potential expansion of the krill fishery in Antarctic waters. The trigger levels seem unlikely to interfere with the pursuit of the krill fishery at current levels of exploitation but it is significant that recent notifications to CCAMLR of intentions to fish for krill exceeded the trigger level of 620,000 tonnes (see: CCAMLR 2007). Moreover, the use of trigger levels and limit levels as effective management tools assumes that the basis for the management strategy itself is sound. This is questionable. Overall the management strategy, while aspiring to be precautionary, in fact lacks much of the empirical information required to manage a fishery on such a basis. Among the key areas of concern are:

1) Standing stock estimates of krill are subject to wide confidence limits on a regional and local basis. These estimates are based on relatively old survey data and the aggregate data do not comprise a sufficient time series to resolve key questions attached to long term krill population trends and potential impacts upon krill-dependent predators.

While the distribution pattern of krill is now relatively well established, large uncertainties exist as to the standing stocks around the continent. Large differences exist in estimates of standing stock according to the methods used, with acoustic surveys tending to give much higher values than net surveys. While recruitment can be predicted to an extent on the basis of seasonal sea ice extent, acoustic surveys around the South Shetland Islands have shown a high inter-annual variation in recruitment of krill into the population (Hewitt *et al.* 2003) with apparent 3 and 8 year cycles in this location. A study in East Antarctica showed that varied krill abundance was reflected in breeding success of an Adélie penguin colony, reinforcing the relationships suggested above between krill and their predators (Nicol *et al.* (2008). Studies of krill carried out as part of the CCAMLR 2000 Synoptic Survey revealed considerable distributional and demographic complexities over the region (Siegel *et al.* 2004). At present, however, in relation to the observed declines in predator breeding performance outlined by Kock *et al.* (2007), it is not possible to resolve the magnitude in changes of overall krill supply relative to predator demand. It is very likely, however, that there has been a change from a situation with a large krill supply relative to predator demand in areas studied around South Georgia. This change may have begun in the 1990s, leaving krill supply close enough to predator demand to alter substantially local krill mortality rates. Finally, this situation could have removed any surplus that existed, leading to an increase in the frequency of years when krill populations are insufficient to support predator demands in the island areas affected.

2) Management of krill is on the basis of a single species model which cannot accommodate fully uncertainties and indeterminacies in the data. Impacts of climate change on krill have been poorly characterised but may be substantial. Currently the models used to manage the species do not account for long term environmental change. Factors associated with success of krill recruitment have not been well characterised.

Strategic fisheries management decisions have been based upon modelling exercises using the so-called ‘Krill Yield Model’ (KYM), which iteratively determines the proportion (γ) of the unexploited biomass (B_o) (estimated from surveys) which can be exploited each year. The process is described in detail by Constable *et al.* (2000). As noted by Thomson *et al.* (2000), this single species model only takes into account the needs of predators in a crude manner, assuming that if krill spawning biomass remains above 75% of its pre-exploitation level, then the needs of predators will be met. The basis on which this percentage figure was selected (in the absence of any empirical information on the needs of krill predators) was because it lay mid way between 100% (no exploitation) and the 50% optimal suggested by surplus production models. The authors go on to suggest that in fact this 75% figure may not be adequately protective of predator populations. The KYM has been developed within CCAMLR into a generalised yield model (GYM) which has also been applied to the management of other fisheries in the region. Recruitment of krill is one of the key components in the GYM so changes that occur with climate or other variability are critical to ensuring that the take is sustainable. The model does not include a function driven by physical variables. This is due in part to the unpredictability and poor understanding of impacts of physical variables on recruitment (Kock *et al.* 2007)

Hewitt *et al.*(2004) point out that the models assume a freely distributed krill population, homogenously distributed predation pressure, and randomly determined recruitment. While the model accounts for some uncertainties in input parameters, spatial and temporal trends in krill demographics, predator demand and fishing pressure are not accounted for. Moreover, there is some evidence that populations in Area 48 may not be comprised of a single stock, confounding the model further. Hewitt *et al* (2002, 2004) note that before any expansion of the fishery takes place to the limits specified by CCAMLR, it will be necessary to establish a system to prevent concentration of fishing effort near to colonies of land breeding krill predators.

The use of yield models by CCAMLR was adopted as an interim measure (Hewitt *et al.* 2002) to the preferred approach of a feedback driven scheme, whereby management measures are tuned in response to ecosystem monitoring. A full realisation of this approach will require a considerable expansion and development of the existing ecosystem monitoring programme, development of multispecies models accounting for predator/prey interactions and high quality information about the distribution of fishing effort.

3) Determinants and drivers of the population structure are incompletely understood and the causes of inter- and intra-annual variation in krill populations are poorly understood.

Knox (2006) details a number of key questions concerning the reproductive behaviour and ecology of krill which have been the target of relatively recent research but which have not been fully resolved as a result. Despite being studied for many decades, an holistic understanding of their biology which enables reliable predictions to be made about population dynamics in the face of environmental change has not been achieved (Kawaguchi & Nicol 2007). These authors note that over the last 30 years general concepts of krill biology and its life history have changed dramatically as more information has emerged both from field and laboratory studies. Hence, their longevity, which was once thought to be between 2–3 years, is now known to be between 5–7 years. Some of the natural environmental interactions are better (but still incompletely) understood such as those with sea ice (see above), ocean currents and primary producers. Even in the case of sea ice, the best understood of the ecological drivers, the relationship with krill is not simple, with both annual and regional exceptions documented.

In addition to the variation between years, considerable intra-annual variation may exist in population densities in any given year. These may be explained in terms of horizontal or vertical migration, dispersion or advection. This has led to two essentially competing views of krill populations. One views the distribution and abundance of krill at a given location as a function of gross current flows through a much more extensive area. The second view is that krill populations may be relatively stationary and associated with specific physical features of the environment. In terms of fisheries management, the difference between these two conceptual views implies considerable differences in the way that fisheries would need to be managed in each case. Kawaguchi & Nicol (2007) suggest that the krill fishery itself could help in understanding of krill biology. They point out that the quantities fished, together with the fishing strategies employed and coupled with logistic considerations mean that the numbers of krill sampled, both in frequency and intensity, far exceed those characteristic of scientific surveys. There are, however, some limitations. Commercial fisheries concentrate effort in areas of open water where krill densities are high and may target the same population for an extended period of time, although targeting specific colours and sizes of krill to obtain an optimal product may lead to refocusing of effort (see: Everson 2000).

Accordingly, while fishery derived data may provide useful information about krill biology, this will not help in understanding krill behaviours under ice or close to the sea-bottom. Moreover, the CPUE data from the fishery will, therefore, reflect density in the targeted aggregation rather than reflect overall regional density of krill.

4) Predator-prey dynamics are incompletely understood and, therefore, management feedback systems are difficult to devise to assure full protection.

In the context of the role of krill in the wider ecosystem, the CCAMLR Ecosystem Monitoring Program (CEMP) was set up to monitor a few selected predators in a few areas, based upon the pragmatic view that full ecosystem monitoring would be impractical. Although elements of the programme have been in place since 1987, it remains unclear how the data could be used to demonstrate the effects of fishing to initiate a management response. Moreover, the impacts of fishing need to be differentiated from any impacts caused by environmental change (Constable *et al.* 2004) which is not possible as things stand.

As pointed out by Constable *et al.* (2000), the precautionary approach is entrenched as a concept within the management strategies used by CCAMLR. The corollary to this, however, is that essential work is still required to develop management procedures that are robust against the unknown and uncertain behaviours of the Antarctic ecosystem. Hence, while the current krill management system is regarded as a precautionary one, much of the framework has been put in place in the face of considerable gaps in the knowledge and that, in the absence of empirical data, approaches based on scientific consensus have been developed. Accordingly, Constable *et al.* (2000) are of the view that CCAMLR is yet to face the real test in its ecosystem approach.

In summary, therefore, expansion of the krill fishery is considered to be inevitable from the current level which is below the estimated long term precautionary yield. Before this occurs, methods will need to be developed to avoid localised (or indeed wider) ecosystem impacts and to establish relevant feedbacks upon the specific impacts of fishing for this target species. It seems, therefore, that more or less every metric of the fishery, or body of data, required to regulate adequately a fishery prosecuted upon krill in Antarctic and sub-Antarctic waters is inadequate to a greater or lesser degree, and given that it targets a keystone species, exploitation has the potential to disturb the whole ecosystem. In view of its potential role in sequestering carbon, exploitation coupled with adverse environmental conditions could also compromise carbon cycling in the region. In combination, the circumstances could conspire to undermine the basis on which the CCAMLR catch limits have been set. Although these limits were set with the intention of being precautionary, it is clear that the current models used to manage the species do not account for long-term environmental changes of the kind now being observed in the Antarctic, such that the alleged precautionary nature of the limits is far from assured.

MSC Certification for the Krill Fishery

Against this management background, Marine Stewardship Council certification is being sought by a single operator, the Norwegian based Aker BioMarine Co. Ltd., for a single vessel which operates within CCAMLR Statistical Area 48 in the Atlantic sector of the Southern Ocean. Aker Biomarine is forecasting a catch of 55,000 tonnes in the 2008/09 season. Even if this single vessel is following best practice and adhering strictly to CCAMLR regulations, it can be argued that, in the context of the fishery as a whole such individual certification runs counter to the principles of the MSC as an assurance of sustainability. It is perfectly possible in theory for a number of operators to be certified by the MSC and, whilst their individual operations may be acceptable, their aggregate operations could well be unsustainable when considered in whole ecosystem terms. Accordingly, in the interests of maintaining a level playing field, individual operation certifications should be discouraged.

Any application for certification must satisfy the three basic MSC principles as follows:

1) The fishing activity must be at a level which is sustainable for the fish population. Any certified fishery must operate so that fishing can continue indefinitely and is not over-exploiting the resources.

While this condition appears to be satisfied in relation to krill fisheries at current levels of exploitation, there are considerable uncertainties attached to krill ecology and population dynamics, together with long-term population trends which mean that sustainability cannot be guaranteed. Climate change impacts are not specifically accommodated by the management model, and long time-series data against which trends in population can be fully assessed are unavailable..

2) Minimising Environmental Impact. Fishing operations should be managed to maintain the structure, productivity, function and diversity of the ecosystem on which the fishery depends.

Such management cannot be guaranteed under the current framework. Antarctic krill (*E. superba*) is a keystone species. The management of krill is currently effected using a model which has only a limited capacity to respond to changes in input variables (see 2 above), and where some input parameters are estimated on the basis of survey work of limited frequency and intensity. In relation to the ecosystem approach mandated by CCAMLR, this aspect has not been developed in relation to krill dependent predators to any meaningful degree. Notwithstanding, the work carried out under the CEMP the predator/prey relationship impacts due to fishing cannot be differentiated from those caused by variation in physical variables, meaning that the management cannot be fine tuned in relation to fishing alone.

3) Effective management: The fishery must meet all local national and international laws and must have a management system in place to respond to changing circumstances and maintain sustainability.

Adherence to the operational legal framework by the Aker vessel cannot be taken as an assurance that the same is true of all vessels operating in the fishery. Hence, appropriate responses to changing circumstances cannot be assured for the fishery as a whole. Moreover, many of the drivers of krill population ecology are incompletely understood, and these uncertainties and indeterminacies mean that it may not be possible to respond to observed changes in an appropriate way.

Conclusion

The massive uncertainties regarding krill biology, krill population dynamics and its role in the wider ecosystem and ecosystem processes coupled with the unknown impacts of rapid climate change in the region, mean that although well-intentioned, CCAMLR's existing management regime cannot be considered precautionary. For these reasons alone, the MSC is not in a position to certify any Antarctic krill fishing operation, as such a certification would clearly be contrary to the MSC's guiding principles. In addition, Aker's application to undergo certification for its krill fishing operation in the Antarctic cannot be viewed in isolation, the certification must also be considered in the context of the fishery as a whole which, as noted above, is set to expand. Given the above, to certify Aker's operation as sustainable would seriously damage the credibility of the MSC.

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APPENDIX D.2

ANALYSIS ON THE ELIGIBILITY OF AKER BIOMARINE'S KRILL FISHERY OPERATIONS FOR MSC CERTIFICATION

RATIONALE IN REGARDS TO A NUMBER OF PERFORMANCE INDICATORS THAT ARE NOT ACHIEVING THE MINIMUM SG 60 NECESSARY FOR MSC CERTIFICATION

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1. GENERAL COMMENTS

1.1 On the eligibility of Aker's Krill Fishery Operations for MSC certification

The MSC's mission is to use its eco-label and fishery certification program to contribute to the health of the world's oceans by recognizing and rewarding sustainable fishing practices. However, certification of Aker Biomarine's Antarctic krill fishery is contrary to this very mission. No portion of the Antarctic krill fishery should be eligible for certification until the entire fishery is subject to an effective and ecosystem-based management system to ensure that fishing operations do not cause unacceptable damage to the Antarctic and Southern Ocean ecosystem. The fishing activities of a single operator cannot be certified without taking into account the capacity of the overarching management system to achieve the minimum standards that ensure the sustainability of the fishery. **In this document, the AKCP presents the rationale against certification in regards to the MSC's 14 Performance Indicators where Aker operations in the Antarctic krill fishery do not or cannot achieve the minimum SG 60 necessary for MSC certification.**

1. 2. On the impact of MSC certification on The Commission for the Conservation of Antarctic Marine Living Resources' (CCAMLR) process towards an ecosystem-based management system for krill

AT this time, MSC certification of Aker Biomarine's Antarctic krill fishery will jeopardize CCAMLR's process towards adopting the necessary provisions for an effective ecosystem-based management system for krill fisheries. On a consensus-based system such as CCAMLR, incentives for fishing nations to push needed reforms will be lost if certification is granted now.

If the Aker Biomarine Antarctic krill fishery were to be certified, it would presumably, after a chain of custody is achieved, result in a label being placed on the product or on those products that contain krill. If history is a pattern with MSC certifications (note Chilean Sea Bass), this certification would be launched with great fanfare and publicity. The message would be sent to the public that Southern Ocean krill fishery is not contentious and a sustainable undertaking. . Attempts to qualify this message - to say that it only applies to the Aker part of the fishery - would be lost on the buying public, as it was with Chilean Sea Bass.

Once it is assumed that the Antarctic krill fishery is a sustainable one, the impetus on CCAMLR to complete the small scale management unit (SSMU) allocation process and development of other adaptive management provisions will be significantly diminished, making further progress toward completion in this consensus- based CCAMLR progress highly unlikely. The risks to the ecosystem of not completing that process are of great concern.

1.3 General concerns in regard to Aker's Krill Fishery Operations' application for MSC certification

CCAMLR has embarked on a process towards the development of an ecosystem-based management system for krill fishing, which includes the spatial distribution of the catch amongst SSMUs and the development of feedback management options that will allow for adjustment to management rules as a result of information obtained on the status of predator populations derived from monitoring programs. However, this process is far from complete. As a consequence, current management rules and controls cannot ensure that fishing operations are not compromising krill availability for predators in a way that threaten predator populations' viability, especially taking into account the cumulative impacts of fishing and climate change.

In addition, as has recently been raised in CCAMLR discussions, there is uncertainty as to the amount of krill actually being removed from the ecosystem, due to the practice by fishing nations to report krill catches based on product information using a range of conversion factors without indicating product composition of catches, and the product-specific conversion factors used. During the 2008 CCAMLR meeting, the CCAMLR Secretariat submitted a working document according to which, a nominal reported catch could actually represent a catch in green weight that is 4 times larger, depending on the conversion factor used. This paper examined uncertainties in krill catch arising from the use of product conversion factors from scientific observer data, and a limited amount from fine-scale (C1) data reported over the past five years. Conversion factors ranged between 1 and 26 across product types. Given this variability in conversion factors, a nominal reported catch of 600 000 tonnes may represent a catch of 2.5 million tonnes in an extreme case, assuming all the catch was boiled product. Information on product-specific conversion factors, as well as the product composition of the catch, is critical to better quantify the level of uncertainty in reported krill catches. [3]

Although reported krill catches are allegedly below the current catch limit, again a questionable assertion given the uncertainty of conversion factors used in reporting actual krill catch, that uncertainty is only part of the problem. The result of CCAMLR's modeling work suggests that the current catch limit, even putting the green weight issue aside, may not be as precautionary as previously assumed and that significant risks to the ecosystem cannot be ruled out.

As noted before, CCAMLR Conservation Measures for krill fishing cannot ensure that krill fishing does not negatively affect the Antarctic marine food web. Although as currently reported, krill catches levels are still below established catch limits, these limits are set for large areas of the ocean and do not take into account the ecological relationships between krill, dependent species, and fishing operations, which occur at much smaller scales. The current fishery for krill coincides almost entirely within foraging ranges of several species of krill-dependent predators, causing competition for krill between fishing vessels and these predators. Particularly, it is yet uncertain if krill fishing may hinder the recovery of whale populations. CCAMLR has acknowledged that the potential for localized effects of the krill fishery on predators is great unless harvest controls are established for smaller areas and not just for large harvesting units, as is currently the case. Until such time as there is a system in place to control the way that concentrated krill fishing in certain areas may be affecting dependent species, certification of this forage fishery would be premature.

Additional concerns for management include long-term environmental factors like global warming, which could have significant effects on krill stocks.[4] CCAMLR's Scientific Committee has acknowledged near impossibility of determining the extent that changes in the ecosystem are caused by fishing operations or by environmental factors.

[3] See WG EMM REPORT 2008, para. 4.35.

[4] See Angus Atkinson, Volker Siegel, Evgeny Pakhomov, & Peter Rothery, Long-term decline in krill stock and increase in salps within the Southern Ocean, Nature, 2004, at 100-103.

Another unresolved issue is related to the bycatch of larval and juvenile fish by the Antarctic krill fishery. There is still uncertainty over the level of this type of bycatch over all seasons and areas in which the krill fishery operates, and from different fishing gears. No mitigation measures are in place to address this problem.

The full development of a management system for krill fisheries is dependent on the gathering of up-to-date relevant scientific information. The biomass of krill is estimated from synoptic surveys that are conducted across the region where krill are found in the Southern Ocean. The last survey undertaken in the whole CCAMLR Area dates back to 2000, bringing into question the relevance of such estimates almost a decade later. Uncertainties in krill biomass estimates, distribution and movement of krill between relevant areas for management make the collection of up-to-date and consistent data an imperative. This information is also needed to make reliable predictions about the reaction of krill populations to climate change. For these reasons, the collection of scientific observer information across the whole krill fishery has also emerged as an urgent priority for CCAMLR scientists. Although Aker Biomarine voluntarily submits scientific observer information to CCAMLR in relation to all its krill fishing operations, the fact that other operators do not submit consistent scientific observer data means that there is no consistency of data collection amongst the fishing fleets and throughout the fishing season – as described by Kawaguchi and Nicol (2007). This information is vital to assess the impact of fishing on the ecosystem and to move forward in the development of management options for SSMUs.

2. Analysis of Aker Biomarine Antarctic krill fishery operations against some of the Performance Indicators (PIs) used in MSC's Fisheries Assessment Methodology

After a review of MSC's Fisheries Assessment Methodology, [5] the AKCP has arrived at the conclusion that Aker Biomarine Antarctic Krill Fishery operations do not meet the MSC standard for certification.

According to the MSC Guidelines:

"any scoring elements or scoring issues within a PI, or the PI itself, which fail to achieve SG60 represent a failure against the MSC standard, therefore the fishery would be ineligible for certification. In such cases, no score shall be assigned. Certification bodies shall record their rationale in narrative form for the element, issue or PI, rather than assigning actual scores of less than 60".[6]

The fishery operations under assessment do not achieve SG 60 in a number of aspects that are detailed below. It has also been found that in a number of PIs, SG 60 scoring is categorized in an ambiguous manner, without offering sufficient elements to conduct a solid and unequivocal assessment. For the Antarctic krill fishery, this results in a situation where a given PI clearly does not apply, and yet, when looking at the formulation of SG 60, it allows some space to argue that the standard may be met. The lack of definition in a number of PIs of what achieving SG 60 means specifically ("in the water") completely undermines MSC's role as a market-based mechanism to foster sustainable fisheries practices.

Analysis of selected PIs

Principle 1

Component: Harvest strategy (management)

PI Category: Harvest strategy

1.2.1 There is a robust and precautionary harvest strategy in place

SG60: The harvest strategy is expected to achieve stock management objectives reflected in the target and limit reference points; the harvest strategy is likely to work based on prior experience or plausible argument; monitoring is in place that is expected to determine whether the harvest strategy is working

[5] Marine Stewardship Council Fisheries Assessment Methodology and Guidance to Certification Bodies Default Assessment Tree, Performance Indicators and Scoring Guideposts. Version 1, 21 July 2008.

[6] Id., paragraph 4.4 (d).

Comment: At the moment, it is uncertain whether there is a robust and precautionary harvest strategy in place for krill fishing in the Southern Ocean, since there is a great degree of uncertainty in regards to krill biomass in the area. The last krill synoptic survey undertaken in the whole CCAMLR Area dates from 2000 almost nine years ago. Biomass estimates were produced as a result of analysis acoustic data from that survey. The methodology to analyze acoustic krill data is constantly evolving, resulting in very different estimates. For example, a difference in the position of individual krill (i.e., angular resolution of the target's position) when hit by the beam of hydro-acoustic systems, could bring a change of one order of magnitude in the resulting biomass estimate. The estimated krill biomass resulting from the 2000 Krill Synoptic Survey was the basis for the current precautionary catch limit in Area 48.

In recent years, CCAMLR has been operating on the basis of a fixed biomass estimate while the analysis of acoustic data is being refined. In consequence, CCAMLR's harvest strategy for krill is based on biomass estimates that are subject to an enormous degree of uncertainty. In addition, the heightened impacts of climate change during the last decade cast even greater uncertainty on the validity of this assessment.

In relation to monitoring mechanisms in place to determine whether the harvest strategy is working, the lack of systematic scientific observation data from the krill fishery is an important deficiency of the system. As it will be expanded below, CCAMLR's Scientific Committee has noted, in relation to this issue, that it has "inadequate information from the fishery on which to base management advice"[7]; see also[8].

Taking into account the comments above, the AKCP concludes that the fishery under assessment does not achieve the minimum SG 60 in relation to this PI

Component: Harvest Strategy

PI Category: Harvest control rules and tools

1.2.2 There are well defined and effective harvest control rules in place

SG60: Generally understood harvest control rules are in place that are consistent with the harvest strategy and which act to reduce the exploitation rate as limit reference points are approached. There is some evidence that tools used to implement harvest control rules are appropriate and effective in controlling exploitation.

Comment: As it has recently been raised in CCAMLR discussions, there is uncertainty as to the amount of krill actually being actually removed from the ecosystem, due to the practice by fishing nations to report krill catches based on product information using a range of conversion factors without indicating product composition of catches, and the product specific conversion factors used. Uncertainty as to the krill caught in different areas hinders CCAMLR's ability to limit catches as the catch limit is approached. According to information submitted by the Secretariat to the last CCAMLR meeting, a reported catch of 125,000 tonnes (2007/08 season) may actually represent a real catch of 500,000 tonnes. This means that under the current reporting system, it is possible for the fishery to actually approach or exceed the catch limit, without triggering the implementation of the control rules that are in place to prevent fishing over the limit.[9]

Taking into account the comments above, the AKCP concludes that the fishery under assessment does not achieve the minimum SG 60 in relation to this PI

Component: Harvest Strategy

PI Category: Information / monitoring

[7] SC- CCAMLR, 2006, para. 4.19.

[8] 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.

[9] According to CM 23-06 (2007), when the total reported catch in any fishing season reaches 80% of the catch limit, catches shall be reported on a 10-day basis instead of a monthly basis. This change of reporting requirements was developed to allow the Secretariat to have catch data in a timely manner so as to close the fishery when the limit is reached.

1.2.3 Information/ monitoring: Relevant information is collected to support the harvest strategy.

SG 60: Some relevant information related to stock structure, stock productivity and fleet composition is available to support the harvest strategy - Stock abundance and fishery removals are monitored and at least one indicator is available and monitored with sufficient frequency to support the harvest control rule.

Comment: Two main issues undermine effective monitoring to support the harvest strategy for the krill fishery. These are: inadequate catch reporting, and lack of consistent scientific observer data.

In regards to catch reporting, and as mentioned above, under the current system, the product-specific catches and conversion factors are not reported and therefore there is a high degree of uncertainty as to the actual catch. This inadequacy was recognized by CCAMLR in its last meeting.[10] And it seriously undermines CCAMLR's ability to monitor fishery removals as needed in the context of this PI.

In relation to observers, the lack of systematic scientific observation data results in the absence of basic information on krill catch, and limits the possibility to estimate stock structure.

For several years, the Scientific Committee (SC) has acknowledged 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) bycatch of fish (e.g., larval *C. gunnari*).

In 2006, and in relation to the observer issue, the SC noted that "it still had inadequate information from the fishery on which to base management advice".[11]

At its 2007 meeting, the Working Group on Ecosystem Monitoring and Management (WG-EMM) considered a range of scientific reasons for higher levels of observer coverage in the krill fishery. The working group noted that systematic coverage is needed to understand the behavior and impact of the fishery as well as routine monitoring to inform the modeling of krill stocks. The meeting made clear that the need for systematic coverage extends across all areas, seasons, vessels and fishing methods. Therefore, although Aker Biomarine voluntarily submits scientific observer information to CCAMLR in relation to all of its krill fishing operations, the fact that other operators do not submit consistent scientific observer data means that the frequency in the monitoring of this fishery is insufficient to support the harvest strategy.

At the last WG –EMM in 2008, an analysis of the behavior of the krill fleet was presented, underscoring the importance of high-quality year-round data from observers on all vessels participating in the krill fishery to assist in interpreting the annual fishing results. The analysis suggested the need for updates of some of the parameters used in the krill fishery fleet dynamics models published in the late 1980s, to reflect changes in the efficiency and scale of the krill fleet's operations. A considerable year-to-year variability was revealed for the probabilities of repeated operation at same locations. Fishery behavior differentiates between market-type considerations/strategies, which are often the argument for changing fishing patterns, and catching efficiency/operational requirements in an area. This highlights the importance of scientific observer data to monitor the performance of the harvest strategy.[12]

Also in 2008, the Scientific Committee drew the Commission's attention to the conclusion of its two main working groups: WG-EMM advice indicated a need for systematic scientific observation of all krill fishing activities; WG-FSA recommended an increase in the levels of scientific observation across the krill fishing fleet.[13]

[10] WG EMM report 2008, para. 4.36: "*In the current reporting system, the product-specific catches and conversion factors are not reported and therefore it is not possible to identify whether the catch reported was based on conversion factors or direct measure of green weight"*.
[11] SC 2006, para. 4.19. *See* also 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.
[12] WG-EMM-08/39, Krill fishery behavior in the southwest Atlantic, S. Kawaguchi (Australia). *See* also WG-EMM 2008, para. 4.20.
[13] SC 2008, para. 4.20.

Taking into account the comments above, the AKCP concludes that the fishery under assessment does not achieve the minimum SG 60 in relation to this PI.

PRINCIPLE 2

Component: bycatch

PI Category: Outcome/Status

2.2.1 The fishery does not pose a risk of serious or irreversible harm to the bycatch species or species groups and does not hinder recovery of depleted bycatch species or species groups.

SG 60: Main bycatch species are likely to be within biologically based limits, or if outside such limits there are mitigation measures in place that are expected to ensure that the fishery does not hinder recovery and rebuilding. If the status is poorly known there are measures or practices in place that are expected result in the fishery not causing the bycatch species to be biologically based limits or hindering recovery.

Comment: The impact of bycatch of fish by the krill fishery is unknown and no mitigation measures are in place. Bycatch species include mackerel icefish (*Champsocephalus gunnari*), overfished to the point of stock collapse in the 1970s and still recovering. [14]

Already in 1992, sampling by research vessels in South Georgia identified bycatch of the following finfish species occuring in large numbers in krill trawls: mackerel icefish (*Champsocephalus gunnari),* blackfin icefish *(Chaenocephalus aceratus),* and the *Myctophidae*. The data indicated that the bycatch of fish in the commercial krill fishery may be significant in some areas of the South Georgia shelf.[15] Anecdotal information from industry sources suggest that large amount of toothfish larvae may be caught as bycatch in this fishery.

At the CCAMLR 2008 meeting, the Scientific Committee noted that there is still uncertainty over the level of bycatch of juvenile and larval fish in the krill catch over all seasons and areas in which the krill fishery operates, and from different fishing gears. The uncertainty about the actual krill catch derived from the different conversion factors used in krill catch reporting adds even greater uncertainty to the extrapolated level of juvenile fish bycatch in the krill fishery.[16] Further, the Commission noted that uncertainties over the level of bycatch of juvenile and larval fish in the krill fishery were still a matter of concern. Two years before, WG-EMM had noted that the occurrence of fish larvae bycatch observed in the krill fishery was higher than the previous general understanding of bycatch in this fishery. The Working Group agreed that such results underscore the importance and need to increase observer coverage in the krill fishery.[17]

Taking into account the comments above, the AKCP concludes that the fishery under assessment does not achieve the minimum SG 60 in relation to this PI.

Component: bycatch

PI Category: Management Strategy

2.2.2 There is a strategy in place for managing bycatch that is designed to ensure the fishery does not pose a risk of serious or irreversible harm to bycatch populations

[14] The South Georgia stock recovered from three episodes of heavy exploitation in the mid-1970s and in the early and mid-1980s. However, stock size remained low after a fourth decline following the 1989/90 season. The stocks around the South Orkney and the South Shetland Islands are still only fractions of their sizes at the beginning of the fishery in 1977/78. K.H. Kock. "A Brief Description of the Main Species Exploited in the Southern Ocean", at: http://www.ccamlr.org/pu/e/e_pubs/am/p7.htm

[15] I. Everson, A. Neyelov and Y. E. Permitin, Bycatch of fish in the South Atlantic krill fishery. Antarctic Science 4 (4): 389-392 (1992).

[16] SC 2008 REPORT, para 4. 15 and 4.19.

[17] WG EMM 2006, para. 3.36.

SG 60: There are measures in place, if necessary, which are expected to maintain main bycatch species at levels which are highly likely to be within biologically based limits or to ensure that the fishery does not hinder their recovery. The measures are considered likely to work, based on plausible argument (e.g. general experience, theory or comparison with similar fisheries/species).

Comment: As explained above, bycatch of finfish species including previously depleted populations is a cause of concern. CCAMLR's Scientific Committee has not been able to develop advice on the acceptable level of bycatch for different fish species in the krill fishery.

Taking into account the comments above, the AKCP concludes that the fishery under assessment does not achieve the minimum SG 60 in relation to this PI.

Component: bycatch

PI Category: Information/monitoring

2.2.3 Information/monitoring: Information on the nature and amount of bycatch is adequate to determine the risk posed by the fishery and the effectiveness of the strategy to manage bycatch.

SG 60: Qualitative information is available on the amount of main bycatch species affected by the fishery; Information is adequate to broadly understand outcome status with respect to biologically based limits; Information is adequate to support measures to manage bycatch.

Comment: The information currently available to CCAMLR cannot support the development of measures to manage bycatch of finfish in this fishery. The lack of systematic scientific observation data is a major impediment to develop mitigation measures. As noted above, in 2006, WG-EMM noted that the occurrence of fish larvae bycatch observed in the krill fishery was higher than the previous general understanding of bycatch in this fishery. The Working Group agreed that such results underscore the importance and need to increase observer coverage in the krill fishery.[18]

Taking into account the comments above, the AKCP concludes that the fishery under assessment does not achieve the minimum SG 60 in relation to this PI.

Component: Endangered, Threatened or Protected (ETP) Species

PI Category: Outcome/Status

2.3.1 The fishery meets national and international requirements for protection of ETP species. The fishery does not pose a risk of serious or irreversible harm to ETP species and does not hinder recovery of ETP species.

SG 60: Known effects of the fishery are likely to be within limits of national and international requirements for protection of ETP species. Known direct effects are unlikely to create unacceptable impacts to ETP species.

Comment: It is hard, if not impossible to score this component because of the way the PI is formulated. Although the PI description mentions the need for the fishery not to "pose a risk of serious or irreversible harm to ETP species and does not hinder recovery of ETP species", these elements are not appropriately incorporated in the minimum scoring failing to ensure that a minimum standard is met. Firstly, SG 60 fails to include any reference about the need not to hinder recovery of the species (a fundamental point in relation to ETP species). Secondly, the statement "known direct effects are unlikely to create unacceptable impacts to ETP species" suggests that for a fishery not to achieve the minimum standard in relation to this PI, only "known effects" can be considered. This formulation is contrary to the precautionary approach, which requires management measures to be more cautious when information is uncertain, unreliable or inadequate. In the case of krill, as mentioned earlier, these uncertainties include but are not limited to the following; the biomass estimate, the actual krill catch and the true impacts of climate change. The absence of adequate scientific

[18] WG EMM 2006, para. 3.36.

information shall not be used as a reason for postponing or failing to take conservation and management measures.[19] This is clearly inconsistent with the MSC methodology, which embraces this formulation of the precautionary approach. [20]

In relation to the krill fishery, the clearest example of affected ETP species is baleen whales. All species of baleen whales are protected under CITES and are major consumers of krill.[21] After an intense hunting that almost led most baleen whale populations to extinction, information in regards to the recovery of these populations is still insufficient. The impact of the current krill fishery on the recovery of baleen whales is unknown.

In addition, little is known about the dynamics of predator-prey interactions and the response of baleen whales to the distribution of their prey. However, recent studies have shown significant relationships between the relative abundance of humpback and minke whales (occurring at ice margins or edges), increasing krill abundance, and certain physical features which may aid in prey aggregation off the Antarctic Peninsula. The relative abundance of humpback whales has also been shown to correlate with distance to shore and it is likely that these whales forage in similar areas as land-based krill predators around the Antarctic Peninsula, where the krill fishery is concentrated. Thus, the current location of krill fishing operations could have a large impact on residential cetaceans.

CCAMLR combines predator abundance estimates with estimated prey consumption rates to estimate the krill biomass consumed by those predators. However, to date direct estimation of consumption rates for baleen whales is not possible (Reilly et al. 2004). Several efforts to model the impact of krill harvesting and predator-prey dynamics in the Southern Ocean ecosystem (e.g. and reviewed by Hill et al. 2006, e.g. Mori and Butterworth 2006) have ignored, made gross assumptions about, or used largely indirect methods for estimating cetacean consumption rates. Therefore, a compelling need for data exists for a fundamental knowledge regarding the ecology of baleen whales and for the monitoring of those species. See comments below (PI 2.3.3) on CCAMLR's Ecosystem Monitoring Program (CEMP) which does not cover whale species.

Taking into account the comments above, the AKCP concludes that the fishery under assessment does not achieve the minimum SG 60 in relation to this PI.

Component: ETP Species

PI Category: Management strategy

2.3.2 The fishery has in place precautionary management strategies designed to: meet national and international requirements; ensure the fishery does not pose a risk of serious or irreversible harm to ETP species; ensure the fishery does not hinder recovery of ETP species; and minimize mortality of ETP species.

SG 60: There are measures in place that minimize mortality, and are expected to be highly likely to achieve national and international requirements for the protection of ETP species; the measures are considered likely to work, based on plausible argument (e.g. general experience, theory or comparison with similar fisheries/species).

Comment: As in the previous PI (2.3.1), it is important to note that the formulation of this PI is misleading because although the PI description mentions the need for the fishery to "not hinder recovery of ETP species", this element is not explicitly incorporated in the minimum scoring which must be required to ensure that a

[19] Article 6.2 of the UN Agreement for the implementation of the provisions of UNCLOS of 10 December 1982 relating to the conservation and management of straddling fish stocks and highly migratory fish stocks. Also known as the "Fish Stocks Agreement.

[20] Marine Stewardship Council Fisheries Assessment Methodology and Guidance to Certification Bodies Default Assessment Tree, Performance Indicators and Scoring Guideposts. Version 1, 21 July 2008, para. 8.2.24.

[21] All cetacean species are protected under either Appendix I or II of CITES. Baleen whales, major consumers of krill, are granted the strictest protection under Appendix I. See CITES Appendices at http://www.cites.org/eng/app/E-Jul01.pdf.

minimum standard is met. This element is especially important in the case of whales since failure to incorporate it will compromise the ability of whales to recover to pre-hunting levels.

In relation to the krill fishery, as noted above, all baleen whales protected under CITES are dependent on krill as the major food source. The concentrated krill fishing effort in coastal areas overlaps with the foraging ranges for many whales species such as humpback whales. Although CCAMLR is planning to subdivide the krill catch limit amongst SSMUs in order to prevent excessive catch concentration in localized areas, this subdivision has not yet been undertaken. Consequently, the 620,000 tonne limit currently applies across Subareas 48.1, 48.2, 48.3 and 48.4, with no further spatial limitations. This does not respond to the reality of the fishery which is largely concentrated in coastal areas around the Antarctic Peninsula. To the effect of concentrated fishing it is important to add the impact of climate change on krill populations, which further reduces the availability of prey (krill) for these species. See comments on PI 2.5.1 below for an explanation of this issue.

In summary, currently there are no measures in place to ensure that the fishery does not pose a risk of serious or irreversible harm to ETP species (baleen whales) and that the fishery does not hinder their recovery.

Taking into account the comments above, the AKCP concludes that the fishery under assessment does not achieve the minimum SG 60 in relation to this PI.

Component: ETP species

PI Category: Information/ Monitoring

2.3.3 Relevant information is collected to support the management of fishery impacts on ETP species, including: information for the development of the management strategy; information to assess the effectiveness of the management strategy; and information to determine the outcome status of ETP species.

SG 60: Information is adequate to broadly understand the impact of the fishery on ETP species; information is sufficient to qualitatively estimate the fishery related mortality of ETP species; information is adequate to support measures to manage the impacts on ETP species.

Comment: As an initial comment it is important to note that again SG 60 is formulated in such a lax manner as to render ineffective the scoring procedure – it does not clearly ensure that for a fishery to be certified, the minimum information requirements on ETP species supports a precautionary management strategy. In order to overcome this deficiency, SG 80 would need to be the minimum standard in relation to information/monitoring requirements on ETP species.

In relation to the krill fishery and its potential impact on baleen whales, direct estimation of current krill consumption rates for baleen whales is not possible. Several efforts to model the impact of krill harvesting and predator-prey dynamics in the Southern Ocean ecosystem have ignored, made gross assumptions about, or used largely indirect methods for estimating cetacean consumption rates. The current level of knowledge regarding the ecology of baleen whales is inadequate to support measures to manage the impacts of the krill fishery on baleen whales and evaluate the outcome status of baleen whales populations.

Monitoring of krill-dependent predators is a key aspect of the management system in order to manage fishery-related impacts. The CCAMLR Ecosystem Monitoring Program (CEMP) has been designed to monitor the effects of the krill fishery on krill predators as opposed to those produced by environmental changes. Currently, data are being gathered from a network of determined sites (CEMP sites) in relation to a limited number of krill-dependent predators in land-based colonies which were selected as indicator species. A list of monitored parameters was developed for 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. In the context of whales, it is important to note that CEMP does not include the monitoring of the status of whale populations.

Taking into account the comments above, the AKCP concludes that the fishery under assessment does not achieve the minimum SG 60 in relation to this PI.

Component: ecosystem

PI Category: Outcome / Status

2.5.1 The fishery does not cause serious or irreversible harm to the key elements of ecosystem structure and function.

SG 60: The fishery is unlikely to disrupt the key elements of underlying ecosystem structure and function to a point where there would be a serious or irreversible harm.

Comment: The krill fishery targets the core of the Antarctic food web. Antarctic krill are central to the Antarctic marine food web, as most organisms are either direct predators of krill or are just one trophic level removed from it. Consequently, the fishery has the potential to undermine the key role of krill in the ecosystem structure and function, thus causing irreversible harm, unless effective measures are in place to prevent this. As noted above, krill fishing catches are concentrated in areas of high krill productivity and availability, which are key for maintaining the balance of the ecosystem.

For many marine mammals and sea birds, krill is the most abundant food source. Areas of highest krill concentration are often close to the land-based breeding colonies of krill-eating birds and seals. These predators depend on krill being within reach of their colonies in order to feed and rear their offspring during the Antarctic summer. It is precisely in these areas where the krill fishery is currently concentrated.

The Antarctic ecosystem is already being impacted by climate change. The Antarctic Peninsula, where major krill spawning and nursery areas are located (and also an area where fishing is concentrated), is one of the world's fastest-warming areas. In this area, the mean air temperature has risen by 2.5°C in the last 50 years. Global climate change will continue to result in changes to the Southern Ocean's temperature, acidity and sea ice coverage, with consequences on krill populations that are not yet well understood. Nonetheless, there is already evidence of direct consequences for krill stocks through the loss of sea ice.

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 in relation to annual krill availability. Similarly, 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).

Therefore, concentrated krill fishing in these areas has the potential to exacerbate effects of global warming, undermining the ecosystem's resilience to cope with climate-change related impacts. Until there is a krill-specific management system in place that incorporates the combined impacts of fishing and climate change, it will be impossible to know to what extent the fishery is disrupting the key elements of underlying ecosystem structure and function to a point where there would be a serious or irreversible harm.

The Antarctic marine ecosystem has already gone through profound changes as a result of whale hunting and climate change. The potential effect of fishing a key component of the ecosystem in this context is unknown. In 2007, WG-EMM noted that the results of a comprehensive review of the structure and operation of the Scotia Sea ecosystem indicated that a combination of historical exploitation and the effects of climate change could lead to significant and rapid changes over the next two to three decade.

In recent years, CCAMLR's working groups have advised that the continuation of the current fishing pattern can lead to considerable negative impacts on the ecosystem. At the last Scientific Committee meeting, it was noted that even under the currently applicable catch limit, the traditional distribution of the fishery is likely to be harmful to the ecosystem.[22]

Comments to PI 2.5.2 (see below) show that CCAMLR currently lacks measures that can ensure that no ecosystem irreversible impacts occur as a result of fishing.

[22] SC 2008, para. 3.6, 3. 9, 3.32, 3.18; SC 2006, para. 3.11

Taking into account the comments above, the AKCP concludes that the fishery under assessment does not achieve the minimum SG 60 in relation to this PI.

Component: ecosystem

PI Category: Management Strategy

2.5.2 There are measures in place to ensure the fishery does not pose a risk of serious or irreversible harm to ecosystem structure and function.

SG 60: There are measures in place, if necessary, that take into account potential impacts of the fishery on key elements of the ecosystem. The measures are considered likely to work, based on plausible argument (e.g., general experience, theory or comparison with similar fisheries/ ecosystems).

Comment: Comment: CCAMLR Conservation Measures for krill fishing cannot ensure that this fishery does not pose a risk of irreversible harm to ecosystem structure and function. This is mainly because the 620,000 tonnes catch limit does not take into account the ecological relationships between krill, dependent species, and fishing operations, which occur at much smaller scales.[23]

CCAMLR has acknowledged this and has started a process towards the establishment of krill catch limits at the level of SSMUs in Area 48. Although the SSMUs were defined in 2002, there are still no catch limits in place for these SSMUs. CCAMLR Working Groups have undertaken a risk assessment of the different management options for SSMUs.

At the last CCAMLR meeting, advice from WG-EMM clearly indicated that for an allocation of the 620,000 tonnes krill catch limit based on options 2 and 3, the risk of negative impact on predators was negligible.[24] This advice was the result of an assessment of the relative risks of the management options 2, 3 and 4[25] and based on different catch levels, using the modeling tools available. Option 1 (corresponding to historical fishing distribution that reflects the current fishing pattern) was not subject to this assessment as it had been disregarded in previous years for its greater potential for harmful effects on the ecosystem. In spite of WG-EMM advice on the adequacy of using options 2 and 3 for the allocation at this stage based on the best available science, the Scientific Committee was unable to reach consensus and endorse this approach.

Recent Scientific Committee deliberations clearly show that delaying SSMU allocation would in fact result in an Option 1 scenario, which is estimated to have greater significant risks to the ecosystem than any of the other management options. This is because Option 1 reflects the historical fishing distribution (i.e., main krill fishing grounds) where the fishery largely overlaps with foraging ranges of krill-dependent predators in coastal areas. As noted before, recent CCAMLR work indicates that the current catch limit is not as precautionary as previously assumed.[26]

Furthermore, as acknowledged by the Scientific Committee at its last meeting, sufficient vessel capacity now exists in the krill fleet to exceed the existing catch limit for Subareas 48.1, 48.2, 48.3 and 48.4. This underscores the need to make rapid progress on SSMU allocation of the krill catch.[27] In spite of this evidence, CCAMLR has not been able yet to adopt measures and make substantial progress on this issue.

Taking into account the comments above, the AKCP concludes that the fishery under assessment does not achieve the minimum SG 60 in relation to this PI.

Component: ecosystem

[23] As per CM 51-01, the catch limit applies Subareas 48.1, 48.2, 48.3 and 48.4 combined.
[24] According to available models, evaluation of Options 2 and 3 included allocations of 70% and 62% respectively of the total catch to pelagic SSMUs.
[25] Option 2: estimates of predator demand in each SSMU from available predator abundance data and consumption rates; Option 3: estimates of the proportion of krill in each SSMU derived from the CCAMLR 2000 survey; Option 4: the difference between estimates of krill standing stock and predator demand.
[26] SC 2008, para. 3.1- 3.21, and 3.30-3.34.
[27] SC 2008, para. 4.4.

PI Category: Information / Monitoring

2.5.3 There is adequate knowledge of the impacts of the fishery on the ecosystem

SG 60: Information is adequate to identify the key elements of the ecosystem (e.g. trophic structure and function, community composition, productivity pattern and biodiversity). Main impacts of the fishery on these key ecosystem elements can be inferred from existing information, but have not been investigated in detail.

Comment: The impacts of the krill fishery on the Antarctic ecosystem are basically unknown. This is because available information does not allow distinguishing the effects of fishing from those derived from climate change. Furthermore, uncertainties derived from climate change are yet to be considered by CCAMLR in the development of models for krill management at the SSMU level.

Acknowledging difficulties to infer fishery-related impacts on the ecosystem, CCAMLR established an ecosystem monitoring system (CEMP) which was designed to monitor the effects of the krill fishery on krill predators as opposed to those produced by environmental changes. As previously stated, CEMP data are currently gathered from a network of determined sites (CEMP sites) in relation to a limited number of krill-dependent predators in land-based colonies which were selected as indicator species. Fieldwork and data acquisition for predator parameters (indicator species) are voluntarily carried out by CCAMLR Member countries and submitted to the CCAMLR Secretariat. Nevertheless, in spite of the ambitious objective of CEMP, current monitoring sites in Antarctica respond to shifting national priorities and are not representative of all the areas that are being currently fished. As CEMP data are essential to monitor the impact of fishing operations renewed efforts should be put in place in order to expand coverage of this monitoring program in order to ensure that appropriate and representative data are collected for all SSMUs. Already in 2003, the Scientific Committee acknowledged that the current design of the CEMP may never allow these different factors to be satisfactorily distinguished.[28] Since then, CEMP sites have not been expanded, and in some cases, some CEMP sites have been discontinued.

Furthermore, some attempts have been made to model complex food webs in the Southern Ocean, but there is a substantial shortage of data on numerous parts of these food webs (Hill et al, 2006). 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. This includes whales and mesopelagic fish, the latter having been recently identified as a major source of uncertainty in relation to which very little information is available. [29] As acknowledged by a CCAMLR workshop in 2008, there is still some way to go before dependent species requirements for krill could be established. For some species that have been identified as key species in terms of krill consumption, available data were found to be simply inadequate. [30]

Taking into account the comments above, the AKCP concludes that the fishery under assessment does not achieve the minimum SG 60 in relation to this PI.

PRINCIPLE 3

Component: Fishery- specific management system

PI Category: Decision - making processes

3.2.2 The fishery-specific management system includes effective decision-making processes that result in measures and strategies to achieve the objectives.

[28] SC 2003, para. 3.12.
[29] SC 2008, para. 3.6 (iii).
[30] Predator Survey Workshop, Hobart, Australia (16-20 June 2008).

SG 60: There are informal decision-making processes that result in measures and strategies to achieve the fishery-specific objectives. Decision-making processes respond to serious issues identified in relevant research, monitoring, evaluation and consultation, in a transparent, timely and adaptive manner and take some account of the wider implications of decisions

Comment: CCAMLR management decisions take the form of *conservation measures*, which are adopted by consensus of all Commission Members at CCAMLR annual meetings, and are binding upon all Members. The application of the rule of consensus in decision-making[31] emanates directly from the fact that CCAMLR was adopted within the framework of the Antarctic Treaty, which formalized the need to respect the delicate balance of sovereign interests between states claimant and non-claimant to territories of Antarctica. The rule of consensus may facilitate implementation once measures have been adopted, as CCAMLR measures are accepted by all Members. However, in the case of Antarctic krill, the practice of a small minority of fishing nations to block consensus on needed reforms is impeding CCAMLR to adopt timely measures to achieve its management objectives.

The most notable example is the need for systematic scientific observer coverage on board krill vessels. CCAMLR achievements in developing innovative approaches to fisheries management in other fisheries 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).

CCAMLR's *Scheme of International Scientific Observation* was adopted in 1992 to gather and validate fishery-related scientific information. These data are needed to assess the status of the populations of Antarctic marine living resources and the impact of fishing on such populations, as well as on those of related and dependent species (Sabourenkov and Appleyard, 2005).

Scientific observers are required for most CCAMLR fisheries and it is anomalous that this requirement does not apply to the krill fishery, the largest CCAMLR fishery in terms of total catches (Kawaguchi & Nicol, 2007). The importance of systematic scientific observer data for the management of this fishery has been highlighted above. CCAMLR's scientific working groups have been repeatedly calling for systematic observer coverage on board the krill fishery at least for the last five years. This recommendation was consistently blocked at the level of the Scientific Committee by representatives from a small minority of fishing nations (Japan and Korea) based on non-scientific reasons. This practice seriously undermines the Convention's requirement that all management measures be taken based on the best scientific evidence available.

It is worth noting that, at the XXVI CCAMLR Meeting in 2007, the Scientific Committee had agreed to a process to achieve full systematic observer coverage for krill fisheries in the near future.[32] Under this process, krill fishing nations would submit plans to the 2008 meetings of relevant CCAMLR working groups detailing how they would achieve systematic and consistent collection of scientific observation data. Consequently, Japan submitted a proposal to WG- EMM in July 2008 for 50% observer coverage. Discussions at the WG-EMM meeting resulted in an agreement to deploy 100% observers for a trial period of two years starting from December 2009, after which the Scientific Committee would evaluate the level of ongoing observer coverage required for the krill fishery. Unfortunately, Japan overturned this position (despite its prior agreement at the WG-EMM meeting) and opposed the endorsement of agreement by the Scientific Committee. Korea and China supported Japan in this position. Virtually all remaining CCAMLR Members expressed their strong disappointment with this outcome and their support for 100% observer coverage. [33] At the Commission, several

[31] CCAMLR, Art. XXII (1).

[32] It was agreed that "systematic coverage" means a level of coverage that ensures data collection across all areas, seasons, vessels and fishing methods to provide consistent, high-quality data for assessment of a multi-vessel, multi-nation fishery.

[33] SC 2008, paras. 6.22- 6.31.

delegations noted that politics had been inserted into the Scientific Committee's work, and that if not stopped, this trend would greatly impact CCAMLR's ability to achieve its mandate.[34]

The information included above clearly shows that although obtaining systematic scientific observation data is an urgent priority for CCAMLR in order to achieve management objectives, decision-making processes have not enabled CCAMLR to address the key issues identified by its scientific bodies.

Taking into account the comments above, the AKCP concludes that the fishery under assessment does not achieve the minimum SG 60 in relation to this PI.

Component: Fishery- specific management system

PI Category: Research Plan

3.2.4 The fishery has a research plan that addresses the information needs of management

SG 60: Research is undertaken, as required, to achieve the objectives consistent with MSC's Principles 1 and 2. Research results are available to interested parties

Comment: As highlighted throughout this document, there is still a considerable degree of scientific uncertainty in relation to krill fisheries management. CCAMLR needs to address these uncertainties as a matter of priority in order to make allocation of catch limits amongst SSMUs, a key component to prevent irreversible harm to the ecosystem.

For example, we are still a long way from understanding the biology of krill to the point that would enable us to predict how krill populations react to environmental changes (Kawaguchi & Nicol, 2007). 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.

As noted above, some attempts have been made to model complex foodwebs in the Southern Ocean, but there is a shortage of data on substantial parts of these food webs (Hill et al, 2006). In relation to krill predators, most research has been conducted on land-based predators. 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. This includes whales and mesopelagic fish, the latter having been recently identified as a major source of uncertainty in relation to which very little information is available. [35]

In May 2007, an international workshop was convened by the *Lenfest Ocean Program* 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).

As acknowledged by a CCAMLR workshop in 2008, there is still some way to go before dependent species requirements for krill could be established. For some species that have been identified as key species in terms of krill consumption, available data have found to be simply inadequate. [36]

CCAMLR contemplates the development of a research plan for new and exploratory fisheries, a requirement that applies to fishing in new areas where no catch limits are in place. However, this requirement does not apply to the krill fishery operating in the current fishing grounds (Subareas 48.1-48.4), even though the research needs for the development of a management system at the SSMU level are imperative. It has been noted that krill fishing vessels can gather and provide invaluable information for management in complementary ways to research vessels (Kawaguchi & Nicol, 2007). However, krill vessels fishing in Subareas 48.1-48.4, where Aker Biomarine is currently operating, are not required to provide this information nor there is a plan in this regard.

[34] See CCAMLR XXVII Report, paragraphs 4.16- 4.27
[35] SC 2008, para. 3.6 (iii).
[36] Predator Survey Workshop, Hobart, Australia (16-20 June 2008).

In closing, the Antarctic Krill Conservation Project would like to reiterate its position that the Aker part of the krill fishery cannot achieve the scoring guidepost of 60 on the 14 indicators as detailed above. Since failing to achieve SG 60 on one indicator is grounds for failing the assessment, we urge that the fishery not be awarded certification until the above problems are addressed.

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The reports of CCAMLR WG-EMM, Scientific Committee and Commission are found at: www.ccamlr.org

3.2 Further references

The AKCP would like to add the following relevant references in addition to the sources that are already being used for this assessment:

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4. ACRONYMS

CCAMLR Commission for the Conservation of Antarctic Marine Living Resources

CEMP	CCAMLR Ecosystem Monitoring Program
SC	CCAMLR Scientific Committee
WG-FSA	Working Group on Fish Stock Assessment
WG-EMM	Working Group on Ecosystem Monitoring and Management

Appendix D.3

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MSC Fisheries Assessment: Antarctic krill fishery

February, 2009

WWF's Antarctic & Southern Ocean Initiative (ASOI) was established to advocate the protection of the biodiversity of the Antarctic and Southern Ocean through an ecologically representative network of MPAs; sustainable management of legal fisheries and measures to address illegal, unregulated and unreported fishing; the recovery and stabilization of populations of Southern Ocean seabirds; and the improved resilience and adaptation ability of the system to the impacts of climate change. The Initiative is hosted by WWF Australia.

A number of WWF national offices directly contribute to the aims and objectives of the ASOI, including WWF Australia, WWF-New Zealand, WWF South Africa, WWF-UK, WWF-US, WWF-Norway and associate Fundacion Vida Silvestre Argentina (FVSA). Other WWF offices engage in advocacy at a national level ahead of key political opportunities and decision-making meetings, such as the annual meetings of the Antarctic Treaty Consultative Parties (ATCM) and the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR).

As a contribution to the Initiative's work on sustainable legal fisheries in the Southern Ocean, ASOI is interested in the Marine Stewardship Council certification / recertification of any Southern Ocean fisheries, including the South Georgia and South Sandwich Islands Patagonian toothfish longline fishery, South Georgia icefish pelagic trawl fishery, Australian mackerel icefish fishery, the New Zealand Ross Sea toothfish longline fishery (RSLT) and the Antarctic krill fishery.

WWF considers that precautionary management of the krill fishery, which is transparent and enforceable, is fundamental to the health and status of krill stocks and all the Southern Ocean species dependent on krill and the health of the wider ecosystem. The expected expansion of the krill fishery is currently not matched by investments in science and monitoring of impacts on predator populations required for precautionary management of the fishery, and poses huge challenges for the current and future sustainability of the fishery.

WWF's ASOI has a number of concerns about the potential certification of the Antarctic krill fishery. The key issues are *Catch Limits for Antarctic krill, Small Scale Management Units, Technology, Scientific Observers, Research and Monitoring, and Integrating Climate Change impacts into Ecosystem-based Management*. The issues are described in detail below.

Proposed certification of the Aker BioMarine Antarctic krill fishery

Antarctic krill, *Euphausia superba,* is considered to be the lynch pin of the Antarctic food chain. Krill is worth millions of dollars to industrial fishing operations and there is a growing interest in entering into the fishery. For almost 40 years the Antarctic krill fishery has been the largest fishery in the Southern Ocean for which Russia, Japan, Chile, Korea, Ukraine, Poland and Norway have been the major players. From 1990 until today, about 100 000 tons of krill has been harvested annually. Heightened interest in the krill fishery and changing technology may lead to more participants entering the fishery, which, if not well managed, could result in localized depletion of krill and serious damage to the Southern Ocean foodweb. It is important to meet these challenges by ensuring that adequate and effective conservation and management measures are in place.

Maintaining krill populations and making informed decisions to protect wildlife that depend on krill as a food source is fundamental to the orderly development of the krill fishery. Yet there is still insufficient knowledge about the impacts of the fisheries on krill populations and dependent predators. There can be little doubt, however, that krill fishing can have significant localized impact on predator populations. There is a close relationship between krill and baleen whale distributions, and the current fisheries are operating close to shore where land-based predators forage. Reduced abundance of krill in these areas may pose significant risks to krill dependant predators, such as seals and penguins.

Furthermore, recognizing that the Southern Ocean is already experiencing impacts associated with global climate change, the regulations that apply to the krill fishery must use the precautionary approach and consider climate impacts when making management decisions.

WWF's ASOI has a number of concerns about the potential certification of the Antarctic krill fishery. The key issues are outlined below:

- **Catch Limit for Antarctic Krill** – The current catch limit for Antarctic Krill in Area 48 (Subareas 48.1, 48.2, 48.3 and 48.4) is 3.47 million tonnes, which is around 10 % of the estimated total biomass in this division. WWF is concerned that while this represents a smaller catch limit than for most other fisheries, it may fail to protect krill predators at the local scale where they compete with industrial trawlers for a smaller number of krill.

  In 2007 CCAMLR amended Conservation Measure 51-01 to set an interim catch limit for Area 48 at 620 000 tonnes until CCAMLR has divided the entire catch limit of 3.47 million tonnes into so-called SSMUs. The origin of this interim catch limit was the agreement that even a relatively low catch limit could lead to localized depletion of krill, if the entire catch was taken in one small area, and krill predators would be left without a food source.

  WWF strongly supports this interim catch limit and believes that it must remain in place until CCAMLR has adopted an adaptive feedback management system that not only divides the catch limit into SSMUs, but is flexible enough to respond to ongoing monitoring.

  WWF also believes that for the fishery to be certified it must be able to demonstrate that there is no significant localized impact on predator populations, and ensure that the fishing effort is well-dispersed to avoid conflict and competition with krill predators at a local scale.

- **Small Scale Management Units (SSMU)** –To address concerns that intensive fishing in small areas would adversely impact krill predators, CCAMLR divided Area 48 (Subareas 48.1, 48.2 and 48.3) into 15

SSMU's in 2002. CCAMLR's Scientific Committee is currently considering how to divide the total catch limit among the SSMUs. WWF acknowledges the challenges related to accurately dividing the catch into SSMUs, and believes there is an urgent need for more detailed knowledge about the relationship between krill biomass and predator populations in space and time, the effects of krill harvesting on predator populations and the impacts of climate change on krill recruitment and survival to be able to make the correct division.

WWF believes that it is essential that the Aker BioMarine krill fishery contributes with information related to how the fishing effort is distributed according to the proposed SSMU's and in relation to predator distribution, to be able to conclude on potential localized impacts of the krill fishery.

- **Technology** – Aker BioMarine has introduced innovative technology to the fishery that has never before been used in the Antarctic. This advanced catching and on-board processing technology allows vessels to maximize catches and improve profitability. The application of these technologies to krill fishing in the Antarctic enables operators to increase catch up to 120 000 tonnes per year per vessel (equal to the total annual krill catch of all vessels in recent years).

  WWF is concerned about the unknown impacts of this technology on the Antarctic marine ecosystem, especially in relation to the bycatch of marine larvae. As a requirement the fishery must document the level of bycatch of marine larvae, and contribute to further study using new and existing data of the impact of bycatch of marine larvae as part of the assessment.

- **Scientific Observers** – The krill fishery in Area 48 is the only fishery in the Southern Ocean that CCAMLR exempts from its International Scheme of Scientific Observation. However, the data required by CCAMLR's Scientific Committee to implement ecosystem-based management of the krill fishery is substantial and cannot be met without a robust observer program. WWF believes that the Antarctic krill fishery must be subject to a comprehensive international scientific observer program in accordance with CCAMLR's Scheme of International Scientific Observation, and that the krill fishery should not be allowed to expand until all participants agree to comply.

  WWF advocates 100% observer coverage of all krill vessels, in accordance with CCAMLR's Scheme of International Scientific Observation to collect data necessary to evaluate and mitigate the impact of all krill fishing technologies on the Antarctic ecosystem, and improved catch and effort reporting to allow a haul-by-haul comparison between traditional trawl methods and Aker's recently introduced pumping technology to inform management decisions.

- **Research and monitoring -** There is an urgent need for more detailed knowledge about the spatial relationship between krill biomass and predator populations, the effects of krill harvesting on predator populations and the impacts of climate change on krill recruitment and survival. However, data submitted to the CCAMLR Ecosystem Monitoring Program (CEMP) has been decreasing in recent years and new investments in krill fishing are not being matched by the appropriate investments in science needed for a robust, scientifically-based management system.

  WWF believes that it is the responsibility of all participants in the krill fishery to contribute to research in the region, by both allowing researchers to enter onboard the vessels, allowing independent scientific observers onboard and by contributing to monitoring costs through a dedicated CEMP Fund.

- **Integrating Climate Change impacts into Ecosystem-based Management** – The mean air temperature has risen by 2.5˚C in the last 50 years over the Antarctic Peninsula. Global climate change will continue to result in changes to the Southern Ocean's temperature, acidity and sea ice coverage, with consequences on krill populations that are not yet well understood. Nonetheless, there is already some evidence of direct consequences for krill stocks through the loss of sea ice, and we know from observations of current patterns in the Arctic and other parts of the world that climate impacts can happen more quickly and at a greater scale than anticipated by models or scenarios within polar regions. In 2007, the CCAMLR Working Group on Ecosystem Monitoring and Management noted that the results of a comprehensive review of the structure and operation of the Scotia Sea ecosystem indicated that a combination of historical exploitation and the effects of climate change could lead to significant and rapid changes over the next two to three decades.

  WWF believes that krill management needs to be adaptive and flexible in order to allow rapid adjustments as new information on the impacts of climate change becomes available. Failure to do so could mean that current management may prove to be inadequate as changes in seasonality, food availability, and migration result in changes in krill stocks that could not been foreseen under non-climate change scenarios. The fishery must have in place the mechanisms to cope and respond to these matters in a timely manner, and we are concerned that this is not currently the case.

Marine Protected Areas - Provisions for the development of a network of marine protected areas are well established under the Madrid Protocol on Environmental Protection to the Antarctic Treaty and the Convention on the Conservation of Antarctic Marine Living Resources, but so far these provisions have not been used to their full potential. A process has now been established with a workplan adopted in November, 2008 to identify and designate an ecologically representative network of marine protected areas in the Southern Ocean, including the prioritization of a number of areas within Area 48.

While it is unlikely that all the areas identified for protection will be highly protected, i.e. no or extremely limited activity allowed, WWF is hopeful that a reasonable percentage of sites would be highly protected meaning that no fishing would be allowed. The future management of fisheries in Area 48 will need to take into account the development of an ecologically coherent network of MPAs in the area.

WWF believes that all fisheries, including krill fisheries, in area 48 must be cognizant of the fact that a network of marine protected areas is likely to be established in the area in the near future, and should be supportive of the need to include networks of MPAs in the delivery of ecosystem-based management in the region. In addition, they should commit to abide by any future management arrangements agreed through the Antarctic Treaty Consultative Meetings and CCAMLR meetings for the future development and management of an ecologically representative network of MPAs in the region.

- **Expertise of the assessment team** - WWF remains concerned at the limited Southern Ocean marine scientific expertise in the assessment panel. Given the importance and significance of the Southern Ocean ecosystem, it is difficult to comprehend why this expertise has been overlooked in the current assessment panel. While we recognize the competency of the panel, we believe the assessment team should include at least two scientists with significant Antarctic marine scientific expertise. WWF has previously offered names of possible candidates who have considerable Antarctic marine science and fisheries expertise and has also provided names of possible independent peer reviewers including Steven Nicol

(Australian Antarctic Division (AAD)), Phil Tratham (British Antarctic Survey), So Kawaguchi (AAD), and William K. de la Mare (AAD).

WWF urges that one or more of these experts to be consulted in the evaluation of the suitability of this fishery for MSC-certification.

This briefing provides an overview of the issues and major areas of concern to WWF, further information and references are available if required.

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WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by:

- conserving the world's biological diversity
- ensuring that the use of renewable natural resources is sustainable
- promoting the reduction of pollution and wasteful consumption.

Appendix E: Comments Received Following Stakeholder Review of the Public Draft Report

Norwegian College of Fishery Science, University of Tromso, Norway.

Comment:
Considering the importance for mankind of Climate Change and the Kyoto and other initiatives to reduce the emissions of greenhouse gases I am disappointed to see that the MSC still has not included energy efficiency aspects in its fishery assessment principles. This clearly weakens the value of the MSC ecolabel for environmentally concerned consumers.

Moody Marine Response:

The Aker BioMarine fishery was assessed against the MSC Fisheries Assessment Methodology (FAMv1). The question of inclusion of energy efficiency aspects to be included within the assessment methodology is outside the scope of this assessment and should be raised with the MSC directly.

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Ms. Seran Davies
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September 18, 2009

Re: Moody Marine Ltd. Draft Assessment Report of Aker Biomarine Antarctic Krill Fishery

Dear Ms. Davies:

The Monterey Bay Aquarium and New England Aquarium would like to take the opportunity to comment on Moody Marine Ltd.'s draft assessment of the Aker Biomarine Antarctic Krill fishery.

Founded in 1984, the Monterey Bay Aquarium (MBA) is a leader in ocean conservation and providing recommendations on seafood sustainability. The MBA's Seafood Watch program researches and evaluates wild-caught and farmed seafood for sustainability, and shares these seafood recommendations with the public and other interested parties. Our recommendations and scientific reports are publicly available at www.seafoodwatch.org.

Founded in 1969, the New England Aquarium (NEAq) is a global leader in ocean exploration and marine conservation and is committed to building awareness and finding innovative solutions through our marine conservation and research initiatives. The NEAq's Sustainable Seafood Advisory Services aim to foster long-term sustainability of seafood resources and their supporting ecosystems by raising public awareness and working with the seafood industry to realize best practices within wild-capture fisheries and aquaculture operations.

As organizations with similar end goals (*e.g.*, a global supply of sustainable seafood products), MBA and NEAq agree with the guiding principles and processes of the Marine Stewardship Council (MSC), while recognizing the challenges and potential benefits of certification programs, especially in regard to fisheries products. We believe that a robust, credible certification program for sustainable seafood is critical to help achieve the sustainable use of marine resources and ultimately ocean health. The MSC has established a clear, robust process for assessing fisheries around the world, including the use of third-party certifiers and stakeholder engagement in the assessment process. We believe that participating in this process strengthens the outcome of these assessments and reflects our strong support for the MSC.

The certification of Antarctic krill would be precedent-setting as the first fishery that is used primarily as feed/oil product and not for direct consumption by humans (with a few exceptions) to be certified as sustainable to the MSC standards. Antarctic krill is considered a keystone species of vital importance to the health and proper functioning of the Antarctic marine ecosystem. The krill feed directly on phytoplankton, thus converting primary production to a useable food source for a wide variety of higher trophic levels, from fish, to birds and marine mammals. The National Marine Fisheries Service and Pacific Fishery Management Council deemed healthy levels of Pacific krill to be of enough significance to ban fishing of this species in the U.S. West coast Exclusive Economic Zone (EEZ) as decreases in krill biomass have been shown to have negative impacts on a variety of other commercially important species in that region.

The life history characteristics of forage species (*e.g.*, high fecundity, short life spans), combined with their multiple functions in marine food webs, makes it challenging to define sustainability – particularly for a primary consumer like krill. Forage species are commonly subject to cyclic fluctuations between years of high and low abundance, which are often difficult to correlate with specific environmental factors. Therefore, forage species do not lend themselves easily to predictive fishery models and other typical methods of assessment.

We appreciate Moody Marine Ltd.'s detailed review of the Aker Biomarine Antarctic krill fishery and management program. However, we are currently conducting our own evaluations of this fishery and have some sustainability concerns that directly affect the scoring of this fishery with respect to the MSC Performance Indicators.

- Many components of CCAMLR's ecosystem management plan have yet to be implemented (*e.g.*, allocation of quota among small scale management units). Without provisions ensuring CCAMLR's continued progress in this regard, certification of the fishery at this point could remove the incentive to implement these components. This is especially concerning because certification of the fishery may lead to dramatically increasing catch levels.
- The spatial nature of fishing and the potential for localized depletion of krill populations and the subsequent effects on predators is not taken into consideration.
- There is no process for identifying and managing the impacts of climate change or ocean acidification and ocean processes. This is of particular importance for the Antarctic krill fishery because rates of acidification are predicted to be faster at the poles, and the effects of climate change may impact the timing and extent of spring and summer phytoplankton blooms and ice cover, both of which directly effect krill food supply.
- There is no detailed assessment of the bycatch of larval fish with Aker's new technology.
- Considerable time has passed since the last area-wide stock assessment (2000) from which biomass estimates were derived. There were several assumptions used in determining biomass estimates, and the validity of these assumptions (evenly distributed predation pressure, randomly determined recruitment, etc.) is questionable.

To address these concerns, we believe the following actions must be taken for this fishery to meet the principles of the MSC. Based on our understanding of the MSC Fishery Assessment Methodology, we believe this fishery would only warrant certification by the MSC if the following actions are taken:

- Aker Biomarine must provide detailed information on the location of fishing effort (*e.g.*, VMS data), and spatially explicit data on the catch of krill, retained species and bycatch species to CCAMLR and the MSC on an annual basis.
- A mechanism for continually monitoring the spatially explicit impact of Aker Biomarine's fishing activity (VMS data) and other fishing vessels' activity in the same region must be established, and remain in place for several years so that their activities

can be evaluated to distinguish normal annual fluctuations in predator and krill populations from those caused by fishery removal.

- CCAMLR must set spatial management at a scale relevant to predator foraging areas including appropriate spatially explicit reference points, harvest control rules, ecosystem evaluations, and monitoring information; and Aker must abide by this management.
- Should the trigger level of 620,000t be exceeded, the fishery must be closed unless and until CCAMLR accepts an adequate spatially explicit system.
- CCAMLR must provide an evaluation of how climate change impacts the harvest strategy, including consideration of how a regime shift and decrease in krill abundance have been incorporated into the harvest strategy within 5 years. As part of this evaluation, a system of research closed areas should be established to compare effects of fishing versus effects of climate change.
- Aker Biomarine must maintain 100% observer coverage in all fishing areas. Data collected is to be reported to CCAMLR and be made publicly available.

We thank you for the opportunity to comment on the draft assessment of the Aker Biomarine Antarctic Krill fishery, and hope you will work to address our concerns and strengthen the outcome of the assessment.

Sincerely,

Ed Cassano
Senior Director, Department of Conservation Outreach
Monterey Bay Aquarium

Heather Tausig
Associate Vice President, Conservation
New England Aquarium

CC: Brad Ack
Regional Director – Americas
Marine Stewardship Council

Jim Humphreys
Fisheries Director – Americas
Marine Stewardship Council

Moody Marine Response to Monterey Bay and New England Aquarium Comments:

Forage species do not lend themselves easily to predictive fishery models and other methods of assessment
Many components of CCAMLR's ecosystem management plan have yet to be implemented (e.g. allocation of quota among small scale management units). Without provisions ensuring CCAMLR's continued progress in this regard, certification of the fishery at this point could remove the incentive to implement these components. This is especially concerning because certification of the fishery may lead to dramatically increasing catch levels.
This assessment has followed the MSC guidance for low trophic species. The certification is for a proportion of the fishery (Aker vessels) up to the CCAMLR trigger catch level. It is not considered probable that this assessment will impact upon CCAMLR's commitment to the management of the krill fishery as a whole. This assessment is not a carte blanche for the fishery to continue as it is, indeed conditions for certification have been imposed along with several recommendations for improvement within the fishery as a whole have also been made within this report

The spatial nature of fishing and the potential for localised depletion of krill populations and the subsequent effects on predators is not taken into consideration.
The spatial nature of fishing and the subsequent impacts to local populations has been specifically considered within this assessment under Principle 1 and Principle 2.
There is no process for identifying and managing the impacts of climate change or ocean acidification and ocean processes. This is of particular importance for the Antarctic krill fishery because rates of acidification are predicted to be faster at the poles, and the effects of climate change may impact the timing and extent of spring and summer phytoplankton blooms and ice cover, both of which directly affect krill food supply.

The Aker BioMarine Krill Fishery was assessed for certification using the MSC Fishery Assessment Methodology (FAMv1). Climate change was considered by the assessment team as part of the certification report and the team followed the MSC guidance within the FAM for low trophic level species. Specific Performance Indicators which score climate change specifically within the MSC methodology is to be raised with the MSC directly. Also, the detection and response to environmental changes is down to ongoing management of the fishery and will be monitored in ongoing surveillance audits.

There is no detailed assessment of the bycatch of fish larvae with Aker's new technology.
The bycatch of fish larvae from the continuous pumping system used by Aker has been the subject of a recent report on data and research on this aspect of the *Saga Sea* operation. This information was used in this assessment (see MRAG, 2009).

Considerable time has passed since the last area-wide stock assessment (2000) from which biomass estimates were derived. There were several assumptions used in determining biomass estimates, and the validity of these assumptions (evenly distributed predation pressure, randomly determined recruitment, etc) is questionable.
Large scale surveys, currently at approximately decadal intervals should take account of longer term variation, such as due to climate change. Although it would be useful to increase the frequency of such surveys, the current timescale, and precautionary approach to harvest, is considered adequate to accommodate such large scale effects. The next survey is due within the coming year (2010) with small scale surveys also being proposed to take account of variation in local krill demand by dependent species. The absence of empirical information on the response of krill stock to harvesting was recognised by the assessment team and the assumptions used to determine biomass estimates and their validity was also evaluated within the scoring of this assessment (section 4 of this report).

To address these concerns, we believe the following actions must be taken for the fishery to meet the principles of the MSC. Based on our understanding of the MSC Fishery Assessment Methodology, we believe this fishery would only warrant certification by the MSC if the following actions are taken:

Aker Biomarine must provide detailed information on the location of fishing effort (e.g. VMS data), and spatially explicit data on the catch of krill, retained species and bycatch species to CCAMLR and the MSC on an annual basis.

Aker provide VMS (satellite) data continuously during the fishing operations, and in the rare cases where the signal from the vessel is temporarily lost, the information can subsequently be recovered because all data are stored automatically on board. This is provided to Norway (and then passed onto CCAMLR). Catch data including quantity and locations are also submitted to CCAMLR. In addition, Aker BioMarine also submit data on retained species (through their observer program). There is no discarded bycatch from the Aker vessel due to the nature of the gear.

This data will also be verified by the assessment team during the annual surveillance audits which are a condition of MSC certification for the 5 year duration of the certificate.

A mechanism for continually monitoring the spatially explicit impact of Aker Biomarine's fishing activity (VMS data) and other fishing vessels' activity in the same region must be established, and remain in place for several years so that their activities can be evaluated to distinguish normal annual fluctuations in predator and krill populations from those caused by fishery removal.
All fishing information is submitted by Aker to CCAMLR as is the activity of the other fishing vessels within the fishery. This information is used by CCAMLR in its management framework.

CCAMLR must set spatial management at a scale relevant to predator foraging areas including appropriate spatially explicit reference points, harvest control rules, ecosystem evaluations, and monitoring information; and Aker must abide by this management.
Aker BioMarine follows all CCAMLR management without exception. Based upon the current performance of the fishery the recommendation of appropriate reference points, harvest control rules, ecosystem evaluations and monitoring information was stated within the assessment report (section 13.2) should catches exceed the catch trigger level of 620,000t. Reference points consistent with the Precautionary Upper Catch Level (PUCL) are also a condition of this certification.

Should the trigger level of 620,000t be exceeded, the fishery must be closed unless and until CCAMLR accepts an adequate spatially explicit system.
The scoring for this certification assessment was carried out on the basis of the catch trigger level of 620 000t not being exceeded. If this level is exceeded then the certification is revoked. It is not therefore in the interest of the client to exceed this level. The comment regarding fishery closure until CCAMLR accepts a spatially explicit system is beyond the scope of this assessment and should be presented to CCAMLR.

CCAMLR must provide an evaluation of how climate change impacts the harvest strategy, including consideration of how a regime shift and decrease in krill abundance have been incorporated into the harvest strategy within 5 years. As part of this evaluation, a system of research closed areas should be established to compare effects of fishing versus effects of climate change.
This is outside the scope of this assessment and is a question for CCAMLR.

Aker Biomarine must maintain 100% observer coverage in all fishing areas. Data collected is to be reported to CCAMLR and be made publicly available.
The observer data collated from the Aker vessel is submitted to CCAMLR (and made available through MRAG reports). There is no intention to alter this and the continuation of this program was considered as being essential during the certification assessment.

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September 18, 2009

Dear Ms. Davies

We write to express our concerns about the Draft Report on Marine Stewardship Council (MSC) certification of the Aker Biomarine Antarctic krill fishery. Our comments echo those that some of us submitted to the MSC earlier this year (attached). Therein we found the MSC evaluation standards inadequate when applied to low-trophic level fisheries with respect to ecological processes, climate forcing, and governance.

In the attached comments and herein, we assert that Aker's Antarctic krill fishery should not be certified by the MSC. Certification is premature and removes any incentive for the fishery to adopt important ecosystem management measures. Moreover, certification sets a dangerous precedent. Low-trophic level species act as prey for fishes, marine mammals and seabirds and regulate trophic dynamics and thus their removal can dramatically impact marine ecosystems. Products from these fisheries are often destined for use in aquaculture feed, and aquaculture certification programs will use the MSC seal as an assurance of sustainability. It is imperative, therefore, that certification of Antarctic krill and other low trophic level fisheries only be awarded when sound management and proper safeguards are in place.

The Draft Report ignores many important concerns expressed by the stakeholders and reviewers. This includes the comments of Dr. Stephen Nicol, an internationally recognized krill ecologist who has worked with the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR) for over 20 years. The Report dismisses Dr. Nicol's conclusion that the fishery fails to meet the basic criteria for Performance Indicator (PI) 2.1.1 and 2.1.2 and his recommendation that lower scores be assigned for seven other PIs. We are unclear as to the value of such reviews when the advice provided is disregarded. Furthermore, Dr. Nicol noted the lack of consultation by the certifiers with those knowledgeable about Antarctic krill and with CCAMLR. As he was one of only two reviewers involved in this critical certification process, Nicol's concern adds impetus to the need to explain your rationale of ignoring his advice and recommending certification.

The most notable concerns of the reviewers and stakeholders as well as our own are as follows:

- *CCAMLR has not yet implemented an ecosystem management approach to krill fisheries*. While CCAMLR has theoretically determined that an ecosystem-minded fisheries management framework is required, specific agreement on the operationalization of this approach, including requirements for the fishery, have neither been agreed upon by CCAMLR nor implemented. At present, there is still no spatially explicit harvest regime. The Aker vessels operate in a krill-rich area characterized by high densities of marine mammals, sea birds and penguins yet there is currently no information on the impact of localized krill removal on these marine resources.
- *The current CCAMLR ecosystem monitoring program is insufficient and has no feedback loop with management decision-making*. As indicated by Dr. Nicol, the current CCAMLR Ecosystem Monitoring Program (CEMP) is inadequate in terms of regions and species coverage and thus cannot measure the ecological impact of localized krill harvesting activities. Data already collected are not being used to develop conservation measures. Consequently there is no management policy in place to regulate the ecosystem impacts of fishing activities.
- *The trigger level needs to be revised and Small Scale Management Units (SSMUs) need to be implemented to adequately protect the Antarctic ecosystem*. A new risk assessment undertaken by CCAMLR and presented at the July 2009 WG EMM (Working Group on Ecosystem Monitoring and Management) meeting concluded that the current precautionary krill catch limit (trigger level) of 620,000 tonnes may not be sufficient. Simulation studies indicate that an expansion of the fishery to the trigger level without any spatial constraint is likely to risk depletion of krill-dependent predators. As a consequence, in the absence of krill catch limit allocations amongst SSMUs, it is necessary to adopt additional measures, such as subdividing the trigger limit and constraining, if not eliminating, fishing in some areas. As noted in the MSC review by Dr. Nicol, localized depletion of krill could occur well before the overall trigger level is reached and this could have negative consequences for the Antarctic ecosystem.
- *Aker needs a proven track record prior to certification.* Aker's continuous fishing method has not been fully studied with respect to the impact of its spatially intensive krill catch rates or catch of postlarval and larval krill, juvenile fish and other macrozoooplankton taxa. The relatively new technology does not have a history of testing. Even though a condition has been placed on the fishery to evaluate by-catch, more extensive detailed studies are essential. The burden of proof should be shifted so that no harm is proven PRIOR to certification.
- *The overall management system AND Aker's activities must be responsible for the fishery to be certified*. For Aker's fishery to be sustainable, the overall fisheries management system under which it operates must be effective. As noted above, CCAMLR has not yet implemented an ecosystem-based management approach and there are currently no restrictions on locally intensive krill harvesting. Observer coverage in the fishery is limited and, as noted by Dr. Nicol, very few observer reports have ever been submitted over the history of the fishery. The overall effectiveness of CCAMLR management needs to be established PRIOR to certification. As the Antarctic krill fishery is set to expand dramatically in future

years, the management system must also be capable of handling such an expansion.

In addition to Dr. Nicols' comments regarding the failure of the fishery to meet PI's 2.1.1 and 2.1.2, the fishery also fails to meet the SG60 criteria for the following PI's:

PI 1.2.1: For the fishery to achieve a score of 60, monitoring should be in place that determines whether the harvest strategy is working. Given that there is no monitoring on the spatial scale at which Aker operates, nor full observer coverage of the Antarctic krill fishery, we cannot see how the fishery has achieved a passing grade.

PI 1.2.3: To achieve a score of 60, krill stock abundance and fishery removals must be monitored and at least one performance indicator (e.g., predator species) monitored with sufficient frequency to support the harvest control rule. We are unaware of any indicator species being monitored, particularly on the spatial scale necessary to support the harvest control rule. The uncertainty about krill biomass and population dynamics (e.g., localized population structure and recruitment) and the lack of population surveys at an appropriate spatial scale further preclude a passing grade for the fishery.

PI 2.3.3: A passing score requires that information is available to understand the impact of the fishery on Endangered Threatened and Protected (ETP) species. As stated in the Draft Report, CEMP is inadequate due to its spatial scale of monitoring. Additionally, current ecological monitoring does not consider baleen whales, which are increasing in abundance and may need considerable amounts of krill to support expanding populations. We are therefore unaware of any spatially explicit information at the scale of Aker's operation that shows that the fishery will not adversely affect ETP species.

PI 2.5.1: This PI requires that the fishery is unlikely to disrupt the key elements underlying ecosystem structure and function to a point where there would be serious or irreversible harm. While this PI was given a low score, we believe the fishery should have failed based on this indicator. There is still a lack of information on the localized effect of the krill fishery and the burden of proof should be on the fishery to prove no localized effect. As the Draft Report states "…studies have indicated that localised effects of krill fishing on predators might occur." (pg 96).

PI 2.5.2: A score of SG 60 requires that measures are in place that account for the potential impacts of the fishery on key elements of the ecosystem. Without spatially explicit knowledge, the PI cannot be scored so highly.

PI 2.5.3: This indicator requires that adequate information is available to identify the key elements of the ecosystem and infer the main impacts of the fishery on these key ecosystem elements. Neither the CEMP program, nor the modeling exercises, nor the information derived from a very poor scientific observer scheme has sufficiently addressed this PI on the spatial scale at which Aker operates.

We are pleased to see that two conditions have been placed on the fishery. However, we believe that additional conditions should be fulfilled before the fishery can be MSC certified, including the following. Some of these conditions would need to be accepted by CCAMLR rather than Aker. This is again illustrative of the fact that certification is premature because the overall management system set by CCAMLR is still ineffective.

1. Aker should be required to complete an evaluation of the impact of its fishing activity on predators and krill populations. This evaluation must include quantitative information about predator abundance (e.g., through surveys and visual censuses during test fisheries) in the areas affected by krill fishing and the impact of the total take by all fisheries in the area. A model illustrating no irreversible impact should be available prior to certification. The model should be tested annually using data from the fishery.
2. Prior to MSC certification of Aker, CCAMLR should have adopted a management scheme that includes spatially explicit reference points and harvest control rules and an adequate ecosystem monitoring system.
3. Aker should be required to provide annual reports to the MSC detailing the location of fishing effort (e.g., provide VMS data), spatially-explicit data on the catch of krill and retained species, and any incident of by-catch. The annual report should include an assessment of the total fisheries effort in Aker's area of operation, a comparison of the total take to any updated biomass estimates for krill, and an account of the ecosystem parameters being measured to gauge the impact of fishing.
4. Prior to certification, an evaluation of how climate change impacts Aker's harvest strategy should be presented. This should include how a regime shift and decrease in krill abundance is incorporated into the harvest strategy. This will necessitate examining comparative data (e.g., on predator abundance) from areas closed to fishing and consideration of historic data on of the impacts of natural declines in krill abundance (i.e., in years with limited sea-ice) on predator survival and breeding success. As closed areas have not yet been established by CCAMLR, meeting this condition requires that CCAMLR adopt new measures.

Given all of the concerns noted above, the Aker fishery should not be certified. Certification at the present time risks the credibility of the MSC and the health of the Antarctic ecosystem. A delay in certifying this fishery would allow time for CCAMLR to adopt an ecosystem management approach, for the MSC low trophic level fisheries workshop (set to occur in October 2009) to consider this fishery, and the MSC's new Low Trophic Level Fisheries Working Group to review the treatment of low trophic level fisheries in the assessment process.

We request that you chose not only to decline certification but also to address each concern expressed above and to provide specific steps that Aker and CCAMLR can take to achieve MSC certification in the future. This will ensure that MSC holds true to its mission of fostering sustainable fisheries as well as rewarding responsible actors.

Sincerely,

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Statement on forage species and the Marine Stewardship Council (MSC)

We are writing to express our concern about Marine Stewardship Council (MSC) certification of forage species fisheries. Forage species are small, plankton-feeding pelagic fishes and crustaceans that play a pivotal role in marine ecosystems and are increasingly the target of reduction fisheries to produce aquaculture feed. In fulfilling its mission to transform seafood markets and promote sustainability through certification and ecolabelling, MSC is presently overseeing its first review of forage species under new criteria measuring the ecosystem impacts of fisheries. The availability of MSC certified forage species products will fill a pressing need as aquaculture producers seek sustainable feeds.

In undertaking these first reviews, the MSC is at a critical juncture and could set the standards for when forage fisheries can be considered sustainable. Moving forward too quickly, however, could jeopardize MSC's credibility and the health of marine ecosystems while curtailing processes that could lead to well-managed fisheries.

Based on our combined expertise in marine ecology and fisheries, this letter presents our general views on forage species management, the MSC assessment standards and the management of three candidate fisheries (Gulf of California sardine, Antarctic krill, Peruvian anchoveta). We have two main points. First, we find the MSC standards for forage species lacking in adequately considering ecological processes, climate forcing, and governance. Second, we contend that none of the candidate fisheries should be certified until significant ecosystem-minded management improvements occur and empirical data and modeling predictions demonstrate that these fisheries cause no adverse ecosystem impact. We ask that the MSC significantly revise the certification criteria and direct its accredited certification bodies to consider our critique when reviewing the candidate fisheries.

Our analysis of the MSC criteria and suggestions for revision are preliminary. We strongly believe that the MSC should seek further guidance from the scientific community on improved standards for forage species management.

I. Forage species and the need for ecosystem-based management

Forage species often serve an important and unique role in marine ecosystems. As small, plankton-feeding pelagic fishes and crustaceans, forage species are prey for other fishes, marine mammals and seabirds and transfer energy from plankton to these higher trophic levels (Cury et al. 2000)[1]. These species can also influence ecosystem processes through top-down control. Forage species thus maintain energy flow through ecosystems and can regulate overall trophic dynamics. Reduction in forage species availability can negatively impact predators and ecosystems (Crawford 2007; in Alder et al. 2008; Link et al. 2009). In most systems, only a few forage species occur, so ecosystems may not be resilient to forage species removal.

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[1] That forage species are often few in number compared to species richness at other trophic levels is often referred to as a "wasp-waist" richness pattern. Their influence over higher and lower trophic levels is referred to as "wasp waist" control. See Cury et al. 2000 for more background.

Forage species population dynamics are complex and ecologically and environmentally controlled. Oceanographic conditions can drive dramatic fluctuations in biomass ("climate-forcing"). The relationship between population processes (e.g., recruitment) and climate can be difficult to predict, especially with climate change. Climate variability can further affect forage species predators through changes in recruitment that are not directly related to trophic flows.

Forage fisheries must therefore be managed under a regime that accounts for the dynamics of the target stock, its predators and prey, and climate-forcing. Management must be precautionary and adaptive, include feedback loops, and exist within a governance framework that requires an ecosystem approach. Taking an overly simplistic approach may indeed result in the same failed expectations and unwelcome outcomes seen throughout the history of natural resource management (Doak et al. 2008). In our critique of the MSC certification criteria and the three candidate fisheries, we comment on whether these basic ideas are considered.

II. MSC certification scheme for forage species

In order to achieve MSC certification, fisheries must be managed consistent with three Principles (1. Target Species, 2. Ecosystems, and 3. Management Systems) as outlined in the MSC's Fisheries Assessment Methodology (FAM). Thirty-one Performance Indicators (PI's) are used to score a fishery and a Scoring Guidepost (SG) of at least 60 on all PI's is needed for certification. The FAM outlines SG indicators for scores of 60, 80 and 100. The current methodology is a result of a review designed to incorporate ecosystem concerns and applies to all fisheries entering assessment after July 2008. To date, no forage fisheries have been certified under these revised criteria.

We feel that the MSC criteria do not reflect the ecological importance of forage species or the complexity of their management. Many SG100 indicators should be the basic requirements for certification and therefore shifted to the SG 60 level. Moreover, environmental drivers and ecosystem linkages are not adequately considered in biological or governance guideposts. In Annex I, our specific recommendations are outlined.

Concerning the health of the target species (Principle 1), the basic SG60 indicators fall short. As reference points are the limits and targets that guide management actions to ensure fisheries health, they *should* (rather than "can" (SG60)) be estimated for any certified forage fishery. These reference points must be precautionary with respect to predator requirements, prey dynamics, environmental variability, and uncertainty. When predators are constrained in distribution or foraging range, spatially explicit reference points are necessary. Environmental variability and climate-forcing is not adequately covered in the SG's for harvest strategy and rebuilding of depleted stocks. Given the critical role played by forage species and potential systemic effects of their collapse, fisheries for depleted forage species should only be certified when current strategies *demonstrate* rebuilding, something only required at SG 100.

Principle 2 seeks to protect the integrity of the ecosystem and an important PI is to avoid serious or irreversible harm to marine ecosystems through fishing. While we agree that this is the appropriate goal, the practical guidance provided to measure this outcome is insufficient, confusing and vague. As with Principle 1, specific criteria requiring that fisheries management be guided by an understanding of the interaction of climate forcing, fishing and ecosystem processes are lacking. Moreover, SG60 does not require an understanding of the impact of the fishery on predators and the ecosystem. Empirical data and/or modeling predictions on fisheries impacts should be a required for certification. At present, only SG100 requires a fishery to collect data on fishery impacts, feed them back into management, and develop strategies to manage ecosystem impacts. Because of the variability of forage species in response to climate-forcing and their critical role in the ecosystem, feedback mechanisms for ensuring management effectiveness and implementation should be required for certification.

Principle 3 seeks to ensure that governance and fisheries management effectively implements Principles 1 and 2. We believe that the MSC may be overlooking the fact that legal frameworks for managing forage fisheries within an ecosystem context may not exist and may need to be explicitly required for certification. Shifting SG100 indicators to SG60 will ensure that short and long term fisheries management objectives explicitly maintain forage species at levels adequate to maintain their ecological role and that fisheries management decision-making is precautionary.

As the MSC undertakes forage fisheries assessments, transparency is paramount. At the very least, all interested parties should be able to review the documents considered. In many countries where forage fisheries operate, transparency may be lacking, and the multi-institutional framework helpful in overseeing and balancing the process may be absent. External expert review (in addition to that performed by the accredited certification body) of stock assessments, ecosystem models, and fisheries management plans should also be a minimal requirement for forage species certification.

III. Candidate Fisheries

In our critique of three candidate forage fisheries below -- Antarctic krill, Gulf of California sardines, and Peruvian anchoveta -- we focus on issues unique to forage species. General management problems also occur in these fisheries. For krill, full compliance and standardization in reporting is lacking. For sardine and anchoveta, transparency in management practices is needed. All fisheries suffer from a lack of adequate observer coverage, lending uncertainty to claims of by-catch sustainability.

Should more information on the Antarctic krill and Gulf of California sardine fisheries become available to us, we could critically assess the fisheries in light of our critique above. We have requested detailed information from the certifiers under Policy Advisory 7, which concerns transparency, but had not received such information at the time of writing.

Antarctic Krill

In the Southern Ocean ecosystem, Antarctic krill serves as the prey base for fishes, birds and marine mammals (Forcada et al. 2005; Leaper et al. 2006; Hill et al. 2007; Karpouzi et al. 2007). Sea ice density, climate, and oceanography affect krill population dynamics (Loeb et al. 1997; Hewitt & Linen Low 2000; Atkinson et al. 2004; Murphy et al. 2007; Thorpe et al. 2007). Annual and longer term (e.g., decadal) variability in krill abundance and recruitment occurs and can be influenced by predator dynamics (May et al. 1979; in Hewitt & Linen Low 2000; Ainley et al. 2006; Reiss et al. 2008; Loeb et al. 2009). Climate change will impact the dynamics of krill and their predators as will fishing and the combination of the two factors (Quentin et al. 2007; Santora et al. 2009).

Managed through the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR), the maximum harvest limit for the krill fishery is 3.47 million tonnes, less than 10% of the existing biomass if biomass estimates are correct, which is uncertain. Spatial management of the harvest will be invoked once a catch level of 620,000 tonnes is reached, which is the historic maximum harvest recorded (Hewitt et al. 2004). Discussions are underway at CCAMLR regarding whether this level is adequately precautionary because of potential negative effects of geographically concentrated harvest (CCAMLR SC 2008). A recent study indicates that spatially concentrated harvest already occurs (Kawaguchi et al. 2006). Spatial management may constrain if not eliminate fishing in some areas due to predator impact. A revised spatial management scheme may be developed by CCAMLR late in 2009.

Spatially explicit management is imperative for the fishery. Predators can be geographically constrained (e.g,. land-based breeding colonies of marine mammals and seabirds) and depend upon localized sources of krill (Hewitt & Linen Low 2000; Reid & Croxall 2001). Fishing effort and foraging ranges overlap. Modeling efforts are studying the ecological linkages and effects of the krill fishery (e.g., Constable 2004; Palomares et al. 2005; Hill et al. 2007; Southwell et al. 2008). More effort is needed to understand how foraging predators respond to changes in krill patches so that ecosystem-based management models account for the scale and scope of the needs of krill predators and fisheries. How climate change will interact with ecological processes and fishing and affect the Southern Ocean system is unknown. At the very least, a scheme of closed areas is needed to track the effects of climate change in the absence of fishing and separate climate and fishing effects. Spatially explicit precautionary catch limits may also be needed to buffer against potential climate impacts.

Aker BioMarine's fishery for Antarctic krill is now being assessed for MSC certification. The fishery will use a new continuous pumping technology enabling catch of up to 120,000 tonnes per year per vessel, equivalent to the total annual krill catch of all vessels in recent years. Total as well as localized harvest may therefore dramatically increase in the near future. Concerns have been voiced about the by-catch of juveniles and larvae of non-target species with this new technology and its impact on the ecosystem. The use of this new technology thus changes the environment within which CCAMLR has operated and time is needed to understand and incorporate its impact.

Certification of any portion of the krill fishery is premature and could halt an important process within CCAMLR that is moving towards ecosystem management at a time when catch levels are poised to dramatically increase. *An accepted biomass estimate, spatially explicit management plan that accounts for predator demands and krill population dynamics, and consideration of climate change is needed before the fishery can achieve a passing grade*. *Without spatial management and detailed study of by-catch, Aker's harvest may cause serious or irreversible harm to krill, its predators and the ecosystem.* Feedback management systems should further be operational on the scale of spatial management units to adjust fishing levels in response to ecological monitoring prior to MSC certification.

Gulf of California Sardine

The Gulf of California sardine (*Sardinops sagax*) serves as prey for marine mammals, seabirds and large predatory fish (Nevárez-Martínez et al. 2001; García-Rodríguez & Aurioles-Gamboa 2004; Velarde et al. 2004; Vieyra et al. 2009). Sardine biomass can dramatically fluctuate due to environmental variability and fishing (Rykaczewski & Checkley 2008; Lluch-Cota et al. 1999, 2007). A collapse of the Gulf of California sardine fishery occurred during the El Niño of 1992, before which landings reached a historic peak in 1989 (Cisneros-Mata et al. 1995, Velarde et al. 1994, 2004). Only a partial recovery has occurred. The fishery has been in the MSC assessment process since 2007.

Available knowledge of the species, ecosystem, and fishery suggests that current fisheries management practices fail to meet many MSC criteria. There is no robust, species-specific stock assessment and there is strong evidence the species is overharvested (Velarde et al. 1994, 2004). From an ecosystem perspective, the biomass needs of predators, in terms of quantity, space and species composition are unclear (López-Martínez et al. 1999; Velarde et al. 2004; Vieyra et al. 2009; Velarde et al. in press). The relationships between population processes (e.g., recruitment), climate, and trophic considerations are uncertain. For instance, variability in climate also determines the recruitment and breeding success of sardine predators (Velarde and Ezcurra 2002, Aburto-Oropeza et al. 2007, Vieyra et al. 2009). Independent climate impacts on the recruitment of species throughout the food chain may result in nonlinear, unpredictable changes in food web structure. The fishery may pose a risk to endangered and protected species (e.g., Heermann's Gulls and Elegant Terns), fin whales, humpback whales, and dolphins (Heckel et al. 2008), threaten fisheries of sardine predators (e.g., amberjacks and leopard groupers; Viesca-Lobatón et al. 2008) and result in top-down effects on species and processes lower in the food web.

Lack of transparency in fisheries management practices precludes any assessment of sustainability. Official statistics on sardine landings have been unavailable since 2004. Moreover, no evidence has been produced that fishing quotas are based on a model accounting for stock abundance and demography, oceanographic conditions, and biomass needs of predators. *Given these factors, there is no scientific evidence that current levels of biomass removal can be considered sustainable, nor is there any rigorous and credible system being implemented to calculate sustainable levels of stock harvesting in the future. An analysis of how demography and trophic interactions are modulated by climatic and oceanographic fluctuations is still needed and must be complemented by a spatially explicit framework for biomass removal that accounts for the needs of predators.* Given the lack of transparency in the governance and fishery management decision-making framework, we cannot see how this fishery captures the spirit of Principle 3 or is in accordance with the newly adopted MSC policy on transparency (Policy Advisory 7).

Peruvian Anchoveta

The Peruvian anchoveta (*Engraulis ringen)* fishery is the largest single-species fishery in the world (Chavez et al. 2008). Anchoveta is an important prey species for fish, birds, and marine mammals and strong trophic interactions occur among ecosystem components (Muck 1989). Anchoveta biomass varies with climate on decadal and annual scales and the system undergoes regime shifts wherein temperature and dominant species (i.e. sardine (*Sardinops sagax*) changes (Chavez et al. 2008; Swartzman et al. 2008).

Intensive fishing combined with the strong El Niño led to the collapse of the anchoveta population in the 1970's, which had a dramatic effect on seabirds. Seabird health is linked to anchoveta availability and seabird declines have occurred in El Niño years and with fishery collapse (Hays 1986; in Alder & Pauly 2006). Seabirds compete with the anchoveta fishery, which has reduced the available biomass for birds from 14% to 2%. Reduced anchoveta abundance also negatively affects marine mammals.

Despite this, the fishery is not managed under an ecosystem framework. Fishing quotas are set based upon historic observations of strong recruitment with biomass reserves of five millions tons. The current harvest limit is five to six million tons annually, which is 30-35% of the biomass. The basis of this limit is not, however, legislatively mandated and therefore subject to change. Should the limit revert back to prior practices, 80-85% of the anchoveta biomass could be removed. While additional information is needed to estimate the biomass needs of fish predators, sufficient information exists on birds and mammals to create a management scheme to account for the needs of predators. Spatial limits in the fishery are not comprehensive in addressing predator demands. Lastly, the ecosystem impact of the catch of "retained species" (i.e. non-target species captured in the anchoveta fishery retained for feed production) has not been fully studied.

Current harvest practices do not consider climate effects. El Niño events may become more frequent and stronger with climate change and anchoveta biomass may in turn fluctuate more dramatically. Managing for climate change requires an understanding of how oceanographic processes affect anchoveta, their predators and other small pelagics that become targets of the fishery when anchovetas decline. Models are under development to account for climate-forcing, spatial distribution, trophic interactions and fishing, but questions remain (Bertrand et al. 2008; Fréon et al. 2008; Guénette et al. 2008).

The anchoveta fishery may soon enter the MSC certification process. Exploratory meetings have been held. Given that all of the major Peruvian fishing companies are pursuing certification, there is tremendous opportunity for the MSC to push for sweeping reform of the fishery. At present, however, the management system does not comply with biological or governance criteria as set forward by the MSC.

Prior to awarding certification *the MSC should require the biomass considerations of predators are accounted for within a spatially explicit framework. An updated ecosystem model illustrating the impacts of the fishery must be available along with a mechanism for integrating modeling results into management practices. Moreover, an ecosystem based framework must be* *with compliance illustrated.* Lastly, evidence of how climate change is factored into fisheries management should be provided.

IV. MSC and forage species: maintaining credibility and avoiding adverse consequences

The three species highlighted here support some of the most productive ecosystems on Earth. Some argue that harvesting forage species should not ever be permitted given their critical role in the ecosystem. Others suggest that because of their productivity and potential resilience, forage fisheries should be encouraged. At risk, however, is the loss of higher level predators and alteration of ecosystem function through both bottom-up and top down effects. Regardless, forage species will likely continue to be exploited for use in fishmeal and oil and for direct consumption. The MSC can set the standard for the conditions under which removal of these important species can be deemed sustainable.

Predicting the consequences of poor management of forage resources is difficult but one example illustrates that caution is necessary. Intensive harvest of the Namibian sardine and other small pelagics in the Northern Benguela current ecosystem caused a shift in the species composition of the system, with sardine and anchovy replaced by the pelagic goby as the principle forage species. Due to the additive effects of fishing and environmental anomalies, small pelagics did not recover after fishing was curtailed, and sardines still remain at only 10% of their former abundance. Other major ecosystem consequences have ensued (e.g., Bakun and Weeks 2004) as well as a dramatic decline of Namibia's seabirds (Crawford 2007; Crawford et al. 2007). Most importantly, intensive fishing may have altered the trophic control mechanism so that environmental factors exert a greater influence (Watermeyer et al. 2008). This example highlights the interaction of fishing and environmental drivers with unintended consequences. Had a precautionary approach been adopted, such as that we are advocating for here, the collapse of the Namibian sardine fishery may have been avoided.

None of the candidate fisheries are managed under a regime that can protect against serious or irreversible harm to the ecosystem. Until evidence can be provided that each candidate fishery conducts decision-making using a spatially explicit model that accounts for the dynamics of the target stock, predator needs and environmental forcing, none should be certified. Ecosystem models exist for the areas where these fisheries operate and competent ecosystem modeling should be a part of the requirements for certification. Efforts to track the effects of fishing and climate change should also be demonstrated. While the krill fishery may eventually function within a governance and fisheries management framework that mandates an ecosystem approach, nothing suggests that the sardine and anchoveta fisheries do now or will in the future.

The MSC scoring system should push for innovative and sound management, raising the bar for fisheries performance. While research is still needed on the management of forage species, progress is evident. Studies are moving forward with allocating biomass estimates for predators and the fishery, in South Africa (Crawford 2007) and the Northwest Atlantic (Tyrell et al. 2008) and showing how natural mortality due to predation can vary within and across years (Read & Brownstein 2003) as well as age classes (Moustahfid et al. 2009). Studies on the effects of climate on predation rates are still lagging as are those on the impacts of forage fish on species and interactive processes lower in the food web.

Forage species present further unique challenges. Given the potential for extreme temporal volatility in forage fish populations, the certification status of forage species may need to be revised with challenging frequency. The marketplace availability of products from these fisheries may therefore be erratic if management systems are properly designed to respond to stock abundance variability. Special care is needed in communications and outreach to ensure that consumers and industry can in fact change behavior in step with such rapid resource flux. This is a cardinal, but hopefully a solvable problem.

Certifying forage fisheries in countries where many currently operate may require a more in-depth, staged or externally-reviewed assessment process. There may be fewer organizations available to offer stakeholder opinions and a limited number of qualified experts. Community participation in public issues may be insignificant and transparency in fishing practices may be nonexistent. In operationalizing Principle 3, MSC has the opportunity to push for important changes in fisheries governance, beginning with appropriate transparency mechanisms, and possibly resulting in external review of assessment and management systems.

The MSC may also wish to incorporate additional standards into their assessment framework. Social standards would be particularly relevant in evaluating the Peruvian anchoveta fishery, which has tremendous societal and health-related impacts. Another standard could concern the end-use of the target catch. Sustainability could be ranked higher if products were destined for human consumption rather than indirect and less efficient use in the aquaculture of higher predators. This is particularly important for the anchoveta fishery where 99% of the harvest is converted to animal feed rather than used as food for the Peruvian population.

Given that forage species exert important influence over ecosystems, the MSC must exercise caution in calling any forage species sustainable. Certified forage fisheries should be those that move beyond the status quo of fisheries management, implementing measures that account for single species stock dynamics, ecosystem interactions, predator requirements, climate effects and necessary governance and management frameworks. We ask that the MSC pause to consider our concerns before certifying any forage fishery and to significantly revise their approach to forage species assessments. We again stress that our comments are preliminary and strongly encourage the MSC to seek further guidance from the scientific community on forage species management.

We look forward to your feedback regarding our concerns and would welcome engaging in a constructive dialogue addressing the problems that we have identified. We believe that the implementation of our ideas will not only improve the MSC approach, but moreover, the stewardship of our oceans through sustainable fisheries and sound market-based approaches.

Sincerely,

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Annex I. Detailed critique of the MSC FAM for forage species

Within Principle 1, a minimum requirement for Scoring Guidepost (SG) 60 should be that reference points are (rather than can be) estimated. These reference points should explicitly consider predation mortality and the biomass needs of dependant predators. A recent study of Atlantic mackerel found SSB_{MSY} to be more than twice as high when predation is considered (Moustahfid et al. 2009). For Performance Indicator (PI) 1.1.2, the SG 60 level should explicitly consider predation and trophic position (currently SG80) and maintain B_{msy} at a level that is precautionary with respect to the ecological role of the species (currently SG100).

Reference points must consider the influence of environmental and spatial variability. This necessitates an understanding of how biomass fluctuates over time and through history and interacts with climate forcing. Spatially explicit reference points should be when predators are constrained in distribution or foraging range (e.g., breeding colonies; also see Kaschner et al. 2006). For P1 1.1.3 (Stock Rebuilding) environmental variability must also be considered when dealing with depleted stocks of forage species. Given the critical role played by forage species and potential systemic effects of their further collapse, fisheries for depleted forage species should only be certified where current strategies demonstrate rebuilding. This requires shifting SG100 criteria to SG60 for this indicator.

The Harvest Strategy (PI 1.2) scoring system does not reflect the critical role of forage species in the ecosystem or climate-forcing. To meet SG60, climate forcing should be factored into harvest strategy development. In addition, for PI 1.2.1, a basic score of SG60 should require that the strategy is responsive to the state of the stock (currently SG80) and that it maintains stocks at the target level (SG100). For PI 1.2.2, a minimum SG60 requirement should be that uncertainty regarding climate and predation is accounted for in harvest control rule selection, thereby incorporating SG 80 and SG100 elements. This should be reflected in PI 1.2.3 in terms of the information and monitoring required. For PI 1.2.3, SG 80 criteria should be the minimum required for SG60. New SG100 criteria would state that there is a history of an effective harvest strategy and harvest control rules that buffer against climate effects and consider predator needs. Lastly, with respect to PI 1.2.4 a scoring guidepost for SG 60 should require external reviews of the assessment of the stock.

For Principle 2, we agree that the Outcome (PI 2.5.1) should be no serious or irreversible harm but are unclear as to how to practically differentiate amongst SG 60, 80 and 100, even with the explanatory notes on percentages. We would appreciate further examples within the criteria regarding practical situation that would meet the scoring guideposts. With respect to the Management Strategy (2.5.2), a management strategy should be in place along with feedback mechanisms for ensuring effectiveness and implementation. This requires a shift of the SG 100 criteria to SG60.

More importantly, the Scoring Guideposts for 2.5.3 (Information/Monitoring) inadequately capture the PI of having "…adequate knowledge of the impacts of the fishery on the ecosystem". Identifying key elements (SG60) and broadly understanding the functions of key elements (SG80) are insufficient for meeting the PI; empirical data or modeling predictions should be required. SG 60 should further require determining of the impact of the fishery on other ecosystem components, feeding them back into management and developing strategies to manage ecosystem impacts. An understanding of the interaction of climate forcing, fisheries and ecosystem processes should also be required. Lastly, studying whether the target forage species is replaceable, in terms of biomass, quality and suitability as a prey item should be mentioned. Such changes would align Principle 2 with the ecolabelling guidelines of FAO, which require that adverse ecosystem impacts of the fishery are assessed and addressed (e.g., FAO 2005).

When by-catch or retained species are forage species, special attention is warranted. We did not see this mentioned in the corresponding Principle 2 components (PI 2.1, 2.2).

Regarding Principle 3, MSC may be overlooking the fact that legal frameworks for managing forage fisheries within an ecosystem context may not exist. This should be an explicit requirement for MSC certification and is particularly relevant to PI 3.1.1 where it is expected that a legal and/or customary framework exists that ensures Principles 1 and 2 are met and to PI 3.1.3 regarding long-term objectives. For 3.1.3 SG60, long-term objectives of maintaining forage species at levels consistent with their ecological role and in the face of climate should be explicit and required by management policy (currently SG 100).

Transparency in the consultation process should be required and consultation should, at the very least, provide opportunity for all interested parties to be involved, thereby shifting SG 80 criteria to SG 60 for PI 3.1.2. This is especially important where many forage fisheries operate because transparency may be lacking and the multi-institutional framework helpful in overseeing and balancing the process may be absent. Within this context, external review should be required for PI 3.2.5 at SG 60. Lastly, decision-making processes (PI 3.2.2) for forage species fisheries should always be precautionary, so SG 60 should incorporate this element from the SG80 guidepost.

As demonstrated in previous analyses, forage species can score poorly on Principle 2 indicators yet still obtain an overall passing grade. We also highlight Principle 1 and 3 elements essential to proper management of forage species. With this in mind, PI 1.1.2, 1.1.3 (where appropriate), 1.2.1, 1.2.2, each component of 2.5 and 3.1.1 and 3.1.3 should be weighted more heavily when considering low trophic level fisheries.

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Moody Marine Response to Pew Coordinated Response:

CCAMLR has not yet implemented an ecosystem management approach to krill fisheries. While CCAMLR has theoretically determined that an ecosystem-minded fisheries management framework is required, specific agreement on the operationalization of this approach, including requirements for the fishery, have neither been agreed upon by CCAMLR nor implemented. At present, there is still no spatially explicit harvest regime. The Aker vessels operate in a krill-rich area characterized by high densities of marine mammals, sea birds and penguins yet there is currently no information on the impact of localized krill removal on these marine resources.

CCAMLR Conservation Measure 51-01 (2008) states that 'the krill catches in Statistical Subareas 48.1, 48.2, 48.3 and 48.4 shall not exceed a set level (the trigger level of 620 000t), until a procedure for division of the overall catch limit into smaller management units has been established, and that the Scientific Committee has been directed to provide advice on such a subdivision' SSMU-specific TAC levels would not be implemented until the trigger level of catches is achieved, and despite notifications to fish, recent catch levels have been far below that level. The issue of sub-area vs local impacts of krill fishing is also already noted within the report by the assessment team. There are key sites in each of the CCAMLR sub-areas of 48, which have high and consistent time series, being Bird Island, Signy Island, and Admiralty Bay (CCAMLR WG-EMM-08/4), which appears to provide a basis to monitor the impact of krill fishing on predators and their breeding success. However, some more localised impacts may not be identified due to the shortfalls in data collections from some sampling sites. Furthermore, the ability to distinguish the effects of fishing from environmental variability may be limited.

The current CCAMLR ecosystem monitoring program is insufficient and has no feedback loop with management decision-making. As indicated by Dr. Nicol, the current CCAMLR Ecosystem Monitoring Program (CEMP) is inadequate in terms of regions and species coverage and thus cannot measure the ecological impact of localized krill harvesting activities. Data already collected are not being used to develop conservation measures. Consequently there is no management policy in place to regulate the ecosystem impacts of fishing activities.

We refer back to our original response to the peer reviews on this.

The trigger level needs to be revised and Small Scale Management Units (SSMUs) need to be implemented to adequately protect the Antarctic ecosystem. A new risk assessment undertaken by CCAMLR and presented at the July 2009 WG EMM (Working Group on Ecosystem Monitoring and Management) meeting concluded that the current precautionary krill catch limit (trigger level) of 620,000 tonnes may not be sufficient. Simulation studies indicate that an expansion of the fishery to the trigger level without any spatial constraint is likely to risk depletion of krill-dependent predators. As a consequence, in the absence of krill catch limit allocations amongst SSMUs, it is necessary to adopt additional measures, such as subdividing the trigger limit and constraining, if not eliminating, fishing in some areas. As noted in the MSC review by Dr. Nicol, localized depletion of krill could occur well before the overall trigger level is reached and this could have negative consequences for the Antarctic ecosystem.

See comments above.

Aker needs a proven track record prior to certification. Aker's continuous fishing method has not been fully studied with respect to the impact of its spatially intensive krill catch rates or catch of postlarval and larval krill, juvenile fish and other macrozoooplankton taxa. The relatively new technology does not have a history of testing. Even though a condition has been placed on the fishery to evaluate by-catch, more extensive detailed studies are essential. The burden of proof should be shifted so that no harm is proven PRIOR to certification.

The bycatch of fish larvae from the continuous pumping system used by Aker has been the subject of a recent report on data and research on this aspect of the *Saga Sea* operation. This information was used in this assessment (see MRAG, 2009).

The overall management system AND Aker's activities must be responsible for the fishery to be certified. For Aker's fishery to be sustainable, the overall fisheries management system under which it operates must be effective. As noted above, CCAMLR has not yet implemented an ecosystem-based management approach and there are currently no restrictions on locally intensive krill harvesting. Observer coverage in the fishery is limited and, as noted by Dr. Nicol, very few observer reports have ever been submitted over the history of the fishery. The overall effectiveness of CCAMLR management needs to be established PRIOR to certification. As the Antarctic krill fishery is set to expand dramatically in future years, the management system must also be capable of handling such an expansion.
This certification is only relevant up to the catch level of 620 000t. Any certification would not apply if the fishery expanded and overall catches from the fishery (rather than just the unit of certification) increased above the trigger level The management measures of CCAMLR were deemed to be effective for the fishery at this level. Aker (the subject of this certification) carry 100% international observer coverage and all reports are submitted to CCAMLR.

Responses to the individual Performance Indicator comments (1.2.1, 1.2.3, 2.1.1, 2.1.2, 2.3.3, 2.5.1, 2.5.2, 2.5.3) have been incorporated within the response to the AKFP comments below.

We are pleased to see that two conditions have been placed on the fishery. However, we believe that additional conditions should be fulfilled before the fishery can be MSC certified, including the following. Some of these conditions would need to be accepted by CCAMLR rather than Aker. This is again illustrative of the fact that certification is premature because the overall management system set by CCAMLR is still ineffective.

1. Aker should be required to complete an evaluation of the impact of its fishing activity on predators and krill populations. This evaluation must include quantitative information about predator abundance (e.g., through surveys and visual censuses during test fisheries) in the areas affected by krill fishing and the impact of the total take by all fisheries in the area. A model illustrating no irreversible impact should be available prior to certification. The model should be tested annually using data from the fishery.

Akers' fishing impacts on krill populations and predators was specifically considered within the scoring of this assessment.

2. Prior to MSC certification of Aker, CCAMLR should have adopted a management scheme that includes spatially explicit reference points and harvest control rules and an adequate ecosystem monitoring system.

This has been generated within Condition 1 and the recommendations for the fishery by the assessment team.

3. Aker should be required to provide annual reports to the MSC detailing the location of fishing effort (e.g., provide VMS data), spatially-explicit data on the catch of krill and retained species, and any incident of by-catch. The annual report should include an assessment of the total fisheries effort in Aker's area of operation, a comparison of the total take to any updated biomass estimates for krill, and an account of the ecosystem parameters being measured to gauge the impact of fishing.

For the duration of the MSC certificate (5 years) Aker BioMarine will be subject to an annual surveillance audit by the assessment team. This audit is a condition of certification and generates a report which is made publicly available through the MSC website. However, it is not MSC/Moody Marine that manage the fishery, but CCAMLR. Such information is already considered by CCAMLR.

At the moment Aker provide VMS (satellite) data continuously during the fishing operations, and in the rare cases where the signal from the vessel is temporarily lost, the information can subsequently be recovered because all data are stored automatically on board. This is provided to Norway (and then passed onto CCAMLR). Catch data including quantity and locations are also submitted to CCAMLR. In addition, Aker BioMarine also submit data on retained species (through their observer program). There is no bycatch from the Aker vessel due to the nature of the gear.

Ongoing management of the fishery will be valuated by the assessment team during the annual surveillance audits.

4. Prior to certification, an evaluation of how climate change impacts Aker's harvest strategy should be presented. This should include how a regime shift and decrease in krill abundance is incorporated into the harvest strategy. This will necessitate examining comparative data (e.g., on predator abundance) from areas closed to fishing and consideration of historic data on of the impacts of natural declines in krill abundance (i.e., in years with limited sea-ice) on predator survival and breeding success. As closed areas have not yet been established by CCAMLR, meeting this condition requires that CCAMLR adopt new measures.

Climate change has been considered within the report. Aker will have to assess the associated risk of over fishing according to the predator and recruitment criteria as a fulfilment of the assessment criteria. Certification is only granted up to the catch trigger level of 620 000t

The remaining comments concerning the statement on forage species and the Marine Stewardship Council are outside the scope of this assessment and are for the MSC to address.

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September 20, 2009

Dr. Andrew Hough
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Dear Dr. Hough:

ASOC would like to express our concerns about the public draft report on certification of the Aker Biomarine Antarctic Krill Fishery. Based on our analysis, the information presented in that report does not support Moody Marine's conclusion that the Aker krill fishery meets MSC standards for certification. ASOC has been an active participant in CCAMLR since its inception, and is a partner with the Pew Charitable Trusts in the Antarctic Krill Conservation Project (AKCP). Thus we feel particularly qualified to comment on issues related to the krill fishery.

As the base of the major Antarctic foodweb, Antarctic krill is a critically important species, with many factors making even precautionary management of its stocks a very complex matter. Many obstacles to truly sustainable management of krill remain. While current krill fishing limits are considered "low," it is far from certain that even at these levels krill fishing would not be harming foodweb relationships.

Moody Marine has failed to adequately consider all available information in assigning passing scores to the fishery on some indicators. It often assigns passing or high scores when the evidence provided does not support its conclusions. Moody Marine in several cases glosses over the concerns and recommendations of one of the experienced peer reviewers who evaluated the report. Until these issues can be resolved and it can be proved that the Aker krill fishery fully adheres to MSC principles, ASOC urges Moody Marine to reconsider its decision to certify the fishery. Below are our general comments on the report, and specific comments on individual performance indicators (PIs) and scores.

I. General Comments

A. Omission of Climate and Environmental Change from Assessment Criteria

Although the report mentions climate change several times, it is not included explicitly in any Performance Indicators. Loss of sea ice coverage, the result of global climate change that is currently underway,[1] has negatively and dramatically affected krill abundance in the area in which

[1] IPCC, 2007a. Climate Change 2007 – The physical science basis. Contribution of Working Group I to the Fourth Assessment

the Aker fishing activity takes place, as documented in articles published in major scientific journals over the past 10 years. Yet the general discussion portion of the report refers to it as a "potential long-term change" or "future climate change.[2] Likewise, the section of the report that details the reasoning for each PI score mentions climate change as something to be incorporated into future models, implying that it is not at present a significant factor, but this is contrary to fact.

Moreover, the ecosystem is still recovering from previous overexploitation of baleen whale and demersal fish stocks. The recovery of these stocks depends on krill availability in the fishing area.[3] As krill catches increase, it is critical that information on all the factors affecting the population is incorporated into management decisions, including climate and other environmental change. The operative form of CCAMLR's management strategy is precautionary and ecosystem based, and CCAMLR has just begun to examine the most appropriate ways to incorporate climate change into management decisions.

ASOC submits that the MSC assessment methodology must explicitly address the potential for climate change to impact fisheries and fish populations and must have procedures in place for obtaining information on climate change impacts and incorporating them into management decisions before certifying the fishery. Without such procedures, reliable information on how the fishery is responding to fishing, predator consumption, and climate change pressures cannot be fully understood, and appropriate management decisions cannot be made to protect the ecosystem.

The inclusion of information about environmental impacts as well as fishing impacts into management decisions would be consistent both with MSC's precautionary approach to harvest strategies, and its requirement that "low trophic level species" such as krill, should be maintained at higher population levels because of the disproportionate impact to the ecosystem if the population size declines.

B. Certification of a Single Operator

The decision to assess and consider certification of Aker Biomarine, only one of dozens of operators in the krill fishery, reveals a significant problem with MSC Principles and Criteria. The sustainability of a fishery must be considered in the context of all the operators involved if the MSC label is to have any credibility. This is particularly evident in the case of observer coverage, because only with accurate and extensive reports from all operators will CCAMLR have the information it needs to make effective management decisions.

Aker Biomarine, to its credit, has 100% observer coverage and submits its reports to CCAMLR. Some other operators, however, do not, and there has been considerable disagreement within CCAMLR about how to obtain 100% observer coverage for all krill operators. CCAMLR cannot rely on Aker's information alone. If Aker Biomarine were the only operator in a certain area,

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Report of the IPCC; and Turner, J., Colwell, S.R., Marshall, G.J., Lachlan-Cope, T.A., Carleton, A.M., Jones, P.D., Lagun, V., Reid. P.A. and S. Iagovkina. 2005. Antarctic climate change during the last 50 years. International Journal of Climatology, 25 (3), 279-294. Warming rate of Vernadsky / Faraday = 0.56˚C per decade over past 50 years (Turner et al., 2005); Rate of global warming = 0.13˚C per decade over last 50 years (IPCC 2007).

[2] Medley, P., G. Pilling, A. Payne, A. Hough, S. Davies (2009). Public Comment Draft Report for Antarctic Krill Pelagic Trawl Fishery. Moody Marine Ltd. Available online <http://www.msc.org/track-a-fishery/in-assessment/southern-ocean/aker-biomarine-antarctic-krill>, pgs. 29, 35, and 43.

[3] Branch, T.A. 2009. Humpback abundance south of 60S from three completed sets of IDCR/SOWER circumpolar surveys. *Journal of Cetacean Research and Management*, in press; Branch, T.A., Stafford, K.M., Palacios, D.M., Allison, C., Bannister, J. L., Burton, C.,L.K., Cabrera, E., Carlson, C.A., Galletti Vernazzani, B., Gill, P.C., Hucke-Gaete, R., Jenner, K.C.S., Jenner, M.-N. M., Matsuoka, K., Mikhalev, Y.A., Miyashita, T., Morrice, M.G., Nishiwaki, S., Sturrock, V.J., Tormosov, D., Anderson, R.C., Baker, A.N., Best, P.B., Borsa, P., Brownell, R.L.Jr, Childerhouse, S., Findlay, K.P., Gerrodette, T., Ilangakoon, A.D., Joergensen, M., Kahn, B., Ljungblad, D.K., Maughan, B., McCauley, R.D., Mckay, S., Norris, T.F., Oman Whale and Dolphin Research Group, Rankin, S., Samaran, F., Thiele, D., Van Waerebeek, K., and Warneke, R.M. 2007. Past and present distribution, densities and movements of blue whales *Balaenoptera musculus* in the Southern Hemisphere and northern Indian Ocean.

fishing a relatively discrete krill population, it could possibly be argued that there existed a separate "Aker Biomarine Krill Fishery" but Aker Biomarine fishes the same krill populations in the same areas as all the other krill operators. Therefore, as one of the peer reviewers highlights, making determinations about the fishery without consideration for other operators makes it possible that Aker may contribute to unsustainable impacts on krill or the surrounding ecosystem. The MSC standards that allow a single operator to be considered for certification without considering the actions of others fishing the same stock must be rewritten. It cannot be plausibly argued that the actions of other operators are irrelevant if MSC's primary concern is for marine species and ecosystems.

C. Scoring and Response to Peer Reviewer Comments

Moody Marine's approach to the presentation of information and its rationale for scoring is at times confusing and at others insufficiently detailed. ASOC reiterates its objections to the format of scoring comments and references, which we noted in our comments on the Ross Sea Toothfish Fishery Public Draft Report. A reading of the scoring comments is necessary for understanding Moody Marine's reasoning behind the scores given for each indicator, yet the discussion and references are grouped separately, making it nearly impossible to check Moody's assertions against its citations.

Moreover, the responses to the numerous concerns of one of the peer reviewers are often dismissive and inadequate. For example, one reviewer, who has extensive experience with CCAMLR and has published numerous papers on Antarctic krill, questions a high score given on an indicator concerning the management of the fishery, noting the problems with making decisions in CCAMLR's consensus-based system.[4] Moody Marine's response is that CCAMLR is better than other management bodies, and that "not everyone will be happy with the direction that response takes!"[5] Since the scoring criteria for PI 3.2.2 is that the "[t]he fishery-specific management system includes effective decision-making processes that **result in measures and strategies** to achieve the objective"[6] (emphasis ours), Moody Marine clearly has not addressed the reviewer's point, which is not that unpopular decisions might not be made, but that decisions are often not made at all.

In this and other instances it does not appear that Moody Marine has made a serious attempt to answer the reviewer's concerns. Although in some cases Moody did reduce scores, those reductions are only partial concessions. Moody Marine claims that "[t]he performance of the current plan, based upon the precautionary trigger level, is considered likely to work based upon prior experience, where historical catches were much greater but appeared to have minimal impacts on the ecosystem."[7] The reviewer responds that "[a]s there was no systematic monitoring of the ecosystem in the early 1980s it is not possible to make this statement."[8] Moody Marine admits that the reviewer has a point, reducing the score to 80, but the erroneous text in the scoring comments remains.

II. Principle 1 Performance Indicators and Scores

Principle 1 states that "a fishery must be conducted in a manner that does not lead to over-fishing or depletion of the exploited populations and, for those populations that are depleted, the fishery must be conducted in a manner that demonstrably leads to their recovery." Achieving the required scores for some of the performance indicators under this principle should be very difficult given the

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[4] Medley et al., 136.
[5] Medley et al., 136.
[6] Medley et al., 110.
[7] Medley et al., 135.
[8] Medley et al., 135.

uncertainties regarding the degree to which climate change will cause krill population declines, as well as uncertainties and insufficiencies regarding the available data on krill and krill fishing.

PI 1.2.1 Harvest Strategy
Antarctic krill forms the base of the upper food web in the deep-water portion of the Southern Ocean and has been studied extensively by scientists. Nevertheless, significant uncertainties regarding many aspects of krill biology and distribution remain,[9] complicating efforts to develop a sustainable harvest strategy. One of the most important areas where knowledge is still incomplete is population size. The most recent biomass estimates, upon which current catch limits are based and upon which Moody Marine bases its scores for this indicator, were compiled in 2000. Those estimates were produced using acoustic data, and the methods used to interpret this data can result in estimates that vary greatly in size, a point one of the reviewers makes.[10] Furthermore, krill stocks in the Southern Ocean have been shown to be in a state of long-term decline due to climate change.[11]

The problematic acoustic survey data is the basis for present catch limits and the "trigger" limit of 620,000 tonnes. When catches reach this level, the entire catch is supposed to be divided into small scale management units (SSMUs) to help ensure that fishing does not compete with krill predators. The decision to delay SSMU implementation until the trigger limit is reached is problematic because of the known relationship between declines in krill and predator recruitment success.[12] As Moody Marine acknowledges, "[t]here is no specific justification for this catch trigger level, except that it is only 18% of the catch limit."[13] One of the peer reviewers notes the problem of possible concentration of the catch and emphasizes that the potential effects on predators are unknown, particularly since the krill catch in the past was dispersed over a larger area, unlike the current catch, which targets a relatively small area.

Moody Marine responds that it is unlikely that the entire catch could become concentrated in a small area and that the potential problem of predator impact prior to SSMU implementation is a problem for CCAMLR. This is circular reasoning, which passes responsibility for future problems away from MSC. These responses do not address the central problem, which is that without further examination of these uncertainties it is impossible to claim that the harvest strategy is "robust and precautionary" and thus deserves the very high score of 95.

PI 1.2.2 Harvest Control Rules and Tools
Despite the existence of CCAMLR harvest control rules, uncertainty exists over whether the actual krill catch matches the reported amount due to the differences in conversion factors used by different countries in reported catch data. One of the peer reviewers for the Moody Marine public draft report notes that there is insufficient information available to determine the extent of the problems associated with conversion factors, but Moody Marine only notes that it is not likely that conversion factor errors are large enough to mean that the actual catch limit is over 3.47 million tonnes.[14]

This misses the point. Because of differing conversion factors, it is possible that the current catch already exceeds the *trigger* limit, since information presented at last year's CCAMLR meeting indicated that conversion factor errors could result in a catch of 500,000 tonnes being reported as

[9] Nicol, S. (2006). Krill, currents and Sea Ice: *Euphausia superba* and its Changing Environment. Bioscience 56 (2): 111-120.
[10] Medley et al., 128.
[11] Atkinson, A., V. Siegel, E. Pakhomov, and P. Rothery (2004). Long-term decline in krill stock and increase in salps within the Southern Ocean. *Nature* **432**, 100-103
[12] Reid, K., and J.P. Croxall (2001). Environmental response of upper trophic-level predators reveals a system change in an Antarctic marine ecosystem. Proceedings of the Royal Society B 268: 377-384.
[13] Medley et al., 66.
[14] Medley et al., 129.

125,000 tonnes.[15] Until the conversion factor issue is resolved before it is inappropriate to give a passing score for this PI.

PI 1.2.3 Information and Monitoring

Obtaining adequate information both about krill biology and from operators continues to be problematic for the Antarctic krill fishery. As mentioned above, differences in conversion factors engender uncertainty about the accuracy of catch data. Moreover, although Aker Biomarine has committed to 100% international observer coverage and voluntarily provides observer reports to CCAMLR, other operators do not have 100% observer coverage, and/or do not submit accurate observer reports according to CCAMLR's format. As a reviewer notes, "observer coverage is not sufficient to detect basic problems in the fishery – this has been pointed out repeatedly by WG-EMM."[16] Full observer coverage is vital to obtaining information on krill size, stock structure, by-catch, and fleet behavior, all of which are necessary to develop effective management advice. Moody Marine thinks it sufficient that "the more significant the problem and its impact, even quite low amounts of sampling will detect it."[17] How it can be "sustainable" to wait for major problems to develop instead of detecting them early is rather mystifying.

Furthermore, as Moody Marine acknowledges in its scoring comments "[t]he life history [of krill] remains uncertain."[18] Many factors impact local krill populations, including sea ice extent, ocean currents and the size of predator populations, and krill scientists point to large amounts of uncertainty regarding the determinants and drivers of krill populations and recruitment.[19] Given the importance of local krill populations to dependent predators, understanding these finer points is critical, even though the overall harvest of krill is presently a small portion of the estimated biomass.

III. Principle 2 Performance Indicators and Scores

Principle 2 states that "fishing operations should allow for the maintenance of the structure, productivity, function and diversity of the ecosystem (including habitat and associated dependent and ecologically related species) on which the fishery depends)." Fulfilling the required parameters of the PIs under this principle is especially critical for krill given its key role in the Antarctic marine ecosystem.

PI 2.1.1 Risk to Retained Non-target Species

Although by-catch of adult species is not a significant problem for the krill fishery, catch of fish larvae is important. Improved krill fishing technology such as the pumping system used by Aker further increases the potential for larval by-catch thoughout the fishery, which likely will affect the recruitment rate of nontarget species. This new technology has not been subject to detailed environmental impact assessment. Species known to be taken as by-catch in the krill fishery are *Champsocephalus gunnari*, *Notothenia rossii*, and lanternfish. *C. gunnari* and *N. rossii* are both considered depleted due to overfishing in the 1970s and 1980s, and it is thought that larval loss in fishing is an important factor. Currently, CCAMLR does not have any standards in place for krill by-catch, nor are there plans to measure and monitor by-catch, so it is impossible to determine the overall impact of krill fishing on, and risk to, these non-target species.

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[15] Leape, G., V. Gascon, R. Werner, A. Pearl, M. Fischer (2009). Analysis on the Eligibility of Aker Biomarine's Krill Fishery Operations for MSC Certification. Antarctic Krill Conservation Project. Comments submitted to Moody Marine.
[16] Medley et al., 131.
[17] Medley et al., 131.
[18] Medley et al., 72.
[19] Nicol, S. (2006). Krill, currents and Sea Ice: *Euphausia superba* and its Changing Environment. Bioscience 56 (2): 111-120.

Moody Marine has scored this indicator at 65 and created a condition that Aker conduct a risk assessment to determine if "the main retained species [*C. gunnari* and *N. rossi*] are beyond biologically based limits as a result of larval fish catch at current and trigger levels."[20] Moody Marine maintains that it is not likely that larval by-catch is occurring at unsustainable levels at present, including the entire krill fishery in this statement. As the peer reviewer points out, however, in reality there is significant uncertainty around the actual level of by-catch,[21] because of low observer coverage throughout the fishery. Since Moody Marine indicates that its decision to assign a low but passing score for this PI is based on its assessment of the risk to non-target species throughout the Area 48 krill fishery, the condition attached for certification should not be predicated solely on Aker's risk assessment and mitigation strategies.

PI 2.1.2 Management Strategy for Retained Species

As with the prior PI, Moody Marine argues that larval by-catch does not present a serious risk in this fishery, and claims that the trigger level and "low" catches of krill are equivalent to measures specifically designed to keep by-catch from exceeding sustainable limits. One of the peer reviewers counters that "[t]he current catch level cannot be viewed as a measure that maintains retained species at a high level" because the concentration of fishing in small areas could easily lead to significant impacts on by-catch species.[22] This PI is scored at 60 and has a condition attached, but with so little evidence that there is any formal, evidence-based larval by-catch management strategy in place, ASOC disagrees that the fishery should be given a passing score on this PI.

PI 2.5.1 Fishery and Impact on Key Elements of Ecosystem Structure and Function

Moody Marine's assertion under this PI that the "fishery is highly unlikely to disrupt the key elements underlying ecosystem structure and function to a point where there would be a serious or irreversible harm"[23] is extremely inaccurate. Although Moody Marine points to models and simulations suggesting the risk of ecosystem harm is low, there are very few data obtained directly from the fishery that support this assertion. One of the peer reviewers additionally comments that "I am not sure that many scientists working in the CCAMLR community would be prepared to agree with this" due to the aforementioned uncertainties about krill biology and lack of observer reports, as well as the limited amount of information available from the CCAMLR Ecosystem Monitoring Program (CEMP).[24]

Moody Marine does not acknowledge the limitations of the CEMP, but rather characterizes it as a "substantial resource" of information on the ecosystem, even as it notes that the number of CEMP sites included in the database have decreased in the past few years,[25] while krill fishing has increased. The peer reviewer additionally notes that "[t]here are a number of problems with CEMP…1. There are very few sites and they are not strategically located, particularly for SSMUs... 2. There has been no serious attempt to investigate whether predator parameters measured actually respond to changes in fishing pressure."[26] Sites now under assessment are not all near where fishing actually occurs, so their information is of limited value for management decisions.

Because of the critical role of Antarctic krill in the Southern Ocean food web, the inadequacies of CEMP and the lack of knowledge about krill and the impacts of krill fishing are extremely problematic. Decreased krill population size has been shown to relate directly to declines in the reproductive rate of krill-dependent species, such as seals and birds. Location-specific information on these and other krill predators is currently insufficient to ensure that appropriate management

[20] Medley et al., 139.
[21] Medley et al., 134.
[22] Medley et al. 134.
[23] Medley et al., 95.
[24] Medley et al., 135.
[25] Medley et al., 22.
[26] Medley et al., 129.

decisions can be made to prevent harm from fishing. Furthermore, there exists a huge discrepancy between current estimates of krill abundance and how much krill there once was to sustain past populations of baleen whales.[27] The recovery of the depleted populations of baleen whales would thus be slowed by decreased krill availability.

CCAMLR has noted that the current krill fishing occurs in known foraging areas of krill predators. Even though the reported catch has not yet exceeded the trigger level, there is nothing to prevent the catch from being concentrated in a few areas, increasing the likelihood that local populations of predators will be affected.

Overall, there is not enough information on krill, the krill fishery, or krill predators to assign Aker a passing score on this indicator.

PI 2.5.2 Management Strategy

As a peer reviewer notes, stating that the current management plan for protecting the ecosystem will work based on past experience is impossible because "there was no systematic monitoring of the ecosystem."[28] Without any monitoring, it cannot be accurately stated that the ecosystem was not affected by earlier, higher krill catches. Additionally, the need to ensure that depleted populations of baleen whales and demersal fish can continue to recover or begin recovering is not addressed. It appears that Moody Marine is only evaluating "the effectiveness of the plan…for maintaining ecosystem elements."[29] For the management strategy to be effective and safeguard the ecosystem, it must ensure that fishing operations will not slow or halt the recovery of depleted species, not simply maintain the status quo.

PI 2.5.3 Information/Monitoring of Ecosystem Impacts

ASOC reiterates earlier concerns about the lack of information available about either krill or krill predators. Furthermore, it has been recognized within the WG-EMM of CCAMLR that sufficient information is not available.[30] It is alarming that despite these problems, particularly with the CEMP, Moody Marine still scores this PI at 85, and repeatedly refers to the CEMP as evidence of adequate information and monitoring. Moody Marine must provide more justification for its belief in the sufficiency of CEMP beyond stating that "[t]he information collected through observers, ecosystem studies, and the CEMP provides sufficient information."[31] Many participants in CCAMLR, including one of the report's peer reviewers, strongly disagree with this statement, yet Moody Marine provides no detail to back up its assertions and score.

IV. Principle 3 Performance Indicators and Scores

Principle 3 requires that a "fishery is subject to an effective management system that respects local, national and international laws and standards and incorporates institutional and operational frameworks that require use of the resource to be responsible and sustainable." The krill fishery is managed by CCAMLR, a body whose precautionary, supposedly ecosystem-based management principles are sound in theory, but are not consistently carried out because of the difficulties of reaching consensus and lack of observer data.

PI 3.2.2 Decision-making Processes

Although CCAMLR has won praise for its early adoption of a precautionary, ecosystem-based approach to fisheries management, as one of the peer reviewers points out, CCAMLR is ultimately

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[27] Willis, J. 2007. Could whales have maintained a high abundance of krill? Evolutionary Ecology Research 9:1-12.
[28] Medley et al., 135.
[29] Medley et al., 97.
[30] Medley et al., 135.
[31] Medley et al., 101.

a "political organization…which operates by consensus."[32] Decisions necessary to fulfill CCAMLR's requirements often do not get made because of political disagreements, as the peer reviewer notes and ASOC members have previously pointed out in prior comments to Moody Marine. Even if CCAMLR has adopted progressive governing principles, Moody Marine cannot consider those principles evidence of "effective management" if steps have not been taken to implement them. Moody Marine, in response to the peer reviewer's criticism of CCAMLR, explains that "from a purely comparative position, the score is probably correct at 90."[33]

The relative performances of fisheries management organizations are not at issue in this PI.[34] What is at issue is CCAMLR's performance, and it is disheartening that Moody Marine dismisses the concerns of a CCAMLR veteran. CCAMLR should be evaluated on its ability to meet the PI, not given a high score because it appears to operate better than other fisheries management organizations.

The reviewer additionally notes that "[a]lthough CCAMLR does have a formalized procedure of making decisions, there have been notable problems with reaching consensus on key issues such as the mandatory carriage of scientific observers"[35] and that "[t]here is little doubt that the data being collect (*sic*) are insufficient to detect impacts of fishing – and there is no mechanism [in CCAMLR] to alter the krill management approach even if impacts were detected."[36] ASOC, as an observer to CCAMLR, firmly agrees with these assertions and finds it stunning that Moody Marine has scored many of the PIs under Principle 3 so highly.

V. Concluding remarks

ASOC does not find that the Aker krill fishery meets MSC standards for certification. We submit that the draft report does not present adequate information to support either the passing scores given on some performance indicators or Moody Marine's recommendation to certify the fishery. Certifying any part of the krill fishery as sustainable is premature at this stage, when available information is insufficient to ensure that neither krill populations nor krill predators are harmed by fishing pressure. The uncertainties are simply too great, given krill's importance to the ecosystem.

Moreover, ASOC is concerned that the MSC's standards are not strong enough to ensure true sustainability in the Antarctic context since they do not account for current or future climate and environmental impacts on Antarctic ecosystems and species.

If Moody Marine ignores the voluminous and detailed comments being submitted by stakeholders opposing this certification, we predict that certifying this fishery will draw condemnation from the scientific community as well as NGOs and generate negative publicity for MSC.

Sincerely,

James N. Barnes

James N. Barnes
Executive Director

CC: Seran Davies, Rupert Howes, Chris Ninnes

[32] Medley et al.,127.
[33] Medley et al., 136.
[34] The text of the PI (3.2.2) under which the reviewer makes his comments is "Decision-making processes. The **fishery-specific management system** includes effective decision-making processes that result in measures and strategies to achieve the objective." (Moody Marine, 136; emphasis ASOC's).
[35] Medley et al., 136.
[36] Medley et al., 130.

Moody Marine Response to ASOC comments

A. Omission of Climate and Environmental Change from Assessment Criteria
Although the report mentions climate change several times, it is not included explicitly in any Performance Indicators. Loss of sea ice coverage, the result of global climate change that is currently underway,[1] has negatively and dramatically affected krill abundance in the area in which the Aker fishing activity takes place, as documented in articles published in major scientific journals over the past 10 years. Yet the general discussion portion of the report refers to it as a "potential long-term change" or "future climate change.[2] Likewise, the section of the report that details the reasoning for each PI score mentions climate change as something to be incorporated into future models, implying that it is not at present a significant factor, but this is contrary to fact. Moreover, the ecosystem is still recovering from previous overexploitation of baleen whale and demersal fish stocks. The recovery of these stocks depends on krill availability in the fishing area.[3] As krill catches increase, it is critical that information on all the factors affecting the population is incorporated into management decisions, including climate and other environmental change. The operative form of CCAMLR's management strategy is precautionary and ecosystem based, and CCAMLR has just begun to examine the most appropriate ways to incorporate climate change into management decisions.

ASOC submits that the MSC assessment methodology must explicitly address the potential for climate change to impact fisheries and fish populations and must have procedures in place for obtaining information on climate change impacts and incorporating them into management decisions before certifying the fishery. Without such procedures, reliable information on how the fishery is responding to fishing, predator consumption, and climate change pressures cannot be fully understood, and appropriate management decisions cannot be made to protect the ecosystem.
The inclusion of information about environmental impacts as well as fishing impacts into management decisions would be consistent both with MSC's precautionary approach to harvest strategies, and its requirement that "low trophic level species" such as krill, should be maintained at higher population levels because of the disproportionate impact to the ecosystem if the population size declines.
The Aker BioMarine Krill Fishery was assessed for certification using the MSC Fishery Assessment Methodology (FAMv1). Climate change was considered by the assessment team as part of the certification report and the team followed the MSC guidance within the FAM for low trophic level species. Specific Performance Indicators which assess climate change within the MSC methodology should be raised with the MSC directly.

B. Certification of a Single Operator
The decision to assess and consider certification of Aker Biomarine, only one of dozens of operators in the krill fishery, reveals a significant problem with MSC Principles and Criteria. The sustainability of a fishery must be considered in the context of all the operators involved if the MSC label is to have any credibility. This is particularly evident in the case of observer coverage, because only with accurate and extensive reports from all operators will CCAMLR have the information it needs to make effective management decisions.

Aker Biomarine, to its credit, has 100% observer coverage and submits its reports to CCAMLR. Some other operators, however, do not, and there has been considerable disagreement within CCAMLR about how to obtain 100% observer coverage for all krill operators. CCAMLR cannot rely on Aker's information alone. If Aker Biomarine were the only operator in a certain area, fishing a relatively discrete krill population, it could possibly be argued that there existed a separate "Aker Biomarine Krill Fishery" but Aker Biomarine fishes the same krill populations in the same areas as all the other krill operators. Therefore, as one of the peer reviewers highlights, making determinations about the fishery without consideration for other operators makes it possible that Aker may contribute to unsustainable impacts on krill or the surrounding ecosystem. The MSC standards that allow a single operator to be considered for certification without considering the actions of others fishing the same stock must be rewritten. It cannot be plausibly argued that the actions of other operators are irrelevant if MSC's primary concern is for marine species and ecosystems.

The Aker BioMarine Krill Fishery was assessed for certification using the MSC Fishery Assessment Methodology (FAMv1). This methodology assess the whole stock under Principle 1 and then focuses on the unit of certification for Principles 2 and, in part, 3. This assessment has therefore considered the other operators and their removals of krill from the fishery under Principle 1. When considering retained, bycatch, ETP and habitats, the 'Unit of Certification' (i.e. the continuous trawl method in Area 48) is examined specifically as its impacts will be unique. At the ecosystem level, however, we examined the potential impact of the trigger level, which was identified as the 'limit' of catch within the current certification assessment. This approach was considered essential in this fishery.

C. Scoring and Response to Peer Reviewer Comments

Moody Marine's approach to the presentation of information and its rationale for scoring is at times confusing and at others insufficiently detailed. ASOC reiterates its objections to the format of scoring comments and references, which we noted in our comments on the Ross Sea Toothfish Fishery Public Draft Report. A reading of the scoring comments is necessary for understanding Moody Marine's reasoning behind the scores given for each indicator, yet the discussion and references are grouped separately, making it nearly impossible to check Moody's assertions against its citations.

The text used within the scoring comments tables is presented (with citations) within the main body of the report. The text within the scoring tables provides the specific rationale for the score allocated to a particular PI. A reading of the scoring comments is definitely considered as being necessary to provide an understanding of the rationale behind the scores and the reference shows the information used in making such decisions. The discussion for this rationale is grouped under headings taken from the SG Guidelines table for each Performance Indicator to provide the reader with a clearer understanding of how each score was derived.

Moreover, the responses to the numerous concerns of one of the peer reviewers are often dismissive and inadequate. For example, one reviewer, who has extensive experience with CCAMLR and has published numerous papers on Antarctic krill, questions a high score given on an indicator concerning the management of the fishery, noting the problems with making decisions in CCAMLR's consensus-based system.[4] Moody Marine's response is that CCAMLR is better than other management bodies, and that "not everyone will be happy with the direction that response takes!" Since the scoring criteria for PI 3.2.2 is that the "[t]he fishery-specific management system includes effective decision-making processes that result in measures and strategies to achieve the objective" (emphasis ours), Moody Marine clearly has not addressed the reviewer's point, which is not that unpopular decisions might not be made, but that decisions are often not made at all.
In this and other instances it does not appear that Moody Marine has made a serious attempt to answer the reviewer's concerns. Although in some cases Moody did reduce scores, those reductions are only partial concessions. Moody Marine claims that "[t]he performance of the current plan, based upon the precautionary trigger level, is considered likely to work based upon prior experience, where historical catches were much greater but appeared to have minimal impacts on the ecosystem." The reviewer responds that "[a]s there was no systematic monitoring of the ecosystem in the early 1980s it is not possible to make this statement." Moody Marine admits that the reviewer has a point, reducing the score to 80, but the erroneous text in the scoring comments remains.

Comments from the peer reviewers (who both have experience within CCAMLR) were considered and answered by the assessment team (see Appendix B). As a result of the peer reviews some of the Performance Indicators were rescored and the scoring comment text amended for the appropriate scoring level. It should also be borne in mind that the assessment team have specifically reviewed this particular fishery, including numerous meetings, and have agreed a collegiate score for each PI. Working individually, differences in opinion will always lead to alternative scoring patterns.

Responses to the individual Performance Indicator comments (1.2.1, 1.2.2, 1.2.3, 2.1.1, 2.1.2, 2.5.1, 2.5.2, 2.5.3, 3.2.2) have been incorporated within the response to the AKCP comments below.

COMMENTS OF THE

Pew Environment Group's Antarctic Krill Conservation Project

ON

PUBLIC COMMENT DRAFT REPORT FOR

ANTARCTIC KRILL PELAGIC TRAWL FISHERY
Client: Aker BioMarine

Authors: *P. Medley, G. Pilling, A. Payne, A. Hough, S. Davies*

Ref: 82063
Certification Body:
Moody Marine Ltd

SUBMITTED BY

GERALD LEAPE
RODOLFO WERNER
VIRGINIA GASCON
MICAELA FISCHER
ANDI PEARL

Washington, DC - USA

September 18, 2009

1. CONCERNS ON THE MSC CERTIFICATION OF THE ANTARCTIC KRILL FISHERY

These are the comments from the Pew Antarctic Krill Conservation Project on the draft report recommending certification for a minor part of a krill fishery that even CCAMLR is not ready to acknowledge is sustainable. In addition, CCAMLR, the competent regional fishery management organization, does not yet have an ecosystem based fishery management system in place for krill.

A separate complaint will be filed on the process that has been followed related to this assessment. For the purposes of this paper, we will focus our comments directly on the report.

We begin with a summary of our primary concerns which include a misinterpretation of comments we made in our previous submission. Further, we include in this document very specific concerns in relation to the scoring comments that support the score granted in relation to several PIs. For better clarity we have pasted your original paragraphs in this document and we have included them in boxes. The section of our comments that are included in this document will be in a green font to distinguish them from the rest of the text. Within our comments, we also felt compelled to comment substantively on your broad dismissal of Steve Nicol's comments.

Hopefully this style will be helpful to you as you attempt to review and, hopefully, respond to our comments.

To ensure that it is clear, after reviewing your draft report, the Pew Environment Group's Antarctic Krill Conservation Project believes for the reasons detailed in our comments below that the Aker Biomarine Antarctic krill fishery ***should not be*** *certified.*

2. GENERAL COMMENTS ON THE DRAFT ASSESSMENT REPORT

The AKCP is concerned by the draft assessment report and considers that it is flawed in the following aspects:

2.1 Misapplication of MSC guidelines in relation to the "unit of certification"

The AKCP noticed that the assessment team is using the concept of "unit of certification" in a way which is inconsistent with the MSC guidelines for certifiers, which specify that the unit of certification is *"the fishery or fish stock (=biologically distinct unit) combined with the fishing method/gear and practice (=vessel (s) pursuing the fish of that stock)."*

Therefore, according to the definition above, it is clear that the unit of certification, according to the MSC guidelines for certifies, refers to the whole Antarctic krill fishery operating in Area 48. The concept cannot be applied to one single vessel, or a group of vessels operated by a company, as suggested by the assessment team. This is especially concerning since, along the assessment; Moody Marine is applying the concept of "fishery" or "unit of certification" in an inconsistent, in an attempt to make the best fit of the PIs under discussion. For example, in some PIs, this incorrect application of the concept of unit of certification is used in order to justify a score granted to the *Saga Sea* independently, when it was clear that the score could not be applied to the whole fishery due to existing flaws in the management system.

Introductory text extracted from 6. Ecosystem Characteristics – 6.4: Ecosystem Impacts (page 48):

> *As noted by Leape et al. (2009), Option 1, which assumes the current distribution of catches continues at the higher level, resulted in impacts on the predator population in earlier ecosystem simulation runs, and was hence abandoned for further analysis. This represents an implicit acknowledgement that action on SSMU specific quotas must occur once the precautionary trigger level is reached. While the current certification has taken the position that the fishery can be considered for certification up to the trigger level, it is clear that an agreed approach to devising SSMU-level quotas is needed before moving beyond that point.*

The statement above misinterprets the ideas presented in our previous submission to this certification process. While we recognized that action at the SSMU level must occur, we did not categorize that action only as necessary when the fishery reaches the trigger level. In fact, in our paper we said that "recent CCAMLR work indicates that the current catch limit (in reference to the trigger level) is not as precautionary as previously assumed" and that "delaying SSMU allocation would in fact result in an Option 1 scenario, which is estimated to have greater significant risks to the ecosystem than any of the other management options". Thus there was no "implicit acknowledgement" in our paper that "*action on SSMU specific quotas must occur once the precautionary trigger level is reached*".

- Lack of appropriate referencing throughout the report: although references are provided at the end of scoring comments to each PI, there is no referencing of specific statements and information in the text which are used to support the scoring granted for each PIs. This leaves the reader with no possibility to confirm the source of the information provided, or the accuracy of the statements included in the report. This is especially concerning since in many instances the assessment team makes very general reference to studies, projects or data which are not commonly quoted in CCAMLR meetings. This inadequate use and citation of references is particularly ironic given the expectation of the MSC and Moody Marine that stakeholders *"are to provide objective evidence in support of any additional claims or any claimed errors of fact"* in their response to the report. It is not an acceptable policy to require stakeholders a higher standard in their comments to the one applied by the certifier.

2.2 Inappropriate use of the information, incorrect argumentation

- The report continues numerous incorrect statements about Antarctic krill management issues: as highlighted throughout AKCP's comments to the draft report, there are numerous incorrect statements about the management of the Antarctic krill fishery. These statements are used to support too high scores for several PIs, and no objective evidence or adequate referencing is provided to sustain them. Here we include a few example of these incorrect statements which are further addressed within our comments (in each PI we include detailed explanation why these statements are incorrect):

    - *"Stock, catches and predator populations are being monitored"* (in relation to PI 1.2.1).

    - *"Sufficient information exists in relation to the stock structure to support the harvest strategy"* (in relation to PI 1.2.3).

- *"Catch composition, potentially providing information on selectivity and stock structure, is monitored through the observer coverage. These data are not currently used in the harvest strategy, partly because of the low level of exploitation"* (in relation to PI 1.2.3).

- *"Part of the monitoring procedure includes CEMP, which estimates the abundance of the predator populations"* (in relation to PI 1.2.3).

- *"Stock abundance and fishery removals are regularly monitored at a level of accuracy and coverage consistent with the harvest control rule"* (in relation to PI 1.2.3).

- *"Measures are in place within the fishery as a result of the currently low catch level of krill (well below the precautionary trigger level), and the restriction of fishing around CEMP management sites, which will provide some localised protection"* (in relation to PI 2.1.1).

- (In relation to by catch of fish larvae): *"there is sufficient information to develop estimates of outcome status with respect to adult biologically based limits"* (in relation to PI 2.1.3).

- *"Simulation results suggest the strategy is likely to work based on current information"* (in relation to PI 2.5.2).

- (In relation to CEMP): *"there are key sites in each of the CCAMLR sub-areas of 48, which have high and consistent time series, being Bird Island, Signy Island, and Admiralty Bay, which provides a basis to monitor the impact of fishing of all types on predators and their breeding success"* (in relation to PI 2.5.3).

- *"Procedures are being developed to take account of both environmental variation and harvesting effects in the formulation of conservation measures governing commercial harvesting in the Convention Area"* (in relation to PI 2.5.3).

- *"The information available from the different sources, which provide Area 48 scale and smaller-scale catch data, predator numbers and trends, ecosystem interactions, and the potential impact of fishing on krill on the ecosystem, is sufficient to support the development of the strategies detailed above, in order to manage ecosystem impacts and detect any increase in risk level"* (in relation to PI 2.5.3).

- The report contains contradictory statements: as highlighted throughout our comments, we found several contradictory statements provided by the assessment team, often in relation to the same PI. This fact not only undermines the technical quality of the report but it also directly affects the result of the assessment, since these statements are used to support too high scores. Here we provide a couple of examples:

  - *"The harvest strategy remains untested"*, versus *"the harvest strategy has not been fully tested"*. The standard applied required the following: *"the harvest strategy may not have been fully tested but monitoring is in place and evidence exists that it is achieving its objectives"* (in relation to PI 1.2.1).

- "*In theory a single synoptic survey is adequate" (in relation to PI 1.2.3)* as opposed to *"assuming complete biomass surveys occur every 10 years (the next would be no sooner than 2010), it is not clear that this would be frequent enough to monitor stock status"* (PI 1.2.1).

- The scoring comments are not clear and often mix up different issues: this makes it very difficult to follow the line of thought of the assessment team to reach their conclusions. This is a common feature of Moody Marine comments (for example, see our comments in relation to PIs 2.3.3, 2.5.1 and 2.5.3, among others).

- The MSC standards are not consistently applied through the scoring comments to the same PI: this makes is difficult to follow what was the standard finally applied and how. This is highlighted throughout our comments (see for example comments to PI 1.2.3).

2.3 Incorrect substantive conclusions

- Scoring inconsistent with comments provided: for some PIs, the comments included as basis for scoring do not have a logical link with the score finally granted. In these cases the information and opinions provided throughout the scoring comments fail to support the conclusion that the fishery reaches the standard given. On the contrary, in some cases the comments lead the reader to the thought that the standard is clearly not met but in the end the authors include a sentence such as: "*given the relatively low level of catch, the level of monitoring is adequate*", to support the scoring granted. The impression the reader gets is that the scoring was decided independently of the information gathered and presented by the assessment team, and of the comments provided by at least one of the reviewers. This is the case for example in relation to PIs 1.2.1; 2.1.1 and 2.1.2 (see our comments in the subsequent point in relation to the scoring of PIs for non-target retained species).

- Issue a failing score don't prescribe a condition: the AKCP found the assessment of PIs 2.1.1, 2.1.2 and 2.13 particularly striking. In the case of non- target retained species it is clear that, given the available information, the minimum standard for SG 60 was not achieved. This was to some extent acknowledged by the assessment team when they stated, in their final remark in relation to PI 2.1.2:

  "Based upon low catch levels dictated by the current catch trigger level (620 000t), the measure can be expected to result in relatively minimal impacts on adult fish biomass, based upon plausible argument. There is some evidence that this is likely to work due to those low catch levels. However, there is no objective basis for this confidence without additional study".

  Given the acknowledgement by the assessment team that there is no objective basis for confidence in the current strategy, it is therefore clear that the following required standard (SG 60) was not met: *"the measures are considered likely to work, based on plausible argument (e.g., general experience, theory or comparison with similar fisheries/species)".* Taking into account that SG 60 is a minimum score, Moody Marine should have applied this standard by not scoring this PI (as required by the MSC criteria). The appropriate action, consistent with the MSC scoring criteria, would have been to refuse certification (based on a failure to meet the minimum standard on this PI), and not to introduce a condition.

In addition, the condition introduced for this PI is unrealistic. To assess, within two years, *"the associated risks that the main retained marine fish species are beyond biologically based limits, at current and trigger levels"*, is an impracticable task for Aker Biomarine alone. For this assessment to be conducted, the plan outlined in the draft assessment report is that *"independent scientific observers will be employed during all krill fishing operations to assess marine larvae by catch*". It is difficult to imagine how marine larvae by-catch can be assessed unless independent scientific observers can be employed on board all krill fishing vessels and not only Aker's. Taking into account the difficulties that CCAMLR has been facing over the last years to agree on a systematic scientific observer scheme on krill, the prospects for this plan to be put into practice are very unclear to say the least.

3. COMMENTS ON THE ANALYSIS OF SELECTED PERFORMANCE INDICATORS (PIS)

PRINCIPLE 1

Component: Harvest strategy (management)

PI Category: Harvest strategy

1.2.1 There is a robust and precautionary harvest strategy in place

Moody Marine Score: 95

SG 80: The harvest strategy is responsive to the state of the stock and the elements of the harvest strategy work together towards achieving management objectives reflected in the target and limit reference points.

The harvest strategy may not have been fully tested but monitoring is in place and evidence exists that it is achieving its objectives.

Moody Marine comments:

"The harvest strategy is responsive to the state of the stock and is designed to achieve stock management objectives reflected in the target and limit reference points. While the harvest strategy has not yet matured, there is clear evidence of ongoing development of the strategy and interim controls on fishing that are precautionary and appropriate for the current level of development".

AKCP: The statement above is solely based on the existence of "*interim controls on fishing that are precautionary and appropriate for the current level of development*". However it does not specify what interim controls the statement refers to and how these controls are designed to achieve the management strategy. Thus, this statement is not supported by any objective information.

The stock is currently only lightly exploited, so the harvest strategy remains untested. If catches and stock productivity remain at the current level, the stock will not be at risk.

AKCP: This statement appears inconsistent with the paragraph above and fails to show that the harvest strategy meets the requirement of SG 80. The statement that "*if catches and stock productivity remain at the current level, the stock will not be at risk*" is not sustained by any scientific evidence.

In addition, it is important to note that SG 80 pictures a harvest strategy that "*may have not been fully tested*", while this paragraph acknowledges that the strategy *"remains untested".* Judging from the meaning of these terms, "fully tested" and "untested" represent different standards and it is unclear what standard was applied by the assessment team. Logically, if the strategy "remains untested" this does not warrant a score of SG 80. The question of the difference between "fully tested" and "untested" needs to be answered as it relates to the standard that was applied. It also needs references to support their conclusion.

> *Monitoring of the stock, based on biomass surveys, has been patchy since the last synoptic survey, so the state of the stock is surmised based on the low levels of catch relative to the potential yield. The primary objective of the strategy is to maintain the stock at a level to protect its role in the ecosystem as the main prey species to a large number of predators. This is to be achieved, in the first instance, by limiting the exploitation in areas important to predators to levels which will not put those predator populations at risk.*

AKCP: Surprisingly if one looks at the score granted for this PI, the logical conclusion from this paragraph is that the state of the stock is not sufficiently monitored to show that the management strategy is meeting its objectives, as required by SG 80. The paragraph acknowledges that the monitoring of the stock "*is patchy*". However it goes on to affirm that the state of the stock is "*surmised based on the low levels of catch relative to the potential yield",* which constitutes a very poor standard. Guessing that the stock must be in good state because catches are low cannot constitute an equivalent to monitoring. This statement also ignores very important factors such as:[1]

- The last biomass survey dates from 2000 and significant errors in calculating pre-exploitation biomass (B_0) from the 2000 data have been identified.
- Impacts of climate change may have been significant since then
- As discussed at the last WG-EMM meeting, 99% of the catch is concentrated in coastal areas where only 27% of the krill biomass is deemed to be found.
- Uncertainties in relation to catch data (conversion factors) and krill escapement mortality (see our comments to PI 1.2.2. below) indicate that krill mortality as a result of fishing may be significantly higher than the mortality suggested by official catch data.

The factors above, together with the key role that krill plays in the ecosystem in relation to which the availability of krill in coastal areas is an essential issue, require that robust monitoring strategies be in place in order to meet a minimum sustainability standard. In these circumstances, the practice of "surmising" that the stock must be in good state because catches are relatively low as compared to the potential yield constitutes a very low standard that fails to sustain the score warranted in relation to this PI.

In relation to the second part of the paragraph: "*The primary objective of the strategy is to maintain the stock at a level to protect its role in the ecosystem as the main prey species to a large number of predators. This is to be achieved, in the first instance, by limiting the exploitation in areas important to predators to levels which will not put those predator populations at risk*": it is to note that this assessment fails to recognize that the development of management rules to limit the exploitation in areas important to predators is stalled at the level of CCAMLR's Working Group on Ecosystem Monitoring and Management (WG-EMM). The CAMLR Commission endorsed the boundaries of small-scale management units (SSMUs) in 2002, and issued a mandate to the Scientific Committee (SC) and its working groups to develop catch limits for these SSMUs, but progress on this issue has been much slower than initially expected. Thus this statement is incorrect, as there are no measures in place to "*limiting the exploitation in areas important to predators to levels which will not put those predator populations at risk".*

[1] All these issues are further developed throughout this document, and they are only listed here as an indication.

Furthermore, since 2002, 6 options for the subdivision of krill catch limits amongst SSMUs have been put forward in general terms. Options 1-4 are "static" options, while options 5 and 6 constitute forms of feedback management.

In 2007, in view of the difficulty to implement a feedback management system for the krill fishery because of the lack of empirical data and monitoring, CCAMLR adopted a staged approach for the allocation of krill catches among SSMUs in Area 48 (applicable to Subareas 48.1 to 48.4). The idea was to implement an allocation in stages, based on the best scientific evidence available at each stage.

The initial stage of this process included an evaluation of the risks to krill, predators and the fisheries of the different options for subdividing the catch given the current uncertainties in order to determine the overall level of fishing that is believed to be "safe" and how it can be subdivided into SSMUs. It was agreed that for the development of advice for Stage 1, subdivision options 2-4 would be considered (option 1 was discarded as it was deemed to imply high risks to the ecosystem). It was also agreed that the further development of feedback management approaches (Option 5) and structured fishing (Option 6) would be given priority from 2009 onwards.[2]

Although in 2007 it was expected that advice on "Stage 1" of this subdivision could be delivered by the SC in 2008, this was not the case, as it is further explained in our comments to PI 2.5.2 below. Prospects for Stage 1 allocation to be agreed at this year's CCAMLR meeting (2009) are also unreal. It is thus difficult to imagine how CCAMLR will be able to start developing feedback management options (Stage 2) from 2009 onwards, as initially planned.

In the meantime, new risk assessment conducted in the context of WG-EMM shows that the current trigger level is not as precautionary as initially thought, and that risks to the ecosystem are likely to occur if catches approach the figure of 620,000 tones. [3] Under these circumstances, it is difficult to see how CCAMLR could achieve its objectives unless measures are adopted to restrict fishing in coastal areas.

The harvest strategy is reasonably precautionary with a TAC (620 000 t) interim "trigger" being set well below the estimated potential yield, but 50% higher than the highest annual catch reported in 1986/87 of 400 835 t. Once this trigger level is reached, quota management must be implemented on small scale management units (SSMU). The objective of SSMU quotas would be to prevent local depletion depriving dependent predator populations of adequate opportunities to obtain their prey. Quotas based on SSMU have not yet been developed, but have been subject to considerable research and development.

AKCP: the assessment team recognized here an important element and that is that the trigger level is 50% higher than the highest annual catch reported in the late 80s. As it will be discussed later, at that time there was no systematic ecosystem monitoring in place and therefore there are no data on the potential impacts on predators as result of historical catch levels. The fact that the trigger level figure is so much higher than the historical maximum catch adds to the arguments presented further in this document indicating the non precautionary nature of the trigger level to

[2] See for example SC-CCAMLR XXVI, paragraphs 3.36-3.38; CCAMLR XXVI, paragraphs 4.16-4.20; SC-CCAMLR XXVII, paragraphs 3.1-3.21.

[3] WG-EMM-09/12, George M. Watters, Simeon Hill, Jefferson T. Hinke, and Phil Trathan. "the Risks of not Deciding to Allocate the Precautionary Krill Catch Limit among SSMUs and Allowing Uncontrolled Expansion of the Krill Fishery up to the Trigger Level" (2009), hereafter quoted in this document as "Waters et al. (2009)".

protect predators in accordance to the latest risk assessment presented at the WG-EMM meeting in July 2009.

There is no specific justification for this catch trigger level, except that it is only 18% of the catch limit. The catch limit (potential yield) for Area 48 has been set according to the lowest level between the "recruitment" and "predator" precautionary criteria in the harvest control rule. In the last assessment, lowest yield was produced by the predator based rule. However, this catch limit will not apply until the SSMU quotas have been achieved.

AKCP: As it will be further developed below, the latest simulation studies conducted (Watters et al., 2009) indicate that the trigger level may not be sufficient to protect predators from the effects of fishing as these paragraphs seem to suggest. See comments above in relation to the lack of progress on SSMU quotas by CCAMLR.

The harvest strategy has not been fully tested, but monitoring is in place and evidence exists that it is achieving its objectives. The stock, catches and predator populations are being monitored, and there is no evidence that they are being affected by harvesting. The current catches are too low to have a significant impact on the overall stock size.

AKCP: It is important to note a striking inconsistency in the paragraph above with the statement included a few paragraphs before: while before it was acknowledged that *"the strategy remains untested",* it is now considered that the *"harvest strategy has not been fully tested"*. This discrepancy has already been noted and expanded on above. In relation to the second part of the paragraph, it is clearly incorrect to say that the stock, catches and predator populations are being monitored. Lack of monitoring in relation to the stock has been briefly highlighted before, including issues related to the last biomass survey conducted -which will be further developed in our comments to PI 1.2.2- so the problems with stock monitoring will not be reiterated here. In relation to the monitoring of catches, problems related to the poor scientific observer data, the uncertainty in relation to reported catches due to the variety of conversion factors used, and the escapement mortality of krill seriously affect the monitoring capacity of the management system. In relation to predators, it is incorrect to say that predator populations are being monitored. CCAMLR's Ecosystem Monitoring Program (CEMP) only monitors some predator colonies in a few areas. The coverage of the program is limited and many areas that are subject to heavy fishing are not being monitored at all. [4]

Most importantly, it has been recognized that, with the existing design of CEMP, it may never be possible to distinguish between different and potentially confounding causal factors, such as fishing versus environmental changes.[5] In this context, the statement "*there is no evidence that [predators] are being affected by harvesting*" is inappropriate and cannot be used as a basis for any scoring.

However, catches remain low largely because of market constraints rather than through management control. There is currently no incentive for IUU fishing or to misreport catches. Unless catches significantly increase, the current strategy is clearly adequate by default and direct evidence that the strategy is able to achieve its objectives would only become available as exploitation increases.

[4] *See* for example WG-EMM Report 2007, paragraph 5.5. See also CCAMLR XXVI/BG 25, "The need for a strategic plan for the management of the Antarctic krill fishery – Antarctic and Southern Ocean Coalition".

[5] CCAMLR, Report of the CEMP Review Workshop (2003), SC-CCAMLR XXII, Annex 4, Appendix D, para. 3.12.

AKCP: It is difficult to understand what is meant here by *"the current strategy is clearly adequate by default".* As it was mentioned before and it will be further developed through this document, there are at least serious doubts that the harvest strategy is adequate since the currently applicable catch limit (i.e., trigger level) cannot be deemed to be sufficiently precautionary to prevent localized depletion of krill. The statement that *"direct evidence that the strategy is able to achieve its objectives would only become available as exploitation increases"* ignores the fact that CCAMLR has currently no effective means to monitor the impact of a catch increase on krill nor on its predators. This is because scientific observer coverage of the fishery is still patchy (see our comments to the PI 1.2.3 below) and also because of the limitations of CEMP to monitor impacts on krill predators. Unless CEMP is significantly improved and expanded, CCAMLR will have no tools available to detect impacts from fishing even if catches increase.

Monitoring is extensive both with on-board observer coverage for biological sampling of the catch, and CEMP for monitoring the abundance of predator species. Concern has been expressed over reductions of CEMP monitoring, but it is adequate for the current level of catch. The international observer coverage, which is generally considered reliable, is less than 100% in this fishery. There has been no complete biomass survey of Area 48 since 2000, although surveys have been conducted since then covering smaller areas. Assuming complete biomass surveys occur every 10 years (the next would be no sooner than 2010), it is not clear that this would be frequent enough to monitor stock status. CPUE is not used as it is not thought likely to have a simple relationship with stock size.

AKCP: To say that *"monitoring is extensive both with on-board observer coverage for biological sampling of the catch, and CEMP for monitoring the abundance of predator species"* is at best, a serious misinterpretation of reality. CCAMLR working groups, and the Scientific Committee itself, have repeatedly made the point that current observer coverage is clearly insufficient to support management advice.[6] In relation to this point, the AKCP would like to highlight the fact that in our initial comments submitted to this process, this statement had already been made, including details of the conclusions of the different CCAMLR working groups about the lack of sufficient observer coverage in the krill fishery. In spite of this, the draft assessment does not take account of this issue, nor have the AKCP concerns been addressed. The AKCP expects a specific response on this issue in Moody Marine's final assessment.

In relation to the statement that CEMP monitors abundance of predator species, this is also a misinterpretation. CEMP monitors the status of selected colonies and cannot be considered to provide predator abundance data. It is precisely the lack of sufficient information on predator abundance and demand which limits the use of option 4 for allocation of krill catch limits among SSMUs. This is because, as Option 4 applies data on krill biomass minus predator demand in each SSMU as a basis for the allocation, biased estimates in predator demand data result in this option increasing ecosystem risks. This is further explained in our comments to PI 1.2.3.

In relation to the second part of this paragraph, the AKCP agrees with the following statement: *"Assuming complete biomass surveys occur every 10 years (the next would be no sooner than 2010), it is not clear that this would be frequent enough to monitor stock status*". Nevertheless, in view of this reality (acknowledged by the assessment team), we fail to understand how this assessment can support a conclusion that monitoring is sufficient to support the management strategy.

[6] SC-CCMALR XXV, para. 4.19. *See* also 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.

The harvest strategy is periodically reviewed and improved as necessary. There are documented annual meetings of the working group (WGEMM) and of CCAMLR to discuss the harvest strategy, outcomes and problems. There is clear evidence of responses to management issues as they arise. Catch limits are defined in Conservation Measure 51-01 (2008) and are reviewed annually.

AKCP: The first sentence of this paragraph, "*the harvest strategy is periodically reviewed and improved as necessary*" seems to be at odds with the acknowledgement that the strategy remains untested, as already recognized earlier in the draft assessment report. The assessment team fails to explain here how the harvest strategy has been reviewed and improved in recent years. The fact that WG-EMM and CCAMLR discuss issues and problems in relation to this fishery does not mean much unless these discussions are translated into effective measures and actions. In the case of krill, reports from WG-EMM and CCAMLR of the last seven years show major difficulties in making progress in the allocation of catch limits amongst SSMUs (even an interim, Stage 1 allocation has been blocked during the last two meetings), and in providing systematic observer coverage for the krill fishery (progress on this issue has been blocked for more than eight years now in spite of the pressing need for such a measure).

The statement *"there is clear evidence of responses to management issues as they arise"* is an empty statement if this evidence is not described. Contrary to what the assessment team states, catch limits for CM 51-01 have not been reviewed since 2007 in spite of the recent signals that the biomass estimates that support this catch limit are overestimated. CCAMLR's Scientific Committee has agreed that in spite of uncertainties in relation to biomass estimates, improvements to the protocols in setting catch limits will only be agreed and implemented after a period of five years. Thus it is incorrect to say that catch limits are reviewed annually.[7]

Although an amendment was introduced in 2007 to clarify that the trigger level operates as an enforceable catch limit until quotas for SSMUs are established, this trigger level has no scientific basis and was established taking into account maximum historical catches more than 10 years old (as explained earlier in this document). Since then, impacts from climate change have increased significantly and therefore the conditions under which the trigger level operates are different now compared to the time when the maximum historical catches were recorded. Although CCAMLR has pledged to undertake a subdivision of krill catch limits amongst SSMUs as the most effective way to prevent ecosystem impacts, WG-EMM has so far failed to reach consensus on available options for this subdivision since the mandate to undertake this exercise was received in 2002. These circumstances are clearly far away from a situation where *"there is clear evidence of responses to management issues as they arise".* Taking all this into account the AKCP believes that the assessment team fails to support the score of SG 80 warranted in relation to this PI.

WGEMM, 2000; WGEMM, 2007; WGEMM, 2008; SC-CAMLR. 1993; SC-CAMLR. 1994; Trathan and Hill, 2008; CCAMLR Conservation Measure 51-01 (2008)

[7] SC- CCAMLR- XXVII, paragraphs 3.42 and 3.43.

Moody Marine answer to Steve Nicol's comments:

1.2.1 *Monitoring is in place that is expected to determine whether the harvest strategy is working.*

Steve Nicol: This is not correct therefore the scores in this section need to be revised downwards (see below).

Moody Marine Comment to Steve Nicol: See below

The harvest strategy has not been fully tested, but monitoring is in place and evidence exists that it is achieving its objectives. The stock, catches and predator populations are being monitored, and there is no evidence that they are being affected by harvesting.

Steve Nicol: This is not strictly correct – I am unaware of any evidence that exists that the strategy is effective other than the absence of an obvious stock collapse.

Moody Marine Comment to Steve Nicol: The level of monitoring here is assessed in the context of the decision rule (i.e. limit the catch at or below the trigger level). Catches are monitored and, as indicated by the reviewer, there have been many biomass surveys since the synoptic survey which should have reported a decline in biomass had there been one. For the level of catch compared to any estimate of the total biomass, this appears sufficient.

Monitoring is extensive both with on-board observer coverage for biological sampling of the catch, and CEMP for monitoring the abundance of predator species. Concern has been expressed over reductions of CEMP monitoring, but it is adequate for the current level of catch. The international observer coverage, which is generally considered reliable, is less than 100% in this fishery.

Steve Nicol: This comment overstates the level of monitoring quite considerably. By what standard is the level of CEMP monitoring adequate? The less than 100% international observer coverage is actually considerably less with most vessels operating without them.

Moody Marine Comment to Steve Nicol: It is the judgment of the assessment team that, given the relatively low level of catch, the level of monitoring was adequate. This is consistent with the application of the MSC standard across all fisheries.

Krill, with its important trophic role in the Southern Ocean ecosystem, clearly requires greater risk aversion, which is taken into account. The basis for risk management is either to gather more and better information to verify a low negative impact, or reduce risk by management action, usually reduced harvesting. In this case, risk is reduced by keeping catches to a low level. Catches at or below the current trigger level compared to estimates of the total biomass appear low enough to give an acceptable risk. Should the harvest rate increase, the level of monitoring may well become inadequate. Many of the monitoring systems being developed and discussed are preparing for the expansion in the fishery. While we support the development of the improved monitoring system, the certification assessment must apply to the fishery as it is now.

AKCP: The AKCP fully agrees with the reviewer's view that the assessment team is overstating the level of monitoring and also wonders by what standard is the level of monitoring considered adequate. As expressed earlier in our comments to this PI, the "low level of catch" cannot be invoked as a valid reason for poor monitoring to be adequate. Especially, the categorization "low level of catch" cannot be regarded simply in relation to biomass estimates at the level of statistical area, but needs to be considered in the context of the role of krill in the ecosystem and the way the fishery operates (concentrated fishing in coastal areas).

While the level of fishing may be low in general terms, localized impact on predators may occur when coastal areas are heavily fished – it is important to highlight here that 99% of krill fishing takes place in coastal areas close to land-based predator breeding colonies, in overlap with their foraging ranges. As noted above, CCAMLR's monitoring program is dependant on national programs and priorities, and currently only monitors predator colonies in a few sites, which are not representative of the area subject to fishing. As a result, some areas that are currently subject to intensive fishing are not being monitored at all. This is why CCAMLR's ability to detect impacts on predators is very limited even at current catch levels. As it was acknowledged by WG-EMM, with the current CEMP it is not possible to distinguish impacts deriving from fishing from environmental effects including climate change.

In relation to the comment: *"there have been many biomass surveys since the synoptic survey which should have reported a decline in biomass had there been one"*, it is unclear what surveys the assessment team refers to. In any case, assuming they are referring to local surveys in Area 48, this statement fails to understand the value of these surveys. As explained further in our comments to PI 1.2.3, these surveys are useful to estimate inter-annual variability, but they are not good indicators of overall status and trends in biomass. Therefore, these surveys cannot be used to sustain the conclusion that evidence exists that the management strategy is achieving its objectives. We coincide with the view of Dr. Nicol that *"no evidence exists that the strategy is effective other than the absence of an obvious stock collapse".*

The AKCP believes that the reviewer's valuable comments and information were not satisfactorily addressed by the assessment team.

<u>Component:</u> Harvest Strategy

<u>PI Category:</u> Harvest control rules and tools

1.2.2 There are well defined and effective harvest control rules in place

Moody Marine Score: 80

SG 80: Well defined harvest control rules are in place that are consistent with the harvest strategy and ensure that the exploitation rate is reduced as limit reference points are approached.

The selection of the harvest control rules takes into account the main uncertainties.

Available evidence indicates that the tools in use are appropriate and effective in achieving the exploitation levels required under the harvest control rules.

Moody Marine comments:

There is a well defined harvest control rule in place that is consistent with the harvest strategy and ensures that the exploitation rate is low enough that there is little or no risk that the spawning stock biomass will be reduced bellow the limit reference point. The harvest rule is interpreted as the total catch being limited to the trigger level of 620 000t. This limitation ensures that the exploitation rates never approaches the target.
The potential yield calculation uses B_0 rather than the current biomass and will not reduce the exploitation rate as reference points are approached (i.e. there is no feedback).

This calculation however is not yet actually applied as a decision rule, but does demonstrate that the current and trigger level catches are highly precautionary. The stated aim of CCAMLR is to allow the fishery to be developed towards taking the catch indicated by the HCR, which would include further research and monitoring. The exploitation rate is constrained so that limit reference points are not exceeded.

The selection of the harvest control rules takes into account the main uncertainties. The main uncertainties have been considered, and explain the low value of the trigger catch relative to the surveys of krill abundance. However, the harvest control rule is commensurate the level of fishery development, and does not explicitly cover a wide range of uncertainties (e.g. climate change), which would require monitoring and adjustment of the controls in response.

The potential yield estimate is generated from a probabilistic harvest control rule, based on a stochastic simulation taking into account recruitment uncertainty and biomass survey error. The lowest biomass estimate of the various methods is used as the B_0 estimate, and has been adjusted downwards based on a re-evaluation in 2007. As the stock is currently considered only lightly fished, a precautionary level of catch at this stage should be sufficient.

Available evidence indicates that the tools in use are appropriate and effective in achieving the exploitation levels required under the harvest control rules. The tool used to control the harvest is the landings reported by the fishing vessels. The tools have not yet been invoked in this fishery, but the same system applies as used in the toothfish fishery, which, for the legal fishery, has been highly effective. There is some concern as to the accuracy of catch estimates, but the recording is adequate for the current level of catch.

The model uses the most up-to-date parameter estimates for the life history as well as a synoptic survey which combined trawl and acoustic methods to estimate the biomass in 2000. This estimate is treated as the unexploited biomass, although some fishing has occurred before 2000. The decision rule uses a proxy for biomass at MSY, and includes an arbitrary adjustment to allow for additional biomass to support predation.

AKCP: most of the statements in this PI are incorrect and in addition, the concerns that we expressed in our initial submission were not taken into account nor were they addressed.

As it has been explained in different sections throughout this document, recent analyses indicate that the trigger level is not as precautionary as initially thought (Watters et al., 2009). In addition, important uncertainties are not considered by the harvest control rules.

As it was already indicated last year in CCAMLR, there is uncertainty as to the amount of krill actually being removed from the ecosystem, due to the practice by fishing nations to report krill catches based on product information using a range of conversion factors without indicating product composition of catches, and the product specific conversion factors used. Uncertainty as to the krill caught in different areas hinders CCAMLR's ability to limit catches as the catch limit is approached. According to information submitted by the Secretariat to the last CCAMLR meeting (2008), a reported catch of 125,000 tonnes (2007/08 season) may actually represent a real catch of 500,000 tonnes. This means that under the current reporting system, it is possible for the fishery to actually approach or exceed the catch limit, without triggering the implementation of the control rules that are in place to prevent fishing over the limit. In addition, as it has been clearly stated in the WG-EMM report in 2008, with the increasing range of products arising from the krill fishery, the range of conversion factors was likely to get larger.

In view of this situation, in 2008 the Scientific Committee advised that conversion factors were unlikely to be of use in providing back-estimates of landed catch. Therefore, it recommended the direct measurement of green weight of krill, and thus, requested that all vessels participating in the krill fishery in the 2008/09 season report on the utility of the methods presented by ad hoc TASO (Ad Hoc Technical Group for At-Sea Observations) in estimating green weight during operations. Finally, the Scientific Committee requested that Members obtain these reports from their vessels and present them to TASO for consideration at its 2009 meeting (which took place in July 2009).[8] At the TASO 2009 meeting, it was decided that further assessment was still needed of the implications of using variable and fixed conversion factors, noting the need for the implementation of an accurate, repeatable volume-to-mass conversion for krill where volumetric measures are used. Therefore there is still no standardized way to report krill catches, and uncertainty on krill catch data remains.

In addition to the uncertainties associated with the use of conversion factors to indicate krill removals, at the last WG-EMM meeting (July 2009) the issue of krill escapement mortality was discussed and the meeting expressed further concerns on the capacity to effectively measure krill removals during fishing operations. Krill escapement mortality occurs when krill gets squeezed through the nets, an unknown percentage of which gets killed or seriously injured, without being counted as caught. Many different factors such as krill density, type of gear, speed of trawling, and mesh size (both code end and side panels) could affect unseen mortality. At the WG-EMM meeting, it was indicated that mortality of krill could be between 10 and 50% higher than that reported being caught. Therefore, concerns were expressed about this potential level of escapement mortality given the importance of the total amount of krill killed by fishing operations to any assessment and to catch allocation schemes. Furthermore, given the discrepancy between the estimates of mortality of escaped krill, together with the lack of data on the rates at which krill escape from nets in different fishing gears, the WG-EMM recommended that there should be a concerted effort to estimate escape mortality in the krill fishery, including through the evaluation of existing results and the continued development of existing models. Further, the Working Group expressed that it would be important that Members provide information and propose methodologies on how to measure krill escapement mortality so that this issue can be resolved rapidly.

In regards to B_0, at the last WG-EMM meeting (July 2009) it was concluded that current B_0 estimates in Area 48 contain a number or errors (i.e. in the implementation of the methodology) and under-represent uncertainty. Thus, there was agreement that B_0 needs to be recalculated.

[8] SC-CCAMLR XXVII, para. 4.17.

Unfortunately, this calculation will not take place this year and has been deferred to the next meeting of SG- ASAM (Subgroup on Acoustic Survey and Analysis Methods) in 2010.

In informal conversations with scientists that attended the last WG-EMM meeting we were informed that there was a general view that a recalculation will likely reduce estimates of B_0 and krill yield significantly. In any case, a lower B_0 will have an impact on the risk assessment done with the FOOSA model because it will modify the yield multiplier associated to the trigger level. In practical terms, the yield multiplier would increase, representing higher probabilities of risk as the trigger level is approached (as presented in Watters et al., 2009). This means that according to FOOSA, a higher risk would be associated with the trigger level with a lower B_0. As a clarifying point, it is important to note that a change in the value of B_0 would not imply a change in the value of the trigger level as both figures have been established using different procedures. However, under the risk assessment, a lower B_0 would indicate higher risks to predators, reinforcing the proposal that the current trigger limit is not as precautionary as originally thought.

In summary, the information presented in paragraphs above shows that important sources of uncertainties exist not only related to the calculation of B_0, but also in regards to the mortality of krill as a result of fishing (still being assessed), highlighting the constrains associated with the applicability of the harvest control rules under the current conditions. For these reasons, it is not possible to sustain the scoring given to this PI, which requires that *"the selection of the harvest control rules takes into account the main uncertainties";* and *"available evidence indicates that the tools in use are appropriate and effective in achieving the exploitation levels required under the harvest control rules".* It is the view of the AKCP that this PI is scored far too highly.

Component: Harvest Strategy

PI Category: Information / monitoring

1.2.3 Information/ monitoring: Relevant information is collected to support the harvest strategy.

Moody Marine Score: 80

SG 80: Sufficient relevant information related to stock structure, stock productivity, fleet composition and other data is available to support the harvest strategy. Stock abundance and fishery removals are regularly monitored at a level of accuracy and coverage consistent with the harvest control rule, and one or more indicators are available and monitored with sufficient frequency to support the harvest control rule.

AKCP: In general, we are concerned that the specific information included in our initial comments on key issues such as the inadequate scientific observer coverage to sustain the harvest strategy were not incorporate or addressed in this draft report. Monitoring and information aspects are among the weakest points in CCAMLR's management strategy for krill, including problems in relation to lack of updated information on the state of the stock, determining catch data, insufficient observer coverage, and insufficient monitoring of predator species. All these issues were highlighted by many stakeholders including ourselves and also by Dr. Steve Nicol in his review. As it will be shown throughout our comments below, these concerns were not addressed by the assessment team other than just indicating that monitoring is *"adequate taking into account the low levels of catch".* As indicated in relation to PI 1.2.1 above, this statement fails to take into account relevant factors like the role of krill in the ecosystem, the magnitude of existing uncertainties, and the potential effects of localized depletion. During the 2007/08 season, official catch data indicate that more than 156,000 tonnes of krill were removed from the ecosystem (a minimum figure taking into account issues like uncertainty of catch data and krill escapement mortality). Although this figure may seem low if one compares it with the overall catch limit for Area 48, it becomes a more significant amount if we consider that more than 99% of the catch is concentrated in coastal areas, where only 27% of the krill biomass is thought to be concentrated.

Taking into account the notable weakness of CCAMLR's information and monitoring tools in relation to the krill fishery, the ACKP believes that the score given to this PI, should be revised downwards.

The ACKP strongly believes that if certification is granted under these circumstances, an opportunity to introduce an incentive for CCAMLR to improve its monitoring system will be lost. In relation to CEMP, there is a mismatch between CCAMLR Members contributing to the program and those that benefit from the fishery. Unfortunately, investments in krill fishing industry development are currently not being matched by the appropriate investments in science that would be needed for a robust, scientifically-based management system.[9] Therefore, CCAMLR should develop funding mechanisms that ensure that the resources are available for an expanded, on-going monitoring program, such as a dedicated CEMP Fund. Fishing nations have a special responsibility in this regard. If certification is granted in the current situation, there will be no incentive for fishing Members to improve the monitoring system.

In summary, as maintained in our initial submission, we believe that under the current circumstances, the fishery does not achieve the minimum score (SG 60) required for certification in this PI.

We will now offer specific comments in relation to the scoring comments provided by the assessment team in relation to this PI.

Moody Marine comments:

Sufficient relevant information related to stock structure, stock productivity, fleet composition and other data is available to support the harvest strategy. The harvest strategy is primarily based on the 2000 synoptic survey. Other biomass surveys have been conducted since 2000, but have not covered the whole of area 48 and some attempt has been made to reconstruct the time series of biomass. The surveys provide the majority of the information on stock abundance and structure. How frequently synoptic surveys will be conducted in future is not clear. The spatial distribution of biomass, which is even more uncertain, will become more important when SSMU quotas are implemented. *However, the potential yield (catch limit) is based on estimates of the unexploited stock size, so in theory a single synoptic survey is adequate.*

[9] This was recognized by CCAMLR's performance review which recommended CCAMLR to "develop mechanisms to address burden-sharing for research and monitoring among Members so as to reduce the current reliance on a small number of Members and consequent risk to CCAMLR's management approaches if any of these Members reduced their input. The Review Panel viewed this with particular concern given the fundamental importance of research and monitoring to the CCAMLR management approach and the difficulties experienced by scientists in securing funding for monitoring". See CCAMLR-XXVII/8, Report of the CCAMLR Performance Review Panel.

AKCP: In relation to the first part of this paragraph, it is incorrect to say that "*sufficient information exists in relation to the stock structure to support the harvest strategy*". The patchiness of the scientific observation data considerably limits information on current stock structure so it is difficult to understand where this statement comes from. The value of partial surveys is limited as discussed some paragraphs below.

In relation to the rest of the paragraph, although it is acknowledged that the harvest strategy is based on a single study which is now nine years old, and that there is no clear plan to conduct further surveys, the assessment team concludes that *"in theory a single synoptic survey is adequate"*. This is a rather surprising conclusion that seems to be based on a subjective opinion. This statement is also inconsistent with the statement found in Moody Marine's scoring comments to PI 1.2.1 that *"assuming complete biomass surveys occur every 10 years (the next would be no sooner than 2010), it is not clear that this would be frequent enough to monitor stock status".* These inconsistent statements make it hard to understand what standard was applied by the assessment team in scoring this fishery.

On substance, it is to note here that there are many uncertainties associated with the biomass estimate resulting from the 2000 Survey which may have been overestimated (see comments on B_0 in relation PI 1.2.2). Taking into account the considerations expressed above on the concentration of catches in coastal areas and the role of krill in the ecosystem, a single survey by no means can be considered adequate, even if the catch limit is based on estimates of unexploited stock size.

In addition, the CCAMLR 2000 survey provides the baseline point for the projection of yield. It does not allow taking climate change into account since it is a single measurement. In using the KYM (krill yield model) the projection is supposed to take into account factors that might affect future trajectories of krill yield. Nevertheless, since there is no information on the impact of climate change on krill populations it is not possible to factor it in.

The assessment team makes reference to other biomass surveys conducted since 2000, not covering the whole of Area 48. We note with concern that no information is given on the dates and coverage of these surveys, that may help understand to what extent these surveys "provide information on stock abundance and structure that are sufficient to support the harvest strategy". Assuming that the authors are referring here to local surveys conducted at certain sites, such as AMLR surveys around Elephant Island, it is important to note that while these time series are useful in providing local information on krill distribution and abundance, the trends they show are not always the same as those from other areas, and there are a number of inter and intra annual changes that are difficult to interpret. Therefore, it is not possible to extrapolate krill data biomass at i.e., Elephant Island to the rest of Area 48. Therefore while these surveys are useful to estimate inter-annual variability, they are not good indicators of overall status and trends in krill biomass.

Catch composition, potentially providing information on selectivity and stock structure, is monitored through the observer coverage. These data are not currently used in the harvest strategy, partly because of the low level of exploitation. CCAMLR international observer coverage is less than 100%. The Saga Sea has an international observer on board, and within the South Georgia zone (48.3), all vessels must carry international observers. Otherwise vessels use national observers, a scheme which is not considered as reliable by all States.

AKCP: The first sentence of this paragraph is basically incorrect. As indicated in AKCP's initial comments to this assessment process, CCAMLR working groups have repeatedly indicated that the current level of observer coverage does not allow basic management questions to be addressed. In the absence of any response to our initial comments on this issue by the assessment team, we are now obliged to transcribe here again some the information contained in our previous submission, with the specific expectation that the assessment team will now be able to address this issue as it merits.

At its 2007 meeting, the Working Group on Ecosystem Monitoring and Management (WG-EMM) considered a range of scientific reasons for higher levels of observer coverage in the krill fishery. The working group noted that systematic coverage is needed to understand the behavior and impact of the fishery as well as routine monitoring to inform the modeling of krill stocks. The meeting made clear that the need for systematic coverage extends across all areas, seasons, vessels and fishing methods.[10] Therefore, although Aker Biomarine voluntarily submits scientific observer information to CCAMLR in relation to all of its krill fishing operations, the fact that other operators do not submit consistent scientific observer data means that the frequency in the monitoring of this fishery is insufficient to support the harvest strategy.

In 2009, WG-EMM has reiterated that all krill vessels needed to have systematic deployment of scientific observers on board in order to understand the overall impact of the krill fishery, one of the objectives agreed by the Scientific Committee in 2007. As discussed at this and previous WG-EMM meetings, current observer coverage is very far from this goal, especially in Subareas 48.1 and 48.2. This point will be further expanded below.

Continuing with our commentary to the scoring comments, we note with surprise that the assessment team estimates that observer data are not currently used in the harvest strategy, *"partly because of the low level of exploitation".* This statement clearly indicates a lack of understanding of the challenges that CCAMLR is facing. Any reader of the reports of WG-EMM and the Scientific Committee of the last five years would easily conclude that the only reason why observer data are not being used is the lack of statistical power of these data due to the patchiness of the observer coverage. For example, as noted before, the Scientific Committee stated in 2006 that current observer coverage is clearly insufficient to support management advice. As explained below, no progress has been made on the issue of scientific observer coverage in recent years.

Similarly, the assessment team states that *"otherwise vessels use national observers, a scheme which is not considered as reliable by all States*", referring to Subareas other than 48.3. This is a misleading statement in two aspects: firstly, it suggests that most vessels carry national observers outside of Subarea 48.3, which is not true (observers are carried voluntarily by a few vessels only and coverage is very limited); secondly, it suggests that appropriateness of the national observer scheme is a question of opinion. This ignores the fact that CCAMLR has designed an international scientific observation scheme which is based on bilateral arrangements between the flag State ("Receiving Member") and the nationality State of the observer ("Designating Member"), following very specific rules adopted by the Commission.[11] This scheme is considered to be best practice for scientific observation and it is irregular that it is not applied evenly to the krill fishery. In addition, the fact that certain vessels carry government-appointed observers on board does not necessarily mean that the data is received by CCAMLR. For example, at the last WG-EMM meeting in 2009, it was noted that Japan is not currently submitting observer data collected by Japanese national observers.

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[10] WG-EMM Report 2007, para. 4.51.

[11] See "Text of the CCAMLR Scheme of International Scientific Observation", CCAMLR 2009.

The lack of systematic observer data and the resistance by certain CCAMLR fishing Members to accept compulsory deployment of 100% observers was a primary concern of the Scientific Committee in its XXVI meeting (2007). At this meeting an agreement was reached on a process to achieve systematic observer coverage for krill fisheries in the near future.[12] Under this process, krill fishing nations would submit plans to the 2008 meetings of relevant CCAMLR working groups detailing how they would achieve systematic and consistent collection of scientific observation data. Discussions at the 2008 WG-EMM meeting resulted in an agreement to deploy 100% observers for a trial period of two years starting from December 2009, after which the Scientific Committee would evaluate the level of ongoing observer coverage required for the krill fishery.[13] Unfortunately, Japan overturned this position (to which it had agreed at the meeting of the WG) and opposed the endorsement of the Scientific Committee of this agreement. Korea and China supported Japan in this position. Virtually all remaining CCAMLR Members expressed their strong disappointment with this outcome and their support for 100% observer coverage. This included krill fishing nations such as Ukraine, Russia and Norway.[14] As it will be further developed below, prospects are low for systematic observer coverage in the krill fishery in the short term.

Some of the more comprehensive range of information has now been obtained preparing for a higher level of exploitation. There has been research on survey methods and biomass estimation, improvements in catch sampling and the way catches are measured and reported. More accurate data will be necessary if exploitation increases. As the harvest strategy is focused on the role of the species in the ecosystem, part of the monitoring procedure includes CEMP, which estimates the abundance of the predator populations. This is being used with abundance estimates of krill to construct models which can be used to allocated quotas among the SSMUs.

AKCP: the statement above on CEMP is incorrect. **CEMP does not estimate the abundance of predator populations.** Only the breeding population size of some species in certain land-based colonies located in selected CEMP sites are recorded. A list of monitored parameters was developed for CEMP, and fieldwork and data acquisition for predator parameter of indicator species **are voluntarily** carried out by CCAMLR Member countries and submitted to the CCAMLR Secretariat. To be more specific, according to CCAMLR, current parameters being monitored in predator species are the following:

CCAMLR Standard Methods for Monitoring Parameters of Predators Species

- Section 1: Penguins
    - Method A1 – Adult weight on arrival at breeding colony.
    - Method A2 – Duration of the first incubation shift.
    - Method A3 – Breeding population size:
        - A: Ground count.
        - B: Aerial count.
    - Method A4 – Age-specific annual survival and recruitment.
    - Method A5 – Duration of foraging trips.

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[12] It was agreed that "systematic coverage" means a level of coverage that ensures data collection across all areas, seasons, vessels and fishing methods to provide consistent, high-quality data for assessment of a multi-vessel, multi-nation fishery. SC-CCCAMLR XXVI, para. 3.12.

[13] SC-CCAMLR XXVI, para. 3.13-3.16

[14] CCAMLR XXVII, para. 11.4-11.21.

- Method A6 – Breeding success.
- Method A7 – Chick weight at fledging.
- Method A8 – Chick diet.
- Method A9 – Breeding chronology.

- Section 2: Flying Birds
  - Method B1 – Breeding population size.
  - Method B2 – Breeding success.
  - Method B3 – Age-specific annual survival and recruitment.
  - Method B4 – Chick diet.
  - Method B5 – Population size, breeding success .
  - Method B6 – Adult annual survival and recruitment.

- Section 3: Seals
  - Method C1 – Duration of cow foraging/attendance cycles.
  - Method C2 – Pup growth.

- Section 4: Monitoring non krill-dependent species
  - Method T1 – Diet of adult Antarctic shags during the breeding season.

In addition, a CCAMLR specialist workshop on Predator Survey was conducted from 16 to 20 June, 2008, in Hobart, Australia. The workshop was aimed at getting a better understanding of the uncertainty in predator population estimates. At that meeting, it was expressed that estimates of population size should be used with demographic models in order to estimate total population size. In addition, spatial foraging and dispersal models will be needed, to be followed by diet and consumption models, to estimate total consumption. Thus, participants clearly expressed that there is some way to go before dependent species requirements for krill could be established. In addition, it was concluded that CEMP data provide valuable insights into how one might 'correct' historical and current population surveys, but these data in themselves do not help assess population requirements. These data are critical but more in the context of process, rather than abundance.

In addition, in July 2008, the CCAMLR Working Group on Ecosystem Monitoring and Management (WG EMM) noted that estimates of predator consumption are uncertain primarily as a result of incomplete estimates of abundance of predators. It is the lack of comprehensive data on predator abundance and demand (which are strongly correlated) that rules out the use of Option 4 for allocation of krill catch limits amongst SSMUs. This is because, as Option 4 applies data on krill biomass minus predator demand in each SSMU as a basis for the allocation, biased estimates in predator demand data result in this option increasing ecosystem risks, as shown by Watters et al (2008).[15]

Stock abundance and fishery removals are regularly monitored at a level of accuracy and coverage consistent with the harvest control rule, and one or more indicators are available and monitored with sufficient frequency to support the harvest control rule. The harvest control rule is based on catch monitoring. Catch reports are obtained monthly from all vessels and there is no incentive to under-report. Although not an issue for the Aker fishery, discarding is legal in this fishery and some discarding may occur where the size of the krill is important, such as that used for human consumption or bait, but is not likely where catches are used for fish meal.

[15] WG- EMM 2008 Report, paragraphs 2.42 and 2.102.

Conversion factors from the processed weight, which is actually measured, to the live weight are highly uncertain for some products. However, for the current low exploitation rate, these are not likely to be important enough to affect stock status.

"Stock abundance and fishery removals are regularly monitored at a level of accuracy and coverage consistent with the harvest control rule" is an incorrect statement, as shown in our comments to this PI earlier in this section and to PI 1.2.2 above in relation to uncertainties related to catch data and krill escapement mortality.

Although the issue of conversion factors is acknowledged by the assessment team, they just conclude that *"for the current low exploitation rate, these are not likely to be important enough to affect stock status".* This is a subjective statement, not based on any technical analysis. It cannot be considered a valid basis for scoring.

The harvest control rule requires a good understanding of the basic life history parameters. The life history remains uncertain, although there has been clear progress in understanding with results suggesting that krill is relatively long-lived for a small shrimp species. Like all crustaceans, krill cannot be aged reliably so that growth and mortality cannot be estimated easily. The information is sufficient enough to support the current harvest control rule.

The paragraph above is self-contradictory and lacks logical structure. All the information provided points at the lack of understanding in relation of the basic life history of krill, which is key for the harvest control rule. However, after listing the different information gaps, the assessment team simply concludes that *"the information is sufficient enough to support the current harvest control rule".* We fail to see the justification for the assessment team reaching the above conclusion.

There is good information on all other fishery removals from the stock. Fishing only occurs within the CCAMLR area with few if any opportunities for fishing outside. IUU catches are negligible. There is no incentive to misreport.

As shown repeatedly in this section, and also as pointed at by Dr. Nicol in his review, the statement that *"there is good information on all other fishery removals from the stock"* is simply incorrect, due to uncertainties in catch data krill escapement mortality.

References:

WGEMM, 2000; WGEMM, 2007; WGEMM, 2008; Demer and Conti, 2005; Demer et al., 2007; Heywood et al. 2006; Atkinson et al. 2008; WG-EMM-08/46
Foster et al. 2007; Japanese Delegation 2008; WG-EMM-08/5; WG-EMM-07/5; Saunders and Brierley 2007

AKCP: In relation to the references of this section, the AKCP would like to note that the reference *"Japanese delegation 2008"* is included here. It is unclear whether the reference is indicative of a personal communication with a Japanese delegate, or rather a formal statement by Japan at the CCAMLR 2008 meeting. In any case, the reference is concerning, since Japan is the most notable example of a CCAMLR Member that has been consistently blocking the adoption of a systematic scientific observer data-gathering plan by CCAMLR, in spite of the scientific evidence that these data are urgently needed. This has been a matter of serious concern for most WG-EMM Members. For example, in 2007, the WG-EMM report reads: "*Members of the Working Group expressed their frustration that the collection of these data, which have been granted a* *high priority by the Scientific Committee, is being impeded by non-scientific arguments"*.[16] This statement was made in implicit reference to position taken by Japanese scientists at that particular meeting and other meetings of the Scientific Committee and its working groups. It is unfortunate that the assessment team is including as a reference precisely the delegation that is most responsible for CCAMLR not being able to act upon best scientific advice, as required by article IX.4 of the Convention.

Moody Marine answer to Steve Nicol's comments:

1.2.3 *There is good information on all other fishery removals from the stock.*

Steve Nicol: This is not correct because of uncertainty in conversion factors and incidental mortality of krill therefore this criterion should be revised downwards.

Moody Marine Comment to Steve Nicol: See comments above.

PRINCIPLE 2

Component: Retained non-target species

PI Category: Outcome/Status

2.1.1 Status: The fishery does not pose a risk of serious or irreversible harm to the retained species and does not hinder recovery of depleted retained species.

Moody Marine Score: 65 (*A score of 65 means that a condition has been generated- Refer Condition 2)*

SG 60: Main retained species are likely to be within biologically based limits or if outside the limits there are measures in place that are expected to ensure that the fishery does not hinder recovery and rebuilding of the depleted species.

If the status is poorly known there are measures or practices in place that are expected to result in the fishery not causing the retained species to be outside biologically based limits or hindering recovery.

Moody Marine comments:

As this PI considers the status of the retained non-target species, it is judged against the current catch level within the krill fishery as a whole – i.e. on average 113,000 t p.a.

Catches of adult fish during krill fishing are absent due to the fishing gear and methods employed, and the mono-specific swarming behaviour of krill. However, the nature of the Saga Sea fishing process means

[16] WG-EMM 2007 Report, para. 4.56.

that the normal fish larval bycatch that occurs during krill fishing using all gears will be preserved and is therefore measurable. As a result, an identifiable retained component of the catch consists of larvae of several fish species. The CCAMLR observer on board Saga Sea monitors catches of fish larvae, and analyses of resulting data have been performed. The total larval catch is less than 5% of the total catch by weight; this can be considered a 'main' retained species due to the potential vulnerability of this component and the fact that there is a vulnerable species present in this catch.

AKCP: following the logic of the assessment team in regards to this PI which "*considers the status of the retained non-target species, judged against the current catch level within the krill fishery as a whole*", it is difficult to understand why this paragraph concentrates on the monitoring of catches of fish larvae on board the Saga Sea. For any assessment of this particular issue it would be important to consider the monitoring of catches of fish larvae conducted by the fishery as a whole (all vessels) and not by a single vessel or group of vessels (see also our comments in section 2.1 above on the misapplication of the concept "unit of certification" in this assessment). Thus, even if this section provides some information on the monitoring aspects of the Saga Sea, it is insufficient in the context of this PI.

In addition, as we mentioned in our previous submission, the impact of bycatch of fish by the krill fishery is unknown and no mitigation measures are in place. Bycatch species include mackerel icefish (*Champsocephalus gunnari*), overfished to the point of stock collapse in the 1970s and still recovering.[17]

Already in 1992, sampling by research vessels in South Georgia identified bycatch of the following finfish species occurring in large numbers in krill trawls: mackerel icefish (*Champsocephalus gunnari*), blackfin icefish (*Chaenocephalus aceratus*), and the Myctophidae. The data indicated that the bycatch of fish in the commercial krill fishery may be significant in some areas of the South Georgia shelf.[18] Anecdotal information from industry sources suggest that large amount of toothfish larvae may be also caught as bycatch in this fishery.

At the CCAMLR 2008 meeting, the Scientific Committee noted that there is still uncertainty over the level of bycatch of juvenile and larval fish in the krill catch over all seasons and areas in which the krill fishery operates, and from different fishing gears. The uncertainty about the actual krill catch derived from the different conversion factors used in krill catch reporting adds even greater uncertainty to the extrapolated level of juvenile fish bycatch in the krill fishery. Further, the Commission noted that uncertainties over the level of bycatch of juvenile and larval fish in the krill fishery were still a matter of concern. Two years before, WG-EMM had noted already that the occurrence of fish larvae bycatch observed in the krill fishery was higher than the previous general understanding of bycatch in this fishery. The Working Group agreed that such results underscore the importance and need to increase observer coverage in the krill fishery.[19]

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[17] The South Georgia stock recovered from three episodes of heavy exploitation in the mid-1970s and in the early and mid-1980s. However, stock size remained low after a fourth decline following the 1989/90 season. The stocks around the South Orkney and the South Shetland Islands are still only fractions of their sizes at the beginning of the fishery in 1977/78. K.H. Kock. "A Brief Description of the Main Species Exploited in the Southern Ocean", at: http://www.ccamlr.org/pu/e/e_pubs/am/p7.htm

[18] I. Everson, A. Neyelov and Y. E. Permitin, Bycatch of fish in the South Atlantic krill fishery. Antarctic Science 4 (4): 389-392 (1992).

[19] WG EMM 2006, para. 3.36.

In relation to specific comments made by the assessment team on the following Scoring guidepost:

Main retained species are likely to be within biologically based limits or if outside the limits there are measures in place that are expected to ensure that the fishery does not hinder recovery and rebuilding of the depleted species.

Observer analysis reports have stated that overall catches of larval fish is much lower in more southerly areas 48.1 and 48.2 than in Subarea 48.3. While identification of larvae to genera and species level continues, current data indicates that species-specific catch rates were highest for Icefish Champsocephalus gunnari: maximum catch rates being 58.83 individuals per tonne in winter (Subarea 48.3), and for 'other icefish' with 38.3 individuals per tonne in summer (Subarea 48.2). Within 48.3, the key area for C. gunnari larval catch, this species is considered within biological limits and harvested sustainably. Larval stages of this species are not present year round, and consequently are only likely to be at risk for a limited period. The most important concentrations of these larval fish will be present in locations where the water circulation will lead to their retention on the shelf. These are not necessarily the same localities as those of the fishable krill aggregations because those concentrations occur in the localities where they have been brought to the region on the Antarctic Circumpolar Current.

AKCP: The assessment team states that *"Observer analysis reports have stated that overall catches of larval fish is much lower in more southerly areas 48.1 and 48.2 than in Subarea 48.3"* but they fail to provide any reference to this statement. One wonders about this since according to the information available, the observer coverage in Subareas 48.1 and 48.2 is very low (very low numbers of hauls observed) and patchy and should allow this type of conclusions. As mentioned before, the SC noted in 2008 that there is still uncertainty over the level of bycatch of juvenile and larval fish in the krill catch over all seasons and areas in which the krill fishery operates, and from different fishing gears. We fail to see the rationale for the above conclusion. In addition, the assessment team fails to provide references for the remaining statements included in this paragraph, and thus, it is difficult to assess the veracity of these data and put this information under the right context.

Lanternfish, the second most common species in 48.3 in the winter, is no longer the subject of a directed fishery where it is abundant (Subarea 48.3), on the basis of its likely importance as a prey (forage) species in the food web. There is no formal assessment of the status of the stock, but this management measure and the low by-catch levels recorded make it very likely that krill fishing has resulted in a minimal and insignificant reduction in stock size.

AKCP: it is difficult to understand how the assessment team can come to the conclusion that "*krill fishing has resulted in a minimal and insignificant reduction in stock size*" in relation to lanternfish when the same team acknowledges (in the same paragraph) that "*there is no formal assessment of the status of the stock*". It is also difficult to understand what is the "*management measure*" that the assessment team is referring to.

Rockcod larvae (Notothenia spp.) were also identified within the catch. Although these larvae have not been identified down to the species level, it is precautionary to assume these include larvae of the species N. rossii. Directed fishing for the Antarctic rockcod (N. rossii) specifically has been prohibited since 1985, and recovery is being monitored for stocks which were overfished in the late 1960s and early 1970s. Prohibitions are also in place to protect other

rockcod and icefish species (other than C. gunnari, this being the most common genus in 48.2 in the summer) in Area 48. Rockcod appear to remain at low population levels.

AKCP: as presented by the assessment team, Rockcod larvae have been also identified within the catch (a species that was highly depleted in the late 1960s and 1970s), not having recovered and remaining at low population levels. Based on the high level of current uncertainties in regards to larvae bycatch by the krill fishery, it is unsatisfactory that there is no reference in regards to any measure adopted in order to prevent serious or irreversible harm to this retained species and/or to hinder recovery of it (as this PI mandates).

Measures are in place within the fishery as a result of the currently low catch level of krill (well below the precautionary trigger level), and the restriction of fishing around CEMP management sites, which will provide some localised protection.

However, there is no current strategy or partial strategy to react to further findings on the level of fish larval catch within the fishery.

AKCP: it is incorrect to say that "*measures are in place within the fishery as a result of the currently low catch level of krill*", in reference to measures to avoid posing a risk of serious or irreversible harm to retained species and/or to hinder recovery of them. The "low catch level of krill" in relation to the trigger level, as the assessment team proposes, is related to krill and not to the retained species. In addition, the low catch level cannot be viewed as a measure that maintains retained species at a high level since catches can increase up to 620,000 tonnes and can be locally concentrated, which could have significant effects on retained species. Thus, it is wrong to suggest that there are measures in place within the fishery to provide some localized protection. Furthermore, the insufficient level of observer coverage and the high level of uncertainty on bycatch of juvenile and larval fish in the krill catch over all seasons and areas preclude taking any conclusion on the level of protection for retained species.

In regards to CEMP sites, the assessment team shows no understanding on the nature and characteristics of these sites. First of all, these are not "*management sites*" as the assessment team wrongly states, but monitoring sites. In addition, there is no "*restriction of fishing around CEMP sites*" as the assessment team also suggests. CEMP sites are land- based sites and restrictions are related to the access of nationals of contracting parties to each site as mandated by the management plan for each site an in accordance to a particular permit issued for a particular activity. [20] Thus, the information provided in this sentence is wrong; CEMP sites do not provide any localized protection.

Interestingly enough, the assessment team further states that "*however, there is no current strategy or partial strategy to react to further findings on the level of fish larval catch within the fishery".* According to the above statement, there is no justification for the fishery to be awarded even the SG 60 level on this indicator.

If the status is poorly known there are measures or practices in place that are expected to result in the fishery not causing the retained species to be outside biologically based limits or hindering recovery.

[20] CCAMLR Conservation Measure 91-01 (2004) para. 10 and 11.

The highest catch rates are for C. gunnari, which is considered within safe biological limits. While catch rates appear low based upon current information, the Notothenid and other icefish larval catches are of note, given the prohibitions on directed fisheries for these species (in Area 48 and Area 48.3 respectively).

AKCP: as mentioned previously, the depleted status of Rockcod (*Notothenia spp.*) and the uncertainties in regards to the level of catch of juvenile and larvae rockcod, is a matter of concern and should be noted (and acted upon). The same applies to icefish and the uncertainties in regards to the level of larvae catch rates.

Measures in place for the krill fishery as a whole are at present the precautionary trigger level of 620 000t of krill, while practices in place to minimise impact include the current lower level of krill catches. At that trigger level, a maximal catch of 99.5 larvae per tonne equates to 61 700 000 fish larvae caught, a worst-case situation given current information, and ignoring species-specific and area-specific catch rates. This number is not insignificant, and therefore continued monitoring of larval bycatch is warranted, particularly to identify approaches to reduce catches of species (e.g. through spatial or temporal approaches) and the spawning seasons of the different stocks.

However, based upon a conservative evaluation assuming either the current total catch level of krill or the current catch trigger level is taken from one place, and in light of the high rate of natural mortality in younger fish, impacts would be expected to be no more than background variability and hence undetectable at these levels.

AKCP: as stated earlier in this section, the "low catch level of krill" in relation to the trigger level, cannot be viewed as a measure that maintains retained species at a high level. Furthermore, it is confusing that the assessment team states that the maximal catch of fish larvae per tonne at a worse-case scenario is "***not insignificant"*** so that *"continued monitoring of larval bycatch is warranted, particularly to identify approaches to reduce catches of species",* but concludes that "*impacts would be expected to be no more than background variability and hence undetectable at these levels".* There is no objective basis for this conclusion and thus it should not be taken into account.

At a species-specific level, while catch levels of species such as Notothenidae are relatively low (<4 individuals per tonne of krill), that bycatch limits of adults in other adult fish fisheries in the area are (for example) 300t, and the impact at current low catch levels on the viability of adult populations is likely to be slight, there remains a need to reduce bycatch of this and other species to ensure that the fishery does not hinder recovery and rebuilding.

AKCP: the paragraph above does not have any reference and the conclusion that "*the impact at current low catch levels on the viability of adult populations is likely to be slight*" is not the result of any objective analysis but rather a subjective opinion without any information to sustain it.

References: MRAG (2009); CCAMLR CMs 34-04, 34-05, 34-06, 32-07, 33-01, 51-01, 91-01; Iwamu and Naganobu (2008); Client interview; CCAMLR (2008c)

Moody Marine answer to Steve Nicol's comments:

2.1.1

Steve Nicol: Because of the uncertainties over bycatch of larval fish (some of which are highly depleted species) it is difficult to see how this fishery can meet a minimum scoring criterion.

Moody Marine Comment to Steve Nicol: The uncertainty over larval fish bycatch is noted within the SG text. However, the majority of larvae taken are from *C. gunnari*, which is considered sustainably exploited around South Georgia. For potentially over-exploited species, even when the 'worst case' scenario was taken within a rough calculation of the maximal larval mortality at trigger level catches, given the biology of the species the impact was considered to be negligible compared to background variability. However, a condition (condition 2) was raised to address this more fully.

AKCP: as mentioned earlier in this section, the assessment team fails to provide an objective basis to conclude that "*the impact was considered to be negligible compared to background variability*". Furthermore, as stated by Dr. Nicol, there are large uncertainties in regards to the bycatch of fish larvae (some of which are from highly depleted species) indicating that this fishery could not meet the minimum scoring for this PI.

Component: Retained non-target species

PI Category: Management Strategy

2.1.2 There is a strategy in place for managing retained species that is designed to ensure the fishery does not pose a risk of serious or irreversible harm to retained species.

Moody Marine Score: 60 (A score of 60 means that a condition has been generated- Refer Condition 2)

SG 60: There are measures in place, if necessary, that are expected to maintain the main retained species at levels which are highly likely to be within biologically based limits, or to ensure the fishery does not hinder their recovery and rebuilding.

The measures are considered likely to work, based on plausible argument (e.g., general experience, theory or comparison with similar fisheries/species).

Moody Marine comments:

This PI is scored on the basis of the current catch trigger level of 620 000t.

There are measures in place, if necessary, that are expected to maintain the main retained species at levels which are highly likely to be within biologically based limits, or to ensure the fishery does not hinder their recovery and rebuilding.

The current low catch levels of krill represent a measure that reduces the impact of krill fishing on fish larvae, while the precautionary catch trigger level represents a further measure. However, these cannot be viewed as specific (partial) strategies aimed at ensuring fish larval catches are unlikely to affect adult fish population levels; they represent partial strategies directed for krill population management, and their effectiveness for minimising the impact of krill fishing on fish populations has not been formally evaluated.

AKCP: as stated in the previous PI, neither the "low catch level of krill" nor the trigger level represent measures "*to reduce the impact of krill fishing on* fish larvae" as the assessment team suggests. The assessment team further recognizes that "*they represent partial strategies directed for krill population management, and their effectiveness for minimizing the impact of krill fishing on fish populations has not been formally evaluated*". In light of the latter comment, it is clear that there is no way to determine whether the strategy might work because it "*has not been formally evaluated*". Thus, this paragraph does not support the criterion used for this PI, since there is no measure in place that is expected to maintain the main retained species at levels which are highly likely to be within biologically based limits, or to ensure the fishery does not hinder their recovery and rebuilding (as this PI mandates).

There is a strategy in place for collection of information directly from the fishery about other retained species. This allows the impact of future strategies to be monitored. At this stage the level of risk to the adult stocks has been regarded as low (see 2.1.1) but ongoing research is being conducted to quantify the level of bycatch down to the species level. Work on identification of these species of bycatch and analysis of bycatch rates in the krill fishery is currently ongoing through the observer programme.

AKCP: first of all, it is incorrect to say that "*there is a strategy in place for collection of information directly from the fishery about other retained species*". CCAMLR has not yet been able to agree on a systematic observer coverage scheme for the krill fishery which would be the basis for any information collecting strategy. As explained repeatedly throughout this document, systematic observer coverage has been "systematically" blocked by a small minority of fishing nations over many years, and thus there is no system in place to obtain representative information on the catch rate of retained species in the krill fishery. In addition, the CCAMLR's Scientific Committee has not developed advice on the acceptable level of bycatch for different fish species (including previously depleted populations) in the krill fishery, and thus the level of risk to the adult stocks cannot be regarded as low as the assessment team suggests. As stated, this paragraph is incorrect.

C. gunnari is subject to stock assessment, while status of other species are based upon the results of scientific surveys. There is no directed fishery for lanternfish in Subarea 48.3, due to its likely importance as a prey (forage) species in the food web. There is no formal assessment of the status of the stock, but this management measure and the low by-catch levels that are recorded make it very likely that fishing has resulted in minimal and insignificant reduction in stock size.

AKCP: as already mentioned in the previous PI, it is difficult to understand how the assessment team can come to the conclusion that "*krill fishing has resulted in a minimal and insignificant* *reduction in stock size*" in relation to lantern fish when the same team acknowledges (in the same paragraph) that "*there is no formal assessment of the status of the stock*". This is a subjective opinion not based on any rigorous analysis and as such should not be taken into account.

Rockcod (Notothenidae) and other icefish species larvae have also been identified within the catch. Directed fishing for the Antarctic rockcod (Notothenia rossii) has been prohibited since 1985, and recovery is being monitored for historically overfished stocks, while prohibitions on directed fishing are also in place for other icefish species. Limits on the bycatch of adult fish are also in place.

AKCP: as mentioned in the previous PI, the uncertainties in regards to the level of catch of juvenile and larvae rockcod and icefish are a matter of great concern. It is not clear what the assessment team means when they state that "*limits on the bycatch of adult fish are also in place*". This is a vague statement that is not sustained by any further explanation or reference. As in the previous paragraph, this is not an appropriate statement.

The measures are considered likely to work, based on plausible argument (e.g., general experience, theory or comparison with similar fisheries/species).

Based upon low catch levels dictated by the current catch trigger level (620 000t), the measure can be expected to result in relatively minimal impacts on adult fish biomass, based upon plausible argument. There is some evidence that this is likely to work due to those low catch levels. However, there is no objective basis for this confidence without additional study.

AKCP: as we have clearly stated, the current krill catch level alone cannot be regarded as a measure to maintain retained species at high levels. In addition, with the current information it is not possible to conclude that one can expect "relatively minimal impacts on adult fish biomass". What is very disturbing is that the assessment team acknowledges that "*there is no objective basis for this confidence without additional study*" but provides a score to this criterion that allows the fishery to pass and not fail. Under these circumstances, the assessment team should not have given a minimum score to this criterion until this further study was completed, as Dr Nicol has also suggested in his comments (here below).

References: CCAMLR CM 33-01, 34-04, 34-05, 34-06, 32-07, 51-01, 91-01; CCAMLR (2008c); MRAG (2009)

Moody Marine answer to Steve Nicol's comments:

2.1.2

Steve Nicol: The current catch level cannot be viewed as a measure that maintains retained species at a high level. As the catch is allowed to rise to 620,000 tonnes and can be locally concentrated it could significantly affect retained species. The last line of the comments put the case succinctly "However, there is no objective basis for this confidence without further study." Consequently it is difficult to see how a minimum score can be given on this criterion until this further study has been completed.

Moody Marine Comment to Steve Nicol: As per the scoring guidepost text, and as noted above, plausible argument in the worst case scenario suggested that the impact would be lost within background variability. The lack of an 'objective basis' for this means the fishery did not meet the level of the SG80 text, bit a score of 60 was considered appropriate

AKCP: we agree with Dr. Nicol on his comments as we have explained earlier in the document.

Component: Management Strategy

PI Category: Information/monitoring

2.1.3 Information/monitoring: *Information / monitoring:* Information on the nature and extent of retained species is adequate to determine the risk posed by the fishery and the effectiveness of the strategy to manage retained species.

Moody Marine Score: 90

SG 80: Qualitative information and some quantitative information are available on the amount of main retained species taken by the fishery. Information is sufficient to estimate outcome status with respect to biologically based limits. Information is adequate to support a partial strategy to manage main retained species. Sufficient data continue to be collected to detect any increase in risk level (e.g. due to changes in the outcome indicator scores or the operation of the fishery or the effectiveness of the strategy.

AKCP: as a general comment in relation to this PI, we would like to note that it is clear that the information currently available to CCAMLR cannot support the development of measures to determine the risk posed by the fishery and the effectiveness of the strategy to manage retained species as required by this PI. The lack of systematic scientific observation data is a major impediment to achieve this. As noted above, in 2006, WG-EMM noted that the occurrence of fish larvae bycatch observed in the krill fishery was higher than the previous general understanding of bycatch in this fishery. The Working Group agreed that such results underscore the importance and need to increase observer coverage in the krill fishery.

Moody Marine comments

Qualitative information and some quantitative information are available on the amount of main retained species taken by the fishery.

CCAMLR has asked Members to intensify their investigations into the by-catch of juvenile fish and to extend them to other seasons so that CCAMLR can assess more precisely where and when fish are most vulnerable to the krill fishery, and take appropriate action http://www.ccamlr.org/pu/e/e_pubs/am/p6.htm#(ii)Midwater). An observer is present onboard Saga Sea while fishing for krill in Area 48. An appropriate scientific protocol has been developed for sampling fish larvae within the catch, which has been analysed and reported to CCAMLR.
Identification of fish larvae sampled from the catch is ongoing. Species identification has been achieved for most species, but some have so far only been identified to genus level. Quantitative information is therefore available at the species level for specific species, and at the genus level for others.

AKCP: the statement "*CCAMLR has asked Members to intensify their investigations into the by-catch of juvenile fish and to extend them to other seasons so that CCAMLR can assess more precisely where and when fish are most vulnerable to the krill fishery, and take appropriate action*" does not support the scoring, since until these investigations are actually carried out (or made compulsory through a conservation measure), no further information will be available on the impact of the krill fishery on juvenile fish. Thus, this statement does not have any practical implication for scoring under the current circumstances.

As explained in previous sections of this document, although the bycatch monitoring activities conducted on board the Saga Sea set a good example for other vessels, they are not useful to obtain quantitative information on the amount of main retained species taken by the fishery (i.e., all vessels.

Modelling of factors which influence larval bycatch are ongoing, based on the years of data collected so far, and will help develop any further mitigation measures required for the fishery. Due to the nature of the fishery, these data are constrained in time and space, and hence a full analysis of the variability resulting from these factors has not yet been performed.

AKCP: The assessment team acknowledges that a full analysis of variability of the factors which influence larval bycatch has not yet been performed. Thus, this incomplete analysis should not be sufficient to sustain the needed scoring with respect to this PI.

(This achieves SG80 for the first paragraph)

AKCP: it is very difficult to understand how the assessment team can conclude that based on these two paragraphs (which are not sustaining a minimum score for this criterion) a score of SG 80 with respect to this PI.

Information is sufficient to estimate outcome status with respect to biologically based limits.

Given available information on fish larval catch rates by area and season (if partial in cases), biological information of adult growth and mortality estimates, available approaches for estimating –at-age natural mortality, and biomass estimates for many species, there is sufficient information to develop estimates of outcome status with respect to adult biologically based limits. However, this has not yet been performed (see 2.1.1.)

AKCP: it is not true that available information on fish larvae catch rates by area and season, among others, is sufficient "*to develop estimates of outcome status with respect to adult biologically based limits*". As explained above, at the CCAMLR 2008 meeting, the Scientific Committee noted that there is still uncertainty over the level of bycatch of juvenile and larval fish in the krill catch over all seasons and areas in which the krill fishery operates, and from different fishing gears. Thus, your statement is incorrect. In any case, we note that the assessment team recognized that "*estimates of outcome status with respect to adult biologically based limits have not yet been performed*".

(This achieves SG80 for the second paragraph)

AKCP: as in the previous criterion, it is difficult to understand how the assessment team can come to the conclusion that based on this paragraph (which does not serve to provide a minimum score) this criterion achieves SG 80 in regards to this paragraph.

Information is adequate to support a partial strategy to manage main retained species.

Information on the spatial and temporal pattern of larval catch is being developed through the ongoing international observer coverage onboard the Saga Sea. This information is adequate to support the development of partial strategies to manage the main retained species, as necessary, and will be expanded with continual coverage of the vessel in future years. Available information could support strategies such as move-on rules.
(This achieves SG80 for the third paragraph).

AKCP: as a general comment, it is important to note that it is unclear what is meant in this PI by a "partial strategy" and how this partial strategy can achieve sustainability at the level of outcome status. In addition, as explained before, the bycatch monitoring activities conducted on board the Saga Sea are not adequate to support a partial strategy to manage main retained species, since in order to develop this sort of strategy, the overall bycatch of the whole fishery needs to be considered. The assessment team uses the expression "*to support the development of partial strategies to manage the main retained species*" which is not correct and differs from the basic requirement to fulfill this criterion. Therefore, this criterion also fails to achieve the minimum score.

Sufficient data continue to be collected to detect any increase in risk level (e.g. due to changes in the outcome indicator scores or the operation of the fishery or the effectiveness of the strategy).

An international observer monitors the Saga Sea during all fishing activities. This 100% observer coverage collects information not only on the fisheries operations, but also any bycatch, discards and incidental mortalities that occur within the fishery. The observer covered between 20 and 86% of 'trawls' during the fishing season in 2006/07.

AKCP: as stated repeatedly throughout this document, observer activities on board the Saga Sea are not sufficient to obtain the necessary information on the nature and extent of retained species so as to determine the risk posed by the fishery and the effectiveness of the strategy to manage retained species. The information obtained on the Saga Sea cannot be extrapolated to other vessels, fishing in different areas, using different gears, etc. In addition, 100 % observer coverage is not a clear measure of coverage since it only represents the presence of the observer on board; the relevant aspect of the observer coverage is related to the factual observation (i.e. number of hauls observed). Finally, independently of the percentage of observer coverage implemented on the Saga Sea, this criterion cannot be fulfilled since it should be applied to the whole fishery (all vessels).

Using the scientific protocol developed, the sampling of larval retained species is sufficient to detect any increase in risk level. While the lack of full identification of all species means that the

ongoing mortalities of all retained species cannot be noted (some are currently only identified to genus level) further studies are underway to improve this.
(This achieves SG95 for the fourth paragraph)

AKCP: the scientific protocol at its best could provide information on the level of larvae retained species captured during fishing operations conducted by the Saga Sea, but by no means allows detecting any increase in risk level for retained species at the level of operations of the whole fishery, which is required by this PI. Hence, this criterion does not meet the minimum scoring and even less a value of SG95 as suggested by the assessment team.

MRAG (2009); CCAMLR (2008d); client interview

Moody Marine answer to Steve Nicol's comments:

2.1.3

Steve Nicol: It is difficult to see how the scoring of this criterion was arrived at given the overall lack of data and analyses.

Moody Marine Comment to Steve Nicol: 2.1.3 scores against the information available and monitoring in position, for the unit of certification. The Saga Sea has an observer present during 100% of its time at sea. The observer provides quantitative information that has been examined scientifically. This is reflected in the SG80 score of the first section ('qualitative and some quantitative information'). This provides sufficient information, combined with known biological parameters for the species, to develop outcome status with regard to biologically based limits for the species (as was rapidly performed to answer 2.1.1 and 2.1.2, but as noted has not been 'officially' performed, and is the subject of the condition arising from 2.1.1. and 2.1.2) and therefore again meets SG80 text. Information is sufficient to support a partial strategy as noted, again meeting the SG80 text. Given the continued 100% observer coverage on the unit of certification, data are collected in sufficient detail to assess ongoing mortalities of retained species, which would score at the SG100 level, but as noted not all have been identified to this level. A score of 95 was therefore given for this paragraph, which under MSC guidelines provides an overall score of 90. Additional text has been added to clarify this scoring (scores have been added to the text to show how the overall score of 90 was obtained).

AKCP: we fully agree with Dr. Nicol's comment that it is very dubious how the assessment team provided scoring to this criterion given the overall lack of data and analyses.
In relation to the comments provided by Moody Marine that *"2.1.3 scores against the information available and monitoring in position, for the unit of certification"*, it is important to note that this distinction in relation to the "unit of certification" is not present neither in the formulation of this PI, nor in the initial scoring comments provided by Moody Marine, which were always referred to the "fishery". [21] On substance, the AKCP believes that it is not possible to score PIs on non-target retained species in relation to the unit of certification (one vessel) only, since the impact of the fishery on these species is of a cumulative nature. Unless the Saga Sea could ensure a "zero bycatch situation", it is impossible to determine that the impact of the Saga Sea in the context of

[21] See also our comments in section 2.1 above on the misapplication of the concept "unit of certification" in this assessment.

the whole fishery is acceptable and meets the standard required (this is because the Saga Sea is contributing, to an uncertain extent, to the problem). Therefore, in order to support an effective management strategy, information on the bycatch of target non-retained species by the whole krill fishery needs to be available.

Component: ETP species

PI Category: Information/ Monitoring

2.3.3 Relevant information is collected to support the management of fishery impacts on ETP species, including: information for the development of the management strategy; information to assess the effectiveness of the management strategy; and information to determine the outcome status of ETP species.

Moody Marine Score: 95

SG 100: Information is sufficient to quantitatively estimate outcome status with a high degree of certainty.

Information is adequate to support a comprehensive strategy to manage impacts, minimize mortality and injury of ETP species, and evaluate with a high degree of certainty whether a strategy is achieving its objectives.

Accurate and verifiable information is available on the magnitude of all impacts, mortalities and injuries and the consequences for the status of ETP species

Moody Marine comments

Information is sufficient to quantitatively estimate outcome status with a high degree of certainty.

ETP species can be based upon those on the CITES listing. Using South Georgia and South Sandwich Islands entries as a basis, those of concern that may relate to the fishery under certification therefore include:
Commerson's Dolphin/Piebald Dolphin (Cephalorhynchus commersonii)
Spectacled Porpoise (Phocoena dioptrica)
Common Rorqual/Fin Whale (Balaenoptera physalus)
Southern Right Whale (Eubalaena australis)
Antarctic Fur Seal (Arctocephalus gazella)
Subantarctic Fur Seal (Arctocephalus tropicalis)
Southern Elephant Seal (Mirounga leonina)
CCAMLR international scientific observers record information key to the assessment of compliance with CCAMLR Conservation Measures. Under these observer protocols,
detailed observer records are maintained on the presence of ETP species around the vessel during fish activity and any mortality and injury events relating to ETP species are
recorded by the observers, with samples being retained for assessment by Member States. The magnitude of all impacts, mortalities and injuries and the consequences for the

status of ETP species are therefore well known. The observer information obtained is sufficient to quantitatively estimate the status of ETP species interactions with a high degree of certainty. Further monitoring of ETP species (e.g. albatross) occurs through the CEMP monitoring programme.

Information is adequate to support a comprehensive strategy to manage impacts, minimize mortality and injury of ETP species, and evaluate with a high degree of certainty whether a strategy is achieving its objectives.

The CEMP and observer programme provide considerable data to support the ETP injury and mortality mitigation strategies developed and employed by CCAMLR over the past twenty years. Information from these sources and the resulting strategies has reduced the levels of interaction and subsequent injury and mortality of ETP species greatly, identified as monitoring continues. Where needed, the strategy can continue to develop to manage impacts, and minimise mortality and injury of ETP species. While the CEMP programme (given its land-based nature) does not include whale species – in particular baleen whales – CCAMLR have initiated joint programmes with IWC in an attempt to improve the ecosystem modelling and understanding of those krill dependent species, which should improve this information into the future.

Accurate and verifiable information is available on the magnitude of all impacts, mortalities and injuries and the consequences for the status of ETP species.

The Saga Sea has a very good observer coverage rate, at 100% of fishing days covered. The CEMP data provides a time series of key predator population characteristics. Although the degree of data collection under this programme has varied over time, a key site in each sub-area of Area 48 continues to be monitored with high coverage. Ad hoc monitoring has also been performed using underwater camera gear, during gear development and during the early period of commercial use. This allowed direct observation of the efficacy of mitigation measures while fishing. Continued evaluation will continue through the scientific observer programme and there is a high degree of certainty that this strategy is achieving its objectives. Information is therefore sufficient to quantitatively estimate outcome status for the unit of certification with a high degree of certainty. Information from the Saga Sea is adequate to support a comprehensive strategy to manage impacts, minimize mortality and injury of ETP species (although some limitations with respect to whale species are noted), and evaluate with a high degree of certainty whether a strategy is achieving its objectives. Accurate and verifiable information is available on the magnitude of all impacts, mortalities and injuries and the consequences for the status of ETP species.

References: MRAG (2009); Watters et al. (2008a, 2008b); CCAMLR (2008d, 2008e); client interview; CCAMLR CMs 25-03 (2003), 26-01 (2008); Orr et al. (2007); observer reports; CCAMLR observer manual; interview with Greenpeace, interview with WWF; Constable (2008)

Moody Marine answer to Steve Nicol's comments:

2.3.3

Steve Nicol: This score is based on information from CEMP and from scientific observers. Because of the lack of systematic data collection by either of these processes, information is only adequate for this scoring criterion thus the score should be revised downwards.

Moody Marine Comment to Steve Nicol: There seems to be confusion here, since 2.3 scores the direct impact *of the unit of certification* on ETP species, rather than ecosystem impacts *of the krill fishery as a whole*, which are considered under 2.5. As noted in 2.3.1, direct observation through observers and underwater camera studies has shown no fatal interactions with ETP species. In light of this, there is sufficient information to quantitatively estimate outcome status with a high degree of certainty *for the unit of certification*, through the mechanisms noted. To clarify this further, the following changes have been made to the final paragraph:

"Information is therefore sufficient to quantitatively estimate outcome status **for the unit of certification** with a high degree of certainty. Information **from the *Saga Sea*** is adequate to support a comprehensive strategy to manage impacts, minimize mortality and injury of ETP species (although some limitations with respect to whale species are noted), and evaluate with a high degree of certainty whether a strategy is achieving its objectives. Accurate and verifiable information is available on the magnitude of all impacts, mortalities and injuries and the consequences for the status of ETP species."

AKCP: The AKCP agrees with the Dr. Nicol that this PI was greatly over-scored by the assessment team, taking into account the lack of systematic data both from CEMP and the scientific observer program. It is hard to understand how the available data can constitute "accurate and **verifiable** information on the magnitude of all impacts, mortalities and injuries and the consequences for the status of ETP species". For ETP species like Antarctic fur seals monitoring currently only exists in two sites (Cape Shirreff and Bird Islands), and no baleen whale species have ever been covered by CEMP.

In relation to Moody Marine's response to the reviewer that this PI scores the direct impact *of the unit of certification* on ETP species, rather than ecosystem impacts *of the krill fishery as a whole*, we refer to our comments in section 2.1 above on the misapplication of the concept "unit of certification" in this assessment. In addition, it is clear from the drafting of this PI that information is required on the magnitude of ALL impacts of the fishery on ETP species, and not only direct species.[22] This is consistent with the endangered, threatened and protected nature of these species, which merits special consideration of all sorts of impacts (direct and indirect). The overall impacts of the fishery on the ecosystem as a whole constitute a different issue, which is dealt with by 2.5 PIs. The assessment team itself seems to acknowledge this in the scoring comments to this PI when they take into account the fact that CEMP monitors krill predators. As mentioned earlier in this document, the goal of CEMP is to obtain information on the indirect impact of fishing on krill predators. In this context, it is not possible to differentiate indirect impacts on ETP predator species (such as potential competition for a key prey such as krill) by a single vessel and therefore the PI needs to be referred to the whole fishery.

Component: ecosystem

PI Category: Outcome / Status

[22] The PI reads: "Accurate and verifiable information is available on the magnitude of all impacts, mortalities and injuries and the consequences for the status of ETP species".

2.5.1 The fishery does not cause serious or irreversible harm to the key elements of ecosystem structure and function.

Moody Marine Score: 80

SG 80: The fishery is highly unlikely to disrupt the key elements underlying ecosystem structure and function to a point where there would be a serious or irreversible harm.

Moody Marine comments

The Aker BioMarine fishery is part of the larger CCAMLR managed fishery, which contributes part of the total extraction, and so this PI considers the total levels of current extraction. This status PI is therefore judged against the current catch level of krill within the fishery, of on average 113 000t.

The fishery is highly unlikely to disrupt the key elements underlying ecosystem structure and function to a point where there would be a serious or irreversible harm.

Given the pivotal role of krill within the Antarctic ecosystem, a large amount of effort has been invested in assessing the likely impacts of krill biomass fluctuations and removals on ecosystem status and performance.

Current levels of krill extraction are at low levels compared to the precautionary biomass trigger level, which is based upon the biomass estimated from the 2000 krill survey (see 2.5.2). This precautionary level was selected on a precautionary basis using ecosystem considerations as an underlying driver, taking account uncertainty in signal strength, krill inter-annual biomass fluctuations and a risk-based simulation approach.

The predator requirement estimate of 3,466,157 tonnes is approximately 10% of the biomass estimate from the combined krill survey in 2000. Current extraction levels represent 3% of the 2000 total biomass level. At the macro-geographic scale, therefore, expert judgement expects that this level of extraction will not result in disruption to the key elements of the ecosystem structure.

This is supported by some observational and simulation evidence. The CEMP programme, supported by other site-specific monitoring studies (e.g. as performed by BAS), provides a time series of data monitoring breeding success and krill predator population numbers. While declines in particular species have been seen (e.g. Macaroni penguins), the data do not provide a link between these declines and the extraction of krill through fishing at current levels.

AKCP: The statement above suggesting that there is no evidence of the link between observed declines in several krill predator species and impacts from fishing fails to incorporate the need to adopt a precautionary approach to fisheries. According to the precautionary approach, it is not appropriate to wait until conclusive evidence exists that an activity is causing irreversible harm to introduce protective measures. This is particularly relevant in the case of Antarctic krill since, as it has been noted earlier in this document, CCAMLR has acknowledged that in its current configuration, CEMP may never allow to distinguish the impacts from fishing and those caused by environmental factors. Therefore, even if it has not been proved that the decline of certain predators has been caused by krill fishing, the mere observation of a decline is a cause of concern. Until it can be shown that the decline is independent from the fishing activities, it is not possible to conclude, that fishing is not disrupting top predators.

The data have assisted in the parameterisation of complex ecosystem models to investigate the impacts of krill fishing on predator populations. Using the FOOSA model, Watters et al. examined a range of levels of krill extraction relative to the precautionary harvest rate and trigger level for SSMUs. Their simulations suggest that the current trigger level for division of krill TACs into SSMUs appears 'highly likely' to result in the ecosystem remaining within biologically based limits. As a result, current extraction levels, as considered within this PI, are unlikely to result in impacts to local predator populations. However, further study is needed to appropriately define SSMU-scale TAC levels and overall TAC limits. Their simulations take into account a number – but not all – areas of uncertainty. In turn, studies have indicated that localised effects of krill fishing on predators might occur. Therefore this PI is scored at 80.

AKCP: The paragraph above contains confusing statements and shows a lack of adequate understanding of the risk assessment undertaken by Watters et al. in 2008 using the FOOSA model. Firstly, in is unclear what is meant by *"their simulations suggest that the current trigger level for division of krill TACs into SSMUs appears 'highly likely' to result in the ecosystem remaining within biologically based limits".* Before discussing the substance of this statement it is important to note that the authors are using the following term: "*the current trigger level for division of krill TACs into SSMUs*" in a rather confusing and inaccurate way. The trigger level does not provide any instrument/tool **for** division of krill TACs into SSMUs as this expression might let to think. The trigger level only provides **a limit** that cannot be surpassed unless an allocation of krill catches amongst SSMUs is previously agreed. Thus, it does not have any conceptual relationship with the process to allocate krill catches, nor it facilitates or secures the allocation of catches, it only provides a limit. This should be clear and the term should be used in a proper way.

Going now back to substance, what the risk assessment in 2008 did was to analyse possible risks to the ecosystem associated with the use of Options 2, 3, and 4 for allocation of krill catches amongst SSMUs. Since these allocations have not been implemented (no option has been elected yet by CCAMLR), the 2008 risk assessment cannot be used to describe the risk associated with the current situation (i.e., no SSMU allocation at current catch levels). It is important to note, as we already mentioned in our initial comments, that the 2008 risk assessment did not include the analysis of Option 1 (historical distribution of catches, which corresponds to the current fishing pattern) as it had been ruled out earlier by WG-EMM because it was considered to pose a higher risk to predators. Therefore, it is incorrect to conclude that *"as a result, current extraction levels, as considered within this PI, are unlikely to result in impacts to local predator populations".* It is also very surprising to note, that, although the assessment team recognizes that *"studies have indicated that localized effects of krill fishing on predators might occur",* they still conclude that the fishery is highly unlikely to disrupt key ecosystem elements. Clearly this is not a logical conclusion from the evidence presented.

Within the current trigger level, the fishery is highly unlikely to disrupt the key elements underlying ecosystem structure and function to a point where there would be a serious or irreversible harm.

AKCP: In regards to the paragraph above, in addition to the considerations already made in relation to the lack of a consistent analysis of existing data and studies, it is very important to note that there is now new evidence that confirms that the current trigger level is not sufficient to prevent ecosystem impacts as a result of fishing. Watters et al. (2009) have undertaken a new risk analysis aimed at is assessing the risks of allowing expansion of the fishery up to the trigger level without SSMU allocations. The assessment has concluded that such an expansion is likely to risk depletion of krill-dependent predators. Therefore, the paper concludes that current trigger level may not be sufficiently precautionary to achieve CCAMLR's management objectives. Consequently, in the light of the existing information it is incorrect to affirm that *"with the current trigger level, the fishery is highly unlikely to disrupt the key elements underlying ecosystem structure and function to a point where there would be a serious or irreversible harm".* The result of this is that this fishery does not achieve a score of SG 80 for this PI. In fact, with the results of the new risk assessment undertaken, and taking into account that the capacity in the fishery currently exists to reach the trigger level, it is not possible either to state that *"the fishery is unlikely to disrupt the key elements underlying ecosystem structure and function to a point where there would be a serious or irreversible harm"* as required by SG 60 (this is further elaborated below in our comments to Moody Marine's response to Dr. Nicol's review). Therefore, the fishery does not reach a minimum score and should not be certified.

Audit Trace References
Watters et al. (2008 a, 2008b); CCAMLR (2008a, 2008e); Mangel and Switzer (1998); CCAMLR (2008e)

Moody Marine answer to Steve Nicol's comments:

2.5.1
Steve Nicol: Given the uncertainties surrounding the ecology of krill, the lack of observation of the fishery (and its uncertainties) and the immature nature of the CEMP this criterion can be scored at best as: *The fishery is unlikely to disrupt the key elements underlying ecosystem structure and function to a point where there would be a serious or irreversible harm.* The discussion on the risks associated with subdivision of the catch limits does not deal with the risks posed if the catch up to the trigger level is taken in a small area. It is a very bold and brave statement to assert that *Within the current trigger level, the fishery is highly unlikely to disrupt the key elements underlying ecosystem structure and function to a point where there would be a serious or irreversible harm.* I am not sure that many scientists working in the CCAMLR community would be prepared to agree with this. Consequently the score for this criterion should be revised downwards.

Moody Marine Comment to Steve Nicol: The view expressed by the reviewer is highly precautionary, and appears contrary to both the historical pattern of the fishery and the information available from current simulation studies. It is recognised that simulation results are predicated upon the assumptions made during their development. However, a range of assumptions appear to have been used and results at the trigger point were (generally) robust to those assumptions.
Changes in the pattern and level of the fishery, and new evidence arising, would be identified during the annual surveillance audits, and the score could be re-evaluated on that basis. Based upon current information, however, the score appears justified.

AKCP: The AKCP agrees with the reviewer's comments above. We would also like point out again that there is now new evidence that shows that the trigger level is not sufficiently precautionary to prevent irreversible ecosystem impacts from the fishery (Watters et al., 2009). Thus it is not appropriate to wait until annual surveillance audits are performed to re-evaluate the situation, as suggested by the assessment team, since new evidence is available now that requires a new score. As we noted before, the recent risk assessment undertaken in the CCAMLR framework shows that catches up to the current trigger level may pose significant risks to krill predators. It is important to note that, as acknowledged by CCAMLR's Scientific Committee, the capacity now exists within the fishery to exceed the 620,000 trigger level.[23] Since it is now clear that the trigger level does not provide sufficient protection to predators from the impacts of fishing, and catches can increase up to this level with no further provisions in place, it is not possible to sustain that the *"fishery is unlikely to disrupt the key elements underlying ecosystem structure and function to a point where there would be a serious or irreversible harm".* As stated above, it is therefore clear that under the current trigger level the fishery does not achieve SG 60 for this PI.

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Component: Ecosystem

PI Category: Management Strategy

2.5.2 There are measures in place to ensure the fishery does not pose a risk of serious or irreversible harm to ecosystem structure and function.

Moody Marine Score: 80

SG 80: There is a partial strategy in place, if necessary, that takes into account available information and is expected to restrain impacts of the fishery on the ecosystem so as to achieve the Ecosystem Outcome 80 level of performance.

The partial strategy is considered likely to work, based on plausible argument (eg, general experience, theory or comparison with similar fisheries/ ecosystems).

There is some evidence that the measures comprising the partial strategy are being implemented successfully.

Moody Marine comments

There is a strategy that consists of a plan, containing measures to address all main impacts of the fishery on the ecosystem, and at least some of these measures are in place. The plan and measures are based on well-understood functional relationships between the fishery and the Components and elements of the ecosystem.

As noted in 1.1.1 and 1.1.2, the strategy for krill management has been developed in recognition of the role of krill within the ecosystem. The implicit strategy is based upon the precautionary trigger level, which cannot be breached until small-scale management units (SSMUs) are put in place, with SSMU-specific quotas. This strategy of catch limitation is operational, although fishing levels have not been nearly high enough to test the application of this plan. Therefore, the plan is implicitly used to demonstrate that the current catch is much lower than the planned catch and therefore highly precautionary. Modelling has recently been performed to assess the

[23] SC-CCAMLR XXVII, paragraph 4.4.

effectiveness of the plan (i.e. the precautionary trigger level) for maintaining ecosystem elements. However, it cannot be said that the functional relationships between the fishery and the components and elements of the ecosystem are well understood. There are well documented uncertainties within the ecosystem and krill food web, although understanding is adequate to develop and test reasonably robust strategies and the trigger level appears sufficiently precautionary to sustain predator requirements at the global scale.

AKCP: It is important to note that Moody Marine's scoring comments on this PI are difficult to understand since the assessment team is commenting on a different standard (SG 100) that the one finally applied (SG 80). It would be advisable that when a PI is scored downwards as a result of a reviewer's comment, new scoring comments are prepared and referred to the SG finally applied and not to the one applied originally. Otherwise it becomes very difficult to follow through the assessment report.

With to the information available, the assessment team acknowledges that it has been widely recognized that the functional relationships between the fishery and elements of the ecosystem are not sufficiently understood. This is certainly correct and several authors have highlighted it (Hill et. al, 2006; Kawaguchi and Nicol, 2007). It is rather surprising, then that, the assessment team concludes that *"understanding is adequate to develop and test reasonably robust strategies and the trigger level appears sufficiently precautionary to sustain predator requirements at the global scale*". This last statement is not correct for several reasons:

1. First of all, the fishery does not operate at the global scale, but a local scale, and in a concentrated way. Therefore, we think that it is not appropriate to centralize the discussion on the predator requirements at the global scale when this is not the scale at which the fishery operates. This is especially so because concern has been expressed repeatedly at CCAMLR about the overlap between krill fishing operations and the foraging range of land- based krill predators, which could result in a reduction of krill availability for these predators at certain times of the year when food is key to support breeding success.
2. As detailed by Hill et al. (2006) and others, recent attempts to model the system have suffered from a shortage of empirical data on essential issues such as trophic relationships between krill and predators, krill movement and distribution or the effects of environmental change on krill populations. For example, WG-EMM has acknowledged that estimates of predator consumption are uncertain primarily as a result of incomplete estimates of abundance of predators and also that local krill densities are not adequately estimated in available analyses of the CCAMLR-2000 Survey. In addition, the models do not incorporate the dynamics of fish populations whose role in the ecosystem is an important source of uncertainty.[24]
3. As shown above, recent studies (Watters et al., 2009) applying FOOSA provide compelling information that the current management strategy (based on the trigger level as overall krill catch limit until SSMUs are implemented) may not be precautionary, since risks to predators are expected to be significant if catches approach the trigger.
4. In their paper, and due to the level of uncertainty involved, Watters et al. (2009) clarify that their conclusions may be negatively biased, which means that the risk assessment should be considered as indicating minimum risks to the ecosystem for any given harvest rate.

[24] WG-EMM 2008 Report, para. 2.102 and 2.76 to 2.83.

This plan provides for development of a full strategy that restrains impacts on the ecosystem to ensure the fishery does not cause serious or irreversible harm.

The current strategy of the precautionary trigger level is implemented at the Area 48-wide scale. However, the plan is already being further developed to explicitly to take into account the requirements of krill predator species at regional and local geographic level. This extension to a more complete strategy involves the designation of SSMUs (based upon predator population structures) and local-scale quotas, to minimise the chances of localised depletions and thereby restrain impacts on the ecosystem to ensure the fishery does not cause serious or irreversible harm. This plan would require a sufficiently robust reporting/observer system to ensure the process will operate as anticipated. It should be noted that this level of catch is beyond the level of fishing currently being certified. It should also be noted that previous ecosystem modelling showed that division of the precautionary trigger level quota at the SSMU level based on historical fishing patterns (option 1) has been discarded as an approach, as it would have "have relatively greater negative impacts on the ecosystem compared to the other fishing options". Therefore, the division of SSMU-level quotas has been based upon alternative options.
While the strategy is a progression beyond the current approach, the need to define and agree the basis for quota divisions means it cannot therefore be called 'full'.

AKCP: As indicated by Dr. Nicol in his review, several comments in the paragraph above ignore the status of key issues in CCAMLR discussions. For example, the statement *"the plan is already being further developed to explicitly to take into account the requirements of krill predator species at regional and local geographic level"* ignores the fact that the plan to subdivide krill catch limits amongst SSMUs has yet to be agreed. In 2008, the Scientific Committee was unable to deliver advice to the Commission on a Stage 1 allocation based on options 2, 3 and 4, in spite of the work undertaken by WG-EMM to assess the performance of each of these options.[25] This lack of progress was a matter of concern for the CCAMLR Commission where most Members expressed their disappointment that the lack of consensus on SSMUs did not reflect the work undertaken at the working group level. Interestingly, only a few fishing nations, including Norway, expressed the view that the subdivision of krill catch limits amongst SSMUs was not an urgent matter[26].

Similarly, the statement *"this plan would require a sufficiently robust reporting/observer system to ensure the process will operate as anticipated"* is correct but ignores the fact that the issue of requiring systematic scientific observer coverage has been stalled in CCAMLR for many years, and agreement on possible alternatives has been consistently blocked by Japan and Korea. There are no prospects for CCAMLR to solve this issue in the short term. Until these problems are overcome, further development of the SSMU plan will not happen. The assessment of Moody Marine on these points (SSMU allocation and observers) shows a significant lack of understanding of the current situation in regards to the CCAMLR process and the current state of management of the Antarctic krill fishery.

The measures are considered likely to work based on prior experience, plausible argument or information directly from the fishery/ecosystems involved.

[25] SC- CCAMLR- XXVII, 3.19 and 3.20.

[26] CCAMLR XXVII, para. 4.16-4.26.

The performance of the current plan, based upon the precautionary trigger level, is considered likely to work based upon prior experience, where historical catches were much greater but appeared to have minimal impacts on the ecosystem. More reassuringly, the plan has been tested within ecosystem simulation models. These studies have shown that the current trigger level for division of krill TACs into SSMUs is 'highly likely' to result in the ecosystem remaining within biologically based limits. It is noted that fishing extractions greater than this level (which are not part of this certification process) may lead to impacts on predator populations, dependent upon how SSMU-level quotas are derived. It is also noted that their simulations take into account a number – but not all – areas of uncertainty. Further support for current measures comes from the CEMP programme.

AKCP: believes that the statement that the trigger level is considered likely to work based upon prior experience where historical catches were much greater but appeared to have minimal impacts on the ecosystem is a too simplistic statement. The AKCP agrees with Dr. Nicol that there was no systematic monitoring of the ecosystem in the early 1980srendering it impossible to make the above statement. On the other hand, observed climate change effects in Antarctica have increased significantly since those years and therefore it is difficult to know how the system will react today under similar fishing levels.

The statement "*more reassuringly, the plan has been tested within ecosystem simulation models*" is incorrect. As noted above, the simulation studies conducted by Watters et al. in 2008 were aimed at assessing options for SSMU allocation of catch limits amongst SSMUs, and not to test the appropriateness of the trigger level to prevent ecosystem impacts. Although CCAMLR has agreed in concept to develop and implement the SSMU allocations, in reality this plan is at a stand-still and no recommendation for allocations have been made by the Scientific Committee.

As explained above, it is false that simulation "*studies have shown that the current trigger level for division of krill TACs into SSMUs is 'highly likely' to result in the ecosystem remaining within biologically based limits*". In addition, as mentioned in several sections of this document, new simulation studies conducted by Watters et al. (2009) have shown that if catches increase up to the trigger level, ecosystem impacts are likely to occur. Therefore as the trigger level remains in place without any spatial limitation, it is likely that ecosystem impacts will occur as a result of fishing.

The current situation in regards to the current trigger level is very well expressed in the document prepared by Watters et al. 2009 which read as follows: *"In this document our objective is to assess the risks of not deciding to allocate the precautionary krill catch limit among SSMUs and allowing uncontrolled expansion of the krill fishery up to the current trigger level. This is equivalent to assessing the risks of status quo management and of allocating the catch limit among SSMUs on the basis of the spatial distribution of historical krill catches (Option 1). We use the same methodological approach reviewed and endorsed at the last meeting of the WG-SAM and applied at the last meeting of the WG-EMM. Using the reference set of parameterizations developed by Watters et al. (2008a), we show that FOOSA simulates minimal impacts by the current krill fishery, but an uncontrolled expansion of the fishery up to the current trigger level is likely to risk depletion of krill-dependent predators. Therefore, the current trigger level may not be sufficiently precautionary to achieve the objectives of Article II."*

Finally, the last statement of the paragraph by the assessment team that reads *"further support for current measures comes from the CEMP programme",* ignores the fact that in its current configuration, CEMP does not allow to identify the impacts from fishing as opposed to other effects such as environmental changes. Extensive information on the lack of sufficient coverage by CEMP has been already provided elsewhere in this document.

There is some evidence that the measures comprising the partial strategy are being implemented successfully.

While modelling has been performed to assess the performance of the strategy, the full evidence for implementation is not yet available, partly due to the current low-levels of krill fishing in comparison to the precautionary trigger level. In turn, the strategy has not yet been tested for the impacts on the other retained species (see 2.2.2).

AKCP: while it is hard to understand what kind of evidence lead the assessment team to think that the *"measures comprising the partial strategy"* were being implemented successfully taking into account the information available at the time of the assessment, it is now unmistakable – with the recent risk assessment undertaken in the CCAMLR framework- that the current strategy is not likely to be successful.[27] Until CCAMLR introduces some kind of precautionary measures to prevent local concentration of catches in coastal areas, the ecosystem will be at risk from the effects of krill fishing. Therefore the fishery does not reach SG 60 with respect to this PI.

Audit Trace References *Watters et al. (2008a, 2008b); CCAMLR CMs 51-01, 91-01; Trathan and Hill (2008); CCAMLR (2008e); Trathan et al. (2008); Leape et al. (2009)*

AKCP: as it has been the case in numerous parts of this draft assessment report, references are provided very generally, not allowing the reader to verify what statements from the assessment report are supported by the references provided later in the text. In other cases, references are provided to support some statements/conclusions by the assessment team when in reality those references do not support those conclusions. This is the case of the paper by Leape et al. (2009) quoted above, which does not support any of the conclusions presented in this section. In fact, none of the concerns expressed in that paper were addressed nor taken into account by the assessment team.

Moody Marine answer to Steve Nicol's comments:

2.5.2 *The measures are considered likely to work based on prior experience, plausible argument or information directly from the fishery/ecosystems involved.* *The performance of the current plan, based upon the precautionary trigger level, is considered likely to work based upon prior experience, where historical catches were much greater but appeared to have minimal impacts on the ecosystem.*

Steve Nicol: As there was no systematic monitoring of the ecosystem in the early 1980s it is not possible to make this statement.
The discussion on SSMUs ignores the issue that there is no agreed plan to divide the catch and that there is still a considerable risk at a level of 620,000 tonnes. As the measures have not been adequately tested this criterion needs to be adjusted downwards.

[27] Watters et al. (2009).

Moody Marine Comment to Steve Nicol: the lack of a complete ecosystem strategy is noted within the text, and the score was reduced as a result. Simulation results suggest the strategy is likely to work based on current information.

AKCP: the AKCP agrees with the reviewer's comments with respect to this PI and thinks that just down-scoring from SG 100 to SG 80 does not adequately address the concerns raised. In addition, the last statement provided by the assessment team that *"simulation results suggest the strategy is likely to work based on current information"* is incorrect, and no information is provided to verify it. It is unfortunate to see that in answer to the very specific concerns expressed by Dr. Nicol, only a subjective, non verifiable and incorrect statement is provided. As Dr. Nicol has stated *"there is no agreed plan to divide the catch and there is still a considerable risk at a level of 620,000 tonnes"*. Thus, the answer provided by the assessment team is not appropriate.

Moody Marine Comment to Steve Nicol: However, if further information comes to light during the annual surveillance audits, the score could be re-evaluated on that basis (e.g. rapid increase in quota uptake, decision to sub-divide quota based upon approaches indicated to be non precautionary through simulation). In acceptance of some of the observations raised by the reviewer, however, the score has been reduced to 80.

AKCP: as indicated before, new results arising from the risk assessment undertaken by Watters et al. (2009) indicate that if catches increase up to the trigger level, ecosystem impacts are likely to occur. Therefore, it is not appropriate to wait for annual surveillance audits to re-score this PI, since current information already shows that as the trigger level remains in place without any spatial limitation, there is absolutely no guarantee that ecosystem impacts will not occur as a result of fishing. In consequence, the score for this PI should be reduced to reflect that SG 60 is not achieved.

Component: Ecosystem

PI Category: Information / Monitoring

2.5.3 There is adequate knowledge of the impacts of the fishery on the ecosystem

Moody Marine Score: 85

SG 80: Information is adequate to broadly understand the functions of the key elements of the ecosystem.

Main impacts of the fishery on these key ecosystem elements can be inferred from existing information, but may not have been investigated in detail. The main functions of the Components (i.e. target, Bycatch, Retained and ETP species and Habitats) in the ecosystem are known.

Sufficient information is available on the impacts of the fishery on these Components to allow some of the main consequences for the ecosystem to be inferred.

Sufficient data continue to be collected to detect any increase in risk level (e.g. due to changes in the outcome indicator scores or the operation of the fishery or the effectiveness of the measures).

Moody Marine comments

Information is adequate to broadly understand the key elements of the ecosystem

Information collected through the observer programme, CEMP studies, fisheries logbooks, and in particular ecosystem studies that feed into and support the activities of CCAMLR within the Ecosystem Monitoring and Management group provides sufficient information to broadly understand the elements of the ecosystem. Krill form the basis of the Antarctic food chain, as well as representing the equivalent of the 'small pelagic' fish species in the region. As such, maintaining the abundance of krill to underpin the food chain above it is seen as imperative to maintaining a healthy marine ecosystem. As a result, the main interactions between krill and the rest of the ecosystem elements (including fishing) have been investigated. The food web of the Southern Ocean is very well studied, while prey requirements of predators has been the subject of considerable research, along with behavioural and spatial considerations of predator/prey interactions. Krill are known to affect predators such as seabirds and fish when krill population levels are low (e.g. due to low krill recruitments).

CCAMLR monitors the effects of fishing and other ecosystem effects on the species in the Antarctic ecosystem that are either preyed upon by krill or prey on krill, the latter through the CCAMLR Ecosystem Monitoring Program (CEMP) and links with IWC. The Information collected through CEMP has two main functions in order to identify and understand the key elements of the Antarctic ecosystem:(1) Detect and record significant changes in critical components of the marine ecosystem within the Convention Area, to serve as a basis for the conservation of Antarctic marine living resources; and (2) Distinguish between changes due to harvesting of commercial species and changes due to environmental variability, both physical and biological.

CCAMLR states that CEMP's major function is to monitor the key life-history parameters of selected dependent species ('indicator species', which are likely to respond to changes in the availability of the harvested species i.e. krill). The following species have been set as the CEMP indicator species:

Harvested species: Euphausia superba

Dependent Species: Pygoscelis adeliae (Adélie penguin), Pygoscelis antarctica (Chinstrap penguin), Pygoscelis papua (Gentoo penguin), Eudyptes chrysolophus (Macaroni penguin), Diomedea melanophrys (Black-browed albatross), Thalassoica antarctica Antarctic petrel, Daption capense (Cape petrel), Arctocephalus gazella (Antarctic fur seal), Lobodon carcinophagus (Crabeater seal).

CCAMLR has developed CEMP standard methods and established sampling sites. The 'CEMP Standard Methods' include data collection methods and procedures for data analysis aimed at yielding standardised information for comparisons across species and sites. CEMP sites are located in three Integrated Study Regions (ISR) and in a network of additional sites. Sampling levels between CEMP sites vary widely, with data collection in some locations having stopped in the last 20 years. However, there are key sites in each of the CCAMLR sub-areas of 48, which have high and consistent time series, being Bird Island, Signy Island, and Admiralty Bay, which provides a basis to monitor the impact of fishing of all types on predators and their breeding success. However, some more localised impacts may not be identified due to the shortfalls in data collections from some sampling sites. In turn, while information on the relationships between predators and krill are expanding, they are reliant on available information, which can be limited spatially and temporally. However, available information has proved sufficiently robust for ecosystem modelling approaches.

AKCP: insists that the statement that information obtained from active CEMP sites in each Subarea "*provide a basis to monitor the impact of fishing on all types of predators and their breeding success"* is incorrect. As indicated earlier in this document, the current configuration of CEMP does not allow distinguishing the effects of fishing from those associated with environmental change. In addition, information arising from different CEMP sites with similar geographical and oceanographic features, indicate contradictory trends on predator parameters which are difficult to explain.

In regards to the statement: *"available information has proved sufficiently robust for ecosystem modeling approaches",* the statement is also incorrect and it ignores the fact that the usefulness of the models is seriously limited due to the lack of empirical data. It has been repeatedly noted by CCAMLR scientists that there is lack of data for the validation of models (see, i.e., Hill et al, 2006).

Main interactions between the fishery and these ecosystem elements can be inferred from existing information, and have been investigated.

CCAMLR regularly reviews the analyses of CEMP data, and conducts annual assessments that attempt to document ecosystem 'health'. Trends in CEMP parameters and the occurrence of anomalous years in the monitored parameters are identified by species and site. Changes which reflect natural environmental variation and those which may reflect the effects of harvesting are examined. Procedures are being developed to take account of both environmental variation and harvesting effects in the formulation of conservation measures governing commercial harvesting in the Convention Area.

AKCP: as it has been indicated before it is incorrect to say that *"procedures are being developed to take account of both environmental variation and harvesting effects in the formulation of conservation measures governing commercial harvesting in the Convention Area".* This has been the intention when CEMP was established, but to date no procedures have being developed as a result of the information provided by CEMP since the current configuration of CEMP does not allow to come up with any conclusion in regards to the fishing impact or environmental variations. Until CEMP is significantly reformed and expanded in its coverage, it will not be possible to incorporate monitoring data into the formulation of specific conservation measures. This was also acknowledged by CCAMLR's performance review panel when recommending CCAMLR to *"review, and as necessary revise, CEMP to ensure that it can support the application of these procedures and other management decision-making processes in order to achieve the objectives of Article II. Consider approaches to fishery development and monitoring that will allow separation of the effects of fishing and natural variability, or at least that have a demonstrably high probability of achieving the objectives of Article II in spite of not being able to separate these two effects".* [28]

Data are examined regularly, for example through specific workshops (E.g. WG-EMM Predator Survey Workshop) and through the annual CCAMLR-EMM process. *Independent review of the methods and statistical approaches noted that the quality of statistical methodology presented was 'impressive', and no substantive criticisms of the methods adopted were noted.*

[28] See CCAMLR-XXVII/8, Report of the CCAMLR Performance Review Panel.

AKCP: the statements above are not entirely correct. There are not specific workshops in CCAMLR that regularly examine CEMP data. For example, the Predator Survey Workshop was not aimed at looking into data resulting from CEMP, actually CEMP site data were considered, but not to any great extent. In addition, the main outcome of the workshop was a list of key species that participants felt were important to assess in terms of krill consumption, followed by an assessment of their current population status. As it was indicated, for some species data are simply not adequate to make any clear statements about their population status. Actually, one of the pending issues for CCAMLR is to undertake a major revision of the current CEMP so as to come up with a monitoring program that could provide the necessary information for the development of conservation measures. The current CEMP does not allow making any inference about the impact of krill fishing operation or as a result of environmental changes.

In relation to the independent review mentioned by the assessment team, it is not clear to what review they refer to. Secondly, while the statistical methodology may be appropriate, the lack of empirical data does not allow understanding the *"main interactions between the fishery and these ecosystem elements",* such as krill predators, as required by this PI. Therefore the standard above is not met.

However, information is currently limited on the interactions between the fishery and retained larval fish stages. While this is being investigated, the preliminary nature of the study means it has not – yet – been investigated in detail, although the observer plan means that it can be in future years.

AKCP: The statement is misleading, as it seems to suggest that the only problem in relation to this PI is the lack of information in relation to the interactions between the fishery and larval fish. It ignores the fact that understanding of the interactions between the fishery, predators and environmental forcing are still poorly understood. Having said this, although the assessment team recognizes the lack of data on the impact of krill fishing on fish larvae, they are wrong when they say that the observer plan will allow investigating this in detail in future years. The only plan proposed for observer coverage in krill fishing was the one recommended by WG-EMM in 2008, and it was blocked at the level of the Scientific Committee by Japan and Korea in the last CCAMLR meeting (see comments to PI 1.2.3 above).

As explained in several parts of this document, scientific observer data in the krill fishery are gathered voluntarily and are still extremely limited. As a consequence, the necessary information to come up with solid management strategy decisions (and adapt them as changes are occurring) does not exist. Based on the results of the last meeting of WG-EMM (July 2009), there are no expectations for any progress to be made at the next meeting of CCAMLR to take place at the end of October 2009 in regards to observers, since the issue has been deferred to WG-SAM (Working Group on Statistics, Assessments and Modeling) in 2010, which should come up with a recommendation for observer coverage for CCAMLR that hopefully will be take a decision in October/November 2010. Thus, the conclusions of the assessment team are incorrect and do not reflect the current situation regarding observers.

The impacts of the fishery on target, Bycatch, Retained and ETP species and Habitats are identified and the main functions of these Components in the ecosystem are understood.

Sources of fishery impact are identified and measured. There is evidence that the Saga Sea method of fishing results in no direct impacts on bycatch species, ETP species or habitats. As noted above, the impacts on retained larval fish are being investigated.

AKCP: it is totally unclear what is meant by *"sources of fishery impact are identified and measured"*. CCAMLR lacks any method to measure the impact of fishing on krill predators, other than direct interaction between fishing vessels and marine mammals or seabirds. Therefore, this standard is clearly not met. In relation to the impact of krill fishing operations conducted by the Saga Sea on larval fish, the expression that these impacts *"are being investigated"* does not fulfill the PI since this is a work that has been initiated recently and for which no conclusive results have been obtained yet. In any case, some authors are proposing that the impact on fish larvae could be large.[29] In addition, as explained in relation to PIs 2.1.1-2.1.3, the impact of fishing on larval fish by the fishery at large (by the other vessels) is not being investigated, which adds to the uncertainties in regards to understanding the impacts on the ecosystem.

The understanding of the functionality of components underpins a number of ecosystem models that have been developed for the Southern Ocean and areas within it. These have ranged from predator-prey models through to energy flow models and mass-balance models using ECOPATH. A mass-balance model has been developed for CCAMLR sub area 48.1, giving a description of the food web dominated by the phytoplankton–krill–top predators chain, and complemented with alternative food pathways (e.g. through Electrona antarctica), which together gives an enhanced complexity to the system. Model limitations exist, and data gaps include patterns during the winter season, grouping of functional groups, and steady state assumptions. An ECOPATH model for the Scotia Sea/South Georgia shelf has also been developed under the BAS Discovery 2010 programme. This research programme is also using fatty acid and stable isotope analysis to improve both food web structure and model performance. In turn, international cooperation through CCAMLR will improve the model further, with the joint IWC/CCAMLR workshop aiming to include whales within ecosystem models, including that for the Scotia Sea, by sharing consumption/provisioning rates. This workshop included the examination of methods that can incorporate the impacts of future climate change within ecosystem models.

AKCP: The information provided in the paragraph above is confusing and non relevant to the scoring of this PI as it presents details of specific projects that are uncoupled from the discussion of this PI.

In relation to the *"mass-balance model developed for Subarea 48.1"* that is mentioned by the assessment team, it is unclear to what model they refer to since it is not referenced in the report.

In relation to the cooperation between IWC and CCAMLR, while it is a positive initiative that may provide interesting insights into the role of cetaceans in the functioning of the Southern Ocean ecosystem in the near future, until now, no information has been obtained from this cooperation that may support the conclusions required by this PI.

Further models have been specifically developed within CCAMLR to aid ecosystem management decisions, the impact of future decisions on krill abundance and hence predator status, and the movement toward small-scale management units within the fishery. These include the models FOOSA, SMOM and EPOC.

AKCP: while it is true that these models are being developed, as mentioned above, the use of the models is limited by the lack of empirical data. In addition, in recent CCAMLR meetings, the use of these models to provide advice on SSMU allocations have been blocked for several reasons,

[29] See for example WG-EMM 2006 Report, para. 3.36.

lack of empirical data to validate the models being one of them. As a result, the next step in CCAMLR model development is uncertain.[30]

Sufficient information is available on the impacts of the fishery on the Components and elements to allow the main consequences for the ecosystem to be inferred.

The information collected through observers, ecosystem studies and the CEMP provides sufficient information to parameterise the ecosystem models described above. These have been used to examine the main consequences for the ecosystem as a result of fishing at different levels.

AKCP: the paragraph above is too general in focus and incorrect in its conclusion. As it has been shown throughout this document, neither the observer scheme nor CEMP are currently sufficient to identify effects from fishing on the ecosystem, due to their partial coverage. In addition, the ecosystem studies mentioned in this paragraph have not being referenced so that it is unclear about what studies the assessment team is referring to.

Information is sufficient to support the development of strategies to manage ecosystem impacts.

The information available from the different sources, which provide Area 48 scale and smaller-scale catch data, predator numbers and trends, ecosystem interactions, and the potential impact of fishing on krill on the ecosystem, is sufficient to support the development of the strategies detailed above, in order to manage ecosystem impacts and detect any increase in risk level.

AKCP: the paragraph above contains incorrect statements and an incorrect conclusion. First of all, as illustrated throughout this document, there is currently insufficient data on predator abundance in Area 48 both at the large and small scale. Therefore there is no information on "predator numbers" as indicated by the assessment team. There is no empirical information on the impact of fishing on the ecosystem either, only risk assessments using current models which due to the uncertainties involved, are indicators of minimum risks. As reiterated throughout these comments, the last risk assessment undertaken in this context (Watters et al., 2009) indicates that risks to the ecosystem are high if catches approach the current catch limit of 620,000 tonnes. Consequently, it is clear that the standards required for this PI are not met.

Audit Trace References
Agnew (1997); observer reports, Orr et al. (2007); CCAMLR (2008a, 2008b, 2008e); Cornejo-Donosoa and Antezana (2008); Constable (2008); Hill et al. (2007); Plagányi and Butterworth (2008), Watters et al. (2008a, 2008b); Everson (2000); interview with Greenpeace; interview with WWF; Leape et al. (2009)

AKCP: we are very concerned by the reference by the assessment team to interviews with NGO stakeholders to support their conclusions. We compel the authors to indicate what statements made by these stakeholders during the consultation phase have been used to support their conclusions. Similarly, we wonder (again) what statements found in Leape et al. (2009) were considered by the assessment team to support their findings.

[30] See, for example, WG-EMM 2008 Report, paragraph 2.100

Moody Marine answer to Steve Nicol's comments:

2.5.3 *Information / monitoring. There is adequate knowledge of the impacts of the fishery on the ecosystem.*

Steve Nicol: Because of the lack of a mandatory observer scheme, the shortfalls of the CEMP program and the uncertainties over bycatch it is difficult to see how information/monitoring can be considered adequate. WG-EMM has on numerous occasions pointed out the inadequacy of this sort of data collection. This criterion is scored far too highly.

> Moody Marine Comment to Steve Nicol: While the Saga Sea has 100% international observer coverage, other vessels fishing with alternative gears within the fishery may have local observer coverage. The discussion on observer coverage within CCAMLR is noted, as pointed out by the reviewer. In turn, the issue on the shortfalls in CEMP data coverage noted earlier are valid.
> The first SG text scores between 80 and 100, given that knowledge of the key elements of the system is good and key elements are broadly understood.
> The second SG text scores between 80 and 100, given that the main interactions have been investigated, although as noted there are gaps in the information.
> The third SG text scores between 80 and 100, as available information does allow the main functions of the ecosystem components to be known, and in some cases well understood.
> The fourth SG text scores 80, noting the issues with the CEMP data.
> The fifth SG text also scores 80, for the same reason.
> Therefore, the overall score for this PI has been reduced to 85.

AKCP: we agree with the comments made by Dr. Nicol in his review. Simply "noting" that there are issues in relation to the coverage of CEMP or CCAMLR's scientific observer scheme does not mean anything unless the scoring is performed in accordance with this acknowledgement. In addition, earlier in this section, the assessment team mentioned the following: "*The information collected through observers, ecosystem studies and the CEMP provides sufficient information to parameterize the ecosystem models described above*". It is unclear how come on one hand they recognize (note) the shortfall in CEMP data but on the other hand they are stating that the information collected through CEMP, among others, is sufficient to reach conclusions in relation to the ecosystem.

As it has been shown throughout the comments to this PI and in our previous submission, the standards are not met to achieve the minimum score of 60.

PRINCIPLE 3

Component: Fishery- specific management system

PI Category: Decision - making processes

3.2.2 The fishery-specific management system includes effective decision-making processes that result in measures and strategies

Moody Marine Score: 90

SG 80: There are established decision-making processes that result in measures and strategies to achieve the fishery-specific objectives.

Decision-making processes respond to serious and other important issues identified in relevant research, monitoring, evaluation and consultation, in a transparent, timely and adaptive manner and take account of the wider implications of decisions.

Decision-making processes use the precautionary approach and are based on best available information.

Explanations are provided for any actions or lack of action associated with findings and relevant recommendations emerging from research, monitoring, evaluation and review activity.

Moody Marine comments

There are established decision-making processes that result in measures and strategies to achieve the fishery-specific objectives. CCAMLR has well established, transparent and effective decision-making processes. They allow for stakeholder input and clear scientific analysis of the data available within the Working Groups and Scientific Committee, and they result in conservation measures and fisheries strategies designed to achieve their short- and long-term fishery-specific objectives.

Decision-making processes respond to serious and other important issues identified in relevant research, monitoring, evaluation and consultation, in a transparent, timely and adaptive manner and take account of the wider implications of decisions. Generally, fisheries-specific issues identified in relevant research are included in the decision-making processes within the Working Groups and Scientific Committee as appropriate. Where and when necessary, modifications are made to the monitoring and evaluation of the fisheries (through modifications to the complex data-recording systems and observer logbooks). However, we note that there has not yet been adherence to all relevant management issues, notably the need to employ independent international observers to monitor the fishery.

Decision-making processes use the precautionary approach and are based on best available information. The CCAMLR decision-making processes operate on a well publicized schedule and include stakeholder involvement, including observers from different NGOs and stakeholder and interested bodies. CCAMLR has shown, for example through the reduction of seabird mortality and measures to identify and protect VMEs that it is proactive in meeting newly identified management issues. All CCAMLR decision-making on catch limits is based on the precautionary approach (see documentation in section 6 above) and the best available information by national experts working closely together in Working Groups, the Scientific Committee and the Commission.

Formal reporting to all interested stakeholders describes how the management system responded to findings and relevant recommendations emerging from research, monitoring, *evaluation and review activity The whole CCAMLR process is based on dialogue and formal reporting,*

Audit Trace References
CCAMLR Commission Reports. www.ccamlr.org

Moody Marine answer to Steve Nicol's comments:

3.2.2 *Decision-making processes The fishery-specific management system includes effective decision-making processes that result in measures and strategies to achieve the objective.*

Steve Nicol: Although CCAMLR does have a formalised procedure for making decisions, there have been notable problems with reaching consensus on key issues such as the mandatory carriage of scientific observers in the krill fishery. Consequently, this criterion is probably scored too highly.

Moody Marine Comment to Steve Nicol: From an international performance perspective, we do not agree with the reviewer. The CCAMLR procedure is not perfect by any means, but it is far better than in many other areas or commissions, so from a purely comparative position, the score is probably correct at 90. Decision-making is responsive on many important issues; of course, not everyone will be happy with the direction that response takes!

AKCP: we agree with the reviewer's comments and disagree with the assessment team's response to those comments. Dr. Nicol is pointing at very specific problems related to the decision-making process in CCAMLR that affect the capacity of the Commission to take important decisions for the management strategy on krill fisheries. Like Dr. Nicol, the AKCP raised these very specific concerns in our initial submission. The most notable example is the requirement for scientific observers on board krill vessels, which continues to be blocked by a small minority of fishing nations, in spite of the repeated calls by the Scientific Committee and its working groups that systematic observer coverage is urgently needed. To this issue we can now add the lack of consensus on a clear plan to establish quotas at the SSMU level in Area 48, another core issue for managing impacts of krill fishing on the ecosystem.

The assessment team's response to Dr. Nicol that in comparative terms, CCAMLR is performing *"far better than other areas or commissions"* is largely unsatisfactory. This PI is supposed to evaluate the appropriateness of the management system in the context of this fishery.

It is worth quoting here a fragment of CCAMLR's performance review report, which identifies examples of slow response, or inability to respond to scientific advice by the Commission. The case of krill is identified as the most notable example:

"Recommendations for improved biological research and fishery operations in the krill fisheries have been made for many years without adoption and implementation, or with very limited adoption and implementation. This is despite the operation and development of the krill fishery, and its potential effects on dependent species, being one of the main motivations for the establishment of CCAMLR, and that the krill fishery is in most respects a new or exploratory fishery. Specific improvements that are implemented for other CCAMLR fisheries, that have been

formally recommended for the krill fishery, but that have not been adopted and implemented in the krill fishery include: mandatory sampling, reporting and verification by CCAMLR scientific observers; VMS reporting, access and use; 5-day catch and effort reporting, and monthly fine-scale catch and effort reporting'; spatial restrictions, including SSMUs for catch limits; target species move-on rules; by-catch limits and move-on rules; gear and mesh size restrictions; fishery-based research program. Formal recommendations on some of these issues (e.g. scientific observers) go back to at least the year 2000 but without adoption".

Most of the issues highlighted by the performance review panel in relation to krill fisheries management continue unaddressed, including key issues such as scientific observers, spatial restrictions, and a research plan, which have been signaled throughout this document. Clearly, although CCAMLR has established formal decision-making processes to deal with relevant issues, in reality, these processes are not resulting in measures and strategies that achieve fishery-specific objectives, as required by this PI. CCAMLR decision-making processes may be deemed to be effective in general, but certainly not for krill, as highlighted by CCAMLR's performance review.

Taking into account these problems, it is hard to understand how the assessment team led to the conclusion that a SG 80, or even a SG 60, is achieved.

In addition, the response of the assessment team to Dr. Nicol that *"not everyone will be happy with the direction that response takes"* trivializes the seriousness of the issues under discussion. The issue of systematic observer coverage on board krill vessels is not a question of preference, it is a minimum scientific requirement to gather the necessary information to establish an adequate management regime, and as such it has been repeatedly called for by CCAMLR's Scientific Committee. CCAMLR's inability to adopt this recommendation means that the minimum score for SG 60 is not achieved for this PI.

Component: Fishery- specific management system

PI Category: Research Plan

3.2.4 The fishery has a research plan that addresses the information needs of management

Moody Marine Score: 100

SG 100: A comprehensive research plan provides the management system with a coherent and strategic approach to research across P1, P2 and P3, and reliable and timely information sufficient to achieve the objectives consistent with MSC's Principles 1 and 2.

Research plan and results are disseminated to all interested parties in a timely fashion and are widely and publicly available.

Moody Marine comments

A comprehensive research plan provides the management system with a coherent and strategic approach to research across P1, P2 and P3, and reliable and timely information sufficient to achieve the objectives consistent with MSC's Principles 1 and 2. *A comprehensive research plan by CCAMLR exists for krill fisheries, focusing on the monitoring of krill catches, scientific observation and environment monitoring.* *The research plan and its results are disseminated to all interested parties in a timely fashion and are widely and publicly available.*

AKCP: the paragraph above is incorrect since a comprehensive research plan for the Antarctic krill fishery does not exist. As explained below, CCAMLR has not agreed on a plan to tackle the lack of empirical data on key issues for the management of krill fishing in Area 48. In fact, NGOs and CCAMLR Members have recently highlighted this problem and have made specific proposals for a CCAMLR research plan on krill.[31] In fact, as mentioned above, the inexistence of a "*fishery-based research program"* is one of the pending issues in relation to CCAMLR's management of the krill fishery in view of CCAMLR's performance review panel (see comments to PI 3.2.2)

In spite of these calls, CCAMLR has not yet made any progress on this respect, and no concrete plans have been agreed on this respect for the foreseen future. The data gathered through the observer program, CEMP and monitoring of catches does not replace the need for focused research and are not part of a comprehensive plan. In addition, as it has been reiterated throughout this document, data gathered through these channels are patchy and insufficient to achieve the management objectives consistent with MSC principles and indicators. Therefore it is not possible to say that *"a comprehensive research plan by CCAMLR exists for krill fisheries, focusing on the monitoring of krill catches, scientific observation and environment monitoring".* This statement is incorrect and cannot be the basis of the scoring for this PI.

The AKCP is very concerned that the assessment team did not comment on the very specific concerns expressed in our first submission in relation to this PI, and that the only response given is that there is a comprehensive research plan which is not referenced at all. We therefore are obliged to reiterate here our initial comment, with the expectation that a specific response will be provided by the assessment team.

There is still a considerable degree of scientific uncertainty in relation to krill fisheries management. CCAMLR needs to address these uncertainties as a matter of priority in order to make allocation of catch limits amongst SSMUs, a key component to prevent irreversible harm to the ecosystem. For example, we are still a long way from understanding the biology of krill to the point that would enable us to predict how krill populations react to environmental changes (Kawaguchi & Nicol, 2007). 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. Even at a large scale, there are important uncertainties in relation to krill biomass, the last survey being almost 10 years old and no plans to undertake a new survey. As noted above, some attempts have been made to model complex food webs in the Southern Ocean, but there is a shortage of data on substantial parts of these food webs (Hill et al, 2006). In relation to krill predators, most research has been conducted on land-based predators. In spite of these efforts, better understanding of population sizes, diet

[31] See CCAMLR XXVI/BG 25, "The need for a strategic plan for the management of the Antarctic krill fishery", by the Antarctic and Southern Ocean Coalition; CCAMLR-XXVII/43, "Current uncertainties in scientific data for risk assessments in the allocation of krill catch limits among SSMUs in Area 48", by the Delegation of the Ukraine.

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. This includes whales and mesopelagic fish, the latter having been recently identified as a major source of uncertainty in relation to which very little information is available.

In May 2007, an international workshop was convened by the Lenfest Ocean Program 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). As acknowledged by a CCAMLR workshop in 2008, there is still some way to go before dependent species requirements for krill could be established. For some species that have been identified as key species in terms of krill consumption, available data have found to be simply inadequate.

CCAMLR contemplates the development of a research plan for new and exploratory fisheries, a requirement that applies to fishing in new areas where no catch limits are in place. However, this requirement does not apply to the krill fishery operating in the current fishing grounds (Subareas 48.1-48.4), even though the research needs for the development of a management system at the SSMU level are imperative. It has been noted that krill fishing vessels can gather and provide invaluable information for management in complementary ways to research vessels (Kawaguchi & Nicol, 2007). However, krill vessels fishing in Subareas 48.1-48.4, where Aker Biomarine is currently operating, are not required to provide this information nor there is a plan in this regard.

The CCAMLR Ecosystem Monitoring Programme (CEMP; Agnew 1997) provides cross-cutting data on environment and predator abundance to link into fisheries data and targets research at an ecosystem approach to management of the krill fishery.

AKCP: the shortfall on CEMP data has been repeatedly highlighted in this document, and even the assessment team has acknowledged it, so it is difficult to understand how this general statement about CEMP could support the score of this PI. It only provides a general statement on the nature of CEMP, not on the effectiveness of the program and the data that are being generated by the program. In addition, as it has been already clarified in this document, CEMP does not provide information on predator abundance; neither can currently show any light on the effects of fishing on the ecosystem. Therefore the paragraph above is basically incorrect.

An additional research programme for the client group vessels has been developed between Aker BioMarine and British Antarctic Survey and utilising CCAMLR Scientific Observers supplied by MRAG Ltd for 2009. Data requirements above and beyond the standard set of CCAMLR observer data have been defined and will be implemented.

AKCP: It is unfortunate that a research program is generally referred to without providing any detail on what issues this research program is looking at, duration, spatial and seasonal coverage, etc. In any case, it is clear that, since the program only provides information associated to the operations of the Saga Sea, it cannot offer data that is of use for the management of the that could not be extrapolated to the overall fishery. Thus, this individual research program will not be sufficient/appropriate to address the information needs for the management of the krill fishery.

As it has been shown throughout the comments to this PI, the standards are not met to achieve the minimum score of 60.

Audit Trace References *Agnew, D. J. 1997. The CCAMLR Ecosystem Monitoring Programme. Antarctic Science, 9: 235-242.* *CCAMLR website – CCAMLR Ecosystem Monitoring Programme* *http://www.ccamlr.org/pu/e/sc/cemp/intro.htm.* *CEMP Standard Methods http://www.ccamlr.org/pu/e/e_pubs/std-meth04.pdf*

Moody Marine answer to Steve Nicol's comments:

3.2.4 *Research plan. The fishery has a research plan that addresses the information needs of management*.

Steve Nicol: This may be true but it has proved extremely difficult to ensure that the work deemed important by WG-EMM is actually carried out. Because of the difficulty of actioning the plan this criterion ought to be scored lower.

Moody Marine Comment to Steve Nicol: The score is based on the existence of a comprehensive research plan, so the score is in our opinion correct. The effectiveness of that research plan are not addressed in this sub principal, only its existence and communicability.

AKCP: we agree with Dr. Nicol's concerns and his view that this PI was scored too highly. In addition, we would like to note that this PI is directed to a research plan that addresses the information needs of management, as indicated by the formulation of SG 100: *"a comprehensive research plan provides the management system with a coherent and strategic approach to research across P1, P2 and P3, and reliable and timely information sufficient to achieve the objectives consistent with MSC's Principles 1 and 2*". Therefore it is inappropriate to say, in response to the reviewer's concerns, that the effectiveness of the research plan is not addressed in this sub principal, because the effectiveness of the plan is an integral part of the same standard. In addition, earlier in this PI the assessment team stated that "*the research plan and its results are disseminated to all interested parties in a timely fashion and are widely and publicly available".* When reading this statement one wonders if the effectiveness of the supposed research plan is not addressed here what is the point of stating that the results are being disseminated. In any case, as stated before there is no comprehensive research plan and therefore, the standards are not met to achieve the minimum score of 60, let alone a score of SG 100.

Thank you for the opportunity to comment and we would be happy to answer any further questions.

Moody Marine Response to AKCP comments

Misapplication of MSC guidelines in relation to the "unit of certification"
The Aker BioMarine Krill Fishery was assessed for certification using the MSC Fishery Assessment Methodology (FAMv1). This methodology assesses the whole stock under Principle 1 and then focuses on the unit of certification for Principles 2 and 3. This assessment has therefore considered the other operators and their removals of krill from the fishery. When considering retained, bycatch, ETP and habitats, the 'Unit of Certification' (i.e. the continuous trawl method in Area 48) is examined specifically as its impacts will be unique. At the ecosystem level, however, we examined the potential impact of all removal up to the trigger level, which was identified as the 'limit' of catch within the current certification assessment. This approach was considered essential in this fishery.

Lack of appropriate referencing throughout report, incorrect conclusions and incorrect use of the information
The text used within the scoring comments tables is presented (with citations) within the main body of the report. The text within the scoring tables is a specific comment, apart from the general introduction in the main report text which provides the rationale for the score for each PI. A reading of the scoring comments is considered as being necessary to provide an understanding of the rationale behind the scores.

The information used for the assessment was gathered from the stakeholders' consultations and site visit and the MSC Principles and Guidelines were adhered to throughout the assessment.

An example of a contradictory statement identified by AKCP: "The harvest strategy remains untested " versus "the harvest strategy has not been fully tested" needs to be read within the full context of the text (Scoring table P1.2.1).
"The stock is currently only lightly exploited, so the harvest strategy remains untested" is the findings of the assessment team. The further response from the assessment team that "the harvest strategy has not been fully tested, but monitoring is in place and evidence exists that it is achieving its objectives" is in response to the MSC PI text within the SG80 guidelines (see the heading for the paragraph within the scoring comments for this table). This allows clarity for the reader to see how the score is derived.

The condition was prescribed because the assessment team judged the minimum SG60 to have been attained but that the SG80 had not been.

4. Comments on specific selected Performance Indicators (PIs)

<u>Principle 1</u>

PI 1.2.1 Harvest Strategy (AKCP, ASOC, PEW)
Summary of comments: Significant time period since last biomass survey (2000) level of monitoring is inadequate. Concentration of catch in one area. No full observer coverage of the fishery.

The biomass survey and subsequent stock calculations were examined and considered within the report (section 4) and the subsequent scoring of the fishery. The level of monitoring was assessed in the context of the decision rule (i.e. limit the catch at or below the trigger level). Catches are monitored and there have been many biomass surveys since the synoptic survey which would reasonably be expected to have reported a decline in biomass had there been one. For the level of catch compared to any estimate of the total biomass, this appears sufficient.

As stated in response to the peer review comments; it is the judgement of the assessment team that, given the relatively low level of catch, the level of monitoring was adequate. This is consistent with the application of the MSC standard across all fisheries. Krill, with its important trophic role in the Southern Ocean ecosystem, clearly requires greater risk aversion, which is taken into account. The basis for risk management is either to gather more and better information to verify a low negative impact, or reduce risk by management action, usually reduced harvesting. In this case, risk is reduced by keeping catches to a low level. Catches at or below the current trigger level compared to estimates of the total biomass are considered by the assessment team to be low enough to represent an acceptable risk. Should the harvest rate increase, the level of monitoring may well need to be increased. Many of the monitoring systems being developed and discussed are preparing for the expansion in the fishery. While we support the development of the improved monitoring system, the certification assessment must apply to the fishery as it is now.

Information from the fishery is not collected solely through observer coverage of the vessels (e.g. catch reporting). In addition, there is currently no incentive for IUU fishing or to misreport catches.

PI1.2.2 Harvest Control Rules and Tools (AKCP, ASOC)
Summary of comments: Inconsistency of conversion factors which may result in the current catch already exceeding the trigger limit. Uncertainty as to the amount of krill removal. Fishing mortality.

The conversion factors being applied, and concern over the inconsistency in recording the amount of krill removed from the ecosystem (which increases uncertainties in the catch estimates) were specifically considered by the team and were considered for this assessment (see section 4.2). In addition, the absence of information on fishing mortality was also stated.

One of the peer reviewers also noted that "whilst the arithmetic indicates that *in extremis* the actual removals may vastly exceed the recorded amounts, in reality this is an unlikely scenario. The key topic for action is the standardisation of reporting such that reliable estimates of total removals can be made is important. The management regime is aware of this and action is in progress".

PI1.2.3 Information/Monitoring (AKCP, ASOC, PEW)
Summary of comments: Uncertainty regarding krill populations, recruitment and removal from the fishery. Difficulty in obtaining adequate information of krill biology and from operators (problematic for the fishery). Insufficient monitoring to support harvest control rule.

The issues raised by the stakeholders regarding the information available to support the HCR were considered by the team (see section 4). The limitations of this information were also noted and considered.

The HCR is based upon catch reporting with reports being obtained from all vessels involved in the fishery. Issues with underreporting, conversion factors and discarding were addressed within this report. The lack of total international observer coverage amongst the fleet was also considered. SC-CAMLR has also progressed with its review and progress regarding consistent Observer coverage on all krill fishing vessels over the past year. Information on life-history parameters was considered as being satisfactory to support the current harvest control rule.

Japanese delegation reference refers to "Japanese Delegation (2008) Systematic Coverage' by scientific observers on Krill Fishing Vessels. WG-EMM-08/34" (see reference list page 6).

<u>Principle 2</u>
PI2.1.1 Retained non-target species (AKCP, ASOC, PEW)
Summary of comments: Impact of fish bycatch e.g. mackerel icefish is unknown. Improved krill fishing technology (e.g. Aker's continous pumping methodology) increases the potential for fish larval bycatch (which will affect recruitment). New technology has not been subject to EIA. Known species taken as bycatch are considered as depleted e.g. *C.gunnari*, *N.rossii* and lanternfish. Impossible to determine the impact to these non-target species due to lack of monitoring and CCAMLR standards on this.

As stated within the report and scoring tables the gear type and the methods employed by Aker means that adult fish are not captured at all during krill fishing. Bycatch is limited to fish larvae.

Observer analysis reports showing larvae catches to be lower in southerly areas 48.1 and 48.2 were provided by MRAG (2009) (as referenced within the scoring comments table) who provide 100% observer coverage onboard the Saga Sea and analyse the fish larvae bycatch.

The management measure in reference to Lanternfish refers to the withdrawal of the directed fishery for this species. Prohibitions are also in place to protect other rockcod and icefish species.

The uncertainty over larval fish bycatch is noted within the scoring comment report text (section 6) and the scoring table comment text. The majority of larvae taken are from *C. gunnari*, which is considered sustainably exploited around South Georgia. For potentially over-exploited species, even when the 'worst case' scenario was taken within a rough calculation of the maximal larval mortality at trigger level catches, given the biology of the species the impact was considered to be negligible.

Aker BioMarine maintains a 100% observer coverage programme which includes investigations into the species and quantities of fish larvae bycatch (which is reported to CCAMLR). In addition, Condition 2 has been generated for this Performance indicator to address this more fully.

PI2.1.2- Management strategy for retained species (AKCP, ASOC, PEW)
Summary of comments: SG60 (pass) should not be achieved due to lack of formal, evidence-based larval bycatch management strategy in place.

A formal management strategy with evidence that the strategy is implemented and is achieving its overall objective is a requirement of the SG100 scoring level for this P.I. A partial strategy expected to maintain the main retained species at levels which are highly likely to be within biologically based limits with an objective basis for confidence that this strategy will work based upon some information directly about the fishery and/or species involved with evidence that this partial strategy is being implemented successfully are requirements of the SG80 scoring level.

The assessment team judged that none of the above was attained and therefore these scores were not met. The award of 60 was given for this P.I which states that measures are in place, which are expected to maintain the main retained species at levels highly likely to be within biologically based limits and that these measures are likely to work based upon plausible argument e.g. general experience, theory or comparison with similar fisheries/species.

Plausible argument based upon the calculations made by the assessment team using information from the Aker BioMarine investigations into the species and quantities of fish larvae bycatch (MRAG, 2009) is that in the worst case scenario, the impact would be lost within background variability (see scoring text for P.I 2.1.1).

PI2.1.3 Information/Monitoring (AKCP)
Summary of comments: Information currently available to CCAMLR cannot support the development of measures to determine risk posed by this fishery and the effectiveness of this strategy to maintain retained species. Bycatch monitoring activities onboard Saga Sea are not useful to obtain quantitative information on the amount of retained species taken by the fishery i.e. all vessels.

We refer back to our original comments to the peer reviewer response to this P.I:
P.I 2.1.3 scores against the information available and monitoring in position, for the unit of certification (Aker BioMarine vessel- The Saga Sea and not all vessels (in keeping with the MSC requirements for scoring Principle 2)). The Saga Sea has an observer present during 100% of its time at sea. The observer provides quantitative information that has been examined scientifically. This is reflected in the SG80 score of the first section ('qualitative and some quantitative information'). This provides sufficient information, combined with known biological parameters for the species, to develop outcome status with regard to biologically based limits for the species (as was rapidly performed to answer 2.1.1 and 2.1.2, but as noted has not been 'officially' performed, and is the subject of the condition arising from 2.1.1. and 2.1.2) and therefore again

meets SG80 text. Information is sufficient to support a partial strategy as noted, again meeting the SG80 text. Given the continued 100% observer coverage on the unit of certification, data are collected in sufficient detail to assess ongoing mortalities of retained species, which would score at the SG100 level, but as noted not all have been identified to this level. A score of 95 was therefore given for this paragraph, which under MSC guidelines provides an overall score of 90. Additional text has been added to clarify this scoring (scores have been added to the text to show how the overall score of 90 was obtained).

PI 2.3.3 ETP Information/Monitoring (AKCP, PEW)

Summary of comments: Information should be available to understand impact of the fishery on ETP to achieve a passing score. CEMP is inadequate due to its spatial scale of monitoring. Current monitoring does not consider baleen whales (which are increasing in abundance). No spatially explicit information at the scale of Aker's operation which shows the fishery will not adversely affect ETP species. Impossible to differentiate indirect impacts on ETP predator species by a single vessel and therefore the P.I needs to be referred to the whole fishery.

P.I 2.3 scores the direct impact *of the unit of certification* on ETP species, rather than ecosystem impacts *of the krill fishery as a whole*, which are considered within P.I 2.5. As noted in 2.3.1, direct observation through observers and underwater camera studies has shown no fatal interactions with ETP species. In light of this, there is sufficient information to quantitatively estimate outcome status with a high degree of certainty *for the unit of certification*, through the mechanisms noted. Information from the *Saga Sea* is adequate to support a comprehensive strategy to manage impacts, minimize mortality and injury of ETP species, and evaluate with a high degree of certainty whether a strategy is achieving its objectives.

Whales are not considered explicitly within CCAMLR as they remain the prerogative of the IWC and this limitation was raised within the scoring comments table. Indirect effects have been modelled (see scoring text) and the outcome of this was applied to ETP species for this performance indicator. Accurate and verifiable information is therefore available on the magnitude of all impacts, mortalities and injuries and the consequences for the status of ETP species.

PI 2.5.1Ecosystem status (AKCP, ASOC, PEW)

Summary of comments: Lack of information on the localised effects of the krill fishery. Lack of information to support statement that fishery is "highly unlikely to disrupt key elements underlying ecosystem structure and function to a point where there would be serious or irreversible harm". New evidence is available (Watters, 2009) which shows the catch trigger level is not sufficiently precautionary to prevent irreversible ecosystem impacts from the fishery. The 2008 risk assessment did not include analysis of historical distribution of catches because it was considered to pose higher risk to predators. CCAMLR has acknowledged that CEMP may never allow the impacts from fishing and those caused by environmental factors to be distinguished.

The intended probability interpretation supplied by the MSC for scoring SG80 for this P.I is the "there should be no more than a 30% probability that the true status of the Component is within the range where there is risk of serious or irreversible harm". Kinds of evidence required by the MSC are: *Plausible argument and interpretation of direct observations across a range of viewpoints and hypotheses. Based on analogy from similar situations that is supported by significant direct observations from the fishery. Relies on an about even balance of qualitative assessment/judgement and quantitative assessment. Serious or irreversible harm should be interpreted in relation to the capacity of the ecosystem to deliver ecosystem services*.

It is recognised that simulation results are predicated upon the assumptions made during their development. However, a range of assumptions appear to have been used and results at the trigger point were (generally) robust to those assumptions. Calculations made by the assessment team for this P.I were done using the current catch level within the fishery of 113 000t (low levels compared to the precautionary biomass trigger level). The expert judgement of the assessment team was that at the macro-geographic scale these levels of extraction will not result in disruption to the key elements of the ecosystem. The recognition that the localised effects of krill depletion may occur and that further study is required to appropriately define localised TACs as well as the lack of all uncertainties being taken into account by the simulations were all identified by the team within the report and scoring table text. The information was judged as being suitable to meet the MSC requirements for scoring SG80 (see above) but no higher. Changes in the pattern and level of the fishery, and new evidence arising, would be identified during the annual surveillance audits.

PI 2.5.2 Management Strategy (AKCP, ASOC, PEW)
Summary of comments: SG60 requires that measures are in place that account for the potential impacts of the fishery on key elements of the ecosystem. Without spatially explicit knowledge the P.I cannot be scored so highly. Comments ignore the status of key issues in CCAMLR discussions. No monitoring to support the statement that the ecosystem was not affected by earlier higher krill catches. Need to ensure that depleted populations of baleen whales and fish can continue to recover or begin recovering is not addressed. Moody Marine is only evaluating the effectiveness of the plan….for maintaining ecosystem elements". For the management strategy to be effective and safeguard the ecosystem, it must ensure that fishing operations will not slow or halt recovery of depleted species.

The lack of a complete ecosystem strategy is noted within the text as is the lack of full evidence for its implementation, partly due to the low levels of krill fishing. The testing of the strategy for the impacts on elements such as retained species has also not been tested. This was discussed by the assessment team within the main report text and the scoring tables. Simulation results suggest the strategy is likely to work based on current information and this was considered sufficient to evaluate that the strategy is considered likely to work based upon plausible argument (e.g. general experience, theory or comparison with similar fisheries/ecosystems- see SG80 scoring guidelines within table 2.5.2). However, if further information comes to light during the annual surveillance audits, the score could be re-evaluated on that basis (e.g. rapid increase in quota uptake, decision to sub-divide quota based upon approaches indicated to be non-precautionary through simulation).

PI 2.5.3 Information/Monitoring (AKCP, ASOC, PEW)
Summary of comments: Neither the CEMP nor the modelling exercises, nor the information derived from a very poor scientific observer scheme has sufficiently addressed this P.I on the spatial scale at which Aker operates. There is lack of information available about either krill or krill predators. Recognised within WG-EMM of CCAMLR that sufficient information is not available. CEMP does not allow distinguishing the effects from fishing from those associated with environmental change. Information on further models and monitoring programmes is considered non relevant to the scoring of this P.I.

Overall, the assessment considered that with all of the information available the knowledge of the functions of the key elements of the ecosystem is broadly understood. Main impacts of the fishery can be inferred but may not have been investigated in detail and that the main functions of the components of the ecosystem are known. Sufficient information is available to allow some of the main consequences to be inferred and that data continue to be collected. These elements are the requirements of the SG80 guidelines. Limitations of the information e.g. CEMP, discussions on observer programmes within CCAMLR and spatial scales were all recognised as part of the assessment.

Investigations into main interactions between the fishery and ecosystem elements and an understanding of the impacts of the fishery on target, bycatch, retained species, ETP species and habitats are requirements of SG100 which this fishery did not achieve.

Issue with the CEMP data have been recognised by the team (this led to a reduction in scoring of this P.I). In addition, the information on ecosystem models developed for the Southern Ocean are considered as being relevant to this P.I as it provides evidence regarding the understanding of the functionality of the components within the ecosystem.

<u>Principle 3</u>
PI 3.2.2 Decision making processes (AKCP, ASOC)
Summary of comments: Decisions necessary to fulfil CCAMLR's requirements often do not get made because of political disagreements (CCAMLR is a political organisation which operates by consensus).

Evidence of effective management cannot be considered if steps have not been taken to implement them. Although CCAMLR has formalised procedure of making decisions, there have been notable problems with reaching consensus on key issues such as the mandatory carriage of scientific observers and that there is little doubt that the data being collected are insufficient to deter impacts of fishing- and there is no mechanism to alter the krill management approach even if impacts were detected. CCAMLRS decision-making processes may be deemed to be effective in general, but certainly not for krill, as highlighted by CCAMLR's performance review.

CCAMLR decision-making is considered to be appropriately responsive; however, as stated within the scoring table text for this P.I "we note that there has not yet been adherence to all relevant management issues, notably the need to employ independent international observers to monitor the fishery". Despite this the assessment team maintain that the CCAMLR decision-making is responsive on many important issues. Response to findings and relevant recommendations emerging from research, monitoring, evaluation and review activity are reported to all interested stakeholders and the whole CCAMLR process is based upon dialogue and transparency.

PI 3.2.4 Research Plan (AKCP)
Summary of comments: CCAMLR has not agreed on a plan to tackle the lack of empirical data on key issues for the management of krill fishing in Area 48. It is therefore incorrect to state that a comprehensive research plan exists. CCAMLR needs to address scientific uncertainties in relation to krill fisheries management e.g. krill distribution and abundance between and within areas and krill biology.

This performance indicator states that the management system shall incorporate a research plan, appropriate to the scale and intensity of the fishery, which addresses the information needs of management and provides for dissemination of research results to all interested parties in a timely fashion. A comprehensive plan refers to research that goes beyond the immediate short term needs of management to provide research relevant to the long term management needs of the fishery (MSC FAMv1). The research evaluated within this assessment to provide appropriate research on Principle 1 and Principle 2 for this fishery is considered as being appropriate for the scale and intensity of the current fishery (circa 112 000t per annum) with a long term commitment to ensure a sustainable long-term krill fishery. Additional research programmes such as those being developed between Aker and the British Antarctic Survey to supply data above and beyond the standard set of CCAMLR observer requirements will also be provided to CCAMLR.

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Appendix F: Registered companies / vessels within Unit of Certification: eligible to sell MSC certified product

Saga Sea ***Aler BioMarine, Norway***

APPENDIX G: Conservation Measures in Force in 2008 of relevance to the krill Fishery in Area 48.

SUMMARY OF CONSERVATION MEASURES IN FORCE IN 2008 OF RELEVANCE TO THE KRILL FISHERY IN AREA 48

Conservation measure		**Region**
Number	Title	
10-01 (1998)	Marking of fishing vessels and fishing gear	All areas
10-02 (2008)	Licensing and inspection obligations of Contracting Parties with regard to their flag vessels operating in the Convention Area	All areas
10-04 (2007)	Automated satellite-linked Vessel Monitoring Systems (VMS)	All areas
10-06 (2008)	Scheme to promote compliance by Contracting Party vessels with CCAMLR conservation measures	All areas
10-08 (2006)	Scheme to promote compliance by Contracting Party nationals with CCAMLR conservation measures	All areas
10-09 (2008)	Notification system for transhipments within the Convention Area	Various
21-03 (2008)	Notifications of intent to participate in a fishery for *Euphausia superba*	All areas
23-01 (2005)	Five-day catch and effort reporting system	Various
23-02 (1993)	Ten-day catch and effort reporting system	Various
23-03 (1991)	Monthly catch and effort reporting system	Various
23-06 (2007)	Data reporting system for *Euphausia superba* fisheries	All areas
25-03 (2003)	Minimisation of the incidental mortality of seabirds and marine mammals in the course of trawl fishing in the Convention Area	All areas
26-01 (2008)	General environmental protection during fishing	All areas
31-01 (1986)	Regulation of fishing around South Georgia (Statistical Subarea 48.3)	48.3
31-02 (2007)	General measure for the closure of all fisheries	All areas
32-01 (2001)	Fishing seasons	All areas
32-04 (1986)	Prohibition of directed fishery on *Notothenia rossii* in the Peninsula Area (Statistical Subarea 48.1)	48.1
32-05 (1986)	Prohibition of directed fishery on *Notothenia rossii* in the Peninsula Area (Statistical Subarea 48.2)	48.2
32-06 (1985)	Prohibition of directed fishery on *Notothenia rossii* in the Peninsula Area (Statistical Subarea 48.3)	48.3
32-07 (1999)	Prohibition of directed fishery on *Gobionotothen gibberifrons*, *Chaenocephalus aceratus*, *Pseudochaenichthys georgianus*, *Lepidonotothen squamifrons* and *Patagonotothen guntheri* in Statistical Subarea 48.3	48.3
32-17 (2003)	Prohibition of directed fishing for *Electrona carlsbergi* in Statistical Subarea 48.3	48.3
51-01 (2008)	Precautionary catch limitations on *Euphausia superba* in Statistical Subareas 48.1, 48.2, 48.3 and 48.4	48.1, 48.2, 48.3 and 48.4
91-01 (2004)	Procedure for according protection to CEMP sites	
91-02 (2004)	Protection of the Cape Shirreff CEMP site	

SUMMARY OF RESOLUTIONS IN FORCE IN 2008 OF RELEVANCE TO THE KRILL FISHERY IN AREA 48

Resolutions		**Region**
Number	Title	
10/XII	Resolution on harvesting of stocks occurring both within and outside the Convention Area	All areas
19/XXI	Flags of non-compliance	All areas
22/XXV	International actions to reduce the incidental mortality of seabirds arising from fishing	All areas
23/XXIII	Safety on board vessels fishing in the Convention Area	All areas
25/XXV	Combating illegal, unreported and unregulated fishing in the Convention Area by the flag vessels of non-Contracting Parties	All areas
27/XXVII	Use of a specific tariff classification for Antarctic krill	All areas
28/XXVII	Ballast water exchange in the Convention Area	All areas