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Abstract

As global fisheries continue to be overfished, ecosystem-based approaches to fisheries management are increasingly necessary for sustainable fisheries, although to date there has been little implementation of the concept. Understanding of the various impacts of fishing is necessary to move towards such management and a key component of these impacts is fish mortality. However, accurate understanding of mortality effects is undermined by several components of fish catches being unreported; such as discards, illegal, and unregulated catches. This study attempts to reconstruct the fish catches from the west coast of Sweden between 1950 and 2010, including illegal, unreported, and unregulated catches (IUU). Reconstructed total catches in the North Sea were 16% larger than reported by ICES. Within Sweden's EEZ on the west coast, reconstructed catches were 29% larger than those reported by ICES. The reconstructed total catch was mostly from the industrial sector, which contributed 69% of the total catch. Artisanal, subsistence, and recreational catches contributed 19%, 6% and 5%, respectively. Herring made up more than half of the catch (53%) within the EEZ, whilst cod (9%), sprat (7%), and Atlantic mackerel (5.5%) also were important. Reconstructed catches outside the EEZ were 13% larger than reported by ICES and made up almost 81% of the total reconstructed catch. Most of the disparity was caused by unreported catches from industrial fisheries. In keeping with global trends, the Swedish fishery experienced significant decline over the time period, largely due to overfishing and a reduction of herring availability, but also in part as a result of neighboring countries introducing EEZs and reducing available fishing grounds.

Introduction

Marine fisheries worldwide create employment opportunities for many people and fish is an important food source. However, fisheries have a substantial impact on the marine ecosystems and many fish stocks are overexploited (Botsford *et al.* 1997; Pauly *et al.* 1998). In the light of a large and still growing global population and the associated increased demand for protein, the state of marine fisheries and ecosystems becomes an even more serious concern. Ecosystem-based management approaches have been proposed to prevent further depletion of the marine resources (Pikitch *et al.* 2004), but despite broad acceptance of the concept, there has been little implementation in the management of marine fisheries (Mora *et al.* 2009).

In order to move towards ecosystem-based management and sustainable fisheries, we need to improve our understanding of the effects of fishing on the ecosystem. Fisheries have both direct effects trough removal of biomass, but also indirect effects such as degraded habitat, altered food webs etc. (Botsford *et al.* 1997). To improve our understanding of the effects of fishing on marine ecosystems, one key component is the mortality caused by fishing. In addition to reported commercial catches, total mortality includes several other components, including illegal, unreported, and unregulated catches (IUU; Bray 2000) and discards. Generally most of these IUU components are not accounted for and have contributed to the difficulties of understanding fisheries impacts on marine ecosystems (Zeller *et al.* 2011).

Figure 1. Map of west coast of Sweden, with Exclusive Economic Zone (EEZ).

The Swedish west coast (Figure 1) is the most productive of the Swedish coastal waters (Fiskeriverket 2011) and has a long fishing tradition (Hasslöf 1949). This is due to favorable oceanic and coastal conditions in the vicinity of the Atlantic, compared to the less productive Baltic Sea where the salinity is lower (Fiskeriverket 2011). This has also been reflected in catches. At the end of the 1940s, the catch of fishers on the west coast made up around 65% of the total catch in Swedish marine fisheries (Andersson 1954), and in 1960, 75% of the catch was from the west coast (Anon. 1962). During the 1970s, many countries declared EEZs, and Swedish fishers lost access to many previously used fishing grounds in the North Sea and the Atlantic. A large part of the fleet re-directed their effort towards the Baltic Sea (Anon. 2005b). However, also agreements were negotiated with Norway so that fishing in the North Sea could remain to some extent (Yergey *et al.* 2012).

Sweden has a long tradition of collecting fisheries data and annual statistics of Swedish commercial fisheries are available from 1913 (Lundgren 2007). Incomplete accounting of total catches (i.e., including IUU and discards) is not only a problem in developing countries (Zeller *et al.* 2007) but also in developed countries (Zeller *et al.* 2008), and despite extensive data collection system being in place in Sweden, information on IUU components are largely lacking. In 2009, the IUU components were estimated for Swedish fishing in the Baltic Sea, and Baltic Sea catches from 1950-2007 were reconstructed (Persson 2010), using the basic catch reconstruction approach described in Zeller *et al.* (2007). In the present study, catches from the Swedish west coast have been reconstructed with the aim to improve understanding of fisheries impact, and highlight the importance of often unaccounted catch components.

The estimation of historical data is often uncertain, especially for times before stock assessments were initiated (Eero 2012), and data uncertainties exist. However, if we want to get a better understanding of the total mortality caused by fishing, we need to estimate all of the various components. The alternative is the default application of ‘zero catch’ for cases where traditional fisheries science defaults with ‘no data’. Clearly, this would be less ‘accurate’ for components that are known to contribute to mortality. To avoid overestimating, I used a conservative approach during the reconstruction of the catches on the Swedish west coast. All components of the catch had to be estimated from 1950 to 2010, and this was done by combining all available information into anchor points and interpolate between them.

Methods

Reported landings data

It was not possible to extract only the Swedish west coast catches from the FAO data for area 27. Therefore International Council for the Exploration of the Sea’s (ICES) catch statistics database was used (ICES 2011). All catches from the North Sea (everything except ICES areas III b-d) were considered here with unreported and discard proportions applied to all areas. ICES area IIIa contains Sweden’s North Sea EEZ area. The proportional area that Sweden’s EEZ waters occupy within area IIIa (23.45%) was used to split the industrial area IIIa catches into EEZ and non-EEZ catches. For most years and species, the data matched the Swedish official data (e.g. Anon. 1952). However, from the mid-1960s until the middle of the 1970s there were substantial differences between the nationally reported data and ICES catch statistics, especially for herring (*Clupea harengus*). Cross referencing was undertaken, but the reason for the mismatch could not be identified. It was decided that the ICES data would be used as the default baseline, since ICES may have additional information which was not publicly available.

In the Baltic Sea catch reconstruction (Persson 2010), data on herring and sprat (*Sprattus sprattus*) catches were taken from ICES working group reports, since those data were corrected for misreporting of catch area and species ratio. Unfortunately, it was not possible to use similar information to correct the west coast catches since the different types of corrections were not quantified, and ICES catch statistics were used unchanged.

Industrial vs artisanal

Artisanal fishers catch 3% of the total marine catches in Sweden (Fiskeriverket 2010). On the west coast, the artisanal fishers make up a smaller part of the commercial fisheries compared to the fisheries in the Baltic Sea. In the end of the 1970s the artisanal part of the catch was about 6 % of the total reported catches on the west coast (SOU 1978), while it was thought to have been larger in earlier years (Anon. 1962). Therefore, 10% was used as an anchor point in 1950. In 2010, the industrial catches (i.e., defined as all catches from trawl- and seine fisheries) made up almost 98% of the total reported catches on the west coast (fisheries statistics available at The Swedish Agency for Marine and Water Management at https://www.havochvatten.se/en/start.html accessed March 17, 2013), hence the artisanal component was around 2% in 2010. Interpolation was done between the 1950 and 2010 anchor point and this time series of proportions was applied to the area IIIa data. All artisanal catches are taken from within the EEZ and the industrial catches were assumed to be taken in proportion to the area of EEZ versus non-EEZ waters. All catches taken outside of area IIIa are labeled industrial.

Unreported catches

No published information on unreported commercial landings for the 1950-1990 period was found. Therefore, data points were created in 1950 and 1980 based on conservative assumptions: in 1950 there were no quota limitations

(Eero *et al.* 2007) and therefore fewer incentives to under-report catches, but also less enforcement to report catches (Anonymous source, Swedish Board of Fisheries). Therefore, a rate of 5% (of reported landings) was used as a default assumption for under-reporting of all species in 1950. During the 1970s, the quota system was introduced (Søndergaard 2007), and I used 1980 as a breakpoint to reflect the tendency for more unreported catches after the introduction of quotas. The anchor point for the percentage of unreported catches by species for 1980 was derived as half the rate of unreported catches per species identified for a more recent date as described below.

Cod (*Gadus morhua*)

The unreported Swedish catches of cod in the Baltic Sea were estimated as 13.1% in 2006 (Persson 2010). Due to lack of specific information regarding unreported catches on the west coast, we assume that the pattern of under-reporting is similar for all Swedish cod fishers and used 13.1% as an anchor point in 2006. The anchor point for 2006 was based on the average of three different estimates spanning from 2003 to 2008. In 2003, the unreported catches of cod were at least 10% (Fiskeriverket 2004), in 2005 and 2006 it was 21.4% (Anon. 2007b), and in 2008 there were indications that it was at least 8% (Fiskeriverket 2008). Unreported catches are believed to have decreased since 2006 (K.E. Karlsson, pers. comm, Foreign Department of Swedish Tax Agency; J. Löwenadler Davidsson, pers. comm., Swedish Board of Fisheries; B. Sjöstrand, pers. comm., Swedish Board of Fisheries) and therefore 10% was applied in 2010. Before 2004, the unreported catches were thought to have been larger (Fiskeriverket 2004) and therefore 20% was applied in 1990. In the Baltic Sea, the unreported catches of cod in 1987 were estimated at 31% (Persson 2010), hence the presently used 20% for the west coast is thought to be a conservative estimate based on the assumption that Swedish fishers show similar behavior. For 1980, half of the 1990 rate of 20% was used as an anchor point (i.e., 10%) and interpolation completed the time series.

Herring and Sprat

When herring and sprat are landed on the Swedish west coast, fishers are allowed to subtract 2% of the weight of the catch as representing water (Fiskeriverket 2004). This is called the 'water adjustment factor' and was 20% in 1993 under the assumption that the fish bodies absorbed a lot of water when stored onboard. Research showed that the amount of water that the fish body actually absorbed was far from 20%. Therefore, the 'water adjustment factor' has been reduced to 13% in 2003 and to 2% in 2004 (Fiskeriverket 2004). The difference between the 'water adjustment factor' and the actual amount of water absorbed by the fish bodies has allowed for legal underreporting of catches. In a document from the Swedish Board of Fisheries on unreported catches (Fiskeriverket 2004), up to 50% of underreporting in the pelagic fisheries is acknowledged. I used 25% as an anchor point in 1993 which included the legal under-reporting (18%) due to the technical malfeasances of the 'water adjustment factor'. In 2003, the 'water adjustment factor' was decreased to 13% hence we decreased the unreported catch anchor point to 16% accordingly, in the same way the anchor point in 2004 was set to 7% when the difference in 'water adjustment factor' was taken away. Since the unreported catches are thought to have declined even further since then, 5% was applied in 2010. The earliest anchor point of 25% in 1993 was halved to 12.5% and used as an anchor point in 1980. Interpolation was done to complete the time series.

Other species

Cod, herring, and sprat are profitable species and therefore thought to have a larger fraction of unreported landings (Hultkrantz 1997). Since details for unreported catches of other taxa were not found, an assumption based fraction was derived as follows. The average of the first anchor points for the profitable species (20% for cod, and 25% for herring and sprat, average = 23.3 %) was halved (i.e., 11.7%) and used as anchor point in 1990 for other species. This rate was further halved, and 5.8% was applied as 1980 and 2010 anchor points.

Misreported catches

In 2005, 100 t of cod were found to have been reported as pollock (*Theragra chalcogramma*) (Sveriges Radio 2006). This was corrected in the dataset used here. Catches of common dab (*Limanda limanda*) 1956-1959 were thought to have been catches of European flounder (*Platichthys flesus*) since flounder catches for those years were missing and the magnitude of the catches were more in line with the reported flounder catches for the 1950s and 1960s.

Discards

Due to lack of local data on discarding by Swedish fishers for many species, the discard rates from a 2004 Danish study (Anon. 2006) were used. Swedish survey data on discards were used for cod (Anon. 2007a). Herring and sprat were treated differently, as they are caught in pelagic fisheries regarded as fairly 'clean' with not much discards (Anon. 2009). Herring and sprat suffer from under-water discards (Rahikainen *et al.* 2004), which is a type of discard not considered here.[1] Therefore, herring and sprat have a discard rate of zero.

[1] Note that under-water discards and ghost fishing were calculated by the author but were not utilized by *Sea Around Us* as part of their global database. Most countries' reconstructed catch data do not include estimates of under-water discards and ghost fishing, hence for the sake of consistency they were not utilized by the project.

Cod discards

Based on discard data from the Baltic Sea (Anon. 2007a), the discard rates in trawl and gillnet fisheries between 1999 and 2006 were calculated by Persson (2010). The discard rate in the gillnet fishery was 1.85%, and the discard rate in the trawl fishery ranged between 4.7-21%. The different gear specific discard rates were applied to parts of the catch caught by the respective gear. Information on gear specific catch was found in the national Swedish statistics – electronically for later years and printed versions for 1990 and 1980 (www.havochvatten.se, accessed October 2012). The gear ratio in 1980 was carried back to 1950 unchanged since the demersal fishing patterns are thought to have been similar throughout the 20th century (Cardinale *et al.* 2010). To complete the time series, the average discard percentage of the three last years' data was carried forward to 2010.

Flat fishes

Discard rates for common dab (33.4%), European flounder (48.0%), and plaice (*Pleuronectes platessa*; 34.0%) were found in the Danish study from 2004 (Anon. 2006), and the average of the three (38%) was used as discard rate for other flatfish species. Interpolation was used to complete the time series.

Other species

Other species had a discard rate of 6.4% in 2004 (Anon. 2006) and that was used for the entire time series 1950 – 2010. This was thought to be a conservative estimate in an ecosystem perspective since many species without commercial value regularly are discarded by fishers (Fiskeriverket 2003).

Ghost fishing

Ghost fishing is when lost fishing gear, often made up of non-biodegradable material, continue to catch fish after they have been lost or discarded (Brown and Macfadyen 2007). Fish caught this way were calculated by the author but were not considered here.[1]

Non-commercial fisheries

Swedish national studies from 1977 (SOU 1977), 1995 (Nilsson 1996), 2000 (Norström *et al.* 2000), 2005 (Anon. 2005a), and 2007 (Anon. 2007c), were used to derive anchor points for recreational catches. The studies were not equally reliable due to variations in study- and analytical methods. The 1977 study (SOU 1977) was deemed to be reliable due to a large sample size, and the values were used without adjustments. The study from 2007 (Anon. 2007c) was also deemed reliable due to analyze and study method and values were used without adjustments. The studies from 1995 (Nilsson 1996), 2000 (Norström *et al.* 2000), and 2005 (Anon. 2005a) were adjusted for overestimation and also split into different catch areas (see Persson 2010), based on the ratio in the 2007 study (Anon. 2007c). Swedish population data from Statistics Sweden (available at www.scb.se, accessed October 2012) and a calculated catch rate were used to extrapolate the non-commercial catch to 2010.

Information about recreational cod catches of the same magnitude as the coastal fisheries (minus trawl catches) was found in Phil and Ulmstrand (1988). Between 1980 and 1986, this information replaced the interpolated recreational cod catches.

Recreational/subsistence fisheries data

To separate subsistence and recreational catches the ratio of handheld gear and other gear types was used. Recreational fishing was defined as fishing carried out with handheld gear with relaxation and pleasure as the main driver, while subsistence fishing was defined as fishing with other types of gear and self- or family-consumption as the main driver rather than pleasure only. Some fishers use both handheld and other types of gear, and some subsistence fishing is carried out with handheld gear, but this method for separating catches was assumed to be the best given the information available. For 1975, the ratio was about 40% recreational and 60% subsistence (SOU 1978). In 2006, it was about 70% recreational and 30% subsistence fishing (Thörnqvist 2009). As the recreational part of the catches has been increasing over time (SOU 1978; Thörnqvist 2009), 30% recreational and 70% subsistence catches were therefore assumed as anchor points for 1950. It should be noted that 85% of the catch in both recreational and subsistence fisheries was used for home consumption (Thörnqvist 2009).

Results

Within the EEZ

The reconstructed total catch for Sweden within the EEZ in the North Sea, 1950-2010 of 1.5 million t was 29% higher the ICES reported landings for the same time period and area (Figure 2a). Total catches were estimated to be over 29,000 t·year^{-1} in the 1950s, compared to the just under 25,000 t·year^{-1} reported by ICES. Reconstructed total catches peaked in the mid-1960s and early 1990s with an average of 47,000 t·year^{-1} and over 46,000 t·year^{-1}, respectively. Comparative reported catches from ICES for those time periods were only 39,000 t·year^{-1} and just under 35,000 t·year^{-1}, respectively. Catches have decreased drastically in the last decade, with reconstructed total catches averaging 9,000 t·year^{-1} in 2009-2010, and an average of 6,700 t·year^{-1} reported by ICES for the same years. The unreported commercial catches accounted for 49% of the difference for the 1950-2010 time period (unreported landings 40% and discards 9%). Recreational and subsistence catches accounted for the rest with 24% and 27%, respectively.

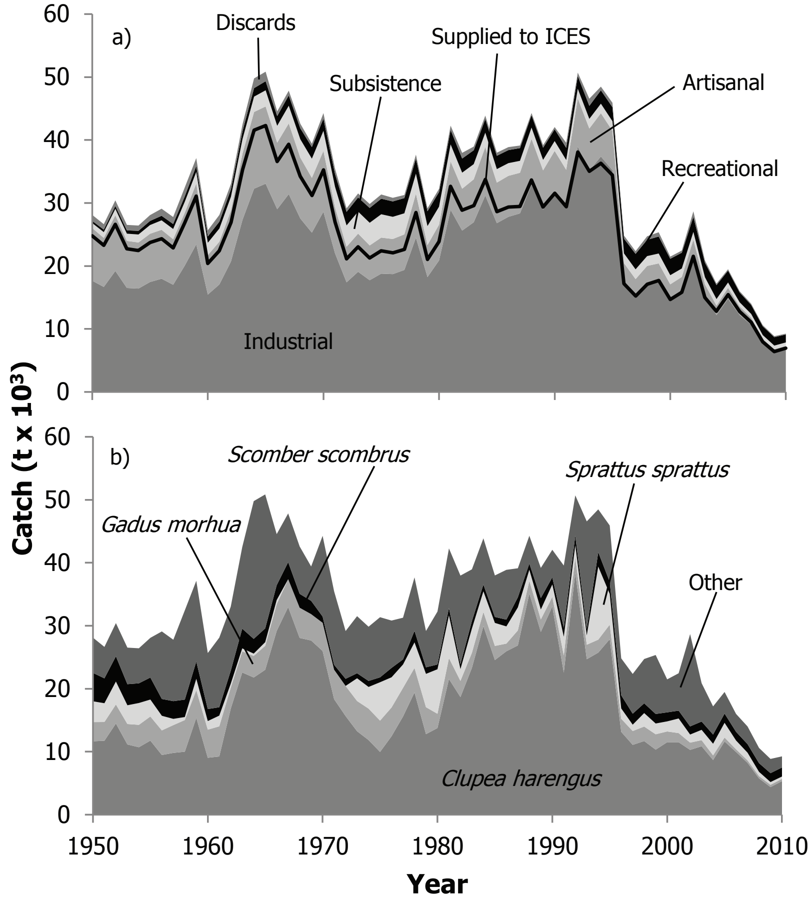

Figure 2. Reconstructed total catch of Sweden within its North Sea EEZ, 1950-2010, a) by sector with the assumed EEZ equivalent ICES data overlaid as a line graph, and b) by major taxa. “Other” includes 108 additional taxonomic categories.

The industrial sector made up 69% of the reconstructed total catch. The artisanal sector contributed 19% to the reconstructed total catch, and recreational and subsistence accounted for 5% and 6% of the remaining catches, respectively. Contribution of the industrial sector increased slightly over the time period, contributing an annual average of approximately 64% from 1950-1980, after which the contribution increased to a high of 78% in 1994 and then fluctuated around a 74% annual average of the total catch within the EEZ from 1995-2010. Artisanal contribution has exhibited a straight decrease from almost 31% in 1950 to 6% in 2010. Industrial and artisanal catches follow the same basic pattern as total catches, with a slight difference being that the artisanal sector exhibits a stable period in the 1970s to late 1990s as opposed to increasing to a second peak before the ultimate decline. Subsistence catches were estimated to increase from 800 t in 1950, to a peak of 3,700 t in 1975, after which catches declined to 540 t in 2010. Recreational catches increased from 340 t in 1950 to 2,470 t in 1975. Catches declined gradually until 1990 and then shot back up to a peak of 2,700 t in 1999. Catches have decreased since to 1,260 t in 2010.

Herring (*Clupea harengus*) made up more than half (53%) of the reconstructed total catch within Sweden’s EEZ in the North Sea between 1950 and 2010 (Figure 2b). Peaks in reconstructed total catch appear to be partially driven by herring catches as herrings percent contribution peaked in the mid-to-late 1960s with an annual average contribution of 65% and in the late 1980s to early 1990s an annual average contribution of 73%. Herring yearly catches followed the same trend as reconstructed total catches, increasing from an average of 11,600 t·year^{-1} in the 1950s, to a peak of 33,000 t in 1967. Catches then declined to a low of 10,000 t in 1975, followed by an increase to a second peak in 1992 of over 38,000 t, before finally declining to an average of 5,100 t·year^{-1} at the end of the time period (Figure 2b).

The reconstructed cod (*Gadus morhua*) catches for the same area were the second largest contributor with 9% of the reconstructed total catch. Contribution of cod to reconstructed total catch in the EEZ generally declined over the time period. Cod contribution peaked in the late 1950s and early 1970s at around an annual average of 16% each time and declined to an average contribution of 3% per year in the late 2000s. Cod catches also followed a decline, averaging 4,300 t·year^{-1} in the 1960s and 1970s, and then decreasing to an average of 380 t·year^{-1} in the late 2000s (Figure 2b).

Sprat (*Sprattus sprattus*) was the third largest contributor to the reconstructed total catches within the EEZ with 7% of the catch over the 1950-2010 time period. Sprat exhibited an immediate decline in percent contribution and catch tonnage at the beginning of the time period before spiking in contribution in the late 1970s with almost 16% of the reconstructed total catch in Sweden's EEZ. Sprat only contributed an annual average of 6.6% of the catch in the late 2000s. Catches started low with an average of almost 1,800 t·year^{-1} in the 1950s and early 1960s. Catches increased in the 1970s and peaked in 1980 at 7,000 t·year^{-1} before declining to approximately 820 t·year^{-1} in the late 2000s (Figure 2b).

Another important contributor was Atlantic mackerel (*Scomber scomber*) with an overall contribution of 5.5% from 1950-2010. The contribution of Atlantic mackerel over the years follows a very interesting pattern, contributing an annual average of 13.5% in the early 1950s, declining to an average of 2.5% per year in the early 1980s, and then increasing back to an average of 12.5% in the late 2000s. The catch of Atlantic mackerel followed a declining and then stabilizing pattern. Catches decreased from 3,700 t·year^{-1} in the early 1950s to a low of 800 t in 1977. Catches then increased slowly to a peak of almost 2,300 t in 1994, before stabilizing at around 1,400 t·year^{-1}in the 2000s (Figure 2b).

Figure 2. Total reconstructed catch of Sweden within its North Sea EEZ, 1950-2010, a) by sector with the assumed EEZ equivalent ICES data overlaid as a line graph, and b) by major taxa. "Other" includes 108 additional taxonomic categories.

Outside the EEZ

The reconstructed total catch for 1950-2010 by Sweden, in the North Sea but outside of the EEZ, was estimated to be 13% higher than the ICES reported landings for the same time period and area. Total unreported landings accounted for almost 82% of the difference and discards accounted for the remaining 18%. Total catches increased from about 114,000 t in 1950 to reach a peak of almost 300,000 t in 1964. Catches then decreased to 66,000 t in 1979 before rising to a secondary peak of over 144,000 t in 1992. Thereafter, catches declined to an average of 62,000 t·year^{-1} in the late 2000s.

Catch from outside the EEZ accounts for almost 80% of the reconstructed total catch. Catch from non-home North Sea ICES areas (i.e., everything except ICES area IIIa) accounted for 33.7% of the catch. Within ICES area IIIa, 30.7% of the catch is estimated to be taken from within the EEZ and 69.3% is estimated to be taken outside the EEZ but still within IIIa.

Around 56% of the total catch outside the EEZ, from 1950-2010, was made up by herring. In 1970, the reconstructed catches of herring peaked, after being at more than 129,000 t. The reconstructed total herring catch was around 12% higher than the herring tonnage reported by ICES. Other important taxa caught outside the EEZ include sprat (5.4%), Atlantic mackerel (5.2%), sand lances or sand eels (Ammodytidae; 4.9%), and Atlantic cod (4.9%).

Discussion

The reconstructed total catch for Sweden in the North Sea (inside and outside the EEZ) was 16% larger than the landings reported by ICES (and by extension also by FAO) on behalf of Sweden, which is likely a conservative estimate. Comparing only the catches taken from within the EEZ, reconstructed catches were estimated to be 29% larger than the ICES reported landings. Catches outside the EEZ were only 13% larger than the ICES data for that area. The largest component contributing to the difference was the unreported commercial catch, which is also the largest IUU component in the Baltic Sea (ORCA-EU 2007). The catches from the west coast make up most of the Swedish marine catches (Fiskeriverket 2011), and when catches on the west coast (inside and outside EEZ) peaked at 351,000 t·year^{-1} in 1964, the equivalent reconstructed catch in the Baltic Sea was just under 77,000 t·year^{-1} (Persson 2010). However, catches on the west coast declined rapidly after the late 1960s and this was mainly due to a substantial decline in herring abundance (SOU 1978), but declining catches may also reflect the loss of access to traditional fishing grounds with the introduction of EEZs by other countries.

There is a global trend of declining catches (Pauly *et al.* 2002) and the pattern of catches on the west coast of Sweden also showed a declining trend over the last few decades. Declining catches and changes in catch composition towards lower trophic level species are generally considered potential signs of overfishing (Pauly *et al.* 1998; Myers and Worm 2005). For example, catches of Atlantic halibut have declined from around 200 t·year^{-1} in the late 19th century to only a few tonnes during the 2000s (Fiskeriverket 2011). Decrease in size and changed life history of species is another consequence of high fishing pressure (Stergiou 2002). The plaice population on the west coast show a decrease in average length by 10 cm since the beginning of the 20th century and the adult biomass is only around 40% of the maximum observed biomass at the beginning of the 20th century and during the 1960s (Cardinale *et al.* 2010).

The fishing effort by Swedish demersal trawlers in Skagerrak and Kattegat (ICES area IIIa) has increased by 200% since the late 1970s and many demersal stocks have declined substantially since then (Svedäng *et al.* 2001). Many local cod stocks are severely depleted and on the verge of going extinct (Cardinale and Svedang 2004). Already in the late 1980s, there were concerns regarding the cod stocks on the west coast and the by-catch of cod in other fisheries (Phil and Ulmestrand 1988). Despite calls for a more comprehensive management approach and the protection of young cod by increasing mesh size in trawls, limited fishing for fish used for reduction fisheries (i.e., fish-meal), and protected nursery areas, fishing continued and the cod stocks declined. This is a clear example of lack of political will that has permeated fisheries management around the world for some time now (Mora *et al.* 2009).

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Appendix Table A1. ICES landings (portion within EEZ only) vs. reconstructed total catch (in tonnes), and catch by sector with discards shown separately for Sweden in the EEZ in the North Sea, 1950-2010.

Year	ICES landings	Reconstructed total catch	Industrial	Artisanal	Subsistence	Recreational	Discards
1950	24,785	28,100	17,700	8,370	795	341	953
1951	23,259	26,600	16,700	7,780	913	399	867
1952	26,618	30,400	19,200	8,830	1,031	459	885
1953	22,731	26,500	16,500	7,480	1,148	521	874
1954	22,458	26,400	16,400	7,320	1,265	585	836
1955	23,730	28,100	17,500	7,660	1,385	652	929
1956	24,325	29,100	18,000	7,770	1,504	721	1,126
1957	22,885	27,800	17,000	7,240	1,623	792	1,108
1958	26,828	32,400	20,000	8,390	1,740	865	1,408
1959	31,099	37,100	23,400	9,640	1,855	939	1,263
1960	20,399	25,700	15,500	6,260	1,967	1,013	966
1961	22,393	28,100	17,100	6,790	2,084	1,093	1,069
1962	26,918	33,000	20,700	8,100	2,199	1,174	862
1963	35,312	42,500	27,300	10,500	2,315	1,258	1,074
1964	41,561	49,800	32,300	12,180	2,439	1,348	1,547
1965	42,295	50,900	33,100	12,260	2,566	1,443	1,511
1966	36,579	44,500	29,000	10,560	2,691	1,540	740
1967	39,313	47,800	31,400	11,230	2,809	1,635	753
1968	34,252	42,600	27,500	9,660	2,922	1,731	737
1969	31,179	39,400	25,300	8,700	3,048	1,837	531
1970	35,241	44,300	28,600	9,660	3,176	1,947	872
1971	26,988	35,500	22,000	7,290	3,287	2,049	823
1972	21,137	29,200	17,400	5,650	3,389	2,149	567
1973	23,027	31,500	19,100	6,060	3,490	2,250	640
1974	21,282	29,800	17,700	5,520	3,598	2,359	627
1975	22,394	31,400	18,800	5,720	3,704	2,470	672
1976	22,095	30,800	18,700	5,580	3,523	2,445	571
1977	22,639	31,300	19,400	5,650	3,347	2,417	494
1978	28,506	37,700	24,500	6,980	3,177	2,387	630
1979	21,020	29,200	18,200	5,080	3,012	2,355	473
1980	23,885	32,300	20,900	5,680	2,854	2,320	513
1981	32,664	42,300	28,900	7,690	2,701	2,283	693
1982	28,843	38,000	25,600	6,650	2,554	2,244	898
1983	29,610	39,000	26,900	6,820	2,412	2,203	583
1984	33,736	43,900	31,200	7,690	2,275	2,160	550
1985	28,607	38,000	26,800	6,440	2,143	2,116	488
1986	29,376	38,900	27,800	6,500	2,017	2,070	477
1987	29,448	39,100	28,300	6,450	1,896	2,022	408
1988	33,652	44,300	32,900	7,280	1,779	1,973	337
1989	29,343	39,200	29,000	6,230	1,667	1,922	415
1990	31,571	42,100	31,700	6,610	1,560	1,870	352
1991	29,403	39,600	29,300	5,940	1,556	1,939	794
1992	38,088	50,700	39,000	7,650	1,546	2,004	552
1993	35,012	46,600	35,200	6,680	1,531	2,064	1,141
1994	36,302	48,500	37,400	6,870	1,512	2,121	587
1995	34,426	45,900	35,200	6,260	1,527	2,230	700
1996	17,199	24,800	17,500	2,990	1,541	2,342	492
1997	15,224	22,300	15,400	2,540	1,553	2,458	420
1998	17,087	24,700	17,300	2,750	1,563	2,578	571
1999	17,696	25,400	17,700	2,710	1,571	2,700	674
2000	14,679	21,500	14,900	2,190	1,453	2,604	341
2001	15,807	22,500	16,000	2,260	1,341	2,507	344
2002	21,538	28,700	21,300	2,870	1,234	2,409	859
2003	15,012	20,900	15,100	1,950	1,133	2,311	361
2004	12,784	17,200	12,200	1,500	1,038	2,211	237
2005	15,472	19,500	14,800	1,730	847	1,887	218
2006	12,747	16,000	12,200	1,350	667	1,556	197
2007	11,090	14,000	10,700	1,120	612	1,427	193
2008	7,962	10,600	7,700	760	599	1,397	171
2009	6,427	8,900	6,200	580	572	1,334	160
2010	6,954	9,300	6,700	590	542	1,264	134

Appendix Table A1. Reconstructed total catch (in tonnes) by major taxa for within the Swedish North Sea EEZ, 1950-2010. 'Others' contain 108 additional taxonomic categories.

Year	*Clupea harengus*	*Gadus morhua*	*Sprattus sprattus*	*Scomber scombrus*	Other
1950	11,650	3,048	3,301	4,509	5,600
1951	11,740	2,975	2,983	3,950	4,990
1952	14,480	3,021	3,642	4,010	5,270
1953	11,150	3,249	2,974	3,347	5,810
1954	10,710	3,555	3,468	3,127	5,560
1955	11,760	3,829	2,689	3,498	6,300
1956	9,480	3,907	2,317	2,671	10,720
1957	9,810	4,412	993	2,813	9,750
1958	10,000	5,023	479	2,768	14,170
1959	15,380	4,396	1,807	2,736	12,820
1960	9,040	4,464	1,366	1,905	8,900
1961	9,240	4,781	1,704	1,333	11,050
1962	16,840	3,321	633	2,066	10,180
1963	22,580	3,349	477	3,125	12,950
1964	21,780	3,424	371	2,338	21,870
1965	23,010	3,804	580	2,193	21,270
1966	29,180	4,249	655	2,352	8,110
1967	32,960	4,428	-	2,701	7,740
1968	28,060	4,799	-	2,204	7,530
1969	27,660	4,183	-	2,115	5,450
1970	25,990	4,472	-	992	12,820
1971	18,340	4,676	-	786	11,660
1972	15,660	4,784	-	1,130	7,590
1973	13,250	4,799	3,611	797	9,060
1974	11,850	4,991	3,439	955	8,610
1975	9,960	4,974	6,092	779	9,550
1976	12,450	4,566	4,793	1,492	7,520
1977	15,590	4,542	3,713	809	6,620
1978	19,410	3,889	4,060	1,833	8,490
1979	12,790	4,278	5,291	1,043	5,770
1980	13,760	2,264	7,071	754	8,410
1981	21,540	3,316	6,802	1,150	9,470
1982	18,670	2,573	1,872	796	14,050
1983	23,320	2,388	3,849	1,190	8,210
1984	29,940	2,249	3,279	1,077	7,340
1985	24,550	2,241	3,655	948	6,590
1986	25,950	1,219	2,729	1,075	7,910
1987	26,870	2,393	3,655	1,608	4,600
1988	35,130	1,996	1,758	987	4,420
1989	29,020	1,985	1,577	1,821	4,790
1990	33,040	1,535	1,976	1,130	4,370
1991	22,560	2,723	2,970	1,423	9,880
1992	38,400	2,445	1,926	1,546	6,380
1993	24,690	2,302	1,477	1,034	17,070
1994	25,730	2,059	11,600	2,288	6,800
1995	27,870	2,311	4,878	1,912	8,950
1996	13,150	2,077	1,642	2,093	5,860
1997	11,090	2,198	1,007	1,745	6,310
1998	11,690	2,303	2,137	1,551	7,040
1999	10,330	2,445	1,709	1,514	9,360
2000	11,510	1,708	1,599	1,435	5,240
2001	11,500	1,452	2,319	1,244	5,940
2002	10,290	1,154	1,284	1,292	14,660
2003	10,860	970	1,639	1,319	6,100
2004	8,680	742	1,840	1,466	4,470
2005	11,630	627	2,338	1,465	3,430
2006	9,960	428	1,394	1,380	2,840
2007	8,230	395	1,218	1,360	2,810
2008	5,760	362	682	1,381	2,420
2009	4,380	364	435	1,414	2,260
2010	5,330	356	372	1,438	1,760