Qualitative network models of the Mediterranean Sea marine food webs

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ABSTRACT

Marine ecosystems are globally threatened due to the effects of global change as a result of human activities, which can alter them at many scales, from individual physiological damage to the loss of ecosystem structure and subsequent deterioration of ecosystem functioning. This is particularly true in marine biodiversity hotspots, such as the Mediterranean Sea, as its basin is one of the most impacted areas in the world. In this sense, in order to develop informed conservation plans it is essential to understand the relationships among the species inhabiting it, and the interlinkages and dependencies between all its components. Food web analyses provide a representation of these relationships, and allow assessing system complexity and resilience. In this study, we aimed at depicting the qualitative food-web structure of the Mediterranean Sea and its main sub-regions, while visualizing its food-web structure and identifying the main similarities and differences between regions. We used the framework set up in a previous study, which built a general qualitative meta-web of the Mediterranean Sea and we substantially updated the results, providing new analysis of the ecological network per sub-regions: Western, Central, Eastern and the Adriatic Sea. We found that food-web information was lacking for many invertebrate species and other small predators, and it was especially scarce within the sub-region of the Central Mediterranean Sea. We also found that while the four sub-regions had many similarities on their food-web structure, the most complex in terms of trophic linkages was the Central Mediterranean one and the least complex was the Adriatic Sea one. Overall, this study makes a significant contribution to the research about the Mediterranean marine ecosystems, can help scientists to identify future research objectives and can be used by policy makers to make informed decisions within a complex system-thinking context to archive a sustainable future.

INTRODUCTION

The oceans were once thought to be immeasurable and an endless source of resources, but it is becoming increasingly proven that they are undergoing serious ecological problems. Issues like overfishing, pollution, climate change or invasive species have become first-order global challenges and are threatening ecosystems integrity, compromising ecosystem services such as food provision (Pauly et al., 1998; Walther et al., 2002).

The Mediterranean Sea is a prime example of this, being one of the most polluted and overfished sea in the world (Food and Agriculture Organization, 2020; UN/MAP, 2017). The implications that this has on its marine inhabitants are complex, causing a wide arrange of “winners” and “losers” due to global change.

To understand all these complex consequences, we need to understand how species interact between each other and with their environment. One of the most important ecological interactions is predation, as it influences the pathways of energy and nutrients flow through the entire food web. This interaction can be portrayed in different representations such as a food chain, or, more complex, a food web. A food web is a depiction of all the prey-predation relations in an ecosystem and it represents both the species-to-species relations and the biological structure of the whole ecosystem.

Food webs provide a necessary integrative vision to understand the interconnection of species, from the primary producers to the apex predators. They are also a representation of how complex and vulnerable an ecosystem is, since complexity has a correlation with the resilience of the ecosystem. A very relevant use of a food web is the comparison between different communities, either those food webs that are from different ecosystems (for example Coll et al., 2014), or from the same region but that occurred in different time periods (for example Kortsch et al., 2021), or even of different possible future scenarios (for example Corrales et al., 2018).

Marine food webs are especially interesting because due to the lack of physical boundaries in the marine environment, they tend to be more complex, and thus, more resilient; yet any impact can have an effect on more species (Dunne et al., 2004). The main issue with marine food webs is that, as a result of their complexity, they usually have to be studied in a small and oversimplified scale.

However, bigger food web representations have been created to study the meta-web structure of basins or regions, such as Planque et al., 2014 or Coll et al., 2019. In 2014, Planque et al. created a food web that encompassed all the Barrens Sea, which then was used for further studies in the area (for example Kortsch et al., 2015). Under the SaFENet project and following the methodology of Planque et al. 2014, a Mediterranean meta-web was created as a first building block of a modelling complex with the final objective of improving the information available to policy-makers to better manage fisheries and Marine Protected Areas (Coll et al., 2019).

This study is built using data from the Mediterranean meta-web previous effort (Coll et al., 2019), yet adding substantial new information available and notably updating the results previously obtained. The main aim of this study was the characterization of the trophic relationships of all the species with available trophic data in the Mediterranean Sea with the creation of a complete database. We then reviewed the compiled food-web data to analyse what information was available and what was lacking, looking at the data in terms of time span, regions and methodological perspective. Finally, we used the completed trophic database to develop meta-web analyses of the whole Mediterranean Sea and of four different regions of the basin and compared them to identify similarities and differences in food-web structure and resilience.

METHODOLOGY

Study area

Our study area is the whole Mediterranean Sea basin (30º N - 46º N / 6º W – 36º E). Although the Mediterranean Sea makes less than 1% of the global ocean it contains up to 18% of the world's macroscopic marine species, of which around 30% are endemic (Bianchi & Morri, 2000; Coll et al., 2010). Therefore, it is considered an important marine biodiversity hotspot albeit under threat. Particularly, the basin contains the world's highest percentage of unsustainable fish stocks (Food and Agriculture Organization, 2020), which in combination with climate change effects, have turned the Mediterranean into one of the most impacted areas in the world (Giorgi, 2006; Kim et al., 2019).

Moreover, its oceanographic and physical diversity makes it essential to consider sub-regions within the Mediterranean Sea. In particular, here we used four sub-regions of the Mediterranean based on the article four of the Marine Strategy Framework Directive 2008/56/EC (2008; Figure 1). Studies outside the Mediterranean where not taken into account for our analyses.

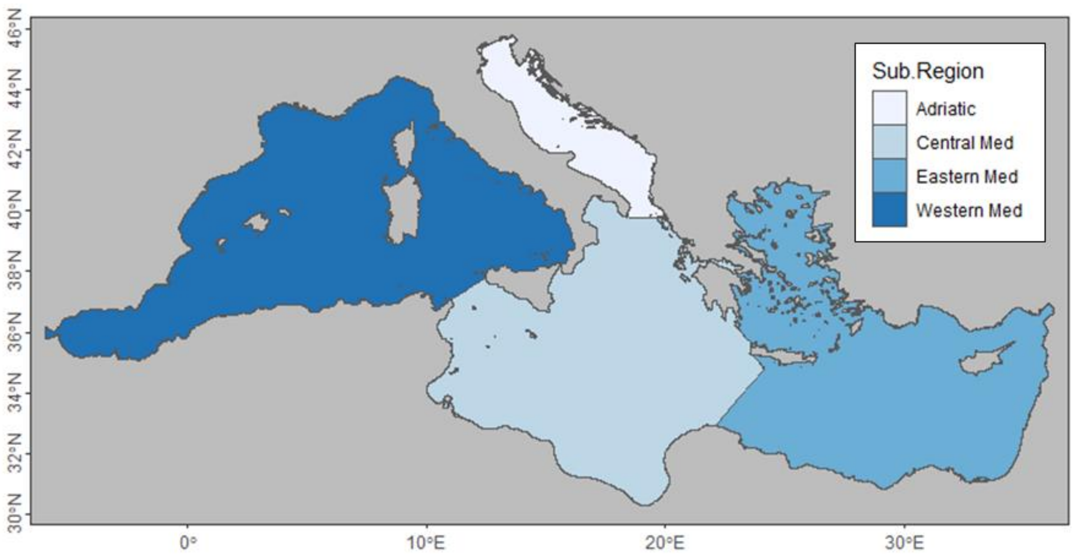

Figure 1: Mediterranean sub-regions considered to analyse trophic data available from the Mediterranean Sea.

Collection of data

We compiled published information in the literature to summarize the existing knowledge regarding trophic interactions among species inhabiting the Mediterranean Sea, covering from primary producers to top predators. To this aim, we revised published papers containing data on the diet of any Mediterranean species and extracted information on the trophic links generated by trophic interactions among species. The literature search was undertaken using the SCOPUS search tool, Web of Science and Google Scholar and used to create a trophic information database. The search terms were: ("feeding habits"), ("Mediterranean"), ("diet"), ("stable isotopes"), ("stomach content"). The best-practice protocols from the PRISMA approach for conducting systematic literature reviews and meta-analysis were adopted (Moher et al., 2009). We also extracted data from the grey literature, found in books, thesis and offline publications. We also used data from previous reviews, mainly Karachle & Stergiou, 2017 and Stergiou & Karpouzi, 2002, and the data collected in Coll et al., 2019.

The database structure contained the following information:

(1) Code of the predator and prey: Each species present in the database was categorised as a prey or a predator had a unique code assigned to it;
(2) Trophic indicators: Quantity how much the prey was predated (collecting whenever was available information on weight (%), number (%), volume (%) and other indicators of the importance of the prey). This data was not used in qualitative analyses;
(3) Metadata: This included information such as: method (i.e. stomach content, stable isotope analysis...), life stage of sampled individuals (i.e. juveniles, adults...), geographical location of sampling, year of sampling and reference. Information regarding the taxonomy and ecology of each species was also obtained from WoRMs and FishBase/SealifeBase websites, using R package rfishbase (Boettiger et al., 2012) from R statistical software v. 4.1.0 (R Core Team, 2021).

Analysis of the database

We performed an exploratory analysis of the database in order to evaluate various parameters such as the abundance of references available per sub-region, per year and per species. To this end, we used the packages dplyr (Wickham et al., 2021) and ggplot2 (Wickham, 2016).

Categorization of each species

To reduce complexity, each species was categorized within a functional group (see Annex 1 for the full list of functional groups and species). In particular, categories were taken from Coll et al., 2019, where a meta-web for Mediterranean species was developed in a collaborative form with researchers from different parts of the Mediterranean Sea (Annex I).

Marine mammals were classified into Bottlenose dolphins (Tursiops truncatus and other dolfins), Striped dolphins (Stenella coeruleoalba), Short-beaked common dolphin (Delphinus delphis), Fin whale (Balaenoptera physalus and other mysticets), Deep-sea cetacean feeders (including five species) and the Monk seal (Monachus monachus). Sea birds were classified in tree functional groups: Endangered and pelagic seabirds, gulls and cormorants and terns. Sea turtles had their own group.

Elasmobranchs were separated into six different groups: Pelagic sharks, Small-spotted catshark (Scyliorhinus canicula), Blackmouth catshark (Galeus melastomus), Other small demersal sharks, Rays and skates and Torpedos. Fish were divided into 40 categories, considering if they were either commercial or non-commercial, their habitat (pelagic or demersal) and highlighting certain families and species such as Sparidae, Scorpaenidae or the sardine (Sardina pilchardus), anchovy (Engraulis encrasicolus) or common pandora (Pagellus erythrinus) due to commercial interest.

Invertebrates were separated 26 groups total, including three groups of cephalopods, Bivalves, Gastropods, commercial and non-commercial Shrimps and Decapods, Sea urchins, Sea cucumbers, Other macro-benthos, Jellyfishes, Red coral, Other coral and gorgonians and Zooplankton (divided into macro, meso-micro and gelatinous). Some important commercial species had their own group such as the Purple sea urchin (Paracentrotus lividus) or the European lobster (Palinurus elephas).

Plants were divided into Mediterranean seagrass (Posidonia oceanica) and other seagrasses; algae in Erected algae, Seaweeds, Small and Large phytoplankton. Detritus, Discards, Imports and Inorganic material also were also depicted as functional groups.

Creation and analysis of the meta-web

Qualitative meta-webs representing each sub-region defined by the Marine Strategy Framework Directive (i.e. Western, Central, Adriatic and Eastern Mediterranean) (Figure

1) were created using presence-absence network data. We used the Diet Calculator program to calculate the presence-absence prey-predator diet matrix (Steenbeek & Coll, 2018).

We used the Cheddar R package: Analysis and Visualization of Ecological Communities R package (Hudson et al., 2013) to analyse the meta-webs created with the prey-predator diet matrix, and to graphically represent them.

Firstly, the food webs were visualized depicting each node as a function of its trophic level, with the lowest trophic-level nodes at the bottom. Circular food webs were created, plotting nodes in a circle. Another representation used of illustrate the structure of the food webs was the “Wagon Wheel”, plotting one central chosen node in the middle, and the others in concentric circles around it, based on the number of trophic links they are away of the focus one (Hudson et al., 2020). We then used a predation matrix that shows interaction between nodes, arranged in node order starting at the top-left, which means that the nodes that coincide with the dashed line are cannibals (Hudson et al., 2013).

Secondly, network qualitative indicators, used to compare the different food-web structures, were also calculated, such as:

(1) the Number of trophic links and nodes,
(2) the Linkage Density (number of trophic links / number of nodes)
(3) the Connectance (number of trophic links / number of nodes ^2) of the food web,
(4) the Mean Maximum Trophic Similarity, that calculates the number of resources and consumers that the nodes have in common (1 meaning they have the same set of resources and consumers and 0 meaning they have no resources or consumers in common; Hudson et al., 2020).
(5) the Omnivory rate, which is the proportion of nodes that are omnivores, that is, that consume two or more species and have a non-integer trophic level (Hudson et al., 2020).

In addition, per functional group we also calculated the Prey Averaged Trophic level.

RESULTS

Database analysis

The trophic database contained a total of 603 references. Of those, 251 (42.54%) contained data from the Western Mediterranean, 160 (27.12%) were from the Eastern Mediterranean, 115 (19.49%) were from the Central Mediterranean and 64 (10.85%) were from the Adriatic Sea (Figure 2).

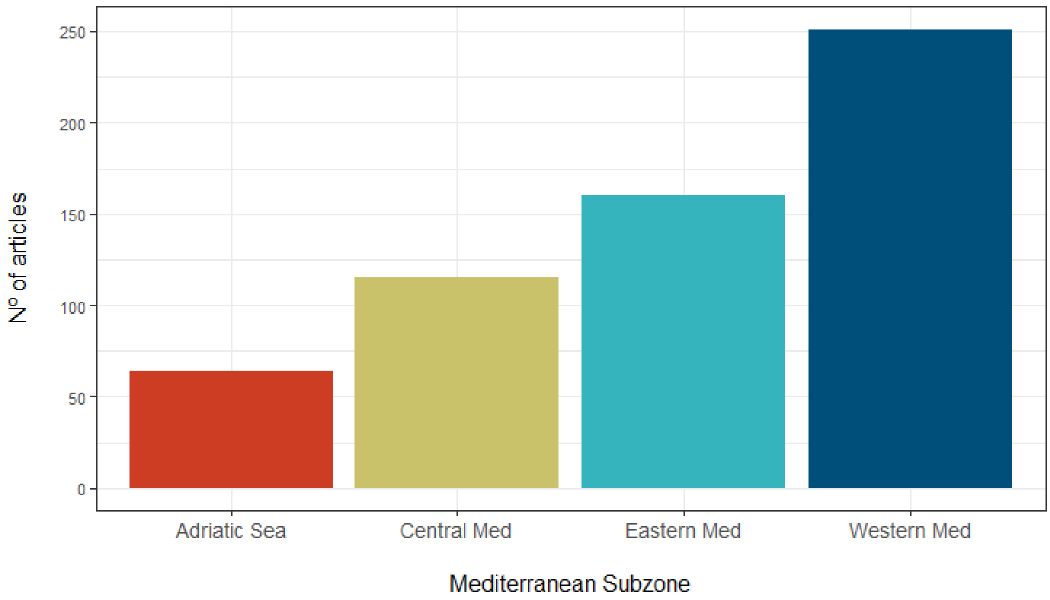

Figure 2: Number of articles per Mediterranean Subzone providing information about trophic ecology of marine species.

The majority of the papers represented samples taken between 2000 to 2009, no matter if we took into account the first or the last year the data was collected. There were ten articles previous to 1970, and overall, we saw a tendency to an increase of publications until the decade of 2010. From 2010 to 2019 we only found 11.94% of the papers available (18.21% if we use the end year data) (Figure 3).

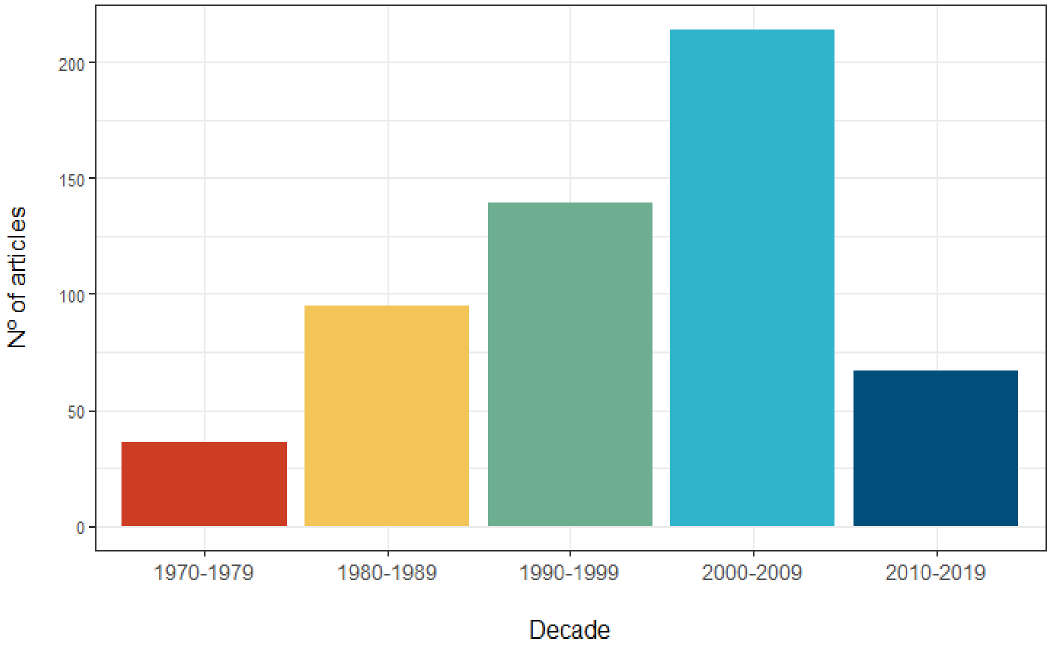

Figure 3: Number of articles per decade providing information about trophic ecology of marine species; taking into account the beginning year of data collected.

We saw that this general trend was consistent in each subzone, especially in the Western Mediterranean Sea that had the most papers published (Figure 4).

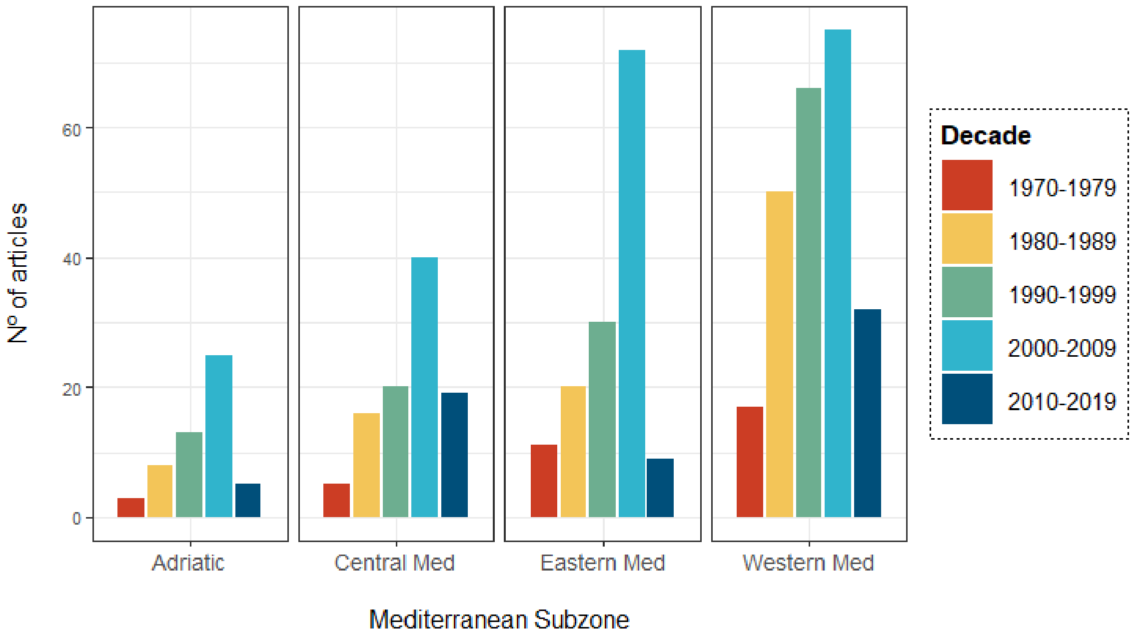

Figure 4: Number of articles per Decade and Sub-region.

The vast majority of the information was obtained using the analysis of Stomach Contents (91.62% of the total of papers) (Figure 5). Stable Isotopes, the second category with 4.01%, is increasing in the last decades, while Visual Observations (1.75%) are declining. Some publications gave the information using a combination of different methods, mostly combining Stomach Contents and another method.

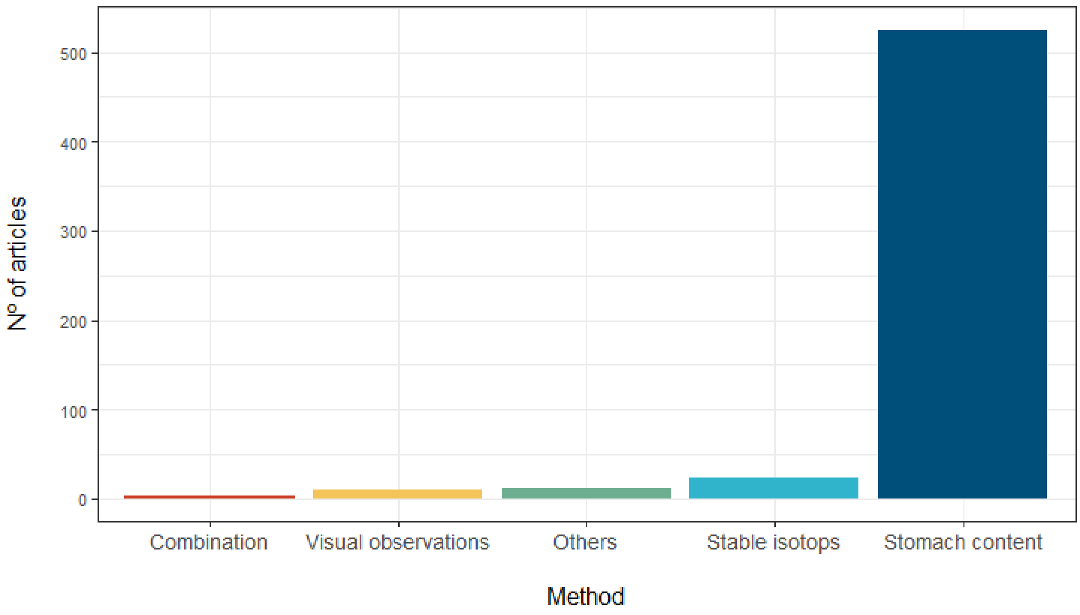

Figure 5: Number of articles per method.

Species observed

We collected information from a total of 2313 taxa, including mainly species but also genus, families and other taxonomic categories. We synthetized those into 91 functional groups. The functional groups that included the greatest number of species and other taxa were “Other macro-benthos” (248), “Macro-zooplankton” (246) and “Non-commercial decapods” (209), which belonged to the “Invertebrates” category (Figure 6).

However, when looking at which functional groups had a majority of publications with trophic information (Figure 7), we saw that these are mostly those of fish and elasmobranch groups.

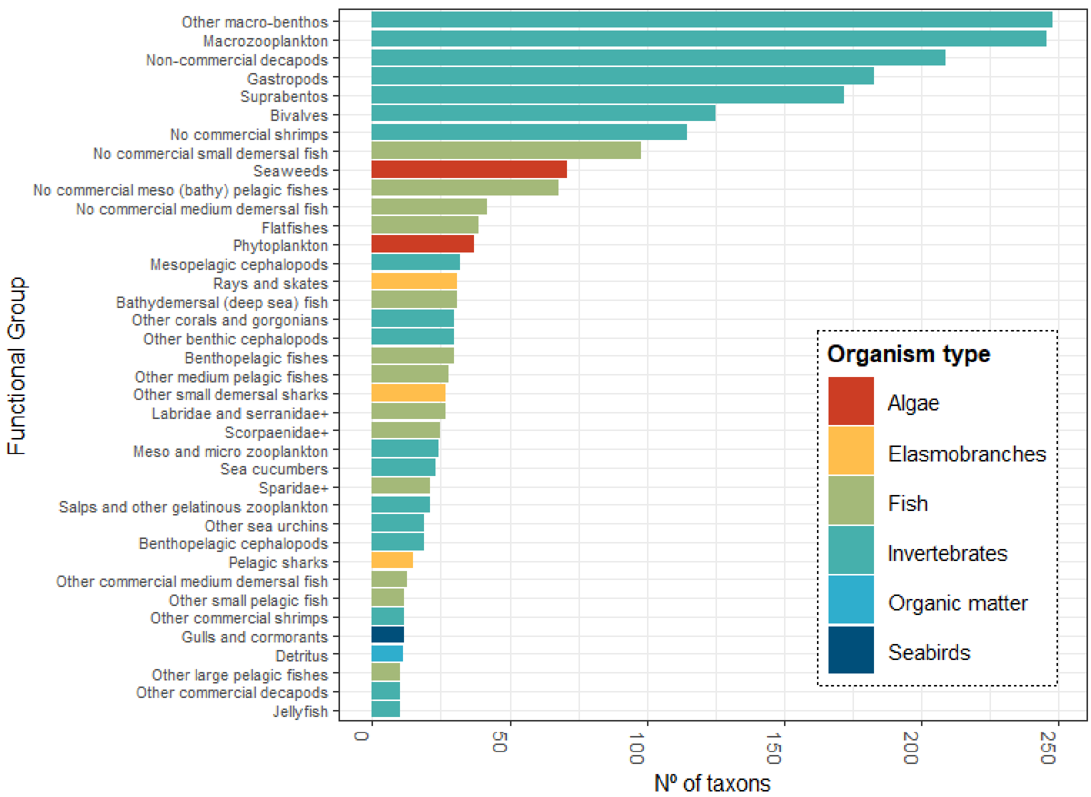

Figure 6: Number of species per Functional group. Only those groups with 10 or more species were included.

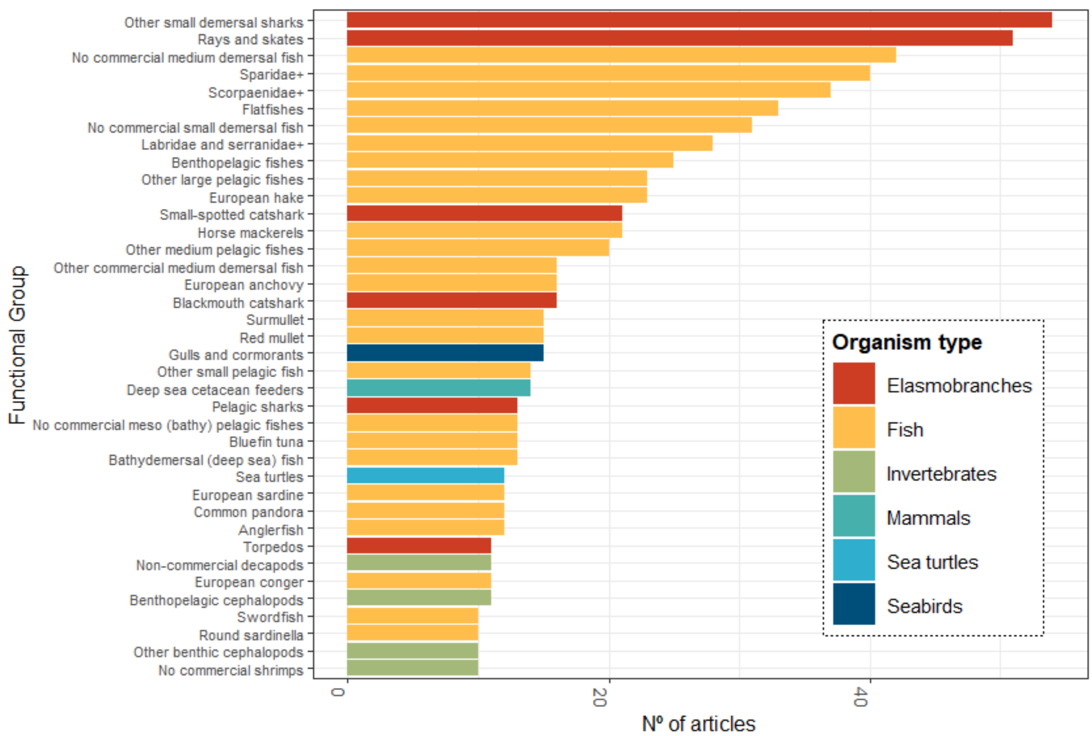

Figure 7: Number of articles per functional group of the predator. Only those groups with 10 or more articles were included.

The species that had more articles studying their diets were European hake (Merluccius merluccius, 22 articles), small-spotted catshark (Scyliorhinus canicula, 21 articles) and European anchovy (Engraulis encrasicolus, 16 articles); which are also species that were represented by their own functional group within our meta-webs.

If we look at the total of publications (Figure 8), it was clear that most studies (77.37%) targeted the feeding habits of fin-fish, followed by elasmobranchs.

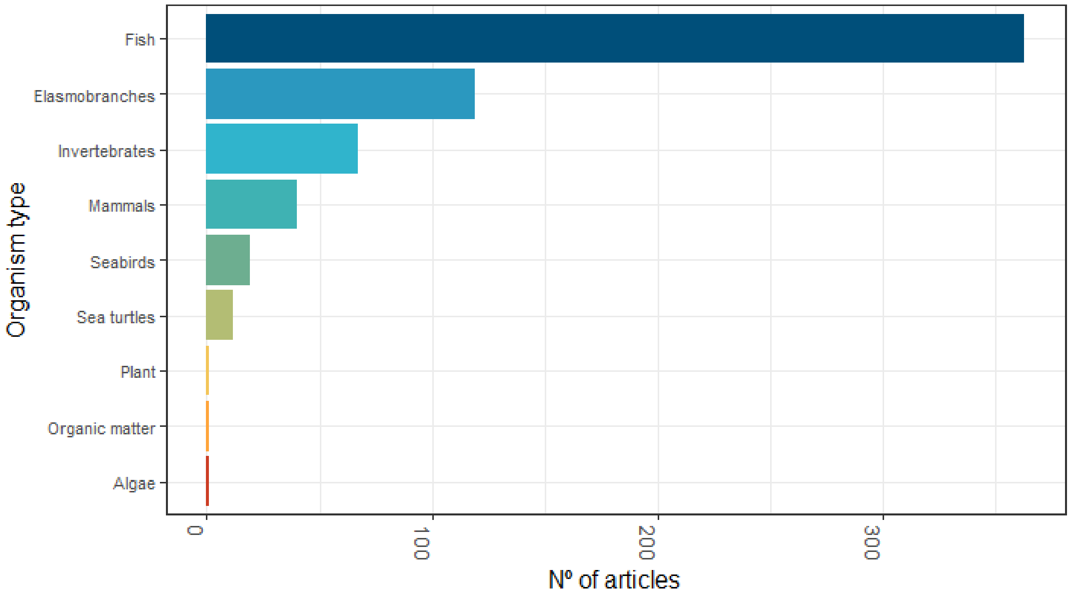

Figure 8: Number of articles per organism type of the prey studied.

Mediterranean Meta-webs

The meta-web of the whole Mediterranean Sea (Figure 9) had a total of 1160 trophic links and 91 nodes. Although we obtained similar results, the specific meta-webs developed for each subregion had a differing number of trophic links (Figure 10; Table 1). In detail, the Western Mediterranean had 1134 trophic links, the Central Mediterranean had 1204, the Eastern Mediterranean 1166 and the Adriatic Sea 1052. All the 5 food webs had the same number of nodes due to our definition of the groups (where species within them can vary but the number of groups were maintained). Of these nodes, 9 where producers, 26 invertebrates, 42 vertebrates ectotherms and 14 vertebrates endotherms.

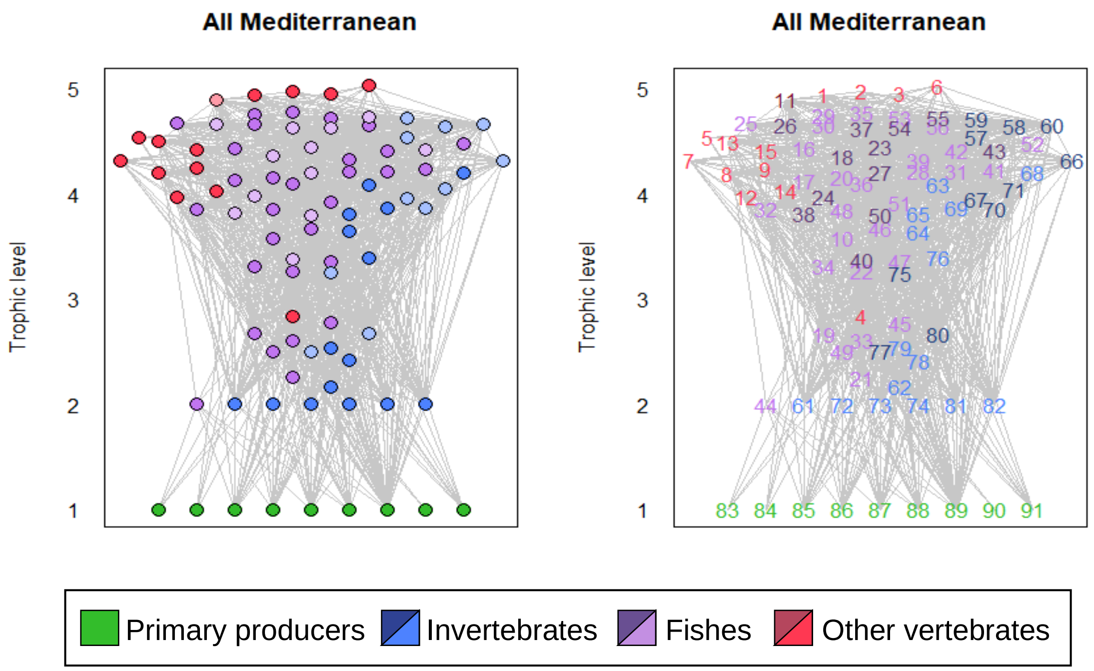

Figure 9: Representation of the meta-web of the Mediterranean Sea. Each number represents a functional group, represented vertically in relation to its trophic level.

As we can see in Table 1, the Central Mediterranean meta-web had the highest number of trophic links and connectance, while the Adriatic Sea had the lowest; same results ae achieved for the Mean Maximum Trophic Similarity. Interestingly, the Omnivory rate was the same in all sub-regions.

	All Med	Western Med	Central Med	Eastern Med	Adriatic Med
Number of Trophic Links	1160	1134	1204	1166	1052
Linkage Density	12.747	12.462	13.231	12.813	11.560
Density	0.078	0.080	0.076	0.078	0.087
Connectance	0.140	0.137	0.145	0.141	0.127
Omnivory rate	0.813	0.813	0.813	0.813	0.813
MMTS*	0.517	0.509	0.523	0.516	0.503

Table 1: Main indicators of the Mediterranean meta-webs. *MMTS= Mean Maximum Trophic Similarity.

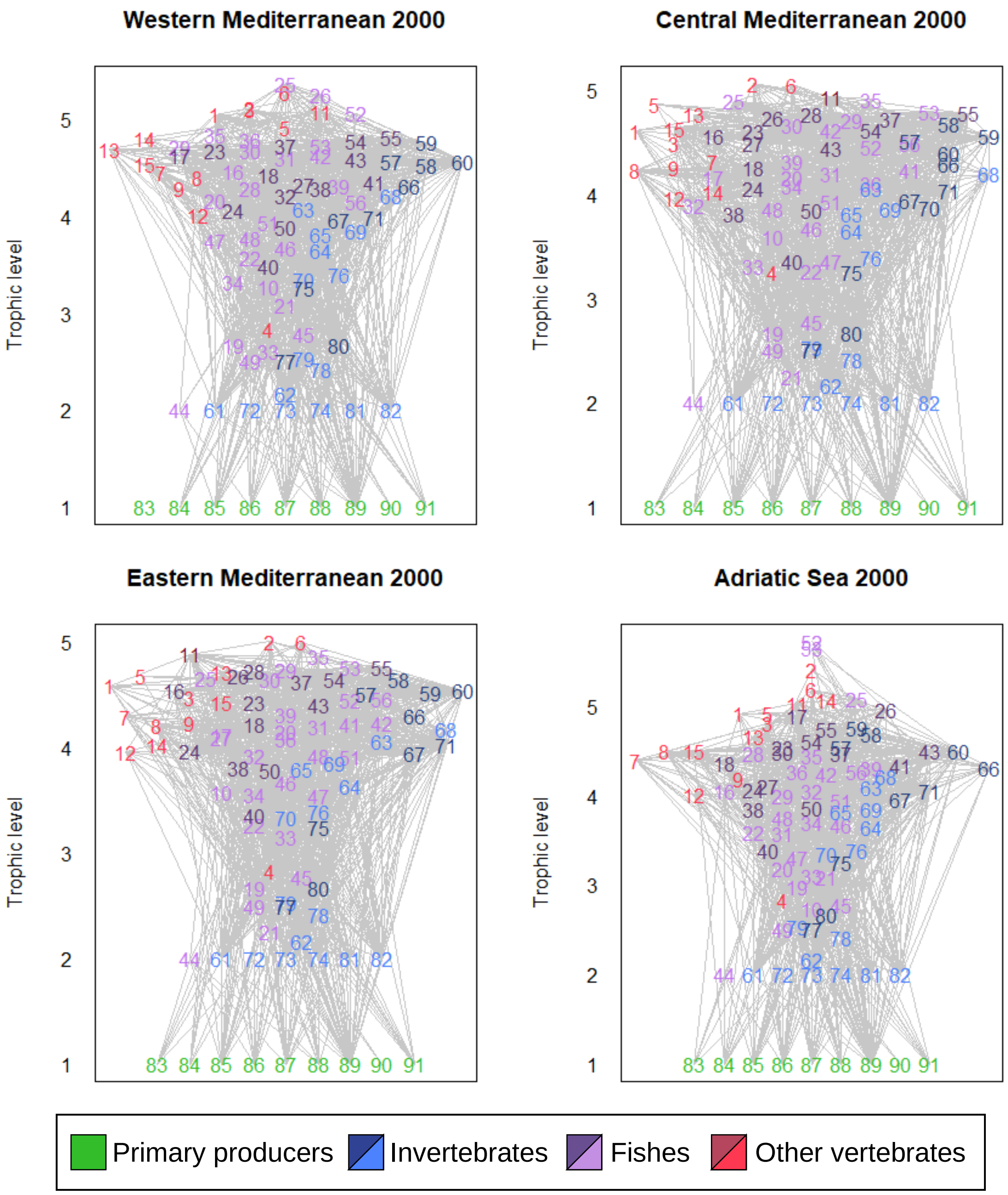

Figure 10: Representation of the meta-web of the sub-regions of the Mediterranean Sea. Each number represents a functional group, represented vertically in relation to its trophic level.

The meta-webs were also graphically represented in a Circular Web (Figure 11). In this visualization, the nodes that are on the left (corresponding mainly to invertebrates and producers) have a higher linkage density than the ones depicted to the right. This figure illustrates the complexity of the Mediterranean food web and the important roles that invertebrates and producers play in the food web.

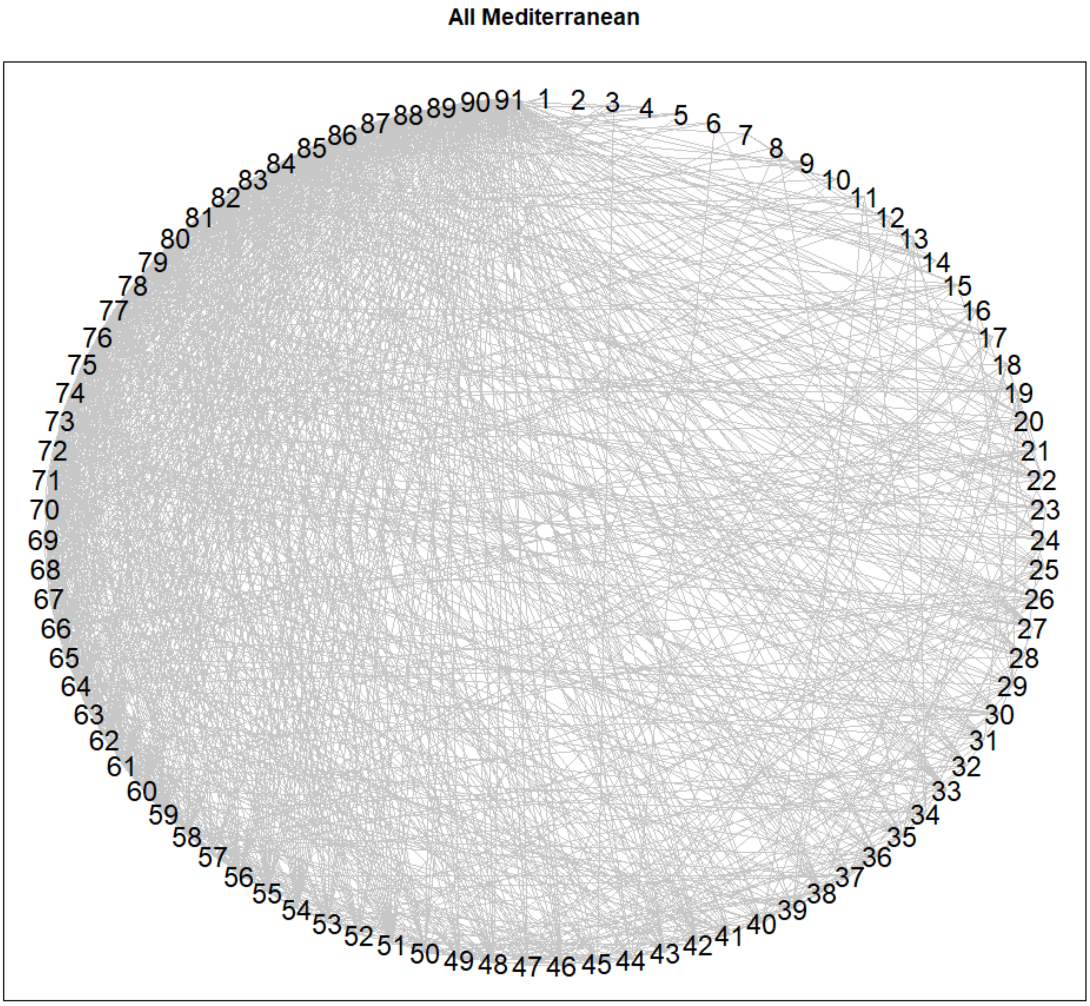

Figure 11: Circular representation of the meta-web of the Mediterranean Sea. Each number represents a functional group.

Another type of representation is the Wagon Wheel one, which allows to represent the nodes of the community as concentric circles away from one chosen central node. In Figure 12, three central nodes were chosen: The European hake (a predatory species conforming one functional group), the European Sardine (an intermediate trophic level species also confirming its own group) and the meso and micro zooplankton (a prey group composed of many species). The three of them were represented using data from the whole Mediterranean Sea meta-web. This representation illustrates the central role of European sardine in the Mediterranean food web according to the size of all the links.

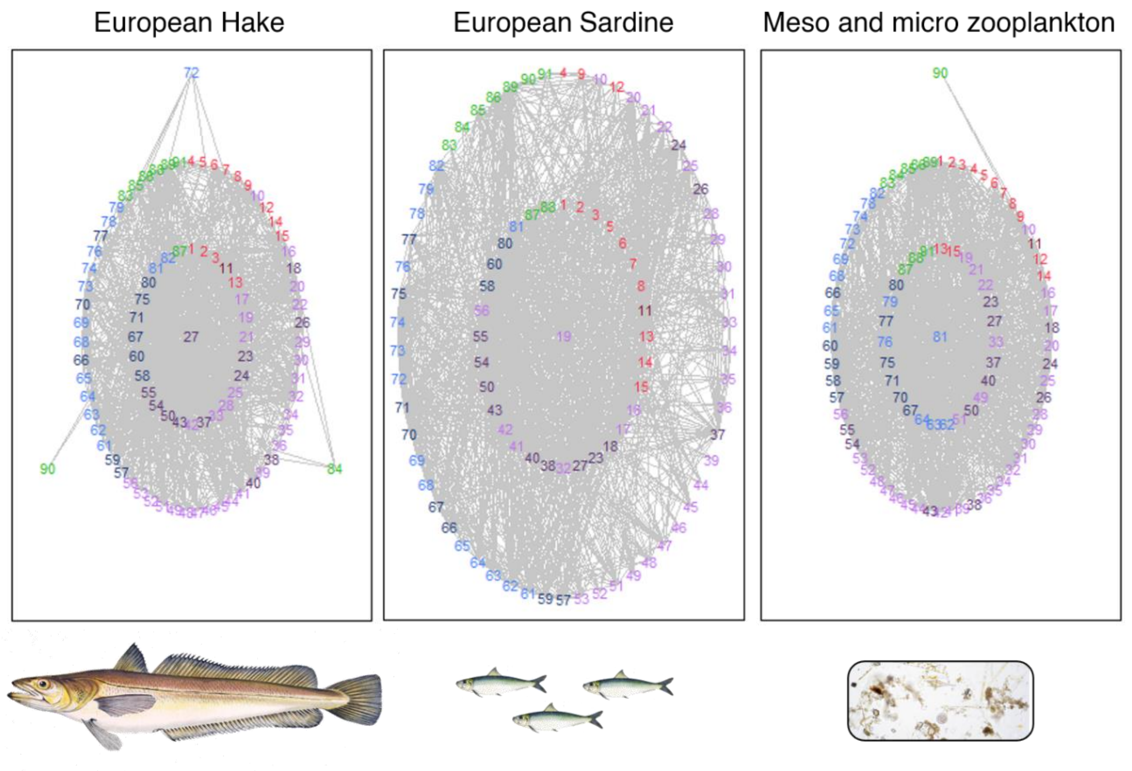

Figure 12: Wagon Wheel representation of the meta-web, using the European hake (node 27); the European sardine (node 19); and the meso and micro zooplankton group (node 81) as a central node. Green numbers represent primary producers, blue numbers invertebrates, purple numbers fish and red numbers other vertebrates; Each number represents a functional group.

Finally, a predation matrix of all of the four- subzones was plotted (Figure 13). From this representation we can observe that most of the interactions are in the bottom left triangle, meaning the majority of groups prey on other groups with higher functional group number, and that some level of cannibalism (within each functional group) exists. We also see that the different categories (producers, invertebrates, vertebrates ectotherms and endotherms) are mostly partitioned in the Mediterranean food web.

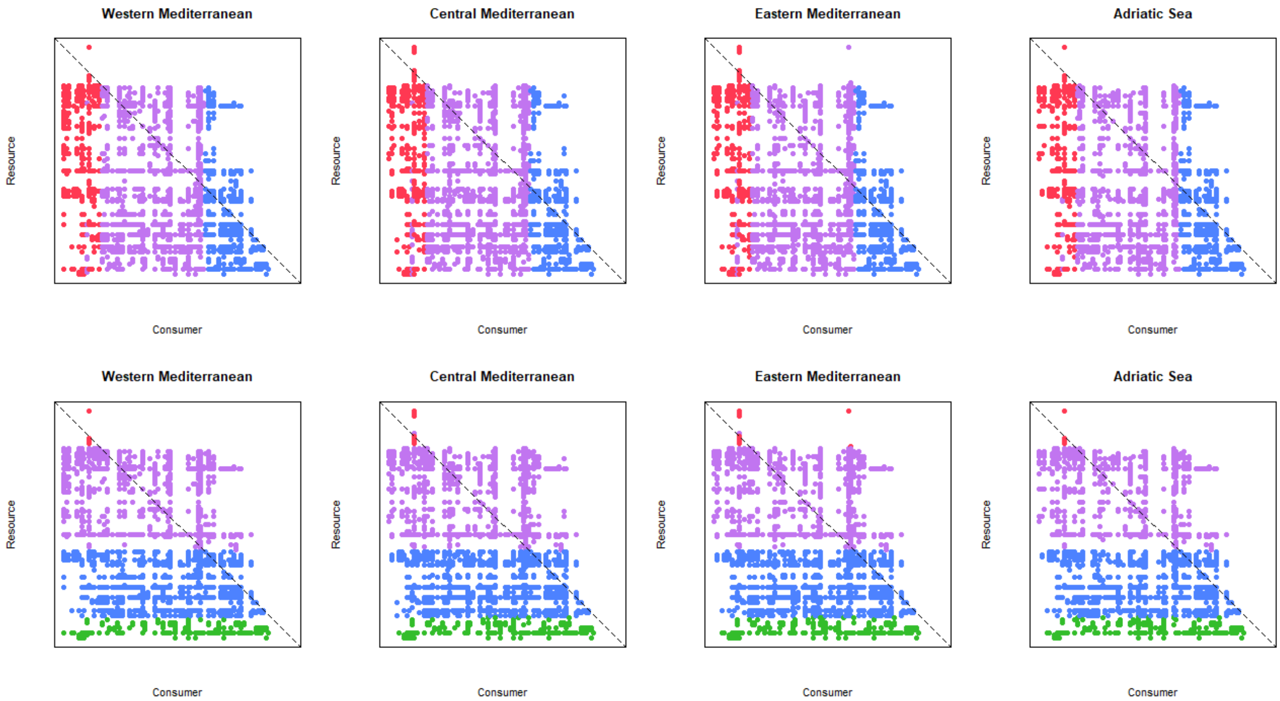

Figure 13: Predation matrix of the sub-regions of the Mediterranean Sea. Green dots represent primary producers, blue dots invertebrates, purple dots fish and red dots other vertebrates.

Finally, small changes in the trophic levels of functional groups of each meta-web were observed, and are shown in Annex II.

DISCUSSION

In this study, we created a meta-web of the Mediterranean sea following previous studies (Coll et al., 2019). For that, we first created a database containing information of the tropic relationship of 2,313 species and other taxa categories, and including information on the ecology and biology of the species. The information was collected from 603 published studies, most of which focused on fish diets (77.37% of the total publications), especially on species with commercial interest. Our study illustrated the gaps of information, especially from the diets of smaller species like invertebrates, even if they represent a larger quantity of species found in the Mediterranean Sea (Coll et al., 2010). This large percentage of invertebrates in the total number of species was also reflected in our study when identifying prey species.

Most of the publications available contained information from the Western Mediterranean Sea, with a percentage higher than the area it covers (33.62% of the area with 42.54% of the studies). In contrast, both the Eastern and especially the Central Mediterranean Sea were unrepresented, having respectively, the 27.12% and 19.49% of the studies with about the 30% of the surface area each. Even if the Adriatic Sea had the least number of publications (10.85%), the proportion is still bigger than its percentage of area (5.56%). This suggest that future scientific efforts to characterise the trophic ecology of Mediterranean marine species should be focused both in the Eastern and Central areas of the basin.

Regarding the time span of the studies, we see a clear upwards tendency until 2000s, when available studies decline during 2010-2020. This may be explained because some studies that have been started in the 2010s decade may still not be finished or published. However, it may also be related with the economic and social crisis that occurred during 2008-2010, with long lasting effects in terms of research funding investment (Katsanevakis et al., 2015). This decline of studies is especially important in the Eastern Mediterranean Sea, in which the publications from the 2010s represent only 12.5% of the ones from the 2000s.

Our study also illustrates that the most common and available methodology used to gain information on trophic ecology of Mediterranean marine species is the traditional Stomach Content analysis. This is a well-known methodology but it entails some problems like the tendency to overestimate or underestimate some prey species with different rates of digestibility (Stergiou and Karpouzi 2001), and the limited temporal representation (Hyslop, 1980). Stable Isotopes analyses, which seem to be gaining popularity yet are still far less used that Stomach Content analysis, could solves some of the traditionally methodology's problems (Miller et al., 2010), being less invasive and providing the possibility of non-lethal samplings (Barría et al., 2018; Bowen & Iverson, 2013). However, due to the low taxonomic resolution that we can obtain from stable isotope analysis, it is still recommended to be used complementarily to Stomach Content analysis when depicting the diet of an organism (Nielsen et al., 2018).

The trophic information gathered during the first part of this study was used to create five different meta-webs: one representing the whole Mediterranean Sea, and then one for each sub-region defined under the MSFD. Overall, the food-web structures that we obtained integrating all the data were similar, since they all had the same number of nodes (91, one for each functional group that we divided the species into). However, they showed different number of trophic links, with the Adriatic Sea showing the lowest numbers and the Central Mediterranean showing the highest ones; and the meta-web of the whole Mediterranean showing intermediate values between the two. This tendency was repeated in the other indicators studied (Density, Connectance and Mean Maximum Trophic Similarity). According to our results, the most complex food-web structure was depicted in the Central Mediterranean Sea, followed by the Eastern Mediterranean, the Western Mediterranean and finally the Adriatic Sea.

These results could be related to the productivity patterns of the Mediterranean basin, which based on the currents, temperatures and primary production have shown that there is a gradient of species productivity from the northwestern to the southeaster Mediterranean Sea, being the Adriatic Sea a highly productive area, too (Bosc et al., 2004; Coll et al., 2010). Therefore, the areas with less productivity could be the areas with a higher complexity due to higher use of resources by predators. However, our results could also be somehow influenced by the number of publications available since the areas with more complexity are the ones with less publications available, too.

In Dunne et al. (2004), different food webs from terrestrial and marine ecosystems were studied. If we compare our food webs to the marine ones from that previous study, ours present a lower connectance (Benguela's food web, from Dunne et al., 2004, has a connectance of 0.24; the Adriatic Sea, from this study, of 0.13, and the whole Mediterranean Sea of 0.14). The lower connectance of the Mediterranean Sea may reflect a degradation of the ecosystem, as previously discussed by Coll et al. (2008).

Coll et al. (2008) studied the degradation of the Mediterranean using food webs from the 1970's and 1990's. Our results show overall a lower Connectance and omnivory rates than both of the food webs from the Adriatic Sea and also the Catalan Sea, if we compare it with the data from the Western Mediterranean, suggesting that the degradation of the ecosystem may have increased with time. However, these discrepancies between both results could be done due to discrepancies in the years used to analyse the data and data availability itself.

Circular web plots showed as well that the invertebrates and primary producers groups are highly interconnected in the Mediterranean food web due to their importance as prey and the overall oligotrophic nature of the Mediterranean basin (Bosc et al., 2004). The Wagon Wheel plots evidenced the central role of the small pelagic fish species in the Mediterranean Sea, such as European sardine and European anchovy, due to their central role as energy flow channelling (Cury et al., 2000; Palomera et al., 2007).

Although this study provides analysis on the data gathered from an unprecedented literature review effort on the topic, we acknowledge some limitations in our analyses such as the fact that marine systems are dynamic, not only in space, but also in time, and we performed a static "analysis. Even though we extracted all the available literature on the feeding habits of Mediterranean species, the temporal distribution of the studies was skewed, being concentrated in the early 2000s. Moreover, there were temporal gaps for some years, so we were not able to create a reliable meta-web per decade to explore temporal changes, but even if we could do so in the future, this would still be a simplification of the reality.

We face a similar issue regarding our spatial analysis of the database, as there is a lot of environmental diversity within the considered sub-regions and the areas are highly heterogenic. However, we can interpret our results as the integration of the processes and dynamics that occurred during a long study period, and can be very useful if comparing them to future similar studies. It is expected that threats to biodiversity will increase in the following decades (Coll et al., 2010). Therefore, it will be essential to perform similar analysis to be able to assess whether the number of trophic links is increasing or decreasing, as an indicator of ecosystem's complexity and thus of ecosystems' health. Another limitation is that all the analyses were done from a qualitative point of view; meaning that we focused on describing the food-web structure without data about the strength of the interactions. Another approach, which is usually more informative is the quantitative one. This one takes into account the biomass for each node, and the consumption rate between prey and predators, and can be very useful in the context of fisheries management. Further studies should utilize the data that we gathered to create quantitative models where possible, and compare our results from quantitative analyses that can complement the present efforts.

In addition, our results can be used to assess different scenarios that try to predict the impact of certain species' extinctions, seeing for example which ones would have the largest impact on the ecosystem, if the removal of apical predators, primary producers, species that are in the middle or that have commercial interest. This could provide interesting results to guide future management options for the basin. Overall, both the database and the meta-webs created here can be interesting resources for scientists and politicians, which can use them to better manage the sea. They can help, for example, to explore what species play key roles in the structure of the food webs and what areas can be more resilient in front of external perturbations, such as changes in human activities and environmental conditions.

CONCLUSIONS

As a result of this study, the following conclusion can be distilled:

- The Western and Adriatic Seas sub-regions are over-represented in terms of trophic studies, while the Eastern and Central Seas are under-represented and future research efforts should concentrate in these areas.
- The trophic data mainly focuses on commercial fish, and smaller species like invertebrates do not have a lot of information available. Future research efforts should target these less studied groups.
- Stomach content analysis is the most used methodology to study the diet of marine animals from the Mediterranean Sa, but stable isotopes present a candidate to rival with it, since it has some advantages.
- The Central Mediterranean sub-region appeared to have the most complex food-web structure, followed by the Eastern Mediterranean, then the Western Mediterranean and finally the Adriatic Sea. This result could be linked with the northwestern to southeaster known productivity gradient of the Mediterranean Sea, but could also be conditioned by studies available.
- The low levels of Connectance and Omnivory rates of the food webs of the Mediterranean underline the higher level of degradation of these ecosystems in comparison with other studies.
- Food webs are important tools to study complex natural systems, can be useful to both scientists and policy makers, and are interesting to visualise the complexity of the marine life.
- This study represents a baseline form where to perform further analyses on food web topology and scenarios extinctions to learn about the Mediterranean resilience and vulnerability to global change.

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Annex I: Species and functional groups

Nº	Functional groups	Species included in each group
1	Bottlenose dolphins	Tursiops truncatus, Dolphins, Odontocetes
2	Striped dolphins	Stenella coeruleoalba
3	Short-beaked common dolphin	Delphinus delphis
4	Fin whale	Balaenoptera physalus, Mysticeti
5	Deep sea-cetacean feeders	Globicephala melas, Grampus griseus, Physeter macrocephalus, Phocoena phocoena, Ziphius cavirostris
6	Monk seals	Monachus monachus
7	Endangered and pelagic seabirds	Calonectris diomedea, Puffinus yelkouan, Puffinus mauretanicus, Hydrobates pelagicus melitensis
8	Gulls and cormorants	Chroicocephalus genei, Laridae, Larus audouinii, Larus cachinnans, Larus fuscus, Larus genei, Larus melanocephalus, Larus michahellis, Larus ridibundus, Phalacrocorax aristotelis, Phalacrocorax carbo, Aves
9	Terns	Gelochelidon nilotica, Hydroprogne caspia, Sterna bengalensis, Sterna hirundo, Sterna sandvicensis, Sternula albifrons, Terns
10	Sea turtles	Caretta caretta, Cheloniidae, Chelonia mydas
11	Pelagic sharks	Alopias, Alopias superciliosus, Alopias vulpinus, Carcharhinus brachyurus, Carcharhinus plumbeus, Carcharias taurus, Carcharodon carcharias, Cetorhinus maximus, Galeocerdo cuvier, Galeorhinus galeus, Isurys oxyrinchus, Lamna nasus, Odontaspis ferox, Prionace glauca, Sphyrna zygaena
12	Non-commercial large pelagic fishes	Mola mola
13	Bluefin tuna	Thunnus thynnus
14	Swordfish	Xiphias gladius
15	Other large pelagic fishes	Seriola dumerili, Coryphaena hippurus, Euthynnus alletteratus, Katsuwonus pelamis, Lichia amia, Regalecus glesne, Tetrapturus belone, Thunnus spp., Thunnus alalunga, Scomberomorus commerson
16	Mackerels	Scomber spp., Scomber colias, Scomber japonicus, Scomber scombrus
17	Horse mackerels	Trachurus spp., Trachurus mediterraneus, Trachurus picturatus, Trachurus trachurus
18	Other medium pelagic fishes	Alosa spp., Alosa alosa, Alosa fallax, Alosa finta, Auxis rochei, Belone spp., Belone belone, Belone svetovidovi, Belonidae, Carangidae, Caranx rhonchus, Clupeidae, Dicentrarchus punctatus, Echeneidae, Engraulidae, Etrumeus sadina, Etrumeus teres, Exocoetus volitans, Pomatomus saltatrix, Sarda sarda, Sardinella spp., Schedophilus medusophagus, Scomberesox saurus, Scombridae, Sphyraena spp., Sphyraena chrysotaenia, Sphyraena sphyraena, Sphyraena viridensis

19	European sardine	Sardina pilchardus
20	European anchovy	Engraulis encrasicolus
21	Round sardinella	Sardinella aurita
22	Other small pelagic fish	Atherina hepsetus, Atherina presbyter, Atherinidae, Bregmaceros atlanticus, Bregmaceros nectabanus, Cubiceps gracilis, Small pelagic fish, Spicara spp., Spicara flexuosa, Spicara maena, Spicara smaris, Sprattus sprattus
23	Benthopelagic fishes	Benthopelagic fish, Cichlasoma bimaculatum, Coelorinchus caelorhincus, Coryphaenoides filamentosus, Decapterus russelli, Dysomma brevirostre, Eretmophorus kleinenbergi, Gadella maraldi, Gaidropsarus biscayensis, Hoplostethus mediterraneus, Hymenocephalus italicus, Lepidion lepidion, Lepidopus caudatus, Lepomis gibbosus, Merlangius merlangus, Moridae, Nezumia spp., Nezumia aequalis, Nezumia sclerorhynchus, Physiculus dalwigki, Ruvettus pretiosus, Saurida lessepsianus, chedophilus ovalis, Sphoeroides pachygaster, Stromateus fiatola, Trichiuridae, Trichiurus lepturus
24	No commercial meso (bathy) pelagic fishes	Aphanopus carbo, Arctozenus risso, Argyropelecus hemigymnus, Aulopiformes, Bathophilus nigerrimus, Bathypelagic organisms, Benthosema glaciale, Brama brama, Centrolophus niger, Ceratoscopelus maderensis, Chauliodus sloani, Coryphaenoides mediterraneus, Cyclothone spp., Cyclothone braueri, Cyclothone pygmaea, Diaphus spp., Diaphus holti, Diaphus metopoclampus, Diaphus rafinesquii, Electrona risso, Evermannella balbo, Gadiculus argenteus, Gadidae, Gonichthys cocco, Gonostoma denudatum, Gonostomatidae, Hygophum spp., Hygophum benoiti, Hygophum hygomii, Ichthyococcus ovatus, Lampanyctus spp., Lampanyctus crocodilus, Lampanyctus pusillus, Lestidiops spp., Lestidiops jayakari, Lestidiops sphyrenoides, Lobianchia spp., Lobianchia dofleini, Lobianchia gemellarii, Maurolicus muelleri, Melanostigma atlanticum, Mesopelagic fishes, Microstoma microstoma, Mora moro, Myctophidae, Myctophum spp., Myctophum punctatum, Nansenia spp., Nansenia oblita, Nemichthys scolopaceus, Notacanthus bonaparte, Notoscopelus spp., Notoscopelus bolini, Notoscopelus elongatus, Paralepididae, Paralepis coregonoides, Paralepis speciosa, Psenes pellucidus, Rhynchogadus hepaticus, Scopelogadus spp., Stomias boa, Sudis hyalina, Symbolophorus veranyi, Tetragonurus cuvieri, Vinciguerria spp., Vinciguerria attenuata, Vinciguerria poweriae, Xenodermichthys copei
25	Anglerfish	Lophius spp., Lophius budegassa, Lophius piscatorius
26	European conger	Conger conger
27	European hake	Merluccius merluccius
28	Other commercial large demersal fish	Gadiformes, Molva spp., Molva dypterygia, Molva macrophthalma, Molva molva, Phycis spp., Phycis blennoides, Phycis phycis
29	Poor cod	Trisopterus spp., Trisopterus capelanus, Trisopterus luscus, Trisopterus minutus
30	Blue whiting	Micromesistius poutassou
31	Common pandora	Pagellus erythrinus
32	Sparidae+	Boops boops, Centracanthus cirrus, Dentex gibbosus, Dentex macrophthalmus, Dentex maroccanus, Diplodus spp., Diplodus annularis, Diplodus cervinus, Diplodus puntazzo, Lithognathus mormyrus, Oblada melanura, Pagellus spp., Pagellus acarne, Pagellus bogaraveo, Pagrus spp., Pagrus auriga, Pagrus caeruleostictus, Pagrus pagrus, Sparidae, Sparus aurata, Spondyliosoma cantharus
33	White seabream	Diplodus sargus
34	Common two-banded seabream	Diplodus vulgaris
35	Common dentex	Dentex dentex

36	Red scorpionfish	Scorpaena scrofa
37	Scorpaenidae+	Chelidonichthys ssp., Chelidonichthys cuculus, Chelidonichthys lastoviza, Chelidonichthys lucerna, Chelidonichthys obscurus, Dactylopterus volitans, Eutrigla gurnardus, Helicolenus dactylopterus, Lepidotrigla spp., Lepidotrigla cavillone, Lepidotrigla dieuzeidei, Paraliparis murieli, Peristedion cataphractum, Scorpaena spp., Scorpaena elongata, Scorpaena loppei, Scorpaena maderensis, Scorpaena notata, Scorpaena porcus, Scorpaenidae, Sebastidae, Trachyscorpia cristulata echinata, Trigla spp., Trigla lyra, Triglidae
38	Groupers	Epinephelus spp, Epinephelus aeneus, Epinephelus costae, Epinephelus marginatus
39	Brown meagre	Sciaena umbra
40	Labridae and serranidae+	Acantholabrus palloni, Anthias anthias, Centrolabrus melanocercus, Coris julis, Ctenolabrus rupestris, Labridae, Labrus bergylta, Labrus merula, Labrus mixtus, Labrus viridis, Lappanella fasciata, Mycteroperca rubra, Serranidae, Serranus cabrilla, Serranus hepatus, Serranus scriba, Symphodus spp., Symphodus cinereus, Symphodus doderleini, Symphodus mediterraneus, Symphodus melops, Symphodus ocellatus, Symphodus roissali, Symphodus rostratus, Symphodus tinca, Thalassoma pavo, Xyrichtys novacula
41	Flatfishes	Arnoglossus spp., Arnoglossus imperialis, Arnoglossus kessleri, Arnoglossus laterna, Arnoglossus rueppelii, Arnoglossus thori, Bathysolea profundicola, Bothidae, Bothus podas, Buglossidium luteum, Citharus spp., Citharus linguatula, Dagetichthys lusitanicus, Dicologlossa cuneata, Dicologlossa hexophthalma, Lepidorhombus spp., Lepidorhombus boscii, Lepidorhombus whiffiagonis, Microchirus azevia, Microchirus boscanion, Microchirus ocellatus, Microchirus variegatus, Monochirus hispidus, Pegusa impar, Pegusa lascaris, Platichthys flesus, Pleuronectiformes, Scophthalmus maximus, Scophthalmus rhombus, Solea spp., Solea aegyptiaca, Solea senegalensis, Solea solea, Soleidae, Symphurus spp., Symphurus ligulatus, Symphurus nigrescens, Synapturichthys kleinii, Zeugopterus regius
42	Other commercial medium demersal fish	Anguilla anguilla, Dicentrarchus labrax, Gaidropsarus spp., Gaidropsarus mediterraneus, Gaidropsarus vulgaris, Gnathophis mystax, Lotidae, Polyprion americanus, Trachinus radiatus, Umbrina canariensis, Umbrina cirrosa, Umbrina ronchus, Zeus faber
43	No commercial medium demersal fish	Anguiliformes, Apterichtus caecus, Atherinomorus lacunosus, Aulopus filamentosus, Balistes capriscus, Caranx crysos, Cepola macrophthalma, Chlopsis bicolor, Congridae, Dalophis imberbis, Echelus myrus, Facciolella oxyrhyncha, Fistularia commersonii, Lagocephalus sceleratus, Mullus spp., Muraena helena, Naucrates ductor, Nerophis maculatus, Ophichthidae, Ophichthus rufus, Ophidion barbatum, Ophidion rochei, Ophisurus serpens, Pomadasys incisus, Sargocentron rubrum, Saurida undosquamis, Siganidae, Siganus javus, Siganus luridus, Siganus rivulatus, Syngnathus spp., Syngnathus acus, Syngnathus typhle, Synodontidae, Synodus saurus, Tetraodontidae, Trachinotus ovatus, Trachinus araneus, Trachinus draco, Upeneus asymmetricus, Uranoscopus scaber, Zeiformes
44	Salema	Sarpa salpa
45	Mugilidae	Chelon auratus, Chelon labrosus, Chelon ramada, Chelon saliens, Liza spp., Mugil cephalus, Mugilidae, Oedalechilus labeo
46	Transparent gobies	Aphia minuta
47	Red mullet	Mullus barbatus
48	Surmullet	Mullus surmuletus
49	Commercial small demersal fish	Ammodytes tobianus, Ariosoma balearicum, Atherina boyeri, Gymnammodytes spp., Gymnammodytes cicerelus

50	No commercial small demersal fish	Aidablennius sphynx, Aphanius fasciatus, Apletodon dentatus, Apogon imberbis, Apogonichthyoides nigripinnis, Apogonidae, Ariomma spp., Blenniidae, Blennius spp., Blennius ocellaris, Buenia jeffreysii, Callanthias ruber, Callionymidae, Callionymus spp., Callionymus filamentosus, Callionymus lyra, Callionymus maculatus, Callionymus pusillus, Callionymus risso, Capros aper, Carapidae, Carapus acus, Champsodon spp., Chlorophthalmus agassizi, Chromis chromis, Clinitrachus argentatus, Coryphoblennius galerita, Crystallogobius linearis, Deltentosteus spp., Deltentosteus collonianus, Deltentosteus quadrimaculatus, Diplecogaster bimaculata, Echiichthys vipera, Echiodon dentatus, Equulites klunzingeri, Gasterosteiformes, Gobiidae, Gobius spp., Gobius auratus, Gobius bucchichi, Gobius cobitis, Gobius cruentatus, Gobius fallax, Gobius geniporus, Gobius niger, Gobius paganellus, Grammonus ater, Hippocampus spp., Hippocampus guttulatus, Hippocampus hippocampus, Jaydia smithi, Lepadogaster spp., Lepadogaster lepadogaster, Lesueurigobius spp., Lesueurigobius friesii, Lesueurigobius sanzi, Lesueurigobius suerii, Lipophrys trigloides, Macroramphosus scolopax, Microichthys coccoi, Microlipophrys adriaticus, Microlipophrys canevae, Microlipophrys dalmatinus, Microlipophrys nigriceps, Nemipterus randalli, Neogobius platyrostris, Parablennius gattorugine, Parablennius incognitus, Parablennius rouxi, Parablennius sanguinolentus, Parablennius tentacularis, Parablennius zvonimiri, Parophidion vassali, Pomatoschistus spp., Pomatoschistus bathi, Pomatoschistus marmoratus, Pomatoschistus microps, Pomatoschistus minutus, Pomatoschistus norvegicus, Salaria pavo, Scartella cristata, Sparisoma cretense, Synchiropus phaeton, Syngnathidae, Syngnathus phlegon, Syngnathus taenionotus, Trachinidae, Tripterygion delaisi, Tripterygion melanurum, Trypterygion spp., Upeneus moluccensis, Upeneus pori, Zosterisessor ophiocephalus
51	Bathydemersal (deep sea) fish	Alepocephalus rostratus, Argentina sphyraena, Argentinidae, Bathypterois, Bathypterois dubius, Bellottia apoda, Benthocometes robustus, Borostomias antarcticus, Bythitidae, Cataetyx alleni, Coelorinchus spp., Coelorinchus labiatus, Coelorinchus occa, Coryphaenoides guentheri, Epigonus spp., Epigonus constanciae, Epigonus denticulatus, Epigonus telescopus, Eutelichthys leptochirus, Glossanodon leioglossus, Macrouridae, Nettastoma melanurum, Nettastomatidae, Notacanthidae, Phosichthyidae, Polyacanthonotus rissoanus, Sigmops elongatus, Sternoptychidae, Stomiidae, Trachyrincus scabrus
52	Small-spotted catshark	Scyliorhinus canicula
53	Blackmouth catshark	Galeus melastomus
54	Other small demersal sharks	Centrophorus granulosus, Centrophorus uyato, Centroscymnus coelolepis, Chimaera monstrosa, Dalatias licha, Echinorhinus brucus, Etmopterus spinax, Galeus atlanticus, Heptranchias perlo, Hexanchus griseus, Hexanchus nakamurai, Mustelus asterias, Mustelus mustelus, Mustelus punctulatus, Oxynotus centrina, Scyliorhinus spp., Scyliorhinus stellaris, Somniosus rostratus, Squalus acanthias, Squalus blainville, Squalus megalops, Squatina aculeata, Squatina squatina
55	Rays and skates	Aetomylaeus bovinus, Bathytoshia centroura, Batoidea, Dasyatis spp., Dasyatis marmorata, Dasyatis pastinaca, Dipturus batis, Dipturus nidarosiensis, Dipturus oxyrinchus, Glaucostegus cemiculus, Gymnura altavela, Leucoraja circularis, Leucoraja fullonica, Leucoraja melitensis, Leucoraja naevus, Mobula mobular, Myliobatidae, Myliobatis aquila, Pteroplatytrygon violacea, Raja spp., Raja asterias, Raja brachyura, Raja clavata, Raja miraletus, Raja montagui, Raja polystigma, Raja radula, Raja undulata, Rajidae, Rhinobatos rhinobatos, Rostroraja alba
56	Torpedos	Tetronarce nobiliana, Torpedo spp., Torpedo marmorata, Torpedo torpedo
57	Coastal benthic cephalopods	Callistoctopus macropus, Macrotritopus defilippi, Octopus defilippi, Octopus vulgaris, Sepia officinalis
58	Benthopelagic cephalopods	Abralia spp., Abralia veranyi, Alloteuthis spp., Alloteuthis media, Alloteuthis subulata, Illex coindetii, Loligo spp., Loligo forbesii, Loligo vulgaris, Mastigoteuthis schmidti, Octopoteuthis sicula, Ocythoe tuberculata, Ommastrephes bartramii, Ommastrephidae, Opisthoteuthis calypso, Todarodes spp., Todarodes sagittatus,Todaropsis eblanae
59	Mesopelagic cephalopods	Abraliopsis morisii, Ancistrocheirus lesueurii, Ancistroteuthis lichtensteinii, Argonauta argo, Brachioteuthidae, Brachioteuthis riisei, Chiroteuthidae, Chiroteuthis veranii, Chtenopteryx sicula, Cranchiidae, Enoploteuthidae, Galiteuthis armata, Gonatus spp., Heteroteuthis dispar, Histioteuthidae, Histioteuthis spp., Histioteuthis bonnellii, Histioteuthis reversa, Lepidoteuthidae, Octopoteuthidae, Oegopsida spp., Onychoteuthidae, Onychoteuthis banksii, Pholidoteuthis boschmai, Pyroteuthis margaritifera, Stoloteuthis leucoptera, Taonius pavo, Teuthida, Teuthowenia megalops, Thysanoteuthis rhombus, Tremoctopus violaceus

60	Other benthic cephalopods	Abraliopsis morisii, Ancistrocheirus lesueurii, Ancistroteuthis lichtensteinii, Argonauta argo, Brachioteuthidae, Brachioteuthis riisei, Chiroteuthidae, Chiroteuthis veranii, Chtenopteryx sicula, Cranchiidae, Enoploteuthidae, Galiteuthis armata, Gonatus spp., Heteroteuthis dispar, Histioteuthidae, Histioteuthis, Histioteuthis bonnellii, Histioteuthis reversa, Lepidoteuthidae, Mesopelagic cephalopods, Octopoteuthidae, Oegopsida, Onychoteuthidae, Onychoteuthis banksii, Pholidoteuthis boschmai, Pyroteuthis margaritifera, Stoloteuthis leucoptera, Taonius pavo, Teuthida, Teuthowenia megalops, Thysanoteuthis rhombus, Tremoctopus violaceus
61	Bivalves	Abra alba, Abra longicallus, Acanthocardia spp., Acanthocardia aculeata, Acanthocardia echinata, Acanthocardia paucicostata, Acanthocardia spinosa, Acanthocardia tuberculata, Aequipecten commutatus, Aequipecten opercularis, Amygdalum politum, Anadara corbuloides, Anadara inaequivalvis, Anadara transversa, Anomia spp., Anomia ephippium, Arca tetragona, Arcidae, Arcopagia balaustina, Astarte spp., Astarte fusca, Atrina fragilis, Atrina pectinata, Bivalvia, Callista chione, Cardiidae, Cardiomya spp., Cardiomya costellata, Carditidae, Cardium spp., Cardium aculeatum, Cerastoderma edule, Chamelea gallina, Chlamys, Clausinella fasciata, Corbula gibba, Crassostrea spp., Crassostrea gigas, Cuspidaria, Cuspidaria cuspidata, Delectopecten vitreus, Donacidae, Donax spp., Donax trunculus, Dosinia spp., Dosinia lupinus, Flexopecten flexuosus, Flexopecten glaber, Gari fervensis, Glossus humanus, Glycymeris, Gouldia minima, Gryphus vitreus, Hiatella arctica, Hiatella rugosa, Laevicardium crassum, Laevicardium oblongum, Lentidium spp., Lentidium mediterraneum, Lima lima, Loripes spp., Lucinella divaricata, Lutraria spp., Mactra stultorum, Mactridae, Mimachlamys spp., Mimachlamys varia, Modiolus spp., Modiolus adriaticus, Modiolus barbatus, Modiolus modiolus, Moerella pulchella, Musculus costulatus, Mytilidae, Mytilus edulis, Mytilus galloprovincialis, Neopycnodonte cochlear, Nucula spp., Nucula nitidosa, Nucula nucleus, Nucula sulcata, Nuculana spp., Nuculana illirica, Nuculana pella, Ostrea spp., Ostrea edulis, Palliolum, Paphia aurea, Papillicardium, Parvicardium ovale, Pecten spp., Pecten jacobaeus, Pecten maximus, Pectinidae, Peronaea planata, Pinna nobilis, Pitar rudis, Plagiocardium papillosum, Pododesmus patelliformis, Pododesmus squama, Poromya granulata, Pteria hirundo, Ruditapes decussatus, Saccella commutata, Solecurtus scopula, Solecurtus strigilatus, Solen marginatus, Solenidae, Spisula spp., Spisula subtruncata, Striarca lactea, Talochlamys multistriata, Tellina spp., Tellina incarnata, Thracia spp., Thracia phaseolina, Thracioidea, Thyasira flexuosa, Veneridae, Venus spp., Venus casina, Venus nux, Venus verrucosa, Yoldiella philippiana
62	Gastropods	Acteon tornatilis, Alvania spp., Alvania cimex, Aplysiaspp., Aplysia depilans, Aplysia fasciata, Aplysia punctata, Aplysiidae, Aporrhais spp., Aporrhais pespelecani, Aporrhais serresianus, Armina loveni, Armina maculata, Armina tigrina, Atlanta spp., Atlanta lesueurii, Atlantidae, Baptodoris cinnabairna, Benthonella tenella, Berthella aurantiaca, Bittium spp., Bittium reticulatum, Bivetiella cancellata, Bolinus brandaris, Bolma rugosa, Buccinum humphreysianum, Caecum, Calliostoma spp., Calliostoma granulatum, Calliostoma laugieri, Calliostoma zizyphinum, Callumbonella suturalis, Calyptraea chinensis, Capulus ungaricus, Cephalaspidea, Cerithiidae, Cerithiopsis tubercularis, Cerithium spp., Cerithium scabridum, Charonia lampas, Chelidonura africana, Chrysallida, Clanculus cruciatus, Colus gracilis, Colus jeffreysianus, Comarmondia gracilis, Conus spp., Coralliophila spp., Crepidula gibbosa, Crepidula unguiformis, Cryptospira strigata, Cylichna cylindracea, Cymbium olla, Cymbulia spp., Dendrodoris limbata, Diodora spp., Diodora graeca, Diodora italica, Doris spp, Doris pseudoargus, Doris verrucosa, Emarginula sicula, Epitonium spp., Epitonium clathratulum, Epitonium clathrus, Eulima spp., Eulima bilineata, Eulima glabra, Euspira spp., Euspira catena, Euspira fusca, Euspira grossularia, Euspira guillemini, Euspira nitida, Euthria cornea, Felimare picta, Folinella excavata, Fusinus spp., Fusinus rostratus, Fusinus syracusanus, Fusiturris similis, Fusiturris undatiruga, Galeodea echinophora, Galeodea rugosa, Gastropoda, Gastropteron rubrum, Gibbula spp., Gibbula albida, Gibbula guttadauri, Gibbula magus, Hadriania craticulata, Heterobranchia, Hexaplex trunculus, Hypselodoris, Janthina pallida, Jorunna tomentosa, Jujubinus striatus, Kaloplocamus ramosus, Lamellaria spp., Lamellaria perspicua, Littorinidae, Mangelia spp., Mangelia attenuata, Mangelia multilineolata, Mangelia paciniana, Mangelia unifasciata, Mangeliidae, Marionia blainvillea, Melanella polita, Monoplex corrugatus, Murex spp., Murex brandaris, Murex trunculus, Muricidae, Muricopsis cristata, Nassariidae, Nassarius spp., Nassarius cuvierii, Nassarius incrassatus, Nassarius mutuhilis, Nassarius reticulatus, Natica spp., Naticarius hebraeus, Naticarius stercusmuscarum, Naticidae, Nudibranchia, Ocenebra edwardsii, Ocenebra erinaceus, Odostomia spp., Odostomia turriculata, Okenia elegans, Omalogyridae, Opisthobranchia, Oxygyrus keraudrenii, Paravitrea, Peltodoris atromaculata, Philine spp., Philine aperta, Philinopsis depicta, Phorcus turbinatus, Pleurobranchaea meckeli, Pleurobranchus membranaceus, Pleurobranchus testudinarius, Pollia dorbignyi, Prosobranchia,Pseudosimnia adriatica, Pseudosimnia carnea, Pyramidellidae, Pyrgulina pupaeformis, Ranella olearium, Raphitoma spp., Raphitoma histrix, Retusa crossei, Ringicula, Rissoa spp., Rissoa paradoxa, Rissoa variabilis, Scaphander lignarius, Semicassis granulata, Semicassis saburon, Smaragdia viridis, Tarantinaea lignaria, Tenagodus obtusus, Tethys fimbria, Tonna galea, Tornus subcarinatus, Triphoridae, Tritia incrassata, Tritia reticulata, Tritonia hombergii, Trochidae, Trophonopsis muricatus, Turbonilla lactea, Turbonilla pusilla, Turritella spp., Turritella communis, Turritella turbona, Umbraculum umbraculum, Vitreolina incurva, Xenophora crispa, Zafra selasphora

63	Deep-water rose shrimp	Parapenaeus longirostris
64	Blue and red shrimp	Aristeus antennatus
65	Giant red shrimp	Aristaeomorpha foliacea
66	Other commercial shrimps	Aristaeomorpha foliacea, Melicertus kerathurus, Metapenaeus monoceros, Metapenaeus stebbingi, Palaemon adspersus, Palaemon elegans, Pasiphaea sivado, Penaeus japonicus, Penaeus semisulcatus, Plesionika edwardsii, Plesionika martia, Trachysalambria curvirostris
67	No commercial shrimps	Acanthephyra spp., Acanthephyra eximia, Acanthephyra pelagica, Acanthephyra purpurea, Acanthomysis spp., Aegaeon spp., Aegaeon cataphractus, Aegaeon lacazei, Akanthophoreus gracilis, Allosergestes sargassi, Alpheidae, Alpheus glaber, Alpheus macrocheles, Alpheus platydactylus, Alpheus rapacida, Aristeidae, Ascidonia flavomaculata, Athanas spp., Athanas nitescens, Balssia gasti, Brachycarpus biunguiculatus, Caridea, Caridion steveni, Chlorotocus spp., Chlorotocus crassicornis, Chondrochelia savignyi, Crangon spp., Crangon crangon, Crangonidae, Deosergestes corniculum, Deosergestes henseni, Erythrops elegans, Erythrops neapolitanus, Eualus spp., Eucopia spp., Eucopia unguiculata, Eusergestes arcticus, Funchalia woodwardi, Gastrosaccus spp., Gastrosaccus sanctus, Gastrosaccus spinifer, Gennadas spp., Gennadas elegans, Haplostylus normani, Hippolyte holthuisi, Hippolyte leptocerus, Hippolytidae, Hymenopenaeus spp., Hymenopenaeus debilis, Jaxea nocturna, Leptochela pugnax, Ligur spp., Ligur ensiferus, Lysmata seticaudata, Nematocarcinus exilis, Ogyrides mjoebergi, Oplophoridae, Palaemonidae, Pandalidae, Pandalina spp., Parapandalus spp., Parasergestes vigilax, Pasiphaea spp., Pasiphaea multidentata, Penaeidea, Periclimenes spp., Periclimenes scriptus, Periclimenes granulatus, Philocheras spp., Philocheras bispinosus, Philocheras echinulatus, Philocheras fasciatus, Philocheras monacanthus, Philocheras sculptus, Philocheras trispinosus, Plesionika spp., Plesionika acanthonotus, Plesionika antigai, Plesionika gigliolii, Plesionika heterocarpus, Plesionika narval, Pontocaris spp., Pontophilus spp., Pontophilus norvegicus, Pontophilus spinosus, Processa spp., Processa acutirostris, Processa canaliculata, Processa edulis, Processa elegantula, Processa macrophthalma, Processa nouveli, Processa parva, Processidae, Robustosergia robusta, Sergestes spp., Sergestes arachnipodus, Sergestes arcticus, Sergestes atlanticus, Sergestes corniculum, Sergestidae, Sergia robusta, Sicyonia carinata, Solenocera membranacea, Solenoceridae, Stenopus spinosus, Synalpheus spp., Synalpheus gambarelloides, Synalpheus tumidomanus, Systellaspis debilis, Tanaidacea, Tanaiidomorpha, Thalassinidae, Thoralus cranchii, Typtonongicola
68	Norway lobster	Nephrops norvegicus
69	European lobster	Palinurus elephas
70	Other commercial decapods	Cancer pagurus, Carcinus aestuarii, Homarus gammarus, Macropipus puber, Maja squinado, Necora puber, Palinurus spp., Palinurus mauritanicus, Penaeus kerathurus, Squilla mantis

71	Non-commercial decapods	Acantharctus posteli, Acanthonyx lunulatus, Achelous hastatus, Alpheus spp., Alpheus dentipes, Alpheus edwardsii, Anamathia rissoana, Anapagurus spp., Anapagurus bicorniger, Anapagurus laevis, Anomura, Atelecyclus spp., Atelecyclus rotundatus, Bathynectes longipes, Bathynectes maravigna, Benthopelagic decapod Crustacea, Brachynotus spp., Brachynotus foresti, Brachynotus gemmellari, Brachynotus sexdentatus, Brachyura, Calappa granulata, Calcinus spp., Calcinus tubularis, Callanassidae, Callianassa subterranea, Callinectes sapidus, Calocarides coronatus, Calocaris macandreae, Charybdis longicollis, Clibanarius erythropus, Coleusia signata, Corystes spp., Corystes cassivelaunus, Dardanus arrosor, Dardanus calidus, Derilambrus angulifrons, Dicranodromia mahieuxii, Diogenes pugilator, Diogenidae, Dorhynchus thomsoni, Dromia personata, Ebalia spp., Ebalia cranchi, Ebalia granulosa, Ebalia nux, Ebalia tuberosa, Ebalia tumefacta, Ergasticus clouei, Eriphia verrucosa, Erugosquilla massavensis, Ethusa spp., Ethusa mascarone, Euchirograpsus liguricus, Eucrate crenata, Eurynome spp., Eurynome aspera, Galathea spp., Galathea bolivari, Galathea dispersa, Galathea intermedia, Galathea nexa, Galathea squamifera, Galathea strigosa, Galatheidae, Geryon longipes, Geryon trispinosus, Gilvossius tyrrhenus, Goneplax spp., Goneplax rhomboides, Gourretia denticulata, Herbstia condyliata, Homola barbata, Idotea spp., Ilia spp., Ilia nucleus, Inachus spp., Inachus aguiarii, Inachus communissimus, Inachus dorsettensis, Inachus leptochirus, Inachus parvirostris, Inachus phalangium, Inachus thoracicus, Ixa monodi, Latreillia spp., Latreillia elegans, Liocarcinus spp., Liocarcinus bolivari, Liocarcinus corrugatus, Liocarcinus depurator, Liocarcinus maculatus, Liocarcinus navigator, Liocarcinus pusillus, Liocarcinus vernalis, Liocarcinus zariquieyi, Lissa chiragra, Lithodes maja, Lophogaster typicus, Macrophthalmus graeffei, Macropipus spp., Macropipus arcuatus, Macropipus tuberculatus, Macropodia spp., Macropodia linaresi, Macropodia longipes, Macropodia longirostris, Macropodia rostrata, Macropodia tenuirostris, Maja brachydactyla, Maja crispata, Maja goltziana, Majidae, Malacostraca, Medorippe lanata, Microcassiope minor, Monodaeus spp., Monodaeus couchii, Munida spp., Munida curvimana, Munida intermedia, Munida iris, Munida rugosa, Munida rutllanti, Munida tenuimana, Myra fugax, Nannosquilloides occultus, Natantia crustaceans, Natatolana borealis, Nepinnotheres pinnotheres, Ocypodidae, Paguridae, Paguristes eremita, Paguristes oculatus, Pagurus spp., Pagurus alatus, Pagurus anachoretus, Pagurus cuanensis, Pagurus excavatus, Pagurus forbesii, Pagurus prideaux, Palicus spp., Pandalina brevirostris, Pandalina profunda, Parasquilla ferussaci, Paromola cuvieri, Parthenope, Parthenopidae, Parthenopoides massena, Percnon gibbesi, Pilumnus spp., Pilumnus hirtellus, Pilumnus hirtellus, Pilumnus villosissimus, Pilumnusinifer, Pinnotheres pisum, Pirimela denticulata, Pisa spp., Pisa armata, Pisa hirticornis, Pisa muscosa, Pisa nodipes, Pisa tetraodon, Pisidia spp., Pisidia bluteli, Pisidia longicornis, Planes minutus, Platysquilla eusebia, Polybius henslowii, Polycheles typhlops, Polychelidae, Porcellanidae, Portunidae, Portunus spp., Portunus latipes, Portunus pelagicus, Pseudosquillopsis cerisii, Reptantia crustaceans, Richardina fredericii, Rissoides spp., Rissoides desmaresti, Rissoides pallidus, Rochinia carpenteri, Scyllaridae, Scyllarides latus, Scyllarus spp., Scyllarus arctus, Scyllarus pygmaeus, Spinolambrus macrochelos, Squilla, Squillidae, Stereomastis sculpta, Stomatopoda, Thia scutellata, Upogebia spp., Upogebia deltaura, Upogebia pusilla, Upogebia stellata, Upogebia tipica, Xanthidae, Xantho spp., Xantho pilipes, Xantho poressa
72	Purple sea urchin	Paracentrotus lividus
73	Other sea urchins	Arbacia lixula, Brissopsis atlantica, Brissopsis lyrifera, Centrostephanus longispinus, Cidaris cidaris, Echinidae, Echinocardium cordatum, Echinocyamus pusillus, Echinoidea, Echinus melo, Gracilechinus acutus, Irregularia, Ova canaliferus, Psammechinus microtuberculatus, Spatangidae, Spatangus purpureus, Spatangus subinermis, Sphaerechinus granularis, Stylocidaris affinis
74	Sea cucumbers	Elpidia glacialis, Havelockia inermis, Holothuria spp., Holothuria forskali, Holothuria mammata, Holothuria poli, Holothuria tubulosa, Holothuroidea, Leptopentacta spp., Leptopentacta elongata, Leptopentacta tergestina, Leptosynapta, Mesothuria intestinalis, Molpadia spp., Molpadia musculus, Myriotrochinae, Ocnus planci, Ocnus syracusanus, Oestergrenia digitata, Parastichopus regalis, Phyllophoridae, Synaptidae, Thyone inermis

75	Other macro-benthos	Acanthochitona fascicularis, Acoetidae, Actinauge spp., Actinauge richardi, Actinia spp., Actiniaria, Actiniidae, Adamsia palliata, Aglaophamus, Alciopini, Ampharetidae, Amphioxus, Amphipholis squamata, Amphipoda, Amphiura chiajei, Amphiura filiformis, Andresia parthenopea, Annelida, Anseropoda placenta, Antalis spp., Antalis agilis,Antalis dentalis, Antalis entalis, Antalis inaequicostata, Antedon spp., Antedon mediterranea, Anthozoa, Aphrodita spp., Aphrodita aculeata, Aplidium spp., Aplidium conicum, Aplidium elegans, Aplidium haouarianum, Aplidium nordmanni, Aponuphis bilineata, Aponuphis brementi, Ascidia involuta, Ascidia mentula, Ascidia virginea, Ascidiella spp., Ascidiella aspersa, Ascidiella scabra, Ascidiidae, Aspidosiphon muelleri, Asteroidea, Astropecten spp., Astropecten aranciacus, Astropecten bispinosus, Astropecten irregularis, Astropecten spinulosus, Astrospartus mediterraneus, Aulactinia verrucosa, Axinella spp., Axinella cannabina, Axinella polypoides, Balanoidea, Bathynectes, Bonellia viridis, Bonelliidae, Botryllus spp., Botryllus schlosseri, Branchiostoma lanceolatum, Calliactis parasitica, Capitellidae, Cavernularia pusilla, Cerianthus spp., Cerianthus membranaceus, Chaetaster longipes, Chaetopteridae, Chitonida, Chondrosia reniformis, Ciona spp., Ciona edwardsi, Ciona intestinalis, Cirratulidae, Cirripedia, Clathria coralloides, Clathrina clathrus, Clitellata, Cnidaria, Crella sigmata, Crinoidea, Ctenodrilus, Cystodytes dellechiajei, Dasybranchus, Demospongiae, Dentaliidae, Dentalium, Diazona violacea, Diopatra neapolitana, Distomus variolosus, Drilonereis, Echinaster sepositus, Echinodermata, Errantia, Eteone siphodonta, Eudistoma spp., Eudistoma mucosum, Eunice roussaei, Eunice vittata, Eunicidae, Euphrosine foliosa, Exogonia, Filograna implexa, Funiculina quadrangularis, Fustiaria rubescens, Glycera spp., Glycera convoluta, Glycera unicornis, Glyceridae, Golfingia vulgaris, Goniada spp., Goniada maculata, Hacelia attenuata, Halocynthia papillosa, Hirudinea, Hyalinoecia spp., Hyalinoecia tubicola, Hydractinia echinata, Hymenodiscus coronata, Idanthyrsus, Ircinia, Laetmonice spp., Laetmonice hystrix, Lagis koreni, Laonice cirrata, Leanira, Leptometra spp., Leptometra phalangium, Lineus, Luidia spp., Luidia ciliaris, Luidia sarsii, Lumbriconereis gracilis, Lumbrineris, Maldane sarsi, Maldanidae, Marthasterias glacialis, Metridium senile, Microcosmus spp., Microcosmus sabatieri, Microcosmus vulgaris, Microeuraphia depressa, Micronereis variegata, Molgula spp., Molgula appendiculata, Molgula manhattensis, Mollusca, Neanthes acuminata, Nematoda, Nemertea, Nephtyidae, Nephtys, Nereis, Notomastus latericeus, Odontaster mediterraneus, Oligochaeta, Onuphidae, Ophidiaster ophidianus, Ophiocomina nigra, Ophioderma longicauda, Ophiomyxa pentagona, Ophiopsila aranea, Ophiothrix spp., Ophiothrix fragilis, Ophiothrix quinquemaculata, Ophiura ophiura, Ophiuroidea, Orbiniidae, Oxydromus, Peltaster placenta, Pennatula spp., Pennatula aculeata, Pennatula phosphorea, Pennatula rubra, Pennatulidae, Petrosia ficiformis, Phallusia mammillata, Phascolosoma granulatum, Phoronida, Phyllodocidae, Platynereis dumerilii, Plutonaster bifrons, Polycarpa spp., Polycarpa mamillaris, Polycarpa pomaria, Polychaeta, Polycitor, Polyclinella azemai, Polyclinidae, Polynoidae, Polyplacophora, Pontobdella muricata, Porifera, Priapulidae, Pseudodistoma cyrnusense, Pteroeides spp., Pteroeides griseum, Pteroeides spinosum, Pyura spp., Pyura dura, Pyura microcosmus, Sabella spp., Sabella pavonina, Sabellidae, Sagartia elegans, Scalpelliformes, Scalpellum scalpellum, Scaphopoda, Scoletoma laurentiana, Sedentaria, Serpula, Serpulidae, Siboglinidae, Sigalionidae, Sipunculidae, Sipunculus spp., Sipunculus nudus, Spionidae, Spongia officinalis, Sternaspidae, Sternaspis scutata, Sthenelais boa, Suberites spp., Suberites carnosus, Suberites domuncula, Suberites ficus, Syllidae, Syllis cornuta, Syllis variegata, Synoicum blochmanni, Terebellidae, Terebellides stroemii, Tethya aurantium, Tethya citrina, Tethyaster subinermis, Thenea muricata, Trichobranchus glacialis, Tubulanus, Tunicata, Turbellaria, Veretillidae, Veretillum spp., Veretillum cynomorium, Verrucidae, Virgularia mirabilis
76	Jellyfish	Aequorea forskalea, Aurelia aurita, Chrysaora hysoscella, Cotylorhiza tuberculata, Ctenophora, Hydrozoa, Pelagia noctiluca, Pleurobrachia pileus, Rhizostoma pulmo, Scyphozoa
77	Salps and other gelatinous zooplankton	Abylopsis tetragona, Chelophyes spp., Chelophyes appendiculata, Clausophyes, Coelenterata, Cymbulia peronii, Diphyidae, Doliolids, Gelatinous plankton, Heteropyramis maculata, Lensia, Pyrosoma spp., Pyrosoma atlanticum, Salpa spp., Salpa fusiformis, Salpa maxima, Salpidae, Siphonophora, Stephanoscyphistoma, Thalia democratica, Thaliacea
78	Red coral	Corallium rubrum
79	Other corals and gorgonians	Alcyonidium, Alcyonium spp., Alcyonium acaule, Alcyonium palmatum, Amathia semiconvoluta, Beania cylindrica, Callogorgia verticillata, Caryophyllia smithii, Cellaria salicornioides, Celleporina caliciformis, Corals and gorgonians, Epizoanthus spp., Eunicella spp., Eunicella cavolini, Eunicella filiformis, Eunicella singularis, Eunicella verrucosa, Isidella elongata, Leptogorgia sarmentosa, Lytocarpia myriophyllum, Metroperiella, Myriapora truncata, Nemertesia antennina, Nemertesia ramosa, Nephtheidae, Plumularia, Reteporella, Scrupocellaria scrupea, Sertularella
80	Macro zooplankton	
81	Meso and micro zooplankton	

82	Suprabenthos	
83	Mediterranean seagrass	Posidonia oceanica
84	Other seagrasses	Cymodocea spp., Cymodocea nodosa, Phanerogama, Zostera spp., Zostera marina, Zostera noltii
85	Erected algae	Amphiroa rigida, Anadyomene stellata, Asparagopsis armata, Botryocladia botryoides, Caulerpa spp., Caulerpa prolifera, Caulerpa racemosa
86	Seaweeds	Chaetomorpha, Champia parvula, Chlorophyceae, Chondria, Chylocladia verticillata, Cladophora, Codium spp., Codium adhaerens, Codium bursa, Codium vermilara, Corallinaceae, Cryptonemia tuniformis, Cystoseira spp., Cystoseira spinosa, Cystoseira zosteroides, Dasycladus vermicularis, Dictyopteris polypodioides, Dictyota spp., Dictyota dichotoma, Erected algae, Flabellia petiolata, Galaxaura, Gelidium spp., Gelidium pusillum, Gloiocladia furcata, Gloiocladia microspora, Gloiocladia repens, Gracilaria corallicola, Halopithys incurva, Halopteris filicina, Hypnea spp., Hypnea musciformis, Jania rubens, Kallymenia, Kuckuckia spinosa, Laminaria rodriguezii, Laurencia chondrioides, Lithothamnion corallioides, Lithothamnion valens, Neurocaulon foliosum, Osmundaria volubilis, Osmundea pelagosae, Padina pavonica, Palmaria spp., Palmophyllum crassum, Peyssonnelia spp., Peyssonnelia rosa-marina, Phaeophyceae, Phycophyta, Phyllophora crispa, Phyllophora herediae, Phymatolithon calcareum, Plocamium cartilagineum, Polysiphonia spp., Polysiphonia subulifera, Porphyra, Pseudochlorodesmis furcellata, Rhodophyta, Rhodymeniaceae, Rytiphlaea tinctoria, Sphacelaria spp., Sphacelaria cirrosa, Spongites fruticulosa, Ulva spp., Ulva rigida, Ulvophyceae, Valonia spp., Valonia macrophysa, Valonia utricularis, Zanardinia typus
87	Small phytoplankton	
88	Large phytoplankton	
89	Detritus	
90	Discards	Discarded from fishing fleet, (mammals, reptiles, seabirds, elasmobranches as bycatch)
91	Imports	

Legend

Mammals	Invertebrates
Seabirds	Plant
Sea turtles	Algae
Elasmobranchs	Organic matter
Fish	

Annex II: Trophic levels of each functional group

Functional group	All Med	Western Med	Central Med	Eastern Med	Adriatic Sea
Mediterranean seagrass	1.00	1.00	1.00	1.00	1.00
Other seagrasses	1.00	1.00	1.00	1.00	1.00
Erected algae	1.00	1.00	1.00	1.00	1.00
Seaweeds	1.00	1.00	1.00	1.00	1.00
Small phytoplankton	1.00	1.00	1.00	1.00	1.00
Large phytoplankton	1.00	1.00	1.00	1.00	1.00
Detritus	1.00	1.00	1.00	1.00	1.00
Discards	1.00	1.00	1.00	1.00	1.00
Imports	1.00	1.00	1.00	1.00	1.00
Salema	2.00	2.00	2.00	2.00	2.00
Bivalves	2.00	2.00	2.00	2.00	2.00
Purple sea urchin	2.00	2.00	2.00	2.00	2.00
Other sea urchins	2.00	2.00	2.00	2.00	2.00
Sea cucumbers	2.00	2.00	2.00	2.00	2.00
Meso and micro zooplankton	2.00	2.00	2.00	2.00	2.00
Suprabenthos	2.00	2.00	2.00	2.00	2.00
Gastropods	2.17	2.17	2.17	2.17	2.17
Round sardinella	2.25	3.08	2.25	2.25	3.09
Red coral	2.42	2.42	2.42	2.42	2.42
Commercial small demersal fish	2.50	2.50	2.50	2.50	2.50
Salps and other gelatinous zooplankton	2.50	2.50	2.50	2.50	2.50
Other corals and gorgonians	2.53	2.53	2.53	2.53	2.53
White seabream	2.61	2.61	3.30	3.16	3.10
European sardine	2.67	2.67	2.67	2.67	2.98
Macro zooplankton	2.67	2.67	2.67	2.67	2.67
Mugilidae	2.77	2.78	2.78	2.77	2.78
Fin whale	2.83	2.83	3.25	2.83	2.83
Other macro-benthos	3.24	3.26	3.25	3.24	3.25
Other small pelagic fish	3.27	3.57	3.26	3.26	3.59
Common two-banded seabream	3.31	3.31	4.08	3.56	3.70
Red mullet	3.36	3.75	3.36	3.54	3.31
Labridae and serranidae+	3.38	3.48	3.35	3.35	3.39
Jellyfish	3.39	3.39	3.39	3.39	3.39
Loggerhead turtles	3.58	3.27	3.59	3.57	2.74
Blue and red shrimp	3.64	3.65	3.64	3.63	3.65
Transparent gobies	3.67	3.67	3.67	3.67	3.67
No commercial small demersal fish	3.79	3.88	3.85	3.79	3.86
Giant red shrimp	3.81	3.81	3.81	3.80	3.82
Groupers	3.81	4.28	3.81	3.81	3.85
Surmullet	3.85	3.77	3.85	3.92	3.75
Sparidae+	3.85	4.21	3.90	3.92	4.05
Other commercial decapods	3.86	3.35	3.86	3.34	3.35
European lobster	3.87	3.85	3.86	3.85	3.84
Bathydemersal (deep sea) fish	3.92	3.93	3.93	3.91	3.93

No commercial shrimps	3.95	3.96	3.94	3.94	3.95
Non-commercial large pelagic fishes	3.97	4.01	3.97	3.96	4.01
No commercial meso (bathy) pelagic fishes	3.98	4.06	4.06	3.97	4.06
Swordfish	4.02	4.80	4.02	4.02	5.06
Non-commercial decapods	4.04	3.99	4.03	4.03	4.05
Deep-water rose shrimp	4.09	4.08	4.06	4.06	4.09
Red scorpionfish	4.10	4.79	4.10	4.09	4.26
Horse mackerels	4.13	4.63	4.16	4.11	4.89
European anchovy	4.16	4.16	4.16	4.15	3.18
Gulls and cormorants	4.20	4.40	4.23	4.21	4.49
European hake	4.20	4.32	4.49	4.10	4.10
Norway lobster	4.20	4.21	4.19	4.18	4.21
Other commercial large demersal fish	4.21	4.28	4.77	4.73	4.46
Common pandora	4.21	4.59	4.19	4.20	3.58
Flatfishes	4.23	4.35	4.24	4.23	4.34
Terns	4.24	4.28	4.25	4.23	4.19
Endangered and pelagic seabirds	4.31	4.45	4.31	4.29	4.39
Other commercial shrimps	4.32	4.31	4.29	4.30	4.31
Brown meagre	4.32	4.30	4.32	4.31	4.31
Other medium pelagic fishes	4.36	4.43	4.25	4.22	4.36
Other commercial medium demersal fish	4.41	4.63	4.62	4.23	4.24
Other large pelagic fishes	4.41	4.54	4.63	4.43	4.49
No commercial medium demersal fish	4.42	4.59	4.45	4.41	4.49
Mackerels	4.43	4.46	4.56	4.54	4.05
Benthopelagic fishes	4.44	4.67	4.61	4.43	4.54
Small-spotted catshark	4.48	5.06	4.45	4.45	5.72
Bluefin tuna	4.49	4.69	4.76	4.72	4.66
Coastal benthic cephalopods	4.53	4.55	4.51	4.51	4.53
Deep sea-cetacean feeders	4.54	4.91	4.86	4.68	4.92
Scorpaenidae+	4.62	4.73	4.73	4.63	4.47
Other small demersal sharks	4.63	4.78	4.62	4.65	4.61
Benthopelagic cephalopods	4.64	4.52	4.67	4.64	4.68
Torpedos	4.64	4.15	4.49	4.46	4.26
European conger	4.66	5.25	4.73	4.69	4.96
Other benthic cephalopods	4.66	4.56	4.39	4.54	4.49
Blue whiting	4.66	4.67	4.66	4.65	4.48
Anglerfish	4.68	5.37	4.89	4.66	5.08
Mesopelagic cephalopods	4.72	4.76	4.55	4.53	4.76
Blackmouth catshark	4.72	4.73	4.79	4.76	5.64
Rays and skates	4.73	4.81	4.78	4.77	4.74
Poor cod	4.75	4.72	4.70	4.74	4.00
Common dentex	4.77	4.83	4.91	4.86	4.45
Pelagic sharks	4.89	5.08	4.93	4.88	5.03
Bottlenose dolphins	4.94	5.05	4.60	4.59	4.91
Short-beaked common dolphin	4.95	5.10	4.49	4.47	4.80
Striped dolphins	4.98	5.11	5.06	5.01	5.41
Monk seals	5.03	5.28	5.05	5.00	5.18