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Reconstruction of Italy's marine fisheries catches (1950-2010)¹

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ABSTRACT

Italian marine fisheries catches were estimated for the 1950-2010 period following a catch-reconstruction approach that looked at all types of fisheries removals: from reported and unreported landings to recreational landings and discards. Using scientific literature, national reports, news media and informal communications with local experts and coast guards we assessed the entire Italian fishery sector. National data sources, which included the Italian Fisheries Statistics (ISTAT and IREPA), were much larger than those reported by the United Nation's Food and Agriculture Organization (FAO), particularly in the early time period with better agreement in more recent years. Therefore, for the purposes of the *Sea Around Us*, we compared the reconstructed data to the FAO reported baseline. The total reconstructed catch for the 1950-2010 time period was estimated to be 2.6 times the data reported by the FAO on behalf of Italy. Results indicated that illegal, unreported and unregulated (IUU) catches constituted 53.9% of the total reconstructed catch, followed by reported catches (38.8%) and discards (7.3%). Industrial fisheries were dominant, with 79.1% of the reconstructed total removals, followed by the artisanal catch (16.8%), with recreational (3.2%) and subsistence (0.9%) fisheries making minimal contributions. As for trends in annual catches over the time period, apart from recreational landings that actually increased in the past decade, all the other fisheries catches have steadily declined since the mid 1980s. Our study is the first that attempted to estimate total Italian fisheries removals using a holistic approach; these methods are particularly important in areas like the Mediterranean Sea, where the multi-species and multi-gear nature of fisheries make the assessment of single-species fisheries resources and their management difficult.

INTRODUCTION

Italy is located in southern Europe and covers an area of approximately 301,270 km². It includes the Italian peninsula, Sicily and Sardinia (the two largest Mediterranean islands), and 71 other smaller islands. The country consists of 21 regions, of which 15 are coastal (Figure 1). The territorial waters extend up to 12 nautical miles from the coast and have a surface area of 7,210 km². The continental shelf around Italy has a surface area of 201,310 km² (Iborra Martin 2006). The Italian Exclusive Economic Zone (EEZ), as theoretically defined by the *Sea Around Us* covers nearly 538,000 km² (www.seaaroundus.org).

Due to its central Mediterranean Sea position, four of the seven Mediterranean subdivisions surround the peninsula: the Tyrrhenian and Ligurian Sea in the west, the Ionian Sea in the south and the Adriatic Sea in the east. This geographic positioning has important consequences for the biophysical features of Italian waters. For example, the distribution of the continental shelf is very uneven; it is very broad and shallow in the Adriatic Sea, which changes to very narrow shelves, and steep deep slopes in the other seas (Francalanci 1993; Cataudella and Spagnolo 2011). Also, the waters range from highly eutrophic in the

¹ (Revised version, updated 1 May 2015)

northern Adriatic Sea, due to river discharges (mainly the Po river), to extremely oligotrophic in the rest of the areas. The diversity of these biophysical conditions translates also to high biodiversity: the Italian waters host important species, such as the Atlantic bluefin tuna (*Thunnus thynnus*), the endangered Mediterranean monk seal (*Monachus monachus*) and the seagrass (*Posidonia oceanica*) (Reijnders et al. 1997; MacKenzie et al. 2009; Giakoumi et al. 2013). Moreover, coralligenous outcrops and two of the most common maërl-forming Mediterranean species, *Lithothamnion corallioides* and *Phymatolithon calcareum* (included in Annex V of the Habitats Directive) are widely distributed along the Italian coasts (Martin et al. 2014).

Italy has a population of 61 million people (ISTAT 2012), over half which reside in coastal regions (Cori 1999; ISTAT 2012). Due to its rich history and culture, Italy is also the world's fifth most visited country in the world with around 43 million tourists annually. Fishing takes place along the entire coastline and catches are landed in well over 800 sites (Iborra Martin 2006; OECD 2010; Cataudella and Spagnolo 2011). The Italian fisheries are among the most important fisheries in the whole Mediterranean. Despite the marginal contribution to the national economy, both in terms of income and employment opportunities, the fishery sector plays a fundamental role in certain regions (e.g., in Sicily and the Puglia region). The Italian fishing industry is characterized by the predominance of small and relatively old vessels, a high diversity of gears, and consequently diverse multi-species catches (FAO 2010; OECD 2010; Cataudella and Spagnolo 2011). The fisheries are mainly represented by the following types of fleets: bottom trawlers, mid-water trawlers, purse seiners, longliners, dredges, multi-purpose vessels and an artisanal fishery.

Italian fisheries management

A comprehensive fisheries management scheme was initiated in 1982 with the law 41/1982. Prior to that, only certain restrictions such as minimum mesh size, minimum legal landing size, and closed areas were mandated by national authorities. With the introduction of this law, National Triennial Plans were established. In particular, all fishing vessels had to possess a license managed by the Directorate General for Fishery and Aquaculture of the Ministry of Agriculture Policy. The license includes characteristics of the vessel (e.g., the name of the vessel, the UE number, GT, kW), limitations of fishing areas, gear use and spatial licensing (e.g., overseas and ocean-going fishing, Mediterranean fishing, and in-shore coastal fishing OECD 2010).

Currently the licensing scheme limits fishing effort mainly in the form of temporal restrictions. Particularly, the closure calendar is chosen annually and is influenced by spawning seasons. Given the strong multi-species nature of Italian fisheries, the closure is subdivided in two to three periods; usually, in the Northern and Central Adriatic Sea, fishing is restricted between mid-July and mid-August, while in the Southern Adriatic and Ionian Sea, it is restricted between mid-August and mid-September and in the Tyrrhenian Sea, it is restricted between mid-September and mid-October. Moreover, the closure is compulsory for the eastern fishing grounds, while it is voluntary in the western grounds. For a 60 day period after the closure, fishing is allowed for 4 fishing days. Starting in 1996 and re-enforced in 2000, a seasonal closure has also been initiated for the tuna fishery. It is forbidden to catch Atlantic bluefin tuna with a seine net from May 1 to May 31 in the Adriatic Sea and from July 16 to August 15 in the whole Mediterranean Sea; it is also prohibited to catch Atlantic bluefin tuna using surface-set longlines with fishing boats greater than 24 m from June 1 to July 31 each year (Council regulation no. 1075/1996, no. 812/2000). In 1992, the European Union (EU) put a 2.5 km limit on the maximum driftnet length. In 1998, the EU banned the use of this gear for the Mediterranean Sea and the northeast Atlantic Ocean. This became fully effective on January 1st 2002. Additionally, in 1994, the EU established a set of restrictions for the main fishing gear types (EU Rule 1626/94) to preserve fisheries resources in the Mediterranean Sea:

- The maximum allowable breadth for dredges was 4 m;
- Seines and *lampara* nets (encircling nets) length of netting were restricted to 800 m and the drop to 120 m, except for tuna seiners;

- Bottom-set nets (gillnets and entangling nets) and trammel nets: the maximum drop of bottom-set nets was 4 m, and it was prohibited to have on board and to set more than 5,000 m of bottom-set nets per vessel;
- Bottom-set longline: it was prohibited to have on board and set more than 7,000 m of longline per vessel;
- Surface-set longline (floating): it was prohibited to have on board and set more than 60 km of longline per vessel;
- In case of towed nets, the mesh size was limited to 40 mm; for encircling nets, the mesh size limit was fixed to 14 mm;
- The operation of trawls and seines was prohibited within three nautical miles (nm) from the coast except for “special fisheries” in which derogation by the national legislation was put in place. This was the case for the “Bianchetto” (*Sardina pilchardus* fry), “Rossetto” (*Aphia minuta mediterranea*) and “Cicerello” (*Gymnammodytes cicerelus* fry) fisheries that were carried out during winter (January 15 to March 15 as a rule) for a period of 60 days. These fisheries have a long history and represented at the local level one of the most important small-scale activities with very large socio-economic impacts. Since 2010, the EU banned these fisheries (small trawling boats with mesh size less than 40mm) throughout the Mediterranean for their unsustainability, stating that only vessels of other gear types with a proper management plan would be allowed to fish (Reg. (CE) n. 1967/2006);
- New set of rules regarding minimum allowable landing sizes;
- Local management plans, established with the Community Regulation N. 1198/2006, aim to a sustainable management of renewable resources along the Italian coast.

In Italy, no quotas or TACs (Total Allowable Catch) have been established to date, except for sedentary species such as clams or for highly migratory species such as Atlantic bluefin tuna, due to the multi-species nature of the fisheries, which does not allow fishers to easily shift their targets from one to the other species (Iborra Martin 2006; OECD 2010; Cataudella and Spagnolo 2011).

In the last decades, the Italian fishing industry has faced declines, both in terms of effort and also in catch, partly due to a decline in the major fisheries resources, and partly as a result of the European Commission regulations (4th Multi-Annual Guidance Plans, MAGPs) to adjust fishing fleet to available fishing resources (Iborra Martin 2006). In parallel, since the late 1980s, there has been a steady increase in farmed fish production, most likely as a result of the growth in domestic demand for fish products. The majority of mariculture production consists of Mediterranean mussels (*Mytilus galloprovincialis*) and Manila clams (*Tapes philippinarum*), followed by gilt-head seabream (*Sparus aurata*) and European seabass (*Dicentrarchus labrax*) (OECD 2010; Cataudella and Spagnolo 2011).

To sustain and properly manage these fisheries resources, it is fundamental to have an accurate time-series of catch data to assess historical trends, and to project future ones. This becomes challenging in a Mediterranean country where statistical reports of catches and effort are often unreliable, and where actual catches are often underestimated (Briand 2000; European Commission 2003). Commercially valuable species often go directly to public markets and regional auctions, and these catches often are not included in the official records and hence go unreported. Also, there is limited monitoring and enforcement, especially in regards to illegal net and mesh sizes, the landing and marketing of undersized fish, and compliance to restrictions on fishing season and areas (Papaconstantinou and Farrugio 2000). Available fisheries statistics exist at the national level (Italian National Statistical Institute–ISTAT; and Institute for Economic Research in Fishery and Acquaculture–IREPA) and as well are supplied to the Food and Agriculture Organization of the United Nations (FAO). These reported catch amounts account only for a part of total fisheries removals and have never been harmonized and/or compared before with total fisheries removals. Thus, the aim of this study is to provide an estimate of a time series of catches for all Italian marine fishing sectors from 1950 to 2010, using all available data sources and accounting for reported and unreported landings, recreational landings and discards. Reconstructed catches are presented for each of the four sub-regional seas: Ligurian; Northern, Central and Southern Tyrrhenian; Ionian; and Northern, Central and Southern Adriatic Sea; and then for the country as a whole. Also, catches from Sicilian and Sardinian waters have been estimated separately.

MATERIALS AND METHODS

Reported landings

The reconstruction of Italy's total fisheries catches for the 1950-2010 period was completed by following the same approach as described in Zeller *et al.* (2007) and applied in Zeller *et al.* (2007). The baseline for reported catches in the creation of the reconstruction was the time-series of capture production from the two Italian national statistical organizations (ISTAT and IREPA) that were then compared to the FAO FishStat database. As previously mentioned, the Italian National Statistical Institute (hereafter ISTAT) and the Institute for Economic Research in Fishery and Aquaculture (hereafter IREPA) were the responsible authorities for collecting the data. In particular, the official catch statistics were first provided by ISTAT for the period from 1950-2001, and only recently the Italian Ministry of Agriculture and Forestry Policies (MIPAAF) transferred the management of the fishery sector to IREPA (from 2005). In 2000, IREPA, before becoming the official national fisheries statistical organization, under a mandate of MIPAAF, and in connection to European legislative requirements, took the coordinating role of optimizing the fisheries statistical scheme to obtain a detailed and harmonized fisheries data collection along the entire Italian coast. This new survey collects data on important aspects of the fishing sectors: namely, total landings per species; prices observed by species; fishing effort; fishing hours; and fishing typologies. This is carried out on a weekly basis by 'local observers' (from within the fisheries sector; i.e., biologists, ship owners, ex-fishers, and business consultants) distributed along the major Italian fishing ports (of which there are approximately 800). The structure of our reconstruction regarding catch allocation followed the spatial allocation outlined in Table 1:

Table 1. Catch allocation reconstruction following ISTAT-IREPA structure.

Sub-regional division	Coastal regions
1. Ligurian	Liguria
2. Tyrrhenian	
- Northern	Tuscany
- Central	Lazio
- Southern	Campania and Calabria West
3. Ionian	Calabria East; Apulia West; Basilicata
4. Adriatic	
- Northern	Emilia Romagna; Veneto; Friuli Venetia Giulia
- Central	Abruzzi; Marches; Molise; Emilia Romagna
- Southern	Apulia East
5. Sardinian	Sardinia
6. Sicilian	Sicily

Here, the Adriatic and the Tyrrhenian Seas were split into Northern, Central and Southern sections to account for their large extent and for significant difference in reported landings. Sicilian and Sardinian waters were considered separately for the same reason (Figure 1). Due to this sub-regional division, gaps and inconsistencies with the data were easier to address and correct (most of the time to species-level) through literature searches. In particular, data from the International Commission for the Conservation of Atlantic Tunas (ICCAT), from scientific papers and/or national reports were included. In addition, once completed, each reconstructed catch dataset (six corresponding to each sub-regional division) was sent for validation to national experts, e.g., researchers from local Universities, from the National Research Council (CNR) and/or from local research institutes.

The taxonomic breakdown of the commercial species used in the reconstruction was taken from ISTAT and IREPA (Table 2). Most of the species were commonly represented, although in a few occasions, some adjustments were made, for example, 'goatfishes' were one group for ISTAT, which IREPA split into red mullet and striped red mullet. In these cases, we decided to use the most detailed list of species, and apply the proportion observed in one source to the other list. In addition, due to the high amount of the very uninformative 'marine fishes nei' in the data, we decided to split this group into several species and/or

groups of species according to the catch composition in the data disseminated by FAO on behalf of Italy. A total of 82 species or taxa were selected for the reconstruction (Table 2).

The nationally reported data over the time period was much larger and much more detailed than that reported by the FAO. All calculations in the creation of the reconstruction are made using the nationally reported data. However, due to the difference between the national and FAO reported data, for the purposes of the *Sea Around Us*, all result comparisons of the reconstruction to reported data were made to the FAO baseline.

Fishing fleets

For the Italian fishing fleet structure, mainly type and number of vessels/fleets, number of fishers, days at sea and Gross Tonnage (GT) were taken from ISTAT and IREPA. From 1950 to 1983, the type of fleets reported by ISTAT consisted of only four groups: trawlers, gillnetters, longliners and various gears. From 1984 to 2001, vessel classification was extended to incorporate eight groups: trawlers, mid-water trawlers, purse seiners, longliners, gillnetters, dredges, multiple and other gears. From 1996, IREPA assigned the following classifications:

- Trawl: operating exclusively or with a temporal frequency (fishing days) >50% using bottom otter trawl or beam trawl;
- Purse seine: operating exclusively or with a temporal frequency (fishing days) >50% using purse seine;
- Mid-water trawl: operating exclusively or with a temporal frequency (fishing days) > 50% using pelagic pair trawl;
- Mechanical dredges (hydraulics dredge);
- Longlines: operating exclusively or with a temporal frequency (fishing days) >50% using drifting or fixed longlines;
- Artisanal fishery (passive gears): vessel length less than 12 meters, and using only fixed gears (set nets, hooks, traps);
- Passive multi-use vessels: greater than 12 meters and using only fixed gears; and
- Multi-technique: vessels which use both fixed and mobile gears with a temporal frequency (fishing days) >50%.

This was done to take into account the high degree of multi-gear use by the Italian fishing fleets (more than 80% of the fleet is authorized to fish with different fishing gears, particularly among small-sized vessels due to their limited capacity of movement that force them to depend on seasonal availability of resources) and their wide dispersal rate along the entire coastline. To standardize and harmonize the two data sources, the most detailed list of fleets was used; also, it was assumed that for the years between 1950 and 1983, the proportion of observed fleets were the same as for 1984. Also, since the number of days at sea and number of fishers were available only from 1996-2010 through the IREPA dataset, we decided to extrapolate these estimates for the 1950-1995 period using the ratio of days at sea and the ratio of fishers per type of fleet observed in 1996. This reconstruction helped us to estimate recreational and subsistence catches and discards (see the following sections).

Table 2. Commercial species used in the reconstruction by the two national statistical organizations (ISTAT and IREPA).

	Common name	Scientific name	ISTAT	IREPA	FAO
1	Albacore	<i>Thunnus alalunga</i>		X	
2	Angler	<i>Lophius piscatorius</i>	X	X	
3	Atlantic bluefin tuna	<i>Thunnus thynnus</i>		X	
4	Atlantic bonito	<i>Sarda sarda</i>	X	X	
5	Atlantic Mackerel	<i>Scomber scombrus</i>	X	X	
6	Billfishes	Istiophoridae			X
7	Big-scale sand smelt	<i>Atherina boyeri</i>	X		
8	Black seabream	<i>Spondyliosoma cantharus</i>			X
9	Blue whiting	<i>Micromesistius poutassou</i>	X	X	
10	Bogue	<i>Boops boops</i>	X	X	
11	Chub mackerel	<i>Scomber japonicus</i>		X	
12	Common dentex	<i>Dentex dentex</i>	X		
13	Common dolphinfish	<i>Coryphaena hippurus</i>			X
14	Common pandora	<i>Pagellus erythrinus</i>	X	X	
15	Common sole	<i>Solea solea</i>	X	X	
16	European anchovy	<i>Engraulis encrasicolus</i>	X	X	
17	European barracuda	<i>Sphyrna sphyraena</i>			X
18	European conger	<i>Conger conger</i>	X		
19	European eel	<i>Anguilla anguilla</i>			X
20	European hake	<i>Merluccius merluccius</i>	X	X	
21	European pilchard	<i>Sardina pilchardus</i>	X	X	
22	European seabass	<i>Dicentrarchus labrax</i>	X		
23	European sprat	<i>Sprattus sprattus</i>			X
24	Flathead mullet	<i>Mugil cephalus</i>	X	X	
25	Flounder	<i>Platichthys flesus</i>			X
26	Forkbeard	<i>Phycis phycis</i>			X
27	Frigate tuna	<i>Auxis thazard thazard</i>	X		
28	Garfish	<i>Belone belone</i>	X		
29	Gilthead seabream	<i>Sparus aurata</i>	X		
30	Goatfishes	Mullidae	X		
31	Gobies	Gobiidae	X		
32	Greater forkbeard	<i>Phycis blennoides</i>			X
33	Groupers	<i>Serranus</i> spp.	X		
34	Horse mackerels	<i>Trachurus</i> spp.	X	X	
35	John dory	<i>Zeus faber</i>			X
36	Leerfishes and amberjacks	Carangidae	X	X	
37	Marine fishes	Marine fishes not identified	X	X	
38	Monkfishes	<i>Lophius</i> spp.			X
39	Pearly razorfish	<i>Xyrichtys novacula</i>			X
40	Picarel	<i>Spicara smaris</i>	X	X	
41	Pilotfish	<i>Naucratus ductor</i>			X
42	Poor cod	<i>Trisopterus minutus</i>		X	
43	Porbeagle	<i>Lamna nasus</i>			X
44	Rays	Rajidae	X	X	
45	Red mullet	<i>Mullus barbatus barbatus</i>		X	
46	Round sardinella	<i>Sardinella aurita</i>			X
47	Saddled seabream	<i>Oblada melanura</i>			X
48	Salema	<i>Sarpa salpa</i>			X
49	Striped seabream	<i>Lithognathus mormyrus</i>			X
50	Sandlances	<i>Ammodytes</i> spp.			X
51	Scorpionfishes and gurnards	Scorpaenidae	X	X	
52	Sharks	Selachimorpha	X	X	
53	Shortbill spearfish	<i>Tetrapturus angustirostris</i>			X
54	Shi drums and brown meagre	Sciaenidae	X		
55	Silver scabbardfish	<i>Lepidopus caudatus</i>			X
56	Stargazer	<i>Uranoscopus</i> spp.			X
57	Striped red mullet	<i>Mullus surmuletus</i>		X	
58	Swordfish	<i>Xiphias gladius</i>	X	X	
59	Thresher sharks	<i>Alopias</i> spp.			X
60	Tunas	Scombridae		X	
61	Turbots	Scophthalmidae	X	X	
62	Weeverfishes	Trachinidae			X
63	White seabream	<i>Diplodus sargus sargus</i>	X		
64	Whiting	<i>Merlangius merlangus</i>		X	

Table 2. Commercial species used in the reconstruction by the two national statistical organizations (ISTAT and IREPA).

	Common name	Scientific name	ISTAT	IREPA	FAO
65	Clams	Bivalvia	X	X	
66	Common octopus	<i>Octopus vulgaris</i>	X	X	
67	Cuttlefishes	Sepiidae	X	X	
68	European flying squid	<i>Todarodes sagittatus</i>	X	X	
69	Great Mediterranean scallop	<i>Pecten jacobaeus</i>		X	
70	Horned octopus	<i>Eledone cirrhosa</i>		X	
71	Marine molluscs	Miscellaneous marine molluscs	X	X	
72	Musky octopus	<i>Eledone moschata</i>		X	
73	Mutable nassa	<i>Nassarius mutabilis</i>		X	
74	Squids	Teuthida	X	X	
75	Blue and red shrimp	<i>Aristeus antennatus</i>		X	
76	Caramote prawn	<i>Melicerus kerathurus</i>	X	X	
77	Deepwater rose shrimp	<i>Parapenaeus longirostris</i>	X	X	
78	European and spiny lobster	<i>Homarus gammarus</i> ; <i>Palinurus vulgaris</i>	X	X	
79	Giant red shrimp	<i>Aristaeomorpha foliacea</i>	X	X	
80	Marine crabs	Brachyura		X	
81	Marine crustaceans	Miscellaneous marine crustaceans	X	X	
82	Norway lobster	<i>Nephrops norvegicus</i>	X	X	
83	Spottail mantis shrimp	<i>Squilla mantis</i>	X	X	

Recreational catches

Until 2010, recreational catches have never been assessed or included in the national fishery statistics. Only in 2010, to fulfill recent EU legislative requirements, the Italian Ministry of Agriculture and Forestry (MIPAAF) first surveyed recreational fishing activities (particularly the number of fishers and gear types) for the marine and freshwater environments. To date, there are only a few sources of information regarding the Italian recreational fisheries. The first preliminary assessment was conducted in 1996 by Anagnopoulos *et al.* (1998), who described recreational fisheries in Italy and Greece with respect to their fleet size, number of fishers, landings, and fishing effort for 1996. This same estimated number of fishers and fleets for each sub-regional division for the year 1996 was used as a first anchor point. Based on other public sources of data (Gordoa *et al.* 2004; Gaudin and De Young 2007; Pawson *et al.* 2007; Cisneros-Montemayor and Sumaila 2010), we were able to obtain three additional anchor points representing the number of fishers for the years 1989, 1993 and 2003, respectively. Population statistics for the 1950-2010 period were extracted from ISTAT (2012) and used to indirectly estimate total catches by local residents. For instance, we used the percentage of observed (from the four anchor points) number of fishers from the total population (1989: 2.2%; 1993: 2.7%; 1996: 2.6% and 2003: 2.7%) to establish a time series of number of recreational fishers for the missing years. Thus, for the 1950-1988 period, it was assumed that 2.2% of the total population were recreational fishers, while for 1990-1992, 1994-1995 and 1997-2002, we interpolated the estimates of the four anchor points, and for the last period (2004-2010), the percentage observed in 2003 (2.7%) was kept constant. Assuming the proportions of recreational fishing fleets per each sub-regional division observed in 1996 was constant throughout the years (Table 3), and two fishers per boat caught 1.6 t·year⁻¹ of fish (Anagnopoulos *et al.* 1998), the total Italian recreational catches for 1950-2010 was derived.

To allocate recreational catches to species-level, we kept the ratio found in Anagnopoulos *et al.* (1998) per each sub-divisional region constant (Table 4).

In addition, since Italian recreational fisheries have been observed catching illegally (e.g., undersized fish, catch above the permitted limits, Table 5) we added an illegal component to the total reconstructed recreational catches (please refer to section below for further details).

Table 3. Percentage of Italian recreational fishing fleets observed in 1996 (Anagnopoulos *et al.* 1998) per each sub-regional division.

Sub-regional division	Recreational fishing fleets (%)
1. Ligurian	13.4
2. Tyrrhenian	
- Northern	12.8
- Central	12.9
- Southern	8.6
3. Ionian	1.2
4. Adriatic	
- Northern	25.6
- Central	9.4
- Southern	6.1
5. Sardinian	5.3
6. Sicilian	4.7
Total	100

Table 4. Percentage of recreational species caught (Anagnopoulos *et al.* 1998) per each sub-regional division: Ligurian (LI); Northern, Central and Southern Tyrrhenian (NT, CT, ST); Sardinian (SAR); Sicilian (SI); Ionian (IO); Southern Northern, Central and Adriatic Sea (NA, CA, SA).

Scientific name	LI	NT	CT	ST	SAR	SI	IO	NA	SA	CA
Carangidae	0	0	10	10	2	3	0	0	0	0
<i>Sarda sarda</i>	4	4	19	19	5	3	8	2	8	8
<i>Boops boops</i>	18	18	0	0	13	22	4	14	4	4
Teuthida	1	1	1	1	1	3	0	0	0	0
<i>Prionace glauca</i>	0	0	0	0	1	0	0	3	0	0
<i>Serranus</i> spp.	2	2	1	1	1	2	1	1	1	1
Sciaenidae	0	0	0	0	1	1	0	2	0	0
<i>Dentex dentex</i>	1	1	11	11	2	1	0	0	0	0
<i>Trachinotus ovatus</i>	1	1	5	5	1	1	0	0	0	0
<i>Coryphaena hippurus</i>	1	1	4	4	1	2	0	0	0	0
<i>Dicentrarchus labrax</i>	0	0	0	0	1	1	3	2	3	3
<i>Platichthys flesus</i>	0	0	0	0	1	0	0	2	0	0
<i>Belone belone</i>	2	2	1	1	6	2	1	15	1	1
<i>Sparus aurata</i>	4	4	0	0	2	0	1	4	1	1
Gobiidae	5	5	0	0	3	0	4	7	4	4
<i>Zosterisessor ophiocephalus</i>	0	0	0	0	1	0	0	3	0	0
<i>Merluccius merluccius</i>	0	0	0	0	1	0	0	2	0	0
<i>Trachurus</i> spp.	15	15	1	1	7	11	7	2	7	7
<i>Scomber</i> spp.	0	0	3	3	7	4	16	7	16	16
Mugilidae	1	1	0	0	3	0	0	9	0	0
<i>Pagellus erythrinus</i>	5	5	6	6	6	14	0	1	0	0
<i>Pagrus pagrus</i>	3	3	0	0	1	0	0	0	0	0
<i>Spicara smaris</i>	2	2	0	0	1	1	0	0	0	0
<i>Mullus barbatus</i>	0	0	0	0	0	0	2	0	2	2
<i>Oblada melanura</i>	7	7	0	0	5	5	2	6	2	2
Scorpaenidae	0	0	2	2	1	2	1	0	1	1
<i>Diplodus</i> spp.	8	8	3	3	7	16	1	2	1	1
<i>Lithognathus mormyrus</i>	0	0	0	0	8	4	28	6	28	28
<i>Xiphias gladius</i>	0	0	3	3	1	1	0	0	0	0
<i>Alopias</i> spp.	0	0	0	0	1	0	2	2	2	2
<i>Chelidonichthys lucerna</i>	0	0	0	0	1	0	7	0	7	7
<i>Thunnus</i> spp.	20	20	30	30	7	1	12	5	12	12
Labridae	0	0	0	0	1	0	0	3	0	0

Unreported landings: illegal and subsistence catches, and discards

In Italy, as in many other parts of the Mediterranean Sea, unreported catches are almost always associated with illegal fishing activities and are an issue of grave concern. The use of illegal fishing gears, trawlers operating inshore inside the limits given by law, fishing in marine protected areas, and catching ‘*bianchetto*’ or undersized species, are the most common infringements found in Italy (ISMEA 2006).

Although the approach carried out by IREPA with observers inspecting landings from the main harbors along the Italian coasts should minimize the quantity of unreported landings, we decided to complement IREPA data with additional information coming from NGO reports and Italian newspapers/TV documentaries.

The best known and ‘observed’ illegal fishing activity along the entire Italian coast was and still is the use of driftnets. At the end of the 1980s, this driftnet fishery was the largest fishery in the Mediterranean Sea with over 700 vessels, driftnets of up to 40 km in length and reported catches of 5,000 tonnes of swordfish and 1,000 tonnes of tunas (Tudela 2004). Despite the maximum length limit of 2.5 km prescribed by the EU in 1992, approximately 650 driftnet boats continued operating with nets measuring on average 10-12 km (Tudela 2004). We calculated our unreported catches from 1992 to 2001, assuming a constant number of boats, with 650 vessels from 1992 to 1998 (Tudela 2004) and 299 vessels (Cornax 2007) from 1999 to 2001, 5% of which operated from Liguria, 49% in the Tyrrhenian Sea, 31% from Sicily, 7% from Sardinia and in the Ionian Sea). We then assumed a constant catch per boat rate (7 t of swordfish and 1.4 t of tunas) based on Tudela (2004) and Cornax *et al.* (2006). From 2002 onwards, driftnet fishing was banned, yet surveys conducted by different NGOs along major Italian ports identified over 150 boats still in operation (landings occurred at night to avoid controls). Also, in 2008, a journalist, Sabrina Giannini, conducted a series of interviews with fishers, and documented the illegal driftnet activities for an Italian TV program (“Report: Mare Nostrum: sfruttamento marino”).² To estimate these unreported driftnet catches for the 2002-2010 period, the following sources were used: OCEANA (Cornax *et al.* 2006; Cornax 2007; Cornax and Pardo 2009), RSPCA in collaboration with Humane Society International and the Whale and Dolphin Conservation Society (2005), and the interview conducted by Sabrina Giannini. The number of boats observed (150) was kept constant for the 2002-2010 period from the different surveys and a constant catch per boat rate of 2 t of swordfish and 0.5 t of tunas was used.

Regarding other illegal activities in the artisanal, industrial and recreational fisheries, only recently have Italian media/newspapers started to report on them. The majority of this news refers to the illegal act and the confiscation of the gear by the Italian Coast Guard, and only few accounts refer to quantities of confiscated species (Table 5). Since 2010, the Italian Coast Guard has started to report on illegal operations at sea and on land. We used the information coming for the Italian Coast Guard database combined with direct interviews conducted with LT Commander Alessio Morelli, Head of the Fisheries National Control Unit-Coast Guard to come up with a rough estimate of the illegal activities occurring in the area.

We were not able to directly estimate the total amount of unreported catches taken for personal consumption (i.e., the subsistence fishery). Thus, to develop such an estimate indirectly, and in a conservative manner, we decided to use and hold constant the lowest value (1 kg of fish·fisher⁻¹·day⁻¹) assessed by Coll *et al.* (2014) for the Spanish subsistence fishery (since Spain shares similar fishing patterns and maritime policies), and given the number of Italian fishers per fleet type and the number of fishing days per type of fleet, per year and per each sub-division. We suspect that the resultant subsistence catches derived here may be a substantial underestimate.

We estimated the Italian discards for the 1950-2010 period mainly using two reports, one by Vassilopoulou (2012) and the other by the European Commission (2011a). Additional scientific papers were added to the reconstruction in regards to local studies (Table 6). Due to the multi-species nature of Italian fisheries (which allows for the catching of several species at the same time), the high demand of seafood in local markets, and the high enforcement costs required for the monitoring of restrictions, fishers rarely discard fish, but retain and land their by-catch, which is an important component of unreported landings. The rates of by-catch and discards were determined by the type of fleet of each sub-regional division and the total catch per type of fleet (Table 6). We then separated the retained by-catch from discards, using data found in the literature (approximately 60% retained and 40% discarded; (Sartor *et al.* 2003; Sánchez *et al.* 2007).

² Available at <http://www.report.rai.it/dl/Report/puntata/ContentItem-1c6411c7-2f60-490d-bd5a-2829c1d233ff.html>.

Table 5. List of illegal catch by species (when specified) reported by Italian media. UN=unknown; BFT=Atlantic bluefin tuna; SWO=swordfish; ALB=albacore; AN=European anchovy; SB=European seabass, OCT=common octopus; CT=cuttlefishes; SO=common sole; CL=clams; PD=common pandora; SU=sea urchins; SA=sardines; MA=Atlantic mackerel; LT=little tunny; TU=tunas (species); CBR=cicerello/bianchetto/rossetto.

Species	Tonnes	Gear	Time	Area	Source
UN	0.045	Trawler (no licence)	Dec 2008	Sicily	http://www.iloveagrimento.it/pesca-illegale-a-porto-empedocle-sequestrati-45-kg-di-pesce/
BFT	7	Unknown (no tuna license)	Jun 2009	Sicily	http://www.lombardiastavola.it/articolo.aspx?id=10361
BFT	43	Unknown (no tuna license)	Jun 2009	South Tyrrhenian -Sicily	http://lombardiastavola.it/articolo.aspx?id=10458
SWO	3	Unknown (undersized)	Jul 2009	South Tyrrhenian -Sicily	http://www.politicheagricole.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/2405
BFT	0.5	Unknown	Jul 2009	South Tyrrhenian -Sicily	http://www.politicheagricole.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/2405
ALB	0.1	Unknown	Jul 2009	South Tyrrhenian -Sicily	http://www.politicheagricole.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/2405
AN	90	Unknown	Oct 2009	South Adriatic	http://www.traniweb.it/trani/informa/11024.html
SB	1	Unknown	Oct 2009	South Adriatic	http://www.traniweb.it/trani/informa/11024.html
OCT;CT;SO	8	Unknown	Oct 2009	South Adriatic	http://www.traniweb.it/trani/informa/11024.html
CL	5	Dredges	Nov 2009	North Adriatic	http://www.consigliodiperterra.com/sequestre-a-chioggia-5-tonnellate-di-vongole-1125.html
UN	0.19	Recreational sale to restaurant	Mar 2010	Liguria	http://www.riviera24.it/articoli/2010/03/16/81567/operazione-besugo-sequestrati-190-kg-di-prodotto-ittico-in-vendita-proveniente-da-pesca-sportiva
PD	0.12	Recreational sale to restaurant	Mar 2010	Liguria	http://www.riviera24.it/articoli/2010/03/16/81567/operazione-besugo-sequestrati-190-kg-di-prodotto-ittico-in-vendita-proveniente-da-pesca-sportiva
BFT	2	PS (no tuna licenses)	Apr 2010	Ionian Sea	http://www.lecceprima.it/cronaca/porto-cesareo-sequestre-2-tonnellate-di-tonno-rosso.html
SU	0.6 (above permitted limit)	Recreational fisher	Aug 2010	South Tyrrhenian	http://www.adnkronos.com/IGN/Regioni/Abruzzo/?id=3.1.825584595
BFT	0.65 (500 juveniles)	PS	Oct 2010	South Tyrrhenian	http://www.italiastavola.net/articolo.aspx?id=17544
CL	0.48	Dredge	Oct 2010	Central Adriatic	http://www.geapress.org/mare/operazione-talasso/7816
BFT	0.3	Dredge	Oct 2010	South Adriatic	http://www.geapress.org/mare/operazione-talasso/7816
SA; MA	2	PS	Oct 2010	Liguria	http://www.geapress.org/mare/operazione-talasso/7816
LT	0.02	Mid-water trawl (no license)	Oct 2010	Ionian Sea	http://www.geapress.org/mare/operazione-talasso/7816
AN	0.011	Mid-water trawl (no license)	Oct 2010	Ionian Sea	http://www.geapress.org/mare/operazione-talasso/7816
UN	0.09	Gillnet	Jun 2011	Liguria	www.guardiacostiera.it
SU	1.2	Unknown	2012	Sicily	http://www.agricolae.it/pesca-illegale-il-bilancio-dellattivit�-di-contrasto-nel-2012-80603/
TU; SWO	1.4 (undersized)	Longline	Oct 2012	South Adriatic	http://www.statquotidiano.it/25/10/2012/vieste-sequestro-14-quintali-tonno-rosso-e-pesce-spada/107443/
SWO	0.085 (20 juveniles)	Unknown	Oct 2012	Sicily	http://livesicilia.it/2012/10/26/porto-empedocle-sequestrati-20-esemplari-di-pesce-spada_203673/
CBR	0.715	Unknown	Jan 2013	South Adriatic	http://www.foggiatoday.it/cronaca/sequestro-bianchetto-manfredonia-calabria-14-gennaio-2013.html
CBR	0.126	Seine	Mar 2013	Ionian Sea	http://bari.repubblica.it/cronaca/2013/01/20/news/incastrati_i_predoni_del_mare-50950505/
CBR	0.1	Unknown	Mar 2013	Ionian Sea	http://www.cn24tv.it/news/65331/pesca-illegale-guardia-costiera-sequestrati-oltre-100-kg-di-bianchetto.html
CBR	0.02	Seine	Apr 2013	Ionian Sea	http://www.lentelocale.it/cronaca/1718-lotta-alla-pesca-illegale-numerosi-sequestri-di-bianchetto-e-cicerello-da-parte-della-guardia-costiera
CBR	0.13	Unknown	Apr 2013	South Tyrrhenian	http://www.ansa.it/web/notizie/regioni/calabria/2013/04/12/Sequestrati-130-chili-novellame_8543000.html
CBR	0.15	Trawlers	Apr 2013	South Adriatic	http://www.manfredonianews.it/sequestro-di-reti-illegali-e-bianchetto

Table 6. Discard and by-catch rates (in %) given to each type of fishing fleet per sub-regional division. Fishing fleet types: T: trawlers; MT: mid-water trawlers; D: dredges; P: purse seiners; AF: artisanal fisheries; MG: multiple gears and L: longline. N/A = not applicable is related to a fishing fleet not being present in a given sub-regional division.

	T	MT	D	P	AF	MG	L
1. Ligurian							
	20 ^{a,b,c,d,e,f}	N/A	N/A	8.5 ^{a,c,d,g}	5 ^{a,c,d,g}	18.4 ^{a,b,c,d,g,h}	40 ^{a,c,d,h,i}
2. Tyrrhenian							
North	20 ^{a,b,c,d,e,f}	N/A	N/A	8.5 ^{a,c,d,g}	5 ^{a,c,d,g}	18.4 ^{a,b,c,d,g,h}	40 ^{a,c,d,h,i}
Central	20 ^{a,b,c,d,e,f}	N/A	20 ^{a,c,d,j}	8.5 ^{a,c,d,g}	5 ^{a,c,d,g}	18.4 ^{a,b,c,d,g,h}	40 ^{a,c,d,h,i}
South	20 ^{a,b,c,d,e,f}	N/A	20 ^{a,c,d,j}	8.5 ^{a,c,d,g}	5 ^{a,c,d,g}	18.4 ^{a,b,c,d,g,h}	40 ^{a,c,d,h,i}
3. Ionian							
	35 ^{a,c,d,g,k}	N/A	N/A	7.5 ^{a,c,d,g}	5 ^{a,c,d,g}	18.6 ^{a,c,d,g}	40 ^{a,c,d,g}
4. Adriatic							
North	67.4 ^{a,d,i,m,n}	18.3 ^{a,d,g,o}	68.5 ^{a,c,d,g,k}	8.5 ^{a,c,d,o}	7 ^{a,c,d,g}	42.9 ^{a,c,d,l}	50 ^{a,c,d,h,i}
Central	67.4 ^{a,d,i,m,n}	18.3 ^{a,d,g,o}	68.5 ^{a,c,d,g,k}	8.5 ^{a,c,d,o}	7 ^{a,c,d,g}	42.9 ^{a,c,d,l}	50 ^{a,c,d,h,i}
South	67.4 ^{a,d,i,m,n}	18.3 ^{a,d,g,o}	68.5 ^{a,c,d,g,k}	8.5 ^{a,c,d,o}	7 ^{a,c,d,g}	42.9 ^{a,c,d,l}	50 ^{a,c,d,h,i}
5. Sardinian							
	20 ^{a,b,c,d,e,f}	N/A	N/A	8.5 ^{a,c,d,g}	5 ^{a,c,d,g}	18.4 ^{a,b,c,d,g,h}	40 ^{a,c,d,h,i}
6. Sicilian							
	20 ^{a,b,c,d,e}	28.3 ^{a,c,d}	N/A	8.5 ^{a,c,d,g}	5 ^{a,c,d,g}	17.5 ^{a,b,c,d,g,h}	50 ^{a,c,d,h,i}

^a European Commission (2011a); ^b Sartor *et al.* (2003); ^c Tsagarakis *et al.* (2013); ^d Vassilopoulou (2012); ^e Vitale *et al.* (2006); ^f Relini (1981); ^g European Commission (2008); ^h Gilman *et al.* (2007); ⁱ MegaPesca (1999); ^j Castriota *et al.* (2004); ^k D'Onghia *et al.* (2003); ^l Botter *et al.* (2006); ^m Sánchez *et al.* (2007); ⁿ Scarcella *et al.* (2007); ^o Santojanni *et al.* (2005); ^p ;

RESULTS

Italy as a whole

The total reconstructed catch for the 1950-2010 time period greatly exceeded the official amount reported by the FAO. Our catch reconstruction estimated that the total catch was 2.6 times the data presented by FAO with approximately 79% caught by industrial fisheries, 17% by artisanal fisheries, 3% by recreational fisheries and <1% by subsistence fisheries, while discards (7% of the total) were predominately (95%) from industrial fisheries (Figure 6a). National landings which did not make it into the FAO data were responsible for the largest proportion of unreported catch, with over 42%, followed by retained by-catch (18%), illegal industrial landings (16%) and illegal artisanal landings (5%). Total reconstructed catches were relatively stable throughout the 1950s and 1960s, averaging approximately 708,000 t·year⁻¹, before increasing between 1971 and 1979 to 1.1 million t. The annual catch plateaued at an average 1.06 million t·year⁻¹ until 1986, when they sharply decreased, dropping to 676,000 t by 1990. Again, annual catches remained mostly steady, with a small increase to 741,000 by 1998, before again sharply decreasing and continuing in the trend until the end of the time series in 2010, when catches were 374,000 t (Figure 6a).

With regards to the taxonomic composition of reconstructed total catches for Italy, catches were highly multi-specific (92 taxa, including the pooled groups 'marine fishes nei' and 'marine invertebrates nei'), but in terms of total tonnage were dominated by small pelagics. Thus, total catches were dominated by the European anchovy (*Engraulis encrasicolus*), which accounted for 18.1% of all catches (Figure 6b). The second most important taxon, in terms of catch tonnage (at least in earlier decades) was the European pilchard (*Sardina pilchardus*), which accounted for 12.5% of total catches from 1950-2010, but has declined substantially in contribution in recent years (Figure 6b). If we group the remaining taxa by family we see that Scombridae (9.0%), Sparidae (7.4%), and Carangidae (4.0%) are also major contributors to the catch. Other groups which contribute significantly to the catch are molluscs (12.4%), crustaceans (5.6%) and sharks and rays (3.9%; Figure 6b).

Reported landings

For reported landings, we compared our assessment with the available sources – the two national sources of statistics (ISTAT and IREPA) and the FAO, and found that data sets were similar only for the last six years (2005-2010, Figure 2), which corresponds with the years which IREPA became the official national statistical source. We were able to check differences between the two national sources due to the fact that IREPA started its data collection in 1996, a few years before the start of its official mandate. Most of the catches per species and per sub-regional division in the ISTAT dataset were on average at least 30-40% lower than the one provided by IREPA. In particular, when comparing the years 2000 and 2001, of the 58 taxa in the IREPA dataset, 49 had catch values greater than 25%, 43 greater than 50%, 33 greater than 75% and 26 greater than 100% (Table 7), while the remaining had similar values between the two sources. Among the sub-regional divisions, Sicily followed by Central Adriatic, South and North Tyrrhenian had the most incomplete catch datasets (Figure 3). Since this inconsistency was already observed in other studies (AdriaMed 2003; Cataudella and Spagnolo 2011) that claim the IREPA database to be the most refined and reliable statistical source for the commercial fisheries sector, the IREPA dataset was used from 1996-2010, while for the remaining time series (1950-1995) ISTAT catch trend and species composition was used. Even with this adjustment, we noted some discrepancies for European anchovies and especially for European pilchard caught in Sardinia with reported values between 2000 and 2010 almost close to zero. With the help of the scientific literature (Cappuccinelli 2005, 2011) we were able to reconstruct the last 10 years of these two small pelagic fish (Figure 4). We were also able to complement our new dataset with catch data of Atlantic bluefin tuna (*Thunnus thynnus*), frigate tuna (*Auxis thazard*), Atlantic bonito (*Sarda sarda*) and swordfish (*Xiphias gladius*), using the ICCAT statistical database for the main Italian sub-regions. The difference between ICCAT and IREPA catches regarding these large pelagics are displayed in Figure 5.

In total, for the 1950-2010 period, Italian reported national landings ranged between approximately 220,000 and 721,000 t·year⁻¹. These data were visibly higher (on average more than two times higher) than the one reported to FAO for the same time period which ranged from 171,000 to 430,000 t·year⁻¹. Overall, we noticed a slight decrease in national reported landings between 1950 (around 480,000 t·year⁻¹) and the beginning of the 1960s (around 400,000 t·year⁻¹) followed by an increase (to around 710,000 t·year⁻¹) in the middle of the 1980s and a general and continuous decline to 2010 (around 220,000 t·year⁻¹). This differs from the trend in the FAO data which increases steadily from 171,000 t in 1950 to a peak in 1985 of 430,000 t, and then fairly steadily declines to 228,000 t in 2010. Looking at the sub-regional divisions, Sicily was the region with the highest national reported landings, with an average value of approximately 149,500 t·year⁻¹, followed by the Central (99,800 t·year⁻¹) and North Adriatic (64,300 t·year⁻¹), North Tyrrhenian (49,300 t·year⁻¹) and South Adriatic (38,900 t·year⁻¹) (Figure 6a). The other sub-regions with lower estimates were South Tyrrhenian (30,500 t·year⁻¹), Ionian (22,900 t·year⁻¹), Sardinian (12,900 t·year⁻¹), Central Tyrrhenian (10,200 t·year⁻¹) and Ligurian Sea (6,200 t·year⁻¹). FAO data is not presented by these sub-regions and thus there is no comparison available. For reconstruction purposes, the FAO baseline that we compare to was proportionally divided into the subregions based on their proportions in the national data. European anchovies and European pilchards were the main fish species reported in the national data throughout the different sub-regions, and they began to decline from the beginning of 1980s. All the other major species, *Trachurus* spp., *Thunnus* spp., European hake, clams and *Scomber* spp. presented similar trends with declines starting from the 1980s or beginning of 1990s. The only two species that have shown an earlier decrease (mid-1970s) were picarel and bogue. Cuttlefishes were the only taxon that fluctuated through time, while ‘miscellaneous marine invertebrates’ was the only taxon which increased, suggesting a decline in accuracy of statistical collection.

Table 7. Taxa present in the IREPA dataset with reported landings >25%, >50% and >100% than the ISTAT dataset.

Taxon	25%	50%	75%	100%
<i>Aristeus antennatus</i>	X	X	X	
<i>Atherina boyeri</i>	X	X		
<i>Auxis thazard thazard</i>	X	X	X	
<i>Bivalvia</i>	X	X	X	X
<i>Boops boops</i>	X	X	X	
<i>Brachyura</i>	X			
<i>Carangidae</i>	X	X	X	X
<i>Conger conger</i>	X	X	X	X
<i>Dentex dentex</i>	X	X		
<i>Dicentrarchus labrax</i>	X	X		
<i>Diplodus sargus sargus</i>	X			
<i>Eledone cirrhosa</i>	X	X	X	X
<i>Eledone moschata</i>	X	X	X	X
<i>Engraulis encrasicolus</i>	X			
<i>Gobiidae</i>	X	X		
<i>Homarus gammarus; Palinurus vulgaris</i>	X	X	X	X
<i>Belone belone</i>	X	X		
<i>Lophius piscatorius</i>	X	X	X	X
Marine fishes not identified	X	X	X	
<i>Merlangius merlangus</i>	X	X	X	X
<i>Merluccius merluccius</i>	X	X	X	X
<i>Micromesistius poutassou</i>	X	X	X	X
<i>Mullus barbatus barbatus</i>	X	X	X	X
<i>Mullus surmuletus</i>	X	X	X	X
<i>Nassarius mutabilis</i>	X	X	X	X
<i>Nephrops norvegicus</i>	X	X		
<i>Pagellus erythrinus</i>	X	X	X	X
<i>Parapenaeus longirostris</i>	X	X	X	X
<i>Pecten jacobaeus</i>	X	X	X	X
<i>Rajidae</i>	X	X	X	X
<i>Sarda sarda</i>	X			
<i>Sardina pilchardus</i>	X			
<i>Sciaenidae</i>	X	X		
<i>Scomber scombrus</i>	X			
<i>Scombridae</i>	X	X	X	X
<i>Selachiimorpha</i>	X	X	X	X
<i>Sepiida</i>	X	X	X	X
<i>Serranus spp.</i>	X	X		
<i>Solea solea</i>	X	X	X	X
<i>Sparus aurata</i>	X	X		
<i>Spicara smaris</i>	X	X	X	X
<i>Squilla mantis</i>	X	X	X	
<i>Teuthida</i>	X	X	X	
<i>Thunnus alalunga</i>	X	X	X	
<i>Thunnus thynnus</i>	X	X	X	X
<i>Todarodes sagittatus</i>	X	X	X	X
<i>Trachurus spp.</i>	X	X	X	X
<i>Trisopterus minutus</i>	X	X		
<i>Xiphias gladius</i>	X	X	X	X

Industrial fisheries

In the 1950-2010 period, industrial fisheries were the major contributor of the total reconstructed landings with an average contribution of 79%. These industrial fisheries consisted of trawlers, mid-water trawlers, dredges, purse seiners, long liners and multiple gears. The catch was made up of 48% reported landings (all reported values moving forward are in relation to FAO data), 43% unreported (and illegal) landings and 9% discards. By region, Sicily was the region with the majority (31.3%) of the industrial landings (reported and unreported) with an average value of approximately 169,000 t·year⁻¹, followed by Central (123,000 t·year⁻¹; 22.8%) and North Adriatic (76,800 t·year⁻¹; 14.2%), North Tyrrhenian (48,000 t·year⁻¹; 8.9%) and South Adriatic (46,100 t·year⁻¹; 8.5%). The other sub-regions were as follows: South Tyrrhenian (30,000 t·year⁻¹; 5.6%), Ionian (21,000 t·year⁻¹; 3.9%), Sardinian (10,900 t·year⁻¹; 2.0%), Central Tyrrhenian (9,900 t·year⁻¹; 1.8%) and Ligurian Sea (6,000 t·year⁻¹; 1.1%) (Figure 6a). European anchovies and European pilchards were the main species, with approximately 24% (8.1 million t) and 17% (5.5 million t), respectively, of the industrial reconstructed total catch for 1950-2010. As for molluscs and

crustaceans, clams (3.4%; 1.1 million t), cuttlefish (1.6%; 512,000 t) and deep-water rose shrimps (1.5%; 486,000 t) were the major contributors.

Industrial discards averaged 52,400 t·year⁻¹ and 8.8% of the reconstructed catch for the sector. Total annual discards followed the same trend as the national reported data. Clams (*Bivalvia*; 12.6%), sharks (*Selachimorpha*; 9.1%) and jacks (*Trachurus* spp.; 6.7%) were the most prominent discarded taxa, followed by rays (*Rajidae*; 5.9%) and whiting (*Merluccius merluccius*; 5.3%).

Artisanal fisheries

For the 1950-2010 period total reconstructed artisanal fishery landings (i.e., boats less than 12 m, using only fixed gears as set nets, hooks, traps), both reported and unreported, ranged between 45,300 and 186,000 t·year⁻¹. Catches were fairly stable and exhibited a slight increase during the 1950-1986 period, averaging 138,000 t·year⁻¹, after which catches decreased to 45,300 t in 2010. At the sub-regional level, we observed some differences in comparison with industrial landings. Sicily was still the first region with the highest landings and averaged 31,000 t·year⁻¹ (25.0%), followed again by Central Adriatic (23,500 t·year⁻¹; 19.0%) while there was a shift between the North Adriatic (14,900 t·year⁻¹; 12.0%) and North Tyrrhenian (14,700 t·year⁻¹; 11.9%) region for third place. Also, changes occurred in the other sub-regions as follow: South Adriatic (11,000 t·year⁻¹; 8.9%), Ionian (8,900 t·year⁻¹; 7.2%) and South Tyrrhenian (8,900 t·year⁻¹; 7.2%) followed by the smallest percentages in Sardinia (5,700 t·year⁻¹; 4.6%), Central Tyrrhenian (3,300 t·year⁻¹; 2.7%) and Ligurian Sea (1,900 t·year⁻¹; 1.6%; Figure 8). Silver scabbardfish (*Lepidopus caudatus*; 5.5%; 412,000 t), bogue (*Boops boops*; 5.2%; 395,000 t) and common dolphinfish (*Coryphaena hippurus*; 5.0%; 380,000 t) were the main landed fish taxa for 1950-2010. As for molluscs and crustaceans, cuttlefish (*Sepiidae*; 6.9%; 519,000 t), common octopus (*Octopus vulgaris*; 5.4%; 410,000 t) and spottail mantis shrimps (*Squilla mantis*; 1.6%; 118,000 t) were the major contributors. Discards made up only 2% of the total reconstructed artisanal catch, averaging 2,500 t·year⁻¹.

Unreported commercial catches and discards

In Italy, the best studied illegal activity is related to driftnets. The estimated unreported catches for the illegal driftnet fishing fleet for the 1992-2010 period were 49,130 t, which consisted of approximately 83% swordfish and 17% tuna species. The areas in which this illegal activity was observed the most were the South Tyrrhenian Sea and Sicily, which contributed 46% and 31% of the 49,130 t, respectively. In addition to this amount, we were able to add an illegal component also from other industrial fishing fleets and the artisanal sector. In particular, a total of approximately 5.9 million t was estimated for the period 1950-2010 of which 76%, 24% came from industrial and artisanal fisheries, respectively.

Retained unreported by-catch per fleet type and per subdivision for the period 1950-2010 accounted for over 5 million t at an average of 82,500 t·year⁻¹, most of which came from industrial fisheries (95%) and from the Central Adriatic (1.6 million t; 33%) and Sicily (1.2 million t; 25%). The major by-catch taxa were clams (*Bivalvia*; 604,000 t; 12.0%), shark (*Selachimorpha*; 446,000 t; 8.9%), jacks (*Trachurus* spp.; 335,000 t, 6.7%) and rays (*Rajidae*; 283,000 t; 5.6%). Discards, on the other hand, were 3.4 million t. Since we applied a proportion to separate the retained by-catch from the discard, the same patterns were observed for the regional subdivisions and discarded taxa. Discards and by-catch due to bottom trawling represented the largest component, totaling 3.8 million t.

Recreational fisheries

The estimated recreational catches for 1950-2010 were around 1.45 million t (Figure 2a) of which 87% were unreported and 13% illegal catches. The Adriatic Sea accounted for 597,000 t (41.1%); the Tyrrhenian Sea 497,000 t (34.3%); Ligurian sub-division 194,000 t (13.4%); Sardinia 77,300 t (5.3%); Sicily 68,100 t (4.7%); and the Ionian Sea 16,700 t (1.2%). The major species caught in Italy by the recreational sector throughout the study period were tuna (*Thunnus* spp.) with 223,000 t (15.4%), bogue (*Boops boops*) with 155,000 t (10.7%), Atlantic bonito (*Sarda sarda*) with 107,000 t (7.4%) and Mediterranean horse mackerel (*Trachurus* spp.) with 97,300 t (6.7%). Overall, we observed a slight increase in recreational catches from 1950 to the late 1980s, followed by a more pronounced growth during the last three decades. Catches increased from 19,200 t in 1950 to 29,800 t in 2010. The recreational fishery accounted for 3% of the total reconstructed catches (Figure 6a).

Subsistence catches

The estimated subsistence catches for the 1950-2010 time period averaged 6,400 t·year⁻¹, with a maximum of 9,100 t in 1982 and minimum of 4,000 t in 2010, contributing only 0.9% of the total reconstructed catch (Figure 6a). In this case, the Central Adriatic Sea and Sicily had the highest removals, with approximately 91,400 t (23%) and 85,600 t (22%), respectively. As for species composition, due to the multi-species nature of Italian fisheries, we assumed a similar pattern as the one observed for reported landings and therefore *Engraulis encrasicolus* (13.5%), *Sardina pilchardus* (10.7%) and molluscs (14.8%) made up the majority of the catches.

Fishing effort

As for the reported catches, we encountered some discrepancies between the two sources in relation to number of fishing vessels and GT values. Thus, we decided to apply the same approach described before, keeping the IREPA dataset (1996-2010) and extrapolated the remaining time series (1950-1995) using ISTAT trends and their corresponding percentages (Figure 7). Results indicated that trawlers had the highest fishing effort followed by purse seiners and artisanal fisheries. In regards to their trends, all fishing fleets decreased, with their maximum size occurring around the end of the 1970s or mid-1980s (only multiple gears had its highest peak in the 1990s) and a steady decline afterwards.

Italian mainland

The reconstructed total catch for the Italian mainland for the 1950-2010 period increases from approximately 379,000 t·year⁻¹ in the 1950s, to a peak of 870,000 t in 1982, and then declines to 295,000 t·year⁻¹ in the late 2000s. The total catch included reported landings (38%), unreported landings (54%) and discards (8%) (Figure 8a). Thus, reconstructed total catches for the mainland were around 2.6 times the reported data suggested (comparison with reported data is based on the fact that we proportionally split the FAO reported data into the various subareas based on the national data). Overall, the Italian mainland accounted for 68% of the reconstructed total catches for Italy. Industrial fisheries had the highest contribution with 77.7% (70.1% landings with 11.4% being by-catch; 7.6% discards), followed by artisanal fisheries, with 17.2% (16.9% landings with 0.5% being by-catch; 0.3% discards) recreational fisheries (4.2%) and subsistence fisheries (0.9%).

As for fin-fish in the industrial landings, the highest percentages observed throughout the mainland were for European anchovies and European pilchards (Figure 8b). In each subdivision, these two species alternated as first or second highest catch and Central Adriatic ended being the region with the highest catches for European pilchard with 1.6 million t (7.2% of total industrial landings) and European anchovies with 1.2 million t (5.6%). The only difference was the Ionian Sea where European hake was the second most caught species (84,300 t) after European pilchards (108,000 t). For crustaceans and molluscs, sub-regional differences were observed: Central and North Adriatic had the highest catch of clams (664,000 t and 409,000 t, respectively) and cuttlefish (176,000 t and 127,000 t, respectively). In the Ionian Sea, the catches were mainly dominated by giant red shrimp (59,000 t) and squid (27,200 t); in the South Adriatic by spottail mantis shrimp (63,200 t) and cuttlefish (62,500 t); in the South Tyrrhenian by squid (30,600 t) and giant red shrimp (22,900 t), in the Central Tyrrhenian by squid (20,200t) and cuttlefish (12,700 t), in the North Tyrrhenian by common octopus (31,100 t) and squid (28,000 t) and in the Ligurian Sea by musky octopus (9,000 t) and squid (5,800 t).

The artisanal fisheries of each sub-division displayed differences both for fish, molluscs and crustaceans: silver scabbardfish, common dolphinfish, monkfish and red mullet were the most common fish, while cuttlefish and common octopus were the most important invertebrates. The Central Adriatic, as with the industrial fisheries, had the highest catches, with silver scabbardfish (79,300 t), red mullet (79,300 t), common dolphinfish (72,700 t), cuttlefish (172,000 t) and sea snails (143,000 t) dominating.

Few differences were also observed in the taxonomic composition of recreational fisheries: while tuna species dominated the catches in Liguria and all the different divisions of the Tyrrhenian Sea, sand steenbras (*Lithognathus mormyrus*) dominated the catches for the Ionian and South/Central Adriatic Seas, and garfish (*Belone belone*) was the most prevalent species in the North Adriatic Sea.

Regarding discards, sharks and horse mackerels (*Trachurus* spp.) were the most important components in the industrial fisheries of the South Adriatic Sea (sharks: 39,700 t; horse mackerels: 32,400 t), Tyrrhenian (highest catch observed in the North Tyrrhenian with sharks: 11,400 t and horse mackerel: 11,000 t), and Ligurian (sharks: 1,700 t; horse mackerels: 1,000 t). In the Ionian Sea, sharks (10,900 t) and rays (7,300 t) were the most discarded and in the Central and North Adriatic Sea clams (242,000 t and 136,000 t, respectively) and horse mackerels (74,800 t and 39,800 t, respectively). In the artisanal

fisheries of each sub-division (which each had the same top discards), we observed the most common discarded commercial species were picarels, Atlantic bonito, gobies, sharks, common Pandora and horse mackerels, and while among invertebrates, it was squids and spottail mantis shrimps.

Overall, the major species/taxa caught in the Italian mainland by all sectors were European pilchard (13.8%) followed by European anchovy (13.5%), clams (4.9%), European hake (3.6%), *Trachurus* spp. (3.3%), and cuttlefishes (3.0%) (Figure 8b).

Sicily

The reconstructed total catch for Sicily for the 1950-2010 period followed a very different trend than that of the mainland waters. Catches peaked in 1952 with 514,000 t, declined to 144,000 t in 1962, and then increased slightly and averaged 243,000 t·year⁻¹ from 1963-1988. Catches then declined again to 136,000 t in 1989 and then stayed steady at 161,000 t·year⁻¹ until a small peak of 181,000 t in 1998. Catches then steadily declined to 68,300 t in 2010. The reconstructed total catch for Sicily included reported landings (41.0%), discards (6.3%), and unreported landings (52.7% from artisanal, industrial, recreational, subsistence fisheries and retained by-catch). Thus, reconstructed total catches were around 2.4 times the reported data. Sicily was the most important and still is a very important region in terms of fisheries removals, accounting for 29% of the total reconstructed catches. However, catches from Sicily have declined in their importance over the years, making up 50% of removals in 1950 and declining to 18% in 2010, tied for second most (with the North Adriatic) behind Central Adriatic with 25%. Industrial fisheries, which comprised trawlers (42%), multiple gears (24%), longliners (19%), purse seiners (14%) and mid-water trawlers (1%) had the highest contribution, with 84.2% of the catch (78.2% landings with 8.9% being by-catch; 5.9% discards), followed by artisanal fisheries with 14.7% (14.3% landings with 0.6% being by-catch; 0.4% discards), subsistence fisheries (0.7%) and recreational fisheries (0.5%) (Figure 9a).

The commercial landings revealed a steep decline since the beginning of the 1950s of both industrial and artisanal fisheries; a different pattern was observed in the subsistence fisheries, which showed an increase until the end of the 1990s and a sharp decline thereafter, and in the recreational fisheries, which grew slowly until recent years. The taxonomic composition of industrial landings were mainly European anchovies (4.0 million t; 38.4%) and European pilchards (1.3 million t; 12.2%) for fish, and deep-water rose shrimp (300,000 t; 2.9%) for crustaceans, while for artisanal landings bogue (211,000 t, 11.2%) and picarel (121,000 t, 6.4%), common octopus (64,100 t; 3.4%) and cuttlefish (48,000 t; 2.5%) dominated. For recreational fisheries, bogue (15,000 t, 22%) and striped sea bream and (10,900 t, 16%) were the main taxa, while for discards, sharks (132,000 t; 15.9%) and rays (86,000 t; 10.3%) were the most dominant. Overall, the major species/taxa caught in Sicily by all sectors were European anchovy (30.7%), European pilchard (9.9%), bogue (4.3%) and *Trachurus* spp. (4.2%) (Figure 9b).

Sardinia

The reconstructed total catch for Sardinia for the 1950-2010 period averaged 14,300 t·year⁻¹ from 1950-1969, increased slightly from 1970-1984 with 19,500 t·year⁻¹, peaked at 46,500 t in 1988, and then steadily declined to an average of 13,200 t·year⁻¹ in the late 2000s. The total reconstructed catch included reported landings (37.9%), discards (33.4%) and unreported landings (58.7%, from artisanal, industrial, recreational, subsistence fisheries and retained by-catch). Thus, reconstructed total catches were around 2.6 times the reported data. Sardinia, despite being the second largest island in the Mediterranean Sea (after Sicily) accounted for only 2.5% of the total reconstructed catches for Italy. Industrial fisheries, mainly trawlers (58%), multiple gears (39%) and purse seiners (3%) had the highest contribution to total catches with 60.7% (57.9% landings with 4.2% being by-catch; 2.8% discards) followed by artisanal fisheries with 30.6% (30.0% landings with 0.9% being by-catch; 0.6% discards), recreational fisheries (6.7%), and subsistence fisheries (2.0%).

Overall, landings showed an increase until the beginning of the 1990s and then a continuous decline up to 2010. On the other hand, subsistence fisheries did not exhibit major changes in their trajectory with a minor peak from the mid-1970s to early 1980s, while recreational fisheries increased steadily with a slight jump in catches occurring at the end of the 1990s (Figure 10a). The taxonomic composition of industrial landings were mainly European pilchard (56,800 t; 8.5%) and striped mullet (35,300 t; 5.3%) for fish, and common octopus (20,900 t; 3.1%), and squid (20,200 t; 3.0%) for invertebrates, while for artisanal landings common octopus (40,300 t; 11.7%), cuttlefish (19,200 t; 5.6%), picarel (29,200 t; 8.4%) and silver scabbardfish (18,600 t; 5.4%) dominated. For recreational fisheries, bogue (10,100 t; 13%) and seabreams (6,200 t; 8%) were the main taxa, while for discards, horse mackerel (3,000 t, 7.6%) and sharks (2,100 t; 5.4%) were the most dominant. Overall, the major species/taxa caught in Sardinia by all

sectors were common octopus (5.5%), European pilchard (5.2%), bogue (4.0%), picarel (4.0%) and European hake (3.8%) (Figure 10b).

Discussion

Italian reconstructed total catches, including reported and unreported commercial landings, recreational and subsistence fisheries, for the 1950-2010 period were approximately 2.6 times the total reported by the FAO for the same period. This difference was mainly caused by poor reporting of commercial catches with unreported commercial landings contributing almost 50% to the total catch (in relation to FAO reporting) and discards contributing another 7%. Even national sources were under-reported. The gap in the official statistics has previously been observed by other studies (AdriaMed 2003; Cataudella and Spagnolo 2011) that claimed ISTAT to fall behind (30-40%) the actual reporting and pointed to changes in data collection, systematic approach and absence of data verification and/or analysis as the causes of this discrepancy. For this reason, the Italian Ministry of Agriculture and Forestry (MIPAF) mandated IREPA to take the coordinating role of optimizing the fisheries statistical scheme to obtain a detailed and harmonized fisheries data collection along the whole Italian coast. Yet, compared to previous studies (AdriaMed 2003; Cataudella and Spagnolo 2011), our reconstruction shows higher values for industrial (53%) and for artisanal fisheries (30%).

Not surprisingly, Sicily was and still is the major contributor of marine resources removal both in the artisanal and industrial sectors, followed by the Adriatic Sea, particularly the Central Adriatic, confirming the importance of these two fishing grounds for the Italian fisheries economy (IREPA 2011). Looking at reported catch trends, all the Italian regions have shown a remarkable decline; with the exception of Sicily that has displayed a reduction in fisheries catches since the beginning of the time period in 1950, pretty much all the other regions have reported a decline in fisheries catches starting around the 1980s. These patterns reinforce the downward trend observed in the Italian fisheries sector over the past decades, as a consequence of the impoverishment of the living marine resources, and the constant increase in fishing costs (e.g., fuel) (Sacco 2011). In particular, after World War II, with an increasing global demand for fish and fish products, in combination with a technological revolution prompting fishing effort and capacity to increase exponentially (Cataudella and Spagnolo 2011), allowing for a rapid increase in catches until 1980. Afterwards, catches rapidly declined, primarily as a result of a decrease in the biomass of small pelagics, particularly European anchovy (*Engraulis encrasicolus*) and European pilchard (*Sardina pilchardus*) (Iborra Martin 2006), as well as many other important demersal and pelagic fish stocks (Arneri 1996; Iborra Martin 2006). Only the catches of marine invertebrates have increased. As for fleets, our study reveals the importance of artisanal fisheries in the area; as in many other parts of the Mediterranean Sea (Tudela 2004), indeed, they represent the highest component in numbers (around 60% of all Italian fishing fleets). From a catch volume perspective, however, trawlers (industrial sector) contribute the most, with approximately 26% of total catches, despite accounting for only 21% of the total number of fishing boats.

Apart from commercial catches, we were also able to look at and assess the Italian recreational fishery. In Italy, this sector is of great social and economic importance, since it is expensive and linked to tourism benefiting the regional economy as well as generating an income for the local population (Anagnopoulos *et al.* 1998; Pawson *et al.* 2007). About half of the recreational fishing vessels are between 4 and 6 m in length and 39% are between 6 and 11 m; all of them are only allowed to use 'lenze' (fishing line) (Anagnopoulos *et al.* 1998). According to our study, the North West regions (Liguria and Tyrrhenian and Sardinia) support the majority of recreational vessels and therefore have the highest catches with tuna, bogue, Atlantic bonito and Mediterranean horse mackerel being the most important species. Since no fishing licenses are required, recreational fishing regulations are difficult to manage and the increase of the sector, particularly in the north-west, poses a growing concern about its impact on fish stocks and increasing conflicts between commercial and recreational fishers. For this reason MIPAAF, following a EU regulation (Regulation (EC) 1224/2009) which establishes an EC control regime specifically for recreational fisheries, introduced in December 2010 the Ministerial Decree aimed at surveying the extent of recreational marine fisheries along the Italian coasts (Tudini 2011). This survey is currently running and since our catch reconstruction ended in 2010, we considered recreational fisheries as unreported.

Unreported and illegal catches, despite being a serious issue in Italian fisheries, have never been assessed and thus considered in the reported data. Our study indicates that these components are very significant, accounting for over half of total fisheries removals. Of the IUU activities, we were able to estimate the impact of driftnets from the beginning of the 1990s, and recreational, artisanal and other industrial fisheries from 1950s. As emerged by this assessment, the continuous use of prohibited driftnets, regardless of EU conversion plans (subsidies for fleet conversion), documents once again a failure in

Italian fisheries management and enforcements by national and regional authorities and the continuation of persistent illicit fishing activities. The loss of revenue due to changes in fishing gears is probably the major reason behind such constant fishing practice (swordfish and tuna species are important and high-value products of the Italian market); the benefits that one driftnet boat could obtain are generally 25% higher than the net added value from an average vessel (Spagnolo and Sabatella 2004). Stopping such fishing practice becomes a priority not only because it contributes to the overexploitation of important fishing resources, but also because it jeopardizes the conservation of other vulnerable species such as cetaceans, turtles and sharks, incidentally trapped in the net (by-catch of no commercial species not considered in this analysis). Regarding other illegal activities (e.g., industrial, artisanal and recreational), in 2010 the Italian Coast Guard has started collecting and reporting infringements at sea and on land in relation to the use of e.g., illegal gears, or undersized species. Unfortunately, this database is still under-representing what is happening along the Italian coastline, but the Coast Guard has committed to improve it in the next few years (European Commission 2011b). Together with subsistence catches, these components represent the least studied and assessed among all the different Italian fishery sectors. Yet, they are key components for understanding and evaluating the impact of fishing on commercial and non-commercial taxa (Zeller *et al.* 2007) and more effort should be invested to properly assess these catch components (e.g., through fishers interviews).

Unreported discards and by-catch are two other aspects of underreported fisheries resource removal, considered pressing issues for marine conservation and fisheries management (Hall and Mainprize 2004; Caddy 2009). In Italy, studies on discards and by-catch have increased in recent years, partly due to the implementation of the EU Data Collection Regulation [Commission Regulation (EC) No 1639/2001; currently, Data Collection Framework, Council Regulation (EC) no 199/2008] which requires Member States to collect data on biological and economic aspects of European fisheries sectors, and partly also to the establishment of the ecosystem approach to fisheries (EAF) (Garcia 2003; Tsagarakis *et al.* 2013). Our results show that, on average, retained by-catch accounts for 11% and discards for 7% of total removals, with bottom trawling being the fleet with the highest impact followed by longline and dredges. These percentages agree with other studies conducted in the Mediterranean Sea which have looked at the contribution of discards and by-catch and estimated a range on average between 10% and 20% (Tsagarakis *et al.* 2013; Ulman *et al.* 2013; Coll *et al.*, submitted). In the Mediterranean Sea, despite an intensive effort promoted by the EU to monitor by-catch and discards, there have been only few attempts to describe general patterns, particularly in relation to historical time series, where the majority of the gaps still exist, and to understand the factors that determine what and how much is discarded (Vassilopoulou 2012). In addition, approaches used to mitigate discards comprise mainly technical measures related to the improvement of gear selectivity which alone has proven to have decreased community evenness and species richness (Coll *et al.* 2008; Tsagarakis *et al.* 2013). Gear selectivity together with spatio-temporal restrictions, enforcement of existing regulations and reduction of fishing pressure should be used as mitigation tools not only for discards/by-catch but also for the entire fisheries management (Tsagarakis *et al.* 2013).

To conclude, our estimates of total fisheries removals for the whole of Italy (1950-2010) revealed a decrease in catch that started in the mid-1980s and that continues to decline. This overall pattern agrees with FAO and national statistics trends highlighting a severe degradation of marine resources in the region. Yet, our results exceed the officially reported amount by a factor of 2.6, which suggests substantial problems in the collection and reporting of actual catch data and quite considerable amount of under-reporting catches. Therefore, the estimates of total fisheries removals presented in this study represent an improvement over official estimates, and should be taken into account when dealing with fisheries management. With many key fish stocks declining, it is necessary for fisheries management to fully capture how much of these resources have been and are being removed and by which sector, so that appropriate decisions for the future are made (Pauly *et al.*, 2014). Our study is the first that attempted to estimate the Italian fisheries removals using a holistic approach; these methods are particularly important in areas like the Mediterranean Sea, where the multi-species and multi-gear nature of fisheries make the assessment of single-species fisheries resources and their management difficult and likely inappropriate.

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Appendix Table A1. Reconstructed total catch versus FAO landings (t) by sector, with discards shown separately, for Italy, 1950-2010.

Year	FAO landings	Total reconstructed catch	Industrial	Artisanal	Subsistence	Recreational	Discards
1950	171,300	715,000	536,000	107,000	4,570	16,800	48,100
1951	170,678	723,000	543,000	109,000	4,570	16,900	47,700
1952	195,366	894,000	688,000	124,000	4,570	16,900	58,600
1953	188,683	803,000	600,000	126,000	4,570	17,100	53,000
1954	197,544	780,000	580,000	124,000	4,780	17,200	51,300
1955	198,144	763,000	568,000	120,000	4,980	17,300	49,900
1956	199,716	801,000	604,000	120,000	5,080	17,400	52,700
1957	185,760	706,000	518,000	116,000	5,080	17,500	46,800
1958	181,903	664,000	486,000	110,000	5,150	17,600	43,600
1959	185,887	640,000	463,000	110,000	4,990	17,700	42,000
1960	184,645	596,000	427,000	105,000	5,240	17,900	38,700
1961	207,972	653,000	471,000	114,000	5,430	18,000	42,700
1962	194,212	557,000	386,000	108,000	5,470	18,100	36,000
1963	202,083	619,000	440,000	112,000	5,480	18,200	40,200
1964	268,842	645,000	453,000	123,000	5,520	18,300	42,400
1965	276,417	688,000	486,000	130,000	5,550	18,500	44,900
1966	284,244	718,000	510,000	135,000	5,810	18,600	45,800
1967	278,550	762,000	537,000	147,000	6,080	18,800	50,800
1968	276,034	726,000	507,000	143,000	6,150	19,000	48,100
1969	282,961	701,000	494,000	133,000	6,450	19,100	46,200
1970	319,617	760,000	556,000	122,000	6,630	19,200	53,600
1971	320,872	730,000	528,000	122,000	6,770	19,300	51,200
1972	349,939	805,000	587,000	130,000	6,880	19,500	58,100
1973	336,476	857,000	636,000	129,000	7,110	19,600	62,900
1974	368,736	898,000	673,000	127,000	7,740	19,700	67,200
1975	354,920	1,069,000	786,000	173,000	7,900	19,800	80,500
1976	361,586	1,056,000	770,000	177,000	8,140	19,900	77,600
1977	312,725	1,013,000	737,000	169,000	8,410	19,900	76,300
1978	339,634	1,093,000	809,000	169,000	8,570	20,000	83,800
1979	355,005	1,114,000	829,000	167,000	8,910	20,100	86,600
1980	358,129	1,052,000	769,000	170,000	8,880	20,100	81,400
1981	381,707	1,086,000	805,000	166,000	9,060	20,200	82,800
1982	395,693	1,117,000	827,000	168,000	9,070	20,200	91,000
1983	403,336	1,021,000	740,000	169,000	8,770	20,100	80,000
1984	422,311	1,044,000	747,000	186,000	8,060	20,100	80,300
1985	430,163	1,071,000	780,000	180,000	7,220	20,200	81,200
1986	398,667	1,035,000	744,000	182,000	7,190	20,200	78,700
1987	374,683	930,000	661,000	168,000	7,220	20,200	70,800
1988	363,880	826,000	577,000	153,000	7,150	20,200	65,100
1989	329,293	773,000	545,000	136,000	7,100	20,200	63,000
1990	302,291	676,000	466,000	126,000	6,950	22,900	52,900
1991	330,793	707,000	490,000	130,000	6,740	22,900	55,200
1992	319,469	697,000	480,000	129,000	6,930	22,900	53,600
1993	330,092	719,000	499,000	129,000	6,680	25,500	55,800
1994	330,704	712,000	493,000	129,000	6,380	25,300	55,200
1995	375,970	742,000	525,000	124,000	6,350	25,400	58,600
1996	354,551	717,000	511,000	114,000	7,280	24,600	56,600
1997	326,260	716,000	516,000	109,000	7,570	24,700	56,200
1998	289,545	741,000	517,000	130,000	8,920	24,500	57,400
1999	264,619	660,000	455,000	119,000	8,590	25,000	50,000
2000	293,405	622,000	437,000	104,000	7,530	24,900	46,100
2001	294,314	556,000	388,000	88,000	6,650	25,000	44,500
2002	254,642	492,000	343,000	79,000	5,790	25,300	36,100
2003	273,255	514,000	364,000	76,000	5,370	25,300	39,900
2004	262,300	480,000	342,000	67,000	4,760	25,500	38,000
2005	278,384	443,000	317,000	59,000	4,470	25,700	34,600
2006	296,900	471,000	344,000	57,000	4,360	25,800	36,800
2007	273,256	447,000	322,000	56,000	4,260	25,700	36,400
2008	221,652	374,000	263,000	46,000	4,240	25,900	30,200
2009	239,564	390,000	275,000	53,000	4,090	26,100	28,700
2010	228,440	374,000	267,000	45,000	4,010	26,400	28,200

Appendix Table A2. Reconstructed total catch (t) by taxa, for Italy, 1950-2010. 'Others' contains 42 additional taxa.

Year	<i>Engraulis encrasicolus</i>	<i>Sardina pilchardus</i>	Scombridae	Sparidae	Carangidae	Mollusca	Crustacea	Elasmobranchii	Other
1950	208,000	98,800	72,800	44,600	24,000	37,300	27,400	30,600	169,000
1951	210,000	99,200	81,200	44,800	24,100	37,500	27,500	30,800	166,000
1952	300,000	129,100	85,400	51,600	27,700	37,600	31,100	37,800	192,000
1953	216,000	109,600	95,400	53,400	28,300	36,600	28,500	34,600	198,000
1954	210,000	107,600	84,200	53,100	27,900	38,000	29,300	33,200	194,000
1955	206,000	108,900	75,200	51,200	27,100	41,200	29,200	32,100	190,000
1956	231,000	116,900	86,700	49,300	26,400	42,000	29,600	33,500	184,000
1957	160,000	98,300	93,800	46,300	24,900	41,500	29,600	29,600	179,000
1958	157,000	89,000	80,200	48,200	24,800	43,300	28,400	27,200	163,000
1959	127,000	97,900	81,000	48,100	27,100	42,200	28,600	27,600	158,000
1960	112,000	92,600	62,800	48,300	32,700	35,200	28,400	25,600	156,000
1961	130,000	96,600	72,900	49,700	33,900	39,300	31,300	27,400	170,000
1962	98,000	67,700	52,700	51,400	27,900	38,200	29,400	23,400	165,000
1963	123,000	77,300	71,100	54,900	27,000	36,000	29,100	25,800	172,000
1964	119,000	67,000	75,900	59,600	30,300	46,900	32,000	26,600	185,000
1965	135,000	72,800	79,100	64,500	28,600	53,000	34,100	28,300	190,000
1966	147,000	80,500	74,000	69,700	33,100	56,700	32,200	30,200	192,000
1967	151,000	65,400	93,700	71,800	31,500	57,700	38,200	32,700	218,000
1968	115,000	81,000	90,300	69,100	30,600	57,200	37,900	29,700	213,000
1969	116,000	80,200	88,700	67,000	28,400	54,400	37,300	28,600	198,000
1970	162,000	110,600	73,000	65,300	29,700	72,300	35,900	28,700	180,000
1971	145,000	102,600	70,200	65,800	30,300	67,600	35,100	27,700	184,000
1972	190,000	98,200	67,800	69,700	32,000	79,500	38,400	30,200	197,000
1973	218,000	119,000	66,800	67,600	32,900	86,300	39,300	31,300	194,000
1974	234,000	139,800	64,900	65,500	33,200	93,700	40,100	32,300	192,000
1975	230,000	149,100	80,300	83,300	40,700	137,800	52,400	38,900	254,000
1976	226,000	127,100	77,000	85,500	40,000	130,500	52,000	39,400	276,000
1977	204,000	134,800	76,200	74,200	38,600	110,400	55,100	40,700	276,000
1978	237,000	178,800	68,600	73,600	40,100	102,400	55,700	40,100	295,000
1979	263,000	159,000	65,900	75,900	39,300	128,300	58,000	40,400	281,000
1980	222,000	130,800	62,300	75,400	36,600	147,900	63,500	36,800	275,000
1981	205,000	197,900	75,700	63,400	36,200	137,600	57,200	37,100	274,000
1982	154,000	228,500	86,500	59,700	40,500	158,400	57,000	36,200	294,000
1983	136,000	174,200	74,100	58,000	44,200	149,800	56,300	35,200	290,000
1984	141,000	135,200	89,700	69,500	47,800	135,200	63,000	43,700	316,000
1985	179,000	138,600	75,800	76,500	51,300	136,900	68,400	45,000	296,000
1986	130,000	157,900	75,500	71,900	46,400	140,400	69,600	42,400	298,000
1987	96,000	132,300	75,900	65,800	43,200	141,500	59,800	40,300	273,000
1988	70,000	108,100	63,300	58,600	38,100	141,800	57,500	35,800	249,000
1989	54,000	124,400	57,500	54,600	38,100	130,000	50,900	31,900	229,000
1990	47,000	82,500	56,600	53,300	31,800	106,400	50,800	31,100	215,000
1991	51,000	86,300	55,600	60,200	35,400	115,300	53,600	35,900	212,000
1992	49,000	59,500	58,100	60,900	31,100	113,300	58,200	35,100	227,000
1993	50,000	74,300	66,600	57,600	32,400	116,100	56,300	34,500	228,000
1994	75,000	60,900	62,300	54,800	32,100	113,000	55,400	34,400	222,000
1995	103,000	74,900	65,600	47,000	31,800	110,900	58,600	31,800	216,000
1996	96,000	90,700	68,100	41,200	29,500	99,200	61,500	29,100	198,000
1997	118,000	78,400	73,500	39,800	27,900	95,000	57,400	29,000	194,000
1998	75,000	58,500	81,500	44,500	32,400	129,100	58,800	31,000	228,000
1999	69,000	55,900	66,600	41,200	25,900	128,800	48,800	20,700	200,000
2000	77,000	41,300	48,700	42,000	22,000	138,200	61,200	16,400	172,000
2001	63,000	39,200	43,400	37,400	20,100	126,900	50,600	15,500	157,000
2002	64,000	36,300	46,700	36,400	19,000	81,100	51,200	13,200	141,000
2003	67,000	32,500	44,500	36,500	18,300	110,400	44,500	14,100	142,000
2004	73,000	30,000	40,500	32,800	17,400	94,700	47,800	12,700	127,000
2005	76,000	16,500	36,400	30,000	17,800	81,000	48,600	13,000	121,000
2006	97,000	19,400	35,700	27,100	18,100	86,500	50,000	12,300	122,000
2007	76,000	19,700	33,700	25,500	16,700	109,300	43,300	10,800	109,000
2008	57,000	16,800	25,600	23,900	14,200	90,300	38,500	9,100	95,000
2009	68,000	21,300	29,900	24,700	15,000	74,700	41,700	9,500	102,000
2010	68,000	21,900	25,500	23,600	14,600	76,200	41,000	8,900	91,000

Appendix Table A3. Reconstructed total catch versus FAO landings (t) by sector, with discards shown separately, for mainland Italy, 1950-2010.

Year	FAO Landings	Total Reconstructed Catch	Industrial	Artisanal	Subsistence	Recreational	Discards
1950	70,130	350,000	257,000	71,700	3,620	13,800	25,300
1951	68,572	343,000	253,000	69,100	3,620	13,900	24,000
1952	65,660	366,000	270,000	74,800	3,610	13,900	25,400
1953	79,694	394,000	292,000	80,600	3,610	14,000	27,500
1954	84,879	388,000	287,000	79,400	3,790	14,100	27,000
1955	91,392	402,000	300,000	81,000	3,950	14,200	27,500
1956	84,219	393,000	293,000	77,800	4,020	14,300	27,200
1957	95,777	409,000	305,000	82,000	3,980	14,400	28,400
1958	91,946	377,000	280,000	75,500	4,010	14,500	25,900
1959	95,887	368,000	272,000	74,500	3,950	14,600	25,200
1960	102,353	363,000	267,000	73,300	4,120	14,700	24,400
1961	124,599	419,000	316,000	80,500	4,220	14,800	28,400
1962	132,398	397,000	293,000	81,300	4,250	14,900	26,400
1963	125,830	410,000	306,000	81,200	4,300	15,000	27,500
1964	166,252	429,000	315,000	90,400	4,320	15,100	29,100
1965	169,733	454,000	335,000	95,500	4,300	15,200	30,500
1966	169,655	463,000	340,000	98,700	4,460	15,300	30,100
1967	164,867	488,000	359,000	104,800	4,640	15,500	33,800
1968	183,108	510,000	377,000	109,200	4,670	15,600	34,900
1969	189,609	493,000	369,000	99,700	4,870	15,700	33,600
1970	204,412	514,000	402,000	87,000	5,010	15,800	38,500
1971	205,366	491,000	381,000	84,800	5,080	15,900	36,700
1972	210,555	518,000	404,000	89,300	5,170	16,000	40,500
1973	206,595	559,000	446,000	88,400	5,260	16,100	44,500
1974	227,270	588,000	475,000	86,900	5,660	16,200	48,100
1975	226,663	725,000	575,000	123,800	5,780	16,300	59,300
1976	236,903	729,000	574,000	128,500	6,000	16,400	57,500
1977	198,932	690,000	540,000	123,900	6,240	16,400	56,500
1978	231,803	786,000	630,000	128,900	6,310	16,500	64,900
1979	265,634	853,000	699,000	126,200	6,610	16,500	70,700
1980	277,025	829,000	669,000	132,800	6,540	16,600	67,900
1981	271,947	799,000	648,000	123,600	6,630	16,600	65,300
1982	299,676	870,000	713,000	130,100	6,630	16,600	76,000
1983	304,252	791,000	633,000	130,900	6,400	16,600	66,200
1984	298,344	763,000	600,000	135,600	6,010	16,600	63,200
1985	305,650	783,000	627,000	130,800	5,170	16,600	63,900
1986	292,896	784,000	619,000	138,800	5,120	16,600	63,700
1987	257,905	671,000	522,000	123,500	5,130	16,600	55,400
1988	261,753	613,000	478,000	109,400	5,120	16,600	53,000
1989	253,869	610,000	481,000	104,200	5,040	16,600	53,500
1990	216,703	502,000	384,000	91,400	4,900	18,900	42,600
1991	236,770	523,000	402,000	93,600	4,730	18,900	44,300
1992	227,621	515,000	391,000	94,500	4,910	18,900	42,900
1993	237,680	535,000	411,000	94,000	4,700	21,000	45,000
1994	237,265	529,000	405,000	94,600	4,420	21,000	44,500
1995	274,629	556,000	437,000	89,000	4,340	21,000	47,700
1996	260,157	536,000	427,000	79,700	4,630	20,300	46,000
1997	234,933	526,000	422,000	74,500	4,880	20,300	45,100
1998	202,925	536,000	415,000	90,300	5,610	20,200	45,300
1999	197,967	502,000	384,000	87,200	5,360	20,500	40,900
2000	213,920	466,000	362,000	73,500	4,640	20,500	38,100
2001	220,508	429,000	335,000	64,100	4,470	20,500	37,600
2002	193,068	381,000	295,000	57,300	3,820	20,800	30,000
2003	204,427	390,000	309,000	52,300	3,580	20,800	32,200
2004	199,833	374,000	296,000	48,700	3,150	21,000	31,600
2005	206,884	340,000	270,000	40,800	2,960	21,200	28,200
2006	219,634	360,000	292,000	39,200	2,870	21,200	30,400
2007	207,885	351,000	283,000	38,800	2,780	21,200	30,600
2008	166,834	292,000	229,000	33,000	2,770	21,300	25,400
2009	178,201	300,000	233,000	37,800	2,660	21,500	23,700
2010	173,060	292,000	230,000	32,400	2,680	21,700	23,500

Appendix Table A4. Total reconstructed catch (t) by major taxa for mainland Italy, 1950-2010. 'Others' contains 83 additional taxa.

Year	<i>Sardina pilchardus</i>	<i>Engraulis encrasicolus</i>	Bivalvia	<i>Merluccius merluccius</i>	<i>Trachurus spp.</i>	Sepiida	Others
1950	50,800	31,400	348	14,400	14,400	10,850	224,000
1951	51,700	33,700	327	13,300	13,400	10,480	216,000
1952	56,600	33,200	370	14,800	14,800	9,130	233,000
1953	61,000	37,600	416	16,400	16,100	8,960	250,000
1954	59,700	37,200	403	15,800	15,600	9,950	246,000
1955	64,300	40,700	532	15,700	15,600	10,790	251,000
1956	65,300	40,900	479	14,900	14,900	11,190	242,000
1957	65,400	41,600	471	15,600	15,500	11,280	255,000
1958	57,100	39,600	467	13,400	12,200	13,740	237,000
1959	54,800	36,700	538	12,600	13,300	14,260	232,000
1960	56,700	37,600	537	12,000	17,000	11,100	225,000
1961	63,100	63,100	728	14,700	16,100	13,140	244,000
1962	47,600	61,700	686	14,000	14,700	14,220	241,000
1963	48,200	67,600	648	12,700	13,600	11,210	253,000
1964	39,700	62,400	845	12,900	13,700	15,310	280,000
1965	45,800	70,900	1,072	13,400	13,300	16,900	288,000
1966	51,200	66,200	1,018	13,900	15,000	15,540	296,000
1967	45,800	64,500	1,257	14,400	15,400	16,910	326,000
1968	56,100	66,200	1,448	14,300	16,700	16,300	335,000
1969	56,600	74,100	1,590	13,900	15,400	14,870	313,000
1970	86,400	85,500	19,233	12,400	14,800	14,380	277,000
1971	76,300	81,300	18,270	11,900	15,500	13,770	270,000
1972	74,500	88,700	21,612	13,400	16,300	17,140	282,000
1973	94,400	106,000	24,662	14,100	17,000	16,290	283,000
1974	114,300	111,200	27,704	14,900	17,700	15,450	283,000
1975	124,900	107,600	37,101	20,400	21,000	18,010	392,000
1976	99,700	119,600	32,921	22,200	21,100	16,310	413,000
1977	116,500	79,200	29,584	23,300	21,000	16,160	400,000
1978	161,600	105,300	34,122	21,600	22,500	12,720	424,000
1979	140,000	174,400	38,092	24,700	23,200	14,650	433,000
1980	113,800	156,500	37,294	21,300	23,400	23,120	449,000
1981	164,400	117,200	36,891	22,100	23,000	17,510	414,000
1982	169,500	118,600	47,813	25,100	26,400	24,810	454,000
1983	137,900	104,200	41,740	22,500	25,600	28,400	426,000
1984	114,600	92,600	40,980	24,000	25,300	20,400	441,000
1985	122,300	117,800	37,058	24,400	26,900	24,950	426,000
1986	140,800	78,200	34,880	22,700	27,300	26,230	450,000
1987	115,700	40,500	33,875	21,800	23,500	20,160	411,000
1988	94,900	45,400	31,571	22,900	24,000	20,730	370,000
1989	113,800	42,100	30,431	21,900	23,000	15,890	359,000
1990	73,900	32,700	23,648	20,200	17,800	14,520	316,000
1991	77,200	35,300	25,404	20,900	20,500	20,850	319,000
1992	50,000	34,100	27,002	24,900	17,000	16,030	341,000
1993	64,700	34,800	26,658	32,100	17,900	16,490	338,000
1994	51,500	59,300	24,269	25,600	17,500	26,750	320,000
1995	65,200	87,400	28,149	29,000	17,600	20,520	304,000
1996	81,500	81,200	27,203	25,000	16,500	13,790	286,000
1997	68,900	102,900	25,355	22,600	14,800	14,490	273,000
1998	47,300	57,200	48,763	30,200	17,900	17,370	312,000
1999	47,400	56,100	53,708	22,700	16,300	18,000	283,000
2000	30,700	60,800	69,561	21,100	14,000	16,510	248,000
2001	31,700	47,400	66,403	20,300	13,400	15,070	230,000
2002	30,000	53,600	33,639	19,400	12,700	10,660	216,000
2003	27,900	60,600	63,053	16,700	11,400	10,410	195,000
2004	22,400	65,300	52,975	15,400	11,300	8,560	193,000
2005	12,900	68,000	39,469	17,700	11,400	8,190	178,000
2006	14,100	84,600	44,312	21,700	11,900	10,570	168,000
2007	15,000	70,400	64,385	17,300	10,800	14,600	154,000
2008	12,800	49,400	53,977	15,800	9,300	10,460	135,000
2009	17,800	56,700	37,453	15,100	10,100	10,190	148,000
2010	19,700	57,100	43,915	14,000	9,600	7,170	136,000

Appendix Table A5. Reconstructed total catch versus FAO landings (t) by sector, with discards shown separately, for Sicily, 1950-2010.

Year	FAO landings	Total Reconstructed Catch	Industrial	Artisanal	Subsistence	Recreational	Discards
1950	98,768	353,000	317,000	34,600	708	886	22,400
1951	99,587	367,000	327,000	38,100	708	892	23,300
1952	127,236	514,000	464,000	48,500	708	897	32,700
1953	106,422	395,000	350,000	43,900	708	902	25,100
1954	108,956	375,000	331,000	42,200	743	909	23,800
1955	103,501	346,000	306,000	37,800	788	915	21,900
1956	112,425	394,000	351,000	40,600	815	920	25,000
1957	86,821	283,000	249,000	32,000	839	925	17,900
1958	86,341	272,000	238,000	32,400	880	931	17,200
1959	86,483	257,000	222,000	33,200	782	937	16,300
1960	78,336	218,000	187,000	29,300	860	944	13,800
1961	79,161	219,000	186,000	31,100	898	950	13,800
1962	57,041	144,000	118,000	24,500	905	956	9,100
1963	72,116	194,000	163,000	29,300	893	963	12,300
1964	97,552	203,000	170,000	31,000	912	971	12,800
1965	101,971	221,000	186,000	33,400	938	978	14,000
1966	110,267	242,000	205,000	34,800	1,001	984	15,300
1967	109,569	261,000	218,000	40,900	1,078	991	16,500
1968	88,546	203,000	168,000	32,600	1,120	997	12,800
1969	87,671	192,000	159,000	31,300	1,212	1,003	12,100
1970	109,086	230,000	195,000	32,800	1,249	1,009	14,500
1971	108,133	220,000	184,000	34,100	1,297	1,017	13,900
1972	132,751	269,000	228,000	38,500	1,325	1,023	17,000
1973	124,441	282,000	240,000	38,700	1,430	1,030	17,800
1974	136,276	295,000	254,000	39,000	1,546	1,037	18,700
1975	122,943	326,000	276,000	47,500	1,585	1,043	20,600
1976	119,086	309,000	259,000	47,000	1,603	1,048	19,500
1977	107,964	301,000	257,000	41,300	1,620	1,053	19,000
1978	103,245	290,000	248,000	39,100	1,701	1,056	18,300
1979	84,420	243,000	201,000	38,800	1,736	1,059	15,300
1980	75,200	203,000	166,000	34,900	1,770	1,062	12,800
1981	103,709	265,000	224,000	38,700	1,850	1,063	16,800
1982	89,811	224,000	188,000	33,000	1,881	1,064	14,200
1983	91,045	206,000	169,000	33,400	1,944	1,064	13,000
1984	115,390	257,000	209,000	45,900	1,662	1,064	16,300
1985	114,037	257,000	212,000	42,300	1,661	1,065	16,300
1986	95,423	221,000	182,000	37,000	1,675	1,065	14,000
1987	102,907	223,000	184,000	36,700	1,697	1,065	14,100
1988	82,525	166,000	132,000	30,900	1,654	1,065	10,400
1989	63,912	136,000	107,000	25,900	1,673	1,066	8,500
1990	75,962	152,000	119,000	29,900	1,669	1,197	9,500
1991	83,715	161,000	127,000	31,900	1,637	1,198	10,100
1992	81,560	159,000	125,000	31,200	1,634	1,199	9,900
1993	82,077	161,000	127,000	31,600	1,612	1,329	10,000
1994	83,761	162,000	128,000	31,600	1,575	1,309	10,100
1995	90,917	165,000	130,000	32,000	1,653	1,309	10,300
1996	84,267	159,000	125,000	30,600	2,324	1,288	9,800
1997	82,410	169,000	134,000	31,100	2,369	1,297	10,400
1998	77,919	181,000	142,000	34,700	2,854	1,298	11,200
1999	59,135	137,000	106,000	27,500	2,785	1,320	8,500
2000	70,707	136,000	106,000	25,800	2,464	1,319	7,400
2001	63,498	107,000	85,000	19,300	1,741	1,320	6,400
2002	53,263	94,000	74,000	17,000	1,605	1,336	5,600
2003	59,884	106,000	84,000	19,400	1,458	1,326	7,100
2004	54,802	92,000	74,000	15,300	1,271	1,340	5,800
2005	58,161	84,000	68,000	13,600	1,196	1,355	5,600
2006	65,265	93,000	77,000	13,500	1,177	1,366	5,800
2007	53,646	79,000	64,000	12,500	1,168	1,361	5,100
2008	46,722	69,000	56,000	10,600	1,163	1,373	4,400
2009	52,426	76,000	62,000	11,400	1,123	1,383	4,500
2010	46,671	68,000	56,000	9,600	1,037	1,390	4,300

Appendix Table A6. Total reconstructed catch (t) by major taxa, for Sicily, 1950-2010. 'Others' contains 82 additional taxa.

Year	<i>Engraulis encrasicolus</i>	<i>Sardina pilchardus</i>	<i>Thunnus</i> spp.	Boops boops	<i>Trachurus</i> spp.	<i>Scomber scombrus</i>	<i>Merluccius merluccius</i>	Others
1950	176,000	47,100	223,400	6,850	6,660	13,880	3,040	81,100
1951	176,000	46,900	222,800	7,870	7,440	13,810	3,290	88,200
1952	266,000	71,000	337,200	9,570	9,420	20,990	4,380	113,800
1953	179,000	47,700	226,300	9,340	8,620	14,030	3,690	100,800
1954	172,000	46,000	218,400	9,630	8,670	13,500	3,610	97,000
1955	165,000	43,900	208,500	8,740	7,880	12,880	3,300	87,700
1956	189,000	50,500	239,800	8,300	7,890	14,870	3,500	94,700
1957	118,000	31,600	149,900	6,090	5,780	9,340	2,540	73,700
1958	118,000	30,400	148,000	9,750	9,510	5,120	2,850	69,400
1959	90,000	41,900	131,600	10,640	10,600	7,520	2,720	70,200
1960	74,000	34,700	109,200	11,390	12,230	13,130	2,700	59,200
1961	66,000	31,800	98,200	10,370	14,240	10,350	2,680	63,800
1962	37,000	18,900	55,500	10,440	9,860	7,210	2,130	49,400
1963	55,000	27,400	82,500	12,630	10,070	9,840	2,660	58,800
1964	56,000	26,000	82,300	15,520	13,380	13,830	2,640	59,900
1965	64,000	25,500	89,200	16,140	11,650	16,260	3,060	65,800
1966	81,000	28,200	108,800	17,760	14,440	16,770	3,310	68,400
1967	86,000	18,500	104,400	18,890	12,090	11,120	3,390	85,300
1968	49,000	24,000	72,500	16,890	9,790	13,930	3,060	65,000
1969	42,000	22,300	64,000	15,530	9,020	15,940	2,980	62,900
1970	77,000	23,100	100,000	16,210	11,010	18,450	3,230	68,200
1971	63,000	25,200	88,400	15,970	10,920	7,480	3,370	73,300
1972	101,000	23,100	123,700	19,000	11,880	6,020	4,150	83,800
1973	111,000	23,700	135,100	18,790	11,880	6,530	4,330	85,400
1974	122,000	24,300	146,500	18,590	11,880	7,030	4,520	87,900
1975	123,000	23,100	145,700	23,320	14,970	5,600	5,390	107,700
1976	106,000	26,400	132,700	22,200	14,190	4,970	5,240	105,800
1977	125,000	17,300	142,300	14,590	12,150	3,080	4,990	100,300
1978	131,000	16,200	147,100	12,880	12,010	3,070	4,190	97,300
1979	89,000	17,900	106,700	10,590	11,100	2,930	4,080	96,700
1980	65,000	16,000	81,100	9,470	7,540	2,800	4,230	88,900
1981	87,000	32,200	119,600	7,930	8,790	8,730	6,400	101,200
1982	35,000	58,200	93,200	7,660	9,310	11,710	6,900	85,600
1983	32,000	35,400	67,300	7,490	11,020	4,240	9,270	92,600
1984	49,000	19,600	68,200	13,510	14,830	6,380	12,920	125,500
1985	61,000	15,700	77,000	16,500	15,430	6,110	15,930	111,000
1986	52,000	16,500	68,200	11,000	11,890	6,120	10,440	98,900
1987	55,000	15,500	70,500	7,600	12,650	6,500	11,230	98,600
1988	25,000	12,200	37,000	5,050	7,740	4,240	12,040	89,700
1989	12,000	9,500	21,700	4,370	8,790	2,530	12,050	73,500
1990	14,000	8,100	22,600	4,060	8,750	2,450	9,310	92,200
1991	15,000	8,700	24,100	4,320	9,340	2,610	9,950	98,000
1992	15,000	8,500	23,700	4,240	9,160	2,560	9,750	97,100
1993	16,000	8,700	24,200	4,370	9,380	2,620	9,990	96,700
1994	15,000	8,700	24,000	4,330	9,320	2,600	9,910	97,700
1995	16,000	8,900	24,700	4,450	9,560	2,670	10,180	97,700
1996	15,000	8,500	23,600	4,280	9,180	2,560	9,770	94,300
1997	15,000	8,500	23,500	4,300	9,230	2,590	9,790	100,000
1998	17,000	9,700	26,900	4,840	10,430	2,920	11,110	106,800
1999	13,000	7,400	20,600	3,890	5,730	2,920	7,680	83,800
2000	16,000	9,500	25,800	3,750	4,180	1,950	6,850	85,200
2001	15,000	7,100	22,300	2,850	3,270	1,470	5,220	66,100
2002	11,000	5,800	16,400	2,550	2,930	1,320	4,630	60,800
2003	7,000	4,100	10,700	2,980	3,390	1,620	5,530	75,000
2004	8,000	6,800	14,700	2,350	2,710	1,270	4,230	61,200
2005	8,000	3,000	10,900	1,800	2,820	840	4,030	60,400
2006	12,000	4,700	16,900	1,600	2,910	900	3,840	60,400
2007	6,000	3,900	9,800	1,600	2,620	820	3,400	53,500
2008	7,000	3,300	10,500	1,170	2,100	650	2,770	48,200
2009	11,000	2,800	14,200	1,050	2,060	590	3,000	50,900
2010	10,000	1,600	12,000	990	1,950	590	2,900	47,000

Appendix Table A7. Reconstructed total catch versus FAO landings (t) by sector, with discards shown separately, for Sardinia, 1950-2010.

Year	FAO	Total Reconstructed					
	Landings	Catch	Industrial	Artisanal	Subsistence	Recreational	Discards
1950	2,402	12,000	7,350	3,390	246	2,090	400
1951	2,518	13,000	7,980	4,140	247	2,100	451
1952	2,471	14,000	8,680	4,270	247	2,110	482
1953	2,567	14,000	8,160	4,450	248	2,120	469
1954	3,708	17,000	10,710	5,120	249	2,140	589
1955	3,250	15,000	9,160	4,400	248	2,150	505
1956	3,071	15,000	9,180	4,450	248	2,170	507
1957	3,162	14,000	8,650	4,210	255	2,180	478
1958	3,616	15,000	9,410	4,350	259	2,190	512
1959	3,516	14,000	8,590	4,350	258	2,210	482
1960	3,956	15,000	8,960	4,470	261	2,220	500
1961	4,213	15,000	9,330	4,670	312	2,240	521
1962	4,773	15,000	9,190	4,580	320	2,250	512
1963	4,137	14,000	8,730	4,170	283	2,270	480
1964	5,038	14,000	8,210	4,050	285	2,290	456
1965	4,712	14,000	8,080	4,140	312	2,300	455
1966	4,322	13,000	7,610	3,930	345	2,320	430
1967	4,114	13,000	7,690	3,900	358	2,330	432
1968	4,380	13,000	7,790	4,010	359	2,350	439
1969	5,681	16,000	9,550	4,570	370	2,360	526
1970	6,119	17,000	10,240	4,760	375	2,380	558
1971	7,373	19,000	11,730	5,820	387	2,400	653
1972	6,633	18,000	10,740	5,410	387	2,410	601
1973	5,440	16,000	9,870	4,650	426	2,430	540
1974	5,190	15,000	9,020	3,920	530	2,440	482
1975	5,314	18,000	11,120	5,030	535	2,460	601
1976	5,597	19,000	11,370	5,460	539	2,470	626
1977	5,830	22,000	13,190	6,950	547	2,480	749
1978	4,586	17,000	10,420	5,130	557	2,490	579
1979	4,951	19,000	11,100	5,800	562	2,490	629
1980	5,904	20,000	12,100	6,290	568	2,500	684
1981	6,051	22,000	12,580	7,760	578	2,500	757
1982	6,207	23,000	12,630	8,180	568	2,500	775
1983	8,039	24,000	14,200	8,360	429	2,510	840
1984	8,578	24,000	14,530	8,150	392	2,510	844
1985	10,477	31,000	18,420	10,600	394	2,510	1,080
1986	10,348	29,000	18,350	9,400	397	2,510	1,033
1987	13,872	36,000	22,980	11,080	401	2,510	1,268
1988	19,603	46,000	29,150	15,700	383	2,510	1,669
1989	11,512	28,000	17,540	8,390	388	2,510	965
1990	9,625	22,000	13,730	6,580	377	2,820	756
1991	10,308	23,000	14,150	6,730	371	2,820	777
1992	10,288	22,000	14,400	6,060	386	2,830	747
1993	10,335	23,000	14,560	6,130	370	3,140	755
1994	9,677	21,000	13,440	5,490	382	3,080	690
1995	10,425	21,000	13,430	5,940	357	3,090	706
1996	10,127	22,000	13,840	6,270	320	3,040	733
1997	8,917	21,000	13,390	5,850	321	3,060	701
1998	8,701	24,000	14,780	7,250	453	3,060	805
1999	7,517	21,000	12,240	6,670	448	3,110	690
2000	8,777	21,000	12,050	6,810	432	3,100	635
2001	10,309	19,000	11,000	6,560	434	3,110	569
2002	8,310	17,000	9,420	5,990	367	3,150	502
2003	8,944	17,000	9,880	5,680	331	3,200	550
2004	7,665	14,000	8,760	3,840	337	3,220	538
2005	13,339	19,000	12,090	5,400	320	3,210	747
2006	12,000	18,000	10,390	5,270	313	3,220	623
2007	11,725	17,000	10,210	5,290	310	3,210	633
2008	8,096	13,000	7,310	3,510	309	3,230	455
2009	8,937	14,000	7,530	4,270	302	3,260	449
2010	8,709	13,000	7,410	4,030	296	3,290	435

Appendix Table A8. Total reconstructed catch (t) by major taxa or for Sardinia, 1950-2010. 'Others' contains 82 additional taxa.

Year	<i>Octopus vulgaris</i>	<i>Sardina pilchardus</i>	<i>Boops boops</i>	<i>Spicara smaris</i>	<i>Merluccius merluccius</i>	<i>Mullus surmuletus</i>	<i>Mugil cephalus</i>	Sepiida	Others
1950	349	925	644	371	572	274	170	403	9,370
1951	714	575	695	413	650	313	192	830	10,080
1952	807	1,533	698	417	652	313	193	937	9,750
1953	888	980	729	441	699	338	207	1,034	9,660
1954	710	1,927	827	534	838	407	251	824	11,900
1955	523	758	751	462	722	348	215	606	11,580
1956	511	1,075	776	482	755	366	226	592	11,260
1957	615	1,391	732	441	689	332	205	714	10,170
1958	616	1,410	764	992	538	804	607	375	10,100
1959	657	1,178	1,100	684	276	715	1,037	399	9,360
1960	654	1,243	969	756	363	719	818	269	10,120
1961	806	1,726	903	680	380	803	960	318	9,980
1962	696	1,265	960	616	361	700	1,104	292	10,350
1963	515	1,743	921	283	425	620	1,111	322	9,500
1964	550	1,357	882	147	376	553	815	344	9,810
1965	415	1,410	1,059	337	371	412	599	292	9,940
1966	485	1,003	987	393	493	401	733	329	9,380
1967	556	1,144	951	492	453	395	736	302	9,260
1968	485	1,005	1,096	873	367	438	754	331	9,150
1969	476	1,316	1,034	1,020	428	622	827	365	10,770
1970	638	1,108	965	968	605	664	798	377	11,630
1971	746	1,055	1,050	910	741	684	817	553	13,770
1972	800	650	1,048	646	627	550	653	605	13,370
1973	761	901	897	634	631	520	660	591	11,780
1974	729	1,154	748	630	639	492	673	583	10,270
1975	1,026	1,140	947	912	758	604	697	635	12,420
1976	1,036	968	1,182	1,038	621	404	514	719	13,360
1977	836	968	1,286	907	538	458	553	661	16,960
1978	785	1,120	1,124	538	384	388	567	564	13,130
1979	1,011	1,139	1,131	879	361	478	710	662	13,590
1980	957	903	1,225	969	404	420	807	675	15,100
1981	1,501	1,322	759	1,093	709	394	1,563	647	15,430
1982	2,471	846	676	919	686	485	1,612	667	15,520
1983	2,325	976	774	1,303	1,155	527	1,107	665	16,670
1984	1,239	879	877	750	580	391	594	531	19,740
1985	1,596	631	975	1,060	859	1,033	735	878	24,150
1986	1,471	639	1,139	870	796	893	756	936	23,150
1987	1,720	1,173	1,476	1,128	1,223	1,200	1,074	990	26,990
1988	2,798	1,025	1,193	907	1,102	1,261	1,349	2,854	35,260
1989	1,356	1,005	1,229	572	730	935	877	1,023	21,090
1990	851	505	891	547	681	939	656	585	17,860
1991	1,003	435	1,092	644	1,026	631	930	527	17,780
1992	681	942	941	730	924	577	1,035	435	17,410
1993	370	825	912	699	823	590	1,128	328	18,520
1994	344	770	858	722	847	781	853	338	16,880
1995	484	786	1,173	765	729	913	2,170	241	15,550
1996	1,219	669	1,104	587	783	962	1,015	391	16,730
1997	1,359	1,002	986	530	729	658	584	549	16,230
1998	2,580	1,502	941	456	841	601	975	697	16,940
1999	2,186	1,021	971	371	923	460	570	812	15,160
2000	1,960	1,005	1,024	1,473	1,528	1,310	26	863	13,200
2001	1,558	448	1,050	1,560	1,578	1,360	23	684	12,840
2002	1,129	477	987	1,394	1,424	1,225	22	498	11,770
2003	1,303	520	984	1,345	1,410	1,213	22	577	11,710
2004	1,191	797	804	883	1,017	843	18	535	10,080
2005	1,425	643	880	1,343	1,319	1,295	22	794	13,300
2006	1,732	634	650	953	1,154	1,277	21	660	12,110
2007	1,466	833	629	1,088	824	753	259	542	12,620
2008	790	644	561	666	537	491	136	414	10,130
2009	1,087	631	542	644	526	606	181	436	10,710
2010	1,057	542	561	587	643	553	133	468	10,480

FIGURES

- Figure 1. Italy with its coastal regions (LI: Liguria; TO: Toscana; LA: Lazio; CAM: Campania; CAL: Calabria; SI: Sicily; SA: Sardinia; BA: Basilicata; PU: APulia; MO: Molise; AB: Abruzzo; MA: Marches; ER: Emilia Romagna; VE: Veneto; FVG: Friuli Venezia Giulia) and the four surrounding sub-regionals seas: Ligurian; (Northern, Central and Southern) Tyrrhenian; Ionian and (Northern, Central and Southern) Adriatic Sea. For the scope of the report Sicilian and Sardinian waters have been considered separately.
- Figure 2. Italian Statistical catch data coming from the two National sources (ISTAT and IREPA) for the 1950-2010 period in comparison with the ones reported to FAO.
- Figure 3. Number of species per each sub-regional division present in the IREPA dataset with catch values greater than 25%, 50%, 75% and 100% compared to the ISTAT dataset
- Figure 4. Comparison between reconstructed and IREPA catches for European anchovies (1) and European pilchard (2) around the coasts of Sardinia. Grey line represents IREPA data while dotted line shows the reconstructed one.
- Figure 5. Comparison between ICCAT, IREPA and reconstructed catches for Atlantic bluefin tuna (a), frigate tuna (b), Atlantic bonito (c) and swordfish (d). Dark line represents ICCAT data, grey line IREPA data while dotted line shows the reconstructed one.
- Figure 6. Whole Italy: a) total reconstructed catch by sector compared to total reported FAO catch (black line) for 1950-2010 period; b) total reconstructed catch by taxa, 1950-2010, the 'others' grouping contains 82 taxa.
- Figure 7. Whole Italy: Reconstruction of total fishing effort (GT*days) per each type of gear for 1950-2010 period.
- Figure 8. Italian mainland: a) total reconstructed catch by sector for 1950-2010 period; b: total reconstructed catch by taxa, 1950-2010, the 'others' grouping contains 82 taxa.
- Figure 9. Sicily: a) total reconstructed catch by sector for 1950-2010 period; b: total reconstructed catch by taxa, 1950-2010, the 'others' grouping contains 82 taxa.
- Figure 10. Sardinia: a) total reconstructed catch by sector for 1950-2010 period; b: total reconstructed catch by taxa, 1950-2010, the 'others' grouping contains 82 taxa.



Figure 1

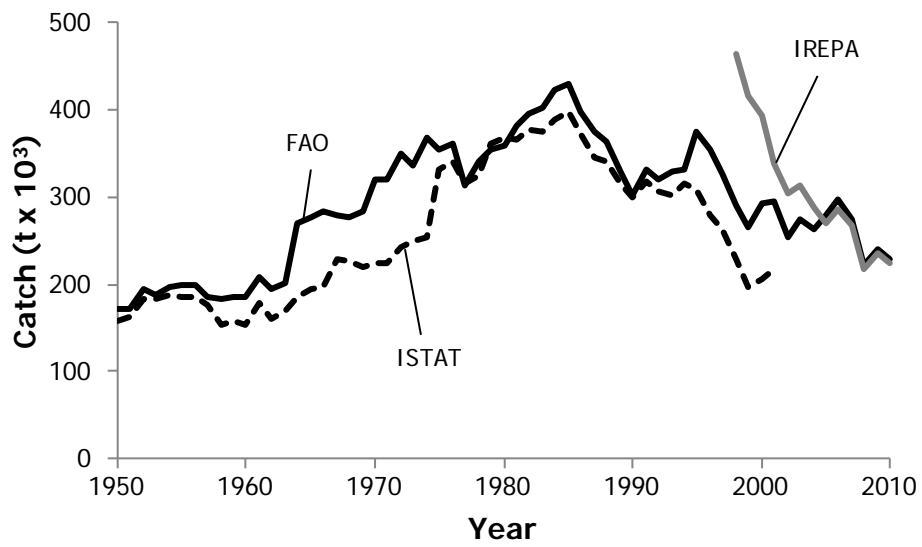


Figure 2

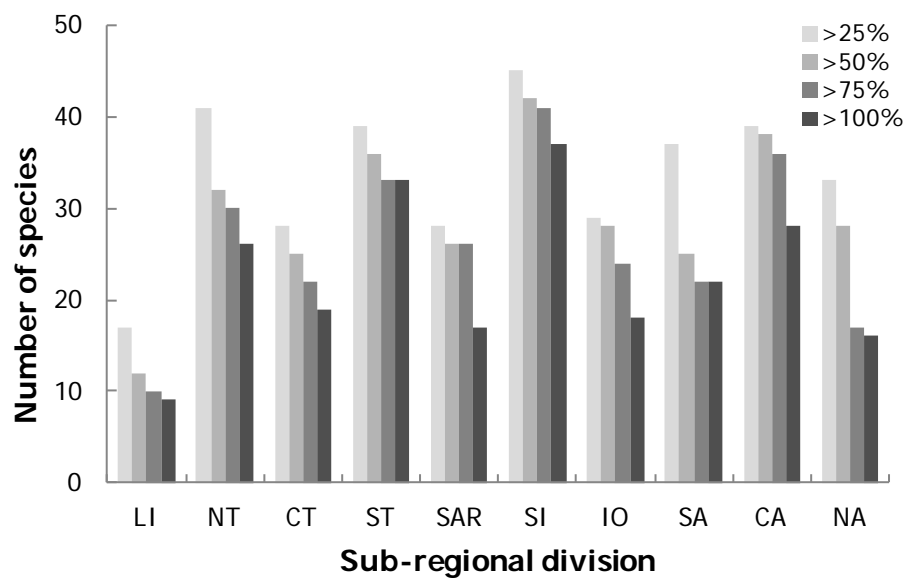


Figure 3

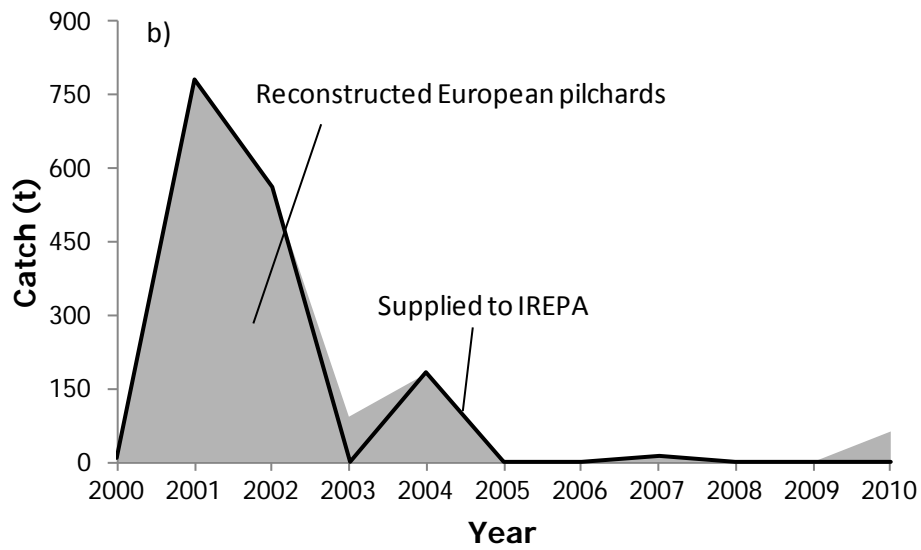
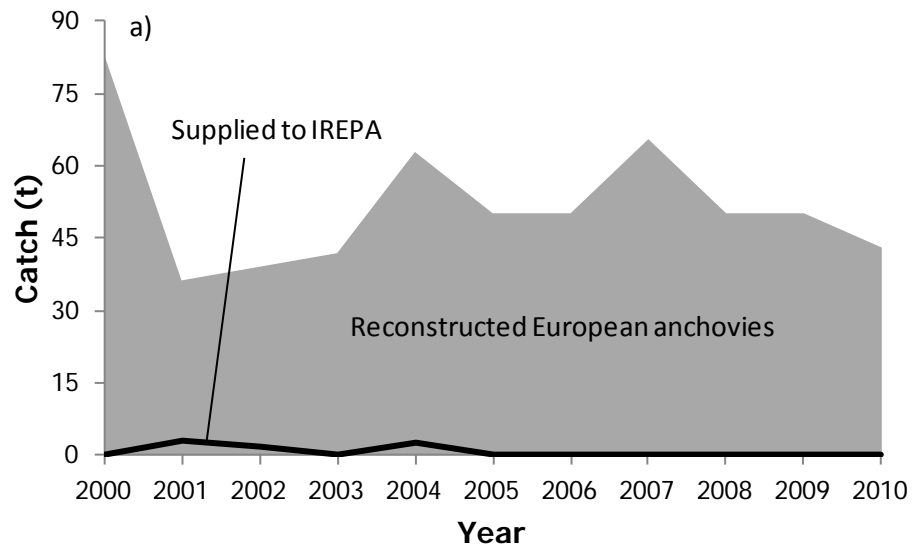


Figure 4.

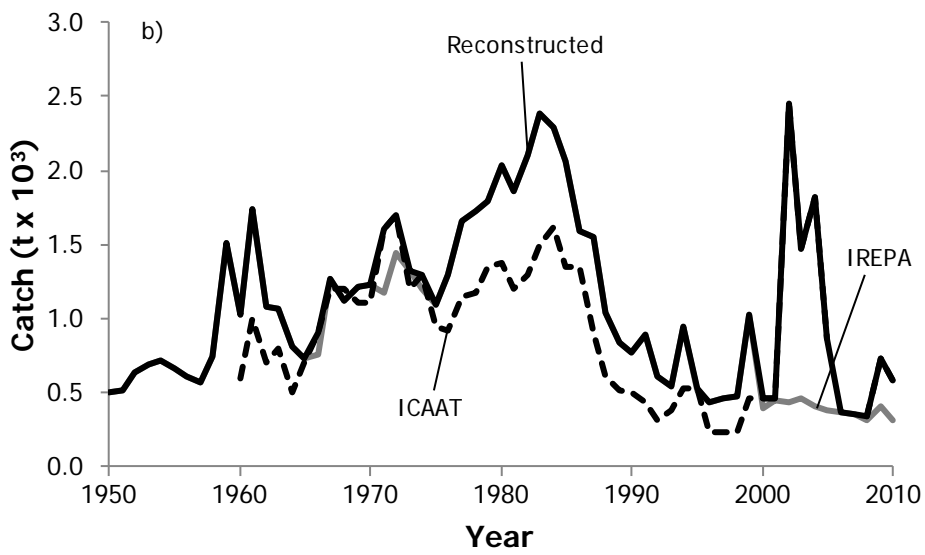
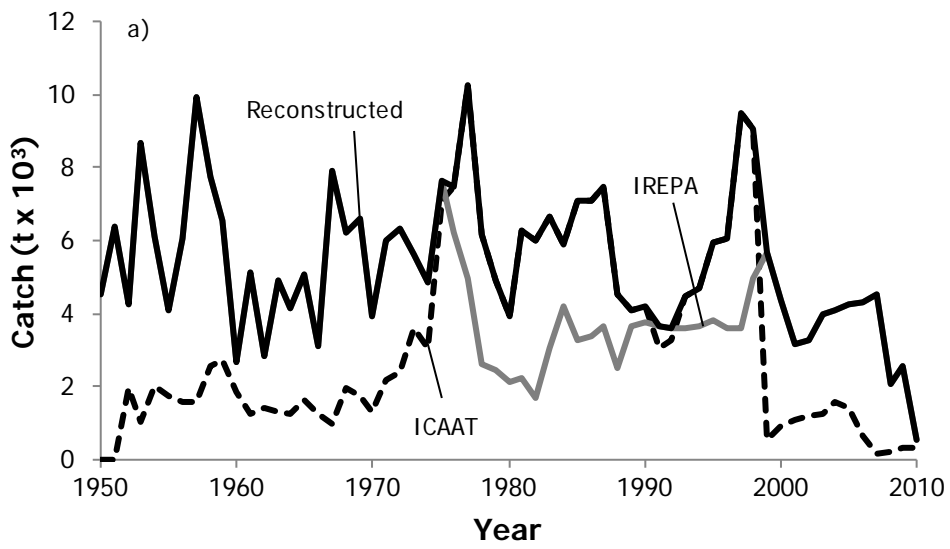


Figure 5 a and b.

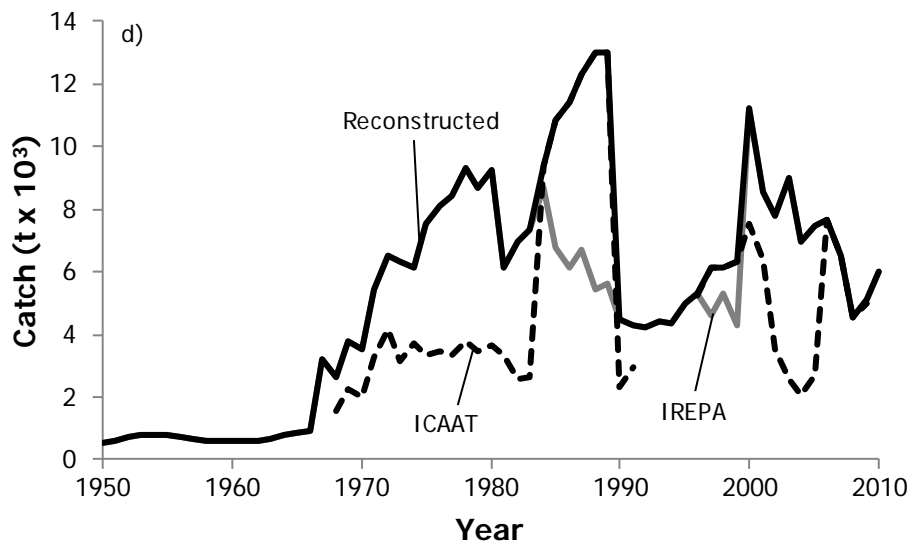
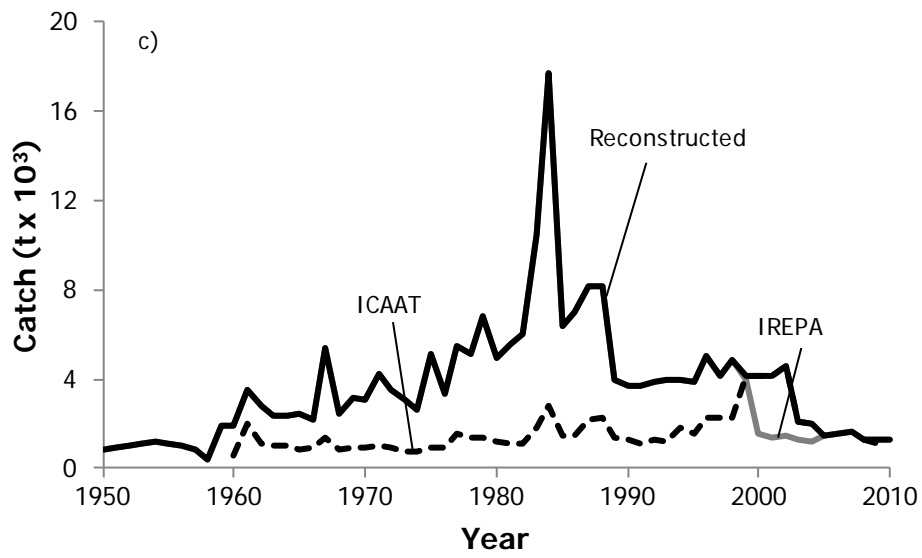


Figure 5 c and d.

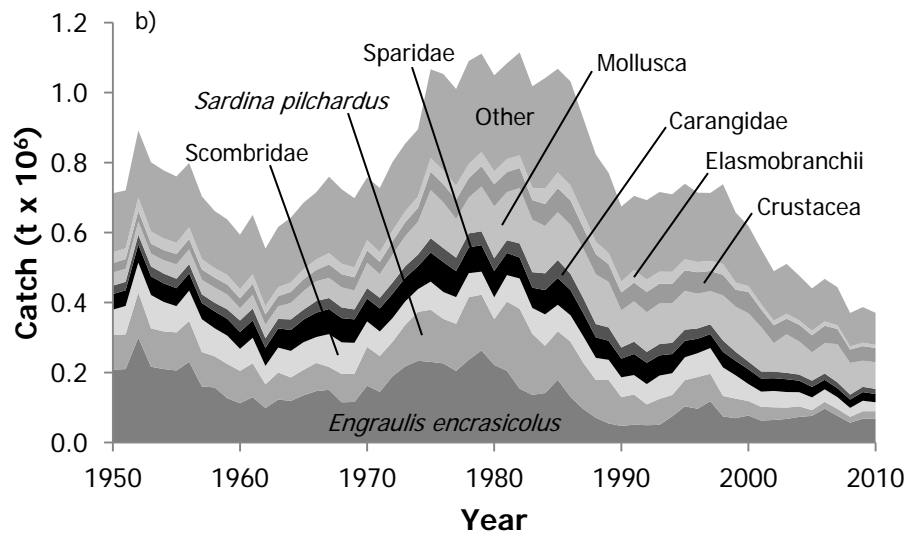
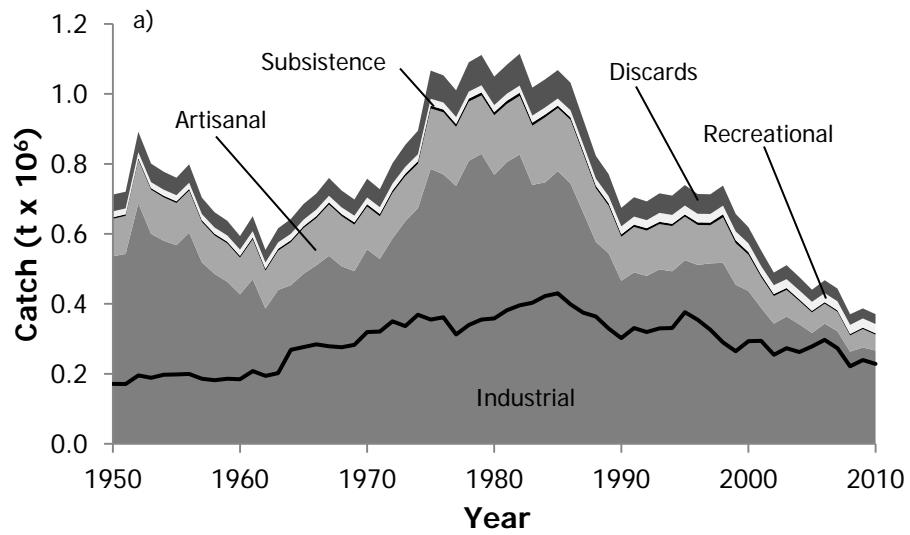


Figure 6.

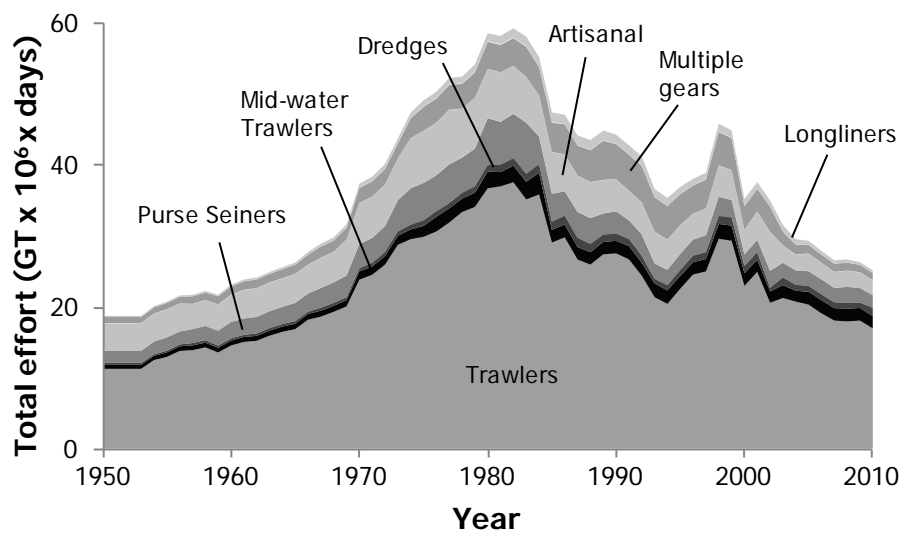


Figure 7.

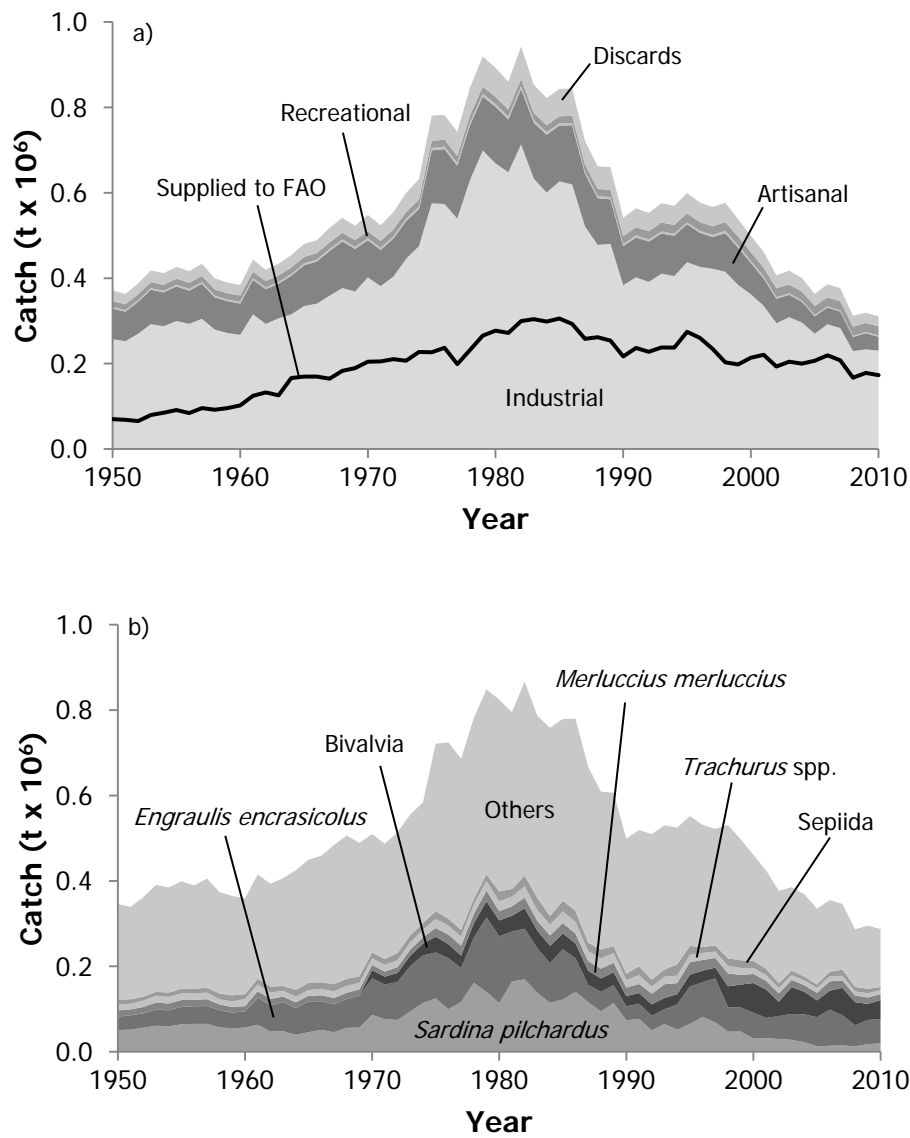


Figure 8.

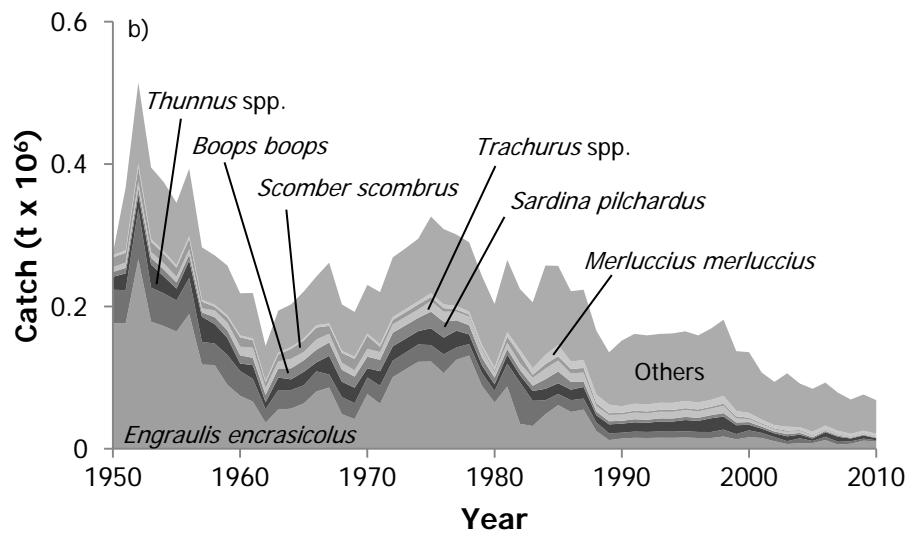
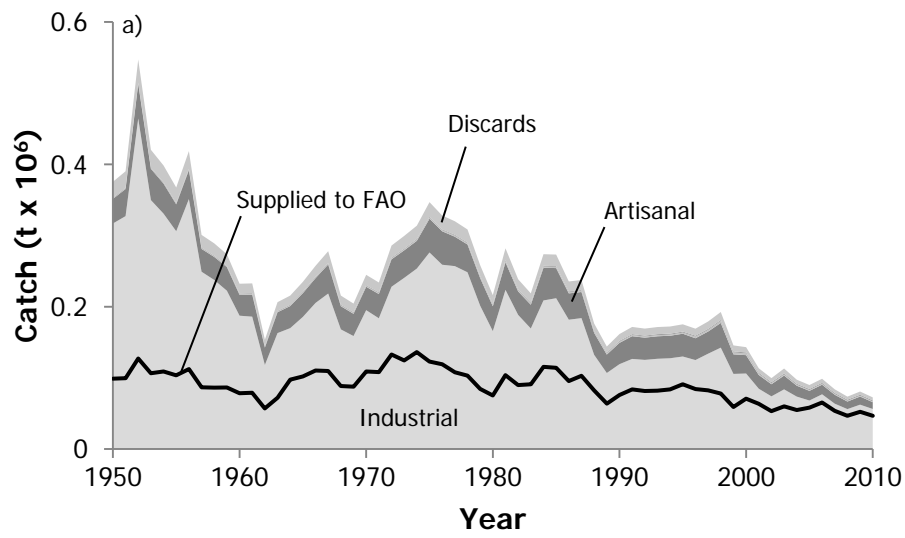


Figure 9.

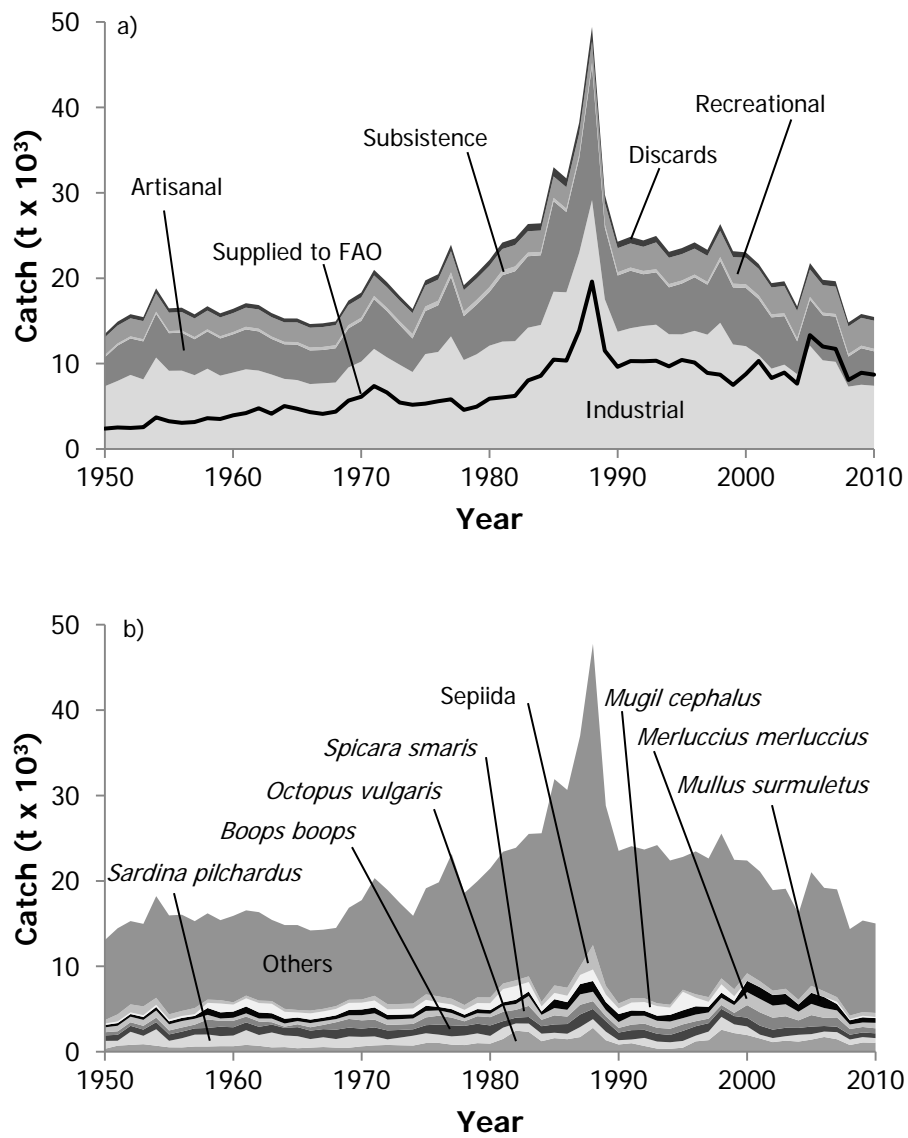


Figure 10.