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MARINE FISHERIES CATCHES OF SUBANTARCTIC ISLANDS, 1950 TO 2010

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Fisheries Centre, University of British Columbia, Canada

Marine Fisheries Catches of SubAntarctic Islands, 1950 to 2010

edited by
Maria Lourdes D. Palomares and Daniel Pauly

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M.L.D. Palomares and D. Pauly (editors)

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Preface

This report presents catch 'reconstructions' for six groups of islands that are part of, or near the sub-Antarctic convergence: France's Crozet and St Paul & Amsterdam, Norway's Bouvet Island and the United Kingdom's Falkland, South Georgia and South Sandwich, and Orkney Islands.

As such, it concludes the *Sea Around Us*' coverage of Antarctica in the widest sense (see map on adjacent page), following up as it does on reports covering Antarctica proper[1], Australia's Heard & MacDonald and Macquarie Islands[2], France's Kerguelen[3] and South Africa's Prince Edward Islands[4].

This now complete coverage of Antarctica for the years 1950 to 2010 will allow a better understanding the expansion of industrial fishing from the North into this ultimate region, which began earlier than generally assumed.

Another generality that we learned is that the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), while somehow reticent to share some of its data, is an effective organization, which tracks and documents Antarctic fisheries, including the discards they generate, very well. CCAMLR is also well aware of and combats illegal fisheries, something which other Regional Fisheries Management Organizations (RFMOs) ought to emulate.

Our Antarctic reports differ from other reports in that, with the exception of the Falklands, they do not have to account for domestic small-scale fisheries given that they deal with the waters surrounding uninhabited lands. This considerably simplified our reconstructions. On the other hand, the catch from most of the waters, which CCAMLR reports by 'season', had to be adjusted to conform to the 12 months of conventional calendars, something which is usually omitted from accounts of Antarctic fisheries.

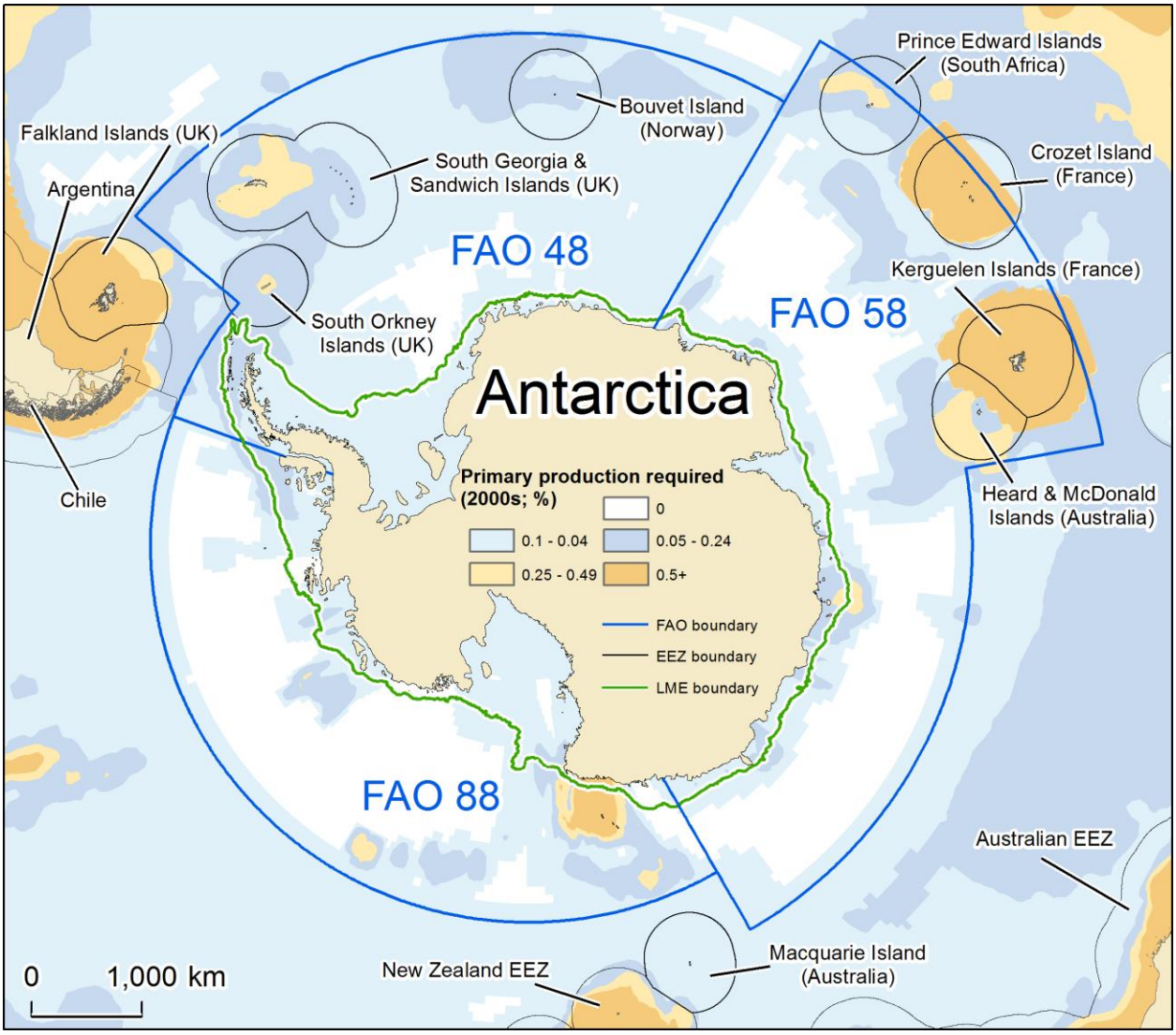
The Editors, also on behalf of the authors, look forward to comments and corrections to the material presented here, which will be considered, and with regards to catch data, will be included in the regular database updates that the *Sea Around Us* intends to perform, and which will be reflected on our website, www.seaaroundus.org.

[1] Ainley D and Pauly D (2013) Fishing down the food web of the Antarctic continental shelf and slope. Polar Record 50(1): 92-107.

[2] Kleisner KM, Brennan C, Garland A, Lingard S, Tracey S, Sahlqvist P, Tsolos A, Pauly D and Zeller D (2014) Australia: reconstructing estimates of total fisheries removals 1950-2010. Fisheries Centre Working Paper #2015-02, 26 p.

[3] Palomares MLD and Pauly D (2011) A brief history of fishing in the Kerguelen Island, France. In: Harper S and Zeller D (eds.), Fisheries catch reconstruction: Islands, Part II, p. 15-20. Fisheries Centre Research Reports 19(4).

[4] Boonzaier L, Harper S, Zeller D and Pauly D (2012) A brief history of fishing in the Prince Edward Islands, South Africa, 1950-2010: In: Harper S, Zylich K, Boonzaier L, Le Manach F, Pauly D and Zeller D (eds.), Fisheries catch reconstructions: Islands, Part III, p. 95-101. Fisheries Centre Research Reports 20(5).


Prince Edward Islands
(South Africa)
Bouvet Island
(Norway)
Falkland Islands (UK)
South Georgia &
Sandwich Islands (UK)
Crozet Island
(France)
Argentina
FAO 48
Kerguelen Islands (France)
FAO 58
South Orkney
Islands (UK)
Antarctica
Primary production required
(2000s; %)
0
0.1 - 0.04
0.05 - 0.24
0.25 - 0.49
0.5+
FAO boundary
EEZ boundary
LME boundary
Chile
Heard & McDonald
Islands (Australia)
FAO 88
Australian EEZ
0
1,000 km
New Zealand EEZ
Macquarie Island
(Australia)

FISHERIES OF THE FALKLAND ISLANDS AND THE SOUTH GEORGIA, SOUTH SANDWICH AND SOUTH ORKNEY ISLANDS[5]

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Abstract

The history of the Falkland Islands, and the islands of South Georgia, South Sandwich and South Orkney Islands, is briefly reviewed, with emphasis on the exploitation of the living resources (marine mammals, fishes) surrounding these islands. This is then used as background for a 'reconstruction' of the catches of fishes and invertebrates, based on a variety of historic sources and catch statistics of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) from the period from 1950 to 2010. These catches evolved from primarily subsistence and artisanal fisheries supplying the staff of whaling stations and (in the Falklands) the local inhabitants in the 1950s and 1960s, to licensed, well documented and managed industrial fisheries with annual average catches of more than 185,000 t in the Falkland Islands, about 96,000 t in South Georgia, 60 t in South Sandwich Islands, and about 79,000 t in South Orkney Islands. These fisheries are currently targeting mainly squids (*Illex argentinus* and *Doryteuthis gahi*) and various species of rockcod (*Patagonotothen* spp.) around the Falklands, krill (*Euphausia superba*) and various high-value demersal fishes (such as the mackerel icefish *Champsocephalus gunnari* and the Patagonian toothfish, *Dissostichus eleginoides*) around the South Georgia, South Sandwich and South Orkney Islands.

Introduction

This account presents a reconstruction of the marine fisheries catches of the Falkland Islands and South Georgia, South Sandwich and South Orkney Islands for the years 1950-2010. The results are tentative and the reconstruction is preliminary. It is mainly based on official statistics of the Falkland Islands Fisheries Department[6] and data extracted from the Commission for the Conservation of Antarctic Marine Living Resource (CCAMLR) for South Georgia, South Sandwich and South Orkney Islands, complemented by historical data from the scientific and geographic literature.

The Falkland Islands (Figure 1), named after the Viscount of Falkland[7], were first colonized by immigrants from San Malô in France at the end of the 17th Century, and hence the name *Iles Malouines* in

[5] Cite as: Palomares MLD and Pauly D (2015) Fisheries of the Falkland Islands and the South Georgia, South Sandwich and South Orkney Islands. In: Palomares MLD and Pauly D (eds) Marine Fisheries Catches of SubAntarctic Islands, 1950-2010, p. 1-20. Fisheries Centre Research Reports 23(1). Fisheries Centre, University of British Columbia, Vancouver, BC.

[6] The Falkland Islands are too far north to be covered by the Commission on the Conservation of Antarctic Marine Living Resources (CCAMLR; see Russ 2007).

[7] Treasurer of the Navy (HMSO 1920) and one of the owners of the *Welfare* commanded by Captain John Strong in 1690, i.e., the first recorded landing in the Falklands, at Bold Cove, Port Howard (Boyson 1924).

French (Charton 1848). The islands were later referred to as *Las Islas Malvinas* in Spanish when the French relinquished the islands to the Spanish in 1767 (see Palomares et al. 2006). The British reclaimed the islands in the 1840s[8], after which a succession of conflicts, notably between Spain and Britain and Argentina and Britain, over who should own these islands ensued, the last culminating in a brief war between Argentina and Britain in 1982[9]. The Falklands consist of 778 islands, of which two, the West and East Islands, are the major ones. Peopled by almost 3,000 inhabitants[10], the Falkland Islands jointly cover 12,200 km^2 and are surrounded by an Exclusive Economic Zone of 551,000 km^2, which contains valuable marine resources within a 179,000 km^2 shelf area and a 44,000 km^2 inshore fishing area[11].

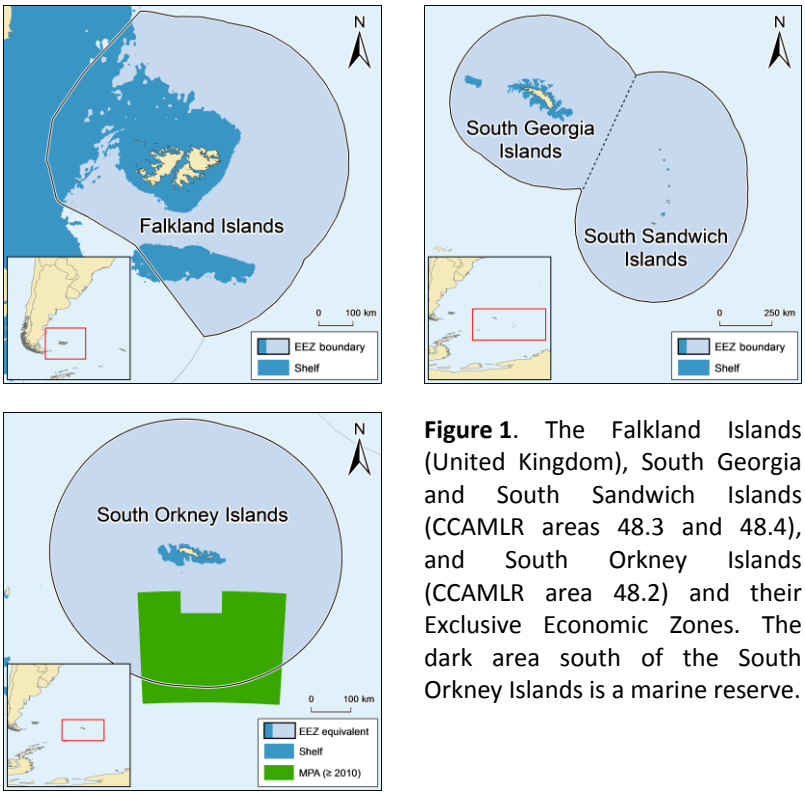

Figure 1. The Falkland Islands (United Kingdom), South Georgia and South Sandwich Islands (CCAMLR areas 48.3 and 48.4), and South Orkney Islands (CCAMLR area 48.2) and their Exclusive Economic Zones. The dark area south of the South Orkney Islands is a marine reserve.

The Falkland Islands Dependencies, defined by the Letters Patent of 21 July 1908 and 28 March 1917, include all the islands and territories from 20°W and 50°W, south of 50°S and from 50°W to 80°W, south of 58°S (HMSO 1959a). This definition includes the islands of South Georgia[12] (35°50'-38°15'W; 54-55°S), South Sandwich (26-28°15'W; 59°18'-59°30'S), South Orkney (44-47°50'W; 60-61°S), South Shetlands (west of the South Orkneys), Graham Land including Palmer, Biscoe and other islands separated from the South Shetlands by the Barnsfield Strait (HMSO 1920). The international legal regime established as the Antarctic Treaty in 1961 led to the establishment of the British Antarctic Territory in 1962 to include only South Georgia and South Sandwich Islands (inclusive of Shag and Clerke Rocks). In 1985, the territory became the British Overseas Territory of South Georgia and South Sandwich Islands (HMSO 1962a), with an EEZ[13] of 1,449,532 km^2, a shelf area of 23,090 km^2 and an inshore fishing area of 14,940 km^2.

[8] Act of Parliament dated 11 April 1843 declared the Falkland Islands as Crown colony, with Port William (renamed Stanley Harbour after Lord Stanley, Secretary of State for the Colonies) and Lieutenant R.E. Moody as Governor (HMSO 1920).
[9] See historical timeline at https://falklandstimeline.wordpress.com/.
[10] Current population based on http://www.falklands.gov.fk/our-people/.
[11] EEZ, shelf and inshore fishing area (IFA) data from the *Sea Around Us* database (see http://www.seaaroundus.org/eez/238.aspx; accessed 11/01/2015). The IFA is defined as the area within 50 km from the coast or 200 m depth, whichever comes first (Chuenpagdee et al. 2006).
[12] Captain Cook, onboard the *Resolution*, landed at Possession Bay on 17 January 1775, and named the islands after King George III (see Cook 1776).
[13] Though also contested by Argentina.

While the South Georgia and the South Sandwich Islands have well defined EEZs (Figure 1), which include 20,000 km^2 of marine reserve (see South Georgia and South Sandwich Islands Government 2012), the South Orkney Islands and surrounding waters are of uncertain legal status, which may have helped to convert them into a marine reserve that is largely accepted internationally since it was declared in 2010[14] (Figure 1). Given that these three island groups are part of the CCAMLR convention (Subareas 48.3, 48.4 and 48.2, respectively), which contain no other island groups, and given that these islands have a similar fauna and history of exploitation (see Kock 1992), we are presenting their catch reconstruction in the same contribution, which thus covers, (i) the Falkland Islands; and (ii) the Antarctic Islands of South Georgia, South Sandwich and South Orkney.

"We go somewhere, use up a resource and move on to the next one"[15]

For over one century, the main industry of the Falkland Islands and its Dependencies was sheep farming, which produces wool, meat, skins and tallow (i.e., fat). Regularly published 'blue books' reporting on the economic progress of the Colony as early as 1846 trace the growth of sheep farming from 1867 onwards, replacing the South American 'gaucho style' wild cattle[16] ranching established by Louis-Antoine de Bougainville's French colony at Fort St. Louis[17] (Pernetty 1773) and surreptitiously continued by the Spanish[18] until the early 1800s (HMSO 1920; Strange 1987).

The introduction of grazing animals (pigs, rabbits and goats, in addition to cattle and sheep) into an ecosystem which had evolved in the absence of such animals (Russ 2007) led to overgrazing of the grass that grew on an acidic and infertile soil. This must have contributed to Charles Darwin's view of the islands as 'desolate', on his first visit aboard the *HMS Beagle* in 1833[19] (see Armstrong 2004). Sheep farming reached a record total production in 1896, and slowly dwindled, presumably because the carrying capacity of the terrestrial grass ecosystem was exceeded. However, at least in the Falkland Islands (South Georgia was by then already an important sealing and whaling station; see Rankin 1951), sheep farming remained profitable given the high value of wool, frozen meat and the low rent of tenured land (HMSO 1920). To this day, sheep farming remains as the major land-based industry in the Falkland Islands, though it has been replaced by fisheries as a major source of income[20].

The exploitation of the marine resources in and around these islands can be traced back to the 1760s, associated with de Bougainville's colony (Headland 1984). By 1775, seals were being extracted for export, e.g., as cargo of seal fur and associated products to Canton (now Guangzhou), China in 1784, with

[14] http://www.mpatlas.org/mpa/sites/5283/

[15] MacArthur (2010), on the 'linear' progression of the Falkland Islands' economy.

[16] No record remains of the wild cattle breed introduced by de Bougainville, whose traits include "*large spreading horns, long hair, broad fore limbs and small hind quarters*" (Strange 1987).

[17] Named after the *St. Louis*, commanded by Jacques Gouin de Beauchêne, which landed there in 1698 (Taillemite 1997).

[18] Spain reclaimed Port Louis in 1766. However, in 1764, the British established a station in Port Egmont, unbeknownst to the Spanish. The discovery of each other's stations in 1769 sparked the first colonial battle for the Falklands between Spain and Britain, which resulted in the dismantling of both camps (HMSO 1920).

[19] Charles Darwin, who visited the Falklands during his voyage with *HMS Beagle*, wrote in his diary on 3 March 1833 in Port Luis: "*Took a long walk; this side of the island is very dreary: the land is low & undulating with stony peaks & bare ridges: it is universally covered by a brown wiry grass, which grows on the peat. In this tract very few plants are found, & excepting snipes & rabbits, scarcely any animals. The whole landscape from the uniformity of the brown color has an air of extreme desolation*." (Armstrong 2000, p. 24-25; see also Pauly 2004).

[20] See http://www.falklands.gov.fk/self-sufficiency/commercial-sectors/agriculture/.

an average load of 2,000-4,000 seals·ship^{-1}·voyage^{-1} (Hofman and Bonner 1985), or an average of 300,000 seals caught by over 100 sealing vessels per season (Palomares et al. 2006). Seal populations quickly succumbed to this overexploitation. Entire populations were annihilated due to indiscriminate removals (see de Saint-Martin 1845), i.e., young, old, male, female seals were taken, mostly due to an ensuing competition for better exports between 'sealer gangs' (Russ 2007). In South Georgia, where sealing and whaling was practiced year round in the 1860s, an estimate of 1.2M seals '*were slaughtered*' in 1865, while a fishing fleet of 5 vessels caught only 600 in 1875 (Rankin 1951). This '*criminal attack*', as referred to by Rankin (1951, p. 34), led to the local extirpation of elephant seals in the Falklands by 1871 (Armstrong 1994) and of fur seals in Beauchêne Island by 1919 (Strange 1976). From the late 1920s to the early 1950s, sea lions were being culled at the annual rate of 7% (Rodriguez and Bastida 1998).

As the seal population declined, whaling was taken up.[21] Technological improvements increased the efficiency of whaling activities, e.g., the explosive harpoon gun invented by Svend Foyn in 1866 (see Tønnessen and Johnsen 1982), and the establishment of permanent coastal whaling stations in South Georgia with inshore floating processing stations[22] in the early 1900s (Stevenson 1915). By the 1920s, the fishery consisted of more than 600 vessels deployed by 21 companies, with six coastal and two floating stations processing an annual average of 9,000 whales (Palomares et al. 2006) and exporting 430,000 barrels of whale oil (Stevenson 1915). This increased the production of whale oil to 10 times the value of sheep wool (Jones 1924). Offshore floating stations were established by 1925 (Gambell 1993), which permitted whaling in open and deep seas. By the early 1930s, there were 41 floating stations and 232 whalers in the open seas (Jahn 1937). In the 1950s, the 'bluebooks' published by the Colonial Office (HMSO, 1954 to 1959) report sealing and whaling as the only industry in the Falklands and its Dependencies, and producing an average of 160,000 barrels of whale oil (from data for the period 1951-1957; HMSO 1959b, p. 53) and 12,000 barrels of seal oil (from data for the period 1953-1957; HMSO 1959b, p. 54). The 'bluebook' for 1958-1959 (HMSO 1960) and those of the years following, however, did not include an entry for whale or seal oil production, presumably because the fishery had ceased[23]. In March 1962, Strange (1987, p. 150) recounts an encounter with a Russian fleet illegally whaling in Falkland waters[24]. He was aboard a small ex-motor fishing vessel (with 6 crew members including the customs officer) observing the Russian ship, which after a while caught *one* whale – the last that he saw alive in those waters.

The probability of developing a finfish fishery was considered as early as the 1920s, because the whale fishery's growth was by then already limited. Jones (1924) writes: *"The fact that the waters off the Falkland Islands and southern South America support quantities of seals and penguins […] presupposes the existence here of at least a fairly large number of fish. Moreover, direct observation has shown the presence of edible species, while shoals of fish resembling small herring are reported from Port Stanley.*

[21] The Republic of Buenos Aires established a settlement in Port Louis in 1820, taking advantage of the void left by the Spanish and British camps. Its then governor, Louis Vernet, quickly claimed exclusive rights to the seal fishery and thus prevented American and British ships from operating in the islands. Louis Vernet's moratorium on 'foreign' vessels was voided when the settlement was destroyed by an American warship, the *Lexington* in 1831 (HMSO 1920), which enabled the continuation of indiscriminate sealing/whaling operations.

[22] 'Bay whaling' (Russ 2007; see also Salvesen 1914 and Headland 1984)

[23] Note that the International Convention for the Regulation of Whaling was signed in Washington DC on December 2, 1946 (see http://iwc.int/history-and-purpose).

[24] Implying that whaling was still in operation, albeit illegally, in those waters.

Whether these fisheries will be developed from the Falkland Islands as a base or from Chile, Argentina, and Uruguay will depend on the countries engaged in the fishing operations and on the market regions. Recently these latter countries have taken initial steps for such development. […] If the fisheries are worked by these countries, little profit will accrue to the Falkland Islands from them. The Falkland Islands have an excellent location for operations on the bank but lack a population with a natural aptitude for the industry. The young men accustomed to life in the sheep stations, rather than change their occupation migrate to Chile or Patagonia. In all probability, therefore, the Falkland Islands will take at best a minor part in the development of these fisheries and will derive little advantage from their exploitation by other countries."

As commercial finfish fishing was not yet developed, sealers (mostly Norwegian and some British; see Tritton 2011), seeking to complement the food ration (mutton was the staple, though beef was consumed in winter; see HMSO reports) supplied by their employers, caught fish for subsistence[25] (Strange 1987). Fanning (1833) described a fishing method using a dam employed at the river mouth, i.e., '*fish wall*' (Strange 1987), to trap large quantities of 'mullet'[26] which enter the river at high tide. A report of such subsistence fishing was also found in the 1954 bluebook (HMSO 1956), stating that in the Falkland Islands, "*occasional catches of mullet and smelt*[27] *by net hauling were sold for local consumption"* (i.e., as artisanal fishing). This information was provided for the Falkland Islands until 1963 (HMSO 1965), but was not found in any of the text reporting the production of the Dependencies. Strange (1987) alludes to the "*occasional catch being advertised by the appearance of gulls"*, implying that in the 1980s, subsistence fishing was still being practiced in the Falkland Islands. Similar observations were made on the considerable finfish populations around South Georgia and South Sandwich Islands (in spite of several attempts to establish shore-based commercial finfish fisheries), and where 'fjord' and 'sea' fishes[28] remained unexploited even after almost a "*century of their discovery*" (by Fanning 1833) and only "*lightly fished (hand lining)*" by residents of the whaling stations (Kock 1992; Wild 1923).

Commercial trawling experiments were conducted in the 1960s by Japanese whaling companies based in Grytviken and Leith in the waters around South Georgia (see Hirabayashi 1963; see also Inoue and Kido 1964) and by the Russian Atlantic Research Institute of Marine Fisheries and Oceanography (AtlantNIRO; based in Kaliningrad) in the waters around South Orkney Islands (Kock 1992; Dickinson 1985). The annual catch of krill and nototheniids in 1965 was recorded at 1,800 t, which increased more than 200 fold to 407,900 t in 1970 (Everson 1981). Meanwhile, the establishment of the Fishery Conservation Zone in 1987 paved the way for commercial fishing operations in the Falkland Islands 9see Dingwall 1992).[13] Note, that at the start of the 1980s, Strange (1987) observed 14 trawlers going back and forth from the Falkland Islands, jigging for squids (though we have not found reports of this fishery in the current literature). The Falkland Islands Government reports recent catches of squid to make up 75%

[25] Sealers supplemented their rations with wildlife, e.g., eggs and birds (i.e., seabirds), and thus had an immense impact on the marine ecosystem (Russ 2007; Strange 1987; Jones 1924).

[26] *Eleginops maclovinus* (Eleginopsidae, Perciformes), also known as 'Patagonian blennie' (FAO-FIES 2014; see www.fishbase.org for other common names), is a euryhaline species, endemic to coastal South American temperate and sub-Antarctic waters (Ceballos et al 2012). This fish is abundant in Falkland waters, with adults migrating from rivers and estuaries into marine coastal waters in spring and reach a maximum age of 11 years (see Brickle et al 2005a).

[27] *Galaxias maculatus* (Galaxiidae, Osmeriformes), also known as Inanga (FAO-FIES 2014) is a catadromous species, important in white bait fisheries (Allen et al 2002).

[28] *Notothenia rossii* (Nototheniidae, Perciformes), occurring in the Southern Ocean (Hureau 1985). The juveniles occur in fjords ('fjord fishes'), and the adult ('sea fishes') occur further away from the coast (Kock 1992).

amounting to about 200,000 t exported to Europe and the Far East[29]. Modern 'bluebooks' published by the CCAMLR and the Falkland Islands Government Fisheries Department record the progress of the finfish fisheries in this region since the 1970s for South Georgia, South Sandwich and South Orkney Islands and since the late 1980s for the Falkland Islands, respectively.

Data sources

Industrial fisheries

Although the Falklands is not defined in any of the CCAMLR conventions (Russ 2007), it was the seat of government, which controlled the "Dependencies" (South Georgia, South Sandwich, South Orkney Islands; see HMSO, 1920). Colonial Office reports (HMSO 1954-1965) summarized the catches of the Falkland Islands and the Dependencies from 1952 to 1967. The earliest catch records by the Falkland Islands Government Fisheries Department (FIG) are from 1987 onwards (FIG 1998, 2000, 2005, 2014). Additional data on hake (1979-1982), southern blue whiting (1970-1985) and squid (1970-1985) fisheries in the Falkland Islands were reported in Csirke (1987). FIG reporting evolved between 1998 and 2014. Earlier FIG reports had aggregated statistics, e.g., categories such as 'Hakes', 'Skates' and 'Others'. Assuming that the same fleets would have targeted the same species (and that the same gears would have the same bycatch), earlier catches were disaggregated based on the catch composition from recent reports.

Table 1. Catches (t) of hake (*Merluccius* spp.) in the Southwest Atlantic; adapted from Csirke (1987, Figure 12). Others here include Germany, Japan and the former Soviet Union. Catch for the Falkland Islands assumed to be 5% of the total removals of hake in the region.

Year	Argentina	Uruguay	Others	Total	Falklands
1970	80,000	3,600	–	83,600	4,180
1971	87,000	3,600	–	90,600	4,530
1972	100,000	7,300	–	107,300	5,365
1973	145,000	3,600	–	148,600	7,430
1974	160,000	3,600	–	163,600	8,180
1975	100,000	7,300	–	107,300	5,365
1976	175,000	7,300	–	182,300	9,115
1977	270,000	22,000	22,000	314,000	15,700
1978	340,000	44,000	14,600	398,600	19,930
1979	365,000	58,000	22,000	445,000	22,250
1980	280,000	58,000	14,600	352,600	17,630
1981	230,000	95,000	7,300	332,300	16,615
1982	280,000	67,000	7,300	354,300	17,715
1983	270,000	80,000	7,300	357,300	17,865
1984	182,000	58,000	7,300	247,300	12,365
1985	263,000	102,000	7,300	372,300	18,615

Reported catches of 'Hakes' (*Merluccius* spp.) were separated, throughout the time series, into *Merluccius hubbsi* (dominant species in catch; assumed at 80%) and *M. australis* (experimental licensing in 2012 established that it made up 20% of the catch; FIG 2013). An earlier catch time series reported for the Southwest Atlantic in Csirke (1987; see Table 1) indicated that Argentina expanded its Rio del Plata fishery using factory vessels in 1979-1982 stationed around the Falkland Islands, and which caught 5,000-10,000 t of hake. Malaret et al. (1986) indicated that 90% of the Southwest Atlantic hake biomass is concentrated off the Falkland Islands, and presumably also where Argentinian and Uruguayan offshore fleets were likely to go, with or without the factory vessels. Thus, we assumed that a certain percentage of the total hake catch reconstructed from Csirke (1987; see Table 1) would have been caught in Falkland waters. Given the estimate for the catch of factory vessels and MRAG (1986a, 1986b) estimates of 20,000-40,000 t in 1984-1985, we are able to discern that catch of hakes in the Falkland Islands may have

[29] See http://www.falklands.gov.fk/self-sufficiency/commercial-sectors/fisheries/.

represented 2-9% (average of 5%) of the total Southwest Atlantic hake removals. Assuming that the 80%:20% assumption also holds for this earlier catch time series, we reconstructed the catches of the two species of hakes from the estimates of hake removals from the Falkland Islands in Table 1. Catches for 1986-1988 were then interpolated from the reconstructed 1985 catches and the disaggregated 1989 catches.

Table 2. Disaggregation of catches (t) for the group 'Skates' based on average % contribution of skate species in the catch by gear targeting skates or by gear which catches skates as bycatch and the total removals as reported in Falkland Islands Government Fisheries Statistics (FIG 2005-2014).

Species	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Amblyraja georgiana	–	–	–	–	–	–	–	417	606	9
Bathyraja albomaculata	515	570	468	566	385	564	766	834	592	1,187
B. brachyurops	1,803	1,994	1,638	1,982	1,349	1,955	1,278	2,155	1,101	1,781
B. cousseauae	–	–	–	–	–	–	–	–	–	10
B. griseocauda	927	1,026	842	1,019	694	1,039	1,284	904	–	651
B. macloviana	–	–	–	–	–	–	–	–	838	–
B. meridionalis	–	–	–	–	–	–	–	–	10	–
B. papilionifera	–	–	–	–	–	–	–	–	7	–
B. scaphiops	–	–	–	–	–	311	–	–	542	457
Zearaja chilensis	–	–	936	1,133	771	1,122	1,261	1,043	740	1,096
Raja flavirostris	1,030	1,140	–	–	–	–	–	–	–	–
Rajidae[a]	876	969	795	963	655	881	1,302	1,599	2,219	732
Total	5,151	5,698	4,679	5,663	3,853	5,872	5,891	6,953	6,655	5,923

[a] Other skates, mostly caught as bycatch and, which cannot be further disaggregated.

Catches of 'Skates' were disaggregated based on the reported % catch composition of gears during the period 2004-2013 which target[30] as well as catch these species as bycatch[31] (Table 2).

Catches reported as 'Others' (miscellaneous Osteichthyes/Chondrichtyes), were disaggregated based on the percent composition of the catch for the period 2006-2013 (Table 3). These percent compositions were applied to the catch of the fishing fleets to obtain estimated catches of the 30 species lumped under 'Others' by fishing fleet. With the exception of the Falkland mullet (*Eleginops maclovinus*; see below), which was reported as part of 'Others' in the 2006 and 2009 reports, all of these catch statistics are reported as industrial catch.

The squid fishery was unregulated until the establishment of the Falkland Islands Fishery Conservation Zone (Arkhipkin et al. 2007), and catch reports for this fishery by the Falkland Islands Government started only in 1989. However, Csirke (1987) reported that a small-scale *Illex argentinus* fishery started in the early 1970s, developing to large-scale offshore operations in 1978. Note that although the fishery is considered small-scale prior to 1978, for *Sea Around Us* purposes this catch is considered industrial as it is foreign catch within the EEZ. His assessment made use of data from Argentina, Japan and Poland and surveillance data from MRAG (see Table 4), estimating that 80% of the total catch from the Southwest Atlantic were from around the Falkland Islands (see also Basson et al. 1996).

Csirke (1987) also presented catch data for the southern blue whiting, *Micromesistius australis* in the Southwest Atlantic. This fishery apparently started in the region in 1977 with Polish distant water fleets

[30] Gears categorized as 'skate target trawls' in FIG reports.

[31] Gears categorized as 'finfish target trawls', '*Doryteuthis gahi* (Patagonia longfin squid) target trawls', and longline sets.

(getting 70-95% of the catch) and later on joined by fleets of the ex-Soviet Union, Argentina, Bulgaria and Japan. These fleets predominantly fished in the Patagonian shelf, notably the area around the Falkland Islands. Thus, we assumed that 90% of the catches presented in Table 5 were obtained from the Falkland Islands.

Table 3. Disaggregation of the catches (t) of the group 'Others' as reported in Falkland Islands Government Fisheries Statistics (FIG 2005-2014).

Species	2006	2007	2008	2009	2010	2011	2012	2013
Allothunnus fallai	0.25	–	0.25	–	–	–	–	0.05
Antimora rostrata	14	16	15	11	12	22	18	16
Brama dussumieri	3	0.25	–	–	–	–	–	–
Champsocephalus esox	23	2	90	0.25	6	0.25	0.25	0.05
Congiopodus peruvianus	–	–	–	–	–	–	–	0.10
Cottoperca gobio	5	30	25	16	11	43	26	18
Cottunculus granulosus	–	–	–	0.25	–	–	–	–
Eleginops maclovinus	1	–	–	0.25	–	–	–	–
Icichthys australis	0.25	–	–	–	–	–	–	–
Iluocetes fimbriatus	–	–	–	0.25	0.25	2	0.25	–
Lamna nasus	1	2	2	3	2	3	1	1
Lampris immaculatus	1	1	1	1	1	1	0.25	
Lithodidae	27	25	0.25	10	1	1	0.25	0.30
Macrouridae	671	622	932	958	450	2,058	225	3
Mancopsetta spp.	–	–	–	0.25	1	–	–	541
Medusae[a]	–	–	–	–	–	–	–	329
Moroteuthis spp.	–	–	–	–	36	33	4	12
Moroteuthis ingens	22	71	29	87	–	–	–	–
Munida spp.	4	348	0.25	0.25	6	1	0.25	–
Others[b]	1,001	483	499	10	96	71	87	436
Patagonotothen spp.	20,210	30,157	60,209	58,149	76,411	55,648	63,510	–
Patagonotothen tessellata	–	–	–	–	–	–	–	1
Pseudocyttus maculatus	–	–	–	0.25	–	–	–	–
Psychrolutes marmoratus	–	–	1	0.25	–	–	–	–
Schroederichthys bivius	–	–	–	–	–	–	–	1
Sebastes oculatus	19	24	6	31	46	104	30	18
Somniosus microcephalus	–	–	–	–	–	–	–	3
Sprattus fuegensis	–	9	–	0.25	1	4	50	12
Squalus acanthias	11	9	5	0.25	1	50	65	72
Stromateus brasiliensis	1	6	102	75	2	12	19	8
Thysmops birsteini	0.25	11	–	–	–	–	–	–
Zygochlamys patagonica	–	14	6	13	3	11	0.25	–
Totals	22,015	31,830	61,923	59,367	77,086	58,064	64,037	1,471

[a] More information will have to be gathered on this catch, which appears to be non-targeted (i.e., bycatch; Lucas Brotz, Fisheries Centre, UBC, pers. comm.).
[b] Can no longer be disaggregated and here treated as 'miscellaneous demersal fishes'.

Industrial catch records for South Georgia, South Sandwich and South Orkney Islands published by CCAMLR (2014) provide data for South Georgia for the period 1970-2013, for South Sandwich for 1973-2013 and South Orkney Islands for 1977-2013, which were re-expressed from 'fishing season' to calendar years[32].

[32] CCAMLR's reporting season is for December of Year N to November of Year N+1; this was here extracted from the CCAMLR database by calendar year (i.e., January-December of Year N).

Table 4. Catches of shortfin squid, *Illex argentinus*, in the Southwest Atlantic; adapted from Csirke (1987, Figure 26). Catches in the Falkland Islands were assumed to be 80% of these (Csirke 1987). Others here include Bulgaria, Germany, Cuba and South Korea.

Year	Total catch	Argentina	Poland	Japan	Others
1970	1,000	1,000	–	–	–
1971	1,000	1,000	–	–	–
1972	1,000	1,000	–	–	–
1973	2,000	2,000	–	–	–
1974	2,000	2,000	–	–	–
1975	2,000	2,000	–	–	–
1976	5,000	5,000	–	–	–
1977	1,000	1,000	–	–	–
1978	73,000	58,500	3,900	3,900	6,700
1979	128,000	89,700	15,600	11,700	11,000
1980	24,000	11,700	7,800	3,900	600
1981	50,000	7,800	19,500	15,600	7,100
1982	190,000	39,000	109,200	35,100	6,700
1983	160,000	23,400	120,900	15,600	100
1984	220,000	27,300	117,000	62,400	13,300
1985	234,000	19,500	97,500	81,900	35,100

Table 5. Catch (t) of southern blue whiting, *Micromesistius australis*; adapted from Csirke (1987; Figure 13). Others here include Bulgaria and Japan. Catch in Falkland Island waters assumed to be 90% of the total catch in the region.

Year	Poland	Soviet Union[a]	Others	Total catch	Falklands
1977	2,000	–	–	2,000	1,800
1978	12,188	4,063	1,750	18,000	16,200
1979	32,500	4,063	3,438	40,000	36,000
1980	52,813	20,313	6,875	80,000	72,000
1981	44,688	16,250	9,063	70,000	63,000
1982	121,875	4,063	12,063	138,000	124,200
1983	223,438	20,313	16,250	260,000	234,000
1984	97,500	8,125	8,375	114,000	102,600
1985	73,125	16,250	7,625	97,000	87,300

[a] Note that Soviet Union was reassigned to Russian Federation in the reconstructions, see text below.

Artisanal, subsistence and recreational fisheries

Although meat (cattle and sheep) is the staple food, fish figures in the diet of these islanders; at least in the Falklands, "*fish is the base for various light main courses*"[33]. Thus, we assume that subsistence fishing in the 1950s to the end of the 1960s would be practiced at least by staff of the whaling stations. We assembled demographic estimates in the Falkland and South Georgia Islands, noting the number of workers based at the whaling stations (see Table 6), i.e., potential subsistence fishers of 'mullet', 'smelt' and 'fjord' and 'sea fishes'. Per capita fish and shellfish consumption for human food by Falkland Islanders for the period 2007-2009 was estimated at 35.2 kg·year^{-1} (FUS 2011[34]). Given that subsistence catch is seasonal (i.e., occasional), we assumed that 5% of the per capita fish consumption can be

[33] See http://recipes.wikia.com/wiki/Falkland_Islander_Cuisine.

[34] *"The FAO calculation for apparent consumption is based on a disappearance model. The three year average considers, on a round weight equivalent basis, a country's landings, imports, and exports"* (FUS 2011).

obtained through subsistence fishing. Thus, 1.76 kg was multiplied with the number of whaling station inhabitants to obtain the annual subsistence catch for the period 1952-1963. This estimate of subsistence catch was then projected backward to 1950 and forward to 2005, and was disaggregated into 3 groups: Falkland mullet (70%), smelt (20%) and mixed marine species (10%). Note that the catch of smelt, is categorized as artisanal catch from 1950 onwards because of the indication that it is sold for local consumption. The catch of the Falkland mullet was categorized as subsistence before 2000 and artisanal thereafter[35].

A similar procedure was followed for South Georgia Island, for the period 1952-1963. The number of workers residing in the whaling stations (Table 6) was multiplied by 1.76 kg (see above; NOAA_NMFS 2012). This catch was applied to *N. rossii* and categorized as artisanal, assuming that it is sold for consumption by the station staff (see Kock 1992)[36]. Artisanal catch of *N. rossii* was backward extrapolated to 1950 and forward extrapolated to 1969. Note that the earliest catch record of *N. rossii* reported by South Georgia to the CCAMLR is in 1970 as part of the industrial fishery fleet of the former USSR. Neither subsistence nor artisanal fishing was estimated for the South Sandwich and South Orkney Islands as these are uninhabited islands. Unreported catches were estimated using data from Agnew (2000, Table 1, p363) and the CCAMLR-Working Group on Stock Assessment of *D. eleginoides* (CCAMLR-WGFSA 2011, Appendix G, Table 1, p.2).

Table 6. Number of inhabitants in the Falkland and South Georgia Islands and number of whaling station staff reported in Colonial Office 'bluebooks' (HMSO 1954-1965). The number of Falkland Islanders apparently fluctuated depending on the number of migrant whalers, which was not regularly reported. South Georgia, on the other hand, was populated mostly by whalers.

Year	Island	Inhabitants	Whaling station workers
1952	Falklands	2,230	500
1953	Falklands	2,220	500
1954	Falklands	2,212	500
1955	Falklands	2,249	500
1956	Falklands	2,294	500
1957	Falklands	2,253	500
1958	Falklands	2,238	500
1959	Falklands	2,173	500
1962	Falklands	1,252	500
1963	Falklands	1,252	500
1952	South Georgia	1,477	1,469
1953	South Georgia	1,449	1,441
1955	South Georgia	1,329	1,329
1957	South Georgia	1,098	1,098
1959	South Georgia	1,252	1,252
1961	South Georgia	1,252	521
1963	South Georgia	1,252	421

Catches by the former USSR 1970-1991 were redistributed to Ukraine and the Russian Federation using the reported CCAMLR landings for the South Georgia Islands for the period 1992-2004, i.e., 15% Russian Federation and 85% Ukraine, following the logic presented in Zeller and Rizzo (2007). Note that the reported landings for the Falkland, South Sandwich and South Orkney Islands did not follow the pattern of reporting for South Georgia Islands. In the Falklands, catches from 1978-1988 were reported under the USSR, no catches were reported between 1988 and 1994, and from 2001 onwards catches were reported only under the Russian Federation. We thus assumed that earlier landings were of the Russian Federation. A similar reporting pattern was observed for the South Orkneys, except that catches made by Ukraine were reported consistently from 1992-2008 and catches by the Russian Federation were reported only for 1992 and 2009-2010. We thus assumed that earlier catches reported under the USSR were taken by Ukrainian vessels. In the South Sandwich Islands, only one catch record was recorded for the Russian Federation in 1992, and we

[35] The mullet catch of the small beach seine fishery (established in 2000; see Brickle et al. 2005b) in 2006 was 0.25 t (FIG 2008) and was 1.0 t in 2009 (FIG 2011).

[36] Falklands is assigned as the fishing entity for this catch, as at the time South Georgia was a dependency of the Falklands. Therefore, for *Sea Around Us* purposes this catch is considered industrial.

assumed that the former USSR did not fish in these islands. Note that the longest reported catch time series in the South Sandwich Islands are for New Zealand and the UK, and covering the period 2005-2010.

Recent sporting news and an angling club web sites indicate the existence of a touristic sport fishery (mostly in freshwater), which is probably catching small amounts of demersal species. However, catch records are not found in any of the government reports. We thus exclude this sector from our analyses.

Results and Discussion

The annual average catches for the Falkland, South Georgia, South Sandwich and South Orkney Islands summarized in Table 7 suggest that the Falkland Islands has the highest annual average catch with over 80% of the annual catch consisting of 5 species (of 48 taxa caught). However, the evolution of the catch over 20-year periods shows that the highest annual catches were taken in the 1970-1989 period, with annual catch per vessel estimates of 19,000 t, 47,000 t and 38,500 t by fleets operating in the Falkland, South Georgia and South Orkney Islands, respectively. The annual average number of fleets operating in the islands shows a 2-3-fold increase in the last 20 years, with annual catch per vessel estimates decreasing 125 times in the Falklands and 2 times in South Georgia Island, but increasing by an enormous amount in the South Sandwich Islands. Though these islands are found in the same region, the main target species differs, with squid in the Falklands, krill in South Georgia and South Orkney and Patagonian toothfish in the South Sandwich Islands (see Aquarone and Adams 2008; Clers et al. 1996; Ashford et al. 1994).

The reconstructed catches for the Falkland and South Georgia Islands, extend coverage of the historical catches to 1950 (reported catches started only in the late 1980s for the Falklands and in the 1970s for South Georgia), with data on subsistence and artisanal fishing practiced by inhabitants of the whaling stations (Figure 2). We estimated an annual average subsistence catch (mostly *E. maclovinus*) at about 0.6 $t \cdot year^{-1}$ and artisanal fisheries catch (of *E. maclovinus*, *G. maculatus* and *I. argentinus*) at 197 t, in the Falklands for 1950-2010. The average annual artisanal catch (the majority being *N. rossii*) for the period 1950-1969 in South Georgia was estimated at 2.1 $t \cdot year^{-1}$. The reconstructed industrial catches of the Falklands ranges from about 4,200 t in 1950 to 355,000 t in 2010, which includes an annual average of over 30,000 t of unreported catches (over the 1950-2010 time period), the highest reaching over 270,000 t in 1983. The South Georgia Islands industrial fisheries ranges from 400,000 in 1970 to 11,400 t in 2010 with an annual average unreported catch (notably krill fisheries bycatch of juvenile fishes; see data in Pakhomov and Pankratov 1994) of about 2,800 $t \cdot year^{-1}$, the highest being in 1989 at 20,000 t (available for 1973-2004).

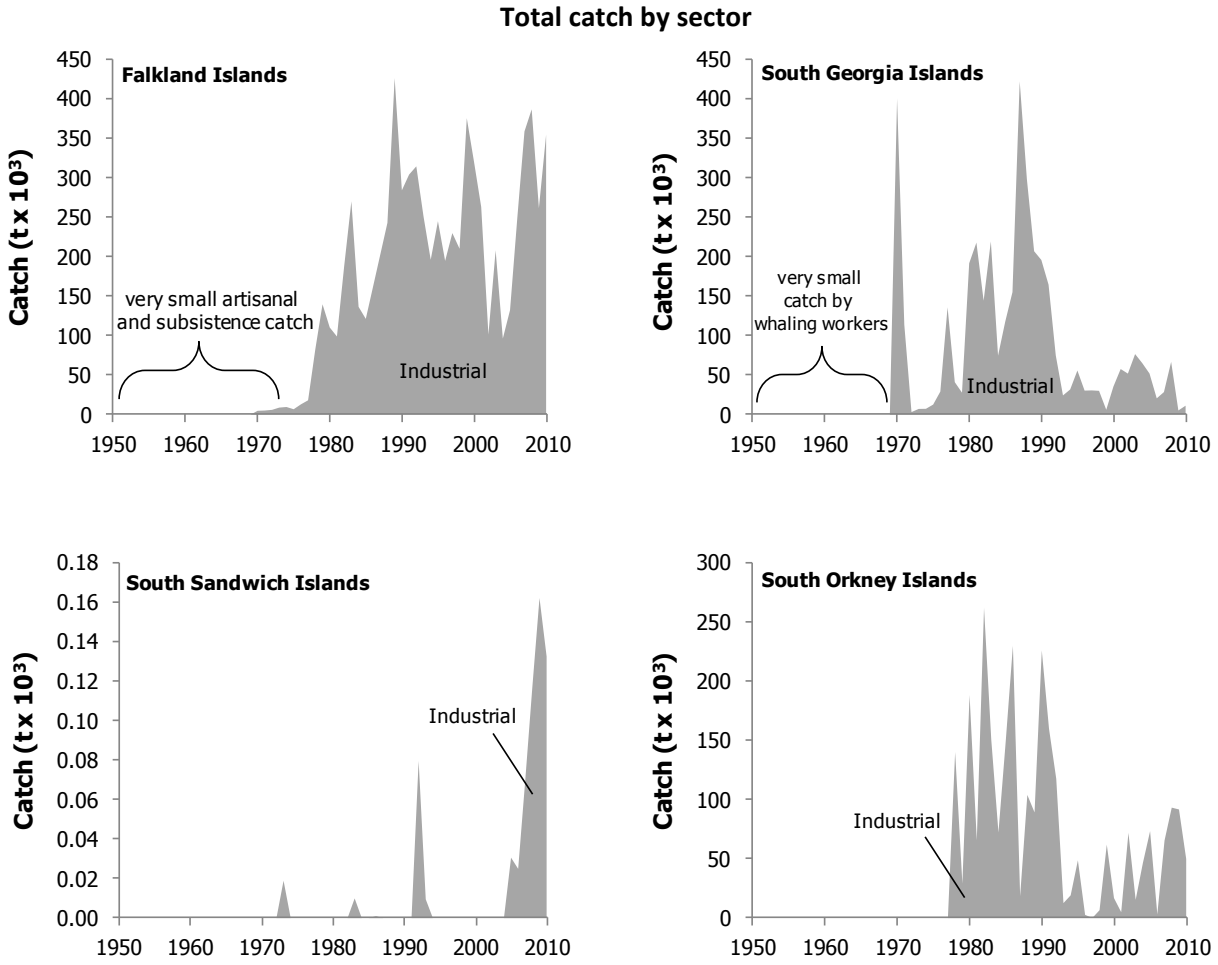

Figure 2A. Catches from 1950-2010 for the Falkland Islands and the Antarctic Islands of South Georgia, South Sandwich and South Orkney by fisheries sector. Note that subsistence and artisanal catches reconstructed for the Falkland are too small to be visible. Artisanal catches by whaling workers in South Georgia were relabelled as industrial as per *Sea Around Us* guidelines . Catches for South Sandwich (1973-2010) and South Orkney Islands (1977-2010) were obtained from the CCAMLR report (2014), are expressed in calendar years and show only industrial catches.

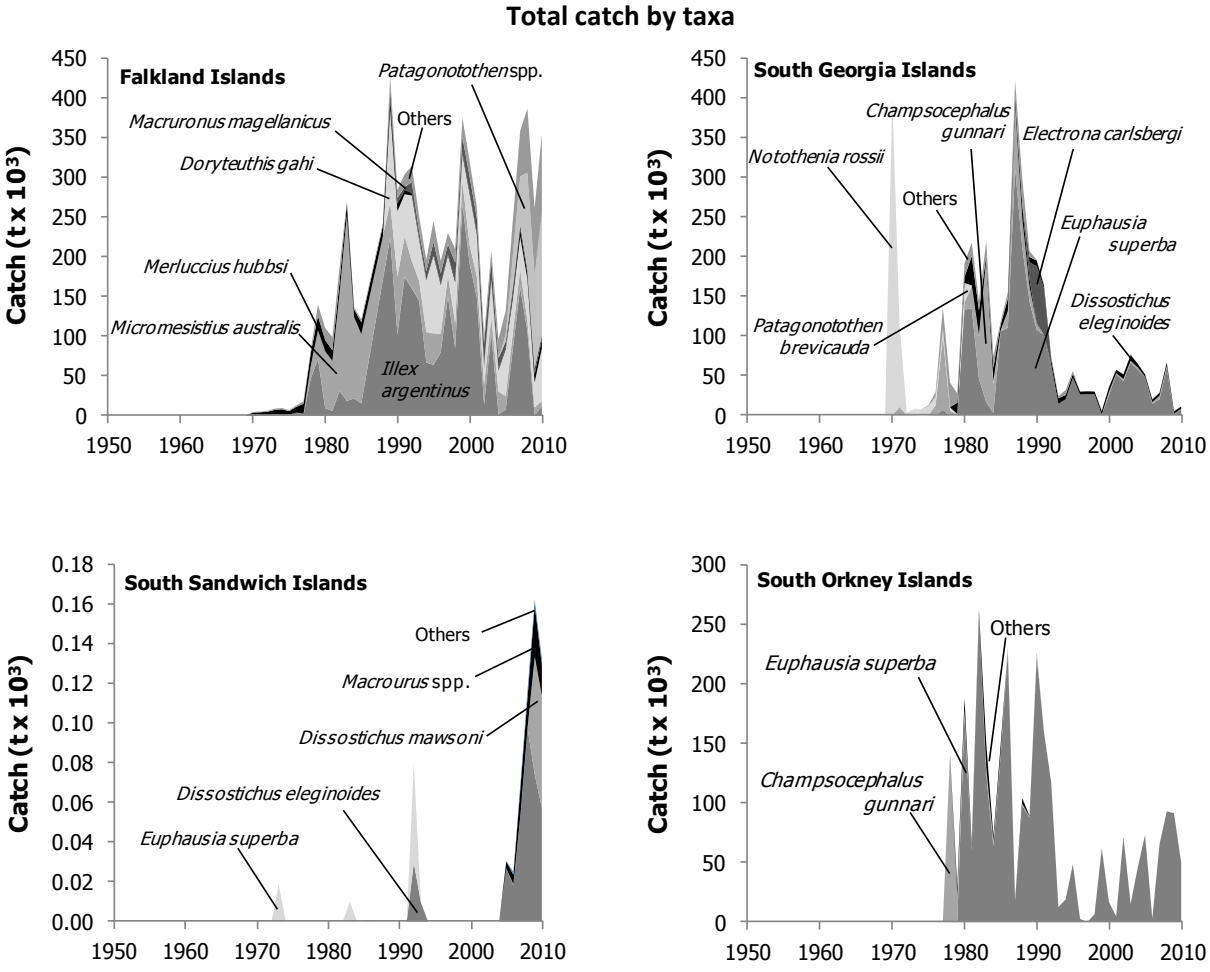

Figure 2B. Catches from 1950-2010 for the Falkland Islands and the Antarctic Islands of South Georgia, South Sandwich and South Orkney by taxa. Note that subsistence (*Eleginops maclovinus*) and artisanal (*Galaxias maculatus*) catches reconstructed for the Falkland Islands and whaling worker catches (*Notothenia rossii*) for South Georgia Islands do not show because of their small amounts as compared to the much larger industrial catch.

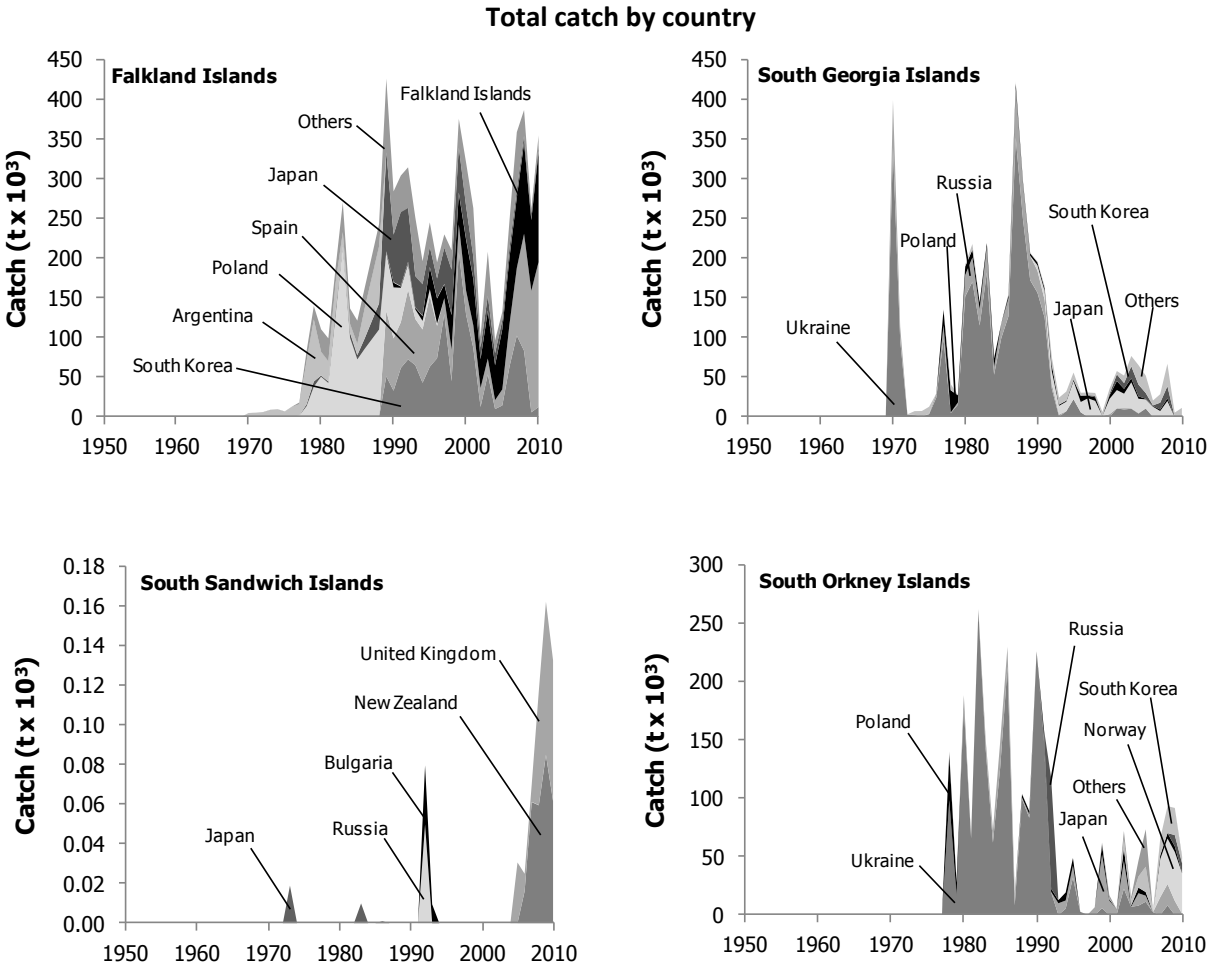

Figure 2C. Catches from 1950-2010 for the Falkland Islands and the Antarctic Islands of South Georgia, South Sandwich and South Orkney by country fishing, i.e., with legal licenses or access agreements. Note that reconstructed subsistence and artisanal catches were assigned to country fishing as Falklands and South Georgia Islands (as opposed to the United Kingdom). Catches by the former USSR in the: a) Falkland Islands were assigned to the Russian Federation; b) South Orkneys were assigned to Ukraine; and c) South Georgia Islands were split (15:85%) between the Russian Federation and Ukraine (see sources of data for more details).

Table 7. Summary of reconstructed data for the Falkland and South Georgia Islands and of the CCAMLR data (expressed in calendar years) for the South Sandwich and South Orkney Islands.

Islands	CCAMLR area	Period of coverage	$Catch_{min}$ (and year)	$Catch_{max}$ (and year)	Annual catch average	Main Fishing fleets	Number of fishing fleets	Main Target species	Number taxa caught
Falklands		1950-2010	0.6 (1962)	426,820 (1989)	124,651	Korea (19%),	35	*Illex argentinus* (39%),	48
		1950-1969			0.8	Spain (19%),	1	*Micromesistius australis* (21%),	
		1970-1989			112,927	Poland (16%)	6	*Dorytheuthis gahi* (16%),	
		1990-2010			254,531		13	*Merluccius hubbsi* (4%),	
								Macruronus magellanicus (4%)	
South Georgia	483	1950-2010	1 (1969)	421,413 (1987)	63,973	Ukraine (68%)	23	*Euphausia superba* (52%)	83
		1950-1969			2	Russian Fed. (12%),	1	*Champsocephalus gunnari* (16%)	
		1970-1989			141,200		3	*Notothenia rossii* (15%)	
		1990-2010			53,207	Japan (8%)	10		
South Sandwich[a]	484	1973-2010	1 (1986)	163 (2009)	60	New Zealand (43%)	5	*Dissostichus eleginoides* (56%)	15
		1950-1969			0	United Kingdom (39%)	0	*D. mawsoni* (18%)	
		1970-1989			10	Russian Fed. (8%)	1	*E. superba* (12%)	
		1990-2010			79		2	*Macrourus* spp. (12%)	
South Orkney[b]	482	1977-2010	26 (1977)	262,270 (1982)	77,463	Ukraine (69%),	15	*E. superba* (91%);	24
		1950-1969			0	Japan (10%)	0	*C. gunnari* (7%)	
		1970-1989			115,389	Norway (6%)	3		
		1990-2010			56,653		4		

[a] The reconstruction of South Sandwich only includes data for the years 1973, 1983, 1986, 1992, 1993, and 2005-2010. Averages shown are over those years only.
[b] The reconstruction of South Orkney only includes data for the years 1977-2010. Averages shown are over those years only.

Disaggregation of the hake, skates and miscellaneous species components of the Falkland Islands fisheries highlighted the species caught as bycatch of the various trawl fisheries. What is interesting is the high catches of *Patagonotothen* spp. (annual average of 49,000 t; 2006-2010 period), lumped with "Others", but practically making up 90% of that category. Recent FIG catch data (2004-2013) also include *Patagonotothen ramsayi*, with annual average catches of almost 40,000 t. These species are members of the cod icefish (Nototheniidae) family, usually benthopelagic to depths of 500 m. Other species of the family known to occur in the area (and mostly restricted to the Patagonia Shelf) are *P. brevicauda*, *P. comucola*, *P. guntheri*, *P. sima*, *P. tessellata* and *P. wiltoni* (see www.fishbase.org). Not much is known of this group of fishes, which grow on average to more than 20 cm, the biggest of which is *P. ramsayi*, growing to more than 44 cm (Erzini 1991), which might explain why it is reported as a separate category. The trend of the time series of catches as shown in Figure 2 gives an impression of 'boom and bust' fisheries behavior, i.e., large spikes interspersed with low catches. However, an increase in the catch during the 1970-1990 period is evident; thereafter, catches fell to less than 100,000 t in the early 2000s. The 'boom and bust' fishing also involves the targeting of new species, and an ongoing expansion into new deeper fishing grounds, as can be assessed by a detailed analysis of taxonomically disaggregated and spatialized catches (see Ainley and Pauly 2013; Aquarone and Adams 2008). This strategy, imported from the far North, where the expansion of industrial fisheries began, is not sustainable (see data in Jones et al. 2000), and it is hoped that CCAMLR and its member countries will succeed in transiting to a different model, in which smaller fisheries operating sustainably over long time periods can generate what will actually turn to be large catches.

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THE FISH AND FISHERIES OF BOUVET ISLAND[37]

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Abstract

Total marine fisheries catches by CCAMLR member countries within the EEZ of Bouvet Island (or *Bouvetøya*, Norway) in the southern Atlantic were estimated from 1970 to 2010, including previously unreported catches from longline fisheries. Mesopelagic and demersal fish species distribution and abundance around Bouvet Island were assessed through the 20th century by various methods. Cumulative marine fisheries catches (including discards) around Bouvet Island from 2004 to 2010 were estimated to be 357 t, which is 1.1 times the estimated amount of reported landings taken from within the Bouvet EEZ (314 t). Marine fisheries catch taken from the whole of the Bouvet CCAMLR sub-area 48.6 were estimated to be 2,870 t over the 1973-2010 time period which is 1.1 times the reported landings presented by the CCAMLR Statistical Bulletin for sub-area 48.6. Pelagic trawl fisheries were not reconstructed in this study (only CCAMLR reported landings included), since neither krill nor myctophids were spatially reported within the Bouvet Island EEZ; however a significant amount of illegal and unreported fishing was suspected. The discrepancy between reported and reconstructed data was largely due to the inclusion of unreported and by-catch components. This study illustrates the need for improved CCAMLR reporting of catches, such as establishing a clear differentiation between retained by-catch and discards, including in their publically available datasets. Improving the fisheries management in Antarctica is critical, since this area constitutes one of the areas of the world most vulnerable to over-fishing.

Introduction

Bouvet Island (or *Bouvetøya*) is an isolated volcanic island in the South Atlantic (54º 24.8'S and 03º 21.5' E; Figure 1) claimed by Norway in 1927 during the first Norwegian '*Norvegia* Expedition' led by Harald Horntvedt, and officially declared a Norwegian dependency in 1930 (Simpson-Housley 1992). The island's total area is 49 km^2, 93% of its surface is covered by ice, and it is un-inhabited due to its harsh climate and topography[38]. Norway signed the United Nations Convention on the Law of the Sea in 1996 and submitted a request on the limits of the continental shelf in the Arctic Ocean on November 2006 (Anon 2009). *Bouvetøya*, with its pristine environment, was declared a nature reserve in 1971 and is an important breeding ground for seabirds and seals (Simpson-Housley 1992; Anon 2008). Bouvet is also well known as the main location for the cult film "Alien vs. Predator".

The fossil records offer a good indication of the ichthyofauna composition and biogeographic significance through geological time in Antarctica (Kock 1992). Antarctic ichthyology started with James Clark Ross's expedition in the southern ocean from 1839 to 1843 (Knox 2006), and the expeditions which followed set the basis for knowledge of Antarctic fish dynamics and distribution. A unique coastal fish fauna was described and represented by only one pisciform suborder: the

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[38] http://commons.wikimedia.org/wiki/Atlas_of_Bouvet_Island [Accessed on 19/09/2013]

Notothenioidei (K.-H. Kock, Johann Heinrich von Thünen Institute, Germany, pers. comm.). These sculpin-like and hake-like species are mostly bottom dwellers. The remaining species are meso-pelagic and most of them entered the southern ocean from the north (K.-H. Kock, pers. comm.). Bouvet Island has also been referred to as a "benthic oasis within a self-sustaining open ocean pelagic system" (Jacob *et al.* 2005).

The closure of shore-based sealing and whaling in the mid-1960s, followed by the decline of pelagic whaling in the early 1970s, marked the beginning of the development of large-scale fishing (Kock 1992; Anon. 2012). Extensive finfish fishing resulted in a great improvement in ichthyological research (Kock 1992; Kellermann and North 1994). Intensive industrial fishing also resulted in serial depletion of fish and major changes in ecological structure in the southern ocean around the mid-1980s (Ainley and Blight 2009). Indeed, catch regulations were non-existent, which led to the global depletion in the Antarctic of several target species such as Patagonian toothfish (*Dissostichus eleginoides*) and mackerel icefish (*Champsocephalus gunnari*) (Ainley and Blight 2009; Anon. 2012). This is why, on May 20, 1980, in Canberra, Australia, the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) was created, and came into force in 1982 (CCAMLR 2002).

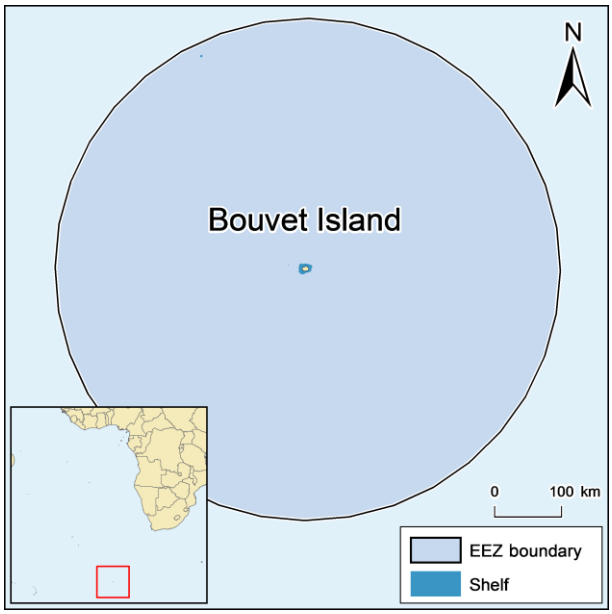

Figure 1. Bouvet Island (Norway) and its Exclusive Economic Zone (within CCAMLR statistical areas 48.6).

Remote locations, combined with harsh climatic conditions of the southern ocean make these areas difficult to access and control. The enforcement of established regulations is the main challenge CCAMLR had to face since its creation (Miller 2009). Indeed, illegal fishing activities in the southern ocean are well recognized by the international community (Bender 2008). This highly organized criminal activity (Molenaar 2004) involves a significant number of vessels fishing simultaneously, leading to a shortage of enforcement capabilities (Molenaar 2004; MRAG 2005). To combat illegal fishing, enormous logistics and financial implications are implemented. Illegal fishing activities are reported by Baird (2006) to be the "cancer" of the Antarctic treaty system, and an international form of organized crime (UNODC 2011).

Intense fishing activities associated with CCAMLR research allowed identification of 270 fish species in Antarctica (Kock 1992), of which 12 are endemic to the southern ocean, with 30 stocks that are fished commercially. Of these 30 stocks, only 13 are considered well documented and almost all are depleted, despite CCAMLR regulations (Kock 1992). Antarctic fishes are particularly sensitive to overfishing, because of specific biological characteristics such as low growth rates, low fecundity and high age at maturity (Johnston 1989; Kock 1992; Ainley and Blight 2009).

Kock (1992) summarized the historical investigations of mesopelagic fish communities and demersal fish fauna around Bouvet Island. The mesopelagic community was evaluated via sampling by large pelagic nets, small bottom gear hydro-acoustic surveys and species composition surveys in 1976 by

Hulley (1981) and Duhamel (1987), which allowed the identification of the following mesopelagic species as the most abundant in the EEZ of Bouvet Island: Antarctic lanternfish (*Electrona antarctica*), rhombic lanternfish (*Krefftichthys anderssoni*), Bolin's lanternfish (*Protomyctophum bolini*) and Brauer's lanternfish (*Gymnoscopelus braueri*).

Demersal fish fauna investigations around Bouvet Island were performed by the Swedish South Polar Expedition in 1901-1903 (K.-H. Kock, pers. comm.) and the American 'ICEFISH' cruise in 2004 (Jones *et al.* 2008). There was also a Norwegian International Polar Year (IPY) project in 2007-2008 – a joint project between the University of Oslo and the Marine Institute in Bergen, documented in 'Cruising for Krill' by Iversen *et al.* (2009). K.-H. Kock (pers. comm.) mentioned that commercial longlining for toothfish (*Dissostichus* spp.) was done within 20 nautical miles around Bouvet Island. Scientific sampling during the 20th century (Lönnberg and Nordenskjöld 1905; Holtedahl 1947; Duhamel *et al.* 1983; Duhamel 1987; Jones *et al.* 2008) using trawls with a small mouth opening, combined with commercially-sized bottom trawlers (Gubsch and Hoffmann 1981), were often inefficient in assessing quantitatively the demersal fish fauna.

A report on the Patagonian toothfish and Norwegian interests was published in 1997 which painted a bleak portrait of the future of the fishery (Album 1997). The report discussed how the fishery, which began off the coast of Argentina and the Falkland Islands around 1993-1994, rapidly expanded eastward in the CCAMLR area, leading to stocks already showing signs of overfishing in 1997. It was reported that Norway wanted to start a trial fishery for Patagonian toothfish in the 1997/98 fishing season around Bouvet Island. However, it was known that Norway had already fished for about 60-70 days in the area, only catching a few tonnes, concluding that it was not a commercially viable option. More recent information from CCAMLR indicates that the fishery in subarea 48.6 was classified as new in 1997, but due to the rampant illegal and unregulated catch of toothfish throughout the CCAMLR management area, the fishery was reclassified as exploratory in 2000 (CCAMLR 2013). Licensed vessels began fishing in 2004 and that is when reported catch for subarea 48.6 begins in the CCAMLR dataset.

Antarctic krill (*Euphausia superba*) is an abundant source of food for numerous animals (Quetin *et al.* 1996; Tynan 1998; Gascon and Werner 2006). Krill fisheries in the southern ocean started in 1960, mainly for producing feed for aquaculture (Gascon and Werner 2006); however, apparently no krill fishing has occurred in the waters of Bouvet Island. Based on the (unpublished) official spatial data of CCAMLR, no catch of krill was ever recorded in the vicinity of Bouvet Island. Thus, there were no krill catches to reconstruct.

This study presents a catch reconstruction from 2004 to 2010 (as there is not fishing prior to 2004) for the commercial demersal and pelagic species in the Bouvet Island EEZ. Intense illegal fishing occurs in South Georgia (Croxall and Nicol 2004), the Kerguelen Islands (Palomares and Pauly 2011) and St. Helena and its dependencies (Booth and Azar 2009), which are respectively west, east and north of Bouvet Island. This work takes into consideration the unregulated fishing activities in the vicinity of Bouvet Island and thus should help to better visualize the overall dynamics driving the Atlantic Antarctic fisheries.

Material and Methods

CCAMLR, Statistical Bulletin

The data used as 'the reported data baseline' for this reconstruction were extracted from the CCAMLR database (CCAMLR 2012). Therein, statistics are presented as "CCAMLR Season", from 1st of December of a particular year to 30th of November of the next year. These data were extracted on a month by month basis, and re-aggregated to a calendar year basis to ensure compatibility with reconstructions from other areas (Zeller *et al.* 2011). Formal reporting of catch to CCAMLR, including discards, is undertaken by flag states (Kock *et al.* 2007; Jones 2012). All by-catch, whether retained or discarded, is recorded and reported on a haul-by-haul basis. The scientific observers also report catch in their logbooks; and these two independent sources of data reported to the secretariat should match (and almost always do) (Jones 2012).

Since fishery catch data are deemed commercially sensitive, they are not publicly available on a haul-by-haul basis. However, they are available to and regularly used by approved scientists conducting work toward providing scientific advice for management of the fishery under CCAMLR rules for data access, and only by CCAMLR member countries via a formal data request to the Secretariat (Jones 2012). CCAMLR kindly agreed to share the official catch data of the trawl fishery operating in sub-area 48.6 since the beginning of the official reporting. The longline catch data shared by CCAMLR only concerned catches over the last few years, and were shared under the condition of not publishing them. However, we were able to infer general patterns from them regarding trawl fisheries targeting mainly krill and lanternfish.

Table 1. Taxa reported in the CCAMLR database for subarea 48.6 (CCAMLR 2012). Species in bold are reported by K.-H. Kock (pers. comm.) to be the most abundant within the Bouvet Island EEZ.

Family	Species
Macrouridae	*Macrourus whitsoni*
	Macrourus spp.
	Coryphaenoides filicauda
	Macrourus holotrachys
Alcyonacea	--
Euphausiidae	*Euphausia superba*
Nototheniidae	*Notothenia kempi*
	Dissostichus spp.
	Dissostichus mawsoni
	Dissostichus eleginoides
	Aethotaxis mitopteryx
	Lepidonotothen larseni
	L. squamifrons
	Paranotothenia dewitti
	Notothenia coriiceps
Channichthyidae	*Chionobathyscus dewitti*
	Chaenocephalus aceratus
	Champsocephalus gunnari
	Pseudochaenichthys georgianus
Moridae	***Antimora rostrata***
Lithodidae	*Paralomis* spp.
	Lithodes spp.
	Lithodes murrayi
Rajidae	*Bathyraja eatonii*
	Raja spp.
Gorgoniidae	--
Myctophidae	--
Muraenolepididae	*Muraenolepis spp.*
	Muraenolepis marmoratus
	Muraenolepis orangiensis
	Muraenolepis microps
Octopodidae	--
Pennatulacea	--
Anthozoa	--
Porifera	--
Bathydraconidae	***Bathydraco antarcticus***
Zoarcidae	***Melanostigma gelatinosum***
Achiropsettidae	***Mancopsetta maculata***

All catches, whether target species or by-catch (discarded or retained), are reported by both the fishing vessel (flag country) as well as by scientific observers (Jones 2012). Depending on the fishery, there are 5-day or 1-day reporting periods for haul-by-haul data. This information is reported directly to the CCAMLR secretariat. It is additionally reported to the FAO via the STATLANT database once a year by the member countries. At the end of the fishing season, the

secretariat compiles a Statistical Bulletin from all of the submitted fishery reports. All catches, including discards, are summarized in the Statistical Bulletin. The CCAMLR area is divided into sub-areas, themselves broken down into Small-Scale Management Units (SSRUs) within which there are research requirements for vessels participating in the exploratory fishery (Kock *et al.* 2007). CCAMLR officially reports five countries operating in sub-area 48.6, which comprises Bouvet Island: Norway, South Africa, Korea, Japan and the former Soviet Union. In Table 1, 12 species and 16 mixed species catches are reported in the CCAMLR database under sub-area 48.6 (CCAMLR 2012).

Estimation of the catch from the Bouvet Island EEZ

The most precise catch data for waters that include Bouvet Island which are publicly available from the CCAMLR database cover the entire sub-area 48.6 (Figure 1). The lower spatial resolution of the publicly available CCAMLR catch statistics does not allow a fine-scale catch allocation within the EEZ of Bouvet Island, as the CCAMLR catch statistics that are publicly available do not differentiate in terms of inside/outside the Bouvet EEZ. Therefore, an indirect procedure was used to approximate the spatial distribution of catches, based on the relative abundance and spatial distribution of commercially exploited marine species (Close *et al.* 2006), which allowed us to identify species whose distribution range map overlap with the Bouvet Island EEZ. From the 28 initially identified taxa caught within sub-area 48.6, only five species and five taxon groups have distributions that overlap with the Bouvet Island EEZ. We estimated the percentage of overlap of each taxon distribution with the Bouvet Island EEZ relatively to the total of Subarea 48.6. Then, we assumed that the probabilities of occurrences expressed by the range maps were proportional to catches, and used their overlaps and probabilities of occurrence to estimate the percentage of the reported catch from Subarea 48.6 that may have been caught in the EEZ of Bouvet Island (Table 2). Thus, we assumed proportionality between relative distribution and actual catches.

Table 2. Percentage of taxonomic distribution within Bouvet Island EEZ, mostly based on the distribution model of Close *et al.* (2006); the 'Reported' catch (in tonnes) is from CCAMLR (2012) and pertains to the cumulative catch by all countries in the years 1972 to 2010..

Family	Species	Reported catch (t)	Distribution within Bouvet Island EEZ (%)
Nototheniidae	--	0.002	6.82
	Dissostichus eleginoides	312.145	26.1
	Dissostichus manwsoni	718.520	N/A
Lithodidae	*Lithodes murrayi*	0.007	52.7
Nototheniidae	*Lepidonotothen squamifrons*	0.048	49.3
Moridae	*Antimora rostrata*	6.400	27.7
Lithodidae	*Paralomis* spp.	0.004	22.0
Muraenolepididae	*Muraenolepis* spp.	0.140	7.40
Macrouridae	*Macrourus* spp.	44.816	34.0
Euphausiidae	*Euphausia superba*	1334	**N/A**
Channichthyidae	--	0.496	1.72
Myctophidae	--	304	N/A
Miscellaneous fish		1.359	1.72[a]

a) Additional non-target taxa with small reported catch amounts were assumed to have the same distribution as crocodile icefishes (Channichthyidae), which shows the smallest percentage within the Bouvet EEZ, in order to be conservative.

Based on the aforementioned information that the toothfish fishery in subarea 48.6 was exploratory prior to 2004, as well as the fact that previous trial fishing resulted in minimal catch, and that we could not find any record of catches during the period, we assumed that catches were negligible before 2004. We did however calculate unregulated catches for the 2004-2010 time period. The unregulated component for the target species of the longline fishery within the CCAMLR area was estimated to be

62% of the regulated fishery by Sumby (2012). However, this estimate is for the time period 1997-2003, and the first year of catch in the Bouvet EEZ is not until 2004. Sumby (2012) also states reported versus unreported values for the 2009/2010 fishing season which give an estimate of unregulated catches equating to 13.6% of reported fisheries. We conservatively applied this estimate to the reported catch of the target species (*Dissostichus* sp.). To estimate the unregulated component of the associated non-target taxa, we assume that the relative ratio of each non-target taxa to the target species in the reported data would be the same for the unregulated fishery, and therefore we also calculated 13.6% of the reported values for those taxa.

Reported data for the longline fishery only begin in 2004. We did not estimate any catch prior to this as various reports corroborate this start date.

Direct reporting from onboard South African observers in CCAMLR areas 58.6, 58.7 and 51 for the longline toothfish fishery from 1997 to 2010 estimated the discard rates for 7 of the non-target longline species in our study (Boonzaier *et al.* 2012). The average of these rates (90%) was used as the assumed discard rate for all other non-target taxa. Target species were found to have negligible discard rates and were thus assumed to be zero. We applied these rates to the estimated unreported non-target longline landings in order to split those catches into retained and discarded by-catch. By-catch including discards are incorporated in CCAMLR official reports by observers. We therefore also applied these rates to the reported landings in order to determine how much of the reported catch is actually discarded. However, for *Sea Around Us* purposes, all CCAMLR data are listed as reported in the database and thus are also shown as 'landings'. We do show these catches as discards in the report though.

Results

The longline fleets targeted Patagonian toothfish (*Dissostichus eleginoides*) and Antarctic toothfish (*Dissostichus mawsoni*) from 2004 to 2010. Here, total reconstructed catch within the Bouvet EEZ was estimated at 357 tonnes compared to reported landings of 314 tonnes. Catches have generally increased over the short time period, from 2 t in 2004 to 135 t in 2010 (Figure 2). Discards were estimated at around 16 t.. Discards increased from around less than a tonne in 2004 to a peak of over 4 t in 2007 before dropping to less than 1 tonne in 2008 and increasing again to just over 3 t in 2010 (Figure 2). Taxonomically, catches consisted of Antarctic toothfish (*Dissostichus mawsoni*; 69%), Pantagonian toothfish (*D. eleginoides*; 26%) and Macouridae (5%; Figure 3).

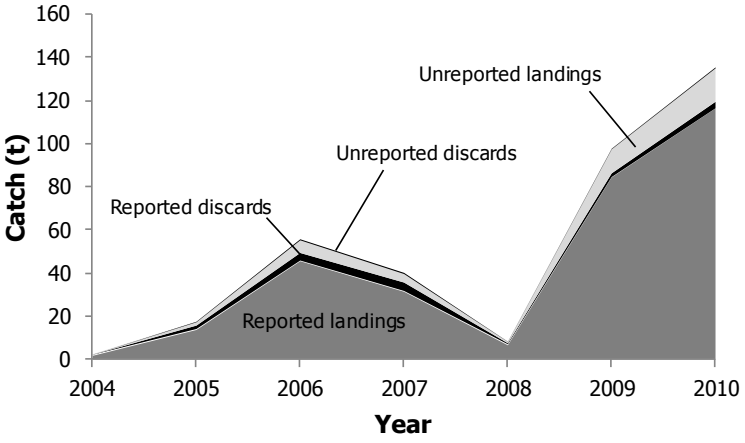

Figure 2. Reconstructed longline catches in the Bouvet Island EEZ by type of catch, 2004-2010.

Reconstructed total catches within the Bouvet CCAMLR sub-area 48.6 accounted for around 2,870 t, which is 1.1 times the total catch reported to CCAMLR (Figure 3). Taxonomically, catches included

krill (*Euphausia superb*; 47%), Antarctic toothfish (28%), Pantagonian toothfish (12%),Myctophidae (11%) and other fishes (2%; Figure 4).

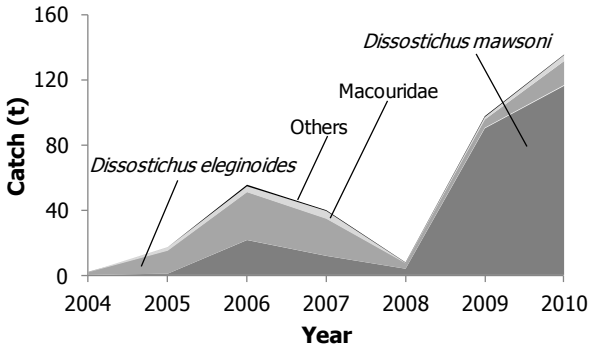

Figure 3. Taxonomic composition of the catch around Bouvet Island, highlighting the importance of the three major species.

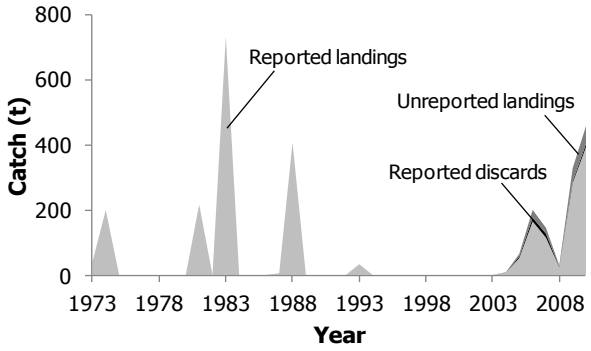

Figure 4. Total reconstructed catches in the Bouvet CCAMLR sub-area (48.6), 1973-2010. Reported discards are too small to be visible.

Discussion

This study summarizes the catches and composition of the longline fisheries in the vicinity of Bouvet Island, based on the scarce information that is publicly available. The CCAMLR catch data for trawlers do not show any sign of activity around Bouvet Island from 1970 to 2010. We therefore assumed conservatively that a trawl fishery never occurred within the Bouvet Island EEZ. However, we suspect a high illegal catch rate in this area because of the substantial lack in monitoring and enforcement (Bender 2008).

Reported and unreported longline catches generally increased from 2004 to 2010. Our catch reconstruction estimated a total of 314 t of reported landings and discards within the Bouvet EEZ between 2004 and 2010. Unreported catch and discards, which were estimated at around 43 t, do not appear to be officially documented (Jones 2012).

FAO (2012) reports only 9 of the 12 taxa identified in this study (i.e., *Lithodes murrayi*, *Antimora rostrata*, *Macrourus* spp., *Lepidonotothen squamifrons*, *Dissostichus eleginoides*, *Lithodes murrayi, Euphasia superba and Dissostichus manwsoni* and the families Channichthyidae, Muraenolepididae and Myctophidae). Furthermore, the FAO reports catches only for the entire Area 48, i.e., the Atlantic Antarctic. On the other hand, CCAMLR (2012) provides officially reported catches at the sub-area scale, but only to the level of the area 48.6, which encompasses more than just the Bouvet Island EEZ. Finally, we have been unable to find Norwegian catch statistics reports dealing only with the Bouvet Island EEZ.

Formal reporting by CCAMLR in its publicly accessible online Statistical Bulletin does not separate between discards and retained catches. This reporting system is problematic for a comprehensive and open understanding by the general public, as it hides the large magnitude of wasted fish. A clear differentiation should be included in publicly available datasets between these two fundamentally different types of catches.

This study has touched on two major issues that should be addressed by CCAMLR and its member countries. Firstly, the considerable amount of unreported catches occurring in its management area

(although this issue was not found to be rampant within the Bouvet Island EEZ, given the information found). The issue of illegal and unreported catch in CCAMLR areas has affected the management regime and threatens the fundamental objectives established by CCAMLR in terms of achieving the sustainable exploitation of marine stocks in the Antarctic (Bender 2008). Clearly, comprehensive estimation of unreported catches, raised to total annual area estimates, should be included in publicly available datasets, and clearly marked as such. Secondly, the publicly accessible dataset needs to clearly separate discarded catch from retained catch. This is a principal requirement of transparency and public accountability of the use of a public resource, especially for an area of substantial global biological heritage such as Antarctic waters.

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A SHORT HISTORY OF THE FISHERIES OF CROZET ISLANDS[39]

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Abstract

Crozet Islands are part of the French Antarctic and sub-Antarctic Territories (TAAF), where in 1996, distant-water fisheries began to conduct annual operations. The target species of the longline fishing fleet is the Patagonian toothfish *Dissotichus eleginoides*, Smitt, 1898. Catches were obtained from Statistical Bulletins of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) for Area 58.6. Data from the TAAF region are provided to the CCAMLR by the French government from the PECHEKER database through the TAAF's fishing observers program. Judicial sanctions and increased surveillance imposed by the French government in the 2000s appears to have stabilized longline catches and reduced illegal fishing after a long period of very high level of illegal fishing.

Introduction

The Crozet Islands are a small sub-Antarctic archipelago (land area of 352 km^2; with an exploitable water area of 10,000 km^2) from 45°95' and 46 50' S and 50°33' and 52°58' E (Figure 1). They are part of the French Antarctic and sub-Antarctic Territories (TAAF), which also include the islands of Kerguelen, Amsterdam and St. Paul (www.taaf.fr). The area was exploited in the 19th century by sealers and whalers, while the current toothfish fishery in the islands began in the mid-1990s (Duhamel and Welsford 2011).

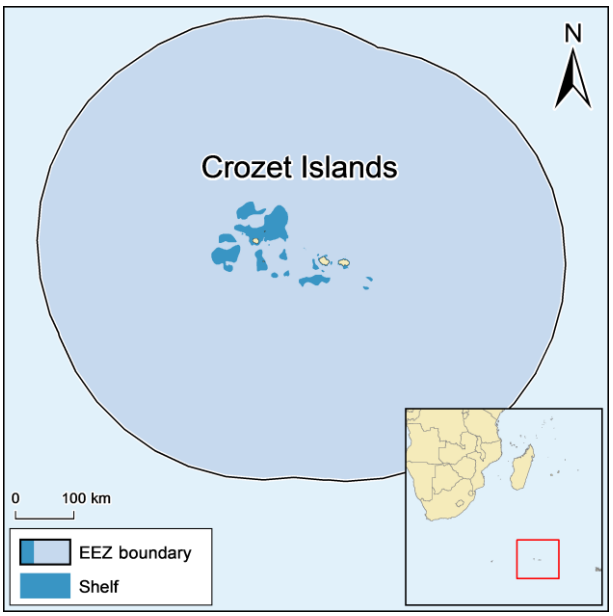

Figure 1. The sub-Antarctic archipelago of the Crozet Islands (45°95' and 46 50' S and 50°33' and 52°58' E) of the French Antarctic and SubAntarctic Territories, CCAMLR area 58.6, with its Exclusive Economic Zone.

Preliminary fishing surveys were conducted by vessels flying the USSR flag from 1967 to 1973, by a Japanese vessel in 1977 (i.e., the JAMARC expedition), and by the French trawler *Austral* in 1984-1988. These initial trawl surveys reported viable catches of marbled rockcod (*Nothothenia rossii*), grey rockcod (*Lepidonotothen squamifrons*) and Patagonian toothfish (*Dissostichus eleginoides*) in the sub-Antarctic zone (CCAMLR 1990a). However, the trawl fishery did not grow rapidly following these preliminary surveys because the sea floor was too rugged to run trawling operations smoothly

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(Duhamel *et al.* 2005). Ukranian longliners began exploratory commercial fishing in the Kerguelen Archipelago in the early 1990s, and we assume that they also explored other sub-Antarctic islands, including Crozet. In 1996, a fleet of French longliners began operating in the Kerguelen archipelago and extended their operations to Crozet, leading to a joint Franco-Japanese exploratory fishing survey performed on the Japanese longliner *Anyo-Maru 22*, which identified commercially viable Patagonian toothfish concentration and provided evidence that longline fishing, being more adapted to rugged terrain, increased the area available for fishing (Duhamel *et al.* 2012). The results of this survey led to the establishment of a regulated longline toothfish fishery with quota set at 700 t·year^{-1}, under the control of the TAAF administration, with fishing grounds that follow the geographic and bathymetric range of Patagonian toothfish, from the shelves to the deep-sea down to 2,000 m. Fishing is conducted during the austral summer, i.e., February to March, at depths of 500-1,800 m (Duhamel *et al.* 2012). The catch from this fishery mainly supplies the Japanese and American markets.

The considerable increase in the market price of Patagonian toothfish which then occurred attracted foreign fishers, and thus illegal fishing, which led to a significant overexploitation of this fish. To remedy this, a series of preventive measures were put in place, viz.: increase in the number and frequency of aerial and maritime Franco-Australian surveillance patrols complemented by satellite monitoring; issuance of fishing and export licenses (as part of the Catch Documentation Scheme established in 2000; see CCAMLR 2000), and judicial sanctions and French diplomatic intervention with the countries of origin of fishing vessels operating illegally. Sanctions against illegal fishers include fines, confiscation of the catch and may go as far as permanent confiscation of the boat; in some cases, boats were destroyed and sunk. About 20 illegal fishing vessels caught in the region were confiscated during the period 1997-2000[40].

Table 1. Legal reported catch and illegal, unreported and unregulated catch (IUU) of Patagonian toothfish, *Dissostichus eleginoides* in the Crozet Islands (French EEZ, Subarea 58.6.), as reported by year by CCAMLR (1990a, b; 1993; 2003; and 2013), in tonnes. Note that catches of 0 imply <0.5 t.

Season	Reported	IUU	Total removals
1977	6	0	6
1978	370	0	370
1983	17	0	17
1987	488	0	488
1988	21	0	21
1994	56	0	56
1995	115	0	115
1996	76	7,875	7,
1997	466	11,760	12,226
1998	1,053	1,758	2,811
1999	1,152	1,845	2,997
2000	1,096	1,430	2,526
2001	1,027	685	1,812
2002	1,225	720	1,945
2003	571	302	873
2004	607	380	987
2005	639	12	651
2006	801	55	856
2007	436	0	436
2008	878	153	1,031
2009	908	0	908
2000	741	0	741
2011	735	0	735
2012	704	0	704

Currently, seven French longliners are licensed to exploit this area, where they mainly target Patagonian toothfish, with grenadiers and rays as bycatch. Each longliner allowed in this zone must have an observer onboard, tasked with submitting reports to the National Museum of Natural History (Paris, France; see Gasco 2011), which is mandated by the French government to collect fisheries data (i.e., observations recorded by fisheries controllers) within the French Antarctic Territories. The data are stored in the PECHEKER database[41] (Martin and Pruvost 2007) and provided annually to the French government and then to CCAMLR (Pruvost *et al.* 2011).

[40] http://taaf.fr/Peche-illicite.
[41] http://www.mnhn.fr/mnhn/UMR7208/equipe4/pecheker.php

Materials and Methods

CCAMLR estimates the gross weight of the catch by applying a conversion coefficient on the production of fillets, gutted fish and other fish products from empirical relationships of the fish product and whole fish wet weight, obtained onboard per target species per vessel per fishing trip (CCAMLR 2010a, b). Finally, this estimated gross weight of the catch is corrected at the end of a vessel's fishing trip as a function of the landed weight.

Patagonian toothfish catches (Table 1) were obtained from 'Annual Bulletins' for the period 1970-1979 from CCAMLR (1990a), 1980-1989 (CCAMLR 1990b), 1983-1992 (CCAMLR 1993). The years 1993-2002 were reconstructed from CCAMLR (2003) and those from 2003-2012 from CCAMLR (2013; see also CCAMLR 2010a, b). Statistics are reported per fishing season, i.e., December to November; however, they can be extracted from the CCAMLR database by calendar year (i.e., January to December).

The bycatch of the longline fisheries includes grenadiers, skates and antimore gadids, in order of importance (see Table 2). The CCAMLR statistics bulletin reports three taxa for rays (*Amblyraja taaf*, *Raja* spp. and Rajiformes), all of which can be considered as catches of the whiteleg skate, *Amblyraja taaf*, because it is the only skate species that occurs in Crozet Island (Duhamel *et al.* 2012). Similarly, grenadiers are reported as *Macrourus carinatus* and *Macrourus* spp., which can be combined as catches of the ridge-scaled rattail, *Macrourus carinatus*, i.e., the only species of grenadier (or rattail) reported from around Crozet Island. Catch statistics for these bycatch species were recorded by the licensed fishing fleet only from 1999. To estimate bycatch for 1996-1998, annual catch for each species was expressed as a proportion of the legal Patagonian toothfish catch and averaged over the period 2007-2012, i.e., the period when reporting was reasonably accurate. These ratios where then multiplied by the legal toothfish catch to obtain estimates of bycatch by the legal fishery for 1996-1998 and in order to account for the suspected under-reporting of bycatch by this fishery for 1999-2011. This bycatch was systematically discarded until 2007, when the major bycatch species began to acquire market values sufficient for them to be retained and then landed.

Table 2. Catch of bycatch species (ridge-scaled rattail, *Macrourus carinatus*; whiteleg skate, *Amblyraja taaf*; blue antimore, *Antimora rostrata*) taken by the longline fishery for Patagonian toothfish, *Dissostichus eleginoides* in the Crozet Islands (French EEZ in Subarea 58.6) as reported by year by CCAMLR (2013), in tonnes.

Season	Rattail	Skate	Antimore
1997	11	2	—
1998	19	2	3
1999	66	4	6
2000	72	11	7
2001	77	14	1
2002	191	41	1
2003	144	80	0
2004	96	67	0
2005	91	13	86
2006	71	32	78
2007	71	3	1
2008	138	46	68
2009	195	45	78
2010	116	56	79
2011	95	29	24
2012	99	75	21

Illegal fishing of toothfish species were adapted from CCAMLR[42] estimates, obtained from landings of processed fish products (frozen cut and gutted fish loins) by foreign fishing vessels (listed in illegal vessel sighting reports) in major ports, e.g., Port Louis (Mauritius), Walvis Bay (Namibia), and Beira (Mozambique) (Duhamel *et al.* 2012). Bycatch generated by this illegal fishery was estimated using the ratios as detailed above.

[42] http://www.ccamlr.org/en/compliance/catch-documentation-scheme-cds.

Results and Discussion

Figure 2 shows the catches presented in Tables 1 and 2 and the re-estimation of bycatch species using the average ratio of bycatch to toothfish catch (i.e., 0.17 for *M. carinatus*, 0.07 for *A. taaf*, and 0.07 for the blue antimore, *Antimora rostrata* for French catch and 0.07, 0.002, and 0.03, respectively, for South African catch) obtained from the 2007-2012 values and applied to the 1996-2006 catch data (see Table 3). The highest levels of illegal Patagonian toothfish catches were observed during the period 1996-2000 (over 642% more than the reported catches), which gradually decreased towards 2007 and was considered eradicated at the end of the time period. The corrected declared bycatch of *M. carinatus* amounted to 15 % of the legal toothfish catch and the bycatch associated with the illegal toothfish catch is 273% of the declared bycatch of this species. For *R. taaf*, the corrected declared bycatch is 6% of the legal toothfish catch and the illegal catch is 327% of the declared bycatch of this species. Finally, the bycatch of *A. rostrata* is 6% of the legal toothfish catch and the illegal catch is 398% of the declared bycatch for this species.

Our results also point to possible overestimations of the reported bycatch for skates and rattails during the 2002-2003 fishing season and for antimores during the 2004-2005 season. We have no idea how this might come about, except maybe for possible observer documentation errors. In addition, we feel that the resulting volume of reconstructed antimore bycatch might be overestimates, as this species is smaller and inhabits waters deeper than any of the other species caught by the longline fleet. However, we believe that our results more or less reflect reality, notably because of the improved documentation of CCAMLR for these exploited species in this zone since 2007.

Our results indicate that over 55,000 t of fish biomass has been removed from the Crozet Island EEZ since the exploratory fishing expeditions of 1975, of which 84% were taken within an 11-year period (1996-2006) of persistent illegal fishing. This indicates an annual removal rate of about 4,200 t per year during that period. Regulation of the toothfish fishery at the beginning of the 2000s reduced this annual removal rate to about 970 t per year or about 4 times less than that of the previous period. This implies a decreased fishing pressure on the stock of Patagonian toothfish and its bycatch species by the current licensed fishing fleet. Active mitigation through a relatively long series of documentation via fisheries observers and a strong political will to implement regulation seems to have worked, in this case within a short period (in 5 years). We recommend that this exercise be continued in order to monitor the trends of this fishery, which will hopefully tend towards stabilization.

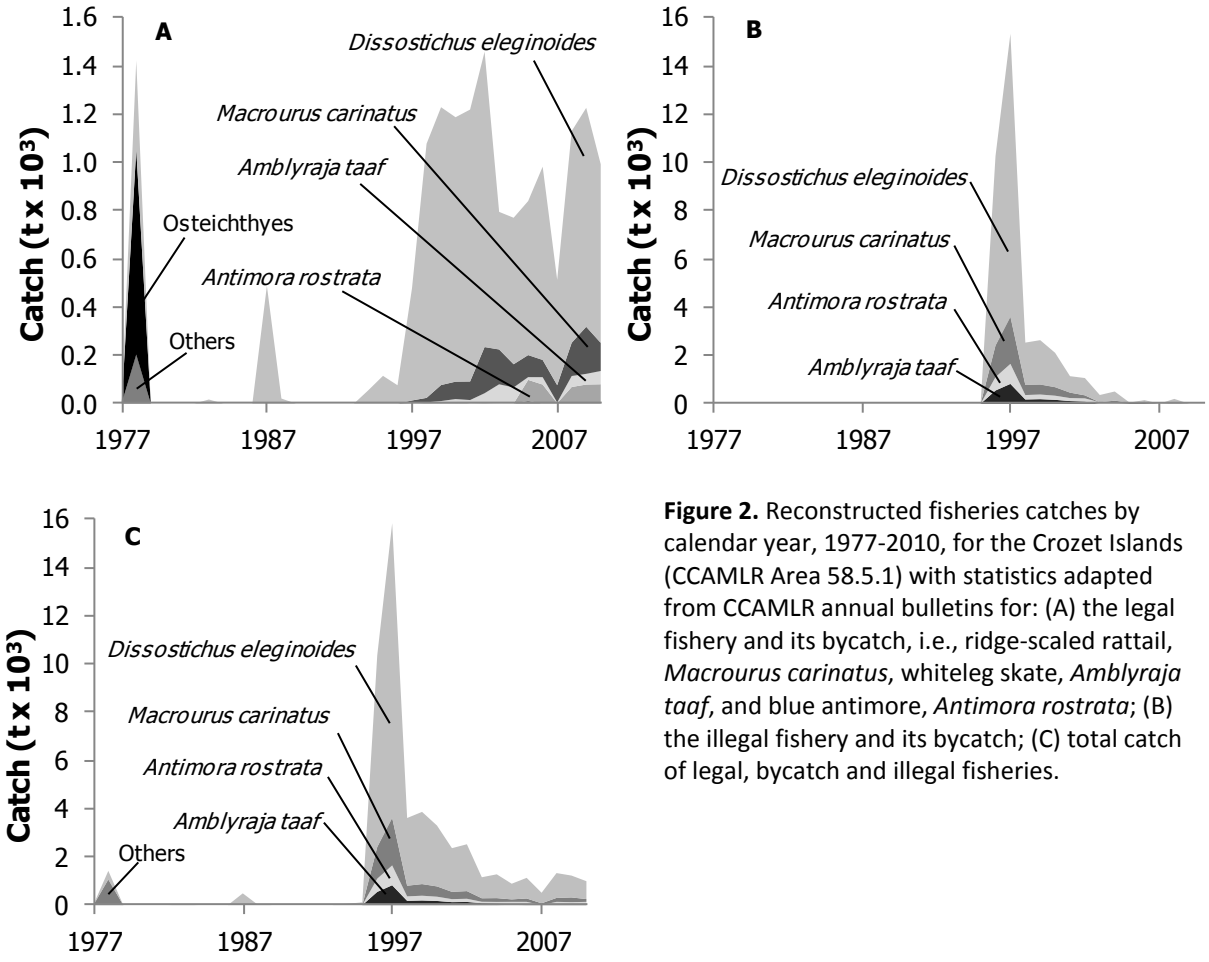

Figure 2. Reconstructed fisheries catches by calendar year, 1977-2010, for the Crozet Islands (CCAMLR Area 58.5.1) with statistics adapted from CCAMLR annual bulletins for: (A) the legal fishery and its bycatch, i.e., ridge-scaled rattail, *Macrourus carinatus*, whiteleg skate, *Amblyraja taaf*, and blue antimore, *Antimora rostrata*; (B) the illegal fishery and its bycatch; (C) total catch of legal, bycatch and illegal fisheries.

Table 3. Reported landings (Rep.) and illegal, unreported and unregulated (IUU) catches taken by longliners within the Crozet Islands (French EEZ in Subarea 58.6) for Patagonian toothfish (*Dissostichus eleginoides*) and its bycatch species, i.e., ridge-scaled rattail (*Macrourus carinatus*), whiteleg skate (*Amblyraja taaf*), and blue antimore (*Antimora rostrata*), re-expressed in calendar years. The average ratio (%) of bycatch species to the reported toothfish landings allowed the estimation of under-reported bycatch (Unrep.) by the licensed fleet (% * Rep. - Rep.). Note that negative values resulting from this may be considered as over-reporting, i.e., an overestimation of the bycatch, but were simply treated as a zero here. Following the same principle, these ratios were multiplied with the IUU estimates to estimate the bycatch taken by the IUU fishing fleet within this EEZ.

Year	Toothfish			Rattail					Skate					Antimore					Reconst. total catch
	Rep.	IUU	Catch	Rep.	%	Unrep.	IUU	Catch	Rep.	%	Unrep.	IUU	Catch	Rep.	%	Unrep.	IUU	Catch	
1977	6	0	6	0	–	–	–	–	0	–	–	–	–	0	–	–	–	–	6
1978	370	0	370	0	–	–	–	–	0	–	–	–	–	0	–	–	–	–	340
1983	17	0	17	0	–	–	–	–	0	–	–	–	–	0	–	–	–	–	16
1987	488	0	488	0	–	–	–	–	0	–	–	–	–	0	–	–	–	–	447
1988	21	0	21	0	–	–	–	–	0	–	–	–	–	0	–	–	–	–	60
1994	56	0	56	0	–	–	–	–	0	–	–	–	–	0	–	–	–	–	51
1995	115	0	115	0	–	–	–	–	0	–	–	–	–	0	–	–	–	–	110
1996	76	7,875	7,951	0	–	6	1,306	1,311	0	–	0	541	542	0	–	3	546	549	11,109
1997	466	11,760	12,226	11	0.02	6	1,950	1,955	2	0.00	3	808	812	0	–	7	816	823	18,151
1998	1,053	1,758	2,811	19	0.02	130	291	422	2	0.00	53	121	174	3	0.00	60	122	182	5,142
1999	1,152	1,845	2,997	66	0.06	109	306	415	4	0.00	60	127	186	6	0.01	64	128	192	4,155
2000	1,096	1,430	2,526	72	0.07	116	237	353	11	0.01	61	98	159	7	0.01	71	99	170	3,677
2001	1,127	685	1,812	77	0.07	112	114	225	14	0.01	62	47	109	1	0.00	76	48	123	2,707
2002	1,225	720	1,945	191	0.16	6	119	126	41	0.03	39	49	88	1	0.00	81	50	131	2,651
2003	571	302	873	144	0.25	0	0	0	80	0.14	0	0	0	0	0.00	38	21	59	1,192
2004	607	380	987	96	0.16	2	59	61	67	0.11	0	0	0	0	0.00	39	26	66	1,233
2005	639	12	651	91	0.14	8	2	10	13	0.02	26	1	27	86	0.13	0	0	0	819
2006	801	55	856	71	0.09	59	9	68	32	0.04	22	4	26	78	0.10	1	0	1	1,141
2007	436	0	436	71	0.16	0	0	0	3	0.01	0	0	0	1	0.00	0	0	0	610
2008	878	153	1,031	138	0.16	0	25	25	46	0.05	0	11	11	68	0.08	0	11	11	1,335
2009	908	0	908	195	0.21	0	0	0	45	0.05	0	0	0	78	0.09	0	0	0	1,219
2010	741	0	741	116	0.16	0	0	0	56	0.08	0	0	0	79	0.11	0	0	0	935
2011	735	0	735	95	0.13	0	0	0	29	0.04	0	0	0	24	0.03	0	0	0	853
2012	704	0	704	99	0.14	0	0	0	75	0.11	0	0	0	21	0.03	0	0	0	864

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LA PECHE AUX ILES SAINT-PAUL ET AMSTERDAM[43]

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Extended Abstract

The uninhabited islands of Saint Paul and Amsterdam (SPA), which are now part of the French Southern and Antarctic Territories (Territoires Australes et Antacrtiques Français or TAAF; see www.taaf.fr) were exploited soon after France claimed them in 1843 for their marine mammal resources (seals, fur seals, whales), until the targeted species were nearly exterminated. This was followed in the early 20th Century by a seasonal fishery for Patagonian rock lobster, *Jasus paulensis* (Heller 1862), conducted by vessels based in La Réunion. Various attempts at canning lobster failed, mostly under harrowing circumstances for those involved, whether from France, Madagascar or La Réunion. However, since 1948, a sustainable model of exploitation of this resource appears to have been found, though quotas of this trap-caught lobster had to lowered and catches declined from 600-1,000 t·year^{-1} in the 1950s-1960s to about 300 t·year^{-1} from 2000-2010. While the lobster catch declined, the (smaller) catch of fishes (notably St. Paul's fingerfin, *Nemadactylus monodactylus*; hapuku wreckfish, *Polyprion oxygeneios*; bluenose warehou, *Hyperoglyphe antarctica*; and yellowtail amberjack, *Seriola lalandi*), fluctuates, reaching a maximum of over 640 t in 1964. The Museum of Natural History (MNHN) in Paris, which is tasked with monitoring this fishery, created the PECHEKER database, used for this catch reconstruction, and which we feel is reliable for the lobster fishery, but is very tentative for the fish catches, that could be estimated only approximately.

Résumé

Les îles de Saint-Paul et Amsterdam font partie des Territoires Australes et Antarctiques Français. Ces deux îles font respectivement 8 et 58 km^2. La zone économique (ZE) s'étend de 34°30' à 42°00 Sud et de 73°12' à 81°45' Est ; elles couvrent 509 000 km^2. Distantes l'une de l'autre de 90 km, elles sont considérées comme territoire français depuis 1843 après la prise de possession par le Capitaine Dupeyrat, à bord de l'Olympe. Les Iles de Saint Paul et Amsterdam sont actuellement administrées par le Territoire des Terres Australes et Antarctiques Françaises (TAAF) dont le siège est à Saint-Pierre à l'île de la Réunion. L'exploitation des ressources marines de ces îles a débuté à la fin du 18ème siècle. D'abord axée sur la chasse aux phoques et aux otaries, puis aux poissons, ces îles sont actuellement régulièrement exploitées annuellement pour la pêche à la langouste et quelques espèces de poissons. Cette pêcherie est soumise à un contrôle strict de l'administration des TAAF sur avis scientifique du Muséum national d'Histoire naturelle (MNHN).

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Chasse aux phoques, aux otaries et aux baleines

Les premières campagnes de pêche dans ces îles remontent à la fin du 18ème siècle. Dès 1792, le capitaine Péron et quatre compagnons vont rester sur l'île de Saint-Paul (Figure 1) pendant 40 mois pour chasser et accumuler ainsi plus de 2 700 peaux de phoques et d'otaries qui seront malheureusement abandonnées sur place. La plupart des campagnes ont d'abord été réalisées par des phoquiers anglais et américains puis entre 1820 et 1840 par des baleiniers français. Les baleines qui fréquentaient les parages de ces îles de mai à octobre étaient chassées au harpon et dépecées à terre. Ainsi alors qu'en 1 800 les otaries se trouvaient sur l'ile par plusieurs centaines, 50 ans plus tard elles étaient devenus très rares (Aubert de la Rüe 1932).

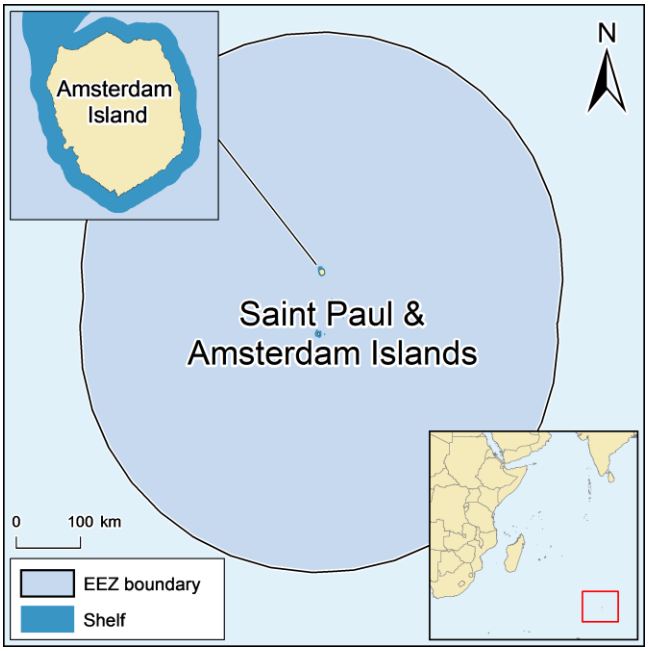

Figure 1. Saint-Paul and Amsterdam Islands, French Antarctic and SubAntarctic Territories (34°30'-42°00' S and 73°12'-81°45' and their Exclusive Economic Zones.

Pêche à la langouste *Jasus paulensis*

Depuis le début du 20ème siècle la pêcherie qui s'est développée et maintenue sur les îles de Saint-Paul et Amsterdam, a pour cible principale la langouste *Jasus paulensis* (Heller 1862). L'exploitation des ressources des îles de Saint-Paul et Amsterdam a été confiée aux frères Bossière en 1908 au même titre que l'ensemble des îles australes, Kerguelen et Crozet. Mais ce n'est qu'en 1928, que les deux frères se décident, sous la pression de la concurrence, à exploiter pour la première fois le stock prometteur de langouste des îles Saint-Paul et Amsterdam. Il crée une nouvelle filiale « La langouste Française » en août 1928 avec pour objectif notamment :

- la fabrication et la conserve de langouste à l'île Saint-Paul,
- la chasse et la pêche de tous les animaux marins avec une réserve concernant les baleines et les cachalots,
- le transport, la préparation et l'exploitation des produits de ces chasses et pêches

La première campagne d'exploitation est organisée en 1928. Le 4 septembre de cette année, 28 bretons partent du Havre à bord de « *l'Austral* » à destination de Saint-Paul qu'ils abordent en octobre 1928 après avoir fait escale à Madagascar afin d'embarquer du personnel supplémentaire pour installer et faire tourner une usine de conserverie. L'usine et les logements sont construits en quelques semaines dans la partie nord du cratère. Un pylône de communication de Télégraphie Sans Fil (TSF) est installé. L'objectif de la compagnie est alors d'atteindre une production de 10 000 boîtes par jour. Après deux mois de pêche expérimentale, début 1929, 50 000 boîtes de queue de langouste sont produites. Pendant les deux premières années les personnels étaient amenés en octobre par le navire-usine « *l'Austral* » se rendant à Kerguelen pour la chasse aux phoques et repartaient en mars à la fin de sa saison. Le personnel était alors obligé d'arrêter brusquement les opérations et de charger les conserves avant d'embarquer sur le navire (Méralli-Ballou 2007).

Fin 1929, une deuxième campagne de pêche est organisée embarquant 119 personnes dont 29 bretons (24 hommes et 5 femmes) et 90 malgaches (60 hommes et 30 femmes) de la région de Tananarive ou de Farafangana (Antanaïmoro). A la fin de cette saison, en mars 1930, 400 000 boîtes sont produites après deux mois de pêche, et sont chargées dans 4000 caisses à bord de « *l'Austral* » en partance pour l'île de la Réunion. Six volontaires, 5 hommes et une femme enceinte, resteront sur l'île à partir de mars 1930, pour assurer l'hivernage de l'usine. Seuls, trois d'entre eux, survivront jusqu'au retour de « *l'Austral* » à l'automne 1930. Des moyens financiers supplémentaires sont obtenus par les armements en juillet 1930 permettant l'achat d'un nouveau bateau et d'approvisionnements pour augmenter la production de l'usine à 15 000 boîtes par jour et permettre d'étendre la durée de pêche sur toute l'année. Malheureusement, les 69 hommes et 30 femmes qui resteront sur l'île pendant la saison 1930-1931 seront rapidement victime d'une épidémie de béri-béri tuant plus de trente personnes et mettant un terme prématuré à la campagne de pêche, le 3 avril 1931(Floch 1982). Seuls 260 000 boites de conserves auront été produites sur le million escompté conduisant à la liquidation de la compagnie en juin 1932 (Arnaud et Beurois 1996).

A cette époque, la pêche se pratiquait à partir d'embarcation à moteur avec 3 ou 4 hommes le long des côtes du cratère de Saint-Paul utilisant des casiers métalliques par des fonds de 15-30 m. Environ 400 manchots, de l'espèce *Eudyptes chrysocome* (Forster 1781) nichant sur les flancs du cratère, étaient massacrés chaque jour à coups de bâton pour servir d'appâts. Le rendement de cette pêcherie permettait d'atteindre près de 25 000 langoustes pour les bonnes journées. Les langoustes, dont les plus grosses ne pesaient pas plus de 1 à 1,5 kg, étaient immédiatement traitées dans l'usine et conditionnées par deux ou trois queues dans les boîtes de conserve (Aubert de la Rüe 1932). Sept ans plus tard, une nouvelle tentative d'exploitation est menée par « Les pêcheries et Conserveries des Mers australes Hohn de Boer et Cie ». Parti de Saint-Malo en mai 1938 « L*'île Bourbon* » appareille de la Réunion en novembre 1938 pour les îles Saint-Paul et Amsterdam. Il ne reviendra qu'avec 20 tonnes de langoustes mettant en faillite la compagnie nouvellement créée (Arnaud et Beurois 1996).

C'est à partir de la saison 1949/50 qu'une pêcherie régulière va se mettre en place. Une « Société Anonyme de Pêche Malgache et de Ravitaillement » (SAPMER) est créée en 1947, elle deviendra La « Société Anonyme de Pêche Maritime et de Ravitaillement » en 1951. Le navire éponyme « *SAPMER* » de 62 mètres équipé de 8 baleinières motorisées avec un équipage de 50 personnes (25 réunionnais et 25 bretons) est le premier à ouvrir une pêcherie qui va devenir annuelle (Duhamel 1980a et b ; Méralli-Ballou 2007). La langouste devient la cible principale après les résultats encourageants d'une première campagne d'exploration en 1949-1950 (Angot 1951a ; Angot 1951b) et après avoir réalisé que l'exploitation de poisson, en particulier la fausse-morue (nom changé récemment en Saint-Paul pour éviter toute confusion), *Latris lineata* (Forster 1801), n'était pas économiquement viable (Méralli-Ballou 2007; Figure 2).

A partir de 1955, des règles de gestion de la ressource sont édictées par les Terres Australes et Antarctiques Française. Un quota de pêche est fixé et la taille des casiers est définie. Plus tard, lors de la création de la ZEE, un carnet de pêche obligatoire et un programme scientifique de suivi des stocks sera mis en place. Le suivi de l'évolution du stock de langouste est confié au Muséum national d'Histoire naturelle (Vranckx 1973 ; Duhamel 1980a et b), Les contrôles au débarquement des captures sont assurés à l'île de la Réunion. Les navires qui ont exploités légalement les stocks de langoustes sont soit des bateaux de pêche (type langoustiers ou chalutiers aménagés « *Sapmer I* », « *Folgor* », « *CIAP* », « *Barbade* », « *Cap-Horn* », « *Austral 1 et 2* ») soit des cargos transformés (« *Sapmer II* », « *Pêcheur Breton* ») (Duhamel 1980a).

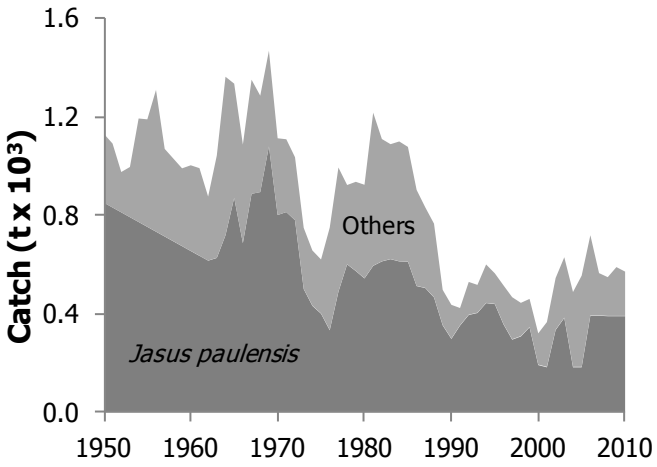

Figure 2. Catch (t) of the Saint Paul rock lobster, *Jasus paulensis*, and other fish and invertebrates for 1950-2010.

Les premiers pêcheurs pirates posent leurs casiers à partir de 1969 (« *Maria-Martina* », « *Jasus* », « *Veriac'h* », « *Perina* » pour ceux identifiés, venus essentiellement d'Afrique du Sud ou d'Australie) et mettent en danger le stock. Cette activité cessera après la création de la Zone Economique Exclusive (1978). En 1971 un armement supplémentaire obtient un quota de langouste suivi un an plus tard de deux nouvelles autorisations accordées à l'Armement des Mascareignes (ARMAS) et à la Compagnie Industrielle d'Armement et de Pêche (CIAP) (Méralli-Ballou 2007). A partir de 1968, plusieurs bateaux travaillent donc dans la zone la plus profonde : 2 en 1968-69, 5 en 1969-70, 4 en 70-71, 5 en 71-72 et 72-73. Alors que trois bateaux se mettent à travailler en zone côtière (Duhamel 1980a). Cette augmentation de l'effort conduit à un effondrement des captures dès 1973-74 et en 1974-1975 les quotas ne seront même pas atteints. Ces trois armements s'unissent en 1975 pour former le Groupement des Armateurs Réunionnais (GAR). Ils obtiennent le monopole de l'exploitation de langouste pour 5 ans à partir d'un seul navire (Méralli-Ballou 2007).

La SAPMER, associée récemment à l'ARMAS (Armement des Mascareignes), reste l'armement autorisé à exploiter la zone (Méralli-Ballou 2007). Pendant toute la période récente la pêche n'aura été suspendue qu'une année en 1958 en raison de problèmes mécaniques du bateau-usine (Grua 1965).

Actuellement, la pêcherie est toujours régulée et soumise à quota par l'administration des TAAF (Journal officiel des TAAF). Chaque bateau autorisé à travailler sur la zone doit désormais accueillir un contrôleur de pêche qui a remplacé le gendarme maritime auparavant embarqué. L'ensemble des données collectées sont intégrées en fin de marée à la base de données « *Pecheker* », du MNHN (Martin & Pruvost 2007). Le suivi scientifique de cette pêcherie continue à être assuré par le MNHN qui ajuste le quota en fonction de l'évolution des stocks.

Le 3 octobre 2006 est créée[44], par un décret interministériel (n°2006-1211), la Réserve naturelle nationale des Terres australes françaises qui concerne un volet marin et s'étend à toutes les eaux

[44] http://www.taaf.fr/La-gestion-de-la-Reserve-naturelle-des-Terres-australes-francaises-421

territoriales (12 milles). Cette réserve doit permettre de renforcer la protection de l'environnement et l'impact des activités humaines sur le milieu marin tout en maintenant une pêcherie de langouste durable. Un plan de gestion a été établi et des mesures de conservation sont mises en place sur les navires pour diminuer l'impact des facteurs anthropiques sur le milieu.

Pêche aux poissons

Ce serait en 1840 qu'un baleinier français aurait noté la présence de bancs de poissons prometteurs pour la pêche conduisant un nommé Camin à créer en 1843 une société intitulée « Compagnie pour les îles Saint-Paul et Amsterdam » et à installer une station de pêche accueillant une soixantaine de pêcheurs pendant une dizaine d'année ramenant par saison près de 40 000 poissons séchés vendus sous le nom de « Morues de la mer des Indes », « bonne morue de Saint-Paul » ou « poissons d'Amsterdam ». Cette pêche devint saisonnière, pendant deux à quatre mois par an et perdura ensuite jusqu'en 1914. Un homme pouvait pêcher 300 à 400 morues par jour soit 1 200 poissons par goélette et par jour (Aubert de la Rüe 1932).

C'est la SAPMER qui affrètera à la toute fin de la première moitié du 20ème siècle un premier navire « *le Cancalais* », ancien terre-neuvas de trois-mâts à moteur auxiliaire équipé de 9 doris et qui appareille du port de Tamatave pour Saint-Paul et Amsterdam, le 21 octobre 1948 avec à son bord une trentaine de marins. Il reviendra le 23 janvier 1949 avec 200 t de poissons séchés. La marée suivante 1949-1950 est moins fructueuse, car l'ensemble de la cargaison pêchée fermente pendant le voyage de retour et ne pourra pas être commercialisée mettant un terme à l'exploitation des poissons (Aubert de la Rüe 1932).

Les ressources mentionnées par Aubert de la Rüe dès 1932 étaient : le poisson bleu, *Nemadactylus monodactylus* (Carmichael 1819), d'une trentaine de centimètres, le plus fréquent nageant à la surface et servant d'appâts pour la pêche des autres poissons et des langoustes ; la fausse morue (maintenant nommé saint-paul), *Latris lineata* (Forster 1801), la plus recherchée par les pêcheurs de l'époque pouvant atteindre 60 cm ; le tazard, *Thyrsites atun* (Euphrasen 1791), pouvant atteindre 1 mètre et le cabot *Polyprion oxygeneios* (Schneider et Forster, 1801) le plus volumineux dont certains individus pesaient plusieurs dizaines de kilo pour près de deux mètres. A cela s'ajoutent le gros-yeux (renommé depuis rouffe antarctique) *Hyperoglyphe antarctica* (Carmichael 1819) et la sériole *Seriola lanlandii* Valenciennes, 1833 (Beurois 1975). Des espèces plus petites dont une sorte de rouget *Serranus novemcinctus* Kner, 1864, une rascasse *Helicolenus mouchezi* (Sauvage 1875) et des pieuvres *Octopus vulgaris* Cuvier 1797, qui sont fréquentes et capturées dans les casiers à langouste sont aussi signalés (Aubert de la Rüe 1932 ; Beurois 1975).

Après avoir connu une forte période d'exploitation au cours du 19ème siècle, l'exploitation des poissons des îles Saint-Paul et Amsterdam a été plus ou moins abandonnée au bénéfice de l'exploitation de langouste. Depuis la reprise régulière de l'exploitation des ressources en 1949, la pêche de poisson vient en complément de la pêche à la langouste. En dehors de la pêche du bleu au carrelet qui ne se pratique qu'à partir du navire-usine (lorsque ce dernier est de taille suffisante) et simultanément à la pêche aux langoustes (puisque le carrelet est appâté avec des têtes de langoustes issues de la production) la pêche aux poissons débute généralement une fois le quota de langouste atteint et se poursuit jusqu'à la fin de la période de pêche autorisée sur la zone. Ces dernières années, la demande des marchés a relancé l'intérêt de la pêcherie de poissons qui se pratique à la ligne à main, à la palangre de fond ou au carrelet (bleu uniquement) à partir des embarcations et du navire-usine autorisés sur la zone.

Ainsi sur les 29 espèces de l'ichtyofaune référencées sur les îles de Saint-Paul et Amsterdam (Duhamel 1989) seules 5 espèces de poissons et un espèce de pieuvre font l'objet d'une pêche commerciale régulière. Trois espèces sont soumises à quota : le saint-paul , le cabot et le rouffe antarctique. Les autres espèces, comme la sériole , le bleu ou les pieuvres, sont seulement soumises à autorisation de capture. L'ensemble de la production est débarqué au Port sur l'île de la Réunion.

Sources des données et résultats

La reconstruction des données de la pêcherie de langouste a été faite en considérant que l'ensemble des captures d'une période de pêche se déroulant au cours de l'été austral, entre novembre de l'année N et mai de l'année N+1, est affecté à l'année N+1.

Pour les périodes 1928 à 1931, les documents consultés exprimaient la production annuelle en nombre de boîtes. Nous avons estimé que le remplissage moyen des boîtes était de 2,5 queues de langouste par boîte sachant qu'il y en avait 2 ou 3 queues de langouste par boîte en fonction de leur taille. Connaissant le nombre de boites embaquées chaque année : 50 000 en 1929, 400 000 en 1930 et 260 000 en 1931, nous pouvons estimer la production à 125 000 langoustes pour la saison 1928-1929, 1 000 000 pour 1929-1930 et 625 000 pour la dernière saison 1930-1931. En considérant le poids moyen entier des langoustes égales à 500 g nous obtenons une capture annuelle en tonne de 62,5 t pour 1929, 500 t pour 1930 et 312,5 t pour 1931. Les données obtenues pour les périodes de 1949 à 1980 proviennent des données de la thèse de Guy Duhamel (Duhamel 1980a), pour la période 1981-1993 du rapport de maîtrise de Patrice Pruvost (Pruvost 1993) et pour la période ultérieure de rapports internes reprenant les débarquements certifiés (Figure 2).

La reconstruction des données de la pêcherie contemporaine de poissons (Figure 3), depuis la seconde moitié du XXème siècle, a été faite selon la même méthode en reportant l'ensemble de la production d'une saison sur l'année de débarque à la Réunion l'année N+1, à l'exception de 1948. En effet, la première campagne de la SAPMER dura du 13 septembre 1948 au 23 janvier 1949 ce qui nous permet de considérer en tenant compte des temps de voyage que l'ensemble des captures avait été effectué au cours de l'année 1948 (Méralli-Ballou 2007). Les captures de 1951 à 1980 ont été obtenues à partir d'un graphique issu de données de la SAPMER fournissant la capture annuelle en tonnes de poissons étêtés et éviscérés et en multipliant par 1,6 pour obtenir le poids du poisson entier. Les données ultérieures relatives à la pêcherie dans la ZEE proviennent des débarquements certifiés et synthétisés dans des documents internes.

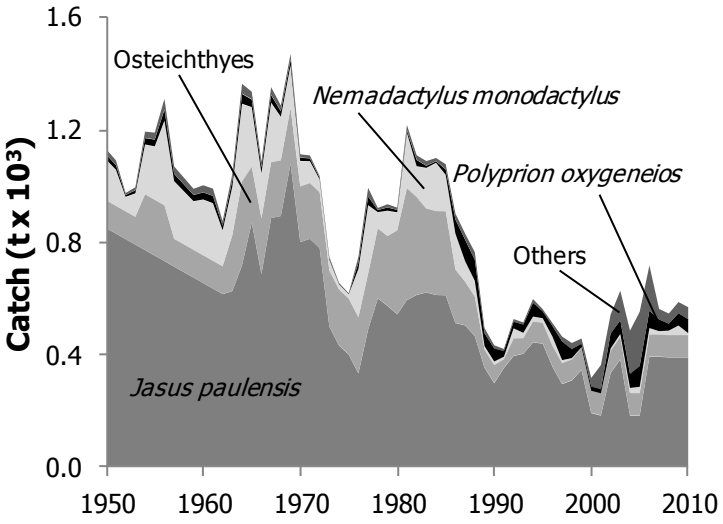

Figure 3. Reconstructed fisheries legal catches (in metric tonnes) for the Saint-Paul and Amsterdam Islands 1950-2010, based on data from the late 1920s.

Discussion

Pêche aux langoustes

Sur la base des données de l'Institut National de la Statistique et des Etudes Economiques (INSEE), il apparait que les captures légales de langouste ont été fluctuantes (principalement en raison des révisions annuelles des quotas) et ont diminué régulièrement dans les années 1980, 1990 et 2000 de 560 tonnes en 1982 à moins de 150 tonnes dans le début des années 2000 (Anon. 1988, 1989, 1991, 1993, 1998, 1999, 2001, 2004, 2005).

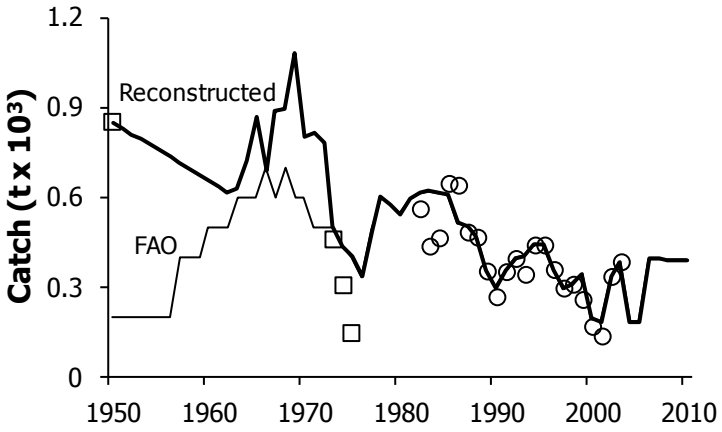

Figure 4. Reconstructed legal catch for the rock lobster fishery in St Paul and Amsterdam. The thin line corresponds to the FAO data as provided in FishStat (FAO 2012), while the thick line corresponds to the corrected time-series, of which the 1950-72 values are based on anchor points provided by Duhamel (1980a) and Méralli-Ballou (2007). White squares correspond to anchor points from Méralli-Ballou (2007) and white circles from certified landings.

Ces données statistiques sont très proches des données enregistrées par la FAO pour les prises de langouste de Saint-Paul provenant des Territoires Australes Français (FAO, 2012). En effet, elles ne sont inférieures que de 8 % en moyenne mais ont une tendance similaire (r^2=0,78). Etant donné que les données chronologiques FishStat couvrent l'ensemble de la période 1950-2010 et peuvent inclure *a posteriori* les changements des statistiques de l'INSEE nous avons pris en compte les derniers chiffres pour cette reconstruction (période 1982-2003). Pour la période 1962-72, nous avons utilisés les données de Duhamel (1980), qui sont beaucoup plus importants que les chiffres donnés par la FAO. De 1950 à 1961 nous avons fourni une interpolation linéaire entre la valeur 1950 (Meralli Ballou 2007) et la valeur de 1962 (Duhamel 1980). Cette dernière étape élimine efficacement l'augmentation progressive et suspecte des données FAO (Figure 4).

Nous avons également estimé qu'il n'y avait pas de captures accessoires dans cette pêcherie (ou qu'elles étaient relâchées dans de bonne condition sachant que la pêcherie utilise essentiellement des casiers) et que la composante non déclarées étaient triviales : quotas stricts et pêcherie bien surveillée (Allain, 1974).

Pêche aux poissons

Les données concernant les captures de poisons, si elles sont historiquement anciennes ne sont pas très précises avant la création de la ZEE. Elles nécessitent un important travail de recherche dans les archives maritimes réunionnaises pour tenter de reconstituer les débarquements à partir des mouvements des goélettes depuis la fin du XVIII ème siècle. La diversité des ressources qui étaient conditionnées salées et séchées ne facilitera cependant pas la tâche d'attribution aux espèces précises et la quantification des volumes en poids vif tels qu'actuellement répertoriés.

Conclusion

Les îles de Saint-Paul et Amsterdam sont connues depuis longtemps pour la richesse de leurs ressources (Aubert de la Rüe 1932; Angot 1951a; Genty 1981; Méralli-Ballou 2007). Elles sont exploitées depuis le début du 19ème siècle. La pêche à la langouste a peu à peu remplacé les pêcheries de poisson qui étaient l'activité principale sur ces îles au 19ème siècle et a connu plusieurs périodes différentes depuis le début du 20ème siècle.

Une première phase d'exploitation de la langouste a été faite de 1929 à 1931 à partir d'une usine construite sur l'île Saint Paul et a permis rapidement d'atteindre un niveau d'exploitation d'environ 500 tonnes sur un stock vierge. Les difficultés rencontrées sur place liées à l'éloignement et à l'isolement n'ont pas permis à la pêcherie de se maintenir au-delà de 1931. Une tentative d'un nouvel armement en 1938 se révèlera infructueux avec seulement 20 tonnes de captures et conduira à l'arrêt de l'exploitation de cette zone pendant une dizaine d'années.

A partir de 1948 une exploitation régulière de la zone se met en place. D'abord orientée sur la capture de poisson en 1948 (200 t) et 1949 (0 tonnes en raison de problème de conservation), c'est l'exploitation de la langouste qui devient prédominante. De 1949 à 1970 les captures sont assez régulières et se maintiennent autour de 600 tonnes par an à l'exception des années 1962-1963 et 1964 où les captures ne dépassent pas 500 tonnes en raison de problèmes mécaniques du bateau-base (Grua, 1965).

Le remplacement du « *Sapmer 1* » en 1966/67 et l'arrivée du « *Folgor* » en 1969/70 permettent d'exploiter la zone profonde et d'augmenter les captures annuelles. Par ailleurs la multiplication des licences de pêche à plusieurs bateaux sur le secteur contribue à une augmentation forte de la production annuelle qui passera de 669 tonnes en 1968 à 1143 tonnes en 1973, sans compter la pêche illégale qui s'est développée (Duhamel 1980a). Cette surexploitation conduit à une chute immédiate et brutale de la production annuelle qui passe de 1099 tonnes en 1974 à moins de 300 tonnes en 1975, 1976 et 1977.

La reconstitution des stocks s'est ensuite accompagnée d'une phase d'augmentation lente de la production jusqu'à 610 tonnes en 1985 mais les rendements s'écroulent de nouveau pour une production à hauteur de 298 tonnes en 1990. Depuis cette période le niveau de capture se maintient aux alentours de 400 tonnes annuelles.

La pêcherie de poisson des îles Saint-Paul et Amsterdam reste fluctuante en fonction du temps consacré à cette pêche par rapport à celle de la langouste, une fois les quotas atteints et de la demande des marchés. Le tonnage annuel des poissons reste modeste et représente en moyenne 30 % de la capture totale de langouste depuis 1951. Alors que de 1954 à 1969 la part de la pêche était assez importante et pouvait représenter jusqu'à 70 % du tonnage de langouste (en raison d'une pêche active au carrelet), dans les années 1970 à 1975 période de plus forte production de langouste ce tonnage ne représentait alors que 10 % des captures car l'effort de pêche était concentré pour atteindre le quota de langoustes. Après l'effondrement du stock de langouste de 1976 à 1990 la capture a représenté une part assez importante des captures entre 80 et 20 % du tonnage avec une capture annuelle s'élevant régulièrement à 200 à 300 tonnes. Les années 90 marquent un fort recul de la production de poisson entre 50 et 90 tonnes annuelles représentant 10 à 20 % de la capture de langouste. Depuis 2000, les captures de poisson sont assez stable entre 100 et 200 tonnes et représente 25 à 30 % des captures totales de langouste (Tableau 1) avec une diversification des méthodes de pêche et des espèces ciblées.

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