

PRELIMINARY ESTIMATE OF TOTAL MARINE FISHERIES CATCHES IN CORSICA, FRANCE (1950-2008)¹

Frédéric Le Manach^a, Delphine Dura^b, Anthony Pere^{cd}, Jean-Jacques Riutort^e, Pierre Lejeune^c, Marie-Catherine Santoni^f, Jean-Michel Culioli^f, and Daniel Pauly^g

^a*Faculty of Science and Technology, University of Plymouth, Drake Circus, Plymouth PL4 8AA, United Kingdom; flm@lavinblue.com*

^b*Institut Polytechnique LaSalle Beauvais, 19 rue Pierre Waguët, BP 30313, Beauvais 60026 cedex, France; delphinedura@gmail.com*

^c*Station de Recherches Sous-marines et Océanographiques, Pointe Revellata, BP33, Calvi 20260, France; a.pere@stareso.com; pierre.lejeune@stareso.com*

^d*Faculté des Sciences et Techniques, Université de Corse Pascal Paoli, 7 avenue Jean Nicoli, BP 52, Corte 20250, France*

^e*Bastia Offshore Fishing Association, 8 Parc Impérial, Furiani 20600, France; jjriutort@gmail.com*

^f*Office de l'Environnement Corse, département "Parc Marin International des Bouches de Bonifacio", base technique de La Rondinara, BP 507, Ajaccio 20176, France; santoni@oec.fr, culioli@oec.fr*

^g*Sea Around Us Project, Fisheries Centre, University of British Columbia, 2202 Main Mall, Vancouver V6T 1Z4, Canada, d.pauly@fisheries.ubc.ca*

ABSTRACT

Corsica is an island in the Western Mediterranean belonging to France, located southeast of the French mainland and west of Italy. The island covers an area of about 8,700 km², is flanked by deep water along its west coast, and by a broad shelf along its east coast. Corsica has fisheries in its coastal lagoons, but its most commercially important fishery is the red spiny lobster (*Palinurus elephas*) fishery, followed by bottom trawling for finfish. Other smaller and poorly documented artisanal and recreational fisheries also occur, but overall fishing pressure appears to be low, and the number of full time fishers is declining. The total reconstructed catch from 1950 to 2008 was 118,700 tonnes - 5 times more than the 23,700 tonnes reported by France to FAO – of which 30% was unreported recreational catch by locals or tourists, 37% was bottom-trawl catch, 10% was associated bycatch (unreported, landed or discarded), and 23% was red spiny lobster and pelagic catches. The estimated mean annual catch in the 21st century was 1,300 tonnes. Field investigations are needed to improve on these data, presented here as a first approximation of total extractions from the waters surrounding Corsica.

INTRODUCTION

Corsica is the fourth largest island of the Mediterranean and a part of France. It is located southeast of the French mainland and north of Sardinia (Italy), and west of the Italian Peninsula (42° N and 9° E; Figure 1). Corsica is characterized by a mountainous landscape and a highly disparate underwater morphology, featuring a steep descent to depth along the western part of the island (down to 3,000 m, 10 km offshore). In contrast, wide expanses of shallow waters are present along the east coast, where a depth of only 150 m has been recorded 11 km offshore, and several lagoons important for the Island's marine fisheries are also found along the east coast (Riutort, 1994).

¹ Cite as: Le Manach, F., Dura, D., Pere, A., Riutort, J.J., Lejeune, P., Santoni, M.C., Culioli, J.M., and Pauly, D. (2011) Preliminary estimate of total marine fisheries catches in Corsica, France (1950-2008). pp. 3-14. In: Harper, S. and Zeller, D. (eds.) Fisheries catch reconstructions: Islands, Part II. Fisheries Centre Research Reports 19(4). Fisheries Centre, University of British Columbia [ISSN 1198-6727].

Corsican waters host numerous fish and invertebrate species (de Caraffa, 1929; Miniconi, 1989, 2001) and valuable habitats (e.g., meadows of seagrass *Posidonia oceanica*), of which most are protected under European Commission directives or national legislations (Anon., 1975; 1979, 1981, 1987, 1992, 1994, 1999) (Figure 1). The *Réserve Naturelle des Bouches de Bonifacio* is the largest marine protected area (MPA) of metropolitan France, covering approximately 800 km² (Figure 1), including a 13 km² no-take zone and 130 km² with restricted fisheries activities. Regulations and monitoring seem to be effective, as increasing catches have been reported in and around this MPA (Santoni and Culioli, unpub. data)

Since the 1950s, tourists have been attracted to Corsica for its natural beauty and pristine habitats, and the tourist population currently reaches 3 million per year (Anon., 2010), with a resident Corsican population of less than 300,000. The tourism industry has a major impact on seafood consumption and hence on marine resources, as already highlighted in the 1960s (Maurin, 1965). Currently, numerous hotels and/or charter companies offer recreational fishing opportunities, separate or in combination with consumption of local seafood.

Despite its potential attractiveness for fishers, the waters around Corsica have never experienced heavy industrial fishing pressure, and the history of Corsican resource extraction was shaped more by land-based than maritime activities. Therefore, there is almost no export of seafood out of Corsica, and a substantial fraction of the seafood consumed locally by Corsicans is imported from the French mainland or other Mediterranean countries.

Currently, the number of professional fishers is declining, and Corsica likely experiences the lowest commercial fishing pressure in the Mediterranean Sea (Riutort, 1994; Relini *et al.*, 1999). As a consequence, fisheries have generally not received much attention, and quantitative analyses of fisheries are scarce, except for the high-profile fishery for red spiny lobster (*Palinurus elephas*) (Pere *et al.*, 2007; 2010) and for MPA fisheries (Rigo, 2000; Santoni, 2002; Mouillot *et al.*, 2007; Rocklin *et al.*, 2009).

Corsica - via France - has only supplied fisheries statistics to the Food and Agriculture Organization of the United Nations FAO since 1970. This study therefore aims to reconstruct Corsican fisheries catches back to 1950, while ensuring that all extractions due to fishing are considered, following the catch reconstruction approach of Zeller and Pauly (2007). Like most countries in the Mediterranean, France has not declared a formal Exclusive Economic Zones for its Mediterranean coast (EEZ; Anon., 1976; Santoni, 2002; Cacaud, 2005). Hence, our estimates of historical catches for the period 1950 to 2008 are deemed to have come from Corsican EEZ-equivalent waters.

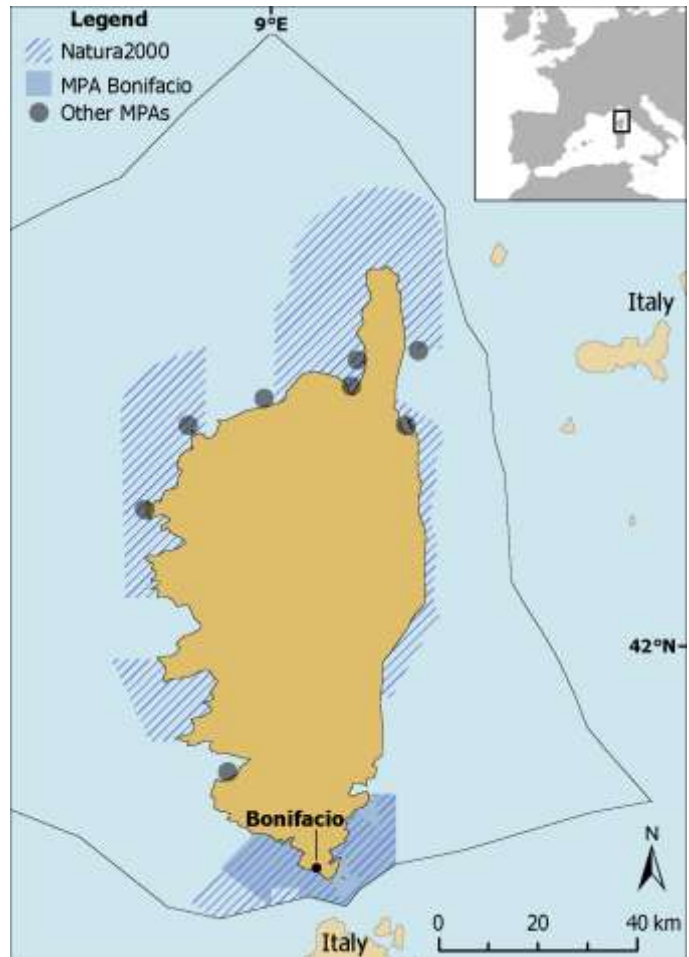


Figure 1: Map of Corsica and its territorial waters (solid black line). Marine Protected Areas (blue areas and grey solid dots) are designated at a state level and aim to protect both habitats and wildlife by controlling, or even excluding human activities (no-take zones). Natura2000 zones (blue stripes) are designated at a European level and aim to protect both habitats and wildlife, without excluding human activities. The level of protection in the Natura2000 zones is lower than for MPAs. Source: www.affaires-maritimes.mediterranee.gov.fr

MATERIALS AND METHODS

Baseline data were extracted from the General Fisheries Commission for the Mediterranean (GFCM) section of the FAO FishStat database (FAO, 2009). As Corsica is remote from the French mainland, we assumed that all catches reported by France within the ‘Sardinia’ FAO fishing area (Division 37.1.3) were Corsican. A bibliographical review of all Corsican fisheries was done to identify the ‘anchor points’ required for inferences on historical catches back to 1950 (Zeller and Pauly, 2007). Data sources included peer-reviewed scientific articles, reports by local institutions, theses and other unpublished accounts, and local expert knowledge.

Total Corsican population

Population statistics were extracted from the National Institute of Statistics and Economic Studies (INSEE, www.insee.fr/fr/themes/theme.asp?theme=2&sous_theme=1&nivgeo=6&type=3 [accessed: October 15, 2010]). Population data were used here to indirectly estimate total catches by local residents (see ‘recreational fisheries: residents and tourists’ sub-section; Figure 2a).

Fishers and fishing vessels in Corsica

The time-series of the population of fishers was obtained from Riutort (1994), and linear interpolations were applied between anchor points for years without data (Figure 2b). The number of fishers after the last anchor point (1993) was calculated by applying the trend in the number of fishers per vessel during the period 1950-1993 to the number of vessels for the period 1994-2008. It is worth noting that these

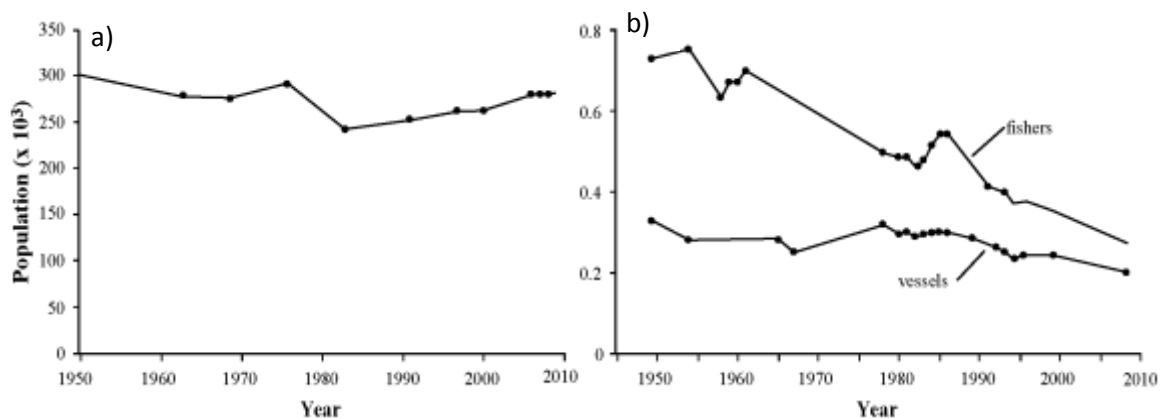


Figure 2. Basic statistics on Corsica: a) total resident Corsican population and b) trends in the number of fishers and vessels in Corsica. Anchor points are represented by closed circles.

vessels are usually smaller than 15 m, and operate close to shore (Miniconi, 1994; Riutort, 1994; Rigo, 2000; Santoni, 2002). The fishing industry in Corsica is therefore more artisanal than industrial, with small vessels (Riutort, 1994), short periods at sea, and a small supply chain (Riutort, 1989). The two time-series in Figure 2b were used to estimate bottom-trawl catches for the 1950-1970 period (see ‘artisanal demersal fishery’ sub-section).

Lobster fishery

Red spiny lobster (*Palinurus elephas*) is mainly exploited along the west coast of Corsica, where its preferred hard-bottom habitats are found. The fishery for lobster is relatively small, and vessels stay close to the coast, fishing at depths not exceeding 200 m (Marin, 1987). The fishery was profitable very early on (de Caraffa, 1929), but it is not well documented. Thus, official catch data are deemed inaccurate, and is at best a reflection of trends (Marin, 1987). Here, we attempt to re-estimate lobster catches for the entire 1950-2008 period using various sources of information.

Statistics were extracted from the *Office de l'Environnement Corse* (2010) for the 1950-1983 period. The early values (1950s) are in accordance with catches at the beginning of the 20th century, i.e., around 300 t-year⁻¹ (Doumenge, 1956). For the 1983-2008 period, values were extracted from studies by Riutort (1999), Marin (1987) and Pere *et al.* (2010).

Changes in gears had an influence on both catch per unit of effort (CPUE) and discard rates (non-marketable lobsters). In the early 1960s, the traps in common use were replaced by trammelnets (Miniconi, 1989), which had higher CPUE, but also generated a higher discarding rate. Discards for traps were estimated to be about 5% during the 1950-1964 period (Riutort, unpub. data). During the 1965-1980 period, fishers were using trammelnets for short trips, and a discard rate of 12.5% was therefore used (Riutort, unpub. data). For the 1981-1994 period, the mean value of 15.7% between the 1965-1980 period (12.5%) and the 1995-1999 period (20%) was used (Riutort, 1999; Pere *et al.*, 2010). For the 2000-2003 period, the same value of 12.5% was used. For the 2004-2007 period, Pere *et al.* (2010) estimated a discarding rate of 11.4%, which was also used for the year 2008.

It is worth noting here that two types of trammelnets are used in Corsica, to target either demersal fish (since before 1950) or red spiny lobster (since the early 1960s). Even when 'lobster trammelnets' are used, a considerable amount of the bycatch is fish. Thus, 55% of total catch were fish species in 2008 (Riutort, 1989; 1994; Santoni and Culioli, unpub. data). This bycatch of fish is retained and landed, and was included in the next sub-section (artisanal demersal fisheries).

Artisanal demersal fisheries

Demersal species are caught in Corsican waters with two types of gears: trammelnets and bottom-trawlers. Trammelnets have been in use for demersal fish for a long time (prior to 1950), while we assumed bottom-trawlers were introduced in the early 1950s (Riutort, 1994). Catches by trammelnets may represent 50% of total fish catches in the province of Bonifacio (Santoni and Culioli, unpub. data), and given that no other studies were available, we used this 50% ratio for the 1965-2008 time-period and the entire island. Thus, the remaining 50% of demersal fish catches were treated as caught by bottom-trawlers as of 1965. For 1950, we set bottom-trawl fish catches as zero, and interpolated linearly to 1965. FAO FishStat contains data on demersal species for the period 1970-1992 only. In the absence of any alternative, we considered these data to be realistic. Indeed, none of the documents available on Corsican fisheries allowed us to make an independent estimate of the bottom-trawl and trammelnet fisheries catches.

Catches per fisher and catches per vessel (CPUE) for the period 1970-1992 were calculated by dividing catches of bottom-dwelling fish reported to FAO by the number of fishers or vessels (Figure 2b). CPUE for the 1950-1970 and 1993-2008 periods were then estimated by extrapolation of the trends of 1970-1992 CPUE time-series. The resulting CPUE data for the 1950-1970 and 1993-2008 periods were then multiplied by the number of fishers or vessels (Figure 2). Our estimate of total catch used the average values of these two catch time-series (one based on CPUE per fisher, one on CPUE per boat), which was then split evenly to create the bottom-trawl and trammelnets components.

Trammelnet fishery

The taxonomic breakdown of trammelnet commercial species in the Bonifacio MPA (Figure 1) was studied by Mouillot *et al.* (2007) from 2000 to 2006. Given that there were no other studies available that included a taxonomic breakdown, we assumed that the percentage of each species remained the same for the entire 1950-2008 time-period, and were similar for the entire island. A recent study concluded that trammelnet discards were representing approximately 10% of total catches, in the MPA of Bonifacio (Rocklin *et al.*, 2009). These discards are composed of damaged, non-marketable fish. We used this study to estimate the taxonomic breakdown of these discards.

Bottom-trawl fishery

We assumed that the species composition of landed bottom-trawl catches were similar to the trammelnet fishery. However, we acknowledge that the species composition can vary significantly between the continental shelf and the slope. For higher depths (on the slope), many other species such as *Nephrops norvegicus*, *Etmopterus spinax*, *Galeus melastomus*, *Merluccius merluccius* or *Trigla lyra* can indeed account for a large part of the catch (Riutort, pers. obs.; Le Manach, pers. obs.). However, as it was not possible to estimate the percentage of each species or the importance of slope bottom-trawling, we did not take these observations into account. To estimate the bycatch by the artisanal bottom-trawl fishery, we used a bycatch rate of 40%, given by Machias *et al.* (2001) and Sanchez *et al.* (2004) for geographically close and similar fisheries. The MEDITS database (Bertrand *et al.*, 1998) - 2009 update - was used to estimate the bycatch taxonomic breakdown. We assumed that non-commercial species occurring in this database were bycatch species, e.g., *Spicara* spp., *Scyliorhinus* spp., *Raja* spp., *Micromesistius poutassou*, *Capros aper*. Furthermore, as fishers land a portion of non-targeted bycatch, notably for their personal consumption and *soupe de roche* ('rockfish soup'), we conservatively assumed that 20% of the bycatch was landed, but unreported, and that the remainder (80%) was discarded.

Recreational fisheries: residents and tourists

To estimate recreational catches by Corsicans, we used a 'Fermi solution', i.e., an approach pioneered by the physicist Enrico Fermi, to estimate unknown quantities from limited data (von Baeyer, 1993; Pauly, 2010). Thus, based on local knowledge (Culioli, pers. obs.; Riutort, pers. obs.), we estimated three anchor points, for 1950, 1980 and 2008. For 1980, we assumed that 30% of the total population, i.e., 76,000 out of 255,000 inhabitants, was potentially recreational fishers. Of these potential fishers, we assumed that 15% were actually fishers, and that they were on average fishing once a month, with yields of 4 kg per trip. For 2008, we used the same assumption that 30% of the total population, i.e., 84,000 out of 280,000 inhabitants, were potentially recreational fishers, but that the proportion of actual fishers increased to 25%. As local residents report that there are less fish now than in the 1980s, we assumed that fishers currently fish on average only 10 times a year, with yields of 1 kg per trip. For 1950, we assumed a stable CPUE and fishing effort compared to 1980, and derived total catches from the total population size.

Similarly, our estimate of recreational catches by tourists was based on the annual number of tourists, and assuming that sport fishing became more attractive in the 1990s. We conservatively assumed that 5% of tourists were catching on average 1 kg·year⁻¹ for the 1950-1990 period, and that 8% of tourists were catching on average 1.5 kg·year⁻¹ for the 1991-2008 period. Given that each tourist currently stays on average 10.3 days in Corsica, these assumptions seem reasonable (Anon., 2010).

Pelagic fisheries

Three pelagic fisheries are taking place in Corsican waters. However, information is scarce and no studies enabled us to re-estimate their total catches. Therefore, we included data as provided to FAO in our total reconstruction (except for small pelagics – see below).

Swordfish

Swordfish (*Xiphias gladius*) started to be targeted by artisanal longliners in the 1980s (Regional Committee of Corsican Marine Fisheries, 2009; Riutort, unpub. data). However, as tonnages are likely small (15-20 t·year⁻¹; Riutort, unpub. data), it is possible that these catches are accounted for in official FAO statistics as 'marine fish nei' (FAO, 2009).

Small pelagics

'Blue fish' (i.e., sardines, anchovies and mackerels) are also fished along the Corsican coast. Several studies report substantial catches during the 1960s and 1970s in Corsica and along the French mainland (Maurin, 1965; Bonnet, 1973; Pichot and Aldebert, 1978). It is worth noting that FAO data include sardine statistics only for 1972-1976 and 2006; data for other years being either non-existent or unrealistically

low. However, older Corsican residents remember very abundant sardine and anchovy catches during the 1950-1960s, most of which were exported to the mainland (Riutort, unpub. data). For the period 1950-1971, we therefore used the average catches for the period 1972-1976, and kept the rest of the time-period unchanged.

Tuna

Maurin (1965) reports 100 tonnes of tuna caught in 1963 by Corsicans. However, he suggests that the tourism industry already accounted for a significant part of unreported catches, although he did not elaborate on this topic. Tuna may also be reported to FAO as 'marine fish nei', and annual catches are likely very low or up to 15 tonnes (Riutort, unpub. data).

RESULTS AND DISCUSSION

Lobster fishery

As expected, our lobster catch reconstruction is very different from official statistics: our values are on average 16 times higher than data provided to FAO, and show a very different pattern over time (Figure 3). Lobster catches decreased from 300 t·year⁻¹ in 1954 to 80 t·year⁻¹ for 1959-1960. Then, catches increased again to 300 t·year⁻¹ by 1962. At this time, a new (unspecified) crash occurred and catches dropped to 100 tonnes annually, staying at that level until the late 1970s. By 1984, catches increased to 250 t·year⁻¹. Since then, catches have been decreasing, reaching 80 t·year⁻¹ by the early 2000s. However, it is worth noting that catches currently seem to be increasing. Overall, the trend of the number of fishers and vessels (Figure 2b), and lobster catches (Figure 3) show a similar pattern, which confirms that this fishery is of great importance in Corsica and largely accounts for much of the fishing pressure.

Fluctuations in lobster catches may be partly explained by new policies and gear modifications, along with biological features (e.g., larval migration; Pere *et al.*, 2011). The first crash in the 1950s likely resulted from increasing fishing pressure, and the following increase in catches is likely the result of a gear change from traps to trammelnets, which increased the CPUE. In 1968, policy-makers decided to close the lobster fishery between the 1st of October and 28th of February each year, which probably played a significant role in the stabilization of catches during the 1970s. Finally, new vessels were introduced in the early 1980s and were responsible for increased fishing effort. This increase is likely to have contributed to the increase in catches until 1984, then to the decrease in catches observed until the mid-2000s.

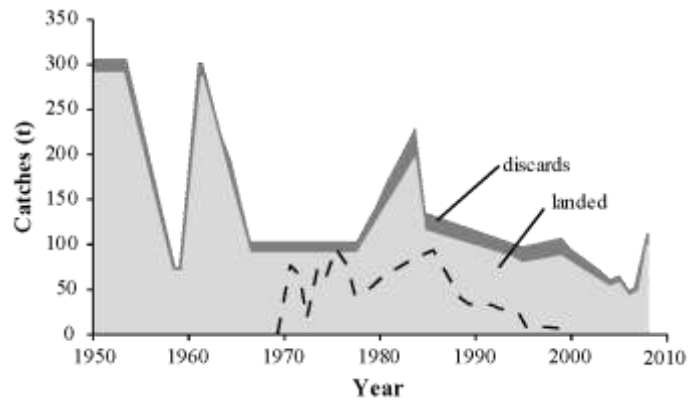


Figure 3: Reconstructed catches of lobsters and associated discards for Corsica, 1950-2008. The dotted line represents official lobster landings data supplied to FAO.

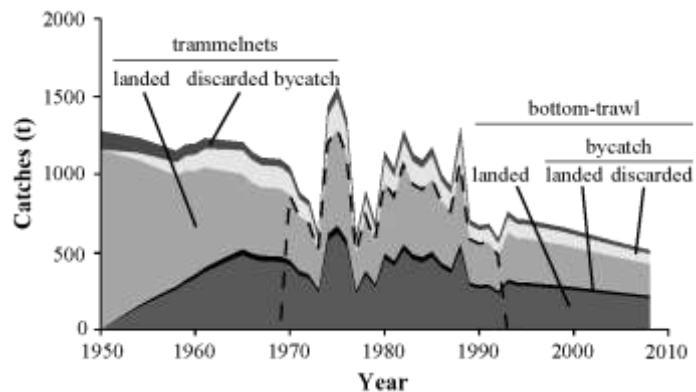


Figure 4: Reconstructed catches and associated bycatch (landed and discarded) for the demersal finfish fishery by the two main gears (trammelnet and bottom-trawler) in Corsica, 1950-2008. The dotted line represents official landings data supplied to FAO.

In the late 1970s, nine small marine protected areas (some of them no longer existing; Figure 1) were created, which also possibly led to the catch increases in the late 1970s early 1980s (Figure 3). The current decrease, which started around 1984, may be due to several factors, such as the decreasing number of fishers, or increasing fishing effort. It seems there is an increase in catches during the last few years. Such an increase could be due to biological parameters (e.g., larval migration), but no data were available to assess the validity of this assumption.

Artisanal demersal fishery

Demersal catches totaled an estimated 56,500 tonnes, compared to only 18,800 tonnes reported to FAO (Figure 4). Catches fluctuated, but declined overall from approximately 1,300 t·year⁻¹ in 1950 to 500 t·year⁻¹ in the late 2000s. Bycatch followed a different trend, totaling 10,300 tonnes and peaking around 250 t·year⁻¹ in the 1980s due to the increasing number of trawlers. Bycatch amounts in the 1950s and the 2000s are similar, slightly above 100 t·year⁻¹ (Figure 4).

Unlike our reconstruction for the lobster fishery (above), the reconstruction of artisanal bottom-trawl fishery catches was mainly based on official statistics. The main novelty in this result comes from the gaps in time-series originally supplied to FAO being filled in. Also, a significant part of total catches (18%) were previously unreported and are now reported as bycatch (either discarded or landed; Figure 4).

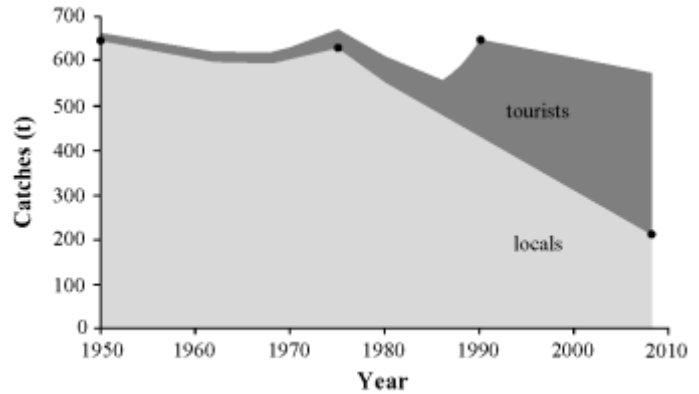


Figure 5: Reconstructed catches by recreational fishers in Corsica, 1950-2008. Anchor points are indicated by closed circles.

Recreational fisheries: residents and tourists

Recreational fisheries were estimated to catch 35,150 tonnes, of which 80% was taken by local resident fishers, and 20% by tourists (Figure 5). These catches were previously not included in statistics provided to FAO.

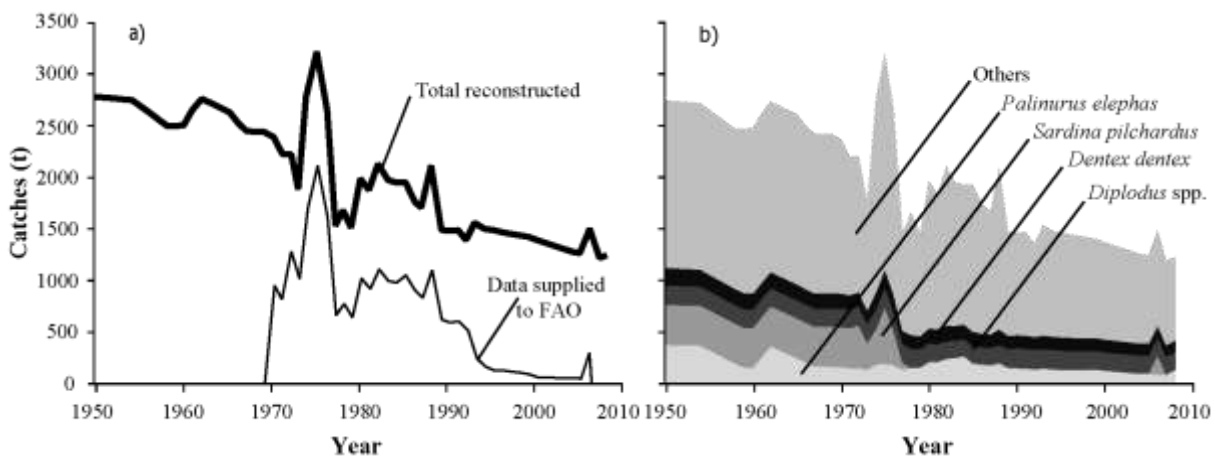


Figure 6: Catches in Corsican waters, showing a) reconstructed total catches versus landings data as supplied to FAO; and b) taxonomic breakdown (top 10 species) of reconstructed total catches in Corsica, 1950-2008. The 'others' group includes *Scorpaena scopa*, *Phycis* spp., *Pagellus*, spp., Labridae, *Serranus* spp., *Seriola dumerili*, *Zeus faber*, as well as other fish species of lower importance in term of percentage, and species of invertebrates.

Based on our assumptions, we estimated that recreational catches by residents were the highest in 1950, with 612 t-year⁻¹, and then declined to 210 t-year⁻¹ by 2008 (Figure 5). On the other hand, recreational catches by tourists were estimated to have increased during the last two decades, increasing from 17 t-year⁻¹ in 1950 to 360 t-year⁻¹ by 2008 (Figure 5).

Overall reconstruction

Reconstructed total Corsican fisheries catches total over 118,700 tonnes since 1950, compared to only 23,700 tonnes reported to FAO by local fisheries authorities. Overall, total catches appear to be steadily decreasing from approximately 2,800 t-year⁻¹ in 1950 to 1,200 t-year⁻¹ by 2008, interrupted by a peak catch of over 3,000 t-year⁻¹ in 1975 (Figure 6a and Appendix Table A1). This decrease seems linked to the decline in both fishers and vessel numbers, but also to declines in fish abundance along the Corsican coast.

Official statistics likely accounted for commercial (artisanal) fisheries only, that is, red spiny lobster and bottom-trawl fisheries. Recreational fisheries by Corsicans, or by tourists, were not considered by official authorities. Finally, we highlighted the existence of discards (for red lobster and bottom-trawl fisheries), which are generally not included in reported statistics (Zeller *et al.*, 2011).

This improved accounting of total catches (versus reported commercial landings) is also evident in the improved taxonomic accounting provided by our study (Figure 6b). Data reported by FAO on behalf of Corsica, besides being of poor quality, also had a poor taxonomic breakdown. Species present in these official data were reported as arbitrary, according to the local fisheries literature. In contrast, we have been able to assign catches to over 30 taxa, of which each had catches allocated in accordance to the literature (Figure 6b and Appendix Table A2).

This study provides an estimate of total fisheries catches in Corsican waters since 1950, and although some sectors such as the pelagic fisheries have not been dealt with in detail, two major conclusions emerge from our work: (1) historical events, changes in gear and emergence of new fisheries illustrate that, despite being assumed to be one of the areas of the Mediterranean with the lowest fishing pressure (Riutort, 1994; Relini *et al.*, 1999), Corsican waters may be exposed to higher fishing pressure than previously assumed; and (2) our results suggest that Corsicans seem to be much more involved in marine resource exploitation than it appears in the literature and in official statistics.

ACKNOWLEDGEMENT

We thank the *Sea Around Us* project, a scientific collaboration between the University of British Columbia and the Pew Environment Group. We also thank Jacques Bertrand (Ifremer) for sharing information and knowledge.

REFERENCES

- Anon. (1975) Décret n° 75-1128 du 9 décembre 1975 portant création de la réserve naturelle de Scandola (Corse). Journal Officiel de la République Française: 12612.
- Anon. (1976) Loi n°76-655 du 16 juillet 1976 relative à la zone économique au large des côtes du territoire de la république. Journal Officiel de la République Française: 4299.
- Anon. (1979) Council Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds. Official Journal L 103: 001-0018.
- Anon. (1981) Décret n° 81-205 du 3 mars 1981 portant création, délimitation, réglementation et gestion (par le préfet) de la réserve naturelle des îles Cerbicales (Corse du Sud). Journal Officiel de la République Française: 704.
- Anon. (1987) Décret n° 87-494 du 29 juin 1987 portant création de la réserve naturelle des îles Finocchiarola (Haute Corse). Journal Officiel de la République Française: 7364.
- Anon. (1992) Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. Official Journal L 206: 7.

- Anon. (1994) Décret n° 94-688 du 9 août 1994 portant création de la réserve naturelle de l'étang de Biguglia (Haute Corse). Journal Officiel de la République Française: 11770.
- Anon. (1999) Décret du 23 septembre 1999 portant création de la réserve naturelle des Bouches de Bonifacio (Corse du Sud). Journal Officiel de la République Française: 14243.
- Anon. (2010) Résultats et enseignements de l'année touristique 2009. Agence du tourisme Corse.
- Bertrand, J.A., Gil de Sola, L., Papaconstantinou, C., Relini, G. and Souplet, A. (1998) An international bottom trawl survey in the Mediterranean: the MEDITS programme. Actes de colloques IFREMER 26: 76-93.
- Bonnet, M. (1973) Les pêches maritimes sur les côtes françaises de la Méditerranée – actualités, perspectives. Science et Pêche 222: 18.
- Cacaud, P. (2005) Fisheries laws and regulations in the Mediterranean: a comparative study. Studies and reviews 75. General Fisheries Commission for the Mediterranean. United Nations Food and Agriculture Organization (FAO), Rome (Italy), 40 p.
- de Caraffa, T. (1929) poissons de mer et la pêche sur les côtes de la Corse. Laffitte Reprints (1980), Marseille, 336p.
- Doumenge, F. (1956) Problèmes d'équipement de la pêche en Corse. Bulletin de la Société Languedocienne de Géographie, 28(4).
- FAO (2009) FishStat Plus - Universal software for fishery statistical time series. v2.3. United Nations Food and Agriculture Organization (FAO), Rome (Italy).
- Machias, A., Vassilopoulou, V., Vatsos, D., Bekas, P., Kallianiotis, A., Papaconstantinou, C. and Tsimenides, N. (2001) Bottom trawl discards in the northeastern Mediterranean Sea. Fisheries Research 53(2): 181-195.
- Marin, J. (1987) Exploitation, biologie et dynamique du stock de langouste rouge de Corse, *Palinurus elephas* Fabricus. Thèse de doctorat d'état. Université d'Aix Marseille II. Faculté des sciences de Luminy, 327p.
- Maurin, C. (1965) La pêche française de 1964 en Méditerranée. Science et Pêche 134: 1-4.
- Miniconi, R. (1989) Les poissons et la pêche en Corse. Thèse de doctorat d'état. Université d'Aix Marseille II. Faculté des sciences de Luminy, 504 p.
- Miniconi, R. (1994) Les poissons et la pêche en Méditerranée : la Corse. Piazzola and La Marge, Ajaccio, France.
- Miniconi, R. (2001) Les poissons de Corse - Biologie, pêche, appellations. 262 p.
- Mouillot, D., Tomasini, J.A., Culioli, J.M. and Do Chi, T. (2007) Développement durable de la pêche artisanale sur le site de la Réserve Naturelle des Bouches de Bonifacio (Corse du sud). Programme MEDD LITEAU 2 : Gestion intégrée des zones côtières. Rapport final, 66 p.
- Pauly, D. (2010) Five easy pieces: how fishing impacts marine ecosystems. Island Press, Washington, DC, 193 p.
- Pere, A., Lejeune, P. and Pelapat, C. (2010) Suivi scientifique de la pêche langoustière corse - Rapport final - Années 2004-2009. Contrat Office de l'Environnement de la Corse - Stareso, 106 p.
- Pere, A., Pelapat, C. and Lejeune, P. (2011) Overview of the corsican fishery and presentation of series of available data. 1st LanConnect Workshop. 21-23 March 2011. Palma de Mallorca (Spain).
- Pere, A., Pelapat, C., Pergent-Martini, C., Livrelli, J.N. and Lejeune, P. (2007) The spiny lobster fishery in Corsica. 8th International Conference and Workshop on Lobster Biology and Management. September 23-28 2007. Charlottetown (Canada).
- Pichot, P. and Aldebert, Y. (1978) La pêche de la sardine en Méditerranée française. Science et Pêche 277: 16.
- Regional Committee of Corsican Marine Fisheries (2009) Corse - l'interdiction de pêcher l'espadon suscite des vagues. Corse Matin.
- Relini, G., Bertrand, J.A. and Zamboni, A. (1999) Synthesis of the knowledge on Bottom fishery resources in central Mediterranean (Italy and Corsica). Biologia Marina Mediterranea 6 (suppl. 1). 868 p.
- Rigo, D. (2000) La pêche professionnelle dans la Réserve Naturelle des Bouches de Bonifacio, effort et productions. Rapport de D.E.S.S. Université de Corse, 53 p.
- Riutort, J.J. (1989) Premières estimation des captures et de l'effort de pêche déployé par les « petits métiers » sur le littoral nord-ouest de la Corse. Etude de la biologie des principales espèces cibles. Rapport Région de Corse, 151 p.
- Riutort, J.J. (1994) La pêche en Corse : le rouget de roche, espèce cible. Project Stareso/EEC XIV - 1/MED/91/006, 167 p.
- Riutort, J.J. (1999) Pêche de la langouste rouge (*Palinurus elephas*), en Corse (production, sélectivité des engins de pêche, effet réserve des cantonnements à crustacés). Rapport final. 117 p.
- Rocklin, D., Santoni, M.C., Culioli, J.M., Tomasini, J.A., Pelletier, D. and Mouillot, D. (2009) Changes in the catch composition of artisanal fisheries attributable to dolphin depredation in a Mediterranean marine reserve. ICES Journal of Marine Science 66(4): 699-707.

- Sanchez, P., Demestre, M. and Martin, P. (2004) Characterisation of the discards generated by bottom trawling in the northwestern Mediterranean. *Fisheries Research* 67(1): 71-80.
- Santoni, M.C. (2002) Evolution de l'effort et des productions de la pêche artisanale sur le site de la Réserve Naturelle des Bouches de Bonifacio. Office de l'Environnement de la Corse : Réserve Naturelle des Bouches de Bonifacio. Rapport de D.E.S.S. Université de Corse, 64 p.
- von Baeyer, H.C. (1993) *The Fermi solution: essays on science*. Random House, New York, 176 p.
- Zeller, D. and Pauly, D., eds. (2007) Reconstruction of marine fisheries catches for key countries and regions (1950-2005). *Fisheries Centre Research Reports* 15(2). Fisheries Centre, University of British Columbia, Vancouver, 163 p.
- Zeller, D., Rossing, P., Harper, S., Persson, L., Booth, S. and Pauly, D. (2011) The Baltic Sea: Estimates of total fisheries removals 1950-2007. *Fisheries Research* 108(2-3): 356-363.

Appendix Table A1: Annual catches by Corsican fisheries.

Year	Domestic fisheries (t)	
	Data reported to FAO	Reconstructed catches
1950	0	2759
1951	0	2751
1952	0	2744
1953	0	2736
1954	0	2728
1955	0	2666
1956	0	2603
1957	0	2540
1958	0	2475
1959	0	2478
1960	0	2484
1961	0	2634
1962	0	2740
1963	0	2698
1964	0	2657
1965	0	2615
1966	0	2506
1967	0	2427
1968	0	2422
1969	0	2421
1970	945	2373
1971	784	2204
1972	1280	2206
1973	966	1757
1974	1719	2772
1975	2128	3195
1976	1632	2647
1977	625	1457
1978	759	1662
1979	607	1450
1980	1012	1968
1981	899	1836
1982	1100	2109
1983	986	1956
1984	967	1930
1985	1042	1934
1986	895	1746
1987	811	1672
1988	1093	2094
1989	604	1473
1990	574	1462
1991	584	1469
1992	502	1358
1993	220	1540
1994	137	1482
1995	99	1468
1996	96	1448
1997	85	1433
1998	74	1418
1999	59	1404
2000	28	1370
2001	26	1342
2002	22	1314
2003	21	1287
2004	23	1259
2005	15	1243
2006	281	1482
2007	0	1194
2008	0	1226

Appendix Table A2: Six most important taxa caught by domestic fisheries in Corsica's EEZ, 1950-2008.

Year	<i>Palinurus elephas</i>	<i>Sardina pilchardus</i>	<i>Diplodus</i> spp.	<i>Dentex dentex</i>	<i>Scorpaena scrofa</i>	<i>Phycis</i> spp.	Others ^a
1950	375	387	189	171	165	106	1366
1951	373	387	187	169	163	104	1368
1952	372	387	186	167	160	102	1369
1953	370	387	185	165	157	101	1371
1954	369	387	184	164	154	99	1371
1955	325	387	183	161	150	96	1363
1956	281	387	182	159	147	94	1354
1957	237	387	181	157	143	91	1343
1958	193	387	180	154	139	89	1332
1959	153	387	179	156	143	91	1368
1960	153	387	178	155	142	91	1378
1961	259	387	177	156	145	93	1416
1962	363	387	176	154	143	92	1424
1963	324	387	176	153	141	90	1426
1964	285	387	176	153	139	89	1428
1965	246	387	176	152	137	88	1429
1966	204	387	176	148	130	83	1377
1967	163	387	176	146	126	81	1347
1968	163	387	176	146	125	80	1343
1969	163	387	178	147	125	80	1342
1970	160	387	179	145	119	76	1306
1971	150	387	182	137	100	64	1184
1972	146	420	184	136	95	61	1164
1973	133	265	186	125	70	45	933
1974	184	348	189	170	164	105	1612
1975	192	548	191	178	178	114	1794
1976	179	328	188	165	154	99	1534
1977	132	70	184	124	68	44	835
1978	150	2	181	137	102	65	1025
1979	154	3	177	125	78	50	862
1980	199	15	174	147	131	84	1217
1981	209	3	172	140	118	75	1120
1982	241	0	169	152	146	93	1307
1983	248	0	167	143	129	82	1187
1984	263	6	165	140	124	79	1154
1985	191	6	162	143	134	86	1212
1986	178	13	160	133	114	73	1076
1987	169	13	165	131	105	67	1022
1988	190	13	171	154	148	95	1325
1989	150	7	179	126	80	51	879
1990	145	6	188	129	76	49	869
1991	142	7	187	129	77	50	876
1992	133	7	186	124	66	42	799
1993	141	7	185	133	86	55	932
1994	135	6	184	130	81	52	894
1995	128	8	183	129	80	51	888
1996	129	4	182	128	79	51	875
1997	130	4	181	127	78	50	864
1998	132	4	180	125	76	49	852
1999	133	4	180	124	75	48	841
2000	125	0	179	123	73	47	824
2001	118	0	178	122	71	45	809
2002	110	0	177	120	69	44	794
2003	103	0	176	119	67	43	780
2004	95	0	175	118	65	42	765
2005	98	0	174	116	63	41	751
2006	83	192	173	115	62	39	819
2007	88	0	172	114	60	38	723
2008	135	0	171	112	58	37	712

^a'Others' comprises *Pagellus*, spp., Labridae, *Serranus* spp., *Spicara* spp., *Raja* spp., other clupeiformes, *Mullus* spp., other *Scorpaena*, *Maja squinado*, *Sepia* spp., *Homarus gammarus*, *Lophius* spp., *Capros aper*, *Micromesistius poutassou*, *Scyllorhinus* spp., other miscellaneous marine fish, cephalopods and crustaceans.