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PRELIMINARY RECONSTRUCTION OF TOTAL MARINE FISHERIES CATCHES FOR THE UNITED KINGDOM AND THE CHANNEL ISLANDS IN EEZ EQUIVALENT WATERS (1950-2010)

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Abstract

Fisheries catches are reconstructed for the United Kingdom (UK) including England, Wales, Scotland, Northern Ireland and the Isle of Man. The Channel Islands (Jersey and Guernsey) are reconstructed separately, as their Exclusive Economic Zone (EEZ) equivalent waters are outside of the UK's EEZ. Publically available reported landings data from the International Council for the Exploration of the Sea (ICES) are used as a baseline for the reconstruction. Estimates of discarded, recreational and unreported catch are used from peer-reviewed and grey literature as well as government reports to reconstruct the fisheries of the UK. The UK's total reconstructed catch including England, Wales, Scotland, Northern Ireland and the Isle of Man is 35% higher than the reported landings for the same entities. Unreported catches largely explain the discrepancies between the reported landings and the reconstructed catch. Overall, reconstructed catch increases from 355,000 tonnes in 1950 to 430,000 tonnes in 2010 with a peak of 950,000 tonnes in 1995. There is a clear and steady decreasing trend in the reconstructed catch from 1988 until present. There is also an overall shift in the last thirty years from fisheries targeting Atlantic herring (*Clupea harengus*) and Atlantic mackerel (*Scomber scombrus*) to more fisheries targeting shellfish. As for the Channel Islands, the reconstructed catch by the Channel Islands is 1.3% higher than reported landings. There is an increase in Channel Islands catch from 300 tonnes in 1950 to a peak of 4,300 tonnes in 1997 and has steadily decreased to 3,400 tonnes in 2010. Edible crab (*Cancer pagurus*) and spinous spider crab (*Maja squinado*) represent 69% collectively of the Channel Islands catch over the time series. There is a need for greater transparency in ICES data with landings designations to 'countries'. England, Wales and Northern Ireland are all reported together for the time series, with Northern Ireland only having separate landings from 1950-1988. The UK government provides catch by 'country' but poor species disaggregation. There is also a need for more transparent and comprehensive current and historic discard data so the problem can be understood in light of the new European Union Common Fisheries Policy's discard ban.

Introduction

The United Kingdom (UK) is an island country comprised of England, Northern Ireland, Scotland and Wales (here listed as 'countries' with regards to catch data). The UK also has three island dependencies within close geographic proximity; Isle of Man in the Irish Sea, and Jersey and Guernsey in the English Channel. With an expansive coastline, fisheries are a cornerstone of culture in the UK. The UK played a pivotal role in the industrialization of fisheries as the site of the industrial revolution and the invention of the Watt steam engine in the 18th century (Roberts 2007). With the invention of the steam engine, railways were able to distribute fish rapidly (Thrustan *et al.* 2010). The steam engine technology was eventually applied to fishing, which allowed for more efficient steam trawlers versus sail powered trawlers (Thrustan *et al.* 2010). These steam-powered trawl vessels, introduced in the 1870s, became so

efficient at taking everything from the ocean floor, vessels were forced to target deeper waters to take more (Roberts 2007).

There was an increase in fishing effort and pressure with the invention of steam trawling but fisheries were halted during both world wars. However, in the years following WWII, there was once again an intensification in fishing pressure (Roberts 2007). Many vessels were going further offshore at this time, to fish in Iceland's territorial waters. This continued until 1975 when Iceland's 200 nm Exclusive Economic Zone (EEZ) was established (Roberts 2007). Steam trawling helped the UK lead the way to global industrialized commercial fisheries, peaking in the 1980s (Roberts 2007). By 2002, there were over 7,000 vessels registered in the UK and 560 in the Channel Islands and the Isle of Man (FAO 2004). This fishery at the time provided over 12,000 jobs to regular workers in the primary sector and contributed approximately £ 1 billion for the UK (FAO 2004). By 2013, there were 6,399 registered vessels in the UK and 12,150 fishermen, a drop of 10% and 7% respectively over the course of the decade (MMO 2013).

Since the UK's fisheries management has been part of the European Union's (EU) Common Fisheries Policy (CFP) which sets quotas for all European countries (FAO 2004). The UK government is responsible for enforcement at a national level of the total quota granted by the EU (FAO 2004). This quota is allocated to fishers through Producer Organisations (POs). Until 2012, the UK government allocated quota to POs directly. Since 2012, the UK government has distributed quota to the Fisheries Administrations (FAs) in Scotland, England, Wales and Northern Ireland, who have then allocated this to their respective national Producer Organisations.¹ There are however, some vessels that are not members of Producer Organisations and fish against quotas that are managed directly by the Fisheries Administrations, the most significant of these being the small-scale fleet of boats under ten metres long.

The Channel Islands are regulated differently from the rest of the UK. Due to their closer proximity to Normandy than the UK, the Channel Islands have had many disputes between fishers in the Channel Islands and in Normandy over the years (Fleury 2011). Guernsey and Jersey are legislatively independent of the UK and responsible for their own fisheries management according to the EU CFP within 12 nautical miles (nm) (Anon. 2014a, 2014b). According to Protocol No. 3 of the Treaty of Accession of the United Kingdom from 1972, Guernsey and Jersey are within the EU for trade purposes, but otherwise considered outside (Anon. 2014b). However, Jersey and Guernsey comply with the UK's obligation to the CFP through Fisheries Management Agreements (FMAs) (Anon. 2014b). A fishing license system in Guernsey was only granted by the Queen in 2013 which requires those individuals fishing with the 12 nm zone to have Bailiwick of Guernsey fishing vessel license (Anon. 2014a). Jersey also has a license scheme implemented for within 12 nm of their shore (Fleury 2011). The Channel Islands have no public records or estimates of discarded taxa or other forms of unreported catches.

Discards are recorded by observers in Scotland but, data for UK fisheries is not publically available. There are many reports and peer-reviewed papers investigating discards. However, there is no publically available database of discarded tonnages. Due to the strong influence of active gear types (i.e., trawling and dredging) in the UK's industrialized fleet, discarding is assumed to be common practice. The marine ecosystems surrounding the UK and its dependencies have many commercially important stocks that have been severely overexploited over time. These factors highlight the importance for the UK to monitor total catch as opposed to only reported landings, to make appropriate management decisions on both the national and EU scale. There has just been a reform of the EU CFP, which will implement an EU wide discards ban. The logistics of its implementations have however not been decided yet.

¹ The Scottish Government www.scotland.gov.uk/Topics/marine/Sea-Fisheries/19213/17681 Accessed 12 December 2014

Methods

Landings

The Marine Management Organisation (MMO) publishes detailed annual landings data for the UK. As the UK is part of the EU “Common Pond” this data does not take into account the borders of the UK EEZ. Landings data from within the UK EEZ only for the time period 2000-2011 was obtained from the MMO through a freedom of information (FOI) request. The data from the FOI request do not provide organization by ICES management area or country fishing, which can be found in the ICES publically available database. The total annual landings from the FOI dataset were then compared to the available public data on total catches across ICES areas.

For shellfish landings in 1994-1999, total catches across ICES areas were taken from annual Sea Fisheries Statistics tables then reconstructions created using the proportions recorded for 2000-2010². Landings from 1991 to 1993 are based on the annual Sea Fisheries Statistics 1991-1993². Landings of shellfishes from 1960-1990 within the EEZ were estimated through records “Landings by British Vessels into the UK by species” in the annual UK Sea Fisheries Statistics². From 1950-1959, the data was transcribed from table 1 of the UK annual Sea Fisheries Statistics, total British landings². The proportions of fin-fishes calculated for 2000-2011 were used to calculate all catches within the EEZ from 1976 (the introduction of EEZs in the region) to 1999.²

We choose to use the data provided by MMO along with estimates of earlier catch to determine the proportion of the catch which is caught within the UK’s Exclusive Economic Zone (EEZ) waters. Yearly totals of the MMO data and ICES data are added together and a proportion of each is taken. These proportions represent all catch from inside the EEZ (MMO) and outside the EEZ (the difference). These proportions are applied to all ICES catch by ICES management area and taxonomic group for Scotland, England, Wales, Northern Ireland and Isle of Man. All catch from Jersey and Guernsey islands are considered within the EEZ and these proportions are not applied. We removed all freshwater taxa, corals and seaweeds from the ICES data.

All catches are then subsequently split by industrial large-scale catch and artisanal small-scale catch. Shellfish landings are split into artisanal and industrial based on the commonly used gear types. Shellfish are largely caught by demersal trawls and seines (38%), dredges (31%) and pots (31%) throughout the UK (Almond and Thomas 2010). Using active gear as an indicator of industrial large-scale fisheries, we designate 69% of the shellfish catch as industrial large-scale and 31% as artisanal small scale (Martin 2012). Norway lobster (*Nephrops norvegicus*) is split into industrial and artisanal catch based upon gear type. By weight, 15% of the *Nephrops* catch comes from creel fisheries (Bennett and Hough 2005). Therefore, the other 85% comes from bottom trawl fisheries. We designate 85% of the Norway lobster catch to be industrial and the other 15% of the catch is artisanal. All other ‘inside’ EEZ catch is split into annual artisanal and industrial catch based upon vessel length data for the time series. Vessel length and gear data were obtained through an FOI request to MMO. All catches from outside the EEZ are assumed to be industrial.

² Marine Management Organisation
http://webarchive.nationalarchives.gov.uk/20140507202222/http://www.marinemanagement.org.uk/fisheries/statistics/annual_archive.htm (Accessed 21 January 2015)

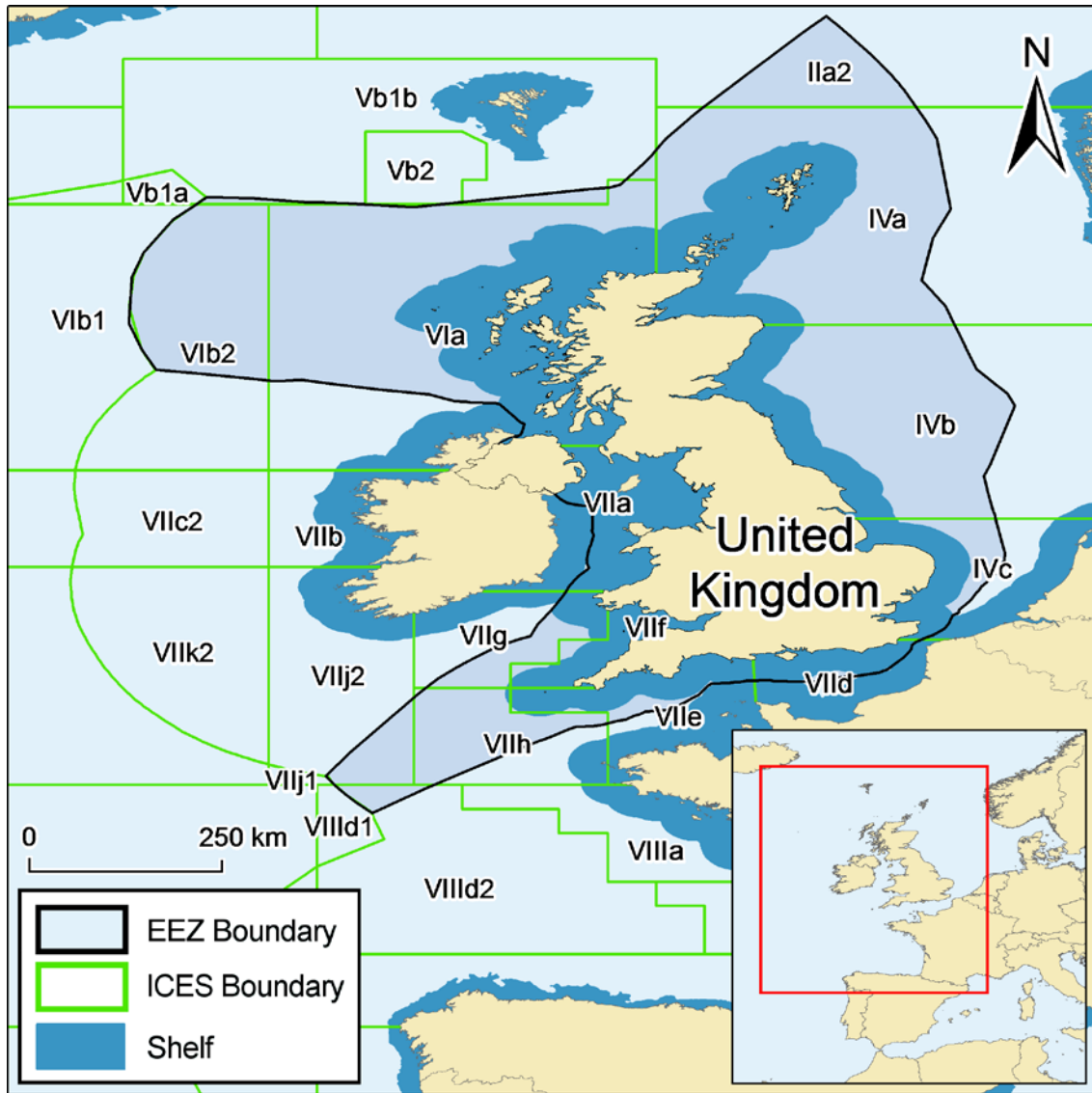


Figure 1. The United Kingdom EEZ equivalent waters including the Isle of Man with corresponding ICES management areas

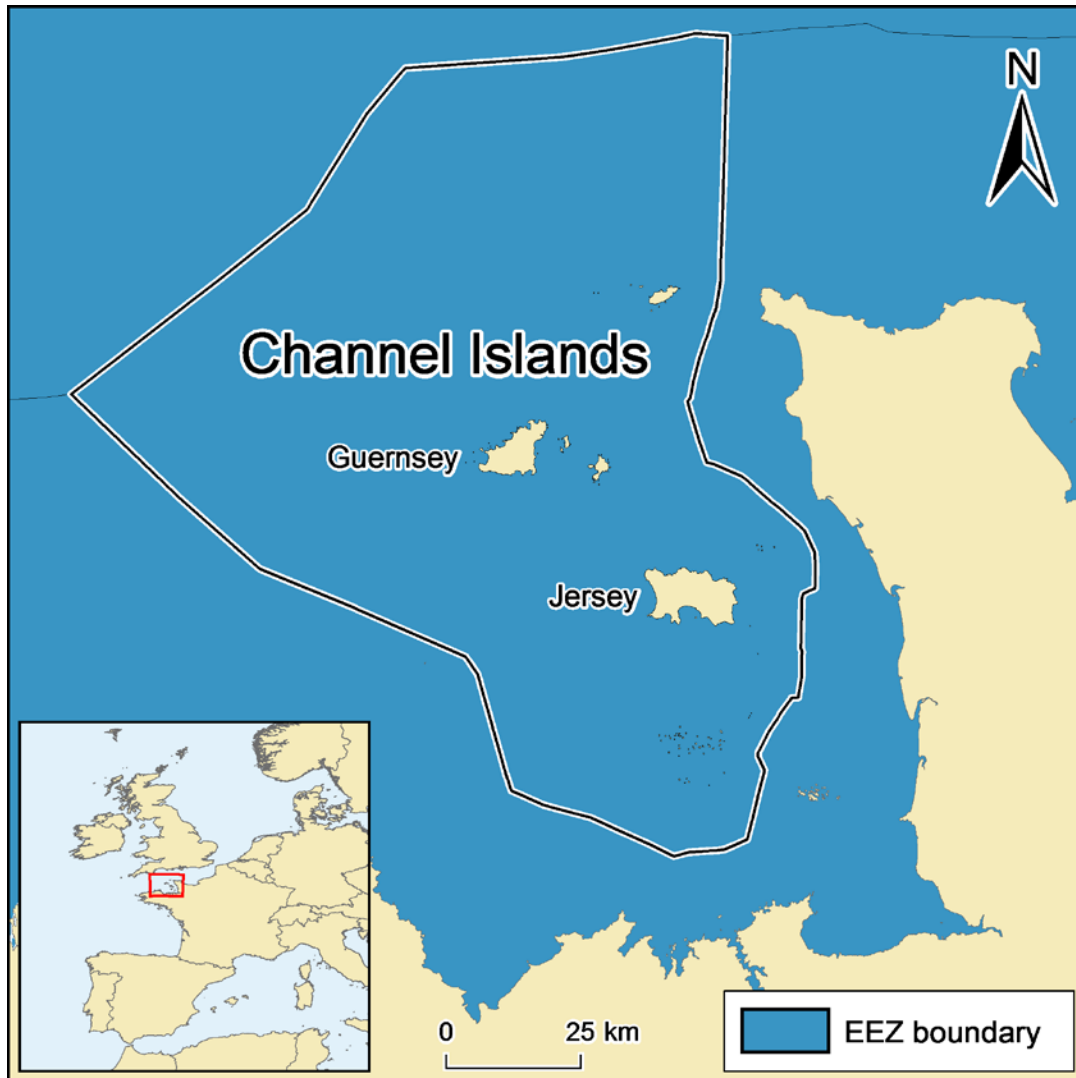


Figure 2. The Channel Islands EEZ equivalent waters within ICES management area VIle.

Unreported catch

The official data records are at lower species resolution prior to 1976 and the catch of non-recorded species are reconstructed. The relationship between each of these species and total catches of recorded species is calculated and used to reconstruct potential catches of these species for 1950-1976.

Further estimates of unreported catch comes from a report on Welsh fisheries, which estimated 10% of the total catch of vessels over 10 m being unrecorded and 50% for vessels under 10 m (NC 2000). A fisheries regulator also estimated unrecorded shellfish landings to be equal to the recorded landed catch (Anon. pers. comm. Inshore Fisheries and Conservation Authority (IFCA)). IFCA's are the regional bodies that manage shell-fishing in England within 12nm of the coast). These estimates are only applied from 1950-2004. This is because the Registration of Buyers and Sellers Legislation enforcing the recording of all fish at the point of first sale was introduced in 2005. This legislation should have had a significant impact on the opportunity to land unreported catch (Anon. 2006; Cardwell 2012).

In 2012, in what was known as the 'Black fish scandal',³ a number of fishermen were prosecuted for not reporting significant catches of Atlantic herring (*Clupea harengus*) and Atlantic mackerel (*Scomber scombrus*) between 2002 to 2005 (170,000 t). We treat this, alongside extensive oral testimony from fishers, as an indicator that there was illegal fishing of herring and mackerel before this point.⁴ We split 170,000 t between these two species over 4 years. We assume that the conviction of these fishers (alongside the parallel implementation of the Registration of Buyers and Sellers) led to a reduction in unreported pelagic landings, and by 2010, we reduce the illegal catch of herring and mackerel to zero. Tonnages were interpolated from 2005-2010. We also assume that the implementation of Total Allowable Catch (TAC) near the end of 1983 under the Common Fisheries Policy (CFP) (Wood and Hopper 1984; Anon. 2014b) increased the incentive to not report catch. We therefore carry back the unreported tonnage from 2002 to 1983 with the beginning of TACs. The unreported catch in 1978 is assumed to be 50% of the tonnage from 1983. All tonnages for years between 1978 and 1983 are interpolated. The unreported tonnage from 1978 is carried back to 1950.

Discards

Estimates of discards within the UK are made by targeting some of the largest fisheries. Discard to landings ratios are determined for multiple years in most cases. In order to estimate an entire time series, years with a missing ratio are interpolated or extrapolated (forward or backward). The discard to landing ratios are applied to the reported landings of target species of the fishery for total discards over the time series. In the case of some fisheries such as scallop dredge or Norway lobster (*Nephrops norvegicus*) trawl, there are species compositions of discards; however, in the case of Atlantic herring, there are only discards of the target species.

The scallop fishery is one of the most valuable fisheries in the UK and happens mostly in the English Channel. Discard to landing ratio was determined using data from a scallop dredge survey in the English Channel in 1997 (Searle and Lansley 1998). The discard to landing ratio was applied to all catch of Great Atlantic scallop (*Pecten maximus*) in the UK in all ICES management areas. We assume that dredging practices are the same in all countries within and dependencies of the UK. This is a conservative estimate, as this does not include discard estimates of the Queen scallop (*Aequipecten opercularis*).

Norway lobster is one of the most lucrative fisheries in all of Europe and largely targeted by beam trawlers. However, catch by creel fishery accounts for 15% of the landings by weight of Norway lobster (Bennett and Hough 2005). It is assumed that discards in the creel fishery are low; therefore only discards from trawling is accounted for. Discard to landing ratios are calculated using discards from commercial vessels in Northern Ireland in 1981 and 1982 (Briggs 1985) and again for 1982-1998 in the Firth of Clyde (Stratoudakis *et al.* 2001). Norway lobster trawl discard to landing ratios are separate for Norway lobster and 'fishes' in the later time period (Stratoudakis *et al.* 2001), so we use the early discard species composition (Briggs 1985) to apply to total fish discards from 1982-1998. The complete discard to landing ratio time series is applied to 85% of all Norway lobster landings in the UK and its dependents.

Marine Science Scotland (formerly The Marine Laboratory) in Aberdeen has been sampling and recording fish discards from the Scottish fleet since 1975 (Jermyn and Robb 1981). In order to determine a complete time series of Atlantic cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*) discard to landing ratios, we use an average of discard to landing ratios for haddock and cod from seine and trawl fisheries from 1975-1980. An average discards to landings ratio from 1975-1980 is assigned for years

³ The Guardian <http://www.theguardian.com/environment/2012/feb/24/fishing-skippers-fined-illegal-catches> (accessed July 15, 2014)

⁴ The Shetland Times <http://www.shetlandtimes.co.uk/2012/03/02/black-fish-was-rife-in-industry-across-scotland-for-decades-says-convicted-fisherman> (accessed July 15, 2014)

1950-2010. Additional discard to landing ratios for cod and haddock are determined using values from 2009 estimates from the Scottish demersal fleet (Fernandes *et al.* 2011). This ratio is carried forward to 2010 and all ratios between 1980 and 2009 are interpolated. The complete time series of discard to landing ratios are applied to all cod and haddock reported landings in all ICES management areas in the UK and its dependants.

Whiting (*Merlangius merlangus*) discard to landing ratios are also accounted for in the surveys from 1975-1980 for seine and trawl fisheries in Scotland (Jermyn and Robb 1981). The average discards to landings ratio from 1975-1980 is carried back to 1950. Whiting discards are also estimated in ICES working group reports for ICES management areas IV (North Sea) and VII (Irish Sea, Celtic Sea, English Channel and the Strait of Dover). Discard to landing ratios are calculated for area VII from 2000-2010 and in area IV from 1992-2010. All years with missing data are interpolated to complete the time series. Discard to landing ratios for area VII are applied to all ICES sub-areas within VII which overlap EEZ equivalent waters from all countries and dependencies of the UK. Discard to landing ratios from area IV are applied to all whiting catch in ICES areas IV and VII (North Atlantic Ocean). This is done to account for most of the catch coming from Scotland in the North Sea. Thus we assume that the fisheries targeting demersal fishes are similar along the Atlantic coast of Scotland.

ICES working groups also estimate discards (ICES 2012) for a number of other species. Atlantic herring (*Clupea harengus*) discard estimates in ICES areas IV and VI a are converted into discard to landing ratios. Atlantic herring discards are provided from 1993-2001 in the North Sea (IV). The 2001 ratio is carried forward to 2010 and an average of the ratio from 1993-1995 is carried back to 1950 to complete the time series. These discard to landing ratios are applied to all Atlantic herring landings in the North Sea by the UK. Further discard to landing ratios are estimated for Atlantic herring in VI a from 1993-2010 and an average rate of 1993-1995 is carried back to 1950. The discard to landing ratios from Area VI a are applied to landings from all of Area VI and VII a for all of the UK and dependancies. The discard to landing ratios from VI a are applied to VII a to account for a great deal of herring catch from this area.

Atlantic mackerel (*Scomber scombrus*) discards from the Atlantic mackerel fishery are estimated using discard to landing ratios from ICES working group from 1986-2010. The discard to landing ratio from 1986 is carried back to 1950. These discard to landing ratios are applied to reported landings of Atlantic mackerel by the UK and all dependencies in all ICES areas that overlap with the EEZ.

Recreational catch

We use the recreational catch estimates from the reconstruction of Irelands' fisheries (Miller and Zeller 2013). The UK and Ireland are culturally similar and neither has reporting requirements for their recreational catch (Miller and Zeller 2013). Therefore, we consider Ireland to be a good proxy for estimating the UK's recreational catch. In Ireland, 1.76% of the population is considered a marine recreational fisher and 1.84% of the UK's population are marine recreational fishers, therefore our estimate is a conservative one (Pawson *et al.* 2007). Ireland's total recreational catch by year is converted into a per capita rate and then that per capita rate is applied to total UK population using data from Populstat⁵ and Worldbank.⁶ The recreational catch for the UK is assumed to exclude the Isle of Man, Jersey and Guernsey because, as dependencies, their populations are likely not included in UK population data.

⁵ Populstat <http://www.populstat.info/> (accessed

⁶ Worldbank <http://www.worldbank.org/> (accessed

Once there is a complete time line of total annual recreational catch, the catch is split into 70% whitefish, 10% European flounder (*Platichthys flesus*) and 20% Atlantic mackerel (Pawson *et al.* 2007). The whitefish catch is split equally between pollock (*Pollachius virens*), Atlantic cod (*Gadus morhua*), whiting (*Merlangius merlangus*), European seabass (*Dicentrarchus labrax*) and Norway pout (*Trisopterus esmarkii*) (Pawson *et al.* 2007).

Results

Landings

The reported landings in the UK for inside the UK's EEZ equivalent waters (Figure 1) were provided by the MMO via a FOI request. The landed tonnages outside of the EEZ represent landings from ICES management areas that overlap with the UK's EEZ but are not within the EEZ (Figure 3). The Channel Islands catch is assumed to all be caught within its own EEZ waters. Reported landings by ICES management areas change over the time series. There is a decrease in catch in areas IV b and IV c of the North Sea, while IV a remains fairly constant. There is a sharp peak in the VII e (part of the English Channel) in the 1980s, while there is a dip in other areas. Catches from the Atlantic Ocean (area VI a) are the highest overall but increase in the mid 1980s and have been sharply declining in the last 5 years.

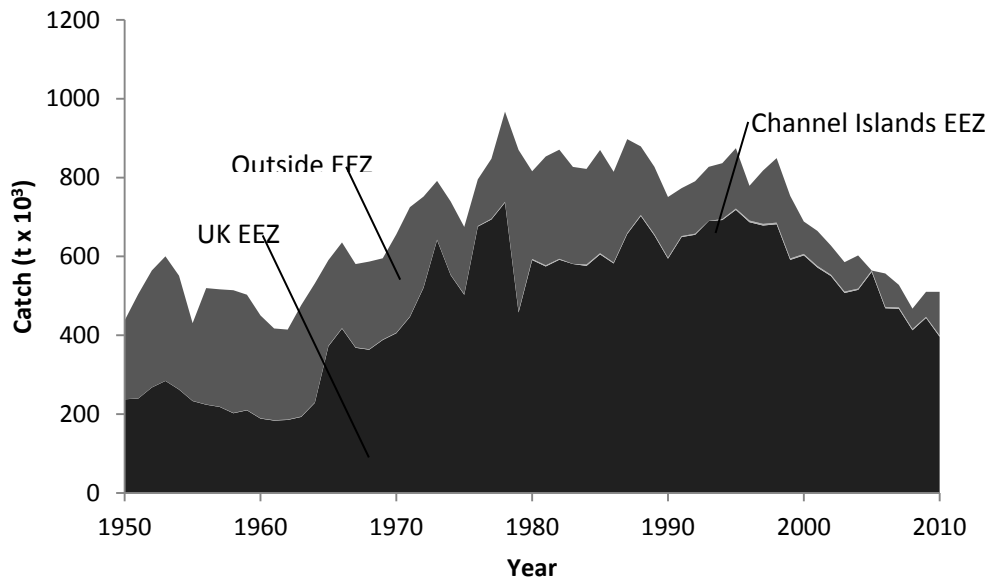


Figure 3. Reported landed catch in corresponding EEZ equivalent waters. Note that the catch outside the EEZ is catch from within ICES management areas which overlap with UK's EEZ.

The reported catch is also allocated to be industrial catch or artisanal catch by vessel sizes. The proportion of artisanal catch decreases from 31% in 1950 to 18% in 2010 (Figure 4a). This implies that there is an increase in catch originating from larger vessels, and fewer fish being caught by smaller vessels, in the last 60 years.

Small pelagic species such as Atlantic mackerel and Atlantic herring comprise the largest proportion of the reported landings: 18% and 14% respectively over the entire time series (Figure 4b). In 1950, Atlantic herring represented 41% of the reported landings, with gadids such as Atlantic cod, haddock and whiting comprising 10%, 10% and 7% respectively. By the 1980s, Atlantic mackerel, Atlantic cod, haddock and whiting all represent 32%, 13%, 11% and 8% respectively. The decrease in Atlantic herring catch likely

comes from a closure in the North Sea fishery in the late 1970s in anticipation of a stock crash, followed by the closure of area VI a and the introduction of a TAC on the fishery being reopened (ICES 2012). There is a large increase in Atlantic herring landings from area VI a west of Scotland as a result of the North Sea fishery being closed in the mid 1970s (ICES 2012). The Atlantic herring fishery in VI a was closed shortly after its growth in anticipation of a stock crash in the 1970s which significantly decreased landings in the UK at this time (Figure 4). These closures also created a new market for Atlantic mackerel which becomes a larger fishery in the late 1970s and early 1980s (Figure 4b). By 2010 there is more fishing for a variety of species, not one single target such as Atlantic herring at the beginning of the time series. Atlantic mackerel, Great Atlantic scallop, Atlantic herring, Norway lobster and haddock represent 26%, 8%, 8%, 7% and 6% respectively.

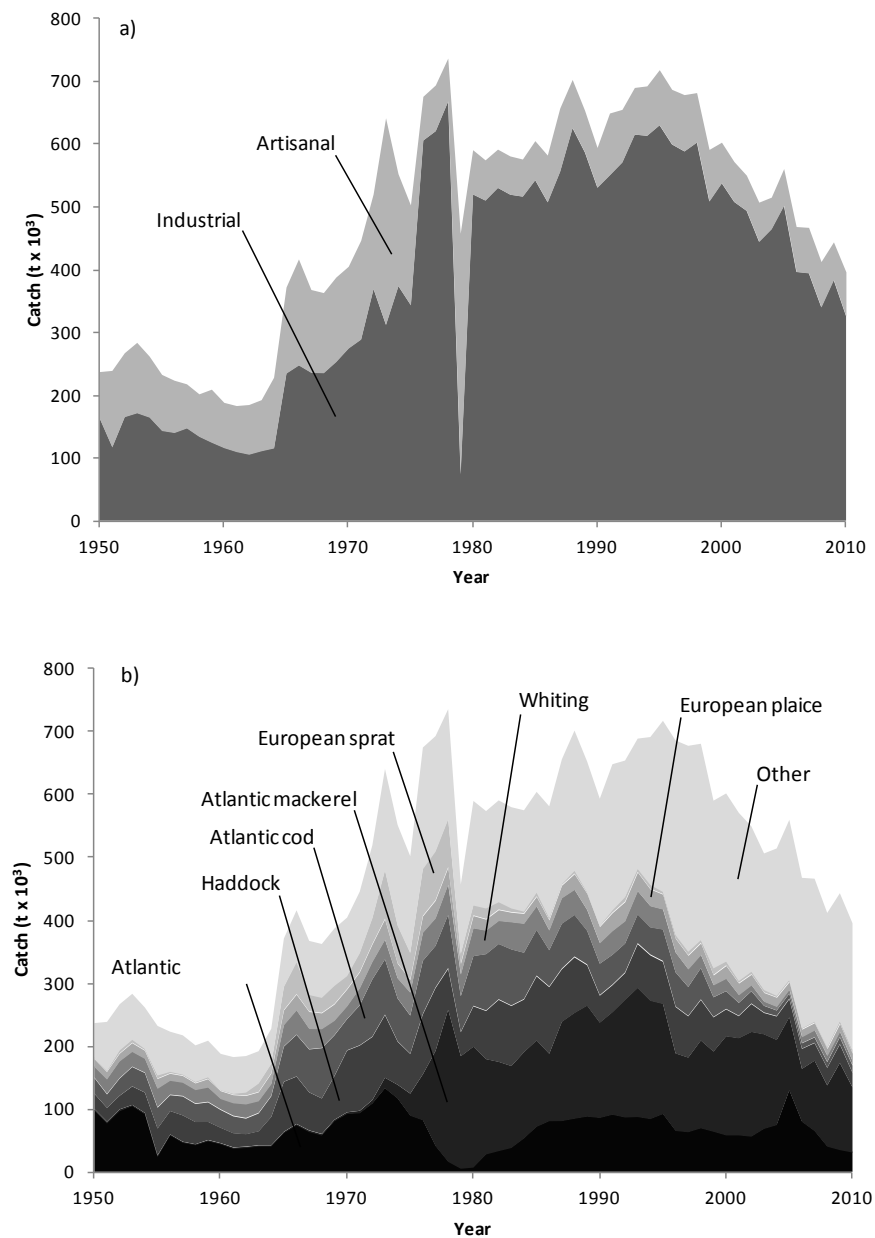


Figure 4. Total reported landings by a) sector and b) taxa for UK and Isle of Man inside EEZ equivalent waters.

Unreported landings

Unreported landings of fish increase from 83,000 t in 1950 to peaks of 262,000 t and 233,000 t in 1972 and 1975. The unreported catch then decreases to 0 t in 2010 (Figure 5). We accept that there is zero unreporting of herring and mackerel as a result of the introduction of the RBS. Atlantic mackerel and Atlantic herring have the highest tonnage of unreported catch over the time series.

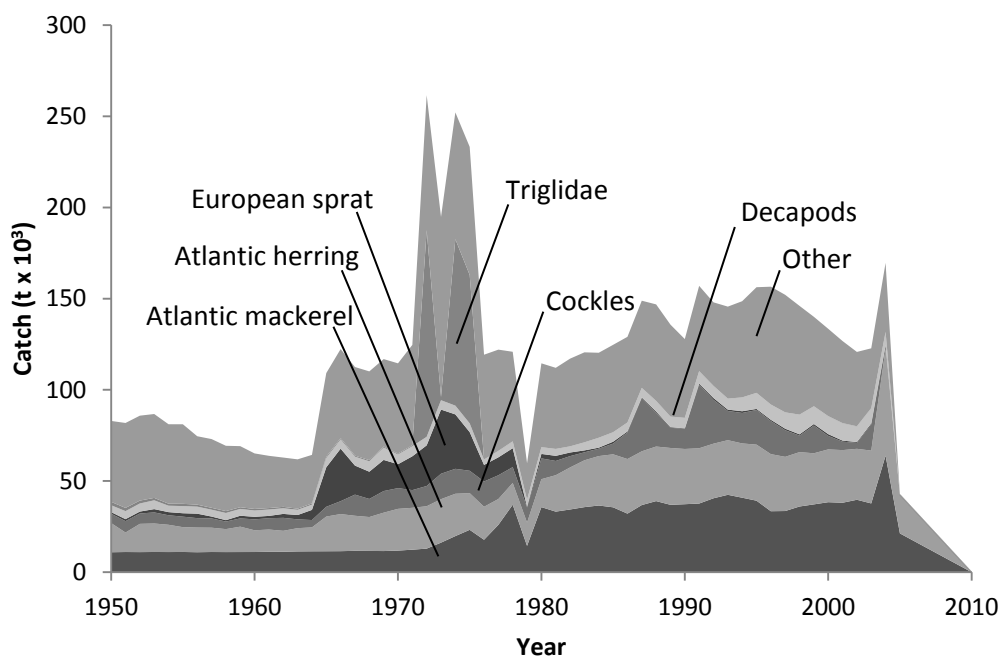


Figure 5. Unreported catches for all of the UK and the Isle of Man.

Discards

Discarded catch is lowest in 1950 with 14,000 t being discarded, 46% of which is haddock. There is an increasing trend in discards until a peak in 1987 of 84,000 t. There is an overall decline from this peak in 1987 to 31,000 tonnes in 2010 (Figure 6). Atlantic cod, whiting, Norway lobster, haddock and scallops comprise 19%, 17%, 16%, 9% and 8% respectively in 2010.

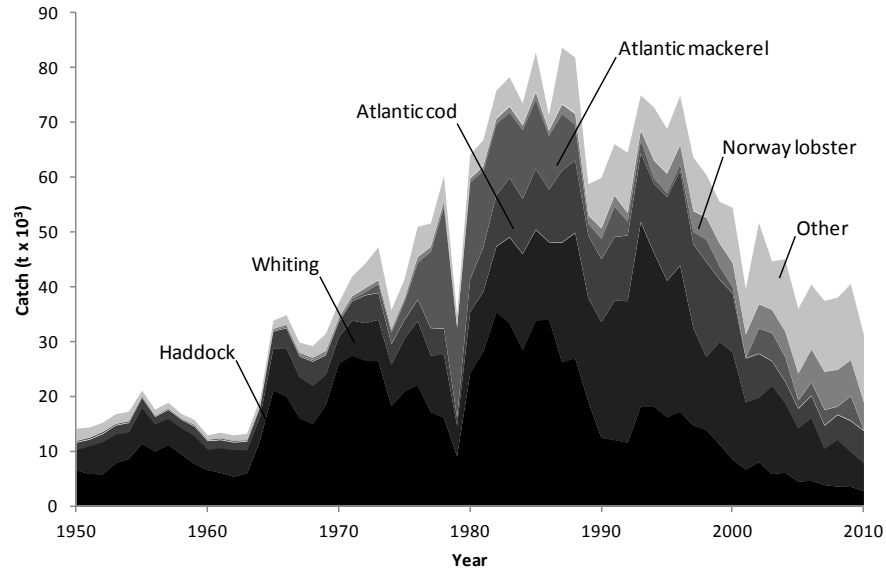


Figure 6. Discards from all UK and the Isle of Man by taxa from 1950-2010.

Recreational catch

Recreational catch for the UK is based on Irish recreational per capita rates. Catch decreases from 20,000 t in 1950 to 3,000 t in 2010. Recreational fishing in the UK is a popular activity, but this popularity has decreased over time. Many species are targeted; however Atlantic mackerel is the most commonly caught (20%). Freshwater angling has remained quite popular over the years; however these species are not included in our estimates.

It should be noted that there is recreational fishing in Jersey and Guernsey but no statistics of catch or licenses so no estimate is made at this time. There is some use of nets and lines for gadids as well as flatfishes and mackerel (Jonathan Shrives, pers. comm., Jersey Department of the Environment). There is also some potting for lobster and crabs in Jersey (Jonathan Shrives, pers. comm., Jersey Department of the Environment).

Total reconstructed catch

The total reconstructed catch within the UK EEZ is 35% higher than reported landings with the addition of discards, unreported catch and recreational catch over time (Figure 7). Catch from outside of the EEZ, but within the ICES overlapping management areas, is 9.6% higher with the addition of discards and unreported catch (Figure 7).

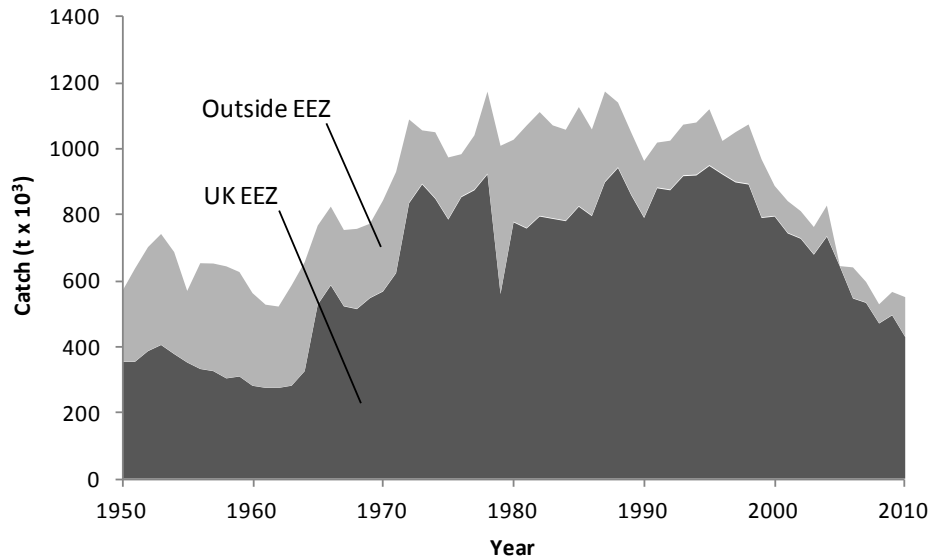


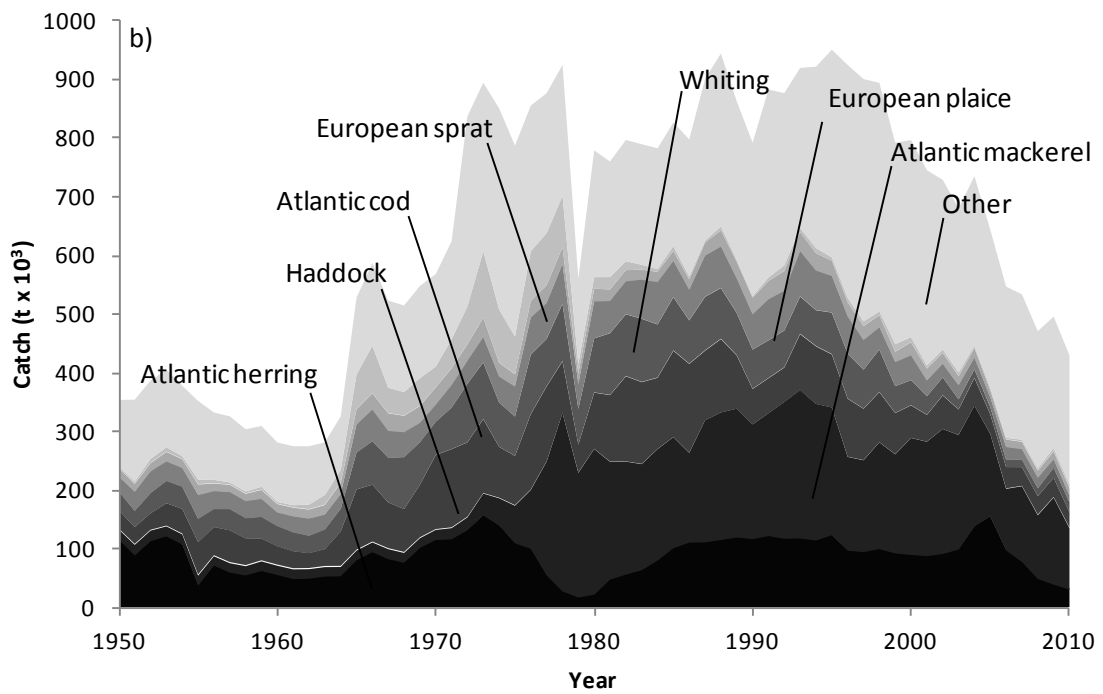
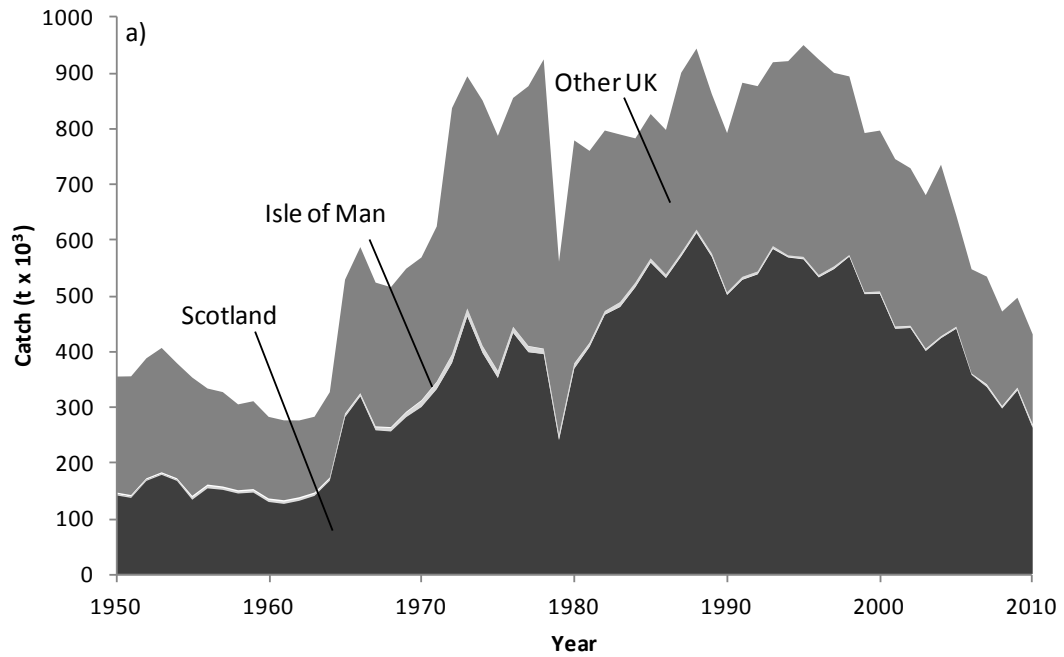
Figure 7. Total reconstructed catch of the UK and the Isle of Man in EEZ and equivalent waters 1950-2010.

The UK and the Isle of Man have an average catch, from both inside and outside the UK EEZ waters, of 622,000 t-year⁻¹ from 1950-1964 (Figure 7). This catch steadily increased to an average of 1,064,000 t-year⁻¹ from 1972-1995 and then declines to 588,000 t-year⁻¹ from 2005-2010 (Figure 7).

Scotland comprises a large proportion (41%) of the total catch within the EEZ of the UK in 1950, which rapidly increases to over 50% in 1963 through until 2010, with the exception of 1967, 1972, 1974-1975 and 1977-1980. The reduction in Scottish catch in the late 1970s is likely due to the closure of North Sea Atlantic herring fisheries at this time (ICES 2012). Catch from the Isle of Man is very small relative to the UK (Figure 8a). The catch from the 'other UK' includes catch from England, Wales and Northern Ireland (Figure 8a). This is due to the way data is reported to ICES; England is reported with Wales for the entire time series and with Northern Ireland as well from 1950-1988.

Atlantic mackerel dominates the catch for the whole of the UK and the Isle of Man (Figure 8b). Atlantic herring comprises the greatest proportion (33%) of the catch in 1950; however, by 1995, Atlantic mackerel comprises 23% of the catch and Atlantic herring represents 13% (Figure 8b). The large catches of Atlantic herring in the early and mid 1970s are a result of a herring targeted fishery taking off in area VI a because of a North Sea closure (ICES 2012). The large dip in Atlantic herring in the late 1970s (Figure 8b) represents the closure of the Atlantic herring fishery in VI a. There is a switch to fishing Atlantic mackerel with the Atlantic herring closures at this time (Figure 8b). Finally, by 2010 Atlantic mackerel comprises 24% and Atlantic herring made up 8% of the catch (Figure 8b). Demersal fishes are also important during the earlier and middle parts of the time series with haddock, Atlantic cod and whiting comprising 25% of the catch combined in 1950, 24% in 1995 and 13% by 2010 (Figure 8b). By 2010, Norway lobster, Great Atlantic scallop and edible crab begin to be more important in the catch (20%).

Catches in the UK are mostly from industrial gear types such as trawling and dredging. Industrial reported and unreported landings comprise 71% of the total reconstructed catch (Figure 8c). Artisanal landings which mostly consists of trap fisheries and small vessels targeting Atlantic mackerel, Atlantic herring, Atlantic cod, haddock and whiting comprises 20% of the catch. Discards also make up a sizable proportion of the reconstructed catch (7%) and this proportion seems to increase slightly over the time series (Figure 8c).



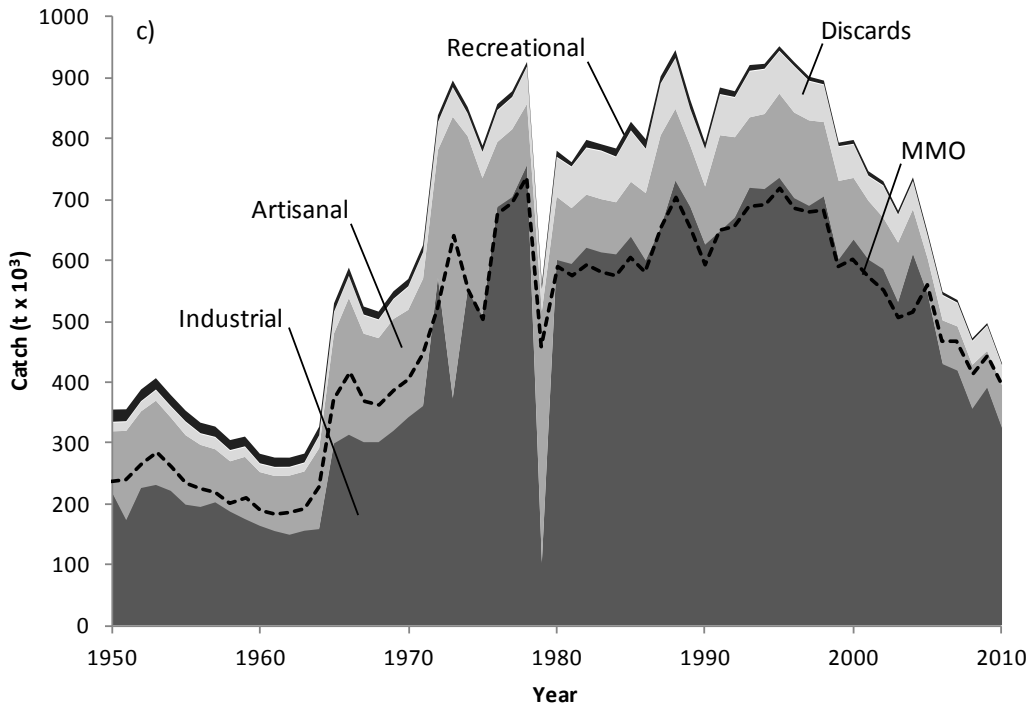


Figure 8. Total reconstructed catch for the UK and dependencies, inside the UK EEZ, by a) original country fishing b) major taxa and c) sector. Note that ‘Other UK’ refers to England, Wales and Northern Ireland. Also note that all figures exclude the Channel Islands as these landings occur outside of the UK EEZ and within their own EEZ.

Scotland

Scotland represents 56% of the catch in the UK over the entire time series (Figure 8a). Scotland’s catch composition changed greatly over time. Total catch increased over time from 144,000 t in 1950 to a peak of 613,000 t in 1988, and has then been steadily decreasing to 264,000 t in 2010 (Figure 8b). Scotland does, however, have a significant catch of Norway lobster over time increasing from nothing in 1950 to 9% of the total catch in 2010 (Figure 9a). This is significant as the monetary value of landed Norway lobster in Scotland represents approximately 10% of all taxa landed in the UK (Stratoudakis *et al.* 2001).

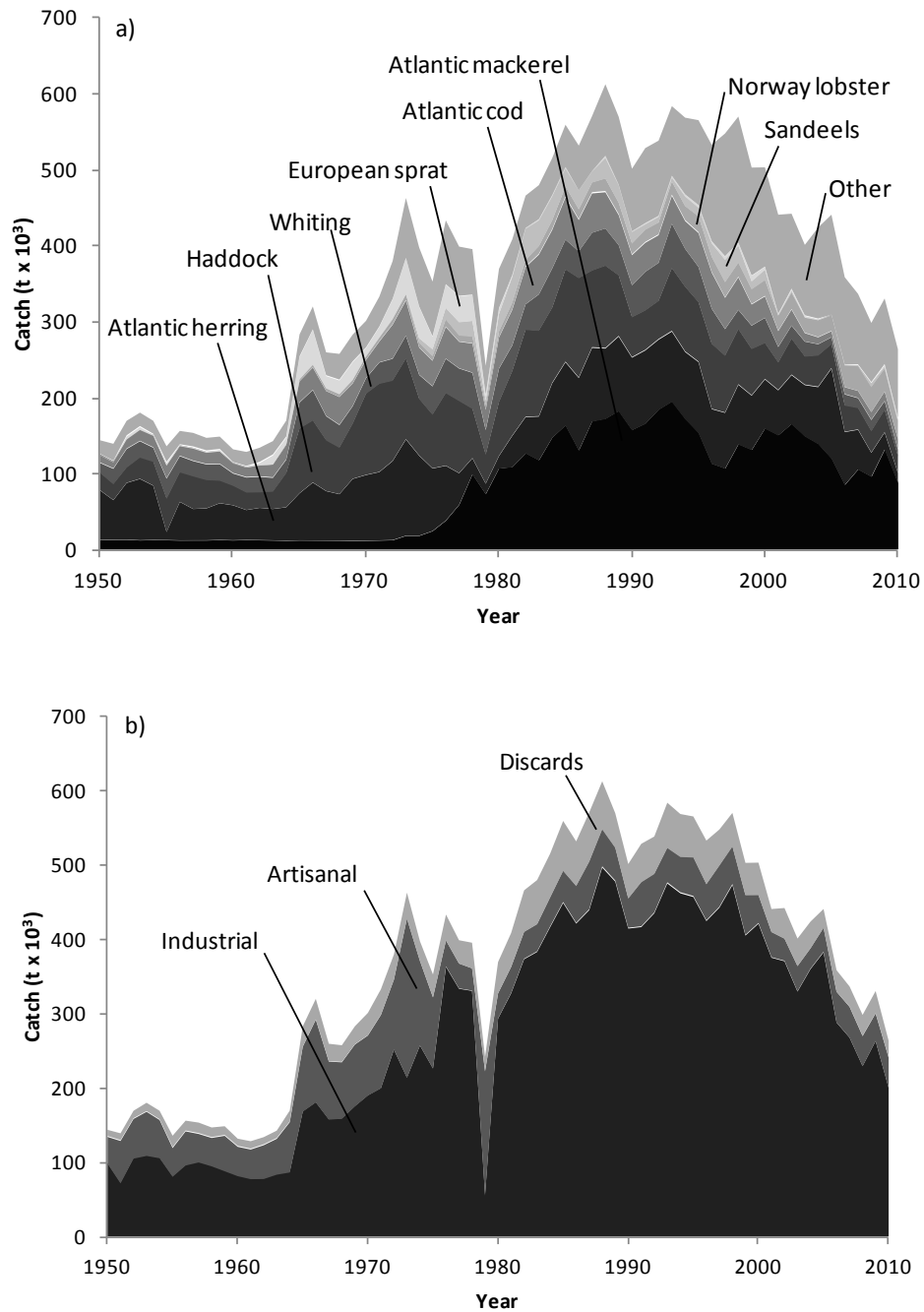


Figure 9. Total reconstructed catch of Scotland by a) major taxa and b) sector from 1950-2010.

Channel Islands

The catch of the Channel Islands increased steadily from 300 t in 1950 to 3,400 t in 2010 (Figure 10a). Edible spider crab and spinous spider crab support the main fisheries for the Channel Islands, making up 44% and 26% respectively of Channel Islands' total catch over the time series. Dredging for Great Atlantic scallop is another important fishery for the Channel Islands, making up 6% of the total catch (Figure 10a). The majority of the Channel Islands' catches are industrial (Figure 10b) mostly due to the large amounts of dredging for scallops.

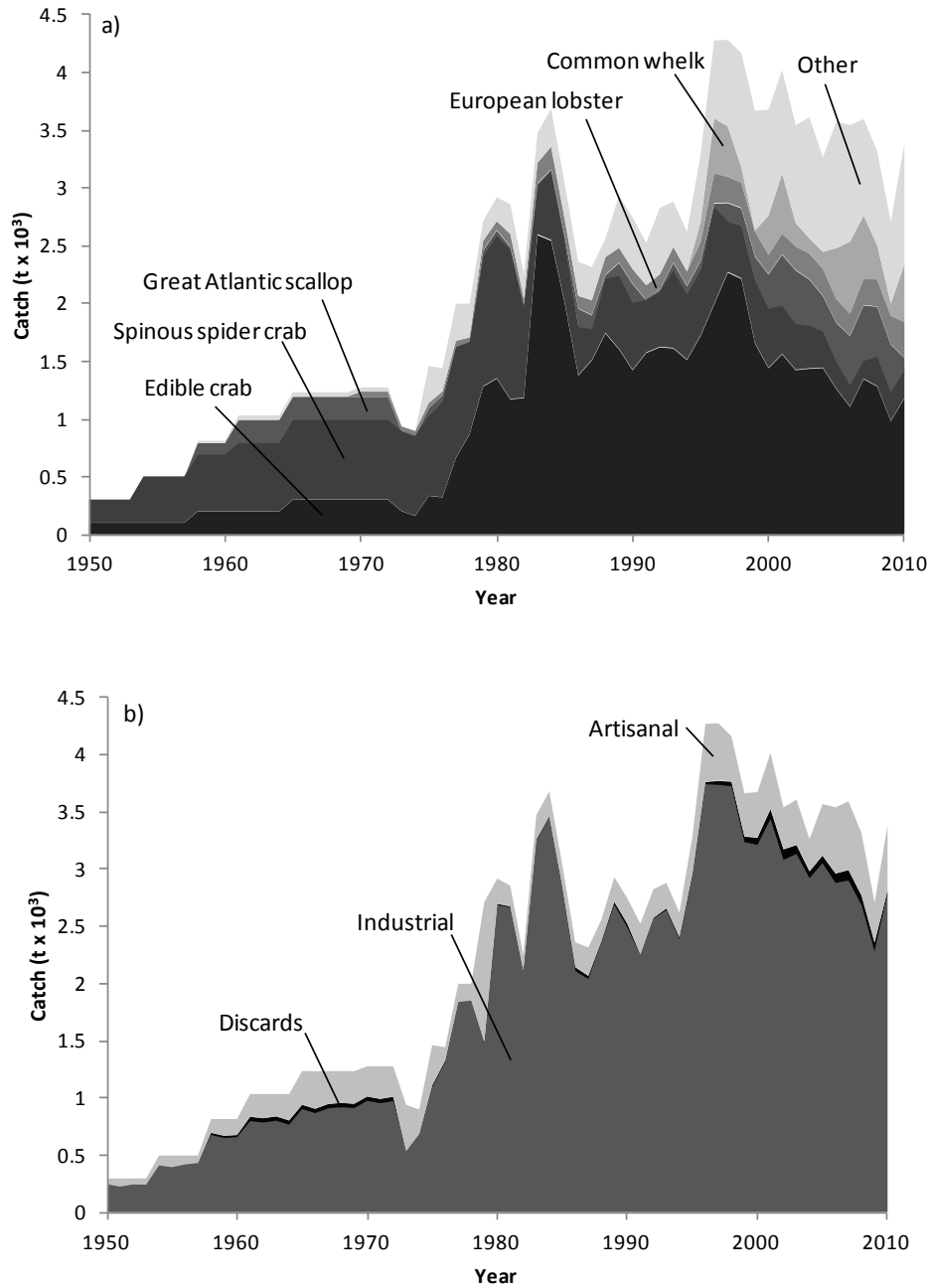


Figure 10. Total reconstructed catch for the Channel Islands by a) major taxa and b) sector from 1950-2010.

Isle of Man

The majority of the Isle of Man's catch comes from the Celtic Sea and consists of Atlantic herring and both queen scallop and Great Atlantic scallop. Total catch increases from 2,700 t in 1950 to a peak of 14,700 t in 1972, with Atlantic herring making up most of the catch over this time (Figure 11a). Catch then decreases to 5,000 t by 2010 which is comprised of 57% queen scallop and 19% Great Atlantic scallop (Figure 11a). The majority of catches from the Isle of Man are considered industrial due the large amounts of dredging for scallops and trawling for Atlantic herring and demersal species (Figure 11b).

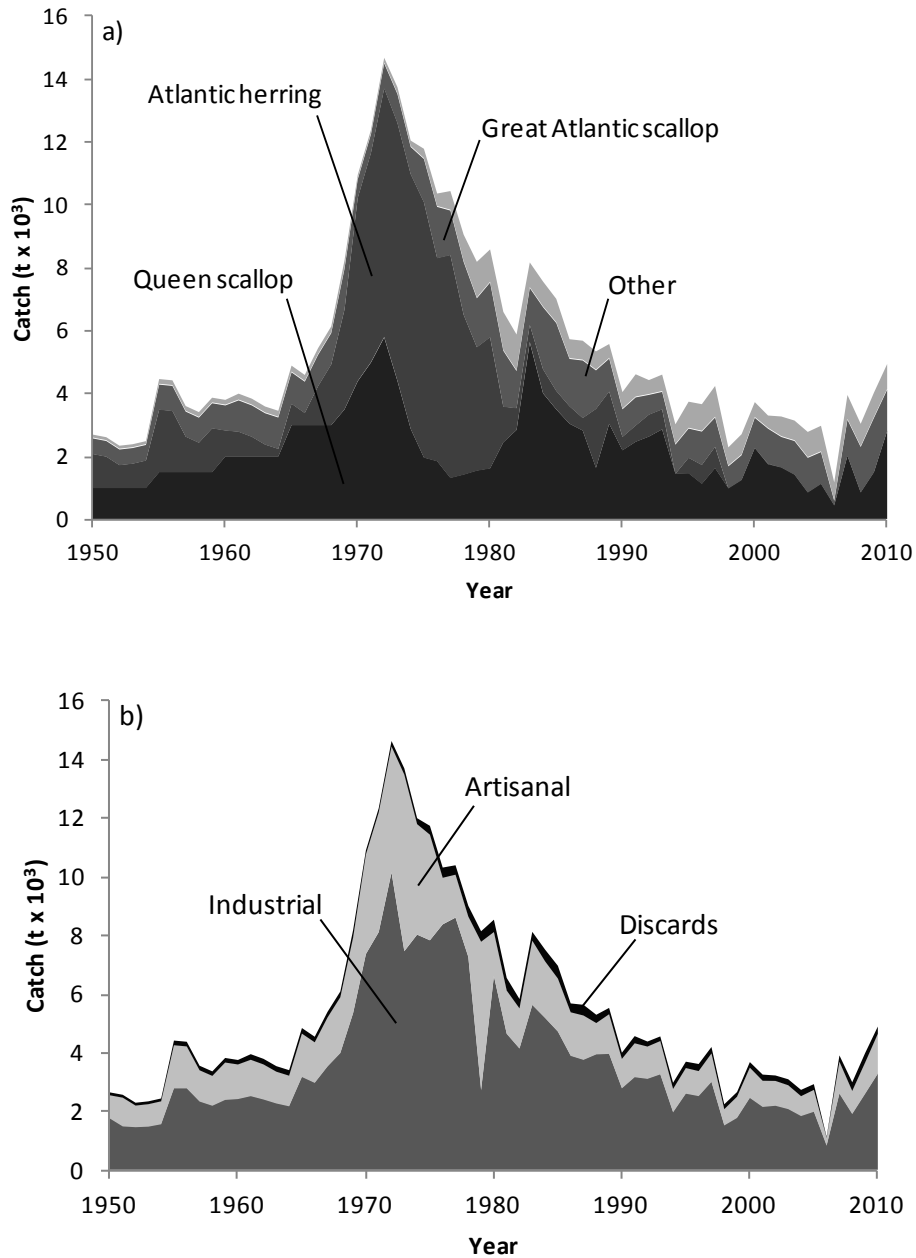


Figure 11. Total reconstructed catch for the Isle of Man by a) major taxa and b) sector from 1950 – 2010.

Discussion

The United Kingdom

The UK has a long history associated with fisheries, including the history of their industrialization. As a country comprised of a number of islands, fisheries provide an important resource to the UK. The total catches of the UK excluding the Channel Islands and including the Isle of Man were 35% higher than the reported data within their EEZ equivalent waters over the investigated time series. The total catches increased from 355,000 tonnes in 1950 to 430,000 tonnes in 2010. The catches peaked in 1995 at 950,000 tonnes and have been on a steady decline since then.

Unreported commercial landings comprise the largest portion of the reconstructed catch at 17% over the whole time series, with discards representing 7% and recreational catch 2%. Estimates of unreported Atlantic herring and Atlantic mackerel using the 'Blackfish' scandal as a proxy represent 17.7% of the unreported catch. The estimate of Welsh undeclared catch contributed 41.4% and recreational catches 6.6%. There were also many taxa unaccounted for from 1950-1975 within the recorded landings statistics which account for the 7.8%. Discards also comprise a significant part of the total unreported catch (26.4%) which is a very conservative estimate.

It is evident that the UK needs stricter regulation regarding landings. Species are currently reported in much finer detail than historically, which represents a significant improvement in reporting. The 2005 RBS legislation should also mean improvements in the reporting of landings. In this historical overview, we have evaluated three forms of unreported landings that had available data estimates. It can be assumed that there are unreported landings in other fisheries which were unaccounted for here. Therefore, we believe these estimates of unreported landings to be conservative. Estimates of discards for the more important commercial fisheries like herring, mackerel, demersal fishes, Norway lobster and scallop are all accounted for. This is still a conservative estimate, as it was likely that discarding practices were greater in 1983 with the introduction of quotas (Wood and Hopper 1984).

Scotland represents 56% of the total reconstructed catch over the time series for the UK; therefore it is also analyzed separately. Scotland has kept landings data separately from the rest of the UK for the whole time series. Scotland has even monitored the impact and amount of discards for the Nephrops fishery since the 1980s (Stratoudakis *et al.* 2001) and the demersal fishery since the 1990s through the Marine Laboratory in Aberdeen, Scotland (Fernandes *et al.* 2011). Scotland mostly targets Atlantic mackerel, which seemed to supplement the Atlantic herring fishery during its closure in the late 1970s (ICES 2012). However, Norway lobster is the most commercially valuable species (FAO 2004). Scotland has very detailed records of reported catch; however, the 'Blackfish' scandal highlights the importance of monitoring forms of illegal and unreported fisheries within their EEZ waters.

The UK as a whole keeps detailed landings data with a great deal of species specific landings. The data is complicated by England and Wales reporting landings together for the entire time series of 1950-2010 to ICES. This data is further complicated by Northern Ireland being reported to ICES independently from 1950-1988, then jointly with England and Wales from 1989-2010. There is no reason given for the shift to inclusion of Northern Ireland with England and Wales. It may have something to do with an event during the course of The Troubles, but this is not obvious, as self-government was restored in Northern Ireland in 1998 (Muldoon *et al.* 2007). The ICES landings data is reported in ICES management areas, which are more specific than the FAO management areas. However, the UK needs to report its landings by each of its components; which will help to increase transparency of data and demonstrate which country is catching what and where.

Channel Islands

The Channel Islands are analyzed separately here as they are outside of EEZ equivalent waters. Our preliminary reconstructed catch is only 1.3% higher than the reported landings from ICES from 1950-2010. However, the Channel Islands landings data from the ICES database is very unclear. There were reported landings from within ICES area VI a, which is the Northern Atlantic off the west coast of Scotland. These catches, along with some that appear to be double-counting in the early period, are further complicated by the fact that the Channel Islands are reported together from 1950-1974 as well as Guernsey being reported separately at this time. The catch in the earlier period, from 1950-1974 appears to be artificially estimated. We found no specific information in regards to discards, unreported catch or recreational catches within the Channel Islands. Therefore, we used estimates from similar fisheries elsewhere in the UK, (for example scallop dredging estimates) and applied them to the reported landings

from the Channel Islands. We assume that these are conservative estimates and further investigation is necessary for the Channel Islands reconstruction. Guernsey only enforced a licensing system within 12 nm in 2013. Before, there was a significant amount of fish caught by 'non-Bailiwick' vessels and Bailiwick vessels within Guernsey's waters (Anon. 2014a). In Jersey, individuals must have valid licenses for scallop diving but there are no records of quantity of these licenses or catches. However, these licenses are valid for 24 scallops per day.⁷ Clearly, there are further catch types to be analyzed in the reconstruction of the Channel Islands' fisheries.

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⁷ Information and public services for the Island of Jersey
<http://www.gov.je/Industry/FarmingFishing/Fishing/Pages/ScallopLicensing.aspx> Accessed 12 December 2014

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