CHAPTER 8/

Fisheries footprint

Kavadas S., Damalas D., Maina I., Thasitis I., Ali M., Jemaa S., Farrag M., Lteif M., Mytilineou Ch., Otero M., Samaha Z., Schüler M.

Latest status of Mediterranean fisheries indicated that 75% of assessed stocks remain overexploited in 2018, including stocks of all priority species – are regarded as overexploited, being the European hake being the most seriously overexploited[1]. Different management efforts are underway to shift this trend across the Mediterranean, as well as to gather a better understanding of fisheries dynamics.

In 2019, the Scientific Advisory Committee on Fisheries (SAC) of General Fisheries Commission of Mediterranean (GFCM) recognise the importance of understanding the extent of fishing footprint impacts for management purpose and advice on the need to adopt binding decisions on mapping the fishing footprint of deep-sea fisheries. Bottom trawling activities in waters deeper than 1,000 m are prohibited in the Mediterranean (Recommendation GFCM/29/2005/1) and two fisheries restricted areas (FRA) has been established to protect the deep-sea sensitive habitats in the E. Mediterranean: Eratosthenes Seamount and the Deep-sea Nile Delta.

Today, robust quantification of the distribution and intensity of fishing vessels working in the deep Eastern Mediterranean is not available. This information can provide evidence base to assess the pressures on deep-sea seabed habitats, enable the characterization of fisheries working on these environments and to estimate the potential impact that the establishment of fisheries closures fisheries closures (e.g. FRAs) or MPAs could have on the fishing industry before and after.

TRACKING SYSTEMS AND FISHING EFFORT ESTIMATE APPROACHES

The introduction of Vessel Monitoring System (VMS), a closed-source tracking system has increased the ability to provide high resolution information on location of individual fishing vessels (typically one position record every 1-2 h) and map fishing grounds and footprint.

Within the European Union, this system is required for all fishing vessels with overall length over 12 m. The data collected by VMS enable management authorities to control and monitor dynamics of fishing activities and asses the implementation of regulations. The information can also be linked to catch and landings data and analyse fishing captures and fishing effort trends.

Complementary to this, the use of other technologies such as the Automatic Identification System (AIS), initially designed as a safety mechanism for vessels to avoid collisions at sea, provides the possibility to enrich the information from larger vessels (e.g. > 15 m length), those that don't have incorporated VMS system as well as for having a higher frequency of the position data recorded (every few seconds). **The roadmap for the implementation of a vessel monitoring system and electronic logbooks in the Mediterranean had recently been agreed in support of monitoring and control of fisheries activities (Resolution GFCM/43/2019/3).**

Vessels over 24 m, which are the vessels most likely to have AIS, account for 2.4% of the Mediterranean region's fleets and vessels between 12 and 24 m represent 8.5% of the region's fleets. Most of the vessels under 12 m and non-motorized vessels (respectively 50.9% and 23.5% of the total fleet) are not likely to have AIS. In the northern Mediterranean, European fleets have adopted AIS for almost 100% of vessels larger than 15 m. By contrast, North African countries have no VMS equipment and an extremely low AIS use, with almost no vessels using this technology[2,3]. As a result, VMS and AIS cannot currently be used to estimate the fishing activity by the African nations in the area (mostly in the southern parts of the Mediterranean Sea) where most of the estimated activity is due to European vessels[4].

This chapter assess, through the use of VMS and AIS data the fishing effort (expressed as days at sea) in the Eastern Mediterranean, particularly that of the bottom trawlers in deep-waters. A fishing pressure index for the deep-water fishing activities of small scale fishing vessels, not equipped with a tracking system (VMS/AIS), was estimated based on a Multi-Criteria Decision Analysis (MCDA). **Accurate mapping estimation of the spatial distribution of these vessels would provide valuable information for Mediterranean fisheries to assess the extent to which it contributes to fishing efforts, where trawling is the main fishing activity and where in some areas its footprint exceeds 80% of the continental shelf[5].**

A vessel monitoring system (VMS) uses satellite-based technology to help locate and identify vessels at sea. The use of Automatic Identification Systems (AIS) with higher resolution signals and other Electronic Monitoring (EM) systems such as those using cameras and gear sensors can also serve as tools to increase monitoring of the fishing effort, tackle IUU fishing and manage MPAs, other vulnerable biodiversity hotspots and restricted areas.

Greek fishing fleet VMS data from 2010 to 2016 were used to map the cumulative fishing footprint from trawlers in the deep waters[1]. Cypriot trawl fishing fleet VMS data from 2014-2015 were also analysed. No VMS data from other Eastern Mediterranean countries were available. As a result the geographical coverage of VMS signals referred to the GSA 20 (Eastern Ionian Sea), GSA 22 (Aegean Sea), GSA 23 (Cretan Sea) and GSA 25 (Cyprus). The analysis of the commercial Greek and Cypriot fishing fleet was performed through the integrated fisheries information system IMAS-Fish[6].

The analysis of VMS data was based on methods developed in the Institute of Biological Recourses and Inland Waters (IMBRW) of the Hellenic Centre of Marine Research (HCMR)[7,8,9]. On that basis, common errors and outliers in VMS dataset were filtered out and removed. Subsequently, speed thresholds for bottom trawlers depending on depth stratum were used to define the 'fishing' activity. It was considered that VMS readings of speed lower than 4 knots correspond to 'fishing', otherwise the signals are characterized to 'steaming'. Vessel positions in or close to harbours were also excluded.

Moreover, the activity of fishing bottom trawlers in other Eastern Mediterranean areas in national and international waters has been addressed through a review of published works as well as publically available aggregated AIS data from 2012 to 2016[2]. Small Scale Fishing (SSF) activities in the Greek and Cypriot waters were also examined using AIS data and a Multi-Criteria Decision Analysis (MCDA) methodological approach. The spatial extent of SSF sector activities is largely unknown therefore; the potential fishing footprint with the corresponding fishing intensity was derived by means of MCDA conducted through a stepwise procedure[10]. Given that the fishing activity of SSF vessels with static gears (nets, long lines) also occur in the deep waters of the Eastern Mediterranean, AIS data from the Global Fishing Watch platform were compiled by flag state and gear type[2]. In this work, over 22 billion AIS signals were processed over a five-year period (2012 to 2016). Estimating the spatial distribution of SSF activities using an MCDA methodological approach as well as information from AIS data, was of utmost importance for verification purposes.

Other type of data such as the commercial fishing fleet operating in deep waters in other areas of the Eastern Mediterranean were also presented based on several published and unpublished information.

1 source: Ministry of Shipping and Island Policy
2 *http://globalfishingwatch.org/map*, *https://www.marinetraffic.com/en/ais/home*

Fishing fleet capacity and deep-water fishing effort of trawlers by country

GREECE

The Greek fishing fleet is largely a coastal fleet made up of vessels in 2020, with the majority (96.52%) being SSF coastal boats3. An outline of the fishing fleet in the previous 2017 and the reduction since 1991 is summarized in Table 8.1. Over this period, the Greek fishing fleet has been reduced by 32.39% and 37.64% in terms of numbers and engine power (kW), respectively. The 56.42% of fishing vessels registered in GSA 22 (Aegean Sea) are distributed in the North Aegean Sea.

The estimated fishing effort of the Greek trawlers operating in the Eastern Ionian Sea (GSA-20) represents the ~12.5% of the total effort (days at sea) exercised by this fleet in all GSAs (GSAs 20, 22, 23). In the Eastern Ionian, approximately 27 trawlers are active, usually fishing in the continental self and only 15% of the effort on the Eastern Ionian Sea (GSA 20) is performed in deep waters (> 200 m).

In the North Aegean Sea and northern part of the South Aegean Sea, bottom trawlers are in larger proportion compared to other areas and the estimated fishing effort of Greek fleet in GSA 22 is ~82% (~210 active trawlers), where the ~27% is practiced in waters deeper than 200 m (~18% in the North Aegean Sea and ~9% in the northern part of the South Aegean). For Cretan Sea - southern part of the South Aegean (GSA 23), the fishing effort is very low and represents 3% of the effort of all GSAs (~9 active trawlers), where the ~34% is performed in waters deeper than 200 m.

From 2010-2016, the cumulative fishing footprint from Greek trawlers operating in deep waters in GSAs 20, 22, 23 is presented in Fig. 8.1. The highest values of deep-water fishing effort are located in Saronikos and Korinthiakos Gulfs in depths 200-400 m. Medium-Low deep-water activities are distributed in all the extend of Greek waters (Ionian, Aegean and Cretan Seas).

Table 8.1. The Greek commercial fishing fleet by Geographical Area (GSA) and fishing category and the reduction (%) from 1991 up to December 2020; Number of fishing vessels and their engine power (in kW) is given by Geographical Area (GSA).

		2017		Reduction (%) (from 1991 to 2020)	
	Fishing category	**Number of fishing vessels**	**kW**	**Number of fishing vessels**	**kW**
GSA 20 EASTERN IONIAN SEA	Artisanal	3405	54396	33,03	33,64
	Boat seine	75	3543	54,27	58,99
	Purse seine	35	6154	12,50	1,38
	Trawl	26	6760	49,02	46,66
	Total	3541	70852,98	148,8130776	140,6638183
GSA 22 AEGEAN SEA	Trawl	9022	191081	38,03	43,86
	Purse seine	142	9198	71,60	74,45
	Artisanal	198	37298	36,33	31,57
	Boat seine	212	63851	40,28	39,13
	Total	9574	301428,25	186,2475535	189,0038711
GSA 23 CRETAN SEA	Artisanal	817	14718	21,37	39,24
	Boat seine	4	349	82,61	77,08
	Purse seine	6	1041	62,50	53,07
	Trawl	10	2937	23,08	32,29
	Total	837	19044,98	189,5523175	201,6859098

CYPRUS

The Cyprus fishing fleet included in the Fleet Register[3] in 2019 was composed of 858 fishing vessels. The latest report indicates that between the period 2009-2019, the fishing Cyprus capacity has been reduced by 27.1% and 17.6% in terms of vessel number and engine power (kW), respectively (due to a scraping program both for trawlers and small scale fishing).

Demersal trawlers range from 19 to 27 m overall length and are categorised based on their type of license to a) those fishing in the territorial waters of Cyprus and b) those fishing in international waters (eastern and central Mediterranean). Regulations and restrictions on the use of trawl nets and minimum landing sizes are established in accordance with national and EU policy regulations.

Table 8.2. Description and development of Cyprus fishing fleet interacting in deep-waters.

Fishing technique	Vessel length (m)	2019			Reduction (%) (from 2008 to 2018)		
		Number of fishing vessels	GT	kw	Number of fishing vessels	GT	kw
Demersal trawlers and demersal seiners	24 - < 40	6	582	2013	-33	-41	-38
Inactive	18 - < 24	-	-	-	-100	-100	-100
Inactive	24 - < 40	1	128	493	-67	-68	-49

Based on the *"Management Plan for the Bottom Trawl Fishery within the Territorial Waters of Cyprus"* which is implemented since the end of 2011[4] (Article 19 of Council Regulation (EC) 1967/2006), only 2 bottom trawlers are licenced to work on a rotational basis in 2 restricted areas. Additionally an extended closed season (from 1st of June until the 7th of November) is employed since the '80s. Other provisions of the Mediterranean Regulation in the relevant Management Plan include minimum distance from the shore and minimum depth.

No fishing footprint from bottom trawlers at depths of more than 200 m was detected over the 2010-2016 time period, as detected from the VMS & AIS data of Cyprus. This is due to that the remaining two vessels operating in national waters had moved their operation closer to the shore, based on the derogation that has been granted to operate at 0.7 nm distance from shore and 50 m depth[5]. No information about static nets and longlines in deep waters is available.

Recently, Fisheries Department of Cyprus started to collect VMS data from the entire SSF vessels.

3 on the 31st of December 2019.
4 Article 19 of Council Regulation (EC) 1967/2006
5 EC 1967/2006.

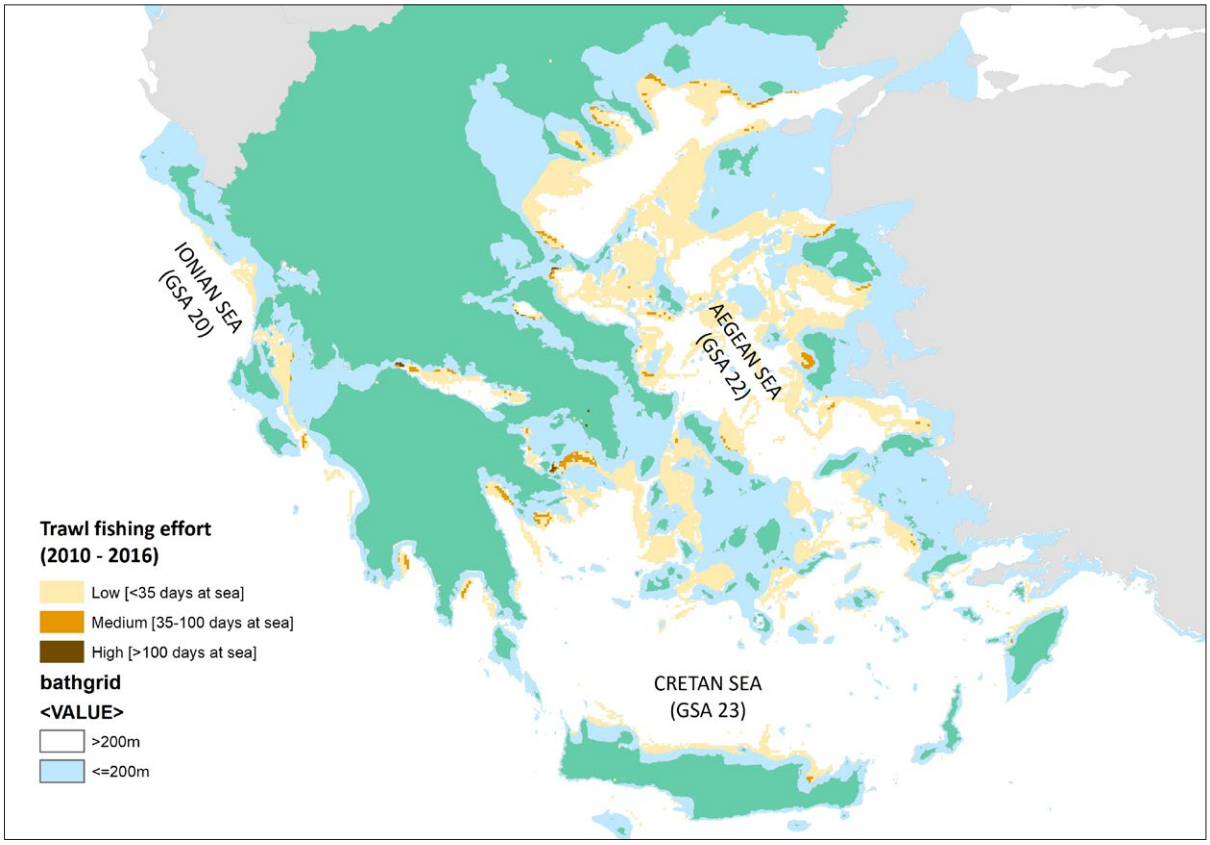

Fig. 8.1. Cumulative fishing footprint of Greek bottom trawlers operating in deep waters in GSAs 20, 22, 23 (period 2010-2016).

TURKEY

The number of marine fishing vessels in Turkey is around 15,877[11]. In 2013, around 32% of the total fishing fleet (4509 vessels) operated in the Aegean Sea where the 95% were artisanal[22]. In the Levantine Sea, the fishing fleet accounted for approx. 1,847 vessels (13.5%) in 2013 where trawlers consisted an important category corresponding to 11% of the fishing fleet in this area, but small scale boats still remain the highest in numbers.

Fishing activities of the Turkish fleet in the Aegean Sea are spatially limited due to the narrow continental shelf, the steep slope and its geomorphological characteristics. The main fishing grounds are mainly located in several bays (e.g. Saros and Edremit Bay in the north, Çandarlı, İzmir, Sığacık and Kuşadası Bays in the centre, and Güllük and Gökova Bays in the south) and around Gökçeada and Bozcaada Islands[12,13]. In 2010, 118 purse seiners and 188 trawlers were certified for fishing in international waters of the Aegean Sea. This increased to 160 in 2014 and 171 in 2015, while it was only 65 in 1997[14]. The main fishing areas known to be used by the Turkish fishing fleet in the international waters of the Aegean Sea Fig. 8.2 are located off Saros Bay, in the Eastern North Aegean Trough, Edremit Ridge, North Psara mounts and off Kuşadası Bay. The main target fish that are caught by the bottom trawl in the deeper waters of the Aegean Sea are the rose shrimp (*Parapenaeus longirostris*), the Norway lobster (*Nephrops norvegicus*), hake (*Merluccius merluccius*), blue whiting (*Micromesistius poutassou*), greater forkbeard (*Phycis blennoides*), blackbelly rosefish (*Helicolenus dactylopterus*), four-spotted megrim (*Lepidorhombus boscii*) and Atlantic horse mackerel (*Trachurus trachurus*)[15,16].

The fisheries along the Levantine coasts of Turkey take place mainly within the territorial waters[17] Iskenderun Bay is the most important fishing area on the Turkey's Levantine coast[18], where small- scale fishery is mainly practiced. The deep red shrimp *Aristaeomorpha foliacea* is the dominant species fished mainly at the depth of 400 m in Mersin Bay[19] and in the deep waters in the Gulf of Antalya[20,21] while other shrimp species

(*Parapenaeus longirostris* and *Aristeus antennatus*) are also commercialised.

The Turkish fishery production in the Aegean Sea is estimated to correspond to 10% of the total production of Turkey, whereas that in the Levantine Sea corresponds to only 6%[22].

Table 8.3. Commercial fishing fleet in Turkey by Geographical Area (GSA) and fishing category (February 2022; Source: GFCM Fleet Register) with indication of number of fishing vessels larger than 15m length overall (LOA).

	GSA 22	GSA 24	GSA 28
	Aegean Sea	**Northern Levant Sea**	**Marmara Sea**
All vessels			
Towed dredges	0	0	0
Miscellaneous gear	3.982	1.548	2.301
Single boat bottom otter trawls	59	176	0
Purse seines	74	43	155
Midwater pair trawls	0	0	0
Beam trawls	0	0	387
Total	**4.115**	**1.767**	**2.843**
VESSELS >15m LOA			
Towed dredges	0	0	0
Miscellaneous gear	2	0	8
Single boat bottom otter trawls	31	116	0
Purse seines	55	22	131
Midwater pair trawls	0	0	0
Beam trawls	0	0	172
Total	**88**	**138**	**311**

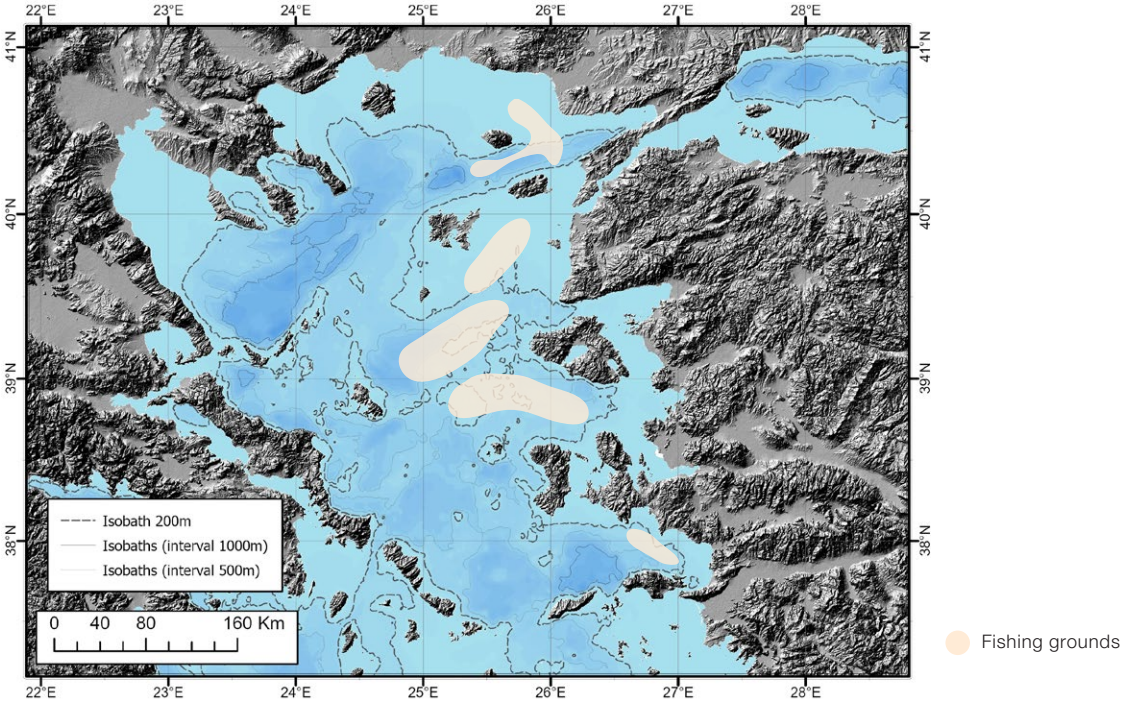

Fig. 8.2. Known fishing grounds in the waters of the Eastern Aegean Sea outside territorial waters[23].

SYRIA

Syria has a very narrow continental shelf (1,160 km^2) that reaches a maximum of 6-8 km in length. Following the short occurrence of the continental edge, the slope leads to the abyssal plain (in some areas, in just 2 km off the shore, bottom depth exceeds 1,500 m). As updated statistical information is unavailable, here we provide a description of the available knowledge on fishing activities and gears used that could be operating in deep-waters.

The trawling area on the shelf is limited to about 310 km^2 (27%) and most commonly other fishing gears (purse seine, gill nets, hooks, longlines, traps, etc) are operating. Before the started the civil war, the fishing fleet consisted of 28 trawlers operating in international waters and 1,850 small scale vessels operating in territorial waters, at depths less than 250 m using various fishing gears (2010). Only bottom longlines were operating in deep waters down to 1,500 m depth. Before 2005, bottom trawling was exerted in Syrian waters at depths less than 250 m. During the 90's, the average catch of trawlers started to decline gradually: from 14.2 kg / boat / hour in 1997, to 11.3 kg / boat / hour in 2002; as a result, the trawling ban since 2005.

In 2017 for a period of 6 months, 5 trawlers were licensed to operate in the deep waters from sunrise to sunset operating at a distance more than 6 nm off the shore (where the depth is more than 250 m). Vessels usually operate at depths ranging between 300 and 750 m, usually fishing 8 to 11 hours per day or 20 days per month. The departure fishing port was Latakia directed towards the south (between 35° 29´ N., and 35° 10´ N.). Fishing trawling gear in used is described by having a wire length used of 1,500 m, followed by 200 m of ropes. The length of the trawl net arms is 14 m, and the total length of the trawl net is 45 m. The horizontal opening of the trawl net is 4 meters, the meshes at the anterior area of the net are 60 mm diamond, and those of the codend 3 are 30 mm diamond.

Annual units effort or catch per effort of trawlers is unknown although is estimated that the average catch is 20.4 kg per boat per hour. The catch composition consists of 52% crustaceans and 48% fish, approximately. No fishing footprint from bottom trawlers was detected from AIS signals by other flag vessels or Syrian trawl vessels as fleets operating in the area don't use AIS or VMS monitoring devices.

LEBANON

The fishing fleet in Lebanon mainly consists of small wooden vessels less than 12 m of length. Trawlers are prohibited by law. Only a small number operate at depths deeper than 50 m, while the majority of fishing vessels are fishing at the bathymetric zone < 50 m, exerting high pressure on the coastal zone. Few artisanal fishermen have proper means and gears to perform deep-water fishing activities, but no information is available about their fishing grounds and catch. Some fishermen set trammel nets with bait up to depths of 300 m and longlines up to depths of 500 m in some regions. The National Centre for Marine Sciences/CNRS-L in collaboration with the Lebanese Ministry of Agriculture (MoA) and the Food and Agricultural Organization of the United Nations (FAO) have implemented several projects to encourage fishermen to invest in deep-water fishery. For example, in the framework of the CIHEAM PESCA-Libano project, which assessed the potentiality of marine coastal resources to support the Lebanese government in strengthening the management of marine resources, a survey was conducted in 2012 and 2013, where gillnets, longlines and trammel nets were set along the coast of Lebanon at depths ranging from 30 to 250 m. Several deep-water fish and shrimp species were caught throughout this survey. In addition, in the framework of the FAO-EastMed project, several experimental fishing trials have been implemented annually since 2015. These trials have also encouraged fishermen to target *Plesionika edwardsii* using Spanish traps, and sustainable trammel nets to help target the European hake *Merluccius merluccius* and the deep-sea red shrimps *Aristaeomorpha foliacea* and *Aristeus antennatus*. Deep-water resources are the priority of fishermen-targeted studies in an attempt to relieve the coastal area from artisanal fishing pressure.

The proposal for the development of Vessel Monitoring System (VMS) for Small Scale Fisheries in Lebanon is underway. For the observational period of 2010-2016, no transmitting AIS signals were observed as transponders are not used by Lebanese fishing vessels or those operating in their waters. According to the Lebanese Ministry, only one large vessel (> 12 m) registered in 2020 was obliged to install an AIS transponder. The latter is the only Lebanese fishing vessel sending an AIS signal currently.

ALEXANDRIA. © JAVARMAN DREAMSTIME.COM

EGYPT

The Egyptian coast of the Mediterranean basin extends for about 1,050 km. However, there is insufficient knowledge about deep-sea fisheries practices[24]. Earlier studies indicated that most fishing activities did not operate at a depth greater than 250 m prior 2011. This is because the main fishing ground is located in the continental shelf off the Nile Delta over shallow waters extending from Alexandria to Port Said[24]. Moreover, the majority of the bottom trawlers operate mainly within the depth range of 100–250 m as the engine power, not exceeding 450 hp, ranges mainly from 100-250 hp. A low number of up to 800 hp vessels operate at the mouth off the Nile Delta[24,25,26].

The first **deep-water fishing activities in Egypt** in depths more than 400 m, were conducted by an Italian trawler during 2009. **The collected catch and effort data on deep shrimps together with other species were published by Ibrahim et al.[24]. Since then, the fishermen have been encouraged to practice in deep waters**. Over the last years (2014-2020), a few trawlers have been licensed to operate in deep- waters, but no sufficient information is available on their activities. From 2015, the catch of deep-water red shrimps started to be recorded from Damietta landing port, representing an amount of 504 tonnes[25]. Egypt has anticipated the installation of VMS devices on board of commercial fishing vessels for monitoring in 2015 to collect information lacking for monitoring fishing activities. However no VMS information is available to date. Fishing landings data in different fishing harbors such as Damietta and Alexandria, indicates an increase of the vessels operating in deep waters in recent years.

The deep-water trawl fishery in Egypt, targeting particularly deep-water shrimps, use the Italian trawl gear in the western and eastern parts of the Nile Delta. Bycatch constitutes about 16-22% of the landed catch, comprising 21 species dominated by *Merluccius merluccius*[24], and another study[27] indicates the occurrence of more than 40 species collected from its deep-waters. The latter study has updated the species in deep-waters with new records reflecting the importance of deep-water fisheries monitoring.

The first record of deep-water shrimps catch from Egypt in 2015 was followed by systematic records of 757 t in 2016, 979 t in 2017 and 845 t during 2018[26]. The European hake fished in deep waters started to be recorded later during 2017 (270 t) and 2018 (845 t)[26]. It is worth noting the decrease of red shrimps catch in contrast of European hake. Further efforts are needed to monitor deep-water bottom trawlers (licensed and not licensed) targeting red shrimps in Egypt to avoid overfishing of their resources and habitats conservation. The establishment of a management plan for deep-water fishery and the use of VMS equipment should be considered among management strategies.

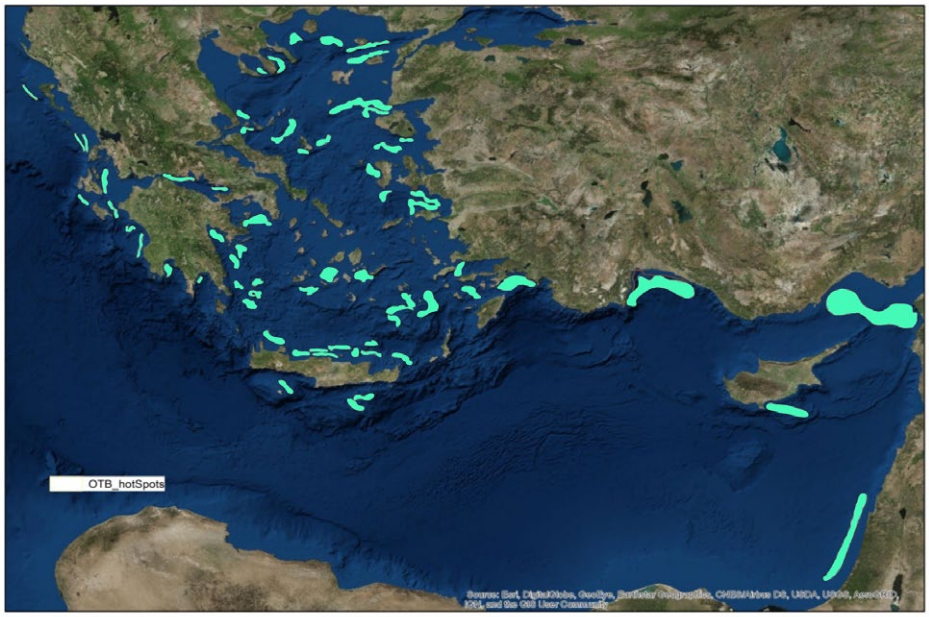

Fig. 8.3. Main fishing grounds of trawlers in the deep waters of the E. Mediterranean based on AIS monthly maps.

(Provided by Marine Traffic and Global Fishing Watch Platforms) during the whole study period (2012-2016).

TRAWLING FOOTPRINT WITH AIS DATA (2012-2016)

1

EASTERN IONIAN SEA

Satellite AIS data indicates that all Greek trawlers operate in the deep waters of the Eastern Ionian Sea (Fig. 8.3). Usually they operate down to 400 m depth (targeting hake, rose shrimp and anglerfish), although some of the fishing vessels operates in waters down to 700 m, **mainly in the Messiniakos Gulf** and in the **area between East Zakynthos Island and the West Peloponnese coasts** targeting deep-water red shrimps (Fig. 8.4). Data analysis also shows over the period of 2012-2016, trawling activity was also exercised by 10 italian vessels, probably targeting red shrimps, in the deep waters of the Eastern Ionian Sea (GSA 20) between 450-900 m depth. Bottom fisheries activities were carried out **on the slope (off north-western Lefkas Island) and close to the sea-canyons** (e.g. west of Othonioi Islands, off Katakolo and Kyparisiakos Gulf) **or seamounts (e.g. off south Kephallinia Ridge)**. Recently, deep-water fishing activity of Italian trawlers (since 2016) is exerted close to **Kythira mount and Lissos Ridge** (west of Antikythira Island) from 300 to 600 m depth.

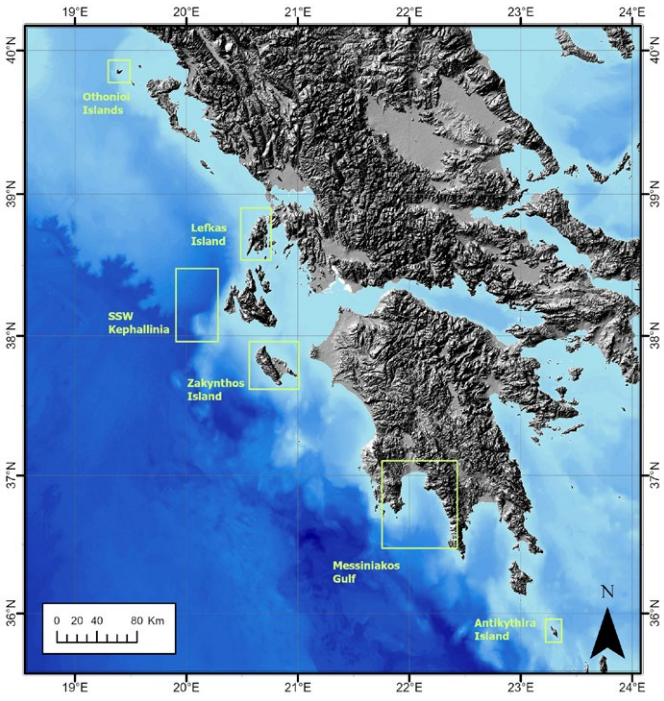

Fig. 8.4. Geographical reference points for trawling footprint in the Ionian Sea.

2

NORTH AEGEAN SEA

The geographical extension of fishing footprint shows that Greek trawlers operate in the deep waters of the North Aegean Sea (GSA 22) at depths less than 600 m, mainly on the slope **(north of Samos basin, W. Skyros basins, around Cavo Doro Ridge basins)** or **close to shallow seamounts (banks)** (e.g. Limos Ridge, N. Ikaria mounts, S. Psara mounts, Cavo Doro North Ridge, between Andros-Tinos N. mounts, N. Psara mounts, Edremit Ridge, S. Sporades mounts) (Fig. 8.5). These fishing vessels are mainly target hake, *Merluccius merluccius*; rose shrimp, *Parapenaeus longirostris*; Norway lobster, *Nephrops norvegicus*, and anglerfish, *Lophius piscatorius*.

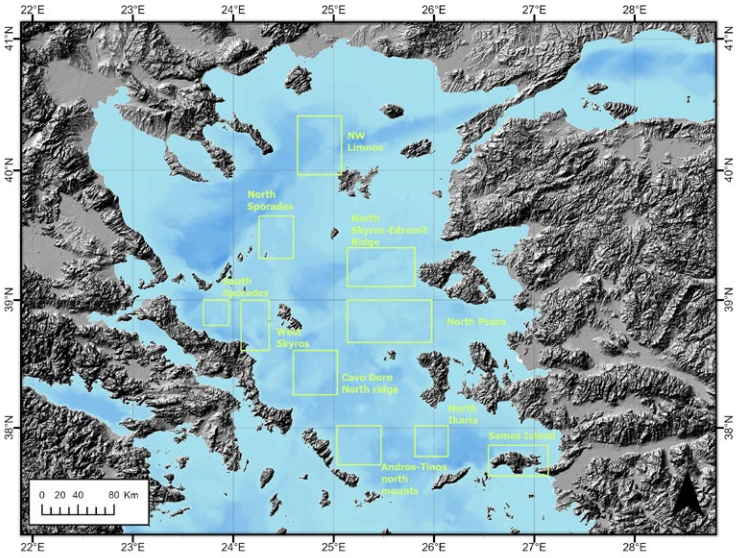

Fig. 8.5. Geographical reference points for trawling footprint in the North Aegean Sea.

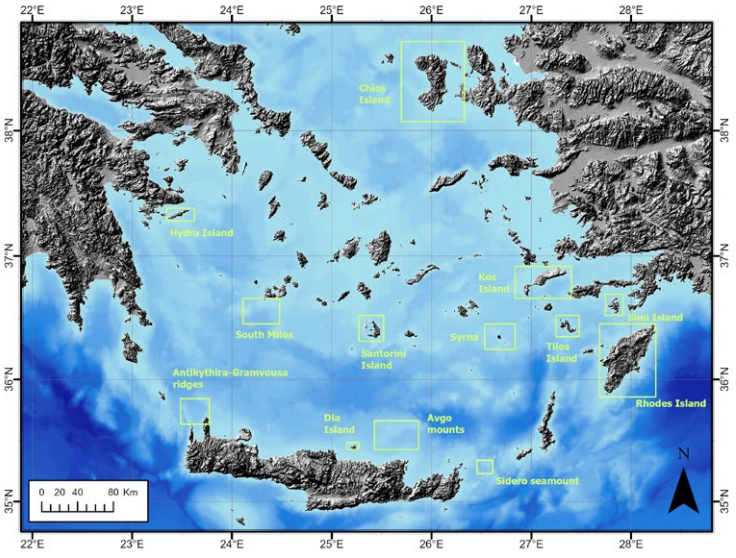

Fig. 8.6. Geographical reference points for trawling footprint in the South Aegean Sea.

From 2012-2016, trawling effort from Turkish vessels were found to operate in the North Aegean Sea mainly **in the Edremit Ridge** in waters less than 300 m depth, **off North Ikaria** and **North Samos Islands** in waters from 200 to 550 m depth from 2013 to 2016 and **in north Psara mounts in < 400 m depths** from 2014 to 2016. These results are in agreement with those reported in the published literature[23]. Considering the the depth range of their activities, it is supposed that fishing vessels mainly target hake, rose shrimp and Norway lobster. Fig. 8.3 presents the main areas of trawlers fishing activity in the deep waters of the study area.

3 SOUTH AEGEAN SEA

Within this region (GSA 22), Greek fishing trawlers operate at depths less than 700 m, mainly **on the slope (South of Chios Island, north of Santorini)** or close to seamounts (e.g. **South Milos mounts, north of Gramvousa mounts**) over the period 2012-2016 (Fig. 8.6). These vessels were mainly targeting hake, *Merluccius merluccius*; rose shrimp, *Parapenaeus longirostris*; and anglerfish, *Lophius piscatorius*.

From 2015, Greek trawlers appear also south of **Hydra Island** at 500-550 m depths, **off Tilos and Simi Islands** at 400-650 m depths and south of Kos at 500-600 m depth including red shrimps among their target species. Other coastal flag state vessels were found working in these waters. Turkish trawlers were found to operate in the South Aegean Sea from 2013 mainly in waters of less than 600 m south **of Chios Island, south of Kos Island, off Tilos and Simi Islands** and in the **northern part of Rhodos Basin**. These deep-water trawl fishery probably target hake, deep-water rose shrimp, blue and red shrimps and other decapod crustaceans. A Spanish trawler was also found to operate close to south Milos mounts operating at 200-500 m depth in 2013 and 2014.

The analysis of the bottom trawl footprint generated with the AIS data further shows that over 2012-2016, italian trawlers operate in the deep waters of the S. Aegean Sea (GSA 22) down to 900 m depth, mainly **north of Crete Island** (north of Gramvousa mounts, Avgo mounts, north of Dia Island, northern part of Rhodos Basin, off Tilos and Simi Islands). From 2015, Italian fishing vessels also appear in the waters **south of Milos mounts** (200-500 m depth) and **in the Syrna mount** (south of Astypalaia Island) (300-700 m depth) and from 2016 in **Sidero Seamount east of Crete**. They probably target deep-water red shrimps. These areas are in agreement with the fishing grounds presented by other authors[28]. Fig. 8.3 presents the main areas of trawlers fishing activity in the deep waters of the study area.

4 LIBYAN SEA

The limited AIS information available in this area (South of Crete - GSA 23), shows only fishing operations from two Italian trawlers from 2015 and a Greek trawler from 2016; along the **north of Gavdos** from 550 to 700 m depth and **in the Chryssi Seamounts** from 600 to 900 m depth (Fig. 8.7) . Most of this fishing activity identified by AIS can be associated with trawlers targeting deep-water red shrimps. Fishing activity of Italian trawlers for red shrimps in the deep waters off Libya coasts (GSA 21) has been previously reported in the area.

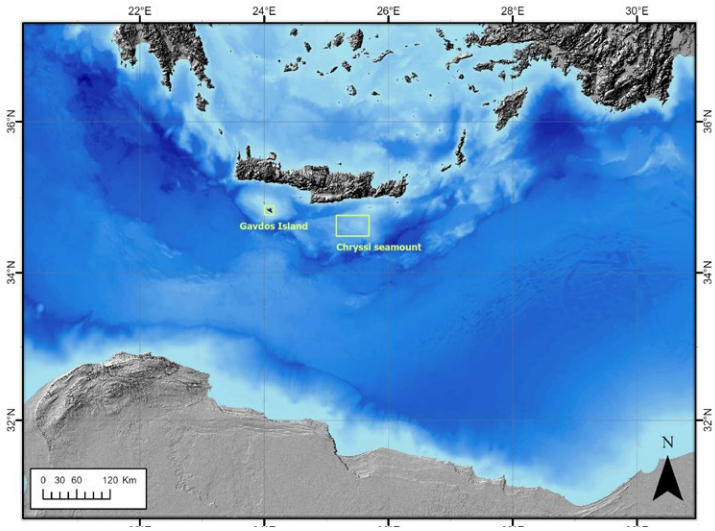

Fig. 8.7. Geographical reference points for trawling footprint in the Libyan Sea.

5 LEVANTINE SEA

The analysis of AIS data suggest the detection of some fishing activities in discrete areas in the Levantine Sea. Individual fishing trips could be identified by Turkish trawl vessels in the area **north of Rhodes basin** and off the south coasts of Turkey operating at depths between 150-800 m and **on the slope off Antalya** fishing from 300 down to 800 m depth from 2013 to 2016 (Fig. 8.8). Turkish trawlers activity, probably targeting red shrimps, was found to extend on the **slope off Iskenderum and Mersin bays** from 2015 to depths ranging between 300-700 m, as reported by literature [19,20,29].

Trawlers from other European countries were found fishing on the **slope off Mersin and Iskenderum bays** at depths ranging between 300-700 m during the whole study period, probably targeting red shrimps.

In Cyprus, AIS effectively documented fishing activity also by a trawler observed on the southern slope, operating at depths ranging between 500-900 m only in 2015 and 2016. Trawlers from other EU countries were also observed operating in **Hecateus seamount, south of Cyprus**, at depths ranging between 500-900 m from 2013 to 2016 (Fig. 8.3). Israeli trawlers were also observed operating systematically on the **slope off Israel coasts** at depths ranging between 200-500 m. In the Southern Levantine, AIS data fail to describe the fishing activity, detecting only an Italian trawler in 2012 operating in waters between 600-700 m depth, probably targeting red shrimps. However, previous publications mention that Italian trawlers operate in the area from 2004 until today[30,28].

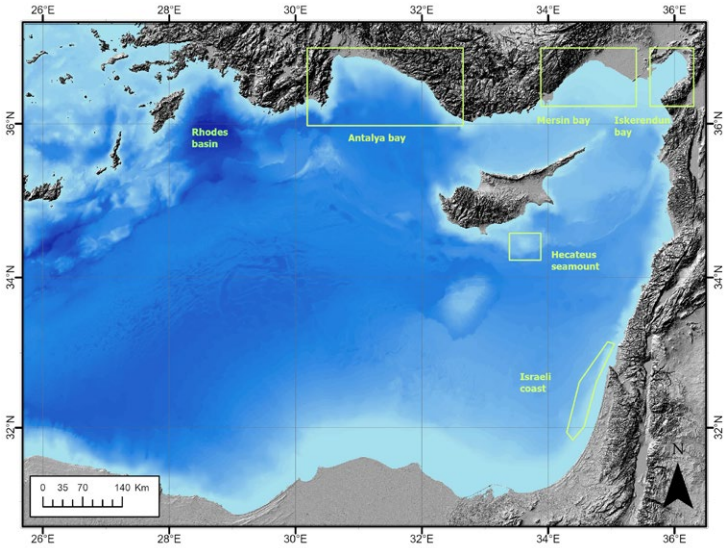

Fig. 8.8. Geographical reference points for trawling footprint in the Levantine Sea.

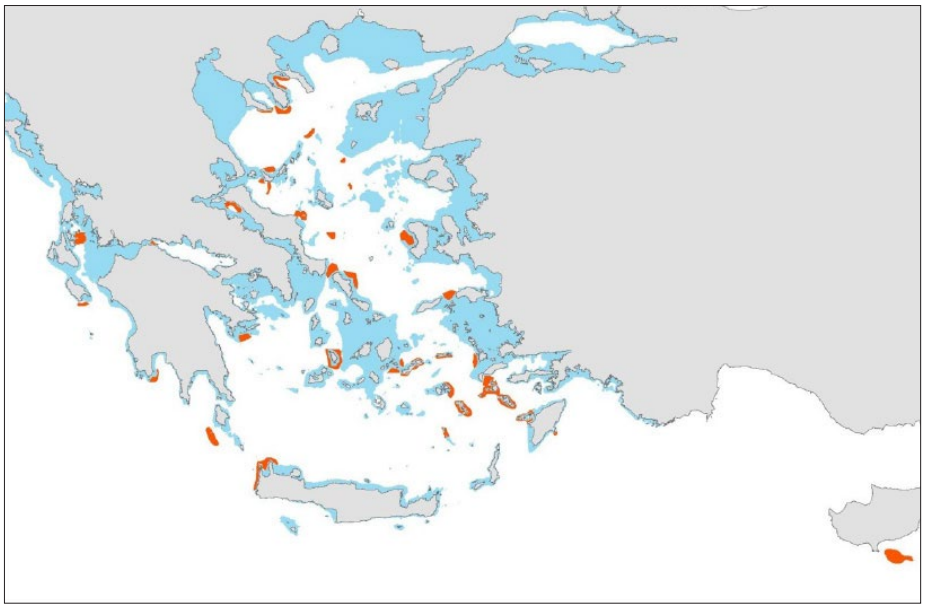

Fig. 8.9. Hotspot areas of Greek and Cypriot small scale vessels fishing activity in waters > 200 m depth, based on AIS and VMS data and MCDA approach.

SMALL SCALE FISHERIES

The study of AIS data from small scale fishing vessels cannot provide reliable estimates due to the fact that the fishing techniques (e.g. static nets, longlines and other passive gears) cannot been correctly attributed to each vessel and because the number of vessels providing data is limited. Therefore, it was not possible to identify and map this fishing activity in the whole E. Mediterranean from the available AIS data set. Nonetheless, for the GSAs 20, 22, 23 and 25, information from VMS and AIS data was combined with the results of MCDA and a series of hot-spot fishing areas at depths > 200 m were identified Fig. 8.9). It is estimated that 850 vessels are occasionally operating in depths deeper than 200 meters, targeting mainly species such as *Merluccius merluccius, Pagrus pagrus, Dentex dentex, Polyprion americanus,* and *Pagellus bogaraveo*. Some of the hotspot areas are located close to seamounts.

Greek small scale vessels were found to operate in the N. Aegean Sea with static gears mainly at Psathoura seamount (North Sporades) at 300-500 m depth (2012-2014), south of Agios Efstratios Island in waters 400-450 m depth (2014-2015), off Cavo Doro North Ridge at 500-700 m depth (2013-2016) and south of Skyros Island at

600-750 m depth (2014-2016) Fig. 8.9). Nevertheless, given that most vessels lack AIS devices, these observations can be considered as indicative of the overall fishing activity in the area. In the S. Aegean Sea, research studies mentioned small scale fishing vessels work in the area of Kymi in E. Evia Island with gill nets targeting *Pagrus pagrus, D. dentex, Spondyliosoma cantharus*, *Diplodus sargus*, *Merluccius merluccius*, *Mustellus* spp., *Pagellus bogaraveo* and *Polyprion americanus*[31].

Small scale vessels from Cyprus were found to operate in the deep waters off Lemessos Gulf (Fig. 8.9).

It is worth mentioning that in 2013 and 2014, two EU vessels have been identified working in the Kythera seamounts area and in the deep waters south of Folegandros and east of Santorini Islands at 450-550 m depth, close to Hydra Island East mounts at 300-450 m, close to Karavi South seamount (Myrtoon Sea mounts) (2014) and in Avgo mounts (off N. Crete).

General Remarks

Fishing activities in the deep waters of the E. Mediterranean are nowadays increasing. Many gaps in knowledge, monitoring and management still exist for this activity. It is of concern that in some cases deep water fishing is conducted in vulnerable ecosystems (e.g. red shrimps fishing grounds coincide with the bamboo coral Isidella fields, *Polyprion americanus,* and *Pagellus bogaraveo* are exploited close to the seamounts). Some bycatch species in deep-water fishing are also characterized as vulnerable (e.g. sharks).

Present findings showed that no specific information exists regarding fishing effort and the corresponding fishing grounds where deep-water trawl fishery is practiced. VMS and AIS data is a helpful tool to visualize this activity, however, fishing vessels operating in the Mediterranean southern areas and in the eastern central region are not equipped with these devices, yet. Moreover, most small-scale vessels even working on static gear and in deep-waters are not using AIS.

The implementation of additional monitoring, control and surveillance actions are needed for a more reliable reporting and management of fishing activities in the deep-sea. Some inconsistencies were detected between information coming from AIS data and fishing activities reported in the literature for various fishing. Moreover, catches and landings are reported not in the GSAs of the fishing activity, but in the landing sites, resulting in bias in the assessment of the stocks of each GSA. For EU member states the mechanism and infrastructure of reporting (ERS) the exact catch composition in place should be revised. No observer system exists for the fishing activities outside national waters, although these should also be reported and monitored in the framework of the national data collection programmes.

While in the right paths, efforts are very needed for the development of an adequate programme to estimate the fishing footprint in the deep-waters of the Eastern Mediterranean, while also have adequate mapping of vulnerable biodiversity impacts and the realisation of specific management measures to protect vulnerable marine ecosystems and the exploited fisheries stocks. To this end, the GFCM Recommendations[6] on a multi-annual management plan for sustainable trawl fisheries targeting giant red shrimp and blue and red shrimp in the Levant Sea (geographical subareas 24, 25, 26 and 27) and Ionian Sea (geographical subareas 19, 20 and 21) are very promising. •

6 Recommendations GFCM/44/2021/6 and GFCM/44/2021/8

CHAPTER 8/

REFERENCES

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

2. Kroodsma D., Mayorga J., Hochberg T., Miller N., Boerder K., Ferretti F., Wilson A., Bergman B., White T., Block B., Woods P., Sullivan B., Costello C., and Worm B. (2018). ***Tracking the Global Footprint of Fisheries.*** Science,359.

3. Merino G., Coll M., Granado I., Gee J., Kroodsma D., Miller N.A., et al. (2019). ***FAO Area 37 - AIS-based fishing activity in the mediterranean and Black Sea***. In: Taconet, M., Kroodsma, and Fernande, J.A. (eds). Global Atlas of AIS-Based Fishing Activity - Challenges and Opportunities. Rome: FAO.

4. Kroodsma D., Miller N.A., Hochberg T., Park J., and Clavelle T. (2019). ***AIS based methods for estimating fishing vessel activity and operations***.In: Taconet, M., Kroodsma, and Fernande, J.A. (eds). Global Atlas of AIS-Based Fishing Activity - Challenges and Opportunities. Rome: FAO.

5. Amoroso R.O., Pitcher C.R., Rijnsdorp A.D., McConnaughey R.A., Parma A.M., Suuronen P., et al (2018). ***Bottom trawl fishing footprints on the world's continental shelves.*** Proceedings of the National Academy of Sciences of the United States of America,115: E10275–E10282.

6. Kavadas S., Damalas D., Georgakarakos S., Maravelias C., Tserpes G., Papaconstantinou C., and Bazigos G. (2013). ***IMAS-Fish: Integrated Management System to support the sustainability of Greek Fisheries resources. A multidisciplinary web-based database management system: implementation, capabilities, utilization & future prospects for fisheries stakeholder.*** Mediterranean Marine Science,14(1): 109–118.

7. Kavadas S. and Maina I. (2012). ***Methodology of analysis of Vessel Monitoring Sysem data: Estimation of fishing effort for the fleet of open sea fihsery, p 165.*** 10th Panhellenic Symposium of Oceanography & Fisheries, Athens, HCMR, Athens.

8. Kavadas S., Carmen B., Andrea B., Piera C., Stefano C., Camilla C., Lorenzo D.-A., Dokos J., Maina I., Martinelli M., Massutí E., Moranta J., Parisi A., Quetglas A., Russo T., Santojanni A., and Vasilopoulou V. (2014). ***Common methodological procedures for analysis of VMS data, including web-based GIS applications related to the spatial extent and intensity of fishing effort.*** PERSEUS Project. ISBN no: 978-960-9798-14-3, 40 + annexes.

9. Maina I., Kavadas S., Katsanevakis S., Somarakis S., Tserpes G., and Georgakarakos S. (2016). ***A methodological approach to identify fishing grounds: A case study on Greek trawlers.*** Fisheries Research,183: 326–339.

10. Kavadas S., Maina I., Damalas D., Dokos I., Pantazi M., and Vassilopoulou V. (2015). ***Multi-Criteria Decision Analysis as a tool to extract fishing footprints and estimate fishing pressure: application to small scale coastal fisheries and implications for management in the context of the Maritime Spatial Planning Directive.*** Mediterranean Marine Science,16(2): 294–304.

11. BSGM. (2015). ***Fishery Statistics, July 2015.*** Ministry of Food, Aquaculture and Livestock, 13 pp.

12. Kinacigil H.T. and İlkyaz A.T. (2012). ***Aegean Sea Fisheries.***In: Tokac, A., Gücü, A.C., and Öztürk, B. (eds). The State of the Turkish Fisheries. Turkish Marine Research Foundation (TUDAV), 34, Istanbul., pp. 233–241.

13. 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.

14. Öztürk B., Karakulak S., and Cira E. (2002). ***The location of living resources to the Aegean issues.*** In: Proceedings of the Symposium on the Aegean Continental Shelf and Related Problems. Atakoy Marina- Istabul., pp. 118–138.

15. Tokac A. and Soykan O. (2009). ***Alternative codend desings to improve size selectivity for Norwat Lobster (Nephrops Norvegicus) and rose shrimp (Parapeneaus longirostris) in the Aegean Sea.*** Crustaceana,82(6): 689–702.

16. Tokac A. and Soykan O. (2015). ***Deep Water Fisheries in The Aegean Sea.***In: Katağan, T., Tokac, A., Beşiktepe, Ş., and Öztürk, B. (eds). The Aegean Sea Marine Biodiversity, Fisheries, Conservation and Governance. TUDAV: 41. Istanbul, Turkey.

17. Avşar D., Mavruk S., Saygu I., and Özgür Özbek E. (2016). ***An Evaluation of The Fishery Landing Statistics Of The Mediterranean Coast Of Turkey: Statistics Of Which Species?*** In: Turan C, Salihoğlu B, Özgür Özbek E, Öztürk B (eds), The Turkish Part of the Mediterranean Sea. Marine Biodiversity, Fisheries, Conservation and Governance. TUDAV, Pub. No 43, pp 275–304

18. Öztürk B. and Kiyağa V.B. (2016). ***Fisheries in Iskenderun Bay fishing gears, Catching Methods and their main problems.*** In: Turan, C., Salihoğlu, B., Özgür Özbek, E., and Öztürk, B. (eds). The Turkish Part of the Mediterranean Sea: Marne Biodiversity Fisheries, Conservation and Governance. TUDAV, Publication No: 43. Istanbul, Turkey.

19. Özcan T., Ateş A.S., Bakir K., and Katağan T. (2016). ***Commercial Crustaceans on the Levantine Sea Coast of Turkey***.In: Turan C., Salihoğlu B., Ö.Ö.E. and Ö.B. (ed). The Turkish Part of the Mediterranean Sea; Marine Biodiversity, Fisheries, Conservation and Governance. TUDAV, Publication No: 43, Istanbul, Turkey.

20. Deval M.C. and Kapiris K. (2016). ***Population structure and dynamics of the blue-red shrimp A. antennatus (Risso, 1816) in the Antalya Bay, E. Mediterranean Sea.*** Scientia Marina,80(3): 339–348.

21. Bayhan K., Cartes J., and Faneli E. (2014). ***Biological condition and trophic ecology of the deep-water shrimp Aristaeomorpha foliacea in the Levantine Sea (SW Turkey).*** Mediteranean Marine Science,16(1): 103–116.

22. İsmen A., Tokac A., and Önal U. (2015). ***Demersal Fishes and Fisheries in The Aegean Sea.***In: Katağan, T., Tokac, A., Beşiktepe, Ş., and Öztürk, B. (eds). The Aegean Sea Marine Biodiversity, Fisheries, Conservation and Governance. The Aegean Sea Marine Biodiversity, Fisheries, Conservation and Governance. TUDAV: 41. Istanbul, Turkey.

23. Kaykac H., Tosunoğlu Z., and Tokac A. (2012). ***Trawl Fisheries***. In: The State of the Turkish Fisheries. TUDAV, Publication Number: 34, Istanbul., pp. 316–328.

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

25. GAFRD. (2015). ***Annual fishery statistics Report***. Ministry of Agriculture, General Authority for Fish Resources Development, Cairo Egypt.

26. GAFRD. (2018). ***Annual fishery statistics Report***. Ministry of Agriculture, General Authority for Fish Resources Development, Cairo Egypt.

27. 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.

28. 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.

29. Bavhan K.Y., Cartes J.E., and Fanelli E. (2015). ***Biological condition and trophic ecology of the deep-water shrimp Aristaeomorpha foliacea in the Levantine Sea (SW Turkey).*** Mediteranean Marine Science,16(1): 103–116.

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. Lefkaditou E., Damalas D., Kavadas S., Leondari C., Siapatis A., and 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. 109–112.