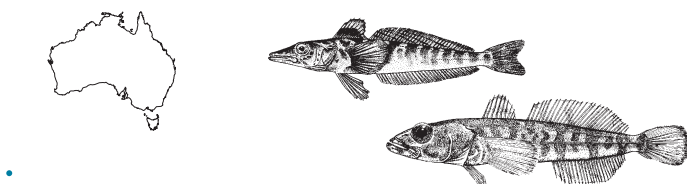


Heard Island and McDonald Islands Fishery



Main features

STATUS

- Patagonian toothfish and mackerel icefish: not overfished and not subject to overfishing.
- Byproduct species: status uncertain.

RELIABILITY OF THE ASSESSMENT

- High for toothfish and icefish.
- Low for byproduct species.

CURRENT CATCH

- 2006–07 total catch: 2413 t (Patagonian toothfish 2412 t; mackerel icefish 1 t).

MAIN MANAGEMENT OBJECTIVES

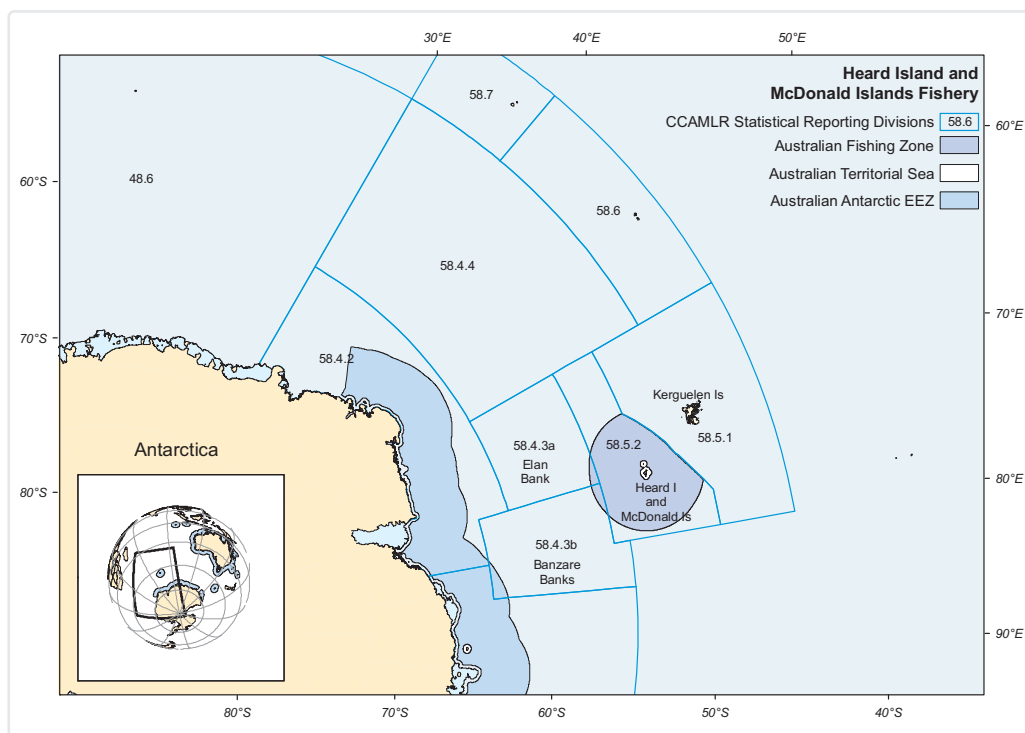
- Management procedures and decision rules are consistent with (and extend) the principles and conservation measures of the Commission for the

Conservation of Antarctic Marine Living Resources (CCAMLR) and the Commonwealth Fisheries Harvest Strategy Policy.

- Principles are precautionary, minimise risk under conditions of uncertainty, and account for ecological links between target species and other species and marine communities.

MANAGEMENT METHODS

- Limited entry (three boats).
- Total allowable catches (TACs) for target and byproduct species: Patagonian toothfish 2427 t; mackerel icefish 42 t for the 2006–07 season.
- Statutory fishing rights (SFRs), including a minimum holding of quota.
- Harvest strategy in place for this fishery since it began in the mid-1990s.



Highlights

- The fishery is a trawl and demersal-longline fishery in the Australian Fishing Zone (AFZ) around Heard Island and McDonald Islands in the sub-Antarctic waters of the Indian Ocean. The target species are Patagonian toothfish (*Dissostichus eleginoides*) and mackerel icefish (*Champsocephalus gunnari*), and a small suite of byproduct species is also taken.
- The fishery is managed by the Australian Fisheries Management Authority (AFMA) in accordance with CCAMLR management principles.
- The CCAMLR decision rules are more conservative than the default reference points defined by the Commonwealth Fisheries Harvest Strategy Policy.
- Recruitment surveys have been conducted since 1990, and the fishery operates under stringent bycatch and observer requirements.
- A major management issue is the illegal, unregulated and unreported (IUU) fishing that occurs across Antarctic waters.

Background

The Australian external territories of Heard Island and McDonald Islands are in the southern Indian Ocean about 4000 km south-west of Perth. They have been described as the only example of an unmodified sub-Antarctic island ecosystem, and are included on the Register of the National Estate and the World Heritage List because of their outstanding biological, geological and scientific values. The islands and their surrounding territorial waters (out to 12 nm) form the Heard Island Wilderness Reserve, which is managed under a formal management plan by the Australian Antarctic Division. The plan prohibits commercial fishing within the 12 nm zone. Waters between 12 nm and 200 nm are part of the AFZ and are under the jurisdiction of AFMA.

The islands lie to the south of the Polar Front (Antarctic Convergence) and are therefore included in the area under the jurisdiction of CCAMLR. Under the commission, 25 member nations seek to manage the Southern Ocean Antarctic ecosystem cooperatively. Its objective is the conservation and rational use of Antarctic marine living resources. The Heard Island and McDonald Islands (HIMI) Fishery falls within CCAMLR Statistical Division 58.5.2. AFMA has separate arrangements for activities in the remainder of the AFZ around Heard Island and McDonald Islands (the southern segment), which is within Division 58.4.3. Under the *Antarctic Marine Living Resources Conservation Act 1981*, the Australian Antarctic Division is responsible for administering Australia's harvesting of Antarctic marine living resources in the remaining high-seas areas of the CCAMLR area, and has a primary role in coordinating Australian fisheries research and assessments.

History of the fishery

There was limited Soviet and Polish fishing around Heard Island and the McDonald Islands through the 1970s. Following a joint Soviet–Australian exploratory fishing expedition in 1987, Australia made a series

of research cruises between 1990 and 1993. The cruises assessed the abundance and distribution of fish stocks in the HIMI sector of the AFZ, finding commercial quantities of Patagonian toothfish and mackerel icefish. The surveyed biomasses of those species were estimated to be much lower than those calculated for the neighbouring plateau around the Kerguelen Islands and, in the case of icefish, were seasonally and spatially variable.

The exploratory trawl surveys allowed calculation of yields, from which CCAMLR initially set TACs in 1995. For Statistical Division 58.5.2 (HIMI) these were 297 t for toothfish and 311 t for icefish, and limits of 50 t each for other deepwater species in that division. AFMA subsequently endorsed two Australian fishing operators to trawl in the new areas, but they did not fish in 1996. For the 1996–97 season, CCAMLR increased the TAC for toothfish in Division 58.5.2 to 3800 t, based on the results of an improved method of estimating recruitment and a refined version of the model used to estimate yield. AFMA responded with an interim management policy, concerned that the large increase in TAC could create enforcement problems and might result in an unsustainable increase in fishing activity. The interim policy restricted fishing to a maximum of three vessels, and to demersal and pelagic trawling. Conditions included the carriage of two observers on every trip, the provision of data, and the development of a fishing plan with a research component. Fishing under the interim policy began in March 1997.

On 29 May 2002, the Heard Island and McDonald Island Fishery Management Plan 2002 came into force, providing for a system of transferable quotas, to be issued as SFRs, and specifying a minimum quota holding (25.5% of the total) before an operator may fish. Retention of quota was conditional on the completion of a specified amount of research conducted annually.

Longline fishing trials for the HIMI Fishery began in the 2002–03 fishing season, subject to conditions to minimise seabird

deaths and injuries. Longline trials continued in the 2003–04, 2004–05 and 2005–06 seasons, with scientific permits granted under the HIMI Fishery Management Plan. No seabird deaths have been recorded in the longline fishery. Longlining became an approved fishing method in November 2005. Two experimental trips using pots (fish traps) to target toothfish were conducted during the 2005–06 fishing season under a scientific permit issued by AFMA, but were not repeated in 2006–07.



Haul of mackerel icefish

Biology

Designated target species of the fishery are Patagonian toothfish and mackerel icefish.

Patagonian toothfish live around most sub-Antarctic islands and submarine plateaus. These areas are separated by large expanses of abyssal basins, which until recently were thought to inhibit the interchange of fish. Recent fish-tagging and genetic work indicates a separation of stocks between the ocean basins, but with evidence of stock connection within the Indian Ocean region. The recapture in the French waters around Crozet Island and Kerguelen Island of 41 tagged toothfish from the HIMI Fishery led the CCAMLR Working Group for Fish Stock Assessment to conclude that Patagonian toothfish in the Indian Ocean probably comprise a meta-population. Toothfish in the Indian Ocean sector are therefore likely to be

a shared stock, extending across national Exclusive Economic Zones and inside and outside the CCAMLR area.

Toothfish are found on the shelf and upper-slope areas at depths from 300 m to more than 2000 m. They are large, active predators, maturing at about 70–110 cm (6.5–8 years) and growing to more than 2 m long and 100 kg. Their maximum age is thought to be at least 40 years. Their diet is mainly mid-water squid and fish, but benthic animals such as prawns, crabs and echinoderms have been recorded, indicating that bottom feeding is also important. Individuals appear to feed infrequently.

Mackerel icefish are found along the Scotia Arc from Shag Rocks and South Georgia in the north, to the west of Adelaide Island (Antarctic Peninsula) in the south, around Bouvet Island and on the Kerguelen–Heard Plateau. They are a shallow-water shelf species, found mainly between 100 m and 350 m, but known to occur as deep as 700 m. They grow to 45–66 cm and, depending on location, can live between 5 and 15 years. Recruitment is highly variable, resulting in levels of available biomass and TAC that vary quite markedly from year to year. A separate small population of icefish (with a different breeding season and length distribution) occurs on Shell Bank on the eastern edge of the Heard Island Plateau. Its commercial exploitation is prohibited.

The 2006–07 fishery

In the 2006–07 fishing season, longline and trawl operations produced a total catch of 2413 t, comprised of 2412 t of Patagonian toothfish (TAC 2427 t) and 1 t of mackerel icefish (TAC 42 t) (see tables). The number and weight of fish that are damaged or suffer from jellymeat condition (which affects toothfish) are included in total catch, but owing to restrictions on disposal of offal designed to protect seabirds there is effectively no discarding of target species in this fishery.

PATAGONIAN TOOTHFISH CATCH HISTORY: CCAMLR DIVISION 58.5.2

FISHING SEASON	VESSEL NUMBERS	REGULATED FISHERY REPORTED CATCH (t)					IUU ESTIMATE (t)	TOTAL REMOVALS (t)
		TAC (t)	LONGLINE	POT	TRAWL	TOTAL		
1989–90			0	0	1	1	0	1
1991–92			0	0	0	0	0	0
1992–93			0	0	0	0	0	0
1994–95		297	0	0	0	0	0	0
1995–96		297	0	0	0	0	3000	3000
1996–97	2	3800	0	0	1927	1927	7117	9044
1997–98	3	3700	0	0	3765	3765	4150	7915
1998–99	2	3690	0	0	3547	3547	427	3974
1999–00	2	3585	0	0	3566	3566	1154	4720
2000–01	2	2995	0	0	2980	2980	2004	4984
2001–02	2	2815	0	0	2756	2756	3489	6245
2002–03	3	2879	270	0	2574	2844	1274	4118
2003–04	3	2873	567	0	2296	2864	531	3395
2004–05	3	2787	621	0	2123	2744	265	3048
2005–06 ^a	3	2584	659	68	1803	2530	112	1937
2006–07 ^a	2	2427	625	0	1787	2412	0	2412

IUU = illegal, unregulated and unreported; TAC = total allowable catch
a Fishing season ends 30 November
Source: adapted from CCAMLR Statistical Bulletin

**PATAGONIAN TOOTHFISH FISHERY BYCATCH SPECIES CATCH HISTORY:
TOTAL ALLOWABLE CATCH AND (REPORTED CATCH) (TONNES)**

FISHING SEASON	UNICORN ICEFISH	GRENADIERS	GREY ROCKCOD	SKATES AND RAYS	OTHER SPECIES
1996–97	– (2)	– (0)	– (0)	– (3)	50 (6)
1997–98	80 (2)	– (0)	325 (3)	120 (3)	50 (3)
1998–99	150 (1)	– (1)	80 (0)	– (2)	50 (3)
1999–00	150 (3)	– (4)	80 (0)	– (6)	50 (5)
2000–01	150 (1)	– (1)	80 (4)	50 (5)	50 (6)
2001–02	150 (4)	50 (4)	80 (1)	50 (4)	50 (10)
2002–03	150 (21)	465 (4)	80 (0)	120 (33)	50 (10)
2003–04	150 (7)	360 (46)	80 (3)	120 (76)	50 (19)
2004–05	150 (36)	360 (74)	80 (2)	120 (79)	50 (12)
2005–06	150 (32)	360 (27)	80 (5)	120 (35)	50 (12)
2006–07	150 (10)	360 (65)	80 (8)	120 (15)	50 (4)

Source: adapted from CCAMLR (2006, 2007)

**MACKEREL ICEFISH AND BYCATCH SPECIES CATCH HISTORY, CCAMLR DIVISION 58.5.2:
TOTAL ALLOWABLE CATCH AND (REPORTED CATCH) (TONNES)**

FISHING SEASON	ICEFISH		UNICORN ICEFISH	GRENADIERS	SKATES AND RAYS	GREY ROCKCOD	OTHER SPECIES ^a
1996–97	311	(227)	– (2)	– (0)	– (1)	– (0)	50 (2)
1997–98	900	(115)	80 (2)	– (0)	120 (0)	325 (3)	50 (2)
1998–99	1160	(2)	150 (1)	– (0)	– (0)	80 (0)	50 (0)
1999–00	916	(137)	150 (2)	– (0)	– (0)	80 (0)	50 (1)
2000–01	1150	(1136)	150 (1)	50 (0)	50 (0)	80 (0)	50 (0)
2001–02	885	(865)	150 (3)	50 (0)	50 (1)	80 (0)	50 (0)
2002–03	2980	(2345)	150 (21)	465 (0)	120 (20)	80 (0)	50 (4)
2003–04	292	(78)	150 (6)	360 (1)	120 (3)	80 (0)	50 (1)
2004–05	1864	(1851)	150 (34)	360 (0)	120 (5)	80 (0)	50 (2)
2005–06	1210	(660)	150 (17)	360 (0)	120 (0)	80 (0)	50 (0)
2006–07	42	(1)	150 (3)	360 (0)	120 (0)	80 (0)	50 (0)

^a A TAC of 50 t has applied to other species since 1996

Note: Move-on rule if catch of any bycatch species exceeds 5% of target species.

Source: adapted from CCAMLR (2006, 2007)

Illegal fishing

IUU fishing within the CCAMLR region—including the HIMI AFZ—has been a significant problem over the past decade. It grew dramatically in the late 1990s, followed by a clear decline in recent years. Demersal IUU longliners target Patagonian toothfish almost exclusively and have been taking well in excess of CCAMLR-agreed TACs across the CCAMLR Convention Area. IUU catch quantities are poorly estimated, and IUU fishing seriously undermines efforts to apply agreed precautionary stock-assessment methods. The estimated IUU catches for the HIMI area were around 7000 t in 1996–97, but there has been little IUU activity in the HIMI AFZ for the past several years (see tables); none was reported in the area in 2006–07.

CCAMLR estimates that between 3756 and 21 926 seabirds were killed between 2006 and 2007 as a consequence of IUU fishing in the convention area, posing a threat of extinction for several seabird

populations in the region. The estimates of seabird mortality during 2007 are the highest since 2003.

CCAMLR measures to counter IUU fishing include the mandatory use of automated, satellite-based vessel-monitoring systems (VMSs). A certification scheme was introduced in 2000, designed to allow only certified catches of toothfish to be imported to the markets of CCAMLR parties. The commission also maintains IUU vessel lists. For its part, Australia has steadily increased its commitment to surveillance and enforcement actions in cooperation with adjoining nations of the CCAMLR region.

Current monitoring and research

Vessels fishing in the HIMI Fishery must always carry two observers, who monitor vessel compliance with permit conditions and collect fisheries, environmental and ecological information, including data on seabirds, marine mammals and bycatch. They also tag fish and collect data and material for specific research programs. CCAMLR has

further data-provision requirements, including the reporting of catch-and-effort information every 10 days.

Each permit holder is required to contribute to research in the fishery by undertaking surveys and tagging fish (mainly Patagonian toothfish). In June–July 2007, a random stratified trawl survey was conducted with the aims of assessing the abundance of juvenile and adult Patagonian toothfish in shallow and deep waters of the Heard Island Plateau, and assessing the abundance of mackerel icefish on the plateau.

The Sub-Antarctic Fisheries Management Advisory Committee and the Sub-Antarctic Resource Assessment Group coordinate Australian research under the Antarctic Fisheries Strategic Research Plan. Significant research effort goes into the annual trawl surveys that underpin the stock assessments of toothfish and icefish. Other areas of research include mitigation of longline bycatch of seabirds; age determination (fish

tagging) and stock definition (genetics and tagging); quantification of illegal and non-reported catches; and ecological risk assessment. Research planned for the near future will concentrate on the biological and ecological parameters of key bycatch species (such as grenadiers, skates and rays).



Heard Island and McDonald Islands Fishery trawl vessel

→ **HEARD ISLAND AND McDONALD ISLANDS
FISHERY HARVEST STRATEGY**

The harvest strategy for the HIMI Fishery is consistent with the principles of CCAMLR and has been in operation since the fishery began in the mid-1990s.

PATAGONIAN TOOTHFISH

Target reference point: maintain spawning biomass at or above 50% of its pre-exploitation median level (S_{50}).

Limit reference point: ensure that the probability of the spawning biomass dropping below 20% of its pre-exploitation median level is less than 10% (S_{20}).

Decision rules: An integrated assessment model (CASAL) is used to estimate the current and initial population size, and to calculate the long-term annual yield over a 35-year projection period that would satisfy

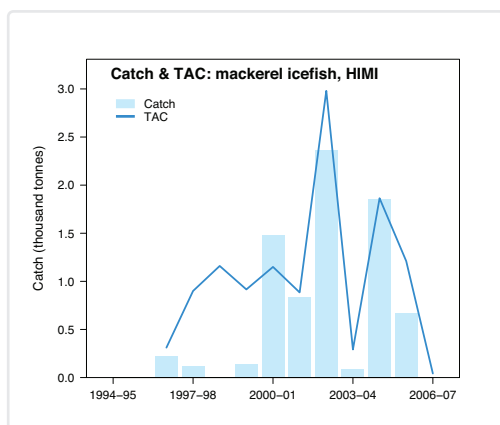
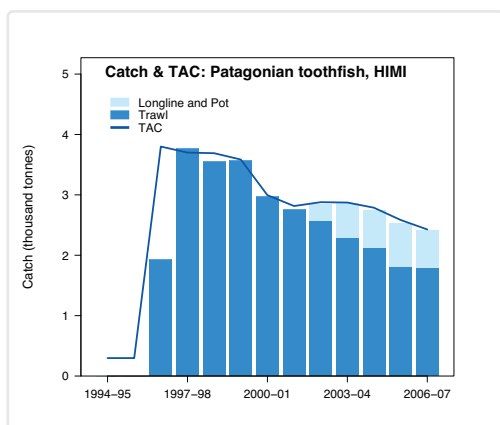
both target and limit reference points. Precautionary catch limits are determined based on the lower yield-estimate that achieves both reference points.

MACKEREL ICEFISH

Target reference point: maintain spawning biomass at or above 75% of its pre-exploitation median level (S_{75}).

Limit reference point: ensure that the probability of the spawning biomass dropping below 20% of its pre-exploitation median level is less than 10% (S_{20}).

Decision rules: similar to those for Patagonian toothfish, except that assessment is based on a generalised yield model and yield is projected over a 2-year period.



Status of stocks

The precautionary approach adopted by CCAMLR requires that the abundance of target and bycatch species remains high enough to meet the ecological needs of dependent species, such as southern elephant seals (*Mirounga leonina*), Antarctic fur seals (*Arctocephalus gazella*) and king penguins (*Aptenodytes patagonicus*), and avoid the likelihood of declining recruitment. A stock-projection model, using trawl-survey estimates of recruitment and its variability, is used to determine TACs that satisfy the CCAMLR decision rules for toothfish and icefish.

The most recent assessments of Patagonian toothfish and mackerel icefish were undertaken after a June–July 2007 random stratified trawl survey of the HIMI portion of Division 58.5.2 (west of 79° 20' E), and used standard CCAMLR approaches.

Patagonian toothfish

The toothfish assessment indicated a continuation of low to moderate recruitment, following some relatively large annual cohorts during the 1990s. The estimated spawning biomass has recently been in decline, but is likely to remain above the 50% target reference point. The assessment took both legal and IUU catches into account, and gave a revised long-term sustainable-yield estimate for 2006–07 of 2427 t (compared

with 2584 t for 2005–06). In 2006, estimates of yield were obtained from both an integrated assessment model (CASAL) and the generalised yield model (GYM), the latter having been used in previous assessments. Results from CASAL were similar to those from GYM, but CASAL takes better account of differences in parameters of the research surveys and provides a better method for incorporating fishery data. Therefore, the CCAMLR Working Group on Fish Stock Assessment decided to use CASAL to estimate yield in the 2006 and future assessments.

The assessment uses an integrated approach that includes survey data, commercial catch data, IUU catch estimates, standardised catch rates and mark–recapture data.

Patagonian toothfish in the HIMI Fishery are not overfished and not subject to overfishing.

Mackerel icefish

Mackerel icefish has more conservative biomass limits because of its importance as a prey item. The projection period for icefish (2 years) is relatively short to account for the species' short lifespan and the large annual differences in cohort abundance. After several years of low recruitment, a 2002 survey identified very strong recruitment of juvenile icefish. That year class has dominated the population structure in subsequent surveys,

and was again confirmed as the dominant year class (4+ cohort) in the 2006 survey. No other strong year class has yet appeared in the population. Given the short lifespan of icefish and the likelihood that the 4+ cohort would disappear in 2006, the yield estimates were based only on those year classes likely to be available to the fishery (that is, <4+ years). This resulted in a TAC that was reduced significantly to 42 t in 2006–07, a marked decrease from the 2005–06 TAC of 1210 t. It is likely that substantial year-to-year variation in icefish yield will remain a feature of the HIMI Fishery.

The assessment includes survey data and commercial catch data, and was based on GYM.

Mackerel icefish at HIMI are not overfished and not subject to overfishing.



Mackerel icefish

Skates and rays

The introduction of demersal longlining resulted in an increase in the bycatch of skates and rays. Reported longline catch peaked at 79 t for the toothfish fishery and 78 t for the icefish fishery in 2004–05 (against a 120 t TAC for each fishery), but has since fallen in both sectors. Collection of fishery and biological data on skates and rays is continuing, but so far the information is not

sufficient to allow the stock assessment to be updated. CCAMLR has identified skates and rays as a priority for which assessments are required. Data collection on bycatch will focus on skates and rays during the 2008–09 fishing year, which has been designated as ‘Year of the Skate’.

Reliability of the assessments

The assessments of Patagonian toothfish and mackerel icefish are considered to be reliable because many sources of uncertainty are explicitly taken into account in the projection model. The consequent precautionary TACs are expected to satisfy CCAMLR decision rules. While the catch-documentation scheme provides a better estimate of the legal toothfish catch, the lack of information on the size of the annual IUU catch remains a source of uncertainty in assessments. The extent to which there is interchange of fish among HIMI and neighbouring areas—such as Kerguelen—has not yet been quantified, complicating the determination of appropriate yields for the HIMI Fishery and adjacent fisheries.

An existing 1997 assessment of skates and rays is not considered to be reliable. No other bycatch stocks in the HIMI Fishery have been assessed.

Environmental issues

Trawling and longlining are subject to stringent operational restraints to reduce impacts on mammals and seabirds. Onboard observers have reported relatively few interactions that caused death or injury.

A total of 16 seabird deaths have resulted from interactions with fishing gear in the trawl sector since 2000–01. This includes two Cape petrel (*Daption capense*) mortalities in the 2006–07 season. No seabird mortalities have been reported in 5 years of longline fishing.

Five marine mammals (four elephant seals and one leopard seal) have been observed killed in the HIMI Fishery since 2004–05; this includes one southern elephant seal in the longline fishery in 2006–07. No marine mammal mortalities were reported in the trawl fishery for the 2006–07 season.

CCAMLR Conservation Measures outline mitigation measures required in the longline and trawl fisheries, including closed seasons, total seabird catch limits per vessel, mandatory streamer (tori) lines and line weighting.

Precautionary TACs are set for a variety of non-target species or species groups in Division 58.5.2 (see tables; for deep-sea species not included in the tables, a TAC of 50 t applies), and fishing must stop if any are exceeded. Additionally, if a single haul catches more than 1 t of a non-target species or more than 2 t of a non-target species group, the vessel must move at least 5 nm and not return to the location for at least 5 days.

Participants in the fishery are required to satisfy strict conditions to lessen environmental impacts. Plastic packaging bands must not be used on bait boxes, and plastic waste must not be discarded at sea. The loss of fishing gear and other non-biodegradable items must be reported. Bycatch species, offal and other waste products from fish processing must be retained on board to avoid attracting birds and mammals.

Discharge of poultry products is prohibited because of disease risks to seabirds. Discharge of brassicas (the plant family that includes broccoli) is prohibited because of the possibility of establishing pests on the islands. Onboard lighting must be kept to a minimum to avoid seabird collisions, and any death of or serious injury to a marine mammal or seabird must be reported.

Illegal foreign fishing poses a significant threat to the sustainability of toothfish catches and the incidental mortality of marine mammals and seabirds.

The HIMI Fishery has been assessed and approved under the strategic assessment provisions of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). This allows export of the fishery's product. In addition, the fishery has obtained certification of the mackerel icefish fishery from the Marine Stewardship Council.

The Heard Island and McDonald Islands Marine Reserve was declared under the EPBC Act in October 2002 after consultation between the then Department of the Environment and Heritage and HIMI Fishery stakeholders. The reserve encompasses some 65 000 km², 85% of which is zoned as highly protected marine reserve (IUCN Category 1a: fishing prohibited). The remaining 15% is zoned as 'conservation'—its conservation values, fishing resources and fishing impacts are being assessed to determine its future management. Fishing may continue in conservation areas under specified conditions.

Further reading

AFMA (Australian Fisheries Management Authority) 2002, *Heard Island and McDonald Islands Fishery management plan 2002*, AFMA, Canberra.

CCAMLR (Commission for the Conservation of Antarctic Marine Living Resources) 2006, *Report of the twenty-fifth meeting of the Scientific Committee—Working Group on Fish Stock Assessment*, CCAMLR XXV, CCAMLR, Hobart, 23–27 October 2006.

CCAMLR (Commission for the Conservation of Antarctic Marine Living Resources) 2007, *Report of the twenty-sixth meeting of the Scientific Committee—Working Group on Fish Stock Assessment*, CCAMLR XXVI, CCAMLR, Hobart, 22–26 October 2007.

CCAMLR (Commission for the Conservation of Antarctic Marine Living Resources) 2007, *Corrigendum. Report of the Working Group on Fish Stock Assessment, Appendix L. Fishery report: Dissostichus eleginoides Heard Island (Division 58.5.2)*, CCAMLR, Hobart, 22–26 October 2007.

Management performance

AFMA's stated objectives for the HIMI Fishery are drawn from the *Fisheries Administration Act 1991* and the *Fisheries Management Act 1991*. AFMA is also required to satisfy CCAMLR Conservation Measures and to have regard to the Heard Island Wilderness Reserve Management Plan.

AFMA considers that the current CCAMLR Conservation Measures are consistent with AFMA's legislated objectives and the Commonwealth Fisheries Harvest Strategy Policy. To support the wilderness reserve, AFMA prohibits fishing within 13 nm of the islands (the 12 nm reserve plus a 1 nm buffer zone), imposes conditions on fishing permits to limit possible environmental effects, and cooperates with agencies to improve knowledge of the marine habitat around the islands.

The management of the HIMI Fishery differs from that of other fisheries in important ways. First, basic information on the status of the stocks was available before fishing began, and precautionary TACs were established from the outset rather than after the fishery had become established. The existence of CCAMLR, the involvement of the Australian Antarctic Division and an established stock-assessment process facilitated this. Second, environmental effects, including direct and indirect effects on non-target species, are accepted as legitimate considerations in determining operating conditions for the fishery. This is reflected in the diverse membership of groups such as the

Sub-Antarctic Management Advisory Committee, the level of cooperation by permit holders and the amount of research effort directed at such topics as predator–prey interactions.

AFMA has responded to this situation with detailed management arrangements that impose strict controls on the fishery. The effectiveness of those controls depends on the extent of illegal fishing in the area, which appears to have diminished over the 2003–04 to 2006–07 seasons. A continuing program of armed customs and fisheries patrols began in 2004–05, providing a substantially increased and year-round capability to prevent and intercept illegal fishing in the Southern Ocean. This is in addition to strong support for CCAMLR's mandatory use of automated, satellite-based VMSs and the catch-certification scheme.