> "
>
> Essential Fish Habitats in the Mediterranean is being defined as "habitats essential to the ecological and biological requirements for critical life history stages of exploited fish species, and which may require special protection to improve the status of the stocks and long-term sustainability[3]"

CHAPTER 7 /

Towards the identification of essential fish habitats for commercial deep-water species

An ecosystem approach to Fisheries is intended to ensure that the planning, development, and management of fisheries will meet social and economic needs, without jeopardizing the options for future generations to benefit from the full range of goods and services provided by marine ecosystems[1].

Implementing an ecosystem approach to fisheries is now a widely accepted concept for delivering management provisions and advice encompassing multiple stocks which inhabit a common and geographically-defined area. It complements the traditional approach to fisheries management.

Among the different management tools available to implement this approach, the identification and protection of **Essential Fish Habitat** (EFH), is known to play a significant role in maintaining populations of commercial species as well as restoring and preserving the ecosystem that sustained it. This is particularly relevant as many of the Mediterranean stocks are overfished[2] and habitat loss and degradation may also be contributing to this. Hence, EFH identification needs to be supported by a policy and a programme of technical management measures to reduce fishing mortality and the indirect impact of fishing in those areas.

This concept was introduced in the Mediterranean fisheries policy to enhance the efforts of recovery plans for fisheries. To date, as part of this approach, a minimum distance from the coastline or a minimum depth has been legislated[1] and a few Fisheries Restricted Areas, e.g. areas identified as EFH, have been declared in the Mediterranean with this main focus (e.g. the Gulf of Lion Rec. GFCM/33/2009/1; Strait of Sicily, EC.CM-GFCM/40/2016/4 and in the Jabuka/Pomo Pit, Rec. GFCM/41/2017/3). At a national level, other spatial-temporal restrictions of fishing activities might contribute towards this objective.

Despite these efforts, additional fisheries recommendations under GFCM (GFCM/41/2017/5) requested that countries make an effort to endorse further actions towards EFH. These action included the adoption of multiannual management plans based on an ecosystem approach to fisheries to guarantee the maintenance of stocks above the levels which can produce maximum sustainable yield (MSY), the establishment of more fisheries restricted areas (FRAs), and the definition of a consistent network of essential fish habitats that also take in to account sensitive habitats.

EFH mapping has been initiated at various levels as an integrated part of the 2017-2020 Mid-Term Strategy for Mediterranean Fisheries[2]. Field data surveys and species distribution modelling has been used as tools to map specific habitat requirements for different life stages of various species. The first maps using model approaches have been produced to identify nurseries and spawning grounds as potential Mediterranean EFH of the European hake *Merluccius merluccius* and mullets *Mullus* sp[3]. These fish resources are considered high priority species for fisheries management in the Mediterranean region given the high exploitation rate and low level of biomass of the stocks.

Potential EFH for exploited deep-sea species is less investigated. These species may use different habitats (nursery, feeding, spawning) during their lives and are dependent on the availability and condition of these habitats to sustain them even at the population level [4,5] and the causes of these declines, apart from overfishing, remain largely unresolved. Degradation of essential habitats has resulted in habitats that are no longer adequate to fulfil nursery, feeding, or reproductive functions. The identification of such areas on both horizontal and vertical (depth) dimensions are important for both the conservation of biodiversity and sustainable management of the fisheries. Identifying and protecting the essential fish habitat (EFH) of deep-water species might also include actions on coastal habitats as some deep-water species might be also highly dependent on these areas for their reproduction and protection during juvenile stages. Yet, the degree to which coastal habitats are important for exploited species has not been quantified.

Even though it may be difficult to define the boundaries of EFH for these deep-sea species, initiating efforts towards the definition of EFH areas, combined with a management which recognizes the importance of such areas, represents an important step towards facilitating an Ecosystem Approach to deep-water fisheries.

The most important criteria used to define EFH are:

- **Nursery grounds where the highest aggregations of recruits are found, and persist over time.**
- **Spawning areas with large seasonal aggregations of mature females, and persist over time.**

For demersal commercial species, for example, these may depend upon a particular type of sea bottom, complex topography or biogenic habitats for their growth and survival. The effective EFH habitat for these species may be a result of the interaction of ecosystem productivity, population dynamics and connectivity. For pelagic species, on the other hand, as their life cycle is intrinsically associated with the water column, the combination of particular oceanographic features and/or the presence of a hydrographic process is a key and needs to be taken into account to identify the hotspots that might be considered as EFH in relation to the main spawning grounds and juvenile concentration areas[3]. The identification of EFH sites for deep-water species

1 EU Council Regulation No 1967/2006 of 21 December 2006. Official Journal of the European Communities, 269: 1–15.
2 http://www.fao.org/gfcm/publications/brochures/midtermstrategy-2017-2020/en/
3 GFCM WGMPA, 2019. http://www.fao.org/gfcm/meetings/info/es/c/1176435/

> “Deep-water species are generally vulnerable to fishing activities, because of their special biological characteristics (longevity, low fecundity, low growth rate, high food competition) and the vulnerable ecosystems they are living in”

brings additional challenges, given the little knowledge we have of the fisheries footprint in most of the Mediterranean, the limited knowledge on many of the commercial species and their relation to the environment. Despite current limitations, we attempt to compile the existing information on some of the most important deep-water fisheries resources in the Eastern Mediterranean to date and identify those potential EFH sites. The ecosystem-based fisheries of EFH sites and the incorporation of ecosystem based fisheries managed measures such as reducing the fishing effort on these grounds, could provide important benefits to those deep-sea fisheries and contribute to improving the state of the communities and resources exploited in the Eastern Mediterranean.

To identify EFH, field survey data from grey and published literature has been gathered in order to:

- estimate and map the spatial distribution of the abundance of juveniles (number of individuals/ km^2) for each species and identify their hotspot areas - nurseries
- identify the hotspots of the spawning grounds, where high abundances of female individuals of each species at the spawning stage occur.
- assess the nursery and spawning ground habitats and provide recommendations for further management measures

Annex I lists the datasets and sources that were used to identify key areas where juveniles and/or spawners aggregate.

In this analysis, five deep-water exploited species were chosen to be reviewed because of their economic importance. The two deep-water red shrimps, **the giant red shrimp** (*Aristaeomorpha foliacea*) and **the blue red shrimp** (*Aristeus antennatus*), **the blackbelly rosefish** (*Helicolenus dactylopterus*), **the blackspot seabream** *(Pagellus bogaraveo)* and **the wreckfish** *(Polyprion americanus).*

Although red shrimps are not long-living and a low growth rate species, they have been mentioned as vulnerable to intensive fishing. According to the Reports of the Working Group of Stock Assessment of Demersal Species (WGSAD-GFCM, 2014; 2018, 2021) many of the stocks of *A. foliacea* and *A. antennatus* in various Geographical subareas (GSAs) of the Mediterranean Sea were assessed as overexploited, particularly in the western Mediterranean. Since a new deep-water red shrimp fishery is nowadays under development in the Eastern Mediterranean, information on these species is required for their sustainable management. Also, both red shrimp species occur in vulnerable ecosystems, such as sea canyons, and have not yet been assessed in the Mediterranean for the IUCN Red List.

Blackbelly rosefish has been considered particularly vulnerable to overfishing due to its biological characteristics (long-lived, late maturity, slow growth) and the abundance of the species was found to be linearly affected by the fishing effort intensity[6]. However, blackbelly rosefish is listed as **Least Concern** for the European and Mediterranean waters[7,8].

Regarding the **blackspot seabream** (*Pagellus bogaraveo*), the historical evidence of overexploitation and population collapse in the Bay of Biscay fishery and in other parts of its geographical distribution, along with its specific biological traits (low growth rate, hermaphroditism) are a cause of concern. As a result of the species vulnerability to overexploitation, the species population dynamics are annually evaluated under WGDEEP (ICES group) for the Atlantic stocks and COPEMED (FAO regional project) for the Western Mediterranean. No particular attention has been received for the species in the Eastern Mediterranean. This species has been listed as **Near Threatened** both globally and in the European waters[9], whilst being listed as **Least Concern** in 2011 for the Mediterranean region[10].

The **wreckfish** *Polyprion americanus* is generally considered as a long-lived, slow growth and late maturity fish species[11], making it highly vulnerable to fishing exploitation. In addition, it has a long pelagic phase that might increase its vulnerability. Moreover, it is living in vulnerable habitats, such as banks and seamounts, that could additionally affect its vulnerability.

Therefore, it is obvious that the above species demand particular attention and any information related to their nurseries and spawning grounds would be essential for their sustainable management.

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Deep-water shrimps

Kapiris K., Bordbar L., Otero M., Thasitis I., Lteif M., Mytilineou Ch., Ali M., Farrag M., Jemaa S., Adamidou A., Dokos J., Kavadas S.

“The giant red deep-water shrimp, *Aristaeomorpha foliacea* plays a key role in deep-sea communities and it is considered one of the most important targets of deep-water trawl fishing. Its distribution has been linked to the distribution of the Levantine Intermediate Water (LIW) from the Eastern Mediterranean Sea”

The two red shrimps, *Aristaeomorpha foliacea* and *Aristeus antennatus* are of great economic interest in the Mediterranean, being among the main target species for the demersal deep-water fishery in the Western and Central Mediterranean. Both species are captured exclusively by trawlers on muddy bottoms in deep waters off the continental shelf, especially near submarine trenches and canyons along the continental slope[12,13]. The giant red shrimp or deep-sea red shrimp *A. foliacea* is a cosmopolitan species while the geographical distribution of the blue and red shrimp *A. antennatus* is confined to the Eastern-Central Atlantic (from the Iberian Peninsula to Angola), the Mediterranean with the exception of the Adriatic Sea[14,15] and the Indian Ocean[16]. The deep-sea red shrimps, *A. antennatus* and *A. foliacea*, are the only Mediterranean representatives of the Aristeidae family.

One important feature of these two commercial species is their longitudinal differentiation along the Mediterranean: The giant red shrimp *A. foliacea* increases in abundance from the Western to the Eastern Mediterranean, while the opposite is true for *A. antennatus.* Their geographical distribution seems to be patchy[17,18]. The bathymetric distribution of them is also different, *A. antennatus* is known to occur at depths ranging from 80 to 3,300 m[19], while *A. foliacea* has been recorded at depths from 123 to 1,100 m, generally on muddy bottoms[20,21].

The biology (reproduction, sex-ratio, feeding habits and population dynamics) of both species is relatively well known particularly in the Western and Central Mediterranean. Genetic studies[22] indicated that *A. antennatus* presented two genetic stocks (or Management Units) in the Mediterranean: one in the Western and the other in the E. Mediterranean. It should be noted that in this study the sampling area of the Eastern Mediterranean was limited only to the Eastern Ionian Sea (GSA 20). According to the authors of this study[22], it is possible that the Strait of Sicily may be serving as a barrier for the migration of individuals and gene flow between the two basins. Moreover, recent studies in the same sampling areas[23], suggest the same genetic differentiation between the Western and Eastern basins for this species, most likely related to differences in environmental conditions. However, other studies with samples geographically closer to both sides of the Strait of Sicily showed that Western and Central Mediterranean (including the South-eastern part of the Sicily Straits, GSAs 13-16) is structured into a large genetically undifferentiated unit[24]. Therefore, it could be suggested that the Western (GSA 13-16[4]) and Eastern (GSA 20) part of the Ionian Sea are genetically differentiated. No genetic studies have been published for the other Eastern Mediterranean (GSAs) for either of the red shrimps. However, recently genetic research is conducted in the framework of the MEDUnits project[5].

4 Mediterranean Geographical Sub-Areas (GSAs) of FAO-GFCM. http://www.fao.org/gfcm/data/maps/gsas/en/
5 DG MARE Specific Contract No. 03EASME/EMFF/2017/1.3.2.3/01/ SI2.793201 -SC03.

FISHERIES

Red shrimps have been exploited commercially since the 1930s in the Western Mediterranean basin[25,26] while new deep fishing grounds have been discovered in recent decades, especially in the Eastern Mediterranean.

Both red shrimps are harvested by bottom trawlers on the slope, commonly at depths ranging from 400 to 800 m. The giant red shrimp *A. foliacea* was heavily exploited in the Western Mediterranean. It is still being fished in the Central Mediterranean whereas its stocks have been considered quasi pristine in the Eastern Mediterranean[13,27,28,29] due to not very developed exploitation. Nonetheless, over the last decades, the red shrimp fishing fleets have expanded their operations to various areas of the E. Mediterranean[30,31,32]. The blue-red deep-water shrimp (*A. antennatus*) although less abundant in the E. Mediterranean, is also an important commercially targeted species.

According to the latest published stock assessment in 2021, the stocks of *A. antennatus* in the regions GSAs 01 (Northern Alboran), 02 (Alboran Island), 05 (Baleares Islands) and 06 (Northern Spain), as well as the stocks of *A. foliacea* and *A. antennatus* for GSA 09 (Ligurian Sea and North Tyrrhenian Sea), 10 (Southern and Central Tyrrhenian Sea) and 11 (Sardinia) were overexploited and the management advice was to reduce fishing mortality. For GSA 18 (Southern Adriatic) and 19 (Western Ionian Sea) the stocks were considered in low overexploitation and relative low biomass. At present, the two recommendations establishing multiannual management plans for sustainable trawl fisheries targeting deep-water red shrimp species in the Levant Sea (GSAs 26–27) and the Ionian Sea (GSAs 20–21) have been established. Another recommendation establishing management measures for sustainable trawl fishing activities targeting giant red shrimp (*Aristaeomorpha foliacea*) and blue and red shrimp (*Aristeus antennatus*) in the Strait of Sicily has also recently been adopted in 2021[6].

> “Bottom trawlers targeting deep-water shrimps affect deep-sea ecosystems, modifying the seafloor morphology and its physical properties, with dramatic consequences on benthic vulnerable communities”

The SOMFI 2020 report shows that the catches of both species have an increasing trend over recent years with an increasing exploitation ratio for blue and red shrimp at Mediterranean level[34]. The maximum landing for the latter was reached in 2018 with 4,400 t while for the giant red shrimp it was 2,900 t in 2017. The available FAO catch data on red shrimps from the Central-Eastern Mediterranean (FAO FishSTAT 1999-2017) showed strong fluctuations between the years from 1999 to 2017, with the highest reported value of 3,721 t in 2000. Catches from the available data in the last 5 years were, on average, 2000 t per year. It is likely that unreported catches are significant[2], since from the Automatic Identification System (AIS) data, it is known that there is an increasing fishing activity in the area nowadays (see Chapter 8). However, It should be taken into consideration that more than 99% of these catches were from the Ionian Sea and less than 1% belong to the Aegean, Libyan and Levantine Seas.

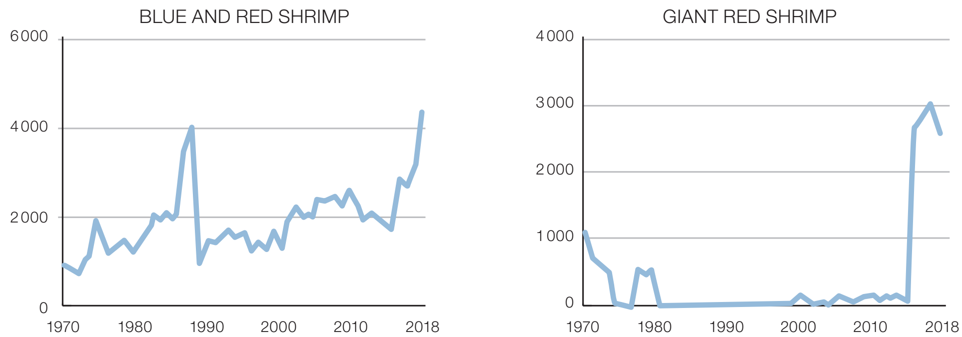


Fig. 7.1. Fisheries landings of both deep-water shrimp species between 1970-2018 in the Mediterranean. Source: SOMFI 2020.

6 Recommendation GFCM/44/2021/6 on a multiannual management plan for sustainable trawl fisheries targeting giant red shrimp and blue and red shrimp in the Levantine Sea (geographical subareas 24 to 27) and Recommendation GFCM/44/2021/8 in the Ionian Sea (geographical subareas 19 to 21). Recommendation GFCM/44/2021/7 on management measures for sustainable trawl fisheries targeting giant red shrimp and blue and red shrimp in the Strait of Sicily (geographical subareas 12 to 16).

7 FAO. 2020. The State of Mediterranean and Black Sea Fisheries 2020. General Fisheries Commission for the Mediterranean. Rome.


CATCHES OF A COMMERCIAL BOTTOM TRAWLER OFF SYRIAN WATERS ©MALEK ALI

In the Central Mediterranean, red shrimp fishery has been traditionally conducted by Italian trawlers. However, the continuous decrease in the catch rate of deep water shrimps in the Strait of Sicily and the absence of deep trawling in the Eastern Mediterranean drove some fishing vessels to start fishing off Crete and Cyprus and off the Turkish coast since 2004[30,35] (Fig. 7.2). In recent years, more trawlers from Greece, Egypt and Turkey have also begun fishing in the Eastern Ionian and Levantine Seas[36]. The fishery in these new fishing grounds resulted in high catch rates and high proportion of large-sized individuals. Nonetheless, limited data is available for most of the regions. Most of the information on both red shrimps from the Eastern Mediterranean originates from the Eastern Ionian Sea, with a very small contribution from the Levantine Sea. Although high catches of red shrimps are known anecdotally in the area, these are probably not all officially registered. According to vessel monitoring system (VMS) data, questionnaires and log book data, the total production of both red shrimps from Greek trawlers in the Eastern Ionian (GSA 20) and Aegean Sea (GSA 22) was estimated to be around 155 t in 2018; from them, half were fished in the Eastern Ionian Sea (GSA 20)[37].

Furthermore, deep-water trawl fishery is practiced mainly off the south coasts of Turkey to exploit both types of red shrimp over the last years. Likewise, other decapod crustaceans such as the deep-water rose shrimp *Parapenaeus longirostris,* the golden shrimp *Plesionika martia* and the striped soldier shrimp *Plesionika edwardsii* are also part of the main target species of these deep-water bottom trawl fishers[38]. In 2013, it was reported that annual landings of red shrimps in Turkish seas were 1364 t[39]. Later in 2016, the trawling fleet from the Antalya Bay, one of the two major fishing areas in Turkey, was composed of 136 boats with a total length between 12 and 24 m and another fleet with 15 vessels having a total length of more than 24 m. In 2017, the number of bottom trawlers increased to 138 and 27, respectively while the total number of Turkish trawlers and beam trawlers working in the Mediterranean in 2020 was 226[34,40]. However, it is unclear how many of these fishing vessels are actively targeting red shrimps.

The fishery of red shrimps is also ongoing in Egypt (GSA 26, Southern Levantine Sea). According to the official authorities the total landings of red shrimps caught by 9 registered commercial trawlers ranged between 504-979 t in 2015-2017. The total port landings of *A. foliacea* in the Egyptian ports in 2017 were 682.2 t, while that of *A. antennatus* were much lower (209.8 t) [41]. In the Egyptian deep-water fishery, the term “red shrimps” includes the four species: *A. foliacea* (69.7%), *A. antennatus* (21.4%), *P. longirostris* (3.8%) and *Plesionika edwardsii* (5.1%). Here, most fishing activities are practised at a depth lower than 250 m, however, there is now a pronounced shift of fisheries from shallow to deep waters[42].

In both national (GSA 25) and international waters (including GSAs 24, 25, 26) around Cyprus, deep-water red shrimp catches, although of minor market relevance for local consumers, have also had an increasing trend between 1965 and 2004 (pers. comm. Thasitis). It is worth noting that, since 1985, Italian and Egyptian fishermen fish in this area and the majority of these activities are related to catching *A. foliacea.* The volume of these catches is unknown.

In Israel, both the giant red shrimp (*A. foliacea*) and the blue and red shrimp (*A. antennatus*) are characterized as commercial and reported in the same localities and depths[43]. No recent fisheries data is available. *A. foliacea* was known to be fished in the Haifa area throughout the year on the edge of a submarine canyon, while *A. antennatus* was known to be caught commercially by trawlers in spring and autumn in muddy bottoms of more than 180 m[43]. Experimental surveys carried out off the coast of Israel at depths between 734 and 1,558 m, between 1988 and 1999, also indicated the presence of *A. antennatus* in the depth range 1,000-1,527 m. At that time, the species was considered abundant, since it consisted of 14% of all the crustaceans caught[44,45].

The contribution of Libyan trawlers to red shrimp catches is considered negligible today[8] and information from Syrian waters relies on anecdotal evidence. The blue and red shrimp (*Aristeus antenna*) has been reported off Lattakia (Syria) in depths between 200-225 m in August 2005[46]. Previous records have reported the presence of *A. foliacea*[44,45] in the same area.

The available information indicates a future offshore expansion of the deep-water red shrimp fishing grounds in the Eastern Mediterranean. The status of the stocks of deepwater red shrimp stocks in the eastern central Mediterranean is not known, but indications provided by SoMFi 2020 report point towards a possible overexploitation of these stocks at the Mediterranean level. Given the unclear situation of the red shrimp stocks, information of fisheries landings by GSA of origin and the increase of the fishing effort and capacity in the area, both *A.foliacea* and *A. antennatus* have been proposed to be incorporated into the list of priority species for data gathering and stock assessments in the Eastern Mediterranean and a set of adopted decisions have been taken[9] with additional precautionary measures to be considered.

Short-term actions by the Mediterranean countries as agreed at the General Fisheries Commision will be driven to work on:

- Definition of Eastern deep-water red shrimp fishing grounds.
- Advancing the work plan for stock assessment and the determination of fishing grounds,
- Improving the monitoring of authorized vessels and establishing a catch certification scheme towards recording the origin of the catch.
- Identification of nursery areas in the Eastern Mediterranean for deep-water blue and red shrimp and particularly the giant red shrimp, *A. foliacea*.
- Analysing the overlap between Vulnerable Marine Ecosystems and deep-water red shrimp fishing grounds.

Fig. 7.2.
Deep-water red shrimps exploited by trawlers in the Eastern Mediterranean (Source: JointMesudmed/EastMed/GFCM; 62, present work).

8 FAOSubMed Report on *A. foliacea*.
9 GFCM Scientific Advisory Commission, 2019.

Essential Fish Habitats

1 EASTERN IONIAN SEA

The two red shrimps coexist in the Eastern Ionian, both horizontally and vertically. However, the blue and red shrimp (*A. antennatus*) has a lower abundance than the giant red shrimp (*A. foliacea*)[49,50].

In the Eastern Ionian, the recruitment, and respectively the reproductive period, seems to last for a long period[51]. The spawning season of female giant red shrimps extends in the Eastern Ionian from late spring to late summer. More particularly, the spawning of the giant red shrimp (*A. foliacea*) begins in April-May, increasing sharply in summer and ending in September[52]. Moreover, *A. foliacea* males can reproduce throughout the year, while *A. antennatus* male reproductive activity seems to be more pronounced during late winter-early spring[51]. In the Eastern Ionian Sea, the smallest reported mature female was 27 mm carapace length (CL) and belongs to 1+ age group[52,53,54]. The deep-water blue and red shrimp (*A. antennatus*) is already sexually active from its first year of life (age 0), and mature individuals are found at a smaller size than those of the giant red shrimp *A. foliacea*. The smallest mature female *A. antennatus* was found to be 18 cm carapace length[51]. According to these studies, the length at first maturity of female *A. foliacea* and *A. antennatus* is considered as 37 and 26 mm CL, respectively[51]. Based on the size at first maturity and the minimum carapace length of the spawning individuals, the analysis considers juvenile individuals as those with CL < 35 mm for *A. foliacea* and < 25 mm for *A. antennatus*.

In the E. Ionian Sea, based on data from 1998 to 2008, the highest values of *A. foliacea* juvenile aggregations (< 35 mm CL) (N/km^2) were found in the Kyparissiakos Gulf and SW of Corfu Island (~ 19,000 N/km^2). Other hot-spot areas (> 10,000 N/km^2) showed a patchy distribution, mainly found West of Corfu Island, SW of Kefallinia Island, in the area between Eastern Zakynthos Island and Western Peloponnese coasts, off the Pylos Gulf and South of Paxi Islands. A lower but distinguished juvenile aggregation was also reported in the Messiniakos Gulf (~ 8,000 N/km^2). It is worth mentioning that high juvenile aggregation was repeatedly found in the first five areas mentioned above (Fig. 7.3).

The areas of higher juvenile blue and red shrimp (*A. antennatus*) aggregations in the Eastern Ionian Sea, based on the data for the period 1998–2018, are presented in Fig. 7.4. The highest value was found in the Kyparissiakos Gulf (~ 200 N/km^2). Other hotspots areas were found South of Othonoi Islands and in the Messiniakos Gulf (~ 100 N/km^2).

Recruitment of *A. antennatus* takes place about four and five months after spawning, which is not significantly different from the 3-month interval period reported for other areas in the Mediterranean[55]. Submarine canyons have been suggested as potential recruitment areas, due to the high abundance of juveniles[55]. These facts along with the limited sampling period clarify the low juvenile abundance reported above.

The highest spawning aggregations of female *A. foliacea* were found in the Kyparissiakos Gulf and S of Kefallinia island (~ 3,000 N/km^2) in late July. Other hot-spot areas were found off the Pylos Gulf, Western and Southwest of Corfu Island (~ 2,000 N/km^2), Southwest of Kefallinia Island, in the area between Eastern Zakynthos Island and Western Peloponnese coasts and South of Paxi Islands (1,000-1,500 N/km^2). It is noteworthy that high aggregations of spawning females were recorded in these areas repeatedly. Furthermore, the areas of highest juvenile aggregations overlap with those of highest spawning female aggregations (Fig. 7.3).

The highest spawning aggregations of female *A. antennatus,* based on data from 1998 to 2018, are presented in Fig. 7.4. The highest value was found SW of Corfu Island (~ 1,000 N/km^2) in late July. Other hotspot areas (500-1,000 N/km^2) were found in the Kyparissiakos Gulf, W of Corfu Island, S-SW of Kefallinia Island and SE of Zakynthos Island. Similarly, juvenile abundance of *A. antennatus*, female spawning individuals were found in less abundance than *A. foliacea*, which might be related to the lower occurrence of this species in the Eastern Ionian Sea and the limited sampling.

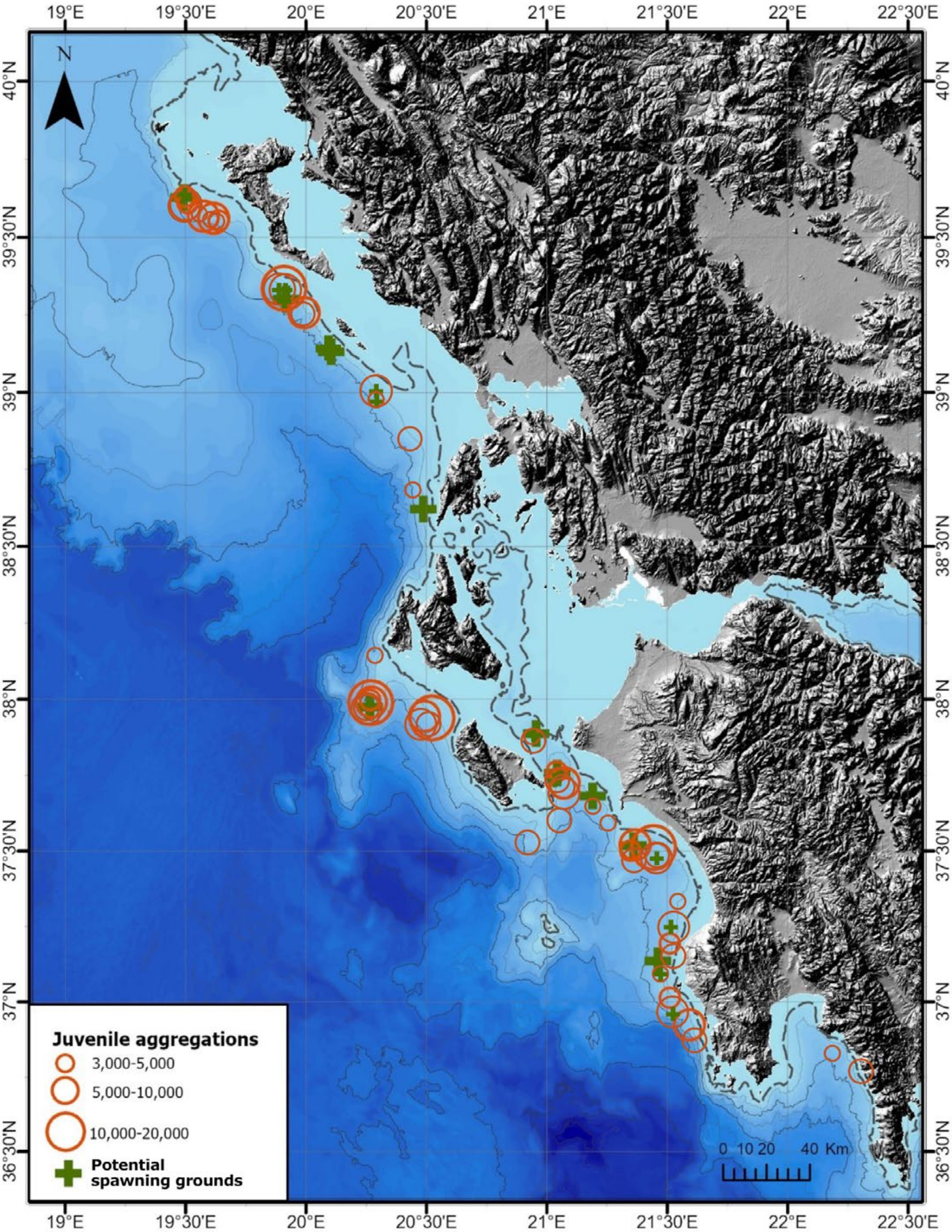


Fig. 7.3. Potential hotspots of juvenile aggregations (red circles) and spawning grounds (green crosses) of *Aristaemorpha foliacea* (N/km²) in the deep waters of the Eastern Ionian Sea based on HCMR available data from 1998 to 2018.

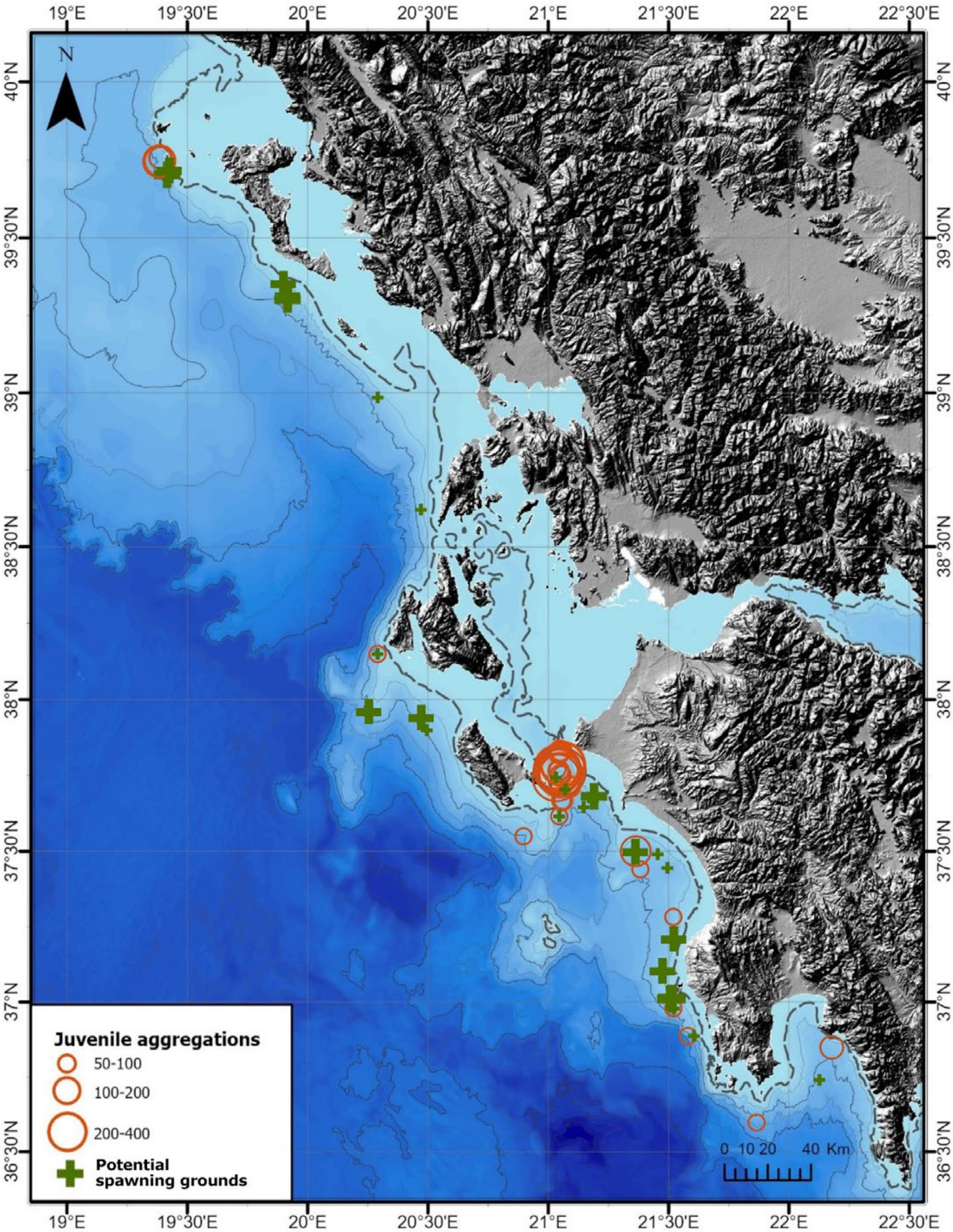


Fig. 7.4. Potential hotspots of juvenile aggregations (red circles) and spawning grounds (green crosses) of *Aristeus antennatus* (N/km²) in the deep waters of the Eastern Ionian Sea based on HCMR available data from 1998 to 2018.

2

AEGEAN SEA

Based on available Greek data from 1998 to 2018 in the North Aegean Sea, very low abundance has been reported for the giant red shrimp *A. foliacea* and particularly for the blue and red shrimp *A. antennatus*. Conversely, in the South Aegean Sea, the abundance of adults of *A. foliacea* was high.

Regarding potential nursery habitats, high abundance of juveniles for *A. foliacea* has been found repeatedly Northeast of Tilos Island (5,000-13,000 N/km^2) and in the Agolikos Gulf, off NE. of Crete Island and South of Kos and Southwest of the Symi Islands (1,000-5,000 N/km^2) (Fig. 7.5). Similarly, the highest abundance of spawning female giant red shrimp have been found in the Argolikos Gulf (~ 1,500 N/km^2) as well as in the NE of Tilos Island (< 500 N/km^2).

The most important juvenile aggregations of blue and red shrimp (*A. antennatus*), indicating potential nursery areas, has been reported in NW Kalymnos Islands (~ 200 N/km^2) followed by NE of Crete Island and SW of Symi Island (100-200 N/km^2) (Fig. 7.6). Hotspots of spawning grounds where the highest abundance of spawning females of this species are, were found SW of Symi island and in the Argolikos Gulf (~ 230 N/km^2) followed by NE of Crete Island (~ 100 N/km^2).

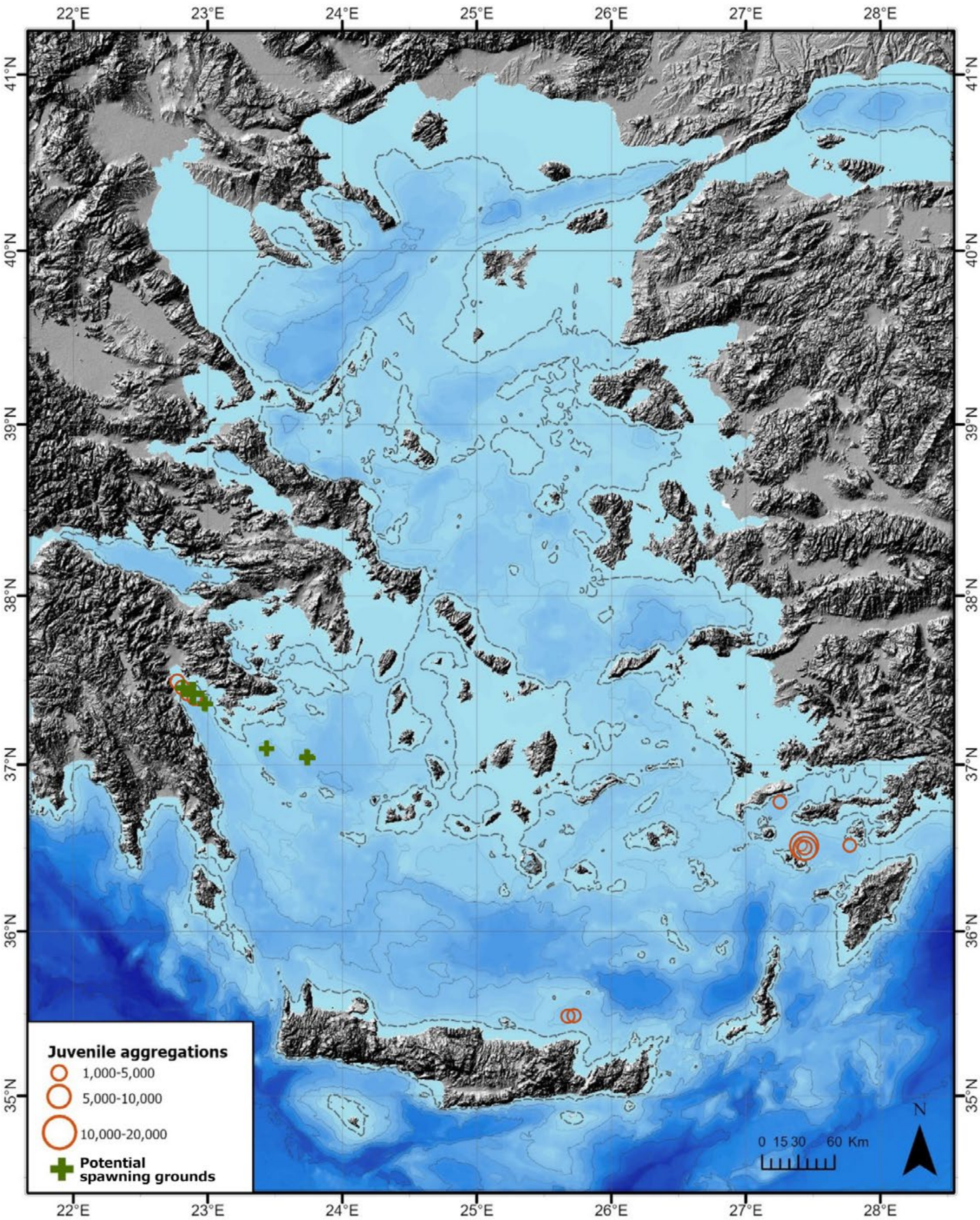


Fig. 7.5. Potential hotspots of juvenile aggregations (red circles) and spawning grounds (green crosses) of *Aristaemorpha foliacea* (N/km^2) in the deep waters of the Aegean Sea based on Greek available data from 1998 to 2018.

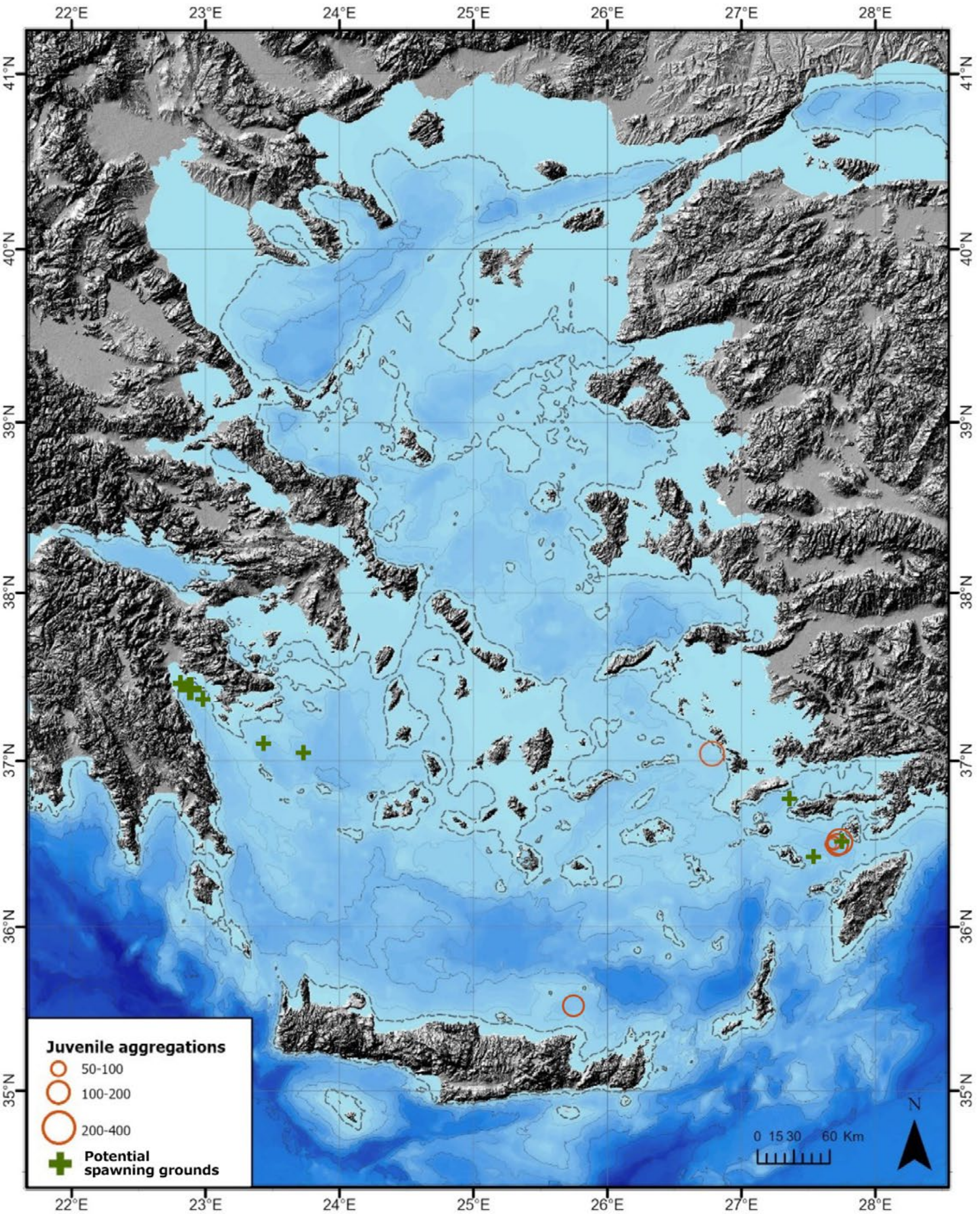


Fig. 7.6. Potential hotspots of juvenile aggregations (red circles) and spawning grounds (green crosses) of *Aristeus antennatus* (N/km²) in the deep waters of the Aegean Sea based on Greek available data from 1998 to 2018.

3 LEVANTINE AND LIBYAN SEAS

Both species of red shrimps have been reported in considerable abundance off South Turkey[40,56,57], Cyprus (Cyprus National Programme 1965-2004; MEDITS data 2005-2017; Thasitis pers. comm.), Syria ([48] Ali pers. comm.), Lebanon[58,59,60], Israel[44,61] and Egypt[41,42,62]. Nevertheless, very limited information is available on spatial distribution and no information on the presence of red shrimps juveniles and spawning females is available from these areas to enable identification of hotspots of nursery and spawning grounds.

GENERAL CONSIDERATIONS

From the biology, population dynamics or ecology point of view, many aspects for both red shrimps are still unknown for the majority of the Eastern Mediterranean waters, namely the stocks of Levantine, Libyan and Aegean Seas. Scarce information is available from the Antalya Bay (Levantine Sea). Even in the Eastern Ionian Sea, where the biological data is more detailed, the information is insufficient and needs updating.

Most Eastern Mediterranean countries do not report the catches of deep-water red shrimps by species; more commonly, catches are reported at the family level. Thus, it is difficult to evaluate the catch trends of each individual species. Moreover, it is clear that the current catches of deep-water red shrimps in the Central-Eastern Mediterranean are higher than what is being reported. Further efforts are also needed in the available data collected by FAO-GFCM from the Eastern Mediterranean to distinguish the origin of the catches from bottom trawl fisheries targeting deep-water rose shrimp or deep-water red shrimps. The data would thus allow a comparison of specific trends in catches at the sub-basin level (Eastern GSA) and more realistic management recommendations to be proposed.

Furthermore, considering the relevance of the deep-water red shrimp fishery, additional assessment of the status of giant red shrimp (*Aristeomorpha foliacea*) and blue and red shrimp (*A. antennatus*) stocks should be conducted in the future, taking into account the peculiarities of the different fleets, including those working in the Eastern Mediterranean basin.

Long-term monitoring is required to define the population dynamics of the red shrimp stocks and elucidate specific aspects associated with the biology/ecology of the species and the possibility of exploitation of the newly identified fishing grounds and the exploitation status of the already exploited stocks in the Eastern Mediterranean. New explorative surveys are also necessary to describe the spatiotemporal distribution of nursery and spawning grounds of both species in the Eastern Mediterranean basin, information that may help their protection and management. With more robust and comprehensive habitat assessments EFH identification could be improved. A preliminary assessment of both deep-sea shrimps in the Eastern Mediterranean with data limited methods is needed in order to have a primary evaluation of their stocks. It should be mentioned that the data used here should be updated since no monitoring survey has been conducted for some years.

In this context, a significant challenge for the sustainable management of deep-water red shrimps in the Eastern Mediterranean should be to elaborate a precautionary management framework before arriving at an overexploited status of the stocks, even if all the required information is not available. In order to achieve a sustainable management plan for this fishery, a series of different measures with a roadmap for implementation have been recommended:

- collecting enough data to support continuous analytical stock assessments
- identify EFH and spawning grounds
- initiate the fisheries footprint, overlap with vulnerable marine ecosystems and incorporating *inter alia* aspects of the FAO DSF Guidelines
- establish fishing authorizations in the immediate future, with the following provisions: landing at designated landing points, ensuring the presence of observers on board, obligation to use VMS, reporting the information on fishing activities
- establishment of a fishing season
- mitigate accidental catch of vulnerable species

Hotspots for juveniles in the Aegean Sea are not very well documented, and further investigation is needed. The lack of information on juveniles and spawning grounds of deep-water red shrimps from the other Eastern Mediterranean regions, particularly the Levantine Sea, highlight the demand for more research, precautionary management measures and the close collaboration of the countries in this area.

> “Areas such as the southwest of Corfu, Kefallinia and Paxi islands, Kyparissiakos Gulf and the area between Zakynthos island and the Peloponnese are potential EFH and spawning grounds for deep-water shrimps in the Eastern Ionian”

10 (GFCM SAC, 2017).

BLUEMOUTH ROCKFISH *HELICOLENUS DACTYLOPTERUS*

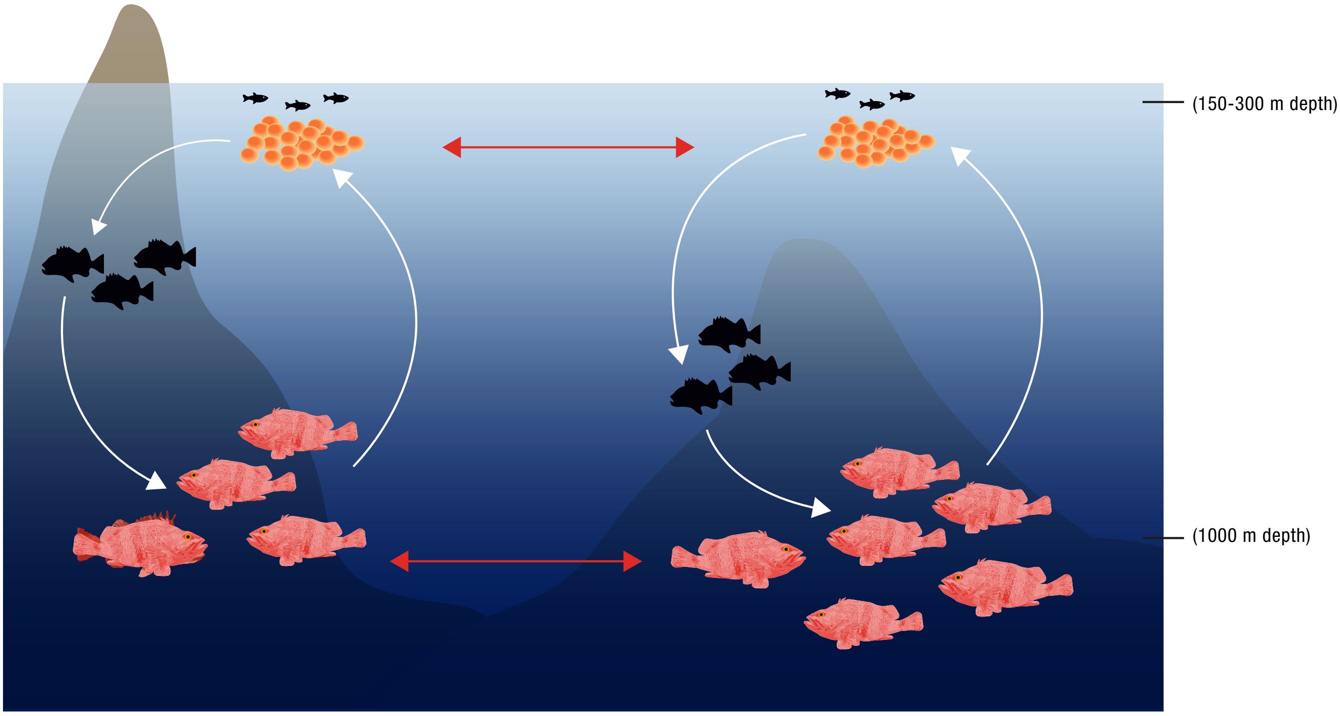
Blackbelly rosefish

Anastasopoulou A., Mytilineou Ch., Thasitis I., Jemaa S., Lteif M., Otero M., Lefkaditou E., Kavadas S., Adamidou A., Dokos I.

The blackbelly rosefish *Helicolenus dactylopterus* also known as the bluemouth rockfish, is a medium sized deep-sea scorpionfish widely distributed in the Eastern and Western Atlantic Ocean, Southern Indian Ocean and Mediterranean basin (except the Black Sea), where it plays an important ecological role in deep-sea fish communities on the coarse and mud-sandy bottoms of the continental shelf and mostly on the upper slope as deep as 1,000 m[64,65]. The species lives in the near-bottom environment of the deep-sea, commonly between 200-1,000 m and is known to be associated with seamounts, living in the vicinity of deep canyons[67], and cold-water corals including black corals, gorgonians and sponges[68].

Research studies reveal that the juveniles are mainly located around 150–300 m depth, whereas the adult specimens are spread over a wider depth range from 200 m to as deep as 1,000 m[69,70].

Available information for the species in the Eastern Mediterranean Sea is related to age and growth, diet, reproduction, length-weight relationships, population structure and fishery. This scorpion fish has a complex reproductive strategy and has been reported to live up to 27 years in the Eastern Mediterranean. From studies carried out in the Western and Eastern Mediterranean, it is known that it has a late maturity at the age of four years, being approximately 13 cm for males and 14.5 cm for females[74,70]. The fertilization is internal and females are able to store sperm in the ovaries for long periods of time and later spawn them in multiple batches of embryos enclosed within a gelatinous matrix. In the Eastern Mediterranean, the spawning period of the Bluemouth rockfish takes place over the winter months from December to April[75,76,77].



Research studies reveal that the juveniles are mainly located around 150–300 m depth, whereas the adult specimens are spread over a wider depth range from 200 m to as deep as 1,000 m[69,70]. Here, a diagram of the life cycle of the species and connectivity hypotheses among different habitats and seamounts. Adapted illustration by IUCN from[162].

FISHERIES

The blackbelly rosefish (*Helicolenus dactylopterus*) has important economic value in some areas of its distribution (e.g. Azores, Central Mediterranean) but the information available on its commercial harvest is scarce. The species is fished by long-lines and bottom trawl in the Atlantic and Western Mediterranean, but in the Central and Eastern Mediterranean mostly appears in the bycatch of bottom trawls and pots targeting other deep-water commercial species such as crustaceans and fish[78-80].

Regarding the fishing pressure, information is scarce. Reported data from landings are available for 2007 from three important fishing ports in the north-west Mediterranean where trawlers captured 70% of the total landings for this species and longliners the remaining 30%[81]. A few other reports also indicated that the species is commonly caught by fishing trawlers such as in the Thyrrenian Sea and the Eastern Mediterranean (e.g. Iskerenderum bay) although there is a lack of information on the catch and effort from the fleets exploiting this resource [70,82]. Fishery-independent data collected through the scientific bottom trawl survey of the MEDITS programme since 1994, also indicates that the species is caught by trawlers[82,83].

The blackbelly rosefish is particularly vulnerable to overfishing due to its biological characteristics (long life, large size, late maturity and slow growth) and the high pressure of trawl fishery in its distribution range [75,82,84-86].

Essential Fish Habitats

Knowledge on spawning grounds and juvenile aggregations of this species are scarce. As in other areas of its distribution, the species seems to prefer canyon areas for spawning[66,67].

1 EASTERN IONIAN SEA

Based on HCMR data from 1984 until 2016, the species presents high abundance values (> 1,000 N/km^2) in the upper slope (500-750 m) of the E. Ionian Sea (Fig. 7.7). The highest values (6,112 and 6,260 individuals/km^2) have been recorded off the Western and SW of Lefkas Island between 214 and 703 m depths.

Potential spawning grounds (high concentrations of mature individuals) were detected in waters deeper than 450 m between the South-East of Zakynthos Island and the West Peloponnese and North of the Kyparisiakos Gulf with a lower aggregation of mature individuals off South-West Lefkas Island (Fig. 7.7). These are areas of sea canyons that may indicate that mature females prefer the canyon areas to breed, a reason that may also explain the low occurrence of mature females in the trawl catches.

Areas of juvenile aggregation (individuals < 10 cm total length) in the Eastern Ionian Sea have been found in the shallower waters of the species spatial distribution, with the highest aggregations occurring in two areas: i) between S Paxoi and NW Lefkas Islands (1,523 N/km^2) and ii) off E. Ithaki (1,237 N/km^2) and E. Kephallinia (417-464 N/km^2) Islands (Fig. 7.7) at depths ranging between 190 and 390 m during the summer months.

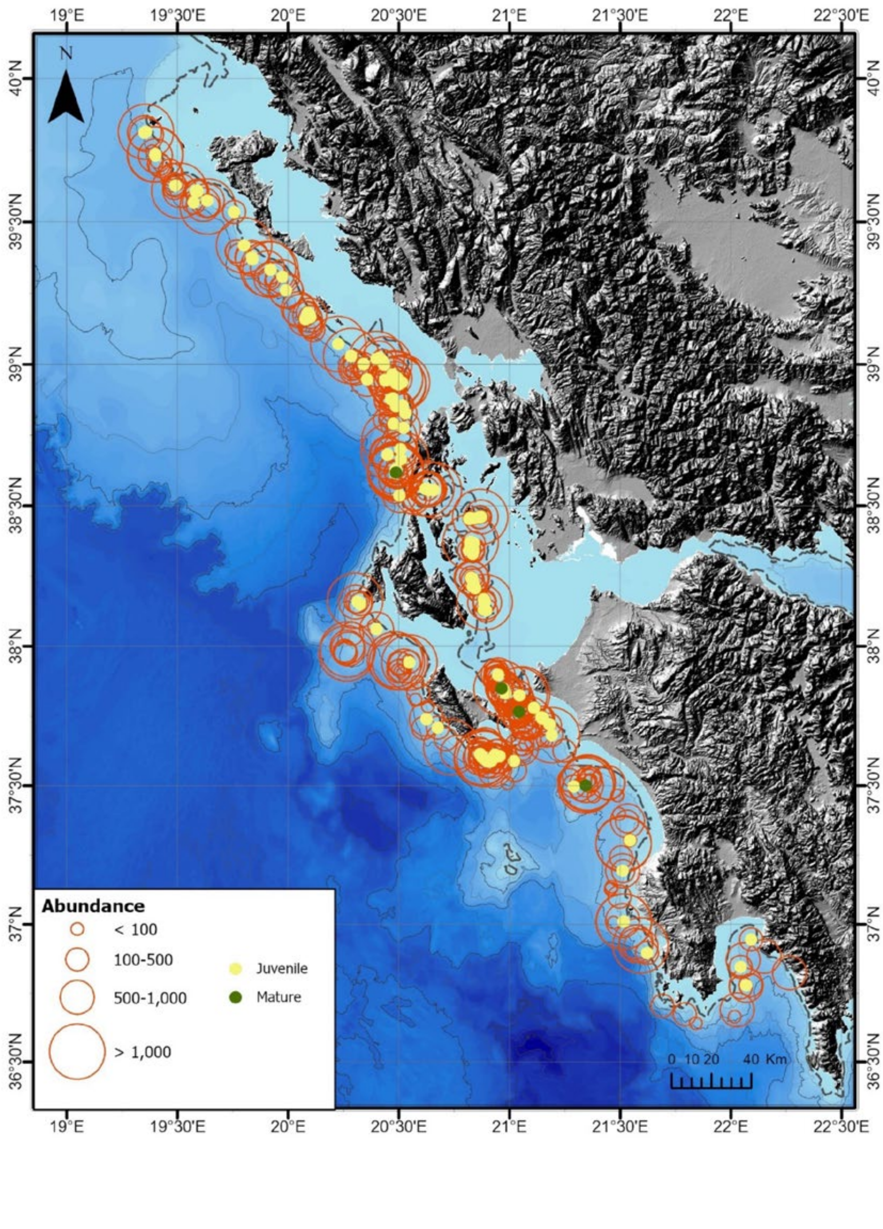


Fig. 7.7. Map of the spatial distribution of the abundance (N/km^2) of *Helicolenus dactylopterus* in the deep waters (> 200 m depth) of the Eastern Ionian Sea from data collected between 1984 and 2016, with hotspot areas of juvenile (yellow dots) and mature female (green dots) aggregations (> 80% occurrence per station). Abundance ranged between 9 and 6,260 N/km^2.

2 NORTH AEGEAN SEA

For the deep waters of the North Aegean Sea, information on blackbelly rosefish is very limited. Based on HCMR and Fisheries Research Institute data from 1990 until 2016, the species abundance ranged from 1.4 to 902 N/Km^2, much lower than that of the E. Ionian Sea, although this could be related to the sampling scheme realized in each area. The highest abundance (902 N/Km2) was observed off West Lesvos Island at 286 m depth (Fig. 7.8).

In the North Aegean, the only area with mature females was detected in the open waters South of Chios Island at 302 m depth (Fig. 7.8). However, it should be noted that the number of mature females was very low as in the case of the Eastern Ionian Sea.

Only one area of high juvenile aggregation (individuals < 10 cm total length) was found in the North Aegean Sea, located off West Lesvos Island at 473 m depth, with highest abundance 418 N/Km^2 (Fig. 7.8).

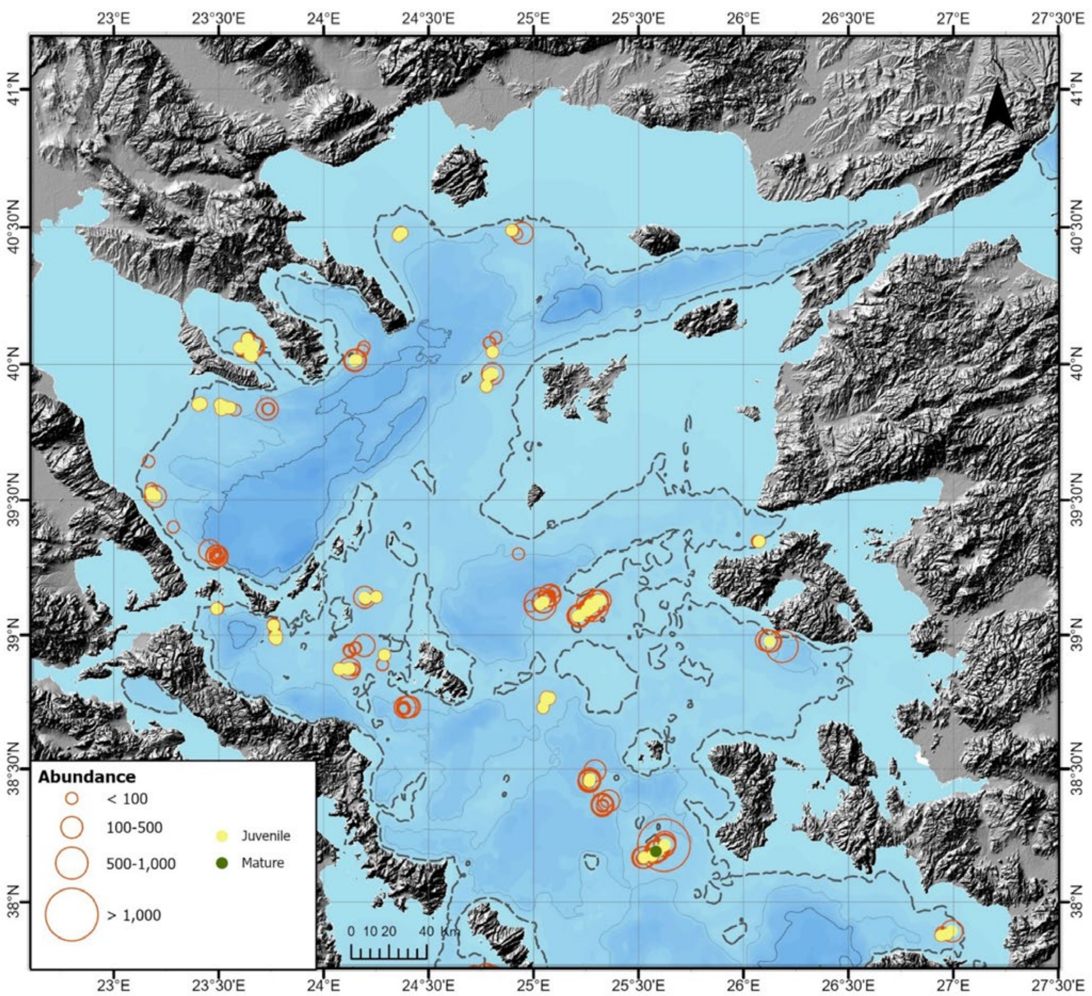


Fig. 7.8. Map of the spatial distribution of the abundance (N/km^2) of *Helicolenus dactylopterus* in the deep waters (> 200 m depth) of the North Aegean Sea, based on data collected from 1994 to 2016, with hotspot areas of juveniles (yellow dots) and mature (green dots) female (> 80% occurrence per station) aggregations.

3 SOUTH AEGEAN SEA

In the South Aegean Sea, existing published information on blackbelly rosefish comes from grey literature[87,88].

Data from 1984 until 2016, the species highest abundance was found: i) off the north coasts of Crete Island and more specifically in the area between the Gulf of Heraklion and Dia Island (2,310-4,207 N/Km^2) at depths between 231 and 241 m, ii) in the area E of Poros Island- Saronikos Gulf (2,384 N/Km^2) at depths ranging between 220 and 400 m, iii) in the Gulf of Mirabelou (off Ag. Nikolaos) (1,315-1,694 N/Km^2) between 315 and 331 m depth and iv) in the area off E Serifos Island-Cyclades (1,359 N/Km^2) (Fig. 7.9). In 2000-2001, experimental fishing with traps, conducted in the area between the Islands of Astypalaea, Kalymnos and Kos at depths ranging between 300-600 m, showed that the abundance in the deeper limit of 600 m depth was quite high, suggesting that the bathymetric distribution of the species may extend into even deeper waters than those initially studied[88].

In the South Aegean, mature individuals were found only in two areas: off the West of Kythnos Island at 548 m and off SE Spetses Island at 530 m, although the number of specimens was always very low (Fig. 7.9).

Hotspot areas of juvenile aggregation coincide with the areas of high abundance: off the area between the Gulf of Heraklion and Dia Island, ii) in the area E of Poros Island- Saronikos Gulf, iii) in the Gulf of Mirabelou (off Ag. Nikolaos) and iv) in the area off E Serifos Island-Cyclades (Fig. 7.9).

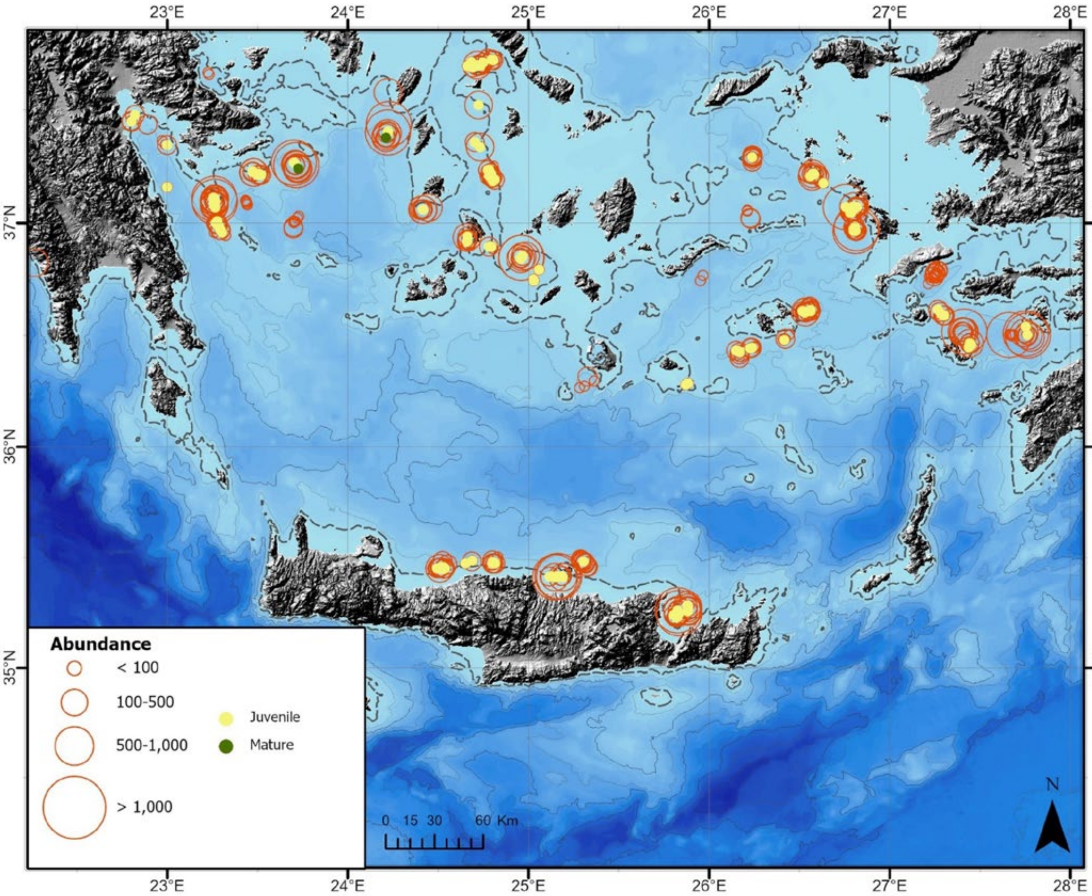


Fig. 7.9. Map of the spatial distribution of the abundance (N/km^2) of *Helicolenus dactylopterus* in the deep waters (> 200 m depth) of the South Aegean Sea, based on data collected from 1984 to 2016, with hotspot areas of juvenile (yellow dots) and mature (green dots) female (> 80% occurrence per station) aggregations.

4

LEVANTINE SEA

The Blackbelly rosefish has been mentioned as the dominant species in terms of abundance in all experimental trawl operations carried out by commercial trawl in the deep waters ranging between 300 and 601 m in the Mersin Bay (Turkey)[57]. In Antalya Bay, the abundance values of this species from experimental surveys varied between 12 and 2,714 N/km^2[75]. Higher abundance values were found in the upper slope (200-499 m) (80.9% of the total catch). Mature individuals have been found mostly (88%) distributed in the middle slope (500-700m), whereas almost all recruits of *H. dactylopterus* (98.6%) were distributed in the waters < 500 m[75].

The analysis of data from MEDITS 2005 to 2017 surveys, carried out off south Cyprus (Fig. 7.10) showed that the highest abundance (533 N/km^2) of the species was observed in a station SW of Cyprus at 307 m depth (Fig. 7.10). However, this may be related to the low sampling effort in deep areas. Mature females and nursery hotspot areas could not be detected.

Experimental fishing trials with gillnets and traps, targeting hake and the *Plesionika edwardsii* shrimp, carried out on the deep shelf and upper slope of South Lebanon at depths ranging between 200 and 320 m in 2012, revealed low abundance (139.2 g/km*day) for the blackbelly rosefish, which was caught as a bycatch[89]. This fact may be related to the sampling depth, location and gear used. In fact, high abundance of the species has been observed in the bathyal (until 842 m) soft substrates of the Lebanon canyons[60] confirming previous findings that this species seems to be associated with canyons. Analysis of Lebanese data from 2013 to 2017 collected by gillnets in depths from 200 to 300 m off Lebanon showed that the abundance of the species in this coastal zone seems relatively low (Fig. 7.11).

The presence of the species in Egyptian waters has been reported in the deep waters (350-750 m) off Alexandria when targeting deep red shrimps (Aristeidae), but no additional information is available[42].

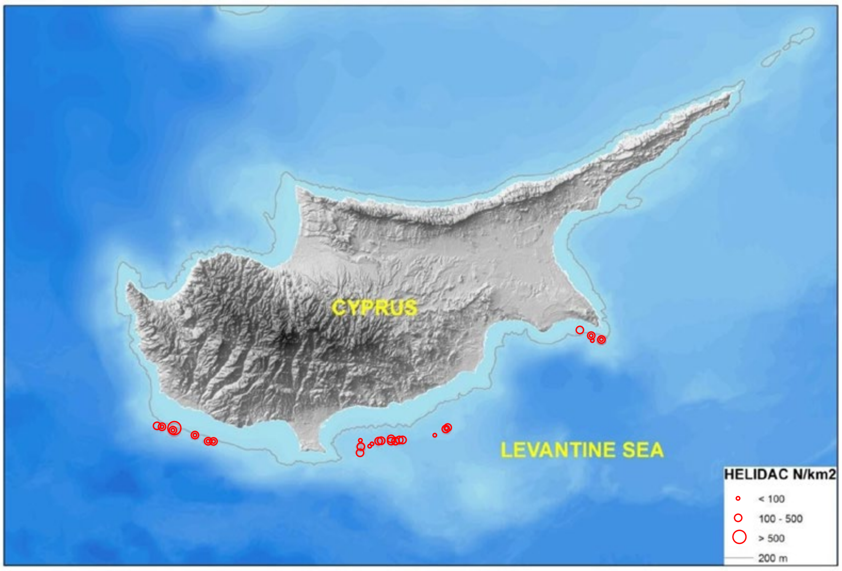


Fig. 7.10.
Map of the spatial distribution of the abundance (N/km²) of *Helicolenus dactylopterus* in the deep waters off Cyprus from 2005 to 2017.

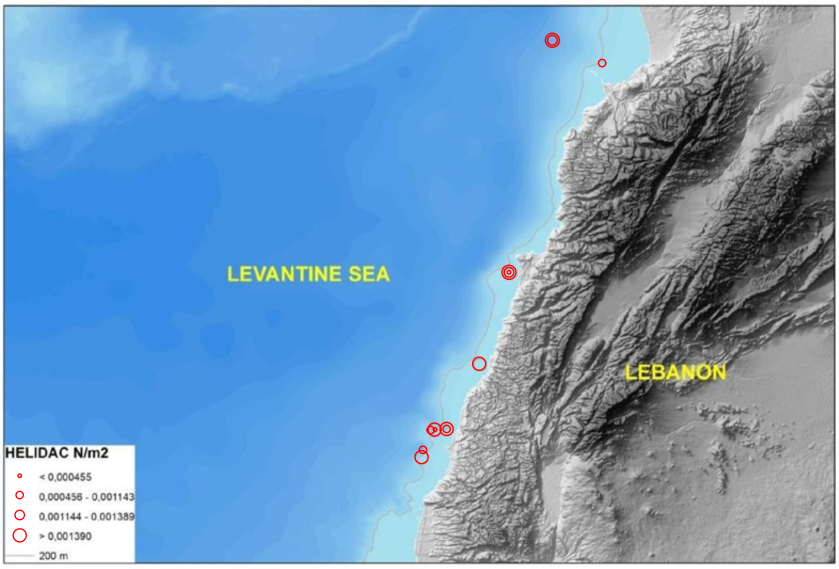


Fig. 7.11.
Map of the spatial distribution of the abundance (N/m²) of *Helicolenus dactylopterus* caught by gillnets in the deep waters off Lebanon (Levantine Sea) from 2013 to 2017.

5 LIBYAN SEA

No specific information on the blackbelly rosefish (*H. dactylopterus*) is available from the Libyan Sea, although the presence of the species in the area has been documented (Machias, unpublished data).

GENERAL CONSIDERATIONS

The review based on published and unpublished information for the blackbelly rosefish *H. dactylopterus* highlighted serious gaps in the basic knowledge for the species in the E. Mediterranean. It should be noted here, that even in the case where data on the species occurrence exist, these are based on scientific surveys with different targets or the data were collected for a limited time period (with the exception of MEDITS surveys). These gaps are more evident for the Aegean, Libyan and Levantine Seas.

The information collected from the literature and the current analysis indicated that the blackbelly rosefish and particularly mature females occur mainly in canyon and coral areas, which enhance the importance of these deep habitats to the species sustainability. In contrast, juveniles occur on the upper slope (< 500 m), grounds that are frequently exploited. This fact may increase juvenile mortality and therefore the vulnerability of the species.

Hotspot spawning and juvenile areas for blackbelly rosefish in the Eastern Ionian Sea and Aegean Sea are indicated here as potential EFHs for the species. Considering the size at first maturity and the low selectivity of the Mediterranean trawl gear for this species (Mytilineou, unpublished data), along with the recent development of the deep-water fishery in the Mediterranean, the sustainability of the species is doubtful. Therefore, given the vulnerability of this resource, more specific work should be planned in the future in order to study and make clear several aspects on the distribution and biology of the species as well the species stock status in areas where deep-water fisheries have already been developed or are under development in the Eastern basin. This information can contribute to the development of adequate management approaches for demersal fisheries resources in this region to ensure the sustainability of these resources and the protection of their essential habitats from adverse fishing effects.


THE BLACKSPOT SEABREAM *PAGELLUS BOGARAVEO* (FAMILY *SPARIDAE*).

Blackspot seabream

Mytilineou Ch., Anastasopoulou A., Otero M., Thasitis I., Damalas D., Lefkaditou E., Kapiris K., Kavadas S., Adamidou A., Dokos I., Ali M., Lteif M.

The blackspot seabream *Pagellus bogaraveo* is a demersal fish that lives near the coast as a juvenile and on the slope down to 800 m as an adult[20,90]. It is found in regions of the Eastern Atlantic Ocean, extending from Mauritania to Norway and the archipelagos of Madeira, Canary Islands and the Azores. Within the Mediterranean, it is more common in the Western basin and less common in the Eastern part, being absent from the Black Sea. The distribution of the species is reported to be closely associated with two atmospheric oscillations, the North Atlantic Oscillation (NAO) and the Arctic Oscillation (AO)[91].

Adults of blackspot seabream can be found forming relatively small shoals above muddy or rocky bottoms, near offshore banks, on seamounts and in cold-water reefs, but juveniles occur in shallower waters. The species presents a peculiar biology with sequential hermaphrodism, it develops as male, but can later reproduce as female although a fraction of the population never changes sex.

This particularity together with the late maturity of the species (the smallest observed mature female was 30 cm long and 5–8 years old) makes them especially sensitive to overfishing and to being affected by different fishing gears[28,89]. In the Strait of Gibraltar, the size at first maturity of females is estimated at 35.7 cm total length[93]. Fishing gears may also affect the species stocks since longlines catch the larger specimens which are females, whereas trawls catch smaller individuals which are males.

FISHERIES

The following three examples from the eastern Atlantic clearly show the vulnerability of the species to fisheries. The blackspot sea bream (*Pagellus bogaraveo*) used to be a major species in the Atlantic landings from the Bay of Biscay up to the early 1980s[92]. From the 1950s to 1970s, the blackspot seabream was exploited intensively, mainly by French and Spanish bottom offshore trawlers, by artisanal pelagic trawlers in the Bay of Biscay and by Spanish longliners in the Cantabrian Sea. The fishery in these areas strongly declined in the mid-1970s, and the stock got seriously depleted. Since the 1980s, it was mainly captured as bycatch and only a few small-scale handliners were still targeting the species. Landings in these areas continued to decrease from 461 t in 1989 to 164 t in 2016[94]. In the years 2019 and 2020, the advice by ICES for the northern region (Celtic Seas and the English Channel, Bay of Biscay) was zero catch and it is recommended to be maintained for years 2021 and 2022[11]. Therefore, no directed fisheries are permitted and catch should be only as bycatch.

11 ICES Advice on fishing opportunities, catch, and effort Celtic Seas and Bay of Biscay and the Iberian Coast ecoregions. 2019, 2020.

In the Azores area, where a longline fishery for the species exists, a decrease was observed since 2005 with a significant expansion of the fishery to offshore seamounts. During the period 2010–2012 the landings continued to decrease significantly. As a consequence, during 2015–2017 technical measures were introduced limiting the fishing areas, updating the minimum conservation reference size to 33 cm, and establishing marine protected areas in coastal and oceanic areas. The current advice given the status of the stocks in Azores grounds is that catches should be no more than 119 t in each of the years 2021 and 2022 for ICES 27.9 (Subarea 9 Atlantic Iberian waters) as well as in other (adjacent) areas, for the Spanish and Moroccan fleets (FAO 34.1.11 and FAO 37.1.1)[12].

The species is also exploited in the Strait of Gibraltar (Atlantic and Mediterranean area) mainly by Spanish, Portuguese and Moroccan fleets using lines and longlines. For the Atlantic waters, the landings from 854 t in 1994, decreased rapidly to 282 t in 1998, when TAC and Quotas were applied (council regulation (EC) No. 2340/2002). Catches in this region continued to be very low (174-165 t during 2017-18) compared to the maximum catches observed in the past during 1993–1994 and 1997 (about 1,000 t) and current ICES advice is that catches should be no more than 119 t in each of the years 2021 and 2022. Given that part of the stock is outside ICES Subarea 9, the TAC does not apply for those adjacent areas in the Strait of Gibraltar (geographical Mediterranean subareas GSA 1 and 3) and those that are part of the management by the Fishery Committee for the Eastern Central Atlantic (CECAF). For the Mediterranean, in 2019, an adaptive multiannual management plan for the sustainable exploitation of blackspot seabream in the Alboran Sea (including Strait of Gibraltar (GSA 1 and 3) was adopted by the General Fisheries Commission of the Mediterranean (GFCM). The operational objective of this recommendation aims to maintain fishing mortality for blackspot seabream in these subareas within agreed precautionary reference points in order to reach and maintain, as soon as possible, a fishing mortality level consistent with the maximum sustainable Yield (MSY). Among the technical measures in place in the short-term are: the prohibition to land specimens of blackspot seabream where the total length of the fish is smaller than 30 cm; the establishment of a register of authorized fishing vessels; the use of a vessel monitoring system (VMS) or any similar system for vessels above 12 metres to track their activity at all times during the fishing trips; the designation of landing ports and catch reporting; and scientific monitoring.

At present, no particular attention has been given to the species in the Eastern Mediterranean although some studies have described the blackspot seabream stock status. The fishery of red seabream in the Eastern Ionian started mainly in the early '80s with longlines[95,96]. However, this gear was gradually replaced by gill nets. In the early years of this fishery the catches of the species were extremely high, but very soon they declined dramatically. The main reasons for the decline seemed to be overfishing, the introduction of gill nets, recreational fishing and ghost fishing[95].

Today, the species is fished mainly in the Eastern Ionian, South Aegean and Cretan Seas with long-lines, gill nets and trammel nets on rocky banks at depths from 200 to 600 m. In the Eastern Ionian Sea and South-eastern Aegean Sea, a total catch of about 80-100 kg/day was common with long-lines in the past[97]. A few years later, the reported average catch was 61.7 kg/day[95]. In the Cretan Sea, during the same period, the maximum reported daily catch was 200 kg/day, decreasing thereafter. Catches have declined in all areas. At the end of the '90s, the catch consisted almost exclusively of *P. bogaraveo*, but a few years later, it decreased to 76% by number and 47% by weight[96]. As a response to this situation, some fishers abandoned this metier, whereas others decreased the mesh size with negative consequences such as the increased quantities of discards, lower price in the market, higher pressure on the stock and reduction of the spawning biomas[98]. The length and age composition of the red seabream in the catches also changed over the years including more young and less older individuals; the length of the red seabreams ranged from 16 to 40 cm[95], whereas in the past the main bulk of the catch ranged between 25-30 cm (Petrakis et al., 1999). According to the HELSTAT data, the annual landings of *P. bogaraveo* from passive gears (longlines, nets) for the years 1994-2004, showed a generally slight declining trend[96].

12 ICES Advice on fishing opportunities, catch, and effort Bay of Biscay and the Iberian Coast ecoregion, 2020.

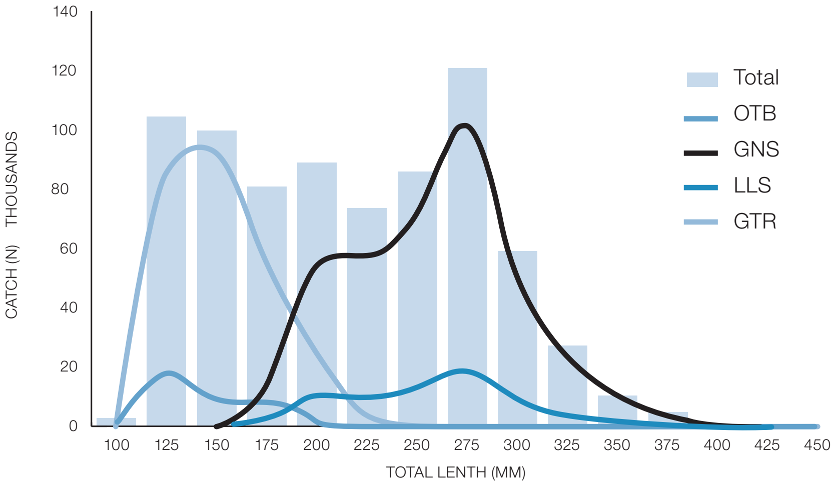


Fig. 7.12.
Catches of blackspot seabream *P. bogaraveo* from different fishing gears in the E. Ionian Sea based on DCF data 2003-2008. OTB: otter trawl; GNS: Gillnet; LLS: longline; GTR: trammel net[99].

An attempt to assess the state of the blackspot seabream stock in the Eastern Ionian Sea during the EU project, DEEPFISHMAN, suggested that the stock was close to overfishing during the period 1998-2002 followed by some improvement in subsequent years, reaching a level of sustainable exploitation in 2008[99]. However, this analysis was based on very poor data and, since then, no further study on the state of the stock has been done. The same study also estimated the size composition of blackspot seabream by fishing gear in this area, indicating that trawl and trammel net catches mainly consisted of young individuals (< 18 cm) (Fig. 7.12), with the latter gear indicating particularly high catches of juveniles.

Blackspot seabream is also an important target of recreational fishery that increases mortality of the species. However, no information on the catches of the species by this type of fishery is available.

Essential Fish Habitats

The existing information for the species in the Eastern Mediterranean Sea is limited. It is known to be abundant in the Ionian and Aegean Sea[90,100,101,102], as shown in Fig. 7.13 and Fig. 7.14, and rare in the Levantine Sea[54,102]. A few individuals (13.7-15.5 cm) have been reported in Israeli waters from 300 to 350 m depth [104] and from the coastal waters of the west coasts of Libya, but in low abundance[105]. Relatively

small *P. bogaraveo* (15-19 cm) have also been recorded from Mersin bay in depths ranging between 300-600 m (Turkish Levantine waters[57]). In Lebanese waters, based on ROV observations, the species was identified in the areas of Sayniq, St. George and Tarablus/Batroum at 178-505 m depth with a sporadic distribution[60]. The first record of *P. bogaraveo* in the Egyptian Mediterranean waters was in the east of the Suez Canal, off Port Said [106]. The species has also been recently reported from Syrian waters[107,108]. The main information on the species essential habitats is mostly from the Eastern Ionian and the Aegean Seas.

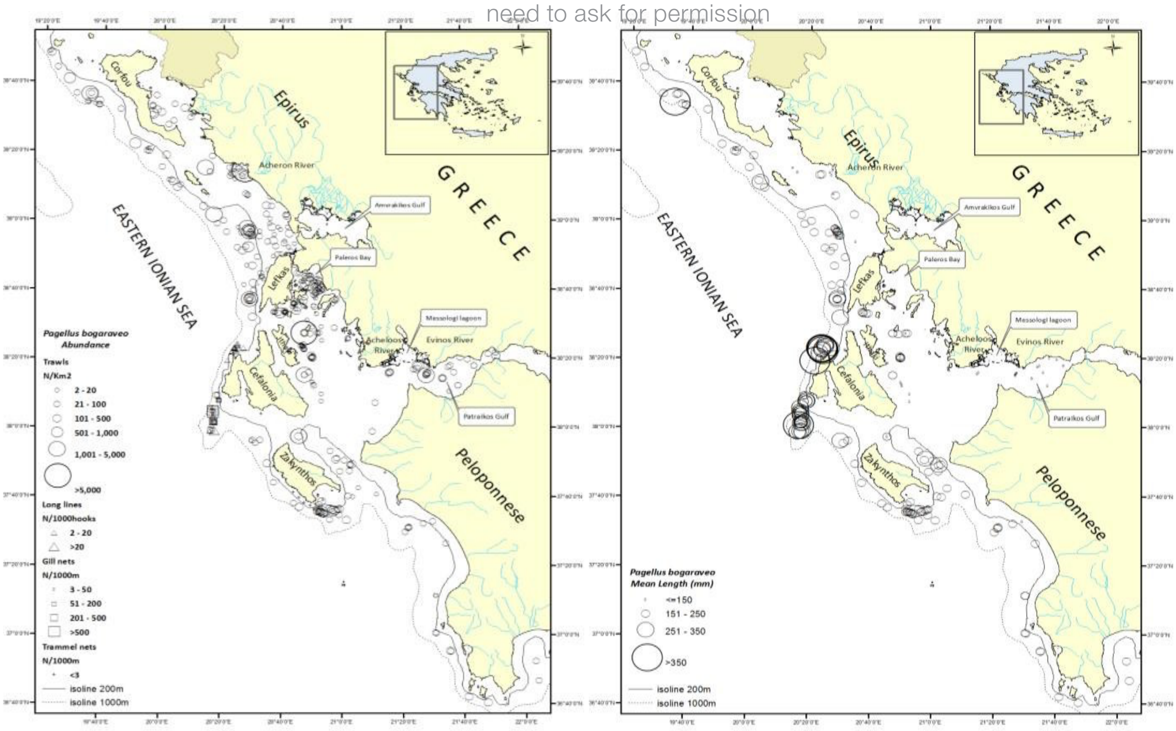


Fig. 7.13. Left: Map of the spatial distribution of the abundance (N/km² for trawl, N/1000 m for trammel and gill nets and N/1000 hooks for long lines) of blackspot seabream *Pagellus bogaraveo* in the Eastern Ionian Sea; Right: Map of the spatial distribution the species mean size (mean LT, mm); data from 1983 to 2010[100].

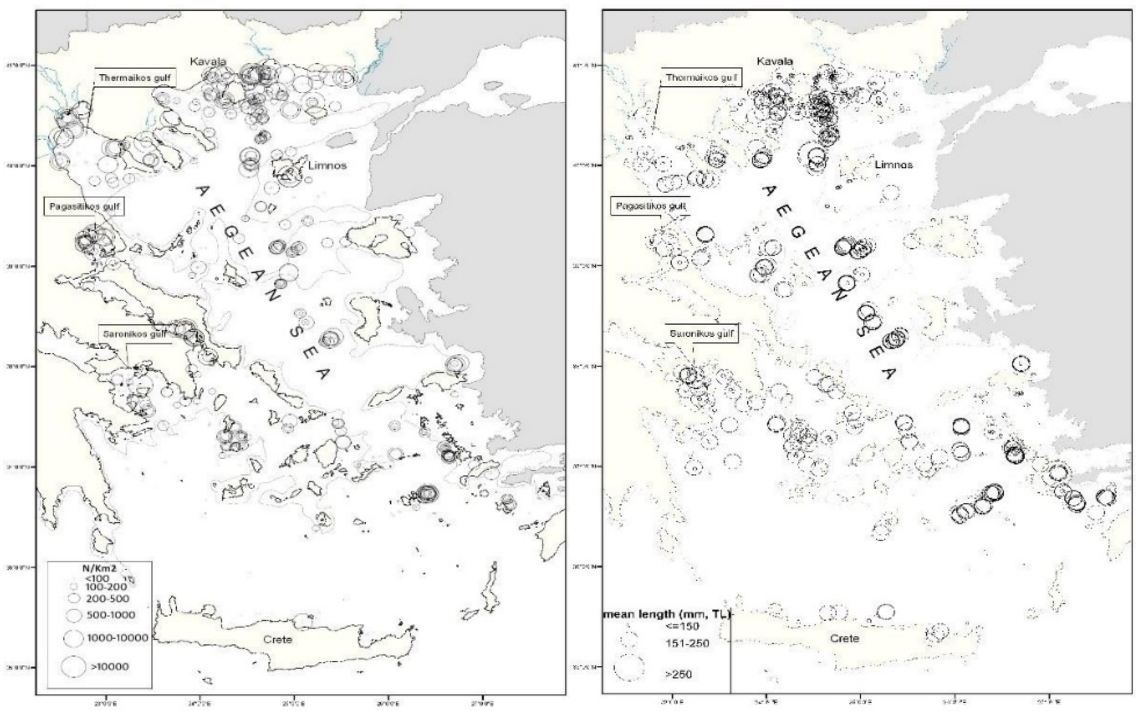


Fig. 7.14. Left: Map of the spatial distribution of the abundance (N/km²) of blackspot seabream *Pagellus bogaraveo* in the Aegean Sea. Right: Map of the spatial distribution of the species mean size (mean LT, mm); data from 1986 to 2009[100].

1 EASTERN IONIAN SEA

Based on the analysis of data from 1983-2010, distribution of the blackspot seabream in the Eastern Ionian is continuous along all the E. Ionian[90], with areas of high abundance in shallow waters or mainly close to river deltas (Fig. 7.13. Left). These areas correspond to juvenile (individuals < 15 cm total length) aggregations (Fig. 7.13. Right). Adults (> 25 cm of total length) are always encountered in deep offshore waters (> 200 m depth).

The analysis of HCMR data from 1998 to 2016 showed that juveniles (< 15 cm TL) of blackspot seabream aggregate in shallow waters, mainly close to river deltas or in closed gulfs. Two of the areas considered as nursery grounds for *Pagellus bogaraveo* in the Eastern Ionian Sea, are located close to Acheron River Delta (western coast of Epirus) and in the area between the east coasts of Ithaki and the west coasts of central Greece, off Acheloos River Delta (Fig. 7.15). Another area, but of lower importance, has been found close to the Evinos River Delta (in Patraikos Gulf), where a non-permanent and of lower abundance juvenile aggregation was found, a fact that may be related to the Evinos river Dam construction in 2002, which reduced river discharge.

2 NORTH AEGEAN SEA

In the North Aegean Sea**,** the analysis of Greek data from the 1986-2009 period, revealed areas with a high presence of juveniles (< 15 cm TL) located close to the Deltas of the Axios, Nestos and Evros Rivers (Fig. 7.14[100]). The analysis of Greek data from 1986 to 2016, revealed a quite similar situation with the highest juvenile aggregations detected in the Thracian Sea, close to Nestos River and in the Toronaios Gulf (in Chalkidiki Peninsula). However, lower concentrations of juveniles were also found north of Samothraki Island and in Thermaikos and Pagassitikos Gulfs (Fig. 7.15)

Information regarding potential spawning grounds of the species in the North Aegean Sea, and particularly off W Limnos and off S. Sporades Islands, is also shown in Fig. 7.15. Similar to the E. Ionian Sea, in the North Aegean Sea, only a small fraction of females were found to be mature. This can be explained by the fact that most of the blackspot seabream data were derived from trawl fishing (and therefore were juveniles), whereas adults of this species (and therefore mature females) are mainly caught by other gears (longlines or gillnets). Further studies, using a more adequate sampling design, are necessary to elucidate the life history of the species in the North Aegean Sea.

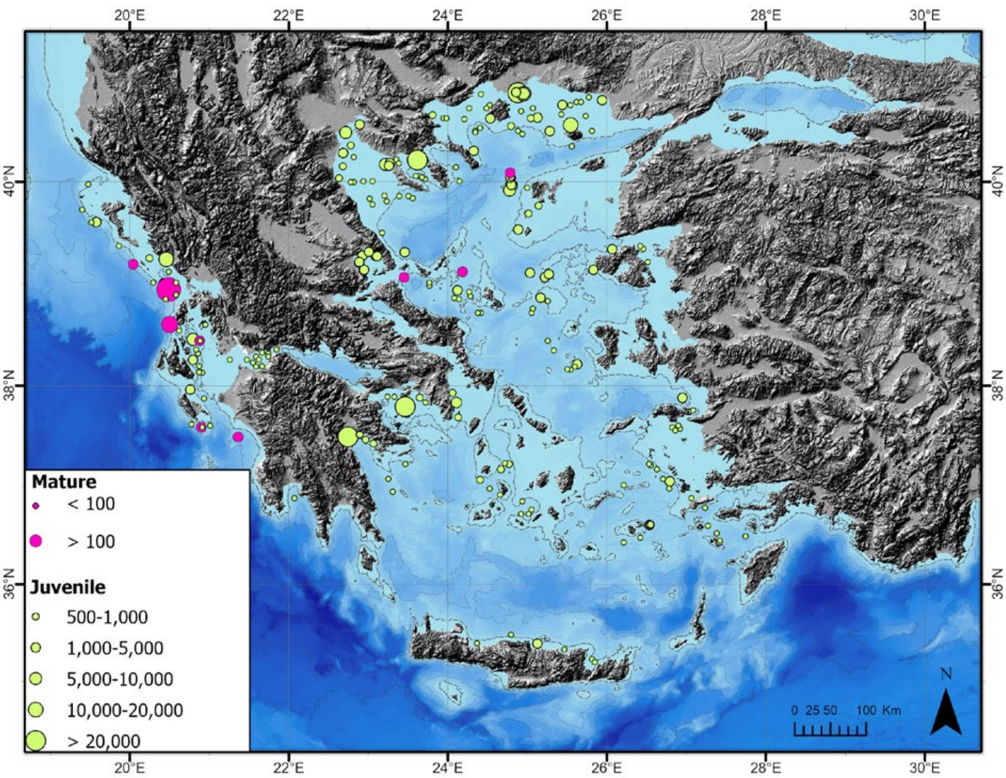


Fig. 7.15.
Map of the spatial distribution of the abundance (N/km^2) of juvenile and mature female blackspot seabream *Pagellus bogaraveo* in the E. Ionian and Aegean Seas, based on data from 1983 to 2016 (HCMR & FRI data).

Information on the blackspot seabream from the Turkish waters in the North Aegean is related more to the occurrence of the species in Gökçeada Island and Saros Bay[101,102]. *P. bogaraveo* is one of the most abundant fish species in all depths (< 400 m depth) in Gökçeada Island waters[101] and other reports indicate that the species is among the ones with higher abundance in the adjacent area of Saros Bay, at 200-500 m depth[102]. Significant quantities of young individuals (< 15 cm), caught by trawling, have been reported from waters off Gökçeada Island (< 400 m depth), probably discarded or sold at a low price, since the species is not regulated by a minimum landing size in Turkish waters[101]. No other information on juveniles and spawning grounds of *P. bogaraveo* is available from the Turkish waters in the North Aegean Sea.

3 SOUTH AEGEAN SEA

In the South Aegean Sea**,** the analysis of Greek data from the 1986-2009 period, revealed areas with a high presence of juveniles (< 15 cm TL), mainly in the Saronikos and Argolikos Gulfs (Fig. 7.14. right[100]). More data until 2016 for the South Aegean Sea, showed similarly high juvenile *P. bogaraveo* aggregations (Fig. 7.15) in the Saronikos Gulf and Argolikos Gulfs, and some aggregations of lower importance in the Petalioi Gulf (South Evoikos Gulf) and in the Cretan waters. However, the species lower occurrence in these locations may be related to the uneven sampling effort exerted among the different areas.

No information is available for the spawning activity or grounds of the species from the South Aegean Sea.

4 LEVANTINE SEA

No specific information on the essential habitats of the species is available from the Levantine Sea, because of the species' low abundance in these waters as well as the lack of a dedicated sampling effort.

The most systematic information comes from Cyprus, based on the MEDITS survey, conducted in the waters of Cyprus from 2005 to 2017. A few young *P. bogaraveo* (~ 9 cm TL) were reported in 2012, close to Lemesos (South Cyprus) in shallow waters (< 100 m depth). The largest individual (22 cm TL) was also found in the same area (off Lemesos) in 2011 in deeper waters (600 m depth). A few individuals (20-21 cm TL) were also collected in the area between Lemesos and Larnaka in depths ranging between 560 and 600 m in 2009 and 2010. Furthermore, a small number of recreational fishers target the species in deep waters using electrical reels (Thasitis, unpublished data).

5 LIBYAN SEA

No specific information on *P. bogaraveo* is available from the Libyan Sea**.** The species has been reported from the Gulf of Messara (South Crete Island) from surveys conducted by HCMR in 2007, but its abundance was greater in surveys conducted from 1988 to 1992, indicating the potential impact of fisheries on this species, as found for other species and the whole fish assemblage in the study area[109].

The species has also been reported from the coastal waters (< 200 m depth) of the west coasts of Libya, presenting, however, some of the lowest catches compared to other species[105].

GENERAL CONSIDERATIONS

The blackspot seabream (*P. bogaraveo)* seems to be relatively important in the commercial fisheries of the Eastern Mediterranean, depending on the area. Specifically, in the Eastern Ionian and Aegean Sea it is fished by both recreational and commercial fisheries, even sometimes indirectly taken as bycatch.

Young *P. bogaraveo* live close to the coasts, in river deltas and closed gulfs. In Greek seas, trawl fishing is not allowed close to river deltas, in waters shallower than 50 m of depth and less than 1.5 km from the coasts[110]. Similar measures exist for the Turkish waters[101]. Therefore, very young specimens (< 15 cm TL) of this species seem to be protected from trawl activities in the coastal areas. However, this work shows that trammel nets, operating in shallow waters, also catch significant quantities of juveniles. Moreover, the part of the larger juveniles that are still immature as a result of the hermaphroditism of the species, live in waters down to 150 m depth[90] which are intensively fished by the trawl, resulting in discards or low value landings[101].

Juveniles are also protected by the existing regulation with a Minimum Conservation Reference Size (MCRS) for the European Mediterranean fisheries, not allowing blackspot seabream < 33 cm to be landed, with the exception of the Gibraltar Strait where a recent recommendation of 30 cm was adopted. However, the MCRS application and the fishermen's compliance with this rule for European Mediterranean countries is difficult given the following factors: a) very few individuals are caught at sizes > 30 cm; b) there is poor monitoring, control and enforcement for MCRS application; c) most individuals at sizes > 20 cm are caught by small scale fishing fleets selling their products unofficially at local markets and restaurants and d) the species is not a target in the sampling frame of the Data Collection Framework (DCF) in the Eastern Mediterranean, resulting in scarce information and absence of a time series, required for accurate assessment. Moreover, the value of MCRS provided for the species in the Mediterranean is based on information for the species biology from the Eastern Atlantic waters[13], where the species reaches very large sizes (52 cm TL[111]) compared to those observed in the Eastern Mediterranean[31].

With regard to the larger individuals (some of them probably still immature), which live in deeper waters near banks, these are mainly caught by longlines and gillnets, which operate without specific management measures, as also happens for recreational fishing, mainly practised in Greek waters by using one line with many hooks.

Significant gaps have been identified through this critical examination of the available information on *P. bogaraveo* biology and population dynamics as well as its commercial and recreational fishery in the two main areas of the species distribution and exploitation, the Ionian and Aegean Seas. These gaps should be addressed in order to achieve a sustainable fishing of this vulnerable species. This implies the necessity to i) conduct more specific surveys with adequate sampling gears focusing on the study of this species, ii) monitor the species by including it in the DCF national fisheries data collection programme and conduct common stock assessments in each GSA region, iii) implement the use of Vessel Monitoring Systems (VMS) to gather information of fishing operations per boat and areas, linking data with landings (and CPUE) geographical distributions and sales at landing port, iv) regulate the commercial and recreational fishing of the species by improving the selectivity of the gears used and by establishing a minimum conservation reference size close to the size at first maturity of this species in the Eastern Mediterranean Basin.

13 STECF-16-09.

Wreckfish

*Lefkaditou E., Otero M., Lteif M.,
Kavadas S., Mytilineou Ch.*

The wreckfish *Polyprion americanus* is a large demersal fish, distributed worldwide on both sides and hemispheres of the Atlantic Ocean, the Mediterranean, Indian Ocean and the South-western Pacific[112]. Like other deep-water species, the wreckfish is generally considered a long living, slowly growing and late maturing fish species[11]. It inhabits continental slopes, oceanic islands and seamounts of temperate and subtropical waters at depths from 40 to 800 m, although they are more frequently found in waters deeper than 300 m down. Juveniles are pelagic until approximately 45-65 cm total length and often found drifting with the currents, associated with floating seaweeds or wreckage[102,104]. To reach sexual maturity and become adults, juvenile wreckfish migrate to the benthic habitat in offshore waters. As adults, they show a preference for habitats of seamounts and banks with deep-water carbonate mounds and cold-water coral colonies at depths from 300-800 m[113,114].

Studies addressing several aspects of wreckfish biology, such as reproductive mode, spawning period, feeding in different life stages, age and growth estimation, length and age at maturity, have been performed in areas where it is commercially exploited. Particularly in the Eastern Mediterranean, wreckfish fisheries and life history have been studied in the framework of a specific European Study project entitled “State of the stocks of European wreckfish (*Polyprion americanus*)”[53]. Even so, little is known of the wreckfish’s life history. This fact together with exceptional longevity and related life history attributes suggest that *P. americanus* is highly vulnerable to fishing exploitation and represents an important challenge for fisheries management (Table 7.1).

Studies from rearing in captivity and wild specimens revealed that wreckfish experience rapid growth during the early years of life reaching a plateau in their growth by 20 years of age[11,117]. It reproduces at great depths shortly after settlement on the bottom[112,118]. Size at first maturity of males is generally slightly lower than that of females, at 68-81 cm. (8-9 years) and 77-95 cm (10-12 years), respectively. Fully mature individuals have been recorded from late autumn to early spring but spawning has also been confirmed in the Eastern Mediterranean during winter over depths of about 1,000 mm off North Crete[118].

FISHERIES

Table 7.1. Technical characteristics of professional fishing gears targeting or having an important by-catch of *Polyprion americanus* in the Eastern Mediterranean

Area	Fishing Gear	Target species	Hook Size	Number of hooks	Length (m)	Snood Distance (m)	Bait	Soak time (hours)	Fishing period	Depth (m)	Source
E. Ionian	Long-line	*M. merluccius*	6-8	600-2,000	3,000-18,000	5-9	*S. pilchardus*	0.2-2	all year	400-700	[97,119,120]
E. Ionian	Long-line	*P. americanus*	6	250	2,700	11	*S. pilchardus*	4-5			[120]
North Aegean (East of Evia Island)	Long-line	*P. bogaraveo*, *P. pagrus*, *M. merluccius*, *P. americanus*, *Mustellus spp.*	12-5		5,000-6,000	6-9	*Scomber* spp., S. pilchardus, ommastrephids	2-3	all year	100-700	[97,119,121]
North Aegean (East of Evia Island)	Drop-line	*P. bogaraveo*	10	50-70			Scomber spp.	0.25-1			[121]
North Aegean (East of Evia Island)	Drop-line	*P. americanus*	0.1	5			Loligo spp.				[121]
SE Aegean (Myrtoan)	Long-line	*P. americanus*							sporadically		[97,119]
SE Aegean	Long-line	*P. bogaraveo*	10		< 300	2	*Scomber* spp.		all year	350-700	[97,119]
SE Aegean	Long-line	*M. merluccius*	5-louv	~ 2,000	20,000	10	*S. pilchardus*		all year	400-800	[97,119]
Cretan	Long-line	*M. merluccius*	6	~ 1,800	11,000	12	*S. scombrus*	2-3	winter	< 600	[97,119]
Cretan	Long-line	*P. americanus*	3	500-4,000	6,000-40,000	10-15	*Scomber* spp.	2-3	October-January	300-1,000	[97,114,119]
Cyprus	Drop-line	*P. americanus*, *P.bogaraveo*, *M. merluccius*, *e.t.c.*		12-20	0.15	0.2	*S. pilchardus*, *Scomber spp.*		September-May		DFMR (2009)*[14]

The wreckfish *Polyprion americanus* is a valuable demersal fish, considered among primary commercial seamount species, i.e. those caught primarily or exclusively on seamounts[122]. It has supported substantial fisheries in:

- the south-western Pacific Ocean: off Tasmania[123] and New Zealand[124];
- the western Atlantic Ocean: at the Blake plateau off south-eastern USA[112,125] and off southern Brazil[126,127];
- some islands in the high seas of the Atlantic: Bermuda, Azores, Madeira[112,128,129,130];
- the Mediterranean Sea: at the sea mount Emile Baudot off the Balearic islands[131], in the Ligurian Sea[132], off west Sardinia in the Tyrrhenian Sea[118], off Malta and the Pelagie Islands in the Sicily strait[133,134], in the South Adriatic[135], the Ionian, southern Aegean and Cretan Seas[31], as well as in the northern Levantine Sea[136,137].

The wreckfish is mainly exploited by small-scale professional and recreational fisheries, the catches of which are not usually included in the official statistics of fisheries. Bottom long-lines and droplines are used to catch adult wreckfish greater than 45 cm and 1.5 kg in weight, with a maximum size recorded of 100 kg for drop-line and around 70 kg for bottom long-lines.

14 Department of Fisheries and Marine Research 2009.

Drop-line or dropper or "filacciuolo" in Italian, is the specific fishing gear used, consisting of a long fishing handline, set vertically down into the water, with a series of fishing hooks (No 0.1-3) attached to snoods, a weight at the bottom of the line and usually a float at the top. Bottom long-lines consist of 800 to 4,000 hooks, bated with squid, mackerel, jack mackerel or gilt sardine. The main line of the gear is 2-3 mm thick, while each hook is fitted to the main line with one or two single lines 1.5-1.8 mm thick and 3-4 m in length. The inter-hook distance is 10-15 m. However, these gear characteristics may change from area to area (Table 7.1).

Small sized individuals, not exceeding 800 g in weight have been reported as bycatches of fisheries using FAD (Fish Aggregation Devices) targeting common dolphinfishes (*Coryphena hippurus*), greater amberjack (*Seriola dumerili*) and pilotfishes (*Naucrates doctor*) off the coasts of Mallorca island, Sicily island and Malta[113,138,139].

Information on the species occurrence, commercial and experimental fisheries in the Eastern Mediterranean has been collected since the 1990's within the framework of short-term projects and studies relevant to deep-sea small scale fisheries (Fig. 7.16). Because of the particular habitat where the species occurs (banks, seamounts) and the lack of specific surveys focusing on the study of this species, information of the species occurrence is based on any available published and unpublished scientific or fisheries information.

Wreckfish catches from the Eastern Mediterranean appeared in Fisheries Official Statistics in 2002, reported mainly by Greece from fisheries in the Aegean and the Eastern Ionian Seas, for some years by Cyprus from a fishery in the Levantine Sea and by Albania in the north-eastern Ionian (Fig. 7.16). Spain is the only country reporting catches of wreckfish from 3 different areas of the western Mediterranean (Fig. 7.17). The Spanish fleet is known to perform bottom longline fishery targeting hake since 1980 in the Gulf of Lions, operating mainly on the slope along the canyons between 160 and 600 m depth off the western Gulf of Lions and progressively expanding to deeper waters and eastwards[148]. In this fishery, wreckfish is a regular by-catch[149].

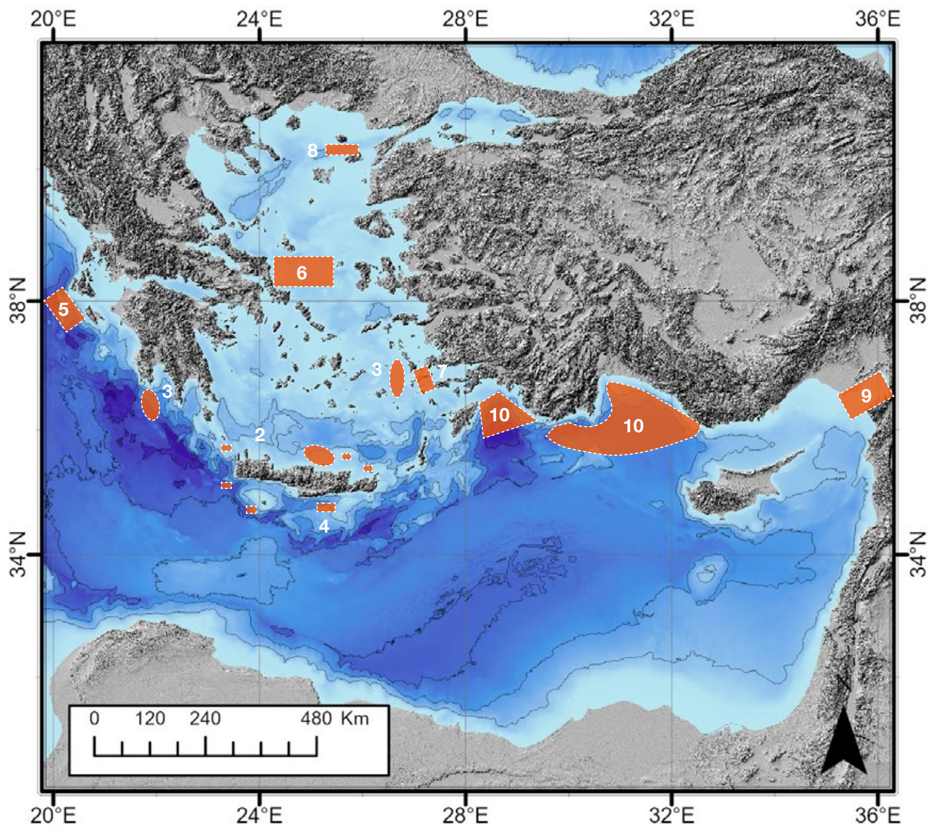


Fig. 7.16. Studied areas and respective studies relevant to wreckfish (*Polyprion americanus*) occurrence and fisheries in the northeastern Mediterranean.

1[119], 2[140], 3[141], 4[142], 5[143], 6[144], 7[145], 8[146], 9[137], 10[147]

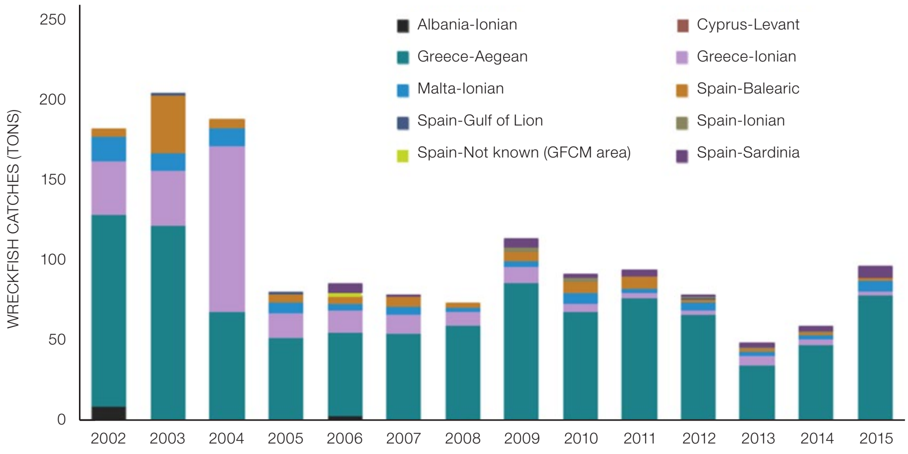


Fig. 7.17. Wreckfish (*Polyprion americanus*) catches in the Mediterranean Sea by country and fishing sub-area during the period 2002-2015. (Source: FAO fishery statistical time)

In the central Mediterranean, wreckfish catches from the Ionian Sea have been reported by Malta since 1996 and by Spain since 2009. Italian catches are not reported, since the species is not commercialized through the fish market but is sold directly to restaurants or to fish shops. In general, due to the small-scale nature of wreckfish fishery, precise landings are hard to monitor by the Statistical Services, thus, only a portion of the catches are expected to be included in the official production data[118]. Furthermore, in many cases *Polyprion americanus* and large-sized Serranids are reported under the category "Groupers" in Official Fisheries Statistics (Gucu, pers. comm.).

1 EASTERN IONIAN SEA

Among other Mediterranean GSAs, the highest wreckfish catches appear in the Eastern Ionian Sea, landed by the Greek fishing fleet. However, landings of wreckfish have been considerably reduced in the area since 2003 (Fig. 7.17). Analysis of longline fishery landings data in the E. Ionian Sea, collected during 2002-2006 under the Data Collection Regulation framework[150,151] indicated important wreckfish catches by métiers targeting hake[152]. However, it is known that, at least until 2013, *Polyprion americanus* was reported in Greek Fisheries Statistics under the common name "stone bass" including also some landings of *Epinephelus caninus.*

According to the information on wreckfish fishing, collected in the framework of the EC FAIR 95-655 on "Developing deep-water fisheries: data for their assessment and for understanding their interaction with and impact on a fragile environment (Deep-fisheries)" Greek small scale fishing fleets comprising of vessels practicing deep-water bottom long-lining, targeted wreckfish from time to time in the Eastern Ionian, using specifically equipped gear. However, as good catches last only for a short period (1-2 weeks) and a long time (> 3 years) is needed for the stock to recover, fishermen target it less frequently and *P. americanus* catches are mainly by-catch of long line fishery targeting hake[119].

Surveys with experimental long-lining (18,000 hooks) in the Eastern Ionian Sea, in the Argostoli Ridge seamounts, in summer and autumn of 2010, resulted in considerable wreckfish catches, comprising of 35 individuals that ranged between 45.5 and 101.0 cm in size (1,800-14,500 g in weight), with individuals larger than 77 cm caught only during summer. Average catch per unit effort (CPUE) was 15.2 kg/1,000 hooks in summerand 3.4kg/1000 hooks in autumn[31]. Observations on professional fishery catches with bottom long-lines, in the framework of DCF (2013-2019), have revealed wreckfish by-catches off the south coasts of the Peloponnese (HCMR, unpublished data) (Fig. 7.16).

Fortnightly experimental fishing with FADs (fish aggregating devices) off the south-western Peloponnese revealed the presence of a few solitary wreckfish juveniles (220-270 mm in TL) only in June and July[153,154] (Fig. 7.16).

2 AEGEAN SEA

Since 2004, the landings of wreckfish in the Aegean Sea have been considerably reduced (Fig. 7.17).

In the North Aegean Sea, the limited available information comes from an investigation of small scale fisheries off the eastern coasts of Evia Island in 2010. Due to the geomorphology of this area, deep-water basins (> 500 m depth) located quite close to the coast, small scale fleet fishing grounds are visited almost all year round. Wreckfish is targeted by a few vessels using specific drop-lines from April until October, but it also consists of important by-catch from bottom long-lines for hake and drop-line fisheries for blackspot seabream practiced throughout the whole year[121].

Frequently published news in the local newspaper "SPORADES" about big wreckfish (17-72 kg) captured by fishermen of the near-by area of Sporades islands, as well as relevant posts on the web regarding fishing off the coasts of the Chalkidiki Peninsula, indicate the occurrence of an important population of the species in the deep-water basins of the north-western Aegean Sea.

Experimental bottom longline fishery carried out from March to August 2016, by Istanbul University in the deep waters between Samothraki and Gökceada (Imvros) Islands (Fig. 7.16), resulted in the capture of only 3 wreckfish individuals from a total of 6,000 hooks used during the study. Sizes of the caught specimens, ranged between 36-71 cm in TL and between 689-5,100 g in weight[155].

Life history and fisheries of wreckfish in the South Aegean Sea were mainly studied in the framework of a specific European Study project entitled "State of the stocks of European wreckfish (*Polyprion americanus*)" (Contract 98/041), whereas the first information was collected during the "Deep-Fisheries project".

Greek small scale fishing fleets comprising of vessels practicing deep-water bottom long-lining, targeted wreckfish from time to time in the Myrtoan, the Cretan and southeastern Aegean Seas, using specifically equipped gear (Table 7.1). In the late '90s, a trammel net fishery also started up in the Cretan Sea targeting wreckfish at depths from 150 to 550 m during daylight, but was not further developed as fishers are not used to targeting wreckfish over flat hard bottoms, but rather in areas of steep slope, which are easier to locate in the open sea and result in higher catches but are not suitable for fishing with nets[118].

Drop-lines were also used, however, as good catches generally lasted only for a short period, fishermen targeted *P. americanus* less and less over the years, exploiting it mainly as by-catch during bottom long line fishery, targeting big-sized fish at depths of between 500 and 850 m. Nowadays, drop-lines are mainly used by sport fishermen as shown by web-news on catches of large specimens (40-105 kg weight) on the slope off Milos, Sifnos and Mykonos island coasts, which might be considered as evidence of wreckfish populations in the deep water basins around the Cyklades Plateau.

In Crete, wreckfish fishing by specific long-lines (Table 7.1) seems to be an alternative to that of the swordfish, as the same fleet operates on both resources, targeting wreckfish when swordfish production is low[118]. The Catch per Unit Effort (CPUE) for *P. americanus* in 1999-2000 was 10-116 kg/1,000 hooks, with a mean of about 50 kg/1,000 hooks. The CPUE declined as the number of hooks increased, although the total catch also increased. Furthermore, the total quantity of catches depended more on the fishing site than on the fishing effort applied (number of hooks). Similarly, Turkish vessels fishing swordfish in the south-eastern Aegean due to low catches have skipped to gillnetting and demersal longlining, targeting mainly groupers, with wreckfish CPUE around 12 kg/1,000 m of gillnets[147].

Two types of experimental FADs (fish aggregating devices), which are not a traditional type of fishing in Crete, were tested in the Northeast Cretan Sea at depths from 80 to 200 m, but they did not attract any wreckfish[118].

3 LIBYAN SEA

The occurrence of fishing grounds visited by Cretan small scale fishing fleet have been mapped off the south-eastern coasts of Crete during the “WreckFish” project, whereas the species has also been recorded during ROV surveys off the south Ierapetra coast and Chryssi Island, over large outcrops and seeps, close to hard substrate reefs colonised by deep-sea corals[142].

The inclusion of *Polyprion americanus* in the ichthyophauna of Libyan[156] waters indicates the species wide distribution in this area.

4 LEVANTINE SEA

In the Levantine Sea, official data on fisheries catches are reported from time to time only by Cyprus, where a few fishermen target *P. americanus* with a specific deep water dropline[136,157].

Fishermen interviews carried out along the south coasts of Turkey between October 2016 and February 2017 showed that wreckfish catches were relatively low (daily catch did not exceed 12 kg) and presented considerable spatial variation in the studied area, however, they were reported all year round among long-line catches and in May and June among those of static nets[137].

According to Lakkis[158] *Polyprion americanus* is very common in the fish markets of Syria and Lebanon. However, the species is not included in the fish species lists published for these areas[107,159] nor is information regarding catches and fishing gears used available. In addition, in the most recent Species Identification Guide for Fishery Purposes in the Eastern and Southern Mediterranean[160] it is mentioned that wreckfish is occasional to rare in the area, a fact that might be also due to the limitation of fishing activities at lower depths than those inhabited by the species and that reporting of occasional catches is mixed with those of groupers. Furthermore, the species is also included in the ichtyofauna list for the Egyptian waters[106], a fact that indicates that the species has a wide distribution in the south-eastern Mediterranean.

Essential Fish Habitats

In conclusion, ecologically important habitats for the wreckfish described here are based on descriptive information, mostly from small-scale fisheries and indirect evidence from recreational fisheries and experimental fishing surveys. Quantitative information, however, is lacking from many areas, making it difficult to visualize hotspots of fish abundance or spawning and nursery grounds.

Nonetheless, deep-water banks are preferred habitats where adult wreckfish can occur in higher concentrations. Areas of presumably high abundance in the Eastern Ionian Sea are known, along the Argostoli Ridge seamounts, particularly during summer and autumn (HCMR, unpublished data). In the North Aegean Sea, locations such as off the eastern coasts of Evia Island as well as Sporades islands and off the coasts of the Chalkidiki Peninsula seem to be important areas, while in the South Aegean, information coming from sport fishers indicate catches of large specimens on the slope off Milos, Sifnos and Mykonos islands, which might be considered as evidence of wreckfish in the deep water basins around the Cyklades Plateau.

As for juveniles, only a few have been recorded during experimental fishing with FADs off the south-western Peloponnese[154,161].

In other areas and sub-regions of the Eastern Mediterranean, little seems to be known to be able to judge where there are other essential habitats (sites) or important fishing grounds of wreckfish.

GENERAL CONSIDERATIONS

The Wreckfish seems to be widely distributed over the slope of the Eastern Mediterranean, associated with deep sea coral habitats and seamounts, although **information coming from the Levantine Sea is very limited**.

Official Statistical Data from Commercial Fisheries in the E. Mediterranean are provided only by Greece and Cyprus, whereas detailed information on the synthesis of fisheries catches is quite limited due, most probably, to the generally low fishing activity in deep waters by the fleets of the Eastern Mediterranean countries and consequently the insufficient sampling of these fisheries even in the European countries under DCF National programmes. In the meantime, the technological improvement in electronic equipment and vessel capacity has facilitated the detection of species-specific localized habitats, both by professional and by sport fishermen. **Monitoring of recreational fishery activity may provide valuable information for the estimation of overall fishing pressure**.

Based on information derived from specific short-term, spatial scale research projects, commercial wreckfish catches consist of large specimens (TL > 45 cm, W > 1.5 kg exploited mainly by deep-water bottom longlines targeting large hake and, to a lesser extent, as by-catch of nets targeting groupers and other large-sized species. It is occasionally targeted by specific bottom long-lines and drop-lines, the latter, used mainly nowadays by recreational fishermen, resulting in larger specimen catches (W: 30-105 kg). FAD fisheries (with fish aggregating devices), exploiting younger individuals, are not operated by small scale fishing fleets in the Eastern Mediterranean. Furthermore, during the reproduction period (winter) the fishing effort of small scale fisheries declines notably due to the bad weather conditions, thus, wreckfish spawning aggregations are somewhat protected. However, landings (at least from Greek vessels) were reduced during the last 15 years.

Minimum reference conservation size (45 cm) is somewhat lower than the species length at first maturity estimated at 68-81 cm and 77-95 cm for males and females, respectively, and should be reconsidered.

To decrease uncertainty related to the species age estimation, the study of otolith microstructure, at least in individuals with TL < 500 mm, should be undertaken in order to clarify the growth rate of juvenile wreckfish under physical environment conditions. As for larger individuals, growth rate confirmation might be attempted through tagging experiments. In general, **further investigation on the biological traits of the species will help assess the status of its stocks.** •

CHAPTER 7 /

REFERENCES

1. Garcia, S.M., Zerbi, A., Aliaume, C., Do Chi, T., and Lasserre, G. (2003). ***The ecosystem approach to fisheries: Issues, terminology, principles, institutional foundations, implementation and outlook.*** In: FAO Fisheries Technical Paper. pp. 71.

2. SRC-EM/GFCM. (2018). ***Subregional Committee for the Eastern Mediterranean (SRC-EM)*** Chania, Crete (Greece), 6–8/3/2018.: 40.

3. STECF. (2006). ***Report of the Scientific, Technical and Economic Committee for Fisheries Opinion on 'Sensitive and Essential Fish Habitats in the Mediterranean Sea''.*** Brussels 3–7 April 2006, http://stecf.jrc.cec.eu.int/.' 63 pp.

4. Seitz, R.D., Wennhage, H., Bergström, U., Lipcius, R.N., and Ysebaert, T. (2014). ***Ecological value of coastal habitats for commercially and ecologically important species***. ICES Journal of Marine Science,71(3): 648–665.

5. Brown, E.J., Vasconcelos, R.P., Wennhage, H., Bergström, U., Stottrup, J.G., Van De Wolfshaar, K., Millisenda, G., Colloca, F., and Le Pape, O. (2018). ***Conflicts in the coastal zone: Human impacts on commercially important fish species utilizing coastal habitat***. ICES Journal of Marine Science,75(4): 1203–1213.

6. Tsagarakis K., Mytilineou, Ch., Haralabous, J., Lorance P., Politou, C.Y. (2013). ***Mesoscale spatio-temporal dynmics of demersal assemblages of the Eastern Ionian Sea in relationship with natural and fisheries factors***. Aquat. Liv. Res,26: 381–397.

7. Papakonstantinou, C., Golani, D., Palmeri, A., and Keskin, Ç. (2011). ***Helicolenus dactylopterus. The IUCN Red List of Threatened Species.***

8. Lorance, P., Cook, R., Herrera, J., de Sola, L., Papaconstantinou, C., and Florin, A. (2015). ***Helicolenus dactylopterus. The UICN Red List of Threatened Species***.

9. Russell, B. (2014). ***Pagellus bogaraveo.*** The IUCN Red List of Threatened Species 2014. e.T170244A42447640.,.

10. Bizsel C., Kara M.H., Pollard D., Yokes B., G.M., and P., F. (2011). ***Pagellus bogaraveo.*** The IUCN Red List of Threatened Species 2011. Downloaded on 02 February 2018,.

11. Wakefield, C.B., Newman, S.J., and Boddington, D.K. (2013). ***Exceptional longevity, slow growth and late maturation infer high inherent vulnerability to exploitation for bass groper Polyprion americanus (Teleostei: Polyprionidae)***. Aquatic Biology,18(2): 161–174.

12. Ragonese, S. (1995). ***Geographical distribution of Aristaeomorphafoliacea (Crustacea: Aristeidae) in the Sicilian Channel(Mediterranean Sea)***. ICES Mar. Sci. Symp.,199: 183–188.

13. Bianchini, M.L., and Ragonese, S. (1994). ***Life cycles and fisheries of the deep-water red shrimps Aristaeomorpha foliacea and Aristeus antennatus***. In: NTR Spec. Publ. pp. 87.

14. Holthius, L.B. (1980). ***FAO species catalogue.*** Volume 1. Shrimps and prawns of the world. An annotated catalogue of species of interest to fisheries. FAO Fisheries Synopsis,1(125): 271 pp.

15. Ribeiro, C.A., and Arrobas, I. (1982). ***Aristeus antennatus (Risso, 1816): some considerations about its biology and fishery in Portuguese waters.*** International Council for the Exploration of the sea,6: 1–23.

16. Sardà, F., Company, J.., and Maynou, F. (2003). ***Deep-sea shrimp A. antennatus Risso, 1816 in the Catalan sea, a review and perspectives.*** Journal of the Northwest Atlantic Fishery Science,31: 127–136.

17. Cau, A., Carbonell, A., Follesa, M.., Mannini, A., Norrito, G., Orsi Relini, L., Politou, C.-Y., Ragonese, S., and Rinelli, P. (2002). ***MEDITS-based information on the deep-water red shrimps A.foliacea and Aristeus antennatus (Crustacea: Decapoda: Aristeidae).*** Scientia Marina,66 (2): 103–124.

18. Company, J.., Maiorano, P., Tselepides, A., Politou, C.-Y., Plaity, W., Rotlant, G., and Sardà, F. (2004). ***Deep-sea decapod crustaceans in the western and central Mediterranean Sea: preliminary aspects of species distribution, biomass and population structure.*** Scientia Marina,68: 73–86.

19. Sardà, F., D'Onghia, G., Politou, C.Y., Company, J.B., Maiorano, P., and Kapiris, K. (2004). ***Deep-sea distribution, biological and ecological aspects of Aristeus antennatus (Risso, 1816) in the western and central Mediterranean Sea***. Scientia Marina,68(SUPPL. 3): 117–127.

20. Fischer, W., Bauchot, M.L., and Schneider, M. (1987). ***Fiches FAO identification des espèces pour les besoins de la pêche.*** (Rèvision 1). Mediterranèe et mer Noir. Zone de pêche 37. Volume II Vertèbres.

21. Politou, C.Y. (2004). ***Evaluation of the distribution and abundance of demersal fisheries resources in Libyan Waters.*** (Final Technical Report) (E.K.Θ.E.N.C.M.R., 2016-10-18).

22. Fernández Hernández, Maria V., Heras S., Maltagliati F., et al. (2011). ***Genetic structure in the blue and red shrimp Aristeus antennatus and the role played by hydrographical and oceanographical barriers***. Marine Ecology Progress Series,421: 163–171.

23. Heras, S., Planella, L., García-Marín, J.L., et al. (2019). ***Genetic structure and population connectivity of the blue and red shrimp Aristeus antennatus.*** Scientific Reports,9: 13531.

24. Maggio, T., Lo Brutto, S., Cannas, R., Deiana, A.M., and Arculeo, M. (2009). ***Environmental features of deep-sea habitats linked to the genetic population structure of a crustacean species in the Mediterranean Sea.*** Marine Ecology,30(3): 354–365.

25. Relini, G., and Orsi Relini, L. (1987). ***The decline of the red shrimps stocks in the Gulf of Genoa***. Investigaciones Pesqueras,51(Supl.1): 245–260.

26. Bas, C. (2006). ***The Mediterranean Sea: Living resources and exploitation***. CIHEAMIAMZ / FAO COPEMED Project. Barcelona.

27. Gönülal, O., Özcan, T., and Katagan, T. (2010). ***A Contribution on the Distribution of the Giant Red Shrimp Aristaeomorpha Foliacea (Risso , 1827) Along the Aegean Sea and Mediterranean Part of Turkey***. Rapp. Comm. Int. Mer Mèdit.,39: 534.

28. Papaconstantinou, C., and Kapiris, K. (2003). ***The biology of the giant red shrimp (Aristaeomorpha foliacea) at an unexploited fishing ground in the Greek Ionian Sea***. Fisheries Research,62(1): 37–51.

29. D'Onghia, G., Capezzuto, F., Mytilineou, C.H., Maiorano, P., Kapiris, K., Carlucci, R., Sion, L., and Tursi, A. (2005). ***Comparison of the population structure and dynamics of A. antennatus (Risso, 1816) between exploited and unexploited areas in the Mediterranean Sea.*** Fisheries Research,76: 23–38.

30. Garofalo, G., Giusto, G.B., Cusumano, S., Ingrande, G., Sinacori, G., Gristina, M., and Fiorentino, F. (2007). ***Sulla cattura per unità di sforzo della pesca a gamberi rossi sui fondi batiali del Mediterraneo orientale***. Biol. Mar. Medit.,14(2): 250–251.

31. Mytilineou, C. (2007). ***Deep Water Fisheries Research in the Hellenic Seas***.In: State of Hellenic Fisheries. pp. 411.

32. Vitale, S., Ceriola, L., Colloca, F., Dimek, M., Falsone, F., Gancitano, V., Garofalo, G., Geraci, M.L., Lelli, S., Morello, E., Scannella, D., Vasconcellos, M., Fiorentino, F. (2018). ***Overview of deep water red shrimp fisheries in the Eastern Mediterranean based on Local Ecological Knowledge.*** Report of the second meeting of the Subregional Committee for the Eastern Mediterranean (SRC-EM), Chania, Greece, 6–8 March 2018. 40 pp.

33. SAC. (2018). ***Report of the second meeting of the Subregional Committee for the E. Mediterranean (SRC-EM).*** Chania, Greece, 6–8 March 2018. 40 pp.

34. FAO. (2020). ***The State of Mediterranean and Black Sea Fisheries.*** General Fisheries Comission for the Mediterranean.Rome, Italy.

35. FAO. (2018). ***The State of Mediterranean and Black Sea Fisheries***. General Fisheries Commission for the Mediterranean. Rome., 172 pp.

36. WGVME-GFCM. (2018). ***Report of the second meeting of the Working Group on Vulnerable Marine Ecosystems (WGVME),*** FAO, Rome. 57 pp.

37. Kapiris, K., Kavadas, S. (2018). ***Fishery and biological data of deep water red shrimps (Aristaeomorpha foliacea, Aristeus antennatus) in the Greek seas***.In: Joint MEDSUDMED/EASTMED/GFCM Data Preparation Meeting. 17-21/9/2018. .

38. Deval, M.C., Bök, T., Ateş, C., Ulutürk, T., and Tosunoğlu, Z. (2009). ***Comparison of the size selectivity of diamond (PA) and square (PE) mesh codends for deepwater crustacean species in the Antalya Bay, eastern Mediterranean***. Journal of Applied Ichthyology,25(4): 372–380.

39. Anonymous. (2013). ***Fishery Statistics 2013.*** State Institute of Sta¬tistics. Prime Ministry. Republic of Turkey, No: 4349. 75 pp.

40. Aydin, C.M., Tiraçin, E.M. (2018). ***Some aspects of population dynamics of red giant shrimp A. foliacea in Antalya Bay (Decapoda: Aristeidae)***.In: Working Group on Stock Assessment of Demersal Species (WGSAD) Session on Deep Water Red Shrimp Fisheries in the Eastern-Central Mediterranean Sea. Rome, Italy, 22-23 November 2018. Rome, Italy.

41. Fahim, R.M., El-Haweet, A.E., Farrag, M.M., Mosaad, A., El-Sayed, M. (2018). ***Biological parameters of A. foliacea***.In: GSA 26. FAO HQ- GFCM, Rome, Italy, 17-22 September 2018. .

42. Farrag, M.M.S. (2016). ***Deep-sea ichthyofauna from Eastern Mediterranean Sea, Egypt: Update and new records***. Egyptian Journal of Aquatic Research,42(4): 479–489.

43. Thessalou-Legaki, M. (1994). ***Distribution of Aristeus antennatus and Aristaeomorpha foliacea in the eastern Mediterranean Sea***. In: Bianchini M.L. & Ragonese S. (Eds.), Life Cycles and Fisheries of the Deep-Water Red Shrimps *Aristaeomorpha Foliacea* and *Aristeus Antennatus*. NTR-ITPP. pp. 61–62.

44. Galil, B.S. (2004). ***The limit of the sea: The bathyal fauna of the Levantine Sea***. Scientia Marina,68(SUPPL. 3): 63–72.

45. Galil, B.S., and Goren, M. (1995). ***The deep sea Levantine Fauna.-New records and rare occurrences***. Senckenbergiana Maritima,25(1–3): 41–52.

46. Hasan, H., Zeini, A., and Noël, P.Y. (2008). ***The marine decapod Crustacea of the area of Lattakia, Syria***. Crustaceana,81(5): 513–536.

47. Saker, F., Farah, S. (1997). ***Classification, ecology of crustaceans in the water of Lattakia (Tichrine University, Lattakia)***. 609–630 pp.

48. Saker, F. (2002). ***Contribution in studies of the specific composition of benthic fauna in the waters of Lattakia***. Union of Arab Biologists, Cairo,18: 287–310.

49. Politou, C.-Y., Tursi, A., Kavadas, S., Mytilineou, Ch., Lembo and R. Carlucci. (2003). ***Fisheries resources in the deep waters of the Eastern Mediterranean (Greek Ionian Sea)***. J. Northw. Atl. Fish. Sci.,31: 35–46.

50. Kapiris K. (2004). ***Biology and fishery of the deep water shrimps A. foliacea (Risso, 1827) and A. antennatus (Risso, 1816) (Decapoda: Dendrobranchiata)***.

51. Kapiris, K., and Thessalou-Legaki, M. (2009). ***Comparative reproduction aspects of the deep-water shrimps Aristaeomorpha foliacea and Aristeus antennatus (Decapoda, Aristeidae) in the Greek Ionian Sea (Eastern Mediterranean)***. International Journal of Zoology: 9 pp.

52. Kapiris, K., and Thessalou-Legaki, M. (2001). ***Observations on the reproduction of Aristaeomorpha foliacea (Crustacea: Aristeidae) in the SE. Ionian Sea***. Rapp. Comm. Int. Mer Médit,36: 281.

53. Anonymous. (2001). ***Exploration of the renewable marine biological resources in the deep waters (INTERREG II)*** (Eds Mytilineou Ch. & Tusri A.). Final Report, vol. IV. 281 pp.

54. Politou, C.Y., Kapiris, K., Maiorano, P., Capezzuto, F., Dokos, J. (2002). ***Deep-water biology of A.foliacea (Risso, 1827) (Crustacea: Decapoda: Aristeidae) in the Mediterranean Sea***.In: 8th Colloquium Crustacea Decapoda Mediterranea, Corfu, Greece. Book of Abstracts: 82. .

55. Sardà, F., and Cartes, J.E. (1997). ***Morphological features and ecological aspects of early juvenile specimens of the aristeid shrimp Aristeus antennatus (Risso, 1816)***. Marine and Freshwater Research,48(1): 73–77.

56. Demirci, A., and Hoşsucu, H. (2016). ***Population characteristics of Aristeus antennatus (Risso , 1816) (Decapoda : Aristeidae) from the Levantine Sea coast of Turkey***. IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS),9(12): 24–28.

57. Bayhan, Y.K., Ergüden, D., and Cartes, J.E. (2018). ***Deep sea fisheries in Mersin Bay, Turkey, Eastern mediterranean: Diversity and abundance of shrimps and benthic fish fauna***. Acta Zoologica Bulgarica,70(2): 259–268.

58. Lelli, S., Lteif, M., Jemaa, S., Khalaf, G. (2014). ***First information on abundance, biology and distribution of the red giant shrimp (A. foliacea) in Lebanese waters***.

In: 20th LAAS International Science Conference - Advanced Research for Better Tomorrow. March 27-29, 2014. .

59. Lteif, M., Jemaa, S., Lelli, S., Khalaf, G., Fakhry, M. (2018). ***Red shrimps in Lebanon- GSA 27***.In: Working Group on Stock Assessment of Demersal Species (WGSAD) Session on Deep Water Red Shrimp Fisheries in the Eastern-Central Mediterranean Sea. Rome, Italy, 22-23 November 2018. .

60. Aguilar, O., Perry, A. L., García, S., Álvarez, H., Blanco, J., Bitar, G.K. (2018). ***2016 Deep-sea Lebanon Expedition: Exploring Submarine Canyons.*** Oceana,SPA/RAC,IUCN Deep-sea lebanon project. 94 pp.

61. Galil, B.S.S., and Goren, M. (1994). ***The deep sea Levantine Fauna.-New records and rare occurrences***. Senckenbergiana Maritima,25(1–3): 41–52.

62. Ibrahim M.A., Hasan M.W.A., El- Far A.M.M., et al. (2011). ***Deep Sea Shrimp resources in the South E. Mediterranean Waters of Egypt***. Egyptian Journal of Aquatic Research,37(2): 131–137.

63. Deval, M.C., Yılmaz, S., and Kapiris, K. (2017). ***Spatiotemporal variations in decapod crustacean assemblages of bathyal ground in the antalya bay (Eastern mediterranean)***. Turkish Journal of Fisheries and Aquatic Sciences,17(5): 967–979.

64. Hureau, J.C., Litvinenko, N.I. (1986). ***Scorpaenidae***.In: P.J.P. Whitehead, Bauchot M.-L., Hureau J.-C., Nielsen J. and Tortonese E. (Eds.). Fishes of the North- Eastern Atlantic and the Mediterranean. UNESCO, Paris. Vol 3. pp. 1211–1229.

65. Quéro, J.C. (1997). ***Les Poissons de Mer des Pêches Françaises***.In: Quéro J.C., Vayne J.J. (Eds.), Les Poissons de Mer Des Pêches Françaises. Delachaux et Niestlé, Paris, pp. 304.

66. Figueiredo, M.J., Figueiredo, I., and Moura, O. (1995). ***Distribution, abundance and size composition of Blackbelly rosefish (Helicolenus dactylopterus) and Mediterranean redfish (Hoplostethus mediterraneus) on the slope of the Portuguese South and Southern West Coasts***. Ices C. M./G:10,: 38.

67. Romeo, T., Castriota, L., Consoli, P., Falautano, M., Florio, G., Perdichizzi, F., Finoia, M.G., Andaloro, F., and Rinelli, P. (2009). ***Bathymetric and longitudinal distribution aanalysis of the rockfish helicolenus dactulopterus (delaroche, 1809) in the southern tyrrhenian sea (central mediterranean)***. Mediterranean Marine Science,10(1): 73–82.

68. Capezzuto, F., Sion, L., Ancona, F., Carlucci, R., Carluccio, A., Cornacchia, L., Maiorano, P., Ricci, P., Tursi, A., and D'Onghia, G. (2018). ***Cold-water coral habitats and canyons as Essential Fish Habitats in the southern Adriatic and northern Ionian Sea (central Mediterranean)***. Ecological Questions,29(3): 9–23.

69. Colloca, F., Carpentieri, P., Balestri, E., and Ardizzone, G.. (2004). ***A critical habitat for Mediterranean fish resources: shelf-break areas with Leptometra phalangium (Echinodermata: Crinoidea).*** Marine Biology,145: 1129–1142.

70. Demirhan, S.A., and Akbulut, F. (2015). ***Age and growth of the Bluemouth Rockfish, Helicolenus dactylopterus (Delaroche 1809) from the North-Eastern Uediterranean Sea, Turkey***. Pakistan Journal of Zoology,47(2): 523–527.

71. Anonymous. (1998). ***Deep Water Fisheries.*** EU/FAIR CT 95-665. Final report.

72. Politou, C.Y., Kavadas, S., Mytilineou, C., Tursi, A., Carlucci, R., and Lembo, G. (2003). ***Fisheries resources in the deep waters of the eastern Mediterranean (Greek Ionian Sea)***. Journal of Northwest Atlantic Fishery Science,31: 35–46.

73. Madurell, T., Cartes, J.E., and Labropoulou, M. (2004). ***Changes in the structure of fish assemblages in a bathyal site of the Ionian Sea (eastern Mediterranean)***. Fisheries Research,66(2–3): 245–260.

74. Muñoz, M., and Casadevall, M. (2002). ***Reproductive indices and fecundity of Helicolenus dactylopterus dactylopterus (Teleostei: Scorpaenidae) in the Catalan Sea (western Mediterranean)***. Journal of the Marine Biological Association of the United Kingdom,82(6): 995–1000.

75. Deval, M.C., Kebapçıoğlu, T., Güven, O., and Olguner, M.T. (2018). ***Population pattern and dynamics of the Bluemouth Helicolenus dactylopterus (Delaroche, 1809) in the eastern Mediterranean Sea***. Journal of Applied Ichthyology,34(3): 568–580.

76. Hossucu, B., Taylan, B. (2015). ***The Islands of the Aegean Sea***.In: An Introduction to Greek Epigraphy. pp. 23–73.

77. Terrats, A., Petrakis, G. (2001). ***Reproductive cycle and fecundity of blue-mouth (Helicolenus dactylopterus, Delaroche, 1809) in the eastern Mediterranean (Ionian Sea, Greece)***. Rapports de la Commission Internationale de la Mer Méditerranée,36: 329.

78. Consoli, P., Battaglia, P., Castriota, L., Esposito, V., Romeo, T., and Andaloro, F. (2010). ***Age, growth and feeding habits of the bluemouth rockfish, Helicolenus dactylopterus dactylopterus (Delaroche 1809) in the central Mediterranean (southern Tyrrhenian Sea)***. Journal of Applied Ichthyology,26(4): 583–591.

79. Çiçek, E.; Karataş, M.; Avşar, D., and Moradi, M. (2014). ***Catch Composition of the bottom trawl***

fishery along the Coasts of Karataş-Adana (Northeastern Mediterranean Sea). International Journal of Aquatic Biology,2(5): 229–237.

80. EastMed. (2013). ***Report of the Sub-regional Working Group on Deep Water Biological Resources in the Eastern Mediterranean.*** Scientific and Institutional Cooperation to Support Responsible Fisheries in the Eastern Mediterranean. GCP/INT/041/EC – GRE –ITA/TD-15. Athens 2013. 37 pp.

81. Muñoz, M., Dimitriadis, C., Casadevall, M., Vila, S., Delgado, E., Lloret, J., and Saborido-Rey, F. (2010). ***Female reproductive biology of the bluemouth Helicolenus dactylopterus dactylopterus: Spawning and fecundity***. Journal of Fish Biology,77(10): 2423–2442.

82. Pirrera, L., Bottari, T., Busalacchi, B., Giordano, D., Modica, L., Perdichizzi, A., Perdichizzi, F., Profeta, A., and Rinelli, P. (2009). ***Distribution and population structure of the fish Helicolenus dactylopterus dactylopterus (Delaroche, 1809) in the Central Mediterranean (Southern Tyrrhenian Sea)***. Marine Ecology,30(SUPPL.1): 161–174.

83. Spedicato M.T., Massutí E., Mérigot B., Tserpes G., et al. (2019). ***The MEDITS trawl survey specifications in an ecosystem approach to fishery management***. Scientia Marina,83(1): 9–20.

84. Massutí, E., Moranta, J., De Gil Sola, L., Morales-Nin, B., and Prats, L. (2001). ***Distribution and population structure of the rockfish Helicolenus dactylopterus (Pisces: Scorpaenidae) in the western Mediterranean***. Journal of the Marine Biological Association of the United Kingdom,81(1): 129–141.

85. Aboim, M.A., Menezes, G.M., Schlitt, T., and Rogers, A.D. (2005). ***Genetic structure and history of populations of the deep-sea fish Helicolenus dactylopterus (Delaroche, 1809) inferred from mtDNA sequence analysis***. Molecular Ecology,14(5): 1343–1354.

86. Anastasopoulou A., Mytilineou, Ch., Dimitriadis G., et al. (2017). ***Aspects on age and growth of Helicolenus dactylopterus from the deep waters of E. Ionian Sea***. Fisheries Centre Research Reports 25(1), 58-63.

87. Papaconstantinou, C., Petrakis, G., Karagitsou, E., Labropoulou, M., Karkani, M., Vassilopoulou, C., Mytilineou, Ch., Lefkaditou, E., Siapatis, A., Kavadas, S., Xatzinikolaou, P., Anastasopoulou, K., Kapiris, K., Terrats, A., Dogrammatzi, A., Bekas, P., et al.(1998). ***Development of Greek fisheries. EPET II/EKBAN (125).*** Final Report, September 1998.

88. Kallianiotis, A. (2012). ***Experimental fishing using fish traps in South East Aegean Sea***. In: EastMed Technical Documents No 15. Report of the Sub-Regional Working Group on Deep Water Biological Resources in the Eastern Mediterranean, Athens, Greece. .

89. Colloca, F. & Lelli, S. (2012). ***Report of the FAO EastMed support to the fishing trials carried out off the South Lebanese Coast***.

90. Mytilineou, C., Tsagarakis, K., Bekas, P., Anastasopoulou, A., Kavadas, S., Machias, A., Haralabous, J., Smith, C.J., Petrakis, G., Dokos, J., and Kapandagakis, A. (2013). ***Spatial distribution and life-history aspects of blackspot seabream Pagellus bogaraveo (Osteichthyes: Sparidae)***. Journal of Fish Biology,83(6): 1551–1575.

91. Báez, J.C., Macías, D., de Castro, M., Gómez-Gesteira, M., Gimeno, L., and Real, R. (2014). ***Assessing the response of exploited marine populations in a context of rapid climate change: The case of blackspot seabream from the Strait of Gibraltar***. Animal Biodiversity and Conservation,37(1): 35–47.

92. Lorance, P. (2011). ***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): 290–301.

93. Sobrino, I., J.G. (2001). ***Studies on age determination and growth pattern of the red (blackspot) seabream [Pagellus bogaraveo (Brünnich, 1768)] from the Strait of Gibraltar (ICES IXa/SW Spain): Application to the species migratory pattern.***In: NAFO SCR Doc. 01/87. Serial No. N4474. Scientific Council Meeting - September 2001 (Deep-Sea Fisheries Symposium - Poster). .

94. WGDEEP-ICES. (2017). ***Report of the Working Group on the Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP)***. Copenhagen, Denmark, 702 pp.

95. Petrakis G., Holst R., Kavadas S. Chilari A., et al. (2001). (2001). ***Pagellus bogaraveo gill net metier in Ionian Sea: Gill net selectivity, assessment and biology.*** Final Report, HCMR, October 2001, Contract Number: 00/046. 55 pp.

96. Mytilineou Ch. and Machias A. (2007). ***Deep Water Fisheries Research in the Hellenic Seas***. In: Papaconstantinou C., Zenetos A., Vassilopoulou V. and Tserpes G. (Eds), State of Hellenic Fisheries. Athens, HCMR Publications, pp. 213–222.

97. Petrakis, G., Chilar,i A., Terrats, A. (1999). ***To sample the landings at Greek ports***.In: Developing Deep-Water Fisheries: Data for Their Assessment and for Understanding Their Interaction with and Impact on a Fragile Environment. EC FAIR Project CT 95-0655. Final Report of Partner No 6 (NCMR). pp. 144.

98. Chilari, A., Petrakis, G., and Tsamis, E. (2006). ***Aspects of the biology of blackspot seabream (Pagellus bogaraveo) in the Ionian Sea, Greece***. Fisheries Research,77(1): 84–91.

99. Haralabous, I., Damalas, D., Mytilineou, Ch., Dokos, J., Anastasopoulou, A., Bekas, P., Dogrammatzi, K. (2012). ***Preliminary stock assessment of black-spot red seabream, Pagellus bogaraveo, in the Ionian Sea (Eastern Mediterranean) and potential harvest control rules***. In: Ecosystem Based Management and Monitoring in the Deep Med. & Atlantic. A Joint Symposium Organized by the EC FP7 Projects: CoralFISH and DeepFishMan, Galway, Ireland. .

100. Bekas, P., Mytilineou, Ch., Kavadas, S., Doko,s J., Anastasopoulou, A., Kallianiotis, A., Peristeraki, P., Petrakis, G. (2013). ***Preliminary study on the distribution and biology of the blackspot seabream Pagellus bogaraveo (Brünnich, 1768) in the Aegean Sea***. In: Proceedings of the Panhellenic Ichthyologists Congress 2013.

101. Keskin, Ç., Ordines, F., Ates, C., Moranta, J., and Massutí, E. (2014). ***Preliminary evaluation of landings and discards of the Turkish bottom trawl fishery in the northeastern Aegean Sea (eastern Mediterranean)***. Scientia Marina,78(2): 213–225.

102. Öz M.İ. and İsmen A. (2017). ***Saros gulf deep sea fish***. In: Turkish Marine Research Foundation (TUDAV), 2017. TURKEY DEEP SEA ECOSYSTEM WORKSHOP PAPERS BOOK 19. Türk Deniz Araştırmaları Vakfı.

103. Golani, D., Ozturk, B., and Basusta, N. (2007). ***Fishes of the Eastern Mediterranean***. Turkish Marine Research Foundation, Istanbul, Turkey, 259 pp.

104. Golani, D. (2005). ***Checklist of the Mediterranean fishes of Israel***. Magnolia Press, Auckland, New Zealand, 1–90 pp.

105. Shakman, B.E., and Kinzelbach, R. (2007). ***Commercial fishery and fish species composition in the coastal waters of Libya***. Rostocker Meeresbiologische Beiträge,18: 63–78.

106. Stamouli C., Akel E., Azzuro E., et al. (2018). ***New Mediterranean Biodiversity Records*** (December 2017). Mediterranean Marine Science, 18(3), 534-556.

107. Saad, A. (2005). ***Check – list of Bony Fish Collected from the Coast of Syria***. Turkish Journal of Fisheries and Aquatic Sciences,106(2): 99–106.

108. Saad, A., Masri, M. & Sabour, W. (2020). ***First confirmed record of Sparid Pagellus bogaraveo (Brünnich, 1768) in the Syrian marine waters (Levantine Basin)***. Mar. Biodivers. Rec.,13(1).

109. Machias, A., Giannoulaki, M., Tsagarakis, K., et al. (2008). ***Study of the state of Messara Bay, aiming at the rational management of its fishery resources.***

110. EU. (2006). ***COUNCIL REGULATION (EC) No 1967/2006 of 21 December 2006 concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea, amending Regulation (EEC) No 2847/93 and repealing Regulation (EC) No 1626/94***. Official Journal of the European Communities,L 269(September 2000): 1–15.

111. Gil Herrera, J. (2010). ***Spanish information about the red seabream (Pagellus bogaraveo) fishery in the strait of Gibraltar region.*** SRWG on shared demersal resources. Ad hoc scientific working group between Morocco and Spain on Pagellus bogaraveo in the Gibraltar Strait area. Málaga, Spain, 30 pp.

112. Sedberry, G., Andrade, C., Carlin, J., Chapman, R., Luckhurst, B., Manooch, C.I.I.I., Menezes, G., Thomsen, B., and Ulrich, G. (1999). ***Wreckfish Polyprion americanus in the North Atlantic: Fisheries, Biology, and Long-lived fish***. American Fisheries Society Symposium 23,23: 27–50.

113. Deudero, S., and Morales-Nin, B. (2000). ***Occurrence of Polyprion americanus under floating objects in western Mediterranean oceanic waters, inference from stomach contents analysis***. Journal of the Marine Biological Association of the United Kingdom,80(4): 751–752.

114. Machias, A., Somarakis, S., Papadroulakis, N., Spedicato, M.T., Suquet, M., Lembo, G., and Divanach, P. (2003). ***Settlement of the wreckfish (Polyprion americanus)***. Marine Biology,142(1): 45–52.

115. D'Onghia G., Maiorano P., Carlucci R., Capezzuto F., Carluccio A., et al. (2012) ***Comparing Deep-Sea Fish Fauna between Coral and Non-Coral "Megahabitats" in the Santa Maria di Leuca Cold-Water Coral Province (Mediterranean Sea)***. PLOS ONE 7(9): e44509.

116. Maiorano, P., Sion, L., Capezzuto, F., Carlucci, R., Mastrototaro, F., Panza, M., Tursi, A., and D'Onghia, G. (2013). ***Exploring deep-sea benthopelagic fauna using a baited lander in the Santa Maria di Leuca cold-water coral province***. Rapp. Comm. int. Mer Médit,40: 716.

117. Lytton, A.R., Ballenger, J.C., Reichert, M.J.M., and Smart, T.I. (2015). ***Age validation of the north atlantic stock of wreckfish (Polyprion americanus), based on bomb radiocarbon (14c), and new estimates of life history parameters***. Fishery Bulletin,114(1): 77–88.

118. Anonymous. (2001). ***Exploration of re-newable resources in the deep waters*** (Mytilineou Ch., Tursi A. et al.) (Sioula A. Ed). State of the marine and coastal area of Adriatic and Ionian Sea. Monitoring and Management. INTERREG II GREECE-ITALY. Final Report HCMR, September 200. 298 pp.

119. Petrakis G., Kapiris K., et al. (1999). ***Description of deep-water fisheries of Greece***.In: Developing Deep-Water Fisheries: Data for Their Assessment and for Understanding Their Interaction with and Impact on a Fragile Environment. EC FAIR Project CT 95-0655. Final Report of Partner No 6 (NCMR). pp. 20.

120. Mytilineou Ch., Papadopoulou K., Smith C., Bekas P., Damalas D., Anastasopoulou A., et al. (2012). ***Information from fishers on the Eastern Ionian deep-water fishery and its interaction with coral habitats***. In: 10th Panhellenic Symposium on Oceanography and Fisheries. .

121. Lefkaditou, E., Damalas, D., Kavadas, S., Leondari, C., Siapatis, A., Kontoyiannis, H. (2016). ***Small-scale fisheries métiers along the eastern coasts of Evvoia island and their association with the marine ecosystem characteristics***. In: Proceedings of the 16th Panhellenic Ichthyological Congress, Kavala, Greece, October 2010. pp. Proceedings volume: 109-112.

122. Pitcher, T., Morato, T., Hart, P.J., Clark, M.R., Haggan, N., et al. (2007). ***Seamounts: Ecology, Fisheries and Conservation. Blackwell Fisheries and Aquatic Resources Series***. 527 pp.

123. Sumpton, W., McLennan, M., Campbell, M., and Kerrigan, B. (2013). ***Assessing technology changes and risks to the sustainable management of deepwater line fisheries in southern Queensland***. 71 pp.

124. Paul, L.J. (2002). ***Can existing data describe the stock structure of the two New Zealand groper species, hapuku (*Polyprion oxygeneios*) and bass (*P. americanus*)?*** New Zealand Fisheries Assessment Report 2002/14, 24 pp.

125. Wyanski, D.M., and Meister, H.S. (2002). ***Analytical Report on the Sex Ratio, Maturity, Reproductive Seasonality, and Annual Fecundity of Wreckfish,***. 29 pp.

126. Peres, M.B., Haimovici, E.M. (1998). ***The wreck grouper, Polyprion americanus (Polyprionidae, Teleostei) fishery off southern Brazil***. Atlantica Rio Grande,20: 141–161.

127. Perez, J.A.A., Wahrlich, R., Pezzuto, P.R., Schwingel, P.R., Lopes, F.R.A., and Rodrigues-Ribeiro, M. (2003). ***Deep-sea fishery off southern Brazil: Recent trends of the Brazilian fishing industry***. Journal of Northwest Atlantic Fishery Science,31: 1–18.

128. Diogo, H., Pereira, J.G., Higgins, R.M., Canha, Â., and Reis, D. (2015). ***History, effort distribution and landings in an artisanal bottom longline fishery: An empirical study from the North Atlantic Ocean***. Marine Policy,51: 75–85.

129. Sedberry, G.R., Ulrich, G.F., and Applegate, A.J. (1994). ***Development and status of the fishery for wreckfish (Polyprion americanus) in the Southeastern United States***.In: Proceedings of the 43rd Annual Gulf and Carribean Fisheries Institute. pp. 168–192.

130. Zeller, D., Watson, R., Pauly, D. (2001). ***Fisheries impacts on North Atlantic ecosystems: catch, effort and national/ regional data sets***. Fisheries Centre Research Report,9(3): 261.

131. Pastor, X., Aguilar, R., Torriente, A., and García, S. (2008). ***Propuesta de áreas marinas de importancia ecológica: Atlántico sur y Mediterrnáneo español***. 132 pp.

132. Canese, S., and Bava, S. (2015). ***The decline of top predators in deep coral reefs***.In: Proceedings of the 1st Mediterranean Symposium on the Conservation of Dark Habitats. pp. 67–68.

133. Camilleri, M. (2005). ***Maltese fisheries and the sustainability of resources around the Maltese islands.*** PhD thesis, School of Earth, Ocean and Environmental Sciences, Faculty of Science, University of Plymouth.

134. Ragonese S. and Rivas G. (1991). ***The small scale fishery of Linosa (Pelagic islands: Mediterranean sea)***.In: La Recherche Face à La Pêche Artisanale. Research and Small Scale Fisheries. pp. 465–466.

135. Ungaro, N., Marano, G., De Zio, V., Pastorelli, A., and Rositani, L. (2005). ***Some information on offshore bottom longline fishery in the southern Adriatic Sea (GFCM Geographical Sub-Area 18)***. In Adriatic Sea small-scale fisheries. AdriaMed Technical Document,15: 98–102.

136. Department of Fisheries and Marine Research, Ministry of Agriculture, R.D., and Environment. (2009). ***Professional fishing methods of Cyprus***. Imprinta LTD.

137. Mavruk, S., Saygu, İ., Bengil, F., Alan, V., and Azzurro, E. (2018). ***Grouper fishery in the Northeastern Mediterranean: An assessment based on interviews on resource users***. Marine Policy,87: 141–148.

138. Andaloro, F., Campo, D., Castriota, L., and Sinopoli, M. (2007). ***Annual trend of fish assemblages associated with FADs in the southern Tyrrhenian Sea***. Journal of Applied Ichthyology,23(3): 258–263.

139. Cannizzaro, L., Bono, G., Rizzo, P., Potoshi, A., and Celesti, A. (2000). ***Diversifying fishing effort in Sicilian fisheries: the case of Fish Aggregating Devices (FADs)***.In: Pêche Thonière et Dispositifs de Concentration de Poissons, Caribbean-Martinique, 15-19 Oct 1999. pp. 449–464.

140. Anonymous. (2001). ***State of the stocks of European wreckfish (Pokyprion americanus).*** IMBC Final Report (Contract 98/0410).

141. Vassilopoulou, et al. (2002). ***Fish aggregating device (FAD) fisheries in the eastern Mediterranean: An Alternative techinique to enhance pelagic fish catches and diversify fishing effort?*** Project No 99/030, Final Report, July 2002.

142. Smith C, Sakellariou D, McCoy F, and Wachsmann S. (2009). ***Deep Coral Environments South of Crete***. pp. 665–668.

143. Mytilineou, Ch. et al. (2011). ***T3.3. Long line experimental fishing assessment of coral-versus non coral habitat fish distribution. Long line experimental fishing in the Eastern Ionian Sea (Greece).*** CoralFISH Final Report (CF 1211).

144. Kontoyiannis, H. (coordinator). (2011). ***The Evia coastal jet at the vicinity of Kimi: Hydrological Structure and importance as a fish spawning ground and with respect to fisheries.*** HCMR Final Report.

145. Roditi, K., Halkos, G., Matsiori, S., and Vadifis, D. (2018). ***Small-scale fishery of the Eastern Mediterranean Sea: A case study in the Kalymnos Island, Greece.*** MPRA Paper 84506. University Library of Munich, Germany.

146. Gönülal O. (2017). ***North Aegean Deep Sea (500-1500 m) Macrofauna Community***.In: Türk Deniz Araştırmaları Vakfı (TUDAV). Turkey Deep-sea Ecosystem Workshop Papers Book 19.

147. Akyol, O., Ceyhan, T. (2017). ***Annual Catch Diary (2014-2015) of a Swordfish Fishing Vessel in Fethiye Region (Mediterranean)***. Türk Denizcilik ve Deniz Bilimleri Dergisi,3(1): 8–14.

148. E.C.-SGFEN. (2001). ***Deep Sea Fisheries.*** Report of the Subgroup Fishery and environment (SGFEN) of the Scientific, Technical and Economic Committee for Fisheries, Commission Staff Working Paper, Commission of the European Communities, SEC(2002) 133. 124 pp.

149. Castro, J., Marín, M., Pierce, G.J., and Punzón, A. (2011). ***Identification of métiers of the Spanish set-longline fleet operating in non-Spanish European waters***. Fisheries Research,107(1–3): 100–111.

150. EU. (2000). ***Council regulation (EC) 1543/2000 establishing a Community framework for the collection and management of the data needed to conduct the common fisheries policy***. Official Journal of the European Communities,7: L 176/1-16.

151. EU. (2001). ***Council Regulation (EC) No. 1639/2001 of 25 July 2001 establishing the minimum and extended Community programmes for the collection of data in the fisheries sector and laying down detailed rules for the application of Council Regulation (EC) No. 1543/20***. Official Journal of the European Union,L222(August 2001): 53–115.

152. Katsanevakis, S., Maravelias, C.D., and Kell, L.T. (2010). ***Landings profiles and potential métiers in Greek set longliners***. ICES Journal of Marine Science,67(4): 646–656.

153. Vassilopoulou, V., Papakonstantinou, K., Bekas, P., and Christidis, G. (2003). ***Preliminary data on the fish community associated with fish aggregating devices (FADs) in Greek waters***.In: 7th Symposium on Oceanography and Fisheries. Book of Abstracts. pp. 332.

154. Vassilopoulou, V., and Anastasopoulou, A. (2007). ***Vii. 11. Pelagic Fish Assemblages Associated With Fish Aggregation Devices (Fads) in Hellenic Waters***. In: State of Hellenic Fisheries. pp. 461.

155. Gönülal, O. (2017). ***Kuzey ege derin deniz (500-1500 m) macrofauna Topluluğu***.In: Gönülal O., Öztürk B., Başusta N., (Eds).Türkiye Derin Deniz Ekosistemi Çalıştayı Bildiriler Kitabı. Türk Deniz Araştırmaları Vakfı, İstanbul, Türkiye, TÜDAV Yayın. pp. 45.

156. Al-Hassan, L.A.J., and El-Silini, O.A. (1999). ***Check-list of bony fishes collected from the Mediterranean coast of Benghazi, Libya***. Revista de Biologia Marina y Oceanografia,34(2): 291–301.

157. Ioannou, G., Michailidis, N. (2011). ***The 100 most important fish species in Cyprus waters***.In: Department of Fisheries and Marine Research, Ministry of Agriculture, Rural Development and Environment, 2011, Publications. pp. 110.

158. Lakkis S. and Sabour W. (2007). ***Distribution and ecology of groupers in Syro-Lebanese coastal waters : are they endangered or menaced.***In: Proceedings of the “2nd Symposium on Mediterranean Groupers”, Nice. pp. 117–120.

159. Goren, M., and Galil, B.S. (1997). ***New Records of Deep-Sea Fishes From the Levant Basin and a Note on the Deep-Sea Fishes of the Mediterranean***. Israel Journal of Zoology,43(2): 197–203.

160. Bariche, M. (2012) ***Field identification guide to the living marine resources of the Eastern and Southern Mediterranean***. FAO Species Identification Guide for Fishery Purposes. Rome, FAO, 610 pp.

161. Vassilopoulou, V., Papaconstantinou, C., Bekas, P., and Christides, G. (2002). ***Prelimiary data on the fish community associated with Fish Aggregating Devices (FADS) in Greek waters.***In: 7th Symposium on Oceanography and Fisheries. Book of Abstracts. pp. 332.

162. Santos R., Pabon A., Silva W., Silva H., and Pinho M. (2020) ***Population structure and movement patterns of blackbelly rosefish in the NE Atlantic Ocean (Azores archipelago)***. Fish Oceanogr. 2020;00:1–11.