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# Are fish sensitive to trawling recovering in the Northeast Atlantic?

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## 1. Abstract

1. The protection of sensitive species from overfishing is a key aspect of the ecosystem approach to fisheries management.
2. We use life history parameters and knowledge of fish shape and habitat to estimate the sensitivity of 270 species in the Northeast Atlantic to demersal trawling and compare sensitivity to the most recent IUCN categorization. Species classified as threatened were on average significantly more sensitive to trawling than other species. Using trawl surveys in European Atlantic waters from 36ºN to 62ºN, we estimated indicators of abundance of 31 highly sensitive species and compared changes in abundance to sensitivity, management measures and value of landings.
3. The abundance of 23 of the 31 sensitive species increased after year 2000 with 14 of the species showing increases significant at the 5% level. The increases were not due to

specific management measures, as less than half of the species were covered by catch limits. Further, sensitivity or value of landings were not related to trends in abundance.

4. Three species (Atlantic wolf-fish, tusk and starry ray) declined significantly. These species are all at their southern distributional limit in the North Sea.
5. *Synthesis and applications*. We recommend monitoring the development of sensitive species to identify species under pressure and allow rapid management actions before species enter the IUCN threatened category. Further, we recommend taking precautions where species are under combined pressure from climate change and fishing.

Keywords: Sensitive fish, abundance indices, species recovery, IUCN categories, fisheries management, life history traits, fish distributions

## 2. Introduction

A key aspect of the ecosystem approach to fisheries management is the protection of species from overfishing (CBD, 2014). However, managing every species in large marine ecosystems is impractical and, therefore, approaches such as risk-based assessments (Hobday et al., 2011) have been proposed to ensure that the most sensitive components are the focus of management. A scoping process identifies priority objectives (Hobday et al., 2011), and a subsequent Population Susceptibility Analysis (PSA) or similar is used to identify the most susceptible species. In Europe, priority objectives stated in the Marine Strategy Framework Directive (MSFD) aim to support 'halting biodiversity loss, ensuring the conservation and sustainable use of marine biodiversity' (European Commission, 2008). These objectives have been confirmed in various large-scale scoping exercises (Rindorf et al., 2017).

The Minimum Viable Population concept is often used in viability analysis of terrestrial populations (Beissinger & McCullough, 2002) and for marine fish populations, the minimum spawning stock per recruit concept plays a similar role. Basically, fishing should not reduce the spawning stock per recruit of a fish population below the minimum level necessary for replacement. For fish, this level is typically in the order of 20 to 40% of the unexploited population (Brooks et al., 2010). Large, slow growing, late maturing fish species with a low level of natural mortality are likely to reach the minimum level at a lower level of fishing mortality than small, fast growing, early maturing species with higher levels of natural mortality (Jennings et al., 1999; Fernandes et al., 2017). Life history characteristics such as asymptotic length $L_\infty$, growth rate $K$, the length at which 50% of the individuals have reached maturity $L_{mat}$, and natural mortality $M$ are therefore often used to indicate the sensitivity of different species to fishing (Hobday et al., 2011; Greenstreet et al., 2012). When species-specific information is missing, an estimate of the maximum length $L_{max}$ of a species can be used to infer asymptotic length, growth rate, natural mortality, and proportion mature at length (Walker et al., 2019).

Following this approach, Le Quesne and Jennings (2012) used a life history model and asymptotic length to predict the sensitivity of different fish species in the Celtic Sea to fishing by estimating the fishing mortality required to reduce the stock to a specific level of spawning stock biomass per recruit relative to the unfished status, using a general relationship between size of the individual and the size selectivity in the fishery. However, in a subsequent study, gear efficiency expressed as the probability of being retained by a particular gear, was shown to have a larger effect on the estimated reference points than the uncertainty associated with general life history relationships (García-Carreras et al., 2015). Gear efficiency depends on the habitat, individual size, body shape and behavior of the fish (Table S1), as well as the properties of the gear (Reid et al., 2007). In 2010-2012, bottom trawl and beam trawl fisheries accounted for 98% of the discards in EU member countries (Catchpole et al., 2017). Hence, while bycatches taken in other fisheries may be important for particular species, the probability of being retained in, or killed by, the bottom trawl and beam trawl fisheries is likely to be most important for demersal fish.

The objective of this study is to identify species sensitive to fishing in the Northeast Atlantic and provide an overview of changes in their abundance in the light of recent effort changes and current management. To achieve this aim, we ranked fish species according to their sensitivity to bottom and beam trawling in the Northeast Atlantic using gear efficiencies estimated by Walker et al. (2017). We then investigated whether species sensitivity was related to IUCN species status (Nieto et al., 2015), and whether management measures are in place to limit the impact of fishing on sensitive species. Finally, we examined the temporal development in the abundance of sensitive species in survey catches throughout the Northeast

Atlantic and compared changes in abundance to sensitivity, current management measures, the decreases in fishing effort from 2000 onwards and market value of the species.

## 3. Materials and methods

### Species sensitivity

Species sensitivity to trawl generated mortality was estimated by applying a length-based Spawning stock per Recruit model (Beverton & Holt, 1957; Gislason et al., 2008) to species recorded in the DATRAS survey database covering the Northeast Atlantic from the coast of Portugal to the North Sea and from the Baltic Sea to west of Scotland (http://www.ices.dk/marine-data/data-portals/Pages/DATRAS.aspx). The maximum length of the species, $L_{max}$, the asymptotic length, $L_{\infty}$, the von Bertalanffy growth rate parameter, $K$, length at first maturity, $L_{mat}$, and the length at which the individuals entered the sensitivity model (length at birth for chondrichthyan and length at metamorphosis for bony fish), $L_{min}$, were derived from the literature whenever possible (Tables S2 and S3), thereby minimizing the variation induced by using one parameter to predict the remaining parameters whenever possible (Thorson et al., 2014).

General relationships between life history parameters and species lengths were used to provide missing values whenever information could not be found in the literature (Table 1).When no growth parameters were available, $L_{\infty}$ was estimated from $L_{max}$ using the equation provided by Froese & Binohlan (2000), $K$ was estimated from a regression of $\ln(K)$ versus $\ln(L_{\infty})$ based on the species in the dataset for which $K$ and $L_{\infty}$ estimates were available ($p<0.0001$, adj.$R^2 = 0.43$, df = 186). When $L_{mat}$ was missing, a regression of $\ln(L_{mat})$ versus $\ln(L_{\infty})$ ($p<0.0001$, adj.$R^2 = 0.91$, df = 155) based on species for which estimates were available was used to derive the missing value. For chondrichthyans, regressions of $\ln(L_{min})$ versus $\ln(L_{\infty})$ differed significantly between egg-laying and live-bearing species (ANOVA, P(>F) = 0.0004, n = 21). Separate regressions of $\ln(L_{min})$ versus $\ln(L_{\infty})$ were therefore used for egg-laying ($R^2 = 0.68$, df = 8) and live-bearing species ($R^2 = 0.81$, df = 10). For bony fish, insufficient information about length at metamorphosis was available and an overall $L_{min}$ of 2 cm was adopted. The life history relationships were entered into the model of Spawning Stock Biomass per recruit. The model was insensitive to changes in the value of $L_{min}$ as long as $L_{min}$ was below the length at which the species is either exploited or mature.

Bottom and beam trawls retain a variable proportion of the fish found in the path of the gear. Some species, such as shallow water or reef-associated species, are difficult to catch because their habitat is not consistently sampled during trawl surveys, while pelagic species, such as Atlantic herring *Clupea harengus* are found in the water column and may pass above the headline of the gear without being caught. Furthermore, among the individuals that enter the mouth of the gear, the smaller individuals and species may escape through the meshes. Towed gears will therefore generate species and size specific fishing mortalities in the area where they operate. Walker et al. (2017) estimated the relative efficiency by which different species groups and sizes of fish were retained by the major towed commercial fishing gears operating in the North Sea. Dividing the species according to their body shape and typical vertical position in the water column, catch efficiency at length (exploitation pattern) was calculated for seven groups (Table S1). We allocated the species to these groups and used the average efficiency of small and large meshed commercial beam trawls and otter trawls estimated by Walker et al. (2017) to provide the relative catch efficiency for each cm of length for each of the seven groups. The resulting exploitation pattern was used to estimate the relative efficiency of towed gears for each of the species and size groups and provided the relative fishing mortality at size by which they would be affected for a given level of overall effort.

As a measure of the sensitivity of each species to fisheries generated mortality, we used the relative level of effort needed to reduce the biomass of mature individuals (the spawning stock biomass) to 25% of its unfished level, $F_{25\%SSB}$, (Table S2). Sensitive species can only tolerate relatively low levels of fishing mortality before their spawning biomass is reduced to 25% of the unfished level. The lower the $F_{25\%SSB}$, the higher the sensitivity. The exact percentage (25%) is of little consequence to the subsequent ranking, as the different F indicators are highly correlated (Le Quesne and Jennings, 2012). To distinguish between sensitive and non-sensitive species, we used the $F_{25\%SSB}$ of the most sensitive of the commercial target species which has shown sustained high catches. Less sensitive species may also be severely impacted by a targeted fishing effort, but here we concentrated on species which are mostly bycaught in mixed fisheries rather than targeted directly. Ana- and catadromous species were excluded from the study.

### Comparison of sensitivities and IUCN ratings, $L_\infty$ and taxonomy

The estimated values of $F_{25\%SSB}$ were analysed to determine if $F_{25\%SSB}$ differed significantly between IUCN ratings (ANOVA) and if there was a linear effect of asymptotic length ($L_\infty$) and a categorical effect of taxonomy (Chondrichthyes, Agnatha and Actinopterygia) in a generalized linear model with a linear effect of $L_\infty$ and a categorical effect of taxonomy. The natural log of $F_{25\%SSB}$ was taken prior to analyses as variance increased with the mean of $F_{25\%SSB}$.

### Management of sensitive species in the EU and value of landing

Current management measures for EU fleets were derived from the latest available decisions on fishing opportunities (European Commission, 2018a, b). Price per kg was derived from the European Market Observatory for Fisheries and Aquaculture Products (www.eumofa.eu, accessed August 12th 2019) and supplemented where prices were lacking with prices from Hanstholm Auction (www.hanstholmfiskeauktion.dk/prices, accessed August 12th 2019). Species were ranked as high value if their value exceeded that of Atlantic cod *Gadus morhua*, medium value if their value was between 50% and 100% of that of Atlantic cod, and low value if their value was not listed or was less than 50% of that of Atlantic cod.

### Development in abundance of sensitive species

Species abundance indices were derived from average survey catch rates in the ICES coordinated international bottom and beam trawl surveys in the area in which the species has historically been reported. Data were downloaded from the ICES DATRAS database (http://www.ices.dk/marine-data/data-portals/Pages/DATRAS.aspx) on July 9th 2019. The time-range for each survey are given in Table S4.

For the Baltic Sea, North Sea and west of Scotland, only hauls in which all fish species caught were recorded were analysed. Catch rates of beam trawls in the North Sea, where several beam widths are used, were standardised to a beam width of 4 m. In the Baltic Sea, catches with the large and small versions of the trawl were considered as two different surveys.

Species which were not accurately identified to species were joined in species groups. Among the sensitive species, this affected the common skate complex (comprising records for *Dipturus* spp., *D. batis*, the invalid synonym *D. flossada,* and *D. intermedius*) and smooth-hounds (*Mustelus asterias* and *M. mustelus*). Annual estimates of mean catch rates were estimated for species observed in at least 50% of the years. The estimated mean included only hauls taken in realised habitat defined as all ICES statistical rectangles in which the species had been recorded during a survey at any time in the data. Consequently, the total number of hauls varied between species.

To provide integrated species indicators, two types of difference between surveys were considered: differences in mean catch rate and differences in interannual variation in catch rate. Differences in mean catch were accounted for by scaling all survey catches to a mean of 1 in the years from 2009 onwards. Species-level indicators were derived by estimating the weighted average of all indicators for the given species. As the study was focused on population abundance indicators for long lived species, we expect a smooth development of the underlying population size over the years. Survey catches may appear more or less smooth, depending on the consistency of the catchability and relative local abundance of the species in the particular survey. To ensure that more weight was placed on surveys showing consistent population development, the combined indicators were weighted with the reciprocal variance around a Loess smoother in time fitted to the logged non-zero catch rates of each species in each survey. Further, to ensure a minimum precision level for the derived indicators, combinations of surveys and species for which the CV of the residuals from the Loess smoother exceeded 0.75 were excluded. Years in which the catch rates exceeded five times the long-term mean were excluded in the analysis of integrated indicators. This removed occasional very large hauls, which occurred for some of the species (e.g. *Raja clavata* and *Squalus acanthias*). Indicators were integrated by region and across all regions. After a period of increasing or stable high fishing pressure, demersal fishing effort in the Northeast Atlantic area has decreased since the 2000s (ICES, 2018a, b, c). We therefore estimated the trends in species abundance from 1980–2000 and from 2000 onwards as the linear trends in log-transformed species-level indicators. In addition, the number of surveys showing positive trends in the two periods was investigated (regardless of significance level). The categorical effect on trend in abundance of value (low, medium or high) and management (species TAC, group TAC or no TAC) was investigated in an ANOVA.

## 2. Results

### Species sensitivity

The estimated values of $F_{25\%SSB}$ for all 270 taxa are given in Table S2. The sensitivities of species from Greenstreet et al. (2012) and Le Quesne and Jennings (2012) were well correlated with those derived by the present method (Correlations = –0.78 and 0.74, respectively, on a log-log scale). Some of the difference between the ratings can be attributed to differences in the assumed values of the life history parameters. For example, Greenstreet et al. (2012) assumed $L_\infty$ of spurdog *Squalus acanthias* to be 90 cm, whereas Le Quesne and Jennings (2012) and this study assumed 120 and 121 cm, respectively. The most sensitive of the commercial target species which has shown sustained high catches was saithe *Pollachius virens*, with a value of $F_{25\%SSB}$ of 0.43. Using this species to define the level below which species can be considered particularly sensitive, 59 species with $F_{25\%SSB} \leq 0.43$ were defined as sensitive species/taxa and used in subsequent analyses. These species were dominated by 33 chondrichthyan taxa, including skates (Rajidae; *Amblyraja hyperborea, A. radiata,* common skate-complex, *D. nidarosiensis, D. oxyrinchus, Leucoraja circularis, L. fullonica, L. naevus, Raja brachyura, R. clavata, R. microocellata, R. montagui, R. undulata, Rajella bathyphila, Rajella fyllae, Rajella lintea* and *Rostroraja alba*), squaliform sharks (*Somniosus microcephalus, Deania calcea, Squalus acanthias, Dalatias licha* and *Etmopterus princeps*), catsharks (Scyliorhinidae; *Galeus melastomus, Scyliorhinus canicula* and *S. stellaris*), hound sharks (Triakidae; *Galeorhinus galeus* and *Mustelus* spp.) and various other species (*Hexanchus griseus, Lamna nasus, Torpedo marmorata, T. nobiliana, Dasyatis pastinaca, D. tortonesei* and *Chimaera monstrosa*). The remaining species comprised a variety of gadiforms (*Brosme brosme, Coryphaenoides rupestris, Macrourus berglax, Molva molva, M. dypterygia, M. macropthalma, Mora moro and Phycis blennoides*) and other species (*Conger conger, Lophius budegassa, L. piscatorius, Brama brama, Argyrosomus regius, Anarhichas* *lupus, A. minor, Dicentrarchus punctatus, Ephippion guttifer, Epigonus telescopus, Sebastes* spp.*, Lepidorhombus whiffiagonis, Hippoglossus hippoglossus, Polyprion americanus, Scophthalmus rhombus, Scorpaena scrofa* and *Synaphobranchus kaupi*).

### Comparison of sensitivities and IUCN assessments, $L_\infty$ and taxonomy

Comparing $F_{25\%SSB}$ to the IUCN assessments, species sensitive to fishing occurred in all IUCN categories. However, average $F_{25\%SSB}$ was significantly higher for species in the Least Concern category ($P<0.0001$) (Figure 1) indicating that less sensitive species were, on average, more likely to be categorized as Least Concern. There was no significant difference in the average $F_{25\%SSB}$ between the Critically Endangered, Endangered, Vulnerable and Near Threatened categories ($P= 0.2594$). None of the species in the Critically Endangered and Endangered categories showed an $F_{25\%SSB}>0.75$ (Figure 2, Table S2). The two species classified as Endangered but not sensitive to demersal fishing pressure were basking shark *Cetorhinus maximus* and thresher shark *Alopias vulpinus*. Six Data Deficient species (*Anarhichas lupus*, *Argyrosomus regius*, *Dasyatis tortonesei*, *Ephippion guttifer*, *Epigonus telescopus* and *Phycis blennoides*) were identified as sensitive species. For the remaining 51 sensitive species, 24 are currently listed by the IUCN as Least Concern.

$L_\infty$ and taxonomy were significantly related to $F_{25\%SSB}$, together explaining 72% of the variation in $F_{25\%SSB}$, while $L_{mat}$ and $K$ did not have a significant effect ($P>0.1958$). The predictive function of species sensitivity for Actinopterygia was estimated as:

$$\widehat{F_{25\%SSB,AC}} = \exp(6.99\ (0.28) - 1.55\ (0.08) * \ln(L_\infty))$$

Values in parentheses denote standard deviation of the estimates. The parameter estimates for Chondrichthyes were not significantly different from 0 ($P = 0.08$). While taxonomy and asymptotic length provided significant information on sensitivity, 28% of the variation was not predictable using linear relationships with taxonomy, $L_\infty$, $K$ and $L_{mat}$ and hence, the full model should be used whenever possible. The limit between low and medium productivity (high sensitivity) fish given in Hobday et al. (2011) for maximum length (>300 cm and 100–300 cm, respectively) and length at maturity (>200 cm and 40–200 cm, respectively) were insufficient to describe the current sensitive species, as 24 sensitive species had values of asymptotic length <100 cm and six additional species had maximum length <100 cm. Five species had a length at maturity <40 cm.

## Management of sensitive species and value of landings

Among the 59 sensitive taxa, landings of four species (6.8%) were subject to species-specific quota management for defined management units, and a further five taxa (8.5%) by genus or family-based quota management (Table S5). Additionally, 13 species of skate (22.0%) would be included within quotas largely set for the complex (Rajiformes). Whilst 13 (22.0%) of the taxa were subject to conservative management (e.g. a combination of prohibited listings and near-zero bycatch TACs), the remaining 24 species (40.7%) are not currently subject to any management measures.

Five high value species had landing values per kg greater than cod (*Dicentrarchus labrax*, *Hippoglossus hippoglossus*, *Lepidorhombus whiffiagonis*, *Scophthalmus rhombus*, *Lophius budegassa* and *L. piscatorius*). Another 10 medium value species attained values between that of cod and half this value (*Anarhichas lupus*, *Etmopterus princeps*, *Macrourus berglax*, *Molva dypterygia*, *Molva macropthalma*, *Molva molva*, *Scyliorhinus canicula*, *Scyliorhinus stellaris*, *Sebastes* spp. and *Squalus acanthias*). The remaining species were categorized as low value species.

## Development in abundance of sensitive species

Of the taxa classified as sensitive, 31 were recorded with sufficient frequency and accuracy in the surveys to allow estimation of trends (Table 2). For some species, indices were highly correlated, whereas for others, the surveys differed in development (Figure 3). The abundance of 24 of the 31 species increased from 1980–2018 (Table 2, Figures 3–4). Among the species showing significant trends, 15 increased and three (starry ray *Amblyraja radiata*, wolf-fish *Anarhichas lupus* and tusk *Brosme brosme*) decreased. These three are at their southern boundary in the surveyed area (Figure 2) whereas this was not the case for the remaining species (except halibut *Hippoglossus hippoglossus;* Figure S1). Starry ray and tusk decreased at a significantly greater rate in the later period than in the period as a whole ($P<0.0181$ in both cases). Among the 10 species showing a significant change in the trend between 1980–1999 and 2000–2018, six exhibited an increasing trend while four deteriorated. Fourteen species showed no significant change between time periods while the remaining six species had insufficient historical data to test for changes in trends.

Categorising the surveys individually according to the trend estimated, trends in 42 of 78 combinations of species and surveys from 1980–1999 were positive, whereas the corresponding number after 2000 was 161 of 209, a change from 54% to 77%.

Among the species listed by IUCN as Critically Endangered, Endangered or Vulnerable, four taxa increased significantly after 2000 (*Dipturus* spp., *Leucoraja circularis*, *Mustelus* spp. and *Squalus acanthias*) whereas four showed no significant change (*Dasyatis pastinaca*, *Galeorhinus galeus, Leucoraja fullonica* and *Hippoglossus hippoglossus*). Among the species assessed as Least Concern, starry ray, tusk and marbled electric ray *Torpedo marmorata* all decreased significantly from 1980 to 2018.

There was no relationship between sensitivity, the presence of a catch limit, the value at landing and the population index trend of the species (P>0.29). For example, the two least sensitive of the species (starry ray and wolf-fish) declined whereas the most sensitive (the common skate complex) increased. The three species showing the greatest increase in the past 20 years had very different management measures: the common skate complex (to be returned to the sea unharmed), Smoothhounds (no management) and undulate ray *Raja undulata* (individual species TAC). Starry ray and wolf-fish showed comparable declines, despite the former being required to be returned to the sea unharmed (since 2014) whereas the latter can be landed. High and medium value species included both declining/stable species (wolf-fish and halibut) and increasing species (*Lophius budegassa* and *Squalus acanthias*), and the same was true of low value species (starry ray and tusk declining and smoothhounds and the common skate complex increasing).

## 3. Discussion

Using life history parameters and knowledge of fish shape and habitat to identify the likely sensitivity for each species, we demonstrated that in general, sensitive demersal marine fish increased in abundance in the Northeast Atlantic since 2000 and in many cases had been doing so since 1980. The analysis identified potentially sensitive species along the Northeast Atlantic shelf, and the trawl survey data integration method allowed the temporal changes in species abundance to be monitored for more than half of these sensitive species. The increase in abundance of most of the sensitive species analysed did not appear to be due to species-specific management measures, as less than half of the species were covered by catch limits and there was no strong evidence of an increase in relative abundance as fishing effort decreased after year 2000. Further, neither sensitivity nor market value appeared to be related to trends in abundance. However, the three species which declined significantly were all at their southern limit in the North Sea, indicating that conditions in the North Sea may be affecting these species more than others, possibly due to the greater changes in water temperature (Hobday and Pecl, 2014).

The accuracy of the identification of sensitive species depends on the accuracy of the parameters included and the method used to derive sensitivity. Thorson et al. (2014) demonstrated the importance of a proper literature review to derive the best available life history parameter estimates. While we performed a detailed literature review, our focus was on the development of the species across all of the sampled parts of the NE Atlantic, and therefore we did not use local values of life history parameters. If the analysis is repeated for a specific area, local values could be used instead, but as information is often sparse for species identified as sensitive, using local values increases the risk of basing the analyses on very limited data, and hence, it may be preferable to use the values given here for analyses even at a more limited spatial scale. While our results on species sensitivity ranking are in broad agreement with findings from other studies, in that larger, slower growing, late maturing species are the most vulnerable to fisheries generated mortality (e.g. Jennings et al., 1999; Ravard et al., 2014), sensitivities based on the life history model were not well explained by a linear combination of life history parameters causing our results to differ from those of Greenstreet et al. (2012). Our results also differed from those of Le Quesne and Jennings (2012) perhaps as a result of including group-specific catchabilities. The methods used to derive catch efficiencies assumed all individuals within a certain size and habitat group are equally likely to be caught in the trawl (Walker et al., 2017). This assumption may not be appropriate for species with variable behavioural responses to the trawl and species that occur on non-trawlable or deeper grounds, such as rocky bottoms, reefs and wrecks. For example, conger eel *Conger conger* inhabits rocky areas of the continental shelf and shelf slope (Xavier et al., 2010). Once settled, it has a relatively sedentary lifestyle. Walker et al. (2017) assumed conger eel to be caught with the same catch efficiency at size as other eel-like species encountered near the seabed, which may be an overestimate. Similar considerations may apply to other species favouring untrawlable habitats. Furthermore, our study did not consider sensitivity of the species to pelagic fisheries or earlier targeted fisheries. Species like basking shark and thresher shark would owe their current IUCN Endangered status to these factors, rather than demersal fisheries.

Information about the survival of individuals that are discarded from different gear types was not available. However, many bycatch species are discarded and, if they survive, their populations may be more resilient to fishing than their life history parameters would indicate. For most fish species, discard mortality will increase with the duration and depth of the tow, the time spent on deck and handling/discarding practices, but survival can also vary in response to size, sex, temperature, catch composition and handling (Ellis et al., 2017). Recent work on capture-release mortality could be used to improve the knowledge of the degree to which released fish survive to reenter the population (Dapp et al., 2016). Needless to say, discard survival will not impact species which are landed.

Spatially explicit models and management measures are potentially useful alternatives for managing sensitive species (Duggan et al., 2015; Walker et al., 2019). Spatially explicit models may provide indication of whether some species are likely to be at greater risk due to fishing than expected from our analyses and whether catches of sensitive species observed to be in decline can be limited by spatial measures (Shephard et al., 2012). However, such analyses must be based on a reliable distribution of the sensitive species, and this was only available for about half the sensitive species identified here.

Le Quesne and Jennings (2012) suggested that significant reductions of fishing effort in the Celtic Sea were required to allow sensitive species such as the common skate complex, spurdog and spotted ray *Raja montagui* to increase. The same conclusion was reached for the North Sea by Walker et al. (2019) for wolf-fish, anglerfish, brill, starry ray, spurdog, smoothhounds, spotted ray and thornback ray (excluding the species not listed here as sensitive). Among these eight species, five were observed as increasing in this study. This may indicate either that these species are less frequently caught outside the heavily fished North and Celtic Sea, providing the possibility for them to increase in less fished areas, or that they are experiencing an increase in productivity due to, for example, warming waters or other ecosystem changes.

The IUCN ratings of the species were in broad agreement with the sensitivity of the species, and species ranked in the Critically Endangered, Endangered or Vulnerable categories were generally classified as sensitive in our analysis. However, the IUCN ranking of different species was not a reliable indicator of the potential for the species to sustain fishing pressure – the Least Concern and Data Deficient species included starry ray, tusk, marbled electric ray and wolf-fish , which were all ranked as sensitive and all decreased significantly from 1980 to 2018, indicating the potential error of assuming that species listed in these categories are not under pressure. Ideally, the status of these species should be updated during the next IUCN assessment cycle using survey data under the IUCN criteria (IUCN Standards and Petition Subcommittee, 2017). On the positive side, just above half of the species listed by IUCN as Critically Endangered, Endangered or Vulnerable increased significantly since 2000, hence providing some confidence that these species may in time move out of these categories.

The lack of a direct management of catches of a large proportion of the sensitive species means that some of the species in decline can continue to be caught. We stress here, that while the assumption that the fishing mortality affecting non-target species is unlikely to exceed the fishing mortality affecting target species (Pope et al. 2000), is likely to hold for many species, this is not necessarily the case for species with restricted distributions. Further, the fishing mortality predicted to generate MSY for the more productive species may not be sustainable for sensitive species. Species experiencing negative effects of other pressures or drivers (e.g. climate change) may also be more sensitive to fishing mortality than their general life history parameters would suggest. Due to these caveats, species like wolf-fish, tusk and starry ray, which are at the southern limit of their distributions in the North Sea, are likely to be more sensitive to fishing than indicated in our sensitivity ranking. We recommend further monitoring of sensitive species and more regular assessments of their status to spur management actions before species enter the Critically Endangered, Endangered or Vulnerable IUCN categories. Further, we recommend taking additional precaution where species are under combined pressure from climate change and fishing.

## 4. Authors' contributions

HG and AR conceived the ideas and designed the analyses; HG conducted the literature review and estimated species sensitivity, AR analysed species abundance and led writing of the manuscript. All authors contributed critically to the development of the analyses and manuscript and approved the final draft.

## 5. Acknowledgements

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## 6. Data availability statement

The data used in this work are life history parameters as given in Tables S2 and S3 in the Supporting Information and are available in Dryad as Rindorf (2020) "Life history traits and abundance of Northeast Atlantic fish" (doi:10.5061/dryad.8sf7m0cjd).

## 7. References

Beissinger, S.R., & McCullough, D.R. (2002). Population viability analysis. Chicago: University of Chicago Press.

Beverton, R.J., & Holt, S.J. (1957). On the dynamics of exploited fish populations, Fishery Investigations Series II, Vol. XIX, Ministry of Agriculture. Fisheries and Food, 1, 957.

Brooks, E.N., Powers, J.E., & Cortés, E. (2010). Analytical reference points for age-structured models: application to data-poor fisheries. *ICES Journal of Marine Science*, 67(1), 165-175.

Catchpole, T.L., Ribeiro-Santos, A., Mangi, S.C., Hedley, C., & Gray, T.S. (2017). The challenges of the landing obligation in EU fisheries. *Marine Policy*, 82, 76–86.

CBD (2014). Ecosystem approach sourcebook. Retrieved October 1st 2019 from https://www.cbd.int/ecosystem/sourcebook/default.shtml.

Charnov, E.L., Gislason, H., & Pope, J.G. (2013). Evolutionary assembly rules for fish life histories. *Fish and Fisheries*, 14(2), 213–224.

Dapp, D.R., Walker, T.I., Huveneers, C., & Reina, R.D. (2016). Respiratory mode and gear type are important determinants of elasmobranch immediate and post-release mortality. *Fish and Fisheries*, 17(2), 507–524.

Duggan, J.M., Eichelberger, B.A., Ma, S., Lawler, J.J., & Ziv, G. (2015). Informing management of rare species with an approach combining scenario modeling and spatially explicit risk assessment. *Ecosystem Health and Sustainability*, 1(6), 1–18.

Ellis, J.R., McCully Phillips, S. R., & Poisson, F. (2017). A review of capture and post-release mortality of elasmobranchs. *Journal of Fish Biology*, *90*(3), 653–722.

European Commission. (2008). 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 environmental policy (Marine Strategy Framework Directive). http://data.europa.eu/eli/dir/2008/56/oj

European Commission. (2018a). Council Regulation (EU) 2018/120 of 23 January 2018 fixing for 2018 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters, and amending Regulation (EU).

European Commission. (2018b). Council Regulation (EU) 2018/2025 of 17 December 2018 fixing for 2019 and 2020 the fishing opportunities for Union fishing vessels for certain deep-sea fish stocks

Fernandes, P.G., Ralph, G.M., Nieto, A., et al. (2017). Coherent assessments of Europe's marine fishes show regional divergence and megafauna loss. *Nature Ecology & Evolution*, 1, p.0200.

Froese, R. and Binohlan, C., (2000). Empirical relationships to estimate asymptotic length, length at first maturity and length at maximum yield per recruit in fishes, with a simple method to evaluate length frequency data. *Journal of Fish Biology*, 56(4), 758–773.

García-Carreras, B., Jennings, S., & Le Quesne, W.J. (2015). Predicting reference points and associated uncertainty from life histories for risk and status assessment. *ICES Journal of Marine Science*, 73(2), 483–493.

Gislason, H., Pope, J.G., Rice, J.C., & Daan, N. (2008). Coexistence in North Sea fish communities: implications for growth and natural mortality. *ICES Journal of Marine Science*, 65(4), 514–530.

Greenstreet, S.P., Rossberg, A.G., Fox, C.J., Le Quesne, W.J., Blasdale, T., Boulcott, P., Mitchell, I., Millar, C. and Moffat, C. F. (2012). Demersal fish biodiversity: species-level indicators and trends-based targets for the Marine Strategy Framework Directive. *ICES Journal of Marine Science*, 69(10), 1789–1801.

Hobday, A.J., & Pecl, G.T. (2014). Identification of global marine hotspots: sentinels for change and vanguards for adaptation action. *Reviews in Fish Biology and Fisheries*, 24(2), 415–425.

Hobday, A.J., Smith, A.D.M., Stobutzki, I.C., et al. (2011). Ecological risk assessment for the effects of fishing. *Fisheries Research*, 108(2–3), 372–384.

ICES. (2018a). Baltic Sea Ecoregion – Fisheries overview. https://doi.org/10.17895/ices.pub.4389

ICES. (2018b). Greater North Sea Ecoregion – Fisheries overview. https://doi.org/10.17895/ices.pub.4647

ICES. (2018c). Celtic Seas Ecoregion – Fisheries overview. https://doi.org/10.17895/ices.pub.4640

IUCN Standards and Petition Subcommittee (2017).). Guidelines for Using the IUCN Red List Categories and Criteria. Version 13. Prepared by the Standards and Petitions Subcommittee. Available at http://www.iucnredlist.org/documents/RedListGuidelines.pdf

Jennings, S., Greenstreet, S., & Reynolds, J. (1999). Structural change in an exploited fish community: a consequence of differential fishing effects on species with contrasting life histories. *Journal of Animal Ecology*, 68(3), 617–627.

Le Quesne, W.J., & Jennings, S. (2012). Predicting species vulnerability with minimal data to support rapid risk assessment of fishing impacts on biodiversity. *Journal of Applied Ecology*, 49(1), 1–20.

Nieto, A., Ralph, G.M., Comeros-Raynal, M.T., et al. (2015). European Red List of marine fishes. Luxembourg: Publications Office of the European Union.

Pope, J.G., Macdonald, D.S., Daan, N., Reynolds, J.D. & Jennings, S. (2000) Gauging the impact of fishing mortality on non-target species. *ICES Journal of Marine Science*, 57, 689–696.

Ravard, D., Brind'Amour, A., & Trenkel, V.M. (2014). Evaluating the potential impact of fishing on demersal species in the Bay of Biscay using simulations and survey data. *Fisheries Research*, 157, 86–95.

Reid, D.G., Allen, V.J., Bova, D.J., Jones, E.G., Kynoch, R.J., Peach, K.J., Fernandes, P.G. & Turrell, W.R. (2007). Anglerfish catchability for swept-area abundance estimates in a new survey trawl. *ICES Journal of Marine Science*, 64(8), 1503–1511.

Reynolds, J. D., Dulvy, N. K., Goodwin, N. B., & Hutchings, J. A. (2005). Biology of extinction risk in marine fishes. *Proceedings of the Royal Society of London B: Biological Sciences*, 272(1579), 2337–2344.

Rindorf, A. (2020), Life history traits and abundance of Northeast Atlantic fish, v2, Dryad, Dataset, https://doi.org/10.5061/dryad.8sf7m0cjd

Rindorf, A., Mumford, J., Baranowski, P., Clausen, L.W., García, D., Hintzen, N.T., Kempf, A., Leach, A., Levontin, P., Mace, P., Mackinson, S., Maravelias, C., Prellezo, R., Quetglas, A., Tserpes, G., Voss, R. and Reid, D. (2017). Moving beyond the MSY concept to reflect multidimensional fisheries management objectives. *Marine Policy*, 85, 33–41.

Shephard, S., Gerritsen, H., Kaiser, M.J., Reid, D.G. (2012). Spatial heterogeneity in fishing creates de facto refugia for Endangered Celtic Sea elasmobranchs. *PLoS ONE*, 7(11).

Walker, N.D., Maxwell, D.L, Le Quesne, W.J.F., & Jennings, S. (2017). Estimating efficiency of survey and commercial trawl gears from comparisons of catch-ratios. *ICES Journal of Marine Science*, 74(5), 1448–1457.

Walker, N.D., García-Carreras, B., Le Quesne, W.J., Maxwell, D.L., & Jennings, S. (2019). A data-limited approach for estimating fishing mortality rates and exploitation status of diverse target and non-target fish species impacted by mixed multispecies fisheries. *ICES Journal of Marine Science*, 76, 824–836.

Xavier, J.C., Cherel, Y., Assis, C.A., Sendão, J., & Borges, T.C. (2010). Feeding ecology of conger eels (*Conger conger*) in north-east Atlantic waters. *Journal of the Marine Biological Association of the United Kingdom*, 90(3), 493–501.

TABLE 1. Life history model equations.

| Life history component | | Equation | Reference/Assumption/Data |
|---|---|---|---|
| Deterministic relationships | | | |
| Asymptotic length, $\boldsymbol{L_\infty}$ (cm) | | $L_\infty = 10^{(0.044+0.9841 log_{10}(L_{\max}))}$ | Froese & Binohlan (2000) |
| Von Bertalanffy parameter, $\boldsymbol{K}$ (year$^{-1}$) | | $K = 1.447 * L_\infty^{-0.5132}$ | Data from Table S2 |
| Length at first maturity, $\boldsymbol{L_{mat}}$ (cm) | | $L_{mat} = 0.6106 * L_\infty^{0.9684}$ | Data from Table S2 |
| Minimum length, $\boldsymbol{L_{min}}$ (cm) | Egg-laying Elasmob. | $L_{min} = 0.7918 * L_\infty^{0.5921}$ | Data from Table S2 |
| | Live-bearing Elasmob. | $L_{min} = 0.5399 L_\infty^{0.7977}$ | Data from Table S2 |
| | Actinopterygians | $L_{min} = 2$ | Assumed |
| Body weight at length $L$, $\boldsymbol{W_L}$ (g) | | $W_L = 0.01 * L^3$ | Gislason et al. (2008) |
| Model equations | | | |
| Proportion mature at length, $\boldsymbol{P_L}$ | | $P_L = (1 + e^{(5.5*(1-{}^{L}/_{L_{mat}})})^{-1}$ | Assuming L75%=1.2*$L_{mat}$ |
| Natural mortality at length, $\boldsymbol{M_L}$ (y$^{-1}$) | | $M_L = K * ({}^{L_t}/_{L_\infty})^{-1.5}$ | Charnov et al. (2013) |
| Fishing mortality at length, $\boldsymbol{F_L}$ (y$^{-1}$) | | $F_L = F_{factor} * Catch\ eff.(L)$ | Walker et al. (2017) |
| Total mortality, $\boldsymbol{Z_L}$ (y$^{-1}$) | | $Z_{L+\Delta L/2} = F_{L+\Delta L/2} + M_{L+\Delta L/2}$ | |
| Numbers at length $L + \Delta L$ | | $N_{L+\Delta L} = N_L \left(\frac{L_\infty - (L + \Delta L)}{L_\infty - L}\right)^{Z_L/K}$ | Gislason et al. (2008) |

| | | |
|---|---|---|
| Average numbers in length interval | $\bar{N}_{L,L+\Delta L} = \frac{N_L - N_{L+\Delta L}}{Z_{L+\Delta L/2}}$ | Gislason et al. (2008) |
| Spawning stock per recruit | $\frac{SSB}{R} = \sum_{L=L_{min}}^{L_\infty} \frac{P_L \bar{N}_{L,L+\Delta L} W_{L+\Delta L/2}}{N_{L_{min}}}$ | Gislason et al. (2008) |

573 TABLE 2. Annual change in species ln(index) for the periods 1980–2018 and 2000–2018.

| Species | Annual change from 1980 to 2018 | Annual change from 2000 to 2018 | Probability of same trend from 1980–1999 and 2000–2018 | Number of surveys with positive trend 1980–1999/all surveys | Number of surveys with positive trend 2000–2018/all surveys |
|---|---|---|---|---|---|
| *Amblyraja radiata* | **-0.032 (0.008, P=0.0002)** | **-0.069 (0.009, P<0.0001)** | **0.0181** | 1/2 | 2/5 |
| *Anarhichas lupus* | **-0.070 (0.007, P<0.0001)** | **-0.081 (0.022, P=0.0019)** | 0.7383 | 0/2 | 1/4 |
| *Brosme brosme* | **-0.025 (0.007, P=0.0010)** | **-0.078 (0.015, P<0.0001)** | **0.0042** | 2/3 | 2/5 |
| *Chimaera monstrosa* | **0.045 (0.017, P=0.0152)** | **0.067 (0.015, P=0.0003)** | 0.1080 | 2/2 | 4/5 |
| *Conger conger* | **0.052 (0.008, P<0.0001)** | 0.000 (0.008, P=0.9936) | 0.0786 | 2/3 | 5/10 |
| *Dasyatis pastinaca* | -0.000 (0.027, P=0.9972) | 0.006 (0.036, P=0.8714) | | | 2/2 |
| *Dipturus batis* complex | **0.075 (0.012, P<0.0001)** | **0.092 (0.009, P<0.0001)** | 0.5196 | 4/4 | 5/6 |

| | | | | | |
|---|---|---|---|---|---|
| *Galeorhinus galeus* | -0.011 (0.019, P=0.5632) | 0.039 (0.034, P=0.2759) | 0.6018 | 2/3 | 4/4 |
| *Galeus melastomus* | **0.065 (0.012, P<0.0001)** | **0.064 (0.011, P<0.0001)** | 0.5192 | 2/4 | 8/8 |
| *Hexanchus griseus* | 0.028 (0.015, P=0.0890) | 0.028 (0.015, P=0.0890) | | | 1/1 |
| *Hippoglossus hippoglossus* | 0.012 (0.009, P=0.2041) | -0.029 (0.027, P=0.2940) | 0.4556 | 1/2 | 0/2 |
| *Lepidorhombus whiffiagonis* | **0.023 (0.004, P<0.0001)** | 0.009 (0.008, P=0.2674) | 0.4411 | 3/5 | 14/14 |
| *Leucoraja circularis* | 0.035 (0.020, P=0.0959) | **0.074 (0.017, P=0.0006)** | | | 3/4 |
| *Leucoraja fullonica* | -0.008 (0.013, P=0.5550) | 0.023 (0.018, P=0.2077) | 0.9217 | 1/1 | 2/3 |
| *Leucoraja naevus* | **0.030 (0.006, P<0.0001)** | 0.001 (0.007, P=0.9004) | 0.0551 | 4/5 | 8/10 |
| *Lophius budegassa* | **0.028 (0.009, P<0.0053)** | **0.048 (0.008, P<0.0001)** | **0.0410** | 1/3 | 7/9 |
| *Lophius piscatorius* | **0.026 (0.008, P=0.0046)** | 0.002 (0.010, P=0.8562) | **0.0014** | 3/5 | 6/12 |
| *Molva macropthalma* | **0.122 (0.039, P=0.0054)** | 0.054 (0.037, P=0.1597) | | | 3/3 |

|  |  |  |  |  |  |
|---|---|---|---|---|---|
| *Molva molva* | **0.016 (0.007, P=0.0213)** | **0.049 (0.012, P=0.0007)** | **0.0146** | 1/4 | 5/8 |
| *Mustelus* spp. | **0.095 (0.010, P<0.0001)** | **0.122 (0.010, P<0.0001)** | 0.2205 | 3/4 | 8/8 |
| *Phycis blennoides* | **0.059 (0.015, P=0.0006)** | -0.017 (0.018, P=0.3785) | **0.0010** | 2/3 | 4/7 |
| *Raja brachyura* | 0.011 (0.014, P=0.4289) | **0.059 (0.012, P<0.0001)** | **0.0005** | 0/4 | 6/7 |
| *Raja clavata* | **0.016 (0.008, P=0.0656)** | **0.086 (0.007, P<0.0001)** | **<0.0001** | 2/6 | 11/13 |
| *Raja microocellata* | 0.009 (0.009, P=0.3126) | 0.000 (0.012, P=0.9995) |  |  | 1/3 |
| *Raja montagui* | **0.054 (0.009, P<0.0001)** | **0.050 (0.013, P=0.0015)** | 0.8078 | 2/6 | 10/10 |
| *Raja undulata* | **0.069 (0.019, P=0.0009)** | **0.099 (0.043, P=0.0339)** | 0.8856 | 1/1 | 3/3 |
| *Scophthalmus rhombus* | **0.046 (0.008, P<0.0001)** | 0.052 (0.026, P=0.0593) | 0.0955 | 3/5 | 12/15 |
| *Scyliorhinus canicula* | **0.041 (0.005, P<0.0001)** | **0.069 (0.005, P<0.0001)** | **<0.0001** | 4/6 | 11/12 |
| *Scyliorhinus stellaris* | **0.039 (0.012, P=0.0027)** | **0.079 (0.020, P=0.0012)** | **0.0014** | 1/1 | 4/4 |
| *Squalus acanthias* | **0.039 (0.008, P<0.0001)** | **0.067 (0.021, P=0.0060)** | 0.6783 | 0/4 | 8/11 |

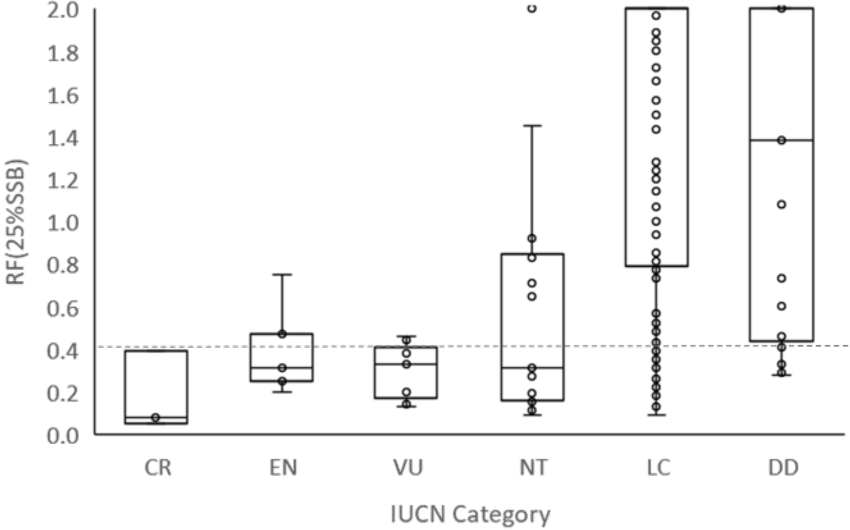
| | | | | |
|---|---|---|---|---|
| *Torpedo marmorata* | **-0.044 (0.016, P=0.0140)** | -0.018 (0.018, P=0.3358) | | 1/1 |

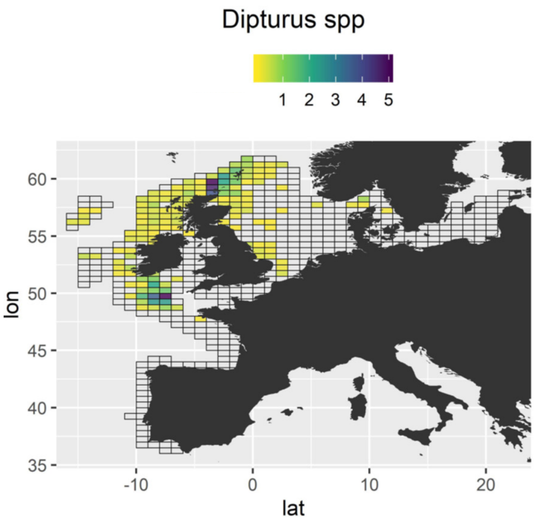
Figure 1. $F_{25\%SSB}$ for each IUCN category (Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC) and Data Deficient (DD)) All values of $F_{25\%SSB}$ >2 are shown as 2. Dotted line signifies the limit between sensitive and non-sensitive species ($F_{25\%SSB}$ = 0.43).

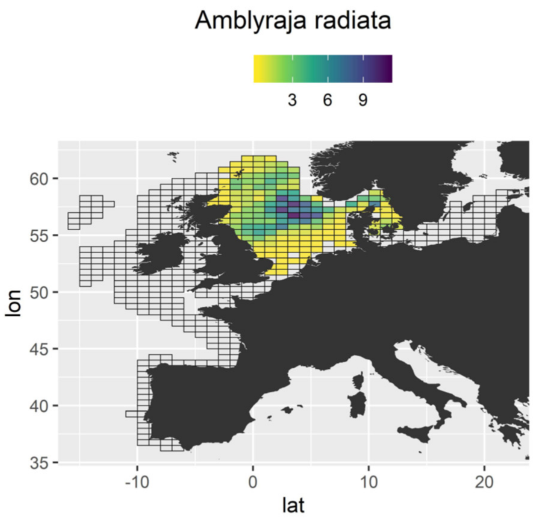
Figure 2. Distribution (colour) of selected sensitive species and extent of surveyed area (grey rectangles). Left panel top to bottom: Increasing species - Common skate complex (*Dipturus* spp.), ling (*Molva molva*), and lesser-spotted dogfish (*Scyliorhinus canicula*). Right panel top to bottom: decreasing species - Starry ray (*Amblyraja radiata*), Atlantic wolf-fish (*Anarhichas lupus*) and tusk (*Brosme brosme*). Distribution data are scaled to a mean of 1 in the period 2009 to 2018. The distribution of the remaining species can be found in the supplementary material.

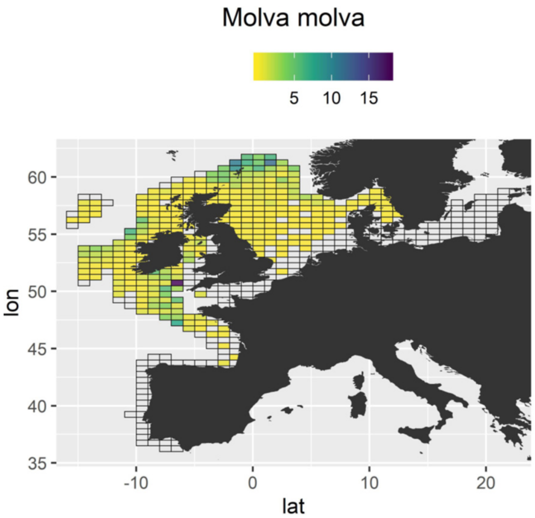
Figure 3. Development of species indicators for individual surveys. Each line is one survey annual index.

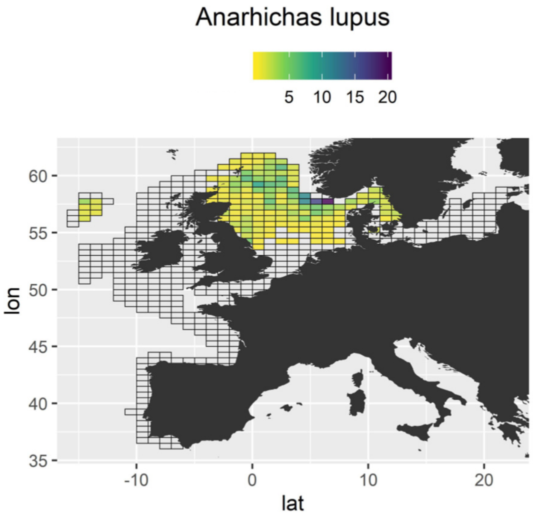
Figure 4. Development of species indicators integrated across surveys and areas. Each point is one survey annual index, black line is a loess fit and grey lines are the 95% confidence intervals of the fitted line. Note that the points are not weighted evenly when estimating the loess, hence the line is not identical to the mean of the points.

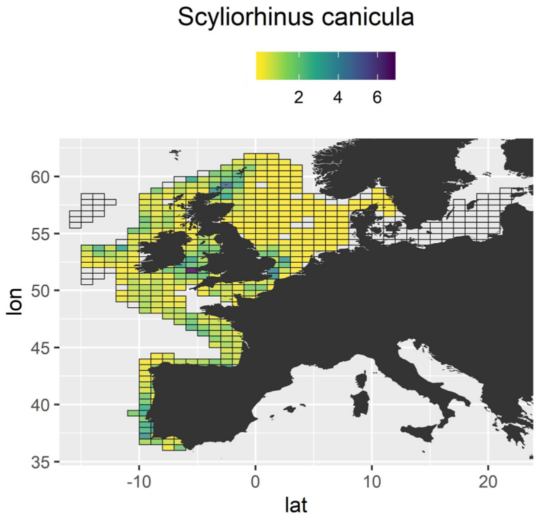

RF(25%SSB)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
CR
EN
VU
NT
LC
DD
IUCN Category

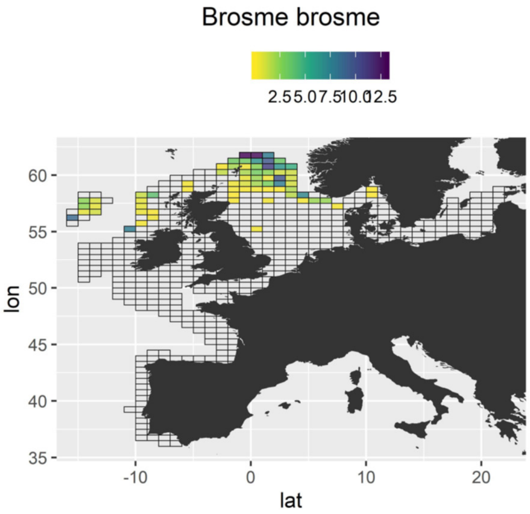

Dipturus spp

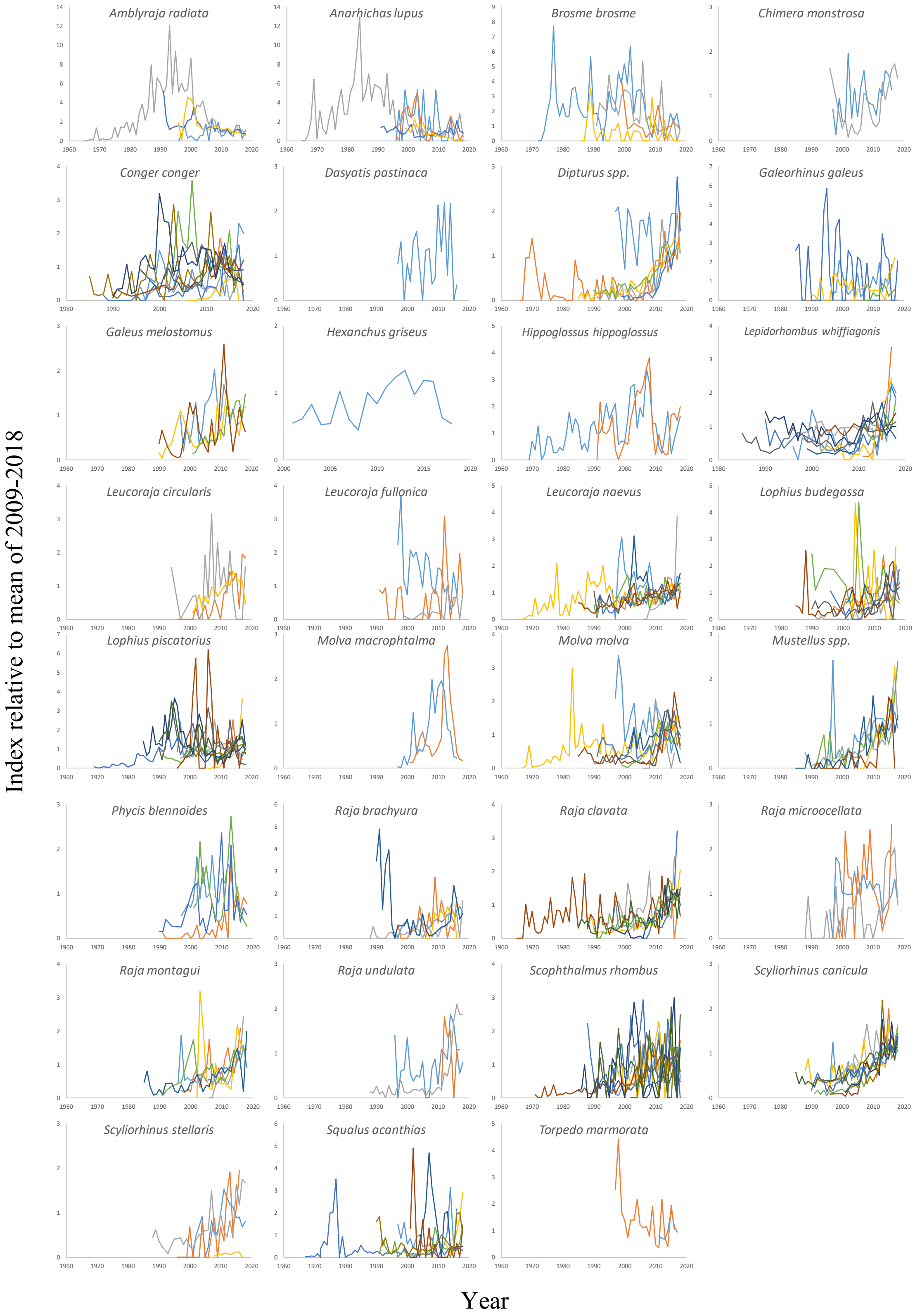

Amblyraja radiata

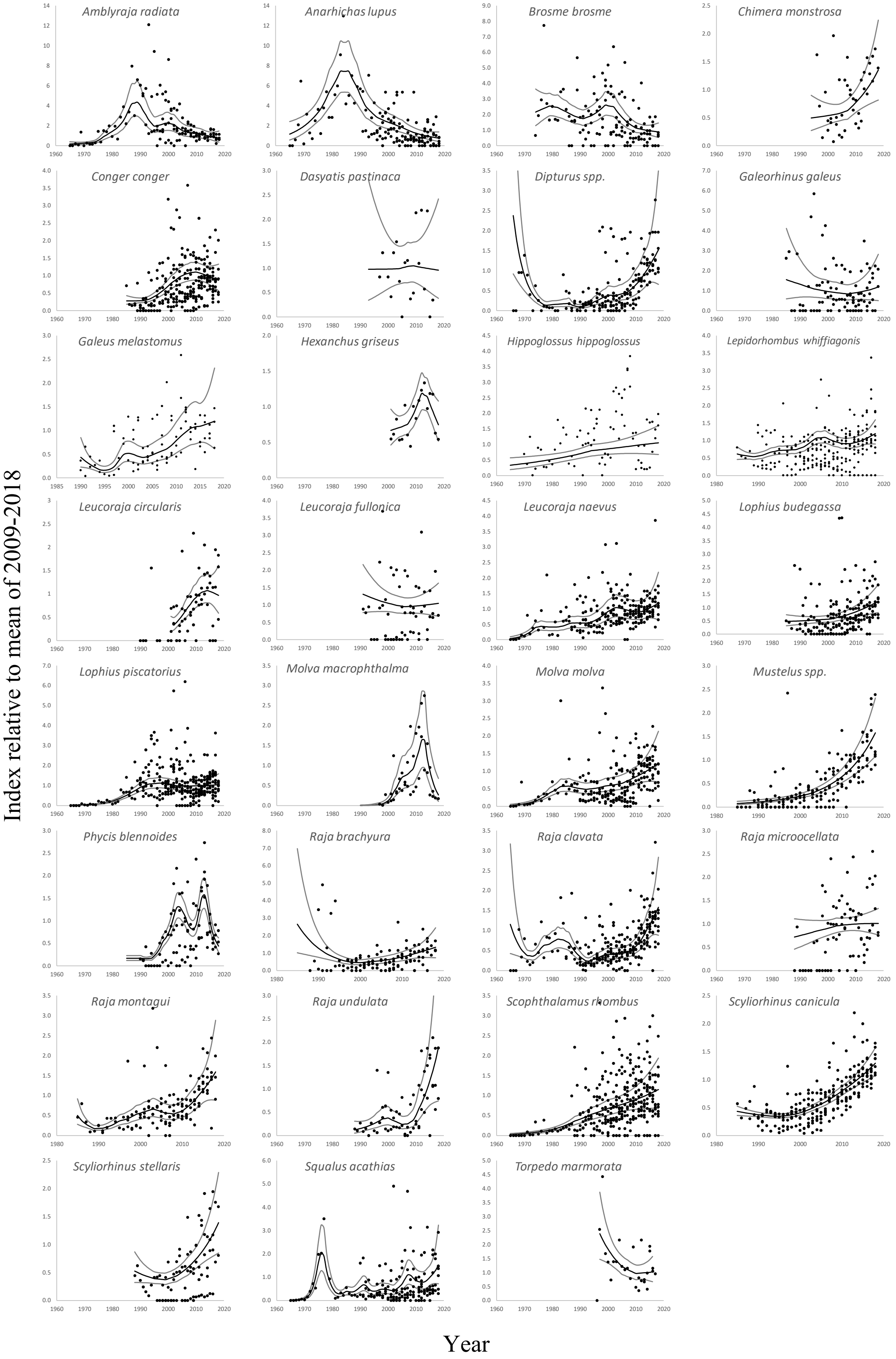

Molva molva


Anarhichas lupus


Scyliorhinus canicula


Brosme brosme


Index relative to mean of 2009-2018
Amblyraja radiata
Anarhichas lupus
Brosme brosme
Chimera monstrosa
Conger conger
Dasyatis pastinaca
Dipturus spp.
Galeorhinus galeus
Galeus melastomus
Hexanchus griseus
Hippoglossus hippoglossus
Lepidorhombus whiffiagonis
Leucoraja circularis
Leucoraja fullonica
Leucoraja naevus
Lophius budegassa
Lophius piscatorius
Molva macrophtalma
Molva molva
Mustellus spp.
Phycis blennoides
Raja brachyura
Raja clavata
Raja microocellata
Raja montagui
Raja undulata
Scophthalmus rhombus
Scyliorhinus canicula
Scyliorhinus stellaris
Squalus acanthias
Torpedo marmorata
Year


Amblyraja radiata
Anarhichas lupus
Brosme brosme
Chimera monstrosa
Conger conger
Dasyatis pastinaca
Dipturus spp.
Galeorhinus galeus
Galeus melastomus
Hexanchus griseus
Hippoglossus hippoglossus
Lepidorhombus whiffiagonis
Leucoraja circularis
Leucoraja fullonica
Leucoraja naevus
Lophius budegassa
Lophius piscatorius
Molva macrophthalma
Molva molva
Mustelus spp.
Phycis blennoides
Raja brachyura
Raja clavata
Raja microocellata
Raja montagui
Raja undulata
Scophthalamus rhombus
Scyliorhinus canicula
Scyliorhinus stellaris
Squalus acathias
Torpedo marmorata
Index relative to mean of 2009-2018
Year

# Supporting Information

## Rindorf et al.: Are fish sensitive to trawling recovering in the Northeast Atlantic?

Table S1. Species groups used for calculating exploitation pattern. From Walker et al. (2017).

| **Species group** | **Group description** |
|---|---|
| **1** | Predominately buried in sediment |
| **2** | On or near the seabed – eel-like |
| **3** | Predominantly on the seabed – flat |
| **4** | Predominantly close to the seabed, but not on it |
| **5** | Midwater species with some seabed association |
| **6** | Pelagic |
| **7** | Predominantly on seabed – lumpiform |

Table S2. Life history parameters, type of exploitation pattern, species group and fishing mortality factor, $F_{25\%SSB}$, necessary to reduce the spawning stock biomass, *SSB*, to 25% of its unfished level. For species with clear sexual dimorphism in $L_{max}$, $L_\infty$ or $K$ (e.g. *Callionymus lyra*), the parameters for females were used, if available.

| Species | $L_{max}$ | $L_\infty$ | $K$ | $L_{mat}$ | $L_{min}$ | Exploitation pattern | Reproduction | Taxonomy | $F_{25\%SSB}$ | IUCN |
|---|---|---|---|---|---|---|---|---|---|---|
| *Rostroraja alba* | | 200 | 0.04 | 129.4 | | 3 | Oviparous | Elasmobranchii | 0.05 | CR |
| *Dipturus batis*-complex | | 254 | 0.057 | 130 | 31 | 3 | Oviparous | Elasmobranchii | 0.08 | CR |
| *Somniosus microcephalus* | | 546 | | 400 | 40 | 7 | Viviparous | Elasmobranchii | 0.09 | NT |
| *Conger conger* | | 265 | 0.07 | | 12.5 | 2 | Oviparous | Actinopterygia | 0.10 | LC |
| *Dipturus nidarosiensis* | 200 | | | 135 | | 3 | Oviparous | Elasmobranchii | 0.11 | NT |
| *Dipturus oxyrinchus* | | 256 | 0.04 | 83 | 17 | 4 | Oviparous | Elasmobranchii | 0.13 | NT |
| *Hexanchus griseus* | 458 | | | 420 | 70 | 4 | Viviparous | Elasmobranchii | 0.13 | LC |
| *Hippoglossus hippoglossus* | | 204 | 0.1 | 112 | 2 | 3 | Oviparous | Actinopterygia | 0.13 | VU |
| *Dasyatis pastinaca* | | 120 | 0.086 | 63 | 20 | 3 | Viviparous | Elasmobranchii | 0.14 | VU |
| *Raja clavata* | | 140 | 0.093 | 72 | 12 | 3 | Oviparous | Elasmobranchii | 0.15 | NT |
| *Rajella lintea* | 114 | | | 97 | | 3 | Oviparous | Elasmobranchii | 0.16 | LC |
| *Lophius piscatorius* | | 167 | 0.077 | 86 | 2 | 7 | Oviparous | Actinopterygia | 0.16 | LC |
| *Molva molva* | | 183 | 0.118 | 95 | 2 | 2 | Oviparous | Actinopterygia | 0.18 | LC |
| *Raja brachyura* | | 155 | 0.129 | 84 | 15 | 3 | Oviparous | Elasmobranchii | 0.19 | NT |
| *Raja microocellata* | 91 | | | 78 | 13 | 3 | Oviparous | Elasmobranchii | 0.20 | NT |
| *Leucoraja circularis* | 117 | | | | | 3 | Oviparous | Elasmobranchii | 0.20 | EN |
| *Leucoraja fullonica* | 120 | | | | | 3 | Oviparous | Elasmobranchii | 0.20 | VU |
| *Molva dypterygia* | | 155 | 0.126 | 88 | 2 | 2 | Oviparous | Actinopterygia | 0.20 | VU |
| *Raja undulata* | | 113 | 0.149 | 86 | 14 | 3 | Oviparous | Elasmobranchii | 0.20 | NT |
| *Amblyraja hyperborea* | 112 | | | | 17 | 3 | Oviparous | Elasmobranchii | 0.22 | LC |
| *Lophius budegassa* | | 94 | 0.10 | 54 | 2 | 7 | Oviparous | Actinopterygia | 0.22 | LC |
| *Scyliorhinus stellaris* | 162 | | | | 16 | 7 | Oviparous | Elasmobranchii | 0.22 | NT |
| *Deania calcea* | | 119 | 0.08 | 105 | 32 | 5 | Viviparous | Elasmobranchii | 0.25 | EN |
| *Brosme brosme* | | 84 | 0.109 | 48 | 2 | 7 | Oviparous | Actinopterygia | 0.26 | LC |
| *Coryphaenoides rupestris* | | 76 | 0.1 | 47 | 2 | 4 | Oviparous | Actinopterygia | 0.26 | EN |

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|---|---|---|---|---|---|---|---|---|---|---|
| *Mora moro* | | 74 | 0.05 | | 2 | 5 | Oviparous | Actinopterygia | 0.26 | LC |
| *Rajella bathyphila* | 90 | | | | | 3 | Oviparous | Elasmobranchii | 0.26 | LC |
| *Anarhichas minor* | | 107 | 0.158 | 83 | 2 | 7 | Oviparous | Actinopterygia | 0.27 | NT |
| *Raja montagui* | | 73 | 0.18 | 60 | 12 | 3 | Oviparous | Elasmobranchii | 0.27 | LC |
| *Chimaera monstrosa* | | 64 | 0.10 | 46 | 10 | 4 | Oviparous | Holocephali | 0.28 | NT |
| *Macrourus berglax* | | 62 | 0.04 | 28.5 | 2 | 5 | Oviparous | Actinopterygia | 0.28 | LC |
| *Phycis blennoides* | | 113 | 0.0886 | 33 | 2 | 7 | Oviparous | Actinopterygia | 0.28 | DD |
| *Brama brama* | | 71 | 0.08 | | 2 | 4 | Oviparous | Actinopterygia | 0.29 | LC |
| *Dicentrarchus punctatus* | | 103 | 0.07 | | 2 | 5 | Oviparous | Actinopterygia | 0.29 | LC |
| *Dasyatis tortonesei* | 250 | | | 60 | 20 | 4 | Viviparous | Elasmobranchii | 0.30 | NA |
| *Etmopterus princeps* | 75 | | | 61 | 18 | 4 | Viviparous | Elasmobranchii | 0.32 | LC |
| *Polyprion americanus* | | 152 | 0.07 | 77.9 | 2 | 5 | Oviparous | Actinopterygia | 0.31 | NT |
| *Scyliorhinus canicula* | | 75 | 0.15 | 57 | 9 | 7 | Oviparous | Elasmobranchii | 0.31 | LC |
| *Squalus acanthias* | | 121 | 0.07 | 63 | 27.5 | 5 | Viviparous | Elasmobranchii | 0.31 | EN |
| *Leucoraja naevus* | | 84 | 0.197 | 56 | 11.9 | 3 | Oviparous | Elasmobranchii | 0.32 | LC |
| *Molva macrophthalma* | 108 | | | | 2 | 4 | Oviparous | Actinopterygia | 0.34 | LC |
| *Scophthalmus rhombus* | | 85 | 0.15 | 37 | 2 | 3 | Oviparous | Actinopterygia | 0.32 | LC |
| *Dalatias licha* | | 165 | 0.15 | 138 | 42 | 4 | Viviparous | Elasmobranchii | 0.33 | EN |
| *Epigonus telescopus* | 75 | | | 56 | 2 | 4 | Oviparous | Actinopterygia | 0.33 | DD |
| *Galeorhinus galeus* | | 163 | 0.075 | | | 5 | Viviparous | Elasmobranchii | 0.33 | VU |
| *Mustelus mustelus/asterias* | | 124 | 0.146 | 85 | 30 | 4 | Viviparous | Elasmobranchii | 0.33 | VU |
| *Scorpaena scrofa* | | 62 | 0.081 | 29 | 2 | 7 | Oviparous | Actinopterygia | 0.33 | LC |
| *Synaphobranchus kaupi* | 100 | | | | 2 | 4 | Oviparous | Actinopterygia | 0.35 | LC |
| *Torpedo marmorata* | | 57 | 0.187 | 44 | 12 | 3 | Viviparous | Elasmobranchii | 0.34 | LC |
| *Lepidorhombus whiffiagonis* | | 61 | 0.142 | 31 | 2 | 3 | Oviparous | Actinopterygia | 0.35 | LC |
| *Lamna nasus* | | 333 | 0.061 | 245 | 79 | 6 | Viviparous | Elasmobranchii | 0.39 | CR |
| *Rajella fyllae* | 60 | | | | 8 | 3 | Oviparous | Elasmobranchii | 0.40 | LC |
| *Amblyraja radiata* | | 66 | 0.23 | 46 | 10 | 3 | Oviparous | Elasmobranchii | 0.40 | LC |
| *Argyrosomus regius* | | 172 | 0.15 | 90 | 2 | 4 | Oviparous | Actinopterygia | 0.40 | LC |

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|---|---|---|---|---|---|---|---|---|---|---|
| *Anarhichas lupus* | | 91 | 0.23 | 73 | 2 | 7 | Oviparous | Actinopterygia | 0.41 | DD |
| *Ephippion guttifer* | 80 | | | | 2 | 4 | Oviparous | Actinopterygia | 0.42 | DD |
| *Galeus melastomus* | 67 | | | 45 | | 7 | Oviparous | Elasmobranchii | 0.44 | LC |
| *Torpedo nobiliana* | 180 | | | | 23 | 5 | Viviparous | Elasmobranchii | 0.44 | LC |
| *Pollachius virens* | | 107 | 0.19 | 71 | 2 | 4 | Oviparous | Actinopterygia | 0.43 | LC |
| *Sparus aurata* | | 85 | 0.13 | 36.5 | 2 | 4 | Oviparous | Actinopterygia | 0.43 | LC |
| *Myliobatis aquila* | 183 | | | | | 5 | Viviparous | Elasmobranchii | 0.40 | VU |
| *Scophthalmus maximus* | | 65 | 0.26 | 46 | 2 | 3 | Oviparous | Actinopterygia | 0.46 | VU |
| *Solea senegalensis* | | 55 | 0.18 | | 2 | 3 | Oviparous | Actinopterygia | 0.46 | DD |
| *Cetorhinus maximus* | | 1000 | 0.062 | 500 | 175 | 6 | Viviparous | Elasmobranchii | 0.47 | EN |
| *Dicentrarchus labrax* | | 85 | 0.097 | 43 | 2 | 5 | Oviparous | Actinopterygia | 0.49 | LC |
| *Merluccius merluccius* | | 130 | 0.16 | 50 | 2 | 4 | Oviparous | Actinopterygia | 0.49 | LC |
| *Pollachius pollachius* | | 86 | 0.186 | 47 | 2 | 4 | Oviparous | Actinopterygia | 0.49 | LC |
| *Nettastoma melanurum* | 80 | | | 53.5 | 2 | 1 | Oviparous | Actinopterygia | 0.50 | LC |
| *Dentex gibbosus* | | 98 | 0.15 | 34.7 | 2 | 4 | Oviparous | Actinopterygia | 0.51 | LC |
| *Paralichthys dentatus* | | 82 | 0.24 | 37 | 2 | 3 | Oviparous | Actinopterygia | 0.52 | LC |
| *Lepidorhombus boscii* | | 46 | 0.15 | | 2 | 3 | Oviparous | Actinopterygia | 0.53 | LC |
| *Trachipterus arcticus* | | 303 | | | 2 | 6 | Oviparous | Actinopterygia | 0.54 | LC |
| *Scymnodon ringens* | 110 | | | | | 5 | Viviparous | Elasmobranchii | 0.57 | LC |
| *Myoxocephalus quadricornis* | | 62 | 0.16 | | 2 | 7 | Oviparous | Actinopterygia | 0.58 | LC |
| *Etmopterus pusillus* | | 51 | 0.13 | 44.58 | | 4 | Viviparous | Elasmobranchii | 0.60 | DD |
| *Pagellus bogaraveo* | | 51 | 0.14 | 40 | 2 | 4 | Oviparous | Actinopterygia | 0.71 | NT |
| *Gadus morhua* | | 119 | 0.27 | 59 | 2 | 4 | Oviparous | Actinopterygia | 0.73 | LC |
| *Helicolenus dactylopterus* | | 31 | 0.09 | 23 | 2 | 7 | Oviparous | Actinopterygia | 0.74 | LC |
| *Alopias vulpinus* | | 484 | 0.11 | 303 | 92 | 6 | Viviparous | Elasmobranchii | 0.75 | EN |
| *Glyptocephalus cynoglossus* | | 44 | 0.2 | | 2 | 3 | Oviparous | Actinopterygia | 0.76 | LC |
| *Chelon labrosus* | | 61 | 0.12 | | 2 | 5 | Oviparous | Actinopterygia | 0.77 | LC |
| *Deania profundorum* | 79 | | | | | 5 | Viviparous | Elasmobranchii | 0.79 | LC |
| *Gnathophis mystax* | 60 | | | | 2 | 1 | Oviparous | Actinopterygia | 0.80 | LC |

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|---|---|---|---|---|---|---|---|---|---|---|
| *Malacocephalus laevis* | 60 | | | | 2 | 2 | Oviparous | Actinopterygia | 0.80 | LC |
| *Merlangius merlangus* | | 74 | 0.16 | 28 | 2 | 4 | Oviparous | Actinopterygia | 0.78 | LC |
| *Myxine glutinosa* | 80 | | | 25 | 2 | 1 | Oviparous | Agnatha | 0.80 | LC |
| *Diplodus cervinus* | | 58 | 0.15 | 28.4 | 2 | 1 | Oviparous | Actinopterygia | 0.80 | LC |
| *Dentex canariensis* | | 85 | 0.15 | 20 | 2 | 4 | Oviparous | Actinopterygia | 0.83 | LC |
| *Eutrigla gurnardus* | | 46 | 0.16 | 25 | 2 | 7 | Oviparous | Actinopterygia | 0.83 | LC |
| *Etmopterus spinax* | | 56 | 0.12 | 31 | 11 | 4 | Viviparous | Elasmobranchii | 0.83 | NT |
| *Thunnus thynnus* | | 319 | 0.093 | 104 | 2 | 6 | Oviparous | Actinopterygia | 0.83 | NT |
| *Callanthias ruber* | 60 | | | | 2 | 4 | Oviparous | Actinopterygia | 0.84 | LC |
| *Prionace glauca* | | 371 | 0.13 | 221 | 40 | 6 | Viviparous | Elasmobranchii | 0.85 | NT |
| *Xiphias gladius* | | 264 | 0.12 | 145 | 2 | 6 | Oviparous | Actinopterygia | 0.85 | LC |
| *Chelon aurata* | | 69 | 0.14 | 34 | 2 | 5 | Oviparous | Actinopterygia | 0.86 | LC |
| *Pleuronectes platessa* | | 48 | 0.23 | 23 | 2 | 3 | Oviparous | Actinopterygia | 0.87 | LC |
| *Cyclopterus lumpus* | | 53 | 0.26 | 35 | 2 | 7 | Oviparous | Actinopterygia | 0.92 | NT |
| *Neoraja iberica* | 33 | | | 28 | | 3 | Oviparous | Elasmobranchii | 0.97 | LC |
| *Beryx decadactylus* | | 68 | 0.11 | 21.8 | 2 | 5 | Oviparous | Actinopterygia | 0.95 | LC |
| *Lepidopus caudatus* | | 195 | 0.23 | | 2 | 5 | Oviparous | Actinopterygia | 1.00 | LC |
| *Trachinus draco* | | 38 | 0.15 | | 2 | 1 | Oviparous | Actinopterygia | 1.07 | LC |
| *Mola mola* | | 318 | 0.15 | | 2 | 6 | Oviparous | Actinopterygia | 1.08 | DD |
| *Lycodes vahlii* | 52 | | | | 2 | 2 | Oviparous | Actinopterygia | 1.16 | NA |
| *Pagellus erythrinus* | | 47 | 0.084 | 17 | 2 | 5 | Oviparous | Actinopterygia | 1.14 | LC |
| *Beryx splendens* | | 50 | 0.17 | 33 | 2 | 5 | Oviparous | Actinopterygia | 1.16 | LC |
| *Halargyreus johnsonii* | 56 | | | | 2 | 5 | Oviparous | Actinopterygia | 1.24 | LC |
| *Pegusa lascaris* | | 39 | 0.251 | 22 | 2 | 3 | Oviparous | Actinopterygia | 1.22 | LC |
| *Macroparalepis affinis* | 55 | | | | 2 | 5 | Oviparous | Actinopterygia | 1.28 | NA |
| *Lepidion eques* | | 42 | 0.15 | 29.5 | 2 | 5 | Oviparous | Actinopterygia | 1.28 | LC |
| *Chaunax pictus* | 40 | | | | 2 | 7 | Oviparous | Actinopterygia | 1.29 | LC |
| *Solea solea* | | 39 | 0.32 | 24 | 2 | 3 | Oviparous | Actinopterygia | 1.38 | DD |
| *Trigla lyra* | | 52 | 0.21 | | 2 | 2 | Oviparous | Actinopterygia | 1.38 | DD |

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|---|---|---|---|---|---|---|---|---|---|---|
| *Benthodesmus elongatus* | 100 | | | | 2 | 6 | Oviparous | Actinopterygia | 1.43 | NA |
| *Chelon ramada* | | 47 | 0.15 | 25 | 2 | 5 | Oviparous | Actinopterygia | 1.43 | LC |
| *Galeus atlanticus* | 46 | | | 36.9 | | 4 | Oviparous | Elasmobranchii | 1.45 | NT |
| *Gaidropsarus vulgaris* | | 46 | | 27 | 2 | 2 | Oviparous | Actinopterygia | 1.50 | LC |
| *Sarpa salpa* | | 50 | 0.20 | 29.4 | 2 | 5 | Oviparous | Actinopterygia | 1.57 | LC |
| *Trachyrincus murrayi* | 45 | | | | 2 | 2 | Oviparous | Actinopterygia | 1.64 | LC |
| *Platichthys flesus* | | 39 | 0.25 | 18 | 2 | 3 | Oviparous | Actinopterygia | 1.66 | LC |
| *Umbrina canariensis* | | 57 | 0.26 | | 2 | 4 | Oviparous | Actinopterygia | 1.72 | LC |
| *Enchelyopus cimbrius* | 41 | | | 25 | 2 | 2 | Oviparous | Actinopterygia | 1.85 | LC |
| *Pagrus pagrus* | | 60 | 0.17 | 22.6 | 2 | 4 | Oviparous | Actinopterygia | 1.86 | LC |
| *Microchirus azevia* | | 34 | 0.35 | 23 | 2 | 3 | Oviparous | Actinopterygia | 1.89 | LC |
| *Chelidonichthys obscurus* | 51 | | | | 2 | 4 | Oviparous | Actinopterygia | 1.92 | LC |
| *Microstomus kitt* | | 35 | 0.1955 | 16 | 2 | 3 | Oviparous | Actinopterygia | 2.00 | LC |
| *Chelidonichthys lucerna* | | 52 | 0.25 | 28 | 2 | 5 | Oviparous | Actinopterygia | 2.03 | LC |
| *Gaidropsarus mediterraneus* | 50 | | | | 2 | 4 | Oviparous | Actinopterygia | 2.04 | LC |
| *Mugil cephalus* | | 49 | 0.302 | 33 | 2 | 5 | Oviparous | Actinopterygia | 2.08 | LC |
| *Lumpenus lampretaeformis* | | 48 | 0.205 | 20 | 2 | 2 | Oviparous | Actinopterygia | 2.13 | LC |
| *Cepola macrophthalma* | | 61 | 0.23 | 23.8 | 2 | 4 | Oviparous | Actinopterygia | 2.17 | LC |
| *Chelidonichthys cuculus* | | 41 | 0.24 | 28 | 2 | 5 | Oviparous | Actinopterygia | 2.19 | LC |
| *Hoplostethus mediterraneus* | | 30 | 0.11 | 16.5 | 2 | 5 | Oviparous | Actinopterygia | 2.20 | LC |
| *Citharus linguatula* | | 30 | 0.19 | | 2 | 3 | Oviparous | Actinopterygia | 2.23 | LC |
| *Chauliodus sloani* | 40 | | | | 2 | 5 | Oviparous | Actinopterygia | 2.51 | LC |
| *Limanda limanda* | | 33 | 0.19 | 14 | 2 | 3 | Oviparous | Actinopterygia | 2.53 | LC |
| *Zeus faber* | | 51 | 0.47 | 36 | 2 | 4 | Oviparous | Actinopterygia | 3.01 | DD |
| *Myoxocephalus scorpioides* | 30 | | | | 2 | 7 | Oviparous | Actinopterygia | 3.11 | NA |
| *Raniceps raninus* | 30 | | | | 2 | 7 | Oviparous | Actinopterygia | 3.11 | LC |
| *Lampanyctus crocodilus* | 36 | | | | 2 | 5 | Oviparous | Actinopterygia | 3.16 | LC |
| *Labrus bergylta* | | 44 | 0.103 | | 2 | 4 | Oviparous | Actinopterygia | 3.16 | LC |
| *Diplodus sargus* | | 50 | 0.13 | 21.6 | 2 | 4 | Oviparous | Actinopterygia | 3.21 | LC |

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|---|---|---|---|---|---|---|---|---|---|---|
| *Trachyrincus scabrus* | | 49 | 0.22 | | 2 | 4 | Oviparous | Actinopterygia | 3.24 | LC |
| *Scorpaena porcus* | | 29 | 0.16 | 13.8 | 2 | 7 | Oviparous | Actinopterygia | 3.31 | LC |
| *Micromesistius poutassou* | | 33 | 0.24 | 21 | 2 | 5 | Oviparous | Actinopterygia | 3.45 | LC |
| *Zeugopterus punctatus* | 28 | | | | 2 | 3 | Oviparous | Actinopterygia | 3.49 | LC |
| *Nezumia sclerorhynchus* | | 26 | 0.16 | 15 | 2 | 5 | Oviparous | Actinopterygia | 3.62 | LC |
| *Argentina silus* | | 43 | 0.19 | 29 | 2 | 4 | Oviparous | Actinopterygia | 4.05 | NA |
| *Zoarces viviparus* | | 35 | 0.37 | 17 | 5 | 7 | Viviparous | Actinopterygia | 4.19 | LC |
| *Cyttopsis rosea* | 31 | | | | 2 | 5 | Oviparous | Actinopterygia | 4.21 | DD |
| *Echiodon drummondii* | 30 | | | | 2 | 2 | Oviparous | Actinopterygia | 4.23 | LC |
| *Arnoglossus imperialis* | 25 | | | | 2 | 3 | Oviparous | Actinopterygia | 5.78 | LC |
| *Polymetme corythaeola* | 26 | | | | 2 | 5 | Oviparous | Actinopterygia | 5.92 | LC |
| *Acantholabrus palloni* | 25 | | | | 2 | 5 | Oviparous | Actinopterygia | 6.33 | LC |
| *Sarda sarda* | | 81 | 0.35 | 37 | 2 | 6 | Oviparous | Actinopterygia | 6.84 | LC |
| *Entelurus aequoreus* | 60 | | | | 2 | 6 | Oviparous | Actinopterygia | 7.11 | LC |
| *Trigloporus lastoviza* | | 28 | 0.409 | 16 | 2 | 7 | Oviparous | Actinopterygia | 7.24 | DD |
| *Mullus surmuletus* | | 51 | 0.19 | 17 | 2 | 4 | Oviparous | Actinopterygia | 7.63 | DD |
| *Hippoglossoides platessoides* | | 25 | 0.34 | 15 | 2 | 3 | Oviparous | Actinopterygia | 7.65 | LC |
| *Chlorophthalmus agassizi* | | 19 | 0.24 | | 2 | 5 | Oviparous | Actinopterygia | 7.86 | LC |
| *Caranx rhonchus* | | 45 | 0.30 | | 2 | 4 | Oviparous | Actinopterygia | 7.92 | DD |
| *Polymetme thaeocoryla* | 22 | | | | 2 | 5 | Oviparous | Actinopterygia | 7.97 | LC |
| *Notoscopelus kröyeri* | | 15 | 0.20 | | 2 | 5 | Oviparous | Actinopterygia | 8.04 | NA |
| *Balistes capriscus* | | 46 | 0.33 | | 2 | 4 | Oviparous | Actinopterygia | 8.10 | DD |
| *Dicologlossa cuneata* | | 27 | 0.42 | 15 | 2 | 3 | Oviparous | Actinopterygia | 8.14 | LC |
| *Spondyliosoma cantharus* | | 41 | 0.11 | 20 | 2 | 4 | Oviparous | Actinopterygia | 8.48 | LC |
| *Lestidiops jayakari* | 20 | | | | 2 | 5 | Oviparous | Actinopterygia | 8.97 | LC |
| *Melanogrammus aeglefinus* | | 50 | 0.30 | 20 | 2 | 4 | Oviparous | Actinopterygia | 8.87 | LC |
| *Chirolophis ascanii* | 18 | | | | 2 | 5 | Oviparous | Actinopterygia | 10.41 | LC |
| *Nezumia aequalis* | | 16 | 0.18 | 4.5 | 2 | 5 | Oviparous | Actinopterygia | 10.53 | LC |
| *Gaidropsarus biscayensis* | 40 | | | | 2 | 4 | Oviparous | Actinopterygia | 10.55 | LC |

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|---|---|---|---|---|---|---|---|---|---|---|
| *Pholis gunnellus* | | 22 | 0.1986 | 10 | 2 | 2 | Oviparous | Actinopterygia | 11.00 | LC |
| *Trisopterus luscus* | | 47 | 0.21 | 18 | 2 | 4 | Oviparous | Actinopterygia | 11.28 | LC |
| *Belone belone* | | 58 | 0.468 | 45 | 2 | 6 | Oviparous | Actinopterygia | 12.64 | LC |
| *Coelorinchus caelorhincus* | | 39 | 0.15 | | 2 | 4 | Oviparous | Actinopterygia | 12.85 | DD |
| *Gadiculus argenteus* | 15 | | | | 2 | 5 | Oviparous | Actinopterygia | 12.96 | LC |
| *Leptoclinus maculatus* | 20 | | | | 2 | 2 | Oviparous | Actinopterygia | 14.20 | LC |
| *Echiichthys vipera* | | 15 | 0.33 | | 2 | 1 | Oviparous | Actinopterygia | 15.69 | LC |
| *Sebastes viviparus* | | 36 | 0.07 | 15 | 2 | 4 | Viviparous | Actinopterygia | 16.88 | LC |
| *Serranus cabrilla* | | 39 | 0.10 | 15.4 | 2 | 4 | Oviparous | Actinopterygia | 16.97 | LC |
| *Blennius ocellaris* | 20 | | | | 2 | 7 | Oviparous | Actinopterygia | 17.13 | LC |
| *Trachurus picturatus* | | 50 | 0.11 | 27.7 | 2 | 6 | Oviparous | Actinopterygia | 17.59 | LC |
| *Trisopterus esmarkii* | | 20 | 0.71 | 14 | 2 | 5 | Oviparous | Actinopterygia | 18.27 | LC |
| *Microchirus variegatus* | | 21 | 0.374 | 14 | 2 | 3 | Oviparous | Actinopterygia | 18.33 | LC |
| | | | | | | | | | | |
| *Agonus cataphractus* | | 15 | 0.475 | | 2 | 7 | Oviparous | Actinopterygia | 20.00 | LC |
| *Anthias anthias* | 27 | | | | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |
| *Aphia minuta* | | 9 | 2.23 | 5 | 2 | 6 | Oviparous | Actinopterygia | 20.00 | LC |
| *Arctozenus risso* | 30 | | | | 2 | 6 | Oviparous | Actinopterygia | 20.00 | LC |
| *Argentina sphyraena* | | 22 | 0.28 | | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |
| *Argyropelecus olfersii* | 9 | | | | 2 | 5 | Oviparous | Actinopterygia | 20.00 | LC |
| *Arnoglossus laterna* | | 16 | 0.84 | 11 | 2 | 3 | Oviparous | Actinopterygia | 20.00 | LC |
| *Arnoglossus rueppelii* | 15 | | | | 2 | 3 | Oviparous | Actinopterygia | 20.00 | DD |
| *Arnoglossus thori* | | 18 | 0.51 | 12 | 2 | 3 | Oviparous | Actinopterygia | 20.00 | DD |
| *Atherina presbyter* | | 16 | 0.138 | 7 | 2 | 6 | Oviparous | Actinopterygia | 20.00 | LC |
| *Auxis rochei rochei* | | 46 | 0.70 | | 2 | 6 | Oviparous | Actinopterygia | 20.00 | LC |
| *Bathysolea profundicola* | | 15 | 0.58 | | 2 | 3 | Oviparous | Actinopterygia | 20.00 | LC |
| *Benthosema glaciale* | | 7 | 0.36 | | 2 | 6 | Oviparous | Actinopterygia | 20.00 | LC |
| *Boops boops* | | 36 | 0.17 | 14.3 | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |

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|---|---|---|---|---|---|---|---|---|---|---|
| *Buenia jeffreysii* | 6 | | | | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |
| *Buglossidium luteum* | | 12 | 0.54 | 8 | 2 | 1 | Oviparous | Actinopterygia | 20.00 | LC |
| *Callionymus lyra* | | 18 | 0.55 | | 2 | 7 | Oviparous | Actinopterygia | 20.00 | LC |
| *Capros aper* | | 17 | 0.145 | 10 | 2 | 6 | Oviparous | Actinopterygia | 20.00 | LC |
| *Centrolabrus exoletus* | | 13 | 0.69 | 11 | 2 | 5 | Oviparous | Actinopterygia | 20.00 | LC |
| *Ceratoscopelus maderensis* | 8 | | | | 2 | 5 | Oviparous | Actinopterygia | 20.00 | LC |
| *Clupea harengus* | | 30 | 0.33 | 26 | 2 | 6 | Oviparous | Actinopterygia | 20.00 | LC |
| *Cottunculus microps* | 30 | | | | 2 | 4 | Oviparous | Actinopterygia | 20.00 | DD |
| *Crystallogobius linearis* | | 5 | | | 2 | 6 | Oviparous | Actinopterygia | 20.00 | LC |
| *Ctenolabrus rupestris* | | 15 | 0.297 | | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |
| *Dentex maroccanus* | | 32 | 0.18 | 16 | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |
| *Diplecogaster bimaculata* | 6 | | | | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |
| *Diplodus annularis* | | 25 | 0.24 | 13 | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |
| *Diplodus bellottii* | | 26 | 0.27 | | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |
| *Diplodus vulgaris* | | 28 | 0.39 | 17.65 | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |
| *Engraulis encrasicolus* | | 23 | 0.44 | 12 | 2 | 6 | Oviparous | Actinopterygia | 20.00 | LC |
| *Epigonus denticulatus* | 20 | | | | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |
| *Gadella maraldi* | 30 | | | | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |
| *Gaidropsarus argentatus* | 35 | | | | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |
| *Gaidropsarus macropthalmus* | 25 | | | | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |
| *Gasterosteus aculeatus* | | 8 | 0.67 | | 2 | 6 | Oviparous | Actinopterygia | 20.00 | LC |
| *Gobius gasteveni* | 12 | | | | 2 | 2 | Oviparous | Actinopterygia | 20.00 | LC |
| *Gobius paganellus* | | 14 | 0.73 | | 2 | 2 | Oviparous | Actinopterygia | 20.00 | LC |
| *Hygophum benoiti* | 6 | | | | 2 | 6 | Oviparous | Actinopterygia | 20.00 | LC |
| *Hymenocephalus italicus* | | 6 | 0.18 | 2.7 | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |
| *Icelus bicornis* | 19 | | | | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |
| *Labrus mixtus* | | 35 | | 18 | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |
| *Lepidotrigla cavillone* | | 17 | 0.56 | 9.3 | 2 | 2 | Oviparous | Actinopterygia | 20.00 | LC |
| *Lepidotrigla dieuzeidei* | 20 | | | | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |
| *Leptagonus decagonus* | 21 | | | | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |

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|---|---|---|---|---|---|---|---|---|---|
| *Lesueurigobius friesii* | 13 | | | | 2 | 2 | Oviparous | Actinopterygia | 20.00 | LC |
| *Lesueurigobius sanzi* | 11 | | | | 2 | 2 | Oviparous | Actinopterygia | 20.00 | LC |
| *Lithognathus mormyrus* | | 35 | 0.26 | 16 | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |
| *Lycenchelys sarsi* | 20 | | | 11 | 2 | 7 | Oviparous | Actinopterygia | 20.00 | LC |
| *Lycodes gracilis* | | 15 | 0.39 | | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |
| *Macroramphosus scolopax* | | 15.7 | 0.654 | | 2 | 5 | Oviparous | Actinopterygia | 20.00 | LC |
| *Maurolicus muelleri* | | 6 | 0.88 | | 2 | 6 | Oviparous | Actinopterygia | 20.00 | LC |
| *Micrenophrys lilljeborgii* | | 7 | | | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |
| *Microchirus boscanion* | 20 | | | | 2 | 3 | Oviparous | Actinopterygia | 20.00 | LC |
| *Monochirus hispidus* | | 17 | 0.24 | 9 | 2 | 3 | Oviparous | Actinopterygia | 20.00 | LC |
| *Myctophum punctatum* | | 9 | 0.32 | 5 | 2 | 5 | Oviparous | Actinopterygia | 20.00 | LC |
| *Myoxocephalus scorpius* | | 27 | 0.83 | 12 | 2 | 7 | Oviparous | Actinopterygia | 20.00 | LC |
| *Naucrates ductor* | | 44 | 2.15 | | 2 | 5 | Oviparous | Actinopterygia | 20.00 | LC |
| *Nerophis lumbriciformis* | 15 | | | | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |
| *Ophidion barbatum* | 25 | | | | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |
| *Pagellus acarne* | | 34 | 0.21 | 16 | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |
| *Parablennius gattorugine* | 30 | | | | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |
| *Phrynorhombus norvegicus* | | 12 | | | 2 | 3 | Oviparous | Actinopterygia | 20.00 | LC |
| *Pomatoschistus lozanoi* | 8 | | | | 2 | 2 | Oviparous | Actinopterygia | 20.00 | LC |
| *Pomatoschistus norvegicus* | 8 | | | | 2 | 2 | Oviparous | Actinopterygia | 20.00 | LC |
| *Pterycombus brama* | 46 | | | | 2 | 6 | Oviparous | Actinopterygia | 20.00 | LC |
| *Pungitius pungitius* | | 5.7 | 0.13 | | 2 | 5 | Oviparous | Actinopterygia | 20.00 | LC |
| *Sardina pilchardus* | | 19 | 0.4 | 15 | 2 | 6 | Oviparous | Actinopterygia | 20.00 | NT |
| *Scomber colias* | | 56 | 0.19 | 21.6 | 2 | 6 | Oviparous | Actinopterygia | 20.00 | LC |
| *Scomber scombrus* | | 43 | 0.26 | | 2 | 6 | Oviparous | Actinopterygia | 20.00 | LC |
| *Scomberesox saurus* | | 35 | 0.71 | | 2 | 6 | Oviparous | Actinopterygia | 20.00 | LC |
| *Scorpaena loppei* | | 11 | 0.53 | | 2 | 7 | Oviparous | Actinopterygia | 20.00 | LC |
| *Scorpaena notata* | | 18 | 0.43 | | 2 | 7 | Oviparous | Actinopterygia | 20.00 | LC |
| *Serranus hepatus* | | 15 | 0.36 | 7.8 | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |
| *Serranus scriba* | | 28 | 0.16 | 17.3 | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |

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|---|---|---|---|---|---|---|---|---|---|---|
| *Sprattus sprattus* | | 14 | 0.63 | | 2 | 6 | Oviparous | Actinopterygia | 20.00 | LC |
| *Stomias boa* | 32 | | | | 2 | 6 | Oviparous | Actinopterygia | 20.00 | LC |
| *Symphodus bailloni* | 20 | | | | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |
| *Symphodus melops* | | 21 | 0.31 | 16 | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |
| *Symphodus roissali* | | 13 | 0.59 | 5 | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |
| *Taurulus bubalis* | | 19 | 0.251 | | 2 | 7 | Oviparous | Actinopterygia | 20.00 | LC |
| *Taurulus lilljeborgi* | 7 | | | | 2 | 7 | Oviparous | Actinopterygia | 20.00 | NA |
| *Trachurus mediterraneus* | | 43 | 0.21 | 20 | 2 | 6 | Oviparous | Actinopterygia | 20.00 | LC |
| *Trachurus trachurus* | | 40 | 0.21 | 22 | 2 | 6 | Oviparous | Actinopterygia | 20.00 | LC |
| *Triglops murrayi* | | 18 | 0.22 | | 2 | 7 | Oviparous | Actinopterygia | 20.00 | LC |
| *Trisopterus minutus* | | 24 | 0.40 | 13 | 2 | 4 | Oviparous | Actinopterygia | 20.00 | LC |
| *Xenodermichthys copei* | 31 | | | | 2 | 6 | Oviparous | Actinopterygia | 20.00 | LC |
| *Zeugopterus regius* | 20 | | | | 2 | 3 | Oviparous | Actinopterygia | 20.00 | LC |

Table S3. References for life history parameters used.

| Species | Source of $\boldsymbol{L}_{max}$ or $\boldsymbol{L}_{\infty}$ & $K$ | Source of $\boldsymbol{L}_{mat}$ | Source of $L_{min}$ |
|---|---|---|---|
| *Acantholabrus palloni* | Gomon, M.F. and P. Forsyth, 1990. Labridae. p. 868-882. In J.C. Quero, J.C. Hureau, C. Karrer, A. Post and L. Saldanha (eds.) Check-list of the fishes of the eastern tropical Atlantic (CLOFETA). JNICT, Lisbon, SEI, Paris; and UNESCO, Paris. Vol. 2. | | |
| *Agonus cataphractus* | Pauly, D., 1978. A preliminary compilation of fish length growth parameters. Ber. Inst. Meereskd. Christian-Albrechts-Univ. Kiel (55):1-200. | | |
| *Alopias vulpinus* | Natanson, L.J., Hamady, L.L. and Gervelis, B.J., 2016. Analysis of bomb radiocarbon data for common thresher sharks, Alopias vulpinus, in the northwestern Atlantic Ocean with revised growth curves. Environmental biology of fishes, 99(1), pp.39-47. | Smith, S.E., R.C. Rasmussen, D.A. Ramon and G.M. Cailliet, 2008. The biology and ecology of thresher sharks (Alopiidae). p. 60-68. In M.D. Camhi, E.K. Pikitch and E.A. Babcock (eds) Sharks of the open ocean. Blackwell Publishing, Oxford, UK, 502 p. | Moreno, J.A., Parajúa, J.I. and Morón, J. 1989. Biolgía reproductiva y fenología de Alopias vulpinus (Bonnaterre, 1788) (Squaliformes: Alopiidae) en el Atlántico nororiental y Mediterráneo occidental. Scientia Marina 53(1): 37-46. |
| *Amblyraja hyperborea* | Last, P.R., W.T. White, M.R. de Carvalho, B. Séret, M.F.W. Stehmann and G.J.P. Naylor, 2016. Rays of the world. CSIRO Publishing, Comstock Publishing Associates. i-ix + 1-790. | | Last, P.R., W.T. White, M.R. de Carvalho, B. Séret, M.F.W. Stehmann and G.J.P. Naylor, 2016. Rays of the world. CSIRO Publishing, Comstock Publishing Associates. i-ix + 1-790. |
| *Amblyraja radiata* | Jennings, S., S.P.R. Greenstreet and J.D. Reynolds, 1999. Structural change in an exploited fish community: a consequence of differential fishing effects on species with | Jennings, S., S.P.R. Greenstreet and J.D. Reynolds, 1999. Structural change in an exploited fish community: a consequence of differential fishing effects on species with contrasting life histories. J. Animal Ecol. 68:617-627. | Last, P.R., W.T. White, M.R. de Carvalho, B. Séret, M.F.W. Stehmann and G.J.P. Naylor, 2016. Rays of the world. CSIRO Publishing, Comstock Publishing Associates. i-ix + 1-790. |

| | | |
|---|---|---|
| | contrasting life histories. J. Animal Ecol. 68:617-627. | |
| *Anarhichas lupus* | Liao, Y.-Y. and M.C. Lucas, 2000. Growth, diet and metabolism of common wolf-fish in the North Sea, a fast-growing population. J. Fish Biol. 56(4):810-825. | Gunnarsson, A., Hjörleifsson, E., Thórarinsson, K. and Marteinsdottir, G., 2006. Growth, maturity and fecundity of wolffish Anarhichas lupus L. in Icelandic waters. Journal of fish biology, 68(4), pp.1158-1176. |
| *Anarhichas minor* | Gunnarsson, A., Hjörleifsson, E., Thórarinsson, K. and Marteinsdóttir, G., 2008. Growth, maturity and fecundity of female spotted wolffish Anarhichas minor in Icelandic waters. Journal of Fish Biology, 73(6), pp.1393-1406. | Gunnarsson, A., Hjörleifsson, E., Thórarinsson, K. and Marteinsdóttir, G., 2008. Growth, maturity and fecundity of female spotted wolffish Anarhichas minor in Icelandic waters. Journal of Fish Biology, 73(6), pp.1393-1406. |
| *Anthias anthias* | Bauchot, M.-L., 1987. Poissons osseux. p. 891-1421. In W. Fischer, M.L. Bauchot and M. Schneider (eds.) Fiches FAO d'identification pour les besoins de la pêche. (rev. 1). Méditerranée et mer Noire. Zone de pêche 37. Vol. II. Commission des Communautés Européennes and FAO, Rome. | |
| *Aphia minuta* | Iglesias, M., E.B. Brothers and B. Morales-Nin, 1997. Validation of daily increment deposition in otoliths. Age and growth determination of Aphia minuta (Pisces: Gobiidae) from the northwest Mediterranean. Mar. Biol. 129(2):279-287. | Iglesias, M. and B. Morales-Nin, 2001. Life cycle of the pelagic goby Aphia minuta (Pisces: Gobiidae). Sci. Mar. 65(3):183-192. |
| *Arctozenus risso* | Muus, B.J. and J.G. Nielsen, 1999. Sea fish. Scandinavian Fishing Year Book, Hedehusene, Denmark. 340 p. | |
| *Argentina silus* | Bergstad, O.A., 1993. Distribution, population structure, growth, and reproduction of the | Johannesen, A. & Monstad, T., 2003.Distribution, growth and exploitation |

| | | |
|---|---|---|
| | greater silver smelt, Argentina silus (Pisces, Argentinidae), of the Skagerrak and the north-eastern North Sea. ICES J. mar. Sci. 50:129-143. | of greater silver smelt (Argentina silus (Ascanius, 1775)) in Norwegian waters 1980-83. Journal of Northwest Atlantic Fishery Science 31:319-332 |
| *Argentina sphyraena* | Lee, J.Y., 1963. Les Argentines du Golfe du Lion, Argentina sphyraena L., Argentina leioglossa Val. Rev. Trav. Inst. Pêches Marit. 27(1-4):189-202. | |
| *Argyropelecus olfersii* | Reiner, F., 1996. Catálogo dos peixes do arquipélago de Cabo Verde. Publ. Avuls. Inst. Port. Invest. Mar. 2:339 p. | |
| *Argyrosomus regius* | González-Quirós, R., J. del Árbol, M.M. García-Pacheco, A.J. Silva-García, J.M. Naranjo and B. Morales-Nin, 2011. Life-history of the meagre Argyrosomus regius in the Gulf of Cádiz (SW Iberian Peninsula). Fish. Res. 109(1):140-149. | González-Quirós, R., J. del Árbol, M.M. García-Pacheco, A.J. Silva-García, J.M. Naranjo and B. Morales-Nin, 2011. Life-history of the meagre Argyrosomus regius in the Gulf of Cádiz (SW Iberian Peninsula). Fish. Res. 109(1):140-149. |
| *Arnoglossus imperialis* | Schneider, W., 1990. FAO species identification sheets for fishery purposes. Field guide to the commercial marine resources of the Gulf of Guinea. Prepared and published with the support of the FAO Regional Office for Africa. Rome: FAO. 268 p. | |
| *Arnoglossus laterna* | Deniel, C., 1990. Comparative study of growth of flatfishes on the west coast of Brittany. *Journal of Fish Biology*, *37*(1), pp.149-166. | Deniel, C., 1990. Comparative study of growth of flatfishes on the west coast of Brittany. *Journal of Fish Biology*, *37*(1), pp.149-166. |
| *Arnoglossus rueppelii* | Nielsen, J.G., 1986. Bothidae. p. 1294-1298. In P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.) Fishes of the North-eastern Atlantic and the Mediterranean. UNESCO, Paris. Vol. 3. | |

| | | |
|---|---|---|
| *Arnoglossus thori* | Deniel, C., 1990. Comparative study of growth of flatfishes on the west coast of Brittany. J. Fish Biol. 37(1):149-166 | Félix, P.M., Vinagre, C. and Cabral, H.N., 2011. Life-history traits of flatfish in the Northeast Atlantic and Mediterranean Sea. Journal of Applied Ichthyology, 27(1), pp.100-111. |
| *Atherina presbyter* | Pombo, L., Elliott, M. and Rebelo, J.E., 2005. Ecology, age and growth of Atherina boyeri and Atherina presbyter in the Ria de Aveiro, Portugal. Cybium, 29(1), pp.47-55. | Moreno, T., Castro, J.J. and Socorro, J., 2005. Reproductive biology of the sand smelt Atherina presbyter Cuvier, 1829 (Pisces: Atherinidae) in the central-east Atlantic. Fisheries research, 72(1), pp.121-131. |
| *Auxis rochei rochei* | Valeiras, X., D. Macias, M.J. Gomez, L. Lema, S. Garcia-Barcelona, J.M. De Urbinqa Ortiz and J.M. de la Serna, 2008. Age and growth of bullet tuna (Auxis rochei) in the western Mediterranean Sea. Collect. Vol. Sci. Pap. ICCAT 62(5):1629-1637 | |
| *Balistes capriscus* | Burton, M.L., J.C. Potts, D.R. Carr, M. Cooper and J. Lewis, 2015. Age, growth, and mortality of gray triggerfish (*Balistes capriscus*) from the southeastern United States. Fish. Bull. 113(1):27-39. | |
| *Bathysolea profundicola* | Cau, A. and A. Deiana, 1983. Reproduction et accroissement dans quelques Soleidae de la Mediterranee du centre occidental. Rapp. Comm. int. Mer Médit. 28(5):61-62. | |
| *Belone belone* | Potoschi, A., A. Cefali and G. Cavallaro, 1983. Notes on the biology of Belone belone gracilis Lowe 1839, captured in the area of the strait of Messina. Mem. Biol. Mar. Ocean. 13:19-36. | Muus, B.J. and J.G. Nielsen, 1999. Sea fish. Scandinavian Fishing Year Book, Hedehusene, Denmark. 340 p. |
| *Benthodesmus elongatus* | Nakamura, I., 1995. Trichiuridae. Peces sables, cintillas. p. 1638-1642. In W. Fischer, F. Krupp, | |

| | | |
|---|---|---|
| | W. Schneider, C. Sommer, K.E. Carpenter and V. Niem (eds.) Guia FAO para Identification de Especies para lo Fines de la Pesca. Pacifico Centro-Oriental. 3 Vols. FAO, Rome. | |
| *Benthosema glaciale* | Gjøsaeter, J., 1973. Age, growth and mortality of the myctophid fish Benthosema glaciale (Reinhardt) from western Norway. Sarsia 52:1-14. | |
| *Beryx decadactylus* | Krug, H., D. Carvalho& J.A. González2010. Age and growth of the alfonsino Beryx decadactylus(Cuvier, 1829) from the Azores, Madeira and Canary Islands, based on historical data. Arquipelago. Life and Marine Sciences 28:25-31 | Estácio, S. and Krug, H., 2001. Aspects of the reproduction of six exploited demersal fish species in the Azores Archipelago. Fauna and Flora of the Atlantic Islands. Arquipelago, Life and Marine Sciences, suppl 2(Part B), p.83. |
| *Beryx splendens* | Rico, V., J.M. Lorenzo, J.A. González, H.M. Krug, A. Mendonça, E. Gouveia and M.A. Dias, 2001. Age and growth of the alfonsino Beryx splendens Lowe, 1834 from the Macronesian archipelagos. Fish. Res. 49(3):233-240. | Lehodey, P. and R. Grandperrin, 1996. Age and growth of the alfonsino Beryx splendens over the seamounts off New Caledonia. Mar. Biol. 125:249-258. |
| *Blennius ocellaris* | Bauchot, M.-L., 1987. Poissons osseux. p. 891-1421. In W. Fischer, M.L. Bauchot and M. Schneider (eds.) Fiches FAO d'identification pour les besoins de la pêche. (rev. 1). Méditerranée et mer Noire. Zone de pêche 37. Vol. II. Commission des Communautés Européennes and FAO, Rome. | |
| *Boops boops* | Zuniga, L.R., 1967. Estudio del crecimiento de Boops boops (L.) del Levante Español. Inv. Pesq. 31(3):383-418 | Layachi, M., M.H, Idrissi, M. Ramdani, F. Sahnouni and R. Flower, 2015. Growth and reproduction of the Bogue Boops boops L. 1758 in the editerranean coastal area |

|  |  |  |
|---|---|---|
|  |  | between Nador and Saidia (Morocco). Bull. Inst. Sci., Rabat, Sec. Sci. Vie, (37). |
| *Brama brama* | Lobo, C. and K. Erzini, 2001. Age and growth of Ray's bream (Brama brama) from the south of Portugal. Fish. Res. 51(2-3):343-347. |  |
| *Brosme brosme* | ICES, 2018. Report of the Working Group on Biology and Assessment of Deep-sea Fisheries Resources. Stock annex: Tusk (Brosme brosme) in subareas 4 and 7–9, and in divisions 3.a, 5.b, 6.a, and 12.b (Northeast Atlantic) | ICES, 2018. Report of the Working Group on Deep Sea Fisheries. Stock annex: Tusk (Brosme brosme) in subareas 4 and 7–9, and in divisions 3.a, 5.b, 6.a, and 12.b (Northeast Atlantic) |
| *Buenia jeffreysii* | Miller, P.J., 1986. Gobiidae. p. 1019-1085. In P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.) Fishes of the North-eastern Atlantic and the Mediterranean. Volume 3. UNESCO, Paris. |  |
| *Buglossidium luteum* | Deniel, C., 1990. Comparative study of growth of flatfishes on the west coast of Brittany. *Journal of Fish Biology*, *37*(1), pp.149-166. | Muus, B.J. and J.G. Nielsen, 1999. Sea fish. Scandinavian Fishing Year Book, Hedehusene, Denmark. 340 p. |
| *Callanthias ruber* | Edwards, A., 1990. Fish and fisheries of Saint Helena Island. Centre for Tropical Coastal Management Studies, University of Newcastle upon Tyne, England. |  |
| *Callionymus lyra* | Beverton, R.J.H. and S.J. Holt, 1959. A review of the lifespans and mortality rates of fish in nature, and their relation to growth and other physiological characteristics. p. 142-180. In G.E.W. Wolstenholme and M. O'Connor (eds.) CIBA Foundation colloquia on ageing: the lifespan of animals. volume 5. J & A Churchill Ltd, London. |  |

| | | | |
|---|---|---|---|
| *Capros aper* | Hüssy, K., Coad, J.O., Farrell, E.D., Clausen, L.W. and Clarke, M.W., 2012. Sexual dimorphism in size, age, maturation, and growth characteristics of boarfish (Capros aper) in the Northeast Atlantic. *ICES Journal of Marine Science*, *69*(10), pp.1729-1735. | Hüssy, K., Coad, J.O., Farrell, E.D., Clausen, L.W. and Clarke, M.W., 2012. Sexual dimorphism in size, age, maturation, and growth characteristics of boarfish (Capros aper) in the Northeast Atlantic. *ICES Journal of Marine Science*, *69*(10), pp.1729-1735. | |
| *Caranx rhonchus* | CECAF, 1979. Report of the ad hoc working group on west African coastal pelagic fish from Mauritania to Liberia (26°N to 5°N). CECAF/ECAF Ser. 78/10. FAO, UNDP, Rome. 161 p. | | |
| *Centrolabrus exoletus* | Sayer, M. D. J., R. N. Gibson, and R. J. A. Atkinson. "Growth, diet and condition of corkwing wrasse and rock cook on the west coast of Scotland." Journal of Fish Biology 49, no. 1 (1996): 76-94. | Sayer, M. D. J., R. N. Gibson, and R. J. A. Atkinson. "Growth, diet and condition of corkwing wrasse and rock cook on the west coast of Scotland." Journal of Fish Biology 49, no. 1 (1996): 76-94. | |
| *Cepola macrophthalma* | Stergiou, K.I., P. Economidis and A. Sinis, 1992. Age, growth and mortality of red bandfish, Cepola macrophthalma (L.), in the western Aegean Sea (Greece). J. Fish Biol. 40(3):395-418. | Stergiou, K.I., E.D. Christou, D. Georgopoulous, A. Zenetos and C. Souvermezoglou, 1997. The Hellenic seas: physics, chemistry, biology and fisheries. p. 415-538. In A.D. Ansell, R.N. Gibson and M. Barnes (eds.). Oceanography and marine biology: an annual review. UCL Press. | |
| *Ceratoscopelus maderensis* | Hulley, P.A., 1990. Myctophidae. p. 398-467. In J.C. Quero, J.C. Hureau, C. Karrer, A. Post and L. Saldanha (eds.) Check-list of the fishes of the eastern tropical Atlantic (CLOFETA). JNICT, Lisbon; SEI; Paris; and UNESCO, Paris. Vol. 1. | | |
| *Cetorhinus maximus* | Pauly, D., 2002. Growth and mortality of the basking shark *Cetorhinus maximus* and their implications for management of whale sharks *Rhincodon typus*. IUCN SSC SHARK SPECIALIST | Pauly, D., 2002. Growth and mortality of the basking shark *Cetorhinus maximus* and their implications for management of whale sharks *Rhincodon typus*. IUCN SSC SHARK | Sund, O. 1943. Et brugdelbarsel. Naturen 67: 285–286. |

| | | |
|---|---|---|
| | GROUP. Elasmobranch biodiversity, conservation and management: Proceedings of the International Seminar and Workshop, Sabah, Malaysia, 1997. IUCN: Gland, Switzerland and Cambridge, UK:199-208. | SPECIALIST GROUP. Elasmobranch biodiversity, conservation and management: Proceedings of the International Seminar and Workshop, Sabah, Malaysia, 1997. IUCN: Gland, Switzerland and Cambridge, UK:199-208. |
| *Chauliodus sloani* | Masuda, H., K. Amaoka, C. Araga, T. Uyeno and T. Yoshino, 1984. The fishes of the Japanese Archipelago. Vol. 1. Tokai University Press, Tokyo, Japan. 437 p. (text). | |
| *Chaunax pictus* | Smith, M.M., 1986. Chaunacidae. p. 369-370. In M.M. Smith and P.C. Heemstra (eds.) Smiths' sea fishes. Springer-Verlag, Berlin. | |
| *Chelidonichthys cuculus* | Marriott, A.L., J.W. Latchford and I.D. McCarthy, 2010. Population biology of the red gurnard (Aspitrigla cuculus L.; Triglidae) in the inshore waters of Eastern Anglesey and Northwest Wales. J. Appl. Ichthyol. 26:504-512. | Marriott, A.L., J.W. Latchford and I.D. McCarthy, 2010. Population biology of the red gurnard (Aspitrigla cuculus L.; Triglidae) in the inshore waters of Eastern Anglesey and Northwest Wales. J. Appl. Ichthyol. 26:504-512. |
| *Chelidonichthys lucerna* | McCarthy, I.D. and Marriott, A.L., 2018. Age, growth and maturity of tub gurnard (Chelidonichthys lucerna Linnaeus 1758; Triglidae) in the inshore coastal waters of Northwest Wales, UK. Journal of applied ichthyology, 34(3), pp.581-589. | McCarthy, I.D. and Marriott, A.L., 2018. Age, growth and maturity of tub gurnard (Chelidonichthys lucerna Linnaeus 1758; Triglidae) in the inshore coastal waters of Northwest Wales, UK. Journal of applied ichthyology, 34(3), pp.581-589. |
| *Chelidonichthys obscurus* | Wilhelms, I., 2013. Atlas of length-weight relationships of 93 fish and crustacean species from the North Sea and the North-East Atlantic (No. 12). Johann Heinrich von Thünen Institute, Federal Research Institute for Rural Areas, Forestry and Fisheries, 552 p. | |

| | | | |
|---|---|---|---|
| *Chelon aurata* | Campillo, A., 1992. Les pêcheries françaises de Méditeranée: synthèse des connaissances. Institut Francais de Recherche pour l'Exploitation de la Mer, France. 206 p. | Campillo, A., 1992. Les pêcheries françaises de Méditeranée: synthèse des connaissances. Institut Francais de Recherche pour l'Exploitation de la Mer, France. 206 p. | |
| *Chelon labrosus* | Richter, H., 1995. Age and growth of thick-lipped grey mullet Chelon labrosus (Risso 1826)(Pisces: Mugilidae) in strangford Lough, Co Down. *The Irish Naturalists' Journal*, pp.134-139. | | |
| *Chelon ramada* | Autem, M., 1979. Contribution à l'étude biologique des zones de dilution du littoral méditerranéen: estuaires, étangs lagunaires. USTL Montpellier (France). 343 p. Thèse 3ième cycle. | Campillo, A., 1992. Les pêcheries françaises de Méditeranée: synthèse des connaissances. Institut Francais de Recherche pour l'Exploitation de la Mer, France. 206 p. | |
| *Chimaera monstrosa* | Moura, T., I. Figueiredo, P.B. Machado and L.S. Gordo, 2004. Growth pattern and reproductive strategy of the holocephalan Chimaera montrosa along the Portuguese continental slope. J. Mar. Biol. Ass. U.K. 84(4):801-804. | Moura, T., I. Figueiredo, P.B. Machado and L.S. Gordo, 2004. Growth pattern and reproductive strategy of the holocephalan Chimaera monstrosa along the Portuguese continental slope. J. Mar. Biol. Ass. U.K. 84(4):801-804. | Stehmann, M. and D.L. Bürkel, 1984. Chimaeridae. p. 212-215. In P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.) Fishes of the north-eastern Atlantic and the Mediterranean. UNESCO, Paris. vol. 1. |
| *Chirolophis ascanii* | Makushok, V.M., 1986. Stichaeidae. p. 1122-1123. In P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.) Fishes of the North-eastern Atlantic and the Mediterranean. UNESCO, Paris. Vol. 3. | | |
| *Chlorophthalmus agassizi* | Maiorano, P., L. Sion, R. Carlucci, F. Capezzuto, A. Giove, G. Costantino, M. Panza, G. D'Onghia and A. Tursi, 2010. The demersal faunal assemblage of the north-western Ionian Sea (central Mediterranean): current knowledge | | |

| | | | |
|---|---|---|---|
| | and perspectives. Chemistry and Ecology 26 (Supplement):219-240. | | |
| *Citharus linguatula* | Moutopoulos, D.K., A. Ramfos, A. Mouka and G. Katselis, 2013. Length-weight relations of 34 fish species caught by small-scale fishery in Korinthiakos Gulf (Central Greece). Acta Ichthyol. Piscat. 43(1):57-64. | | |
| *Clupea harengus* | Jennings, S. and Beverton, R.J.H., 1991. Intraspecific variation in the life history tactics of Atlantic herring (Clupea harengus L.) stocks. ICES Journal of Marine Science, 48(1), pp.117-125. | Jennings, S. and Beverton, R.J.H., 1991. Intraspecific variation in the life history tactics of Atlantic herring (Clupea harengus L.) stocks. ICES Journal of Marine Science, 48(1), pp.117-125. | |
| *Coelorinchus caelorhincus* | Massuti, E., B. Morales-Nin and C. Stefanescu, 1995. Distribution and biology of five grenadier fish (Pisces: Macrouridae) from the upper and middle slope of the northwestern Mediterranean. Deep-Sea Research 42(3):307-330. | | |
| *Conger conger* | Correia, A.T., Manso, S. and Coimbra, J., 2009. Age, growth and reproductive biology of the European conger eel (Conger conger) from the Atlantic Iberian waters. Fisheries Research, 99(3), pp.196-202. | | Correia, A., Antunes, C. and Coimbra, J., 2002. Aspects of the early life history of the European conger eel (Congerconger) inferred from the otolith microstructure of metamorphic larvae. Marine Biology, 140(1), pp.165-173. |
| *Coryphaenoides rupestris* | Bergstad, O.A., 1990. Distribution, population structure, growth and reproduction of the roundnose grenadier Coryphaenoides rupestris (Pisces: Macrouridae) in the deep waters of the Skagerrak. Mar. Biol. 107:25-39. | Bergstad, O.A., 1990. Distribution, population structure, growth and reproduction of the roundnose grenadier Coryphaenoides rupestris (Pisces: Macrouridae) in the deep waters of the Skagerrak. Mar. Biol. 107:25-39. | |

| | | | |
|---|---|---|---|
| *Cottunculus microps* | Muus, B.J. and J.G. Nielsen, 1999. Sea fish. Scandinavian Fishing Year Book, Hedehusene, Denmark. 340 p. | | |
| *Crystallogobius linearis* | Miller, P.J., 1986. Gobiidae. p. 1019-1085. In P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.) Fishes of the North-eastern Atlantic and the Mediterranean. Volume 3. UNESCO, Paris. | | |
| *Ctenolabrus rupestris* | Pauly, D., 1978. A preliminary compilation of fish length growth parameters. Ber. Inst. Meereskd. Christian-Albrechts-Univ. Kiel (55):1-200. | | |
| *Cyclopterus lumpus* | Kasper, J.M., Bertelsen, B., Ólafsson, H.G., Holst, J.C., Sturlaugsson, J. and Jónsson, S.P., 2014. Observations of growth and postspawning survival of lumpfish Cyclopterus lumpus from mark-recapture studies. *Journal of Fish Biology*, *84*(6), pp.1958-1963. | Albert, O.T., Torstensen, E., Bertelsen, B., Jonsson, S.T., Pettersen, I.H. and Holst, J.C., 2002. Age-reading of lumpsucker (Cyclopteruslumpus) otoliths: dissection, interpretation and comparison with length frequencies. Fisheries Research, 55(1-3), pp.239-252. | |
| *Cyttopsis rosea* | Karrer, C. and A. Post, 1990. Zeidae. p. 631-633. In J.C. Quero, J.C. Hureau, C. Karrer, A. Post and L. Saldanha (eds.) Check-list of the fishes of the eastern tropical Atlantic (CLOFETA). JNICT, Lisbon; SEI, Paris; and UNESCO, Paris. Vol. 2. | | |
| *Dalatias licha* | da Silva, H.N., 1988. Growth and reproduction of Kitefin shark Dalatias lici (Bonn, 1788) in Azorean waters. *ICES CM*.1988/G:21 | da Silva, H.N., 1988. Growth and reproduction of Kitefin shark Dalatias lici (Bonn, 1788) in Azorean waters. *ICES CM*.1988/G:22 | da Silva, H.N., 1988. Growth and reproduction of Kitefin shark Dalatias lici (Bonn, 1788) in Azorean waters. *ICES CM*.1988/G:23 |
| *Dasyatis pastinaca* | Yigin, C.C. and Ismen, A., 2012. Age, growth and reproduction of the common stingray, | Yigin, C.C. and Ismen, A., 2012. Age, growth and reproduction of the common stingray, | Ismen, A. 2003. Age, growth, reproduction and food of common |

| | | | |
|---|---|---|---|
| | Dasyatis pastinaca from the North Aegean Sea. *Marine Biology Research*, *8*(7), pp.644-653. | Dasyatis pastinaca from the North Aegean Sea. *Marine Biology Research*, *8*(7), pp.644-653. | stingray (Dasyatis pastinacaL., 1758) in Iskenderun Bay, the eastern Mediterranean. Fisheries Research 60:169–176 |
| *Dasyatis tortonesei* | McEachran, J.D. and C. Capapé, 1984. Dasyatidae. p. 197-202. In P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.) Fishes of the north-eastern Atlantic and Mediterranean. UNESCO, Paris. Vol. 1. | Yigin, C.C. and Ismen, A. 2012. Age, growth and reproduction of the common stingray, Daysatis pastinaca from the North Aegean Sea. Marine Biology Research 8: 644-653. | Ismen, A. 2003. Age, growth, reproduction and food of common stingray (Dasyatis pastinaca L., 1758) in Iskenderun Bay, the eastern Mediterranean. Fisheries Research 60:: 169-176. |
| *Deania calcea* | Clarke, M.W., Connolly, P.L. and Bracken, J.J., 2002. Catch, discarding, age estimation, growth and maturity of the squalid shark Deania calceus west and north of Ireland. *Fisheries Research*, *56*(2), pp.139-153. | Clarke, M.W., Connolly, P.L. and Bracken, J.J., 2002. Catch, discarding, age estimation, growth and maturity of the squalid shark Deania calceus west and north of Ireland. *Fisheries Research*, *56*(2), pp.139-153. | Cox, G. and M. Francis, 1997. Sharks and rays of New Zealand. Canterbury Univ. Press, Univ. of Canterbury. 68 p. |
| *Deania profundorum* | Bass, A.J., L.J.V. Compagno and P.C. Heemstra, 1986. Squalidae. p. 49-62. In M.M. Smith and P.C. Heemstra (eds.) Smiths' sea fishes. Springer-Verlag, Berlin. | | |
| *Dentex canariensis* | Mennes, F., 1985. Multispecies assessment of fish stocks off the Western Sahara region with emphasis on the family Sparidae. Fishbyte 3(3):5-10. | Bauchot, M.-L. and J.-C. Hureau, 1986. Sparidae. p. 883-907. In P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.) Fishes of the north-eastern Atlantic and the Mediterranean. volume 2. UNESCO, Paris. | |
| *Dentex gibbosus* | Pajuelo, J.G. and J.M. Lorenzo, 1995. Biological parameters reflecting the current state of the exploited pink dentex Dentex gibbosus (Pisces: Sparidae) populations off the Canary Islands. S. Afr. J. Mar. Sci. 16:311-319. | Pajuelo, J.G. and J.M. Lorenzo, 1995. Biological parameters reflecting the current state of the exploited pink dentex Dentex gibbosus (Pisces: Sparidae) populations off the Canary Islands. S. Afr. J. Mar. Sci. 16:311-319. | |

| | | |
|---|---|---|
| *Dentex maroccanus* | Lamrini, A. and A. Bouymajjane, 2002. Biologie de Dentex maroccanus (Valenciennes, 1830) dans la région de Safi. Actes Institute Agronomique et Veterinaire (Maroc) 22(1):11-18. | Lamrini, A. and A. Bouymajjane, 2002. Biologie de Dentex maroccanus (Valenciennes, 1830) dans la région de Safi. Actes Institute Agronomique et Veterinaire (Maroc) 22(1):11-18. |
| *Dicentrarchus labrax* | ICES, 2016. Report of the Working Group for the Celtic Seas Ecoregion (WGCSE), 4–13 May 2016, Copenhagen, Denmark. ICES CM 2016/ACOM:13. 1343 pp. | Pawson, M.G., S. Kupschus and G.D. Pickett, 2007. The status of sea bass (Dicentrarchus labrax) stocks around England and Wales, derived using a separable catch-at-age model, and implications for fisheries management. ICES J. Mar. Sci. 64:346-356. |
| *Dicentrarchus punctatus* | Gravier, R., 1961. Les Bars (Loups) du Maroc Atlantique Morone labrax (Linné) et Morone punctata (Bloch). Rev. Trav. Inst. Pêches Marit. 25(3):281-292. | |
| *Dicologlossa cuneata* | Félix, P.M., C. Vinagre and H.N Cabral, 2011. Life-history traits of flatfish in the Northeast Atlantic and Mediterranean Sea. J. Appl. Ichthyol. 27:100–111. | Félix, P.M., C. Vinagre and H.N Cabral, 2011. Life-history traits of flatfish in the Northeast Atlantic and Mediterranean Sea. J. Appl. Ichthyol. 27:100–111. |
| *Diplecogaster bimaculata* | Muus, B.J. and J.G. Nielsen, 1999. Sea fish. Scandinavian Fishing Year Book, Hedehusene, Denmark. 340 p. | |
| *Diplodus annularis* | Pajuelo, J.G. and J.M. Lorenzo, 2001. Biology of the annular seabream, Diplodus annularis (Sparidae), in coastal waters of the Canary Islands. J. Appl. Ichthyol. 17:121-125. | Pajuelo, J.G. and J.M. Lorenzo, 2001. Biology of the annular seabream, Diplodus annularis (Sparidae), in coastal waters of the Canary Islands. J. Appl. Ichthyol. 17:121-125. |
| *Diplodus bellottii* | Mennes, F., 1985. Multispecies assessment of fish stocks off the Western Sahara region with emphasis on the family Sparidae. Fishbyte 3(3):5-10. | |

| | | | |
|---|---|---|---|
| *Diplodus cervinus* | Pajuelo, J.G., J.M. Lorenzo and R. Domínguez-Seoane, 2003. Age estimation and growth of the zebra seabream Diplodus cevinus cervinus (Lowe, 1838) on the Canary Islands shelf (Central-east Atlantic). Fish. Res. 62(1):97-103. | Pajuelo, J.G., J.M. Lorenzo and R. Domínguez-Seoane, 2003. Age estimation and growth of the zebra seabream Diplodus cevinus cervinus (Lowe, 1838) on the Canary Islands shelf (Central-east Atlantic). Fish. Res. 62(1):97-103. | |
| *Diplodus sargus* | Pajuelo, J.G. and Lorenzo, J.M., 2004. Basic characteristics of the population dynamic and state of exploitation of Moroccan white seabream Diplodus sargus cadenati (Sparidae) in the Canarian archipelago. Journal of Applied Ichthyology, 20(1), pp.15-21. | Pajuelo, J.G. and Lorenzo, J.M., 2004. Basic characteristics of the population dynamic and state of exploitation of Moroccan white seabream Diplodus sargus cadenati (Sparidae) in the Canarian archipelago. Journal of Applied Ichthyology, 20(1), pp.15-21. | |
| *Diplodus vulgaris* | Gonçalves, J.M.S., L. Bentes, R. Coelho, C. Correia, P.G. Lino, C.C. Monteiro, J. Ribeiro and K. Erzini, 2003. Age and growth, maturity, mortality and yield-per-recruit for two banded bream ( Diplodus vulgaris Geoffr.) from the south coast of Portugal. Fish. Res. 62(3):349-359 | Gonçalves, J.M.S., L. Bentes, R. Coelho, C. Correia, P.G. Lino, C.C. Monteiro, J. Ribeiro and K. Erzini, 2003. Age and growth, maturity, mortality and yield-per-recruit for two banded bream ( Diplodus vulgaris Geoffr.) from the south coast of Portugal. Fish. Res. 62(3):349-359 | |
| *Dipturus batis*-complex | Du Buit, M.H., 1977. Age et croissance de *Raja batis* et de *Raja naevus* en Mer Celtique. J. Cons. CIEM 37:261-265. | Du Buit, M.H., 1977. Age et croissance de *Raja batis* et de *Raja naevus* en Mer Celtique. J. Cons. CIEM 37:261-265. | Clark, R.S. 1922. Skates and rays (Raiae) No.1. Egg capsules and young. Journal of the Marine Biological Association of the United Kingdom 12: 577–643. |
| *Dipturus nidarosiensis* | Muus, B.J. and J.G. Nielsen, 1999. Sea fish. Scandinavian Fishing Year Book, Hedehusene, Denmark. 340 p. | Follesa, M.C., Cannas, R., Cabiddu, S., Cau, A., Mulas, A., Porcu, C. and Cau, A., 2012. Preliminary observations of the reproductive biology and diet for the Norwegian skate Dipturus nidarosiensis (Rajidae) from the central western Mediterranean Sea. Cybium, 36(3), pp.473-477. | |
| *Dipturus oxyrinchus* | Yigin, C. and A. Ismen, 2010. Age, growth, reproduction and feed of longnosed skate, | Yigin, C. and A. Ismen, 2010. Age, growth, reproduction and feed of longnosed skate, | Last, P.R., W.T. White, M.R. de Carvalho, B. Séret, M.F.W. Stehmann and G.J.P. |

| | | | |
|---|---|---|---|
| | Dipturus oxyrinchus (Linnaeus, 1758) in Saros bay, the north Aegean Sea. J. Appl. Ichthyol. 26(6):913-919. | Dipturus oxyrinchus (Linnaeus, 1758) in Saros bay, the north Aegean Sea. J. Appl. Ichthyol. 26(6):913-919. | Naylor, 2016. Rays of the world. CSIRO Publishing, Comstock Publishing Associates. i-ix + 1-790 |
| *Echiichthys vipera* | Creutzberg, F. and Witte, J.I., 1989. An attempt to estimate the predatory pressure exerted by the lesser weever, Trachinus vipera Cuvier, in the southern North Sea. *Journal of Fish Biology*, *34*(3), pp.429-449. | | |
| *Echiodon drummondii* | Trott, L.B. and J.E. Olney, 1986. Carapidae. p. 1172-1176. In P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.) Fishes of the North-eastern Atlantic and the Mediterranean. UNESCO, Paris. Vol. 3. | | |
| *Enchelyopus cimbrius* | Cohen, D.M., T. Inada, T. Iwamoto and N. Scialabba, 1990. FAO species catalogue. Vol. 10. Gadiform fishes of the world (Order Gadiformes). An annotated and illustrated catalogue of cods, hakes, grenadiers and other gadiform fishes known to date. FAO Fish. Synop. 125(10). Rome: FAO. 442 p. | Jennings, S., Greenstreet, S.P. and Reynolds, J.D., 1999. Structural change in an exploited fish community: a consequence of differential fishing effects on species with contrasting life histories. Journal of Animal Ecology, 68(3), pp.617-627. | |
| *Engraulis encrasicolus* | Silva, A., P. Carrera, J. Massé, A. D. Uriarte, M. B. Santos, P. B. Oliveira, E. Soares, C. Porteiro and Y. Stratoudakis, 2008. Geographic variability of sardine growth across the northeastern Atlantic and the Mediterranean Sea. Fish. Res. 90:56-69. | ICES, 2010. Report of the Workshop on Age reading of European anchovy (WKARA), 9-13 November 2009, Sicily, Italy. ICES CM 2009/ACOM:43. 122 pp. | |
| *Entelurus aequoreus* | Muus, B.J. and J.G. Nielsen, 1999. Sea fish. Scandinavian Fishing Year Book, Hedehusene, Denmark. 340 p. | | |

| | | | |
|---|---|---|---|
| *Ephippion guttifer* | Cousseau, M.B., 1993. Las especies del orden gadiformes del Atlántico sudamericano comprendido entre 34° y 55°S y relación con las de otras áreas. Frente Marit. 13:7-108. | | |
| *Epigonus denticulatus* | Gon, O., 1986. Apogonidae. p. 546-561. In M.M. Smith and P.C. Heemstra (eds.) Smiths' sea fishes. Springer-Verlag, Berlin. | | |
| *Epigonus telescopus* | Paulin, C., A. Stewart, C. Roberts and P. McMillan, 1989. New Zealand fish: a complete guide. National Museum of New Zealand Miscellaneous Series No. 19. 279 p | Dunn, M.R., 2009. Review and stock assessment of black cardinal fish (Epigonus telescopus) on the east coast of North Island, New Zealand. New Zealand Fish. Assess. Rep. 2009/39. 55 p. | |
| *Etmopterus princeps* | Compagno, L.J.V., 1984. FAO Species Catalogue. Vol. 4. Sharks of the world. An annotated and illustrated catalogue of shark species known to date. Part 1 - Hexanchiformes to Lamniformes. FAO Fish. Synop. 125(4/1):1-249. Rome, FAO. | Cotton, C.F., Grubbs, R.D., Dyb, J.E., Fossen, I. and Musick, J.A., 2015. Reproduction and embryonic development in two species of squaliform sharks, Centrophorus granulosus and Etmopterus princeps: Evidence of matrotrophy?. *Deep Sea Research Part II: Topical Studies in Oceanography*, *115*, pp.41-54. | Cotton, C.F., Grubbs, R.D., Dyb, J.E., Fossen, I. and Musick, J.A., 2015. Reproduction and embryonic development in two species of squaliform sharks, Centrophorus granulosus and Etmopterus princeps: Evidence of matrotrophy?. *Deep Sea Research Part II: Topical Studies in Oceanography*, *115*, pp.41-54. |
| *Etmopterus pusillus* | Coelho, R. and Erzini, K., 2007. Population parameters of the smooth lantern shark, Etmopterus pusillus, in southern Portugal (NE Atlantic). Fisheries Research, 86(1), pp.42-57. | Coelho, R. and Erzini, K., 2007. Population parameters of the smooth lantern shark, Etmopterus pusillus, in southern Portugal (NE Atlantic). Fisheries Research, 86(1), pp.42-57. | |
| *Etmopterus spinax* | Coelho, R. and Erzini, K., 2008. Life history of a wide-ranging deepwater lantern shark in the north-east Atlantic, Etmopterus spinax (Chondrichthyes: Etmopteridae), with implications for conservation. *Journal of Fish Biology*, *73*(6), pp.1419-1443. | Coelho, R. and Erzini, K., 2008. Life history of a wide-ranging deepwater lantern shark in the north-east Atlantic, Etmopterus spinax (Chondrichthyes: Etmopteridae), with implications for conservation. *Journal of Fish Biology*, *73*(6), pp.1419-1443. | Coelho, R. and Erzini, K., 2008. Life history of a wide-ranging deepwater lantern shark in the north-east Atlantic, Etmopterus spinax (Chondrichthyes: Etmopteridae), with implications for |

| | | | |
|---|---|---|---|
| | | | conservation. *Journal of Fish Biology*, *73*(6), pp.1419-1443. |
| *Eutrigla gurnardus* | McCarthy, I.D., Cant, J. and Marriott, A.L., 2018. Population biology of grey gurnard (Eutrigla gurnardus (L.); Triglidae) in the coastal waters of Northwest Wales. Journal of applied ichthyology, 34(4), pp.896-905. | McCarthy, I.D., Cant, J. and Marriott, A.L., 2018. Population biology of grey gurnard (Eutrigla gurnardus (L.); Triglidae) in the coastal waters of Northwest Wales. Journal of applied ichthyology, 34(4), pp.896-905. | |
| *Gadella maraldi* | Cohen, D.M., T. Inada, T. Iwamoto and N. Scialabba, 1990. FAO species catalogue. Vol. 10. Gadiform fishes of the world (Order Gadiformes). An annotated and illustrated catalogue of cods, hakes, grenadiers and other gadiform fishes known to date. FAO Fish. Synop. 125(10). Rome: FAO. 442 p. | | |
| *Gadiculus argenteus* | Wilhelms, I., 2013. Atlas of length-weight relationships of 93 fish and crustacean species from the North Sea and the North-East Atlantic (No. 12). Johann Heinrich von Thünen Institute, Federal Research Institute for Rural Areas, Forestry and Fisheries, 552 p. | | |
| *Gadus morhua* | Daan, N., 1974. Growth of the North Sea cod, Gadus morhua. Neth. J. Sea Res. 8(1):27-48. | Oosthuizen, E. and Daan, N., 1974. Egg fecundity and maturity of North Sea cod, Gadus morhua. Netherlands Journal of Sea Research, 8(4), pp.378-397. | |
| *Gaidropsarus argentatus* | Muus, B.J. and J.G. Nielsen, 1999. Sea fish. Scandinavian Fishing Year Book, Hedehusene, Denmark. 340 p. | | |
| *Gaidropsarus biscayensis* | Cohen, D.M., T. Inada, T. Iwamoto and N. Scialabba, 1990. FAO species catalogue. Vol. 10. Gadiform fishes of the world (Order Gadiformes). An annotated and illustrated | | |

| | | |
|---|---|---|
| | catalogue of cods, hakes, grenadiers and other gadiform fishes known to date. FAO Fish. Synop. 125(10). Rome: FAO. 442 p. | |
| *Gaidropsarus macropthalmus* | Cohen, D.M., T. Inada, T. Iwamoto and N. Scialabba, 1990. FAO species catalogue. Vol. 10. Gadiform fishes of the world (Order Gadiformes). An annotated and illustrated catalogue of cods, hakes, grenadiers and other gadiform fishes known to date. FAO Fish. Synop. 125(10). Rome: FAO. 442 p. | |
| *Gaidropsarus mediterraneus* | Cohen, D.M., T. Inada, T. Iwamoto and N. Scialabba, 1990. FAO species catalogue. Vol. 10. Gadiform fishes of the world (Order Gadiformes). An annotated and illustrated catalogue of cods, hakes, grenadiers and other gadiform fishes known to date. FAO Fish. Synop. 125(10). Rome: FAO. 442 p. | |
| *Gaidropsarus vulgaris* | Cohen, D.M., T. Inada, T. Iwamoto and N. Scialabba, 1990. FAO species catalogue. Vol. 10. Gadiform fishes of the world (Order Gadiformes). An annotated and illustrated catalogue of cods, hakes, grenadiers and other gadiform fishes known to date. FAO Fish. Synop. 125(10). Rome: FAO. 442 p. | Morato, T., Afonso, P., Santos, R.S., Krug, H.M. and Nash, R.D.M., 2003. The reproduction, age and growth of the spotted rockling. Journal of fish biology, 62(6), pp.1450-1455. |
| *Galeorhinus galeus* | Ferreira, B.P. and C.M. Vooren, 1991. Age, growth, and structure of vertebra in the school shark Galeorhinus galeus (Linnaeus, 1758) from southern Brazil. Fish. Bull. 89:19-31. | |
| *Galeus atlanticus* | Rey, J., Coelho, R., Lloris, D., Séret, B. and Gil de Sola, L., 2010. Distribution pattern of Galeus atlanticus in the Alboran Sea (south | Rey, J., Coelho, R., Lloris, D., Séret, B. and Gil de Sola, L., 2010. Distribution pattern of Galeus atlanticus in the Alboran Sea (south |

| | | |
|---|---|---|
| | western Mediterranean) and some sexual character comparison with Galeus melastomus. *Marine Biology Research*, *6*(4), pp.364-372. | western Mediterranean) and some sexual character comparison with Galeus melastomus. *Marine Biology Research*, *6*(4), pp.364-372. |
| *Galeus melastomus* | Costa, M.E., Erzini, K. and Borges, T.C. 2005. Reproductive biology of the blackmouth catshark, Galeus melastomus (Chondrichthyes: Scyliorhinidae) off the south coast of Portugal. Journal of the Marine Biological Association of the United Kingdom 85(5): 1173-1183. | Moore, D.M., F.C. Neat and I.D. McCArthy, 2013. Population biology and ageing of the deep water sharks *Galeus melastomus, Centroselachus crepidater* and *Apristurus aphyodes* from the Rockall Trough, north-east Atlantic. J. Mar. Biol. Assoc. U.K. 93(7):1941-1950. |
| *Gasterosteus aculeatus* | Yershov, P. and A. Sukhotin, 2015. Age and growth of marine three-spined stickleback in the White Sea 50 years after a population collapse. Polar Biology 38(11):1813-1823. | |
| *Glyptocephalus cynoglossus* | Nilsen, R., Gutvik, O.K., Nilssen, E.M. and Hopkins, C.C.E., 1991. Population parameters of the witch flounder, Glyptocephalus cynoglossus (L.)(Pisces: Pleuronectidae), from Malangen, northern Norway. Fisheries research, 12(3), pp.259-278. | Nilsen, R., Gutvik, O.K., Nilssen, E.M. and Hopkins, C.C.E., 1991. Population parameters of the witch flounder, Glyptocephalus cynoglossus (L.)(Pisces: Pleuronectidae), from Malangen, northern Norway. *Fisheries research*, *12*(3), pp.259-278. |
| *Gnathophis mystax* | Bauchot, M.-L., 1987. Poissons osseux. p. 891-1421. In W. Fischer, M.L. Bauchot and M. Schneider (eds.) Fiches FAO d'identification pour les besoins de la pêche. (rev. 1). Méditerranée et mer Noire. Zone de pêche 37. Vol. II. Commission des Communautés Européennes and FAO, Rome. | |
| *Gobius gasteveni* | Miller, P.J., 1990. Gobiidae. p. 925-951. In J.C. Quero, J.C. Hureau, C. Karrer, A. Post and L. Saldanha (eds.) Check-list of the fishes of the | |

| | | | |
|---|---|---|---|
| | eastern tropical Atlantic (CLOFETA). JNICT, Lisbon, SEI, Paris; and UNESCO, Paris. Vol. 2. | | |
| *Gobius paganellus* | Azevedo, J.M.N. and A.M.V. Simas, 2000. Age and growth, reproduction and diet of sublittoral population of the rock goby Gobius paganellus (Teleostei: Gobiidae). Hydrobiologia 440:129-135. | Azevedo, J.M.N. and A.M.V. Simas, 2000. Age and growth, reproduction and diet of sublittoral population of the rock goby Gobius paganellus (Teleostei: Gobiidae). Hydrobiologia 440:129-135. | |
| *Halargyreus johnsonii* | Cohen, D.M., T. Inada, T. Iwamoto and N. Scialabba, 1990. FAO species catalogue. Vol. 10. Gadiform fishes of the world (Order Gadiformes). An annotated and illustrated catalogue of cods, hakes, grenadiers and other gadiform fishes known to date. FAO Fish. Synop. 125(10). Rome: FAO. 442 p. | | |
| *Helicolenus dactylopterus* | Kelly, C.J., Connolly, P.L. and Bracken, J.J., 1999. Age estimation, growth, maturity, and distribution of the bluemouth rockfish Helicolenus d. dactylopterus (Delaroche 1809) from the Rockall Trough. ICES Journal of Marine Science, 56(1), pp.61-74. | Kelly, C.J., Connolly, P.L. and Bracken, J.J., 1999. Age estimation, growth, maturity, and distribution of the bluemouth rockfish Helicolenus d. dactylopterus (Delaroche 1809) from the Rockall Trough. ICES Journal of Marine Science, 56(1), pp.61-74. | |
| *Hexanchus griseus* | Compagno, L.J.V., 1984. FAO Species Catalogue. Vol. 4. Sharks of the world. An annotated and illustrated catalogue of shark species known to date. Part 1 - Hexanchiformes to Lamniformes. FAO Fish. Synop. 125(4/1):1-249. Rome, FAO. | Ebert, D.A., 2002. Some observations on the reproductive biology of the sixgill shark Hexanchus griseus (Bonnaterre, 1788) from South African waters. African Journal of Marine Science, 24, pp.359-363. | Cox, G. and M. Francis, 1997. Sharks and rays of New Zealand. Canterbury Univ. Press, Univ. of Canterbury. 68 p. |
| *Hippoglossoides platessoides NS* | Jennings, S., Greenstreet, S.P. and Reynolds, J.D., 1999. Structural change in an exploited fish community: a consequence of differential fishing effects on species with contrasting life | Jennings, S., Greenstreet, S.P. and Reynolds, J.D., 1999. Structural change in an exploited fish community: a consequence of differential fishing effects on species with contrasting life histories. | |

| | | |
|---|---|---|
| | histories. Journal of Animal Ecology, 68(3), pp.617-627. | Journal of Animal Ecology, 68(3), pp.617-627. |
| *Hippoglossus hippoglossus* | Haug, T., 1990. Biology of the Atlantic halibut, Hippoglossus hippoglossus (L. 1758). Adv. Mar. Biol. 26:26-35. | Haug, T., 1990. Biology of the Atlantic halibut, Hippoglossus hippoglossus (L. 1758). Adv. Mar. Biol. 26:26-35. |
| *Hoplostethus mediterraneus* | D'Onghia, G., A. Tursi, C.A. Marano and M. Basanisi, 1998. Life history traits of Hoplostethus mediterraneus (Pisces: Beryciformes) from the North-Western Ionian Sea (Mediterranean Sea). J. Mar. Biol. Ass. U.K. 78:321-339. | D'Onghia, G., A. Tursi, C.A. Marano and M. Basanisi, 1998. Life history traits of Hoplostethus mediterraneus (Pisces: Beryciformes) from the North-Western Ionian Sea (Mediterranean Sea). J. Mar. Biol. Ass. U.K. 78:321-339. |
| *Hygophum benoiti* | Hulley, P.A., 1990. Myctophidae. p. 398-467. In J.C. Quero, J.C. Hureau, C. Karrer, A. Post and L. Saldanha (eds.) Check-list of the fishes of the eastern tropical Atlantic (CLOFETA). JNICT, Lisbon; SEI; Paris; and UNESCO, Paris. Vol. 1. | |
| *Hymenocephalus italicus* | Maiorano, P., L. Sion, R. Carlucci, F. Capezzuto, A. Giove, G. Costantino, M. Panza, G. D'Onghia and A. Tursi, 2010. The demersal faunal assemblage of the north-western Ionian Sea (central Mediterranean): current knowledge and perspectives. Chemistry and Ecology 26 (Supplement):219-240. | Massuti, E., B. Morales-Nin and C. Stefanescu, 1995. Distribution and biology of five grenadier fish (Pisces: Macrouridae) from the upper and middle slope of the northwestern Mediterranean. Deep-Sea Research 42(3):307-330 |
| *Icelus bicornis* | Fedorov, V.V., 1986. Cottidae. p. 1243-1260. In P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.) Fishes of the North-eastern Atlantic and the Mediterranean. UNESCO, Paris. Vol. 3. | |
| *Labrus bergylta* | Dipper, F.A., C.R. Bridges and A. Menz, 1977. Age, growth and feeding in the ballan wrasse, | |

| | | | |
|---|---|---|---|
| | Labrus bergylta Ascanius 1767. J. Fish Biol. 11:105-120. | | |
| *Labrus mixtus* | Bauchot, M.-L., 1987. Poissons osseux. p. 891-1421. In W. Fischer, M.L. Bauchot and M. Schneider (eds.) Fiches FAO d'identification pour les besoins de la pêche. (rev. 1). Méditerranée et mer Noire. Zone de pêche 37. Vol. II. Commission des Communautés Européennes and FAO, Rome. | Quignard, J.-P. and A. Pras, 1986. Labridae. p. 919-942. In P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.) Fishes of the north-eastern Atlantic and the Mediterranean. UNESCO, Paris. Vol. 2. | |
| *Lamna nasus* | Natanson, L.J., Mello, J.J. and Campana, S.E., 2002. Validated age and growth of the porbeagle shark (Lamna nasus) in the western North Atlantic Ocean. Fishery Bulletin, 100(2), pp.266-278. | Jensen, C.F., Natanson, L.J., Pratt Jr, H.L., Kohler, N. and Campana, S.E., 2002. The reproductive biology of the porbeage shark (Lamna nasus) in the western North Atlantic Ocean. Fishery Bulletin, 100(4), pp.727-738. | Jensen, C.F., Natanson, L.J., Pratt Jr, H.L., Kohler, N. and Campana, S.E., 2002. The reproductive biology of the porbeage shark (Lamna nasus) in the western North Atlantic Ocean. Fishery Bulletin, 100(4), pp.727-738. |
| *Lampanyctus crocodilus* | Hulley, P.A., 1990. Myctophidae. p. 398-467. In J.C. Quero, J.C. Hureau, C. Karrer, A. Post and L. Saldanha (eds.) Check-list of the fishes of the eastern tropical Atlantic (CLOFETA). JNICT, Lisbon; SEI; Paris; and UNESCO, Paris. Vol. 1. | | |
| *Lepidion eques* | Magnússon, J.V., 1998. Age, maturity and other biological parameters of two morid species Lepidion eques (Günther, 1887) and Antimora rostrata Günther, 1878, in Icelandic waters. ICES C.M. 1998/O:32. 22 p. | Magnússon, J.V., 1998. Age, maturity and other biological parameters of two morid species Lepidion eques (Günther, 1887) and Antimora rostrata Günther, 1878, in Icelandic waters. ICES C.M. 1998/O:32. 22 p. | |
| *Lepidopus caudatus* | Tuset, V., González, J.A., Santana, J.I., Lopez, A.M. and Diaz, M.G., 2006. Reproductive pattern and growth in Lepidopus caudatus (Osteichthyes, Trichiuridae) from the Canary | | |

| | | |
|---|---|---|
| | islands (Eastern-Central Atlantic). Electronic Journal of Ichthyology, 1, pp.26-37. | |
| *Lepidorhombus boscii* | Landa, J., Perez, N. and Piñeiro, C., 2002. Growth patterns of the four spot megrim (Lepidorhombus boscii) in the northeast Atlantic. Fisheries Research, 55(1-3), pp.141-152. | |
| *Lepidorhombus whiffiagonis* | Macdonald, P., Angus, C.H. and Marshall, C.T., 2013. Spatial variation in life history characteristics of common megrim (Lepidorhombus whiffiagonis) on the Northern Shelf. *Journal of sea research*, *75*, pp.62-68. | Macdonald, P., Angus, C.H. and Marshall, C.T., 2013. Spatial variation in life history characteristics of common megrim (Lepidorhombus whiffiagonis) on the Northern Shelf. *Journal of sea research*, *75*, pp.62-68. |
| *Lepidotrigla cavillone* | Campillo, A., 1992. Les pêcheries françaises de Méditeranée: synthèse des connaissances. Institut Francais de Recherche pour l'Exploitation de la Mer, France. 206 p. | Colloca, F., M. Cardinale and G.D. Ardizzone, 1997. Biology, spatial distribution and population dynamics of Lepidotrigla cavillone (Pisces: Triglidae) in the central Tyrrhenian Sea. Fish. Res. 32(1):21-32. |
| *Lepidotrigla dieuzeidei* | Bauchot, M.-L., 1987. Poissons osseux. p. 891-1421. In W. Fischer, M.L. Bauchot and M. Schneider (eds.) Fiches FAO d'identification pour les besoins de la pêche. (rev. 1). Méditerranée et mer Noire. Zone de pêche 37. Vol. II. Commission des Communautés Européennes and FAO, Rome. | |
| *Leptagonus decagonus* | Andriashev, A.P., 1986. Agonidae. p. 1265-1268. In P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.) Fishes of the North-eastern Atlantic and the Mediterranean. volume 3. UNESCO, Paris. | |

| | | | |
|---|---|---|---|
| *Leptoclinus maculatus* | Muus, B.J. and J.G. Nielsen, 1999. Sea fish. Scandinavian Fishing Year Book, Hedehusene, Denmark. 340 p. | | |
| *Lestidiops jayakari* | Post, A., 1986. Paralepididae. p. 274-278. In M.M. Smith and P.C. Heemstra (eds.) Smiths' sea fishes. Springer-Verlag, Berlin. | | |
| *Lesueurigobius friesii* | Muus, B.J. and J.G. Nielsen, 1999. Sea fish. Scandinavian Fishing Year Book, Hedehusene, Denmark. 340 p. | | |
| *Lesueurigobius sanzi* | Miller, P.J., 1990. Gobiidae. p. 925-951. In J.C. Quero, J.C. Hureau, C. Karrer, A. Post and L. Saldanha (eds.) Check-list of the fishes of the eastern tropical Atlantic (CLOFETA). JNICT, Lisbon, SEI, Paris; and UNESCO, Paris. Vol. 2. | | |
| *Leucoraja circularis* | Stehmann, M., 1990. Rajidae. p. 29-50. In J.C. Quero, J.C. Hureau, C. Karrer, A. Post and L. Saldanha (eds.) Check-list of the fishes of the eastern tropical Atlantic. Junta Nacional de Investigaçao Cientifica e Tecnológica, Lisbon, Portugal. Vol. 1. | | |
| *Leucoraja fullonica* | Muus, B.J. and J.G. Nielsen, 1999. Sea fish. Scandinavian Fishing Year Book, Hedehusene, Denmark. 340 p. | | |
| *Leucoraja naevus* | Gallagher, M.J., C.P. Nolan and F. Jeal, 2005. Age, growth and maturity of the commercial ray species from the Irish Sea. J. Northw. Atl. Fish. Sci., 35: 47-66. | Maia, C., K. Erzini, B. Serra-Pereira and I. Figueiredo, 2012. Reproductive biology of cuckoo ray Leucoraja naevus. J. Fish Biol. 81:1285-1296. | Clark, R.S., 1922. Rays and Skates (Raiœ) No. 1.—Egg-Capsules and Young. Journal of the Marine Biological Association of the United Kingdom, 12(4), pp.578-643 |
| *Limanda limanda* | Rijnsdorp, A.D., A.D. Vethaak and P.I. Van Leeuwan, 1992. Population biology of dab | Rijnsdorp, A.D., A.D. Vethaak and P.I. Van Leeuwan, 1992. Population biology of dab | |

| | | |
|---|---|---|
| | *Limanda limanda* in the southeastern North Sea. Mar. Ecol. Prog. Ser. 91:19-35. | *Limanda limanda* in the southeastern North Sea. Mar. Ecol. Prog. Ser. 91:19-35. |
| *Lithognathus mormyrus* | Monteiro, P., Bentes, L., Coelho, R., Correia, C., Erzini, K., Lino, P.G., Ribeiro, J. and Gonçalves, J.M., 2010. Age and growth, mortality and reproduction of the striped sea bream, Lithognathus mormyrus Linnaeus 1758, from the south coast of Portugal (Algarve). Marine Biology Research, 6(1), pp.53-65. | Monteiro, P., Bentes, L., Coelho, R., Correia, C., Erzini, K., Lino, P.G., Ribeiro, J. and Gonçalves, J.M., 2010. Age and growth, mortality and reproduction of the striped sea bream, Lithognathus mormyrus Linnaeus 1758, from the south coast of Portugal (Algarve). Marine Biology Research, 6(1), pp.53-65. |
| *Lophius budegassa* | Landa, J., Pereda, P., Duarte, R. and Azevedo, M., 2001. Growth of anglerfish (Lophius piscatorius and L. budegassa) in Atlantic Iberian waters. *Fisheries Research*, *51*(2-3), pp.363-376. | Duarte, R., M. Azevedo, J. Landa and P. Pereda, 2001. Reproduction of the anglerfish (Lophius budegassa Spinola and Lophius piscatorius Linnaeus) from the Atlantic Iberian coast. Fish. Res. 51(2-3):349-361. |
| *Lophius piscatorius* | Farina, A.C., Azevedo, M., Landa, J., Duarte, R., Sampedro, P., Costas, G., Torres, M.A. and Cañás, L., 2008. Lophius in the world: a synthesis on the common features and life strategies. ICES Journal of Marine Science, 65(7), pp.1272-1280. | Farina, A.C., Azevedo, M., Landa, J., Duarte, R., Sampedro, P., Costas, G., Torres, M.A. and Cañás, L., 2008. Lophius in the world: a synthesis on the common features and life strategies. ICES Journal of Marine Science, 65(7), pp.1272-1280. |
| *Lumpenus lampretaeformis* | Pauly, D., 1978. A preliminary compilation of fish length growth parameters. Ber. Inst. Meereskd. Christian-Albrechts-Univ. Kiel (55):1-200 | Muus, B.J. and J.G. Nielsen, 1999. Sea fish. Scandinavian Fishing Year Book, Hedehusene, Denmark. 340 p. |
| *Lycenchelys sarsi* | Muus, B.J. and J.G. Nielsen, 1999. Sea fish. Scandinavian Fishing Year Book, Hedehusene, Denmark. 340 p. | Nash, R.D. and Geffen, A.J., 2005. Aspects of the general biology of Sars' eelpout, Lycenchelys sarsi (Collett, 1871)(Pisces, Zoarcidae), in Oslofjorden, Norway. Marine Biology Research, 1(1), pp.33-38. |
| *Lycodes gracilis* | Nash, R.D., 1986. Aspects of the general biology of Vahl's eelpout, Lycodes vahlii gracilis | |

| | | |
|---|---|---|
| | M. Sars, 1867 (Pisces, Zoarcidae), in Oslofjorden, Norway. Sarsia, 71(3-4), pp.289-296. | |
| *Lycodes vahlii* | Andriashev, A.P., 1986. Zoarcidae. p. 1130-1150. In P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.) Fishes of the North-eastern Atlantic and the Mediterranean. volume 3. UNESCO, Paris. | |
| *Macroparalepis affinis* | Post, A., 1986. Paralepididae. p. 274-278. In M.M. Smith and P.C. Heemstra (eds.) Smiths' sea fishes. Springer-Verlag, Berlin. | |
| *Macroramphosus scolopax* | Borges, L., 2000. Age and growth of the snipefish, Macrorhamphosus spp., in the Portuguese continental waters. Journal of the Marine Biological Association of the United Kingdom, 80(1), pp.147-153. | |
| *Macrourus berglax* | Murua, H., 2003. Population structure, growth and reproduction of roughhead grenadier on the Flemish Cap and Flemish Pass. *Journal of Fish Biology*, *63*(2), pp.356-373 | Murua, H., 2003. Population structure, growth and reproduction of roughhead grenadier on the Flemish Cap and Flemish Pass. *Journal of Fish Biology*, *63*(2), pp.356-374 |
| *Malacocephalus laevis* | Iwamoto, T., 1986. Macrouridae. p. 330-341. In M.M. Smith and P.C. Heemstra (eds.) Smiths' sea fishes. Springer-Verlag, Berlin. | |
| *Maurolicus muelleri* | Gjøsaeter, J. and K. Kawaguchi, 1980. A review of the world resources of mesopelagic fish. FAO Fish. Tech. Pap. No. 193. FIRM/TI93. 151 p. | |
| *Melanogrammus aeglefinus* | Baudron, A.R., Needle, C.L. and Marshall, C.T., 2011. Implications of a warming North Sea for | Baudron, A.R., Needle, C.L. and Marshall, C.T., 2011. Implications of a warming North Sea for the growth of haddock |

| | | |
|---|---|---|
| | the growth of haddock Melanogrammus aeglefinus. Journal of Fish biology, 78(7), pp.1874-1889. | Melanogrammus aeglefinus. Journal of Fish biology, 78(7), pp.1874-1889. |
| *Merlangius merlangus* | Ross, S.D., Nielsen, J.R., Gislason, H., Nielsen, A. and Andersen, N.G., 2018. Growth and food consumption of whiting Merlangius merlangus. Journal of fish biology, 93(2), pp.334-343. | Jennings, S., J.D. Reynolds and S.C. Mills, 1998. Life history correlates of responses to fisheries exploitation. Proc. R. Soc. London B 265:333-339 |
| *Merluccius merluccius* | ICES, 2017. Report of the Working Group for the Bay of Biscay and the Iberic waters Ecoregion(WGBIE). Stock annex: Hake (Merluccius merluccius) in divisions 8.c and 9.a, Southern stock. | Murua, H., 2010. The biology and fisheries of European hake, Merluccius merluccius, in the north-east Atlantic. In Advances in marine biology (Vol. 58, pp. 97-154). Academic Press. |
| *Micrenophrys lilljeborgii* | Fedorov, V.V., 1986. Cottidae. p. 1243-1260. In P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.) Fishes of the North-eastern Atlantic and the Mediterranean. UNESCO, Paris. Vol. 3. | |
| *Microchirus azevia* | Félix, P.M., Vinagre, C. and Cabral, H.N., 2011. Life-history traits of flatfish in the Northeast Atlantic and Mediterranean Sea. Journal of Applied Ichthyology, 27(1), pp.100-111. | Félix, P.M., Vinagre, C. and Cabral, H.N., 2011. Life-history traits of flatfish in the Northeast Atlantic and Mediterranean Sea. Journal of Applied Ichthyology, 27(1), pp.100-111. |
| *Microchirus boscanion* | Schneider, W., 1990. FAO species identification sheets for fishery purposes. Field guide to the commercial marine resources of the Gulf of Guinea. Prepared and published with the support of the FAO Regional Office for Africa. Rome: FAO. 268 p. | |

| | | |
|---|---|---|
| *Microchirus variegatus* | Deniel, C., 1990. Comparative study of growth of flatfishes on the west coast of Brittany. J. Fish Biol. 37(1):149-166 | Deniel, C., 1990. Comparative study of growth of flatfishes on the west coast of Brittany. J. Fish Biol. 37(1):149-167 |
| *Micromesistius poutassou* | Estimated from ICES. 2017. Report of the Working Group on Widely Distributed Stocks (WGWIDE),<br>30 August -5 September 2017, ICES Headquarters, Copenhagen, Denmark. ICES CM 2017/ACOM:23. 1111 pp. | Estimated from ICES. 2017. Report of the Working Group on Widely Distributed Stocks (WGWIDE),<br>30 August -5 September 2017, ICES Headquarters, Copenhagen, Denmark. ICES CM<br>2017/ACOM:23. 1111 pp. |
| *Microstomus kitt* | King, P.A., Hannan, J.F., McGrath, D. and Veldon, M., 2006. Population dynamics, age, growth and maturity of lemon sole Microstomus kitt (Walbaum 1792) sampled between 2000-2002 off the west coast of Ireland. Marine Institute. | |
| *Mola mola* | Nakatsubo, T. and H. Hirose, 2007. Growth of captive ocean funfish, Mola mola. The Agriculture, Forestry and Fisheries Research Information and Technology Center. Http://www.affrc.go.jp | |
| *Molva dypterygia* | Pauly, D., 1978. A preliminary compilation of fish length growth parameters. Ber. Inst. Meereskd. Christian-Albrechts-Univ. Kiel (55):1-200. | Cohen, D.M., T. Inada, T. Iwamoto and N. Scialabba, 1990. FAO species catalogue. Vol. 10. Gadiform fishes of the world (Order Gadiformes). An annotated and illustrated catalogue of cods, hakes, grenadiers and other gadiform fishes known to date. FAO Fish. Synop. 125(10). Rome: FAO. 442 p. |
| *Molva macrophthalma* | Postel, E. and M.-H. Du Buit, 1964. Liste des poissons observés à la criée de Concarneau en fin Juillet-début Août 1964. Tailles maximales | |

| | | |
|---|---|---|
| | enregistrées. Bulletin de la Société Scientifique de Bretagne 39:113-117. | |
| *Molva molva* | Pauly, D., 1978. A preliminary compilation of fish length growth parameters. Ber. Inst. Meereskd. Christian-Albrechts-Univ. Kiel (55):1-200. | Cohen, D.M., T. Inada, T. Iwamoto and N. Scialabba, 1990. FAO species catalogue. Vol. 10. Gadiform fishes of the world (Order Gadiformes). An annotated and illustrated catalogue of cods, hakes, grenadiers and other gadiform fishes known to date. FAO Fish. Synop. 125(10). Rome: FAO. 442 p. |
| *Monochirus hispidus* | Amaral, V. and H.N. Cabral, 2004. Ecology of the whiskered sole in the Sado estuary, Portugal. J. Fish Biol. 64(2):460-474. | Amaral, V. and H.N. Cabral, 2004. Ecology of the whiskered sole in the Sado estuary, Portugal. J. Fish Biol. 64(2):460-474. |
| *Mora moro* | Vieira, A.R., Figueiredo, I., Figueiredo, C. and Menezes, G.M., 2013. Age and growth of two deep-water fish species in the Azores Archipelago: Mora moro (Risso, 1810) and Epigonus telescopus (Risso, 1810). Deep Sea Research Part II: Topical Studies in Oceanography, 98, pp.148-159. | |
| *Mugil cephalus* | Apostolidis, C. and K.I. Stergiou, 2014. Estimation of growth parameters from published data for several Mediterranean fishes. J. Appl. Ichthyol. 30(1):189-194. | Campillo, A., 1992. Les pêcheries françaises de Méditeranée: synthèse des connaissances. Institut Francais de Recherche pour l'Exploitation de la Mer, France. 206 p |
| *Mullus surmuletus* | Mahé, K., Coppin, F., Vaz, S. and Carpentier, A., 2013. Striped red mullet (M ullus surmuletus, L innaeus, 1758) in the eastern E nglish C hannel and southern N orth Sea: growth and reproductive biology. Journal of Applied Ichthyology, 29(5), pp.1067-1072. | |

| | | | |
|---|---|---|---|
| *Mustelus mustelus/asterias* | Farrell, E.D., S. Mariani and M.W. Clarke, 2010. Age and growth estimates for the starry smoothhound (Mustelus asterias) in the Northeast Atlantic Ocean. ICES J. Mar. Sci. 67:931-939. | Compagno, L.J.V., 1984. FAO Species Catalogue. Vol. 4. Sharks of the world. An annotated and illustrated catalogue of shark species known to date. Part 2 - Carcharhiniformes. FAO Fish. Synop. 125(4/2):251-655. Rome: FAO. | Compagno, L.J.V., Dando, M. and Fowler, S.L. 2005. Sharks of the World. Harper Collins. |
| *Myctophum punctatum* | Wörner, F., 1975. Untersuchungen an drei Myctophidenarten, Benthosema glaciale (Reinhardt, 1837), Ceratoscopelus maderensis (Lowe, 1839) und Myctophum (M.) punctatum Rafinesque, 1810 aus dem Nordwestafrikanischen Auftriebgebieten, im Frühjahr 1972. Kiel University. 136 p. Thesis. | Wörner, F., 1975. Untersuchungen an drei Myctophidenarten, Benthosema glaciale (Reinhardt, 1837), Ceratoscopelus maderensis (Lowe, 1839) und Myctophum (M.) punctatum Rafinesque, 1810 aus dem Nordwestafrikanischen Auftriebgebieten, im Frühjahr 1972. Kiel University. 136 p. Thesis. | |
| *Myliobatis aquila* | McEachran, J.D. and B. Séret, 1990. Myliobatididae. p. 67-70. In J.C. Quero, J.C. Hureau, C. Karrer, A. Post and L. Saldanha (eds.) Check-list of the fishes of the eastern tropical Atlantic (CLOFETA). JNICT, Lisbon; SEI, Paris; and UNESCO, Paris. Vol. 1. | Breder, C.M. and D.E. Rosen, 1966. Modes of reproduction in fishes. T.F.H. Publications, Neptune City, New Jersey. 941 p. | |
| *Myoxocephalus quadricornis* | Pokrovskaya, T.N., 1951. Biology of fourhorn sculpin. Trudy Instituta Okeanologii AN SSSR 6:132-149. | | |
| *Myoxocephalus scorpioides* | Coad, B.W. and J.D. Reist, 2004. Annotated list of the arctic marine fishes of Canada. Can. MS Rep. Fish Aquat. Sci. 2674:iv:+112 p. | | |
| *Myoxocephalus scorpius* | Luksenburg, J.A. and Pedersen, T., 2002. Sexual and geographical variation in life history parameters of the shorthorn sculpin. Journal of fish biology, 61(6), pp.1453-1464. | Luksenburg, J.A. and Pedersen, T., 2002. Sexual and geographical variation in life history parameters of the shorthorn sculpin. Journal of fish biology, 61(6), pp.1453-1464. | |

| | | | |
|---|---|---|---|
| *Myxine glutinosa* | Muus, B.J. and J.G. Nielsen, 1999. Sea fish. Scandinavian Fishing Year Book, Hedehusene, Denmark. 340 p. | Muus, B.J. and J.G. Nielsen, 1999. Sea fish. Scandinavian Fishing Year Book, Hedehusene, Denmark. 340 p. | |
| *Naucrates ductor* | Vassilopoulou, V., A. Siapatis, G. Christides and P. Bekas, 2004. The biology and ecology of juvenile pilotfish (Naucrates ductor) associated with Fish Aggregating Devices (FADs) in eastern Mediterranean waters. Medit. Mar. Sci. 5(1):5-17. | | |
| *Neoraja iberica* | Stehmann, M.F.W., B. Séret, E.M. Costa and J. Baro, 2008. *Neoraja iberica* n. sp., a new species of pygmy skate (Elasmobranchii, Rajidae) from the southern slope of the Iberian Peninsula (Eastern North Atlantic). Cybium 32(1):51-71. | Stehmann, M.F.W., B. Séret, E.M. Costa and J. Baro, 2008. *Neoraja iberica* n. sp., a new species of pygmy skate (Elasmobranchii, Rajidae) from the southern slope of the Iberian Peninsula (Eastern North Atlantic). Cybium 32(1):51-71. | Stehmann, M.F.W., B. Séret, E.M. Costa and J. Baro, 2008. *Neoraja iberica* n. sp., a new species of pygmy skate (Elasmobranchii, Rajidae) from the southern slope of the Iberian Peninsula (Eastern North Atlantic). Cybium 32(1):51-71. |
| *Nerophis lumbriciformis* | Dawson, C.E., 1986. Syngnathidae. p. 628-639. In P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.) Fishes of the North-eastern Atlantic and the Mediterranean. Volume 2. Unesco, Paris. | | |
| *Nettastoma melanurum* | Deval, M.C., Güven, O., Saygu, İ. and Kabapçioğlu, T., 2014. Length-weight relationships of 10 fish species found off Antalya Bay, eastern Mediterranean. Journal of applied ichthyology, 30(3), pp.567-568. | Porcu, C., Follesa, M.C., Gastoni, A., Mulas, A., Pedoni, C. and Cau, A., 2013. The reproductive cycle of a deep-sea eel, Nettastoma melanurum (Nettastomatidae: Anguilliformes) from the south-eastern Sardinian Sea (central-western Mediterranean). Journal of the Marine Biological Association of the United Kingdom, 93(4), pp.1105-1115. | |
| *Nezumia aequalis* | Massuti, E., B. Morales-Nin and C. Stefanescu, 1995. Distribution and biology of five grenadier | Massuti, E., B. Morales-Nin and C. Stefanescu, 1995. Distribution and biology | |

|  |  |  |
|---|---|---|
|  | fish (Pisces: Macrouridae) from the upper and middle slope of the northwestern Mediterranean. Deep-Sea Research 42(3):307-330. | of five grenadier fish (Pisces: Macrouridae) from the upper and middle slope of the northwestern Mediterranean. Deep-Sea Research 42(3):307-330. |
| *Nezumia sclerorhynchus* | Rannou, M., 1976. Age et croissance d'un poisson bathyal: Nezumia sclerorhynchus (Macrouridae, Gadiformes) de la mer d'Alboran. Cah. Biol. Mar. 17(4):413-421. | Cohen, D.M., T. Inada, T. Iwamoto and N. Scialabba, 1990. FAO species catalogue. Vol. 10. Gadiform fishes of the world (Order Gadiformes). An annotated and illustrated catalogue of cods, hakes, grenadiers and other gadiform fishes known to date. FAO Fish. Synop. 125(10). Rome: FAO. 442 p. |
| *Notoscopelus kröyeri* | Froese, R. and C. Binohlan, 2003. Simple methods to obtain preliminary growth estimates for fishes. J. Appl. Ichthyol. 19(6):376-379. |  |
| *Ophidion barbatum* | Karakulak, F.S., H. Erk and B. Bilgin, 2006. Length-weight relationships for 47 coastal fish species from the northern Aegean Sea, Turkey. J. Appl. Ichthyol. 22:274-278. |  |
| *Pagellus acarne* | Pajuelo, J.G. and J.M. Lorenzo, 2000. Reproduction, age, growth and mortality of axillary seabream, Pagellus acarne (Sparidae), from the Canarian archipelago. J. Appl. Ichthyol. 16:41-47. | Pajuelo, J.G. and J.M. Lorenzo, 2000. Reproduction, age, growth and mortality of axillary seabream, Pagellus acarne (Sparidae), from the Canarian archipelago. J. Appl. Ichthyol. 16:41-47. |
| *Pagellus bogaraveo* | Lorance, P., 2010. History and dynamics of the overexploitation of the blackspot sea bream (Pagellus bogaraveo) in the Bay of Biscay. ICES Journal of Marine Science, 68(2), pp.290-301. | Lorance, P., 2010. History and dynamics of the overexploitation of the blackspot sea bream (Pagellus bogaraveo) in the Bay of Biscay. ICES Journal of Marine Science, 68(2), pp.290-301. |
| *Pagellus erythrinus* | Coelho, R., Bentes, L., Correia, C., Gonçalves, J., Lino, P.G., Monteiro, P., Ribeiro, J. and Erzini, K., 2010. Life history of the common pandora, | Coelho, R., Bentes, L., Correia, C., Gonçalves, J., Lino, P.G., Monteiro, P., Ribeiro, J. and Erzini, K., 2010. Life history of the common pandora, Pagellus |

| | | |
|---|---|---|
| | Pagellus erythrinus (Linnaeus, 1758)(Actinopterygii: Sparidae) from southern Portugal. Brazilian Journal of Oceanography, 58(3), pp.233-245. | erythrinus (Linnaeus, 1758)(Actinopterygii: Sparidae) from southern Portugal. Brazilian Journal of Oceanography, 58(3), pp.233-245. |
| *Pagrus pagrus* | Pajuelo, J.G. and J.M. Lorenzo, 1996. Life history of the red porgy Pagrus pagrus (Teleostei: Sparidae) off the Canary Islands, central east Atlantic. Fish. Res. 28(2):163-177. | Pajuelo, J.G. and J.M. Lorenzo, 1996. Life history of the red porgy Pagrus pagrus (Teleostei: Sparidae) off the Canary Islands, central east Atlantic. Fish. Res. 28(2):163-177. |
| *Parablennius gattorugine* | Bauchot, M.-L., 1987. Poissons osseux. p. 891-1421. In W. Fischer, M.L. Bauchot and M. Schneider (eds.) Fiches FAO d'identification pour les besoins de la pêche. (rev. 1). Méditerranée et mer Noire. Zone de pêche 37. Vol. II. Commission des Communautés Européennes and FAO, Rome. | |
| *Paralichthys dentatus* | Desfosse, J.C., 1995. Movements and ecology of summer flounder, Paralichthys dentatus, tagged in the southern mid-Atlantic bight. Unpubl. PhD. diss., College of William and Mary, Williamsburg, VA. 187 p. | Desfosse, J.C., 1995. Movements and ecology of summer flounder, Paralichthys dentatus, tagged in the southern mid-Atlantic bight. Unpubl. PhD. diss., College of William and Mary, Williamsburg, VA. 187 p. |
| *Pegusa lascaris* | Félix, P.M., Vinagre, C. and Cabral, H.N., 2011. Life-history traits of flatfish in the Northeast Atlantic and Mediterranean Sea. *Journal of Applied Ichthyology*, *27*(1), pp.100-111. | Félix, P.M., Vinagre, C. and Cabral, H.N., 2011. Life-history traits of flatfish in the Northeast Atlantic and Mediterranean Sea. *Journal of Applied Ichthyology*, *27*(1), pp.100-111. |
| *Pholis gunnellus* | Cheetham, C. and Fives, J.M., 1990, January. The biology and parasites of the butterfish Pholis gunnellus (Linnaeus, 1758) in the Galway Bay area. In Proceedings of the Royal Irish Academy. Section B: Biological, | Qasim, S.Z., 1957. The biology of Centronotus gunnellus (L.)(Teleostei). *The Journal of Animal Ecology*, pp.389-401. |

| | | | |
|---|---|---|---|
| | Geological, and Chemical Science (pp. 127-149). Royal Irish Academy. | | |
| *Phrynorhombus norvegicus* | Nielsen, J.G., 1986. Scophthalmidae. p. 1287-1293. In P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.) Fishes of the North-eastern Atlantic and the Mediterranean. UNESCO, Paris. Vol. 3. | | |
| *Phycis blennoides* | Casas, J.M. and Piñeiro, C., 2000. Growth and age estimation of greater fork-beard (Phycis blennoides Brünnich, 1768) in the north and northwest of the Iberian Peninsula (ICES Division VIIIc and IXa). Fisheries Research, 47(1), pp.19-25. | Cohen, D.M., T. Inada, T. Iwamoto and N. Scialabba, 1990. FAO species catalogue. Vol. 10. Gadiform fishes of the world (Order Gadiformes). An annotated and illustrated catalogue of cods, hakes, grenadiers and other gadiform fishes known to date. FAO Fish. Synop. 125(10). Rome: FAO. 442 p | Casas, J.M. and Piñeiro, C., 2000. Growth and age estimation of greater fork-beard (Phycis blennoides Brünnich, 1768) in the north and northwest of the Iberian Peninsula (ICES Division VIIIc and IXa). *Fisheries Research*, *47*(1), pp.19-25. |
| *Platichthys flesus* | Froese, R. and C.C. Frieß, 1992. Synopsis of biological data on Platichthys flesus (L.), ICES assessment units 22 and 24, using the FISHBASE format. ICES C.M.1992/J:41. International Council for the Exploration of the Sea, Copenhagen. | ICES, 2014. Report of the Benchmark Workshop on Baltic Flatfish Stocks (WKBALFLAT), 27–31 January 2014, Copenhagen, Denmark. ICES CM 2014/ACOM:39. 320 pp. | |
| *Pleuronectes platessa* | Van Walraven, L., Mollet, F.M., Van Damme, C.J.G. and Rijnsdorp, A.D., 2010. Fisheries-induced evolution in growth, maturation and reproductive investment of the sexually dimorphic North Sea plaice (Pleuronectes platessa L.). Journal of Sea Research, 64(1-2), pp.85-93. | Van Walraven, L., Mollet, F.M., Van Damme, C.J.G. and Rijnsdorp, A.D., 2010. Fisheries-induced evolution in growth, maturation and reproductive investment of the sexually dimorphic North Sea plaice (Pleuronectes platessa L.). Journal of Sea Research, 64(1-2), pp.85-93. | |
| *Pollachius pollachius* | Pauly, D., 1978. A preliminary compilation of fish length growth parameters. Ber. Inst. Meereskd. Christian-Albrechts-Univ. Kiel (55):1-200. | Alonso-Fernandez, A., Villegas-Rios, D., Valdés-López, M., Olveira-Dominguez, B. and Saborido-Rey, F., 2013. Reproductive biology of pollack (Pollachius pollachius) from the Galician shelf (north-west Spain). | |

| | | |
|---|---|---|
| | | Journal of the Marine Biological Association of the United Kingdom, 93(7), pp.1951-1963. |
| *Pollachius virens* | Beverton, R.J.H. and S.J. Holt, 1959. A review of the lifespans and mortality rates of fish in nature, and their relation to growth and other physiological characteristics. p. 142-180. In G.E.W. Wolstenholme and M. O'Connor (eds.) CIBA Foundation colloquia on ageing: the lifespan of animals. volume 5. J & A Churchill Ltd, London. | Beverton, R.J.H. and S.J. Holt, 1959. A review of the lifespans and mortality rates of fish in nature, and their relation to growth and other physiological characteristics. p. 142-180. In G.E.W. Wolstenholme and M. O'Connor (eds.) CIBA Foundation colloquia on ageing: the lifespan of animals. volume 5. J & A Churchill Ltd, London. |
| *Polymetme corythaeola* | Schaefer, S., R.K. Johnson and J. Badcock, 1986. Photichthyidae. p. 243-247. In M.M. Smith and P.C. Heemstra (eds.) Smiths' sea fishes. Springer-Verlag, Berlin. | |
| *Polymetme thaeocoryla* | Parin, N.V. and O.D. Borodulina, 1990. Survey of the genus Polymetme (Photichthyidae) with a description of two new species. J. Ichthyol. 30(6):108-121. | |
| *Polyprion americanus* | Sedberry et al. 1999 Wreckfish in the North Atlantic- Fisheries, Biology, and management of a widely distributed and Long-lived fish | Peres, M.B. and S. Klippel, 2003. Reproductive biology of southwestern Atlantic wreckfish, Polyprion americanus (Teleostei: Polyprionidae). Environ. Biol. Fish. 68:163-173. |
| *Pomatoschistus lozanoi* | Muus, B.J. and J.G. Nielsen, 1999. Sea fish. Scandinavian Fishing Year Book, Hedehusene, Denmark. 340 p. | |
| *Pomatoschistus norvegicus* | Muus, B.J. and J.G. Nielsen, 1999. Sea fish. | |

| | | | |
|---|---|---|---|
| | Scandinavian Fishing Year Book, Hedehusene, Denmark. 340 p. | | |
| *Prionace glauca* | Nakano, Hideki, and John D. Stevens. 2009. “The Biology and Ecology of the Blue Shark, Prionace Glauca.” Sharks of the Open Ocean: Biology, Fisheries and Conservation. wiley, 140–51. doi:10.1002/9781444302516.ch12. | Nakano, Hideki, and John D. Stevens. 2009. “The Biology and Ecology of the Blue Shark, Prionace Glauca.” Sharks of the Open Ocean: Biology, Fisheries and Conservation. wiley, 140–51. doi:10.1002/9781444302516.ch12. | Stevens, J.D., 1975. Vertebral rings as a means of age determination in the blue shark (Prionace glauca L.). J. Mar. Biol. Ass. U.K. 55:657-665. |
| *Pterycombus brama* | Robins, C.R. and G.C. Ray, 1986. A field guide to Atlantic coast fishes of North America. Houghton Mifflin Company, Boston, U.S.A. 354 p. | | |
| *Pungitius pungitius* | Herczeg, G., Gonda, A., Kuparinen, A. and Merilä, J., 2012. Contrasting growth strategies of pond versus marine populations of nine-spined stickleback (Pungitius pungitius): a combined effect of predation and competition?. Evolutionary Ecology, 26(1), pp.109-122. | Herczeg, G., Gonda, A., Kuparinen, A. and Merilä, J., 2012. Contrasting growth strategies of pond versus marine populations of nine-spined stickleback (Pungitius pungitius): a combined effect of predation and competition?. Evolutionary Ecology, 26(1), pp.109-122. | |
| *Raja brachyura* | Gallagher, M.J., Nolan, C.P. and Jeal, F., 2005. Age, growth and maturity of the commercial ray species from the Irish Sea. *Journal of Northwest Atlantic Fishery Science*, *35*, pp.47-66 | Gallagher, M.J., Nolan, C.P. and Jeal, F., 2005. Age, growth and maturity of the commercial ray species from the Irish Sea. *Journal of Northwest Atlantic Fishery Science*, *35*, pp.47-67 | Clark, R.S., 1922. Rays and Skates (Raiœ) No. 1.—Egg-Capsules and Young. Journal of the Marine Biological Association of the United Kingdom, 12(4), pp.578-643 |
| *Raja clavata* | Gallagher, M.J., Nolan, C.P. and Jeal, F., 2005. Age, growth and maturity of the commercial ray species from the Irish Sea. *Journal of Northwest Atlantic Fishery Science*, *35*, pp.47-66 | Gallagher, M.J., Nolan, C.P. and Jeal, F., 2005. Age, growth and maturity of the commercial ray species from the Irish Sea. *Journal of Northwest Atlantic Fishery Science*, *35*, pp.47-67 | Pawson, M.G. and J.R. Ellis, 2005. Stock identity of elasmobranchs in the northeast Atlantic in relation to assessment and management. J. Northw. Atl. Fish. Sci., 35: 173-193. |
| *Raja microocellata* | Ryland, J.S. and Ajayi, T.O. 1984. Growth and population dynamics of three Raja species in | McCully, S.R., F. Scott and J.R. Ellis, 2012. Lengths at maturity and conversion factors | Clark, R.S., 1922. Rays and Skates (Raiœ) No. 1.—Egg-Capsules and Young. Journal |

| | | | |
|---|---|---|---|
| | Carmarthen Bay, British Isles. Journal de Conseil Internationale de Exploration de la Mer 41: 111-120. | for skates (Rajidae) around the British Isles, with an analysis of data in the literature. ICES J. Mar. Sci. 69(10):1812-1822. | of the Marine Biological Association of the United Kingdom, 12(4), pp.578-643 |
| *Raja montagui* | Gallagher, M.J., C.P. Nolan and F. Jeal, 2005. Age, growth and maturity of the commercial ray species from the Irish Sea. J. Northw. Atl. Fish. Sci., 35: 47-66. | Gallagher, M.J., C.P. Nolan and F. Jeal, 2005. Age, growth and maturity of the commercial ray species from the Irish Sea. J. Northw. Atl. Fish. Sci., 35: 47-66. | Serena, F., 2005. Field identification guide to the sharks and rays of the Mediterranean and Black Sea. Rome : Food and Agriculture Organization of the United Nations; Ix, 97 p., [14] leaves of plates :ill. (some col.), col. Maps ; 25 cm |
| *Raja undulata* | Moura, T., Figueiredo, I., Farias, I., Serra-Pereira, B., Coelho, R., Erzini, K., Neves, A. and Gordo, L.S., 2007. The use of caudal thorns for ageing Raja undulata from the Portuguese continental shelf, with comments on its reproductive cycle. Marine and Freshwater Research, 58(11), pp.983-992. | Serra-Pereira, B., Erzini, K. and Figueiredo, I., 2015. Using biological variables and reproductive strategy of the undulate ray Raja undulata to evaluate productivity and susceptibility to exploitation. Journal of fish biology, 86(5), pp.1471-1490. | Serra-Pereira, B., Erzini, K. and Figueiredo, I., 2015. Using biological variables and reproductive strategy of the undulate ray Raja undulata to evaluate productivity and susceptibility to exploitation. Journal of fish biology, 86(5), pp.1471-1490. |
| *Rajella bathyphila* | Ebert & Stehmann 2013 Sharks, batoids and chimaeras of the North Atlantic. FAO Species Catalogue for Fishery Purposes (7) Rome, 523 pp. | | |
| *Rajella fyllae* | Muus, B.J. and J.G. Nielsen, 1999. Sea fish. Scandinavian Fishing Year Book, Hedehusene, Denmark. 340 p. | | Clark, R.S., 1922. Rays and Skates (Raiœ) No. 1.—Egg-Capsules and Young. Journal of the Marine Biological Association of the United Kingdom, 12(4), pp.578-643 |
| *Rajella lintea* | Ponomarenko, N.P. 1961. Raja lintea Fries at the border between the Norwegian and the Barents Sea. [in Russian]. Zoologichesky Zhurnal 40(8): 1260-1261. | Bigelow, H.B. and W.C. Schroeder, 1953. Sawfishes, guitarfishes, skates and rays. p. 1-514. In J. Tee-Van et al. (eds.) Fishes of the western North Atlantic. Part two. New Haven, Sears Found. Mar. Res., Yale Univ. | |
| *Raniceps raninus* | Cohen, D.M., T. Inada, T. Iwamoto and N. Scialabba, 1990. FAO species catalogue. Vol. | | |

| | | |
|---|---|---|
| | 10. Gadiform fishes of the world (Order Gadiformes). An annotated and illustrated catalogue of cods, hakes, grenadiers and other gadiform fishes known to date. FAO Fish. Synop. 125(10). Rome: FAO. 442 p. | |
| *Rostroraja alba* | Kadri, H., Marouani, S., Bradai, M.N., Bouaïn, A., & Morize, E. (2014). Age, Growth, Mortality, Longevity and Reproductive Biology of the White Skate, Rostroraja alba (Chondrichthyes: Rajidae) of the Gulf of Gabès (Southern Tunisia, Central Mediterranean). Turkish Journal of Fisheries and Aquatic Sciences, 14, 193-204. http://doi.org/10.4194/1303-2712-v14_1_21 | Kadri, H., Marouani, S., Bradai, M.N., Bouaïn, A., & Morize, E. (2014). Age, Growth, Mortality, Longevity and Reproductive Biology of the White Skate, Rostroraja alba (Chondrichthyes: Rajidae) of the Gulf of Gabès (Southern Tunisia, Central Mediterranean). Turkish Journal of Fisheries and Aquatic Sciences, 14, 193-204. http://doi.org/10.4194/1303-2712-v14_1_21 |
| *Sarda sarda* | Rey, J.C., E. Alot and A. Ramos, 1986. Growth of the Atlantic bonito (Sarda sarda Bloch, 1793) in the Atlantic and Mediterranean area of the Strait of Gibraltar. Inv. Pesq. 50(2):179-185. | Cayré, P., J.B. Amon Kothias, T. Diouf and J.M. Stretta, 1993. Biology of tuna. p. 147-244. In A. Fonteneau and J. Marcille (eds.) Resources, fishing and biology of the tropical tunas of the Eastern Central Atlantic. FAO Fish. Tech. Pap. 292. Rome, FAO. 354 p. |
| *Sardina pilchardus* | Pauly, D., 1978. A preliminary compilation of fish length growth parameters. Ber. Inst. Meereskd. Christian-Albrechts-Univ. Kiel (55):1-200. | Beverton, R.J.H., 1963. Maturation, growth and mortality of clupeid and engraulid stocks in relation to fishing. Cons. Perm. Int. Explor. Mer, Rapp. p.-v. Réun. 154:44-67. |
| *Sarpa salpa* | Villamil, M.M., Lorenzo, J.M., Pajuelo, J.G., Ramos, A. and Coca, J., 2002. Aspects of the life history of the salema, Sarpa salpa (Pisces, Sparidae), off the Canarian Archipelago (central-east Atlantic). Environmental Biology of Fishes, 63(2), pp.183-192. | Villamil, M.M., Lorenzo, J.M., Pajuelo, J.G., Ramos, A. and Coca, J., 2002. Aspects of the life history of the salema, Sarpa salpa (Pisces, Sparidae), off the Canarian Archipelago (central-east Atlantic). Environmental Biology of Fishes, 63(2), pp.183-192. |

|  |  |  |
|---|---|---|
| *Scomber colias* | Vasconcelos, J.M.A., M.A. Dias and G. Faria, 2011. Age and growth of the Atlantic chub mackerel Scomber colias Gmelin, 1789 off Madeira Island. Arquipelago. Life Mar. Sci. 28:57-70. | Vasconcelos, J., M. Afonso-Dias and G. Faria, 2012. Atlantic chub mackerel (Scomber colias) spawning season, size and age at maturity in Madeira waters. Arquipelago. Life Mar. Sci. 29:43-51. |
| *Scomber scombrus* | Villamor, B., Abaunza, P. and Fariña, A.C., 2004. Growth variability of mackerel (Scomber scombrus) off north and northwest Spain and a comparative review of the growth patterns in the northeast Atlantic. Fisheries Research, 69(1), pp.107-121. |  |
| *Scomberesox saurus* | Potoschi, A., 1996. Observations about some biological aspects of Scomberesox saurus (Walbaum, 1792) in the area of the Straits of Messina. Oebalia 12:139-146. |  |
| *Scophthalmus maximus* | Jones, A., 1974. Sexual maturity, fecundity and growth of the turbot, Scophthalmus maximus L. J. Mar. Biol. Ass. U.K. 54:109-125. | Jones, A., 1974. Sexual maturity, fecundity and growth of the turbot, Scophthalmus maximus L. J. Mar. Biol. Ass. U.K. 54:109-125. |
| *Scophthalmus rhombus* | Félix, P.M., Vinagre, C. and Cabral, H.N., 2011. Life-history traits of flatfish in the Northeast Atlantic and Mediterranean Sea. Journal of Applied Ichthyology, 27(1), pp.100-111. | Félix, P.M., Vinagre, C. and Cabral, H.N., 2011. Life-history traits of flatfish in the Northeast Atlantic and Mediterranean Sea. Journal of Applied Ichthyology, 27(1), pp.100-111. |
| *Scorpaena loppei* | Ordines, F., M. Valls and A. Gouraguine, 2012. Biology, feeding, and habitat preferences of Cadenat’s rockfish, Scorpaena loppei (Actinopterygii: Scorpaeniformes: Scorpaenidae), in the Balearic Islands (western Mediterranean). Acta Ichthyol. Piscat. 42(1):21-30. |  |

| | | | |
|---|---|---|---|
| *Scorpaena notata* | Neves, A., V. Sequeira, A.R. Vieira, R.B. Paiva and L.S. Gordo, 2015. Age and growth of small red scorpionfish, Scorpaena notata (Actinopterygii: Scorpaeniformes; Scorpaenidae), a common discard species from the Portuguese fishery. Acta Ichthyol. Piscat. 45(1):13-20. | | |
| *Scorpaena porcus* | Siblot-Bouteflika, D., 1976. Contribution à l'étude des Scorpènidés de la région d'Alger. University de Marseille. Thesis. | Bradai, M.N. and A. Bouain, 1990. Données sur la reproduction de Scorpaena porcus du Golfe de Gabès. Rapp. Comm. Int. Mer Médit. 32(1):265. | |
| *Scorpaena scrofa* | Matić-Skoko, S., Stagličić, N., Kraljević, M., Pallaoro, A. and Dulčić, J., 2015. The biological traits of the large red scorpionfish, Scorpaena scrofa: Temporal and ontogenetic dynamics. Estuarine, Coastal and Shelf Science, 152, pp.91-99. | Matić-Skoko, S., Stagličić, N., Kraljević, M., Pallaoro, A. and Dulčić, J., 2015. The biological traits of the large red scorpionfish, Scorpaena scrofa: Temporal and ontogenetic dynamics. Estuarine, Coastal and Shelf Science, 152, pp.91-99. | |
| *Scyliorhinus canicula* | Ivory, P., F. Jeal and C.P. Nolan, 2005. Age determination, growth and reproduction in the lesser-spotted dogfish, *Scyliorhinus canicula* (L.). J. Northw. Atl. Fish. Sci. 35:89-106. | Ivory, P., F. Jeal and C.P. Nolan, 2005. Age determination, growth and reproduction in the lesser-spotted dogfish, *Scyliorhinus canicula* (L.). J. Northw. Atl. Fish. Sci. 35:89-106. | Ivory, P., F. Jeal and C.P. Nolan, 2005. Age determination, growth and reproduction in the lesser-spotted dogfish, *Scyliorhinus canicula* (L.). J. Northw. Atl. Fish. Sci. 35:89-106. |
| *Scyliorhinus stellaris* | Ellis, J.R., Dulvy, N.K., Jennings, S., Parker-Humphreys, M. and Rogers, S.I., 2005. Assessing the status of demersal elasmobranchs in UK waters: a review. JMBA-Journal of the Marine Biological Association of the United Kingdom, 85(5), pp.1025-1047. | | Ellis, J.R., Dulvy, N.K., Jennings, S., Parker-Humphreys, M. and Rogers, S.I., 2005. Assessing the status of demersal elasmobranchs in UK waters: a review. JMBA-Journal of the Marine Biological Association of the United Kingdom, 85(5), pp.1025-1047. |
| *Scymnodon ringens* | Compagno, L.J.V., 1984. FAO Species Catalogue. Vol. 4. Sharks of the world. An annotated and illustrated catalogue of shark | | |

| | | |
|---|---|---|
| | species known to date. Part 1 - Hexanchiformes to Lamniformes. FAO Fish. Synop. 125(4/1):1-249. Rome, FAO. | |
| *Sebastes viviparus* | Jennings, S., S.P.R. Greenstreet and J.D. Reynolds, 1999. Structural change in an exploited fish community: a consequence of differential fishing effects on species with contrasting life histories. J. Animal Ecol. 68:617-627. | Drevetnyak, K.V. and Kluev, A.I., 2005. Advances in Reproductive Biology: Methodology and Applications for Fisheries Science (Session Q). ICES CM 2005/Q:31 |
| *Serranus cabrilla* | Bouain, A., 1983. Croissance lineaire des serrans des cotes sud-est de la tunisie. Rapp. Comm. int. Mer Médit., 28(5):87-91. | García-Díaz, M.M., V.M. Tuset, J.A. González and J. Socorro, 1997. Sex and reproductive aspects in Serranus cabrilla (Osteichthyes: Serranidae): macroscopic and histological approaches. Mar. Biol. 127:379-386. |
| *Serranus hepatus* | Labropoulou M., Tserpes G., Tsimenidis N. 1998. Age, growth and feeding habits of the brown comber Serranus hepatus (Linnaeus, 1758) on the Cretan shelf. Estuarine Coast. Shelf Science, 46: 723-732. | Soykan, O., A.T. Ilkyaz, G. Metin and H.T. Kinacigil, 2013. Growth and reproduction of brown comber (Serranus hepatus Linnaeus, 1758) in the central Aegean Sea, Turkey. Turk. J. Zool. 37:211-217. |
| *Serranus scriba* | Bouain, A., 1983. Croissance lineaire des serrans des cotes sud-est de la tunisie. Rapp. Comm. int. Mer Médit., 28(5):87-91. | Tuset, V.M., M.M. García-Díaz, J.A. González, M.J. Lorente and I.J. Lozano, 2005. Reproduction and growth of the painted comber Serranus scriba (Serranidae) of the marine reserve of Lanzarote Island (central-eastern Atlantic). Estuar. Coast. Shelf Sci. 64(2-3):335-346. |
| *Solea senegalensis* | Félix, P.M., C. Vinagre and H.N Cabral, 2011. Life-history traits of flatfish in the Northeast Atlantic and Mediterranean Sea. J. Appl. Ichthyol. 27:100-111. | |

| | | | |
|---|---|---|---|
| *Solea solea* | Du Pontavice, H., Randon, M., Lehuta, S., Vermard, Y. and Savina-Rolland, M., 2018. Investigating spatial heterogeneity of von Bertalanffy growth parameters to inform the stock structuration of common sole, Solea solea, in the Eastern English Channel. *Fisheries research*, *207*, pp.28-36. | Mollet, F.M., Kraak, S.B. and Rijnsdorp, A.D., 2007. Fisheries-induced evolutionary changes in maturation reaction norms in North Sea sole Solea solea. Marine Ecology Progress Series, 351, pp.189-199. | |
| *Somniosus microcephalus* | Nielsen, J., Hedeholm, R.B., Heinemeier, J., Bushnell, P.G., Christiansen, J.S., Olsen, J., Ramsey, C.B., Brill, R.W., Simon, M., Steffensen, K.F. and Steffensen, J.F., 2016. Eye lens radiocarbon reveals centuries of longevity in the Greenland shark (Somniosus microcephalus). Science, 353(6300), pp.702-704. | Yano, K., Stevens, J.D. and Compagno, L.J.V., 2007. Distribution, reproduction and feeding of the Greenland shark Somniosus (Somniosus) microcephalus, with notes on two other sleeper sharks, Somniosus (Somniosus) pacificus and Somniosus (Somniosus) antarcticus. Journal of fish biology, 70(2), pp.374-390. | Yano, K., Stevens, J.D. and Compagno, L.J.V., 2007. Distribution, reproduction and feeding of the Greenland shark Somniosus (Somniosus) microcephalus, with notes on two other sleeper sharks, Somniosus (Somniosus) pacificus and Somniosus (Somniosus) antarcticus. Journal of fish biology, 70(2), pp.374-390. |
| *Sparus aurata* | Arias, A., 1980. Crecimento, régimen, alimentarión y reproduc-ción de la dorada (Sparus aurataL.) y del róbalo(Dicentrarchus labraxL.) en los esteros de Cádiz. Inv. Pesq., 44: 59-83. | Bauchot, M.-L. and J.-C. Hureau, 1986. Sparidae. p. 883-907. In P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.) Fishes of the north-eastern Atlantic and the Mediterranean. volume 2. UNESCO, Paris. | |
| *Spondyliosoma cantharus* | Neves, A., Vieira, A.R., Sequeira, V., Paiva, R.B. and Gordo, L.S., 2017. Modelling the growth of a protogynous sparid species, Spondyliosoma cantharus (Teleostei: Sparidae). Hydrobiologia, 797(1), pp.265-275. | Gonçalves, J.M. and Erzini, K.A.R.I.M., 2000. The reproductive biology of Spondyliosoma cantharus (L.) from the SW Coast of Portugal. Scientia Marina, 64(4), pp.403-411. | |
| *Sprattus sprattus* | Iles, T.D. and P.O. Johnson, 1962. The correlation table analysis of a sprat (Clupea sprattus L.) year-class to separate two groups differing in growth characteristics. J. du Conseil 27(1):287-303. | | |

| | | | |
|---|---|---|---|
| *Squalus acanthias* | Slauson, T.P., P.M.J. Woodhead and R. Castaneda, 1983. The age, growth and maturation of the spiny dogfish Squalus acanthias, in the Northwest Atlantic. Mar. Sci. Res. Cent. Spec. Rept. No. 49, State Univ. Stony Brook, N. Y., USA. | Slauson, T.P., P.M.J. Woodhead and R. Castaneda, 1983. The age, growth and maturation of the spiny dogfish Squalus acanthias, in the Northwest Atlantic. Mar. Sci. Res. Cent. Spec. Rept. No. 49, State Univ. Stony Brook, N. Y., USA. | Holden, M. J., and Meadows, P.S. 1962. 1964. The fecundity of the spurdog (Squalus acanthias L.). ICES J. Con., 28: 418–424. |
| *Stomias boa* | Gibbs, R.H. Jr., 1990. Stomiidae. p. 296-299. In J.C. Quero, J.C. Hureau, C. Karrer, A. Post and L. Saldanha (eds.) Check-list of the fishes of the eastern tropical Atlantic (CLOFETA). JNICT, Lisbon; SEI, Paris; and UNECO, Paris. Vol. 1. | | |
| *Symphodus bailloni* | Quignard, J.-P. and A. Pras, 1986. Labridae. p. 919-942. In P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.) Fishes of the north-eastern Atlantic and the Mediterranean. UNESCO, Paris. Vol. 2. | | |
| *Symphodus melops* | Pauly, D., 1978. A preliminary compilation of fish length growth parameters. Ber. Inst. Meereskd. Christian-Albrechts-Univ. Kiel (55):1-200. | Quignard, J.-P. and A. Pras, 1986. Labridae. p. 919-942. In P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.) Fishes of the north-eastern Atlantic and the Mediterranean. UNESCO, Paris. Vol. 2. | |
| *Symphodus roissali* | Quignard, J.-P., 1966. Recherches sur les Labridae (Poissons Téléostéens) perciformes des côtes européennes. Systématique et biologie. Naturalia Monspeliensia Sér. Zoologique 5:1-247. | Quignard, J.-P. and A. Pras, 1986. Labridae. p. 919-942. In P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.) Fishes of the north-eastern Atlantic and the Mediterranean. UNESCO, Paris. Vol. 2. | |
| *Synaphobranchus kaupi* | Reiner, F., 1996. Catálogo dos peixes do arquipélago de Cabo Verde. Publ. Avuls. Inst. Port. Invest. Mar. 2:339 p. (cited in Fishbase) | | |

| | | | |
|---|---|---|---|
| *Taurulus bubalis* | Lamp, F., 1965. Beiträge zur Bestandskunde und Fortpflanzungsbiologie der Seeskorpione, Myoxocephalus scorpius (Linnaeus 1758) und Taurulus bubalis (Euphrasen 1786) in der Kieler Förde. Kiel University. 140 p. Thesis. | | |
| *Taurulus lilljeborgi* | Fedorov, V.V., 1986. Cottidae. p. 1243-1260. In P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.) Fishes of the North-eastern Atlantic and the Mediterranean. UNESCO, Paris. Vol. 3. | | |
| *Thunnus thynnus* | Cort, J.L., 1991. Age and growth of the bluefin tuna, Thunnus thynnus (L.) of the Northeast Atlantic. ICCAT/SCRS/90/66:213-230. | Corriero, A., Karakulak, S., Santamaria, N., Deflorio, M., Spedicato, D., Addis, P., Desantis, S., Cirillo, F., Fenech-Farrugia, A., Vassallo-Agius, R. and De la Serna, J.M., 2005. Size and age at sexual maturity of female bluefin tuna (Thunnus thynnus L. 1758) from the Mediterranean Sea. Journal of Applied Ichthyology, 21(6), pp.483-486. | |
| *Torpedo marmorata* | Duman, Ö.V., & Başusta, N. (2013). Age and Growth Characteristics of Marbled Electric Ray Torpedo marmorata (Risso, 1810) Inhabiting Iskenderun Bay, North-eastern Mediterranean Sea. Turkish Journal of Fisheries and Aquatic Sciences, 13, 541-549. http://doi.org/10.4194/1303-2712-v13_3_19 | Møller, P.R., 1995. Electric fishes: history and behavior. Chapman & Hall, London. 584 p. | Last, P.R., W.T. White, M.R. de Carvalho, B. Séret, M.F.W. Stehmann and G.J.P. Naylor, 2016. Rays of the world. CSIRO Publishing, Comstock Publishing Associates. i-ix + 1-790 |
| *Torpedo nobiliana* | McEachran, J.D. and de Carvalho, M.R. 2002.. Batoid fishes. In: In: Carpenter, K.E. (ed). (ed.), *The Living Marine Resources of the Western Central Atlantic. Volume 1. Introduction, molluscs, crustaceans, hagfishes, sharks, batoid fishes and chimaeras.*, pp. Pp. 508-589.. FAO, Rome. | | Stehmann, M. and D.L. Bürkel, 1984. Torpedinidae. p. 159-162. In P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.) Fishes of the north-eastern Atlantic and Mediterranean. UNESCO, Paris. Vol. 1. |

|  |  |  |
|---|---|---|
| *Trachinus draco* | Bagge, O., 2004. The biology of the greater weever (Trachinus draco) in the commercial fishery of the Kattegat. ICES Journal of Marine Science, 61(6), pp.933-943. |  |
| *Trachipterus arcticus* | Froese, R. and C. Binohlan, 2003. Simple methods to obtain preliminary growth estimates for fishes. J. Appl. Ichthyol. 19(6):376-379. |  |
| *Trachurus mediterraneus* | Zupa, R., T. Silecchia, P. Carbonara and M.T. Spedicato, 2006. Growth of Trachurus mediterraneus (Steindachner, 1868) in the central-southern Tyyrhenian Sea. Biol. Mar. Medit. 13(2):302-303. | Stergiou, K.I., E.D. Christou, D. Georgopoulous, A. Zenetos and C. Souvermezoglou, 1997. The Hellenic seas: physics, chemistry, biology and fisheries. p. 415-538. In A.D. Ansell, R.N. Gibson and M. Barnes (eds.). Oceanography and marine biology: an annual review. UCL Press. |
| *Trachurus picturatus* | Vasconcelos, J., A. Alves, E. Gouveia and G. Faria, 2006. Age and growth of the blue jack mackerel, Trachurus picturatus Bowdich, 1825 (Pisces: Teleostei) off the Madeira archipelago. Arquipélago. Life Mar. Sci. 23A:47-57. | Garcia, A., Canha, Â., Reis, D. and Diogo, H., 2015. Life history parameters of blue jack mackerel Trachurus picturatus (Teleostei: Carangidae) from north-east Atlantic. Journal of the Marine Biological Association of the United Kingdom, 95(2), pp.401-410. |
| *Trachurus trachurus* | Abaunza, P., Gordo, L., Karlou-Riga, C., Murta, A., Eltink, A.T.G.W., Santamaría, M.G., Zimmermann, C., Hammer, C., Lucio, P., Iversen, S.A. and Molloy, J., 2003. Growth and reproduction of horse mackerel, Trachurus trachurus (Carangidae). Reviews in Fish Biology and Fisheries, 13(1), pp.27-61. | Abaunza, P., Gordo, L., Karlou-Riga, C., Murta, A., Eltink, A.T.G.W., Santamaría, M.G., Zimmermann, C., Hammer, C., Lucio, P., Iversen, S.A. and Molloy, J., 2003. Growth and reproduction of horse mackerel, Trachurus trachurus (Carangidae). Reviews in Fish Biology and Fisheries, 13(1), pp.27-61. |
| *Trachyrincus murrayi* | ICES, 2016. Report of the Working Group on Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP), 20-27 April 2016, ICES |  |

| | | |
|---|---|---|
| | HQ, Copenhagen, Denmark. ICES CM 2016/ACOM:18. 648 pp. | |
| *Trachyrincus scabrus* | Motais, R., 1960. Quelques observations sur la biologie d'un poisson abyssal, Trachyrinchus trachyrinchus Risso, et sur les conditions de vie en mer profonde. Bull. Inst. Océanogr. Monaco (1165):79 p. | |
| *Trigla lyra* | Campillo, A., 1992. Les pêcheries françaises de Méditeranée: synthèse des connaissances. Institut Francais de Recherche pour l'Exploitation de la Mer, France. 206 p. | Campillo, A., 1992. Les pêcheries françaises de Méditeranée: synthèse des connaissances. Institut Francais de Recherche pour l'Exploitation de la Mer, France. 206 p. |
| *Trigloporus lastoviza* | Ordines, F., Farriols, M.T., Lleonart, J., Guijarro, B., Quetglas, A. and Massutí, E., 2014. Biology and population dynamics of by-catch fish species of the bottom trawl fishery in the western Mediterranean. *Mediterranean Marine Science*, *15*(3), pp.613-625. | Ordines, F., Farriols, M.T., Lleonart, J., Guijarro, B., Quetglas, A. and Massutí, E., 2014. Biology and population dynamics of by-catch fish species of the bottom trawl fishery in the western Mediterranean. *Mediterranean Marine Science*, *15*(3), pp.613-625. |
| *Triglops murrayi* | Ottesen, C., 2004. Taxonomy, morphology and biology of Triglops murrayi and Triglops nybelini (family Cottidae) obtained at Svalbard and Jan Mayen. MS thesis, University of Tromsø, Tromsø, Norway . | |
| *Trisopterus esmarkii* | Lambert, G., Nielsen, J.R., Larsen, L.I. and Sparholt, H., 2009. Maturity and growth population dynamics of Norway pout (Trisopterus esmarkii) in the North Sea, Skagerrak, and Kattegat. ICES Journal of Marine Science, 66(9), pp.1899-1914. | Lambert, G., Nielsen, J.R., Larsen, L.I. and Sparholt, H., 2009. Maturity and growth population dynamics of Norway pout (Trisopterus esmarkii) in the North Sea, Skagerrak, and Kattegat. ICES Journal of Marine Science, 66(9), pp.1899-1914. |
| *Trisopterus luscus* | Labarta, U. and M.J. Ferreiro, 1982. Age and growth of the Galician coast pouting | Labarta, U. and M.J. Ferreiro, 1982. Age and growth of the Galician coast pouting |

| | | |
|---|---|---|
| | (Trisopterus luscus L.). Preliminary data. ICES C.M. 1982/G:65. | (Trisopterus luscus L.). Preliminary data. ICES C.M. 1982/G:65. |
| *Trisopterus minutus* | Beverton, R.J.H. and S.J. Holt, 1959. A review of the lifespans and mortality rates of fish in nature, and their relation to growth and other physiological characteristics. p. 142-180. In G.E.W. Wolstenholme and M. O'Connor (eds.) CIBA Foundation colloquia on ageing: the lifespan of animals. volume 5. J & A Churchill Ltd, London. | Beverton, R.J.H. and S.J. Holt, 1959. A review of the lifespans and mortality rates of fish in nature, and their relation to growth and other physiological characteristics. p. 142-180. In G.E.W. Wolstenholme and M. O'Connor (eds.) CIBA Foundation colloquia on ageing: the lifespan of animals. volume 5. J & A Churchill Ltd, London. |
| *Umbrina canariensis* | Dardignac, J., 1961. Les ombrines de côtes Atlantique du Maroc. Rev. Trav. Inst. Pêches. Marit. 25(3):263-279. | |
| *Xenodermichthys copei* | Bernardes, R.Á., J.L. de Figueiredo, A.R. Rodrigues, L.G. Fischer, C.M. Vooren, M. Haimovici and C.L.D.B. Rossi-Wongtschowski, 2005. Peixes de zona econômica exclusiva da região sudeste-sul do Brasil: Levantamento com armadilhas, pargueiras e rede de arrasto de fundo. São Paulo: Editora da Universidade de São Paulo. 295 p. | |
| *Xiphias gladius* | Valeiras, X., J.M. de la Serna, D. Macías, M. Ruiz, S. García-Barcelona, M.J. Gómez and J.M. Ortíz de Urbina, 2008. Age and growth of swordfish (Xiphias gladius) in the western Mediterranean Sea. Collect. Vol. Sci. Pap. ICCAT 62(4):1112-1121. | Macías, D., Hattour, A., De la Serna, J.M., Gómez-Vives, M.J. and Godoy, D., 2005. Reproductive characteristics of swordfish (Xiphias gladius) caught in the southwestern Mediterranean during 2003. Col. Vol. Sci. Pap. ICCAT, 58(2), pp.454-469. |
| *Zeugopterus punctatus* | Nielsen, J.G., 1986. Scophthalmidae. p. 1287-1293. In P.J.P. Whitehead, M.-L. Bauchot, J.-C. Hureau, J. Nielsen and E. Tortonese (eds.) | |

| | | | |
|---|---|---|---|
| | Fishes of the North-eastern Atlantic and the Mediterranean. UNESCO, Paris. Vol. 3. | | |
| *Zeugopterus regius* | Bauchot, M.-L., 1987. Poissons osseux. p. 891-1421. In W. Fischer, M.L. Bauchot and M. Schneider (eds.) Fiches FAO d'identification pour les besoins de la pêche. (rev. 1). Méditerranée et mer Noire. Zone de pêche 37. Vol. II. Commission des Communautés Européennes and FAO, Rome. | | |
| *Zeus faber* | Dunn, M.R., 2001. The biology and exploitation of John dory, Zeus faber (Linnaeus, 1758) in the waters of England and Wales. ICES Journal of Marine Science, 58(1), pp.96-105. | Dunn, M.R., 2001. The biology and exploitation of John dory, Zeus faber (Linnaeus, 1758) in the waters of England and Wales. ICES Journal of Marine Science, 58(1), pp.96-105. | |
| *Zoarces viviparus* | Wiêcaszek, B., 1998. On the morphometry and growth rate in the viviparous eel-pout, Zoarces viviparus (Zoarcidae) from waters of different salinity. Ital. J. Zool. 65:211-214. | Muus, B.J. and J.G. Nielsen, 1999. Sea fish. Scandinavian Fishing Year Book, Hedehusene, Denmark. 340 p. | Muus, B.J. and J.G. Nielsen, 1999. Sea fish. Scandinavian Fishing Year Book, Hedehusene, Denmark. 340 p. |

Table S4. Years included for each survey.

| Region | Survey | Years included |
|---|---|---|
| **Baltic Sea** | BITS Q1 small | 1996-2018 |
| | BITS Q4 small | 1999-2018 |
| **North Sea** | BTS | 1987-2018 |
| | DYFS | 2002-2018 |
| | IBTS Q1 | 1967-2018 |
| | IBTS Q3 | 1991-2018 |
| | SNS | 2002-2018 |
| **West of UK** | ROCKALL | 1999, 2001-2003, 2005-2009, 2011-2018 |
| | SWC-IBTS Q1 | 1985-2018 |
| | SWC-IBTS Q4 | 1990-2009, 2011-2018 |
| | IE-IGFS | 2011-2018 |
| | NIGFS | 2006-2017 |
| | SP-PORC | 2001-2018 |
| **Bay of Biscay/Celtic Sea** | BTSVIII | 2011-2017 |
| | EVHOE | 1997-2016 |
| | FR-CGFS | 1988-2018 |
| | SP-NORTH | 1990-1992, 1994, 1997, 2001-2018 |
| **Iberian Peninsula** | PT-IBTS | 2002-2011, 2013-2017 |
| | SP-ARSA | 1996, 2000-2018 |

Table S5. $F_{25\%SSB}$ average and range for each IUCN category.

| IUCN rating | Average | Minimum | Maximum | Number of species |
|---|---|---|---|---|
| CR | 0.17 | 0.05 | 0.39 | 3 |
| EN | 0.37 | 0.20 | 0.75 | 7 |
| VU | 0.27 | 0.13 | 0.46 | 8 |
| NT | 1.54 | 0.09 | 20 | 18 |
| LC | 9.96 | 0.10 | 20 | 207 |
| DD | 6.17 | 0.28 | 20 | 19 |

Table S6. 2019 EU Catch and landing obligations.

| Type of management | Species | Management applicable |
|---|---|---|
| No TAC | *Anarhichas minor* | No TAC |
| | *Anarhichas lupus* | No TAC |
| | *Argyrosomus regius* | No TAC |
| | *Brama brama* | No TAC |
| | *Chimaera monstrosa* | No TAC |
| | *Conger conger* | No TAC |
| | *Dasyatis pastinaca* | No TAC |
| | *Dasyatis tortonesei* | No TAC |
| | *Dicentrarchus punctatus* | No TAC |
| | *Ephippion guttifer* | No TAC |
| | *Epigonus telescopus* | No TAC |
| | *Galeus melanostomus* | No TAC |
| | *Hippoglossus hippoglossus* | No TAC |
| | *Molva macropthalma* | No TAC |

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|---|---|---|
| | *Mora moro* | No TAC |
| | *Mustelus mustelus/asterias* | No TAC |
| | *Phycis blennoides*[2] | TACs enforce (up to 2017-2018), removed from TAC management from 2019 |
| | *Polyprion americanus* | No TAC |
| | *Scorpaena scrofa* | No TAC |
| | *Scyliorhinus canicula* | No TAC |
| | *Scyliorhinus stellaris* | No TAC |
| | *Synaphobranchus kaupi* | No TAC |
| | *Torpedo marmorata* | No TAC |
| | *Torpedo nobiliana* | No TAC |
| TAC applied at the level of Order | *Amblyraja hyperborea* | Included within the TACs for 'skates and rays' |
| | *Dipturus oxyrinchus* | Included within the TACs for 'skates and rays' |
| | *Leucoraja circularis*[1] | Included within the TACs for 'skates and rays'. Must be reported by species in Subarea 6 and Divisions 7.a-c, 7.e-k. |

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| | *Leucoraja fullonica*[1] | Included within the TACs for ‘skates and rays’. Must be reported by species in Subarea 6 and Divisions 7.a-c, 7.e-k. |
| | *Leucoraja naevus*[1] | Included within the TACs for ‘skates and rays’. Must be reported separately. |
| | *Raja brachyura*[1] | Included within the TACs for ‘skates and rays’. Must be reported separately. Must be promptly release unharmed in ICES Division 2a (minor part of distribution range) |
| | *Raja clavata*[1] | Included within the TACs for ‘skates and rays’. Must be reported separately. Must be promptly release unharmed in ICES Division 3.a (minor part of distribution range). |
| | *Raja microocellata*[1] | Species-specific TAC within skates and rays TAC (applied to Divisions 7.f-g only). Promptly release unharmed in ICES Divisions 2.a and 4 (minor part of distribution range) and in Divisions 6.a-b, 7.a-c, h-k. Included within the TACs for ‘skates and rays’ in Division 7.d and in Subareas 8-9. |
| | *Raja montagui*[1] | Included within the TACs for ‘skates and rays’. Must be reported separately in some areas. |
| | *Raja undulata*[1] | Species-specific TACs (within skates and rays TAC) for Divisions 7.d-e; Subarea 8 and Subarea 9). Promptly release unharmed elsewhere. |
| | *Rajella bathyphila* | Included within the TACs for ‘skates and rays’ |

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| | *Rajella fyllae* | Included within the TACs for ‘skates and rays’ |
| | *Rajella lintea* | Included within the TACs for ‘skates and rays’ |
| TAC applied at the genus-level or family level | *Lepidorhombus whiffiagonis*[1] | TACs for *Lepidorhombus* spp. |
| | *Lophius budegassa*[1] | TACs for anglerfish Lophiidae |
| | *Lophius piscatorius*[1] | TACs for anglerfish Lophiidae |
| | *Scophthalmus rhombus*[1] | TAC for *Scophthalmus rhombus* and *S. maximus* (EU waters of Division 2.a and Subarea 4 only) |
| | *Sebastes* spp. [1] | TAC for *Sebastes* spp. |
| Species-TACs by management area(s) | *Brosme brosme*[1] | TACs in place |
| | *Coryphaenoides rupestris*[2] | Precautionary TACs for 3; 5b, 6-, 7; and 8, 9, 10, 12 and 14. Combined TAC for grenadiers in Greenland and Arctic waters. No TAC in other areas. |
| | *Molva dypterygia*[1] | TACs in place |
| | *Molva molva*[1] | TACs in place |
| Conservative management | *Lamna nasus*[1] | Prohibited species, to be promptly released unharmed when caught (all waters) |
| | *Macrourus berglax*[2] | No target fisheries. Landings of upto 1% of the TAC for *Coryphaenoides rupestris.* |

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| | *Amblyraja radiata*[1] | Prohibited species, to be promptly released unharmed when caught in ICES Divisions 2.a, 3.a and 7.d, and Subarea 4 (the main part of the distribution range in EU waters) |
| | *Dipturus batis*[1] | Prohibited species, to be promptly released unharmed when caught in EU waters of Division 2.a and Subareas 3-4, 6-10. |
| | *Dipturus nidarosiensis*[1] | Prohibited species, to be promptly released unharmed when caught in EU waters of Division 6.a, 6.b, 7a-c, e-h and k. |
| | *Rostroraja alba*[1] | Prohibited species, to be promptly released unharmed in ICES areas 6-10 (the main part of the distribution range in EU Atlantic waters) |
| | *Galeorhinus galeus*[1] | Promptly release unharmed when taken with longlines in Union waters of ICES division 2a and ICES subareas 1, 4, 5, 6, 7, 8, 12 and 14. No TAC for other gears and areas (can be landed as 'others'). Regional and national laws restrict landings in some areas (e.g. UK), but no other species-specific restrictions in other areas |
| | *Squalus acanthias*[1] | Prohibited species, to be promptly released unharmed (unless taken by a fishery within a bycatch avoidance scheme in Subareas 1, 5, 6, 7, 8, 12 and 14) |
| | *Dalatias licha*[1,2] | Managed under the deep-water shark complex. It is prohibited for Union fishing vessels to fish for deep-sea sharks in Subareas 5–9, in Union and international |

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| | | waters of Subarea 10, in international waters of Subarea 12 and in Union waters of CECAF 34.1.1, 34.1.2 and 34.2 (although a limited TAC for deep-sea sharks allows for bycatch in longline fisheries targeting black scabbardfish, except for Subarea 12). Also to be promptly release unharmed when caught in ICES Divisions 2.a, 4 and international waters of 1 and 14. |
| | *Deania calcea*[1,2] | See *Dalatias licha* |
| | *Etmopterus princeps*[1,2] | See *Dalatias licha* |
| | *Hexanchus griseus*[2] | Managed under the deep-water shark complex. It is prohibited for Union fishing vessels to fish for deep-sea sharks in Subareas 5–9, in Union and international waters of Subarea 10, in international waters of Subarea 12 and in Union waters of CECAF 34.1.1, 34.1.2 and 34.2 (although a limited TAC for deep-sea sharks allows for bycatch in longline fisheries targeting black scabbardfish, except for Subarea 12). |
| | *Somniosus microcephalus*[2] | See *Hexanchus griseus* |

[1] EU 2018a. COUNCIL REGULATION (EU) 2019/124 of 30 January 2019 fixing for 2019 the fishing opportunities for certain fish stocks and groups of fish stocks, applicable in Union waters and, for Union fishing vessels, in certain non-Union waters.

[2] EU 2018b. Council Regulation (EU) 2018/2025 of 17 December 2018 fixing for 2019 and 2020 the fishing opportunities for Union fishing vessels for certain deep-sea fish stocks.Supplementary figures

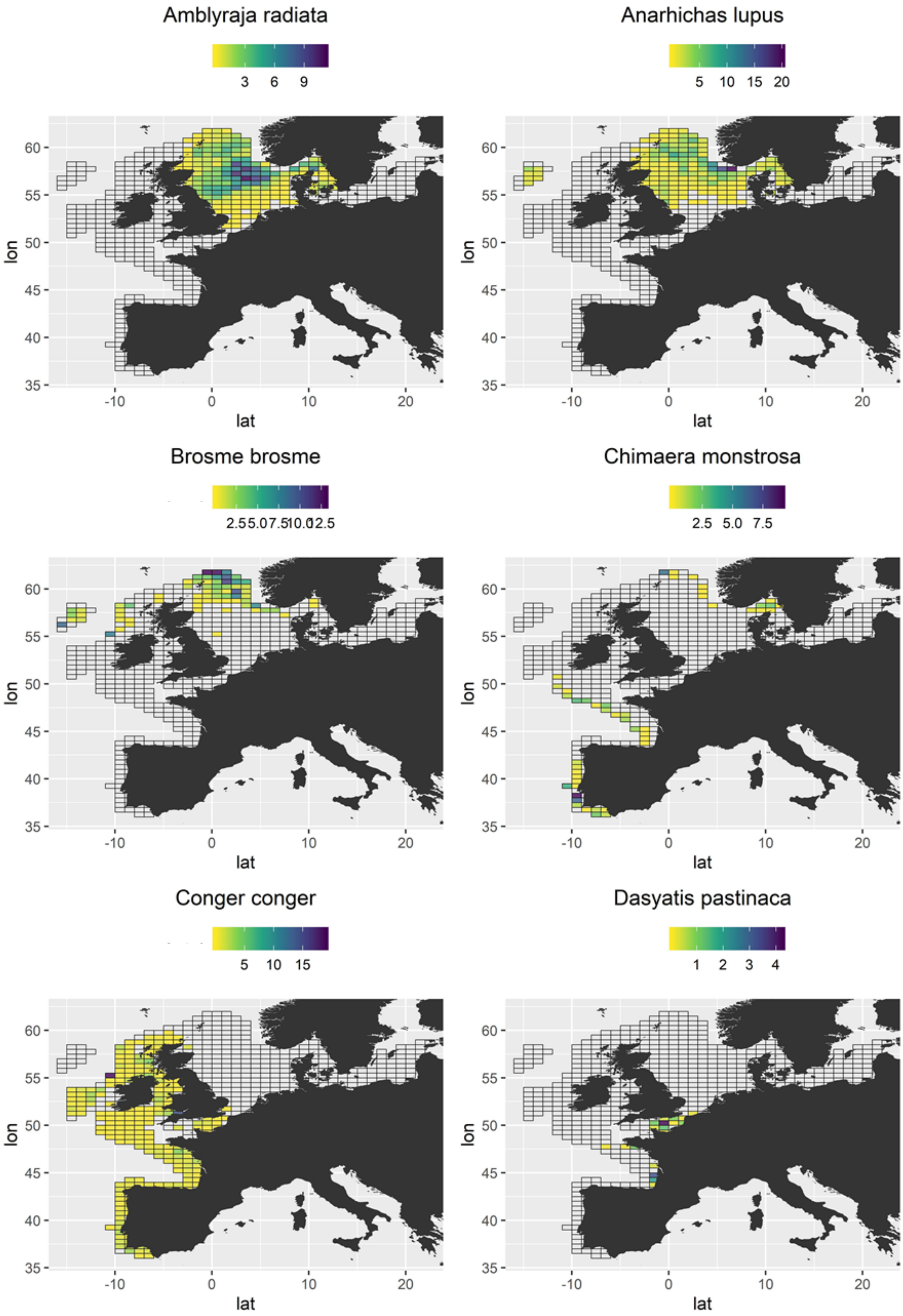

Figure S1. Spatial distribution of sensitive species.

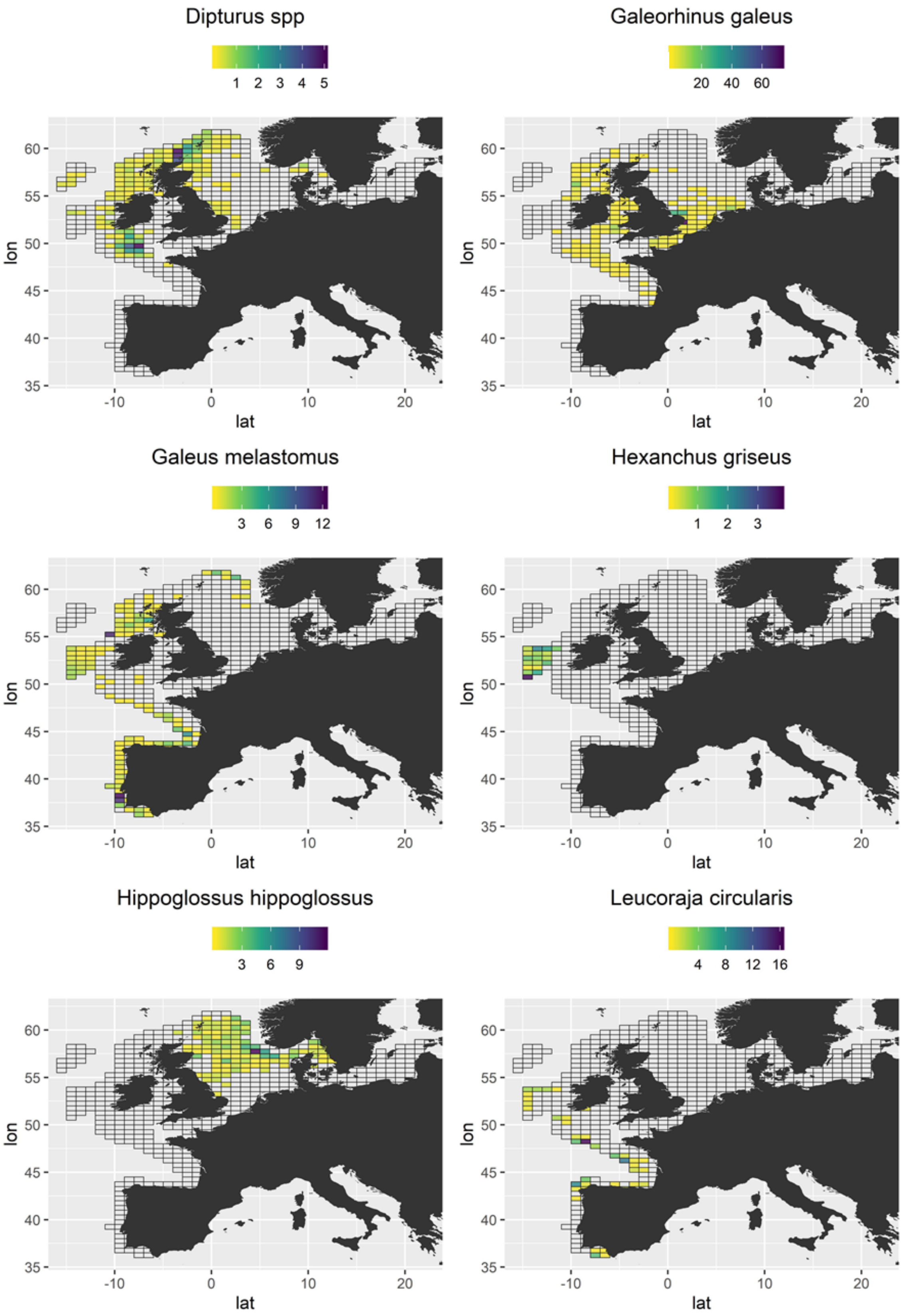

Figure S1. Spatial distribution of sensitive species continued.

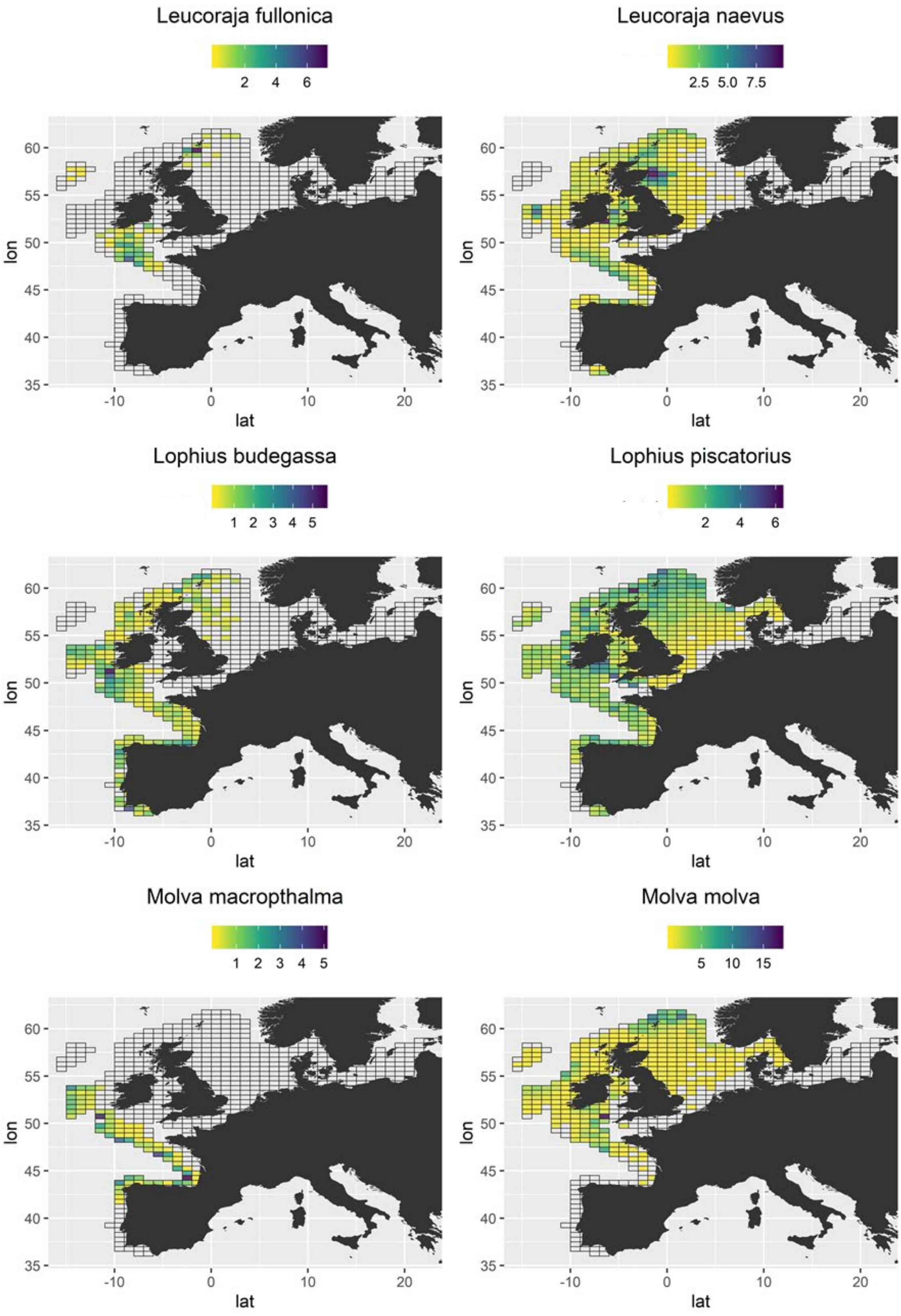

Figure S1. Spatial distribution of sensitive species continued.

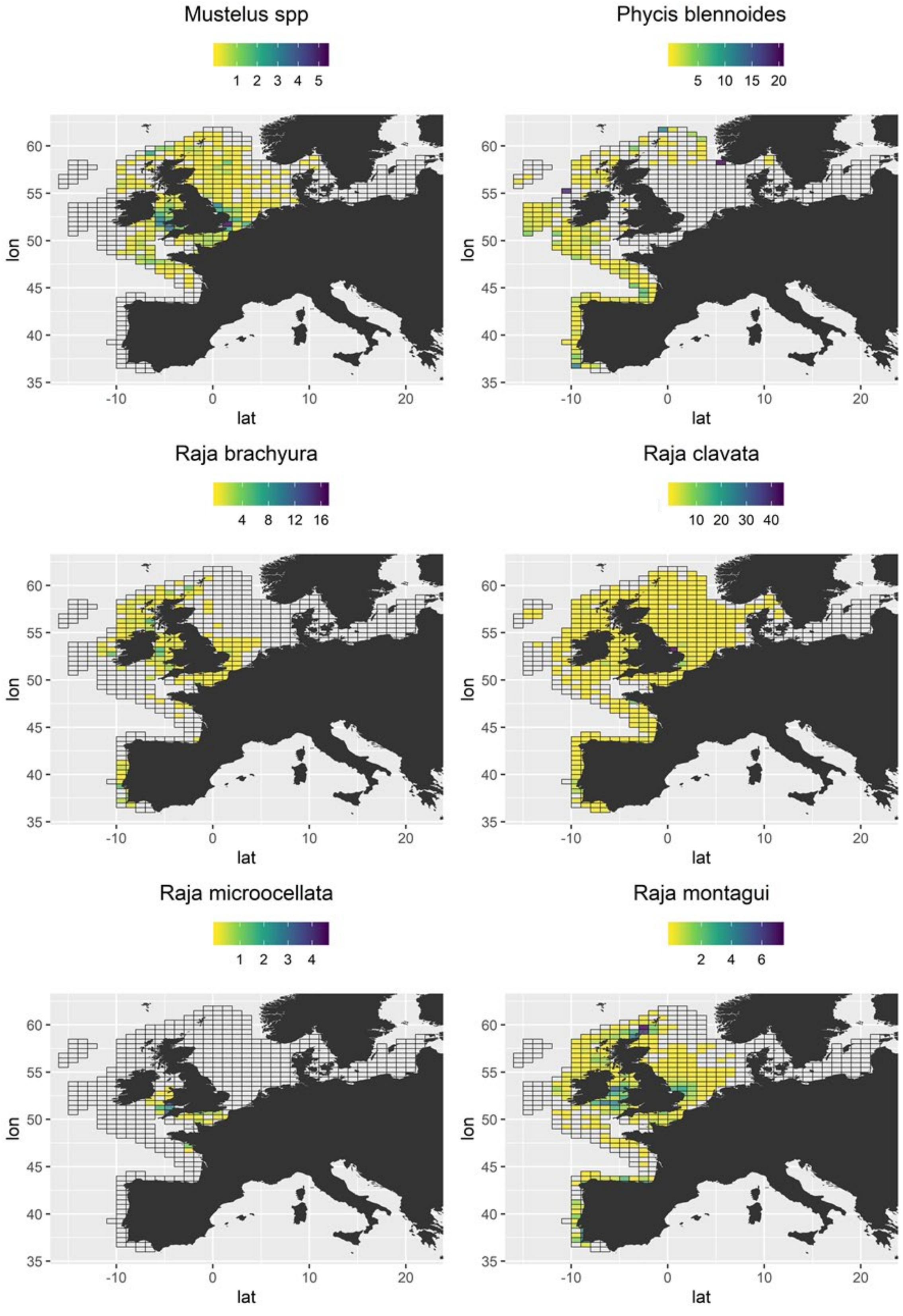

Figure S1. Spatial distribution of sensitive species continued.

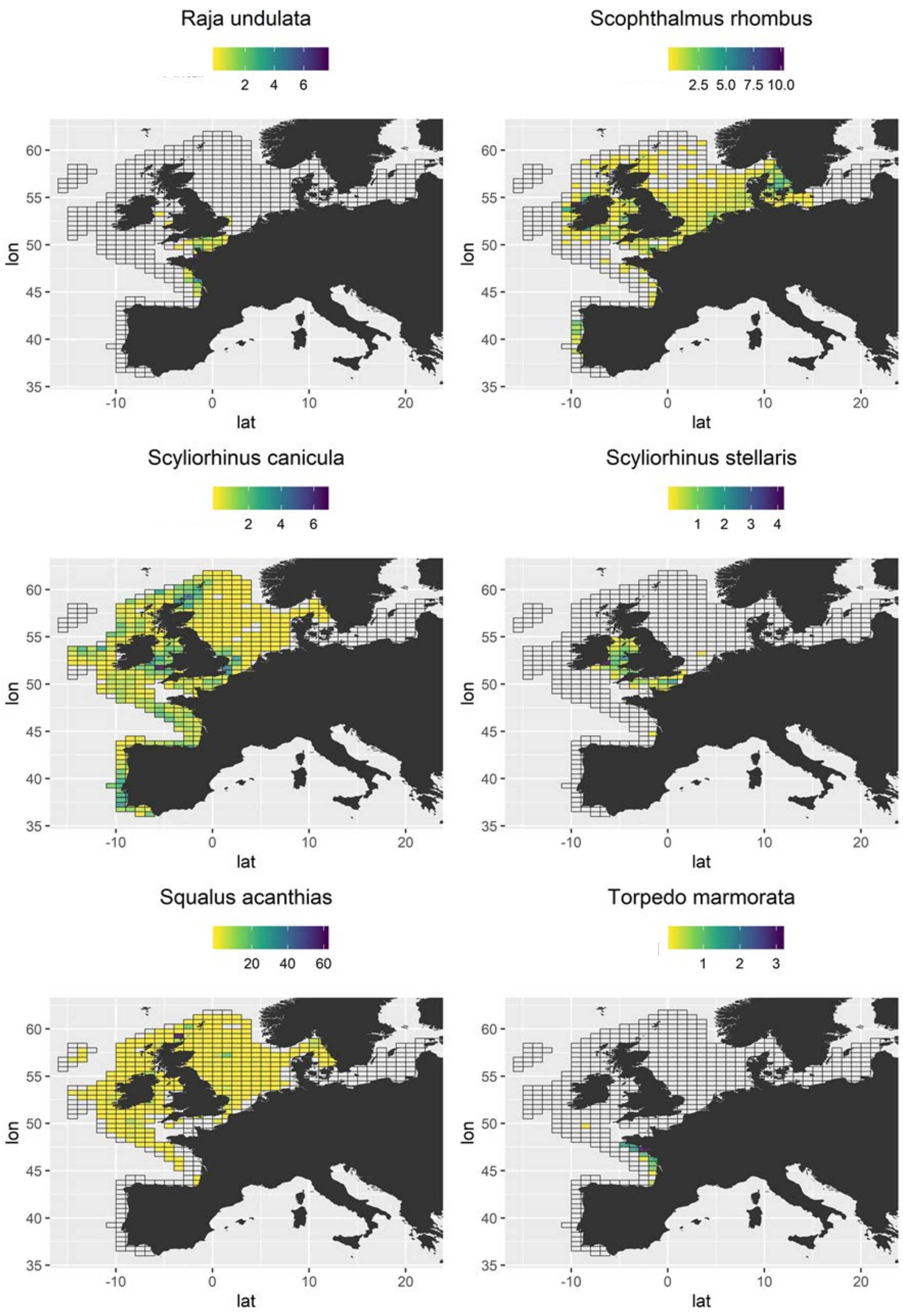

Figure S1. Spatial distribution of sensitive species continued.