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Fish and cephalopods monitoring on the Bay of Biscay and Celtic Sea continental shelves

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Abstract

The demersal fish and cephalopod communities of the continental shelves of the Bay of Biscay and the Celtic Sea have been monitored for more than 30 years by the EVHOE series of fisheries surveys. Since 1987, a total of 4247 stations have been sampled in the fall with a GOV bottom trawl in a depth range of 15 to 600m. The main objective of these surveys is to monitor 22 benthic fish stocks and 10 cephalopods but also to provide a description of the distribution of a total of 250 fish and 50 commercial invertebrate taxa. The dataset (https://doi.org/10.17882/80041) provides abundance and biomass information by station for all observed taxa. Size distributions for a selection of species are also available. These data are part of a larger set of standardized European surveys that provide essential information for monitoring demersal communities in the Northeast Atlantic. We propose here a critical analysis of the dataset especially in terms of the evolution of the sampling effort and strategy as well as the taxonomic precision.

1 Introduction

In North-East Atlantic, monitoring of exploited populations is based on an European network of observation surveys at sea for both pelagic (International Pelagic Surveys, IPS) and benthic (International Bottom Trawl Surveys, IBTS) species. This network is included in the European Data Collection Multi Annual Program (Decision (EU) 2016/1701, EU-MAP Commission EU/2016/1251) to support the implementation of the European Common Fisheries Policy (CFP). Even if the data must be combined with caution (Moriarty et al. 2020), these scientific surveys provide consistent and standardized data (common protocols detailed in ICES, 2017) to ICES assessment and science groups. In particular, the data allow stock assessors to analyze spatial and temporal variations in the distribution and relative abundance of fish populations (notably pre-recruits) as well as those of the biological parameters of the exploited species. These data thus provide fisheries independent abundance indices for commercially valuable species and to collect hydrographical and environmental information.

On the basis of scientific surveys carried out in the North Sea, France aimed to develop comparable monitoring in the Bay of Biscay. In this context, a French groundfish survey, named EVHOE ("EValuation Halieutique de l'Ouest Européen", ICES name "FR-EVHOE-Q4") was initiated in 1987, after two exploratory surveys in 1973 and 1976. A research vessel, "RV Thalassa" (construction year 1960, 66.1 m length, 10.4 m width, 5 m draught), deployed a standardized bottom trawl (GOV) to sample different strata in terms of bathymetry and latitude. Benthic and demersal fish and cephalopods catches were identified, tried, weighted, measured and some specific species are aged, sexed and their sexual maturity are described. The prospected area was extended in the whole Celtic Seas

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since 1997 (Fig. 1), year of the starting of the new French research vessel also named "Thalassa" (construction year 1996, 73.65 m length, 14.9 m width, 6.1 m draught).

EVHOE covers the Celtic Sea (ICES divisions 7fghj) and the French part of the Bay of Biscay (ICES divisions 8ab). The surveys were carried out in the fall from the end of October (distribution of sampling stations among the survey months is shown in Fig.2) and extend from 15 to 600m depth. The collection of robust biological and environmental data allowed to monitor 22 benthic fish and 10 cephalopods stocks (ICES 2019) from the North-East Atlantic.

Table 1: List of stocks monitored by EVHOE survey or for which the data are used for the calculation of assessment indices

Components	Species	Stock (ICES divisions)	ICES code
Fish	*Capros aper*	678	boc.27.6-8
	Chelidonichthys cuculus	3-8	gur.27.3-8
	Gadus morhua	7.e-k	cod.27.e-k
	Galeus melastomus	67	sho.27.67
		89.a	sho.27.89a
	Lepidorhombus whiffiagonis	7.b-k8abd	meg.27.7b-k8abd
	Lepidorhombus boscii	7.b-k8abd	ldb.27.7b-k8abd
	Leucoraja fullonica	67	rjf.27.67
	Leucoraja naevus	678.abd	rjn.27.678abd
	Lophius budegassa	7.b-k8.abd	ank.27.78abd
	Lophius piscatorius	78abd	mon.27.78abd
	Melanogrammus aeglefinus	7.b-k	had.27.7.b-k
	Merlangius merlangus	7.b-ce-k	whg.27.7b-ce-k
	Merluccius merluccius	3.a46-8.abd	hke.27.3a46-8abd
	Micromesistius poutassou	1-91214	whb.27.1-91214
	Mustelus asterias	1-101214	sdv.27.nea
	Pagellus bogaraveo	678	sbr.27.6-8
	Phycis blennoides	1-101214	gfb.27.nea
	Raja clavata	8	rjc.27.8
	Scomber scombrus	1-89.a14	mac.27.nea
	Scyliorhinus canicula	67.a-ce-j	syc.27.67a-ce-j
		8.abd	syc.27.8abd
Crustaceans	*Nephrops norvegicus*	7.agj (FU19)	nep.fu.19
		7.gh (FU20-21)	nep.fu.2021
		7.gf (FU22)	nep.fu.22
		8.ab (FU23-24)	nep.fu.2324
Cephalopods	*Alloteuthis*	8.ab	-
	Illex coindetti	8.ab	-
	Loligo forbesi	8.ab	-
	Loligo vulgaris	8.ab	-
	Rossia macrosoma	8.abd	-
	Sepia elegans	8.abd	-
	Sepia officinalis	8.abd	-
	Sepia orbinyana	8.abd	-
	Todarodes sagittatus	8.ab	-
	Todaropsis eblanae	8.ab	-

From the initial and contractual stock assessment objectives, a more diversified data collection has been put in place to progressively monitor the entire marine ecosystem. In addition to the fish and cephalopods species historically observed, the entire benthic invertebrate community ("benthos") as captured by the trawl has now been recorded since 2008. It provides information on regional biodiversity, improves our understanding of the structure

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and functioning of communities, and addresses new issues related to human impacts from the effects of regional activities such as fishing to global effects such as climate change (*e.g.* Poulard and Blanchard 2005, Rochet, Trenkel et al. 2005). The implementation of the Marine Strategy Framework Directive (MSFD) in 2008 planned monitoring programs to provide data concerning offshore areas. The EVHOE survey was identified as a platform for observing the entire marine ecosystem of the Bay of Biscay and the Celtic Sea. An optimization work was realized from 2013 to 2015 to implement new protocols able to provide new data like seafloor litter, microplastics, zooplankton, contaminants, submarine noise (derived from AIS vessel tracking records) or hydrological data (Baudrier et al., 2018).

In the present paper we provide details of the long term dataset for fish and cephalopods collected on the continental shelves of the Bay of Biscay and the Celtic Sea during the EVHOE survey. Non-commercial invertebrate ("Benthos") data are not included in this first dataset; they will be the subject of a later addition.

2 Data and methods

The EVHOE dataset provides information on catch of benthic and demersal fish and cephalopods of the Bay of Biscay and the Celtic Sea from 1987 to 2020. At the beginning of the series of surveys, the observations were exclusively carried out in the Bay of Biscay. From 1997 onwards the observation area has taken its current extension including the entire Celtic Sea. The research vessel (R/V) also changed in 1997. The “old” R/V Thalassa (“Thalassa I”), the first French stern trawler dated of 1960 and used since the beginning of EVHOE survey was replaced by the actual R/V Thalassa (“Thalassa II”) since 1996. Thalassa II is 73.65 m long and 14.9 m wide stern trawler (gross tonnage of 3022 t). An intercalibration experiment based on paired hauls was conducted in 1996 to estimate conversion coefficients between vessels (Pelletier, 1998). The temporal continuity of data time series may be hindered by a change in survey vessel and become a biais for estimating the abundance of populations in fisheries science.

2.1 Sampling strategy and gear

The usual season of observation is in autumn, but two years (1988 and 1991) also offered additional spring observations (Mahé & Poulard, 2005) but these data are not included into the published dataset. On the other hand, a few years were missing from the data series for autumn sampling (1991, 1993, 1996, 2017) ; the absence of a survey in these years were usually due to technical problems with the R/V. The studied area was limited to the Bay of Biscay, between the latitudes 43°40’N and 48°30’N, from 1987 to 1989. In 1990, the prospected area was extended to the South part of the Celtic Sea (latitude 51°15’N). During the change of research vessel in 1997, a revision of the objectives and sampling protocols was carried out and the observation area was extended to the whole Celtic Sea.

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Table 2: Chronology for the survey IBTS-Q4-EVHOE of the main features of the data acquisition protocols

Year	Vessel	Areas	Sampling strategy	Fishing gear & geometry sensors	Data management	Comments
1973 & 1976	Thalassa I	Bay of Biscay				Preliminary test surveys "RessGasc" not included into the dataset
1987-1989			Randomly stratified	GOV36/47 no gear sensors	Data input in 2 steps: onboard paper and copy in "local spreadsheet /database"	**Start of the EVHOE series**
1990-1995		Bay of Biscay, southern and central Celtic Sea				Missing year: 1991 (spring only) and 1993
1996				GOV36/47 Gear sensors (Scanmar, not recorded)		No data: intercalibration of R/V Thalassa I and II
1997	Thalassa II	Bay of Biscay and whole Celtic Sea		GOV36/47 Gear sensors (Scanmar / Marport from 2014, not recorded)	Data input in 2 steps: onboard paper forms & writing in a Microsoft-Access database	First EVHOE survey with Thalassa II
1998-2015						
2015				GOV36/47 (Marport sensors and trawl explorer, data recorded from 2017 onwards)	Data input in 1 step with Allegro c. software* & writing in centralized/ database ("Harmonie"**)	Implementation of the new on-board data entry system "Allegro campagne"
2016			Fixed		Adding a connected electronic ichthyometer	New sampling strategy, strata Cn7, Cc7,Cs7 not included in the new scheme
2017						Year not included into the dataset (only 15 points sampled due to technical issues)
2018-2019					Data control tools implementation ***	2019 missing points into strata Cn2 and Cn3 due to meteorological issues
2020						relocation of 4 stations of the Celtic Sea (within the same strata) to comply with UK MPA areas

* www.ifremer.fr/allegro/ ; ** Leblond et al. 2008 ; *** R shiny application for data control ("TUTTI controller")

The trawl used for sampling is a GOV 36/47 ("Grande Ouverture Verticale", see description in ICES, 2017). From the standard GOV trawl, the Exocet Kite is replaced by additional buoyancy 66 floats in-stead of 60, and 21 floats of 4 litters compensate for the weight of Marport sensors placed in the middle of the headline. The gear has an average horizontal opening around 20.6 m (wingspread range between 17 and 22m) and vertical opening around 4m (range from 3.5 to 5m). The doors are plane-oval of 1350 kg. Trawl sweeps of different lengths are used depending on the operating depth: sweep of 50 m for depths less than 140 m, sweeps of 100 m for deeper depths.

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The net is fitted with a 20 mm codend liner. During the trawling, the gear parameters were monitored by "Scanmar" system (Table 2) and in recent years by "Marport" system. The parameters that are monitored are the door spread, the wing spread, the headline height and the height of ground rope. They allow appreciating the behavior of the gear during fishing operations but also to assess the area or even the volume sampled. The accuracy of trawling parameters has therefore evolved over time and the data from the trawl geometry sensors were not recorded until year 2017. In order to preserve the homogeneity of the dataset, and despite the existence of actual trawl parameters values recorded from 2017 onward, standard median value of horizontal trawl opening (20.6 m) is utilized. The swept area (about 0.076 km^2 for a standard 30' tow) was then calculated from the distance covered by the trawl. The file also provides the duration of the haul, which is a useful standard effort value when combining data from different surveys using a similar fishing gear. Moreover, the trawl is equipped with a CTD probe allowing for each station to record temperature, depth and salinity profiles (the latter only for stations less than 300m deep). Additionally, a number of navigational parameters or meteorological variables were also monitored but are not included into the published dataset.

The sampling scheme defined a geographic stratification that separates the Bay of Biscay in 2 areas and the Celtic Sea into 3 areas and seven depth strata from 20 m to 600 m (Fig. 1 and Table 3). From 1987 to 2015, the sampling strategy followed a stratified random strategy (Fig. 1). A Neyman allocation on numbers variance averaged on the 4 most important commercial species (hake, the two species of monkfish and northern megrim) was utilized to set the number of stations per stratum. The number of stations proportional to the surface of the stratum and minimum of two stations per stratum. Each sampled station was obtained by random selection from a set of reference stations trawlable in the sampled area with the aim of sampling at least 140 stations per year. The area covered included only the Bay of Biscay in 1987, it was extended to the southern part of the Celtic Sea from 1990 (not sampled in 1994 and 1995 following damage to the propulsion engine) and since 1997 has covered the whole of the Bay of Biscay and the Celtic Sea.

From 2016, the sampling strategy was changed to a fixed sampling strategy. The reason for this change was that the spatial coverage of some large strata was too highly variable from one year to another. Thus, depending on the random selection of points, areas of significant size were left unobserved. The stabilization of sampling points also facilitated analyses that aimed at studying the spatial structures of species or communities and their evolution over time. Finally, this change made it possible to better harmonize the sampling strategies with the "IBTS" campaigns of other countries. The random selection of stations in 2016 (total number = 155) has been utilized as the reference sampling scheme for the next years. The new sampling design did not include some stations into the Celtic deeper strata (Cs7,Cc7 and Cn7), as well as the points sampled in some part of the shallowest strata of the Bay of Biscay (*e.g.* some rarely sampled points into enclosed bays). In the central-eastern part of the Celtic sea, we added 4 additional to complete strata coverage.

Sampling was carried out with straight tows during the daylight, lasting 30 minutes at the bottom (a minimum of 20 minutes accepted in the protocols to validate a haul) at a constant speed of 4 knots. Some tows were stopped before the end of the total trawl time when excessively high tensions were detected (a sign of large catches) or more recently (from 2018 onward) when a strong pelagic acoustic signal was observed from the on-board sounders. These tows were considered valid and included in the dataset when they lasted at least 20 minutes and that the fishing gear has not suffered any damage. They represent less than 10% of the tows (about 2 to 14 tows per year) with higher proportions in recent years due to the improved control of the trawl variables described above.

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Table 3: Description of sampling strata for IBTS-Q4 Evhoe.

Name	Code	Median depth (m)	Surface (km^2)
EVHOE survey	**EVHOE**		**235420**
Bay of Biscay area	**GG**		**75856**
Southern BoB sector	**Gs**	**116**	**15308**
strata 1	Gs1	27	1960.11
strata 2	Gs2	44	4641.41
strata 3	Gs3	111	4014.68
strata 4	Gs4	156	2994.62
strata 5	Gs5	187	441.75
strata 6	Gs6	379	599.35
strata 7	Gs7	508	656
Northern BoB sector	**Gn**	**121**	**60548**
strata 1	Gn1	26	8201.69
strata 2	Gn2	63	11771.07
strata 3	Gn3	105	17327.21
strata 4	Gn4	137	18854.03
strata 5	Gn5	184	1612.12
strata 6	Gn6	302	1090.2
strata 7	Gn7	518	1691.76
Celtic Sea area	**MC**		**159564**
Southern Celtic sea sector	**Cs**	**151**	**63269**
strata 4	Cs4	139	41500.49
strata 5	Cs5	175	15204.87
strata 6	Cs6	252	3995.49
strata 7	Cs7	457	2564.25
Central Celtic Sea sector	**Cc**	**127**	**59025.29**
strata 3	Cc3	105	20267.46
strata 4	Cc4	128	28211.7
strata 5	Cc5	164	5309.6
strata 6	Cc6	307	3490.58
strata 7	Cc7	512	1746.04
Northern Celtic Sea sector	**Cn**	**81**	**37270.1**
strata 2	Cn2	68	14828.35
strata 3	Cn3	99	22441.75

2.2 Samples sorting, species identifications, biological measurements and sampling

Wherever possible, the entire catch was sorted, with fish and commercial shellfish, crustaceans and cephalopods species identified to the lowest taxonomic level. On the other hand, when the total catch in the trawl was too large (*e.g.* several tons of small pelagic fish), only a fraction of the total catch was fully processed (mostly 1/2 to 1/4 and exceptionally >1/5 of the total catch weight). For the partially sorted part, individuals of rare or particularly large species were still extracted and processed. On average for the recent years (from 2014), those partially processed tows represented 11 to 18% of the total number of stations. Due to a lack of data, this proportion could not be properly assessed for surveys prior to 2014. It can be assumed that this proportion may have been higher in the past, particularly at Thalassa I, due to less efficient sorting facilities.

Individuals lengths were recorded for most fish species and some commercially important cephalopods and shellfish species. Individuals Length was measured at the lower half-centimetre level for small species of pelagic fish, and to the lower 1 cm level for all other fish and cephalopods species. A representative sample was selected (ideally >10 times the number of length classes) when the number of individuals caught was too large to

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be fully measured on board. Sex was determined for a set of fish and commercial invertebrates species (32 to 54 species depending on years and 107 species for the whole time series). For about 20 fish species, ageing material was collected (otoliths, ilicia or scales) and individual weight, length measurements and determination of maturity stages from 2000 onwards were carried out with a sampling strategy following a stratified allocation by length class and by sex. However, these data required significant revision and were not included in the submitted version of the dataset. They will be the subject of an additional publication.

Data entry on board was initially carried out on paper forms that were then copied to computer databases. Starting in 1997, on the R/V Thalassa 2, a computer system for recording catches ("pupitri") allowed for the automated banking of species and their total weight, with individuals informations (sex, counts, size measurements, maturity) still being entered on paper forms. These data were then transferred to an internal database under "Microsoft Access" software (database specific to the EVHOE campaign, not standardized with others IFREMER databases). From 2014 onwards, data was recorded on board with an open-source software especially developed for fisheries surveys ("Allegro Campagne" software, http://www.ifremer.fr/allegro/, https://forge.codelutin.com/projects/tutti). From 2016 onwards, the lengths were also measured using an electronic ichthyometer directly connected to the data management system. Only the sizes of the largest individuals (> 85cm) and the weight data of the sub-samples and individuals fish were still entered manually. In addition, a set of automated data control and correction tools were put in place in recent years (both within the "Allegro" software and from separate dedicated tools greatly improved in 2020). These tools have been applied a posteriori on the whole data series; the EVHOE dataset proposed here (Laffargue et al. 2021) has therefore been significantly corrected.

The dataset consists of 3 tables in a ".csv" file format (Table 4): the "Haul" table provides stations metadata, the "Catch" table including taxa number and biomass, the "Size" table providing length and sex observations for a short list of species. The data provided are identical to the raw data stored in IFREMER's internal database ("Harmonie") and have not been subject to any modifications other than those necessary to recalculate the total catch in the event of subsampling. The "World Register of Marine Species" (WoRMS Editorial Board, 2020) was used to update the taxonomy (valid names and Aphia ID) by utilizing dedicated R packages (« worms 0.2.2" and "worrms 0.4.0"). The provision of this dataset makes it possible to give it an official reference (https://doi.org/10.17882/80041), to make updates more easily accessible and, above all, to provide additional information that is not included in the ICES databases, particularly in connection with the evolution of the protocols. The proposed format will make it possible to link the data coming from other biological compartments (*e.g.* benthos) or environmental observations observed on the same survey but not included in the original protocols.

A set of videos made on board provide additional elements of understanding of all the operations performed and the protocols applied (Lesbats et al. 2019a,b).

Table 4: Tables and fields included in the EVHOE dataset

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Field name	**Data table**			Description
	Haul	**Catch**	**Size**	
Survey	X	X	X	Survey name
Year	X	X	X	year of sampling
StationID	X	X	X	unique haul ID
Month	X			month of the sampling
Distance	X			sampled distance in m
Area	X			sampled area in km^2
Duration	X			haul duration in minutes
Lat	X			Haul latitude in decimal degrees
Lon	X			Haul longitude in decimal degrees
Depth	X			mean depth of the sampled station in m
Taxa		X	X	scientific name of the taxa
AphiaID		X	X	International unique code for taxa
Number		X	X	number of individuals for a given haul, length or sex category
WeightKg		X		Total weight in kg for the taxa in the haul
Sex			X	individuals sex category, N:not observed, I:undetermined, M:male, F:female
Length			X	length class of the individuals in cm

In addition to a description of the data, we propose a short critical analysis by comparing in particular the evolution of the specific richness on the whole series. These results are based on a bootstrap analysis using richness estimates from a random selection of stations and from 1000 permutations (R specaccum function from vegan 2.5.6 library, Oksanen et al 2019, R Core Team 2019).

3 Data availability

The updated EVHOE dataset is provided on the SEANOE platform (Laffargue et al. 2021, https://doi.org/10.17882/80041) which includes automatic duplication to the EMODnet marine data portal (https://www.emodnet-ingestion.eu). The raw collected data were currently banked on an IFREMER's internal general database (Harmonie) collecting in a standardized way the whole data flow of IFREMER fisheries information system (https://sih.ifremer.fr/Donnees). Moreover, the data were annually reported to the ICES database DATRAS (http://www.ices.dk/marine-data/data-portals/Pages/DATRAS.aspx).

4 Discussion: dataset content & quality

The EVHOE series dataset offers a standardized observation of all bentho-demersal ichthyofauna, cephalopods species and some large invertebrates for a long-term series of 32 and 22 years for the Bay of Biscay and Celtic Sea respectively. This survey series inventoried a total of 658 marine taxa (Fig. 3A). The proposed dataset includes

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250 "fishes" (including 34 elasmobranchs, Fig. 3C) and 50 "commercial" invertebrates species (mainly cephalopods and some crustaceans, gastropods and bivalvia, Fig. 3B-D) but does not include the 408 taxa of others non-commercial invertebrates ("benthos") recently inventoried (from 2008 onwards). In the complete dataset for both the Bay of Biscay and the Celtic Sea, pelagic fish largely dominate the catches both in number and biomass (Fig. 4) with 6 main species (*Capros aper, Trachurus trachurus, Micromesistius poutassou, Scomber scombrus, Engraulis encrasicolus and Sardina pilchardus*) and this even if the trawl used does not target and presents a very relative efficiency for this compartment. Among the demersal fish for the whole series of data, 3 species (*Merluccius merluccius, Trisopterus minutus, Trisopterus luscus*) largely dominated the catches in the Bay of Biscay, in the Celtic Sea the pout (*T.minutus*) is also among the main species but this area stands out with the dominance of *Trisopterus esmarkii*, haddock (*Melanogrammus aeglefinus*) and whiting (*Merlangius merlangus*).
However, the complete biological dataset, particularly for the Bay of Biscay (1987-present), should be considered with caution. The change of vessel in 1996 and the intercalibration work has shown significant differences in the catchability of the gears for some of the species caught. A number of conversion parameters between the 2 research vessels were proposed (Pelletier, 1998) but they do not cover all the species observed. Moreover, some species are poorly captured by the gear used (*e.g.* burrowing crustaceans like *Nephrops*, or flatfishes like *Solea solea*) or the sampling strategy does not correctly reflect their distribution for part or all of their life history (*e.g.* species with juvenile in shallow water nurseries). The low sampling effort in the shallowest areas (strata 1) in comparison with the diversity of habitats and associated communities makes the description of benthic communities by this dataset unreliable in this strata.
Observed total species richness varies among year and main areas with three main periods (Fig. 5A-B): years 1987 to 1990 with a lower richness, years 1992 to 2000 with intermediate values and highest values for the years after 2000 (with the exception of a low value in 2003). The similarity of the species list within these years groups is also stronger (see cluster results for the years, Fig. 5C-D). Although at the survey level an evolution of the sampling strategy may account for differences in diversity (*e.g.* "apparition" of *Trisopterus esmarkii* in 1990 linked to the extension in the Celtic Sea), these variations can not only be attributed to a change in the sampling strategy or to a natural evolution of the monitored ecosystems. We can notice that there is greater variability in species richness during the first decade of the data series, particularly visible for the Bay of Biscay areas (Gs, Gn), with interannual variations that are sometimes very large despite an equivalent sampling effort per area. Overall, a « stabilisation » of the annual specific richness has been observed from the 2000s onwards, which mainly reflects a better consideration of all species and a reliability or stabilization of the taxonomic skills of the on-board teams. Diversity analysis or monitoring of a particular species must take into account possible observation deficiencies. For example, the species *Arnoglossus imperialis* is relatively less frequent in the initial part of the survey series (1987-1992) compared to the more recent period. This difference most probably comes from confusion with the closely related species *A. laterna*. Moreover, new taxonomic determination efforts increased the number of species considered as « commercial ones » (*e.g.* from 2010 onward 11 species added to the previously sepiolidae family).
A table provided in the appendix summarized the information about the taxa with identification issues or improvements that occurred during the EVHOE time series.
Moreover, difficulties of identification for some rare species or including not very obvious morphological criteria reduces the validity of this series for some taxa that should be considered with caution (Appendix A). Even if we do not explicitly propose a priori regrouping or modification of the dataset, some of those species should be

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considered for grouping for part or the whole time series according to the desired applications. However, the accuracy of the determination has globally increased and become more reliable over time. The stabilization of the sorting effort, the reduction of the work-load (*e.g.* sorting conveyor belts of the Thalassa 2) and the improvement of the sorting quality thanks to the support of the new computer tools but also the improvement of the quality of the species determination are important factors in the quality increase of the EVHOE series. This stabilization of quality is especially important for analysis and development of relevant indicators in a context of important changes in marine communities under the double effect of local or global anthropogenic pressures (*e.g.* fishing or climate).

The observation scale of EVHOE survey is particularly relevant for covering certain populations, fish stocks or even the biogeographical dimension for certain monitored species. These data are already valued in an operational framework to provide useful indices for fish stock assessment (IFREMER 2020, ICES 2020, Tab.1) or for the assessment of marine ecosystems as developed, for example, for the European Marine Strategy Framework Directive (MSFD, EC, 2008 ; EC, 2017) or in the OSPAR Convention (OSPAR, 2017). The environmental status of fish biodiversity or fisheries resources is assessed from common indicators using EVHOE data (Brind'Amour & Delaunay, 2018 ; Foucher & Delaunay, 2018). Under the MSFD implementation, the EVHOE scientific survey integrates the monitoring program due to standardised methods for monitoring, including spatial and temporal sampling strategies (EC, 2020 ; France, 2015). These data are used to calculate an abundance indice to fill the D1C2 criterium relative to the abundance of fish population. Time series of the indice are analyzed to describe the ecological status of the demersal fish group. It guides the definition of environmental objectives and measures program to achieve or maintain good environmental status of French marine ecosystems. Differents parameters collected during EVHOE were used to evaluate other criteria as D1C3 relative to demographic characteristics or D1C4 relative to geographical distribution of fish population. In another framework, OSPAR Convention aims to achieve a network of well-managed marine protected areas which is ecologically coherent. The quality status of the North-East Atlantic is regularly assessed. EVHOE data were used to calculate different indicators as FC1 - Recovery in the population abundance of sensitive fish species, FC2 - Proportion of large fish (Large Fish Index) or FW3 - Size composition in fish communities (OSPAR, 2017).

We can also note the interest of the data produced to identify certain elements of the remarkable diversity that is all the more appreciable with the improvement in the quality of species determination. In particular, the detection of rare or new species in the study area are valuable data for characterizing regional biodiversity and judging the evolution of continental shelf communities.

The strength of this series also lies in the additional data (hydrological, other biological compartments) acquired simultaneously and offering an increasingly complete panorama of the ecosystems of the continental shelves in the fall period. These additional observations, which are sometimes relatively recent, are processed independently of this dataset and will be the subject of subsequent publications.

5 Table caption

Table 1: List of stocks monitored by EVHOE survey

Table 2: Chronology of the main features of the data acquisition survey IBTS-Q4-EVHOE

Table 3: Description of sampling strata for IBTS-Q4 Evhoe.

Table 4: Description of data tables and associated fields

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6 Figure caption

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Figure 2: Distribution of stations sampled for the whole Evhoe time series, A. proportion by sampling months, B. proportion by sampling sectors for autumn survey (only for autumn months: 9,10,11,12). The black lines on both graphs indicates the total number of sampled stations by year.

Figure 3: Number of taxa observed for the whole time series, A. number per classes for all the taxa (including the benthos species), B. number per order for fishes taxa only, C. number per classes for commercial list of taxa only (standard evhoe protocole) and D. for "commercial invertebrates" taxa.

Figure 4: Abundance in number and biomass of the 10 main species observed in the Celtic Sea during EVHOE 1997-2018 and in the Bay of Biscay during EVHOE 1987-2018 for 4 main groups of species: Benthic Demersal Actinopterygii, Pelagic Actinopterygii, Elasmobranchii and Commercial invertebrates.

Figure 5: Boxplots of the fish taxa richness as obtained from bootstrap analysis of the sampling station richness. The colors indicates the clusters depending on years similarities. Analysis is separately performed for the Bay of Biscay and the Celtic Sea for the whole available time series

References

Baudrier J., Lefebvre A., Galgani F., Saraux C. and Doray M.: Optimising French fisheries surveys for marine strategy framework directive integrated ecosystem monitoring . *Marine Policy* , 94, 10-19 . https://doi.org/10.1016/j.marpol.2018.04.024, 2018

Brind'Amour A. and Delaunay D. : Evaluation de la composante de l'écosystème « Poissons et céphalopodes » du descripteur 1 « Biodiversité » en France métropolitaine. Rapport scientifique de l'Ifremer pour l'évaluation 2018 au titre de la DCSMM. R.RBE/EMH-2018-01 . https://archimer.ifremer.fr/doc/00458/57007/, 2018

European Commission (EC).: Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environment policy (Marine Strategy Framework Directive. Official Journal of the European Union, 25.6.2008 L 164: 19–40, 2008

European Commission (EC).: Commission Decision (EU) 2017/848 of 17 May 2017 laying down criteria and methodological standards on good environmental status of marine waters and specifications and standardised methods for monitoring and assessment, and repealing Decision 2010/477/EU, 2017

European Commission (EC).: Reporting on the 2020 update of Article 11 for the Marine Strategy Framework Directive (MSFD Guidance Document 17). Brussels. Pp 51., 2020

Foucher E. and Delaunay D. : Evaluation du descripteur 3 « espèces exploitées à des fins commerciales » en France métropolitaine. : Rapport scientifique pour l'évaluation 2018 au titre de la DCSMM - R.RBE/HMMN/RHPEB-2018-01 . https://archimer.ifremer.fr/doc/00458/57009/, 2018

France. : Arrêté du 28 avril 2015 relatif aux critères et méthodes pour l'élaboration et la mise en œuvre du programme de surveillance du plan d'action pour le milieu marin. JORF n°0103 du 3 mai 2015, p7667. DEVL1425248A., 2015

ICES.: Report of the Workshop for maturity staging chairs (WKMATCH), 11–15 June 2012, Split, Croatia. ICES CM 2012/ACOM:58. 57 pp., 2014

ICES. : Manual of the IBTS North Eastern Atlantic Surveys - Version 4.0 - IBTSWG. Series of ICES survey protocols - SISP 15 - http://doi.org/10.17895/ices.pub.3519, 2017

ICES.: Working Group on Cephalopod Fisheries and Life History (WGCEPH). Volume 2 / Issue 46 - http://doi.org/10.17895/ices.pub.6032, 2019

ICES.: "Dataset collections" portal of the ICES. https://ices.dk/data/dataset-collections, 2020

Ifremer. Population and community indices derived from scientific surveys carried out by Ifremer. http://www.ifremer.fr/SIH-indices-campagnes (11/05/2020), 2020

Laffargue P., Delaunay D., Badts V., Berthele O., Cornou A.-S., Garren F.: **Long term benthic community dataset for fish and cephalopods on the continental shelves of the Bay of Biscay and the Celtic Sea**. SEANOE. https://doi.org/10.17882/80041, 2021

Lesbats Stephane, Garren Francois. : Tutoriel vidéo campagne halieutique - chalutage. https://image.ifremer.fr/data/00624/73617/, 2019a

Lesbats Stephane, Garren Francois, Le Roy Didier. : Tutoriel vidéo campagne halieutique - fonctionnement de la salle de tri du N/O Thalassa. https://image.ifremer.fr/data/00624/73650/, 2019b

Leblond, E., Daures, F., Berthou P., Dintheer C.: The Fisheries Information System of Ifremer: a multidisciplinary monitoring network and an integrated approach for the assessment of French fisheries, including small-scale fisheries. ICES 2008 Annual Science Conference, 22-26 september 2008, HALIFAX, CANADA., 2008

Mahe J.-C. and Poulard J.-C. : Manuel des protocoles de campagne halieutique. Campagnes EVHOE (EValuation des ressources Halieutiques de l'Ouest Europe). DSTH/LBP/05-xxx. https://archimer.ifremer.fr/doc/00036/14707/, 2005

Moriarty M., Sethi S. A, Pedreschi D., Smeltz T. S., McGonigle C., Harris B., Wolf N., Greenstreet S. P. R..: Combining fisheries surveys to inform marine species distribution modelling. ICES Journal of Marine Science 77(2): 539-552., 2020

Oksanen J., Blanchet F. G., Friendly M., Kindt R., Legendre P., McGlinn D., Minchin P.R., O'Hara R. B., Simpson G.L., Solymos P., H. Stevens M.H., Szoecs E. and Wagner, H. vegan: Community Ecology Package. R package version 2.5-6. https://CRAN.R-project.org/package=vegan, 2019

OSPAR.: Summary Status of the OSPAR Network of Marine Protected Areas (2016). Intermediate Assessment 2017. Available at: https://oap.ospar.org/en/ospar-assessments/intermediate-assessment-2017/biodiversity-status/marine-protected-areas/, 2017

Pelletier D.: Intercalibration of research survey vessels in fisheries: a review and an application . *Canadian Journal Of Fisheries And Aquatic Sciences* , 55(12), 2672-2690 . https://doi.org/10.1139/cjfas-55-12-2672, 1998

Poulard, J.-C. and Blanchard F.: "The impact of climate change on the fish community structure of the eastern continental shelf of the Bay of Biscay." ICES Journal of Marine Science 62(7): 1436-1443,2005

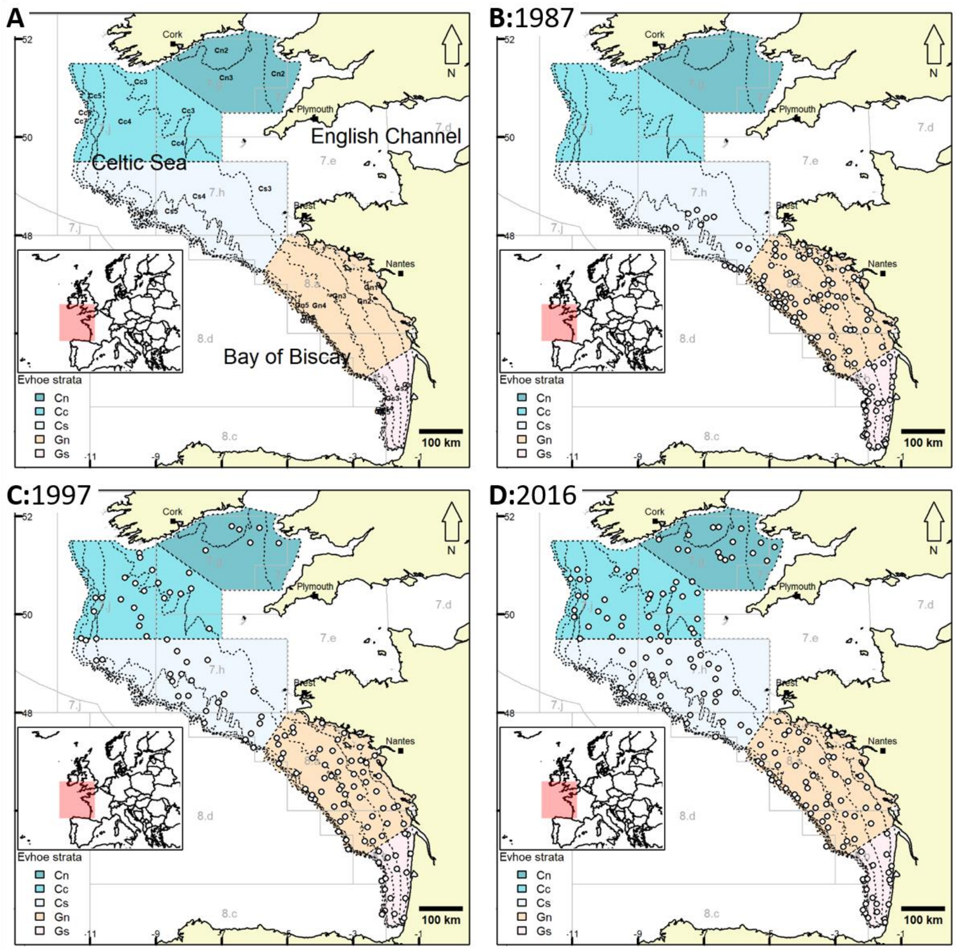
R Core Team. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/., 2019

Rochet, M.-J., Trenkel V., Bellail R., Coppin F., Le Pape O., Mahe J.-C., Morin J., Poulard J.-C., Schlaich I. and Souplet A.: "Combining indicator trends to assess ongoing changes in exploited fish communities: diagnostic of communities off the coasts of France." ICES Journal of Marine Science 62(8): 1647-1664, 2005

https://doi.org/10.5194/essd-2021-146
Preprint. Discussion started: 13 July 2021

ICES.: International Bottom Trawl Survey Working Group (WGIBTS, https://www.ices.dk/community/groups/Pages/IBTSWG.aspx)

WoRMS Editorial Board.: World Register of Marine Species. Available from http://www.marinespecies.org at VLIZ. Accessed 2020-11-30. doi:10.14284/170, 2020



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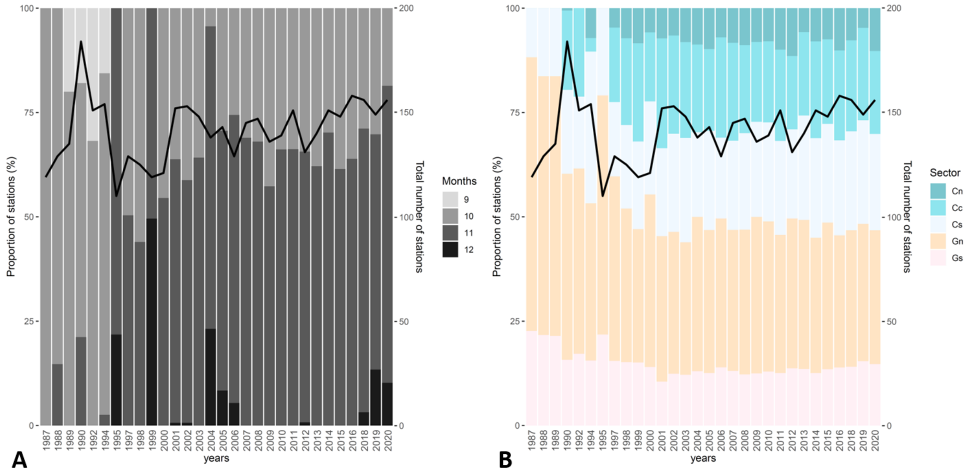

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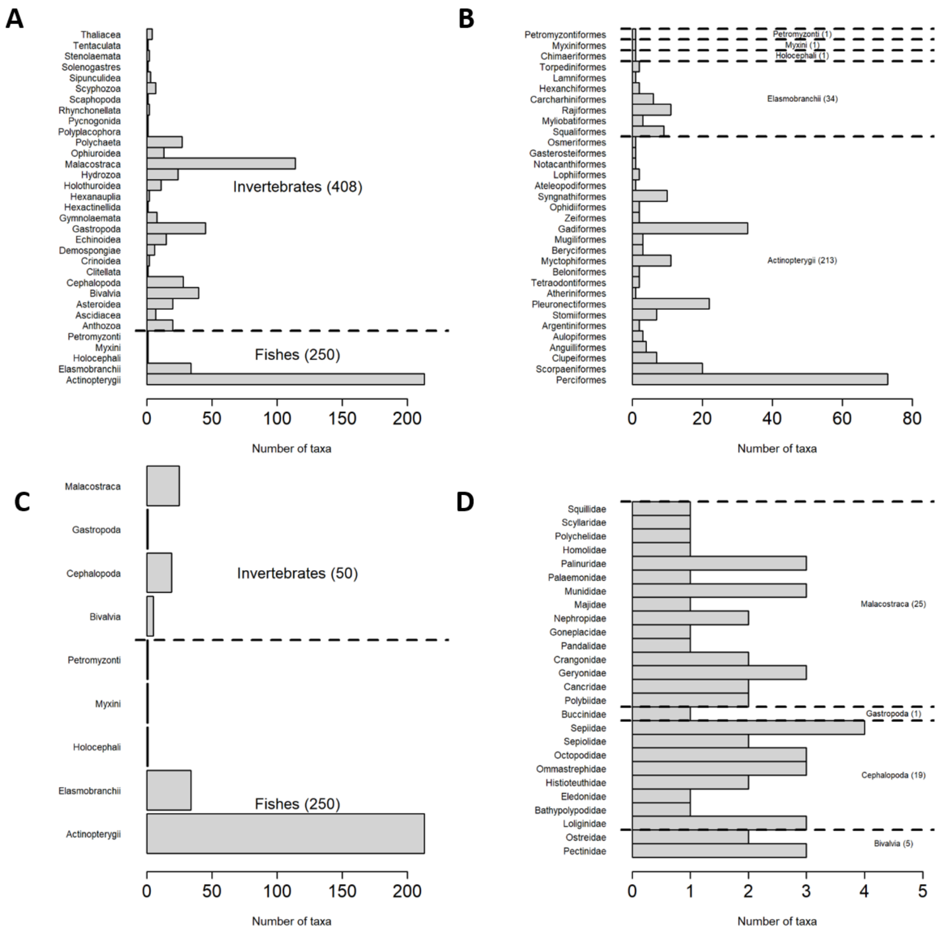

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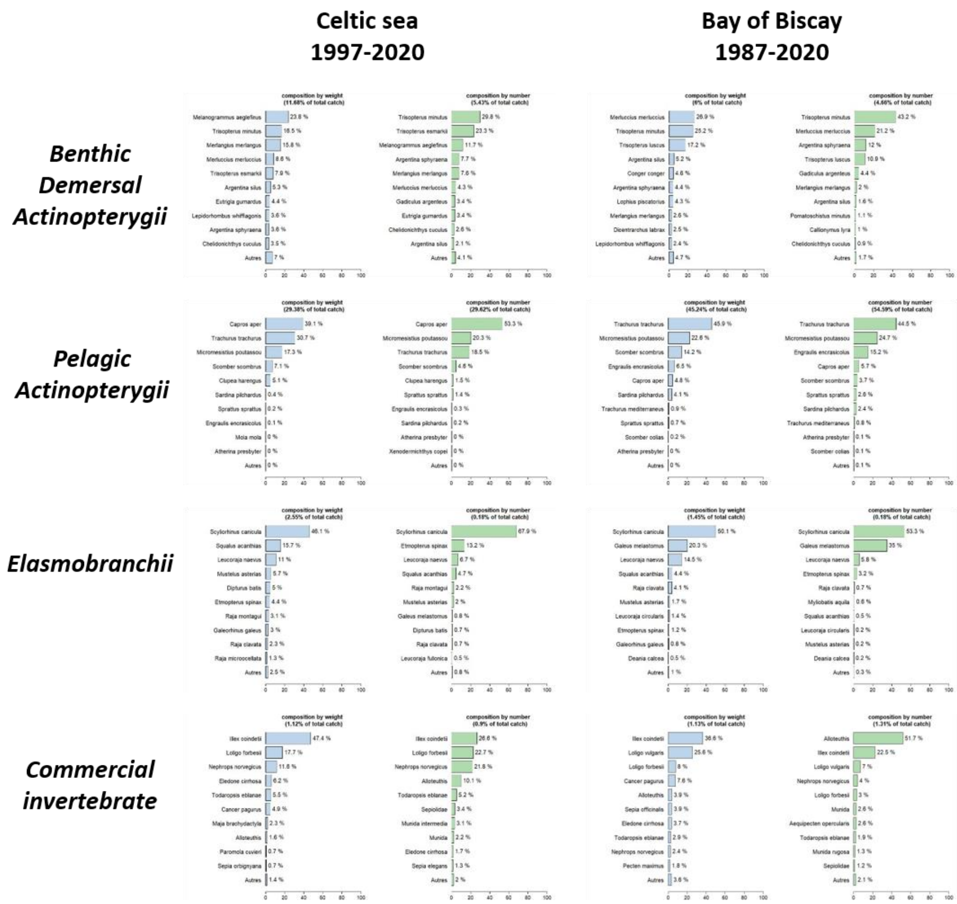

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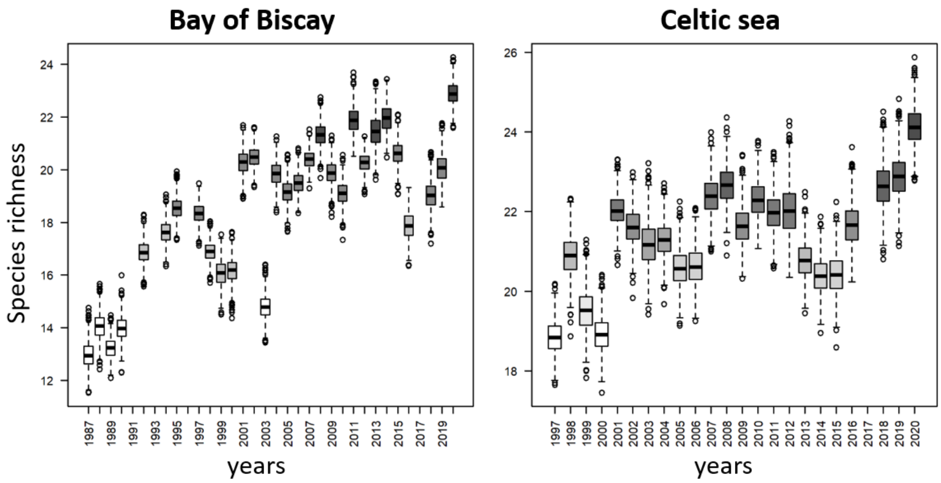

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7 Appendix

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Appendix A - List of species at risk of misidentification during all or part of the EVHOE time series.

Taxonomic group	Dominant species	Rarer species	Comments
Malacostraca	*Munida intermedia, M. rugosa*	*M. rutllanti*	species only considered at the genus level at the beginning of the series. Identification at species level from 2007 onward simultaneously with the development of the observation of the "Benthos"; rarer species remain less easily detectable and identifiable on board
Cephalopoda	*Loligo forbesii, L. vulgaris, Alloteuthis spp.*		Not easy identification between young individuals of the genus Loligo or even with the Alloteuthis which leads to errors during the whole series.
	Sepiolidae		Taken into account from 1995 onward but initially misidentified as « Sepiola or Sepiola atlantica » were regrouped into *Sepiolidae*. This family encompasses 11 species identified from 2010 onward. The small Rossiinae (large adult identified as *Rossia spp*) have generally been put into generic *Sepiolidae* by mistake before 2010.
	Rossia macrosoma	*R. palpebrosa*	Only large individuals identified as belonging to these taxa (the smaller ones confused with others *Sepiolidae*). *R.palpebrosa* only began to be determined in 2016.
Myxini		*Remora brachyptera, Remora remora*	Very rare, the presence of the 2 species is possible and confusions are possible
Holocephali	*Chimaera monstrosa,*	*Hydrolagus mirabilis*	Very deep species *H. mirabilis observed* only in 2004 but possible error
Elasmobranchii	*Deania calcea*	*D. profundorum*	*D. profundorum* only from 2010 with criteria provided by specialists (MNHN) but irregularity of identification still currently due to probable confusion.
	Dasyatis pastinaca	*D. tortonesei*	*D.tortonesei* identified only from 2015 with MNHN* expertise and more obvious criteria (criteria have been refined in 2019).
	Raja undulata, Raja microocellata		Raja microocellata more rare before 2000 due to probable confusion
	Raja montagui	*Raja bravhyura*	The criteria are difficult (even for specialists) and errors are possible especially before 2010 but still likely in recent years.
	Scyliorhinus canicula	*Scyliorhinus stellaris*	Sporadically identified at the beginning of the series, S.stellaris appears more frequent from 2010 which may show confusion between the 2 species.

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Taxonomic group	Dominant species	Rarer species	Comments
	Dipturus batis	*Dipturus cf intermedia*	Distinction of these 2 species only since 2017; they have always been grouped in *D. batis* before.
	Torpedo marmorata	***Torpedo nobiliana***	Confusion between these 2 species is very likely, only the name *T. marmorata* was used in the database until 2019.
Actinopterygii	*Alosa alosa, Alosa fallax*		Potential identification errors between both species on small individuals especially at the beginning of the series
	Ammodytes tobianus, Hyperoplus lanceolatus	*Ammodytes marinus, Gymnammodytes semisquamatus, Hyperoplus immaculatus*	Errors in identification have been frequent; new criteria have been implemented in 2019
	Argentina silus, A. sphyraena		For some part of the time series, the occurrence of *Argentina sphyraena* in the deeper area is doubtful. Small *A.silus* individuals may have been confused with *A.sphyraena*.
	Argyropelecus spp		Deep-sea species rarely caught - identifications sometimes made by specialists but likely errors during the series
	Arnoglossus imperialis, A. laterna	*A. thori*	Confusion with *A. thori* is unlikely, but confusion between *A. imperialis* and *A. laterna* may have existed during the series; the criteria have been refined since 2019.
	Callionymus lyra *C. maculatus*	*C. reticulatus*	Errors of identification have been frequent; the criteria have been refined since 2019.
	Coelorinchus caelorhincus	*Hymenocephalus italicus* *Nezumia aequalis* *Nezumia sclerorhynchus*	Possible misidentifications before 2017 between these rarely caught species with difficult identification criteria
	Diplodus spp		Rare taxa but potentially 4 species poorly identified
	Engraulis encrasicolus	*E. cf. albidus*	Although described in the study area but rare *E. albidus* not easily identified; criteria better defined since recent years but remains difficult to sort with very high abundances of the much more frequent *E. encrasicolus*
	Labrus bergylta, L. mixtus		species rarely caught and possible confusion during the whole time series

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Taxonomic group	Dominant species	Rarer species	Comments
	Lampanyctus crocodilus	*L. intricarius*	For these deep-sea species, the identifications were carried out by specialists few years but the series probably contains errors
		Liparis liparis *Liparis montagui*	To be considered with caution, species very rarely caught and difficult identification criteria.
	Molva molva, M. macrophthalma	*M. dypterygia*	Inversion of occurrence from the 2000s onwards in favour of *M.macrophthalma* due to a reduction of the identification error as compared to the beginning of the series especially with the improved identification supports and criteria between (*M. dypt.* and *M. macrophthalma*).
	Notoscopelus kroyeri	*N. caudispinosus, N. elongatus*	For these deep-sea species, the identifications were carried out by specialists.
	Pagellus spp		Errors of identification have been frequent, especially for young individuals; the criteria have been refined since 2018.
	Pomatoschistus minutus *Lesueurigobius friesii*	*P. lozanoi, P. norvegicus, P. pictus, Gobius paganellus*	The size of the individuals and the difficulties of identification make certain determinations unreliable, particularly of *P. minutus* (*e.g.* only 1 species of the genus *Pomatoshistus* before 2002).
	Scorpaena		Difficulties in identification lead to frequent errors. The species *Scorpaena elongata* is most probably mistakenly identified and has not been described in the Bay of Biscay from others studies.
	Syngnathus acus	*S. phlegon, S. rostellatus,* *S. typhle*	Identifications are difficult and errors are likely to occur during the data series; greater attention paid to these species after 2017.
	Trachurus trachurus	*T. mediterraneus, T. picturatus*	The sometimes very high abundance of horse mackerel in the catches and a consecutive important sub-sampling make the detection of closely resembling but rarer species more difficult.
	Trisopterus luscus, T. minutus	*T. esmarkii*	Absence of *T. esmarkii* especially before 1990 linked to defects of the sampling plan in relation to the distribution area of the species

* MNHN: Museum National d'Histoire Naturelle (*French* National *Museum* of *Natural History)*

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Dataset preparation and processing: V.Badts, O.Berthele, A.S.Cornou, P.Laffargue

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Competing interests

The authors declare that they have no conflict of interest.