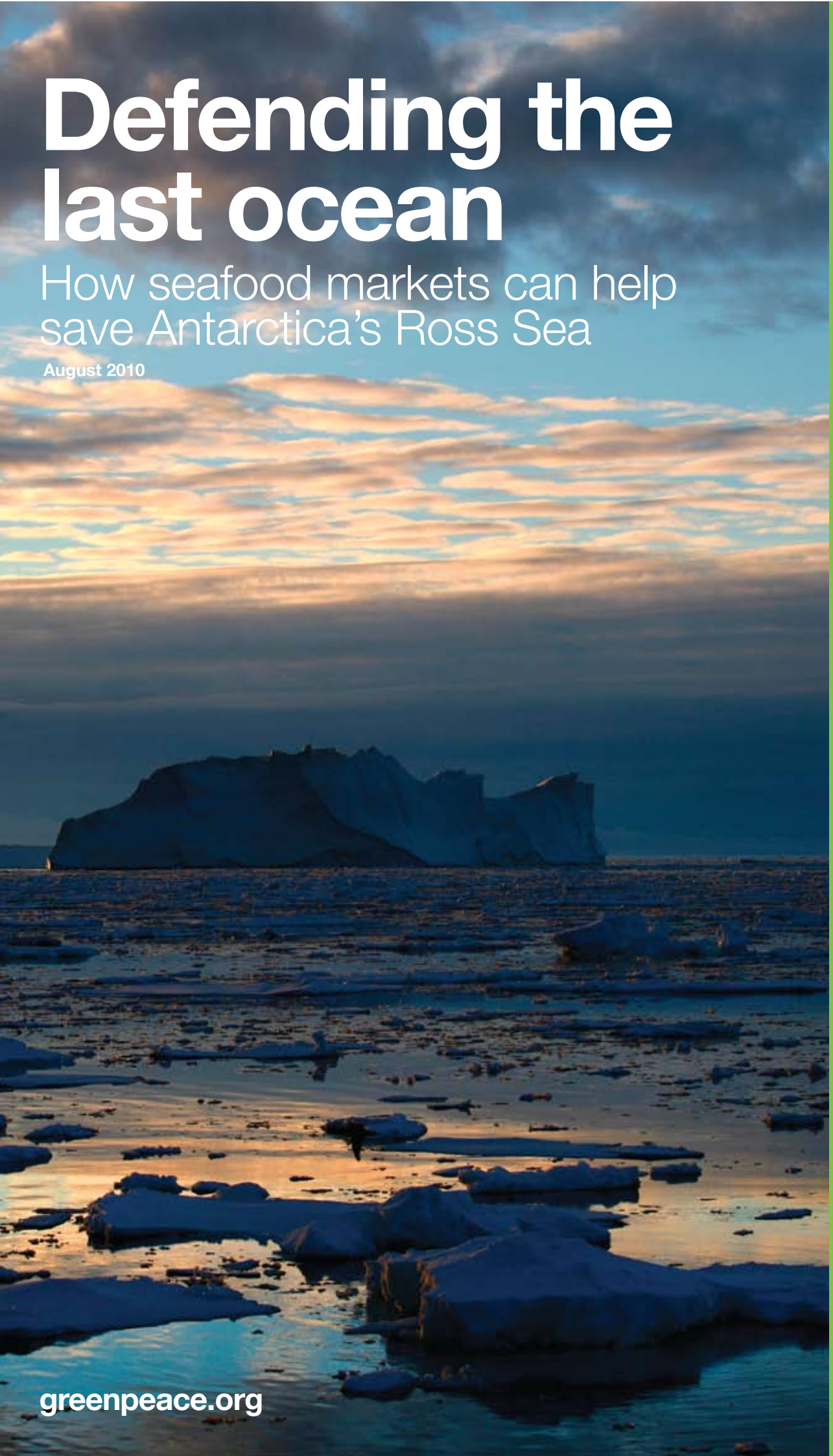
Defending the last ocean

How seafood markets can help save Antarctica's Ross Sea

August 2010



greenpeace.org

GREENPEACE

Defending Our Oceans

Contents

For more information contact:
supporter.services.int@greenpeace.org

Written by:
Cat Dorey and Thomas Lütkebohle

Designed by:
Atomo Design

Acknowledgements:
David Barre, Emmanuel Buovolo, Paloma Colmenarejo, Steve Erwood, Beth Hunter, Sarah King, Richard Page, Steve Smith, Lara Teunissen, Karli Thomas, Nina Thuellen, Casson Trenor

Cover photograph:
Open ice during sunset in the Southern Ocean

Additional photographs courtesy of:

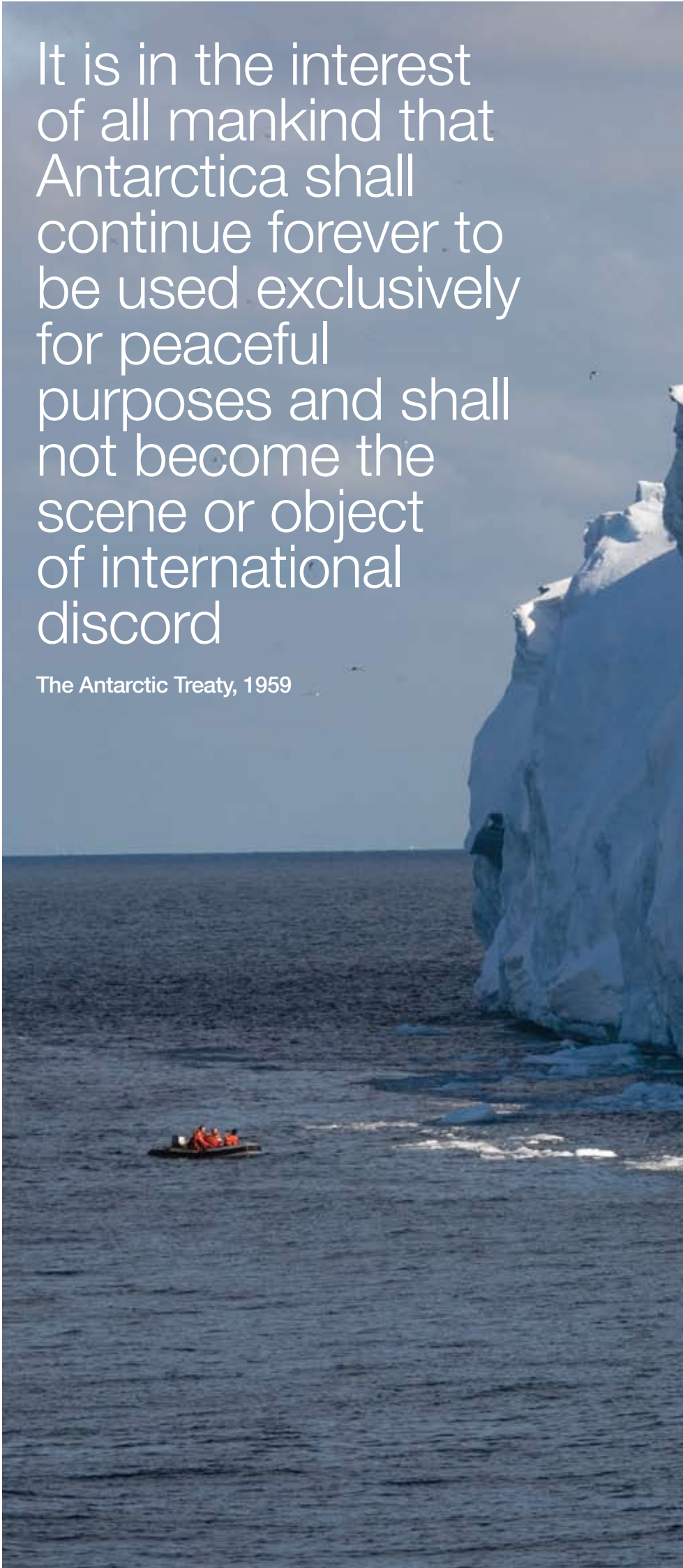
August 2010

JN 333

Published by

Greenpeace International
Ottho Heldringstraat 5
The Netherlands
Tel: +31 20 7182000
Fax: +31 20 7182002

greenpeace.org



It is in the interest of all mankind that Antarctica shall continue forever to be used exclusively for peaceful purposes and shall not become the scene or object of international discord

The Antarctic Treaty, 1959

01

Introduction

In 1959, world governments signed a treaty that aimed to make the Antarctic a natural reserve devoted to peace and science. Later additions to the treaty have provided increased protection for the Antarctic environment. Despite all the progressive elements encompassed within the Antarctic Treaty System (ATS), the Antarctic is still facing numerous threats – climate change, ocean acidification, continued hunting of whales, an increasing number of human visitors and fishing.

Fishing?

In one the most remote and inhospitable places on Earth?

Strange but true.

This is the story of how our fishermen, having taken so many fish from the seas closer to home, are now venturing to the ends of the Earth in order to maintain our insatiable appetite for seafood. This is also the story of how a group of Antarctic scientists, environmentalists, retailers, and chefs are working together to support the protection of the Antarctic's unique and beautiful Ross Sea – the healthiest marine ecosystem remaining on Earth.

This is a call for you to join the action.

Image Iceberg in the Southern Ocean

Image Weddell seal in Antarctica

02

The Antarctic: A natural reserve, devoted to peace and science

Find a map of the world and let your imagination guide you to the southern end of the Earth, to the vast expanse of ice and rock known as the Antarctic. The continent of Antarctica and the Southern Ocean that bathes its icy shores are often described as distant, barren and inhospitable. This reputation is not entirely without merit: Antarctica is the coldest, windiest, highest and driest place on Earth.[1] However, despite its remoteness and extreme climate, the Antarctic teems with life.

Just 2% of this continent is free of ice, allowing only a small toehold for hardy animals and plants. Most of the Antarctic's wildlife is found in its coastal waters. The cold waters of the Southern Ocean can store more oxygen than warmer waters, and are full of nutrients. This enables the Southern Ocean to support a huge range of life forms – up to 75 million different marine species[2] – many of which are found nowhere else on Earth.

The Antarctic's diverse and interlinked wildlife – also known as its ecosystem (see Box 1) – is dependent on a healthy environment. Its remoteness and harsh climate have meant that the Antarctic has been spared from many of the impacts of human development that have degraded ecosystems in most other regions of the Earth.[3]

BOX 1 What is an ecosystem?

An ecosystem is a group of plants and animals and the non-living features (air, water, soil, climate, etc.) of the area in which they live. It is also the many relationships connecting these organisms to each other in a way that supports all of the species living there. There are simple relationships like those of a predator and its prey; a plant that provides shelter and protection for animals; or two species that compete for the same food sources. More complex relationships include the links between a species and the predator of its predator, or those between a species and the predator of its competitor. Migrating species, such as whales, provide links between different ecosystems that may be oceans apart.

An ecosystem has a great number of checks and balances, with every link binding the ecosystem together like the strands in a giant spider web. In essence, the ecosystem acts as a single organism. Damage to one part of an ecosystem will flow along each of these links and affect each part of the ecosystem in some way, sometimes in multiple ways, changing the overall balance. The consequence of any damage to an ecosystem is complicated and very difficult to predict. Even when the initial cause of damage has stopped, the changes may be too many for an ecosystem to recover to its original state. A damaged ecosystem is also more vulnerable to other agents of change such as disease, invasive species and the forces of climate change. Once the balance is destroyed, it may be gone forever.

The region has also been protected by the Antarctic Treaty, originally signed in 1959, and the various additions to this treaty, including the Convention on the Conservation of Antarctic Marine Living Resources, which addresses the management of Antarctic fisheries (see Box 2).

The Antarctic has often been called the last great wilderness. Unfortunately, this unique and beautiful region is no longer pristine. Human activity has been increasing over the past 50 years. Scientists and their support staff from as many as 28 countries and 176 institutions[4] are involved in research projects across the continent, and tourism has increased dramatically in the last decade. Ironically it is the beauty and the near-pristine ecosystem that attract both scientists and visitors.

Those of us who have been nowhere near the South Pole are also having a big impact upon it: the burning of fossils fuels with the resulting release of greenhouse gases, such as carbon dioxide, is changing our Earth's climate and, in a process known as ocean acidification, the chemistry of our oceans. These changes will take their toll on the Antarctic.

Hunting for Antarctic seals began in the 19th century and reduced local populations dramatically. Whaling over the past century has depleted the Antarctic of most of its blue and fin whales and these endangered populations have never recovered.[5, 6] More recently, the finely balanced ecosystems of the Southern Ocean have faced another threat – fishing.

BOX 2 The Antarctic Treaty System and environmental protection[7]

The Antarctic Treaty was signed by 12 countries on the 1st December 1959 and entered into force on the 23rd June 1961. Since then, 47 countries have become parties to the Antarctic Treaty, which establishes the legal framework for the management of Antarctica. Provisions in the treaty have lead to the Antarctic becoming the only continent that is used exclusively for peaceful purposes – no military activities are permitted – and one where international co-operation in scientific investigation is actively promoted.

Since the signing of the original treaty, three other complementary international agreements have been negotiated and together these constitute the Antarctic Treaty System (ATS). The three international agreements are: the Convention for the Conservation of Antarctic Seals (1972), the Convention on the Conservation of Marine Living Resources (1980), and the Protocol on Environmental Protection to the Antarctic Treaty, also known as the Madrid Protocol (1991). Under the ATS, any activities in the Antarctic must be carried out in a way that limits any harmful impacts, and any future activities must be planned with sufficient information to make informed judgements about their possible impacts. The agreement prohibits all activities relating to mineral resources except for scientific research, but does not prohibit fishing.

The Southern Ocean is home to up to 75 million species, many of which found nowhere else on Earth

Image Emperor and Adélie penguins in the Southern Ocean

Image Right-whale dolphin, Southern Ocean

03

Breaching the peace: Fishing in the Antarctic

Fish populations around the world are in serious trouble. Scientists estimate that up to 90% of large predatory fish populations are already gone.[8, 9] Not only are too many fish taken from our seas, but destructive fishing methods destroy seabed habitats, and kill large numbers of non-target species. Overfishing and destructive fishing changes the structure and function of entire ecosystems,[10] reducing their chances of resisting or adapting to natural environmental fluctuations, and to other human threats such as climate change and ocean acidification.

As wealthy nations have fished out their own waters, they have moved further out to sea, into deeper waters, and have sailed south to take fish from the waters of poorer countries like those of West Africa and the Pacific Islands.[11] They have even headed to some of the most distant and dangerous waters on Earth to seek out the last healthy fish populations of the Southern Ocean.

Exploratory fisheries first appeared in the Southern Ocean in the early 1960s with full-scale commercial fisheries underway by the 1970s, targeting fish and krill.[12] In a similar pattern of exploitation seen around the world, fish populations were discovered, exploited, depleted and then the fisheries closed, stock after stock.[13, 14]

Pioneering management

In 1982, almost 20 years after the first fisheries appeared in the Antarctic, the Convention on the Conservation of Antarctic Marine Living Resources came into force as part of the Antarctic Treaty System. It was established 'mainly in response to concerns that an increase in krill catches in the Southern Ocean could have a serious effect on populations of krill and other marine life; particularly on birds, seals and fish, which mainly depend on krill for food'.[15] The Commission for the Conservation of Antarctic Marine Living Resources (known as CCAMLR, pronounced ka-mel-ar) is the international body responsible for implementing this Convention.

CCAMLR manages all fisheries south of the Antarctic Convergence, an area between 50° South and 60° South where the cold polar waters meet the warmer waters of the north (a biological barrier to most Southern Ocean species). At present, CCAMLR regulates fisheries for Antarctic krill, Patagonian toothfish, Antarctic toothfish, mackerel icefish, lantern fish, squid and crabs.

CCAMLR is considered an international leader in its precautionary and ecosystem-based approach to fisheries management. CCAMLR is required to consider not only the target species, but also the whole ecosystem in its management practices. Even when data is lacking, decisions should be made that minimise the risk of any long-term negative effects on ecosystems that a fishery might cause. All vessels operating in CCAMLR waters must carry independent observers to ensure that they operate according to the fishing regulations.[16] Despite its good reputation, CCAMLR faces a particularly difficult problem that threatens to undermine this pioneering approach to management – illegal operators take advantage of the vast size and isolation of the Southern Ocean, especially for the two commercially (and ecologically) valuable toothfish species – Patagonian toothfish and Antarctic toothfish.

Troublesome toothfish fisheries

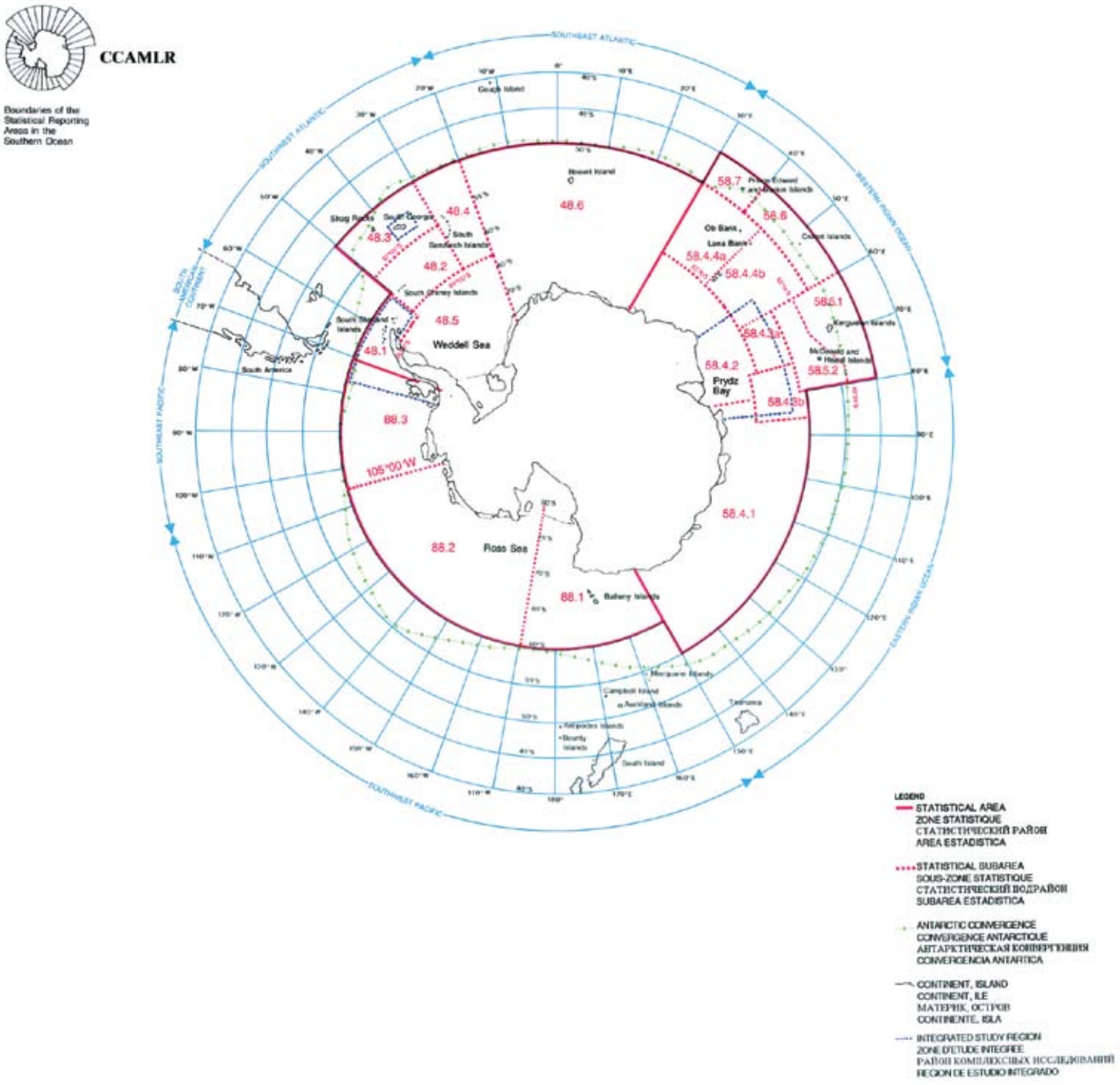
Fisheries for toothfish mainly use bottom longlines (see Box 3) to catch two closely related species. Patagonian toothfish is more abundant in waters north of the 60° South line of latitude, while Antarctic toothfish is usually found south of this line towards the Antarctic continent, including the Ross Sea. Both species are equally abundant between 60° and 65° South.[17] The Ross Sea (south of the 70° South line) is unusual because both species are found there, although the Antarctic toothfish dominates.

Established toothfish fisheries operate in CCAMLR's Atlantic and Indian Ocean management sectors (named by the ocean regions that border the Southern Ocean) where there is sufficient information available to provide appropriate assessments of the potential yield for the fisheries (see Figure 1). There are also several 'exploratory' fisheries targeting toothfish in the southern regions of the Indian and Pacific Ocean sectors. Exploratory fisheries are, in theory, kept small with low catches until enough information is known about the potential impacts of the fishery on the target species and the broader ecosystem to ensure that scientists can provide advice consistent with CCAMLR's management practices.[18]

BOX 3 Bottom longlines of the Antarctic fisheries

The rapid expansion of toothfish fisheries in the late 1990s and earlier this century is linked to the introduction of new longlining techniques that allow fishing vessels to work in deeper and rougher waters. Most vessels use a Norwegian 'autoline' system that has a single long backbone line containing several thousand short (4 metres) branch lines spaced 1–2 metres apart, each with a single hook on the end. The longline is normally stored in several magazines on board the vessel, each containing 1,000–1,200 metres of longline, typically with 950–1,200 hooks. These magazines can be joined together to make the required length of line. Lines run through an automatic baiting machine and each vessel sets and retrieves 10,000–40,000 hooks each day, an equivalent of about 15–50 kilometres of longlines.[19]

Figure 1 **Map of the Antarctic showing the location of the Ross Sea and fishery areas managed by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR).**[20]

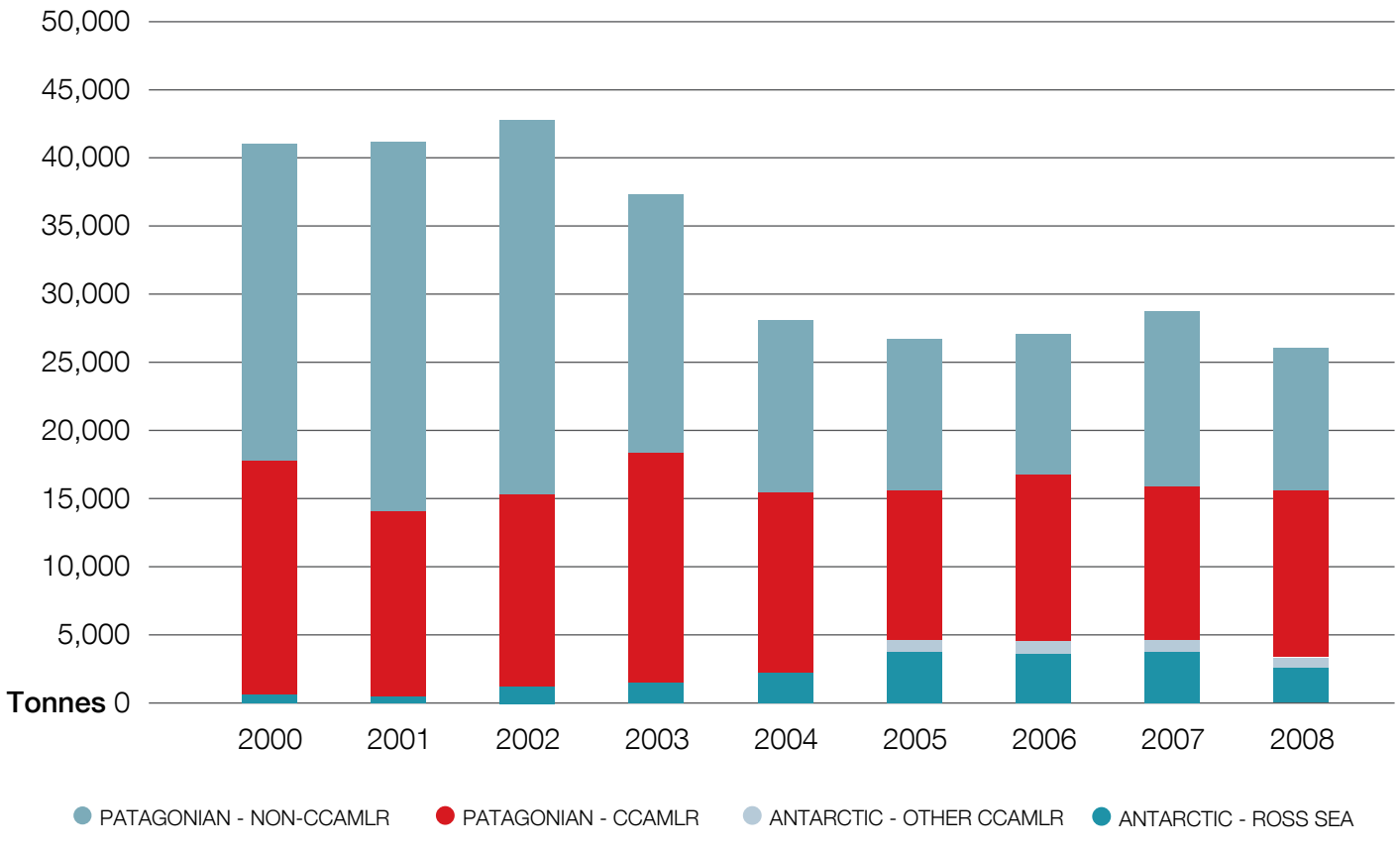


Annual reported toothfish catches within the CCAMLR management area have ranged from 13,804–18,507 tonnes since 2000 (see Figure 2).[21] However, there are also fisheries for Patagonian toothfish outside the regions managed by CCAMLR, particularly in the waters near southern Chile and Argentina. These fisheries take a significant proportion (over 40% each year since 2004) of the total toothfish catch. Reported catches in all areas dropped to a relatively stable level after 2003, possibly due to the introduction of stronger monitoring, control and surveillance measures by CCAMLR in 2003 (see Box 4). In addition to these legitimate fisheries, there are illegal operators targeting toothfish throughout the Southern Ocean.

Illegal, Unregulated and Unreported (IUU) fishing puts the targeted fish species as well as Southern Ocean ecosystems at serious risk. The amount of fish taken by IUU vessels can only ever be estimated, which undermines precautionary management of the stocks, and has lead to overfishing of toothfish in some areas. CCAMLR's estimates of the amount of toothfish taken by IUU vessels may be as much as 50% below the actual amount (see Box 4).

In addition, IUU vessels do not operate under any of the regulations that aim to monitor and minimise the accidental capture and killing of other species by fisheries, especially vulnerable species. Endangered seabirds like albatrosses and petrels are particularly at risk of being caught on longlines in the Southern Ocean, and IUU fishing continues to push these species towards extinction.

Figure 2 Catches of Antarctic and Patagonian toothfish reported to the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR)[22] and the United Nations Food and Agriculture Organisation (FAO),[23] by year (season end) and management area.



BOX 4 Illegal fishing of toothfish in the Southern Ocean

The wildlife trade monitoring network TRAFFIC, estimated that about half the world trade of Patagonian toothfish in 1999–2000 was from illegal fisheries (21,500–33,800 tonnes).[24] CCAMLR's estimate for toothfish caught by IUU vessels at that time was just 8,500 tonnes. In 2002, the Australian government proposed that both toothfish species be listed under the Convention on International Trade in Endangered Species of Wildlife Fauna and Flora (CITES) to provide stronger trade restrictions and reduce the illegal trade.[25] The proposal was not accepted; however, CCAMLR introduced a range of monitoring, control and surveillance measures that have gone some way to reducing the IUU problem, but have by no means solved the issue.

The recent follow-up report from TRAFFIC, looking at toothfish trade data for 2003–2007, suggests that CCAMLR is still underestimating the IUU catch figures for both toothfish species by more than 50% each year.[26] This means that total catches are being underestimated, and the annual catch limits being set for the fishery may be too high to be considered precautionary. Indeed Australian scientists believe that toothfish stocks on the British Australian and New Zealand Antarctic Research Expedition (BANZARE) Bank in the Indian Ocean sector are now overfished due to IUU fishing, and the catch allowance was set to zero for the 2009/10 season while scientists investigate the apparent stock decline.[27]

Deep-water gillnets are also becoming more popular for illegal fishing activities, probably because they do not require bait and require fewer crew than longlines. The use of gillnets creates further management problems as there is no legal gillnet fishery with which to compare the potential catches or other impacts.[28] Deep-water gillnets are indiscriminate and are likely to result in a large bycatch of a range of other fish. Lost or abandoned gillnets continue to catch and kill fish – a process known as ghost fishing. This is a particular problem in rough waters and deep-sea fisheries and is one reason why gillnets have been banned in CCAMLR areas since 2004, as well as in other regions such as the North-East Atlantic. In April 2009, for example, an Australian patrol vessel found an illegal gillnet on the BANZARE Bank in the Indian Ocean sector of the Southern Ocean, but was unable to find the IUU fishing vessel responsible.[29] The net was 130 kilometres long and was set at a depth of 1.5 kilometres. It had already caught 29 tonnes of Antarctic toothfish, and a significant number of skates.

Image Ice in the Ross Sea, Antarctica

04

The Ross Sea: The last frontier

One area of the Antarctic still remains relatively untouched: if you find the most eastern point of New Zealand in the South Pacific, or the International Date Line, and head south, you will arrive in the Ross Sea (see Figure 1 on page 11).

The Ross Sea is a unique region of the Antarctic, both with regard to its physical characteristics and to its wildlife. If you arrive during the winter months of the southern hemisphere, it will be pitch dark and covered by an impenetrable mass of ice. In the endless daylight of the summer months, you will be greeted by a vast expanse of white ice fragments, like paving stones, floating on a dark sea. Here and there, the massive teeth of pale blue icebergs cut through the surface. Heading southward, towards land, you come face to face with the vast cliffs of an enormous ice shelf, 40 metres high and 700 kilometres long, which extends from the land out over the water to cover almost half of the sea – the Ross Ice Shelf. Below you, the Ross Sea continental shelf – the underwater extension of the land before it drops steeply towards the deep ocean abyss – is the largest shelf in the Antarctic.

The Ross Sea is home to an amazing array of creatures that form one of the Antarctic's most unique and complex marine ecosystems. At one end of the spectrum is the huge range of microscopic plants and animals collectively known as plankton. A large array of life forms are found on the seabed, like corals, sponges, algae and shellfish, and the Ross Sea has the richest diversity of fish in the Southern Ocean, including seven species found nowhere else. At the other end of the spectrum are disproportionately large populations of the more familiar species of Antarctic seals, penguins and whales (see Table 1). The Ross Sea's value, in evolutionary terms, has been compared to that of the Galapagos Islands, the African Rift lakes and Russia's Lake Baikal – all designated as World Heritage Sites for their exemplary fauna.[30]

This diverse range of plant and animal marine life – known as 'biodiversity' – has been the focus of many scientific research programmes. Despite this, we still do not understand many of the complex interactions between the different life forms within this ecosystem.

In 2008, a report published in the journal *Science* named the Ross Sea as the one remaining ocean region in the world that has been little affected by human activities.[31] Unlike other marine ecosystems, there are large and healthy populations of top predators – larger fish, birds and mammals – and the relationships or links between all levels of life have remained relatively intact.

For marine scientists this is an extraordinary and rare find, one which provides us with a great opportunity to learn more about continental shelf ecosystems, especially the roles of these top predators. In addition, the Ross Sea is of extraordinary value to scientists as a 'living laboratory' where climate change and its impacts can be investigated without interference from other more direct human impacts.

Table 1 Important species found in the Ross Sea[32]

Group	Common name(s)	Scientific name
Phytoplankton	Various, including diatoms, haptophytes, dinoflagelates, crytophytes	Various
Krill	Crystal krill or ice krill	*Euphausia crystallorophias*
	Antarctic krill	*Euphausia superba*
Small fish	Antarctic silverfish	*Pleuragramma antarcticum*
	Emerald rock cod	*Trematomus bernacchii*
	Bald notothen	*Pagothenia borchgrevinki*
Large fish	Antarctic toothfish	*Dissostichus mawsoni*
Squid	Colossal squid	*Mesonychoteuthis hamiltoni*
Seals	Crabeater seal	*Lobodon carcinophagus*
	Weddell seal	*Leptonychotes weddilli*
	Leopard seal	*Hydrurga leptonyx*
	Ross seal	*Omatophoca rossi*
	Elephant seal	*Mirounga leonina*
Whales	Antarctic minke whale	*Balaenoptera bonaerensis*
	Killer whale or orca	*Orcinus orca*
	Arnoux's beaked whale	*Berardius arnuxii*
Birds	Adélie penguin	*Pygoscelis adeliae*
	Emperor penguin	*Aptenodytes forsteri*
	Snow petrel	*Pagodroma nivea*
	Antarctic petrel	*Thalassoica antarctica*
	South polar skua	*Stercorarius maccormicki*

Dinnertime in the Ross Sea

In any ecosystem, most of the key relationships between different species revolve around predator and prey. These relationships link species together in what is known as a food web. Scientists are just beginning to understand the Ross Sea food web (see Figure 3). A recent stock-take of the Ross Sea by Antarctic scientists shows how important this region is for many species.[33] For the top predators, which have been little impacted by humans compared to other ocean regions, it is especially important.

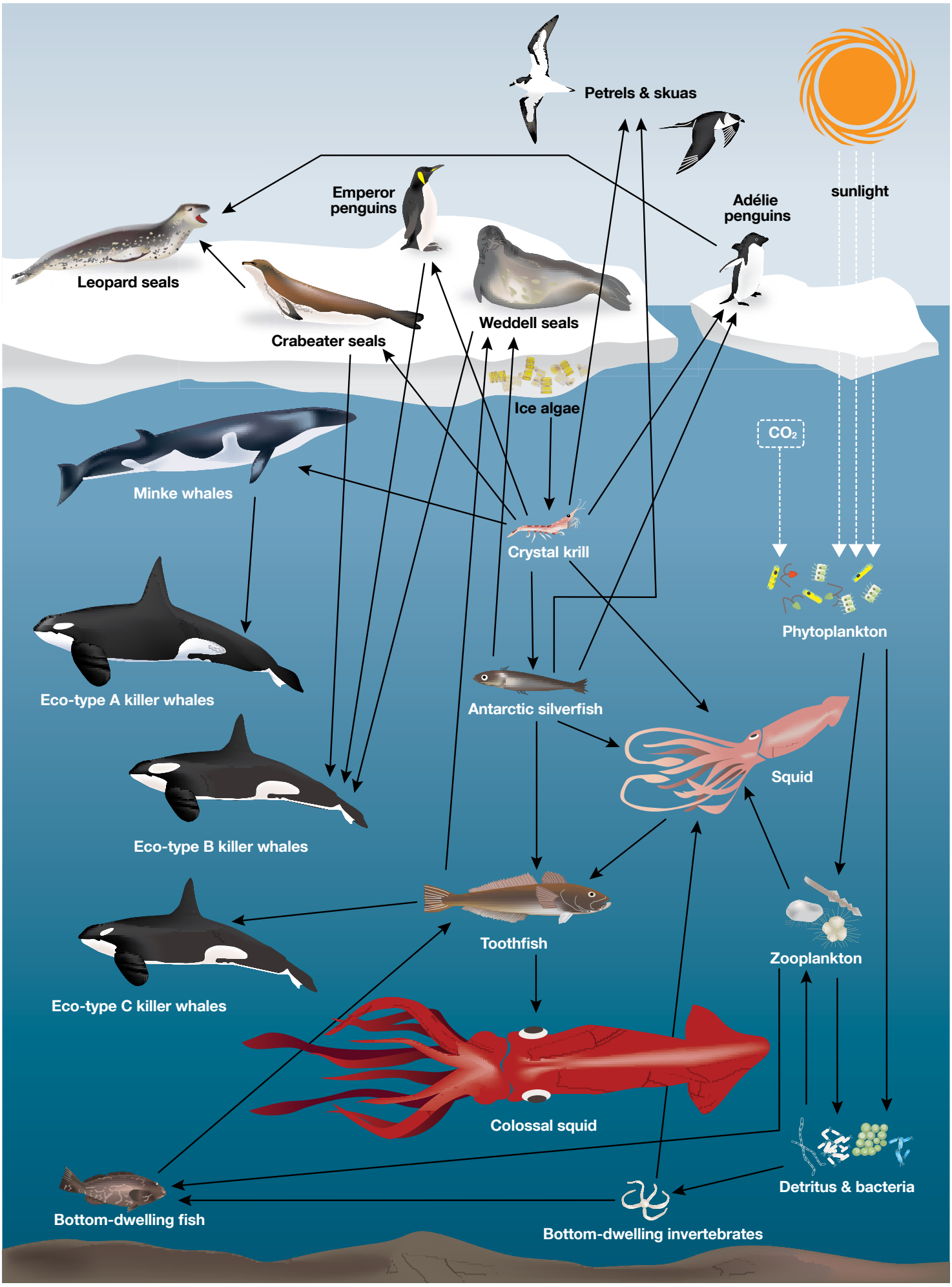
Producers for the food web

The organisms at the first level of any food web are those that make their own food by trapping the energy from the sun (photosynthesis), or from chemical processes (chemosynthesis) occurring in the ocean, and combining it with carbon dioxide (CO_2). These 'primary producers' (including bacteria, tiny phytoplankton and algae in the oceans and plants on land), become food for the next levels of the food web – from microscopic animals known collectively as zooplankton through to a range of fish species.

The primary producers of the Ross Sea ecosystem are so prolific that they are important for the Antarctic as a whole – the amount of food they produce accounts for about 28% of the entire Southern Ocean[34] despite the fact that the Ross Sea covers only about 2% of the area of the Southern Ocean.[35] The most important group of these producers are known as phytoplankton. Interestingly, many types of phytoplankton that are found in other ocean ecosystems are rare in, or absent from, the Ross Sea – another unusual feature of this ecosystem.

Image Anemone in the Ross Sea, Antarctica

Figure 3 **A simplified representation of the key species in the Ross Sea food web.**



Central levels of the food web

Two of the key groups in the centre of the Ross Sea food web are krill (small shrimp-like crustaceans) and a unique family of fish.

Little is known about the precise role and importance of krill in the Ross Sea ecosystem. Crystal krill, also known as ice krill, is thought to be a central species in the Ross Sea food web in its roles as both predator of other tiny marine animals and as a key prey species for many larger animals. Antarctic krill, the dominant prey species in the wider Southern Ocean, is also found in the Ross Sea.

The majority of the fish found in the Ross Sea are from a single family known as the notothenoids.[36] These fish have evolved to live in temperatures of between +2°C and -2°C (the freezing point of sea water) and occupy most depths of the Ross Sea.

Notothenoids share equal billing with crystal krill as key prey species within the Ross Sea food web. This is in contrast to other regions of the Southern Ocean where krill alone is the most important species. Two of the most important notothenoids in the Ross Sea are the Antarctic silverfish and the Antarctic toothfish, which dominate the mid-water depths.

The Antarctic silverfish, like crystal krill, plays a central role in the food web. One and two-year-old fish live near the surface, but move into deeper waters when they grow older. Antarctic silverfish feed mainly on microscopic zooplankton, but will also feed on small crustaceans (mysids and amphipods), and tiny free-swimming sea-snails and sea slugs (pteropods). In turn, these fish become food for Antarctic toothfish, south polar skuas, snow and Antarctic petrels, Adélie and emperor penguins, Weddell seals, minke whales and ecotype-C killer whales. Antarctic silverfish become the most important prey species for the Ross Sea food web at times when, and in areas where, crystal krill numbers are low or absent.

The other important Ross Sea species, the Antarctic toothfish, lives at depths around 600–2,000 metres and feeds mainly on Antarctic silverfish, as well as mysids, squid, and a variety of other fish.[37, 38] In turn, the Antarctic toothfish is an important prey species for Weddell seals,[39] ecotype-C killer whales[40] and colossal squid.[41]

A very important and unusual feature to note about the Ross Sea ecosystem, and indeed the rest of the Southern Ocean, is the absence of large, fast-moving, top-predator fish such as tuna and sharks. Some scientists believe that these large Antarctic toothfish have evolved to fill a similar role to that played by sharks and other top predatory fish in warmer waters. Just like many species of sharks and other large predatory fish in other oceans, the Antarctic toothfish is now facing the threat of fisheries.

Image Tiny, luminous ctenophore unfurling a net of fine filaments to catch food in the Ross Sea, Antarctica

Top predators of the Ross Sea have been little impacted by human activity

Image A minke whale in the Southern Ocean

Top predators of the food web

The Ross Sea ecosystem is especially important for the top predators of this food web, which have been little impacted by humans, compared to other ocean regions.

Whales

Antarctic minke whales are the main whale species found in the Ross Sea and although 40% of the population was lost to whaling in the 1970s and 1980s, their numbers have since increased. It is thought that a core population of these whales was protected from whaling ships by the impenetrable Ross Sea pack ice, which allowed their subsequent recovery.[42] About 6% of the world's minke whales are found here. The endangered blue and fin whales that once frequented the area of the Ross Sea along the continental slope were depleted at the peak of whaling and have never recovered to their former numbers.[43,44]

The Ross Sea also has three varieties of killer whales, also known as orcas. Scientists now believe that the ecotype-C killer whale is a unique species found mainly in the Ross Sea.[45] These animals are smaller than the other types of killer whale, have unique markings, and eat only fish such as Antarctic toothfish, unlike their larger cousins that hunt mainly minke whales, seals and other sea mammals.[46]

There are also small numbers of Arnoux's beaked whales found here, though numbers are unknown.

Seals

The dominant seal species in the Ross Sea is the crabeater seal, and the region may also support as much as half of the entire world's population of Weddell seals. The other seals found here are leopard seals, Ross seals and a few elephant seals.

Birds

About 38% and 26% of the world's Adélie and Emperor penguins, respectively, spend their summers in the Ross Sea. As much as 30% of the world's population of petrels, mainly Antarctic and snow petrels, are also found here, along with a range of other seabirds.

Colossal squid

The colossal squid (*Mesonychoteuthis hamiltoni*) – the sea-monster of many sailors' myths – roams the deep waters of the Southern Ocean.[47] This awesome creature is rarely seen but is thought to grow as long as 15 metres and has a large dome-shaped mantle. It eats large fish, notably Antarctic toothfish. In fact, when a New Zealand fishing vessel in the Ross Sea hauled up a colossal squid in 2007, it was still chewing through its last meal of Antarctic toothfish.[48]

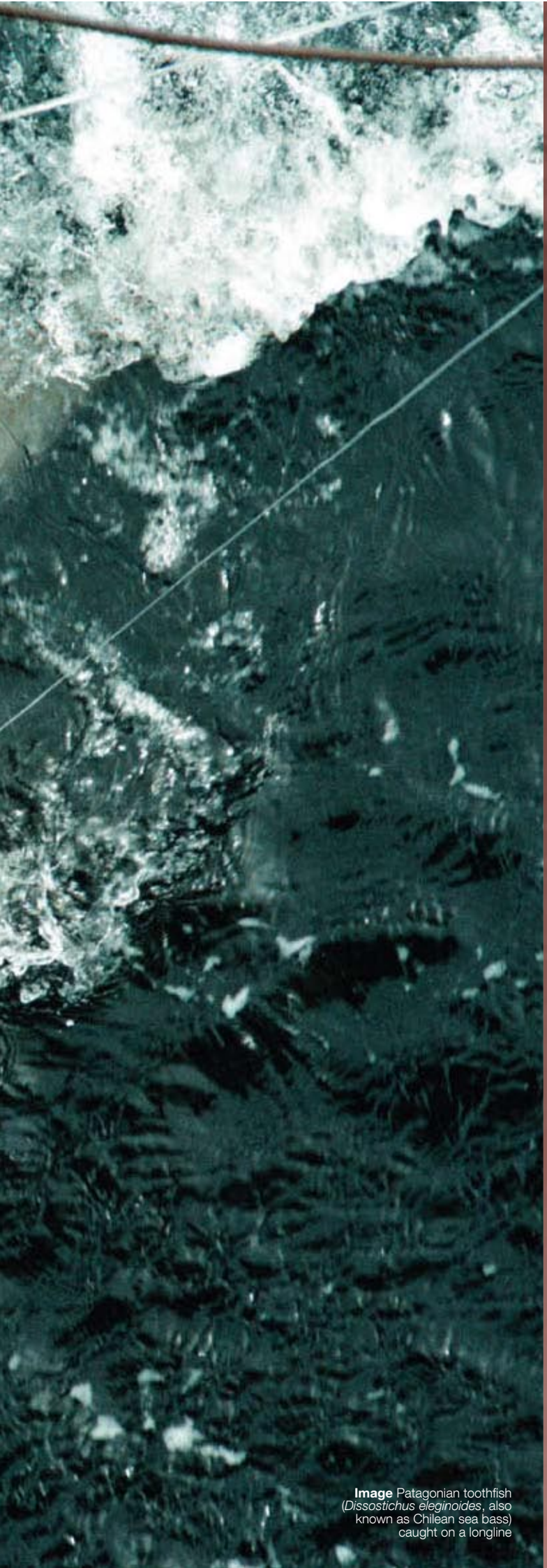


Image Patagonian toothfish (*Dissostichus eleginoides*, also known as Chilean sea bass) caught on a longline

05

The battle for the Ross Sea

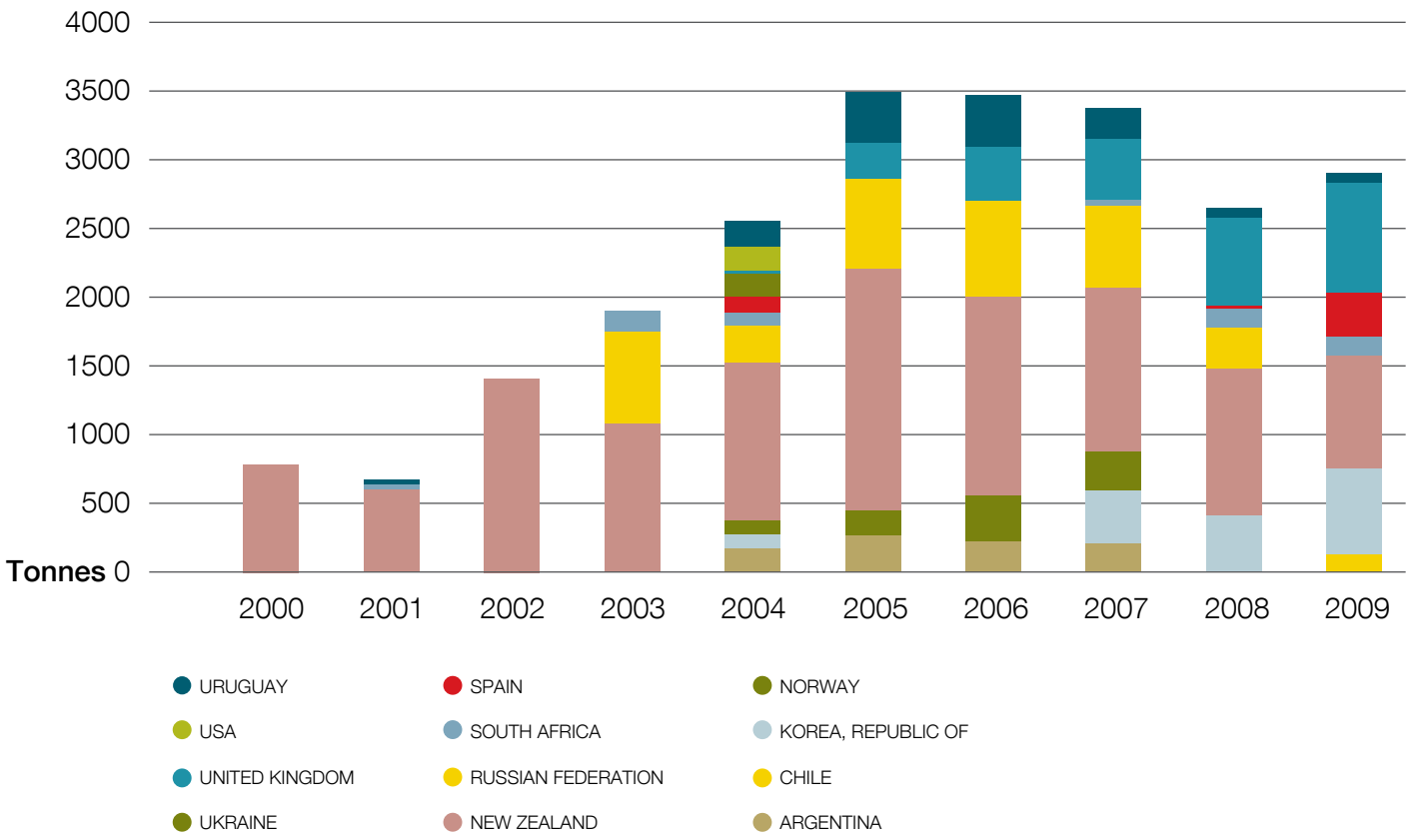
‘We’ve got to back off, as we’ve lost 90% of the big fish. It’s time to protect the last 10% everywhere, especially in the Ross Sea.’

Sylvia Earle, Oceanographer, 21 May 2009, Fairfax VA, USA[49]

Until recently, the Ross Sea remained one of the last productive continental shelf and slope areas in the world still untargeted by commercial fishing, apart from some exploratory fishing by a Soviet trawler fleet during the 1970s. In 1998, vessels from New Zealand led the charge into the Ross Sea, and it has since become a longline fishing ground for Antarctic toothfish.

Up to 12 countries have legally sent vessels to this ‘exploratory’ fishery since 2000 (see Figure 4). The largest number of vessels in the fishery was 21 in the 2004 season. There were 18 vessels from seven countries catching toothfish in the 2010 season.[50] Antarctic toothfish make up over 99% of all reported catches of toothfish in the Ross Sea.[51]

Figure 4 **Reported catches (tonnes) of all countries with fleets targeting Antarctic toothfish in the Ross Sea for the years 2000–2009.**[52]



The fishery is the southernmost fishery in the world, and faces ice conditions and extreme cold that make fishing difficult and dangerous. The fishery starts each summer during January and February, when the sea ice cover retreats and areas of open water known as polynias appear, allowing access to the waters above the continental shelf and slope. Fishing vessels start the season by heading as far south into the Ross Sea as the ice cover allows. As the sea ice forms again, the vessels keep moving north until, by May, they are restricted to the northernmost fishing grounds.

As well as being dangerous for the fishermen, Antarctic scientists now believe that this fishery also carries a grave risk to the ecosystem of the Ross Sea. Recently this became a controversial issue when a group of UK and New Zealand fishing operations applied to be certified as sustainable under the Marine Stewardship Council (MSC) programme. Although the group was recommended for certification, this is currently being disputed by environmental groups, including the Antarctic and Southern Ocean Coalition (ASOC), and a group of about 30 Antarctic scientists (see Box 5).

Box 5 What about certified toothfish?

One Patagonian toothfish fishery has been certified as sustainable under the Marine Stewardship Council (MSC) programme (South Georgia Patagonian toothfish fishery),[53] and a second is under assessment (Kerguelen and Crozet Islands Patagonian toothfish fishery). The Ross Sea Antarctic fishery was also recommended for certification, but at the time of writing – July 2010 – a final decision had not been made.

Greenpeace does not endorse the MSC, as its standards do not adequately address the crises facing our oceans, or ensure that the fundamental principles of precaution and the ecosystem approach are incorporated into fisheries management. For MSC-certified fisheries in the Southern Ocean, issues such as a lack of scientific data, IUU fishing and climate change remain a serious concern. (For further details, please refer to the Greenpeace briefing on MSC, available at: www.greenpeace.org/international/en/publications/reports/marine-stewardship-council-MSC[54])

As one of the first MSC certified fisheries, the South Georgian toothfish fishery caused great controversy, and a coalition of conservation organisations objected to the original certification. One key issue was, and still is, the presence of illegal toothfish fisheries in the Southern Ocean that undermine management of toothfish fisheries. Although the MSC claims that illegal toothfish fishing in the region of this fishery has been significantly reduced, partly due to measures put in place to achieve certification, there is no evidence that this is due to anything more than the usual movement of IUU vessels from area to area, or these vessels simply being displaced to other areas.

Image Seal beneath the ice in the Ross Sea, Antarctica

The disappearance of Antarctic toothfish may already have caused changes to the Ross Sea food web

Image Seal eating toothfish in Antarctica

The key issues expressed by scientists and environmental groups that are concerned by the fishery are as follows:

1 Toothfish are highly vulnerable to fishing
Antarctic toothfish are the largest fish in the whole Antarctic – reaching lengths of up to 2 metres and weighing as much as 100 kilograms.[55] Most female toothfish mature and breed when they reach around 17 years of age and 1.3 metres in length, while male toothfish mature at around 13 years and 1.2 metres.[56] Until very recently Antarctic scientists thought they matured much earlier at about 8–10 years old. The oldest toothfish recorded was 50 years old but few fish older than 30 are caught in fisheries.

A large size and late age of maturity are key indicators that a fish species is highly vulnerable to fishing with a high risk of being fished to extinction.[57] Indeed, Antarctic toothfish have been assessed as having a 'very high vulnerability' to fishing.[58]

2 Little is known about the life cycle of Antarctic toothfish
The breeding habits and early life of Antarctic toothfish remain a mystery, as scientists have never found the eggs, larvae or young toothfish. However, it is thought that the toothfish spawn infrequently in the winter and spring, beneath the sea ice near the seamounts that form the Pacific–Antarctic Ridge to the north and east of the Ross Sea.[59]

Without this vital information, monitoring of toothfish populations is very difficult and an accurate evaluation of the impact of fisheries is not possible. This lack of information, coupled with the high vulnerability of the Antarctic toothfish, highlights the need for extreme care in allowing any fishery to target such a species. Despite this, the current CCAMLR management measures in place for Antarctic toothfish aim to reduce the spawning population to 50% of its original unfished size over a 35-year period.[60]

3 Illegal fishing further undermines management
IUU fishing puts both the target species and the ecosystem at risk. Although IUU fishing is not considered by CCAMLR to be as much of a problem in the Ross Sea as in other parts of the Southern Ocean, IUU vessels have certainly been noted in the area and the continued underestimation of levels of IUU activity by CCAMLR is a major concern.

In the area managed by CCAMLR, there were over 60 instances of IUU fishing observed from 2003–2009.[61] Of these, two IUU vessel sightings were in the Ross Sea within the past two years (the *Zeus* in 2008 and the *Carmela* in 2009, both flagged to Togo). Both vessels had been caught fishing illegally in other CCAMLR areas while under different names and flags, and one vessel had been seen fishing illegally on at least seven other occasions.

4 Current fisheries management is already failing to protect the Ross Sea
The Ross Sea fishery for Antarctic toothfish is still considered 'exploratory' by CCAMLR and catch levels should be so low that there is no chance that overfishing will occur and they will have no impact on the ecosystem. Unfortunately, despite CCAMLR's claims that the catch limits set are precautionary and ecosystem-based, there is evidence that the fishery is already having a negative impact.

Adult toothfish can no longer be caught by scientists studying toothfish in the area of McMurdo Sound, the southern edge of the species' range.[62] As an important predator species within the Ross Sea, any declines in Antarctic toothfish populations are likely to have detrimental impacts on the whole ecosystem. In fact, Antarctic scientists have new evidence that the fishery may already have caused changes to the Ross Sea food web. The disappearance of Antarctic toothfish from McMurdo Sound has been linked to a decline in the numbers of fish-eating killer whales in the area,[63] and a change in the diet of Adélie penguins.[64]

5 The unique Ross Sea ecosystem needs to be protected
The Ross Sea offers marine scientists a unique opportunity to study and understand an unusual and almost pristine ecosystem, and to study the impacts of climate change and ocean acidification without interference from other factors. Closing the area to fishing and making it into a marine reserve will give the ecosystem a chance to recover from any impacts the fishery has already had. This will provide the ecosystem with a better chance of adapting to climate change and ocean acidification. It will also ensure that at least one piece of the Antarctic remains a natural reserve devoted to peace and science.

In recognition of the great value of this unique ecosystem, both CCAMLR and the Antarctic Treaty Consultative Parties have identified the Ross Sea as one of 11 priority areas for the development of a representative network of marine protected areas spread across the Southern Ocean.[65] The target date for establishing the network is 2012, and the first marine reserve, in an area south of the South Orkney Islands, was designated at a meeting in November 2009.[66]

While any fishery remains in the Ross Sea, it may undermine the political processes that put marine reserves in place. For example, the size of the marine reserve in the region of the South Orkney Islands was significantly reduced due to pressure from countries that wanted to protect the interests of the fisheries in the region.[67]

Image Patagonian Toothfish fillets

06

Reducing the market demand for toothfish

The key opposition to the protection of the Ross Sea is likely to come from those countries who fish for and trade in Antarctic toothfish. If we want to ensure that the Ross Sea is protected, the demand for Antarctic toothfish must be reduced. So who is trading in Antarctic toothfish? Where does it get sold? And who is eating it?

Unfortunately, lack of transparency and poor labelling within the global seafood industry make these questions difficult to answer, especially as Antarctic toothfish is not differentiated from Patagonian toothfish. This problem is compounded by the range and variety of names that toothfish is traded under, the complexity of the trade chain, and variability in recording official trade data. We can only identify the key players in the trade of both Patagonian and Antarctic toothfish.

Toothfish traders

Fleets from about 20 nations have been fishing for toothfish in recent years with around half of them taking over 80% of the total catch (Figure 5). The five fleets taking the largest catches in 2007 were from France, Chile, Uruguay, Australia, and the UK. The French fleet has taken around a fifth of the total global catch each year since 2004. There are recent reports that fishing for toothfish in the Ross Sea is becoming unprofitable for some companies due to an increasing number of vessels taking a corresponding lower share of the catch.[68]

In 2008, the top five exporters of toothfish were Uruguay, France, Chile, New Zealand, and Mauritius. In each year from 2004–2008 these five countries made up more than 70% of the total global export trade. France was the leading exporter from 2004–2007, but Uruguay took the lead in 2008 (Figure 6). The top exporters are not always the countries catching the most toothfish.

The top five importers of toothfish in 2008 were: the USA, Japan, China, Korea, and Singapore (Figure 7). Hong Kong, Chile, Canada and Uruguay are also major importers. From 2004–2008, over 40% of toothfish was imported by the USA, and the Asian markets imported an almost equal proportion.

Toothfish eaters

Consumption figures for toothfish are also not readily available. Nevertheless, it is clear from the figures that the five main importing countries identified – USA, Japan, China, Korea and Singapore – represent the top consuming nations as well. The USA, Japan, Korea and Singapore neither export nor re-export toothfish at all or in negligible amounts, and China (a country commonly used for processing) imported at least twice as much toothfish as it exported in the years 2004–2007.[69] Thus the bulk of imported toothfish must be consumed within these countries. In addition Australia and the UK seem to consume toothfish, as they land and catch more toothfish than they exported.

In a final twist, many consumers of toothfish are probably unaware that they are eating Antarctic or Patagonian toothfish. Retailers and restaurants have given toothfish more marketable names such as Chilean sea bass or Antarctic cod, and rarely provide information on where or how the fish was caught.

Toothfish is expensive and unusual, and therefore tends to be sold in the more high-end, exclusive seafood restaurants like Robert DeNiro's Nobu restaurants in London and the USA, as well as speciality seafood shops and seafood markets. It is uncommon in most European supermarkets, except in France where it is sold by supermarket chains such as Intermarché and Ecomarché owned by Les Mousquetaire group. This group has its own fishing fleet including the vessel *Ile de la Réunion*, which targets Patagonian toothfish in the waters around France's Crozet and Kerguelen islands in the sub-Antarctic.

In the USA and Canada toothfish is well-known under its alias Chilean sea bass. In the USA it is found in many supermarket chains: Costco, Delhaize (and associated banners), Giant Eagle, H.E.B., Harris Teeter, Kroger (and associated banners), Meijer, Price Chopper, Publix, Safeway, SUPERVALU (and associated banners), Target, Walmart, Wegmans and Whole Foods. With recent changes to seafood sourcing policies, the only major Canadian supermarket chain still selling toothfish after September 2010 will be Sobeys (see Chapter 7).

Figure 5 **Global catch of toothfish *(Dissostichus* species) in tonnes by country.**[70]

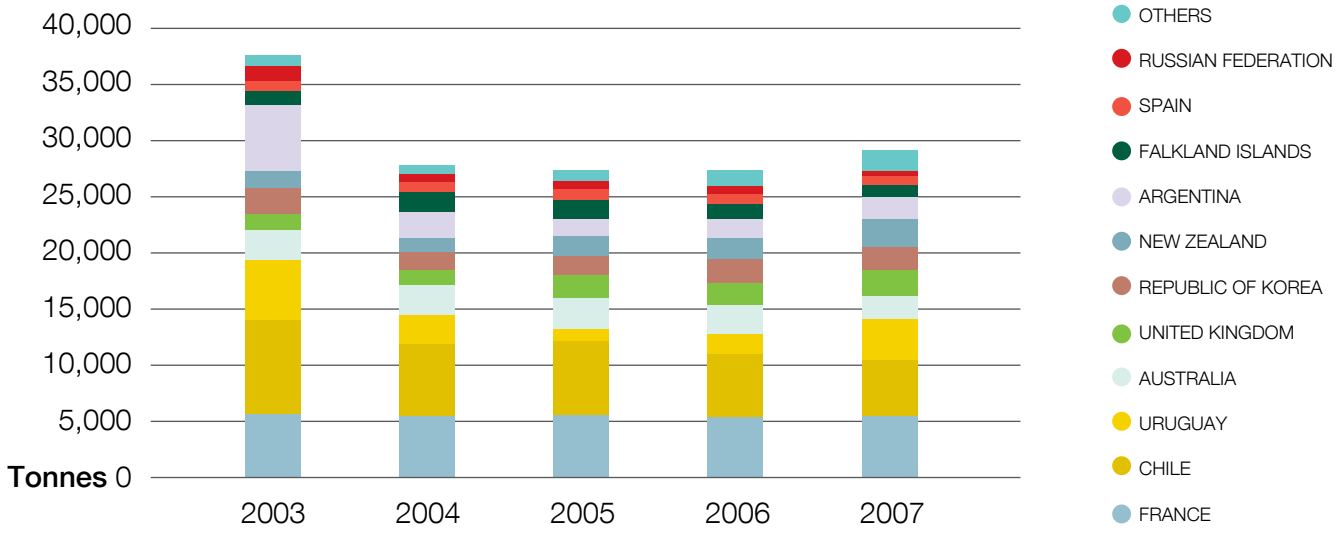


Figure 6 **Leading toothfish (*Dissostichus* species) exporters, 2004–2008.**[71]

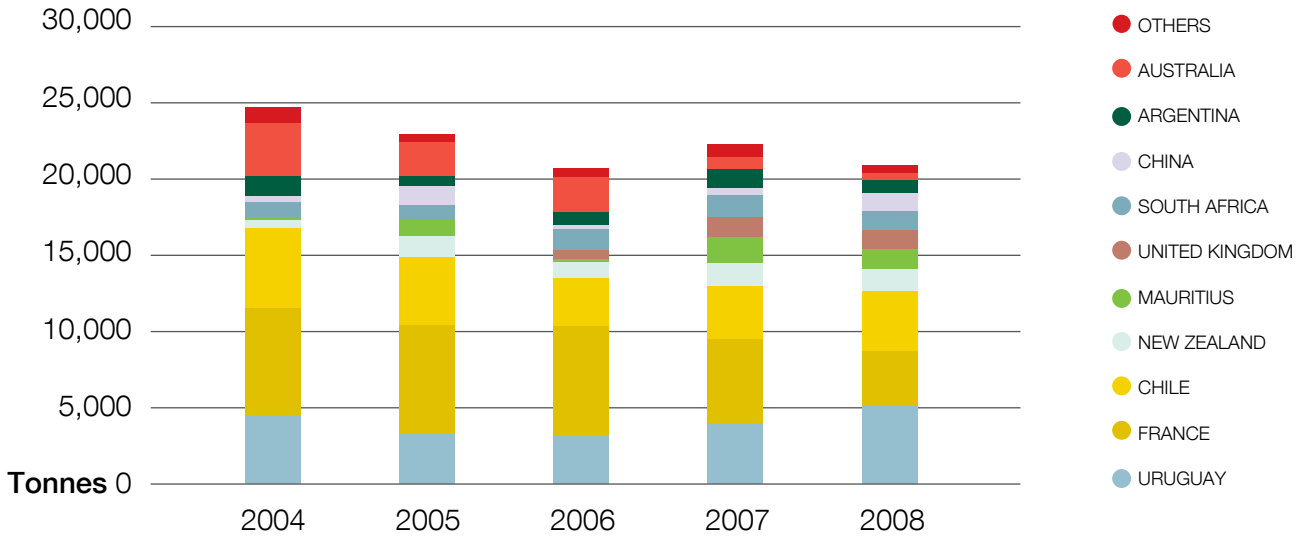
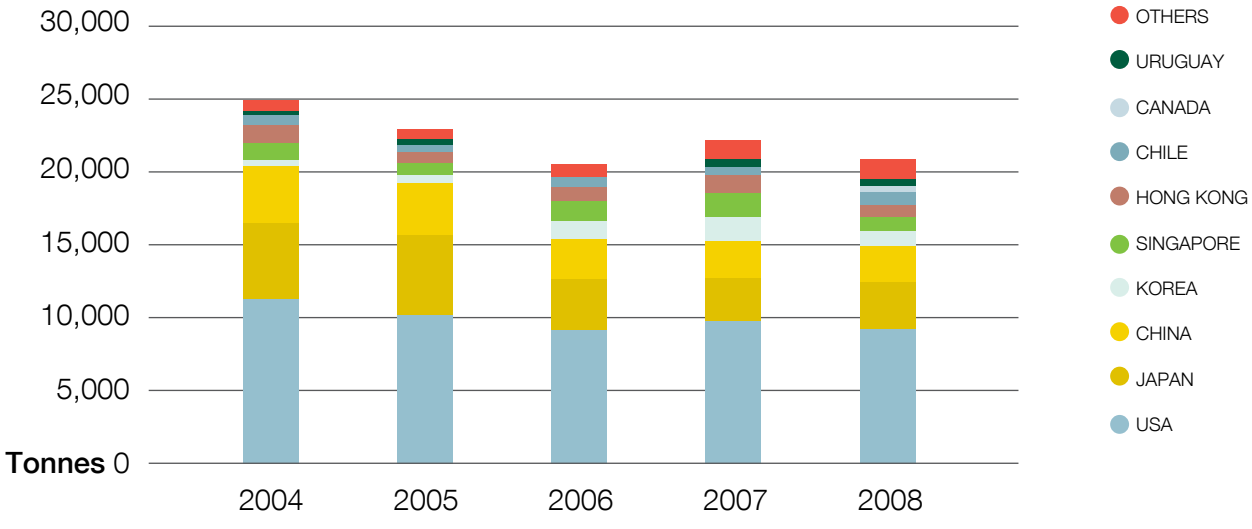


Figure 7 **Leading toothfish (*Dissostichus* species) importers, 2004–2008.**[72]



07

Champions for the Ross Sea marine reserve

The Ross Sea ecosystem must be protected by making it a marine reserve. Marine reserves are protected areas where no extractive processes are allowed. Under the Antarctic Treaty the Ross Sea is already protected from mining and oil and gas extraction, but not yet from fishing.

The political processes that put marine reserves in place can be slow and complex and undermined by short-term fisheries interests. We need a strong show of public support to ensure that the entire Ross Sea shelf and slope is designated as a marine reserve as soon as possible.

‘There is a tremendous amount of science that suggests the Ross Sea is not a place where we should be fishing. I, for one, don’t see the need to compromise the health of our oceans anymore than we already have. You will never see Antarctic toothfish on my menu, MSC-certified or otherwise.’

Hosea Rosenberg, Chef, USA

Image Iceberg in the Ross Sea, Antarctica

Image Adélie penguins on ice south of Buckle Island, Balleny Islands group

Retailers lead the way

Retailers around the world are joining the growing sustainable seafood movement by removing the most unsustainable choices from their freezers and counters and developing strong policies to ensure that they source sustainable seafood. Toothfish is disappearing from supermarket shelves. In the UK for example, retailers have not sold any toothfish for many years, and leading sustainable seafood retailer Waitrose lists toothfish (Chilean sea bass) on its banned list.[73]

In Canada, retail chains that until recently sold toothfish (as Chilean sea bass) like Loblaw, Safeway and Overwaitea have removed it from their shelves, and Metro plans to do so by September 2010. Sobey's will be the only major Canadian supermarket chain still selling toothfish after this time.

The movement is also growing in the USA. Ahold-USA have publicly stated that they will not sell toothfish products, and Wegmans will not sell any seafood products sourced directly from the Ross Sea "due to unresolved concerns over the fisheries." [74]

Famous US chefs Kin Lui and Hosea Rosenberg refuse to serve Ross Sea toothfish and are publicly supporting the campaign to protect the Ross Sea as a marine reserve.

'We do not sell the following on the basis of sustainability and concerns over declining stocks: North Sea cod, common skate, marlin, wild Atlantic salmon, blue fin and big eye tuna, sturgeon products, shark, ling, dogfish and Chilean sea bass.'

Waitrose, UK

08

How you can help

Please help us to ensure that at least one piece of the Antarctic remains a natural reserve for wildlife and an area devoted to peace and science for humankind.

1 Make a public commitment not to buy, sell or serve any toothfish, certified or otherwise, and publish this on your website. Reducing the demand for toothfish will make it easier to close the Ross Sea fishery.

2 Support the call to make the whole of the Ross Sea into a fully protected marine reserve to preserve this unique and threatened ecosystem for the future. Find out more at: www.greenpeace.org

References

[1] Australian Antarctic Division (2010). Australian Antarctic Division website> About Antarctica> Fact files. Australian Antarctic Division, Kingston, Tasmania, Australia. Accessed June 2010 at: www.aad.gov.au/default.asp?casid=1134

[2] Antarctica New Zealand (2010). Antarctica New Zealand website> Environmental stewardship> Managing resources. Antarctica New Zealand, Christchurch, New Zealand. Accessed June 2010 at: www.antarcticanz.govt.nz/environmental-stewardship/managing-resources

[3] Halpern BS, Walbridge S, Selkoe KA, Kappel CB, Micheli F, D'Agrosa C, Bruno JF, Casey KS, Ebert C, Fox HE, Fujita R, Heinemann D, Lenihan HS, Madin EMP, Perry MT, Selig ER, Spalding M, Steneck R, Watson R (2008). A global map of human impact on marine ecosystems. Science; 319: 948–51. Accessed June 2010 at: www.sciencemag.org/cgi/content/abstract/319/5865/948

[4] Australian Antarctic Division (2010). Australian Antarctic Division website> Science. Australian Antarctic Division, Kingston, Tasmania, Australia. Accessed June 2010 at: www.aad.gov.au/default.asp?casid=58

[5] Reilly SB, Bannister JL, Best PB, Brown M, Brownell RL Jr, Butterworth DS, Clapham PJ, Cooke J, Donovan GP, Urbán J, Zerbini AN (2008). Balaenoptera musculus. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. Accessed June 2010 at: www.iucnredlist.org/apps/redlist/details/2477/0

[6] Reilly SB, Bannister JL, Best PB, Brown M, Brownell RL Jr, Butterworth DS, Clapham PJ, Cooke J, Donovan GP, Urbán J, Zerbini AN (2008). Balaenoptera physalus. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. Accessed June 2010 at: www.iucnredlist.org/apps/redlist/details/2478/0

[7] Australian Antarctic Division (2010). Australian Antarctic Division website> Antarctic Law & Treaty. Australian Antarctic Division, Kingston, Tasmania, Australia. Accessed June 2010 at: www.aad.gov.au/default.asp?casid=76

[8] Myers RA, Worm B (2003). Rapid worldwide depletion of predatory fish communities. Nature; 423: 280–3.

[9] Myers RA, Worm B (2005). Extinction, survival, or recovery of large predatory fishes. Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences; 360: 13–20. Accessed June 2010 at: www.ncbi.nlm.nih.gov/pmc/articles/PMC1636106/

[10] Baum JK, Worm B (2009). Cascading top-down effects of changing oceanic predator abundances. Journal of Animal Ecology; 78: 699–714. Accessed June 2010 at: wormlab.biology.dal.ca/ramweb/papers-total/Baum_Worm_2009.pdf

[11] Pauly D, Watson R, Alder J (2005). Global trends in world fisheries: Impacts on marine ecosystems and food security. Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences; 360: 5–12. Accessed June 2010 at: http://ichthyology.bio.auth.gr/files/coursematerial/m18-1.pdf

[12] Nicol S, Endo Y (1999). Krill fisheries: Development, management and ecosystem implications. Aquatic Living Resources; 12 (2): 105–20. Accessed June 2010 at: www.alr-journal.org/index.php?option=article&access=standard&Itemid=129&url=/articles/alr/pdf/1999/02/alr9230.pdf

[13] Kock K-H (ed) (2000). Understanding CCAMLR's Approach to Management. Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), Hobart, Australia. Accessed June 2010 at: www.ccamlr.org/pu/E/e_pubs/am/text.pdf

[14] Ainley DG, Blight LK (2009). Ecological repercussions of historical fish extraction from the Southern Ocean. Fish and Fisheries; 10: 13–38.

[15] CCAMLR (2010). CCAMLR website> English> General introduction. Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), Hobart, Australia. Accessed June 2010 at: www.ccamlr.org/pu/e/gen-intro.htm

[16] CCAMLR (2010). CCAMLR website> Scientific committee> Scientific observation. Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), Hobart, Australia. Accessed June 2010 at: www.ccamlr.org/pu/e/sc/obs/intro.htm

[17] Hanchet S, Horn P, Stevenson M (2003). Fishing in the ice: Is it sustainable? Water & Atmosphere; 11(3): 24-5. Accessed June 2010 at: www.niwa.co.nz/__data/assets/pdf_file/0018/52191/sustainable.pdf

[18] CCAMLR (2010). CCAMLR website> Publications> Conservation measures> Schedule of conservation measures in force 2009/10. Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), Hobart, Australia. Accessed June 2010 at: www.ccamlr.org/pu/e/e_pubs/cm/09-10/21-02.pdf

[19] AFMA (2009). CCAMLR new and exploratory fisheries. Annual status report. Australian Fisheries Management Authority, Canberra, ACT, Australia. Accessed June 2010 at: www.afma.gov.au/fisheries/antarctic/ccamlr/publications/CCAMLR_strategic_reassessment_2009.pdf

[20] CCAMLR (20010). CCAMLR website> Educational resources> Where?. Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), Hobart, Australia. Accessed June 2010 at: www.ccamlr.org/edu/eng/e-where.htm

[21] CCAMLR (2010). Statistical Bulletin, Vol. 22 (2000–2009). Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), Hobart, Australia. Accessed June 2010 at: www.ccamlr.org/pu/e/e_pubs/sb/intro.htm

[22] CCAMLR (2010). Statistical Bulletin, Vol. 22 (2000–2009). Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), Hobart, Australia. Accessed June 2010 at: www.ccamlr.org/pu/e/e_pubs/sb/intro.htm

[23] FAO (2010). FAO website> Fisheries & aquaculture> Statistics> Global capture production. Food and Agriculture Organisation of the United Nations (FAO), Rome, Italy. Accessed June 2010 at: www.fao.org/fishery/statistics/global-capture-production/en

[24] Lack M, Sant G (2001). Patagonian Toothfish: Are conservation and trade measures working? TRAFFIC Bulletin, Vol. 19 No. 1. Accessed June 2010 at: www.traffic.org/species-reports/traffic_species_fish13.pdf

[25] NET (2002). National Environmental Trust Briefing Book: CITES and toothfish. Convention on International Trade in Endangered Species of Wildlife Fauna and Flora (CITES), Santiago, Chile, 3–15 November 2002. National Environmental Trust (NET), Washington DC, USA.

[26] Lack M (2008). Continuing CCAMLR's Fight against IUU. Fishing for Toothfish. WWF Australia and TRAFFIC International. Accessed June 2010 at: www.traffic.org/species-reports/traffic_species_fish31.pdf

[27] AFMA (2009). CCAMLR new and exploratory fisheries. Annual status report. Australian Fisheries Management Authority (AFMA), Canberra, ACT, Australia. Accessed June 2010 at: www.afma.gov.au/fisheries/antarctic/ccamlr/publications/CCAMLR_strategic_reassessment_2009.pdf

[28] CCAMLR (2009). Report of the Twenty-Eighth Meeting of the Scientific Committee. Hobart, Australia, 26–30 October 2009. Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), Hobart, Australia. SC-CCAMLR-XXVIII. Accessed June 2010 at: www.ccamlr.org/pu/e/e_pubs/sr/drt.htm

[29] AFMA (2009). CCAMLR new and exploratory fisheries. Annual status report. Australian Fisheries Management Authority, Canberra, ACT, Australia. Accessed June 2010 at: www.afma.gov.au/fisheries/antarctic/ccamlr/publications/CCAMLR_strategic_reassessment_2009.pdf

[30] ASOC (2010). Antarctic advocacy> Campaigns to protect Antarctica> Protecting the Ross Sea. The Antarctic and Southern Ocean Coalition (ASOC), Washington DC, USA. Accessed June 2010 at: www.asoc.org/AntarcticAdvocacy/CampaignstoProtectAntarctica/ProtectingtheRossSea/tabid/140/Default.aspx

[31] Halpern BS, Walbridge S, Selkoe KA, Kappel CB, Micheli F, D'Agrosa C, Bruno JF, Casey KS, Ebert C, Fox HE, Fujita R, Heinemann D, Lenihan HS, Madin EMP, Perry MT, Selig ER, Spalding M, Steneck R, Watson R (2008). A global map of human impact on marine ecosystems. Science; 319: 948–51. Accessed June 2010 at: www.sciencemag.org/cgi/content/abstract/319/5865/948

[32] Smith WO Jr, Ainley DG, Cattaneo-Vietti R, Hofman EE (2010). The Ross Sea continental shelf: Regional biogeochemical cycles, trophic interactions, and potential future changes. In: Antarctica: An extreme environment in a changing world. J Wiley & Sons, London, UK, in press. Accessed June 2010 at: www.penguinscience.com/reprints/ross_sea/Ross_Sea_Description.pdf.

[33] Smith WO Jr, Ainley DG, Cattaneo-Vietti R, Hofman EE (2010). The Ross Sea continental shelf: Regional biogeochemical cycles, trophic interactions, and potential future changes. In: Antarctica: An extreme environment in a changing world. J Wiley & Sons, London, UK, in press. Accessed June 2010 at: www.penguinscience.com/reprints/ross_sea/Ross_Sea_Description.pdf

[34] Arrigo KR, Worthen D, Schnell A, Lizotte MP (1998). Primary Production in Southern Ocean waters, Journal of Geophysical Research; 103(C8): 15,587–600. Accessed June 2010 at: www.agu.org/pubs/crossref/1998/98JC00930.shtml

[35] ASOC (2010). The case for inclusion of the Ross Sea continental shelf and slope in a Southern Ocean network of marine reserves. Paper presented by the Antarctic and Southern Ocean Coalition (ASOC) at XXXIII Antarctic Treaty Consultative Meeting, 3-14 May 2010, Punta del Este, Uruguay. Accessed June 2010 at: www.asoc.org/LinkClick.aspx?fileticket=kki85XWZVlg%3d&tabid=197

[36] Eastman JT, Hubold G (1999). The fish fauna of the Ross Sea, Antarctica. Antarctic Science; 11: 293–304. Accessed June 2010 at: http://journals.cambridge.org/action/displayFulltext?type=1&fid=219730&jid=ANS&volumeId=11&issueId=03&aid=219729

[37] Eastman JT (1985). Pleuragramma antarcticum (Pisces, Nototheniidae) as food for other fishes in McMurdo Sound, Antarctica. Polar Biology; 4: 155–60.

[38] Fenaughty JM, Stevens DW, Hanchet SM (2003). Diet of the Antarctic toothfish (Dissostichus mawsoni) from the Ross Sea, Antarctica (CCAMLR statistical subarea 88.1). CCAMLR Science; 10: 1–101.

[39] Ainley, D.G., Siniff, D.B., 2009. The importance of Antarctic toothfish as prey of Weddell Seals in the Ross Sea: A review. Antarctic Science; 21: 317–27.

[40] Ainley DG, Ballard G, Olmastroni S (2009). An apparent decrease in the prevalence of "Ross Sea killer whales" in the southern Ross Sea. Aquatic Mammals; 35 (3): 335–47. Accessed June 2010 at: www.orcanetwork.org/nathist/rossseakws.pdf

[41] Rosa R, Seibel BA (2010). Slow pace of life of the Antarctic colossal squid. Journal of the Marine Biological Association of the United Kingdom; doi:10.1017/S0025315409991494. Published online by Cambridge University Press 20 Apr 2010. Accessed June 2010 at: http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=7577652&fulltextType=RA&fileId=S0025315409991494

[42] Smith WO Jr, Ainley DG, Cattaneo-Vietti R, Hofman EE (2010). The Ross Sea continental shelf: Regional biogeochemical cycles, trophic interactions, and potential future changes. In: Antarctica: An extreme environment in a changing world. J Wiley & Sons, London, UK, in press. Accessed June 2010 at: www.penguinscience.com/reprints/ross_sea/Ross_Sea_Description.pdf

[43] Reilly SB, Bannister JL, Best PB, Brown M, Brownell Jr RL, Butterworth DS, Clapham PJ, Cooke J, Donovan GP, Urbán J, Zerbini AN (2008). Balaenoptera musculus. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. Accessed June 2010 at: www.iucnredlist.org/apps/redlist/details/2477/0

[44] Reilly SB, Bannister JL, Best PB, Brown M, Brownell Jr RL, Butterworth DS, Clapham PJ, Cooke J, Donovan GP, Urbán J, Zerbini AN (2008). Balaenoptera physalus. In: IUCN 2010. IUCN Red List of Threatened Species. Version 2010.1. Accessed June 2010 at: www.iucnredlist.org/apps/redlist/details/2478/0

[45] LeDuc RG, Robertson KM, Pitman RL (2008). Mitochondrial sequence divergence among Antarctic killer whale ecotypes is consistent with multiple species. Biology Letters; 4: 426–9. Published online

2008 June 4. doi: 10.1098/rsbl.2008.0168. Accessed June 2010 at: www.ncbi.nlm.nih.gov/pmc/articles/PMC2610147/

[46] Pitman RL, Perryman WL, LeRoi D, Eilers E (2007). A dwarf form of killer whale in Antarctica. Journal of Mammalology; 88: 43–8. doi:10.1644/06-MAMM-A-118R1.1. Accessed June 2010 at: www.bioone.org/doi/full/10.1644/06-MAMM-A-118R1.1

[47] Rosa R, Seibel BA (2010). Slow pace of life of the Antarctic colossal squid. Journal of the Marine Biological Association of the United Kingdom; doi:10.1017/S0025315409991494. Published online by Cambridge University Press 20 Apr 2010. Accessed June 2010 at: http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=7577652&fulltextType=RA&fileId=S0025315409991494

[48] La Canna X (2007). The Age website> World> Half-tonne colossus squid hauled up from the deep. The Age, Melbourne, VIC, Australia. www.theage.com.au/news/world/halftonne-colossus-squid-hauled-up-from-the-deep/2007/02/22/1171733950894.html

[49] Weller J, Ainley D (2010). The Ross Sea, Antarctica: Science, Policy and the Public in a Pristine Marine Ecosystem. Report from a workshop held at the International Marine Conservation Congress, George Mason University, Fairfax VA USA, 20–22 May 2009. Accessed June 2010 at: www.asoc.org/Portals/0/IMCC%20Ross%20Sea%20Final%20Report-1.pdf

[50] CCAMLR (2009). Report of the Twenty-Eighth Meeting of the Scientific Committee. Hobart, Australia, 26–30 October 2009. Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), Hobart, Australia. SC-CCAMLR-XXVIII. Accessed June 2010 at: www.ccamlr.org/pu/e/e_pubs/sr/drt.htm

[51] CCAMLR (2010). Statistical Bulletin, Vol. 22 (2000–2009). Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), Hobart, Australia. Accessed June 2010 at: www.ccamlr.org/pu/e/e_pubs/sb/intro.htm

[52] CCAMLR (2010). Statistical Bulletin, Vol. 22 (2000–2009). Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), Hobart, Australia. Accessed June 2010 at: www.ccamlr.org/pu/e/e_pubs/sb/intro.htm

[53] MSC (2010). MSC website> Track a fishery. Marine Stewardship Council (MSC), London, UK. Accessed June 2010 at: www.msc.org/track-a-fishery

[54] Greenpeace (2009). Assessment of the Marine Stewardship Council (MSC) Fisheries Certification Programme. Greenpeace International, Amsterdam, The Netherlands. Accessed June 2010 at: www.greenpeace.org/international/en/publications/reports/marine-stewardship-council-MSC/

[55] Hanchet S, Horn P, Stevenson M (2003). Fishing in the ice: Is it sustainable? Water & Atmosphere; 11(3): 24-5. Accessed June 2010 at: www.niwa.co.nz/__data/assets/pdf_file/0018/52191/sustainable.pdf

[56] CCAMLR (2008). Fishery report: Exploratory fishery for Dissostichus spp. in subareas 88.1 and 88.2. The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), Hobart, Australia. Accessed June 2009 at: www.ccamlr.org/pu/e/e_pubs/fr/drt.htm

[57] Reynolds JD, Dulvy NK, Goodwin NB, Hutchings JA (2005). Biology of extinction risk in marine fishes. Proceedings of the Royal Society B: Biological Sciences; 272: 2337–44. Accessed June 2010 at: http://rspb.royalsocietypublishing.org/content/272/1579/2337.full

[58] Froese R, Pauly D (Eds) (2008). FishBase. Online version (01/2008). Accessed June 2010 at: www.fishbase.com/search.php

[59] Hanchet SM, Rickard GJ, Fenaughty JM, Dunn A, Williams MJH (2008). A hypothetical life cycle for Antarctic toothfish (Dissostichus mawsoni) in the Ross Sea region. CCAMLR Science; 15: 35–53. Accessed March 2010 at: www.ccamlr.org/pu/E/e_pubs/cs/Vol-15-2008/02hanchet-et-al.pdf

[60] CCAMLR (2009). Report of the Working Group on Fish Stock Assessment, CCAMLR. Hobart, Australia, 12–23 October 2009. The Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), Hobart, Australia. SC-CCAMLR-XXVIII/4

[61] CCAMLR (2009). Combined IUU vessel lists adopted from 2003 to 2009. Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), Hobart, Australia. Accessed June 2010 at: www.ccamlr.org/pu/E/sc/fish-monit/iuu-list-09.pdf

[62] DeVries AL, Ainley DG, Ballard G (2008). Decline of the Antarctic Toothfish and its predators in McMurdo sound and the southern Ross Sea, and recommendations for restoration. CCAMLR Document EMM-08/21. Accessed June 2010 at: www.penguinscience.com/reprints/ross_sea/Fishing_industry_taking_the_fish.pdf

[63] Ainley DG, Ballard G, Olmastroni S (2009). An apparent decrease in the prevalence of "Ross Sea killer whales" in the southern Ross Sea. Aquatic Mammals; 35 (3): 335–47. Accessed June 2010 at: www.orcanetwork.org/nathist/rossseakws.pdf

[64] DeVries AL, Ainley DG, Ballard G (2008). Decline of the Antarctic Toothfish and its predators in McMurdo sound and the southern Ross Sea, and recommendations for restoration. CCAMLR Document EMM-08/21. Accessed June 2010 at: www.penguinscience.com/reprints/ross_sea/Fishing_industry_taking_the_fish.pdf

[65] CCAMLR (2009). Report of the Twenty-Eighth Meeting of the Scientific Committee. Hobart, Australia, 26–30 October 2009. Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), Hobart, Australia. SC-CCAMLR-XXVIII. (See paragraph 3.26). Accessed June 2010 at: www.ccamlr.org/pu/e/e_pubs/sr/drt.htm

[66] CCAMLR (2009). Report of the Twenty-Eighth Meeting of the Commission. Hobart, Australia, 26 October–6 November 2009. Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), Hobart, Australia. CCAMLR-XXVIII. Accessed June 2010 at: www.ccamlr.org/pu/e/e_pubs/cr/drt.htm

[67] CCAMLR (2009). Report of the Twenty-Eighth Meeting of the Commission. Hobart, Australia, 26 October–6 November 2009. Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), Hobart, Australia. CCAMLR-XXVIII. Accessed June 2010 at: www.ccamlr.org/pu/e/e_pubs/cr/drt.htm

[68] Real N (2010). FIS website> World news> Lower second-half profits for Sanford. Fish Information & Services (FIS). Accessed June 2010 at: www.fis.com/fis/worldnews/worldnews.asp?l=e&country=0&special=&monthyear=&day=&id=34713&ndb=1&df=0

[69] CCAMLR (2010). Statistical Bulletin, Vol. 22 (2000–2009). Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), Hobart, Australia. Accessed June 2010 at: www.ccamlr.org/pu/e/e_pubs/sb/intro.htm

[70] FAO (2010). FAO website> Fisheries & aquaculture> Statistics> Global capture production. Food and Agriculture Organisation of the United Nations (FAO), Rome, Italy. Accessed June 2010 at: www.fao.org/fishery/statistics/global-capture-production/en

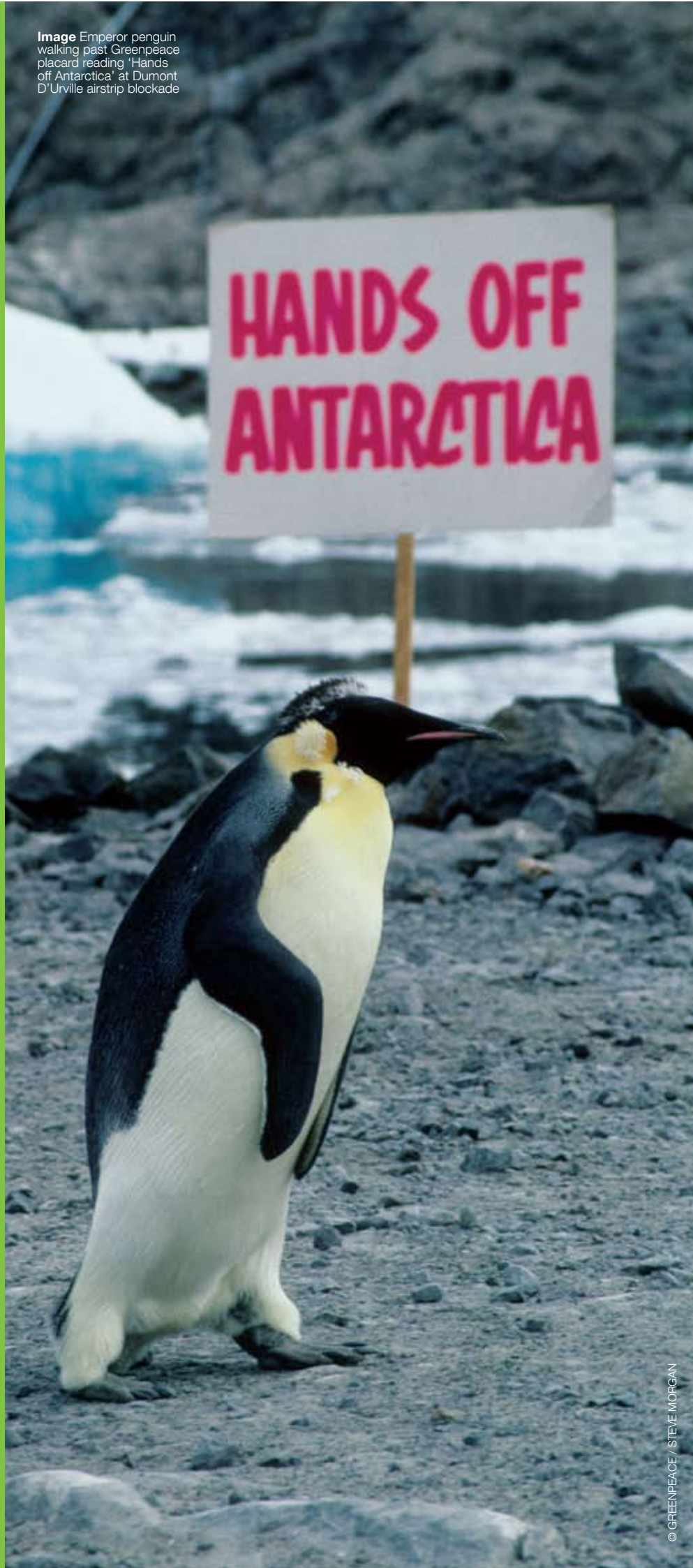
[71] CCAMLR (2010). Statistical Bulletin, Vol. 22 (2000–2009). Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), Hobart, Australia. Accessed June 2010 at: www.ccamlr.org/pu/e/e_pubs/sb/intro.htm

[72] CCAMLR (2010). Statistical Bulletin, Vol. 22 (2000–2009). Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), Hobart, Australia. Accessed June 2010 at: www.ccamlr.org/pu/e/e_pubs/sb/intro.htm

[73] Waitrose (2010). Waitrose website> Food & drink> Food> Product ranges> Fish> Your questions. Waitrose, Bracknell, UK. Accessed June 2010 at: www.waitrose.com/food/productranges/fish/yourquestions.aspx

[74] Wegmans (2010). Wegmans website> About us> Sustainability> Seafood Sustainability: Product Chart. Wegmans, Rochester, NY, USA. Accessed June 2010 at: https://www.wegmans.com/webapp/wcs/stores/servlet/ProductDisplay?storeId=10052&krypto=G2fxk6p%2BKn%2BeE9bnEUF7GfuWNgRlhIbfnKsAU0mB22MoTNZ6pquPTir39XqdlLzY&ddkey=http:ProductDisplay

Image Emperor penguin walking past Greenpeace placard reading 'Hands off Antarctica' at Dumont D'Urville airstrip blockade



GREENPEACE

Greenpeace is an independent global campaigning organisation that acts to change attitudes and behaviour, to protect and conserve the environment and to promote peace.

Greenpeace International
Ottho Heldringstraat 5
The Netherlands
Tel: +31 20 7182000
Fax: +31 20 7182002

greenpeace.org