

CCAMLR's Approaches to Ecosystem Based Management

A paper for the proceedings of the Workshop on Ecosystem based Management held in Cairns, June 2003.

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Abstract

The Convention on the Conservation of Antarctic Living Resources, adopted in 1981, was one of the first pieces of international legislation to adopt an ecosystem based management (EBM) approach. The concepts of EBM are enshrined in the words of Article II of the Convention which specifically indicates the need to safeguard the target species in a fishery, to ensure that ecological relationships are maintained, and to facilitate the recovery of already depleted species. CCAMLR has enacted this ecosystem approach to management at a number of levels. These measures include conventional fishery closures, precautionary catch limits, by-catch minimisation measures and an ecosystem monitoring program. This ambitious exercise has occurred in a region of the ocean that is data-poor, and with extremely high conservation values, where there are complicated ecological relationships, species recovering from historical over-exploitation, and fisheries occurring at multiple ecological levels simultaneously. This paper provides some illustrations of how CCAMLR the ecosystem approach has evolved and will indicate some of the developments that may be applicable to fisheries in other areas.

Introduction

The task of managing the fisheries of the Southern Ocean has been handled by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) for the last 20 years and this Antarctic Treaty-related body has made a number of attempts to incorporate an "ecosystem approach" into its considerations for the harvested species within its jurisdiction. This approach has included attempts to mitigate the various types of by-catch, taking into account the needs of dependent and related species in management models, and the development of an ecosystem monitoring program to investigate the long-term trends in the population of selected land-based krill predators. Management of these unusual fisheries in a difficult and distant part of the world using an ecosystem approach has presented unique challenges and the experiences gained have implications for the development of wider management regimes of other marine systems.

The Convention's aim was to manage resource exploitation using an "ecosystem approach" rather than to manage single species in isolation, as has been the practice in most other fisheries agreements. The adoption of this approach was largely in recognition of the profound effects that harvesting krill might have on the other elements of the ecosystem. The essence of the "ecosystem approach" to management can be found in Article II of the Convention which spells out the management goals in general terms:

Article II.

1. The objective of this Convention is the conservation of Antarctic marine living resources.

2. For the purposes of this Convention, the term "conservation" includes rational use.

3. Any harvesting and associated activities in the area to which this Convention applies shall be conducted in accordance with the provisions of this Convention and with the following principles of conservation:

(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; and

(c) prevention of changes or minimisation 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 introduction of alien species, the effects of associated activities on the marine ecosystem and the effects of environmental changes, with the aim of making possible the sustained conservation of Antarctic marine resources.

There are a number of important elements embodied in Article II. Although the aim of the Convention is conservation this also includes the concept of rational use. Thus harvesting is permitted but this must occur in accordance with the principles set out in the following subparagraphs. The phraseology of subparagraph 3 (a) is aimed to ensure the health of the harvested population and moves beyond the simple concept of maximum sustainable yield. Subparagraph 3 (b) brings in the ecosystem approach and sets similar standards for "dependent and related species" to those applied to harvested species as well making explicit reference to depleted species – this in reference to those species of whales, seals and fish which had already been over-harvested when the Convention was signed. Finally, subparagraph 3 (c) sets out a number of conditions, including timescales over which reversible change is permissible, which would allow for conservation of the Antarctic marine ecosystem. It is implicit in Article that management should follow a precautionary approach, according to which decisions taken should have a low risk of long-term adverse effects. This approach has important implications when working with uncertainty in information, for instance when

the actual size of exploited stocks is not known precisely, or when new stocks are being targeted. CCAMLR was a pioneer in developing what has become known as the 'ecosystem approach' to the regulation of fisheries.

The ecosystem approach does not concentrate solely on harvested species fished but also seeks to minimise the risk of fisheries adversely effecting 'dependent and related species', that is, the species with which humans compete for food. However, regulating large and complex marine ecosystems is a task for which there is currently insufficient knowledge and an absence of adequate tools. Instead, CCAMLR's approach has been to regulate human activities (fishing) so that deleterious changes in the Antarctic ecosystems are avoided.

There is considerable difficulty in describing the full complexity of marine ecosystems so CCAMLR has designated certain species which are considered to be most important in the food chain (indicator species) and has focussed on stocks within geographic regions or management areas. In the case of krill, CCAMLR has also considered a subset of dependent species, including seabirds and seals, which are monitored by the CCAMLR Ecosystem Monitoring Program (CEMP). Because of the complexities of the system, the difficulty of obtaining data and the incomplete knowledge of interactions within the Antarctic marine ecosystems, considerable effort has also been expended into developing methods for incorporating uncertainty into management decisions.

CCAMLR spent a considerable amount of time discussing ways of turning the words of Article II into management actions and this has now been done through a number of mechanisms. Rather than trying to monitor the abundance of dependent species in relation to a specified level of "greatest net annual increment", CCAMLR has adopted precautionary catch limits. These aim to ensure that the effect of fishing on prey abundance is limited to a level that is unlikely to have an impact on predators. The requirements of predators are taken into account through the application of the generalised yield model (GYM).

Incorporation of precaution into management procedures.

The fisheries in the CCAMLR Area consist of pelagic trawl fisheries for Antarctic krill and icefish, benthic trawling and longlining for toothfish and pot fisheries for crabs and for toothfish (Table 1, Figure 1). The krill fishery, and most other fisheries in the Convention Area, is managed using a version of the generalised yield model. Precautionary limits are calculated from an estimate of the total biomass of the krill stock in an area obtained from an acoustic survey, an estimate of the rate of natural mortality (including natural predation), a model of how individual krill grow in weight during their lives, and an estimate of the inter-annual variability in recruitment. This information is used to make a computer population model of a krill stock which is used to calculate a distribution of population sizes both in the absence of fishing and at various levels of fishing mortality. These distributions are used to determine an estimate of the proportion of the unexploited biomass that can

be caught each year (γ). CCAMLR has developed a three-part decision rule for determining this proportion:

1. choose γ_1 so that the probability of the spawning biomass dropping below 20% of its pre-exploitation median level over a 20-year harvesting period is 10%; and
2. choose γ_2 so that the median krill escapement in the spawning biomass over a 20 year period is 75% of the pre-exploitation median level.
3. select the lower of γ_1 and γ_2 as the level of γ for the calculation of the krill yield.

The requirements of predators of krill are taken into account through the process of the decision rules. In decision rule number 2 the level of 75% of the pre-exploitation biomass was chosen as an intermediate value between the case of single-species management where 50% escapement would be acceptable and the case where no fishing was permitted - 100% escapement. This value is subject to refinement as more information becomes available. Additionally, the incorporation of natural krill mortality into the model's formulation ensures that the needs of all predators are taken into account because they are assumed to be the prime cause of mortality in the krill population. The use of these decision rules clearly flows on from the sentiments expressed in Article II of the Convention.

Much of the CCAMLR area that has been fished for krill, and all the areas currently being fished are now subject to precautionary catch limits. The establishment of precautionary catch limits totalling nearly 5 million tonnes per year on the krill fishery, when the catch is only at a level of 120,000 tonnes per year is in itself a highly precautionary and proactive move unparalleled by other fisheries management agreements. The precautionary catch limits apply to statistical units with widely varying areas, all of which are large compared to the scales appropriate to foraging land-based krill predators during their breeding period so there has been considerable attention within CCAMLR to developing a rationale for small-scale management areas. In 2002, CCAMLR adopted a scheme for the subdivision of the krill catch limit based on information on the foraging behaviour of land based predators in the main fishing zones of the South Atlantic.

Bycatch minimisation

The effects of harvesting activities on other elements of the ecosystem have also been addressed by CCAMLR particularly in its approaches to bycatch minimisation. Longliners fishing for Patagonian toothfish set some 5 000 to 15 000 baited hooks during each set and these can attract seabirds which become hooked and drown. Hundreds of thousands of seabirds are estimated to have been killed in the Convention area as a result of longlining, particularly longlining by IUU fishing vessels. In 1989, CCAMLR took its first steps to minimise 'incidental mortality'. Vessels deploying longlines in the regulated fishery in the Convention Area now use various methods to reduce seabird bycatch. Longlines are set at night, offal is not thrown overboard during setting and streamer lines are deployed to minimise interactions

between foraging seabirds and longline baits. The fishing season for toothfish in some areas has also been moved to a time when fewer birds are likely to be in the Convention Area. Night-time setting alone has reduced albatross deaths by about 80% since it was introduced. Despite these measures, CCAMLR estimates that between 1997 and 1999 in excess of 100 000 birds may have been caught in the Convention Area by IUU vessels which are not following CCAMLR's recommendations for measures to reduce seabird mortality. In addition, many Antarctic seabirds are taken by longliners operating outside the Convention Area.

Bycatch of species other than seabirds has also been addressed by CCAMLR. In some cases, total allowable catches (TAC) for target species are linked to allowable by-catch. A fishery may thus be closed when it reaches the TAC level for the by-catch of a particular species, even if the TAC for the target species has not been reached. CCAMLR has also directly prohibited fishing when the risk to by-catch species is thought to be too great, as was the case with the mackerel icefish fishery around the South Orkney Islands. Fishing for icefish in this area has been restricted to midwater trawling, to reduce benthic bycatch.

The management of new and exploratory fisheries has also been subject to precautionary approaches by CCAMLR. The entry of finfish harvesting into new areas has to be accompanied by exploratory research that allows some degree of assessment of the stock in the area and the regulations have strict rules on relocation in the event of encountering significant bycatch.

The CCAMLR Ecosystem Monitoring Program

Possibly the most obvious facet of CCAMLR's attempts to take into account the needs of dependent species has been the establishment and maintenance of the CCAMLR Ecosystem Monitoring Program (CEMP). In 1985 CCAMLR initiated the CEMP to monitor the performance of critical ecosystem components through the choice of a number of key indicator species including: Adelie penguins, chinstrap penguins, macaroni penguins, gentoo penguins, black browed albatross and Antarctic fur seal. The CEMP monitors a variety of indices of predator status and breeding success at a number of sites around the Antarctic and attempts to relate changes in these indices to krill availability, and to distinguish between changes that result from commercial harvesting and those that are a result of natural fluctuations in the biological and physical environment. There are CEMP sites established in the Ross Sea, in the Antarctic Peninsula Region, on South Georgia and in the Indian Ocean sector and data from the programs at these sites are submitted to CCAMLR each year. Attempts are now being made to incorporate CEMP data into management models. The data sets that have been collected are now of sufficient duration that analyses have been undertaken to examine the potential for summarising the many parameters for which data are being collected into a single statistic for each of the predator indices. Such an index would be used to identify anomalies - years when the index diverges significantly from a baseline norm and to make decisions on the effects of

fishing on predator populations. Data from the CEMP have shown that many of the parameters being measured will respond to environmental events and that short-term natural fluctuations can have large effects on monitored populations though these effects may be relatively short lived. To date, there have been no studies that have demonstrated the effects of krill fishing on the monitored population, but this may be because the krill fishery is currently at a low level. The next step in the development of the CEMP is the examination of how data from the monitoring program can be used by the Commission in making management decisions.

Conclusions

CCAMLR was a pioneer in developing a number of concepts that subsequently have been adopted in other management organisations. It manages fisheries that operate in a difficult physical environment and it operates in a unique political environment. CCAMLR's approach to EBM was not a pre-determined path; it began with a small number of stated principles and with time these developed into an relatively comprehensive approach to sustainable management that takes into account wider ecosystem factors in its decision making. This adaptive and flexible approach to EBM can be an example to other RFMOs which are struggling with the concept. Many such organisations are now adopting the ideas of EBM but there appear to be operational difficulties in putting these ideas into practice. Part of these difficulties are caused by the enormity of the task ahead, however, the CCAMLR experience indicates that utilising a variety of approaches to achieve some well stated goals can build to create a regime that has many of the attributes of EBM and that with further development, may well approach a system that can be thought of as fully implementing EBM. Although CCAMLR has established a number of comprehensive management regimes for many of the fisheries in its jurisdictional area it faces threats from global forces. Regional fisheries management organisations, however effective their internal mechanisms may be, cannot operate in isolation. The future success of CCAMLR, and all RFMOs will lie in improving links between them, instilling common principles, such as EBM, into their charters and improving governance on the high seas to remove the threats caused by IUU fishing.

Further reading

CCAMLR's development of an EBM approach is documented on their website: Understanding CCAMLR's Approach to Management (<http://www.ccamlr.org/pu/e/pubs/am/toc.htm>).

Species	Catch in 2001/02	Catch limit for 2002/03
Krill	118,705	4.8 million tonnes
Toothfish	12,817 tonnes*	12,250 tonnes
Icefish	3,506 tonnes	5,161 tonnes
Crabs	113 tonnes	

* Legal catch, estimated IUU catch in 2001/02 = 36,000 tonnes which includes catches reported but which were claimed to have originated outside the CCAMLR Area.

Table 1. Reported and estimated catches for harvested species in the CCAMLR Area.

Figure 1. Catches of fish and krill in the CCAMLR Area.

