

Pilot Assessment of Feeding Guilds



OSPAR

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OSPAR Convention

The Convention for the Protection of the Marine Environment of the North-East Atlantic (the “OSPAR Convention”) was opened for signature at the Ministerial Meeting of the former Oslo and Paris Commissions in Paris on 22 September 1992. The Convention entered into force on 25 March 1998. The Contracting Parties are Belgium, Denmark, the European Union, Finland, France, Germany, Iceland, Ireland, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Convention OSPAR

La Convention pour la protection du milieu marin de l’Atlantique du Nord-Est, dite Convention OSPAR, a été ouverte à la signature à la réunion ministérielle des anciennes Commissions d’Oslo et de Paris, à Paris le 22 septembre 1992. La Convention est entrée en vigueur le 25 mars 1998. Les Parties contractantes sont l’Allemagne, la Belgique, le Danemark, l’Espagne, la Finlande, la France, l’Irlande, l’Islande, le Luxembourg, la Norvège, les Pays-Bas, le Portugal, le Royaume- Uni de Grande Bretagne et d’Irlande du Nord, la Suède, la Suisse et l’Union européenne

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Key Message

Spatially extensive decreases in planktivore feeding guild biomass lower in the food web were evident in the North Sea and Bay of Biscay sub-divisions. In contrast, biomass of the pisco-crustivore and piscivore feeding guilds higher in the food web increased in the Celtic Seas region and Bay of Biscay sub-division.

Message clé

Des diminutions spatialement étendues de la biomasse de la guildes alimentaire planktivore située plus bas dans le réseau trophique étaient évidentes dans les sous-divisions de la mer du Nord et du golfe de Gascogne. En revanche, la biomasse des guildes alimentaires des pisco-crustivores et des piscivores, situées plus haut dans le réseau trophique, a augmenté dans la région des mers celtiques et la sous-division du golfe de Gascogne.

Background (brief)

Food web indicators can reveal how ecosystems are responding to environmental change and anthropogenic pressure in a way that cannot be inferred from studying habitat, species or assemblages alone. Systematic differences in response of typically smaller bodied organisms, feeding lower in the food web (planktivores) relative to those with bigger bodies that utilise different resources (benthivores, pisco-crustivores) and feed higher up the food web (piscivores), could profoundly alter the uptake of nutrients and the efficiency of communities in converting resources into biomass (i.e. ecosystem functioning which supports the provision of ecosystem services).

Inventories of trophic interactions have been collated worldwide, across biomes, and can be applied to infer food web structure and energy flow. Work presented here aimed to further develop a feeding guild indicator, as proposed by Garrison & Link (2000) and Thompson et al. (2020), which uses stomach contents information to group predators into common functional roles within the food web.

Stomach contents data were collated with support from EuroMarine. The newly collated dataset contains >23 000 unique predator-prey interactions from >1 250 000 fish stomachs from across the North Atlantic and Arctic Oceans. The data are used to demonstrate how feeding guilds (i.e. predator groupings based on their taxonomy, body size and diet) can be defined systematically and in a way that is conducive to their application internationally across ecosystems. These guilds are then applied to survey data collected from across the OSPAR Maritime Area to demonstrate observed changes in the relative dominance of key energy pathways that are critical to maintaining ecosystem structure and function.

Background (extended)

Natural food webs are made up of many complex interactions which are largely determined by the size of the interacting organisms because predators are systematically larger than their prey (Brose et al., 2019; Petchey et al., 2008; Woodward et al., 2005). The behaviour of organisms relating to their evolutionary history, including adaptations for specific habitats, also determines whether organisms interact. These properties can be used to predict food web structure and dynamics and categorise predators into functional feeding groups useful for ecosystem status assessment (Garrison and Link, 2000a, 2000b; Thompson et al., 2020). Yet size-, taxon- and diet information have not been synthesised in a marine ecosystem indicator to date because of the large number of observations needed to understand change in many species' diets through maturity. This issue is particularly pertinent for understanding and managing the impact of human activities on marine ecosystems where species distributions, body size, and thus interactions, are changing in response to fishing and climate change, for example (Hiddink and ter Hofstede, 2008; Kortsch et al., 2015;

Magurran et al., 2015; Perry et al., 2005; Simpson et al., 2011), with changes projected to continue worldwide (Cheung et al., 2013, 2009; Fernandes et al., 2020; Jones and Cheung, 2015; Queirós et al., 2018).

This FW7 Candidate Indicator shows a data-driven, reproducible approach to feeding guild assessment that incorporates predator and prey size and predator foraging (e.g. planktivory vs piscivory) that can be used to understand change in ecosystem structure and function across OSPAR Regions. This feeding guild indicator monitors change in the biomass and species richness of differing feeding guilds (currently comprised of fish and elasmobranch only) once individuals have been grouped by a common functional role within the food web. Contrasting directions of change in feeding guild biomasses and species richness demonstrates that there is both change in food web structure (i.e. a change in the distribution of biomass and species across the food web) and functioning as the relative importance of different energy pathways is altered.

Assessment Method

Guild classification

Stomach contents data

The candidate indicator draws together stomach contents data primarily collected from the North Atlantic shelf seas, with important contributions from the Norwegian and Barents Seas in the Arctic Ocean (Figure a). These data come from a combination of previously published and unpublished sources, including DAPSTOM (Pinnegar, 2019), ICES Year of the Stomach (ICES, 1997; www.ices.dk/marine-data/data-portals/Pages/Fish-stomach.aspx), and contributions from NOAA and URI (USA), IEO, CSIC-ICM and CSIC-IIM (Spain), SIME and SLU (Sweden), MFRI (Iceland), IMR (Norway), Ifremer (France), BSS and LKN.SH (Germany; FishNet, <https://www.nationalpark-wattenmeer.de/wissensbeitrag/fishnet/>). The data contain >2m observations from >1.2m stomach samples. After removing samples collected from freshwater and those with missing predator or prey taxonomy, predator size, location or time information, there were a total of 682457 unique stomach samples, representing 14049 unique interactions between 227 predator species and 2157 prey taxa.

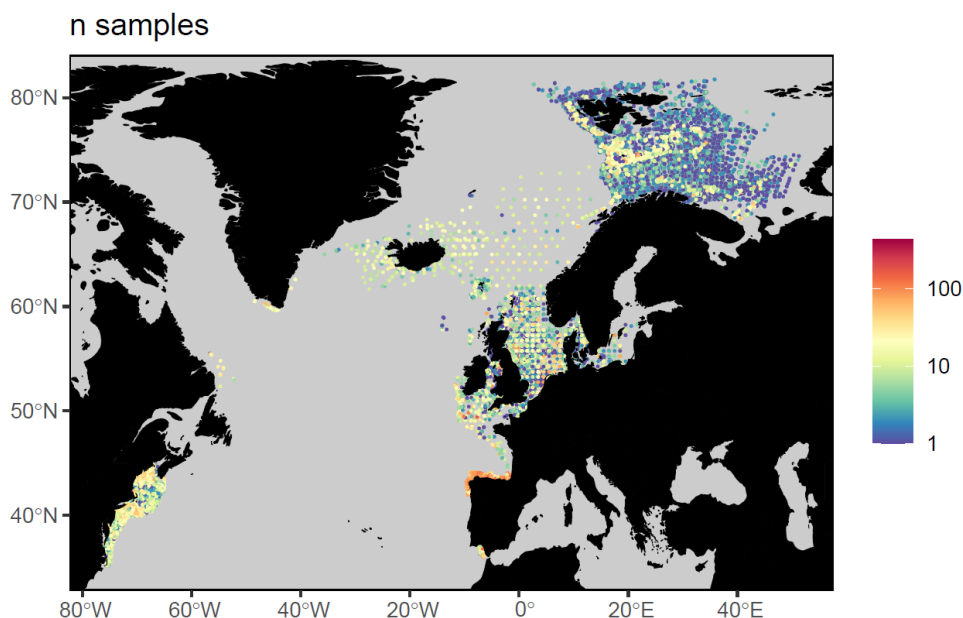


Figure a: Number of stomach samples per haul and haul locations.

Predator categories

Predators were categorised by taxa (typically species) and size. 20 equal size bins were used to categorise predator mass along a Log₁₀ transformed gradient from 0.1 micrograms to 190 tonnes (i.e. capable of capturing organisms from plankton to blue whales). Data for each predator (i.e. taxa size class) was then

estimated across all available samples, with means calculated for % (e.g. relative prey biomass) and continuous data (e.g. prey individual mass).

Prey counts, biomass and predator-prey mass ratio

Prey counts and biomass (wet weight in grams) were available for 55% of the stomach contents data used here. Where prey biomass was unavailable, mean individual prey mass was estimated using linear mixed effects models. Models of predator-prey body mass scaling can be improved by incorporating species traits (Brose et al., 2019). Species-resolved information is valuable when managing fish populations, so fish taxonomy and prey traits (i.e., their functional group; zooplankton, benthos, fish, nekton or other) were applied to improve model fit. Log₁₀ transformed prey biomass (g) was fit as the response, with log₁₀ transformed predator body mass (g), predator species and prey functional group combinations (e.g. cod-zooplankton, cod-benthos, cod-fish and sprat-zooplankton.) as predictors, with an interaction term between predator body mass and predator species and prey functional group combinations. And because prey biomass is reported as the sum of all prey for a given prey taxa, often alongside a count of individuals in the stomach contents data, prey count was fit as an offset in the model. Random intercepts were used for different datasets (e.g., Dapstom and ICES Year of the Stomach), years, sites (a 3 by 3 grid based on latitudinal and longitudinal gradients, each split into 3 equal lengths), sample ID (i.e., identifying all unique samples), and the number of stomachs sampled (some stomach samples contained in Dapstom and ICES Year of the Stomach were pooled when processing). The Akaike information criterion (AIC) was used on nested models to assess the importance of all predictors. The full model had the lowest AIC by >2 units meaning all predictors were retained. Predictions of mean individual prey mass were then multiplied by their counts to give prey biomass per stomach sample where prey biomass data were missing. Where there were no observations of prey biomass for unique predator species and prey functional group combinations (e.g., an interaction was observed but only documented with prey count information), or predictions had relatively high standard error (above or below 10%, e.g., where there were few observations) a model was used with the predator species and prey functional group moved to the random effects, with random slopes for each predator species and prey functional group combination, to predict mean individual prey mass. Where prey counts were unavailable, observed prey biomass was divided by mean individual prey mass, as estimated above. Results from the models are provided in the FW7 CEMP alongside model summary tables to demonstrate model performance.

The scaling relationship between predator and prey mass, often measured using predator-prey mass ratios (henceforth PPMR), constrains energy flow through ecosystems (Barnes, Maxwell, Reuman, & Jennings, 2010; Brose et al., 2008; Brose, Williams, & Martinez, 2006; Schneider, Scheu, & Brose, 2012; Trebilco, Baum, Salomon, & Dulvy, 2013). High PPMRs, where predators typically have many weak interactions by feeding on relatively small prey, help to maintain stability in food webs (Blanchard et al., 2011; Brose et al., 2006; McCann et al., 1998; Otto et al., 2007; Rooney et al., 2006) and ecosystem functioning (Schneider et al., 2016, 2012; Wang and Brose, 2018) because they dampen strong oscillatory dynamics. As such, high PPMR interactions can help mitigate perturbations from climate change, among other stressors (Binzer et al., 2016). PPMR estimates show significant inter-species variation due to differing foraging strategies (Scharf et al., 2000), such that change in species composition can be the biggest driver of change in community-wide PPMR (Reum et al., 2019). Systematic change in predators with relatively high PPMRs in response to anthropogenic pressure would therefore be useful to detect to better understand how changes in feeding guilds may affect ecosystem functioning. Biomass weighted PPMR was estimated (after Reum et al., 2019) for each taxa size class.

Cluster analysis

Guilds were assigned in R version 4.02 using the stats package (R Core Team, 2020) and based on cluster analysis using the 'ward D2' agglomeration method on Bray-Curtis dissimilarities between predator diets. Dissimilarities were based on log₁₀ transformed mean individual prey mass (g), log₁₀ transformed mean biomass weighted PPMR and the mean % biomass contribution of zooplankton (including fish <0.5g),

benthos, nekton (other than fish) and fish. All variables were rescaled to values of or between 0 and 1. Prey were assigned to functional groups after Webb & Vanhoorne (Webb and Vanhoorne, 2020) using the “worrms” package (Chamberlain, 2019).

A relatively simple set of feeding guilds was used ($n = 4$) in order to elegantly capture a broad set of ecosystem components while also explore change in both feeding guild biomass and their species richness in the survey data. This also corresponds with MSFD guidance which calls for four guilds relevant for fish to be defined: planktivores, pelagic and demersal sub-apex predators and apex predators. The cluster-based method performed better than when predators were randomly assigned to guilds. Multiple distinct feeding guilds can therefore be robustly categorised even where small subsets of predator stomach contents are considered (i.e., $n = 30$ stomach samples; see CEMP Guideline: Combined guideline for processing of survey data for fish and food webs common indicators FC2, FC3, FW3 and FW7 (Agreement 2018 - 05)). Predators with fewer than 30 samples have not been classified into guilds.

Changing the number of feeding guilds could be justified, depending on the question, and would be straightforward to implement by taking a different level in the classification tree following Thompson et al. (2020). This is seen as a strength in the candidate indicator approach because feeding guilds are hierarchically structured much like how taxonomic or other trait information has been organised. A table which details the branches from two to five feeding guilds has been provided so that future assessments could choose the level of complexity that suits the needs of the assessment. And, because it is a data-driven, reproducible approach, new information can be systematically integrated to 1) further resolve the number of feeding guilds that can be confidently characterised, 2) their composition and 3) test if seasonal to annual changes in feeding behaviour provides evidence for dynamical classifications.

Spatial and temporal change in feeding guild responses

This is a trend-based assessment. Analysing feeding guild biomass provides simultaneous information on ecosystem structure and functioning, e.g., by revealing areas of high planktivore biomass (structure) which is also indicative of high energy flux between plankton and fish (functioning). Change in feeding guild species richness provides a measure of functional redundancy where, e.g., relatively low or decreasing feeding guild species richness indicates low or decreasing functional redundancy.

The new feeding guild classifications have been applied to processed otter trawl survey data for the Northeast Atlantic shelf seas collected between 1997–2020 (Lynam and Ribeiro, 2022) to reveal spatial and temporal change in the distributions of feeding guild biomass and species richness. Compared with quarter 2 and 3, data from quarters 1 and 4 typically have longer time-series available over much of the study region and so were preferentially selected. Where data from quarters 1 or 4 were not available, otter trawl data from other quarters were used. Table a provides information on the surveys used and their spatial and temporal ranges. The temporal assessment covers 1997-2020 because the majority of the surveys considered have at least a near complete time-series covering that period. Longer time-series do exist for some surveys but including these data would mean looking at long-term change for some areas, but short-term change for others which could confound interpretation.

Spatial gradients and temporal change in the distribution of feeding guild biomass and their species richness were determined for many groundfish surveys carried out across four separate Regions: Greater North Sea, Celtic Seas, Bay of Biscay and Iberian Coast, and the Wider Atlantic (Table a). The strata used here replicate those used for the common food web indicators FC3 and FW3 (Agreement 2018 - 05). Ecological subdivisions were determined for the Greater North Sea using a simplification of those strata proposed by the European Union financed project Towards a Joint Monitoring Programme for the North Sea and Celtic Sea (JMP NS / CS) that took place in 2013, and building upon work in the European Union VECTORS project (Vectors of Change in European Marine Ecosystems and their Environmental and Socio-Economic Impacts) that examined the significant changes taking place in European seas, their causes, and the impacts they will have

on society. In other OSPAR Regions, the strata from the survey design were considered appropriate to represent the ecological subdivisions.

The candidate feeding guild indicator classified 92% of the surveyed biomass which included 120 taxa size classes. However, many rare taxa size classes observed in the survey data (n = 366, representing 8% of the surveyed biomass) remain unclassified due to insufficient stomach contents data. The perspective of change is therefore weighted towards predators contributing most to community biomass and ecosystem functioning. Pearson’s correlation coefficients were used to identify areas of significant temporal change in feeding guild responses per strata. The process of defining feeding guilds, assigning them to survey data and analysing spatial and temporal change in their biomass and species richness are illustrated in Figure b. Haul-level estimates of feeding guild biomass and their species richness have been provided.

Table a: Otter trawl surveys, the Region in which they operate, the period over which they have been undertaken and the number of unique hauls (n).

Survey acronym¹	OSPAR region¹	Quarter¹	Years	n
BBICFraOT4	BBIC	4	1997-2020	1693
BBICnSpaOT4	BBIC	4	2011-2018	902
BBICPorOT4	BBIC	4	2005-2018	1045
BBICsSpaOT1	BBIC	1	2000-2020	673
BBICsSpaOT4	BBIC	4	2002-2020	691
CSFraOT4	CS	4	1997-2020	1180
CSIreOT4	CS	4	2003-2020	2353
CSNirOT1	CS	1	2008-2020	756
CSNirOT4	CS	4	2009-2020	698
CSScoOT1	CS	1	1997-2020	1082
CSScoOT4	CS	4	1997-2020	1210
GNSFraOT4	GNS	4	1998-2020	1907
GNSIntOT1	GNS	1	1997-2020	8827
WAScoOT3	WA	3	1999-2020	701
WASpaOT3	WA	3	2006-2018	1019

1. Survey acronym convention: First 2 to 4 capitalised letters indicate the OSPAR Region (BBIC: Bay of Biscay and Iberian Coast; CS: Celtic Seas; GNS: Greater North Sea; WA – Wider Atlantic). Next capitalised and lowercase letters signify the country involved (Spa: Spain; Bel: Belgium; Por: Portugal; Fra: France; Eng: England; Ire: Republic of Ireland; Nir: Northern Ireland; Sco: Scotland; Ger: Germany; Int: International; Net: The Netherlands. International refers to the two international bottom trawl surveys carried out in the Greater North Sea under the International Council for the Exploration of the Sea (ICES). In the Bay of Biscay and Iberian Coast Region, Spanish surveys are further delimited by (n) for surveys operating in the northern Iberian Coast area and (s) for surveys operating in the southern Iberian Coast area. Next two capitalised letters indicate the type of survey (OT: otter trawl). Final number indicates the season in which the survey is primarily undertaken (1: January to March; 3: July to September; 4: October to December).

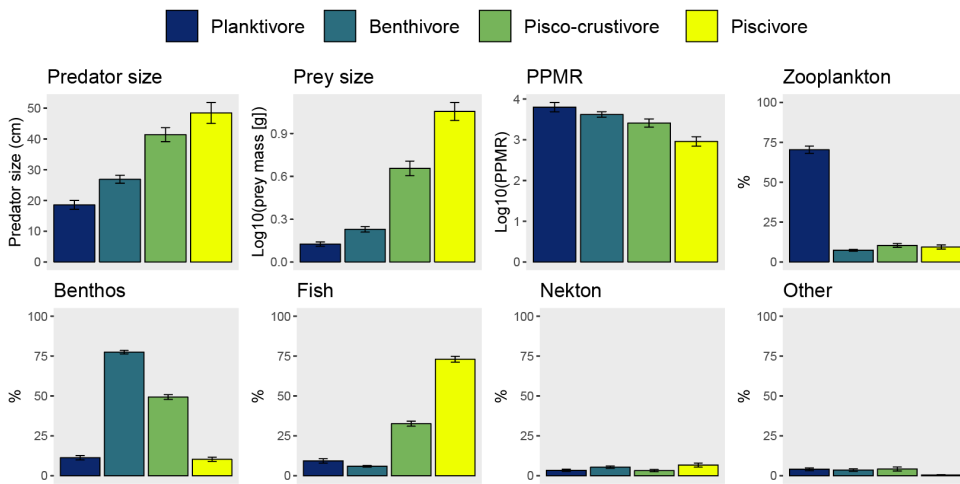


Figure 1: Differences between guilds in predator and prey size, predator-prey mass ratios (PPMR), and % biomass contribution of different prey functional groups. Values are based on means taken across taxa size classes. Error bars represent standard error.

Table 1: Taxa, size bin (Agreement 2018 - 05), feeding guild (Plank = planktivore, Benth = benthivore, P-crust = pisco-crustivore, Pisc = piscivore), minimum and maximum predator sizes (cm) per size bin, and the distribution of stomach samples by taxa size class (n) in the newly compiled stomach contents dataset and which are observed in the survey data.

Taxa	S. bin	Min cm	Max cm	Feeding guild	n
Ammodytes	11	7	14	Plank	144
Ammodytes	12	14	27	Plank	104
<i>Argentina silus</i>	13	20	36	Plank	145
<i>Argentina silus</i>	14	36	65	Plank	141
<i>Argentina sphyraena</i>	12	11	21	Plank	60
<i>Clupea harengus</i>	10	3	6	Plank	32
<i>Clupea harengus</i>	11	6	11	Plank	275
<i>Clupea harengus</i>	12	11	20	Plank	359
<i>Clupea harengus</i>	13	20	36	Plank	1605
<i>Clupea harengus</i>	14	36	67	Plank	202
<i>Echiichthys vipera</i>	12	9	17	Plank	383
<i>Engraulis encrasicolus</i>	12	11	21	Plank	72
<i>Etmopterus spinax</i>	12	13	24	Plank	184
<i>Etmopterus spinax</i>	13	24	44	Plank	240
<i>Gadus morhua</i>	10	3	5	Plank	625
<i>Gadus morhua</i>	11	5	10	Plank	2373
<i>Galeus atlanticus</i>	13	27	50	Plank	134
<i>Galeus melastomus</i>	12	14	27	Plank	1081
<i>Galeus melastomus</i>	13	27	51	Plank	1847
<i>Galeus melastomus</i>	14	51	96	Plank	712
Gobiidae	10	3	5	Plank	53
<i>Helicolenus dactylopterus</i>	11	5	8	Plank	64
<i>Hoplostethus mediterraneus</i>	12	8	15	Plank	35
<i>Hoplostethus mediterraneus</i>	13	15	27	Plank	48
<i>Hyperoplus lanceolatus</i>	12	15	28	Plank	295

<i>Lepidopus caudatus</i>	13	45	82	Plank	96
<i>Lepidorhombus whiffiagonis</i>	11	6	12	Plank	44
<i>Lepidorhombus whiffiagonis</i>	12	12	21	Plank	2388
<i>Lepidorhombus whiffiagonis</i>	13	21	38	Plank	8874
<i>Melanogrammus aeglefinus</i>	9	2	3	Plank	31
<i>Melanogrammus aeglefinus</i>	10	3	6	Plank	138
<i>Merlangius merlangus</i>	9	2	3	Plank	260
<i>Merlangius merlangus</i>	10	3	6	Plank	743
<i>Merlangius merlangus</i>	11	6	11	Plank	1422
<i>Merlangius merlangus</i>	12	11	20	Plank	29299
<i>Merluccius merluccius</i>	11	6	11	Plank	498
<i>Merluccius merluccius</i>	12	11	21	Plank	9093
<i>Micromesistius poutassou</i>	12	12	21	Plank	3054
<i>Micromesistius poutassou</i>	13	21	38	Plank	4373
<i>Sardina pilchardus</i>	13	19	35	Plank	110
<i>Scomber scombrus</i>	12	11	19	Plank	480
<i>Scomber scombrus</i>	13	19	35	Plank	11519
<i>Scomber scombrus</i>	14	35	64	Plank	5684
<i>Scophthalmus rhombus</i>	12	9	16	Plank	96
<i>Scyliorhinus canicula</i>	12	15	27	Plank	1223
<i>Sebastes norvegicus</i>	13	15	28	Plank	861
<i>Sebastes norvegicus</i>	14	28	53	Plank	901
<i>Sprattus sprattus</i>	11	6	11	Plank	652
<i>Sprattus sprattus</i>	12	11	21	Plank	322
<i>Trachinus draco</i>	13	20	37	Plank	193
<i>Trachurus trachurus</i>	12	10	19	Plank	268
<i>Trachurus trachurus</i>	13	19	36	Plank	2450
<i>Trachurus trachurus</i>	14	36	67	Plank	190
<i>Trisopterus esmarkii</i>	10	3	6	Plank	46
<i>Trisopterus esmarkii</i>	11	6	11	Plank	751
<i>Trisopterus esmarkii</i>	12	11	19	Plank	620
<i>Trisopterus esmarkii</i>	13	19	35	Plank	108
<i>Trisopterus minutus</i>	11	5	10	Plank	31
<i>Zeus faber</i>	11	4	8	Plank	40
<i>Zeus faber</i>	12	8	15	Plank	512
<i>Agonus cataphractus</i>	11	5	9	Benth	124
<i>Amblyraja radiata</i>	12	11	20	Benth	76
<i>Amblyraja radiata</i>	13	20	38	Benth	1465
<i>Anarhichas lupus</i>	12	12	21	Benth	431
<i>Anarhichas lupus</i>	13	21	36	Benth	1316
<i>Anarhichas lupus</i>	14	36	65	Benth	1127
<i>Anarhichas lupus</i>	15	65	114	Benth	490
<i>Arnoglossus imperialis</i>	12	11	19	Benth	38
<i>Arnoglossus laterna</i>	11	7	11	Benth	164
<i>Arnoglossus laterna</i>	12	11	20	Benth	150
<i>Callionymus lyra</i>	12	10	21	Benth	744

<i>Callionymus lyra</i>	13	21	44	Benth	1330
<i>Chelidonichthys cuculus</i>	11	6	10	Benth	74
<i>Chelidonichthys cuculus</i>	12	10	18	Benth	938
<i>Chelidonichthys cuculus</i>	13	18	33	Benth	3995
<i>Chelidonichthys lucerna</i>	13	17	33	Benth	911
<i>Chelidonichthys obscurus</i>	12	11	19	Benth	94
<i>Chelidonichthys obscurus</i>	13	19	35	Benth	511
<i>Chimaera monstrosa</i>	14	55	100	Benth	60
<i>Chimaera monstrosa</i>	15	100	183	Benth	51
<i>Ciliata mustela</i>	12	13	23	Benth	64
<i>Citharus linguatula</i>	12	11	20	Benth	156
<i>Conger conger</i>	12	21	36	Benth	641
<i>Dicentrarchus labrax</i>	12	10	18	Benth	39
<i>Dicentrarchus labrax</i>	13	18	33	Benth	144
<i>Enchelyopus cimbrius</i>	12	13	23	Benth	63
<i>Enchelyopus cimbrius</i>	13	23	42	Benth	86
<i>Eutrigla gurnardus</i>	11	5	10	Benth	31
<i>Eutrigla gurnardus</i>	12	10	19	Benth	6053
<i>Gadus morhua</i>	12	10	19	Benth	10464
<i>Gadus morhua</i>	13	19	34	Benth	47461
<i>Gaidropsarus macrophthalmus</i>	11	6	12	Benth	205
<i>Gaidropsarus macrophthalmus</i>	12	12	22	Benth	587
<i>Glyptocephalus cynoglossus</i>	13	22	38	Benth	68
<i>Helicolenus dactylopterus</i>	12	8	15	Benth	1329
<i>Hippoglossoides platessoides</i>	11	6	11	Benth	81
<i>Hippoglossoides platessoides</i>	12	11	20	Benth	1957
<i>Lepidorhombus boscii</i>	11	6	11	Benth	151
<i>Lepidorhombus boscii</i>	12	11	21	Benth	13160
<i>Lepidorhombus boscii</i>	13	21	37	Benth	14638
<i>Lepidorhombus boscii</i>	14	37	68	Benth	51
<i>Lepidotrigla cavillone</i>	11	5	9	Benth	49
<i>Lepidotrigla cavillone</i>	12	9	17	Benth	56
<i>Lepidotrigla dieuzeidei</i>	12	9	17	Benth	65
<i>Leucoraja naevus</i>	13	23	42	Benth	231
<i>Limanda limanda</i>	11	6	10	Benth	68
<i>Limanda limanda</i>	12	10	18	Benth	1119
<i>Limanda limanda</i>	13	18	33	Benth	3972
<i>Lumpenus lampretaeformis</i>	12	21	50	Benth	86
<i>Malacocephalus laevis</i>	12	15	28	Benth	32
<i>Melanogrammus aeglefinus</i>	11	6	10	Benth	357
<i>Melanogrammus aeglefinus</i>	12	10	19	Benth	10466
<i>Microchirus variegatus</i>	12	10	18	Benth	45
<i>Microstomus kitt</i>	12	10	18	Benth	94

<i>Microstomus kitt</i>	13	18	33	Benth	577
<i>Microstomus kitt</i>	14	33	60	Benth	583
<i>Mullus surmuletus</i>	12	9	17	Benth	163
<i>Mullus surmuletus</i>	13	17	30	Benth	887
<i>Mullus surmuletus</i>	14	30	55	Benth	66
<i>Nezumia aequalis</i>	12	13	25	Benth	74
<i>Pagellus acarne</i>	13	16	28	Benth	776
<i>Pagellus acarne</i>	14	28	51	Benth	614
<i>Pagellus erythrinus</i>	13	15	29	Benth	111
<i>Pagellus erythrinus</i>	14	29	54	Benth	121
<i>Phycis blennoides</i>	12	11	21	Benth	1199
<i>Phycis blennoides</i>	13	21	37	Benth	569
<i>Phycis blennoides</i>	14	37	66	Benth	92
<i>Platichthys flesus</i>	10	3	5	Benth	524
<i>Platichthys flesus</i>	11	5	10	Benth	120
<i>Platichthys flesus</i>	12	10	18	Benth	94
<i>Platichthys flesus</i>	13	18	33	Benth	1071
<i>Pleuronectes platessa</i>	11	5	10	Benth	359
<i>Pleuronectes platessa</i>	12	10	18	Benth	1835
<i>Pleuronectes platessa</i>	13	18	33	Benth	7216
<i>Pleuronectes platessa</i>	14	33	62	Benth	2075
<i>Pomatoschistus minutus</i>	11	6	10	Benth	64
<i>Raja clavata</i>	12	13	24	Benth	154
<i>Raja clavata</i>	13	24	43	Benth	1475
<i>Raja clavata</i>	14	43	77	Benth	3013
<i>Raja clavata</i>	15	77	138	Benth	638
<i>Raja montagui</i>	13	21	37	Benth	553
<i>Raja montagui</i>	14	37	65	Benth	1512
<i>Scophthalmus maximus</i>	11	5	9	Benth	141
<i>Scorpaena notata</i>	12	8	15	Benth	56
<i>Scorpaena notata</i>	13	15	27	Benth	34
<i>Serranus hepatus</i>	12	8	15	Benth	134
<i>Solea solea</i>	12	10	19	Benth	224
<i>Solea solea</i>	13	19	34	Benth	453
<i>Solea solea</i>	14	34	62	Benth	39
<i>Spondyliosoma cantharus</i>	13	16	29	Benth	112
<i>Trigla lyra</i>	12	10	19	Benth	731
<i>Trigla lyra</i>	13	19	35	Benth	568
<i>Trigla lyra</i>	14	35	66	Benth	29
<i>Trisopterus luscus</i>	12	9	17	Benth	812
<i>Trisopterus luscus</i>	13	17	31	Benth	3146
<i>Trisopterus luscus</i>	14	31	56	Benth	207
<i>Trisopterus minutus</i>	12	10	18	Benth	1510
<i>Trisopterus minutus</i>	13	18	32	Benth	883
<i>Urophycis chuss</i>	12	9	17	Benth	60
<i>Urophycis chuss</i>	13	17	31	Benth	2390

<i>Urophycis chuss</i>	14	31	59	Benth	2434
<i>Amblyraja radiata</i>	14	38	72	P-crust	2017
<i>Brosme brosme</i>	14	34	61	P-crust	94
<i>Chelidonichthys cuculus</i>	14	33	60	P-crust	67
<i>Chelidonichthys lucerna</i>	14	33	61	P-crust	299
<i>Conger conger</i>	13	36	63	P-crust	7539
<i>Conger conger</i>	14	63	110	P-crust	299
<i>Dicentrarchus labrax</i>	14	33	61	P-crust	45
<i>Eutrigla gurnardus</i>	13	19	35	P-crust	10341
<i>Gadus morhua</i>	14	34	64	P-crust	88031
<i>Helicolenus dactylopterus</i>	13	15	28	P-crust	1713
<i>Helicolenus dactylopterus</i>	14	28	52	P-crust	182
<i>Hippoglossoides platessoides</i>	13	20	35	P-crust	5343
<i>Hippoglossoides platessoides</i>	14	35	63	P-crust	506
<i>Hippoglossus hippoglossus</i>	13	19	35	P-crust	137
<i>Hippoglossus hippoglossus</i>	14	35	62	P-crust	166
<i>Leucoraja naevus</i>	14	42	73	P-crust	520
<i>Limanda limanda</i>	14	33	59	P-crust	240
<i>Melanogrammus aeglefinus</i>	13	19	35	P-crust	23072
<i>Melanogrammus aeglefinus</i>	14	35	64	P-crust	12683
<i>Melanogrammus aeglefinus</i>	15	64	118	P-crust	1134
<i>Pollachius pollachius</i>	13	19	35	P-crust	110
<i>Pollachius virens</i>	13	19	35	P-crust	724
<i>Scophthalmus maximus</i>	12	9	16	P-crust	103
<i>Scyliorhinus canicula</i>	13	27	49	P-crust	6584
<i>Scyliorhinus canicula</i>	14	49	88	P-crust	5808
<i>Spondyliosoma cantharus</i>	14	29	54	P-crust	171
<i>Squalus acanthias</i>	12	14	25	P-crust	55
<i>Amblyraja radiata</i>	15	72	137	Pisc	103
<i>Eutrigla gurnardus</i>	14	35	65	Pisc	476
<i>Gadus morhua</i>	15	64	118	Pisc	28208
<i>Gadus morhua</i>	16	118	217	Pisc	705
<i>Hippoglossus hippoglossus</i>	15	62	113	Pisc	42
<i>Hyperoplus lanceolatus</i>	13	28	53	Pisc	133
<i>Lepidorhombus whiffiagonis</i>	14	38	70	Pisc	545
<i>Lophius budegassa</i>	12	9	16	Pisc	168
<i>Lophius budegassa</i>	13	16	31	Pisc	216
<i>Lophius budegassa</i>	14	31	58	Pisc	371
<i>Lophius budegassa</i>	15	58	108	Pisc	61
<i>Lophius piscatorius</i>	12	8	15	Pisc	145
<i>Lophius piscatorius</i>	13	15	29	Pisc	1279
<i>Lophius piscatorius</i>	14	29	57	Pisc	682
<i>Lophius piscatorius</i>	15	57	112	Pisc	223
<i>Merlangius merlangus</i>	13	20	37	Pisc	61886
<i>Merlangius merlangus</i>	14	37	67	Pisc	4132

<i>Merluccius merluccius</i>	13	21	38	Pisc	7377
<i>Merluccius merluccius</i>	14	38	69	Pisc	2042
<i>Merluccius merluccius</i>	15	69	126	Pisc	58
<i>Molva macrophthalma</i>	12	17	31	Pisc	993
<i>Molva macrophthalma</i>	13	31	55	Pisc	131
<i>Molva macrophthalma</i>	14	55	98	Pisc	37
<i>Pollachius pollachius</i>	14	35	64	Pisc	38
<i>Pollachius virens</i>	14	35	65	Pisc	7197
<i>Pollachius virens</i>	15	65	122	Pisc	2015
<i>Pomatomus saltatrix</i>	13	18	34	Pisc	952
<i>Pomatomus saltatrix</i>	14	34	64	Pisc	849
<i>Scophthalmus maximus</i>	14	29	54	Pisc	2058
<i>Scophthalmus maximus</i>	15	54	98	Pisc	563
<i>Scophthalmus rhombus</i>	13	16	30	Pisc	219
<i>Scophthalmus rhombus</i>	14	30	56	Pisc	1111
<i>Squalus acanthias</i>	13	25	46	Pisc	3400
<i>Squalus acanthias</i>	14	46	85	Pisc	5463
<i>Squalus acanthias</i>	15	85	156	Pisc	358
<i>Zenopsis conchifer</i>	13	19	33	Pisc	72
<i>Zenopsis conchifer</i>	14	33	57	Pisc	48
<i>Zeus faber</i>	13	15	29	Pisc	944
<i>Zeus faber</i>	14	29	55	Pisc	625

Spatial and temporal change in feeding guild responses

There was clear spatial structure and regions of contrasting temporal change across feeding guilds and the various responses (Figure 2 and Figure 3). Planktivore biomass and species richness were generally highest off the northwest coast of Scotland, around the north and west coast of Ireland, in the Irish Sea and in the Bay of Biscay (French continental shelf). Benthivore biomass and species richness were highest in the north and west coast of Ireland, in the Irish Sea with relatively and uniformly high biomass across the North Sea and Bay of Biscay. Pisco-crustivore and Piscivore biomass and species richness generally increased moving west and north across the study area.

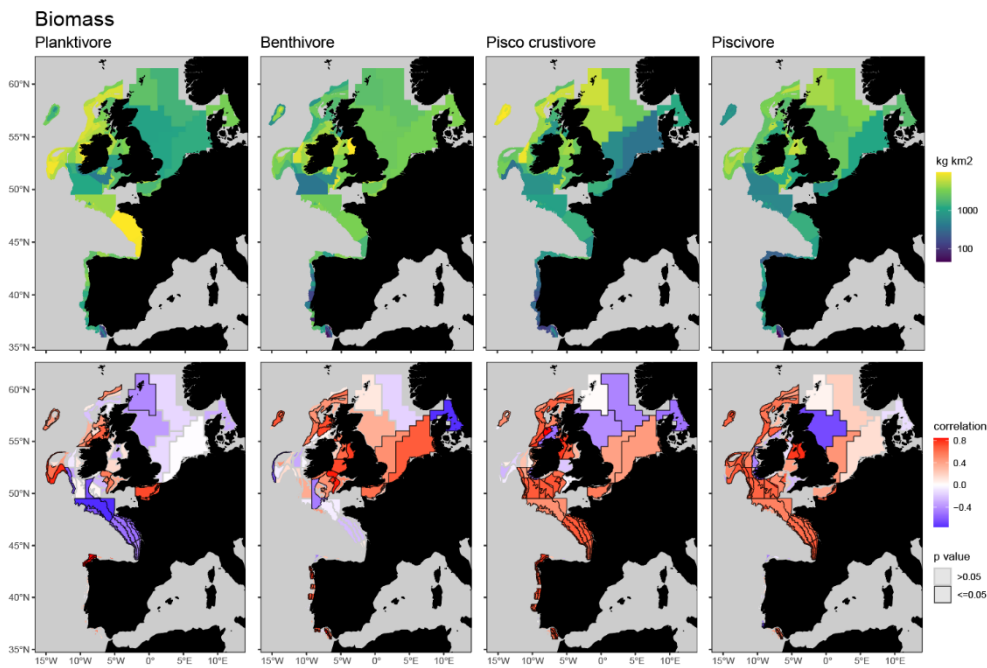


Figure 2: Mean spatial distribution (top row) and temporal change (bottom row) in feeding guild biomass by assessment strata based on otter trawl data. Temporal increases are shown by red cells (Pearson’s correlation values between 0 and +1) and declines in blue cells (correlation values between 0 and -1). Assessment strata where the temporal change (correlation) is significant are highlighted with black borders.

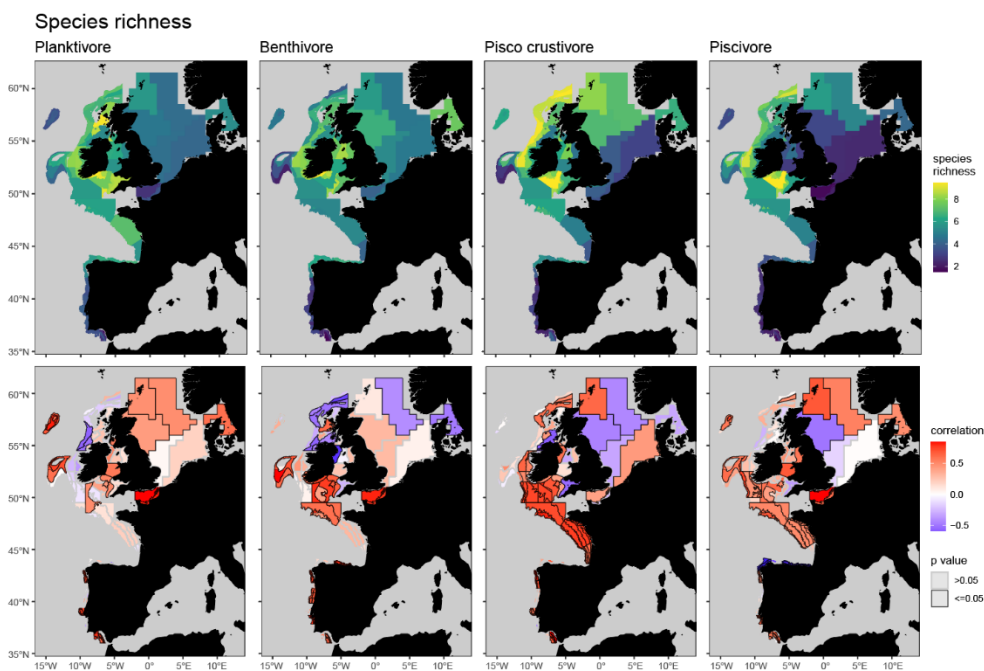


Figure 3: Mean spatial distribution (top row) and temporal change (bottom row) in feeding guild species richness by assessment strata based on otter trawl data. Temporal increases are shown by red cells (Pearson’s correlation values between 0 and +1) and declines in blue cells (correlation values between 0 and -1). Assessment strata where the temporal change (correlation) is significant are highlighted with black borders.

Temporal trends in planktivore responses showed declines in biomass in the Celtic Sea, Bay of Biscay and north-western North Sea, and increases in the English Channel, Bristol Channel, along the north western coast of Spain and in the northwest of the study region (Figure 2 and Figure 3). Increases in planktivore species richness were evident in patches along the west-facing Iberian coast, in the wider Atlantic, in the English Channel, around the south-eastern coast of Ireland, in the northern North Sea and in the Kattegat,

with more minor declines off the northwest coast of Ireland. Benthivore biomass was increasing in the Irish Sea, around the northwest coast of Scotland, in the wider Atlantic off Scotland, in the southern North Sea and eastern English Channel, with patchy increases along the west-facing Iberian coast. There were small scale and minor decreases in benthivore biomass in the Kattegat, south of Ireland and in the wider Atlantic to the west of Ireland. Benthivore species richness was increasing in the English Channel, south and west of Ireland, with decreases northwest of Scotland, in the northwest of the North Sea and in the Kattegat. Pisco-crustivores biomass and species richness were decreasing in the west and northeast of the North Sea, in the Kattegat and between Scotland and Northern Ireland but increasing over much of the rest of the study area. Piscivore biomass was increasing across much of the west of the study region from the Bay of Biscay to the northwest of Scotland, in the south-western North Sea and in parts of the Irish Sea and Gulf of Cadiz. Piscivore biomass was decreasing in the western North Sea and in the coastal region along the west coast of Ireland. Piscivore species richness was increasing in the north and north-eastern North Sea, in the Kattegat, English Channel, Irish Sea, wider Atlantic off Scotland over much of the Celtic Sea, with some patchy increases also off the west-facing Iberian coast. Piscivore species richness showed declines along the coast of northern Spain and in the western North Sea.

Conclusion (brief)

This pilot assessment shows that fish populations and their diversity are changing at different rates and even in different directions across the food web across OSPAR Regions. For instance, in the Bay of Biscay and Celtic Sea there were extensive temporal decreases in the biomass of consumers lower in the food web (planktivores) which contrasted with increases in those higher up (pisco-crustivores and piscivores). This demonstrates that the dominant energy pathways upon which species rely are already altering. Such changes could impact nutrient uptake and transfer efficiency across the food web, on feeding conditions for commercial fish species, higher predators (birds and mammals) and alter the extent of natural pressure on fish prey (e.g. plankton, benthos).

Knowledge Gaps (brief)

Taxa size classes observed in the surveys but not yet classified into feeding guilds because of insufficient stomach contents data. Maps showing where unclassified biomass and species are most prominent and changing through time are provided alongside a table to direct future stomach sampling towards those predators and areas currently under-sampled (Figure 4 and Table 2).

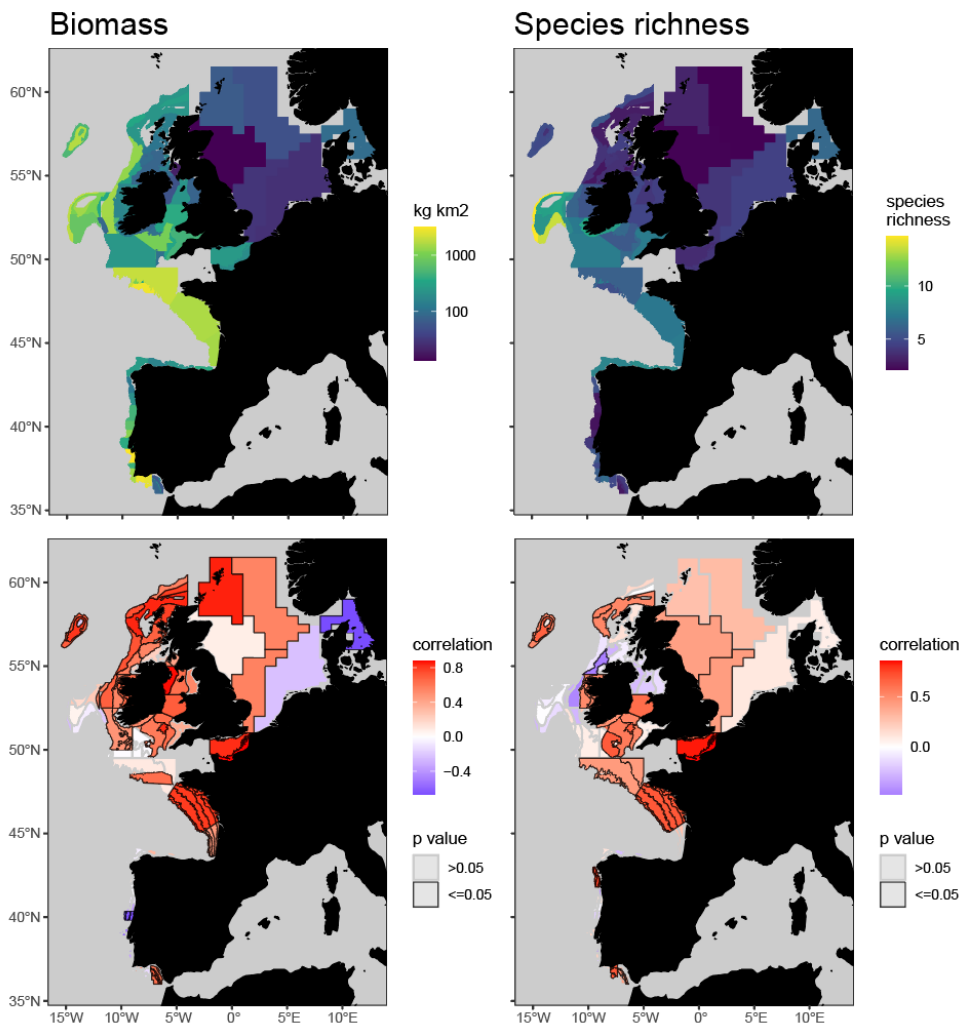


Figure 4: Mean spatial distribution (top row) and temporal change (bottom row) in unclassified fish biomass (left column) and species richness (right column) by assessment strata based on otter trawl data. Temporal increases are shown by red cells (Pearson’s correlation values between 0 and +1) and declines in blue cells (correlation values between 0 and -1). Assessment strata where the temporal change (correlation) is significant are highlighted with black borders.

Table 2: Taxa and sizes observed in the survey data with insufficient stomach contents data to be classified into feeding guilds. Fish are ordered by the sum of their biomass (kg per km²) observed across all hauls to help direct future stomach sampling by prioritising those contributing most to the fish assemblage across the study region.

Taxa	Min cm	Max cm	Sum kg per km ²
<i>Capros aper</i>	8	16	3240041
<i>Trachurus trachurus</i>	5	10	1042657
<i>Capros aper</i>	4	8	441428
<i>Trachurus picturatus</i>	9	16	428259
<i>Sebastes viviparus</i>	15	28	419466
<i>Sardina pilchardus</i>	11	19	389717
<i>Gadiculus argenteus</i>	10	18	360658

<i>Argentina sphyraena</i>	21	38	337196
<i>Trachurus picturatus</i>	16	30	313069
<i>Engraulis encrasicolus</i>	6	11	265764
<i>Capros aper</i>	16	31	242370
<i>Sebastes viviparus</i>	8	15	221067
<i>Mustelus asterias</i>	50	92	176023
<i>Molva molva</i>	77	142	132724
<i>Scomber colias</i>	19	33	114984
<i>Galeorhinus galeus</i>	82	153	111270
<i>Conger conger</i>	110	191	95179
<i>Gadiculus argenteus</i>	6	10	89462
<i>Trachurus mediterraneus</i>	18	34	86786
<i>Scyliorhinus stellaris</i>	85	160	84060
<i>Platichthys flesus</i>	33	60	79759
<i>Maurolucus muelleri</i>	36	58	77134
<i>Boops boops</i>	18	33	76843
<i>Lepidion eques</i>	23	39	76313
<i>Molva molva</i>	42	77	73287
<i>Diplodus vulgaris</i>	15	27	68597
<i>Dipturus batis</i>	102	187	61092
<i>Mustelus asterias</i>	92	167	55315
<i>Raja brachyura</i>	70	125	55209
<i>Chimaera monstrosa</i>	30	55	54496
<i>Deania calcea</i>	87	154	54264
<i>Dipturus batis</i>	187	343	48680
<i>Dipturus batis</i>	55	102	41609
<i>Argentina silus</i>	11	20	40851
<i>Scyliorhinus stellaris</i>	45	85	36300
<i>Trachurus mediterraneus</i>	10	18	32564
<i>Dicentrarchus labrax</i>	61	114	30554
<i>Pollachius pollachius</i>	64	116	30073
<i>Micromesistius poutassou</i>	38	69	29757
<i>Raja brachyura</i>	39	70	29703
<i>Scomber colias</i>	10	19	29396
<i>Scymnodon ringens</i>	70	128	27806
<i>Deania calcea</i>	49	87	26632
<i>Cyclopterus lumpus</i>	38	71	23205
<i>Lophius piscatorius</i>	112	217	22100
<i>Dipturus nidarosiensis</i>	126	226	21348
<i>Raja undulata</i>	74	137	19993
<i>Glyptocephalus cynoglossus</i>	38	67	19115
<i>Serranus hepatus</i>	95	175	18942
<i>Cyclopterus lumpus</i>	20	38	18593
<i>Sprattus sprattus</i>	3	6	18436
<i>Coelorinchus caelorhincus</i>	8	15	16722
<i>Galeorhinus galeus</i>	153	286	15889

<i>Argentina sphyraena</i>	6	11	15738
<i>Sardina pilchardus</i>	6	11	15568
<i>Boops boops</i>	10	18	14845
<i>Micromesistius poutassou</i>	6	12	14300
<i>Molva macrophthalma</i>	98	174	14125
<i>Mustelus mustelus</i>	46	90	12942
<i>Mora moro</i>	34	61	12709
<i>Leucoraja circularis</i>	78	142	12328
<i>Myoxocephalus scorpius</i>	15	28	12301
<i>Spondyliosoma cantharus</i>	9	16	11753
<i>Raja microocellata</i>	68	123	11751
<i>Raja montagui</i>	65	115	10425
<i>Sparus aurata</i>	16	30	10399
<i>Trachurus mediterraneus</i>	5	10	10053
<i>Dipturus batis</i>	30	55	9798
<i>Coelorinchus caelorhincus</i>	27	49	9779
<i>Dasyatis pastinaca</i>	62	116	9115
<i>Mustelus asterias</i>	28	50	8518
<i>Trachurus mediterraneus</i>	34	65	8370
<i>Scymnodon ringens</i>	39	70	8338
<i>Callionymus maculatus</i>	11	21	8108
<i>Hoplostethus mediterraneus</i>	27	50	8077
<i>Mora moro</i>	19	34	7896
<i>Leucoraja circularis</i>	44	78	7040
<i>Microchirus variegatus</i>	18	33	6951
<i>Raja undulata</i>	40	74	6807
<i>Galeorhinus galeus</i>	44	82	6685
<i>Etmopterus spinax</i>	44	79	6577
<i>Phycis blennoides</i>	66	119	6512
<i>Epigonus telescopus</i>	17	32	6417
<i>Trachinus draco</i>	11	20	6258
<i>Chimaera monstrosa</i>	16	30	5688
<i>Cepola macrophthalma</i>	21	54	5475
<i>Coelorinchus caelorhincus</i>	49	89	5401
<i>Arnoglossus laterna</i>	104	180	5207
<i>Raja microocellata</i>	37	68	5060
<i>Lepidion eques</i>	14	23	5014
<i>Zeus faber</i>	55	105	4936
<i>Raja brachyura</i>	125	224	4908
<i>Macroramphosus scolopax</i>	12	23	4820
<i>Buglossidium luteum</i>	9	16	4815
<i>Trachyrincus scabrus</i>	16	28	4786
<i>Boops boops</i>	33	61	4731
<i>Diplodus vulgaris</i>	27	50	4630
<i>Brosme brosme</i>	61	109	4603
<i>Buglossidium luteum</i>	5	9	4532

<i>Dasyatis pastinaca</i>	34	62	4519
<i>Aphanopus carbo</i>	69	122	4475
<i>Glyptocephalus cynoglossus</i>	13	22	4232
<i>Argyrosomus regius</i>	35	67	4138
<i>Lamna nasus</i>	102	193	4120
<i>Sparus aurata</i>	30	56	4022
<i>Agonus cataphractus</i>	9	18	3903
<i>Trachurus picturatus</i>	30	54	3795
<i>Conger conger</i>	191	333	3780
<i>Mustelus mustelus</i>	90	178	3735
<i>Scyliorhinus stellaris</i>	24	45	3647
<i>Merlangius merlangus</i>	227	416	3638
<i>Molva molva</i>	23	42	3553
<i>Molva molva</i>	142	262	3511
<i>Callionymus maculatus</i>	5	11	3439
<i>Trisopterus luscus</i>	5	9	3383
<i>Malacocephalus laevis</i>	28	54	3366
<i>Leucoraja fullonica</i>	46	83	3341
<i>Brama brama</i>	29	51	3266
<i>Malacocephalus laevis</i>	54	103	3219
<i>Argyrosomus regius</i>	18	35	3207
<i>Leucoraja fullonica</i>	83	151	3188
<i>Dalatias licha</i>	74	136	3188
<i>Scorpaena scrofa</i>	27	51	3183
<i>Balistes capriscus</i>	29	53	3133
<i>Chelon labrosus</i>	31	56	3091
<i>Atherina presbyter</i>	6	11	3079
<i>Dipturus oxyrinchus</i>	81	139	3021
<i>Trachinus draco</i>	37	67	2950
<i>Nezumia aequalis</i>	25	47	2763
<i>Zenopsis conchifer</i>	57	99	2762
<i>Dicologlossa cuneata</i>	11	20	2735
<i>Mola mola</i>	36	66	2683
<i>Hydrolagus mirabilis</i>	24	44	2618
<i>Mola mola</i>	19	36	2615
<i>Callionymus lyra</i>	5	10	2591
<i>Merlangius merlangus</i>	67	123	2547
<i>Spondyliosoma cantharus</i>	5	9	2470
<i>Dasyatis pastinaca</i>	116	215	2446
<i>Coelorinchus caelorhincus</i>	15	27	2354
<i>Sarda sarda</i>	21	38	2353
<i>Coelorinchus caelorhincus</i>	89	163	2336
<i>Pagellus acarne</i>	9	16	2319
<i>Cepola macrophthalma</i>	54	137	2262
<i>Alosa fallax</i>	38	69	2262
<i>Chelidonichthys lucerna</i>	61	114	2217

<i>Macroramphosus scolopax</i>	6	12	2213
<i>Myoxocephalus scorpius</i>	8	15	2188
<i>Coelorinchus caelorhincus</i>	4	8	2137
<i>Diplodus bellottii</i>	8	15	2086
<i>Dalatias licha</i>	41	74	2039
<i>Umbrina canariensis</i>	17	31	2039
<i>Somniosus microcephalus</i>	94	168	2018
<i>Raja brachyura</i>	22	39	1947
<i>Maurollicus muelleri</i>	23	36	1858
<i>Entelurus aequoreus</i>	18	37	1814
<i>Alosa fallax</i>	21	38	1813
<i>Myliobatis aquila</i>	38	82	1795
<i>Torpedo marmorata</i>	27	51	1753
<i>Beryx splendens</i>	26	48	1740
<i>Myxine glutinosa</i>	21	36	1738
<i>Lamna nasus</i>	193	364	1678
<i>Diplodus bellottii</i>	15	27	1672
<i>Lepidopus caudatus</i>	25	45	1669
<i>Atherina presbyter</i>	11	20	1664
<i>Scophthalmus maximus</i>	16	29	1635
<i>Lithognathus mormyrus</i>	30	56	1625
<i>Centrolophus niger</i>	36	63	1617
<i>Xiphias gladius</i>	80	145	1520
<i>Scophthalmus rhombus</i>	56	104	1519
<i>Dipturus nidarosiensis</i>	70	126	1491
<i>Epigonus telescopus</i>	9	17	1490
<i>Blennius ocellaris</i>	9	17	1483
<i>Pagrus pagrus</i>	27	51	1464
<i>Ammodytes</i>	27	52	1462
<i>Pagellus bellottii</i>	15	28	1426
<i>Echiichthys vipera</i>	5	9	1422
<i>Dicologlossa cuneata</i>	20	37	1399
<i>Spicara maena</i>	9	17	1398
<i>Dasyatis tortonesei</i>	62	116	1352
<i>Dasyatis tortonesei</i>	116	215	1328
<i>Mola mola</i>	66	123	1296
<i>Dipturus oxyrinchus</i>	139	238	1243
<i>Diplodus vulgaris</i>	8	15	1217
<i>Spicara maena</i>	17	31	1208
<i>Pagellus bogaraveo</i>	16	29	1177
<i>Gaidropsarus vulgaris</i>	35	62	1164
<i>Beryx decadactylus</i>	26	47	1149
<i>Engraulis encrasicolus</i>	132	243	1129
<i>Alepocephalus rostratus</i>	41	74	1121
<i>Centrolophus niger</i>	63	110	1056
<i>Gaidropsarus vulgaris</i>	19	35	1016

<i>Tetronarce nobiliana</i>	69	131	1008
<i>Syngnathus acus</i>	8	14	994
<i>Galeus atlanticus</i>	15	27	984
<i>Liparis liparis</i>	13	23	980
<i>Capros aper</i>	2	4	918
<i>Alepocephalus rostratus</i>	22	41	918
<i>Notacanthus bonaparte</i>	19	34	916
<i>Scomber colias</i>	33	58	902
<i>Labrus mixtus</i>	18	31	902
<i>Hippoglossus hippoglossus</i>	113	204	880
<i>Brama brama</i>	51	91	868
<i>Sebastes viviparus</i>	5	8	859
<i>Entelurus aequoreus</i>	37	75	843
<i>Anguilla anguilla</i>	58	105	835
<i>Beryx splendens</i>	14	26	833
<i>Dicentrarchus punctatus</i>	61	105	829
<i>Arnoglossus imperialis</i>	6	11	825
<i>Trisopterus minutus</i>	3	5	807
<i>Deania profundorum</i>	48	86	803
<i>Trachyrincus scabrus</i>	9	16	800
<i>Rajella bathyphila</i>	126	226	792
<i>Microstomus kitt</i>	5	10	787
<i>Notacanthus bonaparte</i>	34	63	775
<i>Balistes capriscus</i>	16	29	760
<i>Liparis liparis</i>	7	13	758
<i>Pagellus bogaraveo</i>	29	53	746
<i>Taurulus bubalis</i>	16	30	684
<i>Nezumia aequalis</i>	47	87	664
<i>Taurulus bubalis</i>	9	16	663
<i>Argyrosomus regius</i>	67	129	660
<i>Maurolicus muelleri</i>	58	94	646
<i>Raja undulata</i>	22	40	645
<i>Zeus faber</i>	105	201	639
<i>Malacocephalus laevis</i>	199	381	638
<i>Lepidotrigla cavillone</i>	17	30	630
<i>Serranus cabrilla</i>	17	33	627
<i>Notoscopelus kroyeri</i>	118	220	623
<i>Pagrus pagrus</i>	51	96	614
<i>Labrus bergylta</i>	30	55	598
<i>Tetronarce nobiliana</i>	37	69	580
<i>Molva dypterygia</i>	48	88	573
<i>Gadiculus argenteus</i>	3	6	571
<i>Chelidonichthys lucerna</i>	9	17	568
<i>Trachipterus arcticus</i>	111	207	556
<i>Gasterosteus aculeatus</i>	5	9	556
<i>Scymnodon ringens</i>	21	39	556

<i>Sarda sarda</i>	38	69	554
<i>Sphoeroides pachygaster</i>	27	51	554
<i>Sphoeroides pachygaster</i>	14	27	553
<i>Boops boops</i>	5	10	542
<i>Bathysolea profundicola</i>	12	21	542
<i>Cyclopterus lumpus</i>	11	20	540
<i>Anthias anthias</i>	10	20	528
<i>Schedophilus medusophagus</i>	27	49	527
<i>Nemichthys scolopaceus</i>	66	123	517
<i>Schedophilus medusophagus</i>	49	92	513
<i>Alosa fallax</i>	11	21	503
<i>Lumpenus lampretæformis</i>	8	21	495
<i>Pegusa lascaris</i>	18	32	492
<i>Sparus aurata</i>	56	104	490
<i>Leucoraja circularis</i>	142	255	481
<i>Scyliorhinus canicula</i>	88	157	478
<i>Xiphias gladius</i>	145	262	471
<i>Lithognathus mormyrus</i>	16	30	461
<i>Molva dypterygia</i>	88	159	441
<i>Engraulis encrasicolus</i>	3	6	440
<i>Chelon labrosus</i>	56	101	436
<i>Zeugopterus norvegicus</i>	8	14	431
<i>Scymnodon ringens</i>	128	234	428
<i>Squalus blainville</i>	45	84	423
<i>Leucoraja fullonica</i>	25	46	419
<i>Molva dypterygia</i>	27	48	415
<i>Heptranchias perlo</i>	73	133	413
<i>Microchirus variegatus</i>	5	10	396
<i>Deania calcea</i>	28	49	395
<i>Scyliorhinus canicula</i>	9	15	395
<i>Centrophorus granulosus</i>	76	136	388
<i>Myoxocephalus scorpius</i>	28	53	387
<i>Diplodus sargus</i>	30	54	369
<i>Syngnathus acus</i>	25	46	362
<i>Alopias vulpinus</i>	157	303	355
<i>Argyrosomus regius</i>	9	18	351
<i>Enchelyopus cimbrius</i>	7	13	346
<i>Mullus surmuletus</i>	5	9	343
<i>Xenodermichthys copei</i>	11	21	337
<i>Argentina sphyraena</i>	3	6	337
<i>Citharus linguatula</i>	20	37	332
<i>Epigonus telescopus</i>	32	61	327
<i>Deania profundorum</i>	86	153	327
<i>Coryphaenoides rupestris</i>	90	162	327
<i>Leucoraja circularis</i>	24	44	327

<i>Hippoglossoides platessoides</i>	3	6	324
<i>Dicentrarchus punctatus</i>	35	61	321
<i>Leucoraja naevus</i>	13	23	320
<i>Mustelus mustelus</i>	23	46	316
<i>Myliobatis aquila</i>	82	175	314
<i>Nezumia aequalis</i>	4	7	309
<i>Polyprion americanus</i>	53	100	305
<i>Scomber scombrus</i>	64	117	300
<i>Sarpa salpa</i>	29	54	298
<i>Dipturus oxyrinchus</i>	47	81	296
<i>Acantholabrus palloni</i>	16	30	295
<i>Notoscopelus kroyeri</i>	10	18	286
<i>Rajella bathyphila</i>	70	126	285
<i>Pholis gunnellus</i>	13	24	282
<i>Hydrolagus mirabilis</i>	44	79	280
<i>Trachipterus arcticus</i>	60	111	275
<i>Lophius budegassa</i>	5	9	267
<i>Nesiarchus nasutus</i>	73	134	267
<i>Gaidropsarus vulgaris</i>	11	19	262
<i>Pomatoschistus minutus</i>	3	6	258
<i>Stomias boa</i>	25	45	256
<i>Agonus cataphractus</i>	18	36	253
<i>Scorpaena loppei</i>	8	14	248
<i>Rostroraja alba</i>	73	134	244
<i>Amblyraja radiata</i>	6	11	242
<i>Umbrina canariensis</i>	31	56	241
<i>Sebastes viviparus</i>	28	50	241
<i>Serranus cabrilla</i>	9	17	239
<i>Raja clavata</i>	138	248	239
<i>Pagellus bogaraveo</i>	9	16	239
<i>Halargyreus johnsonii</i>	12	22	234
<i>Dipturus batis</i>	16	30	232
<i>Raja miraletus</i>	26	46	230
<i>Diplodus annularis</i>	15	27	229
<i>Synaphobranchus kaupii</i>	22	38	227
<i>Torpedo torpedo</i>	56	110	223
<i>Callanthias ruber</i>	9	17	223
<i>Aphia minuta</i>	3	5	222
<i>Trachurus trachurus</i>	3	5	219
<i>Rostroraja alba</i>	134	248	219
<i>Mora moro</i>	61	110	218
<i>Acipenser sturio</i>	80	148	218
<i>Chimaera monstrosa</i>	9	16	216
<i>Torpedo marmorata</i>	14	27	207
<i>Torpedo marmorata</i>	51	98	207

<i>Alosa alosa</i>	19	34	207
<i>Echiichthys vipera</i>	17	31	204
<i>Citharus linguatula</i>	6	11	202
<i>Labrus bergylta</i>	17	30	201
<i>Raja asterias</i>	39	69	200
<i>Maurolicus muelleri</i>	3	5	196
<i>Phycis phycis</i>	33	59	193
<i>Pollachius virens</i>	10	19	190
<i>Lycodes vahlii</i>	18	32	189
<i>Maurolicus muelleri</i>	5	9	185
<i>Pagellus bellottii</i>	8	15	179
<i>Lycodes vahlii</i>	10	18	174
<i>Solea senegalensis</i>	18	34	173
<i>Pagellus erythrinus</i>	8	15	172
<i>Leucoraja naevus</i>	73	130	167
<i>Argentina silus</i>	6	11	166
<i>Alepocephalus bairdii</i>	40	72	165
<i>Argentina sphyraena</i>	38	69	162
<i>Acantholabrus palloni</i>	9	16	159
<i>Stomias boa</i>	14	25	158
<i>Anguilla anguilla</i>	32	58	154
<i>Raja miraletus</i>	46	82	153
<i>Dicentrarchus punctatus</i>	21	35	152
<i>Pagrus auriga</i>	27	52	151
<i>Brosme brosme</i>	19	34	149
<i>Xenodermichthys copei</i>	6	11	149
<i>Limanda limanda</i>	3	6	147
<i>Alosa alosa</i>	34	61	147
<i>Taurulus bubalis</i>	5	9	146
<i>Symphodus roissali</i>	28	52	145
<i>Pomadasys incisus</i>	16	31	144
<i>Alosa fallax</i>	6	11	144
<i>Aphanopus carbo</i>	39	69	144
<i>Cyttopsis rosea</i>	14	27	143
<i>Arnoglossus laterna</i>	4	7	143
<i>Nesiarchus nasutus</i>	40	73	142
<i>Sprattus sprattus</i>	71	130	141
<i>Umbrina canariensis</i>	9	17	140
<i>Cepola macrophthalma</i>	8	21	138
<i>Diplodus annularis</i>	8	15	138
<i>Belone belone</i>	61	110	135
<i>Raja montagui</i>	12	21	133
<i>Diplodus cervinus</i>	28	50	132
<i>Raja microocellata</i>	20	37	132
<i>Pagrus pagrus</i>	15	27	130
<i>Galeorhinus galeus</i>	23	44	129

<i>Polymetme thaeocoryla</i>	12	22	128
<i>Mora moro</i>	11	19	127
<i>Echiodon drummondii</i>	18	41	124
<i>Ephippion guttifer</i>	27	51	121
<i>Galeus melastomus</i>	8	14	120
<i>Blennius ocellaris</i>	17	32	120
<i>Gobius niger</i>	5	9	119
<i>Lepidion eques</i>	39	66	119
<i>Etmopterus spinax</i>	7	13	115
<i>Halargyreus johnsonii</i>	7	12	114
<i>Solea solea</i>	6	10	113
<i>Dentex canariensis</i>	28	53	111
<i>Sardinella aurita</i>	19	36	109
<i>Malacocephalus laevis</i>	8	15	109
<i>Rostroraja alba</i>	40	73	108
<i>Galeus atlanticus</i>	50	93	108
<i>Scorpaena loppei</i>	25	45	106
<i>Synchiropus phaeton</i>	13	28	102
<i>Dasyatis tortonesei</i>	34	62	101
<i>Merluccius merluccius</i>	3	6	101
<i>Alepocephalus bairdii</i>	22	40	100
<i>Liparis montagui</i>	8	16	96
<i>Malacocephalus laevis</i>	103	199	94
<i>Dalatias licha</i>	22	41	94
<i>Malacocephalus laevis</i>	4	8	93
<i>Beryx decadactylus</i>	14	26	88
<i>Microchirus boscanion</i>	9	17	85
<i>Ctenolabrus rupestris</i>	10	18	83
<i>Belone belone</i>	34	61	82
<i>Arnoglossus thori</i>	10	18	81
<i>Beryx decadactylus</i>	47	85	80
<i>Engraulis encrasicolus</i>	21	39	80
<i>Zeugopterus punctatus</i>	8	14	80
<i>Molva molva</i>	12	23	78
<i>Callionymus reticulatus</i>	6	12	78
<i>Molva dypterygia</i>	15	27	77
<i>Pagrus auriga</i>	52	98	77
<i>Labrus mixtus</i>	31	55	77
<i>Microchirus boscanion</i>	5	9	74
<i>Serranus hepatus</i>	4	8	74
<i>Microchirus azevia</i>	17	31	72
<i>Gaidropsarus vulgaris</i>	3	6	71
<i>Myxine glutinosa</i>	36	63	69
<i>Lepidopus caudatus</i>	82	150	68
<i>Nezumia aequalis</i>	7	13	67
<i>Callionymus maculatus</i>	3	5	66

<i>Gadiculus argenteus</i>	18	32	66
<i>Polymetme corythaeola</i>	13	23	65
<i>Myxine glutinosa</i>	12	21	65
<i>Buglossidium luteum</i>	16	29	65
<i>Phycis phycis</i>	18	33	65
<i>Hyperoplus lanceolatus</i>	8	15	65
<i>Lycodes gracilis</i>	11	26	63
<i>Maurolicus muelleri</i>	2	3	63
<i>Helicolenus dactylopterus</i>	52	94	63
<i>Osmerus eperlanus</i>	6	11	61
<i>Zoarces viviparus</i>	12	23	61
<i>Synaphobranchus kaupii</i>	12	22	61
<i>Zeugopterus norvegicus</i>	4	8	61
<i>Arnoglossus rueppelii</i>	12	22	57
<i>Trachyrincus scabrus</i>	49	88	56
<i>Arctozenus risso</i>	13	24	56
<i>Oxynotus paradoxus</i>	73	133	55
<i>Stomias boa</i>	82	147	55
<i>Atherina presbyter</i>	3	6	55
<i>Lampanyctus crocodilus</i>	12	23	52
<i>Hygophum benoiti</i>	30	54	51
<i>Pholis gunnellus</i>	24	44	51
<i>Ciliata mustela</i>	7	13	50
<i>Anthias anthias</i>	20	41	50
<i>Caranx rhonchus</i>	8	17	50
<i>Galeus murinus</i>	43	79	49
<i>Pegusa lascaris</i>	10	18	49
<i>Myoxocephalus scorpius</i>	5	8	49
<i>Umbrina cirrosa</i>	31	58	49
<i>Sardina pilchardus</i>	35	64	48
<i>Oxynotus paradoxus</i>	40	73	48
<i>Mugil cephalus</i>	31	59	48
<i>Arnoglossus imperialis</i>	19	35	48
<i>Gobius niger</i>	9	17	46
<i>Ciliata mustela</i>	23	41	46
<i>Deania profundorum</i>	27	48	46
<i>Hyperoplus lanceolatus</i>	4	8	46
<i>Alosa agone</i>	17	33	45
<i>Dicologlossa cuneata</i>	6	11	45
<i>Squalus blainville</i>	25	45	44
<i>Alepocephalus rostratus</i>	12	22	43
<i>Callionymus maculatus</i>	21	41	42
<i>Symphodus bailloni</i>	15	28	41
<i>Labrus mixtus</i>	10	18	41
<i>Rajella bathyphila</i>	39	70	41
<i>Microchirus theophila</i>	17	32	40

<i>Sphyraena sphyraena</i>	36	69	39
<i>Sprattus sprattus</i>	21	38	38
<i>Uranoscopus scaber</i>	29	53	38
<i>Ephippion guttifer</i>	14	27	37
<i>Dipturus nidarosiensis</i>	39	70	37
<i>Trachyrincus scabrus</i>	28	49	37
<i>Syngnathus acus</i>	14	25	36
<i>Citharus linguatula</i>	3	6	36
<i>Alosa alosa</i>	11	19	36
<i>Raja asterias</i>	69	123	35
<i>Coryphaenoides rupestris</i>	27	50	35
<i>Lepidion eques</i>	8	14	35
<i>Pollachius pollachius</i>	11	19	35
<i>Molva macrophthalma</i>	10	17	34
<i>Lampanyctus crocodilus</i>	7	12	34
<i>Halargyreus johnsonii</i>	22	40	34
<i>Scyliorhinus stellaris</i>	13	24	33
<i>Pomadasys incisus</i>	8	16	33
<i>Cyttopsis rosea</i>	8	14	33
<i>Lepidotrigla dieuzeidei</i>	17	31	33
<i>Pagrus pagrus</i>	8	15	31
<i>Lepidotrigla dieuzeidei</i>	5	9	31
<i>Callionymus reticulatus</i>	12	26	31
<i>Trigla lyra</i>	5	10	30
<i>Coryphaenoides rupestris</i>	50	90	29
<i>Myliobatis aquila</i>	18	38	29
<i>Syngnathus rostellatus</i>	9	15	29
<i>Pomatoschistus minutus</i>	33	58	28
<i>Bathysolea profundicola</i>	21	39	28
<i>Callanthias ruber</i>	5	9	28
<i>Spicara smaris</i>	10	18	27
<i>Maurolicus muelleri</i>	9	14	27
<i>Glyptocephalus cynoglossus</i>	7	13	27
<i>Echiodon dentatus</i>	20	36	26
<i>Spicara maena</i>	5	9	26
<i>Scomber scombrus</i>	6	11	26
<i>Liparis liparis</i>	4	7	26
<i>Gnathophis mystax</i>	20	36	26
<i>Ruvettus pretiosus</i>	77	140	26
<i>Pagellus acarne</i>	5	9	25
<i>Aphia minuta</i>	5	8	25
<i>Myoxocephalus scorpioides</i>	18	32	25
<i>Gaidropsarus vulgaris</i>	6	11	24
<i>Trachinus draco</i>	6	11	24
<i>Chaunax pictus</i>	14	27	24
<i>Myctophum punctatum</i>	6	10	24

<i>Hymenocephalus italicus</i>	13	24	24
<i>Galeus melastomus</i>	96	181	24
<i>Galeus murinus</i>	24	43	24
<i>Diplodus sargus</i>	16	30	23
<i>Raja brachyura</i>	12	22	23
<i>Dentex gibbosus</i>	31	57	22
<i>Dipturus oxyrinchus</i>	28	47	22
<i>Petromyzon marinus</i>	63	109	22
<i>Scorpaena scrofa</i>	8	15	21
<i>Liparis montagui</i>	4	8	21
<i>Solea senegalensis</i>	34	62	21
<i>Chaunax pictus</i>	27	49	21
<i>Monochirus hispidus</i>	8	14	20
<i>Lepidorhombus boscii</i>	3	6	20
<i>Hymenocephalus italicus</i>	24	43	20
<i>Pagellus erythrinus</i>	4	8	18
<i>Dasyatis pastinaca</i>	18	34	18
<i>Hyperoplus lanceolatus</i>	53	101	18
<i>Syngnathus acus</i>	4	8	18
<i>Arnoglossus thori</i>	5	10	17
<i>Ciliata septentrionalis</i>	9	16	17
<i>Cyttopsis rosea</i>	27	49	17
<i>Symphurus nigrescens</i>	6	11	17
<i>Nerophis ophidion</i>	25	50	17
<i>Gasterosteus aculeatus</i>	9	17	17
<i>Alosa agone</i>	33	62	17
<i>Micromesistius poutassou</i>	4	6	17
<i>Raja clavata</i>	7	13	17
<i>Nemichthys scolopaceus</i>	36	66	17
<i>Dentex maroccanus</i>	15	29	17
<i>Scorpaena loppei</i>	14	25	17
<i>Polymetme thaeocoryla</i>	22	40	17
<i>Phycis blennoides</i>	6	11	16
<i>Blennius ocellaris</i>	4	9	16
<i>Leucoraja circularis</i>	13	24	16
<i>Uranoscopus scaber</i>	16	29	16
<i>Trachyrincus scabrus</i>	5	9	16
<i>Pterycombus brama</i>	28	53	16
<i>Salmo salar</i>	32	59	16
<i>Dipturus nidarosiensis</i>	22	39	16
<i>Benthodesmus simonyi</i>	60	104	16
<i>Chelidonichthys lastoviza</i>	18	33	15
<i>Hydrolagus mirabilis</i>	13	24	15
<i>Labrus bergylta</i>	9	17	15
<i>Dentex gibbosus</i>	17	31	14
<i>Dentex canariensis</i>	15	28	14

<i>Chelidonichthys lastoviza</i>	10	18	14
<i>Microchirus theophila</i>	9	17	14
<i>Naucrates ductor</i>	28	53	14
<i>Eutrigla gurnardus</i>	3	5	14
<i>Rajella bathyphila</i>	22	39	13
<i>Raja undulata</i>	12	22	13
<i>Ciliata septentrionalis</i>	5	9	13
<i>Stromateus fiatola</i>	27	50	13
<i>Chlorophthalmus agassizi</i>	11	22	13
<i>Scorpaena scrofa</i>	15	27	13
<i>Centrolabrus exoletus</i>	19	33	13
<i>Buglossidium luteum</i>	3	5	13
<i>Helicolenus dactylopterus</i>	3	5	13
<i>Deania calcea</i>	16	28	13
<i>Rajella fyllae</i>	43	80	12
<i>Trachipterus trachipterus</i>	66	123	12
<i>Trachipterus arcticus</i>	32	60	12
<i>Chauliodus sloani</i>	18	33	12
<i>Monochirus hispidus</i>	14	25	12
<i>Lophius piscatorius</i>	4	8	12
<i>Stomias boa</i>	8	14	12
<i>Coryphaenoides rupestris</i>	15	27	12
<i>Chelidonichthys lucerna</i>	5	9	12
<i>Ciliata septentrionalis</i>	16	29	11
<i>Plectorhinchus mediterraneus</i>	30	54	11
<i>Chelidonichthys obscurus</i>	35	62	11
<i>Cyclopterus lumpus</i>	6	11	11
<i>Spratelloides lewisi</i>	11	20	11
<i>Dentex maroccanus</i>	29	56	11
<i>Notoscopelus kroyeri</i>	5	10	11
<i>Macrourus berglax</i>	18	35	11
<i>Zeugopterus punctatus</i>	14	26	11
<i>Pegusa lascaris</i>	5	10	10
<i>Osmerus eperlanus</i>	11	20	10
<i>Hoplostethus mediterraneus</i>	4	8	10
<i>Sarpa salpa</i>	16	29	10
<i>Pholis gunnellus</i>	7	13	10
<i>Lycenchelys sarsii</i>	10	16	10
<i>Dentex gibbosus</i>	9	17	9
<i>Gaidropsarus biscayensis</i>	7	12	9
<i>Torpedo marmorata</i>	7	14	9
<i>Symphurus nigrescens</i>	11	19	9
<i>Gaidropsarus mediterraneus</i>	23	42	9
<i>Mustelus asterias</i>	15	28	9
<i>Macrourus berglax</i>	35	65	9

<i>Triglops murrayi</i>	9	19	9
<i>Raja montagui</i>	7	12	8
<i>Lepidopus caudatus</i>	14	25	8
<i>Alosa agone</i>	9	17	8
<i>Synaphobranchus kaupii</i>	38	66	8
<i>Ophidion barbatum</i>	23	42	8
<i>Sardina pilchardus</i>	3	6	8
<i>Hygophum benoiti</i>	16	30	8
<i>Petromyzon marinus</i>	21	36	8
<i>Arctozenus risso</i>	24	44	7
<i>Brama brama</i>	16	29	7
<i>Coryphaenoides rupestris</i>	8	15	7
<i>Zenopsis conchifer</i>	11	19	7
<i>Melanostomias bartonbeani</i>	22	40	7
<i>Entelurus aequoreus</i>	9	18	7
<i>Agonus cataphractus</i>	2	5	7
<i>Spicara smaris</i>	18	35	7
<i>Parablennius gattorugine</i>	9	17	7
<i>Coelorinchus caelorhincus</i>	2	4	7
<i>Arctozenus risso</i>	7	13	7
<i>Zeugopterus punctatus</i>	4	8	7
<i>Umbrina canariensis</i>	5	9	7
<i>Centrolophus niger</i>	21	36	7
<i>Synaphobranchus kaupii</i>	7	12	7
<i>Arnoglossus rueppelii</i>	6	12	6
<i>Ctenolabrus rupestris</i>	5	10	6
<i>Zeugopterus regius</i>	8	14	6
<i>Zoarces viviparus</i>	23	43	6
<i>Arnoglossus laterna</i>	20	34	6
<i>Echiichthys vipera</i>	31	58	6
<i>Raniceps raninus</i>	17	29	6
<i>Nezumia aequalis</i>	2	4	6
<i>Maurolicus muelleri</i>	14	23	6
<i>Argyrosomus regius</i>	5	9	6
<i>Schedophilus medusophagus</i>	14	27	6
<i>Gaidropsarus mediterraneus</i>	12	23	6
<i>Clupea harengus</i>	2	3	6
<i>Benthodesmus elongatus</i>	35	60	6
<i>Trisopterus minutus</i>	32	59	6
<i>Leucoraja fullonica</i>	14	25	6
<i>Zenopsis conchifer</i>	6	11	6
<i>Epigonus denticulatus</i>	6	10	5
<i>Triglops murrayi</i>	5	9	5
<i>Diaphus dumerilii</i>	6	11	5
<i>Callionymus maculatus</i>	41	81	5
<i>Glyptocephalus cynoglossus</i>	4	7	5

<i>Gaidropsarus biscayensis</i>	12	22	5
<i>Nessorhamphus ingolfianus</i>	36	66	5
<i>Argyropelecus olfersii</i>	4	8	5
<i>Ophidion barbatum</i>	13	23	5
<i>Leucoraja naevus</i>	7	13	5
<i>Serranus scriba</i>	16	30	5
<i>Etmopterus pusillus</i>	24	44	5
<i>Raja miraletus</i>	14	26	5
<i>Anthias anthias</i>	5	10	5
<i>Sigmops bathyphilus</i>	24	43	5
<i>Microstomus kitt</i>	3	5	5
<i>Gaidropsarus macrophthalmus</i>	22	42	5
<i>Capros aper</i>	1	2	5
<i>Spinachia spinachia</i>	30	57	5
<i>Halobatrachus didactylus</i>	28	51	5
<i>Conger conger</i>	12	21	5
<i>Gnathophis mystax</i>	36	67	5
<i>Scorpaena loppei</i>	5	8	5
<i>Syngnathus acus</i>	46	82	4
<i>Petromyzon marinus</i>	36	63	4
<i>Gadella maraldi</i>	20	35	4
<i>Lepidorhombus whiffiagonis</i>	3	6	4
<i>Macrourus berglax</i>	10	18	4
<i>Lampetra fluviatilis</i>	18	32	4
<i>Symphodus bailloni</i>	8	15	4
<i>Serranus hepatus</i>	15	28	4
<i>Lycenchelys sarsii</i>	16	26	4
<i>Raniceps raninus</i>	9	17	4
<i>Pomatoschistus minutus</i>	10	18	4
<i>Magnisudis atlantica</i>	13	24	4
<i>Benthodesmus elongatus</i>	60	104	4
<i>Naucrates ductor</i>	15	28	4
<i>Spinachia spinachia</i>	16	30	4
<i>Argyropelecus olfersii</i>	8	15	4
<i>Lampetra fluviatilis</i>	32	58	4
<i>Microchirus azevia</i>	9	17	4
<i>Chelon labrosus</i>	17	31	3
<i>Chimaera monstrosa</i>	5	9	3
<i>Symphodus melops</i>	9	17	3
<i>Zoarces viviparus</i>	7	12	3
<i>Paraliparis membranaceus</i>	9	17	3
<i>Pontinus kuhlii</i>	16	30	3
<i>Trachurus picturatus</i>	5	9	3
<i>Myoxocephalus scorpioides</i>	10	18	3
<i>Mora moro</i>	6	11	3

<i>Caranx rhonchus</i>	17	32	3
<i>Argentina silus</i>	3	6	3
<i>Belone belone</i>	19	34	3
<i>Synchiropus phaeton</i>	6	13	3
<i>Serrivomer beanii</i>	36	66	3
<i>Gaidropsarus argentatus</i>	21	39	3
<i>Sphoeroides pachygaster</i>	7	14	3
<i>Labrus mixtus</i>	6	10	3
<i>Microchirus ocellatus</i>	9	16	3
<i>Myctophum punctatum</i>	3	6	3
<i>Anguilla anguilla</i>	18	32	3
<i>Boops boops</i>	3	5	3
<i>Notacanthus bonaparte</i>	10	19	3
<i>Sigmops bathyphilus</i>	13	24	3
<i>Scorpaena porcus</i>	8	15	3
<i>Callionymus lyra</i>	2	5	3
<i>Gadella maraldi</i>	11	20	3
<i>Polymetme corythaeola</i>	7	13	2
<i>Epigonus denticulatus</i>	10	18	2
<i>Alosa alosa</i>	6	11	2
<i>Trachurus mediterraneus</i>	3	5	2
<i>Echiodon drummondii</i>	8	18	2
<i>Paraliparis membranaceus</i>	5	9	2
<i>Symphodus roissali</i>	15	28	2
<i>Callionymus reticulatus</i>	3	6	2
<i>Macroramphosus scolopax</i>	3	6	2
<i>Pomatoschistus minutus</i>	2	3	2
<i>Bathysolea profundicola</i>	7	12	2
<i>Centrolabrus exoletus</i>	10	19	2
<i>Pomadasys incisus</i>	4	8	2
<i>Spinachia spinachia</i>	5	9	2
<i>Diplodus vulgaris</i>	5	8	2
<i>Lycodes vahlii</i>	5	10	2
<i>Zeus faber</i>	2	4	2
<i>Pagellus bellottii</i>	4	8	2
<i>Chauliodus sloani</i>	10	18	2
<i>Buglossidium luteum</i>	2	3	2
<i>Arnoglossus thori</i>	18	33	2
<i>Spratelloides lewisi</i>	6	11	2
<i>Melanonus zugmayeri</i>	12	22	2
<i>Neoraja iberica</i>	12	22	2
<i>Chelidonichthys obscurus</i>	6	11	2
<i>Hygophum benoiti</i>	9	16	2
<i>Callanthias ruber</i>	17	31	2
<i>Serranus scriba</i>	9	16	2
<i>Echiodon dentatus</i>	11	20	2

<i>Arnoglossus imperialis</i>	3	6	2
<i>Pagrus pagrus</i>	4	8	2
<i>Nessorhamphus ingolfianus</i>	20	36	2
<i>Macroparalepis affinis</i>	13	24	2
<i>Peristedion cataphractum</i>	23	44	1
<i>Diplecogaster bimaculata</i>	2	4	1
<i>Lycodes gracilis</i>	5	11	1
<i>Petromyzon marinus</i>	12	21	1
<i>Ophichthus rufus</i>	38	72	1
<i>Diplodus sargus</i>	9	16	1
<i>Argyropelecus hemigymnus</i>	2	4	1
<i>Argyropelecus gigas</i>	8	15	1
<i>Echiostoma barbatum</i>	12	22	1
<i>Cepola macrophthalmalma</i>	3	8	1
<i>Lestidiops jayakari</i>	11	21	1
<i>Syngnathus rostellatus</i>	15	25	1
<i>Chlorophthalmus agassizi</i>	6	11	1
<i>Limanda limanda</i>	2	3	1
<i>Spondyliosoma cantharus</i>	2	5	1
<i>Mullus surmuletus</i>	3	5	1
<i>Peristedion cataphractum</i>	12	23	1
<i>Benthodesmus simonyi</i>	35	60	1
<i>Scomberesox saurus</i>	28	49	1
<i>Raniceps raninus</i>	5	9	1
<i>Alepocephalus bairdii</i>	12	22	1
<i>Rostroraja alba</i>	21	40	1
<i>Pagrus auriga</i>	14	27	1
<i>Callionymus reticulatus</i>	26	55	1
<i>Lepidion eques</i>	5	8	1
<i>Chaunax pictus</i>	8	14	1
<i>Chelidonichthys lastoviza</i>	6	10	1
<i>Hippocampus hippocampus</i>	8	16	1
<i>Scomberesox saurus</i>	15	28	1
<i>Pleuronectes platessa</i>	3	5	1
<i>Syngnathus rostellatus</i>	5	9	1
<i>Polymetme thaeocoryla</i>	7	12	1
<i>Myxine glutinosa</i>	7	12	1
<i>Hoplostethus atlanticus</i>	6	12	1
<i>Leptoclinus maculatus</i>	8	18	1
<i>Paralepis coregonoides</i>	13	24	1
<i>Zeugopterus regius</i>	14	25	1
<i>Hippocampus hippocampus</i>	5	8	1
<i>Ceratoscopelus maderensis</i>	6	11	1
<i>Raja brachyura</i>	7	12	1
<i>Liparis montagui</i>	16	30	1
<i>Lycodes gracilis</i>	26	59	1

<i>Parasudis fraserbrunneri</i>	12	21	1
<i>Ciliata mustela</i>	4	7	1
<i>Syngnathus typhle</i>	17	31	1
<i>Cyclopterus lumpus</i>	3	6	1
<i>Serranus cabrilla</i>	5	9	1
<i>Squalus blainville</i>	13	25	1
<i>Dipturus oxyrinchus</i>	16	28	1
<i>Ciliata septentrionalis</i>	3	5	1
<i>Osmerus eperlanus</i>	4	6	1
<i>Galeus atlanticus</i>	8	15	1
<i>Alepocephalus rostratus</i>	7	12	1
<i>Centrolabrus exoletus</i>	6	10	1
<i>Hydrolagus mirabilis</i>	7	13	1
<i>Thunnus thynnus</i>	9	18	1
<i>Echiodon drummondii</i>	41	91	1
<i>Microchirus variegatus</i>	3	5	1
<i>Stromateus fiatola</i>	8	15	1
<i>Phycis phycis</i>	10	18	1
<i>Chirostomias pliopterus</i>	12	22	1
<i>Gobius paganellus</i>	5	9	1
<i>Centroscyllum fabricii</i>	15	26	1
<i>Argyrolepecus olfersii</i>	2	4	1
<i>Lumpenus lamprætaeformis</i>	3	8	1
<i>Gadella maraldi</i>	6	11	1
<i>Mustelus mustelus</i>	12	23	1
<i>Parablennius gattorugine</i>	5	9	1
<i>Polymetme corythæola</i>	23	42	1
<i>Epigonus telescopus</i>	5	9	1
<i>Gaidropsarus mediterraneus</i>	7	12	1
<i>Gadiculus argenteus</i>	2	3	1
<i>Symphodus melops</i>	5	9	1
<i>Symphodus bailloni</i>	5	8	1
<i>Xenodermichthys copei</i>	3	6	1
<i>Trachyscorpia cristulata</i>	9	17	1
<i>Carapus acus</i>	20	36	1

- Feeding guild responses to environmental and anthropogenic pressures were not considered here but will be in future (e.g. following Thompson et al., 2020, 2021)
- The knock-on effects of change in feeding guilds across assemblages (plankton, benthos, top-predators) requires further research.
- Where diet data are not yet available (e.g. Portugal), feeding guilds have been inferred based on data from adjacent areas.
- Morphological analysis of stomach contents may under-sample certain prey, e.g. those comprised of only soft tissues.
- PPMRs are based on prey weights from stomach contents and may thus be affected by varying levels and rates of digestion.

- Top-predators (e.g. seabirds, cetaceans) and organisms lower in the food web (e.g. benthos, plankton) have not yet been classified into guilds but diet databases for such taxa do exist and could be included in future.
- Pelagic fish species and juvenile fish are under-sampled using trawls. Acoustic methods and catchability corrections can be applied to address some of these issues, but have not yet been applied at the scale of the OSPAR area.

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Assessment Metadata

Field	Data Type	
Assessment type	List	Pilot Assessment
SDG Indicator	List	14.2 By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts, including by strengthening their resilience, and take action for their restoration in order to achieve healthy and productive oceans
Thematic Activity	List	Biological Diversity and Ecosystems - Targeted actions for the protection and conservation of species, habitats and ecosystem processes
Relevant OSPAR Documentation	Text	Agreement 2018 – 05 CEMP Guideline: Combined guideline for processing of survey data for fish and food webs common indicators FC2, FC3, FW3 and FW7.
Linkage	URL	<p><u>The feeding guild publication this candidate indicator pilot assessment developed from: A feeding guild indicator to assess environmental change impacts on marine ecosystem structure and functioning - Thompson - 2020 - Journal of Applied Ecology - Wiley Online Library</u></p> <p>Open access pre-print: <u>Microsoft Word - Thompson et al Feeding guilds preprint (researchgate.net)</u></p> <p>Survey data were downloaded from: <u>Lynam, C. P., & Ribeiro, J. (2022). A data product derived from Northeast Atlantic groundfish data from scientific trawl surveys 1983-2020. https://doi.org/https://doi.org/10.14466/CefasDataHub.126</u></p>
Date of publication	Date	2022-06-30
Conditions applying to access and use	URL	https://oap.ospar.org/en/data-policy/
Data Source	URL	https://doi.org/https://doi.org/10.14466/CefasDataHub.126



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Our vision is a clean, healthy and biologically diverse North-East Atlantic Ocean, which is productive, used sustainably and resilient to climate change and ocean acidification.

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