* Line sink rate tests conducted prior to entry into the fishery must be conducted on a minimum of two sets. Fishers typically opt to just do the minimum requirement of two sets.

* Fishers know what weights they need to add to achieve the sink rate. This information is shared within the fleet because fishers have an incentive to achieve the sink rate.

* CM 24-02 allows for a protocol that uses a "bottle" test. This method allows for instantaneous feedback. Thus, in the rare event when they might not achieve the specified sink rate, they can apply more weight to the line or decrease the spacing between weights to achieve the desired sink rate.

Entanglement of marine mammals with longline gear is a rare event in Convention waters. Killer whales and sperm whales have been known to eat toothfish off the longline hook, however no known marine mammal entanglements occurred in longline testing trials by the U.S. vessels (Pers. Comm. Chris Jones NOAA).

For the reasons set out above and due to the lack of any reported entanglements, NMFS believes the chance of birds or marine mammals being caught during these line sink rate tests is extremely low and is not an issue that merits attention at this time. Therefore, there is no protected resource basis for restricting (or considering an alternative to do so) areas that the U.S. longline trials could be conducted to areas where there would be little or no protected species interactions. Additionally, to require U.S. longline vessels to travel to a limited number of specified areas to conduct their testing trials would unnecessarily remove their flexibility in conducting the discretionary longline testing trials and, thereby, would likely impose undue economic costs on these fishers. For these reasons, alternatives to restrict areas where these tests can be conducted were considered, but rejected.

SECTION 3.0 DESCRIPTION OF AFFECTED ENVIRONMENT

3.1.a. <u>Biology and Status of the Stocks</u> -- Finfish

Toothfish

Toothfish belong to the Family Nototheniidae (cod icefish) and are related to other Antarctic commercial species, such as the Antarctic silverfish (*Pleuragramma antarcticum*) and the many species of rock cods (including the striped-eye notothen, *Lepidonotothen kempi*). This large and widespread Antarctic family is found throughout the high latitudes of the Southern Hemisphere and coastal Antarctica. The two species of toothfish (*Dissostichus eleginoides* and *D. mawsoni*) are both large predators with a circumpolar distribution. Direct population counts are not practical due to logistical considerations because both species have remote distributions and are found in deep waters over the continental shelf. Traditional methods of estimating stock size using trawling techniques have proved ineffective, and few scientific surveys of local populations have been conducted. Toothfish are also difficult to age, and no aging techniques have been validated, so age-specific data are not entirely reliable. Much of the available data on species occurrence and general abundance has been gathered from commercial fisheries, and a majority of the population information is based on catch-per-unit-effort (CPUE) data and a few local recruitment surveys. However, this data can still be used to conduct stock assessments and calculate yield rates for certain areas.

Patagonian Toothfish

Patagonian toothfish (*Dissostichus eleginoides*), are found in sub-Antarctic and cool temperate waters between 35^{o} and 55^{o} South, in the southeast Pacific (Macquarie Island), continental shelf areas of the southwest Atlantic (southern Chile, Patagonia, Falkland Islands), and the Southern Ocean (South Georgia, islands and seamounts in the Indian Ocean sector). The depth range of this pelagic species ranges from 50 to 3,850 m, with a seasonal shift during the austral summer to deeper waters. Patagonian toothfish are slow growing and long lived, reaching ages of more than 50 years and sizes up to 215 cm. They are opportunistic predators, feeding on a range of other finfishes, amphipods, shrimp, and krill; Chikov and Mel'nikov (1990) reported mackerel icefish as the preferred prey item. Diet items change with growth, and also vary seasonally with the abundance and migrations of major prey species (Arkhipkin *et al*. 2003). As fishes grow older and larger, they move into deeper waters and show a decrease in their hunting activity levels. Age specific differences in depth distributions are explained by prey availability and cannibalism of juveniles by adults. Biogeographical differences also exist in diet composition (Goldsworthy *et al*. 2002). The species feeds year round, with a small peak in April through August. The Patagonian toothfish is found in the diets of seabirds, seals and sea lions, and other finfishes, although it does not seem to form a major component (Goldsworthy *et al*. 2001). There also appears to be little competition between the Patagonian toothfish and other marine predators.

Patagonian toothfish and Antarctic toothfish are quite similar in size and appearance, and it is likely that incorrect identification (both accidental and intentional) occurs. Two diagnostic features can be used to distinguish between the two species. In Patagonian toothfish, there are narrow, scale-free areas on the top of the head, while Antarctic toothfish heads are fully scaled forward to the front of the eye. While this is a reliable distinguishing feature, it is difficult to use on live fishes. In live fishes, differences in the middle lateral line is an easier characteristic to use- in Patagonian toothfish, it extends forward to the forward end of the ventral fin, while it is very short in Antarctic toothfish.

Maturity is reached late in Patagonian toothfish, at 6 to 9 years of age and 38-60cm (Lack and Sant 2001). Females grow faster and reach greater sizes than males. Fecundity is low, ranging from 48,900 to 528,900 eggs per female, and is dependent on female body size (Chikov and Mel'nikov 1990). While there have been some claims from the fishing industry that toothfish taken in commercial fishing operations were largely senescent and no longer contributing to the population, Everson and Campbell (1991) reported that many fish taken commercially are not only sexually mature, but also in or approaching spawning condition. Spawning takes place over the continental shelf and slope in June through September; the large pelagic eggs are found in the upper 500m of the water column in waters 2200 to 4400 m deep (Evseenko *et al*. 1995). Hatching occurs in October and November. Patagonian toothfish exhibit a low resilience, with a minimum population doubling time of 4.5 to 14 years. This results in a high level of vulnerability to overexploitation through non-optimal harvesting practices.

Stock Structure

Appleyard *et al*. (2002) reported restricted gene flow in Patagonian toothfish populations, indicating separate stocks at the Macquarie Islands, Heard and McDonald Islands, and Shag Rocks/South Georgia. Stock separation has also been reported between the Falkland Islands and South Georgia/Kerguelen Islands. Such separations emphasize that depletion in one location is unlikely to be quickly replaced by immigration from another location.

Stock Assessments

Estimates of age and growth have been made in the southwest Atlantic (Zakharov *et al*. 1976), Kerguelen Islands (Hureau and Ozouf-Costaz 1980), and the Indo-Pacific boundary of the Southern Ocean (Horn 1998). However, as noted before, the aging techniques have not been validated and may be imprecise. Currently, recruitment data are available from only two locations within the CCAMLR area- South Georgia and Heard Island (Constable *et al*. in prep). These data were used to calculate long-term annual yield estimates of 3,690 mt at South Georgia and 4,575 mt at Heard Island. Given the large differences in fishing area between the two locations (32,025 km^2 vs. 111,298 km^2, respectively), it appears that productivity of this species can differ markedly between locations. Such differences in productivity limits the application of yield estimates to other areas, and emphasizes the need to calculate population status and trends for each individual stock.

Although full stock assessments have only been carried out for South Georgia and Heard Island, CPUE data are available for other areas as well. Where reliable data exist, reduced CPUE and clear population declines have been shown, especially in areas that are subject to Illegal, Unreported, and Unregulated (IUU) fishing. IUU fishing is a significant problem threatening toothfish stocks, with serious impacts on both short- and long-term yield estimates.

Antarctic Toothfish

The Antarctic toothfish (*Dissostichus mawsoni*) is endemic to the seas around Antarctica, and found broadly distributed between 55^o and 78^o South. It is thought that the Antarctic Convergence serves as an ecological barrier for this species (Vukhov 1972).

The Convergence may also reduce spatial overlap with the Patagonian toothfish, although the extent of overlap between the two species is not fully known. This pelagic species is found in waters ranging from 0 to 1,600 m. The species is long-lived, reaching ages of 35 years or more. Although Horn (2002) reported that Antarctic toothfish grow faster and attain larger sizes than the Patagonian toothfish, the maximum reported size is only 175 cm. The diet of recruits and juveniles is mainly zooplankton, while adults feed on squid, other fishes, amphipods, and mysids. Maturity is reached late at about 8 years of age and 100 cm. Fecundity is higher than in the Patagonian toothfish, with females producing up to 400,000 eggs per season. While less is known about the biology of the Antarctic toothfish relative to the Patagonian toothfish, the two seem to have many characteristics in common. In particular, the two species both exhibit a low resilience (minimum population doubling time 4.5 to 14 years), and are vulnerable to the effects of overexploitation.

Krill

Krill (*Euphausia superba*) are a crustacean species found in the waters of the Southern Ocean. Although they exhibit a widespread distribution, concentrations are associated with permanent large-scale cyclonic eddies found near topographic features that influence the eastward flowing Antarctic Circumpolar Current (ACC). Hewitt and Linen Low (2000) reported a latitudinal asymmetry in krill distribution, with higher numbers being found in the southwest Atlantic sector. The density and distribution of krill is related to both reproductive activity and water movements. Although concentrations of krill are associated with hydrographic features, Daly and Macaulay (1991) reported that physical processes do not appear to directly affect krill; distribution and behavior is instead a function of the need to acquire food and avoid predators. Densities vary with depth; deeper waters (215-315 m) are preferred over shallower and surface waters. Krill often form aggregations that may range in size from small, discreet swarms to layers that can be up to 35 nmi long and 245 m deep. These layers may contain a significant portion of the biomass within an area.

Of the 85 species of euphausids found worldwide, *E. superba* is the largest, longest lived, and maintains the highest biomass. Krill have been documented in the field to live 5 to 6 years, but experimental results show they may reach ages of up to 10 years. Adult size ranges between 30 and 51 mm (Kang *et al*. 1999). Seasonal sea ice plays a vital role in krill ecology, providing both food and shelter for multiple life history stages (Daly and Macaulay 1991). Adults are found in large concentrations under ice cover feeding on algae and depend on marginal ice zones and associated phytoplankton blooms to maintain energy supplies and promote reproductive development during the winter and early spring. First-feeding larvae also depend on ice-edge blooms as an important and predictable food source. Additionally, ice floes provide protection from predation for larvae and juveniles. Both diet and feeding method change seasonally, switching from raptorial and raked feeding in winter to filter feeding on microzooplankton and phytoplankton in the summer (Nishino and Kawamura 1994).

Krill compete with salps for their phytoplankton food; during years of high salp abundance or low phytoplankton densities, they may experience diminished spawning ability. Salps also affect krill populations by feeding on pelagic krill eggs. As the dominant herbivore and a key prey organism, krill form a major component of the Southern Ocean food web (Watkins and Murray 1998). Consumed in large numbers by a variety of predators, these crustaceans are the principal component of the diets of seals, penguins, other seabirds, certain fish species, and squid (Green-Hammond *et al*. 1985). Krill are also an important component in the diets of many other Antarctic species, including several whale species.

Krill spawn in the upper water column of offshore areas during summer in the southwest Atlantic sector near the South Shetland and South Orkney Islands. They are also abundant around South Georgia, but do not appear to spawn there and the population may be transported there from the Bellingshausen Sea via the ACC. During the summer breeding season, spatial segregation of age classes is seen, with juveniles inshore and breeding adults in offshore areas. Brood size varies between 1,000 and 6,000 eggs and does not appear to be linked to female size (Ross and Quentin 1982). The reproductive season lasts about 2 months, with multiple broods being produced in a given season; on average, each female will release about 20,000 eggs per year. Larval distributions follow the same patterns as adult concentrations (Makarov *et al*. 1985). Larvae metamorphose into juveniles during the winter and early spring of the following year. Large interannual variation is seen in recruitment patterns and resulting densities in the areas around the South Shetland Islands and South Georgia; age structure of the population tends to be dominated by one or two age classes at any given time. A repeating cycle of 4 to 5 years is seen, with 1 to 2 years of good recruitment followed by several poor years.

Stock Structure

At least three separate stocks exist in association with topographic features influencing the ACC. The Scotia Arc-Weddell stock in the northern extension of the Weddell Gyre; the Enderby stock in the Eastern Wind Drift between 20^o and 50^o East; and the Kerguelen-Gausberg stock in the Eastern Wind Drift between 85^o and 100^o East; possible additional stocks reside within the northern extensions of gyres in the Ross and Bellingshausen Seas.

Stock Assessments

Krill maintain the largest biomass of any key species in the Antarctic ecosystem. Estimates of standing stock have ranged from less than 100 million mt to more than 1 billion mt and have included a considerable amount of uncertainty (Hewitt and Linen Low 2002). Biomass surveys have only covered portions of the Convention area, adding to this uncertainty. A more recent estimate by Constable and Nichol (2002) estimate the biomass of krill within Convention areas between 64 and 137 million mt. Of this, an estimated 44.3 million mt are found in areas 48.1, 48.2, 48.3, and 48.4; area 58.4 contains 7 to 8 million mt (Hewitt and Linen Low 2000).

Icefish

Family Channichthyidae, the crocodile icefish, are found throughout the Southern Ocean in the waters of Antarctica and southern South America and consist of 24 individual species, some of which are targeted by commercial fisheries and utilized as a food fish. Members of the family are found in deep waters, up to 2,000 meters, but usually reside shallower than 800 meters. Icefish feed mainly on fishes and krill, and reach a maximum size of 75 cm. In addition to cannibalism by conspecifics (i.e., by the same species), icefish are eaten by seals and sea lions, shorebirds, seabirds, and whales and dolphins. Channichthyids are closely related to other members of the suborder Notothenioidei, such as toothfish and rock cod, but differ in that they lack erythrocytes and hemoglobin (Holeton 1970). Several adaptations, including low metabolic oxygen requirements, sluggish activity levels, and a large heart and blood volume, allow these fishes to exist with this unusual physiology. Icefish stocks characteristically undergo large natural variations in abundance. These fluctuations may be either biological in origin or related to environmental fluctuations. The family in general exhibits medium levels of resilience, with minimum population doubling times between 1.4 and 4.4 years.

Mackerel Icefish

The pelagic mackerel icefish (*Champsocephalus gunnari*), is distributed between 48^{o} South and 66^{o} South, in the islands of the Scotia Sea, including the northern part of the Antarctic Peninsula; Kerguelen, Heard, and Bouvet Islands; the South Atlantic, near South Georgia; and the South Orkneys and South Shetland Islands. The species has a depth range of 0 to 700 m, but is generally found in waters shallower than 300 m. Although this predator can live up to 15 years and reach a maximum size of 69.5 cm, few fishes older than 6 years are present in the population. Natural mortality for this species is age-specific and high relative to other Antarctic fish species, and varies spatially and temporally, perhaps due to krill availability. Mysids, fishes, amphipods, copepods, shrimp, sponges, and fish eggs and larvae all make up a part of its diet, although krill are the preferred prey item when and where available. Juveniles and adults often form dense feeding aggregations around krill swarms (Kock 1981). Diel patterns of vertical migrations, remaining near the seabed during the day and moving up into the water column at night, vary with the local availability of krill and the size of the individual fish (the largest fishes are less likely to migrate). Mackerel icefish are eaten by other icefish, fur seals, elephant seals, penguins, and albatrosses. Many of its predators also feed on krill, and tend to feed more intensively on icefish when krill are not abundant (Everson *et al*. 1999). Consumption of mackerel icefish by predators can be quite high, indicating the possibility for competition between vertebrate predatory species and commercial fisheries (Green *et al*. 1998). Condition and survivorship (M=0.5) of mackerel icefish is closely related to krill biomass, although the influence of krill availability appears to be indirect (Everson *et al*. 1999, Kochkin 1995).

The mackerel icefish is quite similar to the pike icefish (*C. esox*), and the two species ranges overlap in the waters surrounding South Georgia. Several characters can be used to distinguish between the two, including pectoral and anal fin ray counts (25-28 and 35-40 in *C. gunnari*, 22-24 and 31-35 in *C. esox*, respectively). Differences in snout length can also be used to identify the species (similar to head length in *C. gunnari*, longer than head length in *C. esox*), and is perhaps more useful for field identifications.

Mackerel icefish mature at 22-32 cm, with exact sizes at maturity varying with location. Spawning occurs mostly in the winter, although timing may depend on fish condition and krill availability, and varies with location (Everson *et al*. 2000). In the Atlantic Sector, a possible weak second spawning season takes place in summer (January). Spawning migrations take place into bays, and while spawning occurs over much of the shelf, it is at a much lower intensity than inshore. Fecundity (1,500 to 31,100) and size of the large yolky eggs (2.2-4 mm) varies with location, and food availability and timing of maturation affects individual fecundity as well (Kock 1981, Kock *et al*. 2000). Not all mature fishes spawn each year, and the true spawning stock biomass is thought to be ~80% of the total stock of fish of spawning size. Hatching occurs in late winter and early spring and larvae are concentrated in the upper 100 m of the water column in bays or within ~4 miles of shore (Trunov *et al*. 2000). As the fishes grow, they move deeper in the water column but remain nearshore as postlarvae and juveniles to feed on mysids and krill (Kock 1981). Recruitment is variable and differs between fishing grounds, and often shows cyclical patterns and a lack of correlation with spawning stock biomass size. It is thought that recruitment strength from year to year may be related to krill abundance during the hatching period. The mackerel icefish exhibits higher resilience and a greater capacity to rebuild than other Notothenioid fishes due to early maturation, high fecundity, and high growth performance (Kock & Everson 1997).

Stock Structure

Several separate fisheries stocks exist within both the Atlantic and Indian Ocean Sectors. Two or three stocks reside in the Atlantic Sector: South Georgia, South Shetland, and South Orkney Islands; South Georgia; and Shag Rocks (Alekseeva & Alekseev 1997, North 1996). In the Indian Sector, two stocks, which were once thought to exist around Pike Bank and Discovery Bank, are now absent. Additional stocks reside at Heard Bank/Gunnari Ridge, the Kerguelen Shelf, Skiff Bank, and the Shell Banks.

Characteristic differences in *C. gunnari* behavior and biology seem to exist between fishes residing in the Atlantic and Indian Ocean sectors. In the Atlantic Sector, the species is restricted to coastal shelf areas and makes several annual migrations: feeding migrations in October through February to the northern shelf areas; spawning migrations from the northeast to the east and north, and from the northwest to the west and south coasts of South Georgia; and post-spawning migrations back to the northeast and northwest. Immature fishes are found within the eastern shelf area. Fishes in the Atlantic sector also grow larger than those found in the Indian Ocean Sector, and differences in growth rates and natural mortality probably exist as well.

Stock Assessments

Stock assessments are typically carried out using bottom trawls at randomly located positions within prespecified depth strata. Because of the scattered nature of mackerel icefish distributions, most hauls contain very few fish but a few contain very large numbers. In the Atlantic Sector, assessments were conducted during the early years of the fishery on icefish in 1975-1978. In Area 48.1, the 1975-76 survey found 20,000 mt around Elephant Island and a comparable amount, 22,162 mt, around South Shetland Island. The most recent stock assessment in 48.1 was carried out in 1998, and found 2,765 mt around Elephant Island, 5,616 mt around South Shetland Island, and a combined biomass estimate for the Statistical Subarea of 8,166 mt. In Area 48.2, surveys around the South Orkney Islands found 140,000 mt in 1975-76 and 40,000 mt in 1977-78. The most recent survey in that area occurred in 1999, and found a total estimated biomass of 3,016 mt. In Area 48.3, early surveys between 1975 and 1982 gave estimates ranging between 1,152 and 226,606 mt. Bottom trawl surveys in the late 1990s indicated episodic declines in abundance; these declines were not attributable to commercial fishing, and may result from shifts in food chain relationships (Everson *et al*. 1999). The most recent survey in 2002 estimated biomass for the Subarea as 47,241 mt.

In the Indian Ocean Sector, recent surveys have estimated biomass in Areas 58.5.1 and 58.5.2. In 58.5.1, a 1996-97 survey of the 1994 cohort found 3,890 mts present in the area in March 1997. This number had dropped to 1,837 mt by May 1997. A brief survey in 1998 indicated that members of the 1994 cohort were nearly absent from the population, but that a new year 1+ cohort was present that would recruit to the fishery in 2002-03. A 2001 survey in Area 58.5.2 estimated 31,882 mt were available in the area; this biomass was low on Shell Bank and concentrated on the southeast part of the Heard Plateau and Gunnari Ridge. Fishery-dependent data in the Indian Ocean Sector indicate a recent sharp decrease in catch-per-unit-effort (CPUE) for the mackerel icefish.

<u>Spiny Icefish</u>

Little is known on the biology of the abundant spiny icefish (*Chaenodraco wilsoni*). It is found widely distributed between 60^{o} South and 78^{o} South, on the Antarctic continental shelf and Antarctic offshore islands, including the South Orkneys, South Shetland, and Elephant Island. Its circumantarctic range closely matches that of the Antarctic silverfish; quasi-stationary mesoscale hydrological features caused by peculiarities of bottom topography, indented coastline, fluctuations in the position and intensity of the Antarctic Circumpolar Current and wind stress seem to cause discontinuities (Trotsenko *et al*. 1990). This benthopelagic species can be found in depths ranging from 200 to 800 m, but is more common in the shallower waters of the continental shelf, especially on banks less than 250 m deep in areas where local upwelling increases food supply. A predator, spiny icefish feed mainly on fishes and krill; variations in feeding are related to size, location, and interannual prey availability (Pakhomov & Shumatova 1992). Juveniles and recruits are known to feed on smaller zooplankton prey items. It is eaten by penguins, seals, and whales and dolphins. Spiny icefish reach a maximum size of 43 cm and are targeted commercially for utilization as a food fish. The species reaches maturity at about 23 cm, and spawning of the large, yolky, demersal eggs occurs in the austral winter (June-August).

Blackfin Icefish

The blackfin icefish (*Chaenocephalus aceratus*), also known as the Scotian icefish, is a demersal species found in waters 5-770 m deep between 53^o South and 65^o South. Its range covers Bouvet Island, the Scotia Sea, and the northern part of the Antarctic Peninsula. Blackfin icefish diets consist mainly of fish and krill, but also a wide variety of other items, including shrimp, seastars, mysids, and other planktonic crustaceans. Feeding migrations take this species far from shore into deeper waters (Lisovenko 1988). The main predators of this species are other icefish. *C. aceratus* are a sexually dimorphic species, with females attaining larger sizes (up to 71 cm) and maturing at larger sizes (48-49 cm) than the males (reach 60 cm, mature at 34-40 cm- Lisovenko 1988). A majority (63%) of the female population of blackfin icefish are sexually immature. Short spawning migrations are made in late summer-early autumn to within 12 miles of the coastal zone, where spawning occurs. Fecundity is positively correlated with size. Recruitment strength has been documented to fluctuate from year to year, causing constant fluctuations in the age structure of the populations (Kompowski 1990).

Unicorn Icefish

The unicorn icefish (*Channichthys rhinoceratus*) is a bathydemersal species found from near shore to water depths of greater than 750 m. It is distributed between 46^o South and 54^o South, and is endemic to the Kerguelen-Heard Plateau . This predator feeds mainly on fishes but also occasionally eats benthic algae. It is eaten mainly by seabirds. The maximum reported size for the unicorn icefish is 60cm.

South Georgia Icefish

South Georgia icefish (*Pseudochaenichthys georgianus*) is known only from the islands of the Scotia Sea and the northern part of the Antarctic Peninsula between 53^o South and 66^o South. *P. georgianus* is a demersal species, with a depth range extending from 0 to 475 m. Krill and fishes make up a significant portion of the diet of this predator; sponges are also eaten. Older fishes regularly feed in near-bottom layers, but may seek food in the water column when benthic resources are scarce. The South Georgia icefish's main predators are mackerel icefish and seabirds. It reaches a maximum size of 60 cm, with both males and females reaching sexual maturity at sizes ranging between 38 and 42 cm (5-6 years); it is known to live at least 13 years (Chojnacki & Palczewski 1981). Eggs are spawned in autumn and hatching occurs at the end of winter. Larvae and juveniles are exclusively pelagic; larvae are abundant in the upper 200 m of the water column in early spring (North & Murray 1992).

Stock Structure

The stock structure of the South Georgia icefish is unknown, although early reports indicate that fishes in the region of South Georgia Island do not form a homogenous, stable stock (Mucha 1980).

Squid

Seven star Flying Squid

The seven star flying squid (*Martialia hyadesi*) has a circumpolar distribution and is associated with the Antarctic Polar Front Zone (APFZ- Gonzalez *et al*. 1997). Its most frequent area of appearance is in the Southwest Atlantic, along the outer shelf and slope, in depths ranging from 1,700 to 2,713 m (Gonzalez & Rodhouse 1998, Ivanovic *et al*. 1998). The species is short-lived, about one year, although it appears some individuals may live for up to two years. Because of its short life cycle, populations are likely to respond rapidly to environmental changes, although oceanographic effects are likely mediated via prey items. Because of large effect of physical conditions on populations, annual catches of *M. hyadesi* fluctuate dramatically from year to year (Rodhouse 1991). It is thought that the appearance of large catches may be related to sea surface temperature (SST) anomalies.

Seven star flying squid feed mainly on finfishes (mainly Myctophids), and squid (cannibalistic on small juveniles); krill and amphipods also make up a portion of the diet. The squid themselves are an important component in the diet of several species of albatross and elephant seals, and taken by a variety of other vertebrate predators as well (Rodhouse 1991). The importance to predators diet changes between years though, as the abundance of the squid varies. Timing of spawning is different between locations, although hatching is thought to occur year-round in the Southwest Atlantic (Arkhipkin and Silvanovich 1997).

Argentine Shortfin Squid

The Argentine shortfin squid (*Illex argentinus*) is distributed along the Patagonian shelf and slope between 22^{o} South and 54^{o} South, and is a Southern Hemisphere example of a western boundary current species. Its range overlaps with that of *Martialia hyadesi* on the southern end of the Patagonian shelf edge. Waluda *et al*. (2001a) found that this squid species distribution is associated with areas of thermal gradients. Uncertainty exists about the stock structure, but it is thought that there are 3-4 separate stocks: summer-spawning stock (SSS), south Patagonic stock (SPS), Bonaerensis-northpatagonic stock (BNS), and the southern Brazil stock (SBS- Martinez *et al*. 2002, Haimovici *et al*. 1998).

I. argentinus live for one year and grow and mature rapidly. Males mature faster, although females grow faster and to a greater size. Feeding occurs at night, especially around dusk and dawn; main food items include locally abundant krill and amphipods, as well as other squids (cannibalistic- Tang 2002). Seabirds, including wandering albatrosses and white-chinned petrels, are the main predators on this species. The species undergoes annual feeding migrations, as well as spawning migrations and ontogenetic movements.

Fecundity ranges between 70,000 and 750,000 eggs per female, and depends on body size (Laptikhovsky & Nigmatullin 1992). The spawning season is protracted. The species shows large interannual variations in recruitment strength that are thought to be related to oceanographic factors. Waluda *et al*. (2001b) documented high abundances associated with lower proportions of frontal waters or higher proportions of favorable-SST waters within the hatching area the previous year. SST shows a negative correlation with abundance and catch levels the next season. Due to the Argentine shortfin squid's short life cycle and other life history characteristics, this species is highly susceptible to recruitment overfishing, and conversely capable of rapid recovery.

Crab

Stone crab resources in the Antarctic are composed of a number of species from the Family Lithodidae, but the Antarctic king crab (*Paralomis formosa* and *P. spinosissima*) is the one of the most abundant and important, both ecologically and commercially. Antarctic king crabs concentrate in areas where environmental conditions tend to be more stable, such as the shelf break, but can be located between 160 and 1,518 m depth (Lopez Abellan & Balguerias 1994). In particular they can be found in the areas around South Georgia and Shag Rocks. The abundance of the two species relative to each other is variable, with *P. formosa* being higher some years, and *P. spinosissima* in other years.

Stock Assessments

A January 2000 abundance estimate by Collins *et al*. (2002) at South Georgia found a density of 8,313 individuals per square kilometer. Densities in different areas within the region were variable; this variability was not related to depth, temperature, or current speed, but was correlated with substrate form.

Other Finfish

Lanternfish

Lanternfish (*Electrona carlsbergi*) (Family Myctophidae) have a circumglobal distribution between the Subtropical Convergence and the Antarctic Polar Front (46^o South to 69^o South). This mesopelagic deep-water species is found between 80 and 140 m depth, and forms the main component of the Deep Scattering Layer in the Pacific Sector of the Southern Ocean. Lanternfish are sexually dimorphic with females attaining a larger size (9.6 cm total length) than males (9 cm). Sexual maturation in females is reached at between 7.6 and 7.8 cm. Maturation of the ovaries is continuous and spawning is serial during the long spawning season spanning the austral autumn and winter (Mazhirina 1991). The maximum reported age for this species is 6 years and the minimum population doubling time is between 1.4 and 4.4 years, making it a medium resilience species.

E. carlsbergi feeds mainly on copepods, hyperiid amphipods, and krill, making diurnal feeding migrations following prey to the surface at night. Ostracods, gastropods, and other planktonic crustaceans also form a smaller component of the diet. Lanternfish are eaten by squid, and to a lesser degree by fishes (especially Channichthyid icefish), sea birds, and seals and sea lions. Their contribution to the diet of predators shows seasonal fluctuations due to seasonal movements of this species related to feeding periods and food availability.

The distribution and behavior of lanternfishes are strongly related to environmental conditions and the availability and distribution of zooplankton prey (Kozlov *et al*. 1991). The bulk of surveyed biomass of lanternfish in the Southern Ocean is found within the Antarctic Convergence area (Filin *et al*. 1991). The South Polar Front Zone (SPFZ) provides optimal physical conditions supporting large concentrations of this species and is where they are found most frequently and regularly. Concentrations at the SPFZ are less dense in winter, when the lanternfish are found in deeper waters (>200m).

Striped-eye Notothen

The striped-eye notothen (*Lepidonotothen kempi*) is a benthopelagic species found between 53^{o} South and 69^{o} South in the Scotia Arc, South Georgia, the South Sandwich islands, the South Orkney islands, the South Shetland Islands, the northern part of the Antarctic Peninsula, the coast of east Antarctica, Scott and Balleny Islands, and Bouvet Island. Striped-eye notothen belong to the widespread Antarctic family Nototheniidae, which includes other commercially and ecologically important species such as toothfish and the Antarctic silverfish. This species closely resembles two other nototheniid species, *L. squamifrons* and *L. macrophthalma*, with significant overlaps in the morphological and meristic characters used to distinguish between the three species. Scheppenhiem *et al*. (1994) reported evidence that the three 'species' may in fact be populations of only one species, *L. squamifrons*, though conclusive evidence has not yet been presented and the issue remains unresolved.

L. kempi reach a maximum size of 50cm and may live up to 19 years. This selective planktonic feeder is found between 160 and 900 meters depth, feeding on a variety of food items including finfish (cannibalistic), amphipods, copepods, isopods, benthic crustaceans, sea cucumbers, nudibranchs, sponges, sea stars, fish eggs and larvae, polychaete worms, krill, and other planktonic invertebrates. Striped-eye notothens, in turn, are preyed on by conspecifics, seabirds, and seals and sea lions. The size at which this species reaches sexual maturity differs between locations and ranges between 19 and 36cm. This low resilience species exhibits a minimum population doubling time of 4.5 to 14 years and is susceptible to the adverse effects of overfishing.

Rattails and Grenadiers

Four species of grenadiers and rattails (*Macrourus)* exist worldwide; three of these (*M. carinatus*, *M. holotrachys*, and *M. whitsoni*) are found within the Southern Ocean. Grenadiers in the Southern Hemisphere have a circumpolar distribution between 34^{o} South and 78^{o} South. These bathypelagic and bathydemersal generalists dominate deep continental shelf and slope fish communities between 200 and 3185 meters depth and share a number of characteristics with their better documented Northern Hemisphere congener, *M. berglax*. Grenadiers harvested in the Southern Ocean are utilized as a food fish and sold under the market name "grenadero". All three species are slow growing and long lived, reaching sizes of 100cm and ages of 30 years or more (Morley *et al*. 2003). They exhibit a number of factors which make them highly susceptible to over harvest and poor management, including a relatively low natural mortality rate; very low resilience, with minimum population doubling times greater than 14 years; low sustainable yields; and a slow potential rate of recovery.

Food items of these predator/scavengers span a wide range of items, including squid, finfish, amphipods, copepods, isopods, shrimp, ostracods, sea cucumbers, polychaete worms, benthic crustaceans, planktonic invertebrates, krill, and mysids. *Macrourus* spp. makes diurnal feeding migrations to the surface in pursuit of prey items (Dudochkin 1988). Grenadiers are eaten mainly by toothfish and elephant seals.

Spawning of *Macrourus* spp. generally occurs during a protracted spawning season spanning autumn and winter. Females spawn their large eggs during a single spawning event in cold waters (De Ciechomski & Booman 1981). Fecundity of grenadiers is low, ranging between 15,000 and 260,000, and increases with size of the females (Morley *et al*. 2003, UNESCO 1976). Sexual maturity is reached rather late, at around 9 years of age and sizes ranging between 21 and 65 cm. This sexually dimorphic species group exhibits a 'bigger-deeper' trend in spatial segregation, so that the larger females are often found at deeper depths than the males. This, combined with other behavioral differences between males and females, makes larger females much more susceptible to being taken as bycatch in longline fisheries targeting other commercial species (Morley *et al*. 2003).

<u>Antarctic Silverfish</u>

The Antarctic silverfish (*Pleuragramma antarcticum*) belongs to the family Nototheniidae, along with toothfish and the striped-eye notothen. This species is distinctive from other Nototheniids in a number of features of its biology and is one of the most phyletically derived species in the family. Although it contains efficient antifreeze glycoproteins and exhibits sluggish behavior as adults like other members of the family, its hematological features in particular differ remarkably, having 3 different hemoglobins instead of just one (Woehrmann *et al*. 1997, Tamburrini *et al*. 1996). The only truly pelagic fish found in Antarctic waters, *P. antarcticum* is found between 0 and 728 meters depth distributed between 60^{o} South and 78^{o} South, and is found on the Antarctic Peninsula; South Shetland, Elephant, Balleny, Scott, and South Orkney Islands; Weddell, Bellingshausen, Ross, and Davis Seas; and Oates, Adelie, Wilhelm, and other coasts of East Antarctica to Prydz Bay. The species reaches a maximum size of 25 cm and a maximum age of 20 years, and shows low levels of resilience, with a minimum population doubling time of 4.5 to 14 years.

The Antarctic silverfish is the most plentiful fish on the Antarctic shelf and plays a pivotal role in High-Antarctic ecosystems due to these exceptional levels of abundance. Main food items include amphipods, copepods, benthic crustaceans, gastropods, polychaete worms, arrowworms, krill, eggs and larvae, and other silverfish (cannibalistic). Ontogenetic changes in diet are seen, with larger items being ingested as the fish grow. The species is preyed on by a number of Antarctic vertebrates, including seals and sea lions, icefish, toothfish, rock cod, other finfish, and shorebirds.

P. antarcticum matures at 3 or 4 years of age, and 12.5 to 13 cm. Fecundity ranges between 4,300 and 17,800 eggs per female, showing an increase correlated with increasing body size (Gerasimchuk 1987). A spawning migration is made to sea areas along the major continental ice shelves where the buoyant pelagic eggs are spawned during the austral spring (Tamburrini *et al*. 1996, Outram and Loeb 1995). The exact timing of spawning varies with location, but in general the spawning period last 3-4 months. Larvae hatch in November and December, and are found in warm shallow waters (0-135 m- Morales-Nin *et al*. 1998). Koubbi *et al*. (1997) reported that the distribution of larvae is strongly tied to hydrological features, especially the development of coastal gyres linked to topography. Postlarvae and juveniles are highly abundant in Antarctic waters during the summer, and are found at deeper depths than the earlier larvae (50-400 m).

Stock Structure

It is likely that the Antarctic silverfish exists as several separate fishery stocks, due to possible spatial isolation. Trotsenko *et al*. (1990) reported that apparent discontinuities in the circumarctic range may be caused by quasi-stationary mesoscale hydrological structures resulting from peculiarities of bottom topography, indented coastlines, fluctuations in the position and intensity of the Antarctic Circumpolar Current, and wind stress.

Blunt Scalyhead

The blunt scalyhead (*Trematomus eulepidotus*) inhabits the continental shelf of Antarctica and nearby islands, including the South Orkneys and South Shetland. Its range extends from 60^{o} South to 78^{o} South. Although it is can be found anywhere between 70 and 650 m depth, it is most commonly found in the shallower waters of the continental shelf, especially on banks less than 250 m deep in areas where nutrients from local upwellings increase the local food supply. Size groupings typically show vertical segregation, with larger fish inhabiting deeper depths (Roshchin 1991). This member of the Family Nototheniidae is a close relative of other rockcod and toothfish. The maximum recorded size for the blunt scalyhead is 34 cm. This species life history characteristics contribute to its low resilience (minimum population doubling time 4.5-14 years). *T. eulepidotus* is a predator and feeds on salps, nudibranchs, amphipods, copepods, polychaetes, krill, other crustaceans, arrowworms, and fish. It is eaten by toothfish, shorebirds, and whales and dolphins.

Spawning of the buoyant pelagic eggs occurs in December through February. Larvae feed mainly on planktonic copepods, while juveniles are often found near the surface in association with krill swarms (Kozlov & Naumov 1987).

3.1.b. <u>Biology and Status of the Stocks</u> -- Cetaceans

<u>Endangered Species Act (ESA) Listed Species</u>

There are six ESA-listed endangered whale species that occur in the CCAMLR Convention Area, including: blue, fin, humpback, right, sei, and sperm whales. The history and status of these six species of endangered large whales as described below were drawn primarily from the special issue of the <u>Marine Fisheries Review</u> "The Great Whales: History and Status of Six Species Listed as Endangered Under the U.S. Endangered Species Act of 1973" (Perry, DeMaster, Silber 1999). The comprehensive status reviews included in that issue are based on published literature from about 1980 through 1998.

Blue whale (*Balaenoptera musculus*)

Blue whales in the Southern Hemisphere are assigned to six stock areas designated by the International Whaling Commission (IWC). These areas are consistent with the presumed blue whale feeding locations, although reliable distributional information on blue whales is scarce. True blue whales are found south of the Antarctic Convergence, in the relatively high latitudes. During summer, the true blue whale is found close to the ice edge (south of lat. 58° S) with concentrations between 66-70° S and long. 60-80° E (CCAMLR Division 58.4.2). On a research cruise in 1995/96 surveying cetaceans in CCAMLR Division 58.4.1, an aggregation of blue whales was found near 65° S and 88° E (Thiele *et al*., 2000).

Blue whales migrate north to temperate waters during the Southern winter to breed and give birth. The locations and consistency of habitat use during the breeding are poorly described. Gestation is 11-12 months. Blue whales become sexually mature at between 5 and 10 years of age. Adult blue whales can attain lengths of about 30 m and weigh up to 160 mt in the Southern Ocean. A second, smaller subspecies, the pygmy blue whale, occurs in sub-Antarctic waters of all three ocean basins in the Southern Ocean.

Like other balaenopterids, blue whales have fringed baleen plates instead of teeth and ventral grooves which allow for the filtering of large quantities of water during feeding on swarms of euphausiids. During the 1995/96 research cruise, an aggregation of blue whales was found near a highly dense krill patch in CCAMLR Division 58.4.1 (Thiele *et al*., 2000). Since 1965, there have been only seven sightings of true blue whale calves in waters south of lat. 60° S despite IWC/International Decade of Cetacean Research (IDCR) surveys in these areas. The IWC Scientific Committee has agreed that, while a reliable estimate of abundance of Southern Hemisphere blue whales could not be developed because data on these stocks were incomplete; there were more than 500 blue whales in the Southern Ocean. In 1996, the IWC calculated an abundance estimate of 1,255 blue whales by combining data from IWC/IDCR and Japanese Sighting Vessel (JSV) surveys from 1978 to 1988. This combined estimate applies to all stocks in the Southern Ocean. Individual stock sizes are not known.

Fin whale (*B. physalus*)

The IWC has divided the Southern Oceans into six baleen whale stock areas. These areas loosely correspond to fin whale stocks, but there is still insufficient distributional data on where these whales breed to validate this designation. Most migrate seasonally from relatively high-latitude Arctic and Antarctic feeding areas in the summer to relatively low-latitude breeding and calving areas in winter. These whales tend to migrate in the open ocean, and therefore, migration routes and the location of wintering areas are difficult to determine. Fin whales spend summer feeding in the relatively high latitudes of both hemispheres, including in the Antarctic waters of the Southern Ocean. They are most abundant in offshore waters where their primary prey (e.g., Euphausiids) is concentrated in dense shoals. A CCAMLR/IWC survey of CCAMLR Subareas 48.1, 48.2, and 48.3 during the Austral Summer of 2000 resulted in an abundance estimate of 4,524 (CV 42.37) (coefficient of variability) fin whales in those areas (Reilly *et al*., 2004). Fin whales attain sexual maturity at 5-10 years of age. Gestation lasts 11-12 months. As with all baleen whales, they give birth to a single young, with an interbirth interval of 2-3 years.

Like other balaenopterids, they have fringed baleen plate instead of teeth and ventral grooves which expand during feeding and allow the whale to engulf large quantities of water along with small crustaceans and fish prey items. The predominant prey of fin whales varies greatly in different geographical areas depending on what is locally abundant. Thus, they may be less prey selective than blue, humpback, and right whales. However, fin whales do depend to a large extent on the small euphausiids and other zooplankton species. In the Antarctic, they feed on krill, *Euphausia superba*, which occurs in dense near-surface schools. This feeding strategy appears to be shared by all baleen whales while in Antarctic waters, in contrast to their feeding habits elsewhere, which tend to be more varied.

There is some speculation, because of the sharing of the Antarctic krill resource between both whale and non-whale predators, that interspecific competition may be a critical factor in the biology of Southern Hemisphere fin whales. There is no direct information of how such ecosystem level interactions may or may not affect the status of baleen whales. However, studies suggest that competition among whales and other small krill predators in the Antarctic ecosystem is relatively low.

Humpback whale (*Megaptera novaeangliae*)

In general, most humpback whales spend the summer feeding in high-latitude waters and then migrate long distances into low-latitude tropical waters for the winter where they breed and calve. A survey was done of cetacean distribution off the Eastern Antarctic (CCAMLR Division 58.4.1) and humpback whales were the most frequently sighted species, with all sightings west of 120° E (Thiele *et al*., 2000). This survey also found about one-third of all humpback sightings to be made near the ice-edge, and were usually correlated with a strong temperature gradient.

Like other baleen whales, humpback whales migrate out of Antarctic waters following summer feeding, to temperate and tropical waters to breed and give birth. Gestation lasts 11-12 months. The average interbirth interval is 2-3 years. Humpback whales attain sexual maturity at approximately 5 years of age. Adults reach about 15m in length, with females being larger than males on average.

The IWC Scientific Committee has recognized data from the IWC/IDCR and JSV surveys of the Antarctic Ocean as valid for population estimation south of lat. 60° S. Recent data on whale populations estimates issued by the IWC indicate a humpback whale population in the Southern Ocean south of lat. 60° S of 10,000. These recent data are from a CCAMLR/IWC survey of CCAMLR Subareas 48.1, 48.2, and 48.3 during the Austral Summer of 2000 resulted in an abundance estimate of 9,366 (CV 27.9) humpback whales in those areas (Reilly *et al*., 2004).

Like other balaenopterids, they have fringed baleen plates instead of teeth that allow for the filtering of small crustaceans and fish. Deep grooves on the ventral surface allow for throat expansion, increasing the volume of water that can be engulfed and then filtered through the baleen. Southern Hemisphere humpback whales feed almost exclusively on Antarctic krill, *Euphausia superba*. Humpback whales utilize a wide range of feeding techniques, at times involving more than one individual and resembling a form of cooperative participation. The two most observable techniques are lob-tail feeding and bubble-cloud feeding.

Right whale (*Eubalaena australis*)

Northern right whales are now the most endangered of the large whales. Southern right whales, in contrast, have shown signs of recovery over the past twenty years (Best, 1990). No final stock designations for the Southern Hemisphere right whales have been made by the IWC. There have been reported high concentrations of right whales between the subtropical and Antarctic Convergence. Whales were found farthest south in January (the austral summer) and began moving north in February. A best estimate for total Southern Hemisphere right whale abundance is about 7,000 based on a 1998 IWC tally of estimates from separate breeding areas. A CCAMLR/IWC survey of CCAMLR Subareas 48.1, 48.2, and 48.3 during the Austral Summer of 2000 resulted in an abundance estimate of 1,670 (CV 61.67) right whales in those areas (Reilly *et al*., 2004).

Southern right whales reach adult lengths of about 14m and 17m, for males and females, respectively. Gestation lasts 12-13 months. Young reach sexual maturity at about 9-10 years of age.

Like other balaenopterids, right whales have fringed baleen plates instead of teeth and ventral grooves which expand to allow for engulfing large quantities of water during feeding on small zooplankton. The feeding for right whales occurs in the spring and fall in both hemispheres, where they take advantage of large concentrations of zooplankton, primarily copepods, found in temperate to subarctic waters. However, as with other baleen whales, they feed extensively on krill while in the Southern Ocean in summer.

Sei whale (*B. borealis*)

Sei whales are found in all oceans. They migrate long distances from high latitude summer feeding areas to relatively low -latitude winter breeding areas. Compared to other balaenopterids, sei whales appear restricted to more temperate waters and occur within a smaller range of latitudes. They do not associate with coastal features, but instead are found in deeper waters associated with the continental shelf edge. Based on history of catches and trends in CPUE, current sei whale abundance estimates range from 9,800 to 12,000 whales in the Southern Ocean. Like other balaenopterids, sei whales have fringed baleen plates instead of teeth and ventral grooves which expand to allow for engulfing large quantities of water during feeding on small zooplankton. Sei whales consume primarily copepods, but they also prey on euphausiids and small schooling fishes when locally abundant.

Sei whales also breed and give birth in temperate or tropical waters. Gestation lasts approximately 11 months, sexual maturity is reached after about 8 years.

In the Southern Hemisphere, there is some evidence that sei whales may minimize direct interspecific competition with blue, fin and minke whales by foraging in warmer waters than do the latter species, by consuming a relatively wider variety of prey, and by arriving later on the feeding grounds than other baleen whales (Kawamura, 1978, 1980, 1994; IWC 1992a). However, Murphy *et al*. (1998) and Fraser *et al*. (1992) suggested that competition among whales and other krill predators in the Antarctic is relatively low. (Clapham and Brownell, 1996).

Sperm whale (*Physeter macrocephalus*)

Sperm whales are often concentrated around oceanic islands and in areas of upwelling and along the outer continental shelf and mid ocean waters. Being deep divers that can remain submerged for long periods, they are rarely found in waters less than 300 m deep. In the Southern Hemisphere, male sperm whales are widely dispersed along the Antarctic ice edge from December to March (austral summer). In contrast, mixed groups of females and immature whales have a southern limit in the South Atlantic of lat. 50-54° S.

Female sperm whales usually inhabit waters deeper than 1,000 m and are found at latitudes less than 40° S, and are thus, usually found far from land (Whitehead, 2002). The larger and older the male, the higher latitudes they inhabit. Large, older males may be found near the pack ice, though they return to lower latitudes for breeding and giving birth (Whitehead, 2002). Gestation lasts 15-16 months. Sexual maturity is attained relatively late in life, at 18-21years for males, 7-13 years for females. Adult males are considerably larger than adult females (around 16m versus 11m).

Sperm whales were heavily whaled during the 20th century. Though it is unclear what affect this had on stocks, it is likely that many stocks, males in particular, were significantly reduced (Whitehead, 2002). Utilizing IWC/IDCR and JSV survey data in 1995, Butterworth *et al*. estimated sperm whale abundances south of latitude 60° S from two surveys as 3,163 (CV= 0.39) and 14,387 (CV= 0.185) and south of latitude 30° S from two winter surveys as approximately 290,000 (CV=0.46) and 128,000 (CV=0.44) in a range of 128,000-290,000 (CV= 0.44-0.46) (Butterworth *et al*, 1995). Given the Antarctic latitudes surveyed, these numbers most likely represent a large proportion of male whales.

The sperm whale is the largest whale of the odontocetes (toothed whales) and does not have baleen plates like the balaenopterids described above. The sperm whale's primary prey consists of larger mesopelagic cephalopod and fish species, including the giant squid. Approximately 40 species of cephalopods are consumed by sperm whales worldwide.

Species Not Listed under ESA

Arnoux beaked whale (*Berardius arnuxii*)

Arnoux's beaked whale is widely distributed in the Southern Ocean from the edge of the antarctic pack ice north to approximately 78° S in the Ross Sea, 24° S near Sao Paulo, 37° S near northern New Zealand, 31° S near South Africa, and 29° S near southeastern Australia (Kasuya, 2002). They are one of the largest species of the family Ziphiidae, and their taxonomic status is not settled (Kasuya, 2002). They travel in tight schools of around 2-9 individuals. They feed primarily on deep-water bottom fish, though squid beaks have been found in stomach contents as well (Kasuya, 2002). Age at maturity for females is between 10-15 years and they live about 54 years; while males mature at 6-11 years and live about 84 years. Abundance in CCAMLR waters is unknown. No significant exploitation of this species has occurred. Little is known of their life history.

Hourglass dolphin (*Lagenorhynchus cruciger*)

The hourglass dolphin has a circumpolar distribution in the Southern Hemisphere (Brownell and Donahue, in press). It is generally limited to antarctic and cold-temperate waters. A recent abundance estimate of 144,300 animals (CV = 0.17) was produced for waters south of the Antarctic Convergence from data from IWC/IDCR cruises and Japanese Sighting Survey Program cruises (Kasamatsu and Joyce 1995). No direct fishery for this species has ever existed.

Killer whale (*Orcinus orca*)

Killer whales are known to occur throughout Antarctic waters (Kasamatsu and Joyce, 1995). Many killer whales leave Antarctica during the austral winter and migrate to lower latitudes (Mikhalev *et al*., 1981; Kasamatsu and Joyce, 1995), although there has been very little survey work conducted in the Antarctic in the austral winter (Gill and Thiele, 1997). Killer whales (*Orcinus orca*) are generally considered to constitute a single species with a cosmopolitan distribution in the world ocean (Rice, 1998). However, during the late 1970s, several different groups of researchers independently concluded that, based on differences in morphology, ecology and acoustic repertoire, there were recognizably different forms of killer whales in Antarctica. The most recent description of killer whales in the Antarctic describes three distinct forms, based primarily on the size and location of their white eye patch and on the presence or absence of a dorsal cape (Pitman & Ensor, 2003): Type A (presumably the nominate form) occurs mainly off-shore in ice-free water, has a circumpolar distribution; Type B mainly inhabits inshore waters, regularly occurs in pack-ice, is distributed around the continent and is regularly sighted in the Antarctic Peninsula area; and Type C inhabits inshore waters and lives mainly in the pack-ice; it occurs mostly off East Antarctica.

The abundance for all Antarctic killer whales has been estimated to be around 80,000 individuals (Boyd, 2002). The three stocks of killer whales have different prey choices: Type A feeds primarily on Antarctic minke whales, Type B feeds primarily on seals (although it may also feed on minke and humpback whales), and Type C has only been recorded feeding on Antarctic toothfish (*Dissostichus mawsoni*, Pitman & Ensor, 2003).

Killer whales have a less seasonal, more diffuse breeding pattern than baleen whales. They are essentially large dolphins, being members of the dolphin family Delphinidae. They attain sexual maturity at approximately 16 years for males, 10 years for females. Gestation lasts about 15 months.

Long-finned pilot whale (*Globicephala melas*)

The long-finned pilot whale has a discontinuous distribution in cold-temperate to subpolar waters of the North Atlantic and the Southern Ocean. Its aggregate abundance is thought to be at least in the hundred of thousands (Reeves and Leatherwood 1994). The abundance for Antarctic long-finned pilot whales has been estimated around 200,000 (Kasamatsua and Joyce, 1995). They feed primarily on squid (Olson & Reilly, 2002).

Minke whale (*Balaenoptera bonaerensis* and *B. acutorostrata subspp.*)

The minke whale has a cosmopolitan distribution in polar, temperate and tropical waters worldwide. Several stocks are recognized around the world. Until recently, only one species of minke whales was recognized; however morphologic and genetic evidence have led the Antarctic minke whale (*B. acutorostrata*) to be fully recognized in 1990 (Rice, 1998; IWC, 2001; as sighted in Perrin & Brownell, 2002). The Antarctic and dwarf minke (*B. bonaerensis*), a small form of the common minke whale, overlap in the Southern hemisphere (Perrin & Brownell, 2002). Both species of minke whales typically occur from 55° S to the ice edge to feed during the austral summer and retreat to lower latitudes during the winter to breed; though some minkes have been observed over-wintering in the Antarctic (Perrin & Brownell, 2002). Abundance for both Antarctic and Dwarf minke whales combined is approximately 750,000 (Boyd, 2002). A CCAMLR/IWC survey of CCAMLR Subareas 48.1, 48.2, and 48.3 during the Austral Summer of 2000 resulted in an abundance estimate of 17,615 (CV 28.3%) minke whales in those areas (Reilly *et al*., 2004).

Minke whales are balaenopterids and in the Antarctic, dwarf minke whales feed primarily on myctophid fishes (Kato & Fujise, 2000; as sighted Perrin & Brownell, 2002), where the Antarctic minke feeds primarily on euphausiids. The consumption of prey by one minke whale during its summer and autumn feeding in the Ross Sea is equivalent to what would be taken by a few thousand Adélie penguins (cf. Ichii & Kato 1991, Woehler 1995).

Minke whales are the smallest of the balaenopterid species, and thus were the last target of commercial exploitation. Adult males reach about 10m, females are larger and may reach about 17m. Gestation lasts about 10 months, sexual maturity is reached at 6-8 years of age.

Minke whales are preyed on both by humans and by killer whales. Whaling for minke whales occurs in the Antarctic where the Japanese take approximately 400 adults per year from the Ross Sea under a scientific permit issued by the IWC (Ichii *et al*. 1998, Brown & Brownell 2001).

Southern bottlenose whale (*Hyperoodon planifrons*)

The southern bottlenose whale has an extensive distribution throughout the Southern Ocean from Antarctic north to about 30° S (IWC 1989; Mead 1989). They have not been exploited on a significant scale and are considered abundant; however, there is no population estimate or even rough figures on the relative abundance of this species (Mead 1989). Little is known regarding life history of this species.

Southern right whale dolphin (*Lissodelphis peronii*)

The southern right whale dolphin has a circumpolar distribution in the pelagic cold-temperate waters of the Southern Hemisphere (Jefferson *et al*. 1993). No population estimates for this species are available, but it is thought to be reasonably abundant (Reeves and Leatherwood 1994). Because of its pelagic distribution, very few specimens of this species have been collected and genetic information would prove valuable in clarifying this species' relationship within the genus *Lissodelphis*. Southern right whale dolphins are occasionally killed in fishing gear, but no large-scale mortality has been documented. The overall status of this species is unknown.

Strap-toothed whale (*Mesoplodon layardii*)

There is relatively little information for any of the species within the *Mesoplodon* genus. They normally inhabit deep ocean waters (>2,000 m) or continental slopes (200-2,000 m), and the distribution of most species tends to be localized (Pitman, 2002). Strandings indicate that *M. layardii* may have limited migration to lower latitudes during the austral winter (Pitman, 2002). Abundance is unknown for any *Mesoplodon* species; however, *M. layardii* appear to be widespread and fairly common in the Southern Ocean (Pitman, 2002). Mesoplodonts feed primarily on mesopelagic squid, though fish have been found in stomach contents as well.

3.1.c. <u>Biology and Status of the Stocks</u> -- Pinnipeds

Introduction

There are seven species of pinnipeds that occur in Antarctic waters of the Southern Ocean. (Antarctic waters are defined as the marine environment south of the Antarctic Convergence, also referred to in the literature as the Polar Front, an oceanographic feature where warmer waters to the north meet colder waters from the south.) Of the seven species, four are pagophilic phocid seals (crabeater seal, *Lobodon carcinophagus*; Weddell seal, *Leptonychotes weddellii*; leopard seal, *Hydrurga leptonyx*; and Ross seal, *Ommatophoca rossii*), two are otariid seals (Antarctic fur seal, *Arctocephalus gazella*; and Subantarctic fur seal, *Arctocephalus tropicalis*), and finally the southern elephant seal, *Mirounga leonine*. A summary with four sections for each species is provided below. The sub-sections are: (1) Distribution and numbers; (2) Status; (3) Life History; and (4) Trophic Links.

Three species, the Antarctic and Subantarctic fur seals and the southern elephant seal have a greater potential for fishery-marine mammal conflicts. Their centralized breeding, high density in foraging areas rich in resources, and their association with marine frontal zones of high productivity and biodiversity result in higher probability of distributional overlap with fisheries. This is especially true of income breeders such as otariids compared to capital breeders such as most phocid pinnipeds (Boyd 2000). The ice seals have less potential for conflict with fisheries of the Southern Ocean. This is because the ice environment also serves as a refugia from fisheries exploitation as no fisheries occur within the polar pack ice. Ice seals also tend to be more dispersed and less dense in their aggregations than do otariid seals or elephant seals. Environments that are seasonally covered by ice and are subject to fisheries exploitation during ice-free periods are an exception. Crabeater seals and leopard seals are more common in seasonally affected areas than are Weddell or Ross seals.

The distribution and ranges for each species are presented in Figures 1-7. For the three non-pagophilic seals that have the greatest potential for conflict with fisheries exploitation the current status (numbers and population trends) by breeding site are presented in Tables 1-3.

Antarctic fur seal (*Arctocephalus gazella*)

Distribution and Numbers

The breeding range of the Antarctic fur seal is restricted mainly to seasonally ice-free islands south of, or close to, the Antarctic Polar Front with over 95% of the species breeding on South Georgia. Other breeding sites, many fuelled by migrants from South Georgia, are established at South Orkney, South Shetland, South Sandwich, Bouvetøya, Heard, Marion, Macquarie, McDonald, Crozet, Prince Edward and Kerguelen Islands. The total population size was estimated as 1.5 million in 1990 but it is thought that the population may have since increased to over 4 million. (Table 4)

Status

NMFS noted in its March 5, 2004 environmental assessment for the AMLR Harvesting Permit No. 22 issued to Top Ocean, Inc., a U.S. firm operating from Montevideo, Uruguay, that during the 2002/03 fishing season 73 seals were taken by a Polish vessel, of which 47 were released alive. The Japanese fleet took nine seals. All were released alive. The scientific observer's report for the F/V Top Ocean included information that two fur seals were drowned by being brought up in the net due to a piece of broken trawl gear.

Revised data for 2002/2003 reported by the CCAMLR Scientific Committee in October 2004 indicate that a minimum of 114 Antarctic fur seals were caught in krill fishing operations in Area 48, 53 of which were killed and 61 released alive (SC-CAMLR-XXIII/4, paragraph 7.228).

In the 2003/04 season, a total of 142 fur seals were observed killed and 12 seals released alive aboard the F/V Top Ocean. Overall a minimum of 292 fur seals were reported by the United Kingdom scientific observers deployed on six of the nine vessels fishing in Subarea 48.3 (the area including South Georgia and the South Sandwich Islands.)

A U.K. observer was on board the F/V Top Ocean from February 21 to September 21, 2004. Trawling for krill was conducted in Subarea 48.3 from June 8 to 15 and from June 23 to August 2, 2004. The UK observer was present on the vessel in Subarea 48.3 from June 20 to July 20, 2004. Of the 142 observed Antarctic fur seal mortalities on the F/V Top Ocean, 138 were reported between June 23 and August 2, 2004.

The AMLR Harvesting Permit No. 22, issued by NMFS in March 2004, authorized F/V Top Ocean to harvest 30,000 mt of krill in CCAMLR Area 48 until November 30, 2004. Because F/V Top Ocean only harvested 8,100 mt of krill during this period, it applied for an extension of its AMLR permit. On November 30, 2004, NMFS amended Top Ocean's AMLR Harvesting Permit No. 22 authorizing harvest of the remaining 21,900 mt of krill until November 30, 2005, or until the authorized harvest limit was taken, whichever occurs first. Because of its earlier bycatch of fur seals, the extended permit required F/V Top Ocean to use a seal excluder device in addition to any other gear modification or fishing practice that reduces or eliminates Antarctic fur seal bycatch. The extended permit also required F/V Top Ocean to report on the efficacy of the seal excluder device and any other modifications to gear or fishery practices used to avoid seal bycatch. Top Ocean, Inc., has adapted a seal excluder device used by Japanese vessels for its F/V Top Ocean. Also, Top Ocean, Inc., was issued a HSFCA permit by NMFS on February 8, 2005, authorizing this fishing for krill in CCAMLR waters subject to the conditions and restrictions of amended AMLR Harvesting Permit No. 22. Both an AMLR permit and a HSFCA permit are required to fish in CCAMLR waters.

The take of Antarctic fur seals by the F/V Top Ocean in the 2003/04 fishing season was very small when compared to a population census taken in 1999/00 for South Georgia (the area of take) by the Scientific Committee on Antarctic Research (SCAR) Expert Group on Seals (a committee of the International Council for Science) which reported a population of Antarctic fur seals (*Arctocephalus gazella*) of 4,500,000 – 6,200,000 with a growing trend (www.scar.org , SCAR Expert Group on Seals subsite, Status of Stocks, Table 1). These numbers were estimated from the number of breeding females and are based on a standard deviation of 300,000. It is a substantial increase from the1990/91 census reporting a population of 2,700,000. Krill fishing took place during the entire period of this increase.

The twenty-eighth meeting of SCAR was held July 25-29, 2004. The Expert Group on Seals reported that both Antarctic fur seals and sub-Antarctic fur seals continue to increase over their entire range. Antarctic fur seals are not listed as either "threatened" or "endangered" under the U.S. Endangered Species Act.

Antarctic fur seals were almost made extinct by commercial sealing for their fur in the 18th and 19th centuries, perhaps only a few hundred of the seals remaining, and small scale hunting continued until 1907. The species is now protected by the

Convention for the Conservation of Antarctic Seals (CCAS), the Antarctic Treaty and the legislation of various countries within its range. In addition, the Antarctic fur seal is listed as an Appendix II species under the Convention to Control International Trade in Endangered Species of Wild Fauna and Flora (CITES). Since protection, the population has been growing steadily, particularly at South Georgia since the 1950s, and population growth is now about 10% per annum (Table 4). Recovery at other sites began presumably from migrants from the South Georgia stock in the late 1950s and in the 1960s.

The importance of krill in the diet of Antarctic fur seals at South Georgia could result in the species being affected by an increased krill fishery in the Southern Ocean as well as by increased competition for krill with other marine mammal species that are now recovering from previous exploitation. Antarctic fur seals have been reported as bycatch in the krill fishery off South Georgia (K.Reid, British Antarctic Survey, pers.comm.).

The entanglement of Antarctic fur seals in man-made debris, particularly around the neck, is a problem as it can cause death by drowning or starvation. A 1988-1989 study at Bird Island, South Georgia, found 208 sightings of entanglement, the main culprits being polypropylene straps, nylon string and fishing net, indicating a figure of 5,000-10,000 fur seals entangled for the entire South Georgia population (Walker *et al*. 1997). The debris is most likely to come from marine traffic in the Southern Ocean.

Unusually high levels of toxic heavy metals have also been found in Antarctic fur seals (De Moreno *et al*. 1997) but the effects and sources of these are uncertain. Some scientists, claiming that the growing population of Antarctic fur seals is now causing environmental problems by polluting lakes and destroying plants in Antarctica, have been pushing for the downgrading of the fur seals' conservation status. However in some areas of its range population growth has slowed far below pre-exploitation levels (Hucke-Gaete *et al*. 2004, Goebel *et al*. 2003).

Antarctic fur seals on World Heritage listed Macquarie Island were afforded additional protection in 2000 by the creation of a new Federal 16 million hectare Marine Park on the eastern side of the island. The Tasmanian government also announced in 2000 an extension to the Macquarie Island Nature Reserve to cover all Tasmanian waters out to three nautical miles surrounding the island

Life History

The breeding season takes place from November to January, the males arriving early to compete, with frequent fighting, for breeding territory that will eventually contain on average 10 females. Females give birth to a single pup 1-2 days after arriving at the rookery and the pups are born from late November through December.

The mother mates 6-8 days after giving birth and then leaves to feed at sea. Depending on local availability of prey resources foraging trips range from overnight to 10 days and range from 40-240 km from the breeding site. Females return to shore after each foraging trip to nurse her pup for 1-2 days. This cycle of feeding and nursing lasts about 4 months. Males do not feed during their time on shore in the breeding season and lose about 1.5 kg in weight per day over the 30 or so days that they are on land.

Adult males measure 1.6-2 m in length and weigh 90-210 kg (average of 188 kg) while adult females are smaller at 1.2-1.4 m and 25-55 kg (average 37 kg). Pups are born measuring 60-73 cm in length and weighing 4.5-6.5 kg, male pups slightly heavier than female pups. Pup mortality over the first year of life has been calculated at 24% and is greater on the denser breeding beaches. Antarctic fur seals are considered shallow divers especially in comparison to other Antarctic phocid seals. They have been known to dive for up to 10 minutes and as deep as 250 m but on average their dives are within 30 m of the surface. Both sexes reach sexual maturity at 3-4 years but males do not attain territorial status until about 6-10 years. Males can live up to 15 years of age, females up to 23 years.

Trophic links

The main food of Antarctic fur seals at South Georgia and the South Shetlands is krill but fish (myctophid species and *Pleurogramma antarcticum*), and squid are also important prey especially outside the breeding season (Daneri and Carlini 1999; Cassaux *et al*. 2003a; Cassaux *et al*. 2003b; Cassaux *et al*. 2004; Daneri *et al*. 1999). The almost total dependence of nursing mothers on krill during the breeding season at South Georgia means that the reproductive success of these colonies is very closely linked to its local availability (Reid and Arnould 1996; McCafferty *et al*. 1998; Croxall *et al*. 1999). Occasionally there are years in which krill abundance is poor and colonies are affected both for that season and, to a lesser extent, for the next season (Croxall *et al*. 1999). The colonies at Macquarie Island and the Kerguelen Islands rely more on a diet of fish and squid (Robinson *et al*. 2002; Lea *et al*. 2002; Cherel *et al*. 1997). Winter diets may depend more on fish (particularly Notothenioids) than during the summer at South Georgia (North 1996; Reid 1995). Antarctic fur seals usually dive to a depth of 30-40 m for an average of about 2 minutes, diving to a shallower depth at night, when they do most of their feeding, than during the day. Leopard seals prey on juveniles and pups especially at higher latitudes (Hiruki *et al*. 1999) and may exert a top-down control of fur seal populations in the South Shetlands that could account for the reduced rate of increase of recovering populations there (Boveng *et al*. 1998). Killer whales are likely also a predator of both juveniles and adults.

Subantarctic fur seal (*Arctocephalus tropicalis*)

Distribution and Numbers

The breeding colonies of the Subantarctic fur seal are generally found on temperate islands in the South Atlantic and Indian Oceans, north of the Antarctic Polar Front. Some populations depend on foraging at the polar front and are sympatric with populations of Antarctic fur seals thus they have been included in this assessment. The largest colonies occur at Gough, Amsterdam and the Prince Edward Islands. Colonies have also recently been established at Tristan da Cunha, St Paul, Îles Crozet and Macquarie Islands (Figure 2). At least 80,000 pups are born annually, giving a worldwide population of between 277,000 and 356,000 (Table 5).

Status

The species was hunted almost to extinction in the 19th century for its fur, and some island colonies were totally wiped out. Small-scale killing for fishing bait and skins took place at Gough Island until the 1950s. All of the colonies are now protected by legislation. Since being afforded protection, Subantarctic fur seals have started to colonize new locations and most populations now show growth rates of 13-15% or more Table 5). The Subantarctic fur seal is listed as an Appendix II species under CITES. There appear to be no major threats currently facing the species.

Subantarctic fur seals on World Heritage listed Macquarie Island were afforded additional protection in 2000 by the creation of a new Federal 16 million hectare Marine Park on the eastern side of the island. The Tasmanian government also announced in 2000 an extension to the Macquarie Island Nature Reserve to cover all Tasmanian waters out to three nautical miles surrounding the island

A recent genetic study was carried out to investigate the potential impacts of commercial sealing and range contractions on the genetic variation and population structure of Subantarctic fur seals (Wynen *et al*. 2000, 2001). The study revealed that despite commercial sealing, high levels of genetic diversity and population structure are still present in the species. Three genetic lineages or clades are apparent, none of which represents fixed geographic distributions. However the seals from Gough, Prince Edward and Amsterdam Islands all differ significantly in the percentages of each clade represented in their populations. The recently established populations at Îles Crozet and Macquarie Island are more similar genetically to each other than they are to any of the potential "source" populations. Results suggest that these populations were recolonized primarily by animals from the Prince Edward Islands and, to a lesser extent, Amsterdam Island.

Life History Traits

The Subantarctic fur seal usually hauls out on rocky shores from November to January in order to breed. The adult males arrive at the breeding grounds just prior to the females and form territories, usually containing between 4-12 females. They defend these territories by means of fighting, vocalization and bluff. The females usually arrive in November-December and their pup is born a few days later with a black coat. Mating takes place about a week after the birth and the female then begins a cycle of feeding at sea for approximately 5 days (although foraging trips lasting a month have been reported) and returning to nurse her pup on land for 2-3 days. The milk that the mothers feed their pups is high-energy, containing approximately 39% fat.

Recent research has revealed that lactating females on Amsterdam Island have one of the longest attendance cycles of the fur seal species, spending an average of 11-23 days at sea from summer to winter (Georges and Guinet 2000). The time that mothers from Amsterdam Island spend ashore nursing their pup is also long, up to 4 days, but remains constant throughout the year. Lactating female Subantarctic fur seals have been recorded foraging up to 530 km from their breeding islands, and appear to forage in association with oceanographic frontal zones where food availability is expected to be greater (Georges *et al*. 2001a). Foraging dives are generally shallow and occur mostly at night when the seals' main prey, myctophid fish, migrate to near the surface. Subantarctic fur seals also consume squid (Georges *et al*. 2001b).

Pup growth during maternal attendance increases for about 220 days of age, after which they begin to lose weight until they wean at around 281 (± 30) days. Adults molt their coats between March and May. Subantarctic fur seal breeding colonies sometimes share space with Antarctic fur seals (*Arctocephalus gazella*) and there is evidence of some inter-breeding between these species at Marion and Macquarie Islands.
Adult males usually measure up to 1.8 m in length and weigh up to 165 kg (average 131 kg), while adult females are about 1.5 m in length and weigh approximately 50-55 kg. Pups are born about 65 cm long and weighing 4-5 kg. Females reach sexual maturity at 4-6 years of age, males at 4-8 years, although males do not achieve territorial status until 10-11 years of age. Males of the species are known to live over 18 years, females over 23 years.

Trophic links

Less is known about the diet of Subantarctic fur seals compared to Antarctic fur seals but because of breeding and foraging locations krill is presumably not a primary item in the diet. Myctophid fish and cephalopods are primary prey (Goldsworthy *et al*. 2001). Sharks and killer whales are known predators.

Southern elephant seal (*Mirounga leonina*)

Distribution and Numbers

The Southern elephant seal is the largest of the pinnipeds. Its main breeding grounds are the subantarctic islands near the Antarctic Polar Front, the population at South Georgia being the largest and containing approximately half of the entire species. Other important populations are at Macquarie Island, Heard Island and the Kerguelen Islands. Rare births have also been reported from New Zealand, Australia and South Africa. The total population has been calculated at about 600,000 (Table 6).

Status

The Southern elephant seal was heavily exploited in the 19th and 20th centuries for its blubber as a source of oil, reducing its numbers considerably. A controlled hunt of adult males continued at South Georgia until 1964. Any killing of the species south of 60ºS is now regulated by the CCAS, while the species is also protected by legislation in various countries within its range. The Southern elephant seal is listed as an Appendix II species under CITES.

Southern elephant seal numbers have decreased significantly over the last forty years, e.g. by 50% on Heard Island, 84% on Marion Island, 57% on Macquarie Island, 90% on Campbell and Signy Islands, and up to 80% on some of the Kerguelen Islands (Table 6). Numbers at the South Georgia colony have remained relatively stable during this time, while the colony in Argentina is the only one that appears to have been increasing. The reasons for this decline in some populations are not yet understood and the effect seems to be specific to Southern elephant seals rather than other animals in the Southern Ocean. Some have suggested that the problem may be due to competition with other marine predators or due to ocean environmental change but both of these are currently speculative. There is currently not much support for the explanation that the problem is due to direct competition with commercial fisheries because, for example, there is no commercial fishing for deep-water species in the feeding areas of the declining Macquarie Island population. However any future increase in fishing in the region could certainly cause problems for the species. In 1999 an Argentinean marine mammal scientist warned that over fishing is threatening the survival of the Península Valdés population, expressing concern about the ever-increasing volume of squid caught by commercial fishers at the seals' feeding grounds along the edge of the continental shelf.

Hindell *et al*. 1994 directly addressed the possible causes of the decline of the Kerguelen stock at least until the mid-1980s and the current decline of the Macquarie Island stock. As has been noted for observed declines in abundance of northern fur seals in the 1970s and the current decline of Steller sea lions, "whatever factor is causing the decline appears to be operating on the younger age classes, possibly before sexual differences in foraging patterns develop." Further, the authors considered evidence regarding causative factors for the observed population dynamics beyond the narrow confines of single-species models by incorporating hypotheses related to competition and large-scale changes in the physical and biological environment.

The explanation that is perhaps most currently favored is that the Southern elephant seal populations overshot their sustainable population levels after recovering from the previous period of commercial sealing, and that they are now regaining their equilibrium constrained by the finite food resources available. Research is however continuing to determine the causes and the decline in populations may well be a complex combination of factors. The Península Valdés colony faces the additional problem of disturbance caused by relatively uncontrolled tourism, some seals there also having been seen with pieces of net around their necks and oil on their bodies.

In 1999 UNESCO's World Heritage Committee designated Argentina's Península Valdés, an important site for the species, as a World Heritage Site. Southern elephant seals on World Heritage listed Macquarie Island were afforded additional protection in 2000 by the creation of a new Federal 16 million hectare Marine Park on the eastern side of the island. In addition, the Tasmanian government announced in 2000 an extension to the Macquarie Island Nature Reserve to cover all Tasmanian waters out to three nautical miles surrounding the island.

Life History Traits

Southern elephant seals give birth and breed in September-November, the larger males arriving a month before the females and other males in order to fight for dominance and the right to a harem of females. Only the largest 2-3% of males each year gain this right and the number of breeding females to which the successful males have access is large, sometimes exceeding 100. The female gives birth between 0-10 days after coming ashore and does not leave the beach to feed until her pup is weaned. During this time she depends on her stored reserves to sustain her and loses an average of 35% of her body weight, a weight loss of 8 kg per day. The nursing period lasts an average of about 23 days and the pup puts on weight very quickly during this period, gaining about 3.5 - 4 kg per day. The mother mates up to 5 days before her pup is weaned, most matings concentrated in the three days before weaning, and then once her pup is weaned she abandons it and returns to sea. The pup leaves the beach about 3-8 weeks later initiating the onset of nutritional independence. Suitable food may not be near at hand for the pup and that means that the amassed body reserves of the pup are an important aspect in its survival. The weaned size of pups is very variable, some being three times the weight of others.

Adult males, up to 10 times the size of breeding females, also do not feed during the breeding season and may lose up to more than 40%, 12 kg per day, of their body weight while ashore. The amount of time spent ashore by males during the breeding season varies greatly, some breeding males spending more than 60 days and up to 90 days on shore (the females only spend 25-30 days ashore). After an intensive period of feeding the adults return to molt for an average of 30-40 days in January-February. They do not enter the water to feed while molting. Some non-breeding bulls molt on the Antarctic continent itself.

Southern elephant seals show a great difference in size between the sexes and also within each sex. The average weight of fully grown adult males is 2,200 kg (maximum over 4,000 kg), while their average length is 4.2 m (maximum 6.2 m). Male elephant seals at Argentina's Península Valdés are significantly smaller than those in the Falkland Islands and South Georgia. Females typically weigh 500 kg (maximum 1,000 kg) and measure an average of 2.7 m in length (maximum 3.7 m). Pups are born about 1.3 m long, the males slightly heavier at about 50 kg compared to 45 kg, but both sexes weigh roughly the same, about 135-140 kg, by the time that they are weaned. Southern elephant seals are known to dive as deep as 2,000 m for as long as 2 hours. Most females reach sexual maturity at 2-4 years of age. Males may reach sexual maturity at 3-6 years of age but few of them breed until 10 years of age. Southern elephant seals can live for up to 23 years.

Trophic links

The Southern elephant seal ranges widely when not breeding or molting, and spends ten months a year intensively foraging over wide areas in the waters of the Antarctic for squid and fish. Studies using diet derived fatty acid signatures as trophic biomarkers indicated that Southern elephant seals had fish-dominated diets during the winter and when foraging around Antarctic continental shelves. Seals had a more cephalopod-dominated diet during the summer and when foraging pelagically (Bradshaw *et al*. 2003).

The squid, *Psychroteuthis glacialis*, has been identified as a primary prey species in several diet studies of Southern elephant seals foraging in Antarctic waters (van den Hoff *et al*. 2003; Piatkowski *et al*. 2002; Daneri *et al*. 2000, Slip 1995). Large fisheries for squid occur in waters adjacent to the Antarctic. Commercially exploitable squid live in Antarctic waters and exploratory fishing for them has already taken place (New Zealand Ministry of Foreign Affairs and Trade, 1995; CCAMLR, 1996).

Toothfish, *Dissostichus eleginoides*, has also been found to be an important prey item for Southern elephant seals (Goldsworthy *et al*. 2001; Green *et al*. 1998).

The seals dive continuously, day and night, for the entire trip to sea, diving to average depths of 300-600 m and for average periods of 20-22 minutes (Slip *et al*. 1994; Field *et al*. 2001; Hindell *et al*. 1999). They spend 90% of their time underwater, spending only 2-3 minutes at the surface between dives. The deepest dives are made during the day. Adult Southern elephant seals make two return migratory trips of up to 2,000 km each way to their Antarctic feeding grounds each year, once after breeding and the second time after molting (Slip *et al*. 1994). An exception to this is the Argentinean population that feeds in the southern Atlantic Ocean rather than in Antarctic waters (Campagna *et al*. 1999). Weaned pups and juveniles are preyed upon by killer whales and sometimes leopard seals.

Crabeater seal (*Lobodon carcinophagus*)

Distribution and Numbers

Crabeater seals are considered to be the most numerous pinniped species in the world (Siniff 1991). They are found throughout the pack ice that surrounds the Antarctic continent, often in more concentrated numbers around the edges.

It is difficult to determine the true size of the crabeater seal population as only limited counts have been carried out due to the problems of surveying in the inhospitable Antarctic climate (Green *et al*. 1995). It is generally believed that there are around 15 million crabeater seals but early results from the multinational Antarctic Pack Ice Seal Survey that took place in 1999-2000 appear to indicate that numbers of the seals are much less than previously thought. The distribution of crabeater seals is generally dependent on the seasonal movement of the pack ice and they are also found elsewhere in the Southern Ocean and near subantarctic islands.

Status

As with other seals of the Antarctic pack ice, crabeater seals have largely been protected from commercial hunting due to their inaccessibility and the high cost of operating in the area. All killing of seals in the Antarctic region is regulated by the Antarctic Treaty and the CCAS. A Soviet Union commercial sealing expedition however killed 4,000 crabeater seals in 1986-1987.

The species' heavy dependence on krill may cause it problems. As populations of marine mammals that were previously hunted in the Southern Ocean, e.g. cetaceans, recover to pre-exploitation levels then competition for krill will increase.

A report produced in 1999 expressed concern that warming global temperatures are impacting ocean ecosystems much earlier and far more broadly than many experts anticipated, and that if global warming continues then species that depend on the diminishing pack ice, such as crabeater seals, will be threatened by decreased habitat and food supply.

Life History Traits

Crabeater seals usually form breeding groups every spring in the pack ice region. These groups consist of a male, female and pup that normally stay together until the pup has been weaned, roughly estimated to be about 14-21 days after its birth. The male is very aggressive towards other males who take an interest in the female during this time. Pups are born mainly in September and October with a light grey coat that they molt about two weeks afterwards. Breeding takes place after the pup has been weaned. At various times, especially during the breeding season, groups of juvenile and non-breeding seals may congregate on the ice. Crabeater seals molt in January and February. Most crabeater seals have obvious scars, both from predator attacks (e.g., Leopard seals) and as a result of fighting during the breeding season.

Trophic links

Crabeater seals feed almost entirely on krill near the Antarctic peninsula but are known to have a more opportunistic and varied diet in other regions. They seem to prefer diving and feeding at night, mostly at dusk and dawn, with shallow dives of less than 40 m lasting less than 5 minutes (Bengtson *et al*. 1992, Nordoy *et al*. 1995). Satellite tracking in one recent research study showed that the seals spent almost all of the night in the water foraging and that most of them were hauled out on the ice and resting by midday (Burns *et al*. 2002). Crabeater seal pups and juveniles are heavily preyed on by leopard seals, especially newly-weaned pups during the spring and summer, and this predation is a key influence on the lifestyle and habits of the species. Killer whales also prey on crabeater seals of all ages.

There is little difference in size between the sexes, male and female adults measuring 2.2-2.6 m in length and weighing approximately 220 kg, although the females are usually slightly heavier. Pups are born about 1.2 m in length and weighing an average of 30 kg. Both females and males achieve sexual maturity at 2.5-6 years, the actual age possibly being dependent on food abundance. Crabeater seals have been known to dive to depths of up to 430 m and for periods in excess of 10 minutes. They can live to about 40 years of age but the average lifespan is 20 years.

Weddell seal (*Leptonychotes weddellii*)

Distribution and Numbers

Usually found on near-shore fast ice (Siniff 1991), unlike the other Antarctic seal species that prefer the pack ice, there are estimated to be about 800,000 Weddell seals around the Antarctic continent (Erickson and Hanson, 1990). Small populations also breed on South Georgia, the South Sandwich Islands, the South Shetland Islands and the South Orkney Islands (Croxall and Hiby 1983).

Status

Weddell seals are widely distributed and abundant, but no good estimate of population size is available. Based on shipboard and aerial censuses, there are probably at least a quarter million in the entire Antarctic, with the largest concentrations in the Weddell Sea (Erickson and Hanson 1990). Large harvests of seals to feed U.S. and New Zealand sled dogs during the mid-1950s apparently depleted the population in McMurdo Sound. During the first 2 years of harvesting by the U.S. station, nearly 25 percent of the 2000 seals that lived in McMurdo Sound were killed for dog food. Nearly all were adults. Kills of 75 to 150 per year continued from the late 1950s through 1982. Immigration of juveniles fueled population growth, but there was another unexplained decline during the 1970s, with the population reaching its lowest point in 1976 to 1978. Recent data from McMurdo Sound, where human impacts on Weddell seals are perhaps greater than throughout the species range, indicate that the abundance of a resident population has remained stable over time (1975-2000) despite annual fluctuations (Cameron and Siniff 2004).

Weddell seals have been protected in the past from commercial hunting by their inaccessibility, although many were killed to provide food for sled dogs, the practice is no longer permitted. All killing of seals in the Antarctic region is now regulated by the CCAS and the Antarctic Treaty. However a commercial hunt of 107 Weddell seals was carried out by the Soviet Union in 1986-1987.

The importance of krill in the diets of the fish and squid, on which Weddell seals feed, along with current pressures on krill stocks from the commercial fishery, could result in the species experiencing a diminished food supply.

Life History Traits

More is known about the lifestyle of the Weddell seal than any of the other Antarctic species. Females haul out on the fast ice in pupping colonies in September (in the more northerly areas), October and November in order to give birth to their pup. The females in a colony are well spaced out and the location of these colonies is alongside annual tide cracks or broken ice. The female nurses her pup for 5-6 weeks, the pup often starting to accompany its mother into the water after about two weeks.

Towards the end of the nursing period the female mates under the ice, the males having maintained underwater territories beneath cracks in the ice with access to several females. Weddell seals use their specially modified front teeth to maintain ice holes in the fast ice to breathe. Studies have shown that adult seals are usually faithful to the same pupping colonies each year, most of them staying within tens of kilometers of the same site all year round. Immature Weddell seals tend to inhabit the pack ice all year round rather than the fast ice region, only moving to the fast ice and selecting a colony when they reach maturity. Weddell seals molt from December to March.

Adult males can measure up to 2.5-2.9 m in length, adult females slightly longer at up to 3.3 m. Weddell seals can weigh up to 400-600 kg. Pups are born measuring about 1.2-1.5 m in length and weighing 22-30 kg. The juvenile mortality rate for Weddell seals is less than that of the other Antarctic species because of the lesser threat of predation. Individuals have been known to dive up to 600 m in depth and a 73 minute dive was once recorded. Females become sexually mature at about 3-6 years, males at 7-8 years. Weddell seals can live up to 22 years of age.

Trophic Links

Being versatile feeders, the main food for the Weddell seal is fish, such as the Antarctic cod and Antarctic silverfish, *Pleurogramma antarcticum* (Burns *et al*. 1998). They also eat some cephalopods and crustaceans (Cassaux *et al*. 1997). Young seals in the pack ice region are more dependent on pelagic prey. Recent research using video cameras attached to Weddell seals showed that the seals are stealth hunters, approaching within centimeters of cod without startling the fish, and that they do not appear to use sound to hunt, relying instead on their acute underwater vision and often using the under-ice surface for backlighting (Davis *et al*. 2003). The seals were observed flushing out smaller fish by blowing air into sub-ice crevices, and were able to return to a small air hole in the ice after traveling almost 3 km away. Weddell seals are excellent divers and feeding dives to depths of 200-400 m for periods of up to 15 minutes are common (Hindell *et al*. 2002). Adult seals suffer little from predation due to their inaccessible location in fast ice and heavy pack ice regions. However some Weddell seals, especially younger seals, are preyed upon by killer whales and to a lesser extent by leopard seals, particularly in the spring and summer when the ice breaks up.

Leopard seal (*Hydrurga leptonyx*)

Distribution and Numbers

The leopard seal is widely distributed in high southern latitudes. It is usually found on the edges of the Antarctic pack ice, but individuals are also present year-round and seasonally on some subantarctic islands (Borsa 1990). Population size is difficult to determine, especially as the leopard seal inhabits such a large inhospitable area and is usually solitary, but an estimate of 220,000-440,000 has been made (Erickson and Hanson 1990).

Status

As with other seals of the Antarctic pack ice, leopard seals have been protected from commercial hunting due to their inaccessibility and the high cost of operating in the area. All killing of seals in the Antarctic region is regulated by the Antarctic Treaty and the CCAS. In 1986-1987 however two Soviet commercial sealing ships killed 649 leopard seals. There is no indication, however, that leopard seals are threatened or depleted.

Life History Traits

The distribution of leopard seals is significantly influenced by the annual expansion and contraction of the pack ice surrounding the Antarctic continent. Higher densities of leopard seals are found on broken ice near the pack ice edge. The leopard seal often hauls out on islands near the continent when the ice contracts, and immature seals are known to gather on subantarctic islands as they migrate north during late autumn and winter when the ice expands. Very little is known about the breeding habits of the leopard seal, but it has been suggested that pupping normally takes place in November and December and that there is a short breeding season about a month later, mating probably taking place in the water.

It is thought that leopard seals most likely give birth on non-fast ice and that there is probably a very short period of suckling, lasting perhaps a month, in which the pup puts on weight and protective blubber very quickly. Leopard seals are known to be very vocal during the breeding season, their calls tending to be soft and lyrical. There are also some regional variations in their calls, which has led to suggestions that there are separate breeding populations with only limited interactions. Pups are born with a soft thick coat, being very similar to the adult coat that is grey colored and spotted, darker on the back than on the front. Adults usually molt between January and February.

The leopard seal is the largest of the four Antarctic seal species. Adult males can measure up to 2.5-3.2 m in length and weigh 200-455 kg, while adult females are slightly larger at 2.4-3.4 m in length and 225-591 kg. Pups are born measuring 1.5-1.6 m in length and weighing about 35 kg. The pup mortality rate in the first year is about 25%. Females probably achieve sexual maturity at 3-7 years, males at 2-6 years. The longest dive recorded is about 15 minutes - due to its feeding habits the leopard seal probably does not need to dive deeply. Leopard seals can live for over 26 years.

Trophic links

Leopard seals eat an amazingly large variety of food, using their wide gaping mouths and massive jaws to great effect. As a circumpolar top trophic level predator their diet varies largely with locality and availability of locally abundant prey (Hiruki *et al* 1999). In winter their most important food is krill. Krill may be especially important food source for juveniles (Walker *et al*. 1998). They also eat cephalopods, fish and other seal species, especially newly-weaned crabeater seals during December and January. Penguins and fur seals are seasonally important part of the diet of some leopard seals in certain localities (Walker *et al*. 1998). Fur seal pups are a major prey item in some areas and leopard seal predation may exert a substantial top down effect in limiting fur seal populations locally (Boveng *et al*. 1998). Southern elephant seals have also been found in leopard seal diets (Walker *et al*. 1998). The only known predator of leopard seals is the killer whale.

Ross seal (*Ommatophoca rossii*)

Distribution and Numbers

Named after the British explorer who obtained the first specimen, less is known about the Ross seal than any of the other Antarctic seals. The species is mostly found on the pack ice around the Antarctic continent, with a wide but dispersed circumpolar distribution. It is very difficult to determine how many of the species there actually are. The Ross seal is however the rarest of the four seal species breeding on the Antarctic pack ice, and one population estimate has been made of about 131,000 (Erickson and Hanson 1990). The greatest abundance of Ross seals appears to be in the Ross and King Haakon VII Seas. Wandering seals have been reported north of 60º S only on very rare occasions.

Status

Ross seals have been protected from large-scale commercial hunting due to their inaccessibility and the high cost of operating in the area. They are protected by the Antarctic Treaty and the CCAS, although 30 were killed in 1986-1987 for commercial purposes under a special permit. In January 1998 the Environmental Protection Protocol to the Antarctic Treaty was ratified, implementing environmental measures such as the banning of mining and oil drilling in Antarctica for at least 50 years, along with the banning of refuse disposal and the use of pesticides in the region. The lesser importance of krill in the Ross seal diet should probably prevent the species from being badly affected by current pressures on krill stocks from the commercial fishery and from increased competition by other Antarctic marine mammals.

Life History Traits

Ross seals are the least studied of the Antarctic seals due to their dispersed and isolated distribution. They are usually observed as solitary individuals, appearing to prefer larger and more concentrated ice located further in from the ice pack edge than that preferred by leopard and crabeater seals. There is not much known about the Ross seal's breeding season, though it appears to take place in November when observations of pups increases (Southwell *et al*. 2003). The female nurses her pup alone for a short period, perhaps 2-3 weeks, and breeding may occur about one month after the pup is weaned. They are thought to molt from late December and January and are subsequently more likely to be fasting and hauled-out during this period (Southwell 2003; Skinner and Westlin-van Aarde 1989; Skinner and Klages 1994).

Adult male Ross seals measure 1.7-2.1 m in length and weigh 130-215 kg, females generally larger at 2-2.4 m and 160-200 kg. Pups are born measuring 1.05-1.2 m in length and weighing about 27 kg. It is thought that females achieve sexual maturity at 3-4 years, males at 2-7 years. Ross seals live at least to age 20 (Skinner and Klages 1994).

Trophic links

The Ross seal is thought to specialize in feeding on cephalopods, particularly squid but is also known to feed on fish (*Pleurogramma antarcticum*) (Skinner and Klages 1994). What little information exists on dive depths of the Ross seal indicates they dive to depths of several hundred meters and prey on diurnally migrating prey. They dive primarily at night and haul out during the day. They dove deeper than crabeater seals foraging in the same area on krill (Bengtson and Stewart 1997). Killer whales prey on some Ross seals and there is possibly also some predation by leopard seals.

Table 4 (Sec. 3.1.c.): Estimated sizes and trends of Antarctic fur seal (*Arctocephalus gazella)* populations.
Source: (SCAR 2002) Status of Stocks Report. Status of stocks tables for Antarctic pinnipeds are annually updated by the SCAR Expert Group on Seals website: (http://www.seals.scar.org/pdf/statusofstocs.pdf).

Site	Pup numbers	Total population	Year of census	Mean annual rate of change	Reference
Macquarie Island	152[a]		1999/00	increasing (1988/89 to 99/00)[a]	Goldsworthy (pers. comm.)
	164[b]		2001/02	increasing	Goldsworthy (pers. comm.)
Heard Island	248		1987/88	+ 23% (1962/63 to 87/88)	Shaughnessy (1993)
	1,012		2000/01	+ 20.1 % (1962/63 to 2000/01)	Goldsworthy (pers. comm.)
McDonald Island	100	300	1979/80	increasing	Johnstone (1982)
Iles Nuageuses (Iles Kerguelen)	2,500[c]		1984/85	increasing	Jouventin & Weimerskirch (1990)
	5,000	?	2000	Increasing	Lea (pers. comm.)
Courbet Peninsula (Iles Kerguelen)	2	?	1984	Increasing	Bester and Roux (1986)
	>200	?	1998	Increasing	Guinet (pers. comm.)
	1,500-1,700	?	2000	Increasing	Lea (pers. comm.)
Ile de la Possession (Iles Crozet)	67	?	1992/93	+ 21.4% (1983 to 92)	Guinet *et al*. (1994)
	234	?	1999/00	+ 16.9% (1992 to 1999)	Guinet (pers. comm.)
	295	?0	2003/04	+ 5.9% (1999/00 to 2003/04)	Guinet (pers. comm.)
Marion Island	251[c]	1,205[d]	1994/95	+ 17% (1988/89 to 94/95)	Hofmeyr *et al*. (1997)
	796[c]	3,821	2003/04	+13.8% (1994/95 to 2003/04)	Hofmeyr *et al*. In preparation-a
Prince Edward Island	?	200	1981/82	increasing	Kerley (1983)
	400	2,000[i]	2001/02	+ 16.2%	Bester *et al*. (2003)
Nyrøysa (Bouvetøya)	2,000	>9,501	1989/90	+7.0% (1978/79 to 89/90))	Bakken (1991)
	15,523[c]	66,128	2001/02	+0.1%	Hofmeyr *et al*. In preparation-b

Table 4. (cont.)

Site	Pup numbers	Total population	Year of census	Mean annual rate of change	Reference
				(1996/97 to 2001/02)	
South Georgia	<600,000[c]	2.7×10^6 [f,g]	1990/91	+ 9.8% (1976/77 to 90/91)	Boyd (1993)
		$4.5\text{-}6.2 \times 10^6$ [f,g]	1999/00	+6% to 14% (1990/91 to 99/00)	Boyd (pers. comm.)
South Sandwich Islands	<500	<2,000	1962/63	?	Holdgate (1962)
	346		1997/98	stable	Boyd (pers. comm.)
South Orkney Islands	<1,000		1970/71	?	Laws (1973), Boyd (1993)
South Shetland Islands	9,300		1991/92-95/96	+ 11% (1994/95 to 95/96)	J.L. Bengtson and D. Torres (pers.comm), Aguayo *et al*. (1992)
	10,057		2000/01	+ 0.9% (1995/96 to 01/02)	Goebel *et al*. (2003)
Cape Shirreff (SSSI No32)	5,313		1991/92	+ 14%[i] (1986/87 to 91/92)	Hucke-Gaete (1999)
	8,455		1999/00	+ 6%[i] (1991/92 to 99/00)	Vallejos *et al*. (2000)
	8,577	21,190	2001/02	+4.6%[i] (1992/93 to 2001/02)	Hucke-Gaete *et al*. (2004)

a - For populations of both *A. tropicalis* and *A. gazella*.
b - Corrected for observer undercount.
c - Corrected for precount mortality.
d - Recalculated from population values in publication .
e - Number of breeding females.
f - Estimated from the number of breeding females.
g - Standard deviation = 300,000.
h - Standard error = 140.
i - Calculated from pup counts.

Table 5 (Sec. 3.1.c.): Estimated sizes and trends of subantarctic fur seal (*Arctocephalus tropicalis*) populations.
Source: (SCAR 2002) Status of Stocks Report. Status of stocks tables for Antarctic pinnipeds are annually updated by the SCAR Expert Group on Seals website: (http://www.seals.scar.org/pdf/statusofstocs.pdf).

Site	Pup numbers	Total population	Year of census	Mean annual rate of change	Reference
Macquarie Island	152 [a]		1999/00	increasing (1988/89 to 99/00) [a]	Goldsworthy (pers. comm.)
Heard Island	1	13	1987/88	?	Goldsworthy & Shaughnessy (1989)
	1	13	2000/01	?	Goldsworthy (pers. comm.)
Ile Amsterdam	>9,638 [b]		1992/93	+ 0.4% (1981/82 to 92/93) [e]	Guinet *et al*. (1994)
	(partial census)		2002/03	Stable 1992/93 to 2002/03	Guinet (pers. comm.)
Ile Saint Paul	365		1992/93	+ 23.8% (1984/85 to 92/93) [e]	Guinet *et al*. (1994)
Ile de la Possession (Iles Crozet)	190		1990/91	+ 21.6% (1978-91) [e]	Guinet *et al*. (1994)
	251		1999/00	+ 3.1% (1990/91-1999/00) [e]	Guinet (pers. comm.)
	322		2003/04	+6.4% (1999/00-2003/04)	Guinet (pers. comm.)
Marion Island	10,137 [c,d]	48,658	1994/95	+ 1.8% (1988/89 to 94/95)	Hofmeyr *et al*. (1997)
	14,915 [c,d]	71,591	2003/04	+4.2% 1994/95 to 2003/04	Hofmeyr *et al*. In preparation
Prince Edward Island	5,372 [c,d]		1988/89	+ 9.7% (1981/82 to 88/89)	Wilkinson and Bester (1990)
	15,000 [f]		2000/01	+ 9.5% (1987/88 to 2000/01)	Bester *et al*. (2003)
Gough Island	>53,076 [b,c,d]		1977/78	+ 14.9% (1955 to 1977/78) [e]	Bester (1987)

Table 5. (cont.)

Site	Pup numbers	Total population	Year of census	Mean annual rate of change	Reference
Tristan da Cunha	50	250	1993/94	Increasing	C. Glass (pers. comm.)
	?	700	1998/99	Increasing	C. Glass (pers. comm.)
Nightingale Island (Tristan da Cunha Group)	?	>500	1998/99	Increasing	C. Glass (pers. comm.)
Inaccessible Island (Tristan da Cunha Group)	>3	>200	1999/00	Increasing	P.G. Ryan (pers. comm.)

a - For populations of both *A. tropicalis* and *A. gazella*.
b - Extrapolation based on a proportion of the total populated area.
c - Corrected for observer undercount.
d - Corrected for pre-count mortality.
e - Recalculated from population values in publication.
f – Extrapolated from peak adult male counts, and known adult male:pup ratios, in breeding colonies.

Table 6 (Sec. 3.1.c.): Estimated sizes and trends of southern elephant seal (*Mirounga leonina*) populations within the three stocks of the Southern Ocean.
Source: (SCAR 2002) Status of Stocks Report. Status of stocks tables for Antarctic pinnipeds are annually updated by the SCAR Expert Group on Seals website: (http://www.seals.scar.org/pdf/statusofstocs.pdf).

Stock	Locality	Year of census	Estimated pup production	% annual rate of change	Period of change	Trend in population abundance	Reference
South Georgia	South Georgia	1995	113,444	0	1985-1995	Stable	Boyd *et al*. (1996)
	South Orkney Islands	1985	<100	?	1948-1985	Uncertain	McCann (1985)
	Bouvetøya	1998	89	?	-	Uncertain	Kirkman *et al*. (2001)
	Falkland Islands	1960	~1,000	?	-	Uncertain	Laws (1960)
	Sea Lion Island	2001	522	0	1989-2001	Stable	Galimberti *et al*. (2001)
		2003	501	-10.9	2002-2003	Declining?	Galimberti (pers. comm.)
	GoughIsland	1998	18	-3.3	1975-1998	Declining	Bester *et al*. (2001)
	King George Island	1995	476	-5.7	1980-1995	Declining	Vergani and Stanganelli (1990), Carlini (pers. comm.)
		1999	301	-6.0	1995-1999	Declining	Carlini (pers. comm.)
		2003	290-400	?	1999-2003	Fluctuating	Carlini (pers. comm.)
	Nelson I. (Duthoit Pt. only)	1985	106	?	-	Uncertain	Vergani *et al*. (1987)
		2003	50-135	?	1985-2003	Fluctuating	Carlini (pers. comm.)
	ValdésPeninsula	1982	6,737	+5.1	1975-1982	Increasing	Vergani *et al*. (1987)
		1999	13,655	+3.6	1982-1999	Increasing	Lewis *et al*. (1998), Lewis (pers. comm.)
		2001	14,510[a]	+3.5	1982-2001	Increasing	Lewis (pers.comm.)
	Livingston I. (Cape Shirreff only)	2003	3-84	?	1998-2003	Fluctuating	Goebel (pers. comm.)
Iles Kerguelen	Marion Island	1994	423	-4.3	1986-1994	Declining	Pistorius *et al*. (1999)
		1997	423	-2.5	1991-1997	Declining	Pistorius *et al*. (1999)
		1999	434	0	1994-2001	Stable	Pistorius *et al*. (2004)
		2003	488	+3.3	1997-2003	Increasing	McMahon *et al*. (2003)
	Heard Island	1985	16,300	~-1.8	1949-1985	Declining	Burton (1986), Slip and Burton (1999)
		1992	17,000-18,000	?	1985-1992	Increasing?	Slip and Burton (1999)
	Iles Kerguelen (Courbet)	1977	45,000	-4.1	1970-1977	Declining	Van Aarde (1980)

Table 6. (cont.)

Stock	Locality	Year of census	Estimated pup production	% annual rate of change	Period of change	Trend in population abundance	Reference
		1992	43,000	0	1984-1992	Stable?	Guinet *et al*. (1992)
		1997	43,782	+1.1%	1987-1997	Stable/incre-	Guinet *et al*. (1999)
	Iles Crozet (Possession)	1976	~ 3,000	-5.8	1966-1976	Declining	Barrat and Mougin (1978)
		1992	575	?	1980-1992	Decreasing	Guinet *et al*. (1992)
		1997	570	0	1990-1997	Stable	Guinet *et al*. (1999)
Macquarie	Macquarie Island	1985	24,000	-2.1	1949-1985	Declining	Hindell and Burton (1987)
		1997	19,300	-1.4	1988-1997	Declining	Burton (pers. comm.)
		2003	22,200	+1.6	1997-2003	Increasing	Burton (pers. comm.)
	Campbell Island	1986	5	-8.6	1947-1986	Declining	Taylor and Taylor (1989)
	Antipodes Island	1978	113	?	-	Uncertain	Taylor and Taylor (1989)

[a] – 4 % mortality added (actual pup production included adult females, weaned pups and dead pups).

The source of Figures 1 - 7 on the distribution by species for Antarctic pinnipeds is the SCAR Expert Group on Seals website: (http://www.seals.scar.org/docs/species.htm).

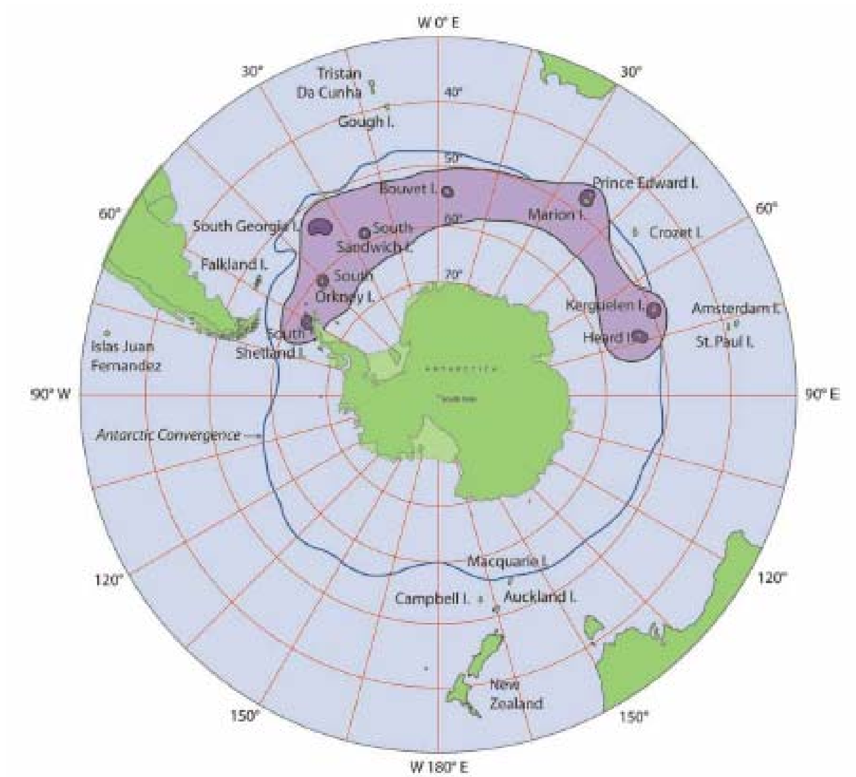


Figure 1. Distribution (breeding range) of Antarctic fur seals.

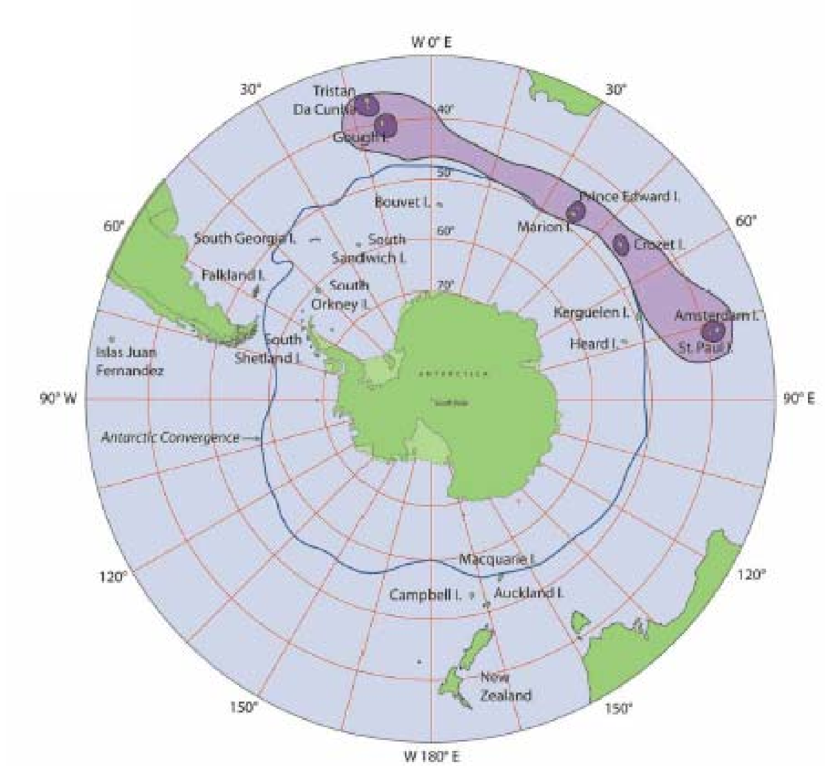


Figure 2. Distribution (breeding range) of the Subantarctic fur seal.

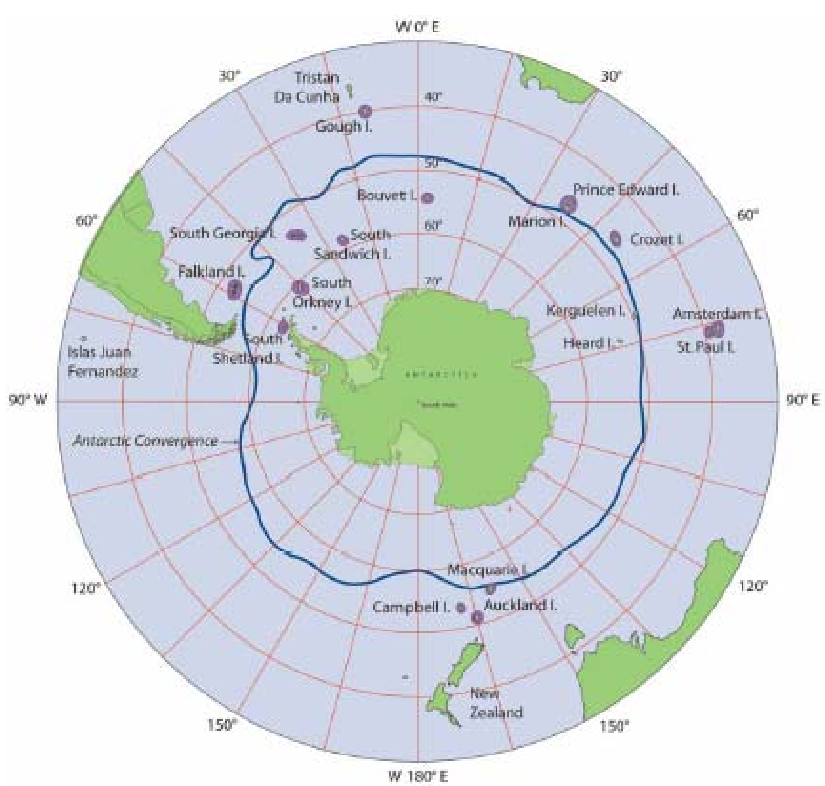


Figure 3. Breeding range of southern elephant seals.

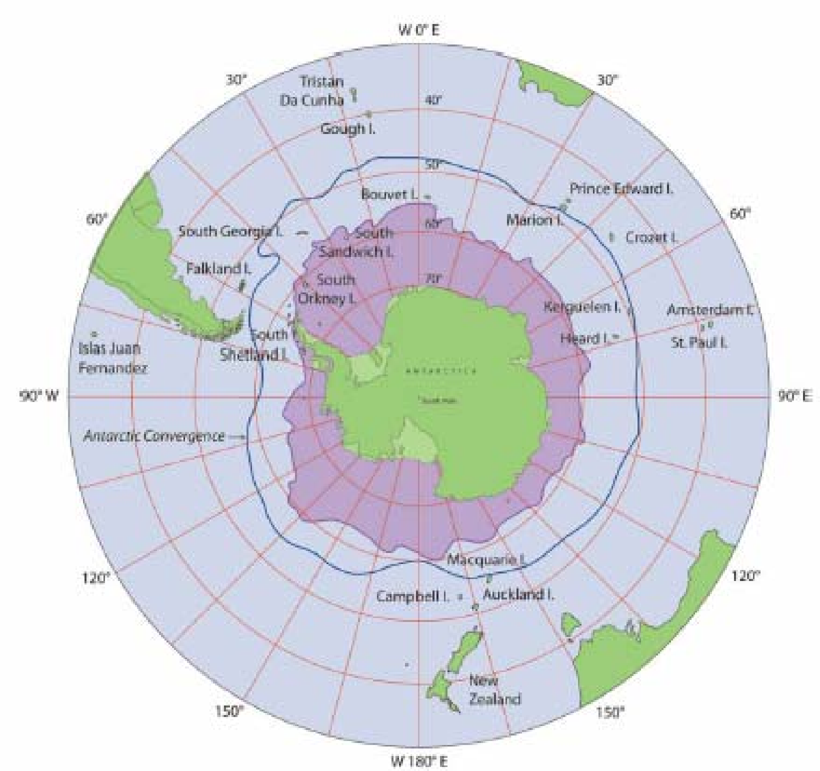


Figure 4. Distribution of the Crabeater seal.

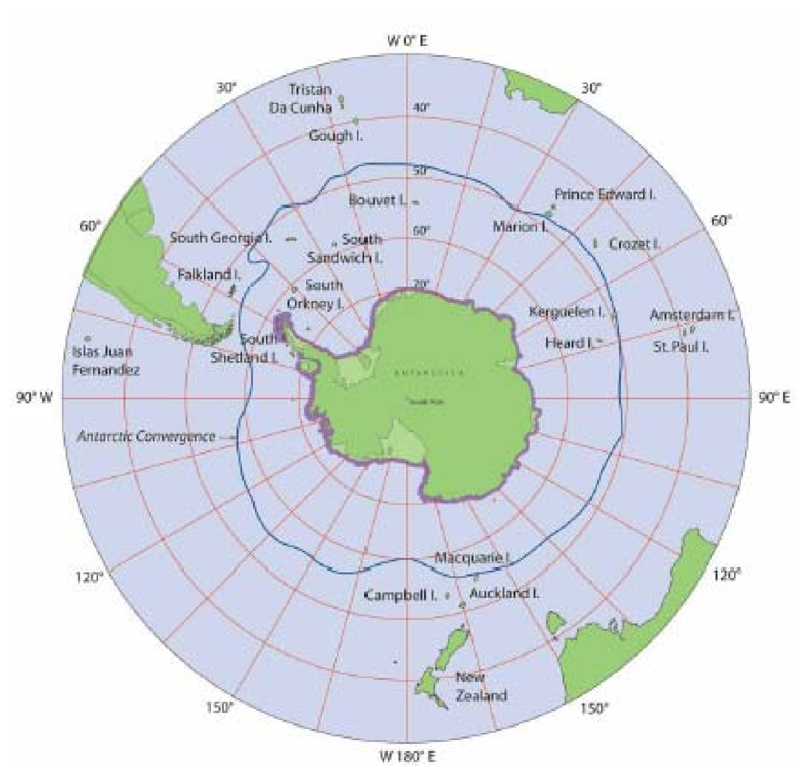


Figure 5. Distribution and range of the Weddell seal.

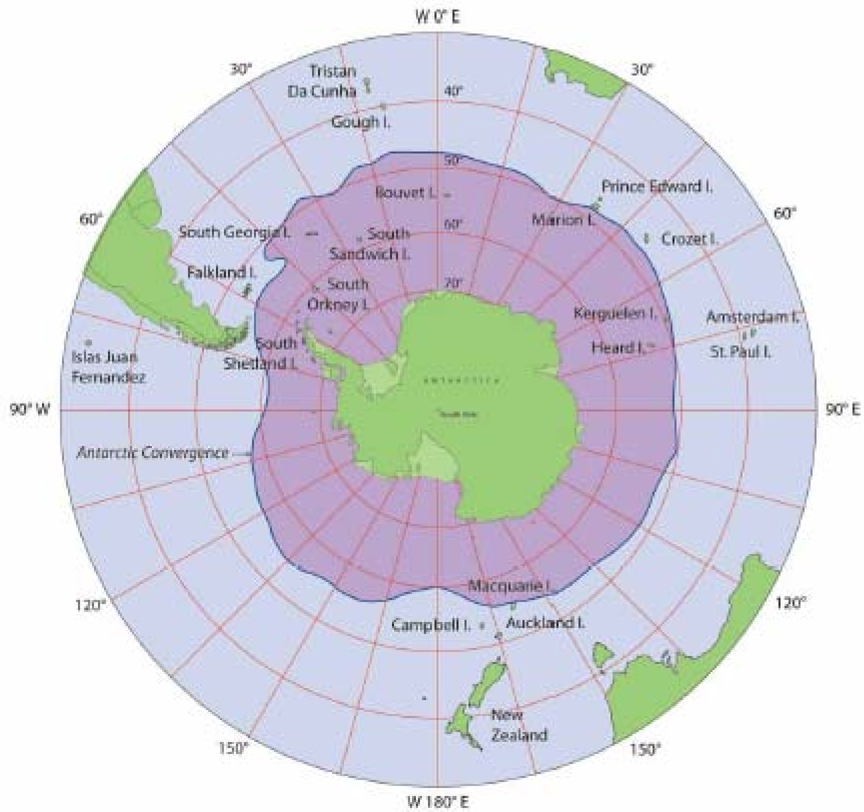


Figure 6. Distribution of the Leopard seal.

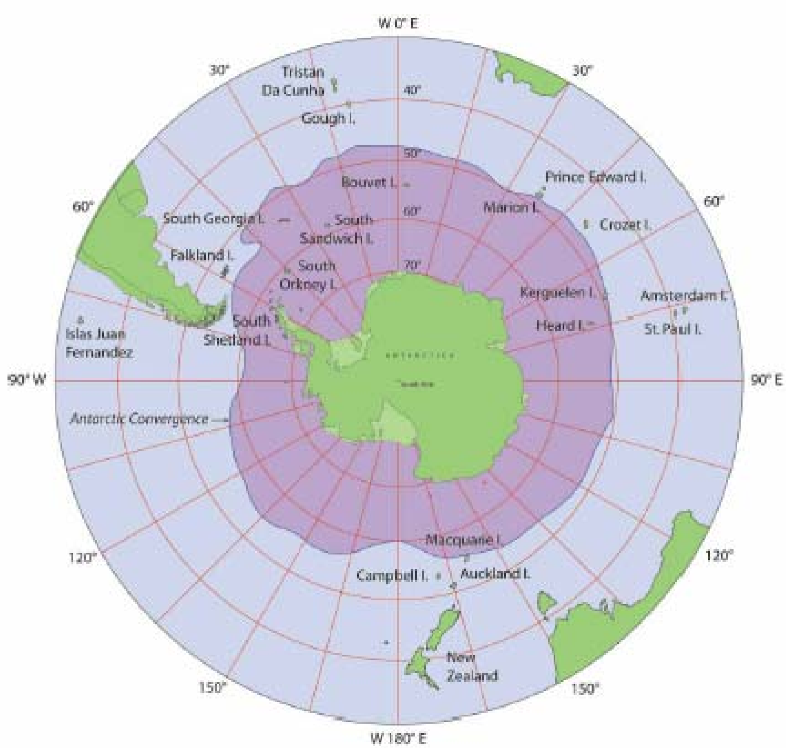


Figure 7. Distribution of the Ross seal.

3.1.d. <u>Life History and Status of Species</u> -- Seabirds

The life history and status of the seabird species that are known to occur in waters managed by parties to CCAMLR and that have the potential to interact with fishing vessels are described in this section. Human and natural impacts on each species are mentioned. Other baseline conditions of seabirds pertinent to CCAMLR waters, specifically direct mortality from incidental take in regulated fisheries and indirect and cumulative impacts associated with fishing, are discussed in Sec. 3.4.b.

Seabirds found in the CCAMLR Convention Area are listed in Table 7. The list is meant to be representative, not comprehensive. Life history and status of the species occurring in CCAMLR waters with the potential for interaction with fishing vessels are described below by taxonomic order. Their status by U.S. law and as defined by the World Conservation Union (IUCN) is provided in Table 7. The CCAMLR Ad hoc Working Group on Incidental Mortality Associated with Fishing (WG-IMAF) identified 20 species of seabirds that were most at risk from longline fisheries in the Convention Area. These 20 species are numbered in Table 7 and discussed in detail. One species of seabird is listed under the U.S. Endangered Species Act, the Amsterdam albatross (*Diomedea amsterdamensis*), which nests on Amsterdam Island, just beyond the Indian Ocean sector of the CCAMLR Convention Area. This species is reviewed more extensively than the others.

Procellariiforms (albatrosses, petrels, and shearwaters):

Most Procellariiformes are characterized by delayed initial breeding, long life span (in some cases over 50 years), strong nest site fidelity, and broad foraging ranges. They nest primarily on islands, but in a variety of habitats. For example, petrels and prions tend to nest in burrows in forest, on the ground under scrub, or in tufted grassy vegetation, while albatrosses almost all nest on the ground or in grasses (West and Nilsson 1994; Nelson 1979).

Albatrosses most often eat cephalopods, fish and crustaceans in varying proportions (Cherel and Klages 1998). Storm petrels and prions primarily eat plankton, though some also eat euphasids (Nelson 1979). The Greybacked storm petrel primarily eats the cypris larvae of the stalked barnacle, *Lepas australis* (Klages *et al*. 1996). Shearwaters are often crepuscular or nocturnal feeders, and are capable of pursuit diving for fish, squid, and crustaceans (Nelson 1979).

Most Procellariiformes are annual breeders, though some are biennial breeders; they lay a single egg each breeding season (Nelson 1979). Generally Procellariiformes are monogamous and have low productivity (BirdLife International 2003).

Procellariiformes are particularly sensitive to mortality from fishing because of their low reproductive rate, high survival, and delayed maturity (Bartle 1990). In addition, the disproportionate mortality of female Grey petrels and Snowy (i.e., wandering) albatrosses observed in longline tuna fishing is of concern (Bartle 1990; Weimerskirch *et al*. 1987). Albatrosses and petrels are the most commonly observed birds around trawl fishing vessels (Petyt 1995). *Procellaria spp*. have primarily been observed foraging over the slope edge (250-780m), and have been found to congregate within 20 km of trawl fishing vessels off the coast of New Zealand (Freeman 1997). Many of the other Procellariiformes are smaller and less aggressive than albatrosses, making the fish or bait less accessible (either through size exclusion or by being out competed by larger birds). Shearwaters are susceptible to incidental catch in near-shore set nets (Taylor 2000). Nocturnal petrels, disoriented by lighted ships, have been killed by crashing into fishing vessels or becoming trapped in them (Taylor 2000). Fishing boats have altered some Procellariiformes foraging patterns (Petyt 1995 and refs therein). The critically endangered (per IUCN categorization) Chatham Island taiko (*Pterodroma magentae*) breeds only on Chatham Island, the greatest risk is probably the abundant mammalian predators on the island (cats, rats, etc.; Imber *et al*. 1994), although it is possible that the taiko could have fisheries interactions.

Charadriiformes (gulls, terns, skuas, jaegers, and sheathbills):

Charadriiformes are a diverse family, including small, plunge-diving terns and large, parasitic skuas. They nest in a variety of habitats, primarily on islands.

Charadriiformes are generally monogamous breeders, and pairs that stay together tend to have higher productivity than those that change mates (Furness and Monagham 1987). They usually delay breeding until they are several years old, and lay one to a few eggs per clutch (Furness and Monagham 1987). While most Chardriiformes are exclusively pair breeders, skuas are cooperative breeders. Skuas build a nest on open ground, and breeding pairs or groups defend territories that are generally retained among years; they raise 1 or 2 chicks (Young 1994).

Terns generally eat small fish and squid (Nelson 1979). The Antarctic tern (Sterna vittata) has been observed foraging on land for krill stranded in an ebbing tide (Favero 1996a). Skuas commonly eat burrowing petrels breeding on the same islands (Young 1994). Sheathbills forage among and kleptoparasitize seabirds, most often penguins, but also Imperial cormorants (*Phalacrocorax atriceps*), and opportunistically eat small vertebrates, algae and invertebrates (Favero 1996b; Jouventin *et al*. 1996).

Compared to Procellariiformes, Charadriiformes are seldom seen from trawl fishing vessels (Petyt 1995). However, gulls, terns, jaegers, and skuas may be affected by prey reduction, and the Antarctic skua has been caught on longline fishing vessels in CCAMLR waters (see Table 21). Gulls are also caught by recreational fishers (Taylor 2000). Sheathbills (Chionidae), a Charadriiform family endemic to Antarctica, do not forage over open water, and so would likely only face indirect effects from fishing related marine debris washing ashore; they could be affected by marine debris as they intercept other seabird food boluses and forage on available food and debris (Jouventin *et al*. 1996). Terns have been caught in seine fishing off Australia (Norman 2000). Gulls have been found entangled or hooked in Australia (Norman 2000).

Sphenisciformes (penguins):

Penguins breed on islands and the mainland in the Antarctic and subantarctic waters managed by CCAMLR. Some penguins nest in burrows (e.g., *Eudyptula spp*.), others nests on land, usually on rocks or vegetation (West and Nilsson 1994; Davis and Darby 1990).

While most penguins lay two eggs, they usually only raise one chick (Taylor 2000). Some penguins are migratory (e.g., Adélie and Chinstrap penguins), while others are sedentary (e.g., Gentoo and Yellow-eyed) (Trivelpiece and Trivelpiece 1990). Some species retain the same mate inter-annually (e.g., Gentoo penguins), while others are less faithful to their mate than most other seabird species (e.g., Adélie) (Trivelpiece and Trivelpiece 1990). As with most long-lived seabirds, Adélie penguin populations are more sensitive to adult survival than other reproductive parameters (Clarke *et al*. 2003).

Penguins forage for fish and their larvae, squid, and crustaceans while swimming underwater; some species are capable of reaching depths of several hundred meters during foraging trips (Nelson 1979).

Penguins are susceptible to incidental mortality associated with capture in near shore set nets, and substantial mortality has been attributed to commercial and recreational gill netting (Taylor 2000; Darby and Dawson 2000; Norman 2000). While penguins are not often caught by longline fisheries, they are occasionally observed with injuries associated with fishing gear (lines or hooks), and have also been caught in lobster pots (Brothers *et al*. 1999; Norman 2000). A crested penguin was observed attending a trawl vessel (Petyt 1995). Indirect effects of prey reduction may also impact penguins (Crawford in press and in WG-EMM-04/28). For example, the African penguin (*Spheniscus demersus*) has been subject to population declines due to lack of prey caused by fishery pressure (Crawford *in press* and in WG-EMM-04/28). While Adélie penguins in some locations are increasing in numbers, extensive krill fishing or environmentally induced prey depletion could reverse this trend (Clarke *et al*. 2003).

Pelecaniformes (cormorants and shags):

Pelecaniformes species in the CCAMLR area breed on islands more than 1 km from shore, near the high tide line on the rocks or in trees. Imperial cormorants (*Phalacrocorax atriceps*) nest at least 100 m from shrub vegetation on nests constructed of algae, guano, feathers, sticks, and shells (Punta *et al*. 2003).

Preferred food items of the Imperial cormorant include small fish, crustaceans, and polychaetes (Punta *et al*. 1993).

Pelecaniformes are susceptible to incidental catch in near shore set nets (Taylor 2000; Norman 2000). Few cormorants were observed in New Zealand trawl fisheries, and none were observed away from Stewart Island (Petyt 1995). Cormorants are rarely caught by longline fisheries, but have been caught in nets (Brothers *et al*. 1999; Norman 2000). As with other seabirds (Monaghan *et al*. 1994), Pelecaniformes could be susceptible to effects from prey reduction.

Specific Species Descriptions

Numbering corresponds to Table 7: "Bird species found in the area managed by CCAMLR parties and their conservation status as defined by the US, CCAMLR and IUCN."

1. Amsterdam albatross (*Diomedea amsterdamensis*)

The Amsterdam albatross (*Diomedea amsterdamensis*) was listed under the ESA in 1995 (60 FR 2899, January 12, 1995). No critical habitat has been designated. This species is listed as critically endangered by the International Union of the Conservation of Nature (IUCN, also known as the World Conservation Union) and it was listed as an endangered migratory species by the Convention for Migratory Species (CMS or Bonn Convention) in 1997 when it was placed under the CMS's Appendix 1. It is one of the most rare bird species in the world.

A small population of this albatross was discovered on Amsterdam Island (37º50' S, 77º31' E) and was described in 1983 as a new species (Jouventin *et al*. 1989). It had formerly been considered a taxonomic subspecies of the wandering albatross (*Diomedea exulans*). The timing of the Amsterdam albatross breeding cycle and its coloration–black line on edge of upper mandible, dark patch on tip of bill, adult brown plumage and dark cap–differ from all of the other known populations of great albatrosses (Jouventin 1994). This species consists of a single population nesting in 400 hectares of the upland plateau of Amsterdam Island in the southeast Indian Ocean. Amsterdam Island is one of the most isolated islands of the world, being located between Australia, Africa and Antarctica at greater than 3,000 km away from any continent. Amsterdam Island is an external territory of France.

Like other Procellariiformes, the Amsterdam albatross is a large bodied, very long-lived species (mean life expectancy of 30 to 40 years), has low fecundity (biennial breeder, laying a single egg at most every 2 years and a chick fledges after about 235 days), and very high adult annual survival. These birds typically start breeding at age 7 (Jouventin *et al* 1989, Weimerskirch *et al*. 1997). The breeding cycle begins with males arriving on the breeding ground from the end of January to mid-February, females arrive approximately 10 days later, eggs are laid mid-February to March, eggs hatch in early May after an approximate 80 day incubation period, and chicks fledge the following January or February (Jouventin *et al*. 1989).

The current population is estimated at 130 birds, including 80 mature individuals with about 18 to 25 breeding pairs (BirdLife International 2003). Although the population has steadily increased since the mid 1980s, its low numbers and low reproductive potential are a cause of concern (Inchausti and Weimerskirch 2001, Weimerskirch and Jouventin

1998). Although the population is still increasing, breeding success has been declining during recent years (Weimerskirch, pers. comm.), possibly caused by disease, which is known to affect nearby breeding yellow-nosed albatrosses on Amsterdam Island (Weimerskirch 2003).

In 1992, probably 75-80% of all Amsterdam albatrosses were banded. Since the mid-1990s, almost every Amsterdam albatross is banded (Weimerskirch, pers. comm.). Little is known about the diet of the Amsterdam albatross but it probably consists of fish, squid and crustaceans (BirdLife International 2003). Given the location of Amsterdam Island near the Subtropical Front, it can be expected that histoteuthids (a squid family) are an important food of the Amsterdam albatross (Cherel and Klages 1997) and foraging is restricted to sub-tropical waters (Inchausti and Weimerskirch 2001), up to 2,200 km away from the breeding colony (Weimerskirch, unpublished data). Limited information on this species' foraging distribution is available from a satellite tracking study conducted on seven birds during the breeding season (incubation phase) in 1996. Satellite fixes from these birds indicate a range extending from about 50º E to 80º E and about 32º S to 45º S (Inchausti and Weimerskirch 2001).

The CCAMLR database contains observer data and commercial data (submitted by vessel operators). The observer data go back to 1995-96 and the commercial data back to 1987 for longline. The CCAMLR database (both longline and trawl gear and observer and commercial data) was queried for the occurrence of records of caught Amsterdam albatrosses (alive or dead). No reports were made of an Amsterdam albatross being caught on fishing gear or of being observed from a fishing vessel (Appleyard, CCAMLR Data Officer, pers. comm. email to Kim Rivera).

Since virtually every Amsterdam albatross is banded (Weimerskirch pers. comm. email), and observers are required to retrieve any bands on incidentally caught birds, identification of these caught specimens could be easily undertaken.

The assessment to consider risk of vessel interaction in CCAMLR areas to the Amsterdam albatross was conducted in 1997 and 1998. Using a coarse scale map of the known foraging range (Croxall 1998), a precautionary interpretation was taken that Amsterdam albatrosses could just occur within the CCAMLR Convention Area boundaries in Divisions 58.5.1 and 58.5.2 (Croxall, pers. comm.). No other subareas or divisions were determined to represent a risk of vessel interaction with the Amsterdam albatross.

It should be noted that the only actual documented and known visits of an Amsterdam albatross occur on the northern border of Division 58.5.1 (see discussion below). No documented observations of an Amsterdam albatross have occurred in Division 58.5.2. Further, the risk assessment notes that the Amsterdam albatross is "breeding species known to visit this area." This species breeds only on Amsterdam Island, which is outside of the Convention Area. The Amsterdam albatross is limited to sub-tropical waters, and is unlikely to interact with toothfish vessels in CCAMLR waters (Inchausti and Weimerskirch 2001)

Except for limited fishing allowed for toothfish for scientific research purposes (in accordance with Conservation Measure 24-01), the taking of toothfish is prohibited in Division 58.5.1 in 2003/04 (Conservation Measure 32-13). There are no conservation measures in place that would allow for fishing of any other species in Division 58.5.1. To date, U.S. vessels have not expressed interest in fishing in either Division 58.5.1 or 58.5.2. However, this may change in the future (Chris Jones, pers comm). Fishing activity in Division 58.5.1 typically occurs within the French EEZ around Kerguelen Island and is managed by the French government. From 1999/2000 to 2001/2002, only French vessels fished in the French EEZ of 58.5.1. Prior to this, vessels from Japan, Russia, Ukraine, and USSR had received licenses from France to fish in its EEZ around Kerguelen Island (Chris Jones, pers. comm.). In addition to being few in number and impact, U.S. vessels fishing in the CCAMLR Convention Area do not overlap with the known foraging range of the Amsterdam albatross.

While the reasons for the present low numbers of the Amsterdam albatross are not well known, the extensive degradation of the island and the impact of longline fisheries operating in the southern Indian Ocean during the 1960s and 1970s have been proposed as possible explanations for its rarity (Inchausti & Weimerskirch 2001). Currently, disease poses the primary threat to the small population (Weimerskirch 2003).

Pelagic longline fisheries for swordfish (*Xiphias gladius*), albacore tuna (*Thunnus alalunjga*), southern bluefin tuna (*T. maccoyii*) occur in sub-tropical waters of the Indian Ocean. These fisheries are fished primarily by the longline fleets of Japan, Taiwan, and Korea (Tuck *et al* 2003). Given the location of Amsterdam Island (37°50' S, 77°31' E) in the Indian Ocean, it is possible that vessels fishing for these species in areas around Amsterdam Island have taken Amsterdam albatrosses. It is possible that the population was already much reduced when longlining started in the central Indian Ocean. However, during the late 1960s and in the 1970s, longline vessels were operating in large numbers over the entire central foraging area, and could have caused mortality of Amsterdam albatrosses especially during the early chick-rearing period, contributing to the decline of the population (Weimerskirch *et al* 1997). To date, there are no verifiable and documented records of incidental take of Amsterdam albatross from longline vessels (Inchausti & Weimerskirch 2001). Although a report of a take from a longliner operating south of Tasmania has been noted (Gales 1998), that record has subsequently been acknowledged as a misidentification (J.P. Croxall, pers. comm., email to Kim Rivera, 12 November 2003). Impacts from fisheries would be greater if fishing was occurring close to the breeding colony (Inchausti and Weimerskirch 2001).

Human predation, habitat degradation (e.g., fires, cattle) and introduction of alien predators are likely sources of direct and indirect impacts on the Amsterdam albatross (Jouventin *et al*. 1989). Since its early discovery (in 1522) and during the subsequent two centuries, Amsterdam Island was frequently visited by sealers, whalers, fishers and other sailors who often reported that they had taken, destroyed or hunted seabirds. Castaways and fishing parties often remained on the island for long periods and lived off the island's fauna. Alien mammals introduced on the island (brown rats, cats, dogs, pigs) have played a major role in depleting the local seabird populations. Additionally, a combination of the expansion the feral cattle population (introduced in 1871) and the occurrence of fires is responsible for habitat degradation and erosion on most of the island, thus preventing seabirds from nesting on more than 70% of it. The current breeding area is confined to a peat bog at the island summit (800 m) but fossil evidence indicates the Amsterdam albatross previously bred down to 300 m altitude (Micol and Jouventin 1995). Cats, rats and cattle are still present and constitute a serious threat for the Amsterdam albatross and its breeding habitat (Jouventin *et al* 1989). A causal link between the expansion in numbers and area occupied by the feral cattle population and the decrease of albatrosses is suspected (Jouventin 1994). Results of systematic surveys for skeletal materials (Jouventin *et al*. 1989) showed that the breeding area of the albatrosses was formerly much larger, and extended over parts of the island where cattle now occur. As early as 1984, scientists proposed that the breeding area (400 ha) be completely protected from disturbance by humans and fenced off to exclude the feral cattle (Jouventin *et al*. 1984).

The threat of the albatross being trampled by cattle is being reduced by the construction of a fence to prevent access to the breeding area (Gales 1993). Additionally, during March and April 1988, the cattle population was reduced in size by almost 50% through the removal of 932 cows (Jouventin 1994). Access by humans to the colony is under strict control to minimize disturbance.

Infectious diseases have the potential to cause rapid decline and extinction in vertebrate populations. Two diseases (worldwide spreading avian cholera and *Erysipelothrix rhusiopathidae*) have been identified as impacting the population of yellow-nosed albatross on Amsterdam Island (Weimerskirch 2004). The diseases are affecting mainly chicks during their first weeks of life with a cyclic pattern between years, but adult birds have also been found dead on the colonies. The outbreak of the disease occurred probably in the mid 1980s when the population started to crash at the same time that chick mortality increased and adult survival declined. These diseases are considered to be the primary threat facing the current Amsterdam albatross population (Weimerskirch 2004, BirdLife International 2003).

2. Antipodean albatross (*Diomedea antipodensis*)

The IUCN listed the Antipodean albatross as Vulnerable because of its limited breeding range. Breeding only occurs on Antipodes Island, Campbell Island, and the Auckland Islands on New Zealand (Birdlife International 2003). Satellite tracked birds revealed that they preferentially forage over deep water at or beyond the edge of the continental shelf, favoring water greater than 2000 m deep (Nicholls *et al*. 2002). Antipodean albatrosses consume histoteuthids, onychoteuthids, and cephalopods (Imber 1999).

Breeding occurs biennially, though birds that fail to fledge young may breed the following year. Population is approximately 17,000 individuals, with 5,150 breeding pairs (Robertson and Gales 1998). Average productivity between 1991 and 1996 was estimated to be 69% on Adams Island in the Auckland Islands (Croxall and Gales 1998).

Threats facing the Antipodean albatross include interactions with longline fisheries throughout their foraging area, and invasive species (pigs and feral cats) on the Auckland Islands (Croxall and Gales 1998). Documented catches of longline vessels were described in Murray *et al*. 1993.

3. Southern royal albatross (*Diomedea epomorphora*)

Southern royal albatrosses only breed on Campbell Island, Enderby Island, Adams Island, and Auckland Island, although more than 99% of pairs breed on Campbell Island (Gales 1998). Global population has been estimated at 7,870 pairs breeding annually (approximately 13,000 total breeding pairs), and 50,000 individuals (Gales 1998). This species was listed as Vulnerable by the IUCN because of its small range (Birdlife International 2003).

Breeding occurs biennially, except in the case of nest failure (Gales 1998). Eggs are laid in sheltered areas on flat ground (Birdlife International 2003). Foraging by breeding adults is limited to the continental shelf and shelf edge within 1250 km of the breeding island (Waugh *et al*. 2002). Foraging during the non-breeding season can extend throughout the southern oceans (Croxall and Gales 1998).

Southern royal albatrosses were killed in trawl fisheries prior to removal of netsonde monitor cables, and are susceptible to capture from longline fishing throughout the southern oceans due to their broad foraging area when not breeding (Bartle 1991, Gales 1998). Mammalian predators are an ongoing threat on Campbell and Auckland Islands (cats, pigs, and rats; Birdlife International 2003). Vegetation changes on Campbell Island may also have affected breeding habitat (Birdlife International 2003).

4. Wandering Albatross (*Diomedea exulans*)

The IUCN has listed the Wandering albatross as vulnerable because the overall population is declining at a rate of over 30% in 70 years, although some populations are declining faster, and others remain stable (Birdlife International 2003). Total population is approximately 28,000 individuals, with around 8,500 breeding pairs (Croxall and Gales 1998). An average population increase of 0.43% per year between 1984 and 2000 was attributed to recovery from a population low in the mid-1980s (Nel *et al*. 2003). However, an 83% decrease of foraging Wandering albatrosses between 1980-1981 and 1997-1998 was noted in Prydz Bay, East Antarctica (Woehler and Watts 2000).

Marion and Prince Edward Islands in the Indian Ocean contain approximately 44% of the world's breeding population of Wandering albatrosses. A long term study at Marion Island found that 87% of birds that fledged a chick waited a full year before attempting to breed, while 81% of birds that failed to fledge a chick breed the next year (Nel *et al*. 2003). The average age of first breeding was 10 years, and breeding success was highest in the 10-25 year age classes. Following loss of a mate, male birds took approximately 4 years to find a new mate, while females took 3 years (Nel *et al*. 2003). Foraging occurs primarily over waters greater than 2,000 meters deep, and preferred food items include histoteuthids, onychoteuthids, and cephalopods (Nicholls *et al*. 2002, Imber 1999).

Longline fishing appears to have mixed impacts on wandering albatrosses. While the discharge of offal from longline vessels provides an additional food source for the birds, large amounts of fisheries related debris, including hooks and rope, are harmful (Nel *et al*. 2003; Huin and Croxall 1996). In a colony of Wandering albatrosses in South Georgia, 20% of food boluses examined contained regurgitated fish hooks (Huin and Croxall 1996). The increased food from the offal is thought to have caused a decrease in age of first breeding since 1997 (Nel *et al*. 2003). Wandering albatross have been caught in the tuna longline fishery off the coast of Brazil and in the Australian EEZ (Neves and Olmos 1998, Gales *et al*. 1998). The Wandering albatross is the most aggressive seabird around longline vessels, making them especially susceptible to accidental hooking (Gales *et al*. 1998). Juvenile males are caught more often than females or adults (Gales *et al*. 1998). Large scale weather patterns may also affect Wandering albatross populations; the El Niño southern oscillation has been correlated with proportion of first time breeders in a colony, possibly due to the changes in food resources related to El Niño effects (Nel *et al*. 2003).

5. Northern royal albatross (*Diomedea sanfordi*)

The Northern royal albatross breeds on the Chatham Islands (44° S, 176°30′ W), South Island of New Zealand (45°46′ S, 170°44′ E), and the Auckland Islands (BirdLife International 2003). Almost all breeding occurs on the Chatham Islands (BirdLife International 2003). Predicted declines of the Northern royal albatross (more than 50% over 84 years), and their restricted breeding range have led to the IUCN classifying it as Endangered (BirdLife International 2003).

Breeding occurs biennially, except in the case of nest failure (Robertson 1998). First breeding generally occurs at 6 years (Robertson 1998). Historically, nests would have been built on vegetation, however, habitat change has lead to egg laying on rocks(BirdLife International 2003). Adult survival is around 95%, juvenile survival to 5 years is around 70% (Robertson 1998).

Northern royal albatrosses forage most often between 30 and 400 km of the coast, and almost exclusively over the shallow waters of the continental shelf and shelf edge (Nicholls *et al*. 2002). Preferred food items include *Mototeuthopsis ingens*, *Pinnoctopus cordiformi, Histioteuthis atlantica*, and *Nototodarus spp*. (Imber 1999).

Average annual productivity fell from 48% in the 1970s to 18% in the 1990s (Robertson 1998). This was apparently due to habitat degradation associated with drier, warmer weather in general and extreme storms in the breeding areas (Robertson 1998).

6. Sooty albatross (*Phoebetria fusca*)

The Sooty albatross has been classified by the IUCN as Endangered due to a 75% rate of decline over 90 years (BirdLife International 2003). Sooty albatrosses breed on the Tristan da Cunha, Gough, Prince Edward, Marion, Kerguelen, Crozet, Amsterdam, and St. Paul Islands (Gales 1998).

Average age at first breeding is 12.7 years (Weimerskirch and Jouventin 1998). Average breeding success between 1966 and 1995 on the French sub-Antarctic Islands was 58%, and juvenile survival to first return to land was 22% (Weimerskirch and Jouventin 1998). Breeding generally occurs once every two years, but failed breeders often attempt again the following year (Marchant and Higgins 1990). In recent decades breeding success has increased, which is expected to slow the population decline (Weimerskirch and Jouventin 1998). Adult survival is near 90% (Weimerskirch and Jouventin 1998).

The high mortality rate of adult Sooty albatrosses has been associated with longline fishing effort in their foraging waters, which include sub-tropical waters of the Indian Ocean, where longline fishing occurs without bycatch observers (Weimerskirch and Jouventin 1998).

7. Light-mantled sooty albatross (*Phoebetria palpebrata*)

Light-mantled sooty albatrosses breed along ridges and inland at Marion Island, Possession Island (46° S, 51° E), South Georgia, Heard and MacDonald Islands, Amsterdam, St. Paul, Crozet, and Kerguelen Islands, Macquarie Island, Auckland, Campbell, and Antipodes Island (Crawford *et al*. 2003, BirdLife International 2003). Pairs breed biennially if they are successful in rearing a chick (Weimerskirch 1987). The population of light-mantled sooty albatrosses on Marion Island is estimated at 192 breeding pairs. The population at Marion Island decreased significantly between 1996-2003, and at Possession Island between 1980 and 1994 (Crawford *et al*. 2003, Weimerskirch and Jouventin 1998).

Annual adult survival between 1966 and 1995 averaged 97.3%, age at first breeding is 12 years on average, and breeding success averages 35.1% (Weimerskirch and Jouventin 1998). Light-mantled sooty albatrosses have nearly the highest adult survival rate and lowest productivity of all albatrosses (Weimerskirch *et al*. 1987).

An 82% decrease of foraging Light-mantled sooty albatrosses between 1980-1981 and 1997-1998 was noted in Prydz Bay, East Antarctica (Woehler and Watts 2000). Decreases in breeding populations have been attributed to mortality associated with longline fishing (Weimerskirch and Jouventin 1998). Light-mantled sooty albatrosses are caught by tuna longline vessels, and are likely caught by toothfish longline vessels (BirdLife International 2003).

8. Buller's albatross (*Thalassarche bulleri*)

The Buller's albatross breeds annually, on only a few islands off of New Zealand, including the Snares (48°02′ S, 166°33′ E) and Solander (46°35′ S, 166°54′ E), the Chatham Islands, and the Three Kings Islands (Birdlife International 2003). Total breeding population in 1996-1997 was estimated at 11,502 pairs (Sagar *et al*. 1999). The population on the Snares increased between 1969 and 1997 (Sagar *et al*. 2000), however, the limited breeding range has led to a listing of the Buller's albatross as Vulnerable by the IUCN (BirdLife International 2003).

Breeding is initiated between December and February and fledging occurs from August to October; incubation and chick rearing are relatively long compared to other albatross species of similar size and breeding regime (Sagar and Warham 1998). Nest mounds are built under *Olearia lyalli* forest, and often used by the same pair for several years (Sagar and Warham 1998). Breeding success was 57% in 1972 (Sagar and Warham 1998). Between 1992 and 1997 adult survival was 0.955, although overall annual survival from 1961 to 1997 was 0.934, because annual survival was lower in the 1960s and 1970s (Sagar *et al*. 2000). Foraging movements outside of breeding season are not well defined, though recent research indicates they forage in South American waters (Sagar and Warham 1998; Spear *et al*. 2003). They were observed feeding in conjunction with small whales (Spear *et al*. 2003). Year-round food preferences are not known, although squid has been found in most food samples from breeding Buller's albatrosses (Sagar and Warham 1998).

Longlining has potential to impact the Buller's albatross population; between 1989 and 1992 the Buller's albatross made up 22% of the total seabird bycatch in Japanese longline tuna fishing in New Zealand waters (Murray *et al*. 1993). Buller's albatrosses have been caught in both trawl and longline fisheries off New Zealand (Sagar *et al*. 2000), and were found foraging off fishing vessels in South American waters (Spear *et al*. 2003). Reduced adult survival in the 1960s and 1970s has been attributed to higher fishing effort in the foraging waters of the Buller's albatross during that time (Sagar *et al*. 2000).

9. Indian yellow-nosed albatross (*Thalassarche carteri*)

The IUCN has listed the Indian yellow-nosed albatross as endangered due to the projected rapid decline of the largest breeding colony associated with disease and incidental mortality from fishing (Birdlife International 2003). Breeding occurs annually, breeding is limited to Prince Edward Island, Crozet Islands, Kerguelen Islands, Amsterdam Island, and St. Paul Island (Weimerskirch *et al*. 1987, BirdLife International 2003). Approximately 70% of the global population of this species nests on Amsterdam Island, where the population has declined at least 36% since 1984 (Gales 1998, Weimerskirch and Jouventin 1998). The predicted rate of decline after 1995 was 7% per year (Weimerskirch and Jouventin 1998).

Adult annual survival averages 85.7% and average breeding success is 24.5%. Average age of initial breeding is 8.7 years (Weimerskirch and Jouventin 1998). Survival of adults and juveniles declined almost 10% from the early 1980s to the mid

1990s (Weimerskirch and Jouventin 1998).

High mortality of Indian yellow-nosed albatross chicks on Amsterdam Island has been associated with illness from bacterial infections, including avian cholera (Weimerskirch 2004). Large numbers of Indian yellow-nosed albatrosses are caught in tuna longline fisheries while wintering over Australasian waters (Weimerskirch and Jouventin 1998).

10. Atlantic Yellow-nosed albatross (*Thalassarche chlororhynchos*)

The Yellow-nosed albatross has been listed by the IUCN as endangered, due to a 58% decline in study populations predicted over 72 years (Birdlife International 2003). The population is estimated between 50,000 and 99,000 individuals with 21,600-35,600 breeding pairs, though population modeling predicts an annual decrease of 1.5-5.5%, depending on location (Birdlife International 2003, Cuthbert *et al*. 2003).

It breeds annually in nests on grass, rocks or under trees, on islands in the Tristan da Cunha archipelago and on Gough Island. Average breeding success is 67-69%. First year breeders are on average 9.7 years old (Cuthbert *et al*. 2003). Adult annual survival varies between 84 and 88%, depending on location; juvenile survival averages 31% (Cuthbert *et al*. 2003). Adult survival of Tristan Island birds has been correlated with longline fishing effort in the vicinity (Cuthbert *et al*. 2003).

Longline fishing off Brazil is viewed as the greatest threat to the Yellow-nosed albatross currently, with more than 900 birds killed yearly (Olmos *et al* 1997). The Yellow-nosed albatross is also known to attend trawlers and tuna longliners off southern Africa (Olmos *et al*. 1997). Mortality from oiling is occasionally observed off the coast of Uruguay (Stagi *et al.* 1998).

11. Grey-headed albatross (*Thalassarche chysostoma*)

The IUCN classifies the Grey-headed albatross as Vulnerable because of an estimated overall decline of approximately 48% over 90 years (BirdLife International 2003).

Breeding occurs in South Georgia, Diego and Ramirez Islands, Kerguelen and Crozet Islands, Marion and Prince Edwards Islands, Campbell Island, and Macquarie Island (Gales 1998). Eggs are laid in October, chicks fledge the following April or May (Gales 1998). Average age at first breeding is 13.5 years (Waugh *et al*. 1999). Grey-headed albatrosses breed biennially, and in some cases less often, although birds that have nest failures during incubation often breed the following year (Prince *et al*. 1994). Breeding success between 1984 and 1996 averaged 40%, and juvenile survival averaged 24% (Waugh *et al*. 1999).

Preferred food items are cephalopods and crustaceans; the presence of the oceanic cephalopod, *Martialia hyadesi* (squid), is positively correlated with breeding success (Xavier *et al*. 2003).

The declining population of Grey-headed albatrosses has been attributed to mortality on longline fisheries (BirdLife International 2003).

12. Salvin's albatross (*Thalassarche salvini*)

The Salvin's albatross breeds primarily on the Bounty Islands; some nests have also been found on the Snares and Chatham Islands, New Zealand, and on the Crozet Islands (BirdLife International 2003). Its restricted breeding range and limited information on population status have led to its listing as vulnerable by the IUCN (BirdLife International 2003).

Breeding occurs on small, bare rocky islands (Croxall and Gales 1998). The Salvin's albatross makes broad movements throughout the South Pacific ocean (Taylor 2000; Spear *et al*. 2003). It forages almost exclusively over the continental shelf, within 250 km of the coastline (Spear *et al*. 2003). Adults are found off the coast of South America primarily in the autumn, and non-breeders are found there more often in the spring (Spear *et al*. 2003).

The Salvin's albatross breeds on islands that are vulnerable to extreme weather events. Longline fishing in New Zealand waters and elsewhere may pose a threat to the birds (BirdLife International 2003). They have been observed foraging in association with toothfish vessels off the coast of Chile (Spear *et al*. 2003).

13. Chatham albatross (*Thalassarche eremita*)

This species is classified as Critically Endangered by the IUCN (Birdlife International 2003). The Chatham albatross breeds only on The Pyramid formation in the Chatham Islands, in the Pacific Ocean between Australia and South America. The population is estimated at 5,300 pairs; population trends have not been determined.

The Chatham albatross is medium sized. Breeding is likely initiated in August-September, with fledging occurring in February-April (Robertson *et al*. 2000). Breeding success is estimated at 50-65% per year, and lower in years of extreme weather (Robertson *et al*. 2003b). Age at first breeding is not known, but birds followed to 6 years of age had not yet attempted to breed (Robertson *et al*. 2000). Time between breeding seasons is spent near Chile and Peru, north to 68° (Robertson *et al*. 2000, Birdlife International 2003). Foraging has been observed within 300 km over the shelf edge and from 1,000-4,500 m (Robertson *et al*. 2000). During non-breeding season, Chatham albatrosses have been observed off the west coast of South America, primarily over pelagic waters in the autumn and over the continental shelf in the spring (Spear *et al*. 2003). Chatham albatrosses have also been observed over Australian waters (Reid and James 1997).

The Chatham albatross is vulnerable due to habitat loss, mortality from interactions with fishing vessels, and possible annual harvest of chicks (Robertson *et al*. 2000). Their nesting island has been subject to damage from extreme weather, resulting in vegetation and soil losses. At least 13 individuals have been confirmed caught by fishing vessels, including a tuna longliner, demersal longliners, and coastal longliners.

14. Campbell albatross (*Thalassarche impavida*)

The Campbell albatross breeds only in the Campbell Islands and a small Island off New Zealand, Jeanette Marie (Taylor 2000; BirdLife International 2003). The IUCN has classified the Campbell albatross as Vulnerable because of its restricted breeding range (BirdLife International 2003). The population declined greatly in the 1970s and 1980s, but is now thought to be slowly increasing (Waugh *et al*. 1999)

Breeding adults forage in waters around Australia, New Zealand, and near the Ross Sea, and outside of breeding season they forage near South America (Waugh *et al*. 1999).

The Campbell albatross nests on grassy ledges and slopes (BirdLife International 2003). Breeding success averaged 66% between 1984 and 1996 (Waugh *et al*. 1999). Annual adult survival averaged 94.5% between 1984 and 1995; average age of first breeding is around 10 years (Waugh *et al*. 1999).

Tuna longline vessels often report bycatch of Campbell albatrosses, and they are occassionally caught by trawl fisheries (Taylor 2000; Murray 1993; Gales et al. 1998). Mortality due to tuna longline bycatch has been implicated as the most likely cause of the population decline of the Campbell albatross seen in the 1970s and 1980s (Taylor 2000). Other threats include predators, such as brown skuas, and the potential for diseases that have been found in other birds on the islands, such as avian cholera and avian malaria (Taylor 2000).

15. Black-browed albatross (*Thalassarche melanophrys*)

This species has been upgraded to Endangered on the IUCN Redlist (Birdlife International 2003). The population has declined approximately 65% in the past 65 years, with greatest declines occurring at the most important breeding sites (Birdlife International 2003).

The Black-browed albatross is primarily found in the southwest Atlantic and southeast Pacific oceans, with approximately half the population breeding the Falkland Islands (Malvinas), 20% breeding on Chilean Islands (Robertson *et al*. 2003b), and the remainder breeding on South Georgia, Crozet and Kerguelen Islands, Heard and McDonald Islands, Macquarie Island, Campbell, Antipodes, and Snares Islands (Croxall and Gales 1998).

Nests are constructed on grassy slopes and along the shore. Annual breeding generally occurs between September and April (Robertson and Gales 1998). Adult survival has been estimated at 91-93% (Weimerskirch and Jouventin 1998, Prince *et al*. 1994). Age at first breeding averages 10 years. Breeding success is approximately 63%

(Prince et al. 1994). Juvenile survival averages 14-29% (Weimerskirch and Jouventin 1998, Waugh et al. 1999).

Preferred food items of Black-browed albatrosses breeding in South Georgia include the icefish, *Champsocephalus gunnari*, and Antarctic kill, *Euphausia superba*; the presence of icefish in the diet is positively correlated with breeding success (Xavier *et al*. 2003).

Birds breeding on the Falkland Islands and elsewhere forage almost exclusively over the continental shelf, making them vulnerable to interactions with fishing vessels (Huin 2002). Black-browed albatrosses are one of the most commonly caught birds by longline fisheries, and their recent population decline may largely be due to their mortality as bycatch (Birdlife International 2003). They have been cited as the albatross at greatest risk from fishing mortality (Weimerskirch and Jouventin 1998). Their broad geographic distribution puts them in contact with longline fishing off Australia, Africa, South Georgia, Brazil, and Chile (Robertson and Gales 1998; Neves and Olmos 1998). Observations on a fishing vessel off the coast of Uruguay which was not using weighted swivels resulted in a catch rate of 481 albatross per 1,000 hooks set; adding weights to the swivels reduced the catch rate to 4.7 albatross per 1,000 hooks set, in both cases Black-browed albatrosses made up the bulk of the birds (Stagi *et al*. 1998). Longline fishing related debris has been found in food samples, including fishing line and the tip of a fishing hook (Xavier *et al*. 2003). Mortality from oiling is occasionally observed off the coast of Uruguay (Stagi *et al*. 1998).

16. White-capped albatross (*Thalassarche steadi*)

The White-capped albatross is closely related to the Shy albatross (*T. cauta*). While some evidence exists to suggest they are separate species, the separation of the two species has been controversial (Abbot and Double 2003, Double *et al*. 2003). For the purpose of this document they are treated as a separate species because they were listed by CCAMLR as a separate species at risk from fisheries interactions. Total breeding pairs are estimated between 65,000 and 80,000, and may be increasing (Taylor 2000; Baker *et al*. 2002). Breeding occurs on islands in the south of New Zealand, including the Auckland, Disappointment, Chatham, and Antipodes Islands (BirdLife International 2003; Robertson *et al*. 1997).

Egg laying is initiated in mid-November (Gales 1998). During the breeding season, adults remain near breeding islands, though dispersal outside breeding season is not well known (Taylor 2000).

The White-capped albatross is frequently caught by tuna longliners, comprising a large portion of seabirds killed on tuna longline and squid trawl vessels in New Zealand waters in 1988-1997 (Taylor 2000). White-capped albatrosses were the most commonly caught bird on squid trawls in New Zealand in 1990, with a catch rate of approximately 0.263 birds per tow, with over 80% of the mortality due to interactions with the netsonde cables (now banned in New Zealand; Bartle 1991). Other threats include feral animals (pigs and cats), and possibly disease (Taylor 2000). Changes in food availability from commercial fishing (offal availability) and climate change may also affect the White-capped albatross in the future (Taylor 2000; BirdLife International 2003).

17. Southern giant petrel (*Macronectes giganteus*)

The overall population of the Southern giant petrel has declined at a rate of 20% over 60 years, leading to its listing as Vulnerable by the IUCN (BirdLife International 2003). Human disturbance is believed to be responsible for more than 90% declines in the breeding population of the Southern giant petrel at some colonies (Woehler *et al*. 2001).

The Southern giant petrel breeds on Islands off Chile and Argentina, the Falkland Islands (Malvinas), South Georgia, South Sandwich Islands, South Orkney and South Shetland Islands, Gough Island, Prince Edward Islands, Crozet and Kerguelen Islands, Heard and McDonald Islands, Macquarie Island, and on the Antarctic Peninsula and continent (BirdLife International 2003). Nesting occurs on grass or bare ground. Outside of the breeding season adults and juveniles disperse broadly (BirdLife International 2003; Hunter 1984). First breeding generally occurs between 6 and 9 years, and adult survival averages 90% (Hunter 1984).

Analysis of stomach contents has revealed a diet of penguins, petrels, cormorants, seal carrion, cephalopods, crustaceans, and fish (Punta and Herrera 1995).

Significant mortality associated with illegal or unregulated longline fishing has been inferred (see CCAMLR 1997, 1998). Prey availability, human disturbance and persecution are also threats (BirdLife International 2003; Woehler *et al*. 2001). Recently, a Southern giant petrel was found dead due to avian cholera (Leotta *et al*. 2003). A study of petrel chick stomach contents found marine debris in 73% of samples, primarily consisting of plastics and other items attributed to trawl fishing vessels (Copello and Quintana 2003.

18. Northern giant petrel (*Macronectes halli*)

The population trend of the Northern giant petrel is unknown, although believed to be stable (Taylor 2000). However, a 99% decrease of foraging Northern giant petrels between 1980-1981 and 1997-1998 was noted in Prydz Bay, East Antarctica (Woehler and Watts 2000).

The Northern giant petrel breeds at South Georgia, Prince Edward, Crozet, Kerguelen, Macquarie, Auckland, Campbell, Antipodes, and Chatham islands, and on islets off Stewart Island (Taylor 2000). Breeding success averages 25%, other reproductive parameters are unknown (Robertson *et al*. 2003b). Foraging outside of breeding season occurs throughout the southern ocean, between 30° S and 64° S (Taylor 2000).

The Northern giant petrel's less colonial breeding habit makes it less sensitive to human disturbance than the threatened Southern Giant-petrel, although it has been observed abandoning nests when handled or approached by humans (Taylor 2000). Introduced species (cats, pigs) and skuas pose a minor threat to eggs and chicks (Taylor 2000). Longline fishing for *Dissostichus eleginoides* in the 1990's to significant bycatch in Northern giant-petrels (CCAMLR 1996-1998). Fishing hooks associated with toothfish fisheries have been found in birds in South Georgia (Huin and Croxall 1996). Northern giant petrels have also been caught by tuna longline vessels, and have been observed attending to trawl vessels, though there are few records of them being caught by trawls (Robertson *et al*. 2003b). Mortality associated with fishing may be exacerbated by loss of habitat due to fur seal range expansion.

19. White-chinned petrel (*Procellaria aequinoctialis*)

This species is classified as Vulnerable because of massive mortality in longline fisheries for toothfish and hake (Birdlife International 2003). The population is expected to decrease substantially in the near future (Birdlife International 2003).

Global population of the White-chinned petrel is estimated at 5 million, with the greatest breeding population on South Georgia (Birdlife International 2003). A recent decline of breeding pairs of approximately 28% at Bird Island in South Georgia has been attributed to longline fishing mortality (Berrow *et al*. 2000). A 95% decrease of foraging White-chinned petrels between 1980-1981 and 1997-1998 was noted in Prydz Bay, East Antarctica (Woehler and Watts 2000).

The White-chinned petrel breeds in colonies throughout the southern ocean, including the Falkland Islands, South Georgia, and the Campbell and Antipodes Islands (Gales *et al*. 1998). Breeding occurs annually, with about 44% success (Berrow *et al* 2000). Food items include cephalopods, crustaceans, and fish (Birdlife International 2003).

White-chinned petrels make up most of the bycatch of some demersal longline fisheries, and are frequently caught in other longline fisheries (Barnes *et al*. 1997, Gales *et al*. 1998). Unlike most albatrosses, White-chinned petrels are often caught at night, making night-setting of lines a less effective conservation measure for this species (Barnes *et al*. 1997, Gales *et al*. 1998). White-chinned petrel have also been observed colliding with netsonde cables on trawling vessels (Schiavini *et al*. 1998). Other threats include predation by rats at South Georgia, and habitat degradation by Antarctic fur seals (*Arctocephalus gazella*; Berrow *et al*. 2000).

20. Grey petrel (*Procellaria cinerea*)

The majority of Grey petrels breed on Gough and other islands in the Tristan da Cunha group; significant breeding populations also occur on Prince Edward and Marion islands, Crozet, Kerguelen and Amsterdam islands, and Campbell and the Antipodes islands (Zotier 1990; BirdLife International 2003).

Breeding occurs annually during the winter, with nest initiation occurring in February (Chastel 1995; Zotier 1990). While egg laying is synchronous, fledging is asynchronous, with chicks fledging from September through October, probably due difficulty obtaining enough food during the subantarctic winter (Zotier 1990). Nest burrows are built in steep, well drained, grassy areas (Bell 2002).

The Grey petrel is often killed by the tuna-longline fishery in New Zealand waters and elsewhere (Bartle 1990; BirdLife International 2003). Introduced predators on the breeding islands are also a serious threat (cats, rats, and Weka [*Gallirallus australis*]), having already been implicated in extinction of breeding populations on some islands (BirdLife International 2003). Although there are no current trend data for this species, it has clearly suffered a historic decline at least, and could be undergoing a serious reduction owing to interactions with fisheries and predation on its breeding islands. Females are disproportionately killed on longline fishing vessels, probably due to the species' sexual segregation during non-breeding season (Bartle 1990).

Table 7 (Sec. 3.1.d.): Bird species found in the area managed by CCAMLR parties and their conservation status as defined by the US, CCAMLR and IUCN. (naming follows IUCN where applicable)

#	Species Name	English Name	Global Population Estimate (breeding pairs)	Reference	U.S. Status	CCAMLR and IUCN Status (SC-CCAMLR-XXII/BG/18 and Redlist)*	CCAMLR Areas (SC-CCAMLR-XXII/ BG/17)
	Procellariiformes						
	Diomedidae	Albatrosses					
1	*Diomedea amsterdamensis*	Amsterdam albatross	18-25	Inchausti and Weimerskirch 2001, Birdlife International 2003	Endangered	Critically Endangered	No data
2	*Diomedea antipodensis*	Antipodean (wandering) albatross	5,150	Robertson and Gales 1998		Vulnerable*	88.1
3	*Diomedea epomophora*	Southern royal albatross	13,000	Gales 1998		Vulnerable*	58.5, 58.6, 58.7
4	*Diomedea exulans*	Wandering albatross	8,500	Croxall and Gales 1998		Vulnerable*	All, only N part of 88.1
	Diomedea gibsoni	Gibson's albatross	5,800	Walker and Elliott 1999			
5	*Diomedea sanfordi*	Northern royal albatross	5,200	Baker *et al.* 2002		Endangered*	58.5, 58.6, 58.7
6	*Phoebetria fusca*	Sooty albatross	15,655	Gales 1998		Endangered*	58.6, 58.7, 58.4.1, 58.4.4
7	*Phoebetria palpebrata*	Light-mantled (sooty) albatross	26,000-130,000	Baker *et al.* 2002		Near-threatened*	All
8	*Thalassarche bulleri (Diomedea bulleri)*	Buller's albatross	11,500	Sagar *et al.* 1999		Vulnerable	
9	*Thalassarche carteri*	Indian yellow-nosed albatross	36,500	Weimerskirch and Jouventin 1998		Endangered*	58.5, 58.7, 58.4.1

#	Species Name	English Name	Global Population Estimate (breeding pairs)	Reference	U.S. Status	CCAMLR and IUCN Status (SC-CCAMLR-XXII/BG/18 and Redlist)*	CCAMLR Areas (SC-CCAMLR-XXII/ BG/17)
	Thalassarche cauta (Diomedea cauta)	Shy albatross	12,200	Gales 1998		*	58.6, 58.7, 58.4.1, 58.4.3, 58.5.1, 58.5.2
10	*Thalassarche chlororhynchos (Diomedea chlororhychos)*	Atlantic Yellow-nosed albatross	21,600-35,600	Robertson and Gales 1998		Endangered*	No data
11	*Thalassarche chrysostoma (Diomedea chrysostoma)*	Grey-headed albatross	82,000	Robertson *et al.* 2003b		Vulnerable*	All, only N part of 48.6
12	*Thalassarche salvini (Diomedea salvini)*	Salvin's albatross	31,000	Taylor 2000		Vulnerable	58.6, 88.1
13	*Thalassarche eremita (Diomedea eremita)*	Chatham albatross	2,500-5,300	Taylor 2000; Robertson *et al.* 2000		Critically Endangered*	88.1
14	*Thalassarche impavida (Diomedea impavida)*	Campbell albatross	19,000-26,000	See Moore 2002; Gales 1998		Vulnerable*	88.1, 58.4.1
15	*Thalassarche melanophyrys (Diomedea melanophyrys)*	Black-browed albatross	615,000	Robertson *et al.* 2003b		Endangered*	All, only NE part of 48.6, 88.1, rare in 58.4.4
16	*Thalassarche steadi*	White-capped albatross	65,000	Baker *et al.* 2002		Near-threatened*	No data
	Procellariidae	Petrels and shearwaters					
	Daption capense	Cape petrel	>100,000	Marchant and Higgins 1990		*	
	Fulmarus glacialoides	Southern fulmar	580,000	Baker *et al.* 2002		(*)	
	Halobaena caerulea	Blue petrel	>600,000	Baker *et al.* 2002			

#	Species Name	English Name	Global Population Estimate (breeding pairs)	Reference	U.S. Status	CCAMLR and IUCN Status (SC-CCAMLR-XXII/BG/18 and Redlist)*	CCAMLR Areas (SC-CCAMLR-XXII/ BG/17)
17	*Macronectes giganteus*	Southern giant petrel	18,750 – 31,000	Baker *et al*. 2002; BirdLife International 2003		Vulnerable*	All
18	*Macronectes halli*	Northern giant petrel	12,000	Baker *et al*. 2002		Near-threatened*	All, only N part of 48.6, 88.1
	Pachyptila crassirostris	Southern fulmar prion	30,000	Taylor 2000			
	Pachyptila desolata	Antarctic prion	25,000,000	Taylor 2000			
	Pachyptila turtur	Southern fairy prion	>1,000,000	Taylor 2000			
	Pagodroma nivea	Snow petrel	>43,000	Baker *et al*. 2002			
19	*Procellaria aequinoctialis*	White-chinned petrel	2,500,000	Marchant and Higgins 1990		Vulnerable*	All, only NE part of 88.1 and extreme N part of 48.6
20	*Procellaria cinerea*	Grey petrel	>50,000	Taylor 2000		Near-threatened*	All, only N part of 48.6, 88.1
	Procellaria conspicillata	Spectacled petrel	2,500-10,000	Ryan and Moloney 2000			
	Procellaria westlanica	Westland petrel	2,000	Taylor 2000			
	Pterodroma inexpectata	Mottled petrel	300,000-400,000	Taylor 2000			
	Pterodroma lessonii	White-headed petrel	>160,000	Baker *et al*. 2002			
	Pterodroma macroptera	Great-winged (Grey-faced) petrel	>940,000	Baker *et al*. 2002			

#	Species Name	English Name	Global Population Estimate (breeding pairs)	Reference	U.S. Status	CCAMLR and IUCN Status (SC-CCAMLR-XXII/BG/18 and Redlist)*	CCAMLR Areas (SC-CCAMLR-XXII/BG/17)
	Pterodroma magentae	Chatham Island taiko	4	Crockett 1994; Imber *et al.* 1994		Critically Endangered	
	Pterodroma mollis	Soft-plumaged petrel	10,000s	Taylor 2000			
	Puffinus assimilis	Subantarctic little shearwater	100,000	Taylor 2000; Imber 1983			
	Puffinus bulleri	Buller's Shearwater	2,500,000	Taylor 2000; Harper 1983		Vulnerable	
	Puffinus carneipes	Flesh-footed shearwater	156,000-4,375,000	Baker *et al.* 2002		*	
	Puffinus creatopus	Pink-footed shearwater	17,000	Guicking 1999		Vulnerable	
	Puffinus gavia	Fluttering shearwater	100,000	Taylor 2000			
	Puffinus gravis	Great shearwater	Millions	Marchant and Higgins 1990			
	Puffinus griseus	Sooty shearwater	Millions	Baker *et al.* 2002		*	48.6, 88.1, 58.4.1, 58.4.2, 58.4.3, 58.5.2
	Puffinus huttoni	Hutton's shearwater	94,000	Taylor 2000		Endangered	
	Puffinus tenuirostris	Short-tailed shearwater	13-16 million	Baker *et al.* 2002		*	88.1, 58.4.1, 58.4.2, 58.4.3, 58.5.2
	Thalassoica antarctica	Antarctic petrel	500,000-7,000,000	Van Franeker *et al.* 1999		*	
	Pelecanoididae	Diving petrels					
	Pelecanoides urinatrix	Subantarctic diving petrel	>1,000,000	Taylor 2000			
	Hydrobatidae	Storm petrels					

#	Species Name	English Name	Global Population Estimate (breeding pairs)	Reference	U.S. Status	CCAMLR and IUCN Status (SC-CCAMLR-XXII/BG/18 and Redlist)*	CCAMLR Areas (SC-CCAMLR-XXII/ BG/17)
	Fregatta tropica	Black-bellied storm petrel	>50,000 - 100,000	Taylor 2000			
	Oceanites nereis	Grey-backed storm petrel	>10,000-50,000	Taylor 2000			
	Oceanites oceanicus	Wilson's storm petrel	>1,000,000	Marchant and Higgins			
	Charadriiformes						
	Chionidae	Sheathbills					
	Chionis alba	Snowy (American) sheathbill					
	Chionis minor	Lesser (Black-faced) sheathbill					
	Laridae	Gulls, terns, skuas and jaegers					
	Catharacta chilensis	Chilean skua					
	Catharacta lönnbergi	Antarctic skua	7,000	Taylor 2000			
	Catharacta maccormicki	South polar skua	8,000	Higgins and Davies 1996			
	Catharacta skua	Great skua	13,000	Phillips *et al*. 1999			
	Larus dominicanus	Southern black-backed gull, Kelp gull	>1,000,000	Taylor 2000			
	Sterna vittata	Antarctic tern	>35,000	Taylor 2000			
	Sterna virgula	Kerguelen tern	2,000	BirdLife International 2003		Near-threatened	
	Sphenisciformes						
	Spheniscidae	Penguins					
	Aptenodytes forsteri	Emperor penguin	>135,000	Marchant and Higgins 1990			
	Aptenodytes patagonicus	King penguin	>1,100,000	Marchant and Higgins 1990			

#	Species Name	English Name	Global Population Estimate (breeding pairs)	Reference	U.S. Status	CCAMLR and IUCN Status (SC-CCAMLR-XXII/BG/18 and Redlist)*	CCAMLR Areas (SC-CCAMLR-XXII/ BG/17)
	Eudyptes chrysolophus	Macaroni penguin	>9,000,000	Marchant and Higgins 1990		Vulnerable	
	Eudyptes chysocome	Rockhopper penguin	3,670,000	BirdLife International 2003		Vulnerable	
	Pygoscelis adeliae	Adélie penguin	>2,600,000	Marchant and Higgins 1990			
	Pygoscelis antarctica	Chinstrap penguin	6,500,000	Marchant and Higgins 1990			
	Pygoscelis papua	Gentoo penguin	260,000	Marchant and Higgins 1990		Near-threatened	
	Pelecaniformes						
	Phalacrocoracidae						
	Phalacrocorax atriceps (verrucosus)	Blue-eyed shag (Kerguelen cormorant, Imperial shag)					
	Phalacrocorax bransfieldensis	Antarctic shag	11,000	Marchant and Higgins 1990			
	Phalacrocorax melanogenis	Crozet shag	1,000	Marchant and Higgins 1990			

* Species with an asterisk in the last column are expected to be vulnerable to fisheries bycatch based on having an average body weight greater than 500 grams, with the capability to swallow hooks (see Baker *et al*. 2002).
# column indicates the number of the corresponding species description under the “Affected Environment” section.

3.2 Fishery Participants, Gear Types, and Affected Area

This section discusses the major fisheries, including gear types and restrictions. It also provides general information on CCAMLR catch and effort data and the use of trawls in the CCAMLR Convention Area. For a description of the affected area, see Sec. 1.1 that describes the Convention Area.

CCAMLR Catch and Effort Data

Catch and effort information is collected by CCAMLR for each fishery. The CCAMLR Statistical Bulletin provides this information and is available to the public (CCAMLR website at: http://www.ccamlr.org/pu/e/e_pubs/intro.htm).. Annual summary catch and effort information includes:

a. Catch and effort by species and area/subarea/division;
b. Catch and effort by species and country;
c. Catch and effort by species and area/subarea/division, species and country;
d. Catch and effort by species and month; and
e. Catch and effort by area/subarea/division, species and month.

For the fisheries for *Dissostichus spp.* (Patagonian toothfish and Antarctic toothfish) and *Champsocephalus gunnari* (mackerel icefish), catch and effort information is collected on a haul-by-haul basis. However, haul-by-haul catch per unit effort (CPUE) is not made freely available to member countries, as it constitutes industrial proprietary information. For *Euphausia superba* (krill) fisheries, catch and effort information is of considerably lower resolution, and required only on a monthly basis. Although site-specific CPUE information is not available for U.S. or foreign vessels, the CCAMLR Statistical Bulletin, Vol. 16, Tables 7.2, 8.2, 9.2, 11.2, 11.3, and 11.4 do provide effort data (by fishing hours, thousand hooks, and pot hauls) by CCAMLR area/subarea/division, target species, and country. Detailed catch and effort data are provided below in the sections addressing the major CCAMLR fisheries.

Use of Trawls in the CCAMLR Convention Area

Fisheries for *Euphausia superba*, *Dissostichus eleginoides* (Patagonian toothfish), and *Champsocephalus gunnari* have been conducted within the CCAMLR Convention Area under various Conservation Measures (CMs) using pelagic trawls, bottom trawls and pots (fish traps). There are three CCAMLR CMs that specify gear restrictions for trawl fisheries.

CCAMLR CM 22-01, enacted in 1986, specifies mesh size regulations for all species, seasons, and areas open to trawl fishing. Articles 1 and 2 of CM 22-01 set forth the requirements for, and use of, gauges to be used in measuring mesh size. Articles 3, 4 and 5 describe the process for determining mesh size and Article 6 provides the procedures for inspection of nets.

CCAMLR CM 22-02, in effect since September 1, 1985, sets forth the mesh size regulations for pelagic and bottom trawls for all *Dissostichus spp.* and targeted demersal finfish, in all seasons and areas open to trawl fishing. It dictates a minimum mesh size of 120 mm for the directed fishery for *Notothenia rossii* and *Dissostichus eleginoides* and 80 mm for *Gobinotothen gibberifrons, Notothenia kempi,* and *Lepidonotothen squamifrons*. This CM does not apply to fishing conducted for scientific research purposes.

CCAMLR CM 22-03, in effect since November 1, 1991, sets forth the mesh size regulations for pelagic and bottom trawls for all *Champsocephalus gunnari* fisheries in all seasons and areas open to trawl fishing except for the waters adjacent to the Kerguelen and Crozet Islands. It specifies a minimum mesh size of 90 mm. As with CM 22-02, this CM does not apply to fishing conducted for scientific research purposes.

Bottom trawling is also conducted for research purposes in Subareas 48.1, 48.2, 48.3, and Division 58.5.2. Specific components and detailed descriptions of research bottom trawls are only available for Subareas 48.1 and 48.2, where scientific surveys are periodically conducted by the U.S. AMLR Program. The U.S. AMLR bottom trawl survey uses a factory made NET Systems Hard Bottom Snapper Trawl (# 92/122/5") rigged with tire gear ground tackle for use on rocky bottom terrain.

Toothfish Fishing

Toothfish (*Dissostichus spp*.) are highly prized table fish with significant imports to markets in Japan, Europe, and North America, where it is marketed as Chilean Sea Bass. Fishing is undertaken in areas managed by CCAMLR, in the EEZs of several countries both inside and outside the CCAMLR Convention Area, and in international waters. Legal fishing of toothfish began primarily as bycatch in the 1970s and developed into a targeted fishery in the mid-1980s with the introduction of demersal longline fishing, originally around South Georgia and Kerguelen Island.

By the mid-1990s, the fishery had expanded from the Falkland Islands and South Georgia to include the waters surrounding several sub-Antarctic Indian Ocean islands. Over the past ten years, fishing effort has been largely concentrated in Subareas 48.3 (South Georgia Island) and 58.5 (Kerguelen and Heard Islands). Historically, Patagonian toothfish harvests have been significantly higher than Antarctic toothfish harvests, but the total CCAMLR catch of Antarctic toothfish has increased steadily for the past several years. Vessels fishing for toothfish are predominantly demersal longliners. There is also a smaller trawl fishery for toothfish, and experimental fishing trials using pot gear.

Within the CCAMLR Convention waters, the Subareas and Divisions currently open for *Dissostichus spp*. fishing are: Subareas 48.3; 48.4; 48.6; Divisions 58.4.1;

58.4.2; 58.4.3; 58.5.1; 58.5.2; Subareas 58.6; 58.7; 88.1 and 88.2. Vessels from Argentina, Australia, France, Japan, Korea, Namibia, New Zealand, Russia, South Africa, Spain, Ukraine, United Kingdom, United States, and Uruguay have participated in the trawl and longline, exploratory and assessed CCAMLR fisheries for toothfish. See Section 2.1 for a discussion of assessed and exploratory fisheries in the CCAMLR region.

Toothfish Longline Fishery Gear Description, Depths Deployed, Locations, and Seasons

A. Gear Description

Longline gear configurations may differ considerably from vessel to vessel in the Southern Ocean *Dissostichus spp.* fishery. However, there are two primary longline gear designs used in these fisheries: the traditional single-line configuration (Figure 8), and the double-line 'Spanish' longline system (Figure 9). The single-line method consists of regularly spaced, anchored buoy lines that support a main line (ground line) with branchlines (snoods) strung with baited hooks. The double-line 'Spanish' system consists of an anchored buoy line that supports a main line in which railings are used to support the fishing line, which is strung with baited hooks. The number of hooks per longline set can vary substantially, averaging 5,000-8,000 hooks.

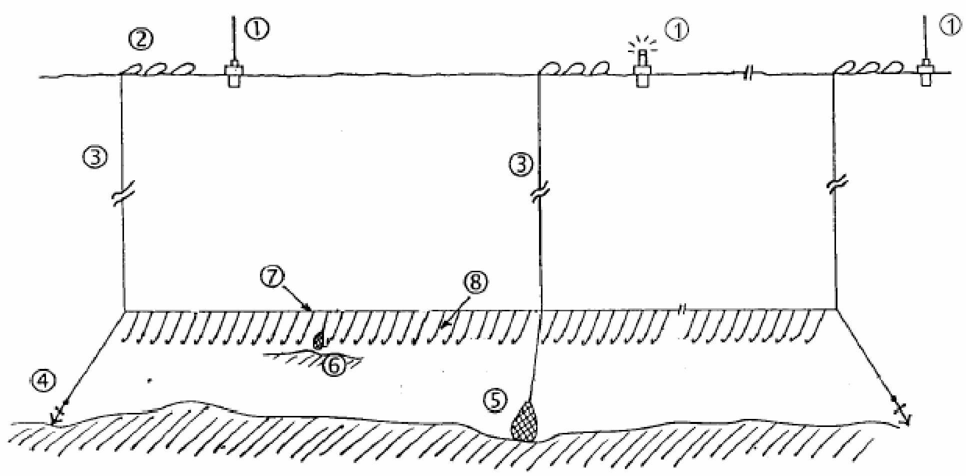


Figure 8 (Sec. 3.2): Configuration of a 'traditional' single-line bottom longline. 1 - Buoys; 2 - Floats; 3 - Buoy line; 4 - Anchor; 5 and 6 - Stone anchors; 7 - Main line (ground line); and 8 - Branchlines (snoods) with hooks. Source: CCAMLR Scientific Observers Manual (http://www.ccamlr.org/pu/e/e_pubs/obsman.pdf).

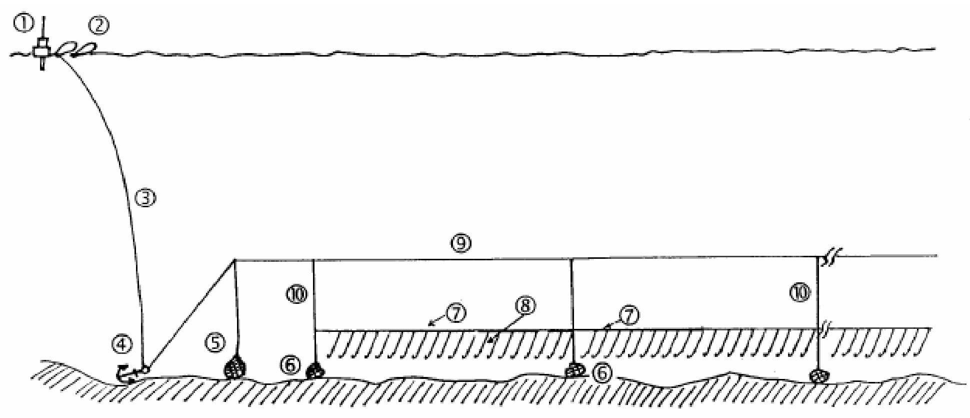


Figure 9 (Sec. 3.2): Configuration of a ‘Spanish type’ double-line bottom longline. 1 - Buoy; 2 - Floats; 3 - Buoy line; 4 - Anchor; 5 and 6 - Stone anchors; 7 - Fishing line; 8 - Branchlines (snoods) with hooks; 9 - Main line; and 10 - Railing. Source: CCAMLR Scientific Observers Manual (http://www.ccamlr.org/pu/e/e_pubs/obsman.pdf).

B. <u>Testing Trials</u>

CCAMLR Conservation Measure 24-02 offers the option of longline testing trials prior to entering CCAMLR Convention waters for any vessel wishing to fish its longline gear during daylight hours in Convention waters. The line-weight testing must be conducted according to one of two CCAMLR protocols (Protocol A for vessels monitoring longline sink rate with Time-Depth Recorders and using longlines to which weights are manually attached; or Protocol B for vessels monitoring longline sink rate with bottle tests and using longlines to which weights are manually attached). NMFS does not have access, other than for two previously flagged U.S. fishing vessels, the F/V America No. 1 and F/V American Warrior, to information on longline testing or weighting trials that occurred <u>outside</u> of CCAMLR Convention waters (i.e., catches in areas of national jurisdiction, as well as catches taken on the high seas).

The America No. 1 conducted trials in the high seas of the South Atlantic (FAO Statistical Area 41) from 21-Nov-03 to 23-Nov-03 at 54°07’ S, 53°33’ W in depths ranging from 1,345 to m 1,737 m. The following map “Longline Testing Trial Sites and CCAMLR Fishing Areas/Subareas” displays the area where the F/V America No. 1 conducted its test trials and the two ports where U.S. fishers have home ported or staged their CCAMLR fishing activities -- Punta Arenas, Chile (53° 11’ S latitude, 70° 56’ W longitude), and Montevideo, Uruguay (35° S latitude, 56° 13’ W longitude) -- during the past decade, and most likely to be used by U.S. vessels that may longline in CCAMLR waters in future years. The map also shows a third port -- Cape Town, South Africa (33° 55’ S latitude, 18° 22’ E longitude) -- that is apt to be used by U.S. longline vessels in future years. The F/V America No. 1 deployed 6 lines using the Spanish longline system. One line consisted of 4,000 hooks and the other 5 contained 10,000 hooks each. Of the 6 lines shot, 3 lines were shot with baited hooks while the remaining 3 were shot without hooks. The vessel successfully completed 20 line sink rate tests as required by

CCAMLR CM 24-02. The observer report indicated no observed interactions with seabirds, pinnipeds, or cetaceans during the course of the F/V America No. 1's testing trials. (Source: Observer report by Hennie Crous, NOAA Observer.)

The F/V American Warrior conducted longline testing trials over a ridge in the Pacific Ocean (FAO Statistical Area 81) from 28-Dec-03 to 29-Dec-03 at 55°29' S, 124°52′ W in depths ranging from 1,100 m to 1,620 m. The following map "Longline Testing Trial Sites and CCAMLR Fishing Areas/Subareas" displays the area where the F/V American Warrior conducted its test trials and the two ports where U.S. fishers have home ported or staged their CCAMLR fishing activities -- Punta Arenas, Chile, and Montevideo, Uruguay -- during the past decade, and most likely to be used by U.S. vessels that may longline in CCAMLR waters in future years. The map also shows a third port -- Cape Town, South Africa -- that is apt to be used by U.S. longline vessels in future years. The F/V American Warrior used 1.4 m hook spacing with 896 hooks per magazine with a total of 4 magazines set per line, for a total of 3,584 baited hooks per line. The observer report indicated no observed interactions with seabirds, pinnipeds, or cetaceans during the course of the F/V American Warrior's testing trials. (Source: Observer report by Eric N. Dobbs, NOAA Observer.)

Because the two most northerly ports mentioned above -- Montevideo, Uruguay and Cape Town, South Africa -- are both essentially located at 35° S latitude, future longline testing trials by U.S. flagged vessels outside CCAMLR waters but on the way to CCAMLR fishing grounds for toothfish are expected to occur south of 35° S latitude and within FAO Statistical Areas 41, 47, 81, and 87, as shown on the following map "Longline Testing Trial Sites and CCAMLR Fishing Areas/Subareas." Fishing vessels can reach all CCAMLR toothfish fishing areas by transiting one or more of these four FAO Statistical Areas.

Longline Testing Trial Sites and CCAMLR Fishing Areas/Subareas

Legend

- **CCAMLR Convention Line**
- **Areas/subareas**

Directed fishing prohibited:

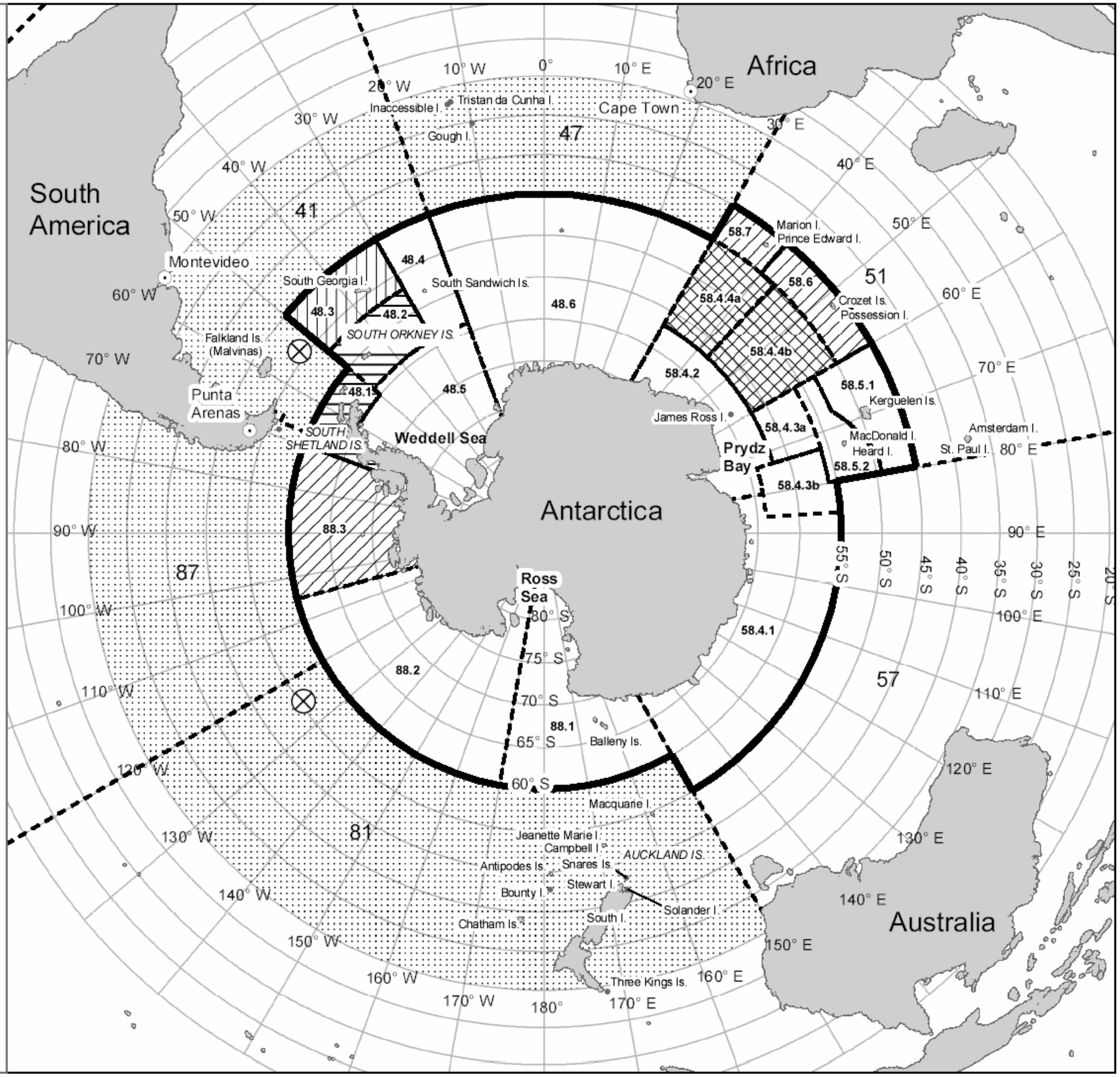
- All finfish
- N. rossii, G. gibberifrons, C. aceratus, L. squamifrons, P. squamifrons, E. carlsbergi, Pseudochaenichthys
- Dissostichus spp.
- Dissostichus spp. and L. squamifrons
- Longline testing trial site
- FAO statistical areas where longline trials are expected to occur

Date: February 3, 2005

Map by: Tim Haverland, NOAA Fisheries Office of Science and Technology

Projection: South Pole Lambert Azimuthal Equal Area

0 1,600 3,200
Kilometers
Approximate scale



C. Depths and Locations of the Longline Fishery

Longline set depths are variable. *Dissostichus spp.* have been fished from 400 to 2,000 meters, with most longlines set around 1,000 meters. Longline fishing for Patagonian toothfish, *D. eleginiodes*, has taken place in several areas of the Southern Ocean, including South Georgia (Subarea 48.3), Kerguelen (Division 58.5.1), Heard and McDonald Islands (Division 58.5.2), Crozet Islands (Subarea 58.6) and Prince Edward and Marion Islands (Subarea 58.7). Antarctic toothfish, *D. mawsoni*, has only been fished commercially in the Ross Sea (Subarea 88.1 and 88.2).

D. Longline Fishing Seasons

The longline fishery in the Southern Ocean can take place at any time during the season established by the CCAMLR Commission for the subarea or division managed, or until the total allowable catch has been reached for that area. The CCAMLR season lasts from 1 December to 30 November, though specific Subareas and Divisions are subject to closures during part of the season. Seasons for *Dissostichus spp*. longline fisheries are set annually in the Schedule of Conservation Measures. The seasons stipulated in the Schedule of Conservation Measures in Force for 2005/2006 are as follows:

Subarea 48.3 – 1 May to 31 August, 2006. The season may be extended to 14 September for any vessel that has demonstrated full compliance with CM 25-02 (all seabird bycatch mitigation measures). Fishing shall also cease for the season for any vessel that catches three seabirds. (CM 41-02).

Subarea 48.4 -1 April to 30 September, 2006. The season may be extended in 14 September for any vessel that has demonstrated full compliance with CM 25-02 (all seabird bycatch mitigation measures). Fishing shall also cease for the season for any vessel which catches three seabirds. (CM 41-03).

Subarea 48.6 (exploratory) –1 December, 2005 to 30 November, 2006 (CM 41-04).

Division 58.4.1 (exploratory) - 1 December 2005 to 30 November 2006. (CM 41-11).

Division 58.4.2 (exploratory) - 1 December 2005 to 30 November 2006. (CM 41-05).

Division 58.4.3a outside areas of national jurisdiction (exploratory) – 1 May to 31 August 2006. (CM 41-06).

Division 58.4.3b outside areas of national jurisdiction (exploratory) – 1 May to 31 August 2006. (CM 41-07).

Division 58.5.2 - 1 May to 31 August 2006. The season may be extended to 30 September for any vessel that has demonstrated full compliance with CM 25-02 (all seabird bycatch mitigation measures). Fishing shall also cease for the season for any vessel that catches three seabirds. (CM 41-08).

Subarea 88.1 (exploratory) - 1 December 2005 to 31 August 2006. (CM 41-09).

Subarea 88.2 (exploratory fishery south of 65° S) – 1 December 2005 to 31 August 2006. (CM 41-10).

Illegal, Unregulated and Unreported Toothfish Fishing

During the past decade, illegal, unregulated and unreported (IUU) fishing for toothfish has been a significant problem within and adjacent to the Convention Area. Substantial catches of toothfish have been taken by longline fishing well in excess of CCAMLR TAC limits. CCAMLR reports that during 1996-1999, the amounts of toothfish taken by IUU fishing have been estimated to be approximately 90,000 mt, which is more than twice the catch taken in CCAMLR regulated fisheries. See Table 8 below. IUU fishing has caused a significant depletion of stocks in some areas as well as unacceptably high levels of seabird bycatch and mortality, including several species of albatrosses and petrels.

However, at its Fall 2002 meeting, the CCAMLR Scientific Committee (SC) noted that in terms of assessing the total removals of toothfish, including an analysis of IUU fishing, there were several components of the issue, the combination of which could lead to a “double counting” of catches. The possible double counting of catches is a result of the different sources of data used by the SC. The information is received in the traditional method as well as from the Catch Documentation Scheme (CDS) data summaries provided by the Secretariat. A further difficulty with the information is that there is some misreporting of catch levels and statistical areas on the Dissostichus Catch Document (DCD) which further compounds the problem of double counting.

For the 2003/2004 fishing season, the estimate of total IUU fishing for toothfish fell dramatically from the previous season. The 2003-2004 estimate of 2,622 mt represented a 75 percent drop from the 10,070 mt estimated during the previous season. The SC noted that the highest level of IUU catch inside the Convention Area during the 2003/04 season was 643 mt from Division 58.5.1, down from 7,825 mt from this Division during the 2002/03 season. CDS-reported catches in Areas 41, 51 and 57 outside the Convention Area also declined.[2] The SC indicated that the likely causes of the decreases in Areas 41, 51 and 57 include the successful implementation of the CCAMLR CDS and other CCAMLR compliance and monitoring measures, a receipt of fewer DCDs due to reflagging, and some depletion of toothfish stocks. With respect to stock depletion as a reason, the SC noted that more data are needed to assess its plausibility. Given that there was a significant decline in the number of toothfish reported as harvested in Areas 51 and 57, this also seems to indicate the success of the U.S. ban on imports from these areas.

[2] SC-CAMLR-XXIII, Annex 5, Table 3.2

Table 8 (Sec. 3.2): Estimates of illegal, unreported, and unreported toothfish catch from the CCAMLR convention area (in mt).

Subarea/Div.	Split Year 1993/94	Split Year 1994/95	Split Year 1995/96	Split Year 1996/97	Split Year 1997/98	Split Year 1998/99	Split Year 1999/00	Split Year 2000/01	Season 2000/01	Season 2001/02	Season 2002/03	Season 2003/04	Season 2004/05
48.3						300-400	396	300	196	3			23
48.4.2										295	113	197	103
58.4.3												246	
58.4.4					900	1,845	1,050	1,540	1,247	880	128		264
58.5.1				2,000	11,825	620	2,100	3,300	4,550	6,300	7,825	643	321
58.5.2				7,200-12,000	7,000	160	800	1,649	2,004	3,489	1,512	637	318
58.6				18,900	1,765	1,748	1,980	660	685	720	354	456	14
58.7				11,900	925	140	220	150	120	78	138	58	72
88.1										92		240	173
Area Ujnknown												145	
Total IUU	6,604[1]	6,171[1]	10,000-20,000[2]	40,000-44,800[3]	22,415[4]	6,653[4]	6,546[5]	7,599[6]	8,802[7]	11,857[8]	10,070[8]	2,622[9]	3,023[10]

Sources:
[1]SC-CAMLR-XIV (1995) Pg. 407
[2]SC-CAMLR-XV (1996) Pg. 313
[3]SC-CAMLR-XVII (1998) Pg. 421
[4]SC-CAMLR-XVIII (1999) Pg. 343
[5]SC-CAMLR-XIX (2000) Pg. 348
[6]SC-CAMLR-XX (2001) Pg. 348
[7]SC-CAMLR-XXI (2002) Pg. 415
[8]SC-CAMLR-XXII (2003) Pg. 440
[9]SC-CAMLR-XXIII (2004) Pg. 580
[10]SC-CAMLR-XX1V (2005) pg 90

Basis for estimating IUU Fishing:

The CCAMLR WG-FSA has used the same method to estimate IUU fishing effort for several years. This method uses information on the number of vessels sighted (which is submitted by CCAMLR Members), and information on fishing trips and catch rates derived from CCAMLR data on licensed vessels.

Because the WG-FSA meets every October before the end of the CCAMLR fishing season (every October), the estimates of IUU catch and effort are then pro-rated to the end of the season (30 November). The estimates of IUU are often revised during the subsequent WG-FSA, when new information is made available to the Secretariat.

CCAMLR is considering methodologies for estimating IUU fishing and facilitating a more direct interaction between the WG-FSA and the CCAMLR Standing Committee on Implementation and Compliance (SCIC). One of the improvements would be to take explicit account of both “seen” and “unseen” IUU fishing, as well as use of a simulation model to arrive at more statistically rigorous estimates and confidence intervals of IUU catches.

To combat IUU fishing for toothfish, CCAMLR introduced a CDS in May 2000 to monitor landings and global trade in toothfish. The CDS is set forth in CCAMLR

Conservation Measure 10-05. To regulate toothfish imports into and re-exports from the United States, NMFS implemented a CDS program in 2000 that requires a Dissostichus Catch Document (DCD) to accompany all shipments. In 2003, NMFS refined those regulations to include a pre-approval system (see 50 CFR 300.113). See Section 2.2 for a discussion of the pre-approval system.

Toothfish Catch and Effort Data

To date, three U.S.-registered vessels have obtained permits to harvest toothfish in the CCAMLR Convention Area. In the 1994/95 fishing season, one U.S. vessel harvested 9 mt of Patagonian toothfish in the CCAMLR Convention Area and 178 mt in the 1995/96 season. (CCAMLR Statistical Bulletin, Vol.17, Table 8.1). In the 2003/04 fishing season, permits were issued for two U.S. vessels (the F/V America No. 1 and the F/V American Warrior) to harvest toothfish in Convention Subarea 88.1. Those vessels harvested 195 mt of toothfish in Subarea 88.1 prior to exiting the fishery in April 2004 (CCAMLR Statistical Bulletin, Vol. 17, Table 8.1).

The total reported catch of Patagonian toothfish within the CCAMLR Convention Area for the 2003/04 season was 11,182 mt and the total reported catch for Antarctic toothfish was 2,584 mt. See Table 10 below. For the 2005/06 fishing season, CCAMLR set a TAC of 12,025 mt for *Dissostichus spp*. in all Convention Areas combined. In setting the TAC, CCAMLR takes into account the impact of IUU fishing on toothfish stocks. The overall TAC is allocated by Convention subareas. It is not allocated by country or vessel and is therefore available to all vessels participating in the fishery until the TAC is reached.

Total global removals (including estimated IUU catches) of toothfish in the 2003/04 season (to October 2004) by longline and trawl was reported by the CCAMLR Scientific Committee as 26,808 mt, compared to 52,714 mt during the 2002/03 season. (Report of the Twenty-Third Meeting of the Scientific Committee, SC-CAMLR-XXIII, Annex 5, Table 3.3)

Based on data reviewed by the CCAMLR Scientific Committee at its Fall 2004 meeting, the reported catch of toothfish within the CCAMLR Convention Area in the 2003/04 fishing season was 13,307 mt compared with 18,507 mt in the previous season. Catch outside the Convention Area was 10,966 mt during the 2003/04 season compared with 24,137 mt in the previous season. The catch of toothfish outside the Convention Areas as reported in the CDS data in 2003/04 was 6,342 mt and 3,701 mt for Areas 41 and 87 respectively, down from 10,001 mt and 5,745 mt. The CDS estimate of 3,746 tons of toothfish caught on the high seas outside the Convention Area during 2003/04 was also much lower than the estimate of 11, 955 mt taken in 2002/03. (Report of the Twenty-Third Meeting of the Scientific Committee, SC-CAMLR-XXIII, Annex 5, Table 3.3)

The Food and Agriculture Organization of the United Nations (FAO) tracks worldwide harvests of toothfish, but does not include IUU catches in its overall totals. The FAO totals are set forth in Table 9 below.

Table 9 (Sec. 3.2): World Catches of Patagonian Toothfish, 1993 – 2003 (in mt)

	Area						
	SW Atlantic	SE Atlantic	So. Ocean (Atlantic)	So. Ocean (Indian Ocean)	SW Pacific (New Zealand)	SE Pacific	Total
1993	3,961		3,089	3,692		20,997	31,739
1994	13,747		508	7,310		20,902	42,467
1995	21,190		3,262	8,119		15,694	48,265
1996	14,951		3,602	5,656	1,061	6,993	32,263
1997	9,599		3,812	8,646	5	8,059	30,121
1998	13,328		3,201	10,168	43	9,172	35,912
1999	11,300		3,636	9,730	1	10,328	34,995
2000	11,122	320	4,939	11,972	0	10,676	39,029
2001	13,815	5	4,048	9,097	14	6,579	33,558
2002	12,566	906	5,744	8,233	12	7,194	34,643
2003	8,867	2,048	7,528	7,225	12	5,952	31,632

Source: FAO, Fishery Statistics, 2005
www.fao.org/fi/statist/statist.asp

Table 10 (Sec. 3.2): Catch by Species and Area (in mt)
Species: *Dissostichus eleginoides* and *Dissostichus mawsoni*

Species	**Area**	**1993/94**	**94/95**	**95/96**	**96/97**	**97/98**	**98/99**	**99/00**	**2000/01**	**01/02**	**02/03**	**03/04**	**04/05 ***
D. eleginoides	48												
D. eleginoides	48.1					0							
D. mawsoni	48.1					1			0				
Total	48.1	0	0	0	0	1	0	0	0	0			
D. eleginoides	48.2					0		36					
D. mawsoni	48.2						0						
Total	48.2	0	0	0	0	0	0	36	0	0			

D. eleginoides	48.3	658	3,371	3,602	3,812	3,201	3,636	4,904	4,047	5,742	7,528	4,497	3,018
D. eleginoides	48.4											0	27
D. eleginoides	48.6											7	49
D. eleginoides	58							56	8				
D. mawsonis	58.4.1												480
D. eleginoides	58.4.2								0		0	20	1
D. mawsoni	58.4.2										117		126
Total	58.4.2	0	0	0	0	0	0	0	0	0	117	20	127
D. eleginoides	58.4.3				0		0						
D. eleginoides	58.4.3a												100
D. mawsoni	58.4.3a												10
D. eleginoides	58.4.3b											7	1
D. mawsoni	58.4.3b												295
D. eleginoides	58.4.4							99					
D. eleginoides	58.4.4a												
D. eleginoides	58.4.4b												
D. eleginoides	58.5												
D. eleginoides	58.5.1	5,381	5,596	4,710	5,059	4,714	4,730	6,139	4,747	4,154	5,291	3,201	3,186
D. eleginoides	58.5.2				1,927	3,765	3,547	3,566	2,980	2,756	2,844	2,864	2,783
D. eleginoides	58.6	56	115	76	466	1,053	1,152	1,096	1,127	1,225	571	467	416
D. eleginoides	58.7			869	1,193	637	301	1,015	235	98	219	133	92
D. eleginoides	88.1				0	1	1	0	34	12	26	13	6
D. mawsoni	88.1					41	296	751	626	1,313	1,805	2,184	3,073
Total	88.1	0	0	0	0	42	297	751	660	1,325	1,831	2,197	3,079
D. eleginoides	88.2									0			
D. mawsoni	88.2									41	106	374	412
Total	88.2	0	0	0	0	0	0	0	0	41	106	374	412
D. eleginoides	88.3					0							
D. mawsoni	88.3					0							
Total	88.3	0	0	0	0	0	0	0	0	0	0	0	
D. eleginoides	Subtotal	6,095	9,082	9,257	12,457	13,370	13,367	16,913	13,178	13,987	16,479	11,182	9,679
D. mawsoni	Subtotal	0	0	0	0	42	296	751	626	1,354	2,029	2,584	4,101
	TOTAL	6,095	9,082	9,257	12,457	13,412	13,663	17,664	13,804	15,341	18,508	13,766	14,074

Source: CCAMLR Statistical Bulletin, Vol. 16 Rev. 1 (Electronic Version), Table 7.1
* CCAMLR WG-FSA

Over the past ten years, fishing effort for Patagonian toothfish has been largely concentrated in Subareas 48.3 (South Georgia Island) and 58.5 (Kerguelen and Heard Islands). See Table 11 below. Outside of Subareas 48.3 and 58.5, Subarea 88.1 is the only other area in which significant effort has been documented (2,777 hours of effort in the 2002/03 season).

Table 11 (Sec. 3.2): Effort (fishing hours) by Target Species and Area
Species: *Dissostichus eleginoides* and *Dissostichus spp.*

Target Species	Area	1993/94	94/95	95/96	96/97	97/98	98/99	99/2000	00/01	01/02	02/03	03/04
D.eleginoides	48.1											
D.eleginoides	48.2											
D.eleginoides	48.3	1,558	4,939		4,022		164	1,542	7,032	12,650	25,599	9,771
D.eleginoides	48.4											
D.eleginoides	58											
D.eleginoides	58.4.1						5					
D.eleginoides	58.4.2							0				
D.eleginoides	58.4.3				8		14					
D.eleginoides	58.4.4											
D.eleginoides	58.5											
D.eleginoides	58.5.1	2,779	2,905	1,557	907	2,510	2,937	4,360	3,513	306		
D.eleginoides	58.5.2				961	796	587	1242	536	23	814	1,020
D.eleginoides	58.6	101	106	8			184					1,247
D.eleginoides	58.7											5,047
D.eleginoides	88.1											
Subtotal		4,438	7,950	1,565	5,898	3,306	3,892	7,144	11,081	12,979	26,413	17,085
Subtotal												
Dissostichus spp	48.1											
" "	48.2											
" "	58.4.2											
" "	88.1										2,777	9,932
" "	88.2											
" "	88.3											
Subtotal											2,777	9,932

Source: CCAMLR Statistical Bulletin, Vol. 17 Rev. 1 (Electronic Version), Table 7.2

Icefish Fishing

Eight species of icefish are caught in the CCAMLR Convention Area, although over 99% of icefish landed is mackerel icefish (*Champsocephalus gunnari*). *C.gunnari* was fished extensively during the late 1970s and in the 1980s. Annual catches of *C. gunnari* peaked at 30,357 mt in Subarea 48.1 in 1978/79, 138,895 mt in Subarea 48.2 in 1977/78 and 178,824 mt in Subarea 48.3 in 1982/83. (Statistical Bulletin, Vol. 16 Rev. 1 (Electronic Version), Table 7.1). In Subarea 58, annual catches of *C. gunnari* peaked at

38,654 mt in Division 58.5.1 in 1976/77 and 15,201 mt in Division 58.5.2 in 1976/77. (Statistical Bulletin, Vol. 16 Rev. 1 (Electronic Version), Table 7.1).

Within the CCAMLR Convention Area, the icefish fishery is conducted using pelagic (midwater) trawls and bottom trawls. Currently, the CCAMLR icefish fishery is limited to Subarea 48.3 and Division 58.5.2. Concern over levels of bycatch of other finfish species (e.g., *Gobionotothen gibberifrons, Chaenocephalus aceratus,* and *Notothenia rossii*), in bottom trawls resulted in a ban on bottom trawling for *C. gunnari* in Subarea 48.3 starting in the 1989 CCAMLR fishing season. Similarly, in Subareas 48.1 and 48.2, *C. gunnari* were depleted in the late 1970s, and the fishery continued at a low level. The fishery has been closed in Subareas 48.1 and 48.2 since 1990 to avoid high bycatch levels and to allow *C. gunnari* stocks to recover. Bottom trawling is still permitted at Heard and McDonald Islands in Division 58.5.2.

Conservation measures aimed at reducing bycatch in the targeted *C. gunnari* fisheries were introduced in 1989 at South Georgia and in 1997 at Heard and McDonald Islands, and have remained in force since then. Bycatch measures have included both “trawl-by-trawl” bycatch limits that encourage trawlers to move away from areas where the catch of another species exceeds certain limits and overall area bycatch limits which would lead to closure of the fishery. (CCAMLR SC, 2001; CM 42-01 and CM 42-02).

Over the last ten years, the average harvest of *C. gunnari* in the CCAMLR Convention Area has been 2,031 mt, with 4,331 mt harvested in the 2002/03 fishing year, representing the largest harvest in the past decade. See Table 12 below. The major producers are Australia, Chile, Great Britain, Korea, Russia, and the Ukraine. The United States has not participated in the directed fishery for this species although it has made small harvests as bycatch in the krill fishery in two recent seasons: 1 mt in the 1998/99 fishing season and 1 mt in the 2000/01 season (no icefish was taken as bycatch by the U.S. krill fisher in 2002/03 or 2003/04). Currently, there are no U.S. vessels participating in the CCAMLR icefish fishery.

In Subarea 48.3, the TAC for the 2003/04 season was 2,887 mt with a limit of 722 mt from March 1, 2004 to May 31, 2004. The inshore waters within 12 nautical miles of South Georgia were closed for the icefish fishery from March 1 to May 31, 2004. In Division 58.5.2, the 2003/04 TAC was 292 mt. (CCAMLR Conservation Measures 42-01 and 42-02.)

Table 12 (Sec. 3.2): Catch by Species and Area (in mt)
Species: *Champsocephalus gunnari* (icefish)

Area	1993/94	94/95	95/96	96/97	97/98	98/99	99/00	2000/01	01/02	02/03	03/04*	04/05*
48.1								1				
48.2	0					1						
48.3	13	10			6	265	4,114	960	2,667	1,986	2,683	200
58												
58.4												
58.4.2								11		0		
58.5.1	1,228	2,708	5	0								
58.5.2				227	115	2	137	1,136	865	2,345	78	1,791
Total	1,241	2,718	5	227	121	268	4,251	2,097	3,532	4,331	2,762	1,991

Source: CCAMLR Statistical Bulletin, Vol. 17 , Table 7.1
* SC-CAMLR -XXIV

In the past decade, fishing effort for *C. gunnari* has been concentrated in Subarea 48.3 and Division 58.5.2, as indicated in Table 13 below. In Subarea 48.3, fishing effort for *C. gunnari* has been concentrated in the months of December, January, and February. In Division 58.5.2, effort has been distributed throughout the year with concentrated effort in March and April in the 2002/03 season.

Table 13 (Sec. 3.2): Effort (fishing hours) by Target Species and Area/Subarea/Division
Species: *Champsocephalus gunnari* (mackerel icefish)

Area	1993/94	94/95	95/96	96/97	97/98	98/99	99/00	2000/01	01/02	02/03	03/04
48.3							639	640	2,019	690	1,101
58.5.1											
58.5.2				88	176	42	50	123	6	602	100

Source: CCAMLR Statistical Bulletin, Vol. 17, Table 7.2

Krill Fishing

The fishery for Antarctic krill began in the 1970s and quickly expanded to annual catches of 300,000 to 500,000 mt during the mid-1980s and early 1990s with effort concentrated in the southwest Atlantic sector. Low catches in 1983, 1984, and 1985 coincided with low krill availability and poor krill predator reproductive success at South Georgia. The decline in catches after 1992 coincides with political changes in the Soviet Union, which until then was the principal harvester. The 1994/1995 level of 135,686 mt is the largest annual catch since 1992. (CCAMLR Statistical Bulletin, Vol. 16 Rev. 1 (Electronic Version), Table 2).

CCAMLR manages fisheries in the Convention Area on a seasonal basis, from December 1 following the annual fall meeting of the Commission to November 30 of the next year. Individual fisheries within a season may be for lesser periods than a full year. The krill fishery, however, is open for the entire year. Krill fishing is conducted using mid-water pelagic trawl gear. The target depth of the hauls for the krill fishery is within the upper 50 meters of the water column. The ocean depths where krill are fished range between 100-4,000 meters. There is no interaction with the krill trawl and the bottom.

Krill is harvested in Convention Areas 48 (the Atlantic Ocean sector) and 58 (the Indian Ocean sector). CCAMLR has set a precautionary catch limit of 4 million mt per fishing season for Area 48. The catch limit is based on a harvest rate of 9.1%, which results in a 4 million mt limit for the aggregate of Subareas 48.1 (1.008 million mt), 48.2 (1.104 million mt), 48.3 (1.056 million mt) and 48.4 (0.832 million mt)(CM-51-01). CCAMLR has agreed to apply precautionary catch limits to smaller management units than these subareas of Area 48, or on such other basis as the CCAMLR Scientific Committee (SC) may advise, if the total catch in Area 48 in any fishing season exceeds 620,000 mt. For a detailed discussion on the calculation of CCAMLR krill catch limits, see 'Assessment Methods' in Section 1.1(3).

The CCAMLR SC factored cumulative harvest into its advice that the precautionary catch limit for krill be set at 4 million mt annually for Area 48. The CCAMLR SC has determined that the present and historic levels of harvest do not affect the reproductive rates or standing stock of krill to a degree that impacts either the continuing krill population or its availability to predator species of whales and seals.

The total catch of all fishers participating in the krill fishery in Area 48 for the 2002/2003 season was 116,866 mt, which was 2.9% of the available TAC for the Area. Japan (three vessels), Korea (two), Poland (one), Ukraine (two) and the United States (one) participated in the krill fishery in Area 48 in the 2002/2003 fishing season.

The total catch of all fishers participating in the krill fishery in Area 48 for the 2003/04 season was 117,899 mt, which was 2.9% of the available TAC for the Area. Great Britain (one), Japan (two vessels), Korea (two), Poland (one), Russia (one), Ukraine (two), the United States (one), and Vanuatu (one) participated in the krill fishery in Area 48 in the 2003/04 fishing season. The total catch of krill in Area 48 for the 2003/04 season was 118,166 mt. One U.S. vessel has participated in the krill fishery in Convention Area 48 during the past four seasons, harvesting 70 mt in the 1999/2000 season; 1,561 mt in the 2000/01 season; 12,175 mt in the 2001/02 season; 10,150 mt in the 2002/03 season; and 8,900 mt in the 2003/04 season.

For the 2005/06 fishing season, CCAMLR has set precautionary catch limits of 440,000 mt and 450,000 mt per fishing season respectively in Divisions 58.4.1 (CM-51-02) and 58.4.2 (CM-51-03). The catch limit in 58.4.1 is further divided into smaller units as follows: 277,000 mt west of 115° E and 163,000 mt east of 115° E. There has been no reported fishing for krill in Area 58 since the 1995/96 season. (CCAMLR Statistical Bulletin, Vol. 17, Table 4.2)

Total annual catches for krill (all countries) in the CCAMLR Convention Area have historically been well below the TAC limits. Recent total annual catches for krill in the Convention Area are as follows: 118,166 mt in the 2003/04 season; 117,728 mt in 2002/03; 125,987 mt in 2001/02; and 104,182 mt were taken in 2000/01. See Table 14 below. Over the past decade, the krill fishing effort has been concentrated in Subareas 48.1, 48.2 and 48.3, which together have accounted for all the reported CCAMLR krill catch since 1996/97. (CCAMLR Statistical Bulletin, Vol. 17, Tables 4.2 and 7.2). CCAMLR records indicate that krill harvests have been recorded in each month of the year (CCAMLR Statistical Bulletin, Vol. 17, Table 11.1.) In Subarea 48.1, effort is concentrated from December through May, whereas in 48.3 effort is concentrated from June through October. Effort in Subarea 48.2 has been disbursed throughout the year. (CCAMLR Statistical Bulletin, Vol. 17, Table 11.2.)

Table 14 (Sec. 3.2): Catch by Species and Area (in mt)
Species-group: Euphausiidae

Area	1993/94	94/95	95/96	96/97	97/98	98/99	99/00	2000/01	01/02	02/03	03/04*	04/05*
41.3.2					74		4					
48												22,678**
48.1	45,085	38,165	61,964	48,843	56,575	38,895	71,977	46,778	10,646	35,377	13,882	965
48.2	19,259	48,833	2,734	99	6,673	62,077	16,891	4,981	72,060	15,427	46,456	67,247
48.3	20,301	47,421	26,452	26,711	26,776	985	25,557	52,423	43,282	66,924	57,829	33,646
48.4												
48.5												
48.6												
58												
58.4												
58.4.1	899	1,266									0	
58.4.2												
58.4.3												
58.4.4			6									
88												
88.1												
88.3												

Source: CCAMLR Statistical Bulletin, Vol. 17, Table 4.2
* SC-CAMLR -XXIV
** Unspecified within Area 48

The total catch by the ten vessels, including the one U.S. vessel, participating in the 2003/04 fishery for krill was 118,166 mt, or 2.9% of the 4,000,000 mt catch limit adopted by the Commission for fishing for krill in Area 48. As in the 2002/2003 season, most of this catch came from within the 15 Small Scale Management Units in Area 48 (north of Livingston Island, west of Coronation Island and northeast of South Georgia). CCAMLR's Scientific Committee reported to the Commission in October 2004 that a total catch of 160,000 mt is a reasonable expectation for the 2004/05 season.

For environmental and logistical reasons, the krill fishery is likely to remain concentrated in the Southwest Atlantic sector of the Southern Ocean as opposed to expanding into the Pacific or Indian Ocean sectors. Because of the favorable fishing conditions in the Southwest Atlantic sector, as well as the proximity to supplies, shelter, ports and potential markets, this region may be viewed as the center of krill fishing operations. Despite the rather restricted potential for spatial expansion, the krill fishery in the South Shetlands may be far from reaching its capacity (Agnew and Nichol, 1996).

Crab Fishing

The crab fishery in the CCAMLR region has historically been very small. Since record keeping began in 1969, only 939 mt of crabs have been harvested from the CCAMLR Convention Area. Of that total, 640 mt were taken in the past ten years. See Table 15 below. The catch has been taken by the United States, Japan, and Great Britain, although the actual catches have been sporadic over time. For the 2005/06 fishing season, the CCAMLR Committee set a precautionary catch limit of 1,600 mt (CM 52-01).

One U.S. crab vessel harvested 299 mt in 1992/93 but found it difficult to market the product, and did not fish in CCAMLR waters in 1993/94. The United States caught 283 mt in 1994/95 and 214 mt in 1995/96, which is approximately 78% of the total catch for the past decade. (CCAMLR Statistical Bulletin, Vol. 17, Table 8.1). However, there has been no U.S. catch since the 1995/96 season. The one U.S. boat that participated in the CCAMLR crab fishery in past seasons has not fished for several seasons and did not seek a permit for the current fishing season.

Table 15 (Sec. 3.2): Catch by Species-group and Area (in mt)
Species-group: Lithodidae (crab)

Area	1993/94	94/95	95/96	96/97	97/98	98/99	99/00	2000/01	01/02	02/03	03/04	04/05*
48.1												
48.3	0	283	214	1	1	2	2	14	112	1	1	
58.4.3				0								
58.6					0	0	0	0	0	0		
58.7				0	0	0	3	0	0	0		
88.1					0				0	0		

Source: CCAMLR Statistical Bulletin, Vol. 17, Table 4.2
* Source: SC-CAMLR -XXIV

The crab fishery is conducted using pots and is limited to Subarea 48.3. Typically, crab pots have a funnel-shaped opening in the top of the pot to allow entry of crabs while also serving as a collar that prevents crabs from escaping. Due to the wide opening of the collar, fish may swim freely in and out of the pot and are seldom captured. Crab pots are generally fished for 18 to 24 hours.

In Subarea 48.3, experimental fishing trials using pots (fish traps) were undertaken March-May in 2000 by the United Kingdom. These trials were conducted to determine whether a commercially viable fishery could be prosecuted using this type of gear. Australia has also notified of their intention to conduct experimental trials using pot gear for *Dissostichus eleginoides* in Division 58.5.2. Pot gear used by the United Kingdom for their trials consisted of semi-conical, approximately 80 cm high, steel frames covered in mesh with a collapsible funnel entrance situated on the side of the pot, orientated horizontally and tapering to the pot interior.

Squid Fishing

Martialia hyadesi (Seven star flying squid)

The *Martialia hyadesi* fishery is an exploratory jig fishery and is limited to Subarea 48.3. To date, Korea is the only country that has participated in this fishery. Korea reported harvests of 52 mt in 1995/96, 81 mt in 1996/97 and 2 mt in 2000/01. (CCAMLR Statistical Bulletin, Vol. 17, Table 9.1). See Table 16 below. For the 2005/06 season, the CCAMLR Committee set a precautionary catch limit of 2,500 mt for the squid fishery. The United States has done no directed fishing for *Martialia hyadesi* in the CCAMLR region.

Illex argentinus (Argentine short fin squid)

The only reported catches of *Illex argentinus* in the CCAMLR Convention area in the past decade were 18 and 49 mt, in the 2000/01 and 2001/02 fishing seasons, respectively. All of the catch was taken by Poland in Subarea 48.3. (CCAMLR Statistical Bulletin, Vol. 17, Table 9.1). The United States has not participated in this fishery and currently there is no active fishery for *Illex argentinus* within the CCAMLR region, due to a lack of participating countries.

Table 16 (Sec. 3.2): Catch by Species and Area (in mt)
Species: *Illex argentinus* and *Martialia hyadesi* (squid)

Species	Area	1993/94	94/95	95/96	96/97	97/98	98/99	99/00	2000/01	01/02	02/03	03/04	04/05
Illex argentinus	48.3								18	49			
Martialia hyadesi	48.3			52	81				2			0	
Total		0	0	52	81	0	0	0	20	49	0	0	

Source: CCAMLR Statistical Bulletin, Vol. 17 Rev. 1 (Electronic Version), Table 7.1

Macrourus Fishing

The exploratory fishery for *Macrourus spp*. is relatively new and still a minor fishery within the CCAMLR region. In the 1999/00 CCAMLR season, 350 mt of *Macrourus spp*. were harvested, which was more than 2 times the amount taken in any of the preceding five years. In 2001/02, the harvest rose to 649 mt, in 2002/03 the harvest was 914 mt, and in 2003/04 835 mt were harvested. (CCAMLR Statistical Bulletin, Vol. 16 Rev. 1 (Electronic Version), Table 7.1). The leading producers in this trawl fishery are France, New Zealand and South Africa, with most of the reported landings coming from Area 58. To date, no U.S. vessels have participated in the *Macrourus spp.* fishery and there has been no expression of interest by any U.S. fisher in doing so. For the 2003/04 CCAMLR fishing season, the *Macrourus spp*. fishery was limited to one Australian vessel with a catch limit of 26 mt and 159 mt in Divisions 58.4.3a and 58.4.3b, respectively (CM 43-02 and 43-03).

Other Finfish

Chaenodraco wilsoni (spiny icefish); *Lepidonotothen kempi* (striped-eye notothen); *Trematomus eulepidotus* (blunt scalyhead) and *Pleuragramma antarcticum* (Antarctic silverfish)

Catches of these species have been very small over the past decade, with zero reported catch in many years. There has been some reported catch by U.S. vessels, but not more than 500 kilograms for any one species in any fishing season. (CCAMLR Statistical Bulletin, Vol. 17, Tables 2 and 3.2). Currently, no U.S. vessels are actively participating in this fishery, nor does it appear likely that any will do so in the foreseeable future.

CCAMLR Conservation Measure 43-04 governed fishing activities for these four finfish species in the 2003/04 season. Under the terms of this CM, fishing was limited to one Russian vessel in Division 58.4.2 using midwater trawl only. The following catch limits applied: 2,000 mt for all species combined; 1,000 mt for *Chaenodraco wilsoni*; 500 mt for *Lepidonothen kempi*; 500 mt for *Trematomus eulepidotus*; and 500 mt for *Pleuragramma antarcticum*.

The Role of the United States in Toothfish Trade

While the United States plays a very small role in toothfish harvest, it plays a very significant role in the lucrative international trade market in toothfish. The first few rows of Table 17 show the CCAMLR harvest of toothfish as well as the total global harvest over the recent past. These data are by calendar year rather than the CCAMLR statistical periods so that they can correspond to trade data. It is broken down by product weight and live weight. TACs are measured in live weight while trade is measured in product weight.

The next row shows U.S. imports of toothfish over the same period. The total value of imports ranges from $92 to $111 million per year with an average value per kilo ranging from $9.76 to $10.54. Note that while all of the U.S. imports are not caught in CCAMLR waters, in terms of live weight, its imports are equal or greater to the total CCAMLR harvest.

The U.S. market is very important to the toothfish fishery with U.S. imports accounting for the largest percentage of global catch. In terms of market weight, they have averaged about 31% over the past four years and the figure will be higher at the completion of 2004. Because of the type of finished products that are imported, the percentage of live weight is much higher. A large part of U.S. imports is fillets as opposed to headed and gutted product and so the ratio of product weight to live weight is lower. In terms of live weight, the United States has imported about 43% of the global harvest of toothfish over the past few years. The preliminary 2004 data indicate that this figure may grow to over 50%.

Tables 18 and 19 show U.S. imports of all species of toothfish, both frozen and fresh product, by volume and by value from 1999 through June 2004. The import data are displayed by supplying country -- both CCAMLR member countries and non-member countries.

Table 17 (Sec. 3.2): Catch and U.S. Imports of Toothfish (*Dissostichus spp.*) by Calendar Year.

	2000			2001			2002			2003			2004 Jan-Oct		
	Product Weight Tonnes	Est. Live Weight Tonnes	Thou-sands US$	Product Weight Tonnes	Est. Live Weight Tonnes	Thou-sands US$	Product Weight Tonnes	Est. Live Weight Tonnes	Thou-sands US$	Product Weight Tonnes	Est. Live Weight Tonnes	Thou-sands US$	Product Weight Tonnes	Est. Live Weight Tonnes	Thou-sands US$
CCAMLR	12,897	17,766		10,782	14,514		11,832	16,319		13,879	19,246		9,352	12,619	
Non-CCAMLR	17,325	23,669		25,933	36,053		23,648	32,545		19,717	25,327		7,620	9,402	
Total Global Catch	30,222	41,435		36,715	50,567		35,480	48,864		33,596	44,573		16,972	22,021	
US Imports	9,518	17,802	$92,916	11,732	21,674	$104,473	11,302	21,071	$111,355	10,551	19,099	$111,258	6,646	11,877	$69,775
% of Global Catch	31%	43%		32%	43%		32%	43%		31%	43%		39%	54%	
Average Price Kilo			$9.76			$8.91			$9.85			$10.54			$10.50

Sources: CCAMLAR Document SCIC-04/10; and National Marine Fisheries Service, Fisheries Statistic Division, Silver Spring MD

Table 18 (Sec. 3.2): U.S. IMPORTS OF TOOTHFISH (*Dissostichus spp.*)
TOTAL FROZEN and FRESH PRODUCT by VOLUME

	1999			2000			2001			2002			2003			2004 (Jan.-Jun)		
	Frozen weight Tonnes	Fresh weight Tonnes	Total weight Tonnes	Frozen weight Tonnes	Fresh weight Tonnes	Total weight Tonnes	Frozen weight Tonnes	Fresh weight Tonnes	Total weight Tonnes	Frozen weight Tonnes	Fresh weight Tonnes	Total weight Tonnes	Frozen weight Tonnes	Fresh weight Tonnes	Total weight Tonnes	Frozen weight Tonnes	Fresh weight Tonnes	Total weight Tonnes
ARGENTINA	2,506.1	0.0	2,506.1	1,897.6	24.3	1,921.9	1,196.2	212.9	1,409.1	1,472.4	17.0	1,489.4	1,227.9	0.0	1,227.9	674.8	0.0	674.8
AUSTRALIA	161.6	0.0	161.6	8.5	0.0	8.5	0.0	0.0	0.0	0.0	0.0	0.0	85.3	0.0	85.3	0.0	0.0	0.0
BRAZIL	9.5	0.0	9.5	72.3	0.0	72.3	0.0	0.0	0.0	21.7	0.0	21.7	64.1	2.3	66.4	0.0	0.0	0.0
CHILE	1,223.9	0.0	1,223.9	1,521.2	782.0	2,303.2	2,021.0	1,447.4	3,468.4	1,582.8	1,321.5	2,904.3	2,279.2	1,079.3	3,358.5	990.8	385.6	1,376.4
FRANCE	323.5	0.0	323.5	240.3	0.0	240.3	623.3	0.0	623.3	949.2	0.0	949.2	869.6	0.0	869.6	401.8	0.0	401.8
INDIA	62.3	0.0	62.3	5.2	0.0	5.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.6	0.0	17.6
JAPAN	0.0	0.0	0.0	0.0	0.0	0.0	18.1	0.0	18.1	0.0	0.0	0.0	25.9	19.4	45.3	1.6	10.9	12.5
NAMIBIA	0.0	0.0	0.0	44.2	0.0	44.2	8.7	0.0	8.7	6.4	0.0	6.4	7.7	0.0	7.7	0.0	0.0	0.0
NEW ZEALAND	113.4	0.0	113.4	173.4	3.8	177.2	209.4	9.6	219.0	771.8	2.7	774.5	574.5	0.0	574.5	428.4	0.0	428.4
NORWAY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	58.3	0.0	58.3
RUSSIAN FEDERATION	0.0	0.0	0.0	0.0	0.0	0.0	122.4	0.0	122.4	41.6	0.0	41.6	262.3	0.0	262.3	0.0	0.0	0.0
SOUTH AFRICA	286.8	0.0	286.8	606.6	25.2	631.8	267.4	0.0	267.4	260.6	0.0	260.6	357.0	0.0	357.0	121.2	0.0	121.2
SOUTH KOREA	0.0	0.0	0.0	497.2	18.9	516.1	657.5	108.6	766.1	368.0	44.2	412.2	150.6	102.8	253.4	79.7	49.8	129.5
SPAIN	72.4	0.0	72.4	0.0	0.0	0.0	237.1	0.0	237.1	99.1	0.3	99.4	420.3	23.0	443.3	175.9	0.0	175.9
UNITED KINGDOM	55.4	0.0	55.4	121.8	0.0	121.8	63.0	0.0	63.0	24.1	0.0	24.1	138.6	0.9	139.5	0.0	0.0	0.0
URUGUAY	928.1	0.0	928.1	1,529.8	0.0	1,529.8	1,518.6	62.9	1,581.5	988.7	39.6	1,028.3	1,001.1	26.2	1,027.3	303.2	45.1	348.3
CCAMLR Sub total	5,743.0	0.0	5,743.0	6,718.1	854.2	7,572.3	6,942.7	1,841.4	8,784.1	6,586.4	1,425.3	8,011.7	7,464.1	1,253.9	8,718.0	3,253.3	491.4	3,744.7
CANADA	0.3	0.0	0.3	0.0	0.0	0.0	2.3	0.0	2.3	1.6	0.0	1.6	1.5	0.0	1.5	0.0	0.0	0.0
GREECE	0.0	0.0	0.0	1.1	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PERU	1.1	0.0	1.1	3.2	23.4	26.6	37.5	50.5	88.0	0.0	121.2	121.2	0.0	250.1	250.1	0.0	114.0	114.0
OTHER CONV.Sub total	1.4	0.0	1.4	4.3	23.4	27.7	39.8	50.5	90.3	1.6	121.2	122.8	1.5	250.1	251.6	0.0	114.0	114.0
BELIZE	0.0	0.0	0.0	47.8	0.0	47.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BRITISH VIRGIN IS.	1.8	0.0	1.8	36.4	0.0	36.4	19.5	0.0	19.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CAYMAN IS.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CHINA	477.3	0.0	477.3	1,061.2	0.0	1,061.2	708.6	0.0	708.6	512.1	5.6	517.7	724.7	0.0	724.7	67.3	0.0	67.3
CHINA - HONG KONG	21.0	0.0	21.0	0.0	0.0	0.0	39.4	0.0	39.4	44.7	0.0	44.7	0.0	0.0	0.0	0.0	0.0	0.0
CHINA - TAIPEI	1.4	0.0	1.4	0.0	0.0	0.0	20.0	0.0	20.0	25.9	0.0	25.9	30.8	0.0	30.8	3.8	0.0	3.8
COLOMBIA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	1.2	0.0	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0
COSTA RICA	0.0	0.0	0.0	34.8	1.6	36.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0
CYPRUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.1	0.0	18.1
ECUADOR	0.0	0.0	0.0	25.7	0.0	25.7	0.0	1.1	1.1	0.0	1.0	1.0	0.0	0.5	0.5	0.0	0.0	0.0
FALKLAND/MALVINAS	20.4	0.0	20.4	107.2	0.0	107.2	528.2	0.0	528.2	452.8	0.0	452.8	452.7	0.0	452.7	244.1	0.0	244.1
FIJI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.6	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GUINEA-BISSAU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GUYANA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HONDURAS	0.0	0.0	0.0	21.4	4.3	25.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INDONESIA	75.5	0.0	75.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.9	0.0	7.9
MALDIVE IS.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MAURITIUS	240.5	0.0	240.5	387.6	0.0	387.6	23.9	0.0	23.9	144.3	0.0	144.3	198.2	0.0	198.2	45.8	0.0	45.8
NICARAGUA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	1.4	0.0	0.0	0.0	0.9	0.0	0.9	0.0	0.0	0.0
PANAMA	127.0	0.0	127.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.6	0.9	29.5	0.0	0.0	0.0
PORTUGAL	8.3	0.0	8.3	39.9	0.0	39.9	6.4	0.0	6.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
REUNION	0.0	0.0	0.0	23.2	0.0	23.2	0.0	0.0	0.0	230.6	0.0	230.6	143.7	0.0	143.7	21.7	0.0	21.7
SAINT HELENA	0.0	0.0	0.0	0.0	0.0	0.0	17.8	0.0	17.8	94.7	0.0	94.7	0.0	0.0	0.0	0.0	0.0	0.0
SEYCHELLES	0.0	0.0	0.0	122.2	0.0	122.2	1,434.3	21.5	1,455.8	1,655.7	0.0	1,655.7	0.0	0.0	0.0	0.0	0.0	0.0
SINGAPORE	18.5	0.0	18.5	0.0	0.0	0.0	10.7	0.0	10.7	0.0	0.0	0.0	0.0	0.0	0.0	17.8	0.0	17.8
THAILAND	14.4	0.0	14.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VENEZUELA	0.0	0.0	0.0	5.1	0.0	5.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VIET NAM	0.0	0.0	0.0	0.0	0.0	0.0	19.7	0.0	19.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER Sub total	1,006.1	0.0	1,006.1	1,912.5	5.9	1,918.4	2,828.5	28.8	2,857.3	3,160.8	7.1	3,167.9	1,579.6	1.7	1,581.3	426.5	0.0	426.5
GRAND TOTAL	6,750.5	0.0	6,750.5	8,634.9	883.5	9,518.4	9,811.0	1,920.7	11,731.7	9,748.8	1,553.6	11,302.4	9,045.2	1,505.7	10,550.9	3,679.8	605.4	4,285.2

Table 19 (Sec. 3.2): U.S. IMPORTS OF TOOTHFISH (*Dissostichus spp.*)

TOTAL FROZEN and FRESH PRODUCT by VALUE

	1999			2000			2001			2002			2003			2004 (Jan.-Jun)		
	Frozen Thousand US $	Fresh Thousand US $	Total Thousand US $	Frozen Thousand US $	Fresh Thousand US $	Total Thousand US $	Frozen Thousand US $	Fresh Thousand US $	Total Thousand US $	Frozen Thousand US $	Fresh Thousand US $	Total Thousand US $	Frozen Thousand US $	Fresh Thousand US $	Total Thousand US $	Frozen Thousand US $	Fresh Thousand US $	Total Thousand US $
ARGENTINA	20,874.6	0.0	20,874.6	16,776.9	232.9	17,009.8	9,727.4	1,529.1	11,256.5	10,622.0	133.3	10,755.3	10,298.8	0.0	10,298.8	5,059.1	0.0	5,059.1
AUSTRALIA	1,040.8	0.0	1,040.8	74.7	0.0	74.7	0.0	0.0	0.0	0.0	0.0	0.0	888.1	0.0	888.1	0.0	0.0	0.0
BRAZIL	49.7	0.0	49.7	404.5	0.0	404.5	0.0	0.0	0.0	215.0	0.0	215.0	580.1	28.6	608.7	0.0	0.0	0.0
CHILE	11,713.6	0.0	11,713.6	15,321.3	8,165.4	23,486.7	17,134.2	14,629.8	31,764.0	16,592.5	13,680.0	30,272.5	25,928.9	12,078.8	38,007.7	11,948.2	4,649.8	16,598.0
FRANCE	2,904.1	0.0	2,904.1	2,185.8	0.0	2,185.8	4,818.0	0.0	4,818.0	8,168.6	0.0	8,168.6	8,682.7	0.0	8,682.7	4,290.3	0.0	4,290.3
INDIA	129.1	0.0	129.1	6.8	0.0	6.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	182.5	0.0	182.5
JAPAN	0.0	0.0	0.0	0.0	0.0	0.0	30.9	0.0	30.9	0.0	0.0	0.0	275.9	201.4	477.3	20.2	267.0	287.2
NAMIBIA	0.0	0.0	0.0	201.6	0.0	201.6	83.5	0.0	83.5	78.1	0.0	78.1	91.2	0.0	91.2	0.0	0.0	0.0
NEW ZEALAND	997.9	0.0	997.9	1,663.6	17.3	1,680.9	1,555.8	42.4	1,598.2	6,931.5	14.4	6,945.9	5,964.4	0.0	5,964.4	4,475.5	0.0	4,475.5
NORWAY	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	722.5	0.0	722.5
RUSSIAN FEDERATION	0.0	0.0	0.0	0.0	0.0	0.0	1,312.6	0.0	1,312.6	449.0	0.0	449.0	3,269.3	0.0	3,269.3	0.0	0.0	0.0
SOUTH AFRICA	2,514.8	0.0	2,514.8	5,260.6	229.8	5,490.4	1,894.7	0.0	1,894.7	2,108.4	0.0	2,108.4	3,644.8	0.0	3,644.8	1,165.5	0.0	1,165.5
SOUTH KOREA	0.0	0.0	0.0	4,521.4	179.2	4,700.6	5,167.6	859.6	6,027.2	3,869.6	380.0	4,249.6	1,651.0	1,125.8	2,776.8	849.5	547.5	1,397.0
SPAIN	723.6	0.0	723.6	0.0	0.0	0.0	1,877.5	0.0	1,877.5	1,021.0	3.3	1,024.3	4,414.4	227.9	4,642.3	1,871.5	0.0	1,871.5
UNITED KINGDOM	630.4	0.0	630.4	1,240.7	0.0	1,240.7	509.5	0.0	509.5	192.2	0.0	192.2	1,543.5	4.2	1,547.7	0.0	0.0	0.0
URUGUAY	9,155.6	0.0	9,155.6	14,431.5	0.0	14,431.5	12,101.0	404.5	12,505.5	9,349.2	407.5	9,756.7	9,724.7	284.5	10,009.2	3,245.4	502.9	3,748.3
CCAMLR Sub total	50,734.2	0.0	50,734.2	62,089.4	8,824.6	70,914.0	56,212.7	17,465.4	73,678.1	59,597.1	14,618.5	74,215.6	76,957.8	13,951.2	90,909.0	33,830.2	5,967.2	39,797.4
CANADA	*2.8*	*0.0*	*2.8*	*0.0*	*0.0*	*0.0*	*5.4*	*0.0*	*5.4*	*8.5*	*0.0*	*8.5*	*12.7*	*0.0*	*12.7*	*0.0*	*0.0*	*0.0*
GREECE	*0.0*	*0.0*	*0.0*	*8.0*	*0.0*	*8.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*
PERU	*8.0*	*0.0*	*8.0*	*37.3*	*298.0*	*335.3*	*82.8*	*481.4*	*564.2*	*0.0*	*1,379.7*	*1,379.7*	*0.0*	*2,783.5*	*2,783.5*	*0.0*	*1,283.9*	*1,283.9*
OTHER CONV.Sub total	*10.8*	*0.0*	*10.8*	*45.3*	*298.0*	*343.3*	*88.2*	*481.4*	*569.6*	*8.5*	*1,379.7*	*1,388.2*	*12.7*	*2,783.5*	*2,796.2*	*0.0*	*1,283.9*	*1,283.9*
BELIZE	0.0	0.0	0.0	536.0	0.0	536.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BRITISH VIRGIN IS.	15.5	0.0	15.5	329.4	0.0	329.4	146.0	0.0	146.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CAYMAN IS.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CHINA	4,996.3	0.0	4,996.3	13,614.8	0.0	13,614.8	8,848.6	0.0	8,848.6	7,067.3	32.0	7,099.3	8,661.5	0.0	8,661.5	130.6	0.0	130.6
CHINA - HONG KONG	223.5	0.0	223.5	0.0	0.0	0.0	485.2	0.0	485.2	543.0	0.0	543.0	0.0	0.0	0.0	0.0	0.0	0.0
CHINA - TAIPEI	2.8	0.0	2.8	0.0	0.0	0.0	56.9	0.0	56.9	25.4	0.0	25.4	41.0	0.0	41.0	4.7	0.0	4.7
COLOMBIA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.6	10.6	0.0	6.5	6.5	0.0	0.0	0.0	0.0	0.0	0.0
COSTA RICA	0.0	0.0	0.0	104.8	4.3	109.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	2.1	0.0	0.0	0.0
CYPRUS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	292.2	0.0	292.2
ECUADOR	0.0	0.0	0.0	102.8	0.0	102.8	0.0	12.6	12.6	0.0	11.1	11.1	0.0	5.4	5.4	0.0	0.0	0.0
FALKLAND/MALVINAS	194.7	0.0	194.7	1,154.9	0.0	1,154.9	5,031.5	0.0	5,031.5	4,535.7	0.0	4,535.7	5,001.6	0.0	5,001.6	2,580.1	0.0	2,580.1
FIJI	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.0	12.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GUINEA-BISSAU	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GUYANA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HONDURAS	0.0	0.0	0.0	193.2	9.5	202.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INDONESIA	299.0	0.0	299.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	32.4	0.0	32.4
MALDIVE IS.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MAURITIUS	2,116.2	0.0	2,116.2	4,097.2	0.0	4,097.2	266.9	0.0	266.9	1,596.3	0.0	1,596.3	2,146.4	0.0	2,146.4	505.6	0.0	505.6
NICARAGUA	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	5.0	0.0	0.0	0.0	2.6	0.0	2.6	0.0	0.0	0.0
PANAMA	1,048.5	0.0	1,048.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	297.9	8.5	306.4	0.0	0.0	0.0
PORTUGAL	12.7	0.0	12.7	270.8	0.0	270.8	19.9	0.0	19.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
REUNION	0.0	0.0	0.0	203.1	0.0	203.1	0.0	0.0	0.0	2,225.8	0.0	2,225.8	1,385.5	0.0	1,385.5	233.6	0.0	233.6
SAINT HELENA	0.0	0.0	0.0	0.0	0.0	0.0	117.3	0.0	117.3	1,027.1	0.0	1,027.1	0.0	0.0	0.0	0.0	0.0	0.0
SEYCHELLES	0.0	0.0	0.0	1,027.5	0.0	1,027.5	14,951.3	119.3	15,070.6	18,681.2	0.0	18,681.2	0.0	0.0	0.0	0.0	0.0	0.0
SINGAPORE	75.0	0.0	75.0	0.0	0.0	0.0	79.1	0.0	79.1	0.0	0.0	0.0	0.0	0.0	0.0	94.9	0.0	94.9
THAILAND	44.0	0.0	44.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VENEZUELA	0.0	0.0	0.0	10.5	0.0	10.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
VIET NAM	0.0	0.0	0.0	0.0	0.0	0.0	62.9	0.0	62.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER Sub total	9,028.2	0.0	9,028.2	21,645.0	13.8	21,658.8	30,065.6	159.5	30,225.1	35,701.8	49.6	35,751.4	17,536.5	16.0	17,552.5	3,874.1	0.0	3,874.1
GRAND TOTAL	59,773.2	0.0	59,773.2	83,779.7	9,136.4	92,916.1	86,366.5	18,106.3	104,472.8	95,307.4	16,047.8	111,355.2	94,507.0	16,750.7	111,257.7	37,704.3	7,251.1	44,955.4

3.3 Habitat

The Southern Ocean surrounds the continent of Antarctica and is bounded to the north by the Antarctic Convergence Zone (ACZ). The ACZ is formed where the cold waters of the Antarctic meet warmer waters to the north and acts as an effective biological barrier, preventing species from crossing it and making the Southern Ocean a substantially closed ecosystem. The Southern Ocean is an old system with a long evolutionary history; the main circulation patterns and water mass distributions were established about 20 million years ago. Covering an area roughly twice the size of the United States (20.3 million square kilometers) and 18,000 kilometers of coastline, it is the largest marine ecosystem and the fourth largest ocean in the world. The vast size and inhospitable conditions of the Southern Ocean make enforcement of CCAMLR measures and prevention of IUU fishing logistically difficult.

Bathymetry

The Southern Ocean is deep, reaching 4,000 to 5,000 meters over most of its area with only limited areas of shallow water. A maximum depth of 7,235 meters is found at the southern end of the South Sandwich Trench. The continental shelf around Antarctica is generally narrow and unusually deep compared to other ocean shelves. The shelf is between 64 and 240 kilometers wide, and is cut in places by numerous valleys and basins. The edge of the shelf lies at depths of 400 to 800 meters, while the global average is 133 meters. A series of underwater ridges and rises to the north of the continent restricts the free flow of bottom water and in some areas may even deflect surface currents. Marine sediments in the Southern Ocean are poorly sorted and consist of muds, fine and coarse sands, pebbles, and small and large boulders that have been gouged from the underlying land surface as ice moves off of the continent. As this ice melts, materials are deposited onto the ocean floor at a rate of about 500 million mt each year. The northern limit of this type of bottom sediments coincides with the average northern extension of pack ice. North of that area is a wide belt (1,000 to 2,000 kilometers) of diatomaceous ooze (build-up consisting of the remains of phytoplankton, primarily diatoms) settled out from surface waters that results from primary phytoplankton production at the seasonal pack ice edge. Ice plays a major role in shaping Antarctic bottom structure, with icebergs scouring benthic habitats and ploughing furrows down to 400 meters depth. The margin around Antarctica is home to several non-living oceanic resources, including possibly large oil and natural gas fields, manganese nodules (a source of manganese, cobalt, and nickel), possible placer deposits (concentrations of valuable minerals), and sand and gravel deposits.

Climate

Antarctica is subject to harsh and often unpredictable weather conditions. The climate of the Southern Ocean has shown a high degree of stability, changing little over the past 3 million years. The atmospheric circulation around Antarctica forms two broad bands that are divided by the Circumpolar Trough at 65 degrees south. The Trough is characterized by highly variable and mostly clockwise atmospheric flow. The

Circumpolar Trough separates a zone of westerlies to the north and polar easterlies to the south, close to the continent. The zone of westerlies, particularly the area between 40 degrees south and the Antarctic Circle, has the strongest average winds found anywhere on earth. The zone of polar easterlies often experiences intense cyclonic storms traveling around the continent due to the large temperature contrast between the pack ice and the open ocean. As a result, much of the area experiences high winds and large waves much of the year.

Sea ice plays a large role in the Southern Ocean climate because of the positive feedback between the extent of the ice and surface albedo (the fraction of incident electromagnetic radiation reflected by a surface; ice reflects more than open ocean). Due to the large amount of sea ice, the climate over the Southern Ocean is actually more characteristic of continental ice sheets than a marine environment. In addition to harsh temperatures and winds, the Southern Ocean habitat is also exposed to increasing amounts of solar radiation as a result of the Antarctic ozone hole that has developed in recent years. This increased solar radiation is suspected of reducing primary (plant) productivity by as much as 15%.

Ice Cover

Sea temperature ranges between –2 and 10 degrees Celsius in the Southern Ocean. In winter, the ocean surface freezes outward to about 65 degrees south in the Pacific sector and 55 degrees south in the Atlantic sector, lowering the surface temperature to well below 0 degrees Celsius. Many areas become entrapped by the developing 500 to 1,500 kilometer-wide belt of ice, though some points along the Antarctic coast are kept free of ice throughout the winter by intense and persistent drainage winds from the interior. During the austral summer, the ice belt can still be about 150 to 800 kilometers wide in many areas, isolating the continent from warmer waters. The ice free zone in the Antarctic ranges between 40 and 85% depending on the time of year. About 1/3 of the coastline of Antarctica is made up of ice shelves, floating ice fed by glaciers emanating from the vast polar plateau and by snowfall upon their surfaces. Moving seaward at rates of up to one meter per day, these ice shelves can be up to 300 meters thick on their seaward edges and have a large influence on near shore circulation and water properties. Land fast ice (attached to the land or ice shelves) can extend up to 50 kilometers outward and may be up to 3 meters thick. Sea ice originating on or at the edge of the polar land mass is dispersed quickly (up to 65 kilometers per day) by strong winds blowing northward into the surrounding Southern Ocean. Huge icebergs with drafts up to several hundred meters, smaller icebergs, and iceberg fragments originate in this area as well, breaking off of the floating ice shelves that have been weakened by wave exposure.

The seasonal icepack grows from an average minimum of about 2.6 million square kilometers in March to 18.8 million square kilometers in September, with about 85% of the pack melting and reforming each year. The advance of the ice in May and June occurs at a rate of 4.2 million square kilometers per month, while the ice retreats at 6.9 million square kilometers per month in November and December. Only in very limited areas of the Southern Ocean (Weddell Sea and parts of the Ross, Amundsen, and Bellingshausen Seas) does multi-year ice form. Even in such areas, the residence time of ice is generally limited to 2 to 3 years. The ice edge is a dynamic zone that responds rapidly to physical forcing (ocean circulation and local winds) and there are large annual and inter-annual and sometimes dynamic short-term variations in the formation and extent of the icepack. Ice, driven by winds and ocean currents, is in almost continual motion and moves in a generally clockwise direction around the continent. Antarctic sea ice is characterized by minimal surface melting and an absence of melt ponds due to the low atmospheric relative humidity in the region. Thus, it is heat from the water that is largely responsible for the seasonal ice retreat; higher biological activity in the ice enhances internal melting by weakening the ice and accelerating break-up.

Pack ice is generally 0.5 to 1 meter thick, with a very rugged bottom that forms an unusual and highly specialized habitat in which many organisms thrive. Sea ice is inhabitable by microscopic plants and animals, which can grow so successfully and in such high numbers that they may stain the underside of the ice a dark brownish green. This serves as an important feeding habitat for a variety of animals during the winter months. In spring, as the ice melts, organisms that have grown and reproduced within the ice are released and a large phytoplankton bloom occurs. As the ecological interface between the open-ocean and pack ice communities, the zone at the ice edge teems with life in the summer when large numbers of animals come there to feed. The zone of melting ice and shelf waters are responsible for ~40% of the total primary production in the Southern Ocean, and almost all of the new production. Sea ice has such a profound influence on productivity that the four ecosystem types (Ice-Free, Seasonal Pack Ice, Permanent Pack Ice, and Zone-independent areas) in the Southern Ocean are related to ice cover.

Circulation Patterns and Water Masses

The Southern Ocean is comprised of three separate and distinct water masses: Antarctic Surface Water, Circumpolar Deep Water, and Antarctic Bottom Water. On the continental shelf around Antarctica, 2 water masses exist: Surface Shelf Water and a modified version of Circumpolar Deep Water. The boundaries between these water masses are sharp and the differing characteristics drive circulation patterns. Antarctic Bottom Water is formed when cold and fresher seawater sinks to the ocean floor as ice shelves melt. It represents the coldest and densest water in the world, and fills much of the deep World Ocean. After sinking to the ocean floor, it moves north, adding oxygen and reducing temperatures of receiving waters in tropical and temperate seas. This cooling effect reaches waters of the Northern Hemisphere and shows the major role that Antarctic waters play in the world's transfer of heat and energy.

Antarctic Surface Water originates near the Antarctic continent and flows north. When it meets sub-Antarctic surface water at the ACZ, it sinks beneath the less-dense sub-Antarctic water and mixes with the underlying water mass (Sub-Antarctic Intermediate Water). North of the ACZ, waters are warmer and saltier, while waters south of the ACZ (in the Southern Ocean) are colder and less salty. Circumpolar Deep

Water is upwelled to the surface at the Antarctic Divergence Zone, an area closer to the continent than the ACZ where water flows up from the bottom and then the flow splits at the surface. Once Circumpolar Deep Water reaches the surface, it mixes with surface waters and moves both south towards the continent and north away from it.

Surface current patterns closely follow atmospheric circulation due to an absence of atmospheric or oceanic barriers. North of the Circumpolar Trough at about 1500 kilometers off the coast of Antarctica, prevailing westerlies drive surface currents to the east in the Antarctic Circumpolar Current (West Wind Drift). The Antarctic Circumpolar current intensifies after it moves through a constriction in the Drake Passage, becoming one of the strongest currents in the world and reaching speeds of ½ knot, or about 4 times the speed of the Gulf Stream in the Atlantic Ocean. Covering a distance of 21,000 kilometers and transporting about 130 million cubic meters of water per second (100 times the flow of all the world's rivers combined), the Antarctic Circumpolar Current is also the largest current in the world. South of the Circumpolar Trough, easterly winds drive the westward-flowing Antarctic Coastal Current (East Wind Drift). This current generally follows the coastline, but low pressure cells along the continental margin cause several circulation gyres, including the large Ross Sea and Weddell Gyres. East-west transport by the Antarctic Coastal Current and the Antarctic Circumpolar Current dominates over north south transport by the movement of Antarctic Bottom Water.

Because of its effect on water temperature and salinity, sea ice plays an important role in the formation and movement of Antarctic water masses. When sea ice forms, it takes up only about 15% of the salt in seawater, leaving the remaining waters salty and dense. As ice melts, it releases large amounts of freshwater, reducing the salinity of surface waters at the ice edge or under perennial sea ice cover. Lower salinity water is less dense and floats on top of saltier water bodies, creating an oceanographic front with enhanced vertical stability. Except at the ice edge during retreat, the Southern Ocean is well mixed and features no pronounced stratification or vertical stability due to the continual sinking of dense water near the continent and upwelling of water at the Antarctic Divergence Zone. This vertical stratification provided by the melting ice has profound effects on primary production and food web dynamics by allowing phytoplankton to remain in the high light, high-nutrient surface waters.

3.4 Potential Fishery Interactions with Protected Species in the Convention Area (including those under the Endangered Species Act and Marine Mammal Protection Act)

Observation of incidental mortality of marine mammals and birds is a priority item for CCAMLR. All marine mammal interactions with, and seabird bycatch by, vessels fishing in the Convention Area are reported to the CCAMLR Data Manager and discussed annually by the CCAMLR Ad hoc Working Group on Incidental Mortality Associated with Fishing (WG-IMAF).

3.4.a. <u>Cetaceans</u>

A. Toothfish Fishery

Some marine species or stocks identified as either endangered or threatened under the Endangered Species Act (ESA) are found in the nutrient-rich waters of the CCAMLR Convention Area and those areas of high seas or of national jurisdiction where toothfish fisheries occur. The primary cetacean species that are found in these waters include: minke, Bryde's, fin, sei and blue whales.

<u>Toothfish consumption by whales</u>

Two species of Dissostichus are known and both have a circumpolar distribution: *Dissostichus eleginoides* (Patagonian toothfish) occurs in sub-Antarctic and cool temperate waters; *D. mawsoni* (Antarctic toothfish) is found in the southerly waters of the Antarctic. Based on CCAMLR international observer reports, sperm whales and killer whales consume toothfish in CCAMLR Division 58.5.2 and 58.4.3 due to interactions with fisheries (see Table 20). More specifically for killer whales, Type C (inhabits inshore waters and lives mainly in the pack-ice; it occurs mostly off East Antarctica) has been observed consuming Antarctic toothfish. The amount of toothfish consumed by individual cetaceans or by cetacean populations is not known.

<u>Interaction of whales with toothfish vessels</u>

Each vessel participating in an exploratory fishery for *Dissostichus* species in the CCAMLR Convention Area is required by CCAMLR conservation measures to have one scientific observer appointed in accordance with the CCAMLR Scheme of International Scientific Observation (CCAMLR scientific observer), and where possible one additional scientific observer, on board throughout all fishing activities within a fishing season. Scientific observers are required to carry out their duties as specified in the CCAMLR Scientific Observers Manual. There are four parts to the manual: Planning Scientific Observations; Logbook Forms and Instructions for Recording Results of Scientific Observations on Commercial Fishing Vessels; Guidelines for Scientific Observers; and Reference Materials. These sections are very detailed as to observer duties. Section 9 of the manual, Summary of Marine Mammal Observations, has three subsections. Subsection 9.1 addresses Marine Mammal Entanglement; 9.2 Mitigation Measures; and 9.3 Fish Loss Due to Marine Mammals, including space for "Comments, including interactions between and within species, interactions with the vessel and fishing gear, as well as the abundance of all species of marine mammals observed during the cruise." All scientific observer reports and comments are received and reviewed by the CCAMLR Ad hoc Working Group on Incidental Mortality Associated with Fishing.

Toothfish fisheries are primarily longline, but there are also trawl fisheries in subareas 58.5.2 and an exploratory trawl fishery in 58.4.3. During the 2001/02 fishing season, seven vessels conducted 10 trawl operations targeting finfish within the

CCAMLR Convention Area. As required by the Commission, all trawlers fishing for finfish carried scientific observers. There have been no reports of interactions with cetaceans and the finfish trawl fisheries; however, there have been reports of interactions of sperm and killer whales with the longline fisheries. No confirmed instance of mortality associated with the toothfish fishery has been reported.

According to the WG-FSA 1999 Report, interactions between longline vessels and marine mammals appear to be increasingly reported by scientific observers. Sperm whale depredation on longlines may be a learned behavior that begins when the whales associate fishing operations with a feeding opportunity (Hill *et al*., 1999). An unidentified dolphin was hooked in Subarea 48.3 but released itself and sperm whales were temporarily entangled on two occasions in longlines in Subareas 58.6 and 58.7 during the 1998/99 fishing season.

In addition to the killer and sperm whale interaction listed in Table 20, the WG-FSA 2000 reported interactions between killer whales, sperm whales and a longline vessel fishing around the Falkland/Malvinas Islands. The interactions reported were complex and restricted to the time of line hauling. Nevertheless, all available evidence indicated that the whales were not taking fish from the line.

In the WG-FSA 2002 Report, interactions with marine mammals resulting in a potential loss of fish were reported in Subareas 48.3, 58.6 and 58.7 and Division 58.4.4. No such interactions were reported for Subarea 88.1 despite sightings of killer whales from the fishing vessels.

In the WG-FSA 2003 Report, interactions between cetaceans and longline finfish fisheries in Subarea 48.3 were summarized between 2000 and 2002. This indicated that sperm whales were recorded during 24% of hauling operations and killer whales, the second most abundant cetacean species, were recorded during 5% of hauls. Catch rates were significantly lower when killer whales were present when compared to hauls with no cetaceans present. The same trend was, however, not observed for catch rates when sperm whales were present during hauling. Sperm whales were likely attracted to areas with high catch rates, but in areas with lower catch rates indications are that depredation by sperm whales can lead to a drop-off in catches. The authors suggested that further investigations are needed to determine the extent of longline–cetacean interactions, to address the problems of longline–cetacean depredation, to standardize observer protocols to ensure the collection of valuable data, and to assess and implement mitigation strategies under controlled experimental conditions. (CCAMLR, 2002)

WG-FSA-03/95 used observer data from Chilean waters adjacent to the Convention Area to quantify the level of sperm and killer whale interactions with demersal longliners. Based on the frequency of toothfish lips and heads hauled, the authors estimated that around 3% of toothfish are taken from the line by sperm and killer whales. The authors also suggested that sperm whales that congregate around toothfish longliners may be susceptible to an increased level of attack by killer whales, although the magnitude of this problem has not been quantified. Dr Micol reported that the documented decline in the number of killer whales in Subarea 58.6 was considered, at least in part, to be a result of the use of firearms and explosive deterrents by IUU longline vessels. (CCAMLR, 2002)

It appears that the interactions between the toothfish longline fisheries and sperm and killer whales are more of a detriment to the fishers than to the whales, since sperm and killer whales are removing fish from the longlines. Fishers will often move to locations where sperm and killer whales are not in order to have higher catch rates (CCAMLR, 2002).

During the 2003/04 season, observers on board U.S. longline fishing vessels reported sighting sperm whales and killer whales in the vicinity of the vessels during the hauling of longlines. Although sperm whales and killer whales are known to feed on toothfish caught on longlines, none of the observers on board U.S. vessels reported any whale entanglements or mortalities in the 2003/04 season. Moreover, there have been no whale entanglements or mortalities reported in the entire history of the CCAMLR toothfish fishery. Interactions between toothfish longline fisheries and sperm and killer whales from 1999-2001 are summarized below in Table 20.

Table 20 (Sec. 3.4.a.): Interactions between marine mammals and longline vessels fishing for toothfish, taken from annual WG-FSA reports of scientific observers.

Subarea	Year	Cruises where Interaction Occurred	Killer Whale	Sperm Whale	Unknown
Subarea 48.3	1999	13 of 17	12	1	0
	2000	9 of 26	6	3	1
	2001	11 of 15	5	4	0
	2002	11 of 18	7	4	0
	2003	15 of 23	10	3	0
	2004	10 of 16	4	4	0
	2005	7 of 8	5	2	0
	2006	8 of 10	6	3	0
Subareas 58.6/58.7	1999	9 of 12	6	4	3
	2000	9 of 11	7	6	2
	2001	1 of 3	1	0	0
	2002	1 of 3	1	0	0
	2003	2 of 2	2	1	0
	2004	1 of 2	0	0	0
	2005	1 of 1	1	0	0
	2006	0 of 1	0	0	0

Information on an artisanal fishery for toothfish off Chile was presented at a meeting by Edu Secchi on behalf of Eduardo Gonzales and Carlos Olavarria. Risso's dolphins, southern right whale dolphins and sperm whales were seen during the surveys; however, only sperm whales interacted with this fishery during this preliminary study. Although the results indicate that the losses caused by the interaction with sperm whales are negligible, fishers have informed about their attempts to keep the whales away from the fishing gear using extreme methods, e.g., shooting and harpooning the whales. One whale has been reported dead due to entanglement in the line

B. Icefish Fishery

Icefish Consumption by whales

Although brief reports were found on the consumption of icefish by land mammals in the Antarctic; there were no reports found on consumption of icefish by cetaceans. It was stated in the CCAMLR *Report of the workshop on approaches to the management of icefish* (Hobart, Australia, 3 to 5 October 2001) that more information is required on impacts of the icefish fishery on predators.

Interaction of whales with icefish vessels

No interactions were found reported on cetaceans and the icefish fishery.

C. Krill Fishery

Some marine species or stocks identified as either endangered or threatened under the Endangered Species Act (ESA) are found in the waters of the CCAMLR Convention Area and those areas of high seas or of national jurisdiction where the krill fisheries occur. Marine mammal species that are listed under the ESA are found in these waters, including six species of large whales: blue, fin, humpback, right, sei, and sperm whales. There are no reported interactions by ESA-listed whale species with krill trawl gear in any of the Convention Area fisheries.

Krill consumption by whales

Everson (1984) estimated the annual consumption of krill throughout the Southern Ocean by baleen whales at 43 million tons, by seals at 128 million tons, by birds at 33 million tons, possibly 100 million tons by squid, and an unknown but substantial quantity by fish. Miller and Hampton (1989) estimated that whales, birds, pinnipeds, fish, and squid together consume 250 million mt of Antarctic krill annually. Everson and de la Mare (1996) indicate that reasonable estimate of krill consumption of Antarctic krill by natural predators is between 150 and 300 million mt.

Other gross estimates of consumption of euphausiids by marine mammals in the North Pacific, the Atlantic and the Southern Hemisphere note consumption of euphausiids specific to species, abundance, average body width (in tons), summer ingestion rate, feeding period, percentage of krill in diet and krill consumed (in tons). Estimates of stock abundances were obtained from working papers and reports of the International Whaling Commission, NMFS reports, and the primary literature. Total consumption of euphausiids by marine mammals is on the order of 125-250 million tons per year in the Southern Hemisphere, with the bulk of the latter being consumed in the Southern Ocean. Of the estimated total krill consumption by baleen whales in the Southern Ocean, two species of minke whales consume approximately two-thirds. Crabeater seals consume more krill than any other marine mammal population in the world (Hewitt and Lipksy, 2002).

Fin and minke whales consume several species of krill in the Southern Ocean throughout the austral summer. The numerically dominant euphausiid in the Southern Ocean is consumed in all areas of the Southern Ocean. Southern right whales have been observed foraging on *E. superba* in the Atlantic sector of the Southern Ocean. Humpback whales have been frequently observed foraging on *E. superba* in bays and fjords along the Antarctic Peninsula. Generalizations from this data include: (1) blue and fin whales appear to have a higher preference for euphausiids than minke, humpback, or bowhead whales; (2) sei and Bryde whales appear to be more opportunistic feeders; and (3) crabeater seals have a higher preference for euphausiids than other seals in the Southern Ocean. (Hewitt and Lipsky, 2002).

Krill abundance can vary dramatically over relatively short periods of time. Baleen whales have adapted to this variability. Their size and ability to accumulate substantial energy stores allow them to integrate over large distances and periods of time in their search for food. Their longevity allows them to spread reproductive effort over several years (Hewitt and Lipsky, 2000). It may be reasonable to expect that whale reproductive output might decline during periods of poor krill availability, but they have evolved life-history strategies to deal with this (Hewitt, pers. comm.).

The estimates cited in the sections on krill biomass and krill consumption indicate that, on average, annual demand for krill by natural predators is nearly double the standing stock. This is possible because the production to biomass (P/B) ratio of krill is approximately 2 to 1. In other words, the reproduction and growth rates of krill result in a production of krill on an annual basis that exceeds the standing stock by approximately 2 to 1 (Hewitt, pers. comm.). This ratio is in agreement with estimates of the P/B for *E. superba* obtained using other approaches (Miller and Hampton 1989).

Interaction of whales with krill vessels

There have been no reports by CCAMLR Scientific observers of whale interactions with or entanglements in krill trawl gear. The NMFS Antarctic Ecosystem liaison to U.S. vessels fishing for AMLR noted that he has not received any reports from observers aboard the U.S. vessel fishing for krill during its four years of fishing in Area

48 of any gear interactions with whales or whale sightings (Jones, pers. comm. E-mail). Most recently, in 2003, a krill trawler in Subarea 48.3 reported no interactions with cetaceans.

3.4.b. Seabirds

Introduction

A description of the pertinent natural history of each seabird species in the waters managed by parties to CCAMLR is described in Sec. 3.1.d. This Sec. 3.4.b. describes other baseline conditions of seabirds (all are migratory birds occurring in the Convention Area and the Amsterdam albatross (*Diomedea amsterdamensis*) is listed under the U.S. Endangered Species Act) as they relate to the Southern Ocean fishery managed by Federal authorities in cooperation with the international agreements through CCAMLR. These accounts summarize the human and natural impacts on each species, to the extent that they are known, and thus (in conjunction with Sec. 3.1.d.) provide the historical and scientific basis for analyzing the potential impacts of the alternatives described in Section 4. Where possible, information common to most or all relevant seabird species is described in the introduction.

The geographic and temporal scope of material presented in Sections 3.1.d. and 3.4.b. are not consistent among species because their distributions and availability of data on the species varies greatly.

Vessels operating in the CCAMLR Convention Area using either longline or trawl gear have been documented to incidentally take seabirds (Table 21 provides a complete list of references). No incidental takes of seabirds have been documented by vessels using pot or jig gear in the CCAMLR Convention Area. Many species of seabirds are known to interact with commercial fishing vessels, particularly vessels deploying longline gear (NMFS 2001). Longline gear is generally deployed from the vessel’s stern, with the main line and attached hooks following the vessel in a downward sloping diagonal line until it enters the water. The baited hooks on this main line remain in the air or near the water surface and are accessible to seabirds for varying times and distances depending on the size of the vessel, sea conditions, gear deployment equipment and methods, and the specific longline gear configuration.

Longline fishing vessels also discharge offal in the form of discarded fish, fish scraps from cleaned fish, and used or discarded bait. The availability of “free” food in the form of offal and bait attracts seabirds to longline fishing operations. Most seabirds killed during longline operations are attracted to the baited hooks when the gear is being set. The birds are sometimes accidentally hooked or entangled while feeding on baits near the surface and are dragged underwater and killed by drowning or by strangulation. Birds are also hooked or entangled during the haul back process but these birds are usually released alive.

The factors potentially affecting seabird hooking and entanglement on longline gear are complex and include geographic location of fishing activity, time of day, season, type of fishing operation and gear used, bait type, condition of the bait (frozen, thawed, dyed), length of time baited hooks remain at or near the surface of the water, water and weather conditions, availability of food (including bait and offal), bird size, bird behavior (feeding and foraging strategies), and physical condition of the bird. Most seabird species probably interact with longline fishing gear; however, only the larger species have the physical capabilities and feeding strategies to face frequent interactions and potential hookings.

In order to assess and monitor the incidental mortality of birds and marine mammals, CCAMLR in 1984 requested that its Members keep records and report the number, species, and where appropriate the age, size, sex and reproductive status of any birds and marine mammals taken incidentally during fishing operations.

In 1992, the CCAMLR established the Ad hoc Working Group on Incidental Mortality Arising from Longline Fishing (WG-IMALF). The group's terms of reference included the review of data on seabird bycatch and the performance of CCAMLR seabird-related measures. In 2001, taking into account that the group also considers incidental mortality associated with trawl fishing, the name of the group was amended to the Ad hoc Working Group on Incidental Mortality Associated with Fishing (WG-IMAF). The group's advice is submitted annually to the CCAMLR Scientific Committee for consideration.

In 1989, CCAMLR noted that the introduction of longline fishing in the Convention Area posed a potential threat to seabirds. CCAMLR has mounted a major campaign, directed by WG-IMALF, to reduce the incidental capture and mortality of seabirds in longline fisheries. In 1989, CCAMLR adopted Resolution 5/VIII "Protection of seabirds from incidental mortality arising from longline fishing". In 1991, CCAMLR adopted the Conservation Measure 29/X "Minimisation of the Incidental Mortality of Seabirds in the Course of Longline Fishing or Longline Fishing Research in the Convention Area" which has subsequently been modified to include a suite of measures designed to prevent, or minimize, the incidental mortality of seabirds. CCAMLR keeps these actions under annual review.

CCAMLR adopted a Scheme of International Scientific Observation in 1992. Observation of incidental mortality of marine mammals and birds is a priority item under the Scheme. International scientific observers are now mandatory for all vessels fishing in the Convention Area. In a number of coastal state Exclusive Economic Zones within the Convention Area, national observers also collect data. Guidelines and instructions for observations are published in the CCAMLR Scientific Observers Manual. The manual is available at http://www.ccamlr.org/pu/e/pubs/obsman03.pdf

Scientific observations of seabirds and marine mammals are carried out on board longline vessels with the following objectives:

(i) to document and quantify seabird catch rates and determine the specific identity, age and sex of all birds caught; (ii) to assess the relative vulnerability of different seabird species; (iii) to monitor the mortality of seabirds per unit of fishing effort; (iv) to document all aspects of a vessel's fishing strategy, methods and equipment which have an impact on seabirds and marine mammals; (v) to assess the effectiveness of CCAMLR measures aimed at reducing the incidental mortality of seabirds; (vi) to ascertain what, in terms of a vessel's fishing operations, contributes to the bird catch rates observed, and to collect data relevant to factors that influence bird catch rates; (vii) to estimate the abundance of marine mammals and record their interactions with longline fishing operations; (viii) to document data on catch rates of fish, wherever this is relevant to the assessment of seabird and marine mammal interactions; and (ix) to collect and retain biological samples. Observers also should take counts of the abundance of all birds by species at 30-minute intervals throughout setting.

CCAMLR manages fisheries in the Convention Area on a seasonal basis, from December 1 following the annual Fall meeting of the Commission to November 30 of the next year. Individual fisheries within a season may be for lesser periods than a full year. The krill fishery, however, is open for the entire year.

All seabird and marine mammal interactions with vessels fishing in the Convention Area are reported to the CCAMLR Data Manager and discussed annually by the WG-FSA. Since 1995, two scientific observers, one of whom must be an observer appointed in accordance with the CCAMLR Scheme of International Scientific Observation, are required in all exploratory fisheries for toothfish in the Convention Area throughout all fishing activities within the fishing season.

Additional CCAMLR information about the incidental effects of fishing can be found at http://www.ccamlr.org/pu/e/sc/imaf/ie-intro.htm

The work of WG-IMAF continues to focus on determining the status of seabirds vulnerable to the impact of longline fishing, evaluating the impact of new and exploratory fisheries in the Convention Area, assessing incidental mortality of seabirds during regulated and illegal, unregulated, and unreported (IUU) fisheries in the Convention Area and adjacent waters and reviewing research into and experience with mitigating measures.

Assessments were undertaken in 1997 to evaluate the magnitude of potential risk of bycatch of albatrosses and petrels in the divisions and subareas of the CCAMLR Convention Area. The assessments are reviewed annually and revised to incorporate new information as it becomes available. The annual assessments are conducted by CCAMLR's working group on IMAF. IMAF was requested to relate the assessments to the timing of fishing seasons, the need to restrict fishing to nighttime, and the magnitude of general potential risk of bycatch of albatrosses and petrels. Based on the IMAF risk assessments, the Commission may annually adopt measures to prohibit longline fishing in specified CCAMLR subareas and divisions during the main albatross and petrel breeding season. Closures are in place in Subarea 48.3 from September 1 to April 1.

Over the past five years the total seabird bycatch and rate of bycatch in regulated fisheries in the Convention Area has been significantly reduced. This has been achieved by a combination of improved compliance with Conservation Measure 25-02 and by delaying the start of fishing until the end of the breeding season of most albatross and petrel species.

By 2001, the operation of regulated longline fisheries in the Convention Area had achieved negligible levels and rates of seabird bycatch in Subarea 48.3, low levels in the South African exclusive economic zone (EEZ) in Subareas 58.6 and 58.7 and no incidental mortality in Subarea 88.1 for the fourth successive year. In 2002, the Scientific Committee noted that, based on reported data, levels of seabird bycatch in the Convention Area had been the lowest ever recorded. Thus, in the Convention Area, the only remaining seabird bycatch problem in regulated fisheries is in the French EEZs in Subarea 58.6 and Division 58.5.1.

In addition to requiring the use of an appropriate suite of measures to minimize seabird bycatch in regulated fisheries, CCAMLR also considers the advice of WG-IMAF for all proposed new and exploratory fisheries. Each year WG-IMAF reviews these proposals and, taking account of the magnitude of potential risk of seabird bycatch in each area concerned, recommends the appropriate suite of mitigation measures (considering especially the need for fishing season restriction and night setting of longlines).

In terms of fishery-related threats to seabirds in the Convention Area, CCAMLR recently endorsed the advice of WG-IMAF and the Scientific Committee that the main threats are now posed by bycatch in IUU fishing in the Convention Area and by bycatch in longline fisheries adjacent to the Convention Area.

Assessment of population level effects:

Due to the longevity of most seabirds and their reliance on high adult survival, rather than fecundity, to maintain a stable population, effects on the population are difficult to discern in the short term. Population level effects resulting from incidental mortality in fisheries have been suggested for several seabirds, including the Wandering albatross, Yellow-eyed penguin, White-chinned petrel, and African penguin (Croxall *et al*. 1990, Darby and Dawson 2000, Barnes *et al*. 1997, Crawford in press and in WG-EMM-04/28; also see Brothers 1991, Murray *et al*. 1993).

Direct mortality from incidental take in regulated fisheries

Direct mortality from incidental take in **longline** fisheries:

Incidents of bycatch in regulated fisheries are summarized to the extent possible in Table 21. The 20 species of seabirds that were identified by WG-IMAF as being most at risk from longline fisheries in the Convention Area are numbered in Table 21. From 1997 to 2003, the bycatch rate (number of birds/1,000 hooks) has been reduced from 0.23-0.52 to 0.0003 (Table 22). By 2001, the operation of regulated longline fisheries in the Convention Area had achieved negligible levels and rates of seabird bycatch in Subarea 48.3, low levels in the South African EEZ in Subareas 58.6 and 58.7 (Table 22). In 2002, the Scientific Committee noted that, based on reported data, levels of seabird bycatch in the Convention Area had been the lowest ever recorded. For Subarea 48.3 the total estimated seabird bycatch in 2003 was only 8 birds at a rate of 0.0003 birds/1,000 hooks, even lower than the values of the last three years; bycatch was slightly higher in 2004 with 18 birds caught at a rate of 0.001 birds/1,000 hooks. No incidental mortality of seabirds was observed in Subarea 88.1 in 2003, for the 7th successive year. In 2004, 1 Southern Giant Petrel was killed in Subarea 88.1. In 2004, there was no seabird mortality in Subarea 88.2 and Divisions 58.4.2 and 58.5.2, presumably due to strict compliance with conservation measures. Overall in 2003, only 15 birds were estimated to be killed in the regulated longline fisheries, and in 2004 58 birds were killed in the regulated longline fisheries (with the exception of the French EEZ). The 2003 level was the lowest level ever recorded and bycatch rates in 2003 and 2004 were negligible in respect of impact on the seabird populations concerned. A document on CCAMLR's work on the elimination of seabird mortality associated with fishing can be found at http://www.ccamlr.org/pu/e/sc/imaf/docs/bg-text.pdf. CCAMLR's efforts to develop and implement effective seabird avoidance measures for longline vessels have proven to be successful with increasingly high vessel compliance with these measures and continued reductions in seabird bycatch. Seabird bycatch by regulated vessels in many CCAMLR areas has been reduced to negligible levels.

At its 2003 annual meeting, CCAMLR adopted revisions to **Conservation Measure 25-02**[1, 2] based on IMAF advice to CCAMLR's Scientific Committee. Those revisions remain in effect and require longline vessels to abide by the following requirements:

1. Fishing operations shall be conducted in such a way that hooklines[3] sink beyond the reach of seabirds as soon as possible after they are put in the water.

2. Vessels using autoline systems should add weights to the hookline or use integrated weight hooklines while deploying longlines. Integrated weight (IW) longlines of a minimum of 50 g/m or attachment to non-IW longlines of 5 kg weights at 50 to 60 m intervals are recommended.

3. Vessels using the Spanish method of longline fishing should release weights before line tension occurs; weights of at least 8.5 kg mass shall be used, spaced at intervals of no more than 40 m, or weights of at least 6 kg mass shall be used, spaced at intervals of no more than 20 m.

4. Longlines shall be set at night only (i.e., during the hours of darkness between the times of nautical twilight[4])[5]. During longline fishing at night, only the minimum ship's lights necessary for safety shall be used.

5. The dumping of offal is prohibited while longlines are being set. The dumping of offal during the haul shall be avoided. Any such discharge shall take place only on the opposite side of the vessel to that where longlines are hauled. For vessels or fisheries where there is not a requirement to retain offal on board the vessel, fish hooks should be removed from offal and fish heads prior to discharge.

6. Vessels which are so configured that they lack on-board processing facilities or adequate capacity to retain offal on board, or the ability to discharge offal on the opposite side of the vessel to that where longlines are hauled, shall not be authorized to fish in the Convention Area.

7. A streamer line shall be deployed during longline setting to deter birds from approaching the hookline. Specification of the streamer line and its method of deployment is given in the appendix to this measure.

8. A device designed to discourage birds from accessing baits during the haul of longlines shall be employed in those areas defined by CCAMLR as average-to-high or high (Level of Risk 4 or 5) in terms of risk of seabird bycatch. These areas area currently Subareas 48.3, 58.6 and 58.7 and Divisions 58.5.1 and 58.5.2.

9. Every effort should be made to ensure that birds captured alive during longlining are released alive and that wherever possible hooks are removed without jeopardizing the life of the bird concerned.

Appendix to Conservation Measure 25-02:

1. The aerial extent of the streamer line, which is the part of the line supporting the streamers, is the effective seabird deterrent component of a streamer line. Vessels are encouraged to optimize the aerial extent and ensure that it protects the hookline as far astern of the vessel as possible, even in crosswinds.

2. The streamer line shall be attached to the vessel such that it is suspended from a point a minimum of 7 m above the water at the stern on the windward side of the point where the hookline enters the water.

3. The streamer line shall be a minimum of 150 m in length and include an object towed at the seaward end to create tension to maximize aerial coverage. The object towed should be maintained directly behind the attachment point to the vessel such that in crosswinds the aerial extent of the streamer line is over the hookline.

4. Branched streamers, each comprising two strands of a minimum of 3 mm diameter brightly colored plastic tubing [6] or cord shall be attached no more than 5 m apart commencing 5 m from the point of attachment of the streamer line to the vessel and thereafter along the aerial extent of the line. Streamer length shall range between minimums of 6.5 m from the stern to 1 m for the seaward end. When a streamer line is fully deployed, the branched streamers should reach the sea surface in the absence of

wind and swell. Swivels or a similar device should be placed in the streamer line in such a way as to prevent streamers being twisted around the streamer line. Each branched streamer may also have a swivel or other device at its attachment point to the streamer line to prevent fouling of individual streamers.

5. Vessels are encouraged to deploy a second streamer line such that streamer lines are towed from the point of attachment each side of the hookline. The leeward streamer line should be of similar specifications (in order to avoid entanglement the leeward streamer line may need to be shorter) and deployed from the leeward side of the hookline.

Footnotes to Conservation Measure 25-02 and its Appendix:

1. Except for waters adjacent to the Kerguelen and Crozet Islands
2. Except for waters adjacent to the Prince Edward Islands
3. Hookline is defined as the groundline or mainline to which the baited hooks are attached by snoods.
4. The exact times of nautical twilight are set forth in the Nautical Almanac tables for the relevant latitude, local time and date. All times, whether for ship operations or observer reporting, shall be referenced to GMT.
5. Wherever possible, setting of lines should be completed at least three hours before sunrise (to reduce loss of bait to/catches of white-chinned petrels).
6. Plastic tubing should be of a type that is manufactured to be protected from ultraviolet

Additional CCAMLR information about the incidental effects of fishing can be found at http://www.ccamlr.org/pu/e/sc/imaf/ie-intro.htm

Direct mortality from incidental take by **trawls**:

Seabirds will also congregate around trawl fishing vessels to feed. Food may be in the form of fish offal (waste) that is discharged from the vessel's processing facilities or fish or fish pieces that can be retrieved during the trawl hauling process. A study of the New Zealand subantarctic squid trawl fishery documented significant mortalities of seabirds that collided with the trawl netsonde cables (Bartle, 1991). Birds have been observed sitting near the discharge chute and attempting to scavenge from the surface or surface dive for food (Williams and Capdeville, 1996). A study in the Kerguelen Islands area noted birds caught in the meshes of the upper front port near the headline of the trawl net or in the codend, during the setting or hauling process (Weimerskirch *et al*. 2000). Studies of finfish trawl fisheries of the Falkland Islands/Malvinas Islands have reported interactions of seabirds with the trawl warp cables and have noted this interaction as the primary cause of seabird mortality in the Falkland Island finfish fleet (Sullivan *et al.* 2003). Observations of trawling operations on vessels fishing for icefish in Subarea 48.3 noted birds congregating around fishing nets during shooting (deploying trawl net) and during hauling, frequently landing on the surface of the net to feed on fish caught in the net (Hicken and Everson 2003). Also noted was significant differences of operations between vessels, which can contribute to variability in interaction rates with seabirds.

The causes of seabird mortalities in trawl fisheries are varied and depend on the nature of the fishery (pelagic or demersal) and the nature and duration of processing discharge (Sullivan *et al*. 2003). Sullivan categorized the direct causes of trawl gear mortalities into two broad groups: (1) cable related mortality, which includes collisions with netsonde cables, warp cables and paravanes; and (2) net-related mortality, which includes all deaths caused by net entanglement.

For a number of years only occasional seabirds were reported as incidentally killed in trawl fishing operations in the Convention Area. In 1994, CCAMLR banned the use of trawl netsonde cables as seabirds were reportedly killed as a result of interactions with cables. This measure was later reinforced and trawl vessels were required to arrange the location and level of deck lighting so as to minimize illumination directed out of the vessel. The discharge of offal was also prohibited during the setting and hauling of trawl gear.

In 2001 trawlers fishing for mackerel icefish in Subarea 48.3 with bottom trawls reported a total of 132 seabirds entangled, three times the total estimated seabird mortality of all regulated longline fishing in this Subarea. In 2002, the bycatch level remained similar. In 2003, 15 incidents of seabird entanglement were recorded in the finfish trawl fishery in Division 58.5.2 and 43 incidents in the finfish trawl fishery in Subarea 48.3. In 2004, 87 incidents of seabird mortality were recorded in the finfish trawl fishery, and an additional 132 birds were released alive; all of the mortality occurred on vessels in Subarea 48.3. Although a decline in bycatch was observed through 2003, as measured by fewer numbers of birds than in previous years, the rate of interaction (birds per haul) does not appear to have been reduced substantially in this time period, and it actually increased in 2004.

In addition to mandatory requirements with Conservation Measure 25-03 (see below) to reduce interactions of seabirds with trawl vessels, Conservation Measure 42-01 requires trawl vessels in Subarea 48.3 to cease fishing if it takes 20 birds.

At its 2003 annual meeting, CCAMLR adopted revisions to **Conservation Measure 25-03** based on IMAF advice to CCAMLR's Scientific Committee. CM 25-03 remains unchanged for the 2004/05 season. It specifies that trawl vessels must comply with the following requirements (except for waters adjacent to the Kerguelen and Crozet Islands):

1. The use of net monitor cables on vessels in the CCAMLR Convention Area is prohibited.

2. Vessels operating within the Convention Area should at all times arrange the location and level of lighting so as to minimize illumination directed out from the vessel, consistent with the safe operation of the vessel.

3. The discharge of offal shall be prohibited during the shooting and hauling of trawl gear.

4. Nets should be cleaned prior to shooting to remove items that might attract birds.

5. Vessels should adopt shooting and hauling procedures that minimize the time that the net is lying on the surface of the water with the meshes slack. Net maintenance should, to the extent possible, not be carried out with the net in the water.

6. Vessels should be encouraged to develop gear configurations that will minimize the chance of birds encountering the parts of the net to which they are most vulnerable. This could include increasing the weighting or decreasing the buoyancy of the net so that it sinks faster, or placing colored streamers or other devices over particular areas of the net where the mesh sizes create a particular danger to birds.

Seabird interactions with other fisheries in the Convention Area:

There have been no reports by CCAMLR Scientific observers of seabird entanglements in krill trawl gear or crab pots. Drift net fishing is not allowed in the Convention Area.

CCAMLR regulates the harvest of crab species within the Convention Area and has set a total allowable annual catch of 1,600 tons. The fishery is limited to one vessel per member country; however, fishing activity has been minimal. In most years, there are no vessels participating in this fishery. In the 2002/03 fishing season one vessel harvested one ton of crab in Area 48.3.

Table 21 (Sec. 3.4.b.): Records of seabird mortality from fisheries bycatch. Bycatch is reported as year, site (CCAMLR Subarea if available); "other interactions," in most cases refers to tuna longline fishing vessels, but includes other longline fishing vessels, pot, jig, and set net fishing, and entanglement in fisheries related marine debris; citations of "CCAMLR YEAR," are from the records of CCAMLR observers on fishing vessels; a blank cell indicates no documented bycatch.

#	Species Name	English Name	Caught in Toothfish Longline	Caught in Trawl	Other Interactions with Fisheries	References
	Procellariiformes					
	Diomedidae	Albatrosses				
1	*Diomedea amsterdamensis*	Amsterdam albatross				
2	*Diomedea antipodensis*	Antipodean (wandering) albatross		NZ; Australia; Chile	1987-1998, NZ; Australia; Central Pacific; Chile	Robertson *et al*. 2003a, 2004; Murray *et al*.1993
3	*Diomedea epomophora*	Southern royal albatross	1996, CCAMLR	1990, NZ; Australia	NZ; Australia; Argentina; Indian Ocean; Atlantic Ocean	CCAMLR 1996; Bartle 1991; Robertson *et al*. 2003a, 2004
4	*Diomedea exulans*	Wandering albatross	1996, CCAMLR; 1997, 1998, CCAMLR (48.3, 58.7)	Weimerskirch *et al*. 1987 (58)	1989-1992, NZ; 1995 Brazil; 1996-1998, CCAMLR (58.7)	CCAMLR 1996, 1997, 1998; Murray *et al*.1993; Neves and Olmos 1998; Bartle 1990; Nel and Nel 1999
	Diomedea gibsoni	Gibson's albatross		Australia	NZ; Australia	Robertson *et al*. 2003a, 2004
5	*Diomedea sanfordi*	Northern royal albatross		NZ; Chile	NZ; Australia; Indian Ocean	Robertson *et al*. 2003a, 2004
6	*Phoebetria fusca*	Sooty albatross	1996, CCAMLR			CCAMLR 1996
7	*Phoebetria palpebrata*	Light-mantled (sooty) albatross	1997, CCAMLR (48.3, 58.7); 1998, CCAMLR (58.7)		NZ; Australia	CCAMLR 1997, 1998; Robertson *et al*. 2003a, 2004

#	Species Name	English Name	Caught in Toothfish Longline	Caught in Trawl	Other Interactions with Fisheries	References
8	*Thalassarche bulleri (Diomedea bulleri)*	Buller's albatross		NZ	1989-1992, NZ; Australia	Bartle 1991; Murray *et al*.1993; Robertson et al. 2003a, 2004
9	*Thalassarche carteri*	Indian yellow-nosed albatross				
	Thalassarche cauta (Diomedea cauta)	Shy albatross			1989-1992, NZ	Murray *et al*.1993
10	*Thalassarche chlororhynchos (Diomedea chlororhychos)*	Atlantic Yellow-nosed albatross	1997, 1998, CCAMLR (58.7); 2000, CCAMLR (58.6, 58.7)		1995, Brazil, demersal longline	CCAMLR 1997, 2000; Neves and Olmos 1998
11	*Thalassarche chrysostoma (Diomedea chrysostoma)*	Grey-headed albatross	1996, CCAMLR, 1997, CCAMLR (48.3, 58.7); 1998, CCAMLR (58.7); 1999, CCAMLR (48.3, 58.6, 58.7); 2000, CCAMLR (58.6, 58.7); 2003, CCAMLR (48.3)	1998, CCAMLR (58.5.1); 2001, CCAMLR (48.3); 1990, NZ	1989-1992, NZ; Australia; Chile; Argentina; Indian Ocean; 1996-1998, CCAMLR (58.7)	Robertson *et al*. 2003a; CCAMLR 1996-2003; Bartle 1991; Murray *et al*.1993; Nel and Nel 1999
12	*Thalassarche salvini (Diomedea salvini)*	Salvin's albatross		NZ	NZ	Robertson *et al*. 2003a, 2004
13	*Thalassarche eremita (Diomedea eremita)*	Chatham albatross		NZ	NZ; Chile; Peru	Robertson *et al*. 2003a

#	Species Name	English Name	Caught in Toothfish Longline	Caught in Trawl	Other Interactions with Fisheries	References
14	*Thalassarche impavida (Diomedea impavida)*	Campbell albatross		NZ	NZ	Murray *et al*.1993; Bartle 1990; Robertson *et al*. 2003a, 2004
15	*Thalassarche melanophyrys (Diomedea melanophyrys)*	Black-browed albatross	2001, 2002 Chile; CCAMLR (48, 58, 88); 1996, CCAMLR; 1997, 1998, CCAMLR (48.3, 58.7); 1999, 2000, CCAMLR (48.3); 2001, CCAMLR (48.3, 58.6, 58.7); 2003 CCAMLR (48.3, 58.5.2)	Patagonian waters; NZ; CCAMLR (48, 88); 1999, 2000, 2001, 2002, CCAMLR (48.3); 2003 CCAMLR (48.3, 58.5.2)	NZ; 1995 Brazil; 1993-4, Uruguay; Australia; Chile; Argentina; S.Africa; Namibia	Arata and Moreno 2002; Robertson *et al*. 2003a, 2004; CCAMLR 1996- 2003; Schiavini *et al*. 1998; Murray *et al*.1993; Neves and Olmos 1998; Stagi *et al.* 1998; Gandini *et al*. 1999
16	*Thalassarche steadi*	White-capped albatross		NZ	NZ; Australia; S. Africa; Namibia	Bartle 1991; Murray *et al*.1993; Robertson *et al*. 2003a, 2004
	Procellariidae	Petrels and shearwaters				
	Daption capense	Cape petrel	2001, Chile; 1999-2002, CCAMLR (48.3); 2003, CCAMLR (48.3, 58.5.2)	1999, 2003, CCAMLR (58.5.2); NZ	NZ	Arata and Moreno 2002; CCAMLR 1999-2003; Murray *et al*.1993; Robertson *et al*. 2004
	Fulmarus glacialoides	Southern fulmar	1998, CCAMLR (48.3)			CCAMLR 1998
	Halobaena caerulea	Blue petrel				

#	Species Name	English Name	Caught in Toothfish Longline	Caught in Trawl	Other Interactions with Fisheries	References
17	*Macronectes giganteus*	Southern giant petrel	1996, CCAMLR; 1997, CCAMLR (48.3, 58.7); 1998, CCAMLR (48.3, 58.6, 58.7); 1999, 2000, CCAMLR (48.3, 58.6, 58.7); 2001, 2002, CCAMLR (48.3)	2003, CCAMLR (58.5.2)	NZ; 1996-1998, CCAMLR (58.7)	CCAMLR 1996- 2002; Murray *et al*.1993; Nel and Nel 1999; Robertson *et al*. 2004
18	*Macronectes halli*	Northern giant petrel	1996, CCAMLR; 1997, CCAMLR (48.3, 58.7); 1998, CCAMLR (58.6, 58.7); 2000, CCAMLR (48.3, 58.6, 58.7) ; 2002, CCAMLR (48.3)	NZ	NZ; Australia; Chile; Argentina; 1997-1998, CCAMLR (58.7)	CCAMLR 1996-2002; Robertson *et al*. 2003a, 2004; Nel and Nel 1999
	Pachyptila crassirostris	Southern fulmar prion				
	Pachyptila desolata	Antarctic prion		2000, CCAMLR (58.5.2); 2002, CCAMLR (48.3); NZ		CCAMLR 2000, 2002; Robertson *et al*. 2004
	Pachyptila turtur	Southern fairy prion		NZ		Robertson *et al*. 2004
	Pagodroma nivea	Snow petrel				

#	Species Name	English Name	Caught in Toothfish Longline	Caught in Trawl	Other Interactions with Fisheries	References
19	*Procellaria aequinoctialis*	White-chinned petrel	2001 Chile; 1996, CCAMLR; 1997, 1998, CCAMLR (48.3, 58.7); 1999, CCAMLR (48.3, 58.6, 58.7); 1998, 2000, 2001, CCAMLR (58.6, 58.7); 2002 CCAMLR (48.3); 2003, CCAMLR (48.3, 58.5.2, 58.6, 58.7, 51)	Patagonian waters; NZ; 1999, CCAMLR (48.3, 58.5.2); 2001, 2002, CCAMLR (48.3); 2000, 2003, CCAMLR (58.5.2)	1995 Brazil; NZ; Australia; Argentina; S. Africa; 1996-1997, CCAMLR (58.7)	Arata and Moreno 2002; CCAMLR 1996- 2003; Schiavini *et al*. 1998; Bartle 1991; Neves and Olmos 1998; Robertson et al. 2003a, 2004; Nel and Nel 1999
20	*Procellaria cinerea*	Grey petrel	1997, 1998, CCAMLR (58.7); 1999-2003, CCAMLR (58.6, 58.7, 51)	NZ	NZ; Australia; S. Africa; Namibia	CCAMLR 1997-2003; Robertson *et al*. 2003a, 2004; Murray *et al*.1993; Bartle 1990
	Procellaria conspicillata	Spectacled petrel			1995 Brazil	Neves and Olmos 1998
	Procellaria westlanica	Westland petrel		NZ	NZ; Australia	Murray *et al*.1993; Robertson *et al*. 2003a, 2004
	Pterodroma inexpectata	Mottled petrel			North Pacific	Robertson *et al*. 2003a
	Pterodroma lessonii	White-headed petrel				
	Pterodroma macroptera	Great-winged petrel		2001, CCAMLR (48.3); NZ	NZ; Australia	CCAMLR 2001; Robertson *et al*. 2003a, 2004
	Pterodroma magentae	Chatham Island taiko				

#	Species Name	English Name	Caught in Toothfish Longline	Caught in Trawl	Other Interactions with Fisheries	References
	Pterodroma mollis	Soft-plumaged petrel				
	Puffinus assimilis	Subantarctic little shearwater				
	Puffinus bulleri	Buller's Shearwater		North Pacific	NZ	Robertson *et al*. 2003a, 2004
	Puffinus carneipes	Flesh-footed shearwater		NZ	NZ; Australia; North Pacific	Robertson *et al*. 2003a, 2004
	Puffinus creatopus	Pink-footed shearwater				
	Puffinus gavia	Fluttering shearwater			NZ	Robertson *et al*. 1998
	Puffinus gravis	Great shearwater			1995 Brazil	Neves and Olmos 1998
	Puffinus griseus	Sooty shearwater	2001 off Chile;	NZ	NZ; Australia; N. Pacific; Argentina	Arata and Moreno 2002; Robertson *et al*. 2003a, 2004; Bartle 1991; Gandini *et al*. 1999
	Puffinus huttoni	Hutton's shearwater			NZ	Robertson *et al*. 2003a
	Puffinus tenuirostris	Short-tailed shearwater		NZ		Robertson *et al*. 2004
	Thalassoica Antarctica	Antarctic petrel				
	Pelecanoididae	Diving petrels				
	Pelecanoides urinatrix	Subantarctic diving petrel		2000, CCAMLR (58.5.2); NZ	NZ	CCAMLR 2000; Robertson *et al*. 2004
	Hydrobatidae	Storm petrels				
	Fregatta tropica	Black-bellied storm petrel				
	Oceanites nereis	Grey-backed storm petrel				
	Oceanites oceanicus	Wilson's storm petrel	1999, CCAMLR (48.3)			CCAMLR 1999
	Charadriiformes					

#	Species Name	English Name	Caught in Toothfish Longline	Caught in Trawl	Other Interactions with Fisheries	References
	Chionidae	Sheathbills				
	Chionis alba	Snowy (American) sheathbill				
	Chionis minor	Lesser sheathbill (Black-faced sheathbill)				
	Laridae	Gulls, terns, skuas and jaegers				
	Catharacta chilensis	Chilean skua				
	Catharacta antarctica Lönnbergi	Antarctic skua			1997-1998, CCAMLR (58.7)	Nel and Nel 1999
	Catharacta maccormicki	South polar skua				
	Catharacta skua	Great skua				
	Larus dominicanus	Southern black-backed gull, Kelp gull				
	Sterna vittata	Antarctic tern	1996, CCAMLR			CCAMLR 1996
	Sterna virgula	Kerguelen tern				
	Sphenisciformes					
	Spheniscidae	Penguins				
	Aptenodytes forsteri	Emperor penguin				
	Aptenodytes patagonicus	King Penguin				
	Eudyptes chrysolophus	Macaroni penguin			1997-1998, CCAMLR (58.7)	Nel and Nel 1999
	Eudyptes chysocome	Rockhopper penguin				
	Pygoscelis adeliae	Adélie penguin		2003, CCAMLR (58.5.2)		CCAMLR 2003
	Pygoscelis Antarctica	Chinstrap penguin				
	Pygoscelis papua	Gentoo penguin	1999, CCAMLR (48.3, 58.6, 58.7)			CCAMLR 1999
	Pelecaniformes					
	Phalacrocoracidae					

#	Species Name	English Name	Caught in Toothfish Longline	Caught in Trawl	Other Interactions with Fisheries	References
	Phalacrocorax atriceps verrucosus	Kerguelen (Imperial) cormorant			Argentina	Gandini *et al*. 1999
	Phalacrocorax bransfieldensis	Antarctic shag				
	Phalacrocorax melanogenis	Crozet shag				

Table 22 (Sec. 3.4.b.): Bycatch numbers and rates (birds/thousand hooks) in longline fisheries in CCAMLR subareas 48.3, 58.6, and 58.7, from SC-CCAMLR-XXIII, Annex 5, Table 7.3.

Subarea	Year							
	1997	1998	1999	2000	2001	2002	2003	2004
48.3								
Estimated bycatch	5,755	640	210*	21	30	27	8	18
Bycatch rate	0.23	0.032	0.013*	0.002	0.002	0.0015	0.0003	0.001
58.6, 58.7								
Estimated bycatch	834	528	156	516	199	0	7	39
Bycatch rate	0.52	0.194	0.034	0.046	0.018	0	0.0003	0.025
88.1, 88.2								
Estimated bycatch	-	0	0	0	0	0	0	1
By-catch Rate	-	0	0	0	0	0	0	0.0001

*Does not include bycatch from the *Argos Helena* line-weighting experiment

Table 23 (Sec. 3.4.b.): Bycatch numbers (birds) in trawl fisheries in the CCAMLR subareas 48.3 and 58.5.2; data from SC-CCAMLR-XXIII, Annex 5, Table 7.18. Bycatch rates are not available for this fishery.

Year	Areas	Number of Vessels	Caught Dead	Caught Alive
1999	48.3	1	6	1
2000	48.3	2	19	5
2001	48.3	3	92	40
2002	48.3	5	68	52
	58.5.2	1	0	1
2003	48.3	3	36	15
	58.5.2	4	6	11
2004	48.3	6	87	132
	58.5.2	2	0	7

Indirect and cumulative impacts associated with fishing

Indirect effects through changes in prey availability:

Seabird species differ greatly from one another in their prey requirements and feeding behaviors, leading to substantial differences in their responses to changes in the environment. Diets consist largely of fish or squid less than 15 cm long and large zooplankton. Although they may take a wide variety of prey species during the year, most seabirds in a given area and time depend on one or a few prey species (Springer 1991). Diets and foraging ranges are most restricted during the breeding season, when high-energy food must be delivered efficiently to nestlings, and are somewhat more flexible at other times of the year.

A major constraint on seabird breeding is the distance between the breeding grounds on land and the feeding zones at sea (Weimerskirch and Cherel 1998). Breeding success in most species varies among years, but in stable populations, poor success is compensated for by occasional good years (Boersma 1998, Russell *et al*. 1999). Adult non-breeding seabird survival is unlikely to be affected by the common interannual variability of prey stock because adults can shift to alternative prey or migrate to seek prey in other regions. In contrast, breeding birds are tied to their colonies and local fluctuations in fish availability can have a dramatic effect on seabird reproduction. If food supplies are reduced below the amount needed to generate and incubate eggs, or if the specific species and size of prey needed to feed chicks are unavailable, local reproduction by seabirds will fail (Hunt *et al*. 1996). The natural factor most often associated with lower breeding success is food scarcity (Kuletz 1983, Murphy *et al*. 1984, Murphy *et al*. 1987, Springer 1991, Furness and Monaghan 1987). Reproductive success, therefore, is usually limited by food availability (Furness 1982). Outside the breeding season, diets, feeding habitats, energy requirements, and distribution have been studied only minimally for most seabird species.

The availability of prey to seabirds depends on a large number of factors and differs among species and seasons. All seabird species depend on one or more oceanographic processes that concentrate their prey at the necessary time and place; these include upwellings, stratification, ice edges, fronts, gyres, and tidal currents (Schneider *et al*. 1987, Coyle *et al*. 1992, Elphick and Hunt 1993, Hunt and Harrison 1990, Hunt 1997, Hunt *et al*. 1999, Springer *et al*. 1999). Oceanographic phenomena that influence seabird foraging habitat primarily are on the scale of hundreds of meters to hundreds of kilometers (Hunt and Schneider 1987). Favorable foraging conditions are likely to last for a relatively short time (hours to weeks) at one spot and for many seabirds foraging in shelf waters, small-scale physical processes that concentrate prey are very important for successful foraging (Hunt *et al*. 1999). Prey availability may also depend on the ecology of food species, including productivity, other predators, food-web relationships of the prey, and prey behavior, such as migration of fish and zooplankton. Many factors that influence prey availability are completely unknown. Most critical is the lack of information on how events beyond a seabird's foraging range may influence the prey availability. Such factors may include environmental changes, fluctuations in region wide stocks of forage and non-forage species, and commercial harvests.

Reductions in the availability of forage fish to seabirds have been attributed to both climatic cycles and commercial fisheries but an NRC study (1996) concluded that both factors probably are significant. Regime shifts are major changes in atmospheric conditions and ocean climate that take place on multi-decade time scales and trigger community-level reorganizations of the marine biota (Anderson and Piatt 1999). In nations with directed forage fish fisheries, some stocks have been decimated due to a combination of climatic and fishery pressures, which led to local population declines in seabirds (Duffy 1983, Anker-Nilssen and Barrett 1991, Crawford and Shelton 1978).

Competition and predation may also influence seabird prey availability. Links between seabirds and other species could be direct or they could be extremely diffuse and indirect. Possible links include competition among seabird species (Mehlum *et al*. 1998, Hunt *et al*. 1999b); competition of piscivorous seabirds with other large marine predators such as marine mammals and fish (Harrison 1979, Hunt 1990, Obst and Hunt 1990); and competition for food among forage species. Little information is available on the magnitude or direction of these potential links.

Seabirds may have impacts on fish stocks within foraging range of seabird colonies, however, because the birds are concentrated there during summer (Springer *et al*. 1986, Roseneau *et al*. 1998, Birt *et al*. 1987). About 15 to 80 percent of the biomass of juvenile forage fish may be removed by birds near breeding colonies each year (Wiens and Scott 1975, Furness 1978, Springer *et al*. 1986, Logerwell and Hargreaves 1997). This suggests that food availability to birds may be limited, at least in a given season, by the size of the local component of fish stocks. Seabirds may, therefore, be vulnerable to factors that reduce forage fish stocks in the vicinity of colonies (Monaghan *et al*. 1994).

As mentioned earlier, the African penguin (*Spheniscus demersus*) has been subject to population declines due to lack of prey caused by fishery pressure (Crawford in press and in WG-EMM-04/28). In some cases fishing can depress prey to the point of affecting seabird populations, though this has not frequently been documented as most research has addressed the direct impacts of fishing. Some sources have attributed the increase of some penguin species recently to the greater availability of krill following the reduction of some Antarctic whale populations (Marchant and Higgins 1990). However, others have argued that the penguin populations (i.e., Adélie and Chinstrip penguins) respond more to sea ice conditions than to krill abundance (Fraser *et al*. 1992 and refs. therein).

<u>Indirect effects by introducing mammalian predators to nesting islands</u>:

Seabirds are extremely sensitive to the introduction of mammalian predators. Non-native mammals have been introduced to islands through several pathways. Some are introduced intentionally as agriculture and companion animals. Others arrive accidentally, such as rats on fishing and other vessels at dock or after a wreck (Brechbill 1977; Jones and Byrd 1979; Bailey 1993). Alien mammals introduced on islands (brown rats, cats, dogs, pigs, cattle) have played a major role in depleting the local seabird populations or driving them to extinction (Jones and Byrd 1979; Moors *et al*. 1992; Burger and Gochfeld). Mitigation measures are being undertaken and eradication programs exist on several seabird breeding islands (see Jouventin 1994 and Gales 1993).

Location of Seabird Breeding Colonies in the Antarctic and Subantarctic

Legend

- **CCAMLR Convention Line**
- **Areas/subareas**

Directed fishing prohibited:

- All finfish
- N. rossii, G. gibberifrons, C. aceratus, L. squamifrons, P. squamifrons, E. carlsbergi, Pseudochaenichthys
- Dissostichus spp.
- Dissostichus spp. and L. squamifrons
- **Amsterdam Albatross foraging area**

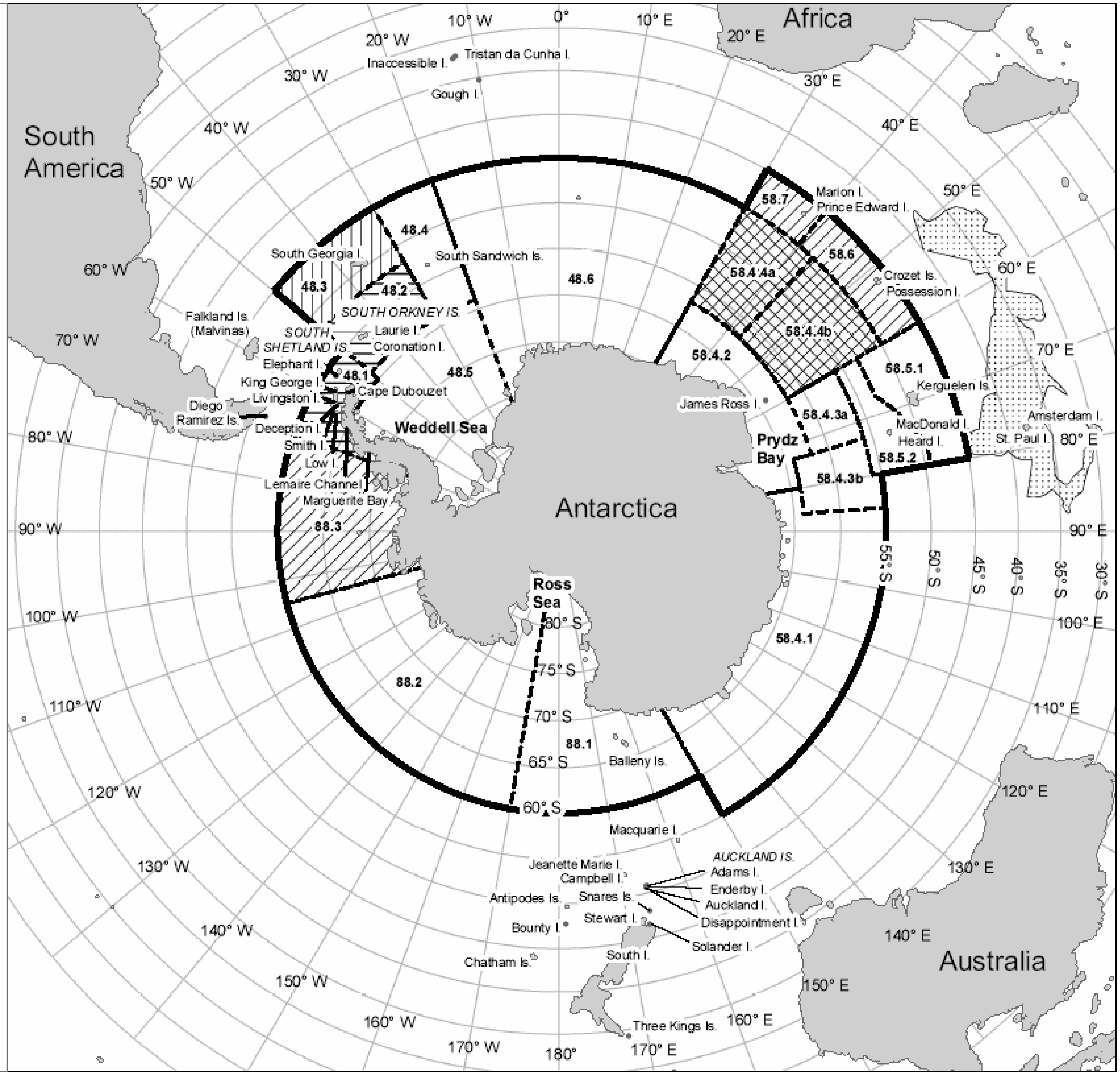
Date: December 1, 2004

Map by: Tim Haverland, NOAA Fisheries Office of Science and Technology

Projection: South Pole Lambert Azimuthal Equal Area

0 1,500 3,000
Kilometers
Approximate scale

Acknowledgement: Unpublished data on Amsterdam albatross foraging range provided courtesy of Dr. Henri Weimerskirch, Centre d'Etudes Biologiques de Chize, Centre National de la Recherche Scientifique, Villiers en Bois, France.



Regulated Fisheries Outside the CCAMLR Area

To address problems of bycatch of Convention Area seabirds in areas adjacent to the Convention Area - historically (since the 1970s) the most important cause of many of the population declines of albatrosses and petrels in the Convention Area – CCAMLR has requested closer collaboration with Members and regional fishery management organizations with jurisdiction and responsibility for longline fisheries in these areas. In particular, CCAMLR is advocating that the use of appropriate measures to minimize seabird bycatch be made obligatory for all longline fishing vessels and that appropriate assistance be given to facilitate this.

IUU Fishing

Illegal, unregulated and/or unreported harvest of toothfish within the Convention Area is estimated annually. Illegal fishing is not reported or suspected in any of the other Convention Area fisheries. For 2002/03 and 2003/04 the reported CCAMLR regulated catch of toothfish was 16,807 mt and 13,307 mt, respectively. The WG-FSA estimated the IUU catch within the Convention Area as 10,070 mt and 2,622 mt for 2002/03 and 2003/04, respectively. Taken together, the estimated catch of toothfish, legal and IUU, within the Convention Area was 26,877 mt and 15,929 mt for 2002/03 and 2003/04, respectively. WG-FSA and WG-IMAF estimated the seabird mortality associated with the estimated IUU catch of toothfish in 2002/03 to be 17,585 seabirds (95% confidence interval range of 14,412 to 46,954), and in 2003/04 to be 5,311 seabirds (95% confidence interval range of 4,352 to 14,166). The decrease in estimated IUU bycatch between 2003 and 2004 reflects reduced toothfish removals or changes to where IUU occurs. The Commission endorsed the advice of its Scientific Committee that such levels of mortality continue to be unsustainable for the populations of albatrosses and giant and white-chinned petrels breeding in the Convention Area.

In addition, there is a reported catch of toothfish from within the EEZs and on the high seas north of the Convention Area in FAO Statistical Area 87 (the west coast of South America), FAO Statistical Area 81 (west of Area 87), and FAO Statistical Area 41 (the east coast of South America) totaling 18,919 mt. See the attached chart of the FAO Statistical Areas (Attachment 5). Thus, globally, for the 2002/03 fishing season, the toothfish catch was 44,920 mt.

It is highly unlikely that vessels engaged in IUU fishing are deploying streamer lines or other effective seabird avoidance gear and methods. Even the minimal additional effort and cost of some mitigation measures (e.g., streamer lines) are unlikely to be borne by vessels fishing illegally. In addition, seabird avoidance techniques are shared among fishers and representatives of their countries through the CCAMLR forum, which IUU fishers have by definition elected not to participate in.

CCAMLR has adopted a list of illegal, unregulated and unreported fishing vessels (the IUU vessel list) for vessels suspected of IUU fishing or trading in toothfish and placed the list on a password protected section on the CCAMLR website. All Members of CCAMLR were urged to prohibit any trade from these IUU vessels. The United States is considering ways to implement this measure through possible future rulemaking. Eight vessels are currently on the list: three Contracting Party vessels and five non-Contracting Party vessels.

Bycatch of seabirds in IUU longline fishing in the Convention Area remains a serious problem. CCAMLR concluded that current levels of mortality remain entirely unsustainable for populations of albatrosses, giant petrels and white-chinned petrels breeding in the Convention Area, many of which are declining at rates where extinction is possible. This situation is viewed by CCAMLR with the greatest concern, and CCAMLR has adopted strict measures have been implemented to address the problem of unregulated fishing, with additional measures under development.

Marine Debris and Discharges

CCAMLR Members have conducted marine debris surveys in the Convention Area for over a decade. There have been no reported incidences of ESA-listed Amsterdam albatross interaction with the surveyed debris. Other seabird species are reported as interacting with marine debris (e.g., wandering albatross). The UK annually reports to CCAMLR on the occurrence of fishing gear, marine debris, and oil associated with seabirds at Bird Island, South Georgia (in SubArea 48.3). The level of marine debris found in seabird colonies at Bird Island has increased particularly since 1998, with fishing gear such as lines and hooks forming the major part of the debris (SC-CAMLR, 2003). Continued evidence of the discarding of longline hooks in offal and bycatch is of concern. Based on items found in regurgitates, an estimated 630 longline hooks and/or snoods were ingested by wandering albatross chicks at South Georgia in 2003 (Phalan, 2003).

CCAMLR has adopted a conservation measure regulating the use and disposal of plastic packaging bands on fishing vessels. The measure prohibits the use on fishing vessels of plastic packaging bands to secure bait boxes. It also prohibits the use of other plastic packaging bands for other purposes on fishing vessels that do not use onboard incinerators (closed systems). Any packaging bands, once removed from packages, must be cut, so that they do not form a continuous loop and must at the earliest opportunity burned in the onboard incinerator. Any plastic residue must be stored on board the vessel until reaching port, and in no case be discarded at sea. CCAMLR placards and brochures on handling, storing, and discarding refuse must be displayed on the vessel and available to the crew.

All vessels participating in the exploratory longline fishery for toothfish in Subarea 88.1 are prohibited from discharging: (i) oil or fuel products or oily residues into the sea, except as permitted in Annex I of MARPOL 73/78 (International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978); (ii) garbage; (iii) food wastes not capable of passing through a screen with openings no greater than 25 mm; (iv) poultry or parts (including egg shells); (v) sewage within 12 nautical miles of land or ice shelves, or sewage while the ship is traveling at a speed of less than 4 knots. In addition, no live poultry or other living birds may be brought into Subarea 88.1 and dressed poultry not consumed must be nautical miles of the coast of the Balleny Islands, an area being considered for protected status.

Potential Oil Spills

At its 2003 annual meeting, CCAMLR discussed safety concerns regarding fishing vessels operating in high latitudes. It also agreed that a definition of suitable specifications for vessels would enhance the health and safety of crew and scientific observers at sea, and would reduce the risk of accidents and pollution in high latitudes. Accordingly, CCAMLR adopted a resolution on ice-strengthening standards for fishing vessels operating in high latitude fisheries in the Convention Area. Members were urged by the resolution to license only those of their flag vessels with a minimum ice classification standard of ICE-1C to fish in the Convention Area. NMFS intends to require U.S. vessels fishing in the Convention Area to meet these standards through implementation of regulations in the future patterned after Decision 4 (2004): Guidelines for ships operating in Arctic and Antarctic ice-covered Waters, ATCM XXVII, Cape Town, South Africa.

Tourism

Tourism in the Convention area is conducted in Subarea 48, the Antarctic Peninsula region. The geographic scope of tourism activities in this region can be divided roughly into several sub areas: (1) South Orkneys including Laurie, Coronation Islands; (2) Elephant Island including nearby islands; (3) South Shetland Islands including Deception, Livingston, King George, Low and Smith Islands; (4) Northeast Antarctic Peninsula From Cape Dubouzet (63º 16' S, 57º 03' W) to James Ross Island; (5) Northwest Antarctic Peninsula From Cape Dubouzet (63º 16' S, 57º 03' W) to the north end of Lemaire Channel; and (6) Southwest Antarctic Peninsula From the north end of Lemaire Channel to the area of Marguerite Bay (67º 34' S). Antarctic visits are mainly concentrated at ice-free coastal zones over the five-month period from November to March. Ship strikes or other harmful interactions by tourist vessels with whales have not been reported.

Tourist expeditions have ventured to Antarctica every year since 1966. Tourism in the Antarctic is predominately by some 20 vessels carrying 45 to 280 passengers each. The ships are ice strengthened and sail primarily to the Antarctic Peninsula region. Some itineraries also include South Georgia and the Falkland Islands (Islas Malvinas). These voyages generally depart from Ushuaia (Argentina), Port Stanley (Falkland Islands) or to a lesser extent from Punta Arenas (Chile), Buenos Aires (Argentina) or Puerto Madryn (Argentina).

Sporadic voyages to Antarctica have also included larger passenger vessels (up to 960 tourists), some of which conduct sightseeing cruises only without landings. Yacht travel to Antarctica is also popular, with nearly all itineraries in the Antarctic Peninsula, and using Ushuaia, Argentina as a port.

3.4.c. <u>Pinnipeds</u>

There is potential for competition between Antarctic fur seals and the krill fishery. Krill (*Euphausia superba*) are a primary component of fur seal diet in Antarctic waters and depletion of krill or entanglement in trawls represent potential threats to fur seal populations. Fur seals also prey on myctophid fish and less commonly on other finfish species and cephalapods. Observers (UK) placed on krill fishing vessels fishing in CCAMLR Subarea 48.3 in 2003 observed Antarctic fur seals taken as by-catch in the krill fishery. The take, however, was attributed to the absence of effective mitigation measures (escape panels in the nets) and lack of experience of crews new to the fishery. Experienced vessels, employing effective mitigation measures, caught no seals.

The only pinniped species shown to have dietary overlap or toothfish in its diet is the southern elephant seal, *Mirounga leonina* (SES). Studies, however, have shown toothfish to be only a minor component of elephant seal diet (Slip 1995, Van den Hoff et al. 2002, Bradshaw et al. 2003, Daneri & Carlini 2002, Daneri et al. 2000). Toothfish and SES may also compete for particular species of fish and cephalapods (Goldsworthy et al. 2001). Depletion of toothfish could potentially benefit SES. Caution should be taken in considering any information on SES diet. Studies of elephant seal diet are necessarily biased due to the long distances and time traveled between visits to shore for breeding and molting and therefore warrant caution when interpreting any trophic links between toothfish and elephant seals (Hindell et al. 2003, Reid & Nevitt 1998).

All other Antarctic pinniped species are associated with ice. Fishery exploitation is confined to ice-free environments. Thus ice can be considered a refugia from fishing for pagophilic pinnipeds.

SECTION 4.0 ENVIRONMENTAL CONSEQUENCES OF ALTERNATIVES CONSIDERED

This section will analyze and compare impacts of alternatives together under each issue by ecological (including biological), economic and social impacts, if any.

4.1 ISSUE ONE: Controls on Harvesting

I. ACTION: <u>Impose harvest limits</u> on amounts of AMLR that may be caught by U.S. vessels in **"assessed (established) fisheries"** (fisheries about which sufficient