

THE FISH AND FISHERIES OF BOUVET ISLAND³⁶

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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 1977 to 2010 were estimated to be 2,427 t, which is 2.2 times the currently reported landings of 1,083 t presented by the CCAMLR Statistical Bulletin for sub-area 48.6. No fishery appears to have occurred in the EEZ-equivalent waters around Bouvet Island prior to the mid-1970s. Pelagic trawl fisheries were not reconstructed in this study, since neither krill nor myctophids were spatially reported by CCAMLR; 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 (54° 24.8'S and 03° 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 km², 93% of its surface is covered by ice, and it is un-inhabited because of its harsh climate and topography³⁷. 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 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

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³⁷ http://commons.wikimedia.org/wiki/Atlas_of_Bouvet_Island [Accessed on 19/09/2013]

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).

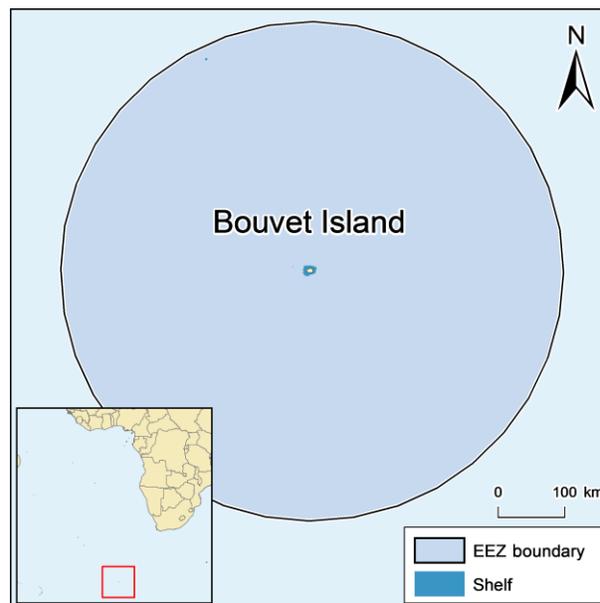


Figure 1. Bouvet Island (Norway) and its Exclusive Economic Zone; CCAMLR statistical areas 48.6.

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 identifying 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 (*Krefflichthys 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, in his personal communication, mentioned that commercial longlining for toothfish (*Dissostichus* spp.) was done within 20 nautical miles around Bouvet Island. Scientific sampling during the 20th century (Lönnerberg 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.

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. The former Soviet Union was the main krill fishing country in the Southern Ocean, and it heavily subsidized the fleets operating there. In the 1980s, this fishery reached its maximum catch of around 735 t, which then dropped drastically because of the break-up of the Soviet Union, with all operations ceasing in 1994. Ten years later, in 2004, Russia officially introduced two vessels to the southern ocean and caught 25,000 tonnes of krill (ASOC 2004). Exploratory fishing campaigns by other countries also occurred, such as the exploratory commercial fishing in 2008 by Norway within the Bouvet Island EEZ (Iversen *et al.* 2009).

This recent, increasing interest in krill fishing led the Marine Stewardship Council (MSC) to develop a krill fishery certification for the South Atlantic (Barnes 2009), despite environmental threats to the krill population (Jacquet *et al.* 2010; Pew 2012). Indeed, the first MSC-certified fishery, operated by Aker Biomarine has started operations, using factory ships specialized for so-called "eco-harvesting", i.e., vacuuming up krill populations (Moran 2012). To our knowledge, no krill fishing, however, is occurring inside Bouvet Island EEZ waters.

This study presents a catch reconstruction from 1970 to 2010 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.

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 Subareas, 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 publicly available from the CCAMLR database covers 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

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	<i>Macrourus whitsoni</i> <i>Macrourus</i> spp. <i>Coryphaenoides filicauda</i> <i>Macrourus holotrachys</i>
Alcyonacea	--
Euphausiidae	<i>Euphausia superba</i>
Nototheniidae	<i>Notothenia kempfi</i> <i>Dissostichus</i> spp. <i>Dissostichus mawsoni</i> <i>Dissostichus eleginoides</i> <i>Aethotaxis mitopteryx</i> <i>Lepidonotothen larseni</i> <i>L. squamifrons</i> <i>Paranotothenia dewitti</i> <i>Notothenia coriiceps</i>
Channichthyidae	<i>Chionobathyscus dewitti</i> <i>Chaenocephalus aceratus</i> <i>Champscephalus gunnari</i> <i>Pseudochaenichthys georgianus</i> <i>Antimora rostrata</i>
Moridae	<i>Paralomis</i> spp.
Lithodidae	<i>Lithodes</i> spp. <i>Lithodes murrayi</i>
Rajidae	<i>Bathyraja eatonii</i> <i>Raja</i> spp.
Gorgoniidae	--
Myctophidae	--
Muraenolepididae	<i>Muraenolepis</i> spp. <i>Muraenolepis marmoratus</i> <i>Muraenolepis orangeiensis</i> <i>Muraenolepis microps</i>
Octopodidae	--
Pennatulacea	--
Anthozoa	--
Porifera	--
Bathyracoonidae	<i>Bathyraco antarcticus</i>
Zoarcidae	<i>Melanostigma gelatinosum</i>
Achiropsettidae	<i>Mancopsetta maculata</i>

and spatial distribution of commercially exploited marine species (Close *et al.* 2006), which allowed 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 six species and six 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	Distribution within Bouvet Island EEZ (%)
Nototheniidae	--	0.002	6.82
	<i>Dissostichus eleginoides</i>	287	26.1
	<i>Dissostichus manwsoni</i>	642	N/A
Lithodidae	<i>Lithodes murrayi</i>	0.007	52.7
Nototheniidae	<i>Lepidonotothen squamifrons</i>	0.048	49.3
Moridae	<i>Antimora rostrata</i>	5.85	27.7
Lithodidae	<i>Paralomis</i> spp.	0.004	22.0
Muraenolepididae	<i>Muraenolepis</i> spp.	0.136	7.40
Macrouridae	<i>Macrourus</i> spp.	32.9	34.0
Euphausiidae	<i>Euphausia superba</i>	1334	5.23 ^a
Channichthyidae	--	0.496	1.72
Myctophidae	--	304	26.4

a) based on distribution maps in FAO (2012).

We established an arbitrary and species specific beginning of each longline fishery based on the reported catch data in area 48 and 58. We took into consideration the catch starting year in area 48 and area 58 for each of the 10 longline species. Except for rattails *Macrourus* spp., all species were caught first in area 48 then later in area 58. Those catch data mainly come from South Georgia located within area 48 (west of Bouvet Island) and from the Kerguelen Islands located within area 58 (east of Bouvet Island). We adopted a conservative approach by assuming fishing around Bouvet Island began when countries started reporting catch data from area 58 (Antarctic Indian Ocean) to FAO (Table 3).

Table 3: Assumed start of fishery for each species in areas 48 and 58 based on FAO and CCAMLR databases.

Taxon	Early start	Late start
Nototheniidae	1977 (area 48)	1979 (area 58)
<i>Lithodes murrayi</i>	1982 (area 48)	2001 (area 58)
<i>Lepidonotothen squamifrons</i>	1988 (area 48)	1989 (area 58)
<i>Antimora rostrata</i>	1995 (area 48)	1998 (area 58)
<i>Paralomis</i>	1995 (area 48)	1998 (area 58)
<i>Muraenolepis</i>	2000 (area 48)	2001 (area 58)
<i>Macrourus</i>	1990 (area 58)	1994 (area 48)
Channichthyidae	1979 (area 48)	1991 (area 58)
<i>Dissostichus eleginoides</i>	1977 (area 48)	1977 (area 58)
Antarctic toothfish	1981 (area 48)	1985 (area 58)
Myctophidae (trawl fishery)	1980 (area 48)	1990 (area 58)

Based on the ex-vessel price per species i.e., 2005 real USD·t⁻¹ (Sumaila *et al.* 2007), we assumed the species in CCAMLR sub-area 48.6 with the highest prices, i.e., Patagonian toothfish (*Dissostichus*

eleginoides) and crocodile icefishes (Channichthyidae), were targeted by Norway, Japan and Korea, while the former Soviet Union largely targeted lanternfish (Myctophidae) with pelagic trawlers.

An individual linear interpolation was performed for each of the 10 longline species based on the CCAMLR (2012) official catch reporting system. Reconstructed longline catches are considered to be near zero in the 1980s when longline fishing started in Bouvet Island, as performed by Norway, Japan, Korea and South Africa (Gunnar 1997; Ainley and Blight 2009). However, only in 2001 were all the 10 species covered in this study simultaneously caught from area 48.6 (Table 3).

The unregulated component for the longline and the trawl fishery around Bouvet Island was estimated to be 62% (Sumbly 2012), which we applied to the estimated reported catch. 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 discards component to be around 87% for 7 of the longline species in our study (Boonzaier *et al.* 2012). By-catch including discards are incorporated in CCAMLR official reports by observers. Thus, discards represent 89.7% of the total catch, which means discards represent 8.7 times the retained catch. We applied this rate to the estimated unreported longline catch. Discards associated with Patagonian toothfish and Crocodile icefishes were considered as negligible, as they are considered as target species by the longline fishery within Bouvet Island EEZ.

Antarctic Krill (Euphausia superba)

Krill fishing in area 48.6 started as early as 1973 (CCAMLR 2012), and Atkinson *et al.* (2008) stated that most of the Antarctic krill population is oceanic and 87% of the total krill population lives below a depth of 2000 m. 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.

Results

The longline fleets targeted Patagonian toothfish (*Dissostichus eleginoides*) from 1977 to 2010, Antarctic toothfish (*Dissostichus mawsoni*) from 1985 to 2010, and crocodile icefish (Channichthyidae) from 1991 to 2010. Here, total reconstructed landings were estimated at 560 tonnes compared to reported landings of 314 tonnes. Landings starting at very low levels in 1977, increasing to around 200 t·year⁻¹ by 2010 (Figure 2). Discards were estimated at around 1,860 t between 1977 and 2010. Discards increased from around 1 t·year⁻¹ in 1978 to 660 t·year⁻¹ in 2010 (Figure 2).

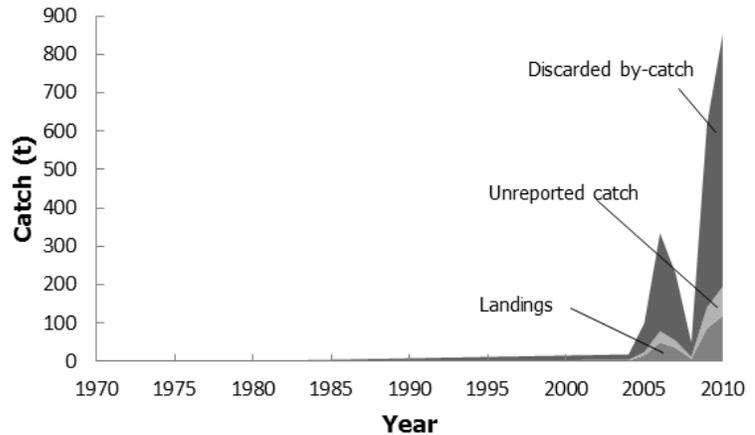


Figure 2. Reconstructed longline catches in the Bouvet Island EEZ by type of catch, 1950-2010.

Thus, reconstructed total catches within the Bouvet Island EEZ accounted for around 2,400 t, which is 2.3 times the total catch reported to CCAMLR for the entire sub-area 48.6 (Figure 3). Taxonomically, catches included 1,500 t of Antarctic toothfish (60%), 700 t of Patagonian toothfish (30%) and other fishes (Figure 4).

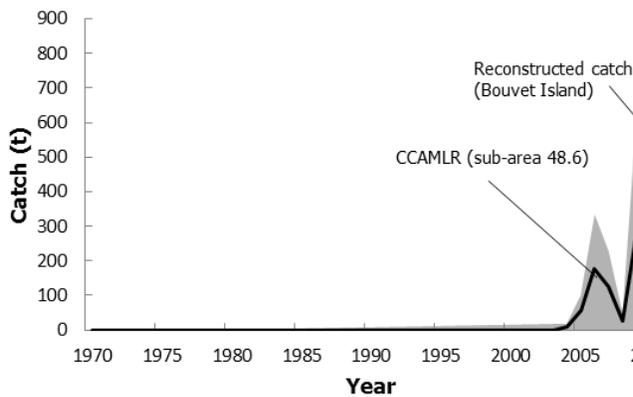


Figure 3. Total reconstructed catches in the Bouvet Island EEZ compared to the official (CCAMLR) reported catch in the entire area 48.6, 1950-2010.

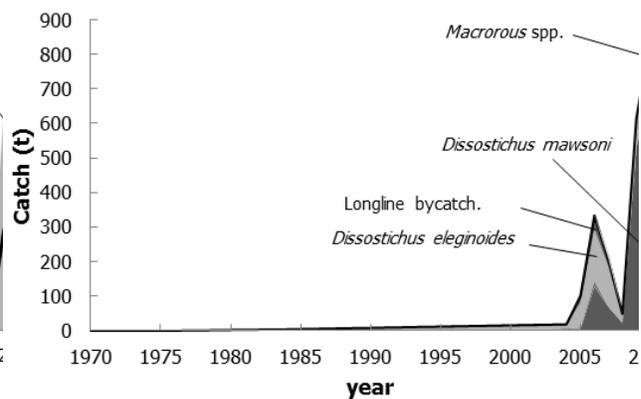


Figure 4. Taxonomic composition of the catch, highlighting the importance of the three major species.

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 increased gradually from 1977 to 2004, after which total catches increased rapidly from 2005 to 2010. Our catch reconstruction estimated a total of 314 t of reported landings for ten species between 1977 and 2010. Unreported catch, which was estimated at around 2,000 t for Bouvet Island from 1977 to 2010, 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 mawsoni* 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 48.6 only. 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 no 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 illustrates 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. The issue of illegal and unreported 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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