THE ECOSYSTEM APPROACH
USED BY CCAMLR
TO SUSTAINABLY MANAGE
THE ANTARCTIC AND
SOUTHERN OCEAN
ECOSYSTEM

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EVOLUTION OF CCAMLR:

During the 1970s, there was a growing concern among Antarctic Treaty Consultative Parties (ATCPs) that living marine resources of the Antarctic and Southern Ocean were being exploited by commercial fisheries (Joyner, 1998). This concern was due to a lack of legislation that existed at the time to implement such concepts that today we are familiar with: maximum sustainable yield; ecosystem management and environmental monitoring, to name a few.

Out of this concern the Agreed Measures for the Conservation of Antarctic Fauna and Flora were signed in 1964, but did not enter into force until 1982. The Convention on the Conservation of Antarctic Seals (CCAS) was ratified in 1972, and entered into force in 1978. The main concern behind the implementation of CCAS was the possible resumption of commercial sealing in Antarctic waters, and the lack of an adequate legal regime to regulate this activity (Rothwell and Davis, 1997). Because CCAS was designed to complement the Agreed Measures, which precluded CCAS by eight years, it does not apply to the Antarctic continent, or to floating sea ice within the Antarctic Treaty area, but only to commercial activities at sea, south of 60° South latitude. CCAS set limits on the number of seals that could be commercially culled. (New Zealand did not ratify the Seals Convention, because it did not agree that seals should be commercially culled (Roper-Gee, pers. comm., 2002).)

In 1975, at the Eighth Antarctic Treaty Consultative Meeting (ATCM), the ATCPs agreed on “the need to promote and achieve...the objectives of protection, scientific study and rational use of Antarctic marine living resources” (Joyner, 1998), i.e: they recognised that there was a lack of protection in place for these resources, and that this needed to be remedied.

In response to these concerns, the Scientific Committee on Antarctic Research (SCAR) set up a working group and programme called BIOMASS (Biological Investigations of Marine Antarctic Systems and Stocks). The aim of BIOMASS was to gain a better understanding of the Antarctic and Southern Ocean ecosystem, including how species interact and interrelate. (Joyner, 1998).
At the following ATCM in 1977, the ATCPs agreed in principle to negotiate a convention to address the issues of protection and conservation of Antarctic marine living resources, and to include measures to protect both commercially and non-commercially exploitable species (Joyner, 1998).

The Convention on the Conservation of Antarctic Marine Living Resources (the Convention) was ratified on 20th May 1980, and came into force on 7th April 1982. Consisting of 33 articles, the objective of the Convention was the conservation of Antarctic marine living resources, with “conservation” defined as including rational use (www.polarlaw.org). The Secretariat for the Convention is based in Hobart, Tasmania, with annual meetings being held in October (Agnew, 1997). The Commission on the Conservation of Antarctic Marine Living Resources (CCAMLR) was established to give effect to the Convention. Today there are 24 members of CCAMLR (Members) (www.ccamlr.org).

The Commission issues Conservation Measures and Resolutions, which set catch limits for harvestable species, so that the use of marine resources of the Antarctic and Southern Ocean can be regulated, and hence sustainably managed (Herr, 2000).

CCAMLR AREA:

Pivotal in the implementation of the Convention is the area to which the Convention applies. Article I states that the Convention applies to all Antarctic marine living resources situated in the area south of 60° South latitude, as well as the area between that latitude and the Antarctic Convergence (the limit of the Antarctic Convergence is defined in subsection 4 of Article I) (www.polarlaw.org). This is critical to the functioning of the Convention for a number of reasons:

- By extending out to the Antarctic Convergence, a holistic approach can be implemented to manage the use of the Antarctic marine ecosystem and its resources, rather than limiting the Convention area to a boundary that has more importance or relevance in a geopolitical sense (such as 60° South), as opposed to an ecological sense;
The CCAMLR area comprises the largest targeted conservation zone in the world (Joyner, 1998), but the main objective is to conserve the Antarctic marine living resources present in the area, rather than just protecting the area itself. This is one of the main differences between the Convention and the Antarctic Treaty and CCAS (Joyner, 1998);

The extensive area that the Convention applies to translates into a huge amount of biomass that CCAMLR is responsible for ensuring the protection and conservation of. This is why the ecosystem management approach used by CCAMLR is so important.

**WORKING GROUPS OF CCAMLR:**

CCAMLR led to a number of working groups being set up in the 1980s, whose purpose was to monitor indicator species of the Antarctic and Southern Ocean ecosystem, so that any changes in the population structure and abundance of these species could be examined, and thus used to sustainably manage the ecosystem. These working groups adopted a precautionary approach (Constable, 2002). Figure 1 shows the timeframe over which the establishment of these working groups took place.

**Figure 1: Key dates in the implementation of CCAMLR working groups**

*(based on Miller, 2002).*

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
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<tbody>
<tr>
<td>1984</td>
<td>WG-FSA set up.</td>
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<tr>
<td>1985</td>
<td>WG-CEMP set up.</td>
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<tr>
<td>1988</td>
<td>WG-Krill set up.</td>
</tr>
<tr>
<td>1992</td>
<td>First joint meeting of WG-CEMP and WG-Krill.</td>
</tr>
<tr>
<td>1994</td>
<td>WG-CEMP and WG-Krill merge to form WG-EMM.</td>
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<tr>
<td>1995</td>
<td>First meeting of WG-EMM.</td>
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**WG-FSA:**

In 1984 the Working Group on Fish Stock Assessment (WG-FSA) was set up to advise the Scientific Committee of CCAMLR (SC-CAMLR) on the potential catch levels for harvested species, excluding krill (Miller, 2002). Initially, WG-FSA used
the maximum sustainable yield model (MSY) to determine the catch levels appropriate for the harvested species, but has since refined this method to take into account the biological optimal yield of these species, to allow for their continued sustainability.

**WG-CEMP:**
Consequently, the CCAMLR Ecosystem Monitoring Programme (CEMP) and Working Group (WG-CEMP) was set up in 1985, with the objective of monitoring a range of selected predator, prey and environmental indicators of the Antarctic and Southern Ocean ecosystem. CCAMLR proposed to then use these indicators to detect and record any changes in components of the ecosystem. Data relating to change in the ecosystem could then be used to determine whether changes were due to either natural events, such as predation, or anthropogenic influences, i.e. harvesting (Agnew, 1997). WG-CEMP could then provide advice to CCAMLR on when overfishing may be having a negative impact on species which are dependent on target species (Constable, 2001).

**WG-KRILL:**
In 1988 the Working Group on Krill (WG-Krill) was set up (Miller, 2002) to specifically deal with the monitoring and management of the long-established and over-exploited krill (*Euphausia superba*) fishery, for which Miller states the terms of reference clearly had a “krill-centric nature” (2002).

It is widely recognised and accepted that krill is, biologically, the most important species in the food chain of the Antarctic and Southern Ocean ecosystem, with its availability directly effecting fish, squid, baleen whales and seals, and indirectly effecting seabirds and some toothed whales (Miller, 2002). In the year from July 1987 to June 1988, at which time the WG-Krill was set up, approximately 380,000 tonnes of krill was caught in the CCAMLR area, with the highest recorded previous figure being approximately 530,000 tonnes caught between July 1981 and June 1982 (Miller, 2002), - the year the Convention came into force. These figures highlighted the urgent need for intervention and management of the krill fishery.
Coupled with this urgency, there was also great concern about the localised over-fishing of krill, as the ramifications of this act does not only affect the krill population directly, but also indirectly affects its predators, through the reduced availability of the amount of krill available (Miller, 2002). And although abundant in volume, krill tends to have a patchy distribution, dependent on the circulation of the Southern Ocean (Everson, 2002), including the Antarctic Circumpolar Current.

The main tool of the WG-Krill has been the Krill Yield Model (KYM), which uses a number of parameters to determine the effects of different harvesting levels on any given target krill population, thereby measuring the sustainability of these krill populations under these different levels. (Everson, 2002). These include growth rate, natural mortality rate, fecundity and life expectancy (Miller, 2002). Catch limits are then set for the different statistical sub-areas which WG-Krill divides the CCAMLR area into, so that krill populations in an area are not over-exploited (Constable and Nicol, 2002).

When implementing the Krill Yield Model, the patchy distribution of krill does not matter on a large scale, with areas being tens of thousands of square kilometres. However, on a smaller scale, with areas being tens or hundreds of square kilometres, the patchy distribution of krill must be taken into account (Everson, 2002).

As a result of the work done by WG-Krill, the annual commercial catch of krill has decreased dramatically, with the catch for the year July 2000 to June 2001 being just over 100,000 tonnes (Miller, 2002).

**WG-EMM:**

The Working Group on Ecosystem Monitoring and Management was formed in 1994, combining the WG-CEMP and WG-Krill. With its main focus being to develop the integrated ecosystem management approach initiated by the previous working groups (Constable, 2002), the WG-EMM uses data collected by Members to monitor the ecosystems of the CCAMLR area, by extrapolating data to set sustainable quota limits.
STRENGTHS OF CCAMLR:

The implementation of the provisions of the Convention saw a new approach to the way the resources of Antarctica and the Southern Ocean were viewed and managed. The main reason for this is that the Convention area extends to the Antarctic Convergence, which is the natural northern limit for a range of many Antarctic and Southern Ocean marine species, due to this being the point at which the warmer subtropical water of the Pacific, Atlantic and Indian Oceans meet the cold waters of the Southern Ocean, causing an upwelling of nutrients, and hence a lot of feeding and breeding activity. Ecologically, this boundary has more importance than 60° South latitude, because it includes whole ecosystems and food chains of Southern Ocean species.

ECOSYSTEM APPROACH:
CCAMLR adopted a broad ecosystem approach to the management of the Convention area. Constable et al (1999) identified five ways in which CCAMLR does this:

1. by adopting a precautionary approach to all fisheries, including by-catch;
2. by developing quantitative decision rules to safeguard the recruitment of target species, and to safeguard predators from the over-exploitation of their prey;
3. by developing methods to achieve scientific consensus and account for uncertainty;
4. by adopting a process for authorising new fisheries, and monitoring the development of exploratory fisheries;
5. by adopting measures to avoid the localised effect in new fisheries, avoid targeting by-catch species and decreasing mortality of birds.

The main strength of the CCAMLR working groups, and the greatest legacy they leave behind, was the use of an all-encompassing approach to the management of the whole of the ecosystem.

RECOGNITION OF IMPORTANCE OF FOOD CHAIN:
Because most marine mammals and birds are apex predators in marine ecosystems, they are heavily reliant on the availability of species lower down in the food chain,
such as phytoplankton, zooplankton, krill, fish and crustaceans. The harvesting of these species on which apex predators are so reliant therefore directly affects the apex predators, and in effect these predators must compete with human interference in order to utilise the marine resources (Laevastu et al, 1996). The effects of localised fishing can also be detrimental to the local predators. CCAMLR recognised from the outset that one of the most important aspects of adopting an ecosystem approach is to be aware that all parts of the food chain can potentially be affected by the harvesting of just one species.

ACQUISITION AND STORAGE OF DATA:
One of the main strengths of CCAMLR is the method used to store and utilise the data gained. Wisely, CCAMLR chose to implement a centralised, standardised data collection system, with the aim of allowing the accessible and efficient storage of CCAMLR data. Today, this data management system is widely recognised as one of the main strengths of the CCAMLR programme.

Agnew (1997) recognised three types of data that are collected by CCAMLR members, which are then submitted to the CCAMLR Secretariat under different deadlines, depending on the type of data:

1. field work and data collection related to predator monitoring programmes are voluntarily carried out by CCAMLR members, with currently nine out of 24 Members doing this (Agnew, 1997). Any data collected during the Antarctic summer field season related to predator monitoring is required to be submitted to the Secretariat by 30th June of the year following the field season, with the data being made available before CCAMLR’s annual meetings in October;

2. data relating to Antarctic fisheries must be submitted to the Secretariat by 30th September of the year following the summer field season. The Secretariat uses this data to calculate prey parameters, such as the population size, weight, sex ratios, and feeding and breeding habits of indicator species;

3. for parameters still under development, such as annual survival and recruitment rates of some penguin species, Members who collect the data record the data themselves, as the Secretariat is, as yet, unable to use this data, until more is accumulated over a longer time period.
CASE STUDY: SANFORD LIMITED (Johannson, pers. comm., 2002)

Sanford Limited is a New Zealand commercial fishing company, with ventures operating out of many South Island ports. Annually, they utilise quotas for many different commercial species in the New Zealand Exclusive Economic Zone, both selling locally and exporting overseas. In 1997, Sanford turned their attention to the Ross Sea Region, to determine whether there was any commercial gain to be made from toothfish.

Sanford Ltd made initial fishing trips to the Ross Sea Region in 1997/1998, in order to explore the potential for the toothfish market. In 1998, Sanford Ltd joined forces with Sealord to form SS Fishing Ltd, operating a vessel in the Ross Sea Region. In 1999/2000, SS Fishing obtained their first commercial haul of toothfish from the Ross Sea. Since this time, Sanford has fished in the Ross Sea Region every year, gaining a haul of toothfish which is then commercially sold.

In order to obtain a license to be able to fish in the Ross Sea Region, Sanford Ltd must annually complete an Initial Environmental Evaluation (IEE) and submit this to the Environmental Assessment Review Panel (EARP). This level of environmental impact assessment is required because the proposed activity will have a minor or transitory impact on the environment. EARP, an independent review panel, assesses all IEE applications for Antarctic and Southern Ocean field work and, in this case, commercial ventures, by New Zealand scientists and companies, and recommends to Antarctica New Zealand whether a license should be granted. Although the Ross Sea does not fall within the Exclusive Economic Zone of New Zealand, because Sanford was proposing a commercial venture in the area, a permit must be obtained from Antarctica New Zealand, as well as a license from CCAMLR, for which a quota limit per species is set.

At this time, CCAMLR had requirements that were designed to decrease the amount of seabirds caught while longline fishing:

1. there was to be no daytime setting of longlines from fishing vessels;
2. offal was to be discharged from the opposite side of the boat from where nets were set;

3. no offal was to be discharged while nets and lines were being set.

In the Ross Sea Region, Sanford found this a problem because they planned to fish there in the summer months, when there is 24 hour daylight. In order to fulfil the CCAMLR requirements of decreasing seabird bycatch while fishing in the Ross Sea Region, Sanford proposed two methods to mitigate, and preferably decrease, the effects of this. Firstly, Sanford developed a method of line weighting while longline fishing. When the lines and fishing nets are put overboard, weights are attached at various intervals along the lines, so that the nets sink at a faster rate than normal. By sinking the lines faster, there is a decreased chance of seabirds seeing, and therefore being attracted to, the bait attached to the long lines. Secondly, while fishing in the Ross Sea Region, Sanford retains all offal from processing onboard their fishing vessel. Both of these measures ensure that seabirds in this area do not view fishing vessels as sources of food, and therefore are less likely to be attracted to them. After testing these methods in New Zealand Exclusive Economic Zone waters, CCAMLR authorised Sanford to use these methods in the Ross Sea, and set a limit of a maximum of three seabirds being caught per season by Sanford, with Sanford having to withdraw from the Ross Sea if this limit was reached. In the 1999/2000 season, Sanford caught no seabirds while longline fishing in the Ross Sea Region.

Sanford presented their methods of decreasing seabird bycatch to CCAMLR meetings, resulting in CCAMLR using these methods to set a higher standard for other countries who utilise the Southern Ocean for commercial uses. Prior to this, the compliance level of countries who actively tried to decrease seabird bycatch was 25%, with these new measures increasing compliance dramatically, almost to 100%.

This case study highlights the strict manner which CCAMLR has adopted, in order to set sustainable harvesting levels for Antarctic and Southern Ocean species, and to protect and conserve other species. By limiting the amount of Sanford’s seabird bycatch to three birds per fishing season, with more than three birds being caught resulting in Sanford’s fishing permit for the region being terminated, Sanford was
forced to come up with more efficient methods of setting and retrieving lines, so that it would be economically worthwhile for Sanford to fish in the Ross Sea Region.

**CONCLUSION:**

From this review of the ecosystem approach adopted by CCAMLR, it is evident that the holistic ecosystem approach adopted has ensured the sustainable use and management of Antarctic marine living resources.

CCAMLR's main strengths lie in their recognition of the food chain as a single entity, in which the fishing or over-exploitation of one species can directly or indirectly effect other species in the food chain. Another strength is the acquisition and storage of data collected by CCAMLR members, which is then used to determine harvest levels and quotas.

However, in the future, it is likely that fishing in the Southern Ocean will remain at present levels or increase, so it is important that CCAMLR continues to apply a holistic ecosystem approach to the management of the CCAMLR area, in order to remain resolute in their commitment to protecting and conserving the marine living resources of the Antarctic and Southern Ocean ecosystem.
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