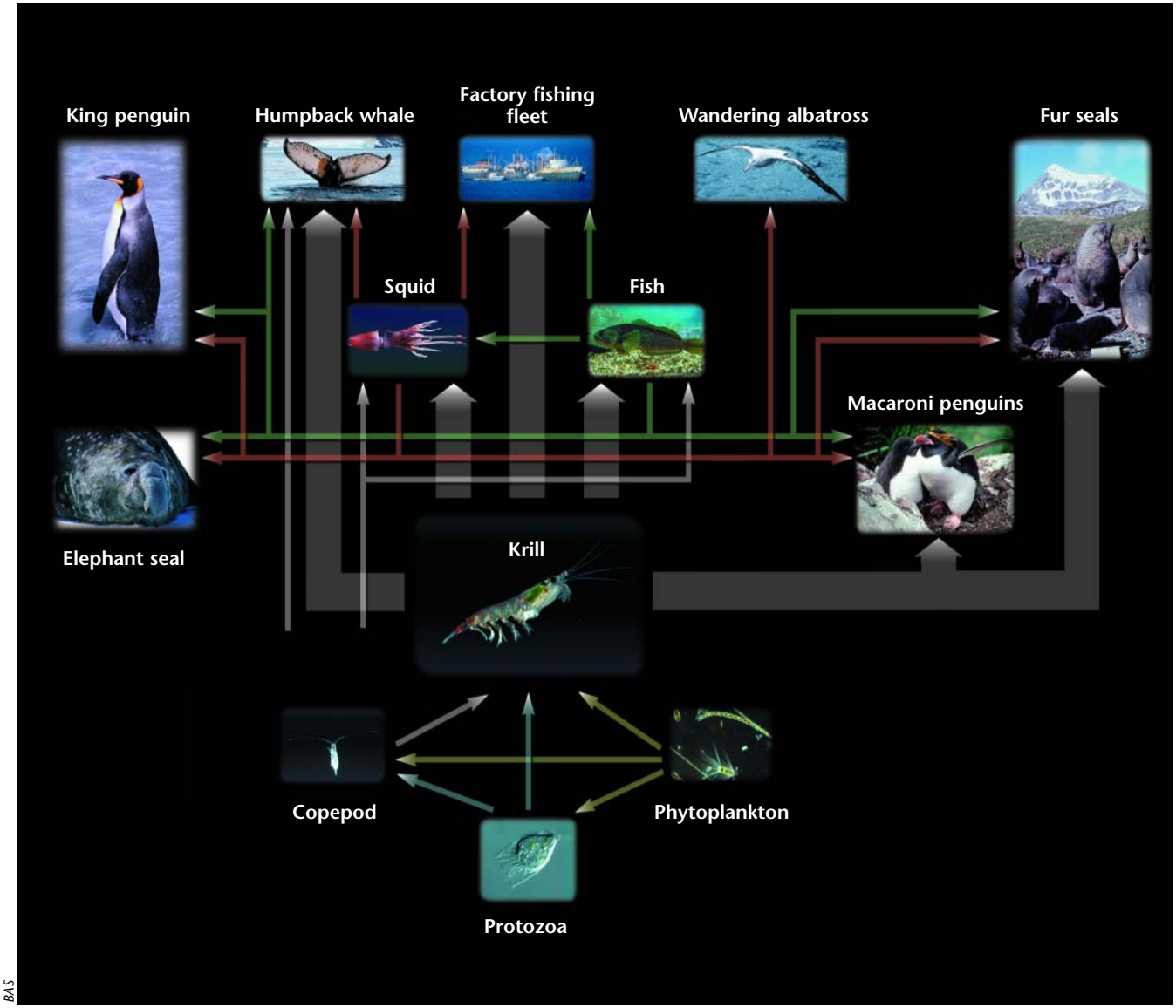
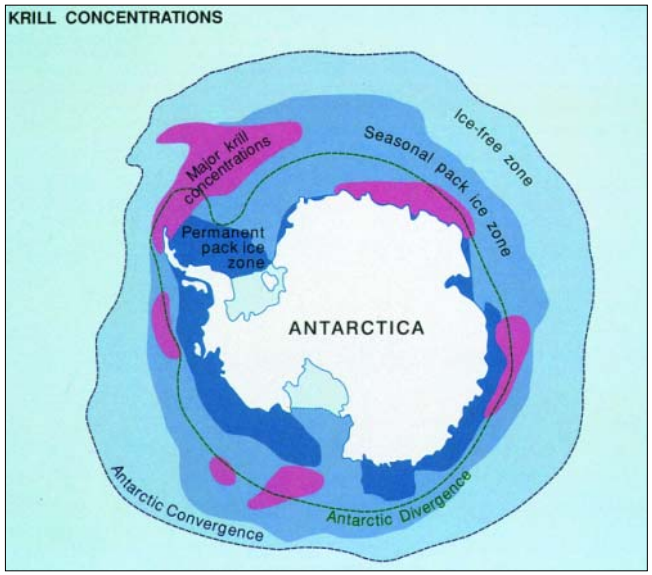
The ecological and commercial importance of krill

Resource MC1



BAS

Interactions in the Southern Ocean food web show the importance of krill



Australian Antarctic Division in Crossley, L. (1995) Explore Antarctica. Cambridge University Press, Cambridge

Major concentrations of krill around the Antarctic continent

BAS

In Japan a number of krill products are marketed and sold

The CCAMLR ecosystem approach

Resource MC2

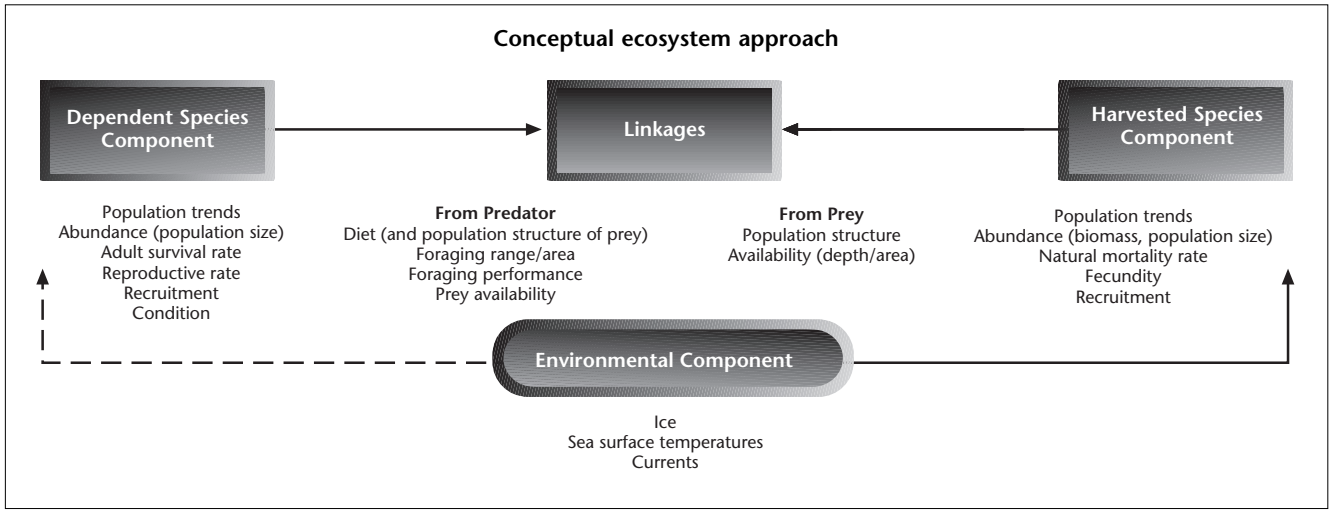
Commercial fisheries in the area south of the Antarctic Polar Front in the Southern Ocean are controlled by the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR). The Convention requires that marine living resources are managed in accordance with three important principles. In simple terms, these are: the single species approach, the ecosystem approach and the precautionary principle.

The single species approach

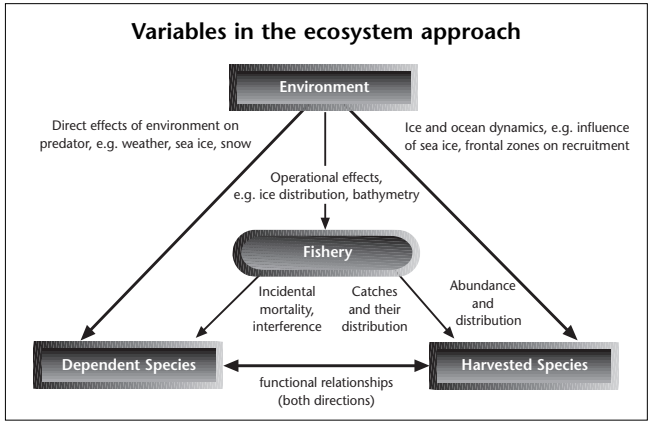
The single species approach looks at each resource on its own and seeks to establish limits on harvesting which are sustainable indefinitely. This is the traditional approach to fisheries and is one that, on its own, is now recognised to have serious deficiencies for two reasons. Firstly, because in practice it has been used to define a target rather than a strict limit. The target is all too often missed and a higher target set. Secondly, because it does not take account of species that are dependent on the one that is being harvested.

The ecosystem approach

The ecosystem approach considers the harvested species both on their own and in relation to dependent species and the environment (see 'Conceptual ecosystem approach' diagram). In this way variation in the distribution and abundance of a harvested species is considered alongside the amounts taken by commercial fishing and that eaten by dependent species. The environment is also taken into account because it can influence both the harvested and the dependent species. The 'Variables in the ecosystem approach' diagram on this page shows arrows linking the components of the ecosystem. These arrows represent processes and form 'linkages' in the conceptual ecosystem approach. In developing an ecosystem assessment, we need first to identify the key species, and then see how they interact together and how they are affected by variations in the environment. Once we have this information we need to determine how fishing activity at a given level is likely to impact the ecosystem.



Source: Both diagrams on this page are from the Report of the Fourteenth Meeting of the Scientific Committee of CCAMLR, Hobart, Australia, 23–27 October 1995. CCAMLR, Hobart.



The precautionary principle

The precautionary principle aims to develop a fishery in a controlled and sustainable fashion, with the consequences of its development on dependent species and the environment being demonstrated before the fishery is allowed to start.

These three principles need to be nested into the overall management package for resources such as krill. The single species approach provides the overall production figure which is then discounted by the amount required to sustain dependent species. This is then moderated to ensure that stocks do not suddenly collapse.

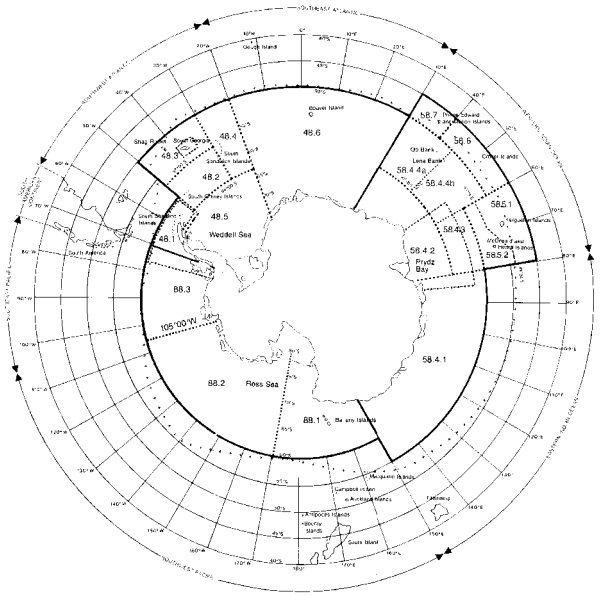
Yield models

Mathematical models can be used to calculate the potential yield fom a fishery. The general form of the yield models is expressed in the form:

$$Y = \lambda B_0$$

where Y is the yield, λ is the discount factor which takes account of growth, mortality, recruitment and uncertainties in the estimators and B_0 is the biomass prior to the onset of large scale fishing. In order to solve this equation we need information on the standing stock (biomass) and

CCAMLR fishing areas. 48.3 includes South Georgia



FCO

also the rates of the population growth, mortality and recruitment. The same basic type of yield model can be used for all the resources; here we concentrate on krill.

Estimating krill yield

To estimate the standing stock of krill, large-scale surveys are undertaken to estimate the average density of the krill and then multiply this by the area of the survey. The best method of estimating density is by using echo sounders. These operate by sending 'pings' of ultra-high frequency sound vertically down into the water and listening for the echoes. The intensity of the echo can be converted to biomass using a constant, the target strength (TS), as a scaling factor. The ping-rate might be once per second so that over a transect length of perhaps over a hundred miles we have a very large number of individual samples to provide an average density. This is important because of the patchy distribution of krill. Below are the results of one such survey in CCAMLR Area 48 and the resultant precautionary catch limits.

Survey area (km²)	Standing stock (million tonnes)	λ	Potential yield (tonnes)
2,982,840	15.1	0.093	1,404,300
		0.140	2,114,000

BAS

Note that in Area 48, because of uncertainties over the various components in the constant λ, two yield estimates were made by the Scientific Committee of CCAMLR. These were considered by the Commission, and as a result, the precautionary catch limit finally adopted was 1.5 million tonnes.

The position of krill within the Southern Ocean food web, whereby whales, seals and birds all prey upon it, means that dependent species may be adversely affected by intensive fishing of krill. This impact will depend on the time of year and the feeding range of the different predators. These are currently being investigated through the CCAMLR Ecosystem Monitoring Programme.

Knowledge of the amount of krill required by dependent species can be used to infer the amount of krill available in a given region. This can be used as a krill biomass estimate in the yield model. This has been done for CCAMLR Subarea 48.3, which includes South Georgia. The appropriate krill consumption values are shown in the table on this page and were used in the formula below to estimate an instantaneous standing stock:

$$B = PT(M^2+V(M))/M^3$$

Where P is the predator krill consumption (9.76), T is the krill retention time in years (0.5), M is the krill natural mortality rate (0.6) and V(M) is the variance of M (0.1).

This calculation produces a total standing stock (biomass) of 10.4 million tonnes. Inserting this figure in the yield equation with a λ of 0.116 gives a potential yield of 1.2 million tonnes of krill for Subarea 48.3.

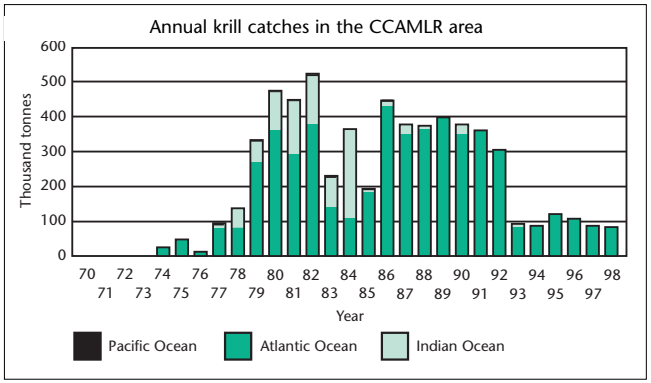
Predator species	Krill consumption (million tonnes)	Foraging range (kilometres)
Macaroni Penguin	3.87	123
Antarctic Prion	1.35	244
White-chinned Petrel	0.21	1218
Diving Petrel	0.18	243
Other Birds	0.10	–
Fur Seal	4.05	150
Total	**9.76**	

CCAMLR

Krill consumption and foraging ranges for a range of predator species breeding on South Georgia

The actual krill catch

Annual catches of krill in the Southern Ocean between 1970 and 1998 are shown below. There has been much variation in the annual krill catch. Currently, the catch represents less than one per cent of the estimated standing stock. The full potential of the krill fishery has not been realised because of a combination of technical and economic factors.



CCAMLR

CCAMLR views on illegal fishing

Resource MC3

• The Commission considered the evidence of illegal, unreported and unregulated fishing in the CCAMLR Area.

• The European Community considered that CCAMLR faced a major challenge resulting from the blatantly illegal and/or non-notified fishing activities. The progress accomplished by the organisation over the last fifteen years is consequently at risk. not only of being undermined, but irreparably damaged by these activities. In its view, CCAMLR must take decisive measures to address this fundamental threat to Antarctic fish stocks and bird populations. Concerted and sustained co-operation by Members was required to ensure the effective application of these measures and the development of additional measures in the inter-sessional period.

• The Delegation of Norway said that reading the report of the Scientific Committee was a chilling experience. It left it with an alarming picture, in particular with regard to the drastic decimation of the stocks of the Patagonian toothfish and the threatening of the collapse of seabird populations killed off as by-catch.

• Norway takes pride in CCAMLR as unique in the context of the Antarctic Treaty System in that it combines the twin aims of preservation and rational utilisation of marine resources in the vast area of the Southern Ocean. With its precautionary and ecosystem approach CCAMLR was a pioneer in designing procedures for rational, sustainable and balanced harvesting of marine resources.

• The situation now before the Commission added up to a serious question as to whether this was still a feasible basis and approach, whether the Commission at this critical moment shall have the political will, and practical ability to take decisions which are commensurate with the challenge, and thus break with alarming trends and rectify the situation.

• The situation is aggravated by the fact – and the Commission cannot close its eyes to this sad fact – that illegal, unregulated fisheries and unreported catches today exceed reported fishing by a factor several times over. No less aggravating is the fact that more than half of the vessels presumed to engage in illegal, unregulated and unreported fishing fly the flags of CCAMLR Member States. That underlines the urgent need for CCAMLR and CCAMLR Member States to bring their own house in order. This, of course, in no way reduced the equally urgent need to bring non-Contracting Parties into compliance with CCAMLR conservation measures as well as regulations of fisheries within zones of national jurisdiction.

• In short, the situation called for collective efforts within CCAMLR, measures by Coastal States and steps *vis-á-vis* non-Contracting Parties to enhance enforcement and compliance with existing and new measures for the conservation and utilisation of living resources in the Convention Area.

• New Zealand commented that CCAMLR faced the most serious challenge in its existence. It was grateful for the work of Working Group – Fish Stock Assessment and the Scientific Committee of CCAMLR, and also for information supplied by State Parties in building up a picture of illegal, unregulated and unreported toothfish fishing. It noted that there was a lot of other information available which added further detail to the picture by naming companies

Dr Graham Robertson/Australian Antarctic Division

A wandering albatross drowned on a longline

and individuals behind these operations. New Zealand knew who they were – but the information could not be tabled at the Commission. New Zealand was concerned and disappointed to learn that so much of this fishing was being carried out by flag vessels, companies or nationals associated with Contracting Parties. CCAMLR must get its own house in order. Urgent action was needed; some existing toothfish stocks would be fished out in 12 to 18 months.

• New Zealand did not want to see the Commission's attention distracted from the problem of illegal fishing. State Parties could ensure that no vessels flying their flags were involved in the toothfish fishery – but the stocks could still be cleaned out by non-Contracting Party vessels. New Zealand believed that the Commission must pay proper attention to the needs of the legitimate fishing industry – those companies which were prepared to abide by the rules and conservation measures needed to be recognised. New Zealand was committed to the ecosystem management approach which was a fundamental principle of the Antarctic Treaty System as a whole, including the soundest way to manage all the resources of the Antarctic.

The challenge for the Convention was to take timely and effective action to curb illegal toothfish fishing.

There was general agreement among Members of CCAMLR that:

1. The evidence of large-scale illegal, unreported and unregulated fishing in the Convention Area advised by CCAMLR Members during 1996/97 and in the beginning of the 1997/98 season, has seriously undermined the work of CCAMLR on achieving the Convention's objective;
2. The extent of existing illegal, unreported and unregulated fishing poses a serious threat to the conservation of stocks of *Dissostichus* spp. in the immediate future and also to the survival of several species of seabirds in the Southern Ocean taken as incidental by-catch in longline fishing operations:
3. Not only vessels of non-Contracting Parties to CCAMLR but also vessels of CCAMLR Contracting Parties were reported fishing in the Convention Area contrary to the CCAMLR conservation measures in force:
4. All information received points to a blatant disregard by non-Contracting Parties of the CCAMLR conservation regime and of the sovereign rights of Coastal States in the Convention Area: and
5. The situation calls for collective efforts within CCAMLR, measures by Flag States and Coastal States and steps to enhance enforcement and compliance with conservation measures regarding living resources in the Convention Area.

This is an extract of the agreed views of CCAMLR concerning illegal, unreported and unregulated fishing as expressed in the Report of the Sixteenth Meeting of the CCAMLR, Hobart, Australia 27 October – 7 November 1997. CCAMLR, Hobart.

An environmental pamphlet published by the Antarctic and Southern Ocean Coalition for distribution to delegates attending the XXII Antarctic Treaty Consultative Meeting held in Tromsø, Norway between 25 May – 5 June 1998.

TAKE ACTION ON ILLEGAL FISHING

Monday's detailed report to the ATCM from the Executive Secretary of CCAMLR concerning the illegal and unregulated fishing occurring within the CCAMLR area is extremely alarming. ECO understands that the Scientific Committee of CCAMLR has made assessments suggesting that Antarctic toothfish *Dissostichus eleginoides* will be commercially extinct within three years if such fishing is not brought under control. The estimated value of this illegal activity is perhaps $3500 million per year. The projected mortality figures for albatross and petrel killed as by-catch in the illegal longline fisheries – perhaps 120,000 birds a year – are equally if not more frightening.

Some of the illegal fishing is being carried out either directly or indirectly by companies licensed in CCAMLR and Antarctic Treaty parties, while most of the illegally caught fish is being sold in CCAMLR member countries.

This situation requires the urgent attention of Antarctic Treaty Parties operating at a political level. It seems surreal to ECO that Treaty Parties have been sitting around the table for the past week congratulating themselves on the fine efforts they are making to protect the Antarctic environment, while the Antarctic region is facing its most serious threat since the era of commercial sealing and whaling. ECO notes the strong expressions of concern by several Parties in response to the CCAMLR report, but asks where these statements lead? Were these issues even discussed in the Heads of Delegation meeting on Monday afternoon following the CCAMLR report?

ECO urges that a series of concerted, co-operative, concrete steps designed to stop the illegal fisheries be considered as a matter of urgency by appropriate fora. We hope that Parties to CCAMLR who are here in Tromsø will take these concrete suggestions to CCAMLR, and work to ensure rapid and effective resolution of these serious issues.

What is clearly missing at this time is the application of serious political will by Antarctic Treaty nations, and indeed the Treaty System as a whole, to find solutions to this problem. Does not the wholesale flouting of international law and the possible extinction of seabird species as well as the commercial extinction of a valuable fishery warrant consideration of possible co-operative actions under the umbrella of the Treaty itself? ECO would say 'YES' and we hope all Parties agree.

The thorny problem of illegal toothfish fishing has been with us for several years. Several solutions have been advanced, and many have been discussed at CCAMLR meetings. Drawing from those past discussions, ECO provides the following 'shopping list' of measures that Antarctic Treaty Parties should both urge CCAMLR to take – and with their CCAMLR 'hats' on – start taking themselves, while here in Tromsø.

1. Co-operative intelligence activities
Using military and civilian satellite data to identify vessels that are involved in unregulated or illegal fishing is a key tool in the hands of several Parties. It is no state secret that the existing panoply of satellites operated by a number of Parties can easily be used to identify those vessels fishing illegally, and to track their movements from and to ports. This is crucial information needed for the other steps outlined here.

2. Co-operative use of enforcement assets
This relates primarily to vessels that could be used to stop the illegal fishing directly, based on the intelligence referred to earlier. During the past two years several Parties have independently undertaken enforcement measures, but this has been *ad hoc* and obviously too limited to have had any real impact on the illegal fishing boats. If available vessels were 'pooled' and assigned different inspection tasks based on allocation to various portions of the illegal fishing zone, the enforcement results will be improved substantially.

3. Co-operative political action toward non CCAMLR states
The focus here would be on states which are sponsoring illegal fishing vessels, including strong efforts to induce them to join and abide by CCAMLR rules, and sanctions if that doesn't work. Parties should be utilising all means available to encourage membership in CCAMLR, including diplomatic, economic aid and economic links. Among possible sanctions are cuts in aid and trade restrictions against illegal fishing states. ECO is certain that the ATCPs, as a group, can stop the illegal fishing by such states if they really want to do so.

4. Aggressive flag state enforcement
This is necessary to ensure that no illegal fishing is being undertaken by vessels registered to a member Party. This has many possible aspects, including use of fines or other penalties for non-compliance and requiring mandatory Vessel Monitoring Systems (VMS) on all vessels operating in the CCAMLR area. Countries may also want to consider legislation to place control on reflagging to avoid the CCAMLR rules.

5. Use of port state enforcement
This can be done both in ports where illegal fishing vessels are picking up supplies and fuel and in ports where they are off-loading the illegally caught fish. There is a link here to having timely and accurate intelligence about the vessels in question, since that would make port state enforcement more reliable and effective. Market monitoring would be useful to help identify where illegal fish is being sold. Key steps that port states should consider taking include seizure of illegal fish, denial of port access to illegal fishers, and legislation to ban sales of illegally caught fish.

6. Co-operative monitoring
This could be achieved by sharing lists of infringing vessels, co-ordinating surveillance activities, and other types of practical information exchange that will support various types of enforcement actions, whether undertaken by an individual Party or in a co-ordinated way.

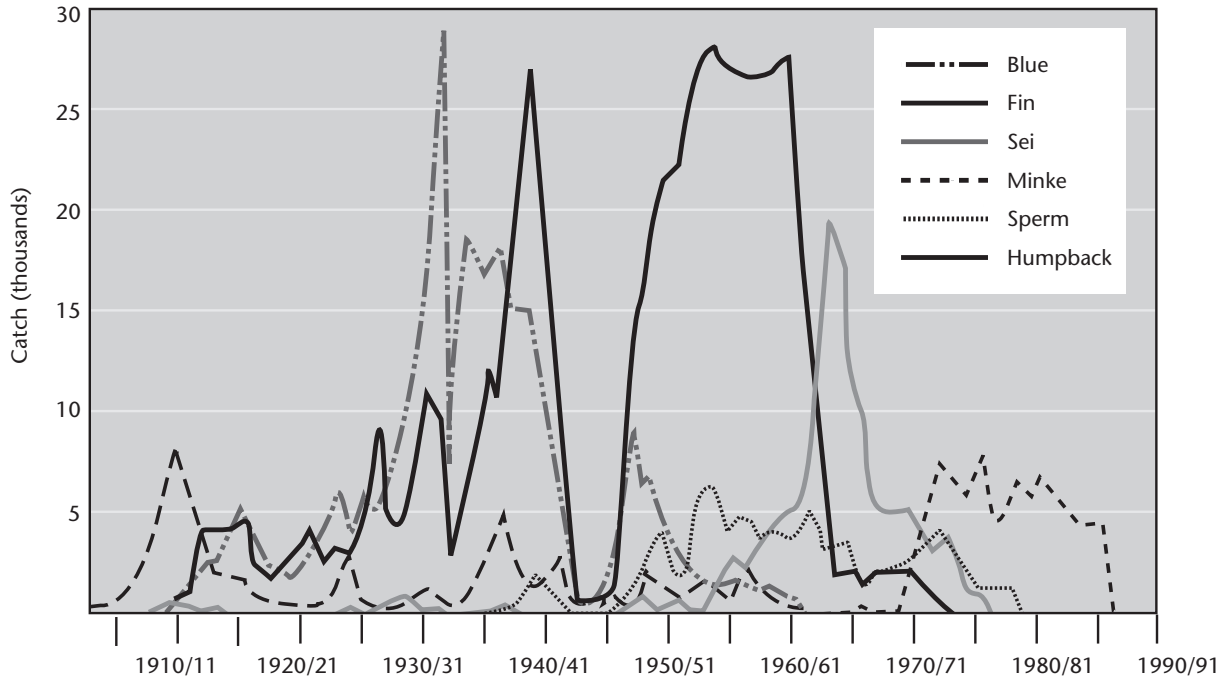
The integrity of the ATS is at stake. As some Parties have noted, this illegal fishing is a cancer eating away at the Treaty itself. The time for talk is over. The time for action is now. Until ECO sees some real action taken to stop the gross illegal fishing for toothfish and the consequent pillaging of seabirds, it will continue to find the rhetoric of Parties sitting around the table here in Tromsø empty and unconvincing.

This is a summary of the views of ASOC as expressed in ECO, volume LXXXXV, No. 4, May 25 – June 6 1998, Tromsø.

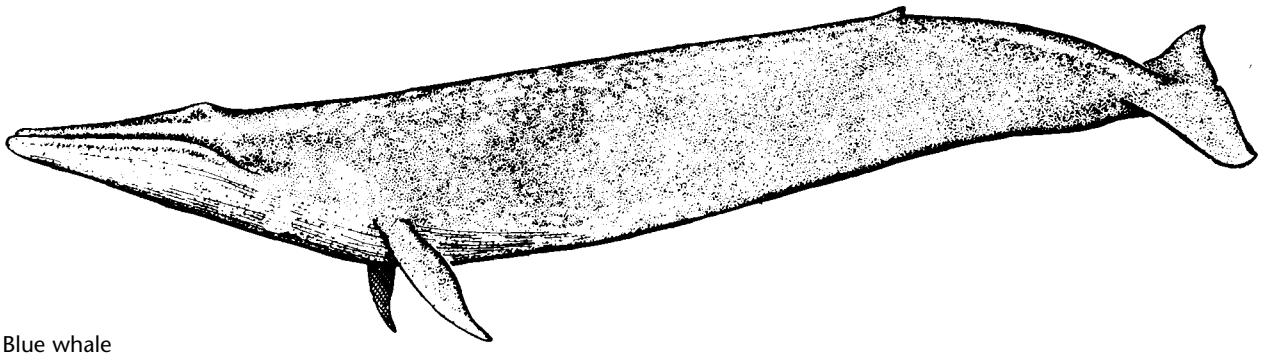
Catches and stocks of whales in the Southern Ocean

Resource MC5

Annual catches of whales in the Antarctic – 1904/05 to 1990/91



Source: Laws, R. in Hansom, J.D. and Gordon, J.E. (1998) Antarctic Environments and Resources: A Geographical Perspective. Longman, Harlow.



Blue whale

IWC

Estimates of whale stocks in the Southern Ocean

Species	Years of survey	Mean population size	95% confidence interval (lower – upper)	
Sei	1985/86–1990/91	360	70	1,970
Blue	1985/86–1990/91	460	210	1,000
Fin	1985/86–1990/91	1,100	440	2,780
Humpback	1985/86–1990/91	5,600	3,270	9,600
Sperm	1985/86–1990/91	14,000	9,700	20,300
Killer	1985/86–1990/91	53,000	29,800	94,200
Pilot	1985/862–1990/91	43,000	8,000	230,000
Minke	1982/83–1988/89	761,000	510,000	1,140,000

Notes:
1. Recent estimates of the number of whales in the Southern Ocean, based largely on surveys carried out on behalf of the International Whaling Commission (IWC) and published in their annual reports. Since 1991 the IWC has ceased to produce such figures because of doubts about their accuracy.
2. The accuracy of these figures is partly dependent on how commonly the various species are encountered; the larger the population, the greater the confidence in the estimate.
3. The 95% confidence interval is a statistical measure which indicates that there is a 95% probability that the true population mean lies between the lower and upper limits

Management and conservation of marine species

Worksheet 13

Many people assume that Antarctica is a pristine wilderness that has never seen human exploitation. The facts of history refute this view. Destructive exploitation of marine living resources has been a feature of the Southern Ocean for over 200 years. Sealers killed huge numbers of fur and elephant seals in the early 1800s. Whaling began in 1904 and over a million large Antarctic whales were killed in the next sixty years. In the 1960s and 1970s, commercial fishing began for fin fish and krill. Pressures continue as fishing for some species is highly profitable and modern techniques, such as large nets and sonar, allow vessels to work efficiently even in very remote locations. This worksheet investigates the management and conservation of marine species in the Southern Ocean and examines fishing of krill and Antarctic sea bass, as well as whaling.

Krill

Krill is one of the most important species in the Southern Ocean ecosystem, it also supports a major commercial fishery. It has been estimated that there are about 600,000 billion krill.

Task 1 Look at Worksheet 12 on Marine Ecosystems and Resource MC1and describe the life history of krill. On which species is krill dependent for food? Which species depend on krill? Comment on the distribution of krill, particularly in relation to ocean currents.
Resource MC1 shows a photograph of krill food products. Describe the uses of krill as food for humans and livestock.

Calculating the production and biomass of krill is difficult because of its tendency to group in swarms. This leads to significant variations in its distribution and density from year to year.

BAS

Antarctic krill

Calculating fishing limits

Traditionally when fishing was a small scale local activity, anyone with a suitable vessel could fish when and where they liked. More recently, quotas have been introduced to prevent large scale commercial overfishing in areas like the North Sea. Quotas are based primarily on estimates of the amount of fish that can be caught whilst allowing the species to reproduce itself – the sustainable yield. There are three key components in this assessment: the biomass, the production rate and the proportion of the stock that must be left in order to reproduce. When information on key components is lacking a precautionary catch limit is set. This is a conservative and pragmatic approach which safeguards the stock.

In the Southern Ocean, direct estimates of krill biomass have been made using echosounders. The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) (see Worksheet 5 on the Antarctic Treaty System) has used these, multiplied by a factor to take account of annual production and inter-annual variation in the stock to calculate a total allowable catch (TAC). This catch limit is applied to a very large area within which catches can be made anywhere. If the sole concern is for krill this does not matter. However, CCAMLR also requires that dependent species, which might be sensitive to local depletion of krill, are also taken into account. This is the ecosystem approach to fisheries management.

Task 2 Refer to Resource MC2 and Worksheet 5 on the Antarctic Treaty System and produce your own summary of the key principles of the CCAMLR ecosystem approach. Suggest why this approach is perhaps more important for krill quotas than for tuna quotas.

Another approach to making assessments of krill biomass is to work backwards from the estimated amounts of krill eaten by different predators annually. In applying this approach, estimates are needed for krill consumption by natural predators (e.g. penguins and seals) in any given area. These are shown for the waters around South Georgia (CCAMLR Subarea 48.3) in Resource MC2, as are the ranges over which the predators forage.

Task 3 Calculate the percentage uptake of krill by each predator species shown in the table in Resource MC2.

- What is the total krill consumption? Why is the range of the white-chinned petrel less significant than that of other species when calculating the area of exploitation?
- Resource MC2 also shows the formula for calculating the instantaneous standing stock of krill. Using the data provided in the resource, calculate the standing stock in Subarea 48.3. Now use this figure to calculate the potential yield of krill in the same Subarea.
- Calculating the standing stock of krill is difficult but getting it wrong could be serious. With reference to the marine food webs already studied (see Resource MC1 and Worksheet 12 on Marine Ecosystems), suggest the possible effects on other animal populations of a decline in krill stocks through over-fishing. How long might it be before all the effects were felt?

In 1998, only 82,802 tonnes of krill were actually harvested in the whole of the Southern Ocean. The highest annual krill harvest was in 1982 when 528,201 tonnes were caught in the Southern Ocean.

Task 4 Resource MC2 shows annual krill catches from 1970 to 1998. How does the actual catch compare to the TAC set by CCAMLR? Why do you think catches have declined? Consider costs, marketability, processing, storage life, alternatives (e.g. from aquaculture) and logistics.

Antarctic 'sea bass' – *Dissostichus eleginoides*

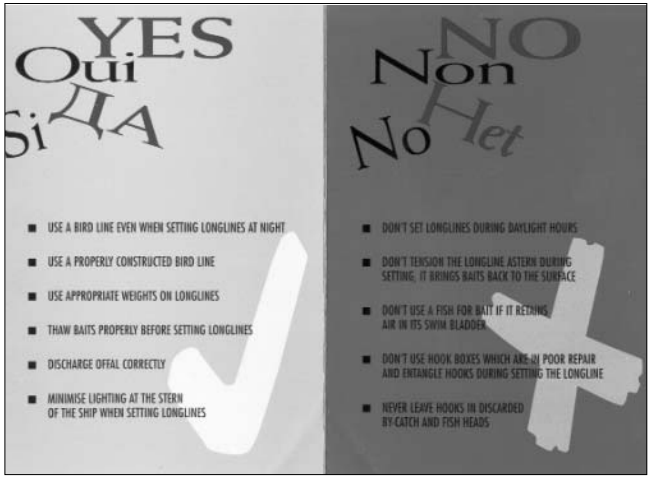
The Patagonian toothfish *(Dissostichus eleginoides)*, which is sometimes marketed in Britain as Antarctic 'sea bass', has recently become the focus of much controversy in Antarctica. The toothfish is carnivorous, grows up to 2 m in length, and has an oily white flesh. It is very valuable, currently worth about £3000 per tonne. It is widely distributed in the Southern Ocean but little is known about the life-cycle of the species or the size of stocks. Significant illegal fishing for this species is now taking place with catches many times higher than the TAC. This has led to alarm among environmental groups and CCAMLR.

Task 5 Resource MC3 is an official report issued in 1997 by CCAMLR outlining its agreed views on illegal, unreported and unregulated fishing in the Southern Ocean. Resource MC4 is on the same subject but written by the Antarctic and Southern Ocean Coalition (ASOC) to lobby the Antarctic Treaty nations at their annual meeting in 1998. ASOC is a group of environmental organisations, including Greenpeace, who want to protect Antarctica.

- Read both the reports. Compare their use of language.
- Why might fishing companies want to fish illegally or not want to report their catches? How easy is it to identify vessels fishing illegally? ➤

➤ • Imagine you are a journalist with a major British newspaper. Write an article examining the problem of illegal fishing for toothfish in the Southern Ocean. Your article should be written in a balanced way. Take account of different views. The story must not exceed 1000 words and it must include a headline and a photograph or map.

Direct damage to fish stocks is not the only environmental impact of fishing. Toothfish are caught using baited long line hooks. The long lines can be many kilometres long and contain thousands of hooks. Birds can get entangled in the lines or hooks as they dive to try and catch the baits. The wandering albatross is particularly vulnerable, and entanglement is causing significant losses to populations on many sub-Antarctic islands.



CCAMLR

CCAMLR pamphlet *Fish the sea not the sky*

Task 6 Look at the pamphlet *Fish the sea not the sky* shown above. This was published by CCAMLR. It is designed for use by fishing crews working in the Southern Ocean. How do you think entanglement could be prevented?

Whales

Whaling in Antarctica is highly controversial. Japan kills about 300–600 minke whales a year in the Southern Ocean for scientific research. Greenpeace has been trying to stop the hunting. Antarctic whaling is not regulated by the Antarctic Treaty System, but by the International Whaling Commission (IWC). In 1982, the IWC introduced a worldwide ban on commercial whaling and in 1994 declared Antarctica a Whale Sanctuary. The rarest whale in the Antarctic is the blue whale. The IWC estimate that about 500 remain, compared with a pre-whaling population of about 250,000. The most numerous whale is the minke, which numbers over 750,000.

Task 7 Examine the graph in Resource MC5 which shows annual catches of Antarctic whales from 1904/05 to 1990/91. Describe the succession of species caught and suggest reasons for this. Look at the table in Resource MC5 showing estimates of whale stocks in the Southern Ocean. Draw a graph showing the estimated stocks of each species, and the variations in these estimates. Remember to take account of the large population differences between species. Why is it difficult to make accurate population counts of whales?

It has been estimated that about 1.5 x 10^8 tonnes of krill per year which were once consumed by whales are now potentially available to other species.

Task 8 What effects do you think the krill surplus has had on other marine species in Antarctica?

As the population of minke whales in Antarctica is so large a sustainable catch would appear to be feasible. Continuing the ban on whaling for this species is therefore an ethical argument rather than a scientific one.

Task 9 Hold a debate in your class to decide whether sustainable whaling in Antarctica should be permitted.