Chilean Seabass

Patagonian toothfish (*Dissostichus eleginoides*)
Antarctic toothfish (*Dissostichus mawsoni*)

Southern Ocean

Bottom Longline

December 9, 2012
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Final Seafood Recommendation

Stock	Fishery	Impacts on the stock Rank (score)	Impacts on other species Lowest scoring species Rank* (subscore, score)	Manage-ment Rank (score)	Habitat and ecosystem Rank (score)	Overall Recommendation (score)
Heard and McDonald Patagonian toothfish	Heard and McDonald Island Patagonian Toothfish Longline	Green 5	Murray's skate Heard and McDonald, Kerguelen sandpaper skate, Pacific sleeper shark, Corals and biogenic habitats, Skates and rays, Benthic invertebrates Yellow, 2.71,2.71	Green 5	Yellow 3.16	**BEST CHOICE 3.83**
Macquarie Patagonian Toothfish	Macquarie Island Patagonian Toothfish – Longline	Green (5)	Southern sleeper shark, Corals and biogenic habitats, Benthic invertebrates Yellow (2.71 2.71)	Green (5)	Yellow (2.6)	**BEST CHOICE (3.64)**
Falkland Islands Patagonian Toothfish	Falkland Islands Patagonian Toothfish – Longline	Green (5)	Antarctic starry skate, White-mouth skate, Porbeagle Falklands, Joined-fins skate, Multispined skate, White-dotted skate, Darkbelly skate, Corals and biogenic habitats, Big-eye grenadier Falklands, Benthic invertebrates Yellow (2.71, 2.71)	Green (3.46)	Yellow (2.74)	**BEST CHOICE (3.37)**

* Rank and color in the 'Impacts on other Species' column is defined based on the subscore rather than the score. See www.seafoodwatch.org for more information about scoring rules.

South Georgia Patagonian Toothfish	South Georgia Patagonian Toothfish – Longline	Green (5)	Grenadiers, Skates and rays Red (2.16, 2.16)	Green (3.87)	Yellow (2.6)	**GOOD ALTERNATIVE (3.23)**
Ross Sea Antarctic toothfish	Ross Sea Antarctic Toothfish Longline	Green (3.83)	Grenadiers, Skates and rays Red (2.16,2.16)	Green (3.46)	Yellow (3)	**GOOD ALTERNATIVE (3.05)**
Kerguelen Islands Patagonian toothfish	Kerguelen Patagonian Toothfish Longline	Green (3.83)	Ridge scaled rattail Kerguelen, White-chinned petrel, Whiteleg skate Kerguelen, Grey petrel, Raya spp. Red (2.16,2.16)	Yellow (3)	Yellow (2.24)	**GOOD ALTERNATIVE (2.73)**
Crozet Island Patagonian Toothfish	Crozet Patagonian Toothfish – Longline	Red (2.16)	Whiteleg skate Crozet, Ridge scaled rattail Crozet, Grey petrel, White-chinned petrel Red (2.16, 2.05)	Red (1.73)	Red (2.12)	**AVOID 2.01**
Chile Patagonian Toothfish	Chile Domestic Patagonian Toothfish – Longline	Red (1.41)	Yellownose skate Red (2.16, 2.16)	Red (1)	Yellow (2.24)	**AVOID (1.62)**
PE&MI Patagonian Toothfish	Prince Edward and Marion Islands Patagonian Toothfish – longline	Red (2.16)	Corals and biogenic habitat Yellow (2.71, 2.71)	Red (1.73)	Yellow (2.74)	**AVOID (2.3)**

The Patagonian toothfish (*Dissostichus eleginoides*) and Antarctic toothfish (*D. mawsoni*) are demersal species with circumpolar distributions in the southern hemisphere. Distributions of these two species overlap in some areas, with the Patagonian species tending to occur further north. Fisheries targeting these species are focused in the Southern Ocean including around Antarctica and in waters inside and outside various state exclusive economic zones. This report evaluates, according to Seafood Watch definitions and criteria, fisheries representing almost 78% of the total reported global landings of these two species in 2010 (contributions of each

stock to total harvest follow in parentheses). Stocks of Patagonian toothfish are harvested primarily using longline methods in waters around South Georgia (~9%), Heard and McDonald Islands (~8%), Kerguelen (~21%) and Crozet Islands (~3%), Prince Edward and Marion Islands (~0.5%), Macquarie Island (~1.0%), the Falkland Islands (~5%), and Chile (~19%). The Antarctic toothfish is harvested in the Ross Sea (~12%) using longlines. Fisheries outside these areas include research fisheries encompassed in the CAMLR Convention Area or domestic fisheries for which insufficient information was available to conduct an assessment.

Patagonian toothfish is ranked as best choice for the fishery around Heard and McDonald Islands (bottom longline), the Falkland Islands (bottom longline), and Macquarie Island (bottom longline). This species is ranked as a good alternative when sourced from South Georgia (bottom longline) and Kerguelen Islands (bottom longline). Patagonian toothfish from Crozet Islands (bottom longline), Prince Edward and Marion Islands (bottom longline), and Chile (bottom longline) are ranked as avoid. Ross Sea Antarctic toothfish (bottom longline) is ranked as a good alternative.

Four toothfish fishery areas have been certified by the Marine Stewardship Council (www.msc.org): South Georgia, Heard and McDonald Islands, Macquarie Island, and the Ross Sea. The fisheries around the Kerguelen Islands have been under assessment since 2009, and the Falkland Islands fishery entered the assessment process in August 2012.

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Executive Summary

This report evaluates the status of Patagonian (*Dissostichus eleginoides*) and Antarctic (*Dissostichus mawsoni*) toothfish fisheries. Fisheries targeting these species are focused in the Southern Ocean including around Antarctica and in waters inside and outside various state exclusive economic zones (EEZs). This assessment reflects approximately 78% of reported global toothfish catch, including the following fishing areas: Macquarie Island, Heard and McDonald Islands, South Georgia, the Falkland Islands, Kerguelen and Crozet Islands, Prince Edward and Marion Islands, Chile, and the Ross Sea (Table 1). Fisheries at Heard and McDonald Islands have historically used both demersal trawl and demersal longline methods, but the trawl fishery is being phased out; therefore, this assessment focuses only on the longline fishery. Other fisheries assessed here deploy demersal longlines. Fisheries in each of these areas are managed as spatially discrete units with separate catch allocations, stock assessments etc. While management is conducted on an area basis, stock structure is known only broadly and is still an active area of research; for instance, investigations of stock boundaries and identification of straddling stocks are underway around the Kerguelen, Heard and McDonald Islands (SC-CAMLR 2011). The findings of this work will inform future management and increase the robustness of management approaches.

Stock assessments are available for almost all fisheries assessed in this report. Most toothfish stock assessments use CASAL. Based on stock assessment models, stocks around South Georgia, Heard and McDonald Islands, Macquarie Island, and the Falkland Islands are abundant, with median biomass at levels above the target reference point ($B_{current}$> 50% B_0). The Ross Sea stock is also above the reference point, but there is greater uncertainty about the stock structure. Around Kerguelen, a preliminary stock assessment exists and has been applied to management for 2012/13, but this assessment requires improvement prior to utilization for longer term management. For the Prince Edward and Marion Islands fishery, the stock has been recognized as depleted and is under conservative management. Its future trajectory is uncertain. Around Crozet, no accepted peer-reviewed stock assessment is currently available, which is considered a high concern due to the high vulnerability of the species. The domestic Chilean fishery has been assessed as being overfished.

In the fisheries assessed here, bycatch comprised 1–26% of the total catch weight (~75–6,400 t) for Patagonian toothfish fisheries and 8% of the total catch weight (~2,500–3,400 t) for the single Antarctic toothfish fishery. Bycatch of most species comprised less than 5% of the catch. However, the high inherent vulnerability of most bycaught species is expected to render them particularly sensitive to fisheries impacts. Species accounting for more than 5% of catch included violet cod (*Antimora rostrata*) (Crozet Islands), *Macrourus* species—including ridge scaled rattail (*Macrourus carinatus*) and bigeye grenadier (*Macrourus holotrachys*)—in all areas except South Georgia, rajids at Kerguelen and Crozet, and the whiteleg skate at Crozet. For white-chinned (*Procellaria aequinoctialis*) and grey (*Procellaria cinerea*) petrels, past impacts in two fisheries (Kerguelen and Crozet Islands) have been severe. Bycatch has decreased substantially in recent years, and data available in the near future is expected to clarify whether

the population status of these species has improved. Threatened or endangered species captured in toothfish fisheries include black-browed albatross (*Thalassarche melanophris*), grey-headed albatross (*Thalassarche chrysostoma*), rockhopper penguin (*Eudyptes chrysocome*), white-chinned petrel, yellownose skate (*Zearaja chilensis*) and the porbeagle shark (*Lamna nasus*). Several other bycaught rajids and sharks are classified as near threatened or data deficient. Most of these species are caught in very low numbers. Cetaceans and pinnipeds are rarely caught. The population status of benthic invertebrates and biogenic habitat-forming organisms, such as corals, are not well known in many areas used by fisheries considered in this assessment, although data collection is underway in most fisheries (albeit often not at the species level). Overlap between fishing activity and these organisms has been reported, and they were scored in accordance with the 'Unknown bycatch matrix'. Limited information is available on the productivity and population structure of most bycatch species. Therefore, ongoing monitoring and research (underway in most fisheries) is important to ensure sustainability limits are not exceeded.

Considerable amounts of both fishery-dependent and fishery-independent information are available with which to manage the harvest of both Patagonian and Antarctic toothfish. Most fisheries are exploited with reference to stock assessments; management targets and policies vary between fisheries. Non-target retained species caught at levels greater than 5% of the catch include ridge scaled rattail at Kerguelen and Crozet, and whiteleg skate at Crozet. Non-target retained species caught at levels comprising less than 5% of catch include whiteleg skate at Kerguelen, Eaton's skate (*Bathyraja eatonii)* and Kerguelen sandpaper skate (*Bathyraja irrasa*) in the Kerguelen and Crozet fisheries, unicorn icefish (*Channichthys rhinoceratus*) and grey rockcod (*Lepidonotothen squamifrons*) in the Heard and McDonald fisheries, and grey rockcod at Macquarie. The stock statuses of retained skates are unknown. Unicorn icefish and grey rockcod at Heard and McDonald are harvested in accordance with catch limits set using stock assessments. All toothfish fisheries assessed here have monitoring procedures in place, which facilitates the development of science advice and enforcement of management measures.

Management of bycatch focuses on documenting and minimizing bycatch through measures such as catch limits and move-on rules. In addition, mitigation measures have been implemented to reduce bycatch, including captures of seabirds and marine mammals. Bycatch reduction measures deployed to reduce seabird and marine mammal captures have proven effective. Reductions in fish bycatch as a result of measures such as move-on rules are not well understood but observers monitor bycatch thoroughly in most fisheries. Quantitative assessments of most bycatch stocks are generally unavailable, however, population monitoring for some species of seabirds is ongoing and tagging programs have been implemented for skates in some fisheries.

Fisheries have minimal to strong mitigation in place to ameliorate benthic impacts, depending on the fishery area. CCAMLR has an active work program on vulnerable marine ecosystems and marine protected areas. Measures in place that reduce the impacts of bottom fishing include limits on fishing intensity (number of vessels and catch), gear modifications (e.g., reduced-

contact bottom longline gear), and significant efforts in spatial management. A diversity of ecosystem management measures is also in place across toothfish fisheries. In all fisheries assessed here, work is currently underway to improve management of benthic and ecosystem impacts. This work is particularly important given the assumptions made about the role of toothfish in its ecosystem when developing management approaches for target catch harvest. These assumptions must be appropriate to ensure effective management of fishing effects.

Four toothfish fishery areas have recently been certified by the Marine Stewardship Council (www.msc.org): South Georgia (longline), Heard and McDonald Islands (trawl and longline), Macquarie Island, and the Ross Sea (longline). The demersal longline fisheries around the Kerguelen Islands have been under assessment since 2009, and the Falkland Islands fishery entered the assessment process in August 2012.

This report takes a precautionary approach in cases of scientific uncertainty. The existence of toothfish fisheries is controversial for a variety of reasons. These include the lack of knowledge of some aspects of the species' life history and ecology, its stock structure, and its vulnerability to overexploitation (including past and current illegal harvests). Consequently, scrutiny of fishing activities, emergent data, and management regimes is expected to remain high. Such interest from a variety of stakeholders will contribute to the identification of any emerging conservation issues.

Introduction

Scope of the analysis and ensuing recommendation

This report evaluates the status of Patagonian (*Dissostichus eleginoides*) and Antarctic (*Dissostichus mawsoni*) toothfish fisheries. Fisheries targeting these species are focused in the Southern Ocean including around Antarctica and in waters inside and outside various state exclusive economic zones (EEZs). This assessment reflects approximately 78% of reported global toothfish catch, including the following fishing areas: Macquarie Island, Heard and McDonald Islands, South Georgia, the Falkland Islands, Kerguelen and Crozet Islands, Prince Edward and Marion Islands, Chile, and the Ross Sea (Table 1). Fisheries at Heard and McDonald Islands have historically used both demersal trawl and demersal longline methods. However, the demersal trawl fishery is being phased out. It currently consists of only one vessel, which is being replaced by a longliner this season (2013), so there will no longer be any toothfish trawling in the HIMI fishery (M. Exel, pers comm, March 21, 2013). Therefore, this assessment focuses only on the longline fishery. Other fisheries assessed here deploy demersal longlines. Fisheries in each of these areas are managed as spatially discrete units with separate catch allocations, stock assessments etc. While management is conducted on an area basis, stock structure is known only broadly and is still an active area of research: investigations of stock boundaries and identification of straddling stocks are still underway around Kerguelen and Heard and McDonald Islands (SC-CAMLR 2011). The findings of this work will inform future management and increase the robustness of management approaches.

Table 1. Summary of toothfish (*Dissostichus* spp.) catches reported by fishery for fisheries included in this assessment. Catch statistics are estimated live weight (tonnes) of landings, from CCAMLR (2012, Table 14, p. 242) (except for the Prince Edward and Marion Islands marked *, for which catch statistics were drawn from SC-CAMLR (2011)), ^ = total catch (tonnes) from Falkland Islands Government (2012), [+] = total catch (tonnes) from Fay (2011), [#] = total catch (tonnes) from Gálvez *et al.* (2011). Management areas are shown in parentheses: SSA = CCAMLR Statistical Subarea. Between fisheries (especially outside CCAMLR SSAs), the start and end dates of fishing years may vary, but the majority falls in the calendar year 2010.

Fisheries included in this assessment	Catch (tons)
South Georgia (SSA 48.3)	2491
Kerguelen Islands (SSA 58.5.1)	5751
Heard and McDonald Islands (SSA 58.5.2)	2141
Crozet Islands (SSA 58.6)	819
Prince Edward and Marion Islands (SSA 58.6, 58.7*)	150
Falkland Islands^	1403
Macquarie Island[+]	278
Chilean Exclusive Economic Zone (and adjacent high seas)[#]	4757 (537)
Ross Sea (SSA 88.1, 88.2)	3322

The total of reported global landings of toothfish in 2010 comprised approximately 27,904 tonnes estimated live weight (CCAMLR 2012).

Species overview

Antarctic toothfish

Toothfish are members of the Notothenidae family. The Antarctic toothfish has a circumpolar distribution. While there is overlap with the distribution of the Patagonian toothfish in some areas (see below), the Antarctic toothfish occurs to the south of the Antarctic Convergence in areas of higher latitude. Population structure is an area of active research. The total number of stocks is currently unknown, and movements of up to 2,300 km have been detected. Genetic differentiation has been identified between the Ross Sea and the Bellinghausen Sea while only weak differences were identified in comparisons between the Pacific, Indian and Atlantic Oceans (Hanchet 2006). Antarctic toothfish have been caught at depths from ~280–2210 m, and fish size generally increases with depth (Hanchet 2006; Hanchet 2010). Knowledge of population, stock structure and reproductive patterns is improving due to ongoing research (e.g., Hanchet *et al.* 2008a; A. Dunn, personal communication). Antarctic toothfish are thought to be mature at lengths over 135 cm. Spawning is thought to occur annually, though individual fish are considered unlikely to spawn every year. Relative fecundity has been estimated at 15–41 eggs per gram of body weight. The age to which 1% of fish survive is estimated to be 35 years. The species is predatory and forages on fish, cephalopods, mysids, and amphipods. Natural predators include cetaceans and pinnipeds. Penguins have been found to consume juvenile toothfish. Predators of eggs and larvae are unknown (Hanchet 2006; Hanchet 2010).

Patagonian toothfish

The Patagonian toothfish is generally found further north than the Antarctic toothfish, including on the southern shelves and slopes off South America and around the sub-Antarctic islands (Collins *et al.* 2010). Genetic analyses, stables isotopes and parasite faunas have all been used to examine population structure and connectivity. The collective results of this work identify separate populations in the western Indian Ocean, Atlantic Ocean, Patagonian/Chilean Shelf, and Macquarie Island (Collins *et al.* 2010). Spawning occurs annually, although every fish likely does not spawn every year. Females mature at around 110–130 cm, while males mature at 90–100 cm. Longevity varies between regions with estimates of approximately 30–55 years, and maturity occurs at around half maximum length. Patagonian toothfish occupy a range of bathymetric zones throughout their life cycle, from shallower depths when young (< 300 m until 6–7 years old) to deeper waters as adults (as deep as 2,500 m) to spawning at around 1,000 m (Collins *et al.* 2010). Genetic analysis shows that while Patagonian toothfish have a broad circumpolar distribution, populations can be extremely isolated (Collins *et al.* 2010). The diet of Patagonian toothfish changes ontogenetically, and the species forages both by scavenging and as a predator. Natural predators include cetaceans and pinnipeds. Predators of eggs and larval Patagonian toothfish are not well known (Collins, M.A. et al. 2010).

While knowledge of these species continues to grow, important gaps remain in understanding the connectivity of populations, certain aspects of reproductive biology, the distribution of eggs, and aspects of the larval and juvenile components of the species' life histories. The species is relatively long lived and slow growing and some of the fisheries targeting them have developed relatively recently. These factors contribute to the value of particularly cautious

management approaches as well as continued research and monitoring to ensure the sustainability of toothfish fisheries in the long term.

Management bodies

Legal toothfish fishing around Antarctica is managed under the Convention on the Conservation of Marine Living Resources (CCAMLR, www.ccamlr.org), or outside the CAMLR Convention Area by states (e.g., the domestic toothfish fisheries of Australia and Chile). Some fishing areas inside the CAMLR Convention Area are also within the exclusive economic zones (EEZ) of member states and are influenced by both domestic and CCAMLR measures. CCAMLR entered into force in 1982.The Convention applies to a defined area approximately delineated as south of 60^{o}S and between 60^{o}S and the Antarctic Convergence (Figure 1). There are currently 25 members and an additional 10 states are party to the Convention. The management approach utilized by CCAMLR includes regulations (Conservation Measures), scientific observation, monitoring, inspection, surveillance, reporting requirements, and a catch documentation scheme. This scheme continues to evolve and is recognized as current global best practice in this area (Clarke, MRAG 2010). Mislabeling of toothfish has been reported (Marko *et al.* 2011), though not substantiated (www.msc.org). A past analysis of the global toothfish trade found difficulty converting traded forms of toothfish back to live catch weights (Lack 2008). Article II of the Convention articulates CCAMLR's approach to management (see: www.ccamlr.org, Appendix B).

Inside EEZ boundaries that fall outside the CAMLR Convention Area, only state fishery management measures apply to the harvest of toothfish. However, CCAMLR Resolutions 10/XII and 18/XXI relate to management of stocks outside the Convention Area, urging (while not requiring) states to harmonize management measures across Convention Area boundaries.

Outside CCAMLR and EEZ boundaries, relevant management instruments include the United Nations Convention on the Law of the Sea. Furthermore, the requirements of the CCAMLR Catch Documentation Scheme apply to all toothfish harvested and traded by CCAMLR Contracting Parties and cooperating non-Contracting Parties, regardless of whether fishing occurred inside or outside the Convention Area. Contracting Parties' vessels also complete catch documentation when fishing on the high seas (CCAMLR Conservation Measure 10-05). Specific import regulations apply in the United States. These require that harvesting vessels to report Vessel Monitoring System data to CCAMLR on a port-to-port basis (i.e., the entire duration of the fishing trip) in order for import permission to be granted (Federal Register 2010). US importers are also required to hold a permit to import Antarctic Marine Living Resources, as well as to obtain a valid pre-approval certificate for each shipment of toothfish proposed for import into the USA (see: www.nmfs.noaa.gov/gpea_ forms/forms.htm). Finally, the USA also prohibits the import of toothfish caught in certain high seas areas outside the CAMLR Convention Area (FAO Areas 51 and 57, Federal Register 2003, 2007). This regulatory framework has significantly reduced IUU fishing and includes global best practice measures (e.g., the catch documentation scheme, Clarke, MRAG 2010). However, IUU activity still occurs

(such as on the high seas), and IUU products may be sold into markets that do not require the measures in place in the legal fisheries assessed here (see below; CCAMLR 2011).

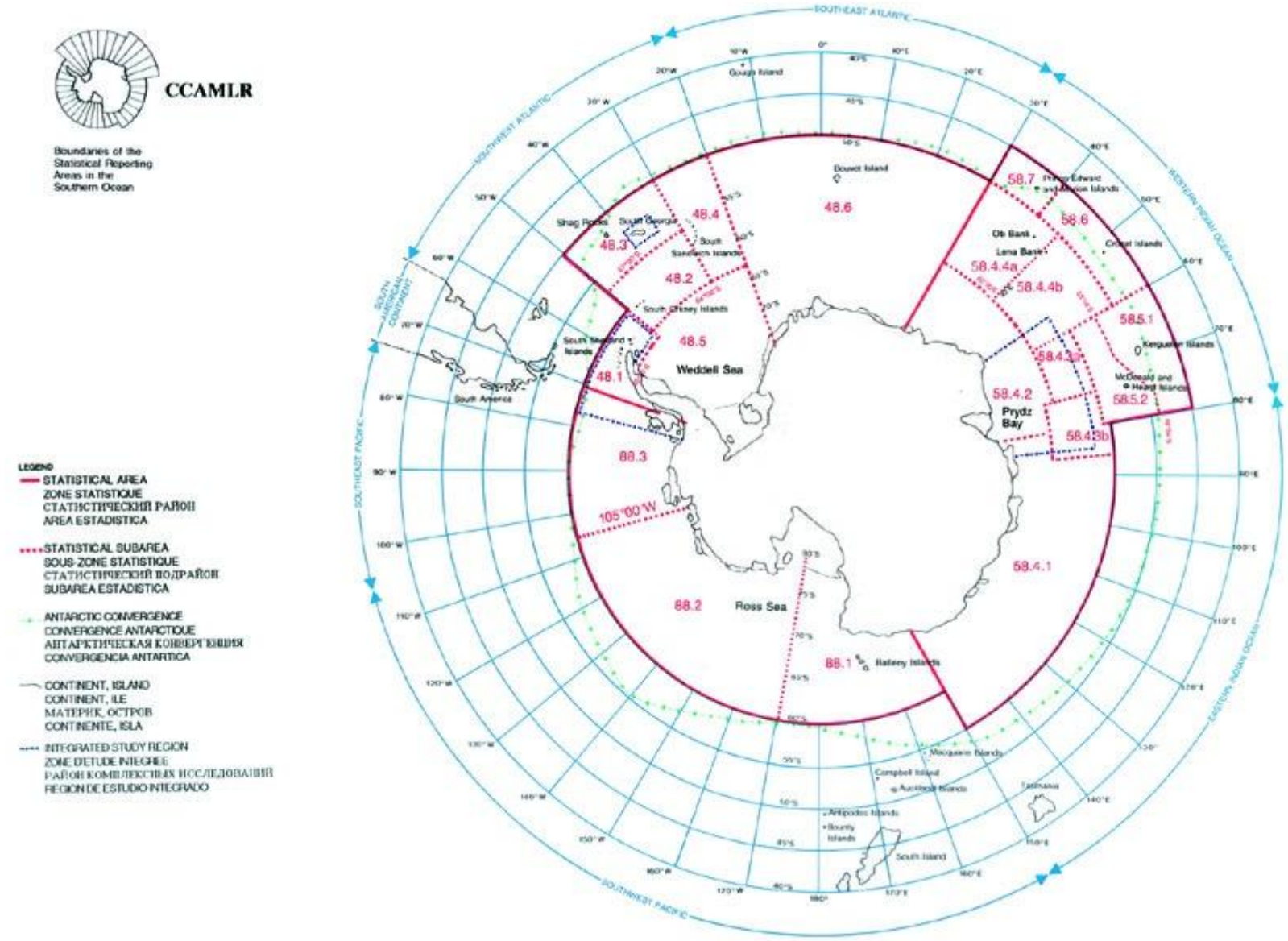

Figure 1. The CAMLR Convention Area and locations of fisheries referred to in the text (source: www.ccamlr.org).

Catch statistics and history of the fishery

Toothfish were initially caught as a bycatch species in trawl fisheries but became a target species in the mid-1980s after deepwater longlining was developed. Subsequently, operations targeting toothfish expanded rapidly. From 1983 to 1992, legally landed catch increased from less than 5000 t to a peak of 40,000 t. Illegal, unreported and unregulated (IUU) fishing operations, which take unknown amounts of toothfish, are thought to have commenced in the early 1990s (Collins *et al.* 2010). Toothfish are currently taken predominantly using demersal longline and demersal trawl methods. In addition to the legal, reported catch described above, an illegal, unreported and unregulated fishery for toothfish persists (e.g., CCAMLR 2011a). Catch histories, including estimates of IUU removals, for fisheries assessed in this report follow (Figures 2–10). IUU exploitation of toothfish is known to have been particularly significant in some areas in the past (e.g., Prince Edward and Marion Islands, Kerguelen and Crozet Islands, and Heard Island; see below). Implementation of a catch documentation scheme (see above), along with surveillance monitoring, has greatly reduced IUU activity (Lack 2008). Residual IUU fishing is believed to occur largely using gillnets in areas outside those utilized by the fisheries assessed here (e.g., CCAMLR statistical subareas 58.4.1, 58.4.2, 58.4.4, SC-CAMLR 2011; CCAMLR 2011a). However, in the fisheries assessed here, little or no IUU activity has been detected in the last five years with the exception of Chilean waters, for which information on IUU was not available. Estimates of toothfish catches and landings resulting from IUU fishing activities are inevitably imprecise and vary widely between years and methods of calculation. For example, Table 2 shows estimates resulting from two methods of calculation. Lack (2008) estimated landings of whole toothfish based on the volume of toothfish products traded globally. Key issues that may limit the accuracy of this analysis include proportion of product consumed domestically (and therefore not entering into international trade), reporting toothfish products under generic codes, access to data, complexity of the trade chain, and the potential for counting toothfish products more than once (Lack 2008). By comparison, CCAMLR figures are estimated using information on IUU vessel activity including sightings of IUU vessels, estimated duration of IUU fishing trips, number of IUU fishing trips, and the likely toothfish catch rate (SC-CAMLR 2006). The large areas of ocean inhabited by toothfish make the total elimination of all IUU activity unlikely. However, the variability in vulnerability of different areas to IUU activity is recognized (SC-CAMLR 2006). In the past, CCAMLR has estimated IUU catches from within its convention area each year. However, the expansion of gillnet usage in IUU activities in recent years renders estimates of IUU catch based on longline catch per unit effort metrics inappropriate. Methods for improving IUU estimates are currently under investigation (e.g., SC-CAMLR 2011).

As the quality and sustainability of harvesting practices can vary significantly between operators and areas, traceability is particularly important for fisheries catching these species. Measures are extensive, as described above, and include additional chain of custody traceability assessments in MSC-certified fisheries.

Table 2. Estimates of toothfish catches (tonnes, liveweight) resulting from illegal, unreported and unregulated fishing activities (sources: SC-CAMLR 2010; WWF/TRAFFIC = Lack, M. 2008).

Year	SC-CAMLR Catch estimate of IUU		WWF/TRAFFIC Trade estimate of IUU catch
	D. eleginoides	*D. mawsoni*	Both species
2003	7324	98	1380
2004	1744	434	6529
2005	1448	1135	8682
2006	714	2706	4473
2007	1609	3091	5671
2008	1303	409	
2009	88	850	
2010	133	1482	

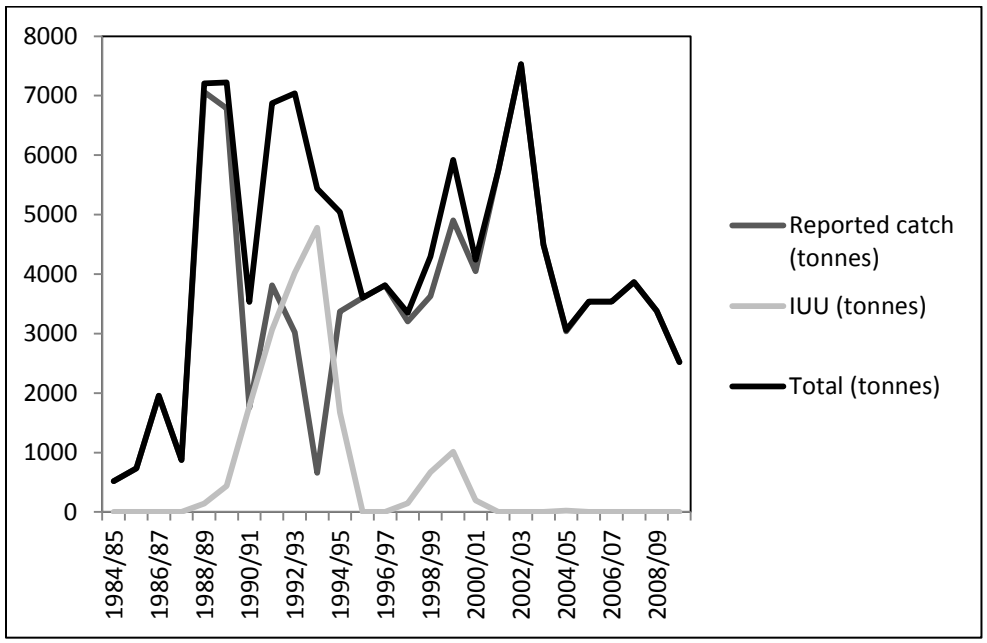

Figure 2. Catch history of the South Georgia toothfish fishery (tonnes caught by year, for the legal, IUU, and total catches) (data from SC-CAMLR 2011).

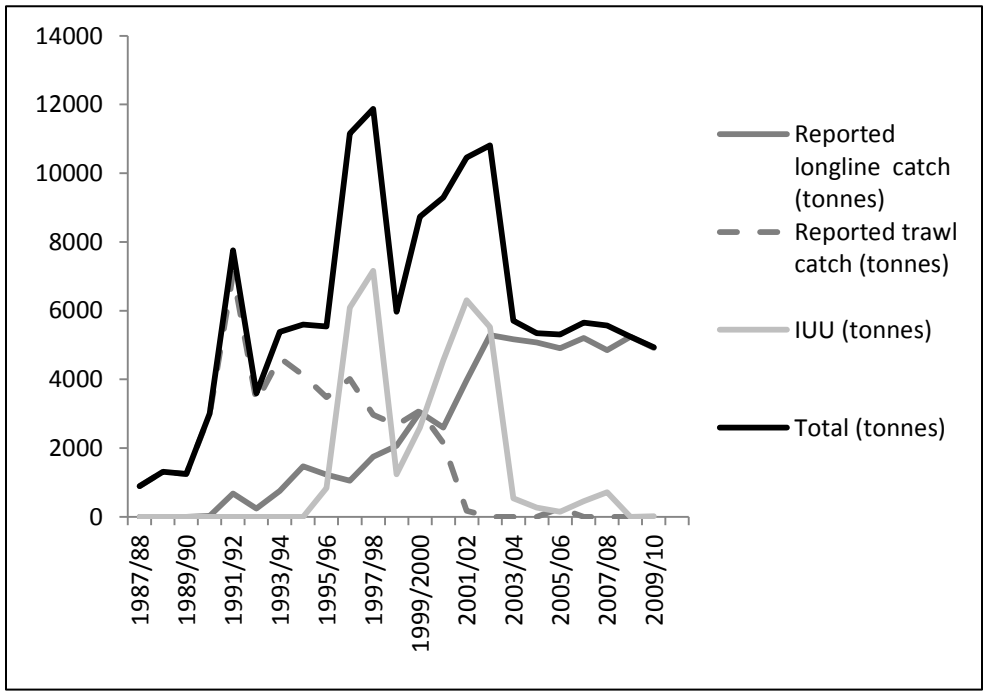

Figure 3. Catch history of the Kerguelen Islands toothfish fishery (tonnes caught by year, for the longline, trawl, IUU, and total catches) (data from SC-CAMLR 2011).

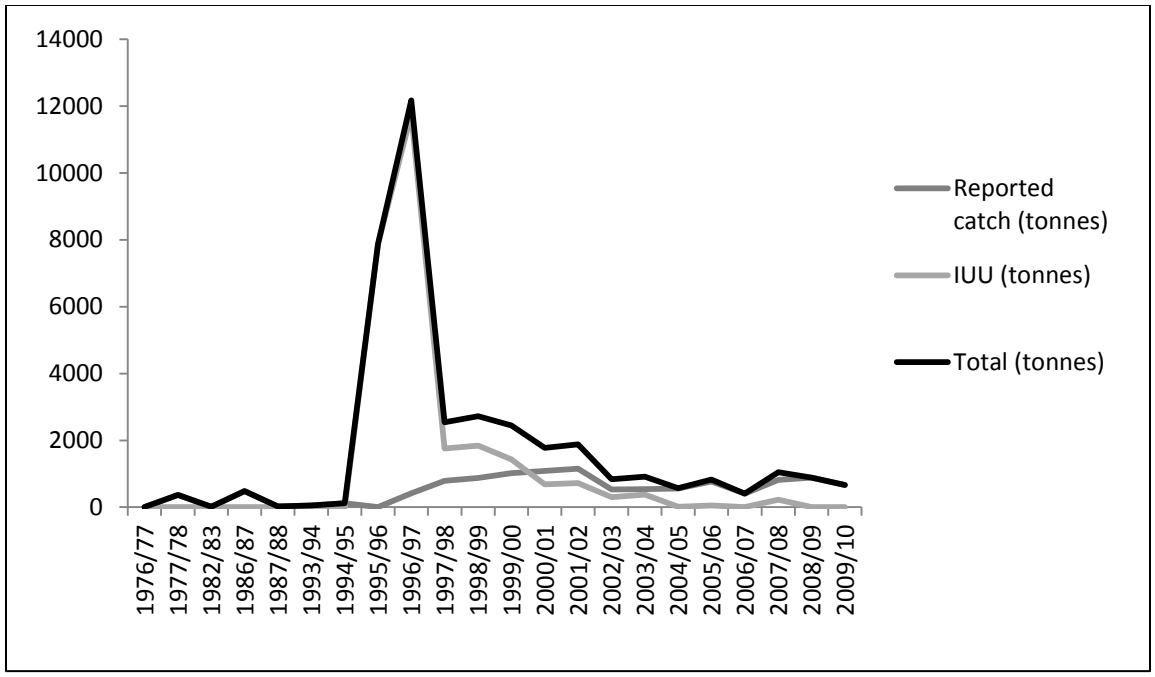

Figure 4. Catch history of the Crozet Islands toothfish fishery (tonnes caught by year, by legal and IUU fishing, and total catches) (data from SC-CAMLR 2011).

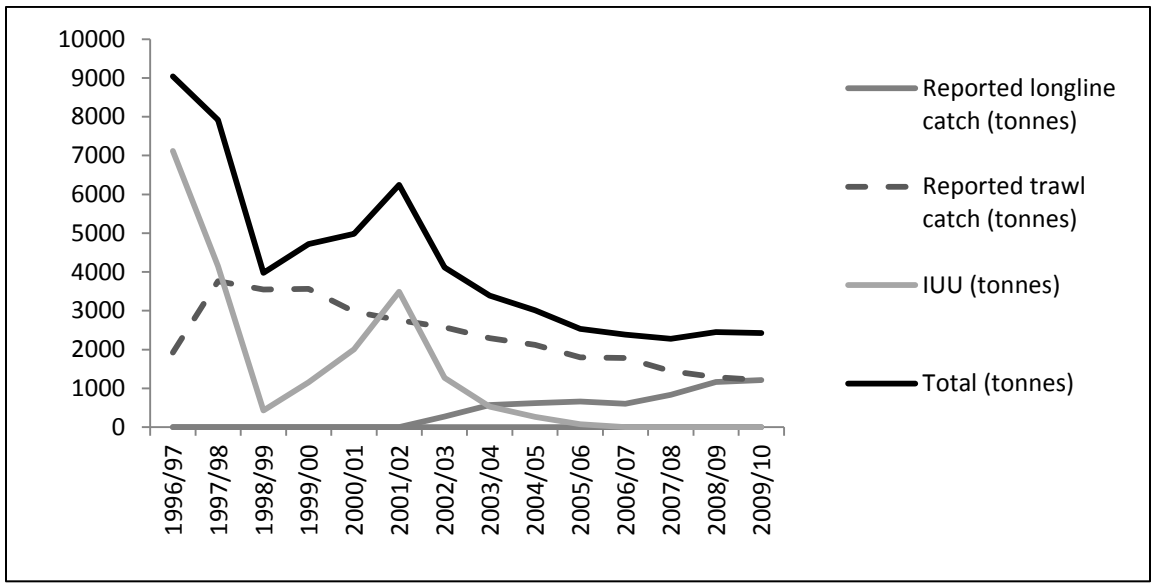

Figure 5. Catch history of the Heard and McDonald Islands toothfish fishery (tonnes caught by year, for the longline, trawl, IUU, and total catches) (data from SC-CAMLR 2011).

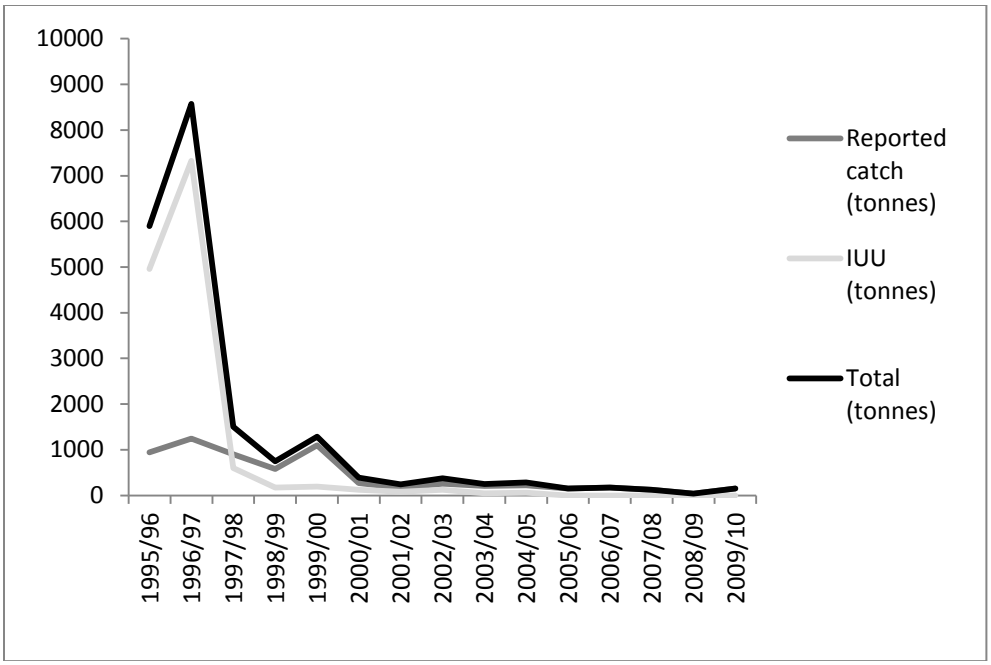

Figure 6. Catch history of the Prince Edward and Marion Islands toothfish fishery (CCAMLR subareas 58.6, 58.7; tonnes caught by year, for the legal, IUU, and total catches) (data from SC-CAMLR 2011).

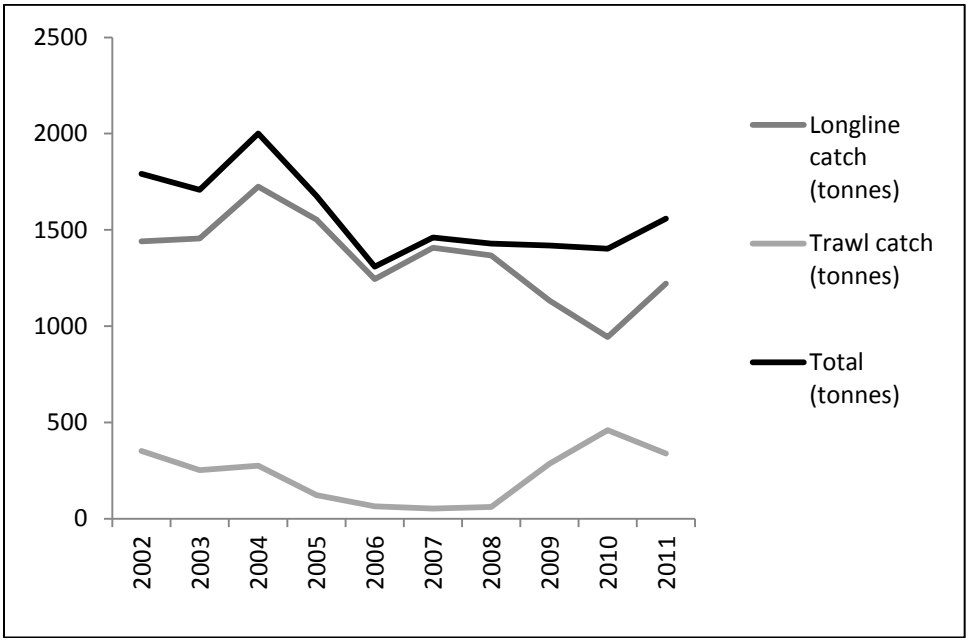

Figure 7. Catch history of the Falklands toothfish fishery (tonnes caught by year, for the longline, trawl, and total catches. Note this fishery is now comprised of one longline vessel (data from Falkland Islands Government 2012).

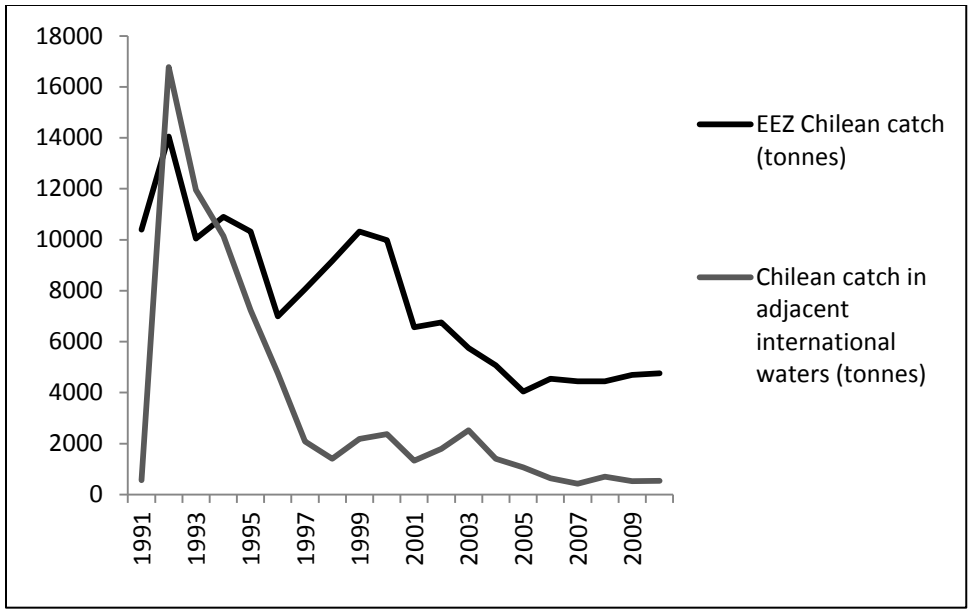

Figure 8. Catch history of the Chilean toothfish fishery (total tonnes caught by year) (data from Gálvez *et al.* 2011).

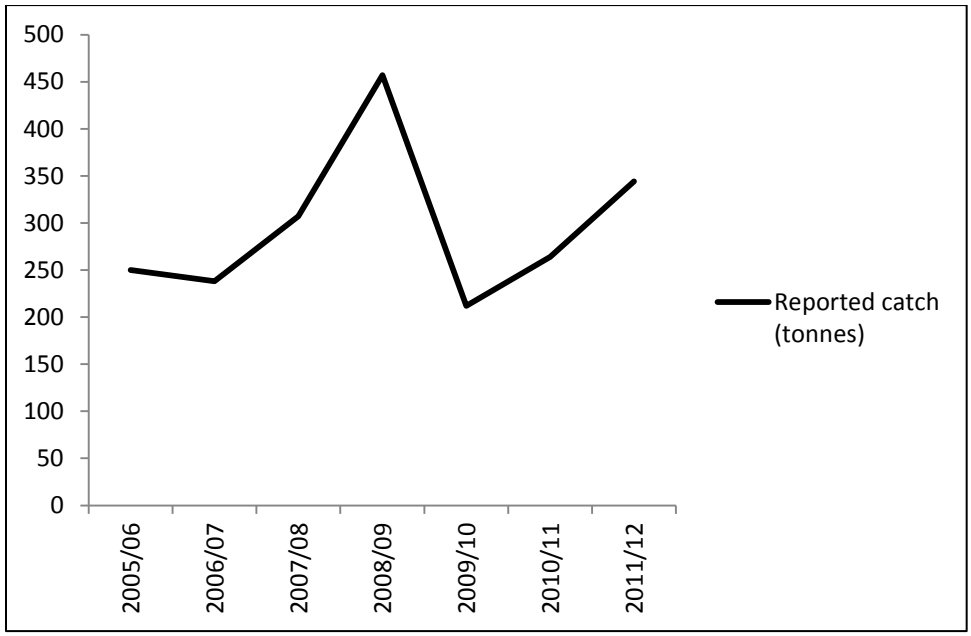

Figure 9. Recent catch in of the Macquarie Island toothfish fishery (total tonnes caught by year) (data from AFMA 2012a).

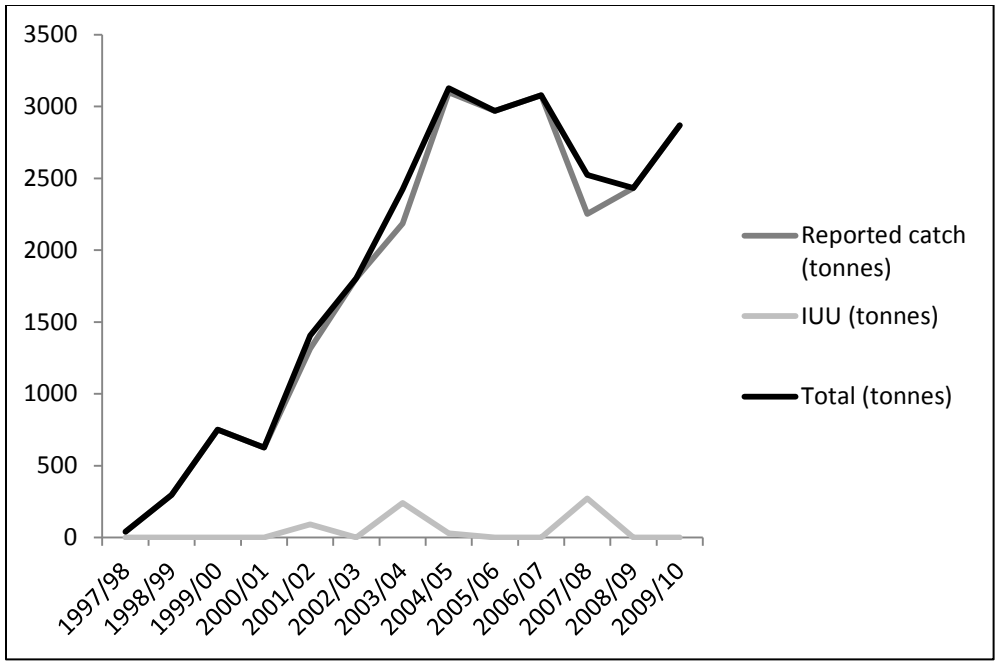

Figure 10. Catch history of the Ross sea toothfish fishery (*D. mawsoni*, tonnes caught by year, for the legal, IUU, and total catches) (data from SC-CAMLR 2011).

Importance to the US/North American market

Although not currently active in the toothfish fishery, the United States imports toothfish for domestic consumption and also re-exports it to a number of destinations, especially Chile, Canada, Japan, and Korea (Table 3).

Table 3. Imports and exports of toothfish into and out of the United States (tonnes, processed weight) by calendar year (Source: CCAMLR 2012).

Year	Imports	Exports	Export destinations, amounts (tonnes, processed weight)
2005	11380	69	Canada (54), Japan (13), Hong Kong (2)
2006	9411	86	Canada (45), Chile (27), Korea (14), United Arab Emirates (< 1), Japan (< 1)
2007	10175	44	Chile (29), Russia (9), Canada (6), United Arab Emirates (< 1), United Kingdom (< 1)
2008	9075	166	Chile (64), Japan (48), Korea (34), Canada (17), United Arab Emirates (3), Netherlands (< 1), United Kingdom (< 1)
2009	8954	114	Hong Kong (81), Chile (17), Canada (11), United Kingdom (4), Japan (1), Netherlands Antilles (< 1), Commonwealth of the Bahamas (< 1), Cayman Islands (< 1), St Kitts and Nevis (< 1), Trinidad and Tobago (< 1)

2010	8158	68	Chile (24), Canada (21), Uruguay (13), Dominican Republic (10), Netherlands Antilles (< 1), Antigua (< 1), Bahamas (< 1), Cayman Islands (< 1), Denmark (< 1), France (< 1), Trinidad and Tobago (< 1), Turkey (< 1)
2011	7859	106	Canada (51), Chile (17), Japan (17), Korea (16), United Arab Emirates (4), Antigua and Barbuda (< 1), Bahamas (< 1), Cayman Islands (< 1), Dominican Republic (1), France (< 1), Netherlands Antilles (< 1), St Kitts and Nevis (< 1), Trinidad and Tobago (< 1),United Kingdom (< 1)

Common and market names
Toothfish are commonly marketed in the United States as Chilean sea bass or Chilean seabass. Another less frequently used (English language) name is white cod (Froese and Pauly 2012; CCAMLR Identification Guide).

Primary product forms
Toothfish are typically processed aboard fishing vessels. Depending on the market, they may be chilled, fresh or frozen, gutted and filleted, or processed into the following cuts: cheeks, collars, heads, or 'headed, gutted and tailed' (Lack 2008; CCAMLR Identification Guide).

Analysis

Scoring guide

- All scores result in a zero to five final score for the criterion and the overall final rank. A zero score indicates poor performance, while a score of five indicates high performance.
- The full Seafood Watch Fisheries Criteria that the following scores relate to are available on our website at www.seafoodwatch.org.

Criterion 1: Stock for which you want a recommendation

Guiding principles

- The stock is healthy and abundant. Abundance, size, sex, age and genetic structure should be maintained at levels that do not impair the long-term productivity of the stock or fulfillment of its role in the ecosystem and food web.
- Fishing mortality does not threaten populations or impede the ecological role of any marine life. Fishing mortality should be appropriate given current abundance and inherent resilience to fishing while accounting for scientific uncertainty, management uncertainty, and non-fishery impacts such as habitat degradation.

Stock	Fishery	Inherent vulnerability Rank	Stock status Rank (score)	Fishing mortality Rank (score)	Criterion 1 Rank (score)
Crozet Island Patagonian Toothfish	Crozet Patagonian Toothfish – Longline	High	High concern (2)	Moderate concern (2.33)	Red (2.16)
Falkland Islands Patagonian Toothfish	Falkland Islands Patagonian Toothfish – Longline	High	Very low concern (5)	Very low concern (5)	Green (5)
Heard and McDonald Patagonian Toothfish	Heard and McDonald Island Patagonian Toothfish – Longline	High	Very low concern (5)	Very low concern (5)	Green (5)
Kerguelen Islands Patagonian Toothfish	Kerguelen Patagonian Toothfish – Longline	High	Low concern (4)	Low concern (3.67)	Green (3.83)

Macquarie Patagonian Toothfish	Macquarie Island Patagonian Toothfish – Longline	High	Very low concern (5)	Very low concern (5)	Green (5)
Ross Sea Antarctic Toothfish	Ross Sea Antarctic Toothfish – Longline	High	Low concern (4)	Low concern (3.67)	Green (3.83)
South Georgia Patagonian Toothfish	South Georgia Patagonian Toothfish – Longline	High	Very low concern (5)	Very low concern (5)	Green (5)
Chile Patagonian Toothfish	Chile Domestic Patagonian Toothfish – Longline	High	High concern (2)	High concern (1)	Red (1.41)
PE & MI Patagonian Toothfish	Prince Edward and Marion Islands Patagonian Toothfish – Longline	High	High concern (2)	Moderate concern (2.33)	Red (2.16)

Justification of ranking

Factor 1.1. Inherent vulnerability: High vulnerability

Key relevant information:

Patagonian and Antarctic toothfish are classified by FishBase as having high vulnerability (Froese and Pauly 2012).

Factor 1.2. Stock status

Key relevant information:

Stock assessment outputs and associated Seafood Watch rankings are summarized below (Table 4). Most toothfish stock assessments use CASAL (Bull *et al.* 2012). CASAL is a generalized

stock assessment model that includes options allowing for the implementation of age- or sex-structured models, single or multiple stocks, single or multiple areas, and maximum likelihood or Bayesian estimation. For all fisheries utilizing stock assessment models, these parameters are updated annually. For fisheries under the CAMLR Convention, decision rules are such that the lower yield of the following two options (i or ii) is implemented in the management approach: (i) the probability of the spawning biomass dropping below 20% of its median pre-exploitation level over a 35-year harvesting period is 10%, or (ii) the median escapement in the spawning stock biomass (SSB) over a 35-year period is 50% of the median pre-exploitation level at the end of the projection period (Constable *et al.* 2000). Constable *et al.* (2000) also describe the development of these decision rules and the assumptions inherent in them (e.g., regarding the ecological role of toothfish). Stocks in most areas are estimated to be above or close to their target levels.

IUU harvest, as estimated by CCAMLR, is included in the catch histories used in stock assessment models (SC-CAMLR 2011). The size and age distributions of catches are also reported annually for CCAMLR fisheries, allowing the detection of cohorts through time. Data included in assessments of toothfish stocks includes catch history, catch characteristics, survey results, and tagging data (e.g., SC-CAMLR 2011). Predation by cetaceans on hooked toothfish is a significant issue in some areas (particularly in Kerguelen and Crozet) but can be incorporated into stock assessment models (e.g., South Georgia, SC-CAMLR 2011).

Some fisheries outside the CAMLR Convention Area use the same reference points as described above (e.g., Macquarie Island). An exception is the Chilean domestic fishery, for which the management target is 30% of 'virgin' spawning stock biomass (using 1987 as the reference year).

For toothfish fisheries in this assessment, and with reference to the Seafood Watch criteria, a target reference point of $B_{current}/B_0$ or $SSB_{current}/SSB_0 \geq 0.5$ was applied. Uncertainties in conclusions drawn from stock assessment outputs arise from factors including changes in fishing fleet structure and gear, assumptions about recruitment, population structure, and the quality of tagging datasets. The size of captured fish has been noted to vary over time (e.g., in South Georgia, where fish weights and sizes decreased between 1995 and 1999, then subsequently increased; Kirkwood and Agnew 2001; SC-CAMLR 2004). Work in these areas continues (see below).

Table 4. Summary of stock assessment findings and Seafood Watch criteria. 'Future work' (underway in most cases) indicates recommended next steps for stock assessments, drawn from the references shown.

Patagonian toothfish				
Stock / fishery	**$B_{current}/B_0$ or $SSB_{current}/SSB_0$**	**Source**	**Future work**	**SFW criteria assessment**
South Georgia	0.53 (95% CI: 0.49 – 0.56)	SC-CAMLR 2011	• Examination of historical changes in fleet selectivity	Very low concern
Heard and McDonald Islands	0.63 0.61 – 0.65	Candy and Welsford 2009; Candy and Constable 2008; Lack *et al.* 2012; D. Welsford and M. Haddon, personal communications	• Re-estimation of the von Bertalanffy growth function using new data • Simplification of spatial structure of fishing selectivity functions • Investigation of a two-sex approach • Inclusion of tagging data to assist estimation of model parameters • Consideration of stock relationship with adjacent fisheries	Very low concern
Macquarie Island	~0.70 0.58 – 0.72 See text below	Fay 2011 Fay *et al.* 2011 M. Haddon, personal communication	• Estimation of movement parameters • Investigation of sensitivities, e.g., assumptions regarding mortality, growth, recruitment • Investigation of uncertainty in spatial parameter estimation	Very low concern
Prince Edward and Marion Islands	See text below	SC-CAMLR 2007 SC-CAMLR 2011 Leslie, R. personal communication	• Continue data collection underway to facilitate future modeling efforts	High concern

Crozet Islands	See text below	SC-CAMLR 2011	• Continuation of tagging program and data collection to allow stock assessment in future • Estimation of toothfish biological parameters	High concern
Kerguelen Islands	0.62–0.67 See text below	Rélot-Stirnemann 2011; SC-CAMLR 2012; See below	• Continuation of tagging program and relevant data collection to increase body of data available for modeling • Verification of data used in modeling • Interpretation of CPUE data and influence of IUU fishing • Biomass estimates • Consideration of stock relationship with adjacent fisheries	Low concern
Chile	0.18 – 0.38 See text below	Zuleta and Hopf 2010; Subsecretaria de Pesca 2011	• Investigate recruitment uncertainty • Continue and expand quantification of catch characteristics • Investigate spatial dynamics, including relationship with Argentinean fishery • Investigate selectivity • Continue data collection given gear changes from 2006: deployment of cachalotera and change in soak time • Data collection and verification to improve rigor of modeling	High concern

Falkland Islands	0.56 See text below	Laptikhovsky *et al.* 2012	• Continue investigation of the new modeling approach now in use for this fishery, especially given declines in SSB	Very low concern
Antarctic toothfish				
Ross Sea	0.80 (95% CI: 0.78 – 0.82) See text below	SC-CAMLR 2011	• Refine method for selection of high quality tagging datasets • Use simulation evaluation methods to investigate the robustness of different assessment methods for achieving CCAMLR's objectives	Low concern

Macquarie Island Patagonian toothfish
Differences in the ratios of $B_{current}/B_0$ arise from the spatial structure of models, i.e., delineation of modelled areas (Fay 2011; Fay *et al.* 2011). The Seafood Watch criteria identify the stock status as a very low concern.

Prince Edward and Marion Islands Patagonian toothfish
There are indications that the stock in this area was extremely depleted by IUU fishing prior to the mid-1990s, such that the biomass remaining was at most a few percent of the pre-exploitation levels (Brandão *et al.* 2002). An exploratory model, constructed with parameters derived from toothfish in other parts of the CAMLR Convention Area but applied to this fishery, concluded that the spawning biomass of Patagonian toothfish was estimated to be at 37% of its average pre-exploitation level (SC-CAMLR 2007). Recent gear changes in this fishery render historic data of limited utility in determining catch per unit effort and stock trajectories. Consequently, an Operational Management Procedure has been derived in lieu of a stock assessment; it is currently in revision. Development of this procedure has focused on catch levels needed to ensure economic rather than biological viability (Brandão and Butterworth 2009). However, total allowable catch levels in this area continue to be low (SC-CAMLR 2011). The modal value of catch-weighted length frequency distributions has increased in the years since 2005; most toothfish are 50–120 cm in length (modal length ~ 60–90 cm) (SC-CAMLR 2011). Seafood Watch criteria identify the stock status as a high concern.

Crozet Islands Patagonian toothfish
No stock assessment has been carried out in this area (SC-CAMLR 2011), and the stock vulnerability is classified as high (see Section 1.1, above). Some variability is evident in length-frequency distributions of fish caught. The modal sizes of fish caught in recent seasons are 55–80 cm, compared to 70–80 cm in length in the mid-1990s. Most fish caught are 50–120 cm long (SC-CAMLR 2011). Seafood Watch criteria identify the stock status as a high concern.

Kerguelen Islands Patagonian toothfish
An assessment agreed to by CCAMLR has been completed for application to management in 2012/13. Modelling work conducted using CASAL has generated an estimated ratio for SSB_{2011}/B_0 of 0.62–0.67. Work continues in refining this assessment, which will be reconsidered by CCAMLR in the future (Rélot-Stirnemann 2011; SC-CAMLR 2012). The catch-weighted length-frequency distributions for this fishery show that most fish caught are 40–120 cm in length. The modal length range has been 60–80 cm in recent seasons, compared to 80–100 cm in the early years of monitoring (SC-CAMLR 2011). Seafood Watch criteria identify the stock status as a low concern given the availability of a stock assessment with significant uncertainty.

Chile Patagonian toothfish
Several methods have been used to model this fishery, and outputs of the different models have varied (Gálvez *et al.* 2011). The domestic management target for this stock is 30% of SSB_0. Currently, the stock is classified as overfished with a high risk of depletion. The stock is estimated to be at 18–38% of B_0 (Zuleta and Hopf 2010; Subsecretaria de Pesca 2011). However, it is also considered to have been stable at low abundance for almost 10 years (Zuleta and Hopf 2010). Depending on the model used, the stock was previously considered to be from just under 12% B_0 to over 20% B_0 and showing signs of depletion (Ministerio de Economía, Fomento y Turismo Subsecretaría de Pesca 2010). This stock is also fished in Argentinean waters (Gálvez *et al.* 2011; Zuleta and Rubilar 2011) with the same management target (M. Exel, personal communication). There are significant uncertainties inherent in the modeling, from the nature and extent of the data itself through to uncertainty brought about by assumptions and recent gear changes. Further work is expected to improve this assessment. Seafood Watch criteria identify the stock status as a high concern.

Falkland Islands Patagonian toothfish
The total biomass of this stock is reported to be increasing (Laptikhovsky *et al.* 2012) while spawning stock biomass has declined over time, stabilizing at levels above 50% B_0 (V. Laptokhovsky, personal communication). The model currently in use is new and requires careful monitoring to ensure it supports delivery on management goals. The ratio of $SSB_{current}$ to SSB_0 is 0.56 (Laptikhovsky *et al.* 2012). Seafood Watch criteria identify the stock status as a very low concern.

Ross Sea Antarctic toothfish
Controversy around the stock assessment model for the Ross Sea has highlighted the model's usage of fishery-dependent data. Ongoing information collection includes fishery-dependent data and fishery-independent data such as a pre-recruit research survey conducted in 2011/12

(Conservation Measure 41-09; SC-CAMLR 2011), and a second survey planned for 2012/13 (SC-CAMLR 2012). The model has been scrutinized and ultimately accepted by a variety of stock assessment experts (it is annually reviewed at meetings of CCAMLR's Fish Stock Assessment Working Group (SC-CAMLR 2011) and as part of the process resulting in Marine Stewardship Council certification (Akroyd *et al.* 2010; Lodge 2010)). Catch-weighted length-frequency distributions show consistency over recent seasons, and there is no evidence of length truncation over time. Distributions over time show peak lengths of ~ 75–150 cm (SC-CAMLR 2011). The stock is estimated to be at ~80% of B_0 (SC-CAMLR 2011); target biomass for the fishery is 50% of B0. While a biomass so far above target reference points and so close to virgin biomass would generally be considered a "very low concern," there is considerable uncertainty in this stock assessment, particularly because there are no fishery-independent data and steepness is unknown, but based on averages for marine teleosts in other parts of the world as reported in Myers et al. 1999 (Dunn et al. 2006). However, the stock assessment is considered best available science and there is no evidence suggesting that abundance is actually below target levels. Uncertainty around stock structure leads to lowering the score for stock status to a low concern, rather than a very low concern, according to Seafood Watch criteria.

Factor 1.3. Fishing mortality

Key relevant information:

When values of fishing mortality (F) were available, they were included below. The meaning of F can be defined as the proportion of total mortality of a fish stock that is accounted for by fishing (Ministry of Fisheries 2011). However, in most models of toothfish stocks, F is not calculated for reasons that include the spatial complexity of the models used to describe these fisheries. Instead, an estimate of the sustainability of harvest can be gleaned from the use of *U*, the exploitation rate, i.e., the proportion of recruited or vulnerable biomass caught during a specified period (Ministry of Fisheries 2011). The value of *U* is calculated as the maximum posterior density (MPD) estimate of annual catch divided by the spawning stock biomass. Where *U* is less than natural mortality (*M*), stocks are deemed to be able to support that level of exploitation (A. Dunn, personal communication).

Table 5. Summary of fishery mortality and Seafood Watch criteria.

Patagonian toothfish				
Stock / fishery	**Natural mortality (*M*)**	**Exploitation rate (*U*) or fishing mortality (*F*)**	**Source**	**SFW assessment**
South Georgia	0.13 see text below	***U***: 0.06	Collins, M. personal communication; SC-CAMLR 2011	Very low concern
Heard and	0.155	***U***: 0.02	SC-CAMLR 2011	Very low

McDonald Islands				concern
Macquarie Island	0.13	***U***: 0.05	Fay 2011 Fay *et al.* 2011 M. Haddon, personal communication	Very low concern
Prince Edward and Marion Islands	See text below		Brandão *et al.* 2002; Brandão and Butterworth 2009	Moderate concern
Crozet Islands	See text below		SC-CAMLR 2011	Moderate concern
Kerguelen Islands	0.155 See text below	***U***: 0.04	Rélot-Stirnemann 2011; SC-CAMLR 2012; See below	Low concern
Chile	0.14 See text below	***F***: ~0.1	Zuleta and Hopf 2010; Subsecretaria de Pesca 2011	High concern
Falkland Islands	0.13	***U***: 0.09; ***F*** = 0.038–0.042 for 2005–2011	Laptikhovsky, V. personal communication; Falkland Islands Government 2012; Laptikhovsky *et al.* 2012	Very low concern
Antarctic toothfish				
Ross Sea	0.13	0.05	SC-CAMLR 2011	Low concern

Patagonian toothfish

South Georgia Patagonian toothfish
Catch-weighted length frequency distributions for toothfish were variable in the 1980s and 1990s but have stabilized in recent years with a peak at around 75 cm. Seafood Watch criteria identify fishing mortality as a very low concern.

Heard and McDonald Islands toothfish
Catch-weighted length-frequency distributions for this fishery area show that smaller fish are caught at shallower depths. The modal size of longline-caught fish is around 75 cm (SC-CAMLR 2011). Seafood Watch criteria identify fishing mortality as a very low concern.

Prince Edward and Marion Islands Patagonian toothfish
Catch limits in this fishery are not currently set according to CAMLR Convention principles, and attempts to assess the status of the stock have delivered contrary results (Brandão *et al.* 2002;

Brandão and Butterworth 2009). No estimates of *F* or *U* are available. This stock meets the Seafood Watch criteria for a classification of a moderate concern.

Crozet Islands Patagonian toothfish
There is no stock assessment available for this fishery (SC-CAMLR 2011), and estimates of *F* and *U* are not available. Consequently, this stock meets the Seafood Watch criteria for a classification of moderate concern.

Kerguelen Islands Patagonian toothfish
A stock assessment has been accepted to guide management of this fishery for 2012/13. However, there are uncertainties inherent in the assessment that require resolution prior to its use for longer-term management (SC-CAMLR 2012). Coincident with the Heard and McDonald Islands assessments, a value for *M* of 0.155 was used for this fishery (SC-CAMLR 2011). Using the estimates of SSB produced to date (Rélot-Stirnemann 2011), the exploitation rate was assessed as 0.04. Given the stock assessment work underway, this fishery is considered a low concern.

Chile Patagonian toothfish
In 2011, the Subsecretaría de Pesca reported that *F>M* and that there was a high risk of stock depletion (Subsecretaría de Pesca 2011). This value of F applies to the industrial fishery only. Fishery mortality due to the artisanal fishery is unknown. An evaluation of high concern is made for this fishery.

Ross Sea
Fishery mortality is assessed as a low concern, with some uncertainty around stock structure.

Criterion 2: Impacts on other retained and bycatch stocks

Guiding principles

- The fishery minimizes bycatch. Seafood Watch® defines bycatch as all fisheries-related mortality or injury other than the retained catch. Examples include discards, endangered or threatened species catch, pre-catch mortality and ghost fishing. All discards, including those released alive, are considered bycatch unless there is valid scientific evidence of high post-release survival and there is no documented evidence of negative impacts at the population level.
- Fishing mortality does not threaten populations or impede the ecological role of any marine life. Fishing mortality should be appropriate given each impacted species' abundance and productivity, accounting for scientific uncertainty, management uncertainty and non-fishery impacts such as habitat degradation.

Patagonian toothfish

South Georgia

Stock	Inherent vulnerability Rank	Stock status Rank (score)	Fishing mortality Rank (score)	Subscore	Score (subscore*discard modifier)	Rank (based on subscore)
Grenadiers	High	High concern (2)	Moderate concern (2.33)	2.16	2.16	Red
Skates and rays	High	High concern (2)	Moderate concern (2.33)	2.16	2.16	Red
Corals and biogenic habitats	High	High concern (2)	Low concern (3.67)	2.71	2.71	Yellow
Benthic invertebrates	High	High concern (2)	Low concern (3.67)	2.71	2.71	Yellow
Porbeagle South Georgia	High	High concern (2)	Very low concern (5)	3.16	3.16	Yellow
Antarctic starry skate South Georgia	High	High concern (2)	Very low concern (5)	3.16	3.16	Yellow
Orca	High	Low concern (4)	Very low concern (5)	4.47	4.47	Green

Elephant seal	High	Very low concern (5)	Very low concern (5)	5.00	5.00	Green

Kerguelen Islands

Stock	**Inherent vulnerability** Rank	**Stock status** Rank (score)	**Fishing mortality** Rank (score)	**Subscore**	**Score** (subscore*discard modifier)	**Rank** (based on subscore)
Ridge scaled rattail Kerguelen	High	High concern (2)	Moderate concern (2.33)	2.16	2.16	Red
White-chinned petrel	High	High concern (2)	Moderate concern (2.33)	2.16	2.16	Red
Whiteleg skate Kerguelen	High	High concern (2)	Moderate concern (2.33)	2.16	2.16	Red
Grey petrel	High	High concern (2)	Moderate concern (2.33)	2.16	2.16	Red
Raya spp.	High	High concern (2)	Moderate concern (2.33)	2.16	2.16	Red
Corals and biogenic habitats	High	High concern (2)	Low concern (3.67)	2.71	2.71	Yellow
Benthic invertebrates	High	High concern (2)	Low concern (3.67)	2.71	2.71	Yellow
Rockhopper penguin	High	High concern (2)	Very low concern (5)	3.16	3.16	Yellow
Giant petrel	High	Very low concern (5)	Very low concern (5)	5.00	5.00	Green

Crozet Islands

Stock	**Inherent vulnerability** Rank	**Stock status** Rank (score)	**Fishing mortality** Rank (score)	**Subscore**	**Score** (subscore*discard modifier)	**Rank** (based on subscore)
Whiteleg skate Crozet	High	High concern (2)	Moderate concern (2.33)	2.16	2.05	Red

Ridge scaled rattail Crozet	High	High concern (2)	Moderate concern (2.33)	2.16	2.05	Red
Grey petrel	High	High concern (2)	Moderate concern (2.33)	2.16	2.05	Red
White-chinned petrel	High	High concern (2)	Moderate concern (2.33)	2.16	2.05	Red
Corals and biogenic habitats	High	High concern (2)	Low concern (3.67)	2.71	2.57	Yellow
Benthic invertebrates	High	High concern (2)	Low concern (3.67)	2.71	2.57	Yellow
Violet cod Crozet	High	Low concern (4)	Low concern (3.67)	3.83	3.64	Green
Giant petrel	High	Very low concern (5)	Very low concern (5)	5.00	4.75	Green

Heard and McDonald Islands longline

Stock	**Inherent vulnerability** Rank	**Stock status** Rank (score)	**Fishing mortality** Rank (score)	**Subscore**	**Score** (subscore*discard modifier)	**Rank** (based on subscore)
Murray's skate Heard and McDonald	Medium	High concern (2)	Low concern (3.67)	2.71	2.71	Yellow
Kerguelen sandpaper skate	Medium	High concern (2)	Low concern (3.67)	2.71	2.71	Yellow
Pacific sleeper shark	High	High concern (2)	Low concern (3.67)	2.71	2.71	Yellow
Corals and biogenic habitats	High	High concern (2)	Low concern (3.67)	2.71	2.71	Yellow
Skates and rays	High	High concern (2)	Low concern (3.67)	2.71	2.71	Yellow
Benthic invertebrates	High	High concern (2)	Low concern (3.67)	2.71	2.71	Yellow
Grey-headed albatross	High	High concern (2)	Very low concern (5)	3.16	3.16	Yellow

Black-browed albatross	High	High concern (2)	Very low concern (5)	3.16	3.16	Yellow
Whitson's grenadier Heard and McDonald	High	Very low concern (5)	Very low concern (5)	5.00	5.00	Green
Elephant seal	High	Very low concern (5)	Very low concern (5)	5.00	5.00	Green
Southern lantern shark	Medium	Very low concern (5)	Very low concern (5)	5.00	5.00	Green

Macquarie Island

Stock	**Inherent vulnerability** Rank	**Stock status** Rank (score)	**Fishing mortality** Rank (score)	**Subscore**	**Score** (subscore*discard modifier)	**Rank** (based on subscore)
Southern sleeper shark	High	High concern (2)	Low concern (3.67)	2.71	2.71	Yellow
Corals and biogenic habitats	High	High concern (2)	Low concern (3.67)	2.71	2.71	Yellow
Benthic invertebrates	High	High concern (2)	Low concern (3.67)	2.71	2.71	Yellow

Falkland Islands

Stock	**Inherent vulnerability** Rank	**Stock status** Rank (score)	**Fishing mortality** Rank (score)	**Subscore**	**Score** (subscore*discard modifier)	**Rank** (based on subscore)
Antarctic starry skate	High	High concern (2)	Low concern (3.67)	2.71	2.71	Yellow
White-mouth skate	High	High concern (2)	Low concern (3.67)	2.71	2.71	Yellow
Porbeagle Falklands	High	High concern (2)	Low concern (3.67)	2.71	2.71	Yellow
Joined-fins skate	Medium	High concern (2)	Low concern (3.67)	2.71	2.71	Yellow

Multispined skate	High	High concern (2)	Low concern (3.67)	2.71	2.71	Yellow
White-dotted skate	Low	High concern (2)	Low concern (3.67)	2.71	2.71	Yellow
Darkbelly skate	High	High concern (2)	Low concern (3.67)	2.71	2.71	Yellow
Corals and biogenic habitats	High	High concern (2)	Low concern (3.67)	2.71	2.71	Yellow
Big-eye grenadier Falklands	High	High concern (2)	Low concern (3.67)	2.71	2.71	Yellow
Benthic invertebrates	High	High concern (2)	Low concern (3.67)	2.71	2.71	Yellow
Ridge scaled rattail Falklands	High	Low concern (4)	Low concern (3.67)	3.83	3.83	Green
Minke whale	High	Low concern (4)	Very low concern (5)	4.47	4.47	Green
Snowy sheathbill	High	Very low concern (5)	Very low concern (5)	5.00	5.00	Green

Prince Edward and Marion Islands

Stock	**Inherent vulnerability** Rank	**Stock status** Rank (score)	**Fishing mortality** Rank (score)	**Subscore**	**Score** (subscore*discard modifier)	**Rank** (based on subscore)
Corals and biogenic habitat	High	High concern (2)	Low concern (3.67)	2.71	2.71	Yellow
Benthic invertebrates	High	High concern (2)	Low concern (3.67)	2.71	2.71	Yellow
Grenadiers PE&MI	High	Low concern (4)	Low concern (3.67)	3.83	3.83	Green
Rajids	High	Moderate concern (3)	Very low concern (5)	3.87	3.87	Green

Chile

Stock	**Inherent vulnerability** Rank	**Stock status** Rank (score)	**Fishing mortality** Rank (score)	**Subscore**	**Score** (subscore*discard modifier)	**Rank** (based on subscore)
Yellownose skate	High	High concern (2)	Moderate concern (2.33)	2.16	2.16	Red
Piked dogfish	High	High concern (2)	Moderate concern (2.33)	2.16	2.16	Red
Thickbody skate	High	High concern (2)	Moderate concern (2.33)	2.16	2.16	Red
Big-eye grenadier	High	High concern (2)	Moderate concern (2.33)	2.16	2.16	Red
Corals and biogenic habitat	High	High concern (2)	Low concern (3.67)	2.71	2.71	Yellow
Ridge scaled rattail Chile	High	High concern (2)	Low concern (3.67)	2.71	2.71	Yellow
Benthic invertebrates	High	High concern (2)	Low concern (3.67)	2.71	2.71	Yellow
Chilean grenadier	Medium	Moderate concern (3)	Low concern (3.67)	3.32	3.32	Green
Banded whiptail	Medium	Moderate concern (3)	Low concern (3.67)	3.32	3.32	Green

Antarctic toothfish

Ross Sea

Stock	**Inherent Vulnerability** Rank	**Stock Status** Rank (Score)	**Fishing Mortality** Rank (Score)	**Subscore**	**Score** (subscore*discard modifier)	**Rank** (based on subscore)
Grenadiers	High	High Concern (2)	Moderate Concern (2.33)	2.16	2.16	Red

Skates and rays	High	High Concern (2)	Moderate Concern (2.33)	2.16	2.16	Red
Antarctic starry skate Ross Sea	High	High Concern (2)	Low Concern (3.67)	2.71	2.71	Yellow
Corals and biogenic habitats	High	High Concern (2)	Low Concern (3.67)	2.71	2.71	Yellow
Benthic invertebrates	High	High Concern (2)	Low Concern (3.67)	2.71	2.71	Yellow
Eaton's skate Ross Sea	High	High Concern (2)	Very Low Concern (5)	3.16	3.16	Yellow
MacCain's skate	High	High Concern (2)	Very Low Concern (5)	3.16	3.16	Yellow
Whitson's grenadier Ross Sea	High	Low Concern (4)	Low Concern (3.67)	3.83	3.83	Green

Justification of Ranking

Factor 2.1 Inherent Vulnerability

Key relevant information:

Inherent vulnerability assessments were drawn from FishBase for all fish species evaluated here (www.fishbase.org, Froese, R. and Pauly, D. 2012). For seabirds and marine mammals, vulnerability was assessed as high as per the Seafood Watch criteria. Bycatch largely comprises species of high and medium inherent vulnerability and includes some groups that are recognized as being particularly vulnerable to removal at the population level (e.g., sharks, skates, rays).

Factor 2.2 Stock status

Key relevant information:

Where listed by the IUCN (i.e., seabirds, marine mammals, sharks, skates and rays; IUCN 2012), stock status of bycaught species was classified in accordance with their IUCN status, as required by the Seafood Watch criteria. Stock or population assessments do not exist for most bycatch species. Also, species from the most commonly bycaught fish taxa are sometimes reported at the genus level (e.g., *Macrourus* spp., *Raja* spp., CCAMLR 2012). Almost all non-target species caught in toothfish fisheries are caught at levels comprising less than 5% of the catch (i.e., the amount guiding Seafood Watch's identification of a 'main' bycatch species. Data from 2008/09 onwards, CCAMLR 2012; Lack *et al.* 2012; Morison *et al.* 2012; J. Barton personal communication; Table 6). The vulnerability of some bycatch species (e.g., skates and rays) to overexploitation has been considered through assessing species caught at levels comprising more than 1% of total catch (Table 6). The effects of IUU fishing on bycatch species are not considered explicitly in this assessment but are recognized as potentially significant (largely in the past for the fisheries considered here, CCAMLR 1997; CCAMLR 2011a).

Patagonian toothfish

South Georgia

Species		Stock status	Basis for assessment	References
Corals and biogenic habitats		High concern	SFW Unknown bycatch matrix	
Benthic invertebrates		High concern	SFW Unknown bycatch matrix	
Porbeagle	*Lamna nasus*	High concern	IUCN status	IUCN 2012
Grenadier	*Macrourus* spp.	High concern	When species unidentified, no information showing stock status with respect to reference points; Stock resilience is low (as scored in Factor 1.1).	CCAMLR 2012
Skates and rays	*Rajiformes* spp.	High concern	Includes species classified as threatened by IUCN	IUCN 2012
Antarctic starry skate	*Raja georgiana*	High concern	IUCN status	IUCN 2012
Orca	*Orcinus orca*	Low concern	IUCN status of Data deficient, global population estimated at 50,000; Single capture reported since 2008	SC-CAMLR 2009; IUCN 2o12
Elephant seal	*Mirounga leonina*	Very low concern	IUCN status of Least concern	IUCN 2012

Macquarie Island

Species		Stock status	Basis for assessment	References
Corals and biogenic habitats		High concern	SFW Unknown bycatch matrix	
Benthic invertebrates		High concern	SFW Unknown bycatch matrix	
Southern sleeper shark	*Somniosus antarcticus*	High concern	IUCN status of Data deficient	IUCN 2012

Kerguelen Islands

Species		Stock status	Basis for assessment	References
Corals and biogenic habitats		High concern	SFW Unknown bycatch matrix	
Benthic invertebrates		High concern	SFW Unknown bycatch matrix	
White-chinned petrel	*Procellaria aequinoctialis*	High concern	IUCN status	IUCN 2012
Grey petrel	*Procellaria cinerea*	High concern	IUCN status	IUCN 2012
Rays	*Raja* spp.	High concern	IUCN status of some species in this group	IUCN 2012
Skates and rays	*Rajiformes*	High concern	IUCN status of some species in this group	IUCN 2012
Ridge scaled rattail	*Macrourus carinatus*	High concern	No evidence to suggest stock is above or below reference points; Unknown and Stock resilience is low (as scored in Factor 1.1)	CCAMLR 2012
Whiteleg skate	*Raja taaf*	High concern	IUCN status	IUCN 2012
Rockhopper penguin	*Eudyptes chrysocome*	High concern	IUCN status	IUCN 2012
Giant petrel	*Macronectes hallii*	Very low concern	IUCN classification of Least Concern	IUCN 2012

Crozet Islands

Species		Stock status	Basis for assessment	References
Corals and biogenic habitats		High concern	SFW Unknown bycatch matrix	
Benthic invertebrates		High concern	SFW Unknown bycatch matrix	
White-chinned petrel	*Procellaria aequinoctialis*	High concern	IUCN status	IUCN 2012
Grey petrel	*Procellaria cinerea*	High concern	IUCN status	IUCN 2012
Ridge scaled rattail	*Macrourus carinatus*	High concern	No evidence to suggest stock is above or below reference points; Unknown and Stock resilience is low (as scored in Factor 1.1)	CCAMLR 2012
Violet cod	*Antimora rostrata*	Low concern	Stock is classified as not overfished but quantitative stock assessment is lacking; volume of captures: 0.5-86 t/year 2001-2011; circumglobal distribution	CCAMLR 2012; Froese, R. and Pauly, D. 2012
Giant petrel	*Macronectes hallii*	Very low concern	IUCN status of Least Concern	IUCN 2012
Whiteleg skate	*Raja taaf*	High concern	IUCN status	IUCN 2012

Heard and McDonald Islands Longline

Species		Stock status	Basis for assessment	References
Corals and biogenic habitats		High concern	SFW Unknown bycatch matrix	
Benthic invertebrates		High concern	SFW Unknown bycatch matrix	
Kerguelen sandpaper skate	*Bathyraja irrasa*	High concern	IUCN status	IUCN 2012
Grey-headed albatross	*Thalassarche chrysostoma*	High concern	IUCN status	IUCN 2012
Black-browed albatross	*Thalassarche melanophris*	High concern	IUCN status	IUCN 2012
Murray's skate	*Rhinoraja murrayi*	High concern	IUCN status	IUCN 2012
Pacific sleeper shark	*Somniosus pacificus*	High concern	Level 3 risk assessment; Volume of captures (0-3 t/year 2001-2011)	Zhou, S. et al. 2009; CCAMLR 2012
Skates and rays	*Rajiformes* spp.	High concern	IUCN status of species that may comprise this group.	IUCN 2012
Elephant seal	*Mirounga leonina*	Very low concern	IUCN status of Least concern; Two captures reported since 2008	SC-CAMLR 2009; IUCN 2012
Whitson's grenadier	*Macrourus whitsoni*	Very low concern	Level 3 risk assessment;Volume of captures (0-64 t/year 2001-2011)	Zhou, S. et al. 2009; CCAMLR 2012
Southern lantern shark	*Etmopterus granulosus*	Very low concern	Stock close to virgin biomass, quantitative stock assessment is lacking but Level 3 risk assessment completed; Volume of captures (0-0.5 t/year 2001-2011)	Zhou, S. et al. 2009; CCAMLR 2012

Falkland Islands

Species		Stock status	Basis for assessment	References
Corals and biogenic habitats		High concern	SFW Unknown bycatch matrix	
Benthic invertebrates		High concern	SFW Unknown bycatch matrix	
White-mouth skate	*Bathyraja papilonifera*	Moderate concern	IUCN status of Data deficient	IUCN 2012
Antarctic starry skate	*Amblyraja georgiana*	High concern	IUCN status of Data deficient	IUCN 2012
Porbeagle	*Lamna nasus*	High concern	IUCN status of Vulnerable	IUCN 2012
Joined-fins skate	*Bathyraja cousseauae*	High concern	IUCN status of Near threatened	IUCN 2012
Multispined skate	*Bathyraja (Rhinoraja) multispinis*	High concern	IUCN status of Near threatened	IUCN 2012
Whitedotted skate	*Rhinoraja albomaculata*	High concern	IUCN status of Vulnerable	IUCN 2012
Darkbelly skate	*Bathyraja meridionalis*	High concern	IUCN status of Data deficient; Volume of captures (4.1 - 10.3 t/year 2009 - 2011)	Laptikhovsky, V. Personal communication; IUCN 2012
Big-eye grenadier	*Macrourus holotrachys*	High concern	No evidence to suggest stock is above or below reference points; Unknown and Stock resilience is low (as scored in Factor 1.1), 58 - 78 t caught/year, 2009 - 2011	Laptikhovsky, V. Personal communication
Ridge scaled rattail	*Macrourus carinatus*	Low concern	Stock is classified as not overfished but quantitative stock assessment is lacking; wide distribution across the Southern Oceans; Volume of captures: 16 - 22 t/year 2009 - 2011	Laptikhovsky, V. Personal communication; Froese, R. and Pauly, D. 2012
Minke whale	*Balaenoptera bonaerensis*	Low concern	IUCN status of Data deficient; Single capture recorded since 2009	IUCN 2012; Laptikhovsky, V. Personal communication

Chile

Species		Stock status	Basis for assessment	References
Benthic invertebrates		High concern	SFW Unknown bycatch matrix	
Corals and biogenic habitat		High concern	SFW Unknown bycatch matrix	
Yellownose skate	*Zearaja chilensis*	High concern	IUCN status	IUCN 2012
Piked dogfish	*Squalus acanthias*	High concern	IUCN status	IUCN 2012
Thickbody skate	*Amblyraja frerichsi*	High concern	IUCN status	IUCN 2012
Big-eye grenadier	*Macrourus holotrachys*	High concern	No information showing stock status with respect to reference points; Stock resilience is low (as scored in Factor 1.1).	F. Goyeneche, unpubl.
Chilean grenadier	*Coelorhynchus chilensis*	Moderate concern	No information showing stock status with respect to reference points; Stock resilience is moderate (as scored in Factor 1.1).	Galvez, P. et al. 2011
Ridge scaled rattail	*Macrourus carinatus*	High concern	stock status with respect to reference points; Stock resilience is low (as	Galvez, P. et al. 2011; F. Goyeneche, unpubl.
Banded whiptail	*Coelorhynchus fasciatus*	Moderate concern	No information showing stock status with respect to reference points; Stock resilience is moderate (as scored in Factor 1.1).	Galvez, P. et al. 2011

Prince Edward and Marion Islands

Species		Stock status	Basis for assessment	References
Corals and biogenic habitat		High concern	SFW Unknown bycatch matrix	
Benthic invertebrates		High concern	SFW Unknown bycatch matrix	
Grenadiers	*Macrourus spp.*	Low concern	Stock is classified as not overfished but quantitative stock assessment is lacking; Widespread species; Low volumes of catch (4 - 46 t/year caught since 2005)	SC-CAMLR 2011; Froese, R. and Pauly, D. 2012
Skates and rays	*Rajids*	Moderate concern	Species composition of catch unknown, although minimal catch occurs (2 t since 2005).	SC-CAMLR 2011; Froese, R. and Pauly, D. 2012

Antarctic toothfish, Ross Sea

Species		Stock status	Basis for assessment	References
Corals and biogenic habitats		High concern	SFW Unknown bycatch matrix	
Benthic invertebrates		High concern	SFW Unknown bycatch matrix	
MacCain's skate	*Bathyraja maccaini*	High concern	IUCN status	IUCN 2012
Eaton's skate	*Bathyraja eatonii*	High concern	IUCN status	IUCN 2012
Antarctic starry skate	*Raja georgiana*	High concern	IUCN status	IUCN 2012
Whitson's grenadier	*Macrourus whitsoni*	Low concern	Yield estimate used to determine bycatch limits	Hanchet et al. 2008b
Grenadiers	*Macrourus spp.*	High concern	When species unidentified, no information showing stock status with respect to reference points; Stock resilience is low (as scored in Factor 1.1).	CCAMLR 2012
Skates and rays	*Rajiformes spp.*	High concern	When species unidentified, no information showing stock status with respect to reference points; Stock resilience is low (as scored in Factor 1.1) and some species are IUCN-classified.	CCAMLR 2012; IUCN 2012

Table 6. Fish bycatch (i.e., non-target, non-retained species) in toothfish fisheries, for which bycatch comprises more than 1% of the total catch by weight (live, unprocessed). The bycatch as a maximum proportion of total catch is shown in parentheses from data collected 2008–2010. (See sources listed below).

Fishery	Species (% total catch)	Source
Patagonian toothfish		
South Georgia	Grenadiers (3.9%)	CCAMLR 2012
Kerguelen Island	Ridge scaled rattail (14%)	CCAMLR 2012
	Whiteleg skate (2.1%)	CCAMLR 2012
	Rajids (7%)	CCAMLR 2012
Crozet Islands	Violet cod (8%)	CCAMLR 2012
	Ridge scaled rattail (16%)	CCAMLR 2012
	Whiteleg skate (5.6%)	CCAMLR 2012
	Rajids (6%)	CCAMLR 2012
Prince Edward and Marion Islands	Grenadiers (6%)	CCAMLR 2012
Macquarie Island	Southern sleeper shark (1-3%)	Morison *et al.* 2012; AFMA 2009, 2011
Falkland Islands	Ridge scaled rattail (1.6%) Bigeye grenadier (5.6%)	V. Laptikhovsky, pers. comm.
Chile	*Coelorhynchus fasciatus*(1.3%)	Galvez *et al.* 2011.
Antarctic toothfish		
Ross Sea	Grenadiers (6.6%) Whitson's grenadier (2.3%)	CCAMLR 2012

Benthic invertebrates and habitat-forming organisms were scored in accordance with the 'unknown bycatch matrix' from the SFW criteria. While understanding of these organisms (and data collection on bycatch patterns) is increasing (e.g., Hibberd and Moore 2009[1]), there are significant knowledge gaps relating to their distribution, abundance, and population statuses. Data collection is often not at the species level, and identification of some species is challenging.

Factor 2.3 Fishing mortality

Key relevant information:

Bycatch includes seabirds, cetaceans, pinnipeds, and a diversity of fish species, especially skates, rays, and grenadiers. For some species, catches were higher in the early years of most toothfish fisheries but are now very low (e.g., <10 individuals annually for seabirds and marine mammals in most CAMLR Convention Area fisheries) due to the introduction of effective bycatch reduction measures. However, the IUCN threat classifications of some bycatch species make ongoing capture a particular concern. More generally, the extent of skate/ray and

[1] http://www.ccamlr.org/en/document/publications/vme-taxa-classification-guide

grenadier captures is cause for ongoing work to ensure sustainability limits are not being exceeded. Data reported at the generic, rather than the specific, level generates cautious assessments due to the unknown species composition of catches. As for the target stocks, precise impacts of past IUU activities on bycatch species are unknown.

This assessment focuses on data reported from 2008/09 onwards (e.g., Table 6) but considers data back to 2001 (CCAMLR 2012; Lack *et al.* 2012; Morison *et al.* 2012; J. Barton personal communication).
For seabirds and marine mammals, reported catch numbers were very low to nil, except for white-chinned petrels and grey petrels in the Kerguelen and Crozet fisheries (see below). Where very low numbers were caught, fishery mortality was evaluated as a very low concern as the fishery was not a substantial contributor to mortality or there was published evidence available that mortality was at a sustainable level.

As above for stock status, benthic invertebrates and habitat-forming organisms were scored in accordance with the 'unknown bycatch matrix'. Data collection on these organisms is underway in some fisheries, but species-level taxonomic resolution is often difficult.

Additional pertinent fishery-specific information is summarized below by fishery, with species assessed individually in the tables above. For some fisheries (e.g., Chile), evaluation of bycatch at the species level is difficult while data collection improves (see Criterion 3.1 below). The post-release survival of bycatch species is highly variable and is affected by depth, buoyancy control mechanisms, and fishing method. For example, some skates survive capture and release (e.g., Benoît *et al.* 2010; Endicott 2010). Mitigation measures in place to reduce seabird captures include area/seasonal closures, discard retention, line-weighting, streamer lines, and the use of *cachalotera* (Moreno *et al.* 2008) for longlines.

Patagonian toothfish

South Georgia

Species		Mortality assessment	Basis for assessment	References
Corals and biogenic habitats		Low concern	SFW Unknown bycatch matrix	
Benthic invertebrates		Low concern	SFW Unknown bycatch matrix	
Porbeagle	*Lamna nasus*	Very low concern	Volume of captures (<2 t since 2001); IUCN classification: Vulnerable, widespread declines reported	CCAMLR 2012; IUCN 2012
Grenadier	*Macrourus* spp.	Moderate concern	Volume of captures (59-162 t/year since 2002)	CCAMLR 2012
Skates and rays	*Rajiformes* spp.	Moderate concern, IUCN status	Volume of captures (4-35 t/year since 2001)	CCAMLR 2012
Antarctic starry skate	*Raja georgiana*	Very low concern	Volume of captures (0-1 t/year since 2001)	CCAMLR 2012
Orca	*Orcinus orca*	Very low concern	Single capture reported since 2008	SC-CAMLR 2009
Elephant seal	*Mirounga leonina*	Very low concern	Single capture reported since 2008	SC-CAMLR 2009

Macquarie Island

Species		Mortality assessment	Basis for assessment	References
Corals and biogenic habitats		Low concern	SFW Unknown bycatch matrix	
Benthic invertebrates		Low concern	SFW Unknown bycatch matrix	
Southern sleeper shark	*Somniosus antarcticus*	Low concern	Level 3 risk assessment*	Zhou, S., Fuller, M. 2011

A Level 3 risk assessment has been completed for this fishery (Zhou and Fuller 2011).

*Whitson's grenadier (*Macrourus whitsoni*) (also caught in the Ross Sea) was caught at Macquarie Island in volumes greater than 5% of total catch in one year (2006/07, when this species was 5.2% of total catch). Such volumes of capture have not been repeated in subsequent years (Morison *et al.* 2012).

*Southern sleeper shark is classified as data deficient (IUCN 2012). This is a particularly vulnerable species caught at Macquarie Island. Individuals of this species can be very large and comprise 1–3% of the total catch in the Macquarie Island toothfish fishery. Experts consider it probable that fishery mortalities are sustainable given capture levels and the availability of unfished habitat; this is subject to ongoing assessment (AFMA 2009, 2011).

Kerguelen Islands

Species		Mortality assessment	Basis for assessment	References
Corals and biogenic habitats		Low concern	SFW Unknown bycatch matrix	
Benthic invertebrates		Low concern	SFW Unknown bycatch matrix	
White-chinned petrel	*Procellaria aequinoctialis*	Moderate concern	Reported captures and bycatch contributing to population declines; improved management and reduced bycatch in recent years may improve status in future	Delord, K. et al. 2005; Barbraud, C. et al. 2008; Barbraud, C. et al. 2011
Grey petrel	*Procellaria cinerea*	Moderate concern	Reported captures and bycatch contributing to population declines; improved management and reduced bycatch in recent years may improve status in future	Delord, K. et al. 2005; Barbraud, C. et al. 2008; Barbraud, C. et al. 2011
Rays	*Raja* spp.	Moderate concern	Volume of captures (273-455 t/year since 2007)	CCAMLR 2012
Skates and rays	*Rajiformes*	Moderate concern	Volume of captures (329-776 t/year 2001-2007); low inherent resilience; genus includes threatened and data deficient species ; efficacy of management is unknown.	CCAMLR 2012
Ridge scaled rattail	*Macrourus carinatus*	Moderate concern	Volume of captures (816-974 t/year since 2007); Species comprises >5% of bycatch by weight; Resilience low	CCAMLR 2012
Whiteleg skate	*Raja taaf*	Moderate concern	Volume of captures (23-142 t/year 2007-2008); Resilience low	CCAMLR 2012
Rockhopper penguin	*Eudyptes chrysocome*	Very low concern	Single capture reported since 2008; Species has a decreasing population trend and is classified by the IUCN as Vulnerable. The cause of population decline is not clear, although contributing factors may be climate change, human consumption, pollution and habitat disturbance.	SC-CAMLR 2008; IUCN 2012
Giant petrel	*Macronectes hallii*	Very low concern	<10 captures reported since 2008; IUCN classification of Least concern	SC-CAMLR 2008; IUCN 2012

Crozet Islands

Species		Mortality assessment	Basis for assessment	References
Corals and biogenic habitats		Low concern	SFW Unknown bycatch matrix	
Benthic invertebrates		Low concern	SFW Unknown bycatch matrix	
White-chinned petrel	*Procellaria aequinoctialis*	Moderate concern	Reported captures and bycatch contributing to population declines; improved management and reduced bycatch in recent years may improve status in future	Delord, K. et al. 2005; Barbraud, C. et al. 2008; Barbraud, C. et al. 2011
Grey petrel	*Procellaria cinerea*	Moderate concern	Reported captures and bycatch contributing to population declines; improved management and reduced bycatch in recent years may improve status in future	Delord, K. et al. 2005; Barbraud, C. et al. 2008; Barbraud, C. et al. 2011
Ridge scaled rattail	*Macrourus carinatus*	Moderate concern	Volume of captures (93-193 t/year since 2007); Species comprises >5% of bycatch by weight; Resilience low	CCAMLR 2012
Violet cod	*Antimora rostrata*	Low concern	Volume of captures (0.5-86 t/year 2001-2011)	CCAMLR 2012
Giant petrel	*Macronectes hallii*	Very low concern	<10 captures reported since 2008; IUCN classification of Least concern	SC-CAMLR 2008; IUCN 2012
Whiteleg skate	*Raja taaf*	Moderate concern	Volume of captures (31-56 t/year 2007-2011)	CCAMLR 2012

Heard and McDonald Islands Longline

Species		Mortality assessment	Basis for assessment	References
Corals and biogenic habitats		Low concern	SFW Unknown bycatch matrix	
Benthic invertebrates		Low concern	SFW Unknown bycatch matrix	
Kerguelen sandpaper skate	*Bathyraja irrasa*	Low concern	Level 3 risk assessment - species assessed as in the high risk category, but no current indications of depletions	Zhou, S. et al. 2009; AFMA 2012b; CCAMLR 2012
Grey-headed albatross	*Thalassarche chrysostoma*	Very low concern	Single capture in 2009; Sustainable based on global population size	SC-CAMLR 2009; IUCN 2012
Black-browed albatross	*Thalassarche melanophris*	Very low concern	Single capture in 2009; Sustainable based on global population size	Lack, M. et al. 2009; SC-CAMLR 2009
Murray's skate	*Rhinoraja murrayi*	Low concern	Level 3 risk assessment - species assessed as in the high risk category, but no current indications of depletions	Zhou, S. et al. 2009; AFMA 2012b; CCAMLR 2012
Pacific sleeper shark	*Somniosus pacificus*	Low concern	Level 3 risk assessment; Volume of captures (0-3 t/year 2001-2011)	Zhou, S. et al. 2009; CCAMLR 2012
Whitson's grenadier	*Macrourus whitsoni*	Very low concern	Level 3 risk assessment;Volume of captures (0-64 t/year 2001-2011)	Zhou, S. et al. 2009; CCAMLR 2012
Skates and rays	*Rajiformes* spp.	Low concern	Level 3 risk assessment - species assessed some rajids as in the high risk category, but there are no current indications of depletions	Zhou, S. et al. 2009; AFMA 2012b; CCAMLR 2012
Elephant seal	*Mirounga leonina*	Very low concern	Two captures reported since 2008; IUCN status of Leas concern	SC-CAMLR 2009; IUCN 2012
Southern lantern shark	*Etmopterus granulosus*	Very low concern	Level 3 risk assessment; Volume of captures (0-0.5 t/year 2001-2011)	Zhou, S. et al. 2009; CCAMLR 2012

Falkland Islands

Species		Mortality assessment	Basis for assessment	References
Corals and biogenic habitats		Low concern	SFW Unknown bycatch matrix	
Benthic invertebrates		Low concern	SFW Unknown bycatch matrix	
White-mouth skate	*Bathyraja papilonifera*	Low concern	IUCN status of data deficient; Volume of captures (4.6 - 11.4 t/year 2009 - 2011)	Laptikhovsky, V. Personal communication; IUCN 2012
Antarctic starry skate	*Amblyraja georgiana*	Low concern	IUCN status of Data deficient; Volume of captures (10.6 - 26.6 t/year 2009 - 2011)	Laptikhovsky, V. Personal communication; IUCN 2012
Porbeagle	*Lamna nasus*	Low concern	IUCN status; Volume of captures (0.6 - 2.1 t/year 2009 - 2011)	Laptikhovsky, V. Personal communication; IUCN 2012
Joined-fins skate	*Bathyraja cousseauae*	Low concern	IUCN status of Near threatened; Volume of captures (1.1 - 2.7 t/year 2009 - 2011)	Laptikhovsky, V. Personal communication; IUCN 2012
Multispined skate	*Bathyraja (Rhinoraja) multispinis*	Low concern	IUCN status of Near threatened; Volume of captures (0.1 - 0.3 t/year 2009 - 2011)	Laptikhovsky, V. Personal communication; IUCN 2012
Whitedotted skate	*Rhinoraja albomaculata*	Low concern	IUCN status of Vulnerable; Volume of captures (0.02 - 0.06 t/year 2009 - 2011)	Laptikhovsky, V. Personal communication; IUCN 2012
Darkbelly skate	*Bathyraja meridionalis*	Low concern	IUCN status of Data deficient; Volume of captures (4.1 - 10.3 t/year 2009 - 2011)	Laptikhovsky, V. Personal communication; IUCN 2012
Big-eye grenadier	*Macrourus holotrachys*	Low concern	Volume of captures (58 - 78 t/year 2009 - 2011)	Laptikhovsky, V. Personal communication
Ridge scaled rattail	*Macrourus carinatus*	Low concern	Volume of captures (16 - 22 t/year 2009 - 2011)	Laptikhovsky, V. Personal communication
Minke whale	*Balaenoptera bonaerensis*	Very low concern	Single capture recorded since 2009; IUCN status of Data deficient	Laptikhovsky, V. Personal communication

Chile

Species		Mortality assessment	Basis for assessment	References
Benthic invertebrates		Low concern	SFW Unknown bycatch matrix	
Corals and biogenic habitat		Low concern	SFW Unknown bycatch matrix	
Yellownose skate	*Zearaja chilensis*	Moderate concern	IUCN status; Population of special concern and management effectiveness is unknown	Galvez, P. et al 2011; IUCN 2012
Piked dogfish	*Squalus acanthias*	Moderate concern	IUCN status; Population of special concern and management effectiveness is unknown	Galvez, P. et al 2011; IUCN 2012
Thickbody skate	*Amblyraja frerichsi*	Moderate concern	IUCN status; Population of special concern and management effectiveness is unknown	Galvez, P. et al 2011; IUCN 2012
Big-eye grenadier	*Macrourus holotrachys*	Moderate concern	58% of the catch by number of individuals	F. Goyeneche, unpubl.
Chilean grenadier	*Coelorhynchus chilensis*	Low concern	Volume of captures (23 t, 2010; <1% of catch)	Galvez, P. et al. 2011
Ridge scaled rattail	*Macrourus carinatus*	Low concern	Volume of captures (20 t, 2010; <1% of catch by weight, 13% by number)	Galvez, P. et al. 2011; F. Goyeneche, unpubl.
Banded whiptail	*Coelorhynchus fasciatus*	Low concern	Volume of captures (39 t, 2010; 1.3% of catch)	Galvez, P. et al. 2011

Prince Edward and Marion Islands

Species		Mortality assessment	Basis for assessment	References
Corals and biogenic habitat		Low concern	SFW Unknown bycatch matrix	
Benthic invertebrates		Low concern	SFW Unknown bycatch matrix	
Grenadiers	*Macrourus spp.*	Low concern	Volume of catch (4 - 46 t/year caught since 2005)	SC-CAMLR 2011
Skates and rays	*Rajids*	Very low concern	Volume of catch (2 t caught since 2005)	SC-CAMLR 2011

Antarctic toothfish

Ross Sea

Species		Mortality assessment	Basis for assessment	References
Corals and biogenic habitats		Low concern	SFW Unknown bycatch matrix	
Benthic invertebrates		Low concern	SFW Unknown bycatch matrix	
MacCain's skate	*Bathyraja maccaini*	Very low concern	Volume of captures (0 - 0.5 t/year 2001-2011)	CCAMLR 2012
Eaton's skate	*Bathyraja eatonii*	Very low concern	Volume of captures (0 - 2 t/year 2001-2011)	CCAMLR 2012
Antarctic starry skate	*Raja georgiana*	Low concern	Volume of captures (1 - 35 t/year, 2001 - 2011)	CCAMLR 2012
Whitson's grenadier	*Macrourus whitsoni*	Low concern	Yield estimate used to determine bycatch limits*	Hancet et al. 2008b
Grenadiers	*Macrourus spp.*	Moderate concern	Volume of captures (56 - 219 t/year, 2001-2011); species not identified	CCAMLR 2012
Skates and rays	*Rajiformes spp.*	Moderate concern	Volume of captures (0 - 26 t/year, 2001-2011); species not identified	CCAMLR 2012

*A yield estimate has been calculated for Whitson's grenadier. This estimate is based on a fishery-independent survey of the Ross Sea slope. The yield estimate is used to set bycatch limits (Hanchet et al. 2008b).

Factor 2.4. Overall discard rate

Key relevant information:

Data reported from toothfish fisheries shows that non-target catches are generally low (Gálvez *et al.* 2011; SC-CAMLR 2011; AFMA 2012b; CCAMLR 2012; V. Laptikhovksy, personal communication). For all fisheries assessed here except Crozet, the discard ratio was below 20% by weight (Table 7).

Table 7. Percentage of discards in relation to total catch (tonnes) for toothfish fisheries in this assessment.

Fishery	(total catch, tons)	Discards (% of total)	Source
Patagonian toothfish			
South Georgia	(1863)	5.4%	CCAMLR 2012
Kerguelen Islands	(6586)	<1 - 21%*	CCAMLR 2012
Crozet Islands	(883)	<1 – 26%*	CCAMLR 2012
Heard and McDonald Islands		<1.1 – 5.8%*	CCAMLR 2012
- Longline	(1557)	9.1%	
Prince Edward and	(132)	6.1%	CCAMLR 2012

Marion Islands			
Macquarie Island	(~385)	6.5%	Morison *et al.* 2012
Falkland Islands	(1399)	14.6%	V. Laptikhovsky, pers. comm.
Chile	(3088)	2.7 – 3.3%*	Galvez *et al.* 2011.
Antarctic toothfish			
Ross Sea	(2573)	8.1%	CCAMLR 2012

*Proportion of particular species retained vs. discarded can vary.

Criterion 3: Management effectiveness

Guiding principle

- The fishery is managed to sustain the long-term productivity of all impacted species. Management should be appropriate for the inherent resilience of affected marine life and should incorporate data sufficient to assess the affected species and manage fishing mortality to ensure little risk of depletion. Measures should be implemented and enforced to ensure that fishery mortality does not threaten the long-term productivity or ecological role of any species in the future.

Fishery	Management: Harvest strategy Rank (score)	Management: Bycatch Rank (score)	Criterion 3 Rank (score)
South Georgia – Patagonian Toothfish – Longline	Very low concern (5)	Moderate concern (3)	Green (3.87)
Kerguelen – Patagonian Toothfish – Longline	Moderate concern (3)	Moderate concern (3)	Yellow (3)
Crozet – Patagonian Toothfish – Longline	Very high concern (1)	Moderate concern (3)	Red (1.73)
Heard and McDonald Island – Patagonian Toothfish – Longline	Very low concern (5)	Very low concern (5)	Green (5)
Macquarie Island – Patagonian Toothfish – Longline	Very low concern (5)	Very low concern (5)	Green (5)
Falkland Islands – Patagonian Toothfish – Longline	Low concern (4)	Moderate concern (3)	Green (3.46)
Ross Sea – Antarctic Toothfish – Longline	Moderate concern (3)	Low concern (4)	Green (3.46)

Prince Edward and Marion Islands – Patagonian Toothfish – Longline	Very high concern (1)	Moderate concern (3)	Red (1.73)
Chile domestic – Patagonian Toothfish – Longline	Very high concern (1)	Very high concern (1)	Red (1)

Justification of ranking

Factor 3.1. Management of fishing impacts on retained species

Key relevant information:
Catch data for all species are recorded by onboard observers and, for CCAMLR fisheries, are also recorded and reported as STATLANT data (e.g., including fishing effort, location, species caught, etc.) provided to the CCAMLR secretariat and published (CCAMLR 2012). In CCAMLR fisheries, observers are deployed in accordance with the CCAMLR Scheme of International Scientific Observation (CCAMLR 2011b). All vessels fishing for toothfish in the Convention Area are required to carry one international (i.e., not from the vessel's flag state) observer. Some also carry national observers. Outside the Convention Area, some toothfish vessels still carry two observers (e.g., at Heard, McDonald and Macquarie islands).

Toothfish is the only species targeted in the fisheries assessed here, although other species (see below) are retained in certain of these fisheries. Scientific information available on Patagonian toothfish, and species associated with its fisheries, is acquired as a result of fishing activity as well as fishery-independent data collection for some fisheries (e.g., trawl surveys, Duhamel and Welsford 2011). Stock assessment approaches are updated as information emerges about stock structure (e.g., the identification and evaluation of straddling stocks). Current work on stock assessment includes combined assessment of toothfish around Kerguelen, Heard and McDonald Islands (Lack *et al.* 2012; D. Welsford, personal communication). The management of the Chilean domestic toothfish fishery would be improved by the development and implementation of a rebuilding strategy for the target stock.

For the fisheries at Kerguelen and Crozet islands, several macrourids and rajids are sometimes retained in addition to toothfish. These species (ridge scaled rattail, Eaton's skate, Kerguelen sandpaper skate, whiteleg skate) are processed upon landing. No stock information is available for these species (SC-CAMLR 2011). Ridge-scaled rattail and whiteleg skate can be caught in volumes greater than 5% of total catch. Information allowing the assessment of stock status for this species is desirable to ensure effective management and that sustainability limits are not exceeded. Similarly, unicorn icefish and grey rockcod are caught and retained in the Heard, McDonald and Macquarie Island fisheries, but at levels less than 5% of total catch (Lack *et al.*

2012; Morison *et al.* 2012). At Heard and McDonald, these species are harvested in accordance with stock assessments. For icefish, the stock assessment has recently been updated and reviewed (Constable *et al.* 1998; SC-CAMLR 2011). For rockcod, the 1998 assessment is still in use (Lack *et al.* 2012). In addition, comprehensive Level 3 risk assessments have been undertaken for Heard, McDonald and Macquarie Island fisheries (Zhou *et al.* 2009; Zhou and Fuller 2011).

With numerous enforcement measures in place, IUU activities have not been detected in most fisheries considered here in recent years (except Chile, for which no information was available). A comprehensive suite of enforcement measures is implemented in the fisheries assessed in this report. Residual IUU fishing occurs outside the fisheries assessed here and is also monitored (CCAMLR 2011). IUU products are not permitted entry to the USA.

Four toothfish fishery areas have been certified by the Marine Stewardship Council (www.msc.org): South Georgia (longline), Heard and McDonald Islands (trawl and longline), Macquarie Island (trawl and longline), and the Ross Sea (longline) fisheries. The demersal longline fisheries around Crozet and the Kerguelen Islands have been under assessment since 2009[2], and the Falkland Islands fishery entered the assessment process in August 2012[3].

Detailed rationale:

Patagonian toothfish

South Georgia *– Very low concern*

Management strategy and implementation (highly effective)
This fishery operates following the objectives and management goals of the CCAMLR approach. These include a precautionary approach, utilization of a management approach that incorporates ecosystem considerations, and the concept of 'rational use' (www.ccamlr.org, see Article 2 of the Convention: Appendix B). Rational use is encompassed in three principles (see Appendix B for exact wording): prevention of population decreases below a level ensuring stable recruitment, maintenance of ecological relationships, and prevention or minimization of ecosystem changes or the risk of such changes that are not potentially reversible over 2–3 decades. Management objectives are made operational through a variety of mechanisms including harvest management rules, bycatch limits, conservation measures, etc. (see below). The management approach and implementation are evaluated annually through consideration of a substantial body of data relating to fishery activities and the broader environmental context of the fishery.

[2] http://www.msc.org/track-a-fishery/in-assessment/southern-ocean/SARPC-toothfish
[3] http://www.msc.org/track-a-fishery/in-assessment/south-atlantic/falkland_island_toothfish

Scientific research and monitoring (highly effective)
This fishery operates under a scientifically accepted stock assessment that is updated annually with new data, allowing delivery on management targets to be assessed (SC-CAMLR 2011). There is a significant body of available data relating to this fishery and extensive ongoing data collection and annual review (SC-CAMLR 2011). Data collection includes full catch reporting, collection of specified biological information on target catch, VMS data, details on gear deployed, etc. Requirements for data collection by observers are determined annually and sometimes include particular projects (e.g., International Polar Year).

Scientific advice (highly effective)
Management measures are developed for this fishery as part of the CCAMLR cycle. This includes extensive and iterative annual evaluation of scientific data (SC-CAMLR 2011). Management appears to closely follow scientific advice as delivered through the CCAMLR process. The domestic quota has, in recent years, been lower than indicated by the CCAMLR management target as a precautionary measure given uncertainty in recruitment (M. Collins, personal communication).

Enforcement (highly effective)
The approach to enforcement is robust and multifaceted, including observers on every vessel, deployment of vessel monitoring systems (VMS), vessel inspections, catch verification (whereby each vessel must return directly to port on completion of fishing and have its catch weighed), uniquely marked hooks on each vessel (to allow identification and tracking of gear), surveillance, a catch documentation scheme for toothfish, and regular reviews of implementation and compliance (CCAMLR 2011a, b; M. Collins, personal communication). The catch documentation scheme is recognized as a global best practice and is effective in greatly reducing the shipment of toothfish of uncertain legality and provenance (Clarke and MRAG 2010). Mislabeled product identified as originating from South Georgia has been highlighted in published work citing genetic analysis as a tool for detection of potential traceability issues (Marko *et al.* 2011). However, subsequent investigation has not confirmed this finding[4]. Traceability in this fishery is monitored through Marine Stewardship Council annual audits of the fishery and as part of MSC's ongoing sampling of certified product (www.msc.org). While no IUU activity has been detected in this fishery in recent years, ongoing vigilance is required given the large areas of ocean over which fishing occurs and the market incentive created by a highly priced fish.

Track record (highly effective)
This fishery has harvested stocks to a level consistent with management targets during the time it has operated (since the mid-1980s, SC-CAMLR 2011). The management target for toothfish has been approached recently in this fishery (SC-CAMLR 2011). A significant body of ongoing research and monitoring work is in place to inform ongoing effective management of the fishery. Consequently, the track record of this fishery is considered 'highly effective'.

[4] http://www.msc.org/newsroom/news/update-lack-of-evidence-blocks-msc-investigation-into-toothfish-mislabelling-claims

Stakeholder inclusion (highly effective)
This fishery has opportunities for stakeholder engagement both domestically and through the CCAMLR process. Participants in CCAMLR working groups include government and private research organizations, industry, and eNGOs. Reviews of fisheries management policy include consultation with known stakeholders and public comment (Medley *et al.* 2009). The Director of Fisheries meets annually with fishery participants, and these meetings are open to stakeholders interested in fishery management. Meeting scope includes fishery management and performance, CCAMLR-related matters (e.g., new information), changes proposed for upcoming fishery activity, and matters raised by meeting participants. In addition, the Director of Fisheries is available to respond to communication outside of these meetings.

Heard and McDonald Islands *– Very low concern*

Management strategy and implementation (highly effective)
This fishery operates following the objectives and management goals of the CCAMLR approach. These include a precautionary approach, utilization of management approaches developed with explicit consideration of the ecosystem effects of harvesting, and the concept of 'rational use' (see Article 2 of the Convention, www.ccamlr.org, Appendix B). As part of Australia's Exclusive Economic Zone, management objectives are made operational through a variety of mechanisms, including harvest management rules, catch limits for non-target species and bycatch, conservation measures, etc. Currently, work is underway to improve quantitative approaches to management of the stock shared by the Heard and McDonald Islands and Kerguelen Islands fisheries. France (within whose Exclusive Economic Zone the Kerguelen fishery falls) is also party to CCAMLR.

Scientific research and monitoring (highly effective)
The toothfish fishery operates using a stock assessment that has been agreed upon as a basis for management (SC-CAMLR 2011). There is a significant body of data available every year to update the model. Given the proximity of the modeled stock to the level targeted by management, increased confidence surrounding the key uncertainties in this model has been recommended (SC-CAMLR 2011). Quantitative approaches to stock management are being investigated by Australian and French scientists given that the Heard and McDonald Islands and Kerguelen Islands fisheries are both targeting the same toothfish stock. Along with the model development described above, this combined approach will increase the rigor of management measures. Stock assessments are available for the retained species in this fishery (unicorn icefish and grey rockcod) (Constable *et al.* 1998; SC-CAMLR 2011), but the rockcod model has not been updated since 1998. Catch of both species occurs at less than 5% of total catch (Table 6) and catch limits are in place (CCAMLR Conservation Measure 33-02). A Level 3 risk assessment has also been completed (Zhou *et al.* 2009).

Scientific advice (highly effective)
Management measures are developed for this fishery as part of the CCAMLR cycle and through Australian domestic processes (Lack *et al.* 2012). This includes extensive and iterative

evaluations of scientific data. Management is based on scientific advice, which is evaluated annually (e.g., SC-CAMLR 2011).

Enforcement (highly effective)
The approach to enforcement is robust and multifaceted, including observers on every vessel, deployment of VMS, satellite surveillance, vessel inspections, vessel-based patrols, a catch documentation scheme for toothfish, and regular reviews of implementation and compliance (as described above; CCAMLR 2011). No IUU activity has been detected in this fishery in recent years, however ongoing vigilance is both planned (www.afma.gov.au) and required given the large areas of ocean over which fishing occurs and the market incentive created by highly priced fish. Joint patrols are also undertaken with French authorities due to the adjacency of French fisheries.

Track record (highly effective)
This fishery has harvested stocks to a level consistent with its management target during the time it has operated (SC-CAMLR 2011). The management target for toothfish has been approached recently in this fishery (SC-CAMLR 2011) and a comprehensive set of monitoring and research measures are in place to inform ongoing fishery management. The track record for this fishery is considered 'highly effective'.

Stakeholder inclusion (highly effective)
This fishery has opportunities for stakeholder engagement through a number of domestically active groups as well as the CCAMLR process (Lack *et al.* 2012). Groups include the Australian Antarctic Division, Australian Fisheries Management Authority, Sub-Antarctic Resource Assessment Group, Coalition of Legal Toothfish Operators, and the Heard and McDonald Island stakeholder group (which includes government, industry, and environmental non-governmental organizations).

Macquarie Island *– Very low concern*

Management strategy and implementation (highly effective)
While located in the Australian Economic Zone and outside the CAMLR Convention Area, this fishery operates following the objectives and management goals of the CCAMLR approach. As described above, these include a precautionary and ecosystem-focused approach, and the concept of 'rational use' (Appendix B). Management objectives are made operational through a variety of mechanisms, including harvest management rules, bycatch catch limits, conservation measures, etc. An Annual Status Report describes legislation and policies utilized in management of the fishery (for target catch as well as non-target and bycatch, habitat impacts, etc.; AFMA 2012). In short, toothfish catch limits are divided amongst regions of the fishery in accordance with the stock assessment model, which is developed using the criteria in Appendix B. Bycatch limits have been implemented and spatial closures are in place (AFMA 2012).

Scientific research and monitoring (highly effective)
This toothfish fishery operates under a publicly available and peer-reviewed stock assessment (Fay 2011; Fay *et al.* 2011). There is a significant body of data available relating to this fishery and extensive ongoing data collection and review (AFMA 2011, 2012b). There is no stock assessment available for grey rockcod; however, catch occurs at less than 5% of total. Catch limits are in place, and a Level 3 risk assessment has been conducted. This factor is considered to be 'highly effective'.

Scientific advice (highly effective)
Management measures are developed through Australian domestic processes and in alignment with CCAMLR measures (AFMA 2012b; Morison *et al.* 2012). Management is based on scientific advice and described in an Annual Status Report addressing measures relating to target catch, non-target and bycatch, habitat impacts, etc. (AFMA 2012).

Enforcement (highly effective)
Enforcement measures include observer coverage on every vessel, the use of integrated computerized VMS, completion of daily logbooks, vessel and aerial surveillance, compliance with the catch documentation scheme, and monitored unloads in port. In Australian ports, unloads are monitored by government officials from the Australian Fishery Management Authority. In ports outside Australia, AFMA also monitors unloads including checking vessels' compliance with Port State measures (CCAMLR Conservation Measure 10-03) and confirming the legality of the landed product (Morison *et al.* 2012). A year-round scientific operation is located on the island and visits by tourist vessels provide additional legal presence. Thus, the approach to enforcement is robust and multifaceted and meets the requirements for assessment as 'highly effective'.

Track record (highly effective)
This fishery has harvested toothfish stocks to a level consistent with its management target during the time it has operated (almost 20 years; Fay 2011; Fay *et al*. 2011). A comprehensive set of monitoring and research measures is in place to inform ongoing fishery management. Consequently, the track record for this fishery is considered 'highly effective'.

Stakeholder inclusion (highly effective)
This fishery has a number of opportunities for stakeholder engagement. Documents are distributed on the Internet by AFMA, and processes for public comment operate on an ongoing basis (Lack *et al.* 2012).

***Prince Edward and Marion Islands** – High concern*

Management strategy and implementation (moderately effective)
This fishery operates in the Exclusive Economic Zone of the Republic of South Africa as well as inside the CAMLR Convention Area. Its management is challenging due to factors including recent fishing gear changes and a history of IUU fishing from which the remaining stock must

recover. An Operational Management Procedure has been published (Brandao and Butterworth 2009) and is currently under revision. This is expected to guide the future management of the target stock (SC-CAMLR 2011). The current catch limit for toothfish in this fishery is considered conservative by managers (R. Leslie, personal communication).

Recovery of stocks of concern (ineffective)
The stock biomass remaining in this fishery following extensive IUU fishing in the 1990s was assessed at a few percent of the pre-exploitation levels (Brandão *et al.* 2002). The management response to the lack of clarity around current stock status and rebuild trajectory has been to harvest at a lower level than a more optimistic stock evaluation would support, if reliable (R. Leslie, personal communication). Given the uncertainty in outcomes for its management approach, this fishery is assessed as 'ineffective' here.

Scientific research and monitoring (moderately effective)
A robust stock assessment is not available for this fishery as outlined above and in Section 1.2. However, a management procedure has been developed (from Brandão and Butterworth 2009) that guides harvest at low levels and is considered to be conservative by the responsible government agency (R. Leslie, personal communication). Data collection is ongoing in this fishery for a number of reasons including ongoing monitoring (e.g., a change to a different configuration of demersal longline) and to allow development of better-informed harvesting strategies. Given the uncertainty in the present situation, including the trajectory of the target stock under current management measures, this fishery is considered 'moderately effective'.

Scientific advice (moderately effective)
Consideration of scientific advice is integral to this fishery. However, an assessment of 'moderately effective' is made due to the explicit consideration of economics in management decision-making (although this may be otherwise appropriate for reasons not related to stock condition; Brandão and Butterworth 2009).

Enforcement (highly effective)
In this fishery, the approach to enforcement is multifaceted, including observers, deployment of VMS, vessel inspections, surveillance, a catch documentation scheme for toothfish, and regular reviews of compliance (CCAMLR 2011a, b). While target stocks in this area are thought to be at low levels compared to before fishing activity, the presence of a legal fishery in this area is expected to contribute to the elimination of illegal fishing activities.

Track record (moderately effective)
More time is needed to evaluate the success of management for toothfish at the Prince Edward and Marion Islands. Management challenges include the recovery of the stock from previously high levels of IUU fishing. While enforcement has ameliorated this condition, gear changes and uncertain stock status require ongoing consideration and potentially novel management approaches.

Stakeholder inclusion (moderately effective)
This fishery has opportunities for stakeholder engagement through the CCAMLR process (SC-CAMLR 2011). The Department of Agriculture, Forestry and Fisheries makes some documents available for consultation via its websites (www.nda.agric.za and www.daff.govt.za). However, the application of this approach to consultation for toothfish fishery management and policy development is unclear.

Crozet Islands – *High concern*

Management strategy and implementation (moderately effective)
The fishery around Crozet Islands is largely located inside the CAMLR Convention Area and the French Exclusive Economic Zone (Delegation of France 2009). Most CCAMLR management measures are applied (Delegation of France 2009). A stock assessment model has not been developed, and target species catch is currently managed using a catch limit derived from an approach-integrating catch per unit effort (SC-CAMLR 2011; TAAF 2011; Reuillard, E. personal communication). This model includes cetacean predation on hooked toothfish. Work on this model will be reported following the 2012/13 fishing season (Reuillard, E. personal communication). The efficacy of measures to reduce catch of non-target retained species is unclear although the provision exists for implementation of several measures (e.g., avoiding areas considered to host 'high densities' of non-target species, and ceasing fishing where bycatch is found to be at 'high densities'; the definition of 'high densities' was not available at the time of writing) (Delegation of France 2011; TAAF 2012).

Recovery of stocks of concern (ineffective)
Management includes measures to limit catch of juvenile toothfish in this fishery, and captains must set test lines before 'normal' fishing begins to check levels of juvenile capture (TAAF 2012). Tagging efforts continue and catch data are regularly reported (SC-CAMLR 2011). Since 2006, 4% of tagged fish have been recaptured. Depths less than 500 m and areas closer than 12 nmi from the coast are closed to fishing in order to facilitate spawning (SC-CAMLR 2011). While the catch limit in place in this fishery is considered precautionary (E. Reuillard, personal communication), the certainty of stock recovery would increase with additional information (e.g., reporting of assessments used to set catch limits).

Scientific research and monitoring (moderately effective)
The toothfish fishery is currently managed using a catch limit, which is implemented annually (SC-CAMLR 2011), although it is not currently incorporated into an accepted stock assessment (SC-CAMLR 2011). Continuing work to resolve the relationship between Crozet, Heard and McDonald-area toothfish will provide for improved management approaches. While not target species, macrourids and rajids are also processed when landed in this fishery, specifically Ridge scaled rattail and whiteleg skate. Landings are recorded and reported, but no stock assessments or evaluations of the sustainability of harvest are available for these species (SC-CAMLR 2011).

Scientific advice (moderately effective)
Consideration of scientific advice appears to have improved significantly in recent years (e.g., SC-CAMLR 2011). However, an assessment of 'moderately effective' is made, given that not all science-based advice has been implemented by management, and the development and implementation of science-based management measures have occurred slowly in many cases (e.g., for reducing the catch of retained non-target species). The continuation of the recent focus on developing and implementing science-based management approaches for all retained species is expected to lead to an improvement in this evaluation over time.

Enforcement (highly effective)
The approach to enforcement is multifaceted in this fishery, including observers or scientific experts onboard vessels, deployment of VMS, vessel inspections, vessel-based patrols, surveillance (including using satellites), detailed permitting arrangements, clearly identified roles and responsibilities for operators, and a catch documentation scheme for toothfish (CCAMLR 2011).

Track record (moderately effective)
Active management and measures that limit target catch are in place. However, uncertain stock status for target and retained species requires ongoing consideration and analysis. Consequently, long-term abundance has not been demonstrated in the retained stocks, as required by this criterion.

Stakeholder inclusion (moderately effective)
This fishery provides opportunities for stakeholder engagement through the CCAMLR process (SC-CAMLR 2011). In addition, three bodies come together during the year to discuss matters relating to the fishery. The Réunion de Concertation Pêche meets once per year for fishery management updates (e.g., conservation measures, quota) and includes scientists, staff from the Terres Australes et Antarctique Françaises (TAAF) administration, the ministries of foreign affairs, fisheries, and overseas, and fishing industry managers. The Comité de pilotage des bonnes pratiques de la pêche (C3P) meets once per year and involves TAAF administration, scientists, fishing industry, managers, captains and essential crew members. The C3P discusses best practices including incidental mortality, bycatch, cetacean depredation of toothfish, etc. the Groupe de travail pêche (GTP) meets three times a year and involves scientists, TAAF administration, ministries of foreign affairs, fisheries and overseas, as well as fishing industry managers. The GTP discusses organization, including funding of scientific research on fisheries management (e.g., fish stock assessment, E. Reuillard, personal communication). Increased transparency could be achieved by documenting and reporting decision-making influences and processes as well as by providing opportunities for public/NGO stakeholder participation. However, members of the public and eNGOs are not known to have requested participation (E. Reuillard, personal communication).

Kerguelen Islands – *Moderate concern*

Management strategy and implementation (moderately effective)
The Kerguelen Islands are located inside the CAMLR Convention Area and also inside the French Exclusive Economic Zone. Most CCAMLR management measures are applied (Delegation of France 2009). In the past, the target species catch was managed using a catch limit that was not derived from a peer-reviewed stock assessment (SC-CAMLR 2011; TAAF 2011; Appendix B). A preliminary stock assessment has been used to derive management advice for the fishery in 2012/13; further work on this assessment is required to set catch limits beyond that timeframe (SC-CAMLR 2012). The efficacy of measures to reduce catch of non-target retained species is unclear, although several measures have been prescribed (e.g., avoiding areas with 'high densities' of non-target species and ceasing fishing where bycatch is found to be at 'high densities'; the definition of 'high densities' was unavailable at the time of writing) (Delegation of France 2011; TAAF 2012).

Scientific research and monitoring (moderately effective)
The toothfish fishery is to be managed through a preliminary stock assessment, implemented for the first time in 2012/13 (SC-CAMLR 2012). Work continues to develop an accepted stock assessment applicable to longer-term management (Rélot-Stirnemann 2011; SC-CAMLR 2011, 2012). Continuing work to improve understanding of the relationship between the Kerguelen and Heard and McDonald-area toothfish is encouraged. While not target species, some macrourids and rajids are processed on landing (ridge scaled rattail, Eaton's skate, and Kerguelen sandpaper skate). Landings are recorded and reported, but no stock assessments or evaluations of the sustainability of harvest are available for these species (SC-CAMLR 2011).

<u>Scientific advice (moderately effective)</u>
Consideration of scientific advice is integral in this fishery and has improved significantly in recent years (e.g., SC-CAMLR 2011). For now, an assessment of 'Moderate' has been made, given that not all science-based advice has been demonstrated through management results, or the implementation of science-based management measures has occurred somewhat slowly over time. The continuation of the recent focus on developing and implementing science-based management approaches for all retained species is expected to lead to an improvement in this evaluation over time.

Enforcement (highly effective)
In this fishery, the approach to enforcement is multifaceted, including observers or scientific experts onboard vessels, deployment of VMS, vessel inspections, vessel-based patrols, surveillance (including using satellites), detailed permitting arrangements, clearly identified roles and responsibilities for operators, and a catch documentation scheme for toothfish (CCAMLR 2011). Joint patrols are also undertaken with Australian authorities given the adjacency of Australian fisheries at Heard and McDonald Islands.

Track record (moderately effective)
Measures that limit target catch and active management are in place. However, the uncertain stock status for non-target retained species requires analysis. Consequently, long-term abundance has not been demonstrated in the retained stocks as required by this criterion.

Stakeholder inclusion (moderately effective)
This fishery has opportunities for stakeholder engagement through the CCAMLR process (SC-CAMLR 2011). Three bodies come together during the year to discuss matters relating to the fishery. The first of these is the Réunion de Concertation Pêche, which meets once per year on fishery management updates (e.g., conservation measures, quota), and includes scientists, the TAAF administration, the ministries of foreign affairs, fisheries, and overseas, and fishing industry managers. The Comité de ilotage des bonnes pratiques de la pêche (C3P) meets once per year and involves TAAF administration, scientists, fishing industry, managers, captains and essential crew members, and discusses best practices, including incidental mortality, bycatch, cetacean depredation of toothfish, etc. Finally, the Groupe de Travail Pêche (GTP) meets three times a year, and involves scientists, TAAF administration, ministries of foreign affairs, fisheries, and overseas, and fishing industry managers, and discusses organization, including funding of scientific research on fisheries management (e.g., fish stock assessment, E. Reuillard, personal communication). Increased transparency could be achieved if decision-making influences and processes were documented and reported, and if opportunities for public/NGO stakeholder participation were more readily available. However, public/eNGOs are not known to have requested participation (E. Reuillard, personal communication).

Chile – *High concern*

Management strategy and implementation (moderately effective)
Some effective management measures are in place in this fishery, but the extent of management differs between groups of vessels targeting toothfish. For example, industrial vessels have been more comprehensively managed than artisanal vessels. Management measures include limited entry into the fishery, restriction of gear to longlines (Subsecretaria de Pesca 1992), catch limits (Subsecretaria de Pesca 2012), VMS, and observer monitoring (see enforcement, below). For artisanal vessels, effort and capacity controls are in place (Subsecretaria de Pesca 1986, 2008), and management has been improved in recent years by the introduction of a requirement for VMS monitoring (port to port, from 2013) and participation in the CAMLR Catch Documentation Scheme (Diario Official de la Republica de Chile 2012). Other management measures include seasonal closures of specified (spawning) areas (Subsecretaria de Pesca 1996). While the fishery occurs outside the Convention Area, management measures described in domestic legislation include specified CCAMLR regulations and conservation measures (Diario Oficial de la República de Chile 2012). The management target requires maintenance of the stock at a minimum of 30% of the biomass in 1987 (the reference year). Challenges include finding statistically robust determinations of catch limits and implementation of catch limits across all sectors of the fleet targeting toothfish. A lack of quotas for artisanal vessels (Gálvez *et al.* 2011) also renders robust management difficult.

Bigeye grenadier can be retained by crew members in the toothfish fishery. Research is underway to investigate the sustainability of the catch of this species (C. Moreno, personal communication).

Recovery of stocks of concern (ineffective)
Some controls exist on harvest and effort (i.e., catch limits for industrial vessels, controls on fishing capacity, see above). However, a high risk of stock depletion has been identified (Subsecretaria de Pesca 2011). The domestic management target is to maintain the stock at 30% SSB_0 Within the uncertainties of the stock assessment, the quota is considered to maintain the stock at current levels (18 – 38% SSB_0) with around 10% exploitation rate for industrial vessels. However, in 2011, exploitation at levels greater than the natural mortality rate was identified (Subsecretaria de Pesca 2011). Currently, management actions are not demonstrably supporting stock recovery. Strengthening management over time will assist stock recovery. An increase in certainty around the stock assessment and a reduction of depletion risks may improve this assessment.

Scientific research and monitoring (moderately effective)
A stock assessment has been completed and quotas are reviewed annually, but the efficacy of current management is constrained by uncertainties including the nature and extent of the data available. However, technical working group structures and the involvement of scientists and industry in the development of management advice is reported to have improved in the years since 2006 (Zuleta and Rubilar 2011). Recent research includes tagging, examination of population structure using otolith chemistry, investigation of cetacean depredation of toothfish on lines, and a study of reproductive biology (Zuleta and Hopf 2010; Subsecretaria de Pesca 2011). Such information has significant potential to improve management and knowledge of the stock. Bigeye grenadier can also be retained by crew members in this toothfish fishery. No stock assessment is currently available for this species, but research is underway investigating the sustainability of this catch (C. Moreno, personal communication).

Scientific advice (moderately effective)
Technical working group structures and the involvement of scientists and industry in the development of management advice is reported to have improved in the years since 2006 (Zuleta and Rubilar 2011). A significant body of work is underway that will lead to the availability of more robust management advice in the future (e.g., Zuleta and Rubilar 2011).

Enforcement (moderately effective)
A variety of enforcement measures are in place in this fishery, including the CCAMLR Catch Documentation Scheme, VMS (Diario Official de la Republica de Chile 2012), logbooks (Zuleta and Rubilar 2011; Rubilar and Moreno 2012), and some observer coverage (focused on industrial vessels). Increasing observer coverage to an identified target level of fishing effort, including for artisanal vessels, would improve this assessment (Zuleta and Rubilar 2011).

Track record (ineffective)
There is a diversity of management measures in place in the domestic Chilean fishery, including some aligned with global best practice (e.g., the CCAMLR Catch Documentation Scheme and deployment of VMS). Stock status was reported to have been approximately stable at a low level of abundance for a decade (Zupeta and Hopf 2010). However, declines in vulnerable biomass and spawning biomass have also been reported since 2007 (Subsecretaría de Pesca 2011). Consequently, the long-term maintenance and recovery of the stock seem uncertain. Nevertheless, many aspects of management continue to improve over time.

Stakeholder inclusion (moderately effective)
Technical working group structures and the involvement of scientists and industry in the development of management advice is reported to have improved in the years since 2006 (Zuleta and Rubilar 2011). For example, terms of reference, minutes, and group remits are documented. The groups appear to be restricted to those whose work relates to the fishery rather than being open to a wider group of stakeholders. However, the group structure appears to connect science and management effectively and to facilitate information exchange amongst a group with diverse backgrounds and interests (Zuleta and Rubilar 2011).

Falkland Islands – *Low concern*

Management strategy and implementation (highly effective)
The Falkland Islands Government has the objective of "Conservation of sustainable resources through effective management of fishing effort."[5] This objective is implemented using tools such as fishing licenses, closed areas, catch limits, reporting, monitoring, and scientific data collection (see below). Similar to CCAMLR toothfish fisheries, the management target for the Falkland Islands fishery is to maintain the spawning stock biomass above 50% of its pre-fishery level (V. Laptikhovsky, personal communication).

Scientific research and monitoring (moderately effective)
This fishery operates using a stock assessment that is updated annually (Falkland Islands Government 2012; V. Laptikhovsky personal communication). Catch and stock levels are monitored, and the total biomass of the stock is considered to be increasing (though not SSB as yet). New data are collected annually in this fishery providing for the review of the model and catch statistics. A new model is in use and its performance is being monitored (Falkland Islands Government 2012; V. Laptikhovsky personal communication). The robustness of this new model will be tested over time.

Scientific advice (highly effective)
There is evidence (based on reduced TACs) and reports that science advice for management is considered explicitly (Falkland Islands Government 2012; V. Laptikhovsky, personal communication). Information from other fisheries is also used for toothfish fishery stock

[5] http://www.fis.com/falklandfish/html/management.html

assessment and management, e.g., documentation of trawl bycatch of toothfish (J. Barton, personal communication).

Enforcement (highly effective)
The Falklands fishery consists of a single vessel that is monitored by an onboard observer. The Falklands government also monitors activities using VMS, aerial surveillance, and vessel-based patrols (V. Laptikhovsky, personal communication). Tourist vessels provide another form of legal presence and an opportunity to detect illegal activity. The CCAMLR catch documentation scheme applies. Fish catch is monitored on a daily basis. Seasonally closed (spawning) areas are also enforced (J. Barton, personal communication).

Track record (highly effective)
The managers of this fishery have responded to stock status including by reducing TACs in order to promote the sustainability of the stock (Falkland Islands Government 2012; V. Laptikhovsky personal communication). Total biomass is now increasing, which is expected to lead to a commensurate increase in spawning stock biomass. Managers monitor spawning stock biomass annually to ensure effective management with respect to harvesting goals (V. Laptikhovsky, personal communication). Consequently, this fishery is considered to have a 'highly effective' track record.

Stakeholder inclusion (highly effective)
There is significant opportunity for involvement in stakeholder involvement in the management of the Falkland Islands fishery. Fisheries statistics are reported monthly and annually, contributing to the transparency of management. Stakeholder bodies include the Falklands Fisheries Liaison Committee (comprised of all fishers and the government Fisheries Department), the Fisheries Advisory Committee (a statutory, monthly forum for consultation between the Government and the industry on fisheries-related issues and to advise the government), the Environmental Committee (a statutory, monthly environmental committee, consulting body, and advisory to the government that includes NGOs, the government Fisheries Department, the fisheries industry, the public, the government Environmental Department, the farming community and others), and the Falkland Islands Fishing Companies Association (a body for fishing industry members provided for in legislation). The views of the Agreement on the Conservation of Albatrosses and the Joint Nature Conservation Committee are represented locally on the Falkland Islands (J. Barton, personal communication).

Antarctic toothfish

Ross Sea – *Moderate concern*

Management strategy and implementation (moderately effective)
This fishery operates following the objectives and management goals of the CCAMLR approach. These include a precautionary approach, use of an ecosystem approach, and following the concept of 'rational use' (see Article 2 of the Convention, www.ccamlr.org, Appendix B). Management objectives are pursued by various mechanisms including harvest management

rules, bycatch catch limits, vessel monitoring systems, conservation measures, etc. (see below, and www.ccamlr.org). The existence and management of this fishery remains controversial due to a number of factors including the location of the fishery, knowledge of the species, population/stock dynamics, and the ecosystems involved (e.g., ASOC 2009; Jacquet *et al.* 2010; Stokstad 2010; Constable 2011). New information is considered annually for this fishery, and defined pathways exist for the translation of new information into management measures. For example, new information on life history characteristics has been incorporated into stock assessment models in the recent past and thereby informs catch limits (SC-CAMLR 2011). However, there remains considerable uncertainty both in the parameters used in stock assessment (see Criterion 1), and in the role of toothfish in the ecosystem (see Criterion 4). Given the high inherent vulnerability of the species, lack of knowledge about the basic species biology, and high uncertainty in the stock assessment, extra caution and close monitoring is warranted. Biomass reference points should ideally be set at a level that takes into account inherent vulnerability and allows for stocks to fulfill their role in the ecosystem; this level is uncertain for Ross Sea toothfish, but target reference points are set in a single-species context (Constable et al. 2000). Greater fishery-independent monitoring, both of toothfish and other components of the ecosystem, are needed to provide the evidence that the management strategy is being implemented effectively. In the absence of this information, and given the high risk of harvesting a highly vulnerable, long-lived and ecologically important predator in a single-species context without greater knowledge, the management strategy of the fishery is considered a moderate concern.

Scientific research and monitoring (moderately effective)
This fishery operates using a stock assessment that is updated annually and has been accepted for management through the CCAMLR process (SC-CAMLR 2011). This model is updated annually with new data (e.g., catch and biological information). There is a significant body of data available relating to this fishery sourced through fisheries activities. A research survey of pre-recruits is planned for 2011/12 and there are other ongoing data collection activities and annual data reviews (SC-CAMLR 2011). However, there is currently no regular collection and incorporation of fishery-independent data, and biological parameters used in stock assessments are poorly known.

Scientific advice (highly effective)
There is a defined and documented pathway by which scientific advice is considered and incorporated into management. Management measures are formulated using scientific information as part of the CCAMLR cycle, which includes extensive and iterative annual evaluation of scientific information (SC-CAMLR 2011).

Enforcement (highly effective)
Enforcement is generally thorough, including observers on every vessel, deployment of VMS, vessel inspections, surveillance, a catch documentation scheme for toothfish and regular reviews of implementation and compliance (CCAMLR 2011). However, this fishery is comprised of vessels from a number of nations whose approach to enforcement may vary. For example, a recent case of significant overcatch was detected and reported, and most CCAMLR members

sought to declare that the vessel involved was fishing illegally. Ultimately, domestic sanctions were applied as a penalty for the reported overcatch (CCAMLR 2011). The significant ice season in the Ross Sea restricts the level of fishing activity possible in this area (including potential illegal activity).

Track record (highly effective)
This fishery has harvested stocks to a level consistent with its management target during the time it has operated (~15 years, SC-CAMLR 2011). The stock is considered to be significantly above the target management level, and a comprehensive suite of monitoring and research measures are in place to inform effective ongoing management. Consequently, the track record of this fishery is considered 'highly effective'.

Stakeholder inclusion (moderately effective)
Vessels flagged to the Republic of Korea, New Zealand, Russia, Spain, the United Kingdom, and Uruguay have all been active in this fishery (SC-CAMLR 2011). The fishery provides opportunities for stakeholder engagement through the CCAMLR process as well as through domestic consultations in some countries. For example, in New Zealand, government-run fisheries and conservation working groups are open to any individual or agency representative, and representatives of non-governmental organizations and industry have joined national delegations to CCAMLR. In the United Kingdom, meetings are held between government, industry, non-governmental organizations, research providers, and other interested parties prior to CCAMLR meetings. Non-governmental organization representatives have also formed part of national delegations to CCAMLR (Akroyd *et al.* 2009). The processes required for Marine Stewardship Council certification provide significant additional opportunities for stakeholder involvement with a subset of the entities fishing in this area (Akroyd *et al.* 2010; www.msc.org). Details of domestic consultation processes in other listed countries were not available at the time of writing.

Factor 3.2. Management of fishing impacts on bycatch species

Key relevant information:

Bycatch data are recorded by observers onboard vessels and, for CCAMLR fisheries, also recorded and reported as STATLANT data provided to the CCAMLR secretariat and published (CCAMLR 2012). Bycatch volume is relatively low in most of the fisheries—usually less than 20% of the catch volume. Few species (or species groups) are caught at volumes greater than 5% of total catch. However, bycatch does include many species with high vulnerability to fishing, including some classified as near threatened, vulnerable, and endangered (e.g., joined-fins skate, white-chinned and grey petrels). Quantitative assessments of many bycatch species populations are not available. Monitoring of captures of all bycatch species, combined with appropriate ongoing research, is therefore critical for effective management. For fish bycatch, management focuses on documenting and minimizing quantities caught (e.g., through bycatch limits). In some fisheries, captures of biogenic habitat-forming organisms are recorded.

Identification (and protection) of vulnerable marine ecosystems is occurring in some fishery areas. For seabirds and some marine mammals, bycatch is reduced through the deployment of a range of effective mitigation devices (e.g., marine mammal excluders, streamer lines, discard retention, line-weighting and area/seasonal closures to reduce seabird catch). Toothfish fisheries generally have strong monitoring procedures in place that facilitate the development of science advice and enforcement of bycatch reduction measures.

Detailed rationale:

South Georgia *– Moderate concern*

Management strategy and implementation (moderately effective)
In this fishery, no species is caught at volumes greater than 5% of total catch. The management approach is drawn from CCAMLR Article 2 and invokes a precautionary and ecosystem-based approach (see above, or www.ccamlr.org, Appendix B). Management measures to reduce bycatch of seabirds and marine mammals are comprehensive and based on global best practice. For fish species, management measures include catch limits for macrourids and rajids, release of skates that are alive on hauling, collection of detailed observer data, assessment of levels of bycatch (including in population contexts when demographic data are available), and at-sea bycatch reduction measures (e.g., move-on rules for bycatch species)(CCAMLR Conservation Measures 33-02, 41-02; Medley *et al.* 2009; SC-CAMLR 2011). Bycatch measures are based on information available but must rely on assumptions when quantitative analyses cannot generate fishery or biologically based bycatch limits (e.g., for the species group of grenadiers, SC-CAMLR 2011).

Scientific research and monitoring (moderately effective)
Observers are present on all vessels. There is a significant body of data available relating to bycatch events in this fishery as well as extensive ongoing data collection and review (SC-CAMLR 2011). Data collection includes full bycatch reporting, VMS data, details on gear deployed, seabird and marine mammal bycatch mitigation measures, potential encounters with vulnerable marine ecosystems, etc. Requirements for data collection by observers are determined annually and sometimes include particular projects (e.g., for the Year-of-the-Skate or International Polar Year). However, for many bycatch species, the scope and history of analyses are limited such that the status of bycatch species cannot be assessed at the population level (SC-CAMLR 2011). Reasons for this include the low bycatch rates of some species.

Scientific advice (highly effective)
Available information has been used to inform catch limits for bycatch species as well as developing recommendations for, and evaluating the implementation of, bycatch reduction measures (e.g., deployment of mitigation devices for seabirds and marine mammals; SC-CAMLR 2011).

Enforcement (highly effective)
Enforcement of measures relating to bycaught species is focused on observer data but more broadly includes other measures as described for retained species above (see Criterion 3.1).

Heard and McDonald Islands *– Very low concern*

Management strategy and implementation (highly effective)
No bycatch species is caught at volumes of more than 5% of the total catch. The management approach is drawn from AFMA and Article 2 of the CAMLR Convention and invokes a precautionary and ecosystem-based approach (see above, or www.ccamlr.org, Appendix B). The goal for bycatch management is to have negligible impacts on bycatch species at the population level. This requires avoiding bycatch, minimizing it, or limiting it (with explicit consideration of uncertainties) when avoidance and minimization do not meet conservation objectives (Constable and Welsford 2011). Risk assessment supports the principles of the management approach (Zhou *et al.* 2009). Management measures to reduce bycatch of seabirds and marine mammals are comprehensive and based on global best practice. For fish species, management measures include catch limits for macrourids and rajids, collection of detailed observer data, assessment of levels of bycatch (including in population contexts when demographic data are available), and at-sea bycatch reduction measures (e.g., catch limits and move-on rules for bycatch species (e.g., CCAMLR Conservation Measures 33-02, 41-08; Lack *et al.* 2009; SC-CAMLR 2011). Data collection on biogenic habitat-forming species is less advanced than for other bycatch species, although spatial protection is considered an important tool for reducing impacts at the population level. A project assessing the vulnerability of benthos to bottom fishing is due to report in 2012 (AFMA 2012b). Bycatch measures are based on information available but must rely on assumptions when quantitative analyses are insufficient to generate fishery or biologically based limits (SC-CAMLR 2011).

Scientific research and monitoring (highly effective)
Observers are present on all vessels. There is a significant body of data available relating to bycatch events in this fishery as well as extensive ongoing data collection and review (SC-CAMLR 2011). Data collection includes full bycatch reporting, VMS data, details on gear deployed, seabird and marine mammal bycatch mitigation measures, potential encounters with vulnerable marine ecosystems, annual fishery-independent trawl surveys, etc. Requirements for data collection by observers are developed yearly and described in annual status reports (e.g., AFMA 2012b). Level 3 (quantitative) risk assessment has been conducted on species that may be bycaught in this fishery.

Scientific advice (highly effective)
Available information has been used to inform catch limits for bycatch species as well as developing recommendations for, and evaluating the implementation of, bycatch reduction measures (e.g., for seabirds and marine mammals, see above; SC-CAMLR 2011).

Enforcement (highly effective)
Enforcement of measures relating to bycatch species is focused on observer data (two observers are present on all vessels) but more broadly includes other measures as described for retained species above (see Criterion 3.1).

***Macquarie Island** – Very low concern*

Management strategy and implementation (highly effective)
Since 2008, one species (southern sleeper shark) has been caught at levels greater than 1% (but less than 5%) of the total catch volume. The management approach for bycatch species includes conducting risk assessments on (possibly) bycaught species (Zhou and Fuller 2011), implementing bycatch limits and seabird bycatch mitigation measures, and ongoing monitoring of bycatch through the presence of observers on all vessels (AFMA 2012b; Morison *et al.* 2012). Seabird bycatch reduction measures include components of global best practice (e.g., discard retention and use of streamer lines).

Scientific research and monitoring (highly effective)
Observers are present on all vessels in this fishery and extensive data collection is completed at sea (AFMA 2012b). Data collection includes full bycatch reporting, VMS data, details on gear deployed, seabird and marine mammal bycatch mitigation measures, potential encounters with vulnerable marine ecosystems, etc. Requirements for data collection by observers are determined yearly and promulgated through annual status reports (e.g., AFMA 2012a). Analysis includes quantitative risk assessment for potential (and actual) bycatch species (Zhou and Fuller 2011)

Scientific advice (highly effective)
Management measures are reviewed annually in this fishery to ensure consistency with CCAMLR and to ensure effective fishery management (AFMA 2012b). There is documented evidence that science advice is considered in management (Morison *et al.* 2012).

Enforcement (highly effective)
Enforcement measures relevant to bycatch species are the same as for retained species (Criterion 3.1, above).

***Prince Edward and Marion Islands** – Moderate concern*

Management strategy and implementation (moderately effective)
This fishery has measures in place to reduce bycatch of some species (e.g., mitigation devices to reduce seabird captures) but not all (e.g., fish and invertebrates) (SC-CAMLR 2011). However, the amount of fish bycatch taken in this fishery is very low (no catch reported for rajids in recent years and less than 5 t of macrourids, although these still comprise more than 5% of total catch volume, SC-CAMLR 2011). If fishing effort increases, mitigation measures for fish bycatch will increase in importance. Seabird bycatch reduction measures utilized by CCAMLR are implemented in this fishery with the exception of the closed season (SC-CAMLR 2011). The

appropriateness of the management approach in facilitating the recovery of bycatch species (which were most likely depleted along with the toothfish stock during extensive past IUU activities) will be tested over time. Harvesting strategies do not explicitly consider impacts on invertebrates, but the gear configuration now used is thought to have lesser impacts than conventional longline gear (Brown *et al.* 2010).

Scientific research and monitoring (moderately effective)
Observers are present on all vessels. Bycatch data for almost all years has been reported to CCAMLR (SC-CAMLR 2011) for this fishery. Data collection includes the deployment of seabird bycatch reduction measures. Recent changes in the fishery (e.g., gear type deployed) mean that data have only been collected for a short time under the current operational regime. Therefore, analyses relevant to the current operational context are difficult to conduct for bycatch species.

Scientific advice (moderately effective)
Consideration of scientific advice is ongoing for this fishery, in accordance with the annual CCAMLR cycle. However, an assessment of 'moderately effective' has been made, given the explicit consideration of economics in management decision making (Brandão and Butterworth 2009).

Enforcement (highly effective)
Enforcement of measures relating to bycatch species is focused on observer data but more broadly includes other measures as described for retained species above (see Criterion 3.1).

Crozet Islands – *Moderate concern*

Management strategy and implementation (moderately effective)
Ongoing changes in bycatch management approaches in this fishery have reduced seabird bycatch considerably in recent years. A range of effective seabird bycatch reduction measures have been deployed (e.g., streamer lines, line weighting, TAAF 2012, Marteau 2011). However, all bycatch (including fish bycatch) has not been reduced to levels comparable to other CAMLR Convention Area fisheries (SC-CAMLR 2011, see above). Measures in place for fish bycatch include a code of conduct that stipulates avoidance of areas of high bycatch densities and the requirement to cut skates from lines if they are not processed. The efficacy of these measures in reducing bycatch has not yet been documented. Management measures relating to biogenic habitat-forming organisms are not yet in place, but marine protected area discussions are underway and refer to species indicative of vulnerable marine ecosystems (SC-CAMLR 2011).

Scientific research and monitoring (moderately effective)
Observers or scientific experts are present on all vessels. Data-based management of the fisheries around the Crozet Islands is progressing, and data collection is ongoing in a variety of areas including data relating to bycatch (e.g., seabirds, marine mammals, fish, vessel positions, and deployment of bycatch reduction measures). However, data are not currently incorporated into stock or population-level assessments for most bycatch species (SC-CAMLR 2011).

Scientific advice (moderately effective)
Consideration of scientific advice is integral in this fishery (SC-CAMLR 2011) and a considerable body of information is available. Recent improvements in science-based management are apparent (e.g., seabird bycatch reductions, Marteau 2011), but not all science advice has been implemented through management in a timely way across bycatch species.

Enforcement (highly effective)
The approach to enforcement in this fishery is multifaceted, including observers or scientific experts onboard vessels, deployment of VMS, vessel inspections, surveillance, detailed permitting arrangements, and clearly identified roles and responsibilities for operators (CCAMLR 2011). Thus, bycatch species benefit from enforcement measures described in Section 3.1 above.

Kerguelen Island – *Moderate concern*

Management strategy and implementation (moderately effective)
Ongoing changes in bycatch management approaches in this fishery have reduced seabird bycatch considerably in recent years. A range of effective seabird bycatch reduction measures has been deployed (e.g., streamer lines, line weighting; TAAF 2012, Marteau 2011). However, not all bycatch (including fish bycatch) has been reduced to levels comparable across CAMLR Convention Area fisheries (SC-CAMLR 2011, see above). Measures in place for fish bycatch species include a code of conduct that stipulates avoidance of areas of high bycatch densities and cutting skates from lines if they are not processed. The efficacy of these measures in reducing bycatch is not yet documented. Management measures relating to biogenic habitat-forming organisms are not yet in place, but marine protected area discussions in progress refer to species that indicate vulnerable marine ecosystems (SC-CAMLR 2011).

Scientific research and monitoring (moderately effective)
Observers or scientific experts are present on all vessels. Data-based management of the fisheries around the Kerguelen Islands is progressing, and data collection is ongoing in a variety of areas including data relating to bycatch (e.g., seabirds, marine mammals, fish, vessel positions, and deployment of bycatch reduction measures). However, data are not currently incorporated into stock or population-level assessments for most bycatch species (SC-CAMLR 2011).

Scientific advice (moderately effective)
Consideration of scientific advice is integral in this fishery (SC-CAMLR 2011) and a considerable body of information is available. Recent improvements in science-based management are apparent (e.g., seabird bycatch reductions, Marteau 2011), but not all science advice has been implemented through management in a timely way across bycatch species.

Enforcement (highly effective)
In this fishery, the approach to enforcement is multifaceted, including observers or scientific experts onboard vessels, deployment of VMS, vessel inspections, surveillance, detailed permitting arrangements, and clearly identified roles and responsibilities for operators (CCAMLR 2011). Thus, bycatch species benefit from the enforcement measures described in Section 3.1 above.

Chile – *High concern*

Management strategy and implementation (ineffective)
Fishing gear configuration is such that seabird bycatch is reported to have been eliminated (Moreno *et al.* 2008). In addition, Chile has completed a National Plan of Action for Seabirds that would otherwise apply (Moreno *et al.* 2003). Marine mammal interactions with fishing gear have also been studied (Rubilar and Moreno 2012). Fish bycatch is not limited currently, and the extent of data collection is unknown relative to the fleets' fishing effort. However, research on Bigeye grenadier is underway, and stock assessments for macrourids are under development (C. Moreno, personal communication). Bycatch limits are not in place for any species. Management for the conservation of biogenic habitat-forming organisms is not yet in place.

Scientific research and monitoring (moderately effective)
Bycatch data are reported and available from certain portions of the Chilean fishery (Gálvez *et al.* 2011). Stock assessments for macrourids are under development. Exploratory studies of some bycatch species have been undertaken (e.g., deep-sea fish and chondrythians; Reyes *et al.* 2009; Reyes and Torres-Florez 2009) and database records are made for all species caught (C. Moreno, personal communication). Several full-time observers are employed, but information on fleet-wide observer coverage levels is not available. Observer coverage focuses on industrial vessels; artisanal vessels do not appear to be routinely monitored by observers (Rubilar and Moreno 2012). Scientific working groups are involved with research and deployment of observers, as well as analysis of data collected (Zuleta and Rubilar 2011).

Scientific advice (moderately effective)
For fish bycatch, the development of scientific advice appears to be in its relatively early stages (e.g., research on Bigeye grenadier and the development of macrourid stock assessments, as described above). However, investigations of marine mammal interactions and seabird bycatch on gear are more established. The components described in the scoring criteria do not fit the Chilean situation well. However, based on the development of management measures for target catch, scientific advice is considered 'moderately effective'.

Enforcement (moderately effective)
Observers have conducted targeted research projects investigating fishing interactions with bycatch species (e.g., marine mammals). This component is scored the same as for Section 3.1 in the absence of other information.

Falkland Islands – *Moderate concern*

Management strategy and implementation (moderately effective)
Management of bycatch in this fishery is focused on minimizing catch and post-capture mortality, however, one grenadier species is caught at volumes greater than 5% of total catch and another at volumes greater than 1%. An assessment of skate viability on release (Benoît *et al.* 2010) is used as a basis for the lack of bycatch limits on these species in this fishery. Seabird bycatch reduction measures are deployed. Enforcing stock catch limits is an indirect measure by which bycatch is limited. Ongoing research and data collection at sea provide information on bycatch species and their abundance (e.g., Arkhipkin *et al.* 2008, 2012; Ruocco *et al.* 2012). For seabirds, National Plans of Action have been developed (for trawl and longline fisheries). Seabird bycatch reduction measures must be deployed such as streamer lines, Brickle curtain, or weighted longlines (J. Barton, personal communication). While observer data is considered to demonstrate that sustainability limits are not currently being exceeded for species such as skates (J. Barton, personal communication), assessments are not made for all species in a population context.

Scientific research and monitoring (moderately effective)
The single vessel comprising this fishery is monitored by an onboard observer. Data collection and publication on bycatch species from this fishery is extensive and ongoing (Arkhipkin *et al.* 2012; Ruocco *et al.* 2012). Some analyses are conducted although as with other fisheries above, analyses of certain species in population contexts are limited. This is sometimes due to low levels of bycatch and/or population-level knowledge of bycatch species.

Scientific advice (highly effective)
There is evidence (based on reduced TACs) and reports that management is responsive to science advice (Falkland Islands Government 2012; V. Laptikhovsky, personal communication).

Enforcement: (highly effective)
The Falklands fishery consists of a single longliner with observer coverage. The Falklands government also monitors activities using VMS, aerial surveillance, and vessel-based patrols (V. Laptikhovsky, personal communication) (see Section 3.1, above).

Antarctic toothfish

Ross Sea – *Low concern*

Management strategy and implementation (highly effective)
The management approach is drawn from CCAMLR Article 2 and invokes a precautionary and ecosystem-based approach (see above, or www.ccamlr.org). Grenadiers are caught at levels greater than 5% of the total catch weight. However, a yield estimate is in place for Whitson's grenadier, and this is used as a basis for bycatch limits. Management measures to reduce bycatch of seabirds and marine mammals are comprehensive and based on global best practice. For fish species, management measures include catch limits for macrourids and rajids, release

of (untagged) skates and rays that are alive on hauling, collection of detailed observer data, assessment of levels of bycatch (including in population contexts when demographic data are available), and move-on rules for bycatch species (e.g., CCAMLR Conservation Measures 33-03, 41-09, 41-10; SC-CAMLR 2011). Bycatch measures are based on information available but must rely on assumptions when quantitative analyses cannot generate fishery or biologically based bycatch limits (e.g., for rajids; SC-CAMLR 2011).

Scientific research and monitoring (moderately effective)
Observers are present on all vessels. There is a significant body of data available relating to bycatch events in this fishery as well as extensive ongoing data collection and review (SC-CAMLR 2011). Data collection includes full catch reporting, VMS data, details on gear deployed, monitoring implementation of bycatch reduction measures, etc. Requirements for data collection by observers are determined annually and sometimes include particular projects. Quantitative assessment has been undertaken and used to generate bycatch limits for Whitson's grenadier. For rajids, an assessment has been investigated but required additional data for completion (SC-CAMLR 2011).

Scientific advice (highly effective)
Management measures are developed for this fishery as part of the CCAMLR cycle. This includes extensive and iterative annual evaluation of scientific data on bycatch species. Available information has been used to inform catch limits for bycatch species as well as to develop recommendations for, and evaluate the implementation of, bycatch reduction measures (SC-CAMLR 2011).

Enforcement (highly effective)
The approach to enforcement of measures relating to bycatch species is focused on observer data but more broadly includes other measures as described for retained species above (see Criterion 3.1).

Criterion 4: Impacts on the habitat and ecosystem

Guiding principles

- The fishery is conducted such that impacts on the seafloor are minimized and the ecological and functional roles of seafloor habitats are maintained.
- Fishing activities should not seriously reduce ecosystem services provided by any fished species or result in harmful changes such as trophic cascades, phase shifts or reduction of genetic diversity.

Fishery	Impact of gear on the substrate Rank (score)	Mitigation of gear impacts Rank (Score)	EBFM Rank (Score)	Criterion 4 Rank (score)
South Georgia – Patagonian Toothfish – Longline	Moderate concern (2)	Minimal mitigation (0.25)	Moderate concern (3)	Yellow (2.6)
Kerguelen Patagonian Toothfish Longline	Moderate Concern (2)	Moderate mitigation (0.5)	High Concern (2)	Yellow 2.24
Crozet – Patagonian Toothfish – Longline	Moderate concern (2)	Minimal mitigation (0.25)	High concern (2)	Red (2.12)
Heard and McDonald Island Patagonian Toothfish Longline	Moderate Concern (2)	Moderate mitigation (0.5)	Low Concern (4)	Yellow 3.16
Macquarie Island – Patagonian Toothfish – Longline	Moderate concern (2)	Minimal mitigation (0.25)	Moderate concern (3)	Yellow (2.6)
Falkland Islands – Patagonian Toothfish – Longline	Moderate concern (2)	Moderate mitigation (0.5)	Moderate concern (3)	Yellow (2.74)
Ross Sea – Antarctic Toothfish – Longline	Moderate concern (2)	Strong mitigation (1)	Moderate concern (3)	Yellow (3)
Prince Edward and Marion Islands – Patagonian toothfish – Longline	Moderate concern (2)	Moderate mitigation (0.5)	Moderate concern (3)	Yellow (2.74)
Chile domestic – Patagonian toothfish – Longline	Moderate concern (2)	Moderate mitigation (0.5)	High concern (2)	Yellow (2.24)

Justification

Factor 4.1. Impact of the fishing gear on the substrate: Moderate concern

Key relevant information:

The toothfish fisheries evaluated here are conducted using bottom longline gear (Gálvez *et al.* 2011; SC-CAMLR 2011; Morison *et al.* 2012). Longline gear targeting toothfish can take a variety of configurations (e.g., trotline, autoline, Spanish longline; SC-CAMLR 2011). All areas fished include at least some rocky substrates, although these may be mixed with other substrate types. Vulnerable marine ecosystems (VMEs) may also be encountered, including (in the CCAMLR context) seamounts, hydrothermal vents, cold water corals, and sponge fields (CCAMLR Conservation Measure 22-06; Gálvez *et al.* 2011; SC-CAMLR 2011; Laptikhovsky *et al.* 2012).

Factor 4.2. Modifying factor: Mitigation of fishing gear impacts

Key relevant information:

In recent years, CCAMLR has actively undertaken a work program on vulnerable marine ecosystems and their management (e.g., including developing and implementing CCAMLR Conservation Measures 22-06 and 22-07; SC-CAMLR 2011). In addition, a significant body of work is underway on marine protected areas (SC-CAMLR 2011). In some fisheries both inside and outside the CAMLR Convention Area, spatial management measures are already in place. Gear modifications are in use in some fisheries to reduce the impacts of fishing on the substrate (Daley *et al.* 2008; Moreno *et al.* 2008; Brown *et al.* 2010). Some fisheries are expected to have diffuse impacts over large areas due to the low intensity of fishing activity. The distribution of habitat types is not well known across fishing areas, but knowledge is gradually improving. Some fisheries are active over large areas and short time periods, which leads to highly diffuse habitat impacts.

Detailed rationale:

Patagonian toothfish

South Georgia – *Minimal mitigation*

Around South Georgia Island in areas utilized for toothfish fisheries, work relating to the management of benthic impacts is ongoing. The main vulnerable and key habitats have been identified, and benthic Restricted Impact Areas (RIAs) have been implemented and enforced. RIAs cover more than 3,500 km^2. Limited fishing is allowed in these areas for toothfish tagging (Government of South Georgia and South Sandwich Islands 2012). An extensive protected area system has recently been established, including a prohibition on bottom trawling that covers over 1 million km^2 and a prohibition on fishing that covers more than 20,000 km^2. Demersal

longline activity is restricted to depths of greater than 700 m (Government of South Georgia and South Sandwich Islands 2012). Observer coverage monitors any benthic material raised on fishing gear. The longline fishery has been estimated to impact ~0.001% of the overall area of fishable seabed, but the footprint is not being actively reduced (Medley *et al.* 2009). CCAMLR measures apply to this fishery (e.g., Conservation Measure 22-08). The measures currently in place meet the Seafood Watch criteria for 'minimal mitigation' of fishing impacts.

Heard and McDonald Islands – *Moderate mitigation*

The Heard and McDonald Island Marine Reserve is reported to provide representative ecosystem protection across 65,000 km^2, comprising 39% of the islands' EEZ waters of trawlable depth (<1000 m). This reserve also excludes longline fishing (AFMA 2012a). This fishery is managed in alignment with CCAMLR measures, and an evaluation of management options for potential additional benthic protection measures is underway (Constable and Welsford 2011). Observer coverage monitors any benthic material raised on fishing gear. Given the large extent of spatial protection and limitations on fishing effort, longline impacts are evaluated as 'moderate mitigation' in accordance with Seafood Watch criteria.

Kerguelen – *Moderate mitigation*

Fisheries around the Kerguelen Islands are catch-limited, vessel-limited, and also subject to spatial allocation of fishing effort. Furthermore, depths of less than 500 m are closed to fishing, and all trawling is forbidden (E. Reuillard, personal communication). The Kerguelen EEZ, is approximately 547,000 km2. The extent of the closed area shelf region (from the coast to the 500m isobath) is 100,495 km2 (Koubi et 1991; Clot 2013); therefore, approximately 20% of the Kerguelen EEZ is protected from all fishing activities. It is important to note that these protected areas likely exceed 20% as the entire EEZ depth contours exceed fishing depths which are a maximum of 2,000 meters, therefore 20% benthic protection represents a minimum area in protection and is likely much greater when you add the non-fishable depths (greater than 2,000 meters). In addition, a significant body of work is underway to develop further proposals for marine protected areas (Anonymous 2011; SC-CAMLR 2011; Koubbi et al. 2012; WG-EMM 2012). France has not enacted measures analogous to CCAMLR Conservation Measures 22-06 and 22-07, as these measures specify fisheries south of 60oS and where an established fishery was in place in the 2006/07 season (Delegation of France 2009). Because a substantial portion of the Kerguelen EEZ is in marine protected areas, mitigating fishing gear impacts is a moderate conservation concern.

Crozet Islands- Minimal Mitigation

Fisheries around Crozet Islands are catch-limited, vessel-limited, and also subject to spatial allocation of fishing effort. France has not enacted measures analogous to CCAMLR Conservation Measures 22-06 and 22-07, as these measures specify fisheries south of 60^oS and where an established fishery was in place in the 2006/07 season (Delegation of France 2009).

Fishing effort is controlled, but not actively reduced in this region, therefore there is minimal mitigation.

Prince Edward and Marion Islands – *Moderate mitigation*

Catch limits for the Prince Edward and Marion Islands fishery restrict fishing effort considerably (SC-CAMLR 2011). Marine protected areas are in place within 12 nmi of the islands, and a process is underway to develop a more substantial network of marine reserves (Nel and Omardien 2008). Vessels use the trotline configuration (as below for Chile and the Falklands), which is considered to have less impact on benthic substrates than other longline configurations (R. Leslie, personal communication; Brown *et al.* 2010). Vessel limits are in place but have not been met (or exceeded) in recent years (SC-CAMLR 2011). This fishery is considered to have two measures from the 'moderate mitigation' category in place. This assessment may improve as marine protection progresses.

Macquarie Island – *Minimal mitigation*

Around Macquarie Island, there is a no-take marine park protecting 162,000 km^2 of the EEZ (34%) (AFMA 2012a). Longlining is excluded from the marine park and fishing intensity is strictly controlled, even though it is not declining. These conditions meet the requirements for a score of 'minimal mitigation'.

Falkland Islands – *Moderate mitigation*

In the Falkland Islands fishery, a single longliner operates over a range of approximately 200,000 km^2, leading to highly diffuse impacts. Further, in recent years this vessel has used a longline gear configuration in which baited hooks are clustered around weights rather than evenly distributed along the line. While untested, this is thought to have less impact on the seafloor than a traditional longline configuration (Brown *et al.* 2010; V. Laptikhovsky, personal communication). This fishery is thus considered to deploy 'moderate mitigation'. Studies of deep-sea coral and vulnerable marine ecosystems are underway (J. Barton, personal communication).

Chile – *Moderate mitigation*

No information specifically relating to habitat protection measures was available for Chile. However, catch limits are set for sectors of this fishery, and some distinctions are made regarding areas fished, vessel size limits (González *et al.* 2001), and vessel entry into the fishery (Subsecretaria de Pesca 1986, 2008, 2012). Chilean vessels also use variants of the configuration of gear described for the Falkland Islands (Moreno *et al.* 2008), which is thought to have less impact on the seafloor than conventional demersal longline gear (Brown *et al.* 2010). In accordance with Seafood Watch criteria, this fishery is considered to exercise 'moderate mitigation'.

Antarctic toothfish

Ross Sea – *Strong mitigation*

This fishery follows CCAMLR Conservation Measures relating to VMEs and has catch limits in place affecting fishing intensity. In the Ross Sea (and all exploratory CCAMLR-managed fisheries), depths of less than 550 m are closed to fishing (CCAMLR Conservation Measure 22-08). Other areas are unavailable for fishing activity due to zero catch allocations (Small Scale Research Units A, D, E, F, M in Statistical Subarea 88.1, and A and B in Subarea 88.2; CCAMLR Conservation Measures 41-09, 41-10). Areas for which fishing is excluded comprise 55% of Subareas 88.1 and 88.2, and include areas throughout the depth profile from 0–1800 m. Distribution of non-fished areas across the depth profile increases the diversity of habitats covered and therefore the representativeness of habitat protection. Move-on rules are in place should VMEs be encountered (although their efficacy has been questioned, e.g., Auster *et al.* 2010). Observer coverage monitors any benthic material raised on fishing gear. Work relating to habitat impacts is ongoing (e.g., identification and protection of VMEs). Some VMEs are already protected (e.g., dense-stalked crinoid communities located in the management unit designated SSRU 881G), and marine protected areas are currently under discussion (SC-CAMLR 2011). Risk assessments are ongoing at multiple levels, including an annual assessment of impacts on known and unknown VMEs (i.e., possible impacts of future fishing activity), which is required in order to gain entry to this fishery (CCAMLR Conservation Measure 22-06). The Ross Sea fishery is considered to have 'strong mitigation' in place.

Factor 4.3. Ecosystem and food web considerations

<u>Key relevant information:</u>

Toothfish are opportunistic carnivores, consumed by seabirds (e.g., petrels and penguins), pinnipeds, and cetaceans (Hanchet 2008; Collins 2010). However, they are identified as an exceptional species given their importance, in ecosystem models, as a fish predator (Pinkerton *et al.* 2010). A range of management policies and procedures relating to ecosystems and food webs are in place (e.g., an ecosystem-focused management approach based on current knowledge (Appendix B), species catch limits, bycatch reduction measures, and spatial closures) and under development (e.g., additional spatial protection measures) in toothfish fisheries. The impacts of IUU fishing on ecosystems are not precisely known but can be qualitatively assessed based on the type of fishing gear used. There is a large body of ecosystem-level research underway, including modeling efforts, which will clarify assumptions made in current management approaches (e.g., trophodynamics of toothfish). In addition to target catch and bycatch-related management described previously, CCAMLR management measures aimed at reducing ecosystem impacts include prohibition of the use of plastic packaging bands and prohibition of the discharge of offal/discards containing hooks. Marine debris is also monitored through land-based surveys. For many fisheries, classification is expected to improve in the near future given spatial protection measures under development.

Detailed rationale:

Patagonian toothfish

South Georgia – *Moderate concern*

CCAMLR management has its foundations in an ecosystem-based approach (see above, Appendix B). In developing harvesting approaches for toothfish, assumptions were made about the species' ecological role (Constable *et al.* 2000). Based on assumptions such as these, toothfish removals in South Georgia have been reported as not high enough to compromise the species' ecological role (Medley *et al.* 2009). Catch limits based on stock assessments developed from CCAMLR principles are in place. Collection of data by scientific observers and other research programs (e.g., seabird population monitoring) ensures an ongoing information stream including many ecosystem components that may be affected by the fishery (SC-CAMLR 2011). Ecosystem modeling has identified uncertainties requiring additional data collection (Medley *et al.* 2010). An evaluation of 'moderate concern' has been made based on the Seafood Watch criteria, while recognizing the significant body of information available on this area.

Heard and McDonald Islands – *Low concern*

Management of fishing activity at Heard and McDonald Islands uses CCAMLR's ecosystem-based approach (Constable *et al.* 2000) and Australian domestic management principles (see above). Australian and French scientists are working together to develop an ecosystem monitoring program for the Heard, McDonald and Kerguelen fisheries (Welsford, D., personal communication). Collection of data by scientific observers ensures an ongoing information stream (SC-CAMLR 2011), which is complemented by research initiatives outside the fishery (e.g., demographic studies of seabirds). In the Heard and McDonald area, spatial protection is a key ecosystem-level management tool (AFMA 2012a), with 39% of the area of trawlable depth closed to all fishing in a marine reserve designed to provide representative habitat protection.

Kerguelen and Crozet Islands – *High concern*

Fisheries around the Kerguelen and Crozet Islands operate under catch limits, although these limits are not yet set using a stock assessment based on consideration of the target species' ecological role (Rélot-Stirnemann 2011, SC-CAMLR 2011). Processes to develop marine protected areas are underway (SC-CAMLR 2011). A significant body of work is underway studying the ecosystem characteristics of the area in which fishing occurs (e.g., see Duhamel and Welsford 2011) including some ecosystem modeling work (Pruvost *et al.* 2005). Although work is underway to improve understanding of the ecosystem (Falguier and Marteau 2011), there are no current explicit efforts to incorporate ecological knowledge into management. Ongoing ecological assessments do not specifically address the ecological role of toothfish, and the expansion of the fishery into deeper water may have unknown ecosystem impacts (Lord *et*

al. 2006). This assessment is expected to improve as current work is completed and emergent management measures are implemented.

Prince Edward and Marion Islands – *Moderate concern*

For the fishery around the Prince Edward and Marion Islands, catch limits are in place (subject to reassessment as data collection using newly implemented trotline gear proceeds, R. Leslie, personal communication), and marine protected areas are under development (Nel and Omardien 2008). Data is being collected on the fishery to ascertain the efficacy of trotline gear and the nature of the catch (R. Leslie, personal communication). This fishery is assessed as a 'moderate concern', given the low level of fishing intensity (SC-CAMLR 2011), the work underway on ecosystem components and modeling (Gurney, L. et al. 2011), and the current spatial protections (Nel and Omardien 2008).

Falkland Islands – *Moderate concern*

The Falkland Islands toothfish fishery is controlled using catch limits and involves only a single vessel fishing over a large area (see above). Management considers target and bycatch species when setting TACs, and measures have been implemented to reduce bycatch (e.g., seabird) (V. Laptikhovsky, personal communication). There is a significant body of information relevant to the ecological context of toothfish fishing (e.g., Arkhipkin *et al.* 2003; Laptikhovsky *et al.* 2008; Arkhipkin and Laptikhovsky 2010). The fishery is evaluated as a 'moderate concern' while recognizing the work done to date and that confidence in the lack of negative ecosystem effects will increase over time under the current management regime. A significant milestone in this respect may be the recently documented increase in the abundance of black-browed albatrosses (*Thalassarche melanophris*) (J. Barton, personal communication).

Macquarie Island – *Moderate concern*

Although it lies outside the CAMLR Convention Area, the Macquarie Island fishery area is managed following the same principles as CCAMLR, and CCAMLR Conservation Measures are implemented when relevant. The Macquarie Island Marine Park offers some ecosystem protection through spatial protection (i.e., areas closed to fishing) on a large scale (34% of the EEZ; AFMA 2012b). Ecological risk has also been examined and reported in this fishery (AFMA 2011). Given this management approach, the policies in place, and the range of measures implemented (including significant spatial protection), this fishery's ecosystem management measures are considered a 'moderate concern'.

Chile – *High concern*

Current management of target species in this fishery is focused primarily on catch limits. However, research is ongoing for particular ecosystem components (e.g., seabirds and marine mammals). A significant milestone with respect to reducing ecosystem impacts of the fishery may be the recently documented increase in the abundance of black-browed albatrosses (G.

Robertson, personal communication). Research is ongoing relating to toothfish, fish bycatch, seabird bycatch, and marine mammal interactions, with minimal focus on the ecological role toothfish play in the system. There are currently no explicit efforts to incorporate the ecological role of toothfish into the management system.

Antarctic toothfish

Ross Sea – *Moderate concern*

Fishing is excluded from 55% of this area across a range of depths (0–1800 m), although a smaller proportion of prime toothfish fishing habitat (at depths 800-1200 m) is protected. The Ross Sea fishery is also managed using the CCAMLR framework, encompassing both precautionary and ecosystem considerations. As for Antarctic toothfish, management approaches are linked to the assumption that this species is unlikely to comprise a significant proportion of the diet of marine mammals and birds (Constable *et al.* 2000), and requires the "maintenance of the ecological relationships between harvested, dependent and related populations of Antarctic marine living resources" (Appendix B). Harvesting decision rules implement these principles through stock assessments and bycatch limits (SC-CAMLR 2011, 2012). Harvesting decision rules are such that the lower yield of the following two options (i.e., i or ii) is implemented in the management approach: (i) the probability of the spawning biomass dropping below 20% of its median pre-exploitation level over a 35-year harvesting period is 10%, or (ii) the median escapement in the spawning stock biomass (SSB) over a 35-year period is 50% of the median pre-exploitation level at the end of the projection period (Constable *et al.* 2000).

Concerns have been raised regarding the effects that the removal of Antarctic toothfish from Ross Sea ecosystems may have on Weddell seals and Ross Sea killer whales, both of which prey on toothfish (DeVries et al. 2008; Ainley and Siniff 2009; Ainley and Ballard 2012). Research suggests that coincident with the increase in the fishery for toothfish, toothfish have declined dramatically in McMurdo Sound and in the vicinity of Ross Island, Ross Sea, while Ross Sea killer whale observations in the area have also decreased (DeVries et al. 2008; Ainley and Ballard 2012).

However, there is controversy over the importance of toothfish as a prey species for these two and other predators. In the balanced trophic model derived by Pinkerton *et al.* (2010), production of large toothfish (>100 cm) satisfies 6.5% of the diet of Weddell seals, 5.6% of the diet of orca and 2.6% of the diet of sperm whales. Further, while recognizing that the importance of toothfish as a food source for these predator species is untested, the authors note that the model does not support the hypothesis that fishing will change the predators' diets by large amounts throughout the Ross Sea (Pinkerton *et al.* 2010). Pinkerton and Bradford-Grieve (2012) reported that the biomass of top predators was 0.5% of the living biomass (excluding bacteria) in the Ross Sea. They identified the six groups of greatest ecological importance in the food web as phytoplankton, mesozooplankton, Antarctic silverfish (*P. antarcticum*), small demersal fishes, Antarctic krill (*Euphausia superba*) and cephalopods.

Two other groups were considered likely to be important: crystal krill (*E. crystallorophias*) and pelagic fishes. These eight groups were recommended as a basis for monitoring ecosystem change. Overall, Antarctic toothfish was assessed as having moderate ecological importance in the wider ecosystem, with a greater impact on medium-sized demersal fishes.

However, the conclusions of the modeling study by Pinkerton et al. (2010) are highly uncertain as well, and Pinkerton notes that the model cannot inform whether toothfish consumption may be important to predators at certain locations or times of year, or whether changes in toothfish availability in the diet of predators could be ecologically important in the Ross Sea. It can certainly not be ruled out that reducing toothfish abundance through fishing may have substantial food web effects, including increasing foraging pressure on predators such as Weddell seals and orcas. In addition, toothfish's importance as a predator is not debated; there are concerns that depletion of toothfish could eventually induce trophic cascades through the release of predation pressure on medium-sized fishes (Pinkerton et al. 2010).

As described above, the importance of toothfish as a prey species remains debated in the scientific literature, while the importance of toothfish as a predator is widely acknowledged. Based on this information and erring on the side of caution, Seafood Watch considers Ross Sea toothfish to be a species of exceptional importance to the ecosystem. As such, it is important that the fishery be monitored not just for changes in toothfish abundance, but also for impacts on predators and prey species. While there are ongoing efforts to better understand ecosystem interactions in the region, regular monitoring of the fishery's ecosystem impacts is not in place. CCAMLR's management target of 50% of virgin biomass is based on the assumption that toothfish are not important prey species (Constable et al. 2000), therefore a single-species approach is used, rather than using CCAMLR's more conservative approach for managing fisheries on important prey species (e.g. krill):

> "….toothfish, as a large predator, is unlikely to constitute much of the diet of seals and birds (SC-CAMLR, 1997). Therefore, the species is considered in a single-species context and the second criterion is applied at the 50% level rather than at the 75% level." (p. 785)

There is continuing work on ecosystem modeling relating to this fishery. Furthermore, several areas remain unavailable to fishing activity (CCAMLR Conservation Measures 41-09, 41-10). However, given the controversy surrounding the toothfish's role in the ecosystem, regular monitoring of ecosystem impacts and explicit incorporation of potential ecosystem concerns into management is needed; until these relationships are clarified, a precautionary approach (e.g. fishing to B75% instead of B50%) would be merited. While data exploring ecosystem impacts are inconclusive, there is a risk of trophic cascades or impacts on predators, particularly as the fishery reduces biomass closer to the B50% target. As such, Seafood Watch considers the ecosystem-based fishery management in the Ross Sea toothfish fishery to be a moderate concern.

Overall Recommendation

The overall recommendation for the fishery is calculated as follows:

- **Best Choice** = Final score ≥ 3.2 **and** scores for Criteria 1, 3 and 4 are all ≥ 2.2 **and** Criterion 2 *subscore* ≥ 2.2

- **Some Concerns** = Final score ≥ 2.2 **and** Criterion 3 ≥ 2.2 **and** **(**Final score ≤ 3.2 **or** scores for Criteria 1 &4 ≤ 2.2 **or** Criterion 2 *subscore* ≤ 2.2)

- **Red**= Final score < 2.2 **or** score for Criterion 3 < 2.2 **or** any one criterion has a critical score **or** two or more of the following are < 2.2: Criterion 1 score, Criterion 2 *subscore*, Criterion 4 score

Stock	**Fishery**	**Impacts on the stock** Rank (score)	**Impacts on other species** Lowest scoring species Rank* (subscore, score)	**Manage-ment** Rank (score)	**Habitat and ecosystem** Rank (score)	**Overall** Recommendation (score)
Heard and McDonald Patagonian toothfish	Heard and McDonald Island Patagonian Toothfish Longline	Green 5	Murray's skate Heard and McDonald, Kerguelen sandpaper skate, Pacific sleeper shark, Corals and biogenic habitats, Skates and rays, Benthic invertebrates Yellow, 2.71,2.71	Green 5	Yellow 3.16	**BEST CHOICE 3.83**
Macquarie Patagonian Toothfish	Macquarie Island Patagonian Toothfish – Longline	Green (5)	Southern sleeper shark, Corals and biogenic habitats, Benthic invertebrates Yellow (2.71 2.71)	Green (5)	Yellow (2.6)	**BEST CHOICE (3.64)**

* Rank and color in the 'Impacts on other Species' column is defined based on the subscore rather than the score. See www.seafoodwatch.org for more information about scoring rules.

Falkland Islands Patagonian Toothfish	Falkland Islands Patagonian Toothfish – Longline	Green (5)	Antarctic starry skate, White-mouth skate, Porbeagle Falklands, Joined-fins skate, Multispined skate, White-dotted skate, Darkbelly skate, Corals and biogenic habitats, Big-eye grenadier Falklands, Benthic invertebrates Yellow (2.71, 2.71)	Green (3.46)	Yellow (2.74)	**BEST CHOICE (3.37)**
South Georgia Patagonian Toothfish	South Georgia Patagonian Toothfish – Longline	Green (5)	Grenadiers, Skates and rays Red (2.16, 2.16)	Green (3.87)	Yellow (2.6)	**GOOD ALTERNATIVE (3.23)**
Ross Sea Antarctic Toothfish	Ross Sea Antarctic Toothfish – Longline	Green (3.83)	Grenadiers, Skates and rays Red (2.16,2.16)	Green (3.46)	Yellow (3)	**GOOD ALTERNATIVE (3.05)**
Kerguelen Islands Patagonian toothfish	Kerguelen Patagonian Toothfish Longline	Green (3.83)	Ridge scaled rattail Kerguelen, White-chinned petrel, Whiteleg skate Kerguelen, Grey petrel, Raya spp. Red (2.16,2.16)	Yellow (3)	Yellow (2.24)	**GOOD ALTERNATIVE 2.73**
Crozet Island Patagonian Toothfish	Crozet Patagonian Toothfish – Longline	Red (2.16)	Crozet Island Patagonian toothfish, Whiteleg skate Crozet, Ridge scaled rattail Crozet, Grey petrel, White-chinned petrel Red (2.16, 2.05)	Red (1.73)	Red (2.12)	**AVOID 2.01**
Chile Patagonian Toothfish	Chile Domestic Patagonian Toothfish – Longline	Red (1.41)	Yellownose skate Red (2.16, 2.16)	Red (1)	Yellow (2.24)	**AVOID (1.62)**

PE&MI Patagonian Toothfish	Prince Edward and Marion Islands Patagonian Toothfish – longline	Red (2.16)	Corals and biogenic habitat Yellow (2.71, 2.71)	Red (1.73)	Yellow (2.74)	**AVOID (2.3)**

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Scientific review does not constitute an endorsement of the Seafood Watch® program, or its seafood recommendations, on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.

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Appendix A: Convention on the Conservation of Antarctic Marine Living Resources, Article 2

The following text describes CCAMLR's approach to management. The full text of the Convention can be viewed at: http://www.ccamlr.org/en/organisation/camlr-convention-text.

Article II

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

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

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

(a) prevention of decrease in the size of any harvested population to levels below those which ensure its stable recruitment. For this purpose its size should not be allowed to fall below a level close to that which ensures the greatest net annual increment;

(b) maintenance of the ecological relationships between harvested, dependent and related populations of Antarctic marine living resources and the restoration of depleted populations to the levels defined in sub-paragraph (a) above; and

(c) prevention of changes or minimisation of the risk of changes in the marine ecosystem which are not potentially reversible over two or three decades, taking into account the state of available knowledge of the direct and indirect impact of harvesting, the effect of the introduction of alien species, the effects of associated activities on the marine ecosystem and of the effects of environmental changes, with the aim of making possible the sustained conservation of Antarctic marine living resources."

Appendix B: Review Schedule

All fisheries included in this assessment are subject to annual reviews. CCAMLR fisheries are reviewed annually in October. Fisheries that have received Marine Stewardship Council certification are subjected to an annual surveillance audit publicized at www.msc.org. For other fisheries assessed (i.e. Chile and Falklands), review timeframes are still annual, but follow independent schedules. Review in February 2014 is recommended.

About Seafood Watch®

Monterey Bay Aquarium's Seafood Watch® program evaluates the ecological sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch® defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. Seafood Watch® makes its science-based recommendations available to the public in the form of regional pocket guides that can be downloaded from www.seafoodwatch.org. The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

Each sustainability recommendation on the regional pocket guides is supported by a Seafood Report. Each report synthesizes and analyzes the most current ecological, fisheries and ecosystem science on a species, then evaluates this information against the program's conservation ethic to arrive at a recommendation of "Best Choices", "Good Alternatives" or "Avoid". The detailed evaluation methodology is available upon request. In producing the Seafood Reports, Seafood Watch® seeks out research published in academic, peer-reviewed journals whenever possible. Other sources of information include government technical publications, fishery management plans and supporting documents, and other scientific reviews of ecological sustainability. Seafood Watch® Research Analysts also communicate regularly with ecologists, fisheries and aquaculture scientists, and members of industry and conservation organizations when evaluating fisheries and aquaculture practices. Capture fisheries and aquaculture practices are highly dynamic; as the scientific information on each species changes, Seafood Watch®'s sustainability recommendations and the underlying Seafood Reports will be updated to reflect these changes.

Parties interested in capture fisheries, aquaculture practices and the sustainability of ocean ecosystems are welcome to use Seafood Reports in any way they find useful. For more information about Seafood Watch® and Seafood Reports, please contact the Seafood Watch® program at Monterey Bay Aquarium by calling 1-877-229-9990.

Disclaimer

Seafood Watch® strives to have all Seafood Reports reviewed for accuracy and completeness by external scientists with expertise in ecology, fisheries science and aquaculture. Scientific review, however, does not constitute an endorsement of the Seafood Watch® program or its recommendations on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.

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Guiding Principles

Seafood Watch™ defines sustainable seafood as originating from sources, whether fished6 or farmed, that can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems.

The following **guiding principles** illustrate the qualities that capture fisheries must possess to be considered sustainable by the Seafood Watch program:

- *Stocks are healthy and abundant.*
- *Fishing mortality does not threaten populations or impede the ecological role of any marine life.*
- *The fishery minimizes bycatch.*
- *The fishery is managed to sustain long-term productivity of all impacted species.*
- *The fishery is conducted such that impacts on the seafloor are minimized and the ecological and functional roles of seafloor habitats are maintained.*
- *Fishing activities should not seriously reduce ecosystem services provided by any fished species or result in harmful changes such as trophic cascades, phase shifts, or reduction of genetic diversity.*

Based on these guiding principles, Seafood Watch has developed a set of four sustainability **criteria** to evaluate capture fisheries for the purpose of developing a seafood recommendation for consumers and businesses. These criteria are:

1. Impacts on the species/stock for which you want a recommendation
2. Impacts on other species
3. Effectiveness of management
4. Habitat and ecosystem impacts

Each criterion includes:

- Factors to evaluate and rank
- Evaluation guidelines to synthesize these factors and to produce a numerical score
- A resulting numerical score and **rank** for that criterion

Once a score and rank has been assigned to each criterion, an overall seafood recommendation is developed on additional evaluation guidelines. Criteria ranks and the overall recommendation are color-coded to correspond to the categories on the Seafood Watch pocket guide:

Best Choices/Green: Are well managed and caught or farmed in environmentally friendly ways.

6 "Fish" is used throughout this document to refer to finfish, shellfish and other invertebrates.

Good Alternatives/Yellow: Buy, but be aware there are concerns with how they're caught or farmed.

Avoid/Red: Take a pass on these. These items are overfished or caught or farmed in ways that harm other marine life or the environment.