A restricted fishing area as a tool for fisheries management: Example of the Capbreton canyon, southern Bay of Biscay

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Abstract:

Marine Protected Areas (MPAs) are generally considered as one of the most important tools, among the many regulations, designed to preserve marine resources as well as enhance fisheries. In the southern Bay of Biscay, local French fishermen requested creation of a restricted area to help settle disputes between the various métiers operating there. This restricted area, which lies mainly in French waters, covers part of a deep submarine canyon off the French and Spanish coasts, known to have a large population of mature hake. This study aims to better understand the effects of a restricted area upon French fleets operating there, particularly upon three main métiers—longliners, gillnetters and trawlers. The study area includes three ICES statistical rectangles. The data, based upon reported landings and auctions sales for the period 1985–2008, were analyzed using multivariate analysis. The fishing activity is more important in one rectangle which includes the restricted area. Bottom longliners and gillnetters, operate mainly in this one while trawlers are less dependent. The first métier concentrates particularly on hake and the second has targeted other species and has become less dependent on hake. Trawlers target a wider range of species. Over the past ten years, the restricted area has contributed to maintain the fleets operating here. The border with Spain adds other constraints over the issue of access to regional fisheries and makes management a little more complicated.

Highlights

► Effects of the regulation upon fleets operating in the Capbreton canyon are examined. ► The circumstances that led to a restricted area creation for gillnetters are showed. ► The access regulations to fishing areas have maintained the different métiers. ► The choice of restricted area location allowed the maintain of longliners.

Keywords: Bay of Biscay ; Restricted area ; Submarine canyon ; Economic dependence ; Métiers’ dynamics
1. Introduction

Fishery management is organized around regulations which concern fishing effort such as vessel number and their technical characteristics, gear prohibition, quotas, closed seasons and area restrictions. The European Union (EU) sets annual catch limits by species (TAC), and national quotas as well as minimum size species. It also issues fishing licenses, regulates mesh sizes and publishes Multi-Annual Guidance Programs under the Common Fisheries Policy (CFP). Specific national or regional licenses are also issued. Among management measures, Marine Protected Areas (MPAs) are increasingly important. They were introduced to protect local marine resources as well as enhance fisheries. However, because they are open to the effects of multiple uses and to external pollution [1], special attention must be paid to their selection if reserves are to be managed efficiently [2]. This concerns both their size and the fishing practices in place as well as specification of the particular protections objectives required. Although MPAs certainly improve fishing practices by promoting best practice and better conservation of biodiversity, their benefits are limited by their number and size [3]. While their role in the protection of species and habitats is clear [4], uncertainty in larval dispersal and adult biomass exportation makes it difficult to measure their full effect upon population and yield sustainability [5].

In France, other spatial management measures are used such as “Restricted Areas” which could be considered as a specific form of MPA. Created on the initiative of professional fishermen, these areas are delimited areas at sea, within which some particular types of fishing gear are temporarily or permanently prohibited in order to protect certain species and/or métiers (according to ICES - the International Council for the Exploration of the Sea – there are three types of fishing unit: the fleet, the fishery, and the métier. The last is defined by ICES as “groups of homogeneous fishing activity, targeting the same (assemblage of) species, using similar gear, during the same period of the year and within the same area”
These restricted areas are set up either by ministerial decree (Order of the Ministry of Public Works and Transport dated the 4th of June 1963) or come under prefectural legislation. Today, there are 47 fishing restricted areas in French waters with 57% located in the Atlantic coast [7].

The Bay of Biscay is a typical mixed fishery with a large variety of species exploited by a wide range of fishing gears such as trawls, longlines, gillnets, pots and dredges [8]. The presence of several métiers in the same area using different techniques has led to the need to regulate their use in the coastal zone. A restricted area was established near Spanish waters by prefectural legislation, at the request of local French fishermen prohibiting gillnet fishing. Most of it is under French control, the rest being within the Exclusive Economic Zones (EEZ). This cross-border location makes management complicated. The original aim was to resolve conflicts between two métiers (bottom longliners and gillnetters) targeting the same species such as hake. This is an old issue dating as far back as 1727 [9]. More important, this restricted area is located on a deep coastal canyon, the Capbreton Canyon, easily accessible by the different fleets.

This article seeks to better understand the circumstances that led to the restricted area creation and its effects upon French fleets operating in this area. Catch statistics together with a detailed description of regulatory events and minutes of discussions of the local fishing committee have been used to examine changes in fishing activities (vessels number, landings and turnover).

2. Material and methods

2.1. Study area

The southern part of the Bay of Biscay is characterized by a narrow shelf with a sandy bottom along the Landes plateau and a rocky littoral on the Basque coast. This region is
crossed by the Capbreton canyon (Fig. 1a), which includes the restricted area studied in this paper.

This canyon is a submarine valley, classified as a “gouf” which begins less than 400 m from the shoreline and extends from east to west, parallel to the Spanish coast for over 250 km. It is subjected to the combination of river plumes and ocean currents i.e. local upwellings and poleward coastal currents along Basque and North Aquitaine coast [10,11,12]. The Capbreton canyon is active with a high amount of organic matter transported toward the abyssal plain [13,14]. The canyon’s geomorphological and hydrological characteristics favor species diversity and biological production of plankton and micronecton aggregations [15,16], as well as megafaunal and scleractinian diversity [17,18,19] and bird and marine mammal concentrations [20,21]. Several studies confirm that submarine canyons are highly productive, hosting a wide variety of benthic, demersal and pelagic fauna [22,23,24].

Such conditions enhance local fishery production [23]. The Bay of Biscay is known to have the biggest nurseries of European hake with adult concentrations in canyons and on the rocky seabed of the shelf break area [25]. In the case of the Capbreton Canyon, the fishing grounds are very localized, particularly for European hake which is targeted by bottom longliners, gillnetters and trawlers.

This study focuses on the area containing this canyon and covers 3 statistical rectangles 15E8, 16E8 and 16E7 [surface 1° longitude x 0.5° latitude] located in the Bay of Biscay (ICES Division VIIIb and VIIIc). Hereafter, these rectangles are denoted R15E8, R16E8 and R16E7. The combination of these three statistical rectangles forms the study area. They delimit three zones with differing access for French and Spanish fleets. The area has a maritime border with Spain and Spanish territorial waters (representing 5.5% of the studied area) which are inaccessible to French fleets.

2.2. Fishing activity
2.2.1. Fleets operating in the study area

This maritime space is mainly characterized by pelagic and demersal fisheries.

The fleets exploiting pelagic fish are purse seiners, baitboaters and pelagic trawlers targeting mackerels (*Scomber scombrus*, *Scomber japonicus*), sardine (*Sardina pilchardus*), horse mackerel (*Trachurus trachurus*), anchovy (*Engraulis encrasicolus*) and tunas (*Thunnus alalunga*, *Thunnus thynnus*). In terms of tonnage, pelagic species constitute the most important landed fishes [26].

The gillnetters, longliners and bottom trawlers fish for demersal species such as hake (*Merluccius merluccius*), monkfish (*Lophius piscatorius* and *Lophius budegassa*), sea bass (*Dicentrarchus labrax*), common sole (*Solea solea*), turbot (*Scophthalmus maximus*) and sparidean. In addition, potters target other benthic species such as large crustaceans (*Cancer pagurus*, *Homarus gammarus*). Most of species as sole, hake, monkfish, anchovy…are managed by TAC - under the Common Fisheries Policy (CFP) of the European Union – and by gears restrictions. Hake and sole have been both subject to management plan since 2002 and since 2006 respectively to increase the spawning stock [8].

In 2008, about 118 French vessels and 350 fishermen were fishing in the study area. They landed 3190t of sea products for a total value of 3700k€ [26,27]. To increase income, 30-35 vessels sell directly to consumers (into 3 local ports: Capbreton, Bayonne, Saint-Jean-de-Luz, see Fig. 1a), avoiding the whole sale market. The fleet consists mainly of single owner operators whose crews are paid under a “shared-wage” system. Bottom longliners hake, gillnetters, pelagic and bottom trawlers represent around 79% of the total French fleet operating in this area. Gillnets and longlines are considered as passive gears but pelagic and bottom towed by boats are considered as active.

This study concentrates upon the main gear types used in the study area: bottom longline, nets (gillnet and trammel net) and trawls (pelagic and bottom trawl). These represent
about 93 boats in 2008: of which longliners represent 19% of this total number, gillnetters 44%, pelagic and bottom trawlers 37%. Bottom longline hake fishing takes place at the edge of the Capbreton canyon. Gillnetters operating in the coastal area use several types of nets (gillnet and trammel) targeting several species. Coastal netters predominate in the sector although large netters are also present. Bottom trawlers operate mainly in the northern sector. While fishing in the canyon itself is excluded both by topography and regulation, they are able to work along the shelf break. The detailed characteristics of the métiers based on gear dimension, location, yields and main target species are shown in table 1.

The fishery data are extracted from the database of the French Fisheries Information System (SIH) of Ifremer. The data are based on landings (in weight) – of all vessels working at least once in these statistical rectangles - and upon whole sale market (in value). Two different datasets were compiled:

- The first (from official logbooks and catch reports) contains information on fishing area, landing dates, landing port and landed weight of species by fishing days. Vessel activity is linked to fish market location until 1989 and since 1990 it has been dissociated from the type and place of sale;

- The second dataset (from fish markets) contains the landed value and quantity by species for each vessel and fishing trip. Current prices for landings were converted to constant prices, using the French consumer price index, with 1985 as the base year. Direct sales are not considered in this study but represent about 28% of the total landed value in local harbors [28].

The data used covers a 24-years period (1985-2008) for the main métiers cited above. The study excludes results of 1999 due to a change in the data recording system which resulted in the loss and degradation of data. The analysis relies upon data for the French fleets as Spanish data are not available.
2.2.2. Local fishing organizations

French professional fishermen are organized nationally and locally. There are the National Committee of Marine Fisheries and Aquaculture (CNPMEM) as well as their regional committee (in this case, CRPMEM Aquitaine) and their local office (in this case, CIDPMEM Pyrénées Atlantiques Landes). Membership is mandatory for professionals.

Their committee members integrate all sea workers such as fishermen, ship-owners, others representing fish traders and the processing industry. These committees are under the authority of the French State. Their role is to improve coexistence between métiers and includes allocation of fishing rights (licenses, quotas ...), supervision of fishing effort (gear and authorized areas, fishing period...). The local fishing committee has a consultative role in fisheries management applying regional decisions and making propositions about sensitive issues in their circumscription that are forwarded to regional level.

2.3. Access regulation

The main legislation concerning the fishing practices in the area is summarized in table 2 and involves the following levels of authority:

- European legislation requires vessels to report catches in their logbooks and also covers stock recovery plans;
- National legislation, presented in this article, adapts or adds to European directives;
- Regional regulations manage the various fishing practices and cover access to fishing grounds and the prohibition of certain types of gear.

Changes to maritime areas accessible to different métiers are listed in table 2 and mapped in figures 1a and 1b above. Different regulatory documents and the work of Tixerant have been used [29].

1 Those types of committees were created by Order n°45-1813 of August 15, 1945.
Historically, the study area was often the source of conflict between French and Spanish fishermen regarding access to and sharing of fishery resources as well as competition for the same market [30,31] (despite signature of a fisheries agreement by both governments in 1967) [32].

Introduction of new gear or technology (for example the pelagic trawl in 1976 or the tuna driftnet in 1986) has led to improvements in catches and turnover. However, it has also resulted in sometimes violent confrontation between the “old” and the “new” métiers (for example, purse seine and pelagic trawl) over the same coveted fishing ground due to its effect upon particular species such as anchovy [33,34].

Two examples of regulation access regarding the studied area are shown below. In the first case, bottom longliners requested closure of some areas to netters because they targeted the same species (hake) in the same area - the canyon - without any possibility of redeployment for the longliners. So, a restricted area was established in 1985 included in 4 rectangles R16E8, R17E8, R17E7 and R16E7 (by prefectural order Ord. n°40 March 5, 1985) prohibiting gillnet fishing in two (rectangular) sections of the canyon including a large part of the continental shelf, which had been traditionally exploited by longliners (Fig. 1a). From 1985 until 1999, the size of this restricted area was 1305 km² (of which 1190 km² lies in the study area). The greater part was located close to the coast with 21% inside the 6 nautical miles limit. Table 3 summarizes the prohibited maritime surface by gear in each studied rectangle. Net fishermen claimed that the restricted area and its location close to the coast strongly handicapped net fishing and caused shortfalls in their catches (Minutes No. 232 of March 17, 1986 – Local fishing committee currently called CIDPMEM Pyrénées Atlantiques Landes). Over the years, they have maintained pressure to obtain a revision of the regulation in this area. They succeeded in reducing this surface in 1999, to 332 km² with a location in R16E8 only: as shown in the figure 1b 65% are in French territorial waters with 3% inside the
6 nautical miles. A portion of the restricted area is also located in the EEZ: French regulations do not apply to foreign vessels (mostly Spanish) which fish there.

In the second case, in addition to the national regulations prohibiting fishing within 3 nautical miles, netters obtained exclusion of trawlers within 6 miles of the coastline from 1981 (by Order n°88 of April 27, 1981 and Order n°21 of February 8, 1993) due to destruction of passive gear by towed gear. The cumulative effect of these regulations (see Table 2) results in limited trawler access in part of the restricted area.

2.4. Main indicators of fishing activity

To better understand and better compare the métiers, a reference trip lasting ten hours was made, entitled hereafter “unit trip (UT)” was used. This choice is considered to be a typical trip for a coastal vessel.

Three families of indicators were retained:

- Fishing Activity Dynamic: the number of vessels and their distribution by rectangle (chosen because this reveals attractiveness of sectors), landings in weight by vessel and by crew member (tonnes vessel\(^{-1}\).crew\(^{-1}\)); landings in weight by vessel and by UT (tonnes vessel\(^{-1}\).10h\(^{-1}\));
- Métier Accessibility: the theoretical maritime surface available expressed in percent by métier. This indicator is built from different regulations mapped in figures 1a and 1b. The spatial boundaries of each regulation were used to calculate the surface of regulated areas in km\(^2\). The percentage of maritime surface available for each métier (“Accessibility”) is calculated using the information and the surface of the ICES rectangles.
- Economic Dependence upon sectors expressed in value: turnover by vessel and by crew member (in k€ vessel\(^{-1}\).crew\(^{-1}\)), turnover by vessel and by UT (in k€ vessel\(^{-1}\).10h\(^{-1}\)).
To better understand the relationships between economic indicators, the percentage of turnover due to the main species has been added in order to highlight those fleets which are vulnerable through dependence upon few species [8].

**2.5. Statistical approaches**

An explanatory multivariate analysis e.g. normalized principal component analysis (PCA) has been applied to the dataset containing all indicators from the three families described above. It is performed using R packages RcmdR and FactoMineR [35]. Information about métiers and sectors is added as supplementary factors. All graphs contain variables with \( \cos^2 > 0.2 \). Evolution of indicators is also presented in classical statistical graphs.

**3. Results**

**3.1. Distribution of vessels in the study area and evolution of the presence of main métiers**

The low activity level of bottom longliners in R16E7 is noticeable despite the fact that a part of the restricted area (which was reserved for them) was contained within this rectangle until 1985. In R15E8, the limited activity of a few bottom longliners varies between 4 to 9 vessels from one year to another during the study period.

The greatest proportion, more than 60%, of total vessels are active within R16E8 (Fig. 2) which contains the restricted area, partially from 1985 to 1999 and entirely thereafter.

During the initial period from 1985 to 1998 (Fig. 3), the presence of each métier in the study area is equivalent in number of boats and trends are similar. For the second period, the number of vessels differs depending on the métier. Bottom longliners are the least represented but their number grew significantly from 2 to 18, between 2000 and 2008. Netters are greater in number and increased from 20 to 41 between 2000 and 2008. The presence of pelagic trawlers is very variable and the number of bottom trawlers remains stable on the second
period. However, the number of gillnetters is twice as large as bottom longliners by 2008 (Fig. 3).

3.2. Economic dependence according to spatial occupancy and fishing activity

criterion

The first three principal components coming from PCA give 37% of total inertia. This seems low but reveals few significant linear correlations between the chosen descriptors and emphasizes their variability from year to year.

Bottom longliners and gillnetters have a high turnover by vessel and by crew member in R16E8. Turnover, especially for bottom longliners, is highly dependent upon R16E8 and upon hake (Fig. 4a and Fig. 4b). Bottom trawlers’ turnover hardly depends at all on R15E8 while sole contributes highly to the gillnetter’s turnover (Fig. 4b). Pelagic trawlers have high levels of landings and turnover by vessel by UT (Dim1) on R16E7 and a turnover strongly dependent on mackerel, bluefin tuna and albacore tuna (Fig. 4a).

Focusing on the sector R16E8 which contains the restricted area, one can notice that more than 75% of bottom longliners’ annual turnover is generated by hake (Fig. 5a) with conger being the second most important contributor. Hake and sole contribute equally to gillnetters’ annual turnover during the first period. However, in the second period hake drops to the same level as gilhead sea bream and sea bass while sole remains stable (Fig. 5b).

Pelagic trawlers are less dependent on hake but more on the pelagic species such as anchovy and mackerel (Fig. 5c). For bottom trawlers, hake is the main contributor in the first period but this changes for the second period in favor of other species such as monkfish, squid and red mullet (Fig. 5d).

The evolution of turnover per boat and per crew member is shown for the main métiers in R16E8 (Fig. 6). In the first period, there was an equivalent turnover between gillnetters and pelagic trawlers while bottom longliners realized a high turnover (max. 25 k€
in 1991) before decreasing from 1992. Trends changed in the second period. Bottom longliners’ turnover is equivalent to that of trawlers while gillnetters’ turnover is higher than the others (between 15 and 20 k€). Bottom trawlers realized the lowest score.

4.1. Quality and available data

Different approaches are usually used to assess the effect of MPAs. Most studies concentrated on the „effects on population or assemblages” or other topics such as fishing yields, indirect socioeconomic effects and ecological indirect effects [36]. These need data detailing results inside and outside the MPA or before and after its establishment [36,37,38]. In this study, the lack of statistical series by vessel before the establishment of the restricted area in 1985 did not allow modeling to simulate the consequences of its creation or to do a comparative empirical study before and after or inside/outside. Although the first three years of the series are incomplete due to the small number of vessels submitting logbook information, the trends in reported catches do reflect the reality of fishing activity and match the evolution of the fishing fleet in the Bay of Biscay [8,26,39].

4.2. Fishermen conflicts

The study area is subject to different types of fishing and in the past the use of different gears in the same fishing grounds has led to conflicts between fishermen. The restricted area was established to resolve conflicts between bottom longliners and gillnetters while sustaining the practice of bottom longline hake fishing. Its location on the canyon covers an area mainly exploited by bottom longliners due to the large presence of adult hake there. The surface of this box enclosure was reduced in 1999 at the request of gillnetters and trawlers. Generally, most conflicts focus on the active against the passive. For example in the Gulf of Mexico, the Fishery Management Council created a MPA to resolve conflict between shrimp and stone-crab fishermen [40]. However, in this case, two passive métiers oppose each other. Other MPAs, with such objectives as increased fishery yields, reduced fishing effort or
ecological protection, have been implemented with varying degrees of success [1,40,41]. In some cases, MPAs simply caused fishermen to move elsewhere rather than reduce the fishing activity [42]. With a rights-based approach, Mascia and Claus [43] studied the consequences of effort displacement during the creation of MPAs. These consequences are classified according to the criteria: gained, lost and secured, which allowed assessing the equity of the MPA. The dimensions considered are welfare, economic well-being, health, education, social capital and culture. In this case study, the size of the restricted area for gillnetters, was too large and was not well accepted, due to loss of fishermen’s earnings. Consequently, they obtained a reduction of the area. Since this took place, the competition to access this space has been reduced and the conflict between longliners and gillnetters has been resolved. In the same period, gillnetters took advantage of prohibited areas for trawlers inside 6 miles, by having more space to spread their nets and to increase their own productivity (Table 2 and Table 3). As mentioned above, the displacement of fishing effort can have economic, social and environmental consequences. There are few analytical studies which quantify the impact of these movements. The concentration of boats into areas outside restricted areas has the potential to increase competition and conflict especially in a context of declining yields [44]. In this case study, trawlers could have been impacted by regulatory measures due to the importance of the prohibited areas for them (around 17%), but they could easily move elsewhere; due to their size, they are able to operate in a wider area and also further offshore, without creating new problems for other boats.

These examples show how each métier within the fisheries committee is able to influence decisions. Conflicts of interest between committee members can lead to ad hoc alliances aimed at influencing decisions in a direction more favorable to some than others and that bargaining powers of different métiers (represented by elected fishermen and ship-owners) can fluctuate greatly over time.
The restricted area established in 1985 was intended to protect the longliners’ hake fishing. It has since evolved into a significant shrinkage of the most important area for this métier and in combination with other national regulations, has mainly released space for netters. The geographic distribution of the various competitors’ métiers has improved, thus promoting better relations between them.

Although the management of this area was achieved gradually step by step rather than as the result of an elaborate plan, the end results appear satisfactory. Fishermen believe that without the restricted area, the métier of longliners would have disappeared (Minutes No. 232 of March 17, 1986 - Local fishing committee CIDPMEM Pyrénées Atlantiques Landes).

Agardy et al. [44] found that the absence of a comprehensive and coordinated strategy over a wide coastal area has often caused the failure of MPA. They suggest it should be implemented with an ecosystem approach to optimize the result of MPA and to avoid creating new problems.

4.3. Economic dependence

The contribution of species to turnover differs according to métier. The results of PCA demonstrate the high contribution of hake to bottom longliners’ turnover. The same for gillnetters although the common sole and others species are also important contributors. In the Bay of Biscay, most fleets derive their main income from one or two species [8]. In this analysis, more than 75% of bottom longliners’ turnover comes from hake. Conger is the second most important, especially during “bad” periods. This makes this métier highly selective but more vulnerable because more sensitive to changes in targeted stock and in prices. Many authors establish that small-scale fisheries are sustained by only a few species and note that some fishing tactics are relatively “clean” with a clear target species.
representing most of the catch [45,46]. In this study, the increasing number of bottom longliners in recent years with a turnover equal to that of other métiers, underlines this métier’s strength. The sustainability of the bottom longliner métier is also related to the status of stocks. Hake stocks collapsed in 1980 and a recovery plan was finally agreed by the EU in 2002 (EC Reg. 494/2002). The increase of the Spawning Stock Biomass (SSB) observed since 2005 can explain that the bottom longliner métier again became more attractive as yields improved [47]. Price variation of species is also an important factor underlying the changes in value of landings [39,48]. The market crisis that occurred in France in the mid-1990s led to a sharp drop in prices of the main landed species in the Bay of Biscay (including hake) between 1991 and 1994. In this study, the decrease observed in the number of bottom longliner vessels during the first period is probably attributable to the drop in hake prices which contribute such a high proportion of landing values.

Although the contribution of hake to the turnover of netters and trawlers has declined, it has been offset by a change in strategy to capture other species. Consequently, the establishment of the restricted area does not seem to have affected their economic viability.

5. Conclusion

Suuronen et al. [41] emphasized that the MPAs in the Baltic Sea were implemented without consulting the fishermen or heeding scientific advice. According to these authors, there should have been better communication between fishermen and other stakeholder groups. This would have resulted in sustainable harvest policies, before implementation of any major management action. This study suggests that the restricted area is appropriately located in the canyon for several reasons: (i) Fishermen were behind the proposal; (ii) Emerging conflicts have been resolved through compromise between them (iii) Bottom longliners operate mainly on the edge of the canyon and the choice of the restricted area
location has enabled maintenance of this “emblematic” métier: which was already practiced by Basque fishermen in the eighteenth century [9,49]; (iv) Today, local fishing committee strongly support and publicize this métier and have begun a process of eco-labeling. Thus the restricted area will enhance the traceability process; (v) It is located on a canyon known to be a productive system with major adult hake concentrations (containing several localized fishing grounds).

Moreover, the adoption by Authority of different regulations governing access to fishing areas according to different métiers (often after consultations or stakeholders’ proposals), has contributed to a better distribution of the fishing effort, thus promoting the viability of different fleets. Other factors which must be taken into account to explain the results of this study include the recovery plans for different halieutic stocks, the multi-annual guidance programs (regulation of fishing effort) and indeed the market conditions.

Part of this restricted area is located in the EEZ (Fig. 1b) and French fishermen complain about the presence there of foreign gillnetters who are permitted under the EU law to use gear otherwise forbidden to the French. Indeed, the study area straddles the Spanish border and approximately 175 Spanish coastal fleet vessels operate there. They also use a wide range of gear during the year: handlines and trolling predominate (respectively 38% and 34%), nets represent 29% whereas longlines are less used (14% of vessel) [50].

In this context, in 2009, the local fishing committee requested application of the French regulations to foreign vessels entering the EEZ part of the restricted area. The French proposal was supported by the South Western Waters Regional Advisory Council (SWWRAC) and is reinforced by another request of the Federation Cofradías from Guipuzkoa (Regional Fishermen Guild Organization of the Basque country in Spain), which represents the interests of the Spanish ship owners and fishermen [30]. This type of cross-border fishery management had already been negotiated between France and the United
Kingdom in the context of the Bay of Granville (in the Channel). Fishermen from Jersey and France succeeded in resolving their historic conflicts by concluding such an agreement in 2000 ratified in 2004. This is based on the possibility (under certain conditions) for fishermen to access fishing areas located in or near the territorial waters of either nation. Application of this treaty is placed under the control of a Joint Advisory Committee of the Bay of Granville, composed of representatives of fishermen, officials and scientists from each state [51]. In the case of Spanish fisheries in the southern Bay of Biscay, their management is slightly different from France. There is an overlap of competences in Spanish territorial waters between the Spanish government, the Basque government (Autonomous Regional Authority) and the Fishermen Guild Organizations, the Cofradías [30]. In 1992, the fishermen of the two nations were able to reach an agreement to end their conflicts about fishing for anchovy known as the “Accord d’Arcachon”; it introduced a quota exchange and included restricted seasons for the fleets of both countries [30,52,53]. The extension of such an area into the EEZ raises the question of its legal status, its control and also its scientific monitoring.

As Forcada et al. [54] point out, efficient management needs a better understanding of the dynamics of artisanal fisheries, the conservation of key habitats and the study of interactions with other activities. A multidisciplinary and cross-border project with strong involvement of French and Spanish stakeholders is in progress in order to improve knowledge and optimize management of this cross-border area.
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Figure Captions

Fig. 1. a) Introduction in 1985 of restricted area for gillnets (1 305 km²). The pelagic trawlers are prohibited in the 3 miles limits.

Fig. 1. b) In 1993, additional prohibition was introduced in the 6 miles limit of for pelagic and bottom trawlers. In 1999, the restricted area for gillnets decreased to 332 km².

Fig. 2. Evolution of active vessels number at least once by rectangle (in %). The total number of vessels is mentioned on the right side in italic.

Fig. 3. Evolution of active vessels number by métier in the study area.

Fig. 4a. PCA Analysis: correlation circle and individuals plot on axis Dim1 and Dim2. The contribution of species in the turnover are presented: ALB = albacore; HAK = hake; SAR = sardine; MAC = common mackerel; MAC_ESP = spanish mackerel; THU = tuna. Métiers and sectors are added as supplementary factors.

Fig. 4b. PCA Analysis: correlation circle and individuals plot on axes Dim2 and Dim3. The contribution of species in the turnover are presented: ALB = albacore; HAK = hake; SOL = common sole; THU = tunas. Métiers and sectors are added as supplementary factors.

Fig. 5. Contribution of 4 main species to turnover, in percentage a) for bottom longliners, b) for gillnetters, c) for pelagic trawlers, d) for bottom trawlers

Fig. 6. Evolution of turnover by vessel by crew member for main métiers in R16E8 (in k€ constant).
Fig. 3
Fig. 4
Fig. 6

The diagram shows the turnover per crew (10^3 e-constant) for different fishing methods over the years 1985 to 2007. The methods include:
- **Bottom longline** (solid line)
- **Gillnets** (circles)
- **Bottom trawl** (dashed line)
- **Pelagic trawl** (dotted line)

The x-axis represents the years from 1985 to 2007, and the y-axis represents the turnover per crew (10^3 e-constant) ranging from 0 to 30.
### Table 1. Characteristics of métiers operating in the southern part of the Bay of Biscay.

<table>
<thead>
<tr>
<th>Métier</th>
<th>Gear dimension</th>
<th>Length vessel (m)</th>
<th>Trip duration</th>
<th>Main location</th>
<th>Season</th>
<th>Annual yields (T/vessel)</th>
<th>Target species (Common name)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottom longline</td>
<td>1200 – 1800 hooks</td>
<td>11</td>
<td>10 – 12 hrs</td>
<td>Edge of the canyon</td>
<td>Spring - Summer</td>
<td>7</td>
<td>Hake (80% of tonnage) Red Sea bream, Conger</td>
</tr>
<tr>
<td>Gillnet</td>
<td>10 km/day</td>
<td>12</td>
<td>&lt; 12 hrs</td>
<td>Coastal zone</td>
<td>All year</td>
<td>8</td>
<td>Hake, Sea bream and Sea bass</td>
</tr>
<tr>
<td>Trammel net</td>
<td></td>
<td>12</td>
<td>&lt; 12 hrs</td>
<td>Coastal zone</td>
<td>All year</td>
<td>8</td>
<td>Sole, Monkfish</td>
</tr>
<tr>
<td>Pelagic trawl</td>
<td>Depends on targeted species</td>
<td>21</td>
<td>&lt; 24 hrs</td>
<td>Coastal zone</td>
<td>Winter – Spring Summer</td>
<td>81</td>
<td>Mackerel Tuna</td>
</tr>
<tr>
<td>Bottom trawl</td>
<td>Depends on targeted species</td>
<td>19</td>
<td>Few days</td>
<td>Shelf break North of the canyon</td>
<td>All year</td>
<td>14</td>
<td>Cephalopods, Red mullet, Monkfish, Hake</td>
</tr>
</tbody>
</table>

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640
Table 2. Regulatory framework in the southern part of the Bay of Biscay [29].

<table>
<thead>
<tr>
<th>Subject</th>
<th>Area</th>
<th>Origin</th>
<th>Date</th>
<th>Type of regulation</th>
<th>Gear, Fleets concerned</th>
<th>Exemption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prohibition Inside 3 miles</td>
<td>VIII ab</td>
<td>Fisheries Depart. (DPMA)</td>
<td>3 Mar. 1977</td>
<td>Ord. n° 1248</td>
<td>Pelagic trawl</td>
<td></td>
</tr>
<tr>
<td>Prohibition Inside 6 miles &amp; South 43°42’ 5 N</td>
<td>16E8, 15E8</td>
<td>Director of Maritime Affairs Bayonne</td>
<td>27 Apr. 1981</td>
<td>Ord. n° 88</td>
<td>Pelagic trawl Bottom trawl Pelagic net</td>
<td>Engine power &lt; 150 CV</td>
</tr>
<tr>
<td>Maritime border</td>
<td>EEZ Bay of Biscay.</td>
<td>Government</td>
<td>10 Dec. 1982</td>
<td>Convention</td>
<td>All fleets</td>
<td></td>
</tr>
<tr>
<td>Restricted area 1 305 km²</td>
<td>16E8, 16E7, 17E7, 17E8</td>
<td>Prefecture</td>
<td>5 Mar. 1985</td>
<td>Ord.n°40</td>
<td>Nets</td>
<td></td>
</tr>
<tr>
<td>Restricted area around landing buoy 0.8 km²</td>
<td>16E8</td>
<td>Prefecture</td>
<td>31 Jul. 1989</td>
<td>Ord. n° 68/89</td>
<td>Passive gears Other gears</td>
<td>No more</td>
</tr>
<tr>
<td>Prohibition Inside 6 miles &amp; South 43°42’ 5 N</td>
<td>16E8, 15E8</td>
<td>Secretariat of State</td>
<td>8 Feb. 1993</td>
<td>Ord. n° 21</td>
<td>Bottom trawl</td>
<td></td>
</tr>
<tr>
<td>Restricted area 332 km²</td>
<td>16E8</td>
<td>Prefecture</td>
<td>23 Jun. 1999</td>
<td>Ord n°156/99</td>
<td>Nets</td>
<td>Except foreign vessels outside French territorial waters – area of 115 km²</td>
</tr>
<tr>
<td>Logbook</td>
<td>EEZ</td>
<td>EEC</td>
<td>29 Jun. 1982</td>
<td>Reg. EC n°2057</td>
<td>All European vessels</td>
<td>Vessel size &gt;10m &amp; &lt; 17 m &amp; trip duration &lt; 24h</td>
</tr>
<tr>
<td>Obligation to report catches</td>
<td>EEZ</td>
<td>Ministry</td>
<td>26 Apr. 1989</td>
<td>Dec. n°89/2773</td>
<td>All French vessels</td>
<td></td>
</tr>
<tr>
<td>Catch reports</td>
<td>EEZ</td>
<td>Ministry</td>
<td>18 Jul. 1990</td>
<td>Ord. n°2091</td>
<td>All French vessels &lt; 10m</td>
<td></td>
</tr>
<tr>
<td>Logbook</td>
<td>EEZ</td>
<td>EEC</td>
<td>12 Oct. 1993</td>
<td>Reg. EEC n° 2847</td>
<td>All European vessels</td>
<td>Vessel size &lt; 10 m</td>
</tr>
<tr>
<td>Operation Permit Implementation</td>
<td>Ministry</td>
<td></td>
<td>8 Jan. 1993</td>
<td>Dec. n°99/33</td>
<td>All French vessels</td>
<td></td>
</tr>
<tr>
<td>Driftnet prohibiting</td>
<td>EEZ</td>
<td>EEC</td>
<td>8 Jun. 1998</td>
<td>Reg EC n° 894/97</td>
<td>All European vessels</td>
<td></td>
</tr>
<tr>
<td>Protection plan anchovy</td>
<td>VIII</td>
<td>EEC</td>
<td>1 Jul. 2005</td>
<td>Reg. EC 1037</td>
<td>All European vessels</td>
<td>Duration 3 months</td>
</tr>
<tr>
<td>Sole fishing license</td>
<td>VIII ab</td>
<td>EEC</td>
<td>23 Jun. 2006</td>
<td>Reg. EC 388/2008</td>
<td>All French vessels</td>
<td>Landings &lt; 2 t/ year⁻¹ or &lt; 100 kg day⁻¹</td>
</tr>
<tr>
<td>Anchovy fishery closure</td>
<td>VIIIabc</td>
<td>EEC</td>
<td>11 Jun. 2006</td>
<td>Reg. EC 1116</td>
<td>All European vessels</td>
<td></td>
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</table>
Table 3. Maritime surface of rectangle and Spanish territorial waters (in km²). Prohibited maritime surface by gear concerned for the French vessels are mentioned (in km² and in percentage of total area).

<table>
<thead>
<tr>
<th>Period</th>
<th>Gears</th>
<th>Prohibited surface in km²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1E8</td>
</tr>
<tr>
<td></td>
<td>Maritime surface km²</td>
<td>463.3</td>
</tr>
<tr>
<td></td>
<td>Spanish territorial waters km²</td>
<td>295</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Period</th>
<th>Gears</th>
<th>Prohibited surface in km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1977</td>
<td>Pelagic trawl</td>
<td>402.9</td>
</tr>
<tr>
<td>1981</td>
<td>Pelagic trawl</td>
<td>460.8</td>
</tr>
<tr>
<td>1981</td>
<td>Bottom trawl</td>
<td>460.8</td>
</tr>
<tr>
<td>1993</td>
<td>All trawls</td>
<td>463.5</td>
</tr>
<tr>
<td>1982</td>
<td>Longlines</td>
<td>295</td>
</tr>
<tr>
<td>1989</td>
<td>Longlines</td>
<td>295</td>
</tr>
<tr>
<td>1985</td>
<td>Gillnets</td>
<td>295</td>
</tr>
<tr>
<td>1999</td>
<td>Gillnets</td>
<td>295</td>
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</tbody>
</table>