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PRELIMINARY ESTIMATES OF TOTAL REMOVALS BY THE NORWEGIAN MARINE FISHERIES, 1950-2010

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ABSTRACT

The present paper estimated Norway's total marine fishery removals within its Exclusive Economic Zone (EEZ), including the waters of the Jan Mayen Island, the Svalbard Archipelago and in distant waters. We accounted for previously unreported portions of catch in commercial fisheries, including their discards, as well as small-scale fisheries such as subsistence and recreational fisheries. Total reconstructed catch in domestic waters averaged 1.29 million t·year^{-1} in the 1950s, peaked at 2.95 million t of catch in 1977 before declining to 1.06 million t in 1990, thereafter rebounding to approximately 1.83 million t·year^{-1} in the 2000s. In total, reconstructed catches were 1.04 times the catch reported by ICES on behalf of Norway (which were deemed to be taken from inside the EEZ waters of Norway, Jan Mayen and Svalbard). Discards accounted for the majority of unreported landings, followed by subsistence catch, unreported commercial landings, and recreational catch.

INTRODUCTION

The Kingdom of Norway is located in the north-east Atlantic and Barents Sea, and consists of the western part of Scandinavia, Jan Mayen Island and the Svalbard Archipelago, as well as several sub-Antarctic islands such as Bouvet Island. Norway has a population of slightly over 5 million people and an Exclusive Economic Zone of over 2 million km^2 (www.seaaroundus.org, Figure 1). While Norway is not a member of the European Union, it maintains close links with the EU and its member countries. The country's economy is heavily driven by resources, dominated by oil and gas, followed by fisheries, forests and minerals.

In the Norwegian marine fisheries (1950-2010) the demersal fleet provides for about 34% and the pelagic fleet for about 66% of the total landings, respectively. There are four main types of gear used by the groundfish vessels in the Norwegian commercial fisheries: trawl (37% of total groundfish landings), gillnet (23%), longline (17%), and Danish seine (11%). There is also an important seasonal and coastal purse seine fishery for young saithe (*Pollachius virens*) (8%) and a jigging fishery (4%) composed of smaller vessels that always deliver their catches to shoreside processing plants. In the pelagic fishery, purse seiners and pelagic trawlers catch about 89% and 10% of the total landings, respectively.

In 1987, Norway introduced a discard ban for most marine fish species which made discarding fish illegal for both Norwegian fishermen (in any fishing zone) and for foreign vessels fishing in the Norwegian Exclusive Economic Zone (EEZ). The main elements of the Norwegian discard policy are the defined minimum mesh size and minimum catch size of fish, the requirement to change fishing grounds if too many undersized fish are caught, the temporary closure of certain fishing grounds (since 1984), bans on discarding commercially important and protected species (since 1987; since 2008 extended to account for nearly all fish species), and the development of selective gear technology in the fishery (since 1992 for deep-water shrimp fishery and since 1997 for the fishery targeting demersal species) (Gullestad *et al.* 2015). Despite the ban on discards, there is still some discarding that occurs. Unfortunately, information on discards is fragmented, incomplete or not available. Norway is currently running a pilot project to better quantify the discarding in several fisheries and to establish cost-effective routines under a management regime where discarding is forbidden.

From 1985-2011, the spawning stocks of the main pelagic species have increased by a factor of 3 from about 6 million t to about 18 million t. Likewise, the spawning stocks of the main commercial demersal species have increased from less than 1 million t to 2.6 million t. Norwegian official landings increased from about 1.5-2.0 million t during 1950-1965 to more than 2.5 million t during 1966-1984 with a peak of 3.4 million t in 1977. For several stocks, such a catch level was not sustainable, and a rapid decline followed until the late 1980s with about 1.5 million t landed in 1990. Strong regulations, monitoring and enforcement turned the negative development around, and the total Norwegian landings have fluctuated since 1992 around 2.5 million $t \cdot year^{-1}$. Major species in the reported data include herring (*Clupea harengus*), capelin (*Mallotus villosus*), Atlantic cod (*Gadus morhua*), saithe (*Pollachius virens*) and mackerel (*Scomber scombrus*).

Since 1940, the number of fishermen has fallen sharply, and since 1970 we have seen a steady decline of more than 500 men per year as shown in Figure 2. Figure 3 shows the number of fishing vessels by length groups. We notice the domination by vessels less than 15 meter and the steady decrease in the number of fishing vessels since the early 1980s.

Key changes in management are summarized by Gullestad *et al.* (2014) who describe the development of the Norwegian framework to prevent overfishing. The reduction in the number of fishermen and vessels has facilitated increased productivity and profitability for those remaining in the industry (Figure 2). Fewer vessels and fishermen have on the other hand reduced the industry's role in the maintenance of rural settlements and employment in coastal communities (Gullestad *et al.* 2014).

The evolution of the Norwegian management framework includes the process to limit access to Norwegian offshore fisheries and later extends this to most of the coastal fisheries. Since 2004, the remaining open access opportunities in coastal fisheries are all small-scale and in many cases regulated by overall TACs, creating small impacts on stocks and investment behavior, and as a result ending subsidies and reducing overcapacity. The national distribution of quotas between fleet groups and between vessels within each group has been quite demanding until 2005 when key distributional issues were settled with durable, long-term solutions. The stakeholder participation in the regulatory process has contributed significantly to the development of fisheries management, and to the industry’s acceptance of regulatory measures. International cooperation in research and management has been instrumental for the development of sustainable fisheries management systems. An appropriate exploitation level according to the precautionary approach, harvest control rules, monitoring, control and surveillance, and finally a more holistic ecosystem approach including integrated ocean management plans are the main pillars in recent fisheries management and development. On January 1st, 2009, the Marine Living Resources Act entered into force. The previous act relating to fisheries focused mainly on the exploitation of commercial stocks, whereas the new act applies to all living marine resources. By integrating conservation and sustainable use as basic principles, the new law represents a regime shift in the management of fisheries.

Norway introduced a discard ban on cod and haddock in 1987, for both economic and ethical reasons. The very existence of the ban has been beneficial in changing the attitudes of fishermen attitudes and discouraging the practice of discarding (Gullestad *et al.* 2015). The discard ban was gradually expanded to new species, and in 2009 an obligation to land all catches was introduced (with certain exemptions). It should be noted that the ban applies to dead or dying fish, viable fish can be released back to the sea. The discard ban was preceded by a program of real time closures of fishing areas (RTCs) which was developed from 1984 onwards.

In Norway, the sale of raw fish shall be undertaken by five geographically separated sales organizations for demersal fish and one for pelagic species, whose statutes have been approved by the Ministry of Fisheries. Under the umbrella of these sales organizations, 344 companies along the coast received fish directly from the fishermen in 2012. Historically, the mandatory first-hand sale was established to protect the small fishing vessel's economic interests and to stabilize markets. Today, the control aspect is the major reason for the maintained support for the system. The sales organizations are responsible for providing accurate catch data, i.e., landings data, for the fisheries statistics. In Norway, this centralized reporting on landings of sea fisheries at the species level started in the 1890s for the main commercial species. Until 1977, the official Norwegian landings statistics only exist on paper in published books.

The fish may be landed as different products, and conversion factors have been established to convert product weight to live weight (round weight) before including the data in the official landings statistics. The accuracy of these conversion factors is continuously considered and adjusted if necessary. As an example, before 1993 the factor for raising headless and gutted fish weight to live weight was 1.6 for cod caught during the Lofoten fishery in the spawning season, and 1.4 for other seasons and areas, while after 1993 a factor of 1.5 has been used on all headless and gutted cod for all areas and seasons. The present reconstruction work has used the historical conversion factors for each time period and area.

The need and reason for reconstructing total catches for Norway from a Norwegian perspective is the awareness that the official landings statistics do not represent the total amount of fish removed from the sea or the total fishing mortality (i.e., Dingsør 2001b; Rejwan *et al.* 2001; Kleiven *et al.* 2011, 2012). Discards by the commercial fleet, although gradually forbidden since 1987, are not quantified, and the recreational and subsistence catches are not included in the official landings statistics. The international time series of Norwegian landings back to 1950, e.g., the FAO and ICES statistics, may not have been corrected if later corrections have been done by the responsible Norwegian authorities. And finally, ICES assessment working groups have, based on additional quality checked information, in some instances adjusted the official statistics.

Attempts to detect and interpret trends in catch data that are not complete and/or contain errors will be both technically and conceptually flawed. Knowing the total removals of fish from the sea is important in order to understand how much the marine ecosystems have been able to provide over time and why variations exist. It tells us something about the yield potential of the marine ecosystems, and it is crucial for stock assessments and ecosystem based management.

In the present report, we contribute to the knowledge base and reconstruction of current and historical total removals by Norway in its Exclusive Economic Zone (EEZ) and in all other areas on the globe where fishing vessels carrying the Norwegian flag are fishing (see Asche and Grønning 2001; Dingsør 2001b; Rejwan *et al.* 2001; Stiansen *et al.* 2009) by estimating the unreported catch based on the best available scientific current and historical data. We broadly follow the 'catch reconstruction' approach of

Zeller *et al.* (2007).We also identify other shortcomings and uncertainties that need to be removed in order to fully reconstruct the historical total removals by Norwegian fisheries in the sixty years from 1950 until 2010.

METHODS

In some cases the different available data sources, i.e., FAO, ICES and national official statistics, show different catch statistics. A general procedure in re-constructing the Norwegian catch statistics has then been to give priority first to the catch figures used by the ICES stock assessment working groups, second to the Norwegian official statistics, and third to the ICES officially statistics that exist electronically back to 1950.

Large- versus small-scale fisheries

According to official statistics, the Norwegian commercial fishing fleet consisted of 6,309 vessels in 2010. Thereof, 5,680 vessels are less than 15 m in length, 378 vessels are between 15-27 m, and 251 vessels are above 28 m. Vessels less than 15 m are less mobile and they conduct small-scale and more coastal fisheries. They have also restrictions on their area of operation due to safety regulations, and they are regulated as a group different from the larger offshore fleet in the national fisheries regulations. In the current re-construction, we have thus treated the vessels less than 15 m as the most practical proxy for the Norwegian small-scale vessel group.

Pelagic fisheries

In the pelagic fishery for herring, mackerel, capelin, blue whiting, horse mackerel and sprat, purse seiners and pelagic trawlers catch about 89% and 10% of the total landings, respectively. In these fisheries, we faced three main challenges when re-constructing the landings: discards of fish brought on deck, slipping of catch before it is brought on deck, and varying practices in subtracting the weight of water in the landings. The factors used to re-construct the official landing statistic are shown in Table (1).

Discards
Before the introduction of individual quotas and when most of the pelagic catches were used for fishmeal (feed) and fish oil production, there were few if any incentives for discarding. Adjustments for discards have therefore only been done once the fraction used for direct human consumption exceeded 50%. This happened for mackerel in 1980, for herring during 1977-1983, for horse mackerel since 1996, and for blue whiting since 1999. For capelin and sprat the share for direct human consumption has been minor, and hence no estimate of discard has been added for these species. Discarding of herring and mackerel has been taken from Napier *et al.* (2002) and EU (2005), i.e., 1% for herring and mackerel in the North Sea (ICES Subarea IV) according to data from 2000-2002.

Slipping
Since there are no data of slipping of catches we have set slipping to be twice the amount of discarding, i.e., 2%. There are currently no data on the amount of slipping, but recently a PhD thesis was written about this subject at the University of Bergen (Tenningen 2014). In the mackerel and herring purse seine fisheries it happens that part of the catch is slipped if the catch is too big. Sometimes also the entire catch is slipped/discarded if the fish has poor quality, is small in size or happens to be a wrong species. In Norway, it is illegal to slip dead or dying fish, but until recently no evidence has existed on whether the fish released should be considered "dead or dying". In former years (1950-1976), slipping of mackerel was a problem when the North Sea (ICES Subarea IV) fishery was at its peak. It mainly happened when a vessel wanted to

add only a few more tonnes to the cargo to fill the vessel 100% before going ashore. The rest of the catch was slipped. During these years, the mackerel was used for fishmeal, fish oil and bait. We have no documentation of the amount slipped, but we have stipulated the slipped amount during 1950-1970 to be about 10%. Probably the same for herring, and the slipped amount has been set to 10% for the years 1950-1967. In the beginning of the blue whiting fishery (1972-1977), and before modern catch sensors were used, it happened that the nets ripped due to too excessively large catches. The blue whiting fishery has been unregulated until relatively recently, and hence had no incentives for slipping or discarding for high grading. Discard/slipping of blue whiting has hence been set to 10% during 1972-1977.

Water fraction
Subtraction of water in landed catches of pelagic fish (pumped ashore with water or landed in containers filled with water-slush) has been done in Norway since 1997. The industry claim that landing of pelagic fish contains water that they don’t want to pay for, and since 1997 the total landed weight has been reduced by an agreed factor to address this. Also before 1997, water was likely included in catch weight, and the reported landings of the actual fish species may therefore be too high since the figures include some water (but lesser and lesser the further back in history one goes due to different catch and transport procedures). The factor used since 1997 has also varied, with 2003 as a special case, before the most realistic factor has been used as a fixed factor in recent years. In our data, we have multiplied landings data with the factor used each year to get a total catch-in-container estimates (i.e., incl. water), and hence comparable with the years before 1997, and with countries not subtracting for water content. From a biological point of view, however, the most accurate estimate of the landings would, however, be to first multiply with the year specific factor used to get the total weight including water, and then to subtract the most likely amount of water (1-2%).

Demersal fisheries

Discards
Norway introduced a discard ban on cod and haddock in 1987, for both economic and ethical reasons. The discard ban was gradually expanded to new species, and from 2009 an obligation to land all catches was introduced (with certain exemptions). It should be noted that the ban applies to dead or dying fish, viable fish can be released back to the sea. The discard ban was preceded by a program of real time closures of fishing areas (RTCs) which was developed from 1984 on.

Unfortunately no routines have been established to estimate the amount of discards before and after the introduction of the discard ban, but some work and projects have been conducted for some species and fisheries to estimate the most likely amount (Dingsør 2001a, 2001b; Humborstad *et al.* 2003; Valdemarsen and Nakken 2003; Ajiad *et al.* 2007; Fossen 2010; 2012, and several working documents from ICES fish stock assessment working groups).

Valdemarsen and Nakken (2003) report 1-10% discards in different fisheries, usually in the 1-5% range, dependent on gear, quota, year-class strength and market. For the present catch reconstruction, we have added 2% annually to the official statistics for the commercial demersal species as a minimum estimate of discards. If other sources of information existed, we increased the discard rate only if we had reason to believe that these discards were not included in the abovementioned 2% rate.

Recreational fisheries

The kinds of recreational and subsistence fisheries in Norway is illustrated in Figure 4. In the present paper, the recreational catches presented by Norway represent the catches taken by foreign tourists and native Norwegians renting rooms and boats at registered tourist fishing companies. Catches taken by native Norwegians fishing for their households (right hand component in Figure 4) are included in the subsistence catches.

Two main anchor points exist for recreational catches in Norway, i.e., Hallenstvedt and Wulff (2001) and Vølstad *et al.* (2011). Hallenstvedt and Wulff (2001) base their estimation on official Norwegian statistics about foreign tourists and their activities in Norway, web-based information from tourist companies and travel agencies and questionnaires among the tourists. The total catch by foreign fishing tourists is estimated to lie between 12,000 and 15,000 tonnes, with an average of 13,400 tonnes. This estimate is not assigned to fish species, but it calculates the ratio between the amount fished by registered tourist fishing companies and the total amount fished by tourists to be about 0.5 in ICES Subareas I/II, and 0.2 in ICES Subareas III/IV. Hallenstvedt and Wulff (2001) do not include Norwegian tourists in Norway, but they provide a time profile on the development of tourist fishing in Norway. Vølstad *et al.* (2011) used a probability-based survey to estimate annual catch and effort of boats used by anglers associated with 445 tourist-fishing businesses during 2009. The present Norwegian re-construction of recreational catches uses the estimates by Vølstad *et al.* (2011) as an anchor point for 2009, multiplies it by a factor of 2 and 5 for ICES Subareas I and II, and Subareas III and IV, respectively, to account for the other tourist fishing segments, and finally uses the time profile suggested by Hallenstvedt and Wulff (2001) to account for the development of tourist fishing in Norway. The same procedure has been used for estimating pelagic recreational catches.

Subsistence fisheries

Currently, the only survey of marine household fishing by Norwegian households (i.e., subsistence) was conducted in 2003 by Hallenstvedt and Wulff (2004). A representative sample of the Norwegian population over 15 years of age were interviewed and asked to give catch per trip and total annual catch by species. In this survey, 43 percent reported that they had fished in the sea last year, or about 1.5 million people nation-wide.

Data from Hallenstvedt and Wulff (2004) show that the Norwegian population caught approximately 48,000 tonnes in 2003 for personal-, family- and household-consumption. The eastern, western and central Norway regions each caught approximately 10,000 tonnes, summing to 30,000 tonnes in total, while in northern Norway the catch was estimated at 18,000 tonnes. The catch re-construction back to 1950 has used the results from this study in 2003 as an anchor point, and extrapolated backwards and forward in time taking into account the growth of the Norwegian population and assumptions about the percentage of the population fishing in the sea. This has been done for both demersal and pelagic species. For coastal sprat, the unreported household catch is only conducted by professional fishermen that set aside a small and unreported quantity for their household and/or for bait in other fisheries. Based on interviews with experienced sprat fishermen and a known number of fishermen conducting this fishery, a subsistence catch of coastal sprat has been estimated.

Note that any catches delivered to sales organizations by native Norwegian that are not registered to commercial fishermen are included in the officially reported and re-constructed landings statistics of the commercial fishery.

RESULTS AND DISCUSSION

Total reconstructed catch within domestic waters (EEZ waters of Norway, Jan Mayen and Svalbard) averaged 1.29 million t·year^{-1} in the 1950s, peaked to 2.95 million t of catch in 1977 before declining to 1.06 million t in 1990, thereafter rebounding to approximately 1.83 million t·year^{-1} in the 2000s (Figure 5a). In total, reconstructed catches were 1.04 times the catch reported by ICES on behalf of Norway (and deemed to be taken within domestic waters). Discards accounted for the majority of unreported landings, followed by subsistence catch, unreported commercial landings, and recreational catch. It should be noted that catches taken within Jan Mayen and Svalbard waters are separated in the database, as these islands have their own EEZs, and therefore the data can be viewed separately.

The amount of unreported catch was higher in the earlier time period, averaging 8% of reported catch in the 1950s and 1960s, and lower in the later time period, approximately 4% in the 1990s and 2000s. The catch in the small-scale subsistence and recreational fisheries is not visible in Figure 5a. Catch in subsistence fisheries gradually increased from approximately 40,000 t in 1950 to a peak of almost 60,000 t in 1992, thereafter declining to about 40,000 t by 2010. Recreational fisheries were substantially smaller with minimal catch in the early time period and growth beginning in the late 1990s as a result of the increase in tourism, with catch eventually reaching 10,000 t by 2010.

Catch by Norway within domestic waters was dominated by Atlantic herring (*Clupea harengus*) which accounted for 23% of catch, capelin (*Mallotus villosus*) accounting for 21% of catch, Atlantic cod (*Gadus morhua*) for 17%, saithe (*Pollachius virens*) for 9%, Atlantic mackerel (*Scomber scombrus*) for 8%, sand lances (*Ammodytes* spp.) for 4%, and haddock (*Melanogrammus aeglefinus*) for 3%, the remaining 15% of catch divided amongst 15 other species and a miscellaneous group represented as 'Others' (Figure 5b).

Within the domestic fishery, the declining trend in effort during the 1990s and 2000s (Figure 2) paired with a simultaneous growth in catch (Figure 5), may indicate a relatively healthy fisheries sector. The shift in the Norwegian management framework to reduce effort while simultaneously investing in legislature to protect the sustainability of the fisheries, i.e., the Marine Living Resources Act, illustrates a prudent shift towards reversing the worldwide trend of overcapacity in fisheries and subsequent overexploitation (Pauly *et al.* 2002). We hope that the efforts of the present paper will further continue this positive trend toward proper fisheries management. Valid catch statistics are vital for accurate stock assessments, setting of the TAC, as well as ensuring proper legislature for commercial and small-scale fisheries alike.

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Table 1. The fractions used to estimate discards, slipping and water content (in landings). Example: with a water fraction of 4% (0.04 in table), the official landing statistics have been multiplied by 1/0.96 = 1.0417.

Time period	Mackerel			**Horse mackerel**			**Herring**			**Blue whiting**	
	Discard	*Slipping*	*Water fraction*	*Discard*	*Slipping*	*Water fraction*	*Discard*	*Slipping*	*Water fraction*	*Slipping*	*Water fraction*
1950-1964	0	0	0	0	0	0	0	0.1	0	0	0
1965	0	0	0	0	0	0	0	0.1	0	0	0
1966	0	0.1	0	0	0	0	0	0.1	0	0	0
1967	0	0.1	0	0	0	0	0	0.1	0	0	0
1968	0	0.1	0	0	0	0	0	0	0	0	0
1969	0	0.1	0	0	0	0	0	0	0	0	0
1970	0	0.1	0	0	0	0	0	0	0	0	0
1971	0	0	0	0	0	0	0	0	0	0	0
1972	0	0	0	0	0	0	0	0	0	0.1	0
1973	0	0	0	0	0	0	0	0	0	0.1	0
1974	0	0	0	0	0	0	0	0	0	0.1	0
1975	0	0	0	0	0	0	0	0	0	0.1	0
1976	0	0	0	0	0	0	0	0	0	0.1	0
1977	0	0	0	0	0	0	0.01	0.02	0	0	0
1978	0	0	0	0	0	0	0.01	0.02	0	0	0
1979	0	0	0	0	0	0	0.01	0.02	0	0	0
1980	0.01	0.02	0	0	0	0	0.01	0.02	0	0	0
1981	0.01	0.02	0	0	0	0	0.01	0.02	0	0	0
1982	0.01	0.02	0	0	0	0	0.01	0.02	0	0	0
1983	0.01	0.02	0	0	0	0	0.01	0.02	0	0	0
1984	0.01	0.02	0	0	0	0	0	0	0	0	0
1985	0.01	0.02	0	0	0	0	0	0	0	0	0
1986	0.01	0.02	0	0	0	0	0	0	0	0	0
1987	0.01	0.02	0	0	0	0	0.01	0.02	0	0	0
1988	0.01	0.02	0	0	0	0	0.01	0.02	0	0	0
1989	0.01	0.02	0	0	0	0	0.01	0.02	0	0	0
1990	0.01	0.02	0	0	0	0	0.01	0.02	0	0	0
1991	0.01	0.02	0	0	0	0	0.01	0.02	0	0	0
1992	0.01	0.02	0	0	0	0	0.01	0.02	0	0	0
1993	0.01	0.02	0	0	0	0	0.01	0.02	0	0	0
1994	0.01	0.02	0	0	0	0	0.01	0.02	0	0	0
1995	0.01	0.02	0	0	0	0	0.01	0.02	0	0	0
1996	0.01	0.02	0	0.01	0.02	0	0.01	0.02	0	0	0
1997	0.01	0.02	0.04	0.01	0.02	0.04	0.01	0.02	0.04	0	0
1998	0.01	0.02	0.04	0.01	0.02	0.04	0.01	0.02	0.04	0	0
1999	0.01	0.02	0.04	0.01	0.02	0.04	0.01	0.02	0.04	0	0.04
2000	0.01	0.02	0.04	0.01	0.02	0.04	0.01	0.02	0.04	0	0.04
2001	0.01	0.02	0.04	0.01	0.02	0.04	0.01	0.02	0.04	0	0.04
2002	0.01	0.02	0.04	0.01	0.02	0.04	0.01	0.02	0.04	0	0.04
2003	0.01	0.02	0.08	0.01	0.02	0.04	0.01	0.02	0.13	0	0.04
2004	0.01	0.02	0.02	0.01	0.02	0.04	0.01	0.02	0.02	0	0.04
2005	0.01	0.02	0.02	0.01	0.02	0.02	0.01	0.02	0.02	0	0.02
2006	0.01	0.02	0.02	0.01	0.02	0.02	0.01	0.02	0.02	0	0.02
2007	0.01	0.02	0.02	0.01	0.02	0.02	0.01	0.02	0.02	0	0.02
2008	0.01	0.02	0.02	0.01	0.02	0.02	0.01	0.02	0.02	0	0.02
2009	0.01	0.02	0.02	0.01	0.02	0.02	0.01	0.02	0.02	0	0.02
2010	0.01	0.02	0.02	0.01	0.02	0.02	0.01	0.02	0.02	0	0.02

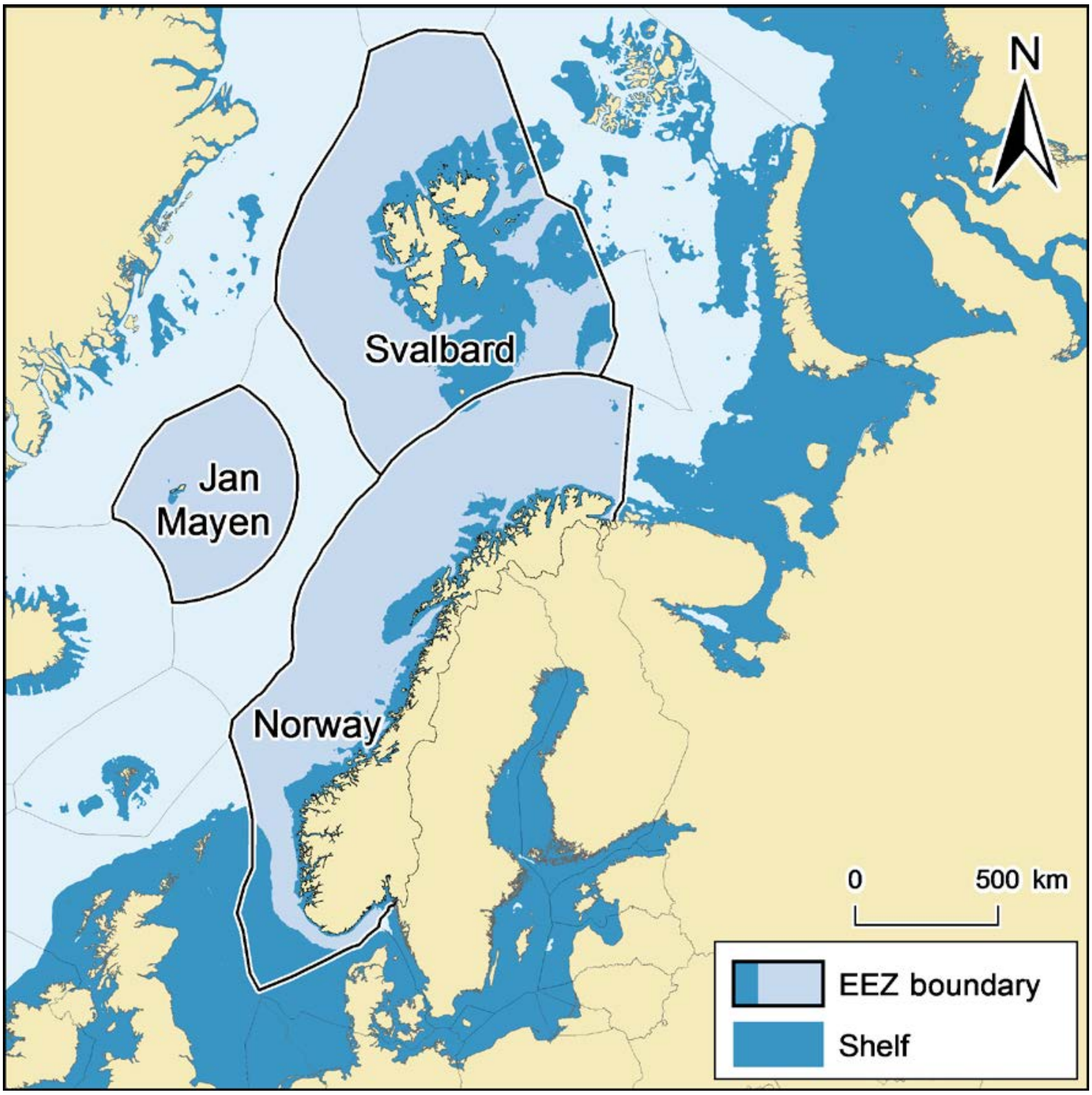


Figure 1: Exclusive Economic Zone (EEZ) and shelf area (to 200 m depth) for Norway, Jan Mayan and Svalbard.

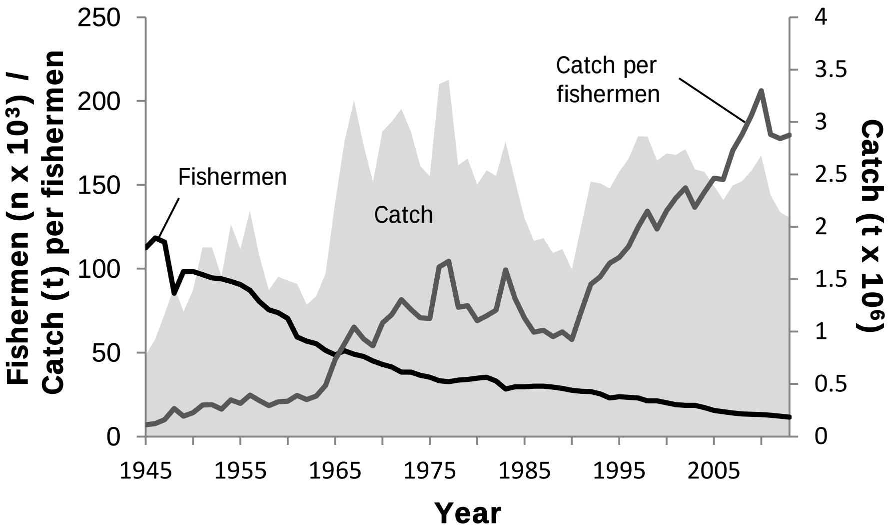


Figure 2. Norwegian reported landings (before reconstruction), number of fishermen and CPUE (catch per fisherman) for 1945 – 2013.

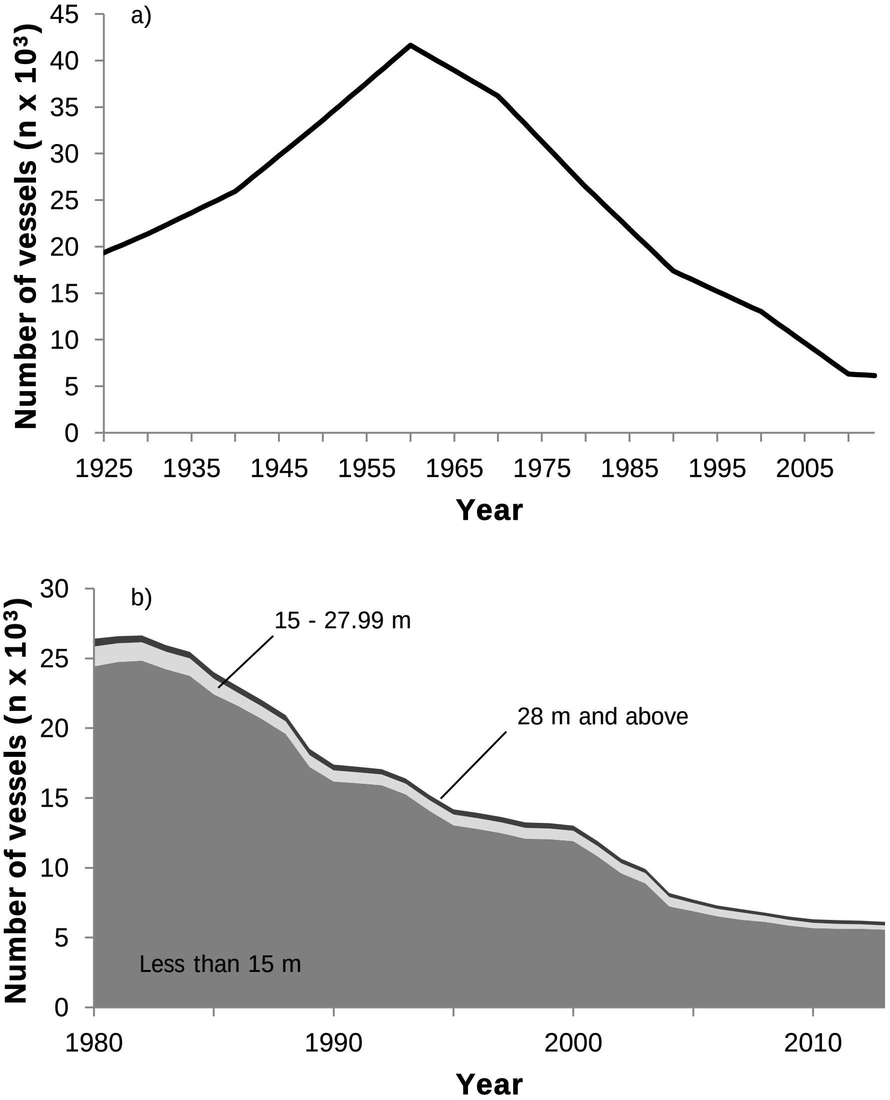


Figure 3. Number of Norwegian fishing vessels by a) total number for 1925-2013; and b) number of vessels by length groups 1980-2013.

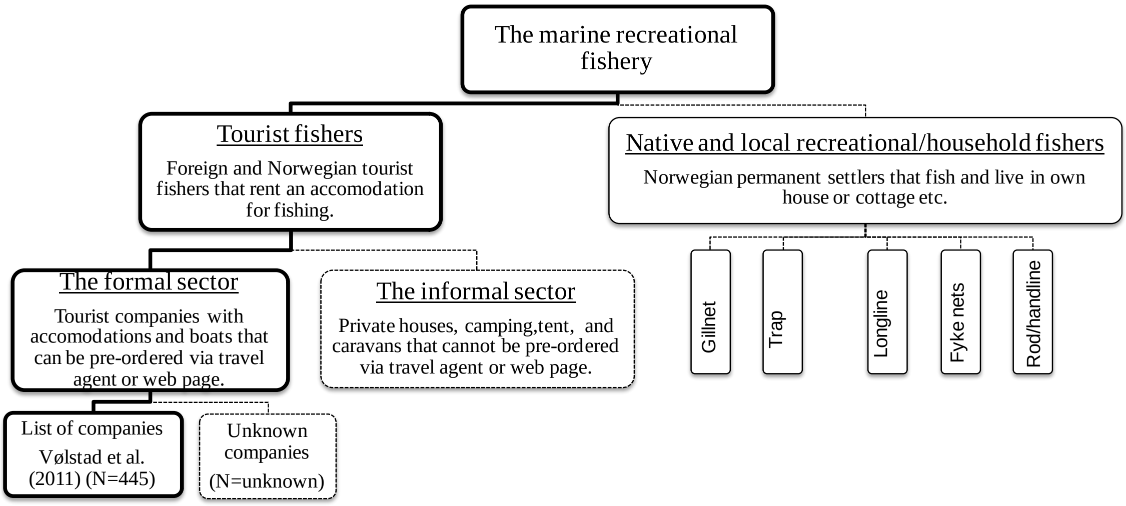
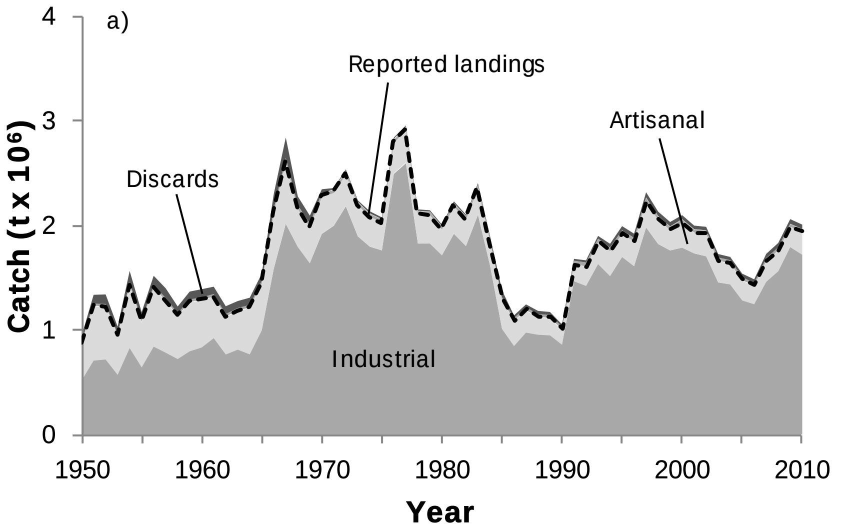


Figure 4. Diagram of marine recreational-fishery sectors in Norway based on the accommodation and resident status of recreational fishers. The study population is shown emboldened. In the present work, the recreational fishery is defined equal to the tourist fisher sector in the figure. The right-hand section of this figure ("Native and local recreational/household fishers") was treated as 'subsistence' fishing.



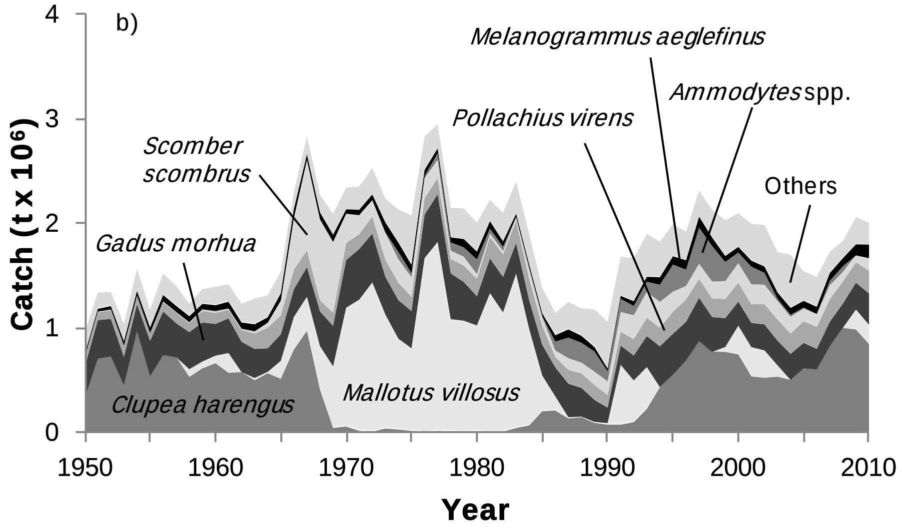


Figure 5. Norway's total reconstructed catch within its Exclusive Economic Zone (EEZ), as well as the EEZs of Svalbard and Jan Mayen, 1950-2010, a) by sector and b) by species, with 'others' composed of 15 other taxonomic groups. The catch of small-scale subsistence and recreational fisheries is not visible in Figure 5a due to its small proportion relative to total catch.

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