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ESTIMATES OF TOTAL MARINE FISHERIES REMOVALS FROM THE NORTHWEST OF SPAIN, 1950-2010

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ABSTRACT

Northwest Spain, which includes the autonomous communities of Galicia, Asturias, Cantabria, and the Basque Country, is one the main fishing regions of the European Union (EU), providing vital economic, cultural, and livelihood opportunities to its people. The present paper 'reconstructed' total fishery removals within the Exclusive Economic Zone (EEZ) and EEZ-equivalent waters of northwest Spain. The reported baseline of landings, taken from the International Council for the Exploration of the Sea (ICES), was adapted to include only catch within the EEZ of Spain. Subsequently, unreported landings were calculated for the commercial sector (industrial and artisanal), their discards, and catch from the subsistence and recreational fisheries. Overall, unreported catch was nearly twice the reported landings (188%), mainly composed of unreported commercial catch and discards.

1 INTRODUCTION

Humanity has entered the Anthropocene era, a time period characterized by human activity as a major driving force behind many environmental changes on the planet (Rockström *et al.* 2009). Consequently, the future is uncertain as we approach potential catastrophic ecological thresholds, which may compromise human welfare for present and future generations (Leach *et al.* 2012).

In the case of marine social-ecological systems, capture fisheries have expanded at a rapid rate since the mid-20th century. As a result of substantial demand for wild-caught fish, the proportion of non-fully exploited stocks has decreased over time due to excessive fishing effort, which is estimated to exceed the optimum by a factor of three to four (Anticamara *et al.* 2011).

1.1 The importance of Spain in global fisheries

Spain is the fishing nation with the largest fleet in Europe in terms of tonnage (415,000 gross tonnes) and the capacity to operate in all the worlds' oceans. While many Spanish fleets operate in distant waters, coastal fleets are the emphasis of the present paper and are also key regions for fisheries catch. Unfortunately, coastal fisheries have become increasingly depleted throughout the 20th century, leading Spanish fleets to fish further away from shore than previously. In the process, the distant-water fleets have become very large, e.g., Spain has the largest tuna fishing fleet in Europe and one of the largest in the world (ranked 6th in terms of global catches).

Historically and to this day, much of Spanish's wealth comes from the health of its own marine ecosystems. The coastal regions not only provide an important contribution to Spain's marine biodiversity; fisheries also provide crucial economic, social, cultural wealth for many coastal communities along the Spanish coastline. The northwest of Spain, in particular, holds many dynamic fisheries and communities where the livelihoods of people are deeply intertwined with the sea.

1.2 The study area (northwest Spain)

The northwest of Spain, as defined here, encompasses four coastal autonomous communities, i.e., Galicia, Asturias, Cantabria, and the Basque Country, with access to the Northeast Atlantic Ocean to the west and the Cantabrian Sea (southern portion of the Bay of Biscay) to the north. Galicia is at the northern boundary of the Iberian–Canary current upwelling system. Seasonal winds promote coastal upwelling at these latitudes, influenced by the Gulf Stream deep-water currents coming from the North Atlantic surface loaded with nutrients. These nutrients are carried through Galician waters and coastline, which is distinctively dotted with a multitude of 'rías', or coastal inlets (Penas 1986), into the Cantabrian Sea and northern coast of Spain (Bode *et al.* 1996), which also boasts a highly varied morphology, ranging from cliff areas with beaches to marshes.

Our study area is depicted in Figure 1 and includes the water 200 nm from the coast of these regions, also defined as northwest Spain's Exclusive Economic Zone (EEZ). As can also be seen in Figure 1, the continental shelf, defined as the coastal zone to 200 m deep, is relatively narrow; its width varies between 20 and 35 km.

Figure 1. The Exclusive Economic Zone (EEZ) and shelf waters (to 200 m depth) of northwest Spain

1.3 Biological features of northwest Spain waters

In Galicia, the rías, which consist of old tectonic valleys currently below sea level from the last glaciations, are very productive due to wind-driven upwelling pulses (Fraga and Mergalef 1979). This upwelling process fertilizes the coastal and shelf areas with deep-water nutrients in discrete events occurring between March and October. The seasonality of surface winds favours certain biological production processes (Bode and Varela 1998), which result in high primary production in the Galician rías, and by extension the entire northwest region of Spain.

Primary production can reach 250 g C/m^2/year in the Ría de Arousa (Varela and Penas 1985), which is far higher than the average primary production observed in the Atlantic Ocean (100 g C/m^2/year) and is close to the estimated average for land ecosystems (Fraga and Mergalef 1979). However, in spite of the biological (Freire and García-Allut 2000) and socioeconomic (Villasante 2012; Macho *et al.* 2013) importance of the northwest small-scale fisheries seafood supply-demand sector and the high level of dependence on fishing activities in Europe, the ecological and economic features of fisheries have received little attention from the scientific community (López Veiga 1993).

1.4 The socio-economic importance of fisheries

The northwest of Spain is the main fishing region of the country and one of the largest in the European Union (EU). The high productivity of the coast, one of the most productive areas of plankton in the world, supports a large number of human settlements. Its communities have one of the highest levels of socio-economic dependence on fishing in Europe, not only due to high fish production and employment but also to the strong relationships between fisheries and other sectors of the local economy (Losada 2000). For example, in Galicia, the fisheries sector employs 4.6% of the active population, a figure which is higher than in any other European country (Seijas 1998).

1.5 Fisheries management

In the early 1980s, Spain initiated a process of decentralization and with this came the creation of distinct autonomous communities. The northwest coast of Spain is composed of four of these, i.e. Galicia, Asturias, Cantabria, and the Basque Country. These autonomous communities have exclusive competencies in the management of their waters; since 1982, the fisheries in each community are thus under regional administration.

Fishing and shell-fishing gathering are activities with a long tradition in the northwest, rooted in a population with a strong sense of 'ownership' of the marine resources. Prior to the decentralization process, fisheries regulations were very relaxed or largely non-existent; in most cases, there was no control of compliance to the law. Under this scenario, the transition from a traditional activity to the development of a professional sector encountered several obstacles, e.g., a high level of poaching and political instability, among others.

All fish and shellfish catches are landed by *cofradías*, essentially fisher guilds that act as socio-economic units. *Cofradías* play an important role in the commercialisation process, as each fisher guild has an associated first-sale market, *lonja*, where fish and shellfish are auctioned on a daily basis to various fish retailers, supermarkets, and restaurants.

The fisher associations are institutions of deep tradition in Galicia, and their existence dates back to the thirteenth century. These institutions evolved from a marked religious role in the early stages to become labour organizations and legal corporations for the fishers. Currently, fisher guilds are public law corporations, acting as organs of consultation and collaboration with each respective autonomous community government in the promotion of the fisheries sector, as well as representing the economic and corporate interests of professionals of the fishing sector.

1.6 Overview of commercial fishing

1.6.1 Artisanal fisheries

The small-scale coastal fisheries operating off the northwest coast of Spain are multispecies and multi-gear, exploiting a diverse range of species. Approximately 50 species are harvested for commercial purpose (Xunta de Galicia 1992). Among the most important species from an economic point of view are crustaceans, e.g., the velvet swimming crab (*Necora puber*), spinous spider crab (*Maja squinado*), and goose

barnacle (*Lepas anatifera*); bivalve molluscs, e.g., several species of clams, razor clams, scallops and cockles; cephalopods, e.g., octopus, cuttlefish, and squid; and fish (a number of species are exploited, but catches are generally low; there are no specific fisheries except for pouting (*Trisopterus luscus*) and European conger (*Conger conger*) (Freire and García-Allut 2000). Of all the species harvested only a few support fisheries that target only one species, essentially common octopus (*Octopus vulgaris*), spider crab, velvet swimming crab and goose barnacle.

The artisanal fleets operate in numerous coastal regions, including rías in Galicia, and shallow oceanic areas that range from the intertidal zone down to 60-80 m depth. The artisanal sector uses low to medium-level of technological equipment, consisting of gears handled by one or two people (the small crew is what makes this technique efficient). The artisanal fleet is comprised of small vessels (usually under 12 m in length) on average six meters in length, with daily activity from Monday to Friday and an average GRT of 2.4.

This sector in provides employment to large population in the northwest and feeds a complex economy, i.e., processing, marketing, transport, etc., in coastal villages and towns, some of which are totally dependent on fishing activities. In the northwest of Spain, most artisanal fisheries have a familiar structure and a system of profit sharing, *sistema a la parte*. This usually consists of productive units made up of very few fishers who are usually related to each other. In fact, the generic makeup of these types of vessels tends to constitute ideal models such as father-son(s), father-in-law-son(s)-in-law, cousins, brothers-in-law, etc., in addition to non-related crew members when various family households are unable to supply new members.

Fishing strategies in artisanal fisheries are characterised by diversification, with a varying patterns of activity (with respect to the species exploited, location of fishing grounds, and gears used) throughout the yearly fishing cycle. Depending on the seasonality of the resources and the regulations of each autonomous region, fishers use different gears and fishing methods throughout the year.

In the northwest, two general models for fisheries management co-exist. Whilst the majority of the marine resources are exploited according to a centralised management system, a different model has been used since the 1990s for a number of sedentary species, which include goose barnacles, sea urchin, razor clams and seaweeds. Generally, exploitation of these species is regulated through territorial users' rights and TAC/quota regulations. While many species exist in artisanal fisheries, below we have highlighted three iconic fisheries of the northwest Spain region, i.e., shellfish, common octopus, and goose barnacle.

The shellfish gathering ("marisqueo") sector in Galicia

Shellfish gathering has historically been considered marginal, as a complementary way to increase household incomes and performed without real administrative control. It was characterized by technological backwardness compared to other related activities, reflected in an aging workforce, high feminization, scarce professional and technological training, lack of investment, all which result in poor marketing, unity, and clear direction for the fisheries.

Traditionally, shellfish gathering can be done ‘on foot’ or ‘by boat’ depending on the area and resource exploited. Marisqueo ‘on foot’ is mostly carried out by women with very rudimentary tools in the intertidal area where the resource can be easily accessed. Marisqueo ‘by boat’ is performed mostly by men in the sub-littoral area.
Several types of conflicts have characterised the development of the activity, e.g., widespread poaching in the early years of the fisheries due to the lack of implementation of legislation, control, monitoring, or enforcement of laws and the co-existence of different types of gears. The latter created conflicts with respect to delineating the limits of exploitation zones for fishers on foot versus those operating from boats.

In the 1990s, when the Government of Galicia took management and administrative action, the marisqueo sector underwent unprecedented change. Prior to 1992, the system of exploitation of shellfish was based on ‘campaigns’, a combination of periods of extraction and closures, while under the new regulations, the system changed to ‘exploitation plans’ for each species and *cofradía*. Notably, annual exploitation plans, designed by *cofradías* and evaluated by fishery biologists working for the regional government, clearly define the number of authorised fishers, fishing grounds, economic and production objectives, stock assessments, number of working days, individual quotas per day, etc.

Despite the progress introduced with these new regulations in the shellfish-gathering sector, the fisheries were still characterised by low profitability and professional qualifications. Hence, in 1996, a technical project was launched that aimed at higher profitability and the professionalization of the sector by introducing innovations and training.

In the years to follow the sector experienced important improvements in terms of profitability and social security. The activity is no longer considered as marginal; fishers are organized in associations with control over the exploitation of the resources, and new generations are entering the profession. Nonetheless, the overexploitation of coastal resources is still driving many people without licenses to exploit shellfish. This increasing level of poaching in the last two years is threatening the stability of the sector.

Goose barnacle fishery

The goose barnacle (*Pollicipes pollicipes)*, is an intertidal filter-feeding crustacean. It inhabits the most exposed cliffs and reefs, in areas facing the open sea, where waves break with extreme violence. The goose barnacle is distributed on the Atlantic coast of Europe and North Africa, between 48ºN and 15ºN, and has a strong spatial structure, consisting of meta-populations sharing a common larval pool. Advection of larvae depends largely of oceanographic conditions that govern larval transport and survival.

The goose barnacles physiognomy is also unique, comprised of a well-developed capitulum with calcified plates for protection and a strong peduncle with a thick integument covered with small, calcified scales that contain the ovary (Barnes 1996). While goose barnacles are not very popular in most countries, in Spain and Portugal they are considered a delicacy and the price can reach 80 €/kg in first-sale auctions.

In northwest Spain, the regional government promoted a co-management system where responsibility for the exploitation of goose barnacle was shared between fisher´s guilds and the fisheries authority through territorial user rights for fishing (TURFs). Since 1992, the exploitation is granted to the *cofradías*, which set an annual plan of exploitation and management of the resource, daily allocation of effort, maximum individual quotas, surveillance and commercialization processes.

The harvesting technique for goose barnacles is simple yet risky, because the resource only occurs in very exposed areas. During low tide, fishers separate animals from the rock substrate with a scraper. Frequently, a fisher is held with a rope by another fisher in order to gain access to the most difficult sites. Prior to the start of harvesting, fishers make a visual inspection of the ground to detect aggregations composed mainly of commercial-sized barnacles (total length greater than four cm). Once the individual daily quota is attained (between three and 10 kg per fisher), they start an *in situ* selection of the catch, breaking aggregations to remove undersized goose barnacles and other organisms. Bycatch is a large portion of the harvest, peaking in bad weather conditions with bycatch accounting for approximately 50% of catch (Molares and Freire 2003).

Octopus fishery

The common octopus (*Octopus vulgaris*) is found in the eastern Atlantic from the Mediterranean Sea and southern coast of England to Senegal in Africa, also occurring off the Azores, Canary Islands, and the Cape Verde Islands. *O. vulgaris* grows to 25 cm in mantle length with arms up to one meter long. It is characterised by a short life cycle of no more than two years, depending on its geographical distribution. Furthermore, it is a terminal spawning species with males maturing earlier than females and being present throughout the year, and females maturing more seasonally. Spawning occurs all year round with two main peaks in spring and autumn, although its location and intensity varies upon on the study site (Otero *et al.* 2007).

The common octopus is one of the most important harvested cephalopods in the world, and it has great social and economic impact in the small-scale fisheries context of northwest Spain, especially in Galicia where catch averages almost 5,000 tonnes per year with an ex-vessel value of 13 million € (Otero *et al.* 2005).

The creel is the main gear used in the octopus fishery. The small-scale octopus fishery targets this species to a maximum depth of 150 m throughout Galician waters, including the rías. The vessels range from 0.3 to 46.6 gross registered tonnage (GRT), with a mean of 4.1 GRT. Boat lengths range between three and 20 m (mean 7.8 m). One to five fishers make up the crew, depending on the size of the boats.

There is a lack of specific exploitation plans or co-management systems in the northwest of Spain for this species (Otero *et al.* 2005). This is due to the complexity of the small-scale fisheries, incorporating a large number of human and biological fishing factors.

1.6.2 Industrial fisheries

Industrial fisheries include not only fishing fleets that operate in the Exclusive Economic Zone of northwest Spain (here referred to as the 'coastal industrial fleet'), but also outside the EEZ. Coastal industrial fleets operate typical industrial gears (trawl, purse seine, etc.) within the EEZ of Spain, and hence are included in the present reconstruction. Other fleets are based in the northwest of Spain, generally Galicia, as well as land their catch there, yet fish further beyond the EEZ of Spain, and hence are not included in the present reconstruction. Examples of this include both the high sea and deep-sea fisheries.

The high sea fleet of northwest Spain fish mainly in EU waters, although other fleets are present in West Africa and elsewhere worldwide. The Galician fleet is devoted mainly to capture fresh fish and operates in waters south and west of Ireland (Sub-ICES areas VI and VII), while the Cantabrian and other communities operate in the Bay of Biscay as well (sub-area VIII - divisions VIIIa and VIIIb).

Deep-sea fisheries consist mostly of freezer trawlers and tuna boats, operating primarily in North Atlantic waters of Svalbard, the Barents Sea, Iceland, in the NAFO fishing zone of Gran Sol; on ground in Angola, Morocco, Mauritania, Namibia, and Senegal in the southwest Atlantic fisheries in Falklands / Malvinas, Argentina and Uruguay through joint ventures; in the Indian Ocean, and in international waters outside the area of jurisdiction of Portugal, Spain and the Azores Islands. This fishing mostly takes place in international waters of the Atlantic, Indian and Pacific Oceans.

Where a given catch was taken is a key issue in stock assessment, and for management purposes. Since national fishing statistics for Spain are based on landing site and not fishing site, they include both coastal and non-coastal industrial catch in statistics, without indication as to where the catch was taken from, an issue addressed in the section below.

2 METHODS

2.1 Catch reconstruction approach

Pauly (1998) pointed out the problems associated with the global fisheries statistics of the Food and Agriculture Organization of the United Nations (FAO) and presented concepts and an approach for 'reconstructing' fishing statistics to include catch not well covered in the global FAO database. This approach was applied to numerous countries and territories from around the world to (re)estimate official fishing statistics (Zeller *et al.* 2007; Zeller and Pauly 2007); other publications can be viewed at www.seaaroundus.org.

Our analysis uses this catch reconstruction approach as applied to the northwest coast of Spain. This approach requires occasional assumptions and interpolations, which are noted in the methods. Despite uncertainties, this method generates results that are preferable to the alternative, where non-reported or missing data are interpreted as zero catch (Zeller and Pauly 2007). Including previously unreported catches is vital, as total fisheries removals are the most fundamental data in assessing the impact of fishing on exploited ecosystems. While we do not claim that the reconstruction provides 'true' catches, these catch estimations certainly represent an improvement over the presently available data and thus can be considered closer to actual catch levels (Zeller and Pauly 2007).

To estimate total fisheries removals from our study area, we followed the catch-reconstruction approach documented in previous studies that consists of six general steps:

(i) Collection of time series of available reported landings from regional (i.e., AR, *cofradías*), national (MARM and other government bodies) and international (FAO) agencies;

(ii) Identification of those fisheries sectors and components that currently produced or could have produced unreported removals using literature searches and secondary data sources (i.e., informal interviews with fishers and fisheries experts, newspapers, and personal observations during visits to harbours, *cofradias* and *lonjas*);

(iii) Searches for available alternative information regarding those sectors and components that produced unreported removals;

(iv) Collection of alternative estimates and development of anchor points in time for missing data;

(v) Interpolation between anchor points for time periods to estimate the different components of unreported removals;

(vi) Estimation of total fisheries removal time series as the sum of total reported landings and unreported removals.

For each year, we defined total fisheries removals (*TR*) as the sum of total fisheries landings (*TL*) and total discards (*TD*) for *S* caught species and *F* number of fishing fleets as follows:

$$TR = \sum_{s=1,\, f=1}^{S,N} (TL + TD) \tag{1}$$

TL for *S* caught species and *F* number of fishing fleets was composed by the following elements:

$$TL = \sum_{s=1,\, f=1}^{S,N} (OL + UL) = \sum_{s=1,\, f=1}^{S,N} (OL + BM + IC + AC + RC + SF) \tag{2}$$

where *OL* is official landings and *UL* is unreported landings. *UL* is composed of unreported catches by the domestic fleet that go to the black market (*BM*) and illegally caught species (*IC*) by foreign fleets in the relevant waters. It also includes artisanal catch (*AC*) not reported in OL, as well as recreational catch (*RC*) and subsistence fishing (*SF*), e.g., the personal consumption of seafood by fishers and their families.

TD for *S* caught species and *F* number of fishing fleets is composed of the following elements:

$$TD = \sum_{s=1,\, f=1}^{S,N} \left(D + PM + GF \right) \tag{3}$$

where *D* is direct boat-based discards from fishing activities (Kelleher 2005), *PM* is underwater discards, of those specimens that die after escaping from fishing nets due to physical damages (Suuronen 2005) and *GF* is ghost fishing mortality of those specimens that die due to lost or abandoned gear or the loss of fishing gear at sea (Macfadyen *et al.* 2009).

We considered all the elements of *TR* that are not included in *OL* as unreported landings. To calculate *TR*, we collected and compiled all material available, from primary literature and official sites, final projects report, grey literature, statistics from regional institutions, estimates from experts, observations in harbour areas and markets, and opinions of local fishers and fisheries experts collected through informal interviews. This study does not include catch from aquaculture activities or species of marine mammals, seabirds, marine turtles, worms, or various seaweed species.

2.2 Reported catch for northwest Spain

There are several differing reported data sources on fisheries landings in northwest Spain. First, there are national data sources, which date back to 1829, although substantial gaps in the data exist from year to year. In 1932, when the Spanish Institute of Oceanography (IEO) began publishing data in its *Fisheries Bulletin,* they gradually crystallized into the format now used: fishing regions division breakdown by fish, crustaceans and molluscs, production figures broken down by years, months, species, gear, etc. Although the Spanish Civil War once again forced a cessation in these publications and hence another data gap, fisheries statistics reappeared in 1940 and were published uninterruptedly until 1986 in what is also known as Spain's *Fishery Yearbook*.

Initially, the fishery statistics for all of the autonomous communities were collected in Marine Fisheries Yearbooks published annually the former Ministry of Agriculture and Fisheries from 1950 to 1986. This information contained detailed data on the number of vessels, port capacity, and taxa captured, which is valuable information for understanding the reality of fishing in northwest Spain. However, after the entry of Spain into the European Economic Community, the Ministry stopped publishing these detailed yearbooks and only decided to provide information on total landings by autonomous communities, ports and species, which significantly reduced the openness and transparency of the fishery statistics in Spain. Additionally, data gaps exist from 1986 to the time when autonomous communities began to publish their own data. In Galicia, for example, this gap lasted a decade; Galicia began to publish its own official data in 1997. This limitation in the later time period, coupled with the limiting factor that Spanish national data do not distinguish coastal from offshore catch (López Losa 2001), makes the use of national data as a reported baseline problematic.

Hence, we looked at other data sources to construct a reported baseline of catch in northwest Spain. Globally, nations have reported their marine fisheries catches to the Food and Agriculture Organization of the United Nations (FAO) since 1950, in addition to reporting to various regional bodies. For the northeast Atlantic (FAO Area 27), the primary regional body is the International Council for the Exploration of the Sea (ICES) which maintains a publicly accessible database of fisheries catches over time. The FAO and ICES databases provide similar data, each reporting landings by country, taxon, year, and fishing area from 1950 to 2010. However, ICES data provides much more detailed fishing area information than FAO. Since fleets from Northwest Spain have historically fished outside of the Spanish Exclusive Economic Zone or EEZ-equivalent waters, i.e., France, Ireland, the United Kingdom, etc., we utilized the ICES data as our reported baseline for the present reconstruction.

ICES data for Spain as the fishing entity were obtained from 1950 – 2010 and any species of seaweed and corals were removed from the data, as these are not included in the *Sea Around Us* reconstructions of marine fisheries. This resulted in 310 species in for FAO Area 27 and 256 species for ICES catch data within northwest Spain's EEZ.

As can be seen in Figure 1, the catch of ICES sub-division VIII c is nearly all in the Northwest Spanish EEZ, while subdivisions VIII e and VIII d only partially within the EEZ (we assumed approximately one third of catches based on a spatial approximation). This is conservative, as it is more cost-efficient for Spanish fleets to fish closer to than further away from shore given a similar species distribution. Furthermore, regions IX a and Ix b are also partially within the Spanish EEZ, yet the ICES Division IX falls within both the Portuguese EEZ as well as the Spanish EEZ in the Southwest Bay of Cadiz. Due to this complexity, the reconciliation of where catch was taken will not be handled in the present reconstruction, and rather in future stages when all ICES data are compared.

Prior to applying these assumptions to the ICES data, however, a few adjustments were made to the data to reconcile reporting inconsistency from the earlier and later time period. Specifically, from 1950 – 1988 all catch in ICES area VIII was reported as area 'VIII not specified' while from 1989 – 2010 catch was mostly divided into specific ICES subdivision, e.g., 'VIII a', VIII b, VIII c, etc. Thus, from 1950 – 1988, we used the average of the regional distribution from 1989 and 1990 in each subdivision to disaggregate the entirety of catch in ICES region VIII from 1950-1988. Furthermore, from 1989 – 2010 there were a few instances when a small portion of catch was labelled as 'VIII not specified,' and in order to be consistent we also disaggregated catch in these case by using the spatial distribution of catch for that year, i.e., 50 t of catch in 1999 would be disaggregated by the subdivision breakdown of catch in 1999.

2.3 Commercial fisheries (artisanal and industrial sectors)

The literature contains many definitions of artisanal fishing (Chuenpagdee *et al.* 2006) that differentiate it from industrial fishing, although these definitions vary between country and region. Artisanal fishing it is often defined as a traditional activity for sale in local market or one that uses passive gears (Orensanz *et al.* 2005). In this study for northwest Spain, small-scale fishing is defined "as the group of vessels which catch species whose life cycle of maturity develops in the Galician continental shelf and not

beyond 200 m deep" (Villasante 2009). Per this definition, certain species, generally sedentary and close to shore, were classified via expert assessment as 'artisanal', while all others were marked as catch from 'industrial' operations.

2.4 Unreported catch within EEZ of Spanish northwest

Unreported catch includes a variety of sectors, e.g., unreported commercial catch (industrial and artisanal), discards, and other small-scale fisheries for the purpose of subsistence or recreation. The methodology for estimating unreported catch is described in detail in the following sections.

2.4.1 Commercial unreported catch

Unreported commercial catches in the northwest of Spain can fall into two categories: not reported to ICES, and not reported at all. Since the present paper used ICES data as the reported baseline, there are several instances when catches unreported in ICES data are actually reported in national Spanish data. These data are hence considered 'unreported' in the present paper, but is still easily quantified, as it was reported to Spain. Another instance of unreported commercial catch is when catch was entirely unreported to any reporting agency, and hence was reconstructed using a variety of assumptions.

Unreported FAO Area 27 catch to ICES

According to López Losa (2001), certain species are not reported in ICES Spanish data from 1950 - 1977, yet are present in the Spanish Fishery Yearbook data during this time period. These species include Atlantic horse mackerel (*Trachurus trachurus*), Atlantic mackerel (*Scomber scombrus*), European hake (*Merluccius merluccius*), European pilchard (*Sardina pilchardus*), albacore (*Thunnus alalunga*), blue whiting (*Micromesistius poutassou*), and European anchovy (*Engraulis encrasicolus*). Furthermore, "very little of this discrepancy can be accounted for by categorizing fish as 'unidentified', 'various; or 'unsorted' instead of their proper species label" (López Losa 2001). This essentially means that any catches of the above mentioned species were not simply labelled elsewhere in the ICES data in a more general taxonomic classification, and hence was truly unreported in the ICES data.

We accounted for this by comparing the Spanish ICES data for all regions with that of the Spanish Fishery Yearbook data (in Galicia) for all relevant species.

Albacore
Comprehensive data for albacore were available starting in 1962 for ICES, while data in the Spanish Yearbook for Galicia were available since 1950. From 1962 – 1976 nearly all the catches (99.8%) were caught in ICES region VIII with sub region unspecified, which would mostly fall within the Spanish EEZ. Hence, for the time period from 1950 – 1961 we assigned all albacore catches by the Galician fleet in the Spanish Yearbook of Fisheries as 'unreported landings' in the ICES data. This was equivalent to an average of 4,125 t, a minimum of 1,093 t to a maximum of 6,546 t within the years

1950 – 1961. There were some years when ICES began reporting data where Spanish Fishery Yearbook data was higher than ICES data, but these years were an exception and hence conservatively excluded from this analysis.

Blue whiting
A similar situation as for albacore was present for blue whiting, where ICES catch only began in 1963 while Spanish Fishery Yearbook data were present since 1950. Regionally, starting in 1963 through the 1960s when ICES data were present, about 95% of the catch was in ICES region VIII and the other 5% in IX, presumably within the EEZ. Hence, we applied the same methodology for albacore to blue whiting catch, with the addition of assuming that 95% of the unreported catch was in ICES region VIII and the other 5% was in region IX a, which was what the ICES data showed for the first year of catch in 1963. There were some years when ICES began reporting data where Spanish Fishery Yearbook data were higher than ICES data, but these years were an exception and hence conservatively excluded from this analysis.

Other species
In comparing the other mentioned species in López Losa (2001), the discrepancies were more arbitrary, as both ICES and Spanish Fishery Yearbook had data for the relevant years, yet Spanish Fishery Yearbook data were higher for some years. Such data discrepancies were less clear cut and hence no 'unreported' catches were added to ICES data.

Unreported catch

In an attempt to provide a first quantification of unreported catch in the northwest of Spain, we carried out a literature research along with a series of interviews in Galicia of fishers and government employees throughout 2009. Our findings indicate that unreported catch in northwest Spain is present, with evidence of unregulated marketing and sales channels. Species sold via these channels include sedentary species like oysters and mussels, or resources of high economic value as the goose barnacle in Roncudo.

Furthermore, nearly all species, based on general taxonomic classification were subject to unreported catches. Therefore, we used the information retrieved from fishers' interviews to estimate unreported catches from the professional sector by species. Each species was assigned a certain ratio of unreported catch as a percentage of landed catch, which was held constant throughout time unless there were data that indicated a different, higher amount. The latter occurred in the case of octopus and hake (1950 – 2010), and European anchovy (years 2005, 2007 – 2009). This ratio was applied to the baseline reported data, as well as the unreported portions of albacore and blue whiting.

2.4.2 Recreational and subsistence fisheries

Calculations of catch for the subsistence and recreational fisheries were gleaned from fisher interviews for Galicia. This was extended to the entire northwest coast (as to include Asturias, Cantabria, and the Basque Country) by using population as a proxy for magnitude of catch. Population anchor points were used for the years 1981, 1991, 2001, and 2011 from (http://www.citypopulation.de/Spain-Cities.html) and in between these

years population was interpolated. We then constructed a ratio of the population in northwest of Spain to population in Galicia alone. Prior to 1981 this ratio was assumed to be the same as in 1981. Then this ratio was applied to the estimated recreational and subsistence catch that was calculated for Galicia.

2.4.3 Discards

Discards rate calculations were taken from Vázquez-Rowe et al. (2011), who assembled discard rates by fleet for the Galician fisheries. We utilized data from the coastal fleet, which is composed of the trawling fleet, purse seining, trolling, and artisanal fleet, each with a discard rate of 42.1%, 3.2%, 0.0%, and 3.6% of total catch. We estimated artisanal discards separately, applying the discard rate of 3.6% of catch (equivalent to 3.8% of landings) to all artisanal landings. Since no species specifications were given, we assumed these species were miscellaneous marine fishes (MMF), labelled 'marine fishes not identified' in the data.

The remaining coastal fleets (trawling fleet, purse seining, trolling) were considered industrial fleets, each contributing 52%, 46%, and 2% to total landings, as per Vázquez-Rowe et al. (2011). The discards of the industrial landings was calculated by taking a weighted average of the discard rates for each fleet, resulting in an overall discard rate at 28% of catch (40 % of landings).

Species were also considered in this weighted average. According to skippers and fishers of the trawl fleet, discards were mainly composed of juvenile hake and hake catches above the specified quota, along with other MMF, both non-marketable fishes and juveniles (Vázquez-Rowe *et al.* 2011). We assumed 75% of discards were hake and 25% were miscellaneous fishes. Purse seine discards were mostly composed of juvenile European pilchard, Atlantic horse mackerel, Atlantic mackerel, in addition to low value species like bogue (*Boops boops*) and other highly damaged or above quota species (Vázquez-Rowe *et al.* 2011). We assumed this roughly corresponded to an equal split between European pilchard, Atlantic horse mackerel, Atlantic mackerel, bogue, and MMF. The results of this can be seen in Table 1, which presents discard rates by taxon for the industrial fleet.

Table 1. Taxonomic composition of commonly discarded fishes in the industrial fisheries of Spain's northwest Exclusive Economic Zone, 1950 -2010.

Common name	Species name	Composition of discards (%)	Discard rate of industrial landings (%)
European hake	*Merluccius merluccius*	72.2	28.5
Marine fishes	Marine fishes not identified	24.8	9.8
European pilchard	*Sardina pilchardus*	0.8	0.3
Atlantic horse mackerel	*Trachurus trachurus*	0.8	0.3
Atlantic mackerel	*Scomber scombrus*	0.8	0.3
Bogue	*Boops boops*	0.8	0.3
		100.0	39.5

As stated previously, ICES areas VIII c, VIII d (partial), VIII e (partial), and IX (partial) jointly cover the entire EEZ of northwest Spain, and thus basing this reconstruction on reported ICES data enabled us to extend the observations made for Galicia to the entire northwest coast of Spain. In particular, since commercial fisheries in Galicia account for

approximately 70% (or higher) of total commercial catch in northwest Spain, this further justified the extension of similar rates of underreporting and discarding in Galicia to the study area. Furthermore, for the recreational and subsistence fisheries, we assumed the per capita catch rate in Galicia was representative of the entire northwest Spanish coast due to similar cultural norms in the catch and consumption of fish.

3 RESULTS

Reconstructed total catch increased from 484,000 t·year^{-1} in the 1950s to an average of 631,000 t·year^{-1} in the 1960s annually, thereafter declining throughout the 1970s to a level of 273,000 t·year^{-1} from 1980 to 2010 (Figure 2a). Reconstructed catch for northwest Spain was nearly twice (188%) the reported amount deemed within the Spanish EEZ (see methodology for reported data). Unreported industrial landings account for about 41% of the unreported amount, unreported artisanal landings are just under 4%, discards account for 54%, recreational catch for 1%, and subsistence was existent yet negligible (<1%) in total unreported catch. A detailed tabular representation of reconstructed catch by sector can be seen in Appendix I.

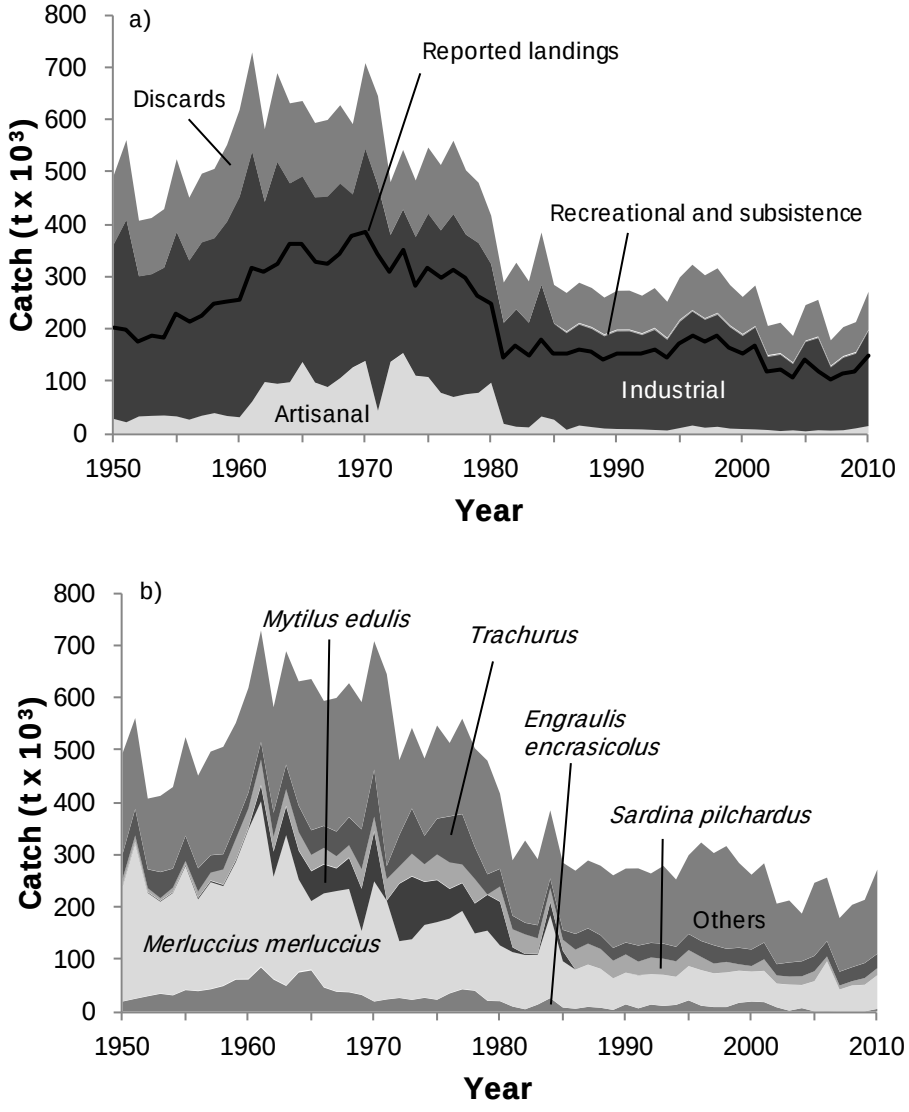

Figure 2. Reconstructed total catch for the northwest of Spain for 1950 to 2010, by a) sector, with official reported data overlaid as line graph; and b) major taxa, with 'others' consisting of over 254 additional taxa.

Reconstructed catch was predominantly composed of European hake (*Merluccius merluccius*, 31%), followed by jack and horse mackerels (*Trachurus*, 12%), European pilchard (*Sardina pilchardus*, 6.4%), European anchovy (*Engraulis encrasicolus*, 6.0%), and blue mussel (*Mytilus edulis*, 5.4%) (Figure 2b). These taxa accounted for about 58% of catch, while the remaining 42% of catch was composed of over 250 additional taxa in smaller proportions than the major taxa. A tabular version of Figure 2b can be referred to in Appendix II.

4 DISCUSSION

This study is a first estimate of total fisheries removals from the northwest of Spain from 1950 to 2010, which is nearly twice the reported 'baseline' catch spatially allocated from ICES data. Unreported catch of commercial species accounts for over 40% of the discrepancy between reported catch and reconstructed catch, thus making this a key opportunity for improvement for improving the quality of landings statistics. This is coupled with the indication from interviewed fishers that a black market for seafood exists in the region, a fact also confirmed with personal observations in harbour areas. Representatives of the Spanish and regional government have stated in the past that unreported catches are a key issue (MAPA 2007), but no clear measures have been adopted to estimate these catches and incorporated in the official statistics.

The role of discards in unreported catch is also substantial (54% of unreported catch), composed mostly of European hake from industrial trawl operations. These fisheries are a ripe area for future research, as there may be an opportunity to understand how to minimize discards of this commercially valuable and readily-consumed species. Furthermore, recreational fishing, although only 1% of unreported reconstructed catch, is still significant from a cultural perspective. Furthermore, given coastal over-exploitation, unreported recreational fishing can be damaging to certain stocks, especially vulnerable species and those in upper trophic levels commonly targeted by recreational fishers.

From a management perspective, any potential improvements in the reporting of data will have to be made at the autonomous community level due to the current structure of fisheries management. This may prove difficult in some regions like Galicia, where the Xunta de Galicia defines the regulations for fishing, despite lack of scientific data and biological knowledge on the stocks and coastal ecosystems of Galicia. Hence, mainly political criteria and lobbies drive regulation (Freire and García-Allut 2000). There is growing evidence that many of the target stocks of coastal fisheries in Galicia are being overharvested or caught with methods that produce significant impact on the environment (Cambiè et al. 2012).

On the other hand, evidence from the past also shows that the more involvement fishers have with the management of the resource on a regional level, the more healthy is the stock, especially in artisanal fisheries. This is seen in goose barnacles fisheries managed by cofradías under TURFs, where the use of exploitation plans has indicated positive production in both biomass and economic value since 1995 onwards (Molares and Freire 2003), although during this period cases of over-exploitation of some specific grounds have been recorded.

Furthermore, in this context where most commercial species are overfished, some fisher's associations have developed their own initiatives. The fisher's guild of Lira, to combat overfishing, poaching, and environmental degradation, e.g., the Prestige oil spill, has pioneered a co-management initiative in the region by proposing the creation of a marine reserve, o*s Miñarzos*. The proposal was designed and developed by the fishers in partnership with biologists, social scientists, environmentalists, and member of the autonomous government of Galicia. Such initiatives are paving the way for healthy coastal stocks in a leading fisheries country of the EU. Hopefully, with more accurate catch statistics, this trend will continue in the years to come.

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REFERENCES

Anticamara JA, Watson R, Gelchu A and Pauly D (2011) Global fishing effort (1950–2010): trends, gaps, and implications. Fisheries Research 107(1): 131-136.

Barnes M (1996) Pedunculate cirripedes of the genus Pollicipes. Oceanography and marine biology 34: 303-394.

Bode A, Casas B, Fernández E, Marañón E, Serret P and Varela M (1996) Phytoplankton biomass and production in shelf waters off NW Spain: spatial and seasonal variability in relation to upwelling. Hydrobiologia 341(3): 225-234.

Bode A and Varela M (1998) Primary production and phytoplankton in three Galician Rias Altas (NW Spain): seasonal and spatial variability. Scientia Marina 62(4): 319-330.

Cambiè G, Ouréns R, Vidal DF, Carabel S and Freire J (2012) Economic performance of coastal fisheries in Galicia (NW Spain): case study of the Cíes Islands. Aquatic Living Resources 25(02): 195-204.

Chuenpagdee R, Liguori L, Palomares ML and Pauly D (2006) Bottom-up, global estimates of small-scale marine fisheries catches. Fisheries Centre Research Reports 14(8): 105.

Fraga F and Mergalef R (1979) Las rías gallegas. pp. 101-121 *In* Estudio y explotación del mar en Galicia. Universidad de Santiago de Compostela. Servizo de Publicacións e Intercambio Científico.

Freire J and García-Allut A (2000) Socioeconomic and biological causes of management failures in European artisanal fisheries: the case of Galicia (NW Spain). Marine Policy 24(5): 375-384.

Kelleher K (2005) Discards in the world's marine fisheries: an update. Food & Agriculture Org.

Leach M, Rokstrom J, Raskin P, Scoones IC, Stirling AC, Smith A, Thompson J, Millstone E, Ely A and Arond E (2012) Transforming innovation for sustainability. Ecology and Society 17(2): 11.

López Losa E (2001) Spanish fisheries in ICES area VIII, 1950-1999. pp. 177-186 *In* Zeller D, Watson R and Pauly D (eds.), Fisheries impacts on North Atlantic ecosystems: catch, effort and national/regional data sets, 9(3) edition. Fisheries Centre Research Reports.

López Veiga EC (1993) Plan de ordenación de los recursos pesqueros y marisqueros de Galicia. Galicia Consejería de Pesca, Marisqueo y Acuicultura, Santiago de Compostela. 880 p.

Losada A (2000) La política del mar. Políticas públicas y autonomía. El caso de la pesca gallega. Edn. Istmo Col. Fundamentos n◦173.

Macfadyen G, Huntington T and Cappell R (2009) Abandoned, lost or otherwise discarded fishing gear. Food and Agriculture Organization of the United Nations (FAO).

Macho G, Naya I, Freire J, Villasante S and Molares J (2013) The key role of the Barefoot Fisheries Advisors in the co-managed TURF System of Galicia (NW Spain). Ambio 42(8): 1057-1069.

Molares J and Freire J (2003) Development and perspectives for community-based management of the goose barnacle (*Pollicipes pollicipes*) fisheries in Galicia (NW Spain). Fisheries Research 65(1): 485-492.

Orensanz J, Parma AM, Jerez G, Barahona N, Montecinos M and Elias I (2005) What are the key elements for the sustainability of 'S-fisheries'? Insights from South America. Bulletin of Marine Science 76(2): 527-556.

Otero J, González ÁF, Sieiro MP and Guerra Á (2007) Reproductive cycle and energy allocation of *Octopus vulgaris* in Galician waters, NE Atlantic. Fisheries Research 85(1): 122-129.
Otero J, Rocha F, González ÁF, Gracia J and Guerra Á (2005) Modelling artisanal coastal fisheries of Galicia (NW Spain) based on data obtained from fishers: the case of Octopus vulgaris. Scientia Marina 69(4): 577-585.
Pauly D (1998) Rationale for reconstructing catch time series. EC Fisheries Cooperation Bulletin 11(2): 4-7.
Penas E (1986) Modelo preliminar del ecosistema de la plataforma continental de Galicia. Boletino del Instituto Espanol de Oceanografia 3(1): 43-56.
Rockström J, Steffen W, Noone K, Persson Å, Chapin III FS, Lambin E, Lenton TM, Scheffer M, Folke C and Schellnhuber HJ (2009) Planetary boundaries: exploring the safe operating space for humanity. Ecology and Society 14(2): 32.
Seijas VV (1998) The future for fisheries-dependent communities: the fisheries-dependent region of Galicia. Journal of Northwest Atlantic Fishery Science 23: 175-184.
Suuronen P (2005) Mortality of fish escaping trawl gears. Food & Agriculture Org.
Varela M and Penas E (1985) Primary production of benthic microalgae in an intertidal sand flat of the Ria de Arosa, NW Spain. Marine Ecology Progress Series 25(2): 111-119.
Vázquez-Rowe I, Moreira MT and Feijoo G (2011) Estimating global discards and their potential reduction for the Galician fishing fleet (NW Spain). Marine Policy 35(2): 140-147.
Villasante S (2009) Magnitud e implicaciones de la política pesquera comunitaria: aplicación de indicadores de sostenibilidad sobre el metabolismo de los ecosistemas marinos. Universidad de Santiago de Compostela.
Villasante S (2012) The management of the blue whiting fishery as complex social-ecological system: The Galician case. Marine Policy 36(6): 1301-1308.
Xunta de Galicia (1992) Plan de ordenación dos recursos pesqueiros e marisqueiros de Galicia. Consellería de Pesca, Marisqueo e Acuicultura, Xunta de Galicia, España.
Zeller D, Booth S, Davis G and Pauly D (2007) Re-estimation of small-scale fishery catches for US flag-associated island areas in the western Pacific: the last 50 years. Fishery Bulletin 105(2): 266-277.
Zeller D and Pauly D, editors (2007) Reconstruction of marine fisheries catches for key countries and regions (1950-2005). Fisheries Centre, University of British Columbia. 163 p.

Appendix Table A1. Reported landings and reconstructed catch by sector for the northwest region of Spain, 1950 to 2010.

Year	FAO landings	Reconstructed total catch	Artisanal	Industrial	Recreational	Subsistence	Discards
1950	200.767	495.000	28.690	333.000	31	12	133.000
1951	200.611	562.000	22.350	386.000	10	14	153.000
1952	175.979	407.000	33.470	267.000	-	11	107.000
1953	186.738	413.000	34.520	270.000	72	54	108.000
1954	182.100	430.000	35.210	282.000	1	8	113.000
1955	229.713	525.000	33.510	352.000	21	-	140.000
1956	215.003	452.000	27.330	303.000	30	12	121.000
1957	225.587	498.000	34.810	331.000	109	-	132.000
1958	246.862	507.000	39.750	334.000	139	1	133.000
1959	251.940	553.000	34.280	370.000	104	-	148.000
1960	255.258	620.000	31.910	420.000	45	-	167.000
1961	316.089	730.000	61.680	477.000	8	-	191.000
1962	308.386	583.000	98.900	344.000	666	45	139.000
1963	323.534	690.000	95.600	423.000	633	-	171.000
1964	364.000	632.000	98.500	379.000	717	582	153.000
1965	361.423	637.000	137.000	354.000	448	-	145.000
1966	328.567	595.000	98.000	353.000	314	-	143.000
1967	325.443	601.000	89.400	364.000	499	-	147.000
1968	344.179	629.000	106.300	372.000	226	-	151.000
1969	377.859	593.000	126.900	330.000	60	-	135.000
1970	386.204	709.000	139.200	405.000	87	-	165.000
1971	343.496	646.000	44.370	429.000	1.320	-	171.000
1972	307.825	481.000	137.400	242.000	1.150	-	101.000
1973	350.970	543.000	154.200	274.000	1.150	-	114.000
1974	284.174	485.000	111.000	265.000	160	-	109.000
1975	318.274	548.000	108.400	311.000	58	712	127.000
1976	297.720	514.000	78.450	310.000	702	142	125.000
1977	314.502	561.000	70.450	349.000	663	498	140.000
1978	296.249	504.000	75.800	304.000	1.024	-	123.000
1979	262,882	480,000	78,440	286,000	378	-	116,000
1980	249,817	417,000	97,620	226,000	152	-	93,000
1981	144,436	289,000	19,310	193,000	329	-	76,800
1982	168,678	327,000	13,830	224,000	300	1	89,000
1983	151,040	291,000	12,610	199,000	71	-	79,200
1984	180,504	385,000	33,310	251,000	128	1	100,000
1985	152,747	284,000	27,250	183,000	443	-	73,400
1986	152,486	269,000	8,050	185,000	2,610	-	73,400
1987	159,506	289,000	16,120	193,000	2,510	-	76,900
1988	156,031	279,000	13,170	188,000	2,780	-	74,800
1989	143,169	260,000	10,450	177,000	2,790	-	70,200
1990	153,226	273,000	9,520	187,000	2,550	-	74,200
1991	151,853	273,000	9,190	187,000	2,450	-	74,400
1992	153,829	264,000	8,750	181,000	2,560	-	71,700
1993	160,612	278,000	7,670	191,000	3,310	-	75,900
1994	147,060	252,000	6,670	174,000	2,790	-	68,900
1995	171,443	299,000	11,310	203,000	3,680	-	80,700
1996	185,715	323,000	16,130	218,000	2,400	-	86,700
1997	177,365	303,000	12,010	206,000	2,430	-	82,000
1998	185,914	316,000	13,720	214,000	3,150	-	85,200
1999	165,751	284,000	10,300	194,000	2,920	-	77,000
2000	154,006	261,000	9,440	178,000	2,840	4	70,800
2001	168,298	283,000	8,750	195,000	1,920	-	77,500
2002	120,462	205,800	7,590	140,000	2,110	9	55,800
2003	121,172	211,900	5,620	146,000	1,860	-	58,100
2004	107,362	186,700	7,000	127,000	1,690	34	50,600
2005	143,176	246,000	5,020	171,000	1,470	197	67,900
2006	117,571	256,000	7,200	176,000	2,060	208	70,000
2007	102,787	178,200	6,480	122,000	1,670	167	48,300
2008	116,400	203,600	7,160	139,000	1,870	39	55,300
2009	119,474	213,100	10,800	143,000	2,040	15	57,000
2010	150,530	271,000	15,180	182,000	1,360	9	72,500

[1] *Spatially allocated as within Spain's Northwest EEZ from ICES data*

Appendix Table A2. Reconstructed total catch (in tonnes) by major taxa for the northwest of Spain by taxon, 1950 - 2010.

Year	*Engraulis encrasicolus*	*Merluccius merluccius*	*Mytilus edulis*	*Sardina pilchardus*	*Trachurus*	Others
1950	19,300	221,000	932	13,800	46,900	193,000
1951	24,600	298,000	890	13,500	50,400	174,000
1952	29,600	197,000	1,060	8,330	35,700	135,000
1953	34,300	176,000	1,280	5,620	49,700	146,000
1954	31,300	196,000	990	9,410	36,000	156,000
1955	41,600	237,000	1,900	7,690	48,000	189,000
1956	39,600	175,000	2,560	12,600	44,200	178,000
1957	43,200	204,000	2,210	16,100	33,100	199,000
1958	49,400	190,000	2,270	29,900	29,000	206,000
1959	62,000	224,000	2,810	41,900	27,200	194,000
1960	62,300	286,000	2,390	38,400	29,700	201,000
1961	85,900	317,000	29,300	51,100	33,000	214,000
1962	62,200	196,000	47,900	29,100	45,700	202,000
1963	49,800	288,000	54,400	34,100	46,400	217,000
1964	76,000	177,000	54,600	36,400	50,000	238,000
1965	80,100	131,000	57,000	31,800	47,000	290,000
1966	46,700	179,000	55,200	32,300	41,800	239,000
1967	38,400	192,000	43,200	23,900	46,900	256,000
1968	37,300	197,000	59,100	25,100	53,400	257,000
1969	32,100	122,000	80,800	38,100	76,000	244,000
1970	19,200	230,000	95,000	29,300	89,900	246,000
1971	23,400	188,000	0	41,700	24,600	368,000
1972	26,200	108,000	110,000	33,500	59,800	144,000
1973	22,500	115,000	120,000	44,300	86,300	154,000
1974	26,500	139,000	82,300	34,300	54,300	148,000
1975	22,700	148,000	80,400	49,700	68,300	178,000
1976	35,100	143,000	56,700	51,300	88,000	141,000
1977	43,100	149,000	53,200	36,100	96,400	183,000
1978	40,300	109,000	57,200	47,600	61,000	189,000
1979	20,600	134,000	68,500	849	38,600	218,000
1980	19,900	106,000	83,700	29,500	33,600	144,000
1981	9,500	104,000	8,950	35,100	25,700	106,000
1982	4,200	103,000	1,770	38,000	21,900	158,000
1983	13,300	94,900	1,940	29,700	24,800	127,000
1984	25,900	158,000	24,500	27,800	18,200	130,000
1985	7,580	88,100	19,600	21,900	18,500	129,000
1986	5,230	74,300	0	38,600	29,900	121,000
1987	8,860	80,200	0	40,500	29,100	130,000
1988	7,090	74,000	0	38,300	26,000	133,000
1989	2,970	59,800	53	33,900	24,400	139,000
1990	13,700	60,000	0	35,200	22,600	142,000
1991	5,970	62,700	290	26,000	30,700	148,000
1992	13,300	57,500	0	32,200	27,900	133,000
1993	10,700	58,900	0	31,000	28,700	149,000
1994	12,800	53,000	0	29,900	27,700	129,000
1995	21,500	64,800	0	31,000	30,500	151,000
1996	11,000	67,500	0	25,600	30,300	189,000
1997	8,470	63,900	0	18,900	34,900	177,000
1998	8,450	65,600	0	20,400	25,100	197,000
1999	16,800	60,600	0	12,500	31,500	163,000
2000	19,200	56,600	0	10,800	31,600	143,000
2001	18,100	59,000	0	22,400	31,800	152,000
2002	8,020	44,800	0	15,600	21,500	116,000
2003	1,490	49,400	0	15,400	26,900	119,000
2004	6,400	43,700	0	16,600	28,700	91,200
2005	136	57,200	0	19,100	29,300	140,000
2006	363	95,000	0	9,560	29,100	122,000
2007	0	41,400	0	7,650	26,400	103,000
2008	60	49,200	0	8,160	26,700	119,000
2009	93	50,400	0	12,900	28,700	121,000
2010	4,950	63,800	0	13,600	27,300	161,000