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Mapping of marine key habitats and assessing their vulnerability to fishing activities

in Foça Special Environmental Protection Area

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For bibliographic purposes, this document may be cited as
UNEP/MAP-SPA/RAC 2020. : Mapping of marine key habitats and assessing their vulnerability to fishing activities in Foça Special Environmental Protection Area. By Kaboğlu, G., Akçalı, B., Kızıldağ, N., Tıraşın, E. M., Atgın, O., Özel, Ö., Oğuz Kaboğlu, S., Cihangir, B., Özdaş, A. H., Açık Çınar, Ş., Yılmaz, F., Önen, S., Bitlis, B., Yılmaz, E. C., Bizsel, K. C., Yıldız, İ. Karayalı, O. & Özgen, Ö. Ed SPA/RAC, Tunis: 299 pp.

Layout
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Cover photos credit
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The present report has been prepared in the framework of the projet **MedKeyHabitats II** project financed by the **MAVA** foundation.

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LIST OF ABBREVIATIONS AND ACRONYMS

°C	Degree Celsius
A	Area
ASTM D421	Standard Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants of American Society for Testing and Materials
ASTM D422	Standard Test Method for Particle-Size Analysis of Soils of American Society for Testing and Materials
B	Benthos Station
BZ	Buffer Zone
CBD	Convention on Biological Diversity
cm	Centimeter
Conv	Convergent Interpolation
CTD	Conductivity-Temperature-Depth
CZ	Core Zone
DDC	Dropdown Camera
DEU-IMST	Dokuz Eylül University-Institute of Marine Sciences and Technology
DGPS	Differential Global Positioning System
EA	Ecosystem Approach
EAF	Ecosystem Approach to Fisheries
EBM	Ecosystem Based Management
EU	European Union
EUNIS	European Nature Information System
FAO	Food and Agriculture Organization of the United Nations
FC	Fish Counting
GCML	Grey Level Co-occurrence Matrix
GES	Good Environmental Status
GIS	Geographic Information System
GRT	Gross Registered Tonnage
GPA	Global Programme of Action for the Protection of the Marine Environment from Land-based Activities
HB	Hard Bottom
ICZM	Integrated Coastal Zone Management
IDW	Inverse Distance Weighted Interpolation
IMAP	Integrated Monitoring and Assessment Proramme of the Mediterranean Sea and Coasts and Related Assessment Criteria
Isoc	Isochore Interpolation
ISSCFG	International Standard Statistical Classification of Fishing Gear
IUCN	International Union for Conservation of Nature
İZKA	İzmir Development Agency (İzmir Kalkınma Ajansı)
kg	Kilogram
kHz	Kilohertz
km	Kilometer
Krig	Kriging Interpolation
m	Meter
MAP	Mediterranean Action Plan
MinCur	Minimum Curvature Interpolation
mm	Milimeter
MNHN/SPN	Muséum National d'Histoire Naturelle-Service du Patrimoine Naturel

MCPA	Marine-Coastal Protected Area
MPA	Marine Protected Area
MSFD	Marine Strategy Framework Directive
N	Number
N2K	European Economic Interest Group
NGO	Non-Governmental Organization
NIS	Non-Indigenous Species
NN	Natural Neighbour Interpolation
NTG	Non-Target Visual Survey Station
PoMS	Posidonia oceanica Monitoring System
PSU	Practical Salinity Unit
QA/QC	Quality Assurance/Quality Control
R/V	Research Vessel
s	Slope (in fish counting)
SAP BIO	Strategic Action Programme for the Conservation of Biological Diversity in the Mediterranean Region
SBES	Single Beam Echosounder
SD	Sediment Sampling
SDF	Standard Data-Entry Form
SE	Standard Error
SEPA	Special Environmental Protection Area
SPA/RAC	Specially Protected Areas Regional Activity Centre
SSS	Side Scan Sonar
TG	Side Scan Sonar Target
TIN	Triangulated Irregular Network Interpolation
TL	Fish Total Length
TPU	Transceiver Processor Unit
TR	Transect
TVKGM	The General Directorate for Protection of Natural Assets of the Ministry of Environment and Urbanization ()
UNEP	United Nations Environment Programme
UTM	Universal Transverse Mercator
UVC	Underwater Visual Census
WGS	World Geodetic System

EXECUTIVE SUMMARY

The Foça Special Environmental Protection Area (SEPA) has been attracted many conservation efforts since its establishment in 1990. The local authorities, local public and NGOs have a high awareness on the environmental problems as a result of these initiatives. However, the human pressure continues to increase on the marine environment, as well as other ecosystem components of the area.

The gap analysis has showed that there are large data gaps in the way of both the determination of the marine habitats in the area, and assessing their sensitivity to fishing practices. For this reason, seabed data acquisition was given a high priority using acoustic techniques with ground-truthing.

This report aims to provide an overall view of the marine habitats of the Foça Special Environmental Protection Area (SEPA) between 0-50 m depths and the sensitivity of these habitats to fishing activities. It is the first application of its kind in the Turkish marine realm, with a great effort of the scientific and technical personnel of the Institute of Marine Sciences and Technology of the Dokuz Eylül University. The study comprises of a multidisciplinary research approach in order to reach the project goals and objectives. The assessments provided comprehensive results of the Foça SEPA habitats and their interactions with the fishing activities.

The report starts with a summary description of the study area, and continues with the methodology applied. The following sections presents the results of the study.

In the study, the bathymetric measurements were conducted to map the seafloor, and the sonar imaging systems were used to map the seabed textures. Oceanographic measurements and sediment samplings were also made in order to obtain information on the seabottom and seabed properties. Dropdown camera visualization and transects were conducted as ground-truthing for habitat mapping. Hard bottom and soft bottom benthos communities were determined by quadrate and grabs. 4 *Posidonia oceanica* monitoring systems were set up in the area.

Another data component in order to reach the project goals was about the fish and fisheries of the Foça SEPA. Fish counting and questionnaire survey with the fishermen were performed to obtain the fish species, their densities, socio-economics of the Foça fishermen, and the spatial information on the fishing practices. The impact of fisheries on the marine habitats were then assessed using habitat distributions and fisheries data.

The bathymetric structure of the Foça SEPA was obtained at its highest resolution, clearly showing the complex morphology of the Foça SEPA, due to the archipelago formation. The seabed sediments in the area were diverse because of this phenomena, from gravelly sediment to silty clay.

The faunistic analysis of the benthic samples collected from soft bottom stations at the coast of Foça SEPA yielded a total of 303 species and 4821 individuals belonging to 12 systematic groups (Porifera, Cnidaria, Plathelminthes, Nemertea, Nematoda, Polychaeta, Sipuncula, Crustacea, Mollusca, Bryozoa, Echinodermata, and Tunicata). Mollusca had the highest number of species (128 species) and individuals (2447 individuals, 50.8%) on the soft bottom samples. Epilithic algae was the dominant group in terms of the percentage cover of hard substrate organisms at all selected stations except for one station. This group was followed by Corallinacea (spp.) considering the percentage cover.

In the study, habitat types of infralittoral rock, infralittoral biogenic habitat (*Posidonia* meadows), infralittoral coarse sediment, infralittoral mixed sediment, infralittoral sand and infralittoral mud were observed and spatially defined. The rock habitats are generally algal-dominated in the study area. In the deeper zones, there are rocky formations affected by sediments. These rock habitats were observed to host Axinella sponges and Brown meagre (Sciaena umbra) (e.g. between Fener and İncir Islands), and other sponge and coralligene species (e.g. between Hayırsız and Orak Islands). The *Posidonia* meadows have a distribution throughout all coasts, except for the inner part of the port and western coast of the Fener Island. Other parts are formed by sedimentary structures such as sands, mixed sediments and muds. The depth limit of the *Posidonia oceanica* increases to the north. In the fieldworks, the southern part (to the south down to Orak Island, which are port and the marine discharge areas) were observed to have high turbidity.

Within the boundaries of the Foça SEPA, 25 fish species were observed by the underwater visual census method (UVC) at three (5-10-20 m) different depth strata. However, around 60 fish species have previously been reported from this region in the literature. One of the major problems is the illegal fishing in the area. Illegal trawling is concentrated on the 50 m depth contour, whereas illegal beam trawling is dense in the area between Orak Island, Incir Island and the mainland. Illegal spear fishing is generally performed on the coasts away from the center. Illegal sea cucumber collection is another activity in the area and it is performed almost at all coasts of the SEPA. The study revealed that fishing practices have interactions with cetaceans, Mediterranean monk seals, turtles, fish and seabird species. Among these, cetacean and monk seal interactions are the most common and distributed ones. The gear density of the commercial fishing is high around the islands, resulting in a high sensitivity of the marine habitats in these areas. On the other hand, illegal fishing is dense between Orak and İncir Islands and the mainland, and the port area. This situation results in a distributed pressure among the habitats in the area.

After these assessments, several recommendations for the protection and management measures to be Introduced in the Foça SEPA were presented. These recommendations are mainly to develop a monitoring and control mechanism in the area, together with some fisheries applications. Additionally, some recommendations for the management and conservation of the habitats in the Foça SEPA were proposed. 5 core zones and 7 buffer zones, all of which are also habitat monitoring areas, were recommended. Furthermore, 23 oceanographic monitoring stations were recommended in order to monitor turbidity and other oceanographic properties. The most urgent management issue is assessed as to take

measures against illegal fishing, which decrease the fish biomass, increase interactions with other marine species and impacts the marine habitats.

The overriding objective of this project was the mapping of marine key habitats and assessing their vulnerabilities to fishing activities in order to achieve long term conservation of the Foça SEPA marine ecosystem. Given the complicated and complex set of sometimes conflicting societal interests in the area, this can best be achieved by adopting a strategy, which considers all stakeholders' interests and strives to strike a balance between human and ecological well-being through transparent and competent governance. The ecosystem approach is ideally suited for this task as it is an adaptive management strategy rooted in the principles of the International Convention on Biological Diversity. The first logical step in the process of achieving a holistic management of the entire Foça SEPA, is the preparation of a fisheries management plan based on the ecosystem approach to fisheries. The final aim should be achieving the ecosystem-based management in the Foça SEPA, which takes all ecological and social systems into consideration. It is obvious that the information obtained, the experience gained and the outputs of the study will contribute to achieve the mentioned goals, through the conservation and sustainable use of the marine resources in the Foça SEPA in the following decades.

1

1

SUMMARY DESCRIPTION OF THE STUDY AREA FOÇA SEPA

Foça is a touristic destination and one of the major fishing villages of the Turkish Aegean coast, located in the Izmir province. This peninsula is an important natural, cultural, historical and social site at the north-east edge of the Izmir Bay and includes one of the 12 coastal/ marine Special Environmental Protection Areas (SEPA) of (Figure-1). It was declared as a SEPA in 1990 in order to protect Mediterranean monk seals (Monachus monachus) in the area, and was enlarged in 2007 to present borders (TVKGM, 2011).

Foça has a 3000-year of history based on documents (Keskin et al., 2011). Foça settlement was called as Phokaia in ancient times. The name of Phokaia was given for the resemblance of the isles in the bay as Seal (Phoca), which is considered to be because of the existence of the seal Figures on the archaic period coins and natural living spaces in the region strengthen the idea that the settlement was named from phocas (Çetin, 2002).

In addition to its historical and cultural sites, the Foça SEPA has also marine and land biological values with national and international significance: the endangered Mediterranean monk seal (Monachus monachus), the Mediterranean endemic seagrass *Posidonia oceanica*, rich avifauna, commercial and non-commercial fish species, and rich marine and land biodiversity (TVKBM, 2016).

The area attracted conservation efforts in 70s because of its natural, historical and cultural values mentioned above. 11 national site areas (a Turkish national protection status, "sit") status categories were assigned in the area in order to protect land components of the SEPA. These categories remain the same with some spatial modifications in the recent years (TVKBM, 2016).

On the other hand, regulations in the marine component of the Foça SEPA started in 90s. The area was granted SEPA status in 1990, largely on account of its monk seal population, and was enlarged to its present borders in 2007, being still the smallest marine and coastal SEPA in with an area of 71.38 km2 (TVKGM, 2011; Bann & Başak, 2011). There have been some other regulations such as navigation regulation zone, which bans cargo vessels greater than 300 GRT and all vessels carrying dangerous substances in some part of the marine components of the SEPA, in addition to fishing regulations (Kaboğlu, 2007). The Foça Peninsula (including part or all of the SEPA borders) was also designated as Pilot Monk Seal Conservation Area for the protection of monk seals (Güçlüsoy & Savaş, 2003), and was assigned as Key Biodiversity Area (BirdLife International, 2010 & 2017) and Important Natural Area (Eken et al., 2006).

The major pressures in the Foça SEPA are listed as 1) Overexploitation and illegal extraction of the fish stocks, 2) Increasing human usage of the marine and coastal environment, 3) Coastal and marine pollution, 4) Damage and destruction of the sea bottom, 5) Invasive marine species Caulerpa cylidracea, and 6) Lack of freshwater supplies and water treatment facilities in the Economic Analysis of the Foça SEPA (Bann & Başak, 2011). Foça region is also considered as one of the major environmental threatened areas due to ports and untreated industrial wastewater (AÇA, 2006).

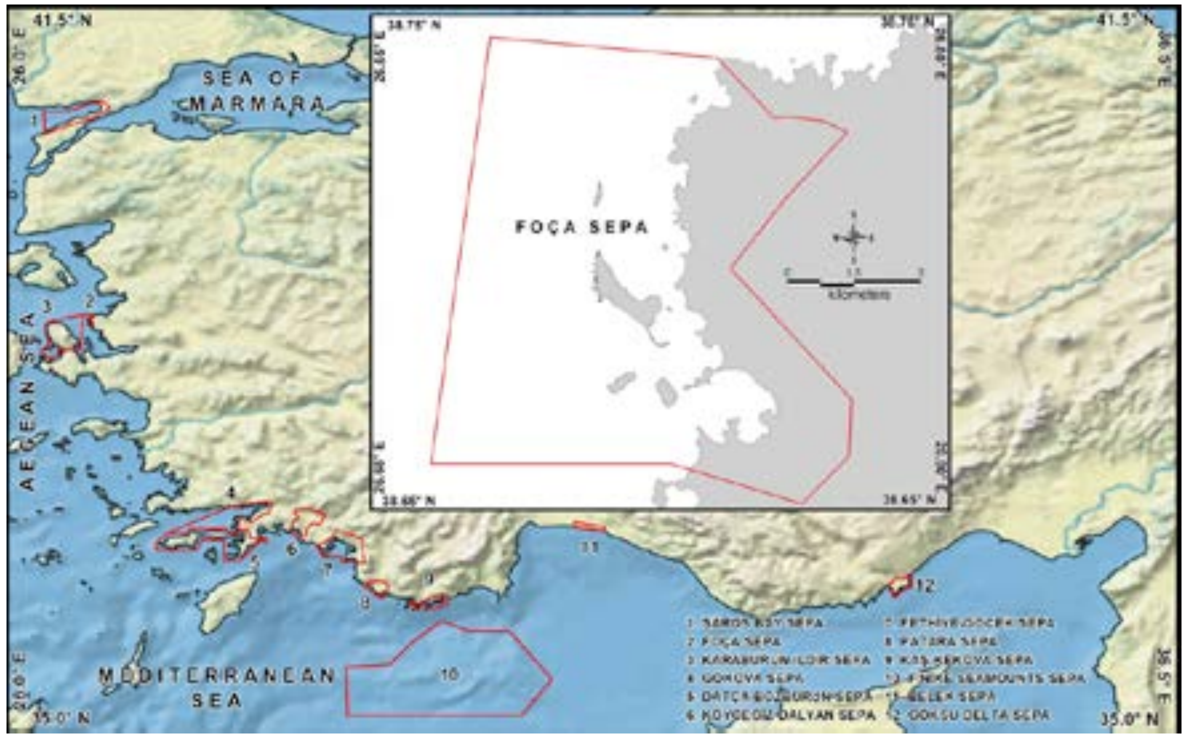


Figure 1

Location of Foça SEPA (Basemap from Natural Earth database, http://www.naturalearthdata.com)

The Foça SEPA coasts are located within the Aslan Cape at the northern and Deveboynu Cape at the southern borders. Geological units of the Foça SEPA coasts and their seaward and landward extensions are characterized generally by Early and Middle Miocene pyroclastics, volcanites and Holocene beach deposits. Volcanic structure had formed a rough terrain in the area (TVKGM, 2016). The archipelago formation is also a result of this structure.

Before 2020, the only component of habitat type mapped was the *Posidonia oceanica* meadows in 2005 (Foça Municipality-SAD-DEU-IMST, 2006; Akçalı et al., 2019). This current research revealed that there are 15 habitat types in the Foça SEPA 0-50 m depth zone. These types are: MA1.5 Littoral rock, MB1.51 Algal-dominated infralittoral rock, MB1.51a Well illuminated infralittoral rock, exposed, MB1.51c Well illuminated infralittoral rock, sheltered, MB1.52 Invertebrate-dominated infralittoral rock, MB1.52a Moderately illuminated infralittoral rock, sheltered, MB1.53 Infralittoral rock affected by sediments, MB1.56 Semi-dark caves and overhangs, MB2.54 *Posidonia oceanica* meadows, MB3.5 Infralittoral coarse sediment, MB3.53 Infralittoral pebbles, MB4.5 Infralittoral mixed sediment, MB5.5 Infralittoral sand, MB5.52 Well sorted fine sand and MB6.5 Infralittoral mud sediment. Another result of the research was that there are 303 benthic species under 12 systematic groups in the soft bottom habitats, and species belonging to 7 taxonomic groups were identified in the hard substratum.

Foça is one of the largest fishing harbors in the Turkish Aegean (Veryeri et al., 2001) and the district is estimated to provide 20% of the Aegean region's fish supply (İZKA, 2009). About 30% of Foça's population is estimated to earn their income from fishing activities (Bann & Başak, 2011). There are 15 trawling and 97 artisanal fishing vessels in the Foça port by 2019 (Foça Fisheries Cooperative, 2019). Trawling and purse seining was banned in the area in 1991. Moreover, all gears other than trammel nets, longlines and fishgarths are prohibited within the SEPA (Anonymous, 2016a). Illegal and recreational fishing is a major pressure for the fish stocks of the area.

2

2 METHODOLOGY OF THE STUDY

The methodology applied within the project comprises of three main steps: 1) gap analysis (Phase-I), 2) fieldworks (Phase-II), and 3) data analysis and preparation of the outputs (Phase-II & III). The tasks involved in these steps are presented according to the definitions in the technical specifications in this chapter. Detailed information on gap analysis and fieldwork missions can be reviewed from the Phase-I (Summary report of the available knowledge and gap analysis report) and Phase-II (Phase II: Fieldwork report) reports.

2.1. Available Knowledge and Gap Analysis

The conceptual, technical, and organizational bases of gap analysis have been developed and widely used since the underlying principles of gap analysis were discussed in 1980s (Scott et al., 1993; Jennings, 2000). In this study, we applied a simplified and modified form of gap analysis method presented by Langhammer et al., 2007. Gap analysis within the context of this study can be defined as follows:

> "A method for determining the gaps in the available knowledge for the achievement of predetermined goals and objectives in a specific area, which specifies the limits and prioritization of components of interest"

The meaning of the terms used in the definition and applied methodology are as follows:

Predetermined goals and objectives: The goals and objectives of the project "Mapping of marine key habitats and assessing their vulnerability to fishing activities in Foça Special Environmental Protection Area, " (See section 1. Introduction)

Specific area: Foça SEPA (0-50 m isobaths)

Components of interest:

1. Physical (geophysical, geomorphologic and oceanographic) features: bathymetry, sonar, sediment, CTD (conductivity-temperature-depth)
2. Biological features: marine habitats, benthos, fish, marine mammals
3. *Posidonia oceanica* monitoring
4. Fisheries socio-economics: socio-economics of fishermen, gears-area use-effort, fleet, target species, fish underwater visual survey
5. Fisheries impact on marine habitats: marine habitats, fishing gears-area use-effort

Gap/limits: no-data (full gap), geographical coverage, acquisition date, resolution, reliability

Priority: the level of obligation to fill the gap in each component of interest as high, moderate or low priority

We performed a systematic review in order to obtain all scientific and grey literature, in addition to the institutional available data, and performed a synthesis to both datasets to define the gaps. A systematic review is defined as a research method that "...attempts to collate all empirical evidence that fits pre-specified eligibility criteria in order to answer a specific research question" (Higgins & Green, 2008). We performed our systematic review in Google, Google Scholar, ISI Web of Knowledge, SCOPUS and ResearchGate platforms in order to reach to all peer reviewed and grey literature about the defined components of interest subjects. The results were than filtered according to the case that if they include any data/results for the Foça SEPA.

2.2. Spatial Distribution of Habitats

The gap analysis performed in the Phase-I showed that the data required for the basis of determining the spatial distributions of marine habitats had a significant gap. Bathymetry, sonar imaging and seabed sediment properties were the data needed to define the characteristics of the seafloor, and they had a high priority for the accomplishment of the project. The fieldworks for determination of spatial distribution of habitats were performed with R/V Dokuz Eylül 3 and a local boat Seyyah between 26.10.2019 and 03.11.2019. Detailed information on the fieldworks (e.g. line & station coordinates) and daily reports are given in the Digital Annex-I and Digital Annex-II, respectively.

2.2.1. Geophysical Survey: Single Beam Echosounder (SBES)

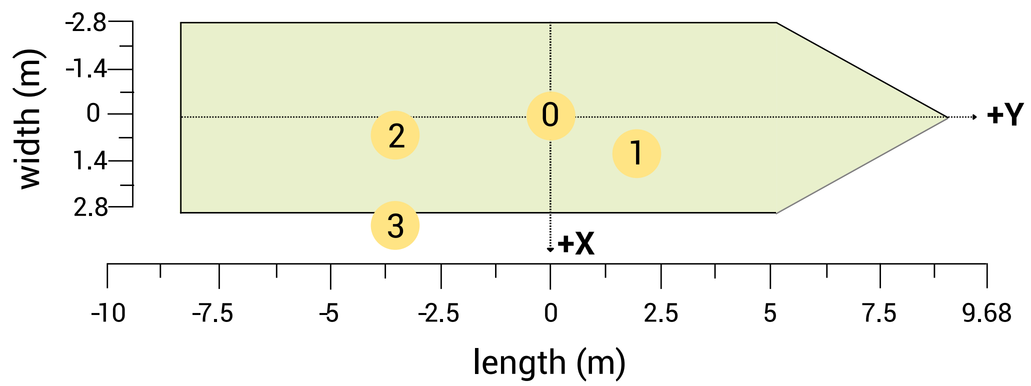
The first phase of SBES data collection study started on 27.10.2019 with R/V Dokuz Eylül 3 belonging to DEU-IMST. R/V Dokuz Eylül 3 data collection phase was carried out until 31.10.2019. Afterwards, the data collection in the shallow zones started with a small local boat (Seyyah) and this process was completed between 02.11.2019 and 03.11.2019. The equipment used in the data collection phase is given in Figure-2. The data was collected in the UTM WGS84 projection system. The geodesic parameters of the used coordinate system are given in Table-1.

Table 1
Geodesic parameters used in the SBES survey

UTM zone	35
Ellipsoid	WGS 84
Inverse flattening	298.257223563
Semi major axis	6378137
Projection	UTM (North)
Origin scale	0.999600000000
Central meridian	0.0000"'027°00
Origin latitude	0.0000"'000°00
False easting	500000.0000

Figure 2
Data collection components a) Single Beam Echo Sounder Transducer, b) SBES System Unit, c) TSS motion sensor, d) NAVIPAC navigation system (left), Hydro Pro Data Collection System, e) CTD Probe

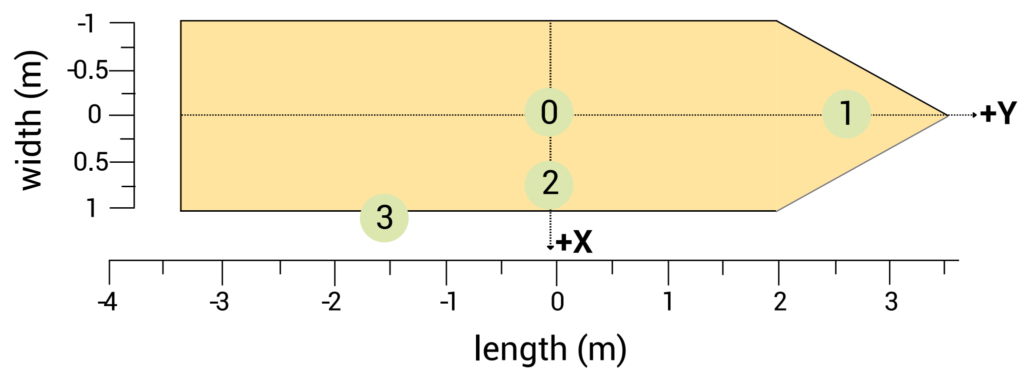
The positions of the equipment used on R/V Dokuz Eylül 3 and the local boat Seyyah are shown in **Figure-3** and **Figure-4**, respectively.



NO	SENSOR	X(meter)	Y(meter)	Z(meter)
0	Origin	0	0	0
1	SeaStar DGPS receiver	2.0	1.0	4.8
2	TSS (Motion Sensor)	0.40	-3.5	2.2
3	Single Beam Echosounder (SBES)	3.2	-3.4	-1.8

Figure 3

R/V Dokuz Eylül 3 sensor offsets and locations



NO	SENSOR	X(meter)	Y(meter)	Z(meter)
0	Origin	0	0	0
1	SeaStar DGPS receiver	0	2.75	1.5
2	TSS (Motion Sensor)	0.75	0	0
3	Single Beam Echosounder (SBES)	1.2	-1.5	-0.8

Figure 4

Local boat (Seyyah) sensor offsets and locations

SBES data was acquired on 49 orthogonal lines with 200 m spacings. Data was also collected on 3 control lines perpendicular to these lines and on 2 transit lines (**Figure-5**).

During the study, CTD data were collected at 5 stations, one per each survey day. Before SBES data were acquired, water column sound velocity information was obtained and entered into data collection software.

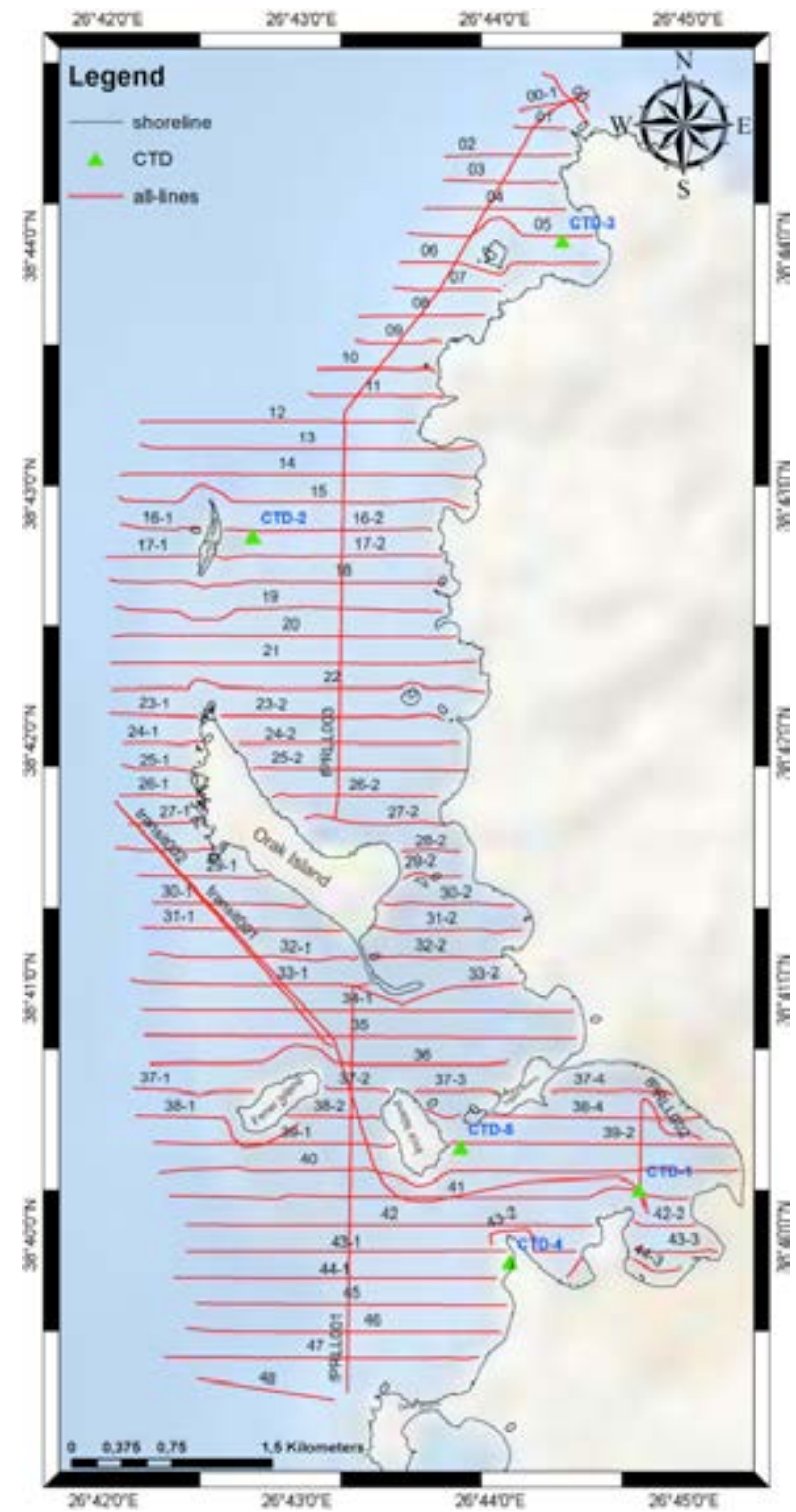


Figure 5

Map of the SBES survey lines and CTD locations

2.2.2. Side Scan Sonar Survey (SSS)

With the aim of conducting cartographic inventories of marine key habitats in the Foça SEPA, sea floor was mapped by using Side Scan Sonar (SSS) up to 50 m depth with R/V Dokuz Eylül 3.

Klein 3000H dual frequency (445 and 900 kHz), high-resolution digital SSS data were acquired to create mosaic map of seafloor (**Figure-6**). The survey lines were spaced to assure a minimum overlap of 10% between adjacent lines (**Figure-7**). Line spacing were fixed and parallel to each other. A frequency of 445 kHz was set between 20 m to 50 m depth contours, with the range of 150 m (total swath width of 300 m), while SSS was towed by cable. The height of the towfish above the seafloor was approximately 10% of the range. The survey lines were adapted both sea floor topography and shoreline.

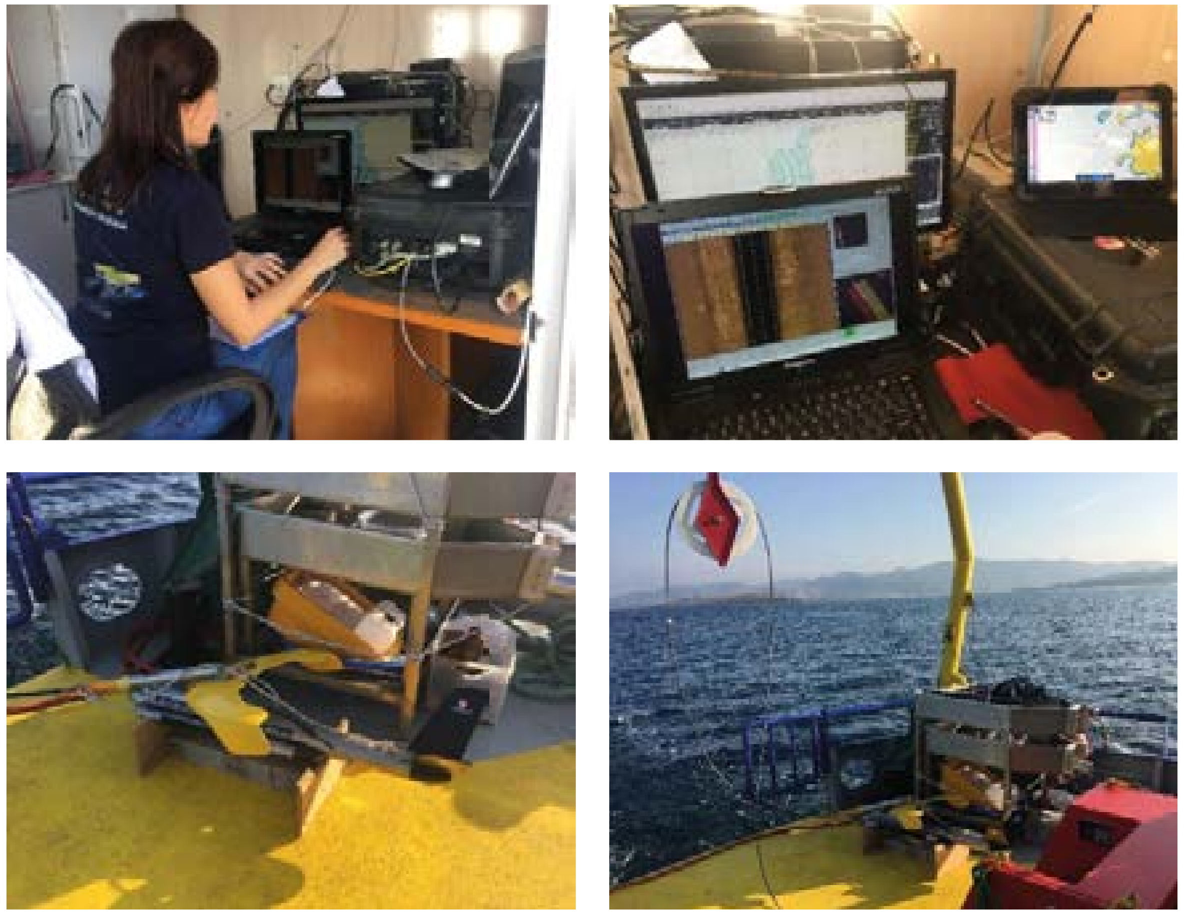


Figure 6
SSS operation on R/V Dokuz Eylül 3 (software laptop and TPU (above); towfish and winch (below))

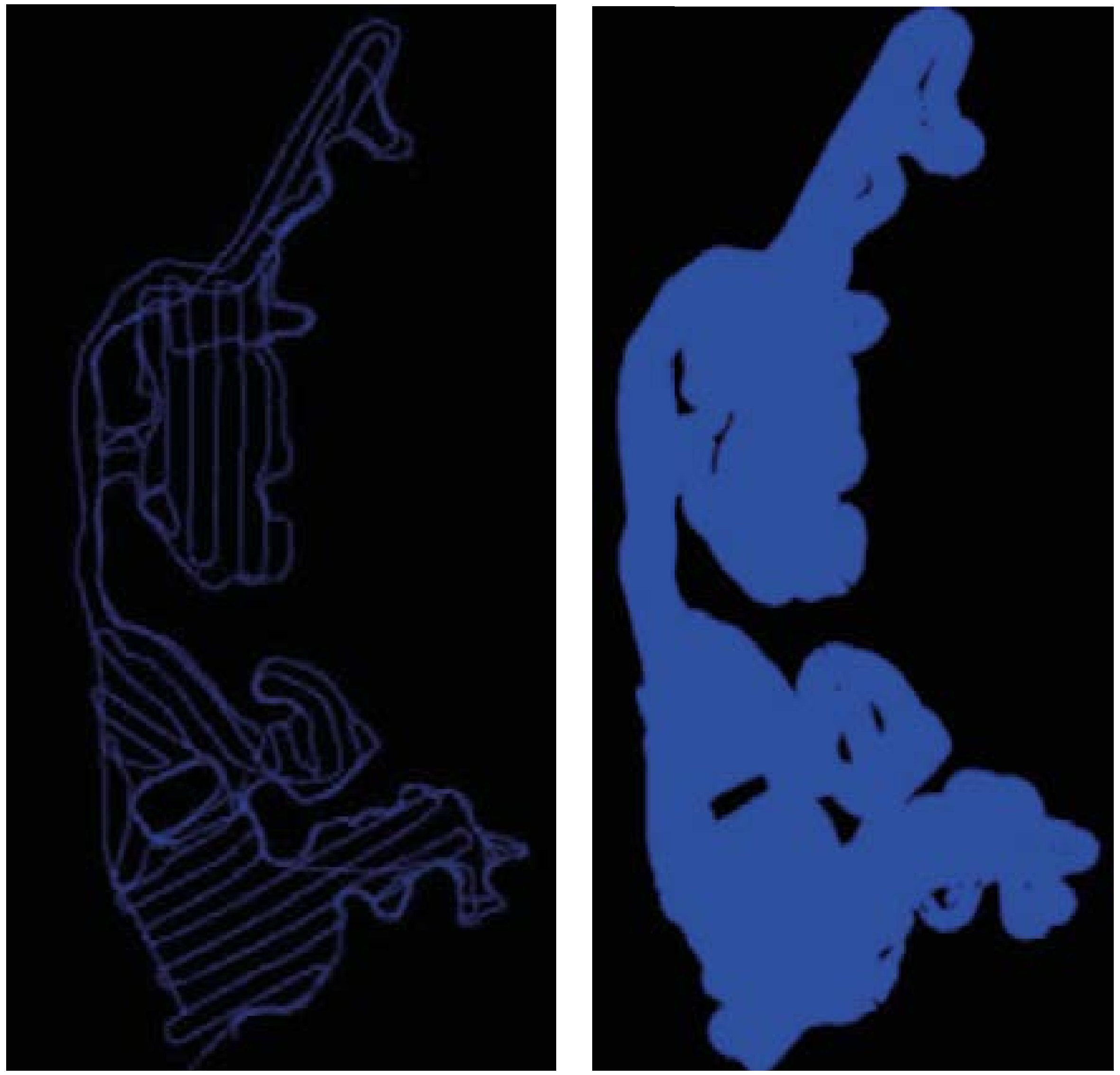


Figure 7
SSS survey lines (left) and mosaic coverage map (right)

Due to some difficulties such as intended coastline, shallows and rocky outcrops, dense fishing activity, anchored boats, buoys, fishnets, etc. on the survey lines, some areas in shallow waters close to the shore were partly imaged within only safety depth limits for both towfish and the research vessel.

SSS was operated with side-mounting method, in order to avoid any risk from exposed rocks and shallows. In the shallow waters, the frequency and the range was adjusted to 900 kHz and 50 m respectively. Due to the fact that the shallow regions that is suiTable for side-scan sonar operation was able to image by using R/V Dokuz Eylül 3 covering the large amount of coastline, a small boat not required to use.

Data acquisition speed was between 3 and 4 knots. The positional data were provided by JRC differential global positioning system (DGPS) during the survey. Klein SSS Software interface was used, which is capable of integration with a navigation software and real time update of the layback (cable out). The corrected towfish position was calculated by the software by inputting layback parameters (xyz offset of sheave according to DGPS antenna and cable out length).

2.2.3. Seabed Sediment Sampling

Seabed sediments were collected with Van Veen grab sampler by R/V Dokuz Eylül 3 in the project. The survey was performed at 15 stations (Figure-8).

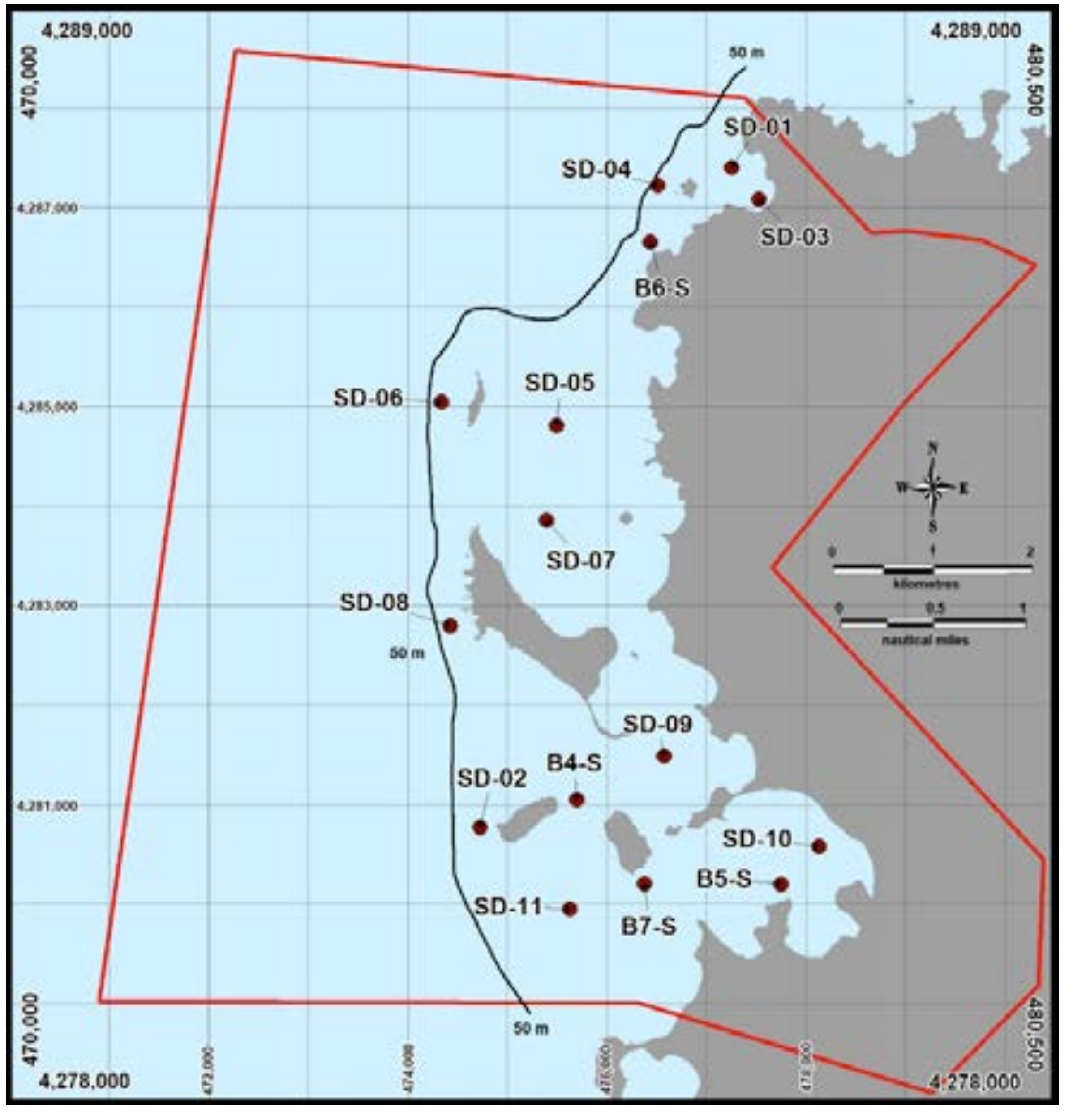


Figure 8

Location of sediment sampling stations

After the marine survey completed, samples were stored to be analysed at the Geology Laboratory of DEU-IMST. ASTM D421 and ASTM D422 standards were applied for mechanical sieve analysis and hydrometer analysis, respectively.

2.2.4. CTD Measurements

CTD measurements were made using Sea Bird Scientific SBE19 Plus V2 SeaCAT profiler CTD device by R/V Dokuz Eylül 3. The survey was conducted at 38 stations in the study area (Figure-9).

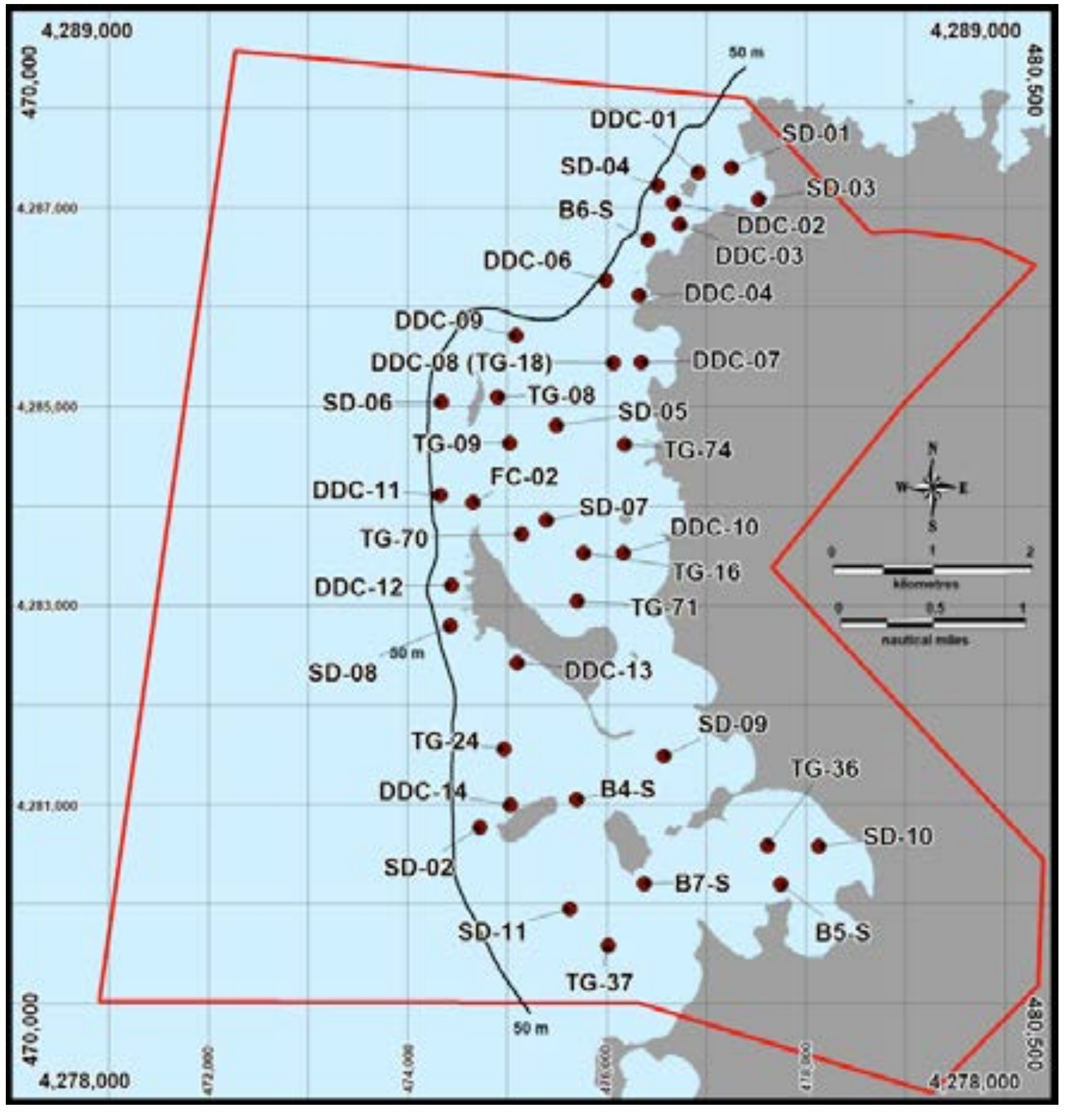


Figure 9

Location of CTD measurement stations

The data was transported to PC using Seaterm V2 software and hex files were created for each station. Then, these files were converted to the cnv format using SBE Data Processing 7 software. The profile data was opened in MS Excel software and was checked for erroneous data.

2.3. Preliminary Analysis: Analysis of SBES and SSS

The main goal in the preliminary analysis was to plan ground-truthing data acquisition for habitat characterization tasks using acoustic data. For this reason, the project team made a meeting after acoustic (SBES & SSS) survey at DEU-IMST on 05.11.2019 and made survey (sampling and measurement) plans.

2.3.1. Preliminary Analysis of SBES Data

The entire data set was completed with primarily a 50x50 m grid spacing and a sea floor bathymetry map was created (Figure-10). Depth values range from 0 to -63 m. Seabed depth values vary between 0 and -5 m at coastal and island margins.

The 3D drawing of the generated bathymetry depth map are given in Figure-11. When the 3D bathymetry map is examined, it is seen that the islands have an interrelated morphology under the water column. Especially between Orak Island and Hayırsız Island, it is clearly seen that the two islands are connected to each other at depth of -25 m. Similarly, there is a connection between İncir Island and Fener Island with a depth of -2 m between İngiliz Cape and İncir Island.

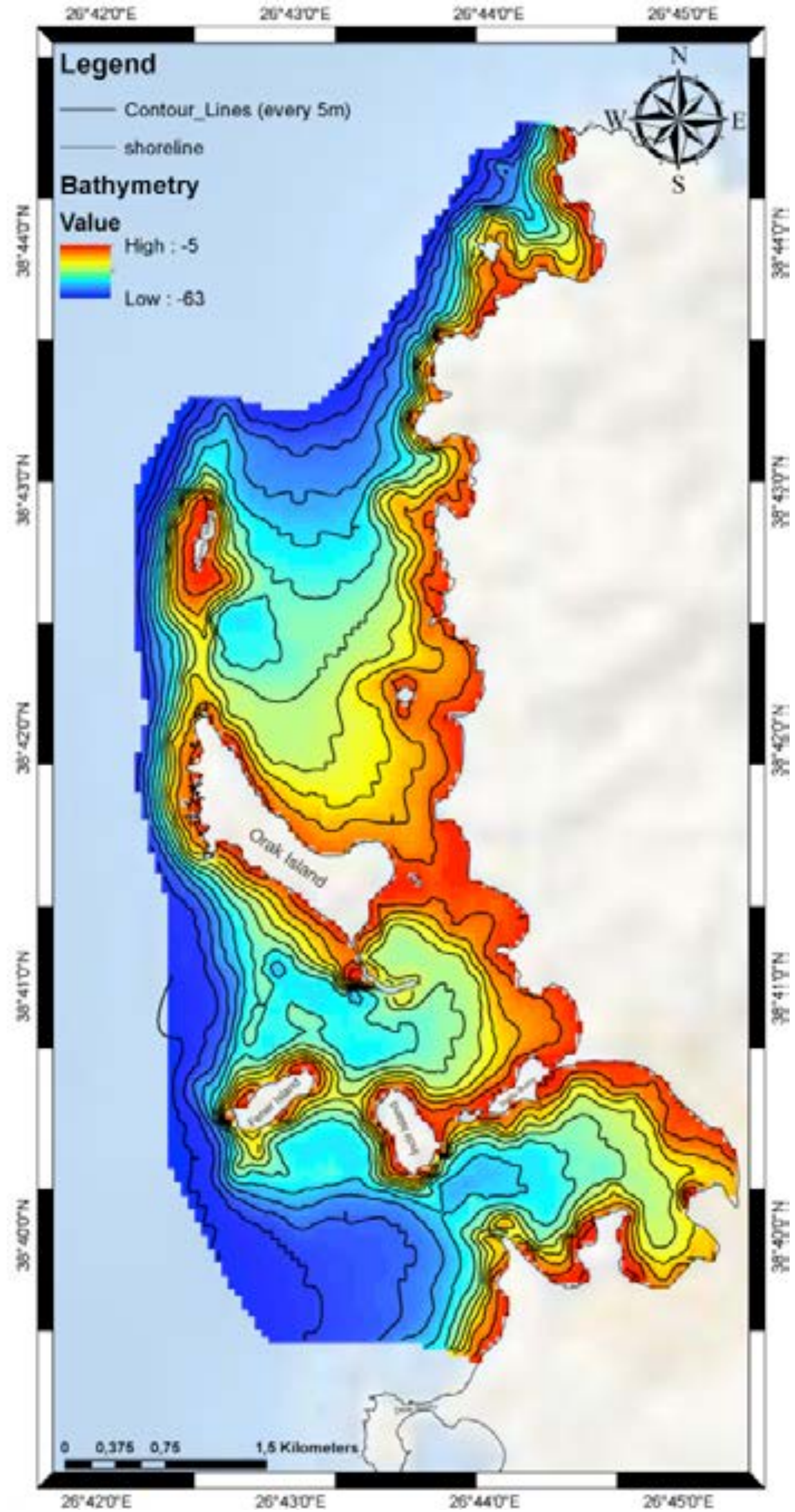


Figure 10

2D bathymetry grid map (cell size 50 m)

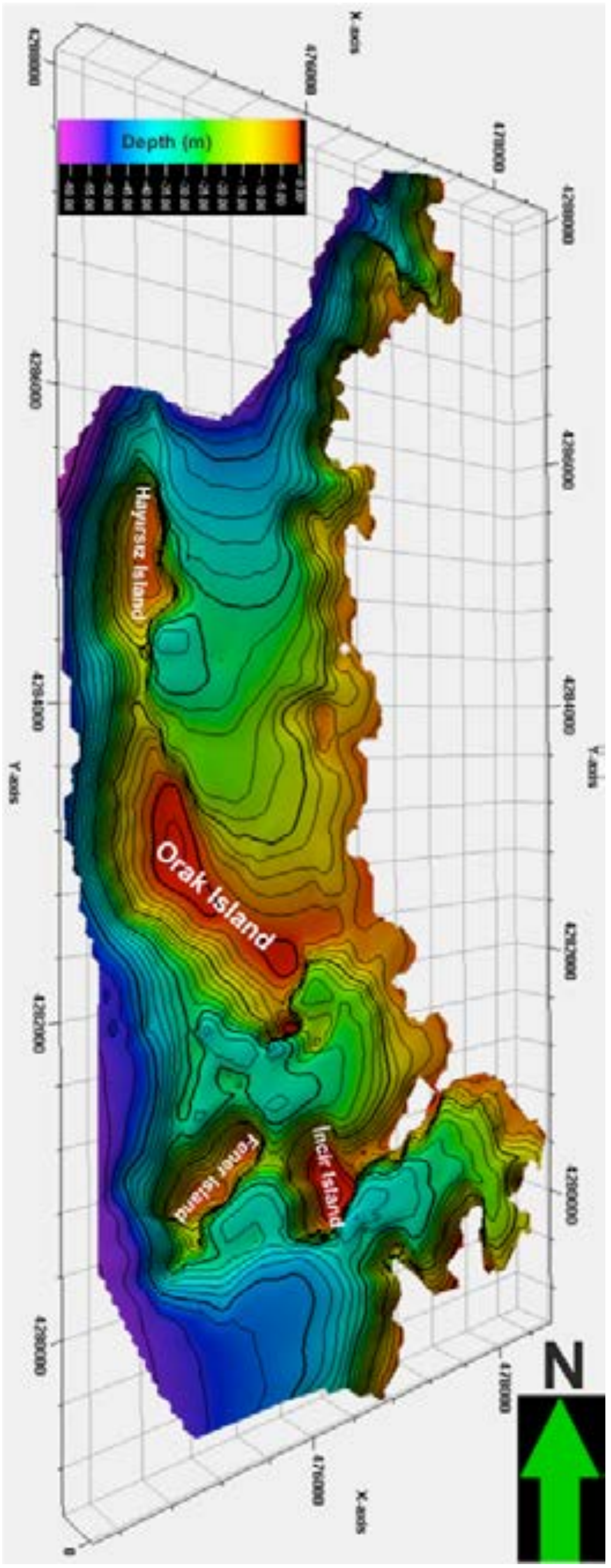


Figure 11

Preliminary 3D bathymetry map of the study area (vertical exaggeration 5 times)

2.3.2. Preliminary Analysis of SSS Data

75 target images were exported during the SSS survey in order to plan the following habitat characterisation surveys (Figure-12). With SSS survey, hard bottom (rocks, reef, etc.) and soft bottom (sediment) with sand ripples were defined, the degree of damage or fishing and anchoring activities were clearly observed, pipeline and geological structures were followed and fish groups could be observed.

The *Posidonia* limits were defined on the mosaic and mapped visually without using the ground-truthing data in order to obtain possible borders for monitoring system set-up (Figure-13).

After preliminary analysing of SSS data, the stations were defined for hard and soft bottom survey, fishing counting, and *Posidonia* monitoring surveys. Three different zones including seagrass, hard bottom and soft bottom were determined for each station for benthic survey. The stations were located between Aslan Cape and Foça inner harbour at the depths between 15-30 m. Similarly, three different zones including seagrass, hard bottom and soft bottom were defined for fishing counting. The stations located between 5-25 m. The stations for *Posidonia* monitoring were determined between Aslan Cape and Fener Island at the depths between 15 – 25 m.

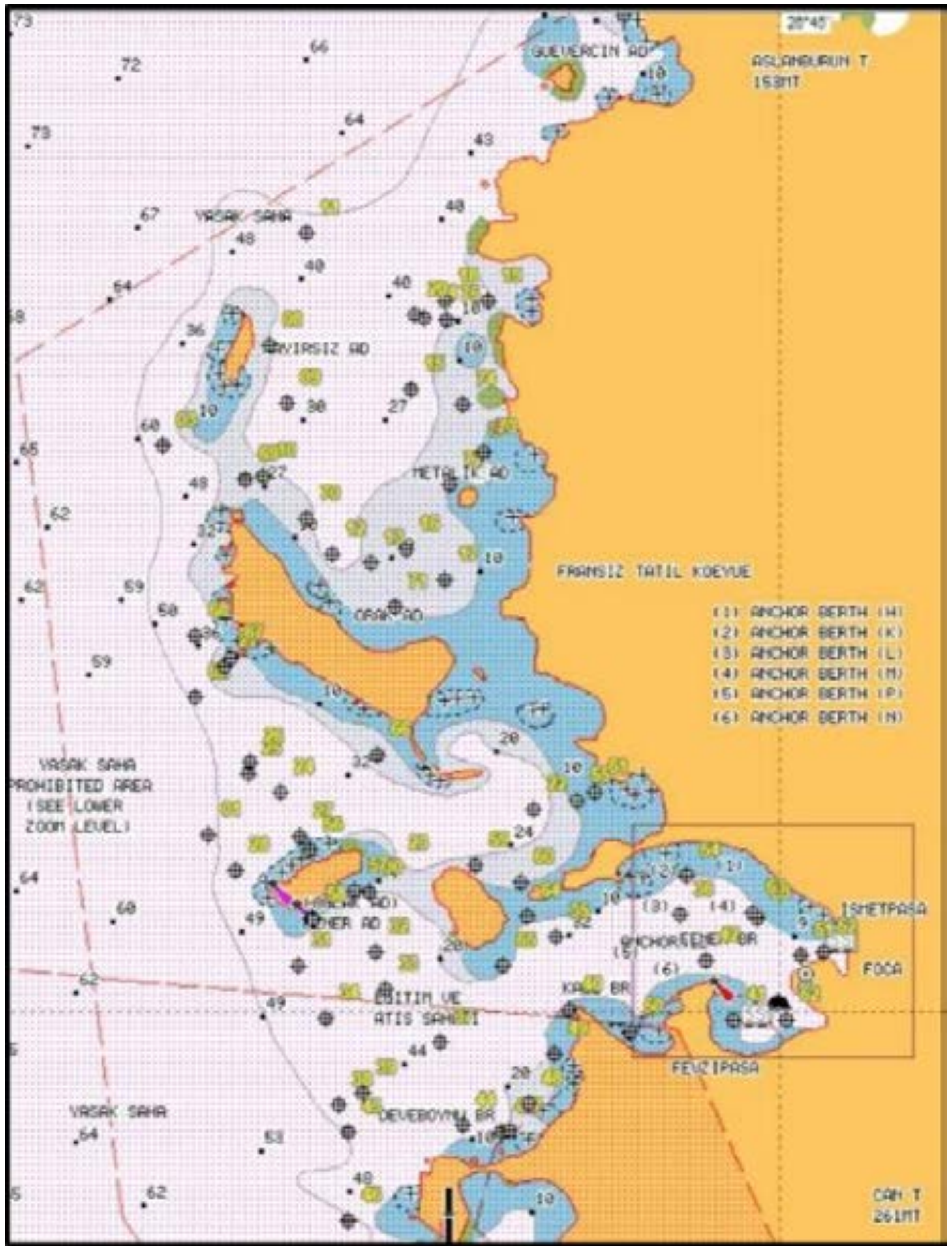


Figure 12

The location map of targets

Figure 13

Preliminary *Posidonia* oceanica boundary on SSS mosaic map (green line)

2.4. Habitats Characterisation

Soft and hard bottom benthos samplings, transect survey, dropdown camera survey and underwater visualization were made for ground-truthing in the study area. All these surveys were conducted with R/V Dokuz Eylül 3 and R/V Dokuz Eylül 4 research vessels of DEU-IMST. R/V Dokuz Eylül 3 was in operation between 06.11.2019 and 11.11.2019, whilst R/V Dokuz Eylül 4 started to its survey mission on 06.11.2019, and continued to its operation until 16.11.2019. InflaTable boats of these two research vessels were also used in the missions. Detailed information on the fieldworks (e.g. line & station coordinates) and daily reports are given in the Digital Annex-I and Digital Annex-II, respectively.

2.4.1. Soft Bottom Survey

The soft bottom benthic sampling was performed with R/V Dokuz Eylül 3 research vessel of DEU-IMST. Soft-bottom samples were collected at 8 stations (depth range: 14.9-25 m), of which 4 stations had sandy-mud sediment and 4 stations had *Posidonia oceanica* meadows (Figure-14).

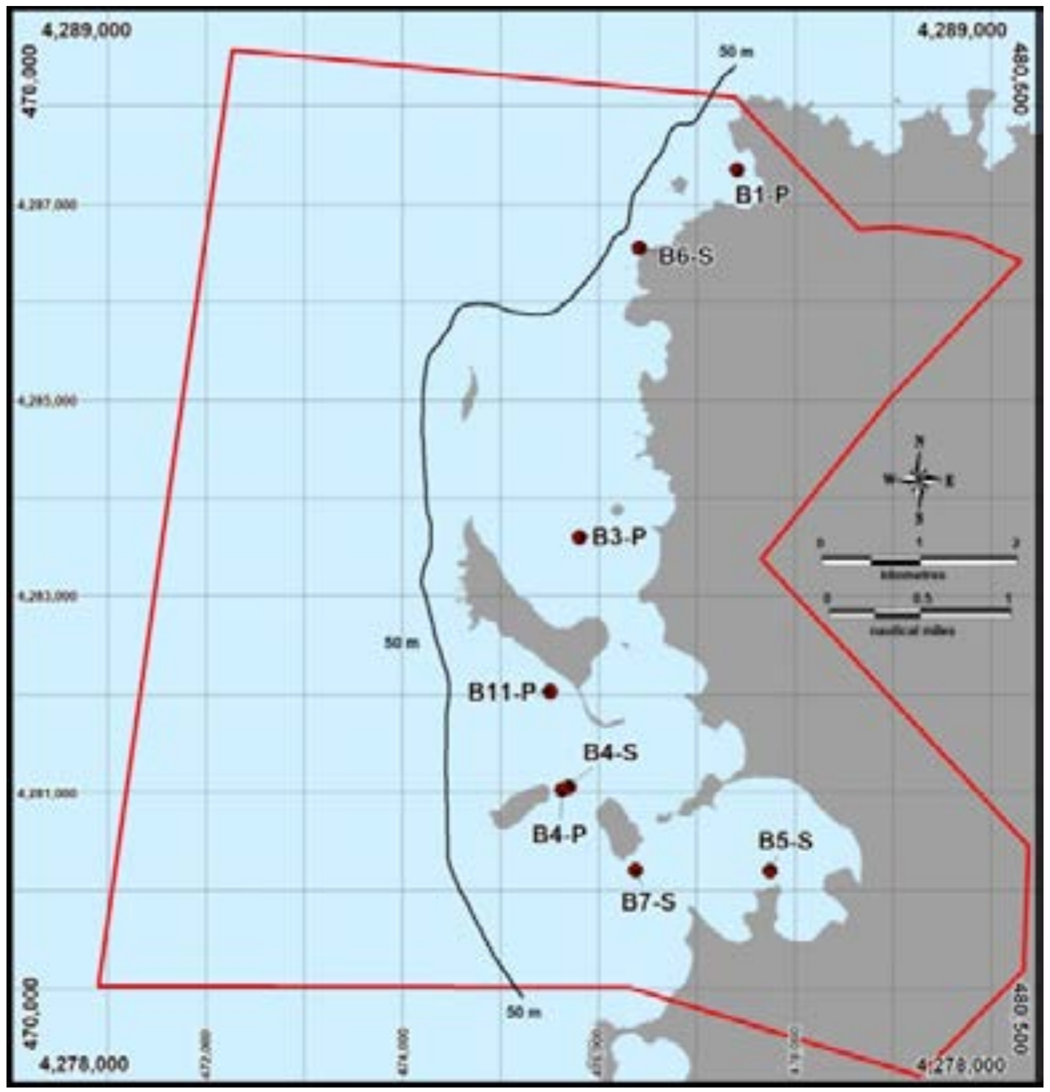


Figure 14

Map of study area showing soft bottom stations

Sandy-mud samples were collected by using a Van Veen grab and *P. oceanica* samples were collected by using a quadrate with 20 x 20 cm in dimension. Soft bottom samples were sieved with a 0.5 mm mesh on board. Photographs of benthic samples on sieve were taken with a digital camera. The retained material was put in jars containing 10% seawater-formalin solution.

2.4.2. Hard Bottom Survey

The study was performed with R/V Dokuz Eylül-4 of DEU-IMST at 7 stations (Figure-15).

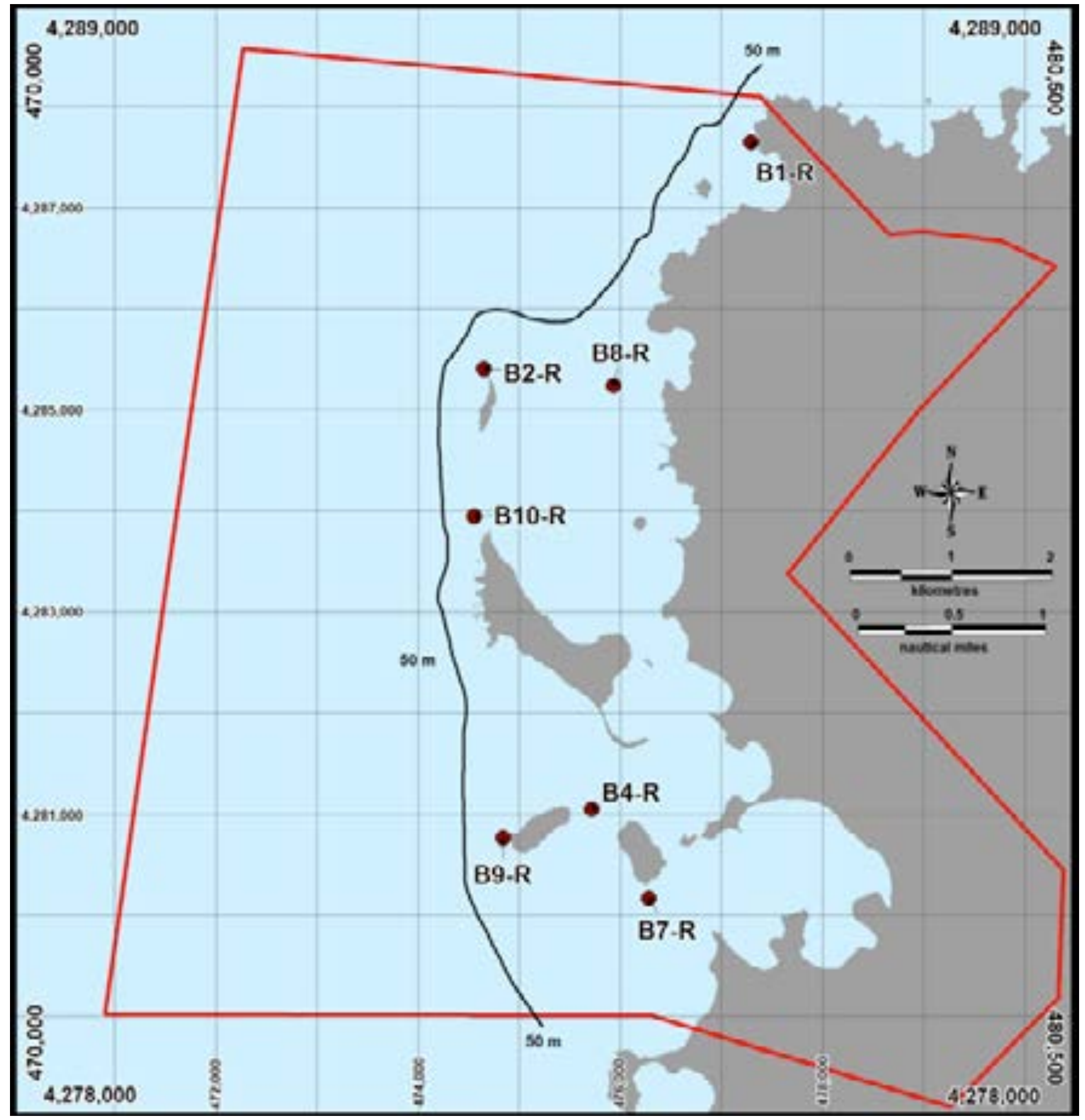


Figure 15

Map of study area showing hard bottom stations

At these seven stations (depth range: 7.5-25 m), photo-quadrates of 0.25 m^2 were used. The quadrate was placed randomly on hard substrata and photographed.

2.4.3. Transect Survey

Transect survey was performed in 13 lines with the R/V Dokuz Eylül 4 of DEU-IMST in 12-15 November 2019 (Figure-16) in order to determine habitat types in the shallow zones of the Foça SEPA. A marked transect line in every 5 meters of 200 meters in total, was used in the study. The transect line started in an exact coordinate with a precise angle. The work was done by two divers. The transect line was laid out by a diver to the coastline at a certain angle. The other diver followed the transect line and noted habitat changes along with their depths and meters. Videos of the all transect lines were also recorded in order to capture habitat types and changes along each transect.

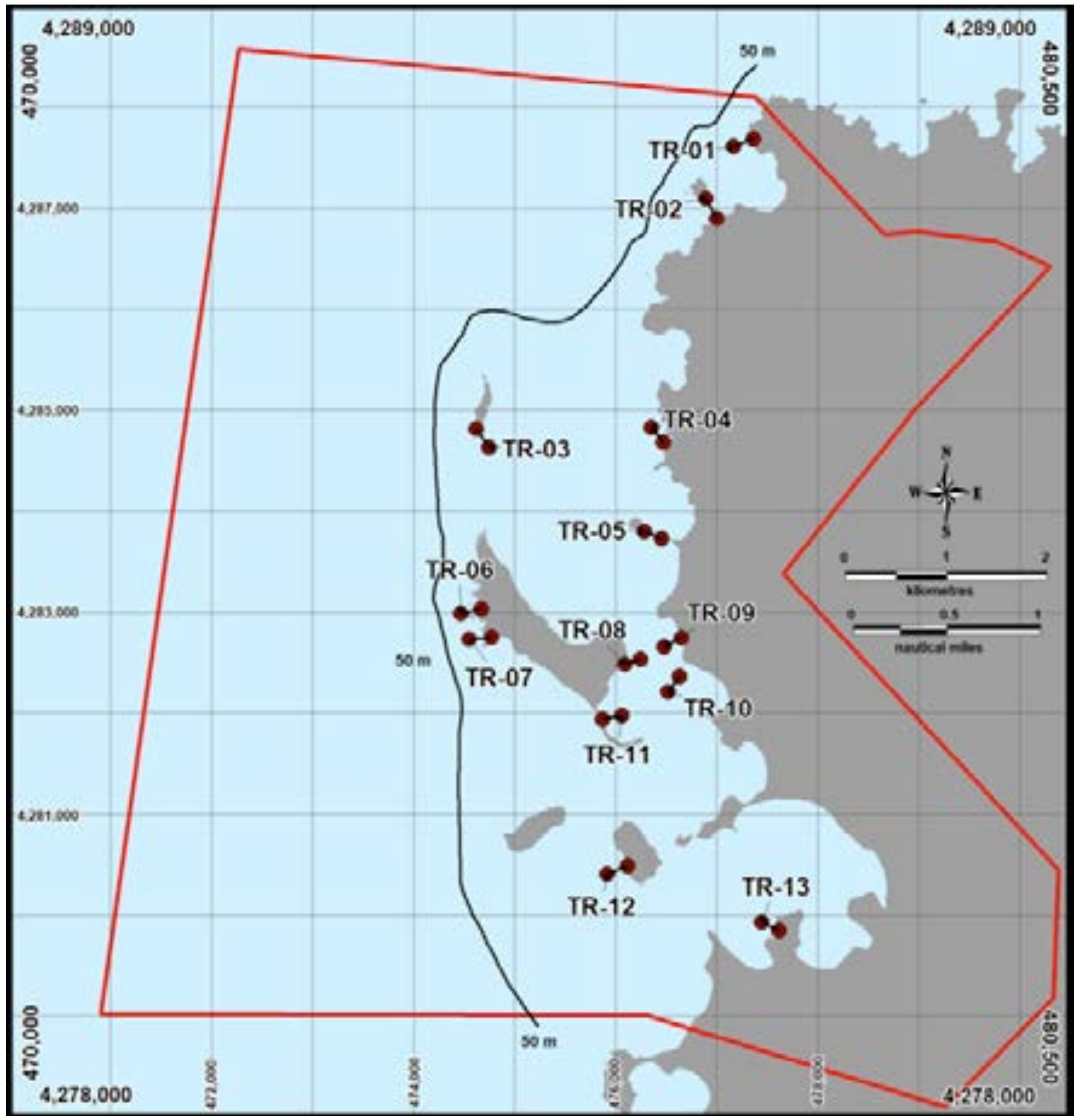


Figure 16

The location of transect survey lines

2.4.4. Dropdown Camera Survey

Dropdown camera (DDC) survey was performed with R/V Dokuz Eylül 3 research vessel of DEU-IMST. It started during acoustic surveys and continued in the habitats characterisation missions. The survey was made using a special produced camera system, which consists of HD camera, light, 90 m cable, hard disk and monitor. It records HD video and it can operate until about 90 m depth with its cable and light. During acoustic surveys, the DDC system was first tested, used in the SSS target locations and then modified for the following survey in the habitat characterisation mission.

The DDC survey was conducted at 64 stations: 31 SSS targets (TG), 4 soft bottom stations (B), 2 fish counting vessel locations (FC), 11 sediment sampling stations (SD) and 16 additional locations (DDC and NTG) were visually sampled for ground-truthing (Figure-17). With these stations, to visualize different locations in the study area was the main objective of the DDC survey in order to gather as much as ground-truthing data for habitat identification.

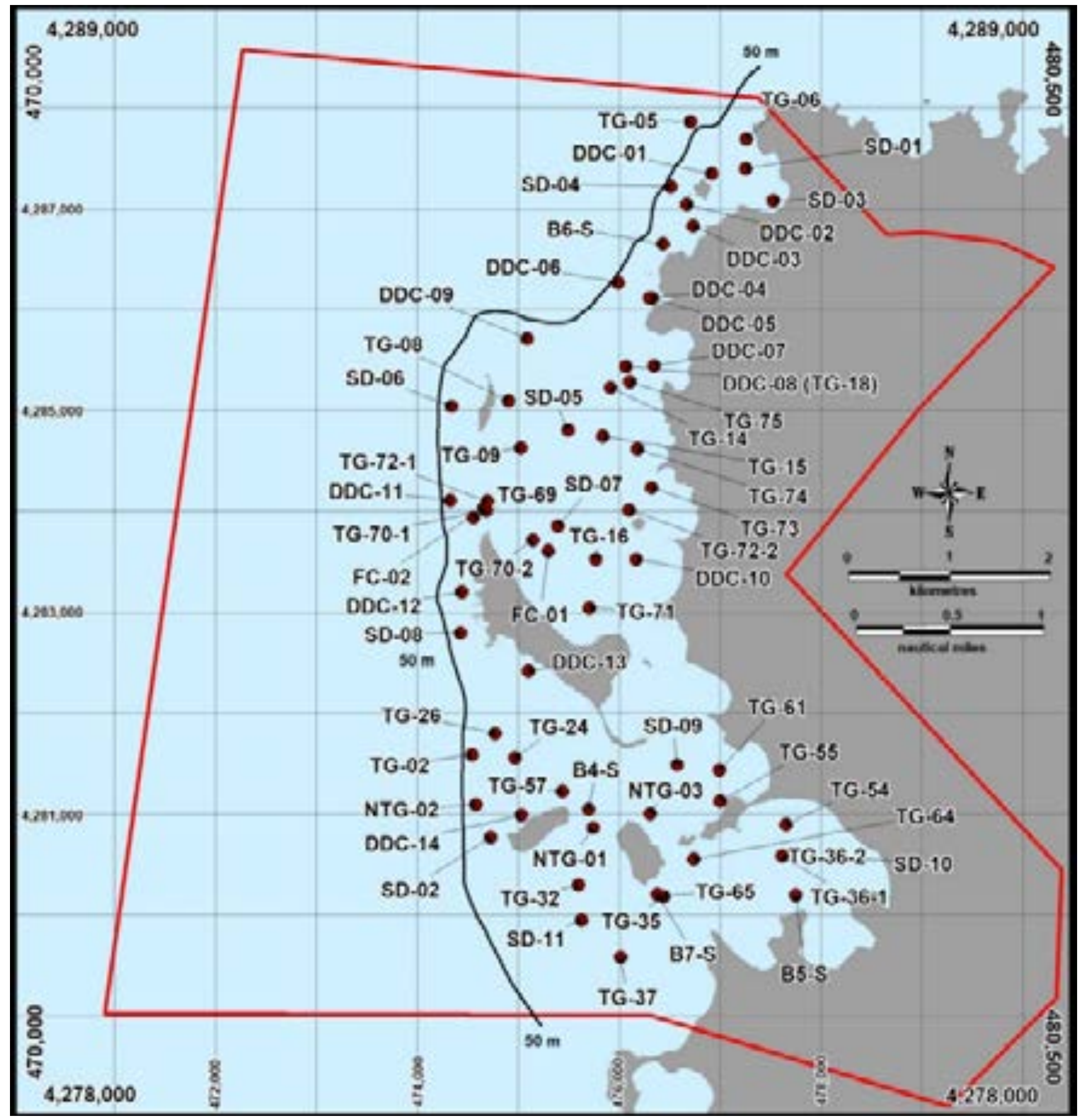


Figure 17

Map of DDC survey stations

2.4.5. Underwater Visualization

The main aim of the underwater visualization was to record site works both on research vessel deck and underwater. The underwater recordings have been done during the habitat characterisation surveys. All of the diving sites and underwater works in these areas were recorded by the video and photo cameras.

Totally, 93 underwater sites (29 diver+64 dropdown camera locations) between the depths of 2 and 50 m were visually recorded. Additionally, studies performed on the deck of research vessels and boats were also visually recorded during the fieldwork missions. During the whole fieldworks, a total of 3152 photographs were taken and 419 videos were recorded both on deck and underwater (Table-2). Total length of the videos were 17 hours, 16 minutes and 35 seconds. Among these, 1625 photographs and 370 videos with total length of 16 hours, 41 minutes and 25 seconds were underwater visualization.

Table 2
Visualization details for fieldwork surveys

Mission	Task	Number of photos taken	Number of videos recorded	Total length of videos
Spatial distribution of habitats	SBES & SSS surveys	916	30	00:22:23
Habitats characterisation	On-deck visualization	611	19	00:12:47
	Benthic sampling	307	19	00:35:41
	Transect survey	154	77	05:40:50
	Dropdown camera survey		68	06:33:03
Monitoring network	4 P. oceanica monitoring system	899	102	01:37:04
Fish counting	Underwater visual census	265	104	02:14:47
Total		**3152**	**419**	**17:16:35**

Selected video files were edited and rendered with DaVinci Resolve 16 software. Four films were prepared from the selected video files. The first one was 24 minutes 32 seconds long about the field works. The second one was 3 minutes 43 seconds long as a short footage of the first film (Digital Annex-III). The third one was 28 minutes 41 seconds long about the habitats and species within the study area limits of the Foça SEPA. The fourth one was 5 minutes 55 seconds long as a summary of the habitats-species video (Digital Annex-IV). The long and short versions of the videos about habitats and species also included survey location maps in the upper left corner. Other than that, 100 images were selected from the general photos to identify certain habitats, species and progress of the work (Digital Annex-V).

2.5. Initiation of a Monitoring Network

Four *Posidonia oceanica* monitoring systems (PoMS) were set up in the Foça SEPA with R/V Dokuz Eylül 4 and its inflaTable boat. Two of them were set up in the lower limit of *P. oceanica* meadow. The other two were placed at the upper limit. One group of PoMS (one lower limit, one upper limit) was set up in the southern region, where pressure is likely to be high. The other group was set up in the northern region, where pressure is less compared to the southern region (Figure-18).

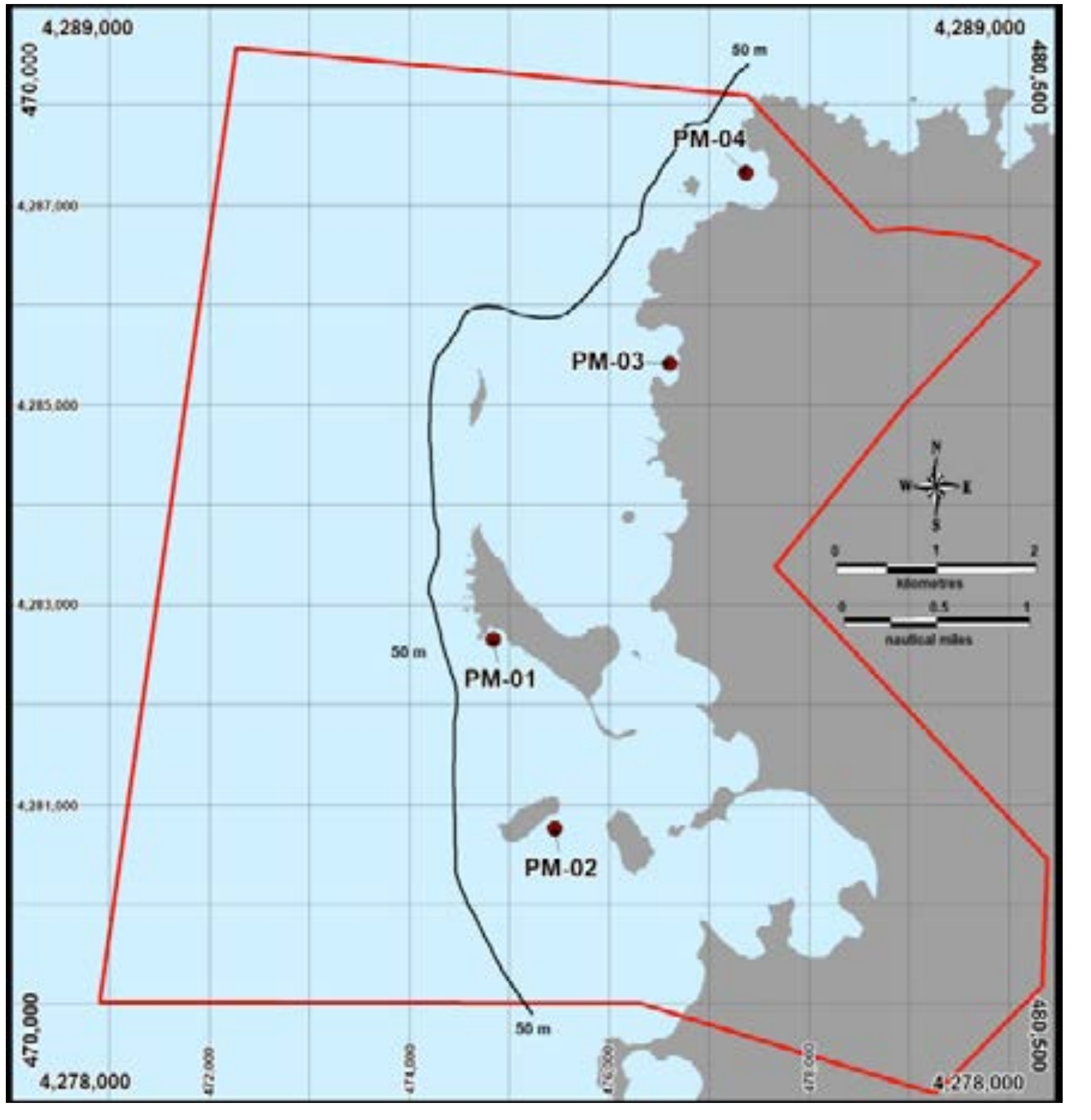


Figure 18
Map of PoMS locations

Four data loggers were placed upward at the 6th marker of each PoMS (Figure-19). Those loggers will collect temperature and light data in every hour.

Figure 19

Data loggers (temperature + light) of PoMS

In-situ measurements were made in all PoMS for the baseline state. Depth of the markers, the marker to marker and photo stick to marker angles, density, coverage, burial, and plagiotropgic rhizome percentage of the meadow were recorded to characterize the PoMS.

2.6. Fish Counting

In the study area, observations were carried out in November 7-9, 2019 with R/V Dokuz Eylül 3 and its inflaTable boat at three different depth strata (four replicates), 5-10-20 m. in six stations, which were selected according to benthic characteristics from SSS data (hard, soft, meadow habitats) (Figure-20).

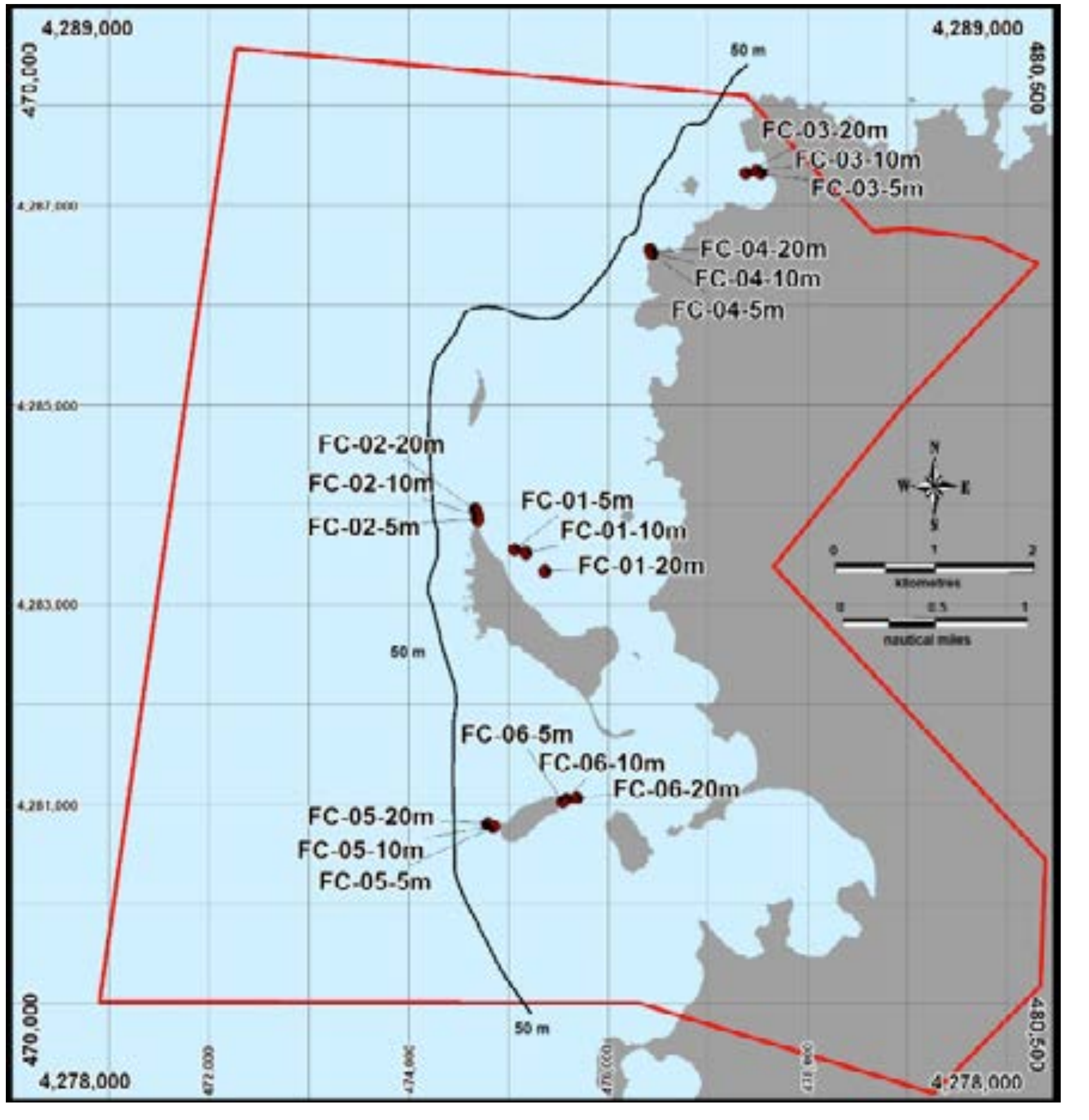


Figure 20

Map of fish counting locations

The UVC was performed at 20 m long and 2 m wide parallel sections. For this purpose, 20 m length rope with negative buoyancy was used. In this context, an area of 80 m^2 was observed at each depth strata. Markings and dimensions of the observed species were recorded on the underwater board where the species known to exist in the area.Data obtained using the Underwater Visual Census (UVC) method:

1. In the first stage, the presence and number of fish species were recorded at the work station. According to the maximum length of the species; previously determined length groups (juvenile, small, medium and large) were used for estimating the length of the observed fish.
2. Environmental and benthic properties were recorded.
3. Length observations of the observed fish:

   Fish length (TL):

   0.5 cm for those smaller than 1.5 cm
   1 cm for those between 1.5-10 cm
   2 cm for those between 10-30 cm
   For larger than 30 cm, was recorded according to 5 cm length intervals.

Total number of individuals and lengths of fish, depth, slope, characteristics of the bottom structure were recorded. One of the two scuba diver observed the cross-section, targeting fast swimmers (those in the category 1-4 according to Harmelin, 1987), advancing quickly and 1-2 m above the bottom, while the other moving slowly and closer to the bottom, less moving species (5-6 category according to Harmelin, 1987).

Environmental conditions (for example, intensity of prevailing winds, continental slope, depth) were also noted during observation.

The slope (s) of the region were evaluated in 5 classes: Light (0<s<25°), Significant (25° <s<45o), Vertical (45°<s<70°), Steep (70°<s<90°) and Reverse slope (>90°).

The benthic habitat characteristics were roughly noted according to the percentage of pavement: rocky, boulder, rubble, sand, algae (calcareous, etc.), seagrass

2.7. Training

Training activities were made in two ways: 1) On-deck trainings, 2) Training seminar. On-deck trainings were given to the observers from national institutions by the experts during the surveys on R/V Dokuz Eylül 3 and R/V Dokuz Eylül 4. 3 trainees from 3 different organizations attended to the on-deck training activities. The aim of these trainings were to present the on-going studies at that time, with the explanation of the survey systems used and the methodologies applied. After the fieldworks, a training seminar was given by four experts from the project team to 10 participants on 13.12.2019 in the Foça Library. 4 representatives from 3 different governmental bodies, 1 representative from the municipality, 2 representatives from local NGOs, 1 representative from university and 2 Foça citizens participated in this 2.5 hours of training seminar.

A total of 9 presentations, which were supplemented by project survey videos and images, were made by the experts at the seminar. Additionally, training materials about these 9 topics were prepared and submitted to the participants, together with the project information poster, which was prepared in the Phase-I (Digital Annex-VI).

2.8. Identification, Quantification and Spatial and Temporal Distribution of Commercial Fishing Activities and Unauthorised Fishing in Foça SEPA

A special fisheries questionnaire (Annex-2) was prepared and used to interview representatives and members of the fishery cooperative from 21.09.2019 to 16.11.2019 in Foça. During this period, 24 of 97 (25%) registered artisanal fishers were interviewed. Because only about 30 of the 97 registered fishers are actually actively fishing year-round, interviewing 24 of them was considered sufficient.

The survey was designed to gather information pertaining to the topics listed below:

- Basic social and economic status of fishers
- Professional information
- Fishing practices
- Financial expenses and professional issues
- Interaction with the environment
- Illegal (Unauthorized) fishing
- Fishers' opinions on the Foça SEPA
- Spatial and temporal distribution of commercial fishing effort
- Spatial and temporal distribution of illegal fishing activities
- Interaction with marine life

A GIS database was created for the fisheries spatial analysis. The study area consists 34 grid cells, whereas the Foça SEPA grid system, which was created for broader and further analysis, includes 91 cells (Figure-21). Fishing grounds, effort, interaction with habitats and species and illegal fishing practices were mapped using this grid system and its related database.

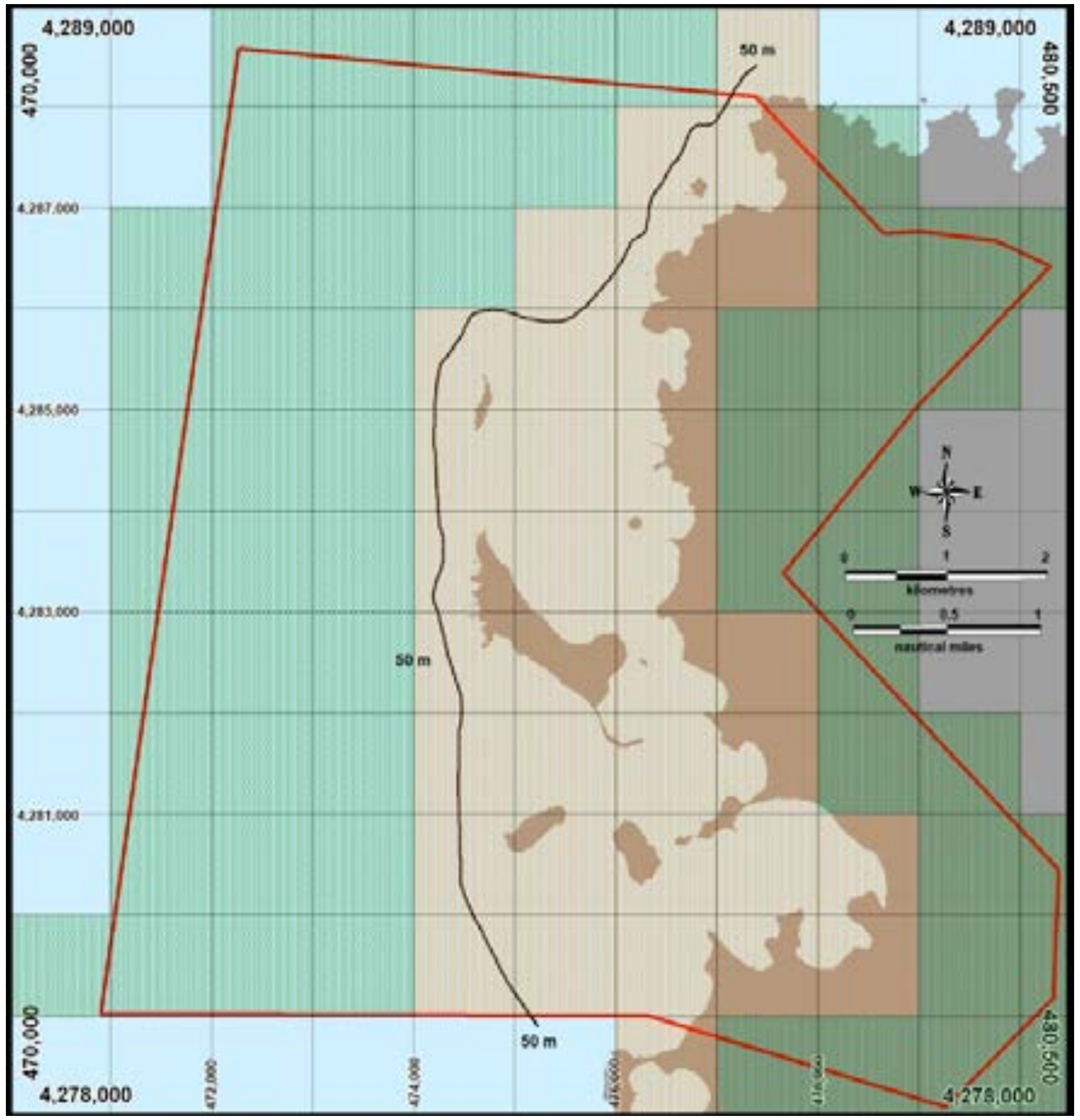


Figure 21

Map of fisheries spatial analysis grids (green: SEPA grids, light brown: study area grids)

2.9. Determining the Nature of the Interaction Between Rules-Based and Unauthorised Fishing Activities and Key Habitats, In Order to Measure the Risks Engendered by These Activities

The MNHN/SPN, 2012 protocol (Figure-22) for assessing risks of habitat deterioration by fishing activities was applied using "Overview of the potential interactions and impacts of commercial fishing methods on marine habitats and species protected under the EU Habitats Directive" as reference (N2K, 2015).

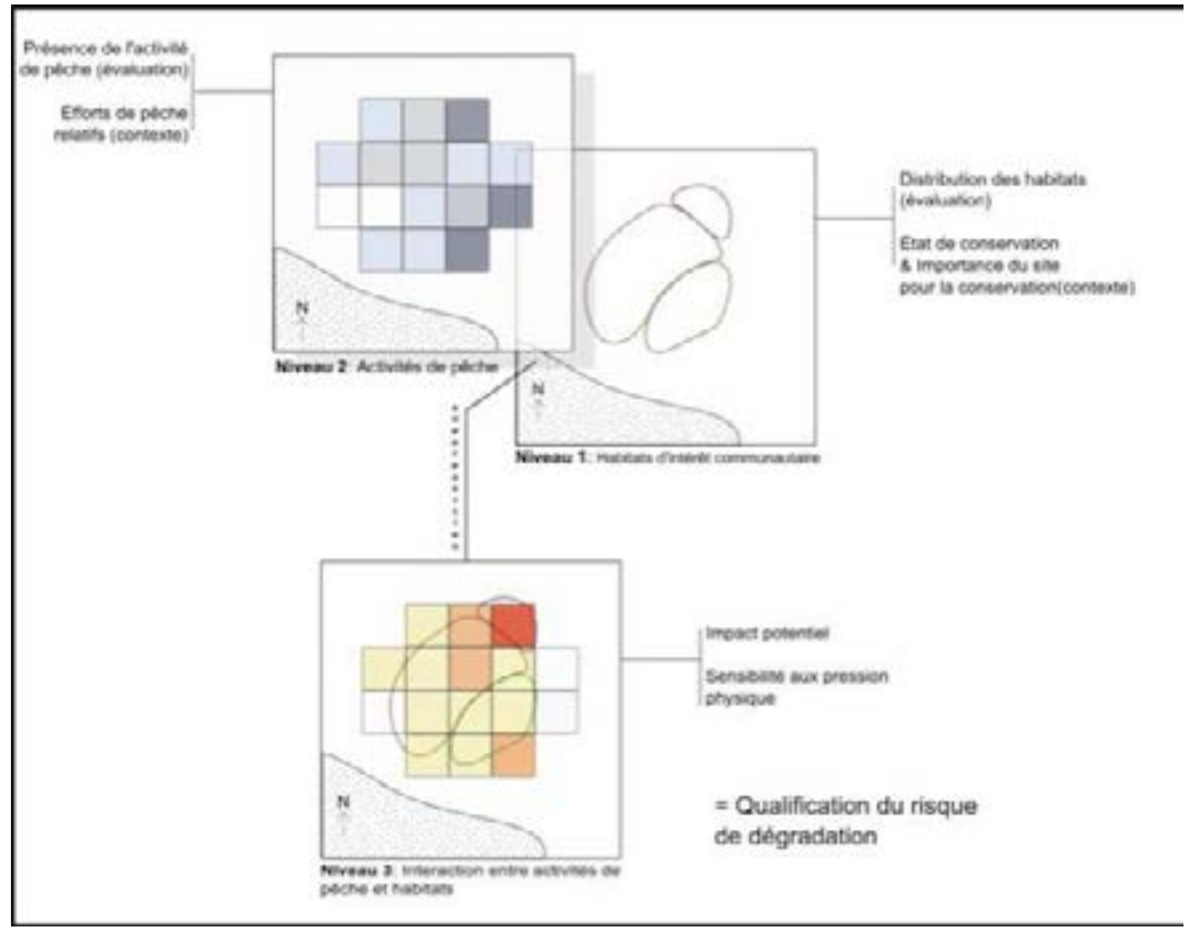


Figure 22

Schematic diagram of the method for assessing risks of habitat deterioration by fishing activities (Source: MNHN/SPN, 2012)

The data input to this task was supplied by habitat mapping and fisheries questionnaire surveys. The 1x1 km grid system, which was used for fisheries assessments (Figure-21), was applied in the spatial analysis of fisheries interactions and impacts on the habitats.

2.10. Elaboration of the Maps

The maps were produced through data processing and digitizing procedures in GIS.

2.10.1. SBES Data Processing

Single beam bathymetry system recorded approximately 10 beams per second, resulting in a high volume of depth data along each line. Some of these depth data were scattered and produced deviations from neighbour depth information. TSS motion sensor was included in the SBES system in the project. In this way, the 3D movement of the ship (roll, pitch, yaw) was taken instantly and the depth value was corrected in the data acquisition software HydroPro. The deviations were corrected by "Navedit" data processing module of HydroPro software. In "Navedit" module, "heave" correction values that corresponding to depth values are seen in Figure-23.

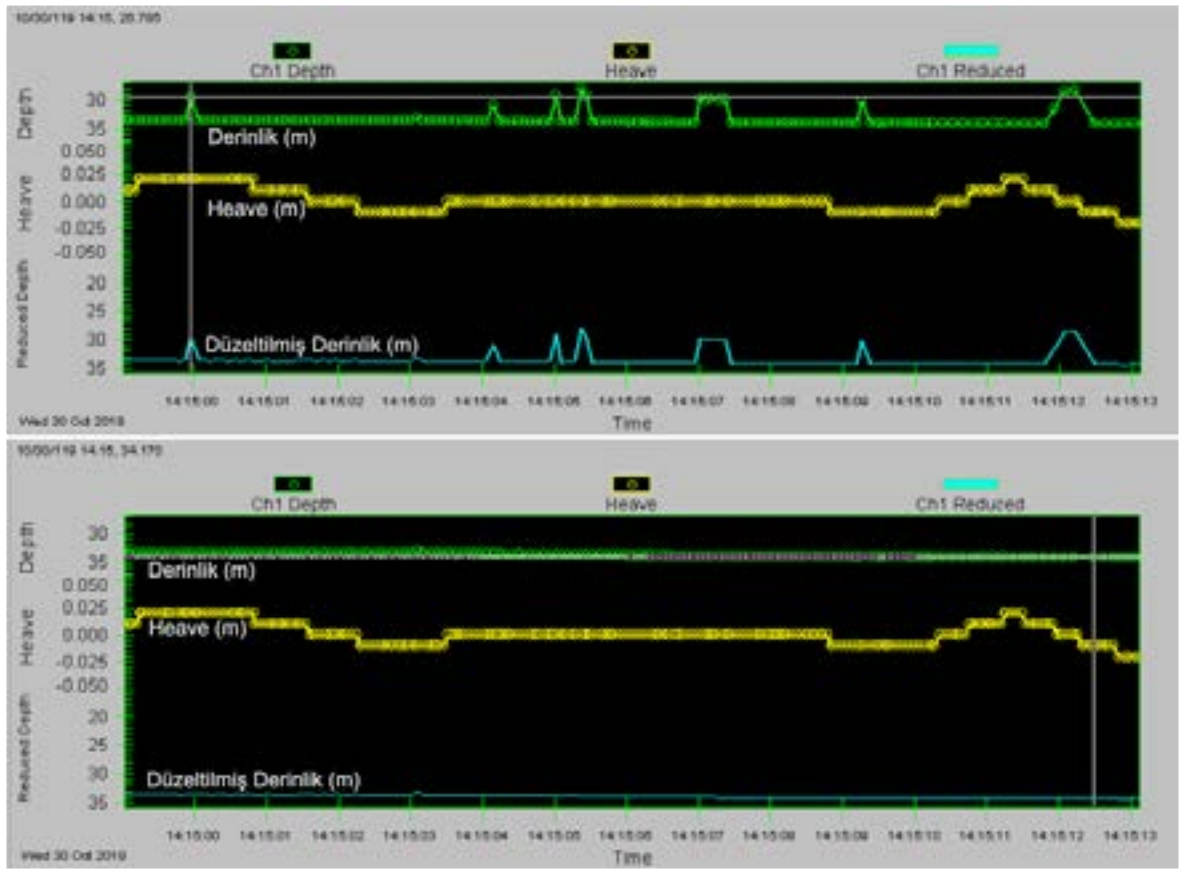


Figure 23

Zoomed image of some scattered values in fDK046 line, heave values and corrected depth values

When the data set consisting of tens of thousands of points is examined, it is possible to see these scattering values at many points. Scattered spots were detected on all lines. All scattered points along a line were identified when applying the correction. Firstly, it was decided whether these points were real data or not. When it was decided that the data was scattered, the required value for that point was determined and scattering was removed by "interpole" process. A total of 4 scattered points are shown in the zoomed image of the data for the fDK046 line (Figure-24). There are depth points measured at 31,70 m on either side of the value measured as 27.04 m. When the column to the right of the Figure is viewed, the measurement times corresponding to the depth values are shown. The time required for the deviation to be determined as 27.4 meters is 188 milliseconds, it is not possible for a depth measured at 31.70 m to be reduced back to 31.70 m by measuring 27.4 m. in such a short time. Therefore, it was determined that similar points are scattering by considering time and deviation amounts. The values to be corrected were determined by zooming from the beginning to the end of the line and the correction was applied at that moment. The values previous and next scattered points were interpolated to eliminate scattering. This process was applied to all SBES lines.

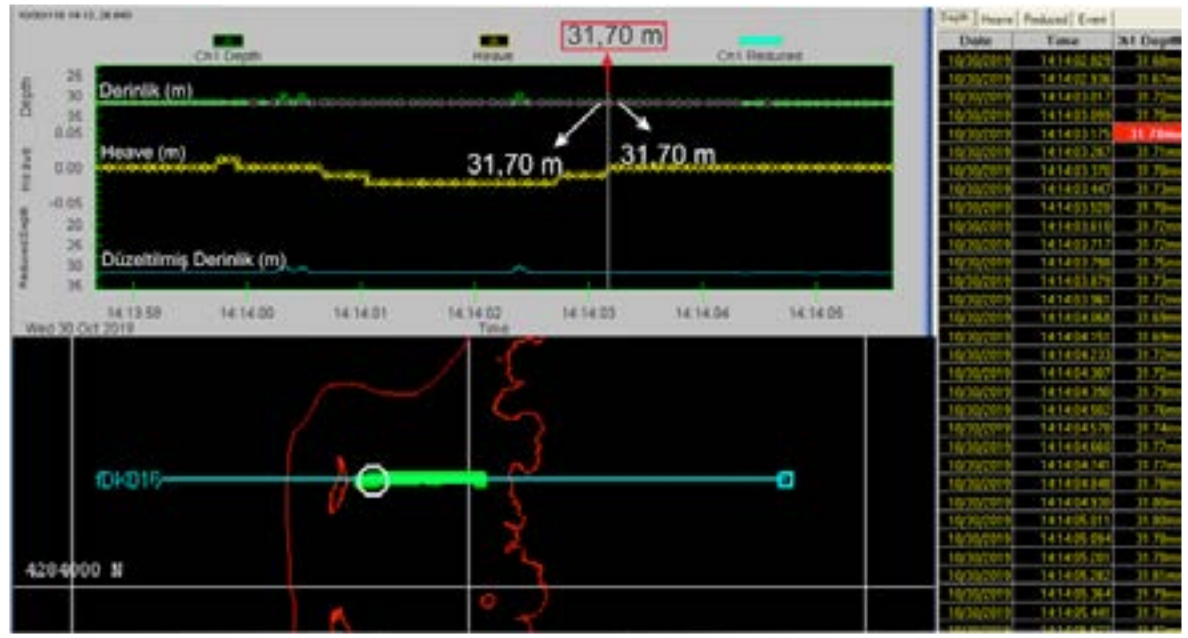


Figure 24

Zoomed image of some scattered values in fDK046 line, heave values and value to be corrected

Then, all corrected depth values were exported. After the data processing steps were completed, they were opened together with the graphics program and combined into the appropriate intersection point and converted into a single line and recorded as a one file which are ".dat" format.

2.10.2. SSS Data Processing

Totally 135 km SSS data were collected adapted both sea floor morphology and coastline (Table-3). SSS mosaic was created in Chesapeake SonarWiz software after bottom track and slant range correction process. Mosaic image was exported as GeoTiff file (Figure-25). The targets were defined on the mosaic image both during acquiring data and after data processing.

Table 3
The statistical data of SSS

Total survey lines	41
Total length of survey lines	135.584 m
Target number	75

Figure 25
SSS mosaic map after bottom track and slant range corrections

2.10.3. Coastline Digitizing

Since coastline layer is important for obtaining a detailed bathymetry in irregular shoreline topography and is the boundary for bathymetry data (Gorman et al., 1998; Jakobsson et al., 2002; Parker, 2002; Jordan et al., 2010; Hell et al., 2012), an updated coastline was digitized from GoogleEarth using 2019 satellite images with 1/1000 scale.

2.10.4. Mapping Procedures

The coastline vector layer was digitized as a polyline and then converted to polygons in the GIS software for use as land objects in the basemap. Additionally, the polylines of this coastline layer were converted to point objects with "zero depth" value in order to be used for fine scale bathymetry mapping (Figure-26).

Figure 26
Obtaining zero depth point objects from coastline layer: bathymetry and coastline layers overlaid (left), point objects created for the whole digitized coastline (middle), point objects zoomed (right)

A total of 5300 point objects with 10 m intervals were created by this procedure. Then, zero value was assigned to each object and their UTM WGS84 coordinates were obtained by the GIS software, resulting in XYZ data for the zero value coastline. These data were merged to SBES data in the following periods for enhancing the details in the bathymetry mapping.

A set of grids without integration of the coastline zero values were generated for draft mapping and preliminary analysis of the SBES data (Figure-27). These grids were generated with Natural Neighbour (NN), Triangulated Irregular Network (TIN) and Petrel bathymetry gridding techniques.

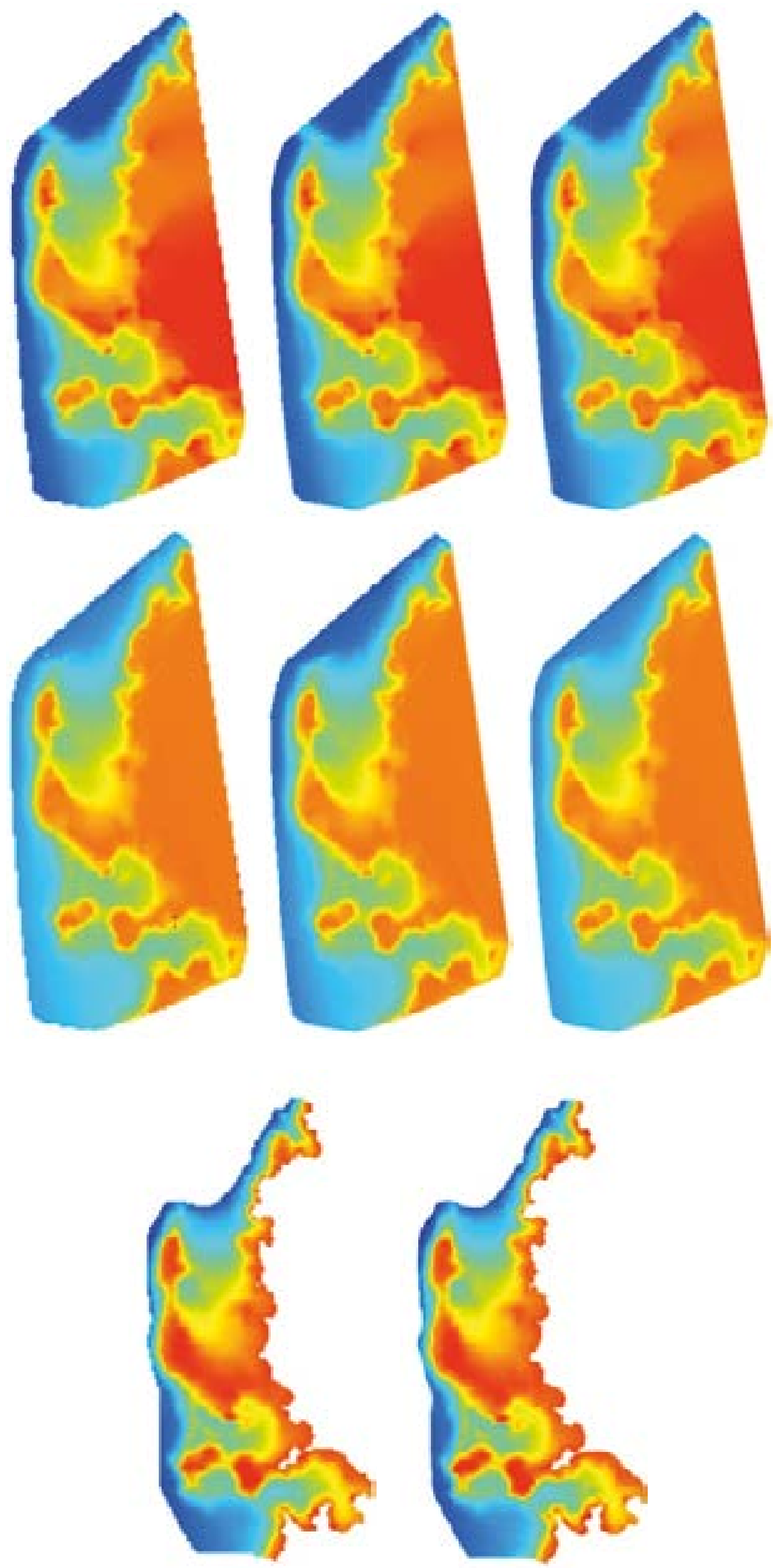


Figure 27

Bathymetry gridding-Top: NN with grid c ell size 50 m (left), 22 m (default, middle), 1 m (right); Middle: TIN with grid cell size 50 m (left), 22 m (default, middle), 1 m (right); Petrel bathymetry with grid cell size 50 m (left) and 1 m (right)

After embedding of coastline XYZ data, another set of grids with and without integration of the coastline zero values were generated for choosing the best bathymetry mapping. These grids were generated with Convergent (Conv), Inverse Distance Weighted (IDW), Isochore (Isoc), Kriging (Krig), Minimum Curvature (MinCur), in addition to Natural Neighbour (NN) and Triangulated Irregular Network (TIN) interpolation techniques with 5 m grid resolution (Figure-28 & 29). After comparison of all these techniques, Minimum Curvature interpolation was chosen as the best bathymetry mapping solution.

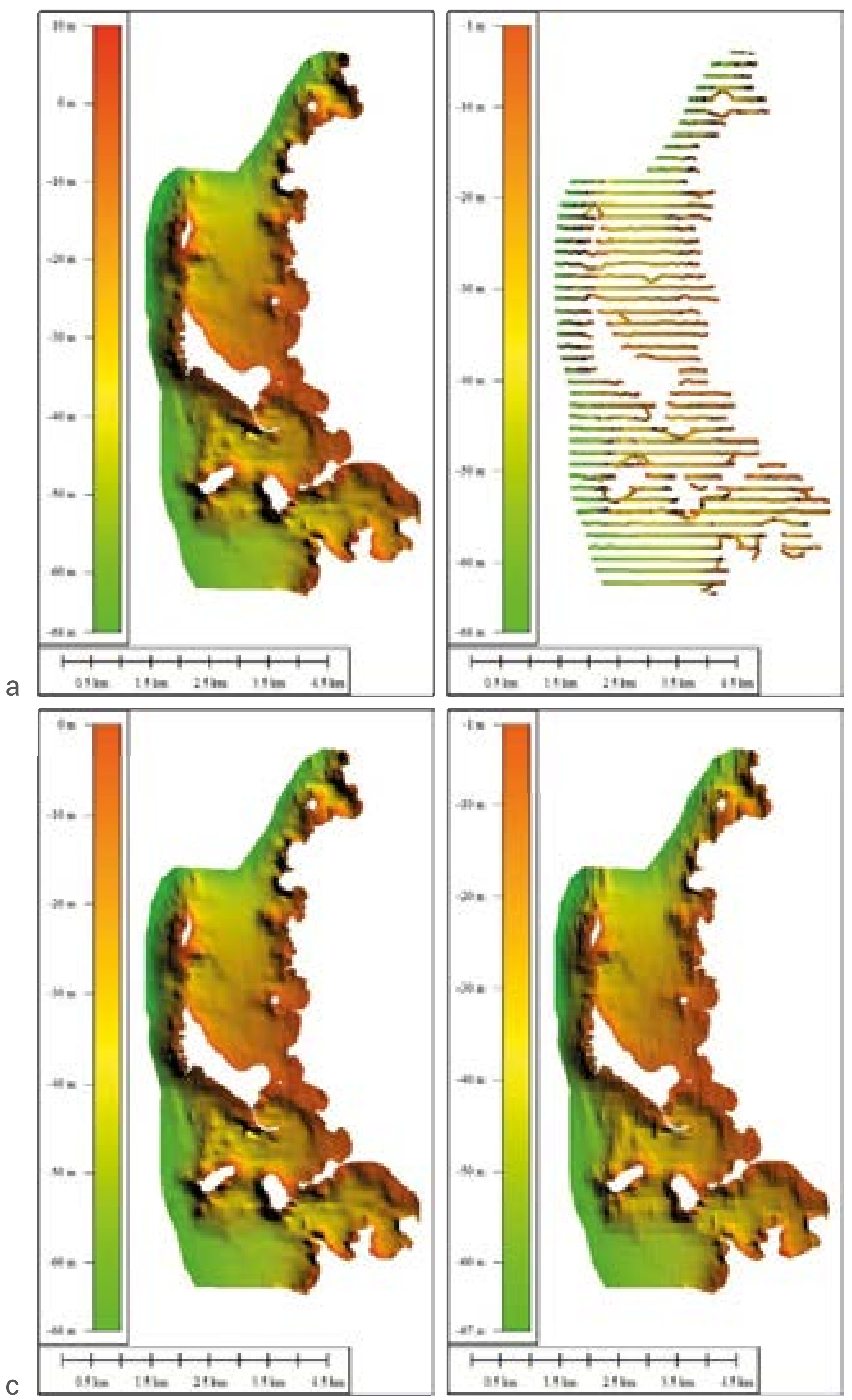


Figure 28

Bathymetry gridding-a) Conv., b) IDW, c) Isoc., d) Krig., e) MinCur., f) NN and g) TIN interpolation grids without zero depth data

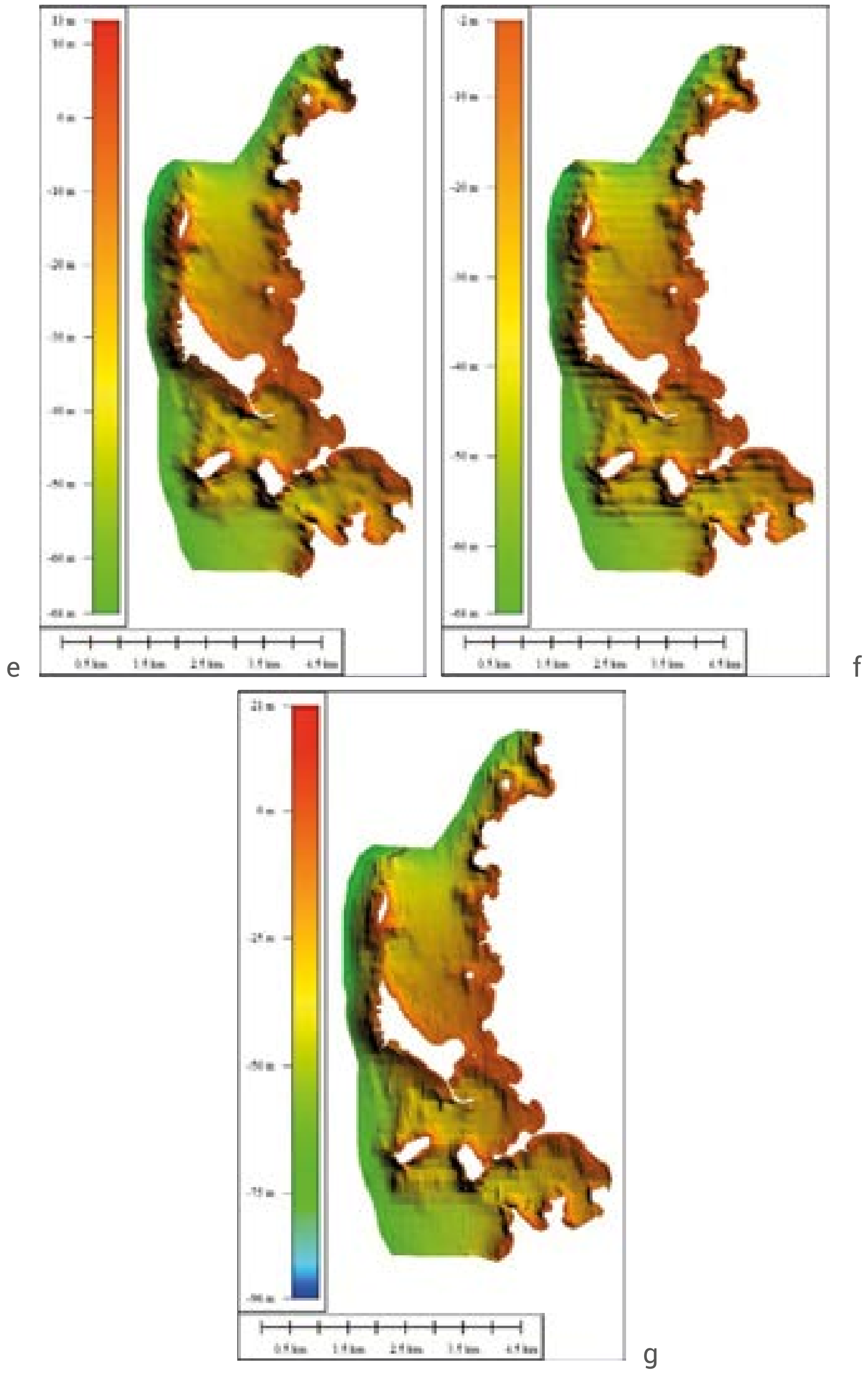


Figure 28

Cont.

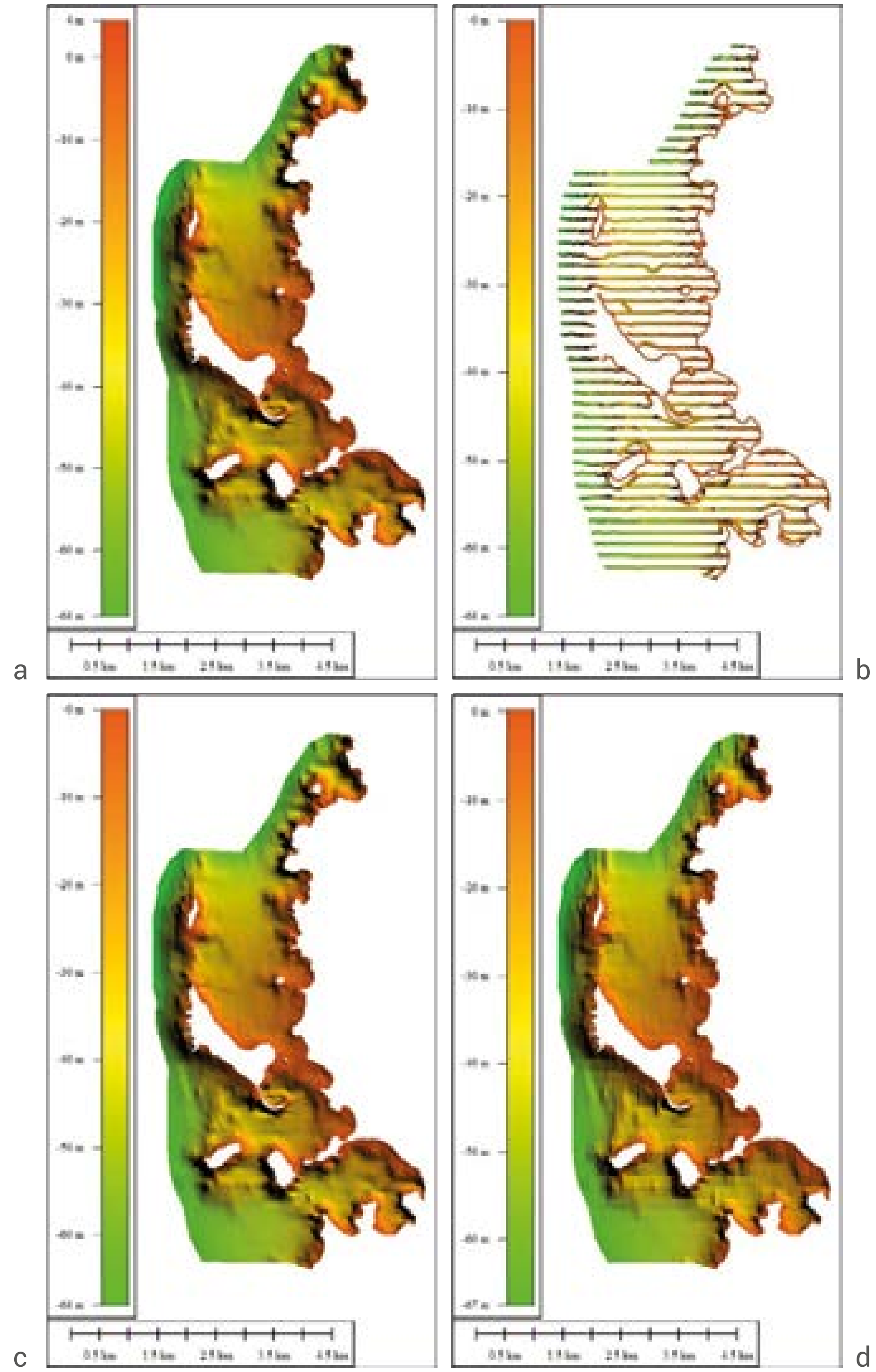
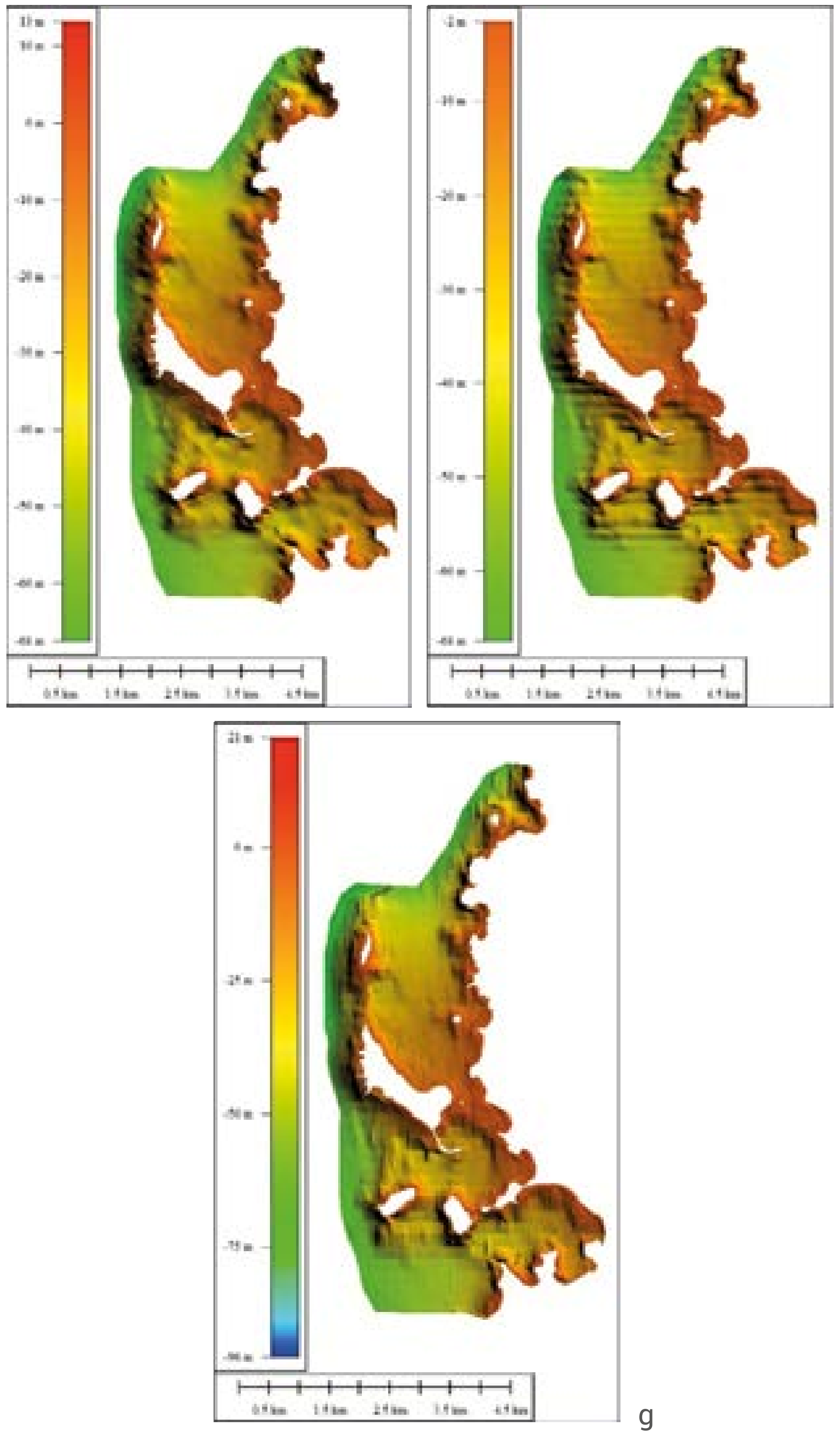


Figure 29

Bathymetry gridding-a) Conv., b) IDW, c) Isoc., d) Krig., e) MinCur., f) NN and g) TIN interpolation grids with zero depth data



e f g

Figure 29

Cont.

2.10.5. Preparation of the Maps

Final thematic maps were produced in GIS software (MapInfo, GlobalMapper, ArcGIS) meeting the necessary scale and resolution specifications as well as other map elements such as legends, symbols and colour palettes (as referred in the Technical Specifications).

The thematic maps included the following items as standard:

- Map with UTM grids
- Map name
- Study area layout
- Legend
- Scale
- North arrow
- Projection/datum information
- Project information and logos
- Map metadata

The following maps were produced within the project (**Digital Annex-VII**):

1. Bathymetry map
2. Side scan sonar map
3. Geomorphological map
4. Habitat types map
5. Fish biomass map
6. Fishing effort map
7. Illegal fishing map
8. Fisheries-habitat interaction map
9. Map of sensitivity of habitats to fishing activities
10. Proposal map

The maps were produced according to the following technical properties:

- Projection/datum: UTMWGS84, Zone 35N
- Scale: 1:5000
- Bathymetry grid resolution: 1 m
- Sonar mosaic image resolution: 0.25 m
- Digital map resolution: 200 dpi

The layout of the 1/5000 scaled maps are given in **Figure-30**.

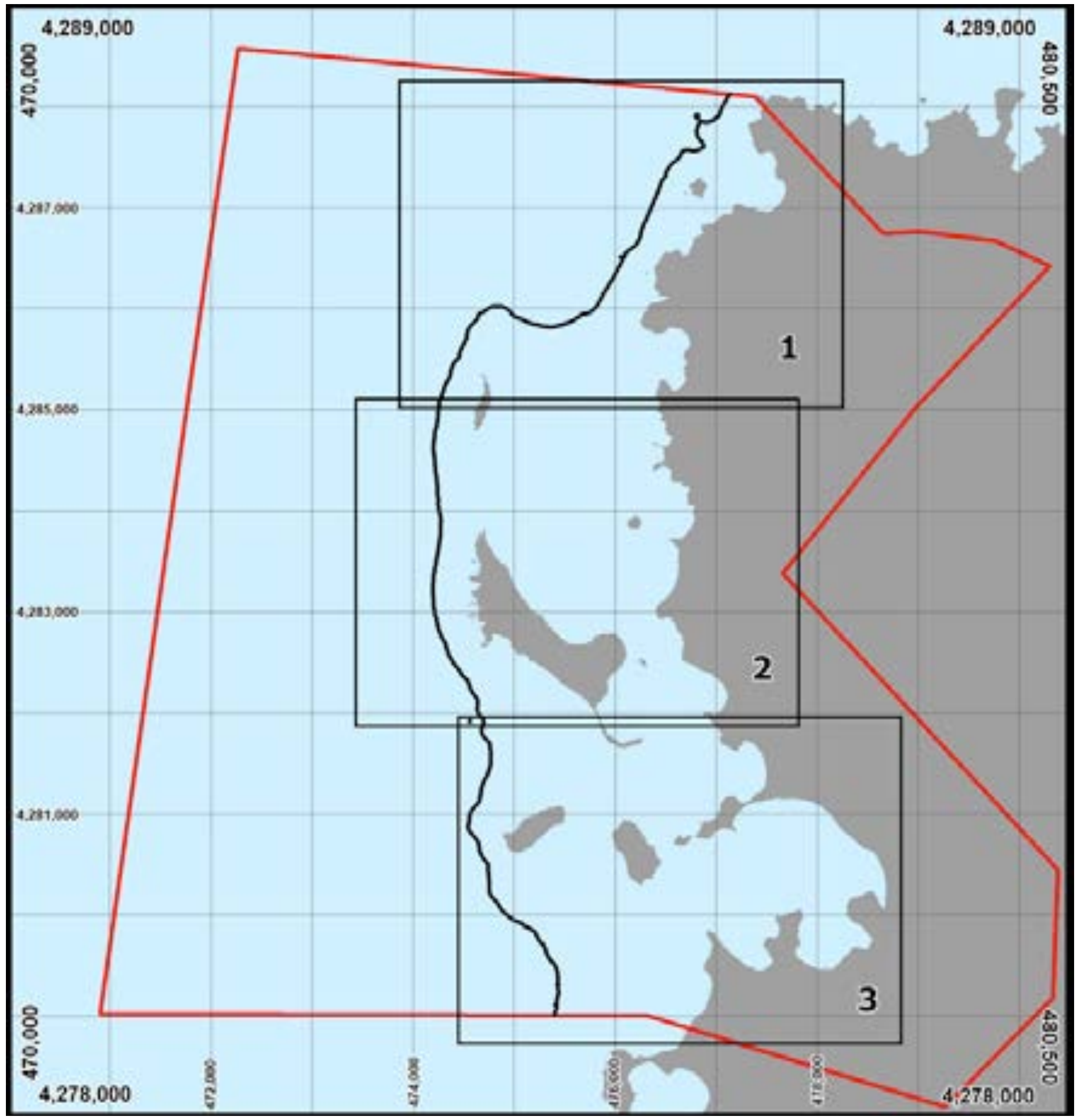


Figure 30

The layout of the 1:5000 scaled maps

2.11. Fieldwork Overview: Teams, Routes and Geo-Referenced Remarks

DEU-IMST had a limited time to complete the fieldworks mentioned in the previous sections according to project schedule as the fieldwork dates were just before the winter season. For that reason, DEU-IMST allocated a considerable human resources to the fieldwork missions. A total of 13 scientists and 12 vessel crew members involved in these studies, with various team combinations. 6 scientists and 5 crew member attended to the 9 days of acoustic measurements with R/V Dokuz Eylül 3 between 26.10.2019 and 03.11.2019.

6 scientists and 5 crew member performed the 7 days of sediment (SED), CTD, benthos (B), fish counting (FC), and dropdown camera (DDC) surveys with R/V Dokuz Eylül 3 between 06.11.2019 and 12.11.2019. 6 scientists and 4 crew members joined to 10 days of *Posidonia oceanica* monitoring station set up (PoMS), transect (TR) and benthos (B) surveys with R/V Dokuz Eylül 4 between 06.11.2019 and 15.11.2019.

The human effort in the fieldworks can be summarized as follows:

- Total scientist effort on R/V Dokuz Eylül 3: 76 person*days
- Total scientist effort on R/V Dokuz Eylül 4: 46 person*days
- Total crew effort on R/V Dokuz Eylül 3: 80 person*days
- Total crew effort on R/V Dokuz Eylül 4: 40 person*days

Being aware of the conditions, DEU-IMST allocated its two research vessels - R/V Dokuz Eylül 3 and R/V Dokuz Eylül 4- with their inflaTable boats to the project field missions to finalize all the field works on time (Figure-31). These two research vessels operated at the same dates between 06.11.2019 and 12.11.2019. A local boat (Seyyah) was also hired and used in the shallow SBES survey. A total effort of 28 vessel*days was spent in the field works.

Figure 31

Research vessels and boats in fieldwork operations: R/V Dokuz Eylül 3 in front of the Orak Island (top left), R/V Dokuz Eylül 4 down to the Hayırsız Island (top right), boat of R/V Dokuz Eylül 3 on fish counting operation (bottom left), boat of R/V Dokuz Eylül 4 on transect survey operation (bottom right)

The vessel effort in the fieldworks can be summarized as follows:

- Total effort of R/V Dokuz Eylül 3: 16 vessel*days
- Total effort of R/V Dokuz Eylül 4: 10 vessel*days
- Total effort of local boat Seyyah: 2 vessel*days

In order to finalize all fieldwork missions on their schedule, we additionally had to make a dynamic survey plan and practice in order not to lose any or much time during the field works. We practiced some fundamental survey strategies such as follows:

- When weather conditions were bad, we changed our survey plan and performed the surveys between the islands and the mainland if applicable.
- We sometimes anchored at a location somewhere in the study area to continue the next day, not to lose any time for mobilization to and from port.
- When weather conditions didn't allow us to conduct a survey, we spent our day with other tasks (e.g. DDC test, SBES QA/QC).
- Although a team member was assigned for the underwater visualization, it was also performed with different cameras and by different staff during the surveys to be opportunistic against any time loss.

The effort of the fieldworks can be expressed in the routes taken during the surveys. A total route of 1149.4 km was taken by the R/V Dokuz Eylül 3, R/V Dokuz Eylül 4, their inflaTable boats and the local vessel (Table-4 & Figure-32). The details of daily routes and maps are given in the Digital-Annex-I.

Table 4
Routes taken in the fieldworks

Routes by vessels

Vessel	Route taken (km)
R/V Dokuz Eylül 3	652.5
R/V Dokuz Eylül 4	263.4
R/V Dokuz Eylül 3 boat	18.6
R/V Dokuz Eylül 4 boat	122.4
Seyyah	92.5
Total	**1149.4**

Routes by activities

Activity	(Route taken (km
Mobilization	300.7
SBES and SSS surveys	393.9
PoMS	129.4
SED, CTD, B, DDC & TR	325.4
Total	**1149.4**

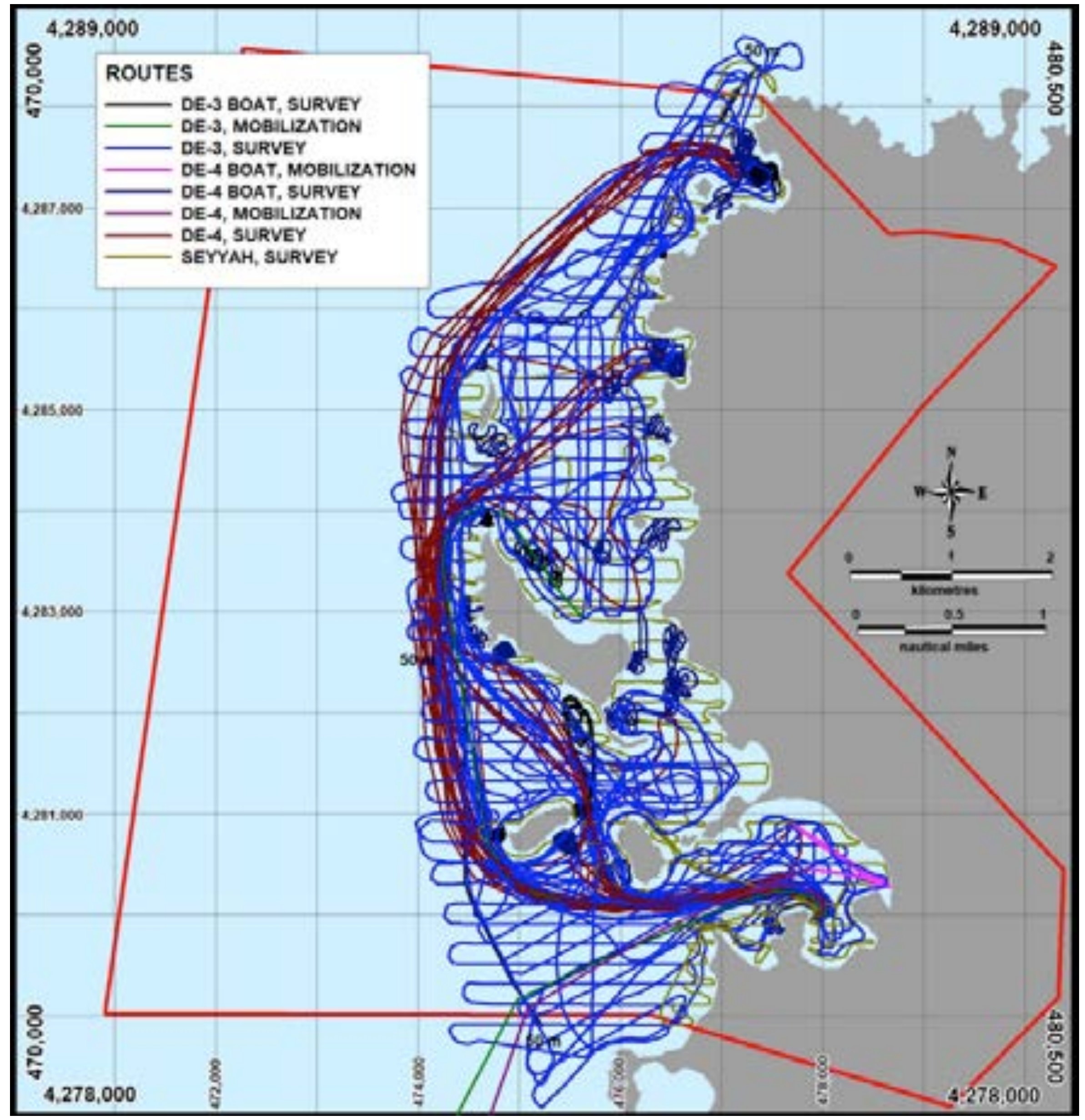


Figure 32
All routes taken by research vessels and boats in the study area (digitized from GPS tracks and station coordinates)

3

3

BATHYMETRIC STRUCTURE OF THE FOÇA SEPA

The sea floor map obtained as a result of the study carried out with a single beam bathymetry system (SBES) is given in **Figure-33**. The map was produced with the "Minimum Curvature" method with a grid spacing of 1x1m.

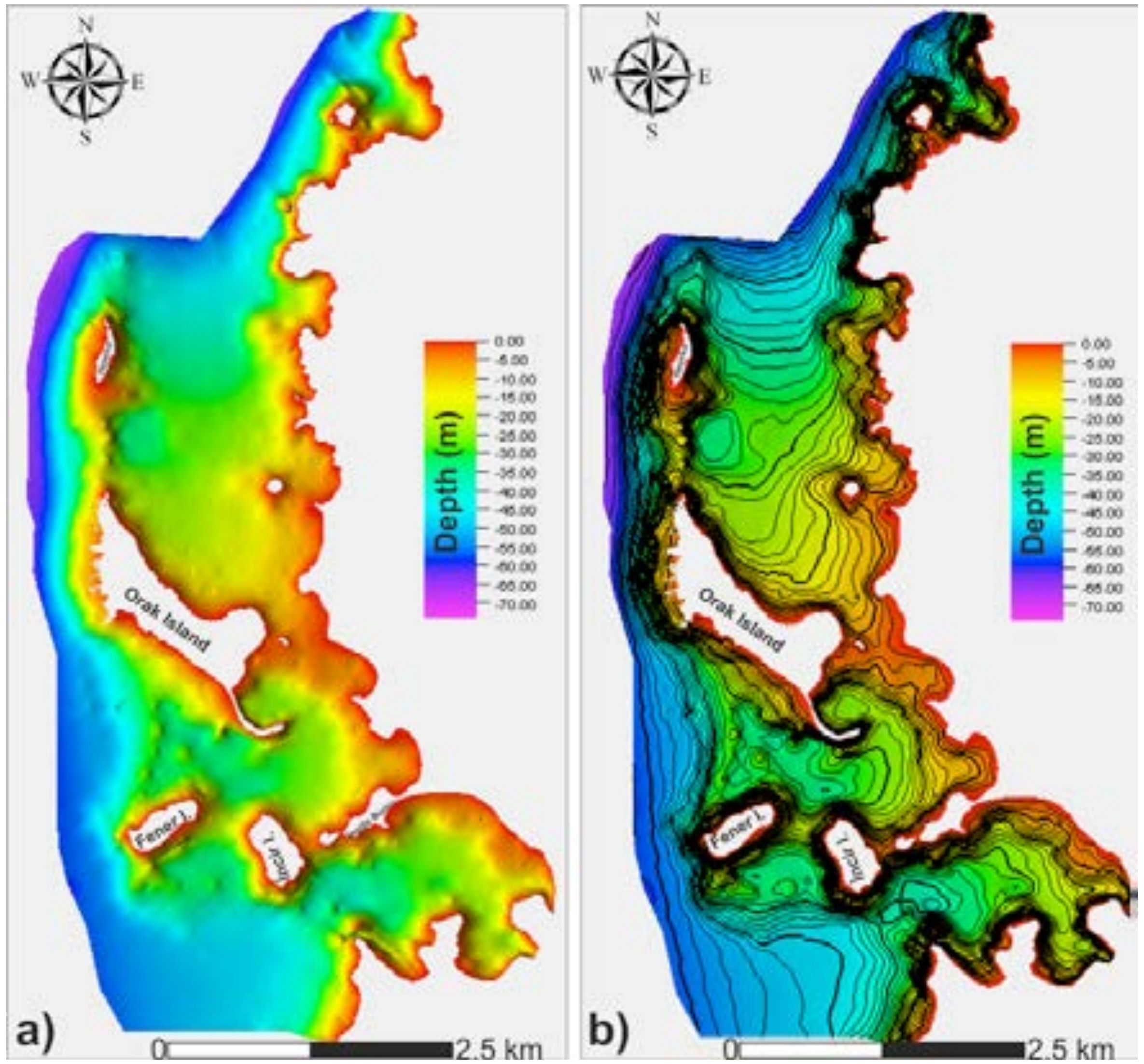


Figure 33

a) The bathymetry map of Foça, b) The contoured view of the bathymetry map of Foça (2m int.)

The study area shows many variations in the morphological sense. The biggest reason is that there are many island and heel structures in the area. The general view of these structures are seen in Figure-34 in three dimensions from different angles.

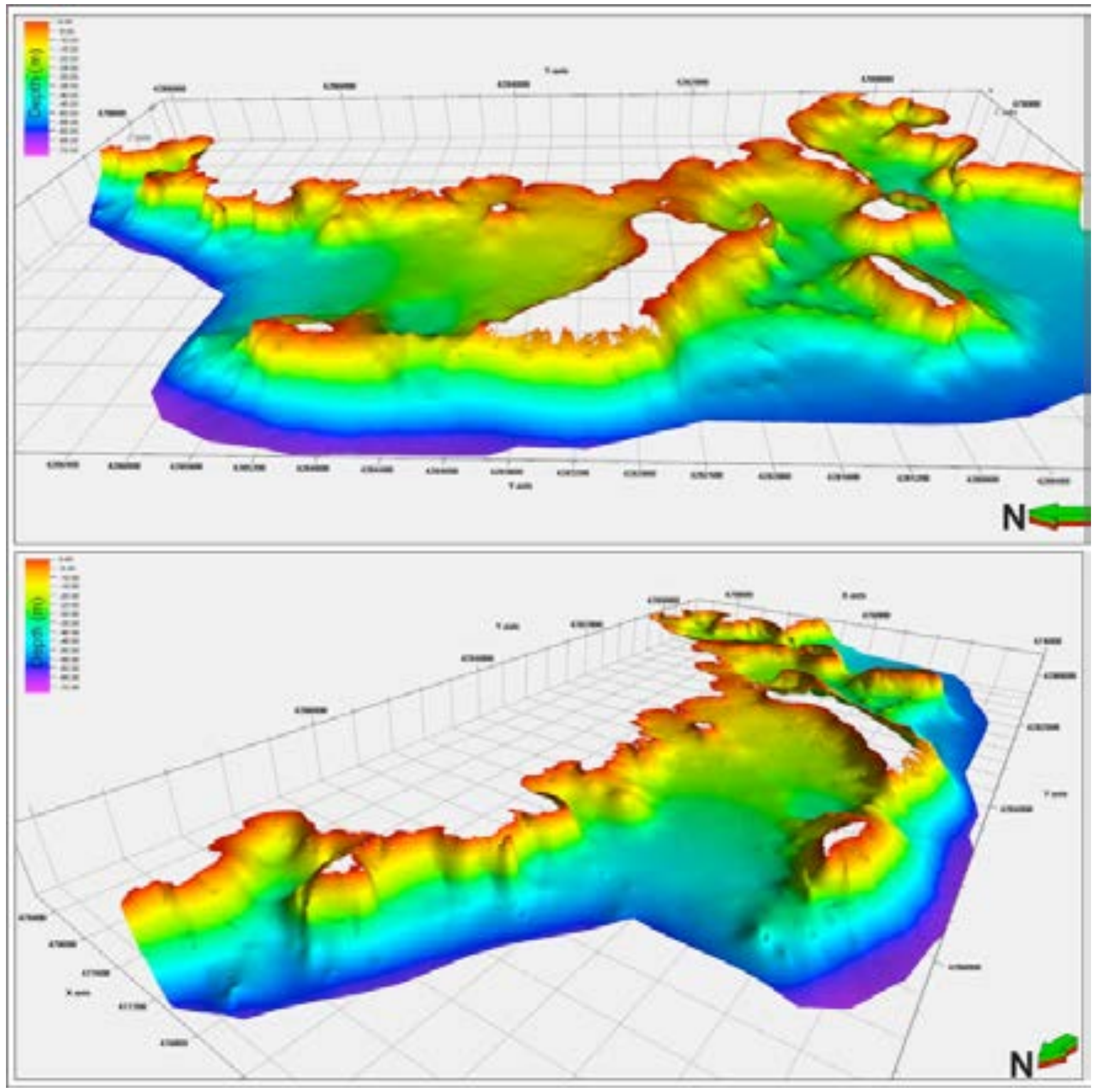


Figure 34

3D representation of the morphological changes observed in the study area

The Foca bathymetry map is divided into 6 different areas to facilitate interpretation and is shown on the bathymetry map (Figure-35). While selecting these areas, the following morphological features are taken into account:

- sudden depth changes on the seabed,
- low slope depth changes on the seabed,
- coves,
- shallow depths in the working area,
- islands in the study area.

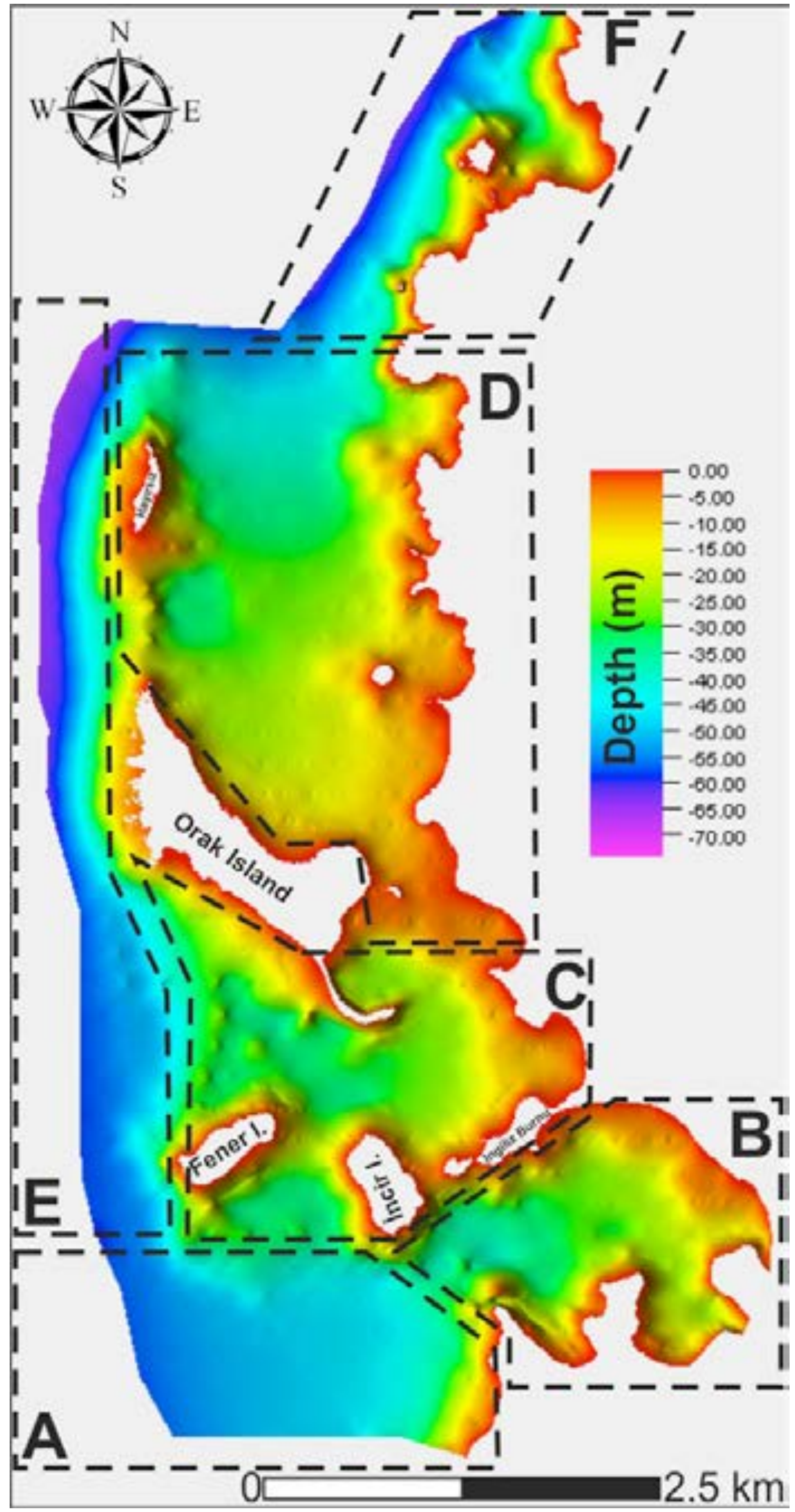


Figure 35

Foça bathymetry map divided into 6 different areas

When the study area is interpreted within the framework of the areas divided from south to north:

Area A is located to the south of the study area and its deepest point is -55 m. The depths in the area increase linearly from east to west. Area B represents the inner bay where the Foça settlement area is located. Area B is connected to Area A through a small channel between İncir Island and Kale Burnu. The deepest part of the B area is -37 m (Figure-36).

When a profile section in the middle of the A-B regions is examined, the depths in the A region are passed to the area B and shallow between Incir Island and Kale Burnu. As the a-b profile (cross 1) passes through the A and B regions, the slope of the deepening region in the A region is quite low compared to the slope in the B area (Figure-36). The region dividing the A and B areas into two corresponds to a small channel located in the middle of the profile section and the depth of this region is -37 m.

Area C is surrounded by Orak Island in the north and Fener and İncir Islands in the south, and its deepest place is -35 m. When the C area is examined except for the island margins and coastline, it is seen that its slope is quite low compared to other areas. e-c profile (cross2) shows that most of which is located in the C area, it is seen that the depth of the section within the E area deepens rapidly with a rather high slope compared to the C area (Figure-37).

Area D is bordered by a polygon that includes the north-east of the Orak and Hayırsız Islands. The depths in the area increase from south to north and the deepest part of the area is -50 m. Area E is located in the west of the Hayırsız, Orak and Fener Islands and constitutes the deepest region of the study area. This region also forms the western boundary of the study area (Figure-38).

Throughout the e-d profile (cross3) passing through the E-D areas, the slope within the E area is observed to be quite high compared to the slope in the D area. These two areas are separated from each other by the shallows between Orak and Hayırsız Islands and water depth drops to -18 m in this region. After the region that passes from area D to area E, at 0.5 km such a short distance the water depth reaches from -18 m to -65 m depth a with a high slope (Figure-38).

The slopes in the e'-d 'profile, which pass through the same areas and located just north of the Hayırsız Island, are almost the same as the slopes in the e-d profile (Figure-39). Since it is only a section taken from the northern region of the D area, the deepest place in this section is -43 meters.

Area F is the northernmost part of the study area, and is the area that reaches the shortest distance to - 60 m contour from the shore. Therefore, its slope is the fastest-changing region compared to all coastal areas in the study area (Figure-40).

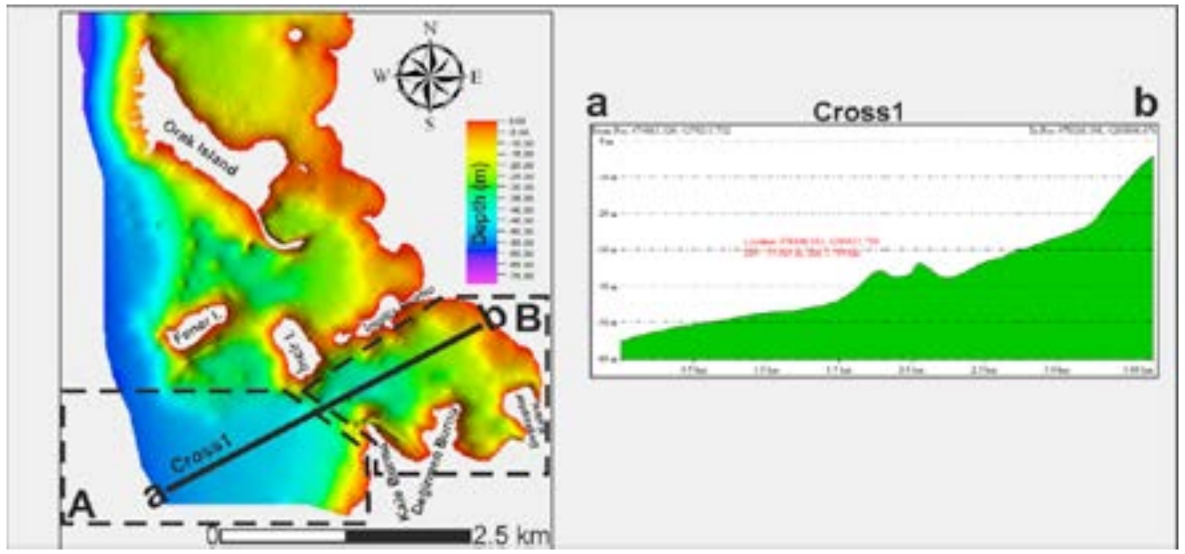


Figure 36

Profile crossing through areas A and B

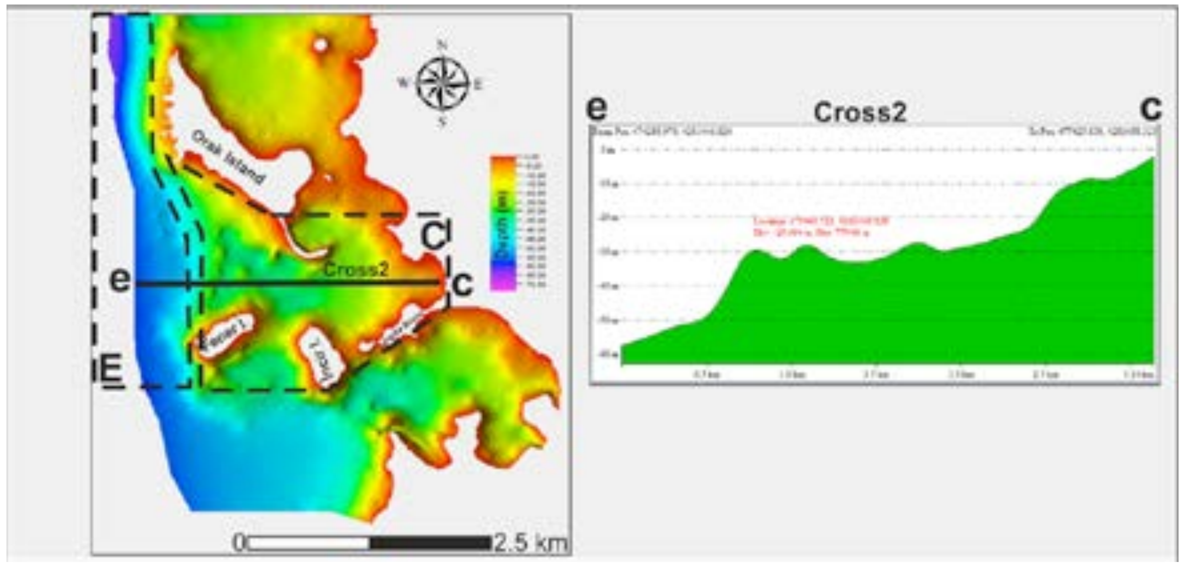


Figure 37

Profile crossing through areas E and C

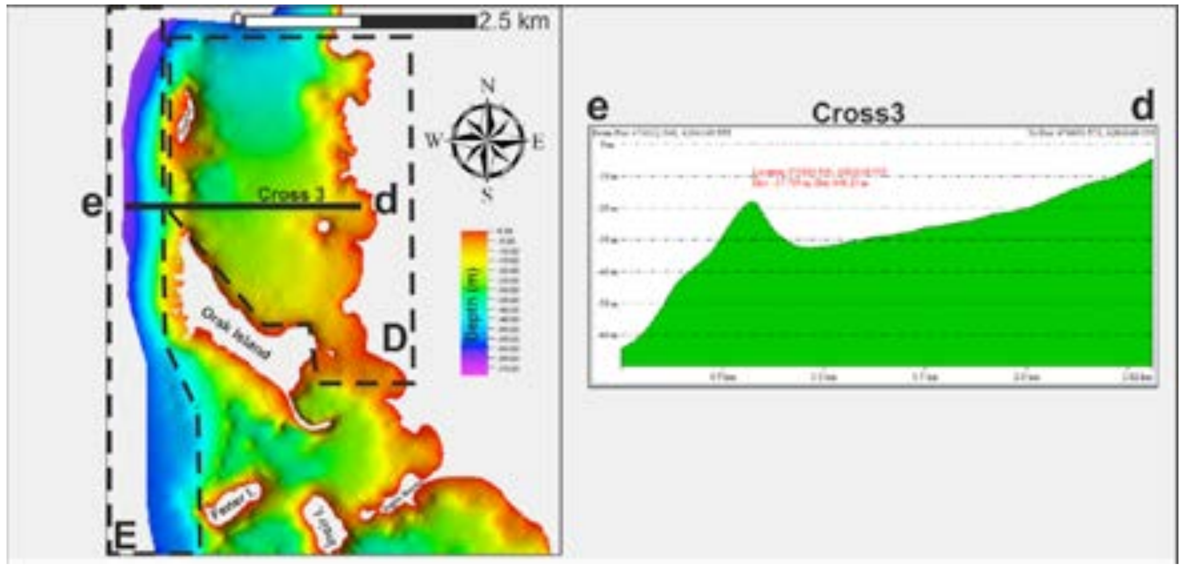


Figure 38

Profile section passing through the E and D areas

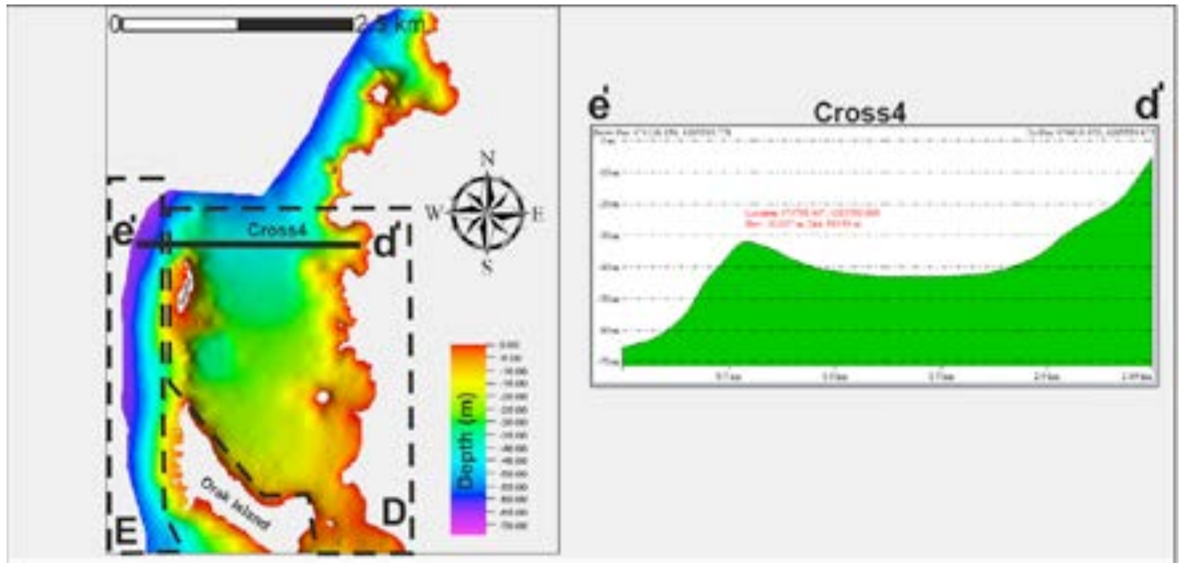


Figure 39

Profile section through the E and D areas

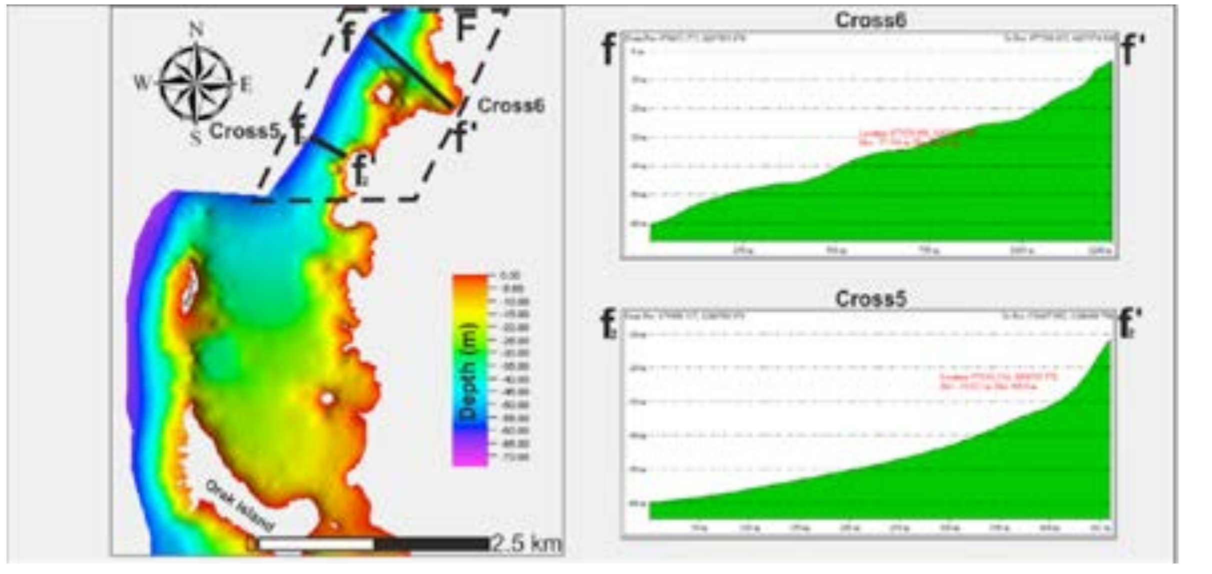


Figure 40

Profile sections passing through the F area

There are many shallow areas between the islands and the coastline in the study area. Profiles taken from these regions are also given in Figure-41. The shallowest places of these shallows vary between -2.5 m and -4 m.

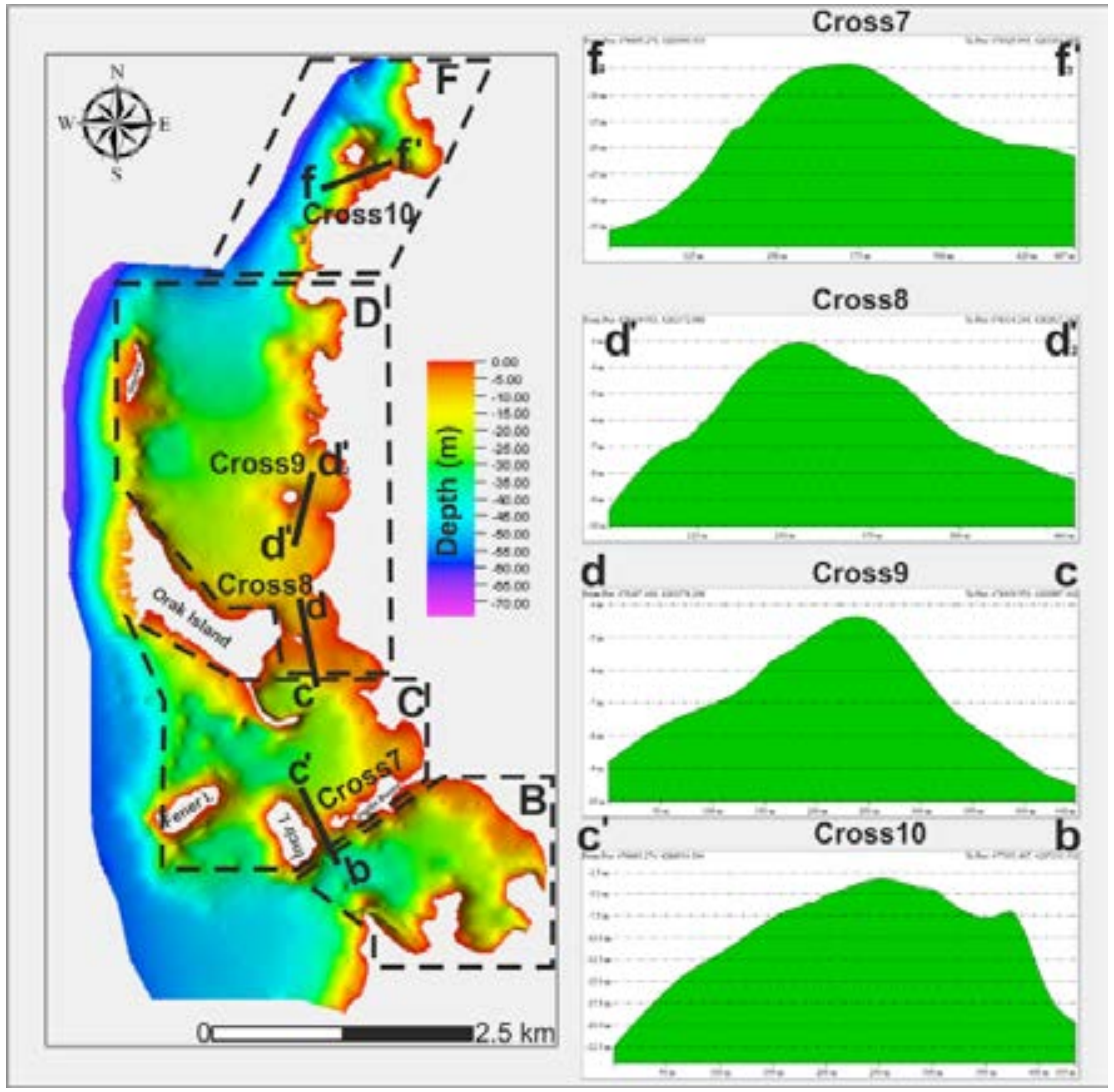
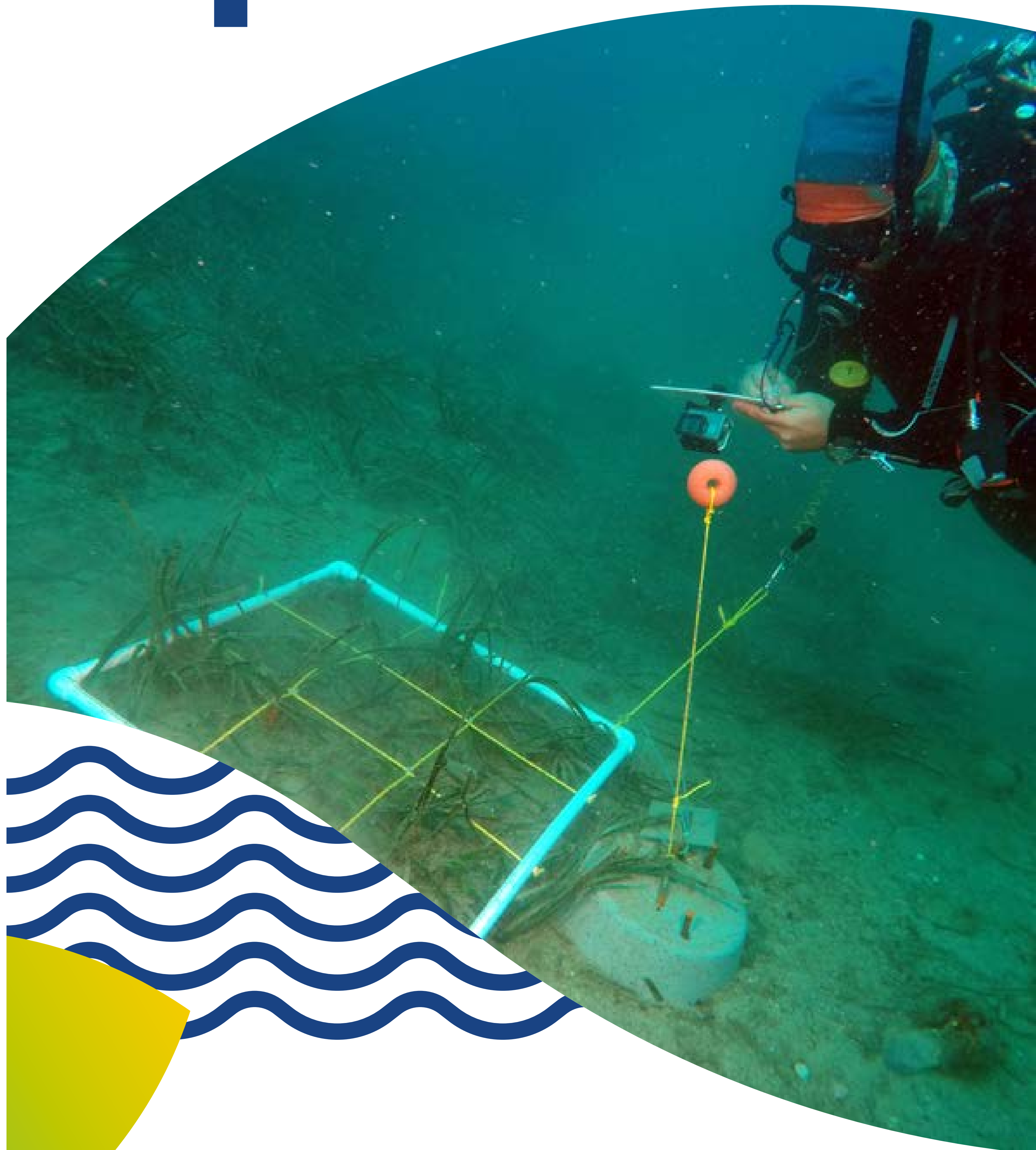


Figure 41

Profile sections between the islands and the coastline

4



4

SEABED STRUCTURE OF THE FOÇA SEPA

4.1. Seabed Features of the Foça SEPA

The roughness of the bottom, the topography of the seafloor, the boundary between sediment and meadow, the damage on habitat due to human or natural process, pipeline, shipwreck, etc. were determined by SSS. Man-made structures and hard rocks produced high backscatters or stronger acoustic return corresponding to lighter tone; whereas sediment characteristics of light to moderate signals coincided coarse-grained sand and the pattern of weak backscatter or dark tone confined to mud and fine sand.

Three bottom types had been identified: hard bottom, soft bottom and meadow cover (Figure-42). Study area is dominated by soft bottom, which is generally observed between 10- 50 m water depth. The strongest backscatter intensity observed largely over the smooth seabed in the areas of northern part of Orak island; between Orak and Fener Islands and also southern part of Fener Island confined to coarse sediment. The weak-to-moderate acoustic pattern coincides with relatively fine sediments in the south westernmost part of the study area between Fener Island and Deveboynu cape.

The shoreline and the coasts of the islands are characterized by rocky and reef features up to 30 m. Some scattered fragments are observed over the inner harbor basin such as buoy materials, broken blocks, and the other debris. Three shipwrecks were detected in the harbor, southern coast of Fener island and western side of the Orak island. The E-W directed pipeline located on the southern part of Orak island was observed between the coat and 50 m depth contour.

A heavy damage was observed in the inner harbor. The *Posidonia* meadow covers a large area reaches up to 25 m depth contour between the north of Orak Island and Metalik Island. However, damage on meadow was observed in some regions due to fishing activities (Figure-43 to 50).

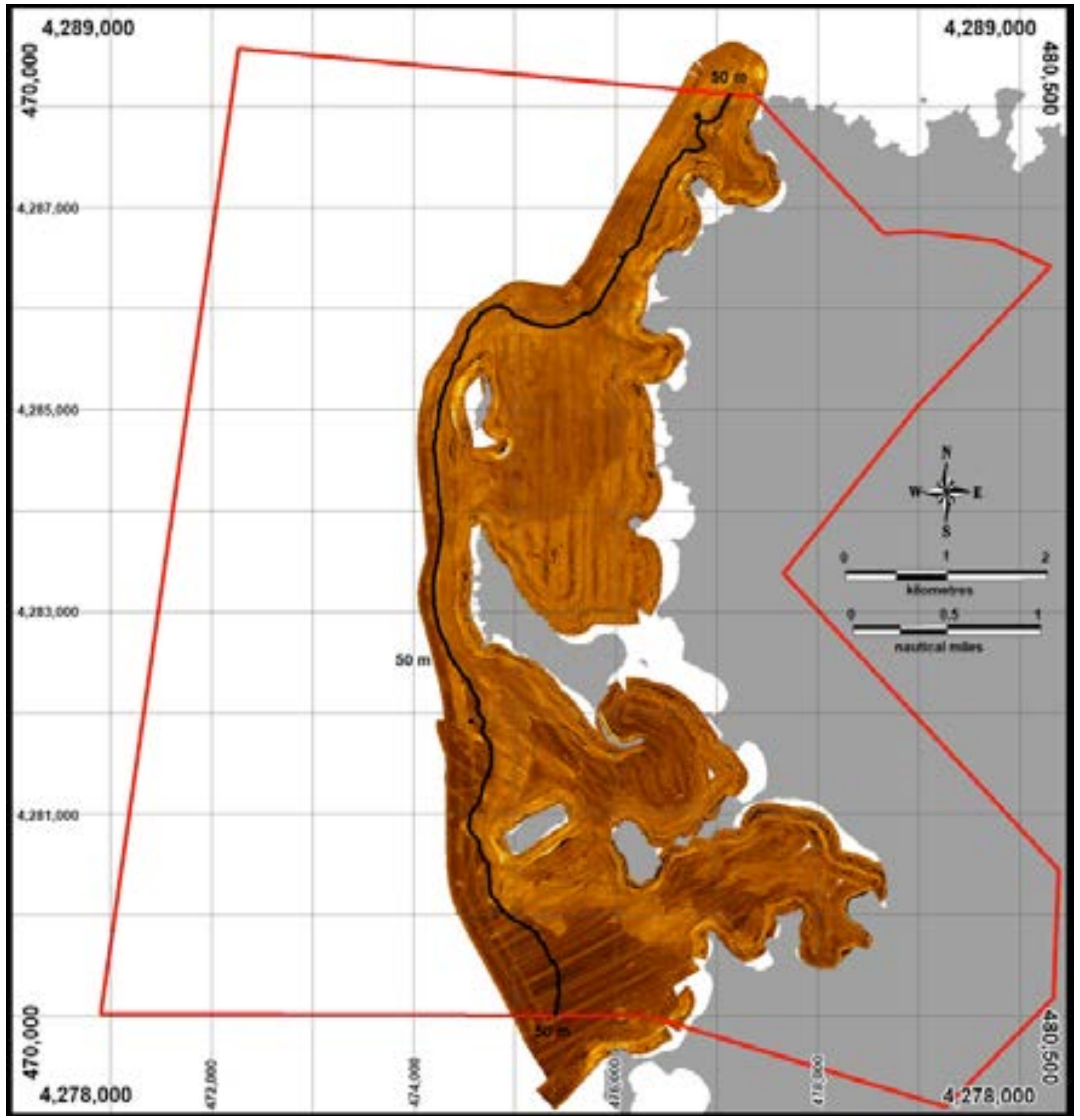


Figure 42
The mosaic map of the study area

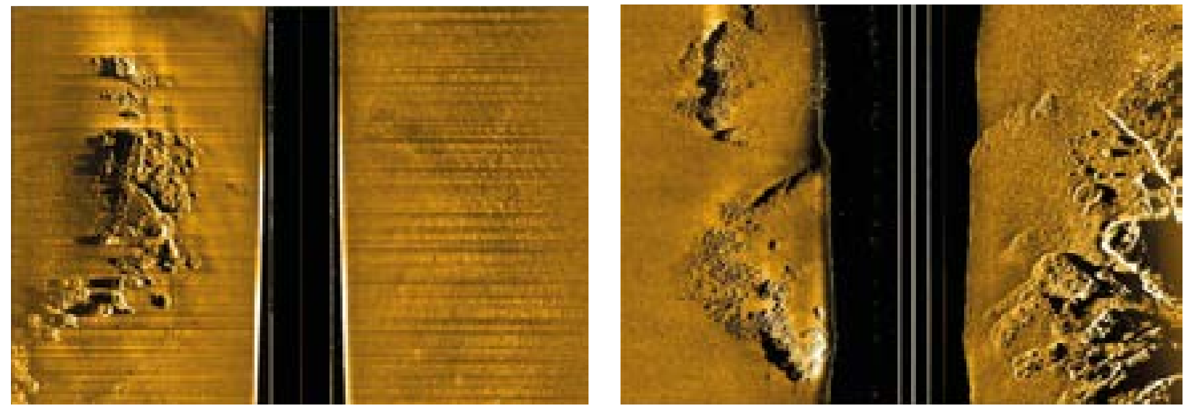


Figure 43
SSS images of hard bottom: sediment and rocks (left) and reef structure (right)

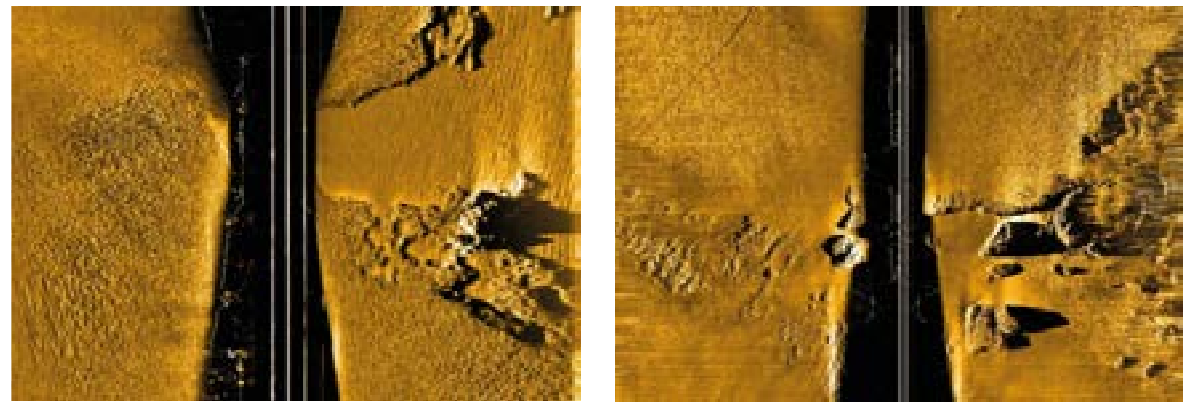


Figure 44
SSS images of soft bottom: the boundary between sediment and *Posidonia* (left) and *Posidonia*, rocks, and sand structures (right)

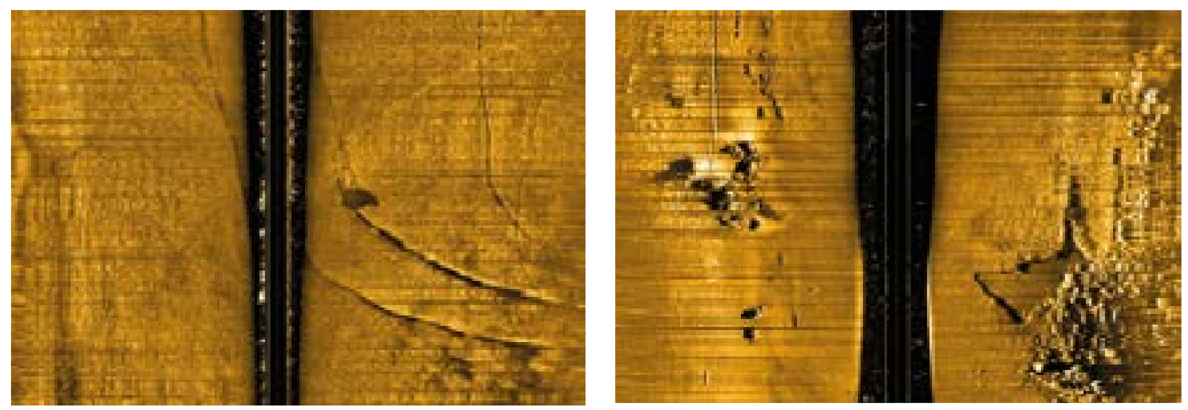


Figure 45
The damage due to fishing activity on *Posidonia* (left) and sediment (right)

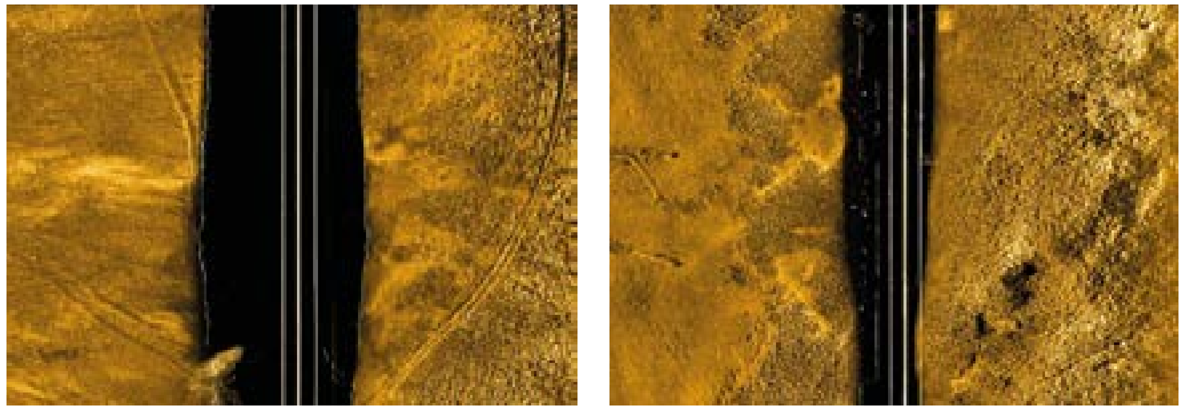


Figure 46

High-resolution SSS images of the boundary between *Posidonia* and sand and damage on *Posidonia*

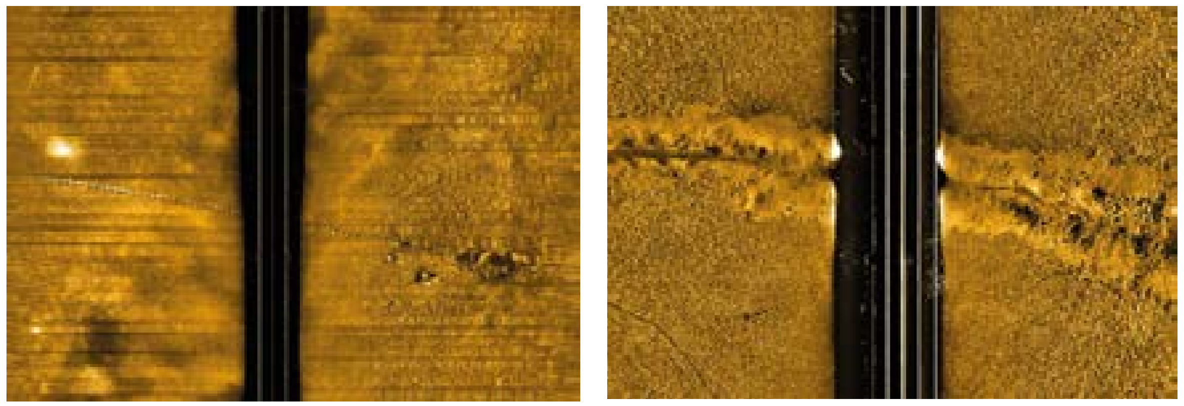


Figure 47

SSS images of pipeline: low-resolution (left) and high-resolution (right)

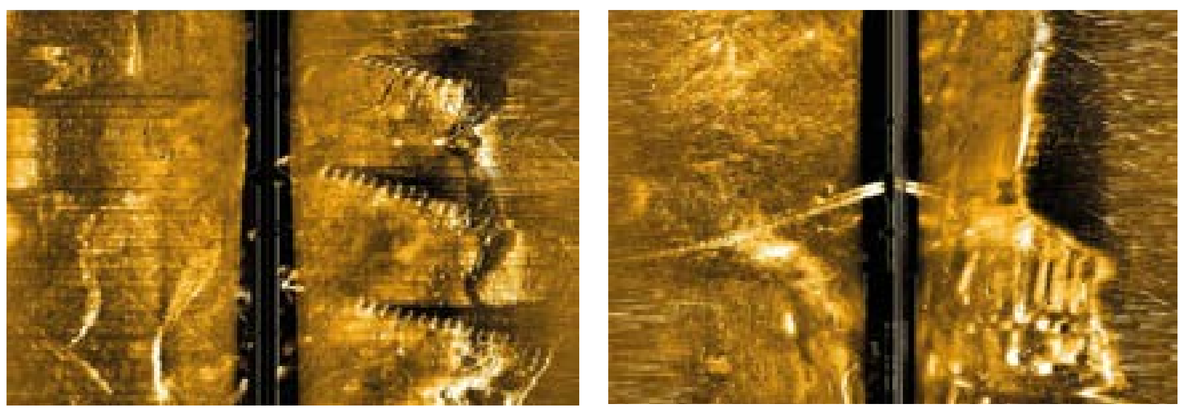


Figure 48

Pier legs and debris in the inner harbour

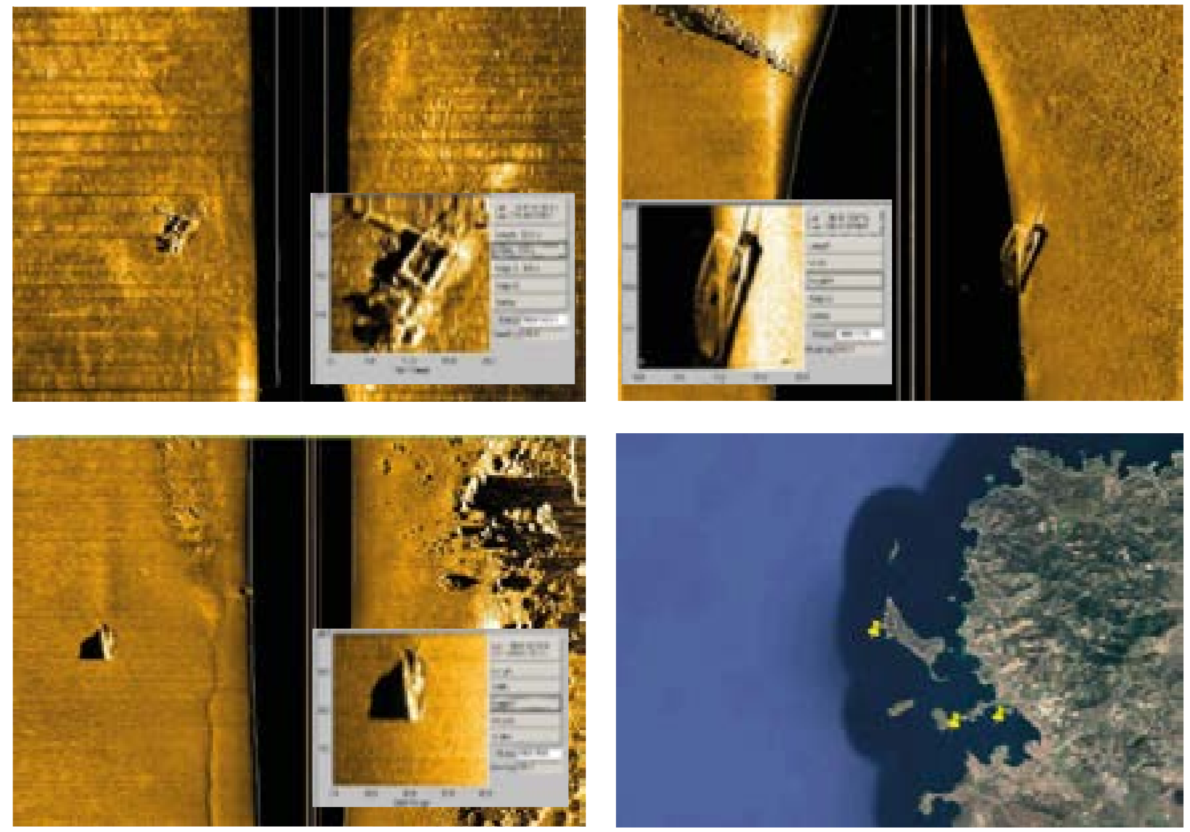


Figure 49

Shipwrecks located in the harbor (upper left), southern coast of Fener island (upper right) and western side of the Orak island (down left)

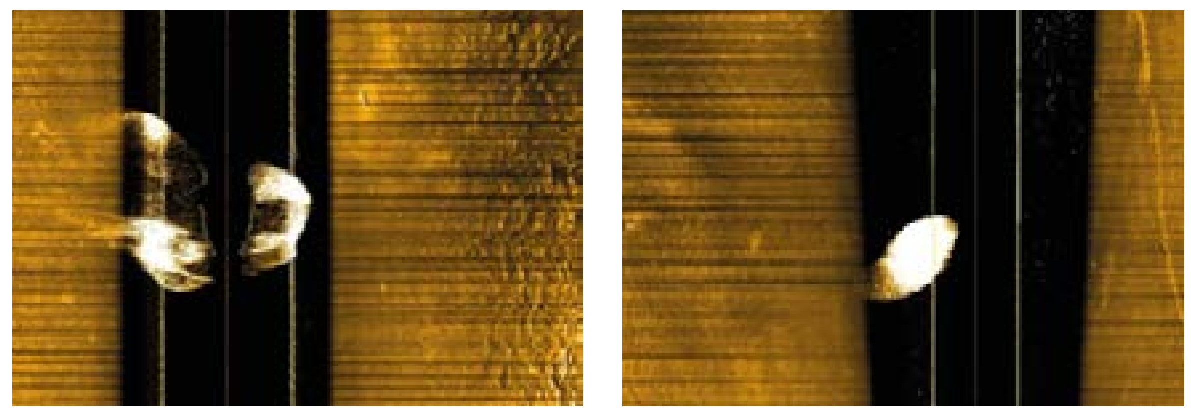


Figure 50

Fish group observed between the depth of 40 and 50 m

4.2. Seabed Sediments of the Foça SEPA

The results showed that the sea bottom sediment characteristic of the study area has a wide range of variation. According to the percentages of the grain sizes, the seabed sediment classes were determined. These percentages can be seen at Table-5. Sand is the most encountered sediment class in the study area. Clay and silt with sand are the other most common classes. Gravelly sediments are also seen rarely.

Table 5
Grain size classes and their percentages of the seabed sediment of all stations

STATION CODE	Pebble & Shells (%)	Sand (%)	Silt (%)	Clay (%)	Seabed Sediment Class
B4-S	6.79	58.37	16.53	18.30	CLAYEY SAND
B5-S	1.07	87.52	11.40	0.00	SAND
B6-S	5.83	94.11	0.07	0.00	SAND
B7-S	48.74	41.55	9.70	0.00	GRAVELLY SEDIMENT
SD-01	0.51	68.97	14.50	16.02	CLAYEY SAND
SD-02	12.46	86.87	0.68	0.00	GRAVELLY SEDIMENT
SD-03	2.26	97.37	0.37	0.00	SAND
SD-04	12.14	75.62	12.24	0.00	GRAVELLY SEDIMENT
SD-05	2.96	75.68	21.35	0.00	SAND
SD-06	9.85	62.97	12.77	14.41	CLAYEY SAND
SD-07	1.40	36.10	39.23	23.28	SAND SILT CLAY
SD-08	1.25	90.66	8.09	0.00	SAND
SD-09	2.07	54.52	22.28	21.13	SAND SILT CLAY
SD-10	26.35	37.12	11.58	24.95	GRAVELLY SEDIMENT
SD-11	0.11	8.13	28.94	62.82	SILTY CLAY

11 of the stations has fine sediment characteristics and 4 of them has coarse sediment characteristics. The classification diagrams of these classes (according to Shephard 1954) are presented in Figure-51 and Figure-52.

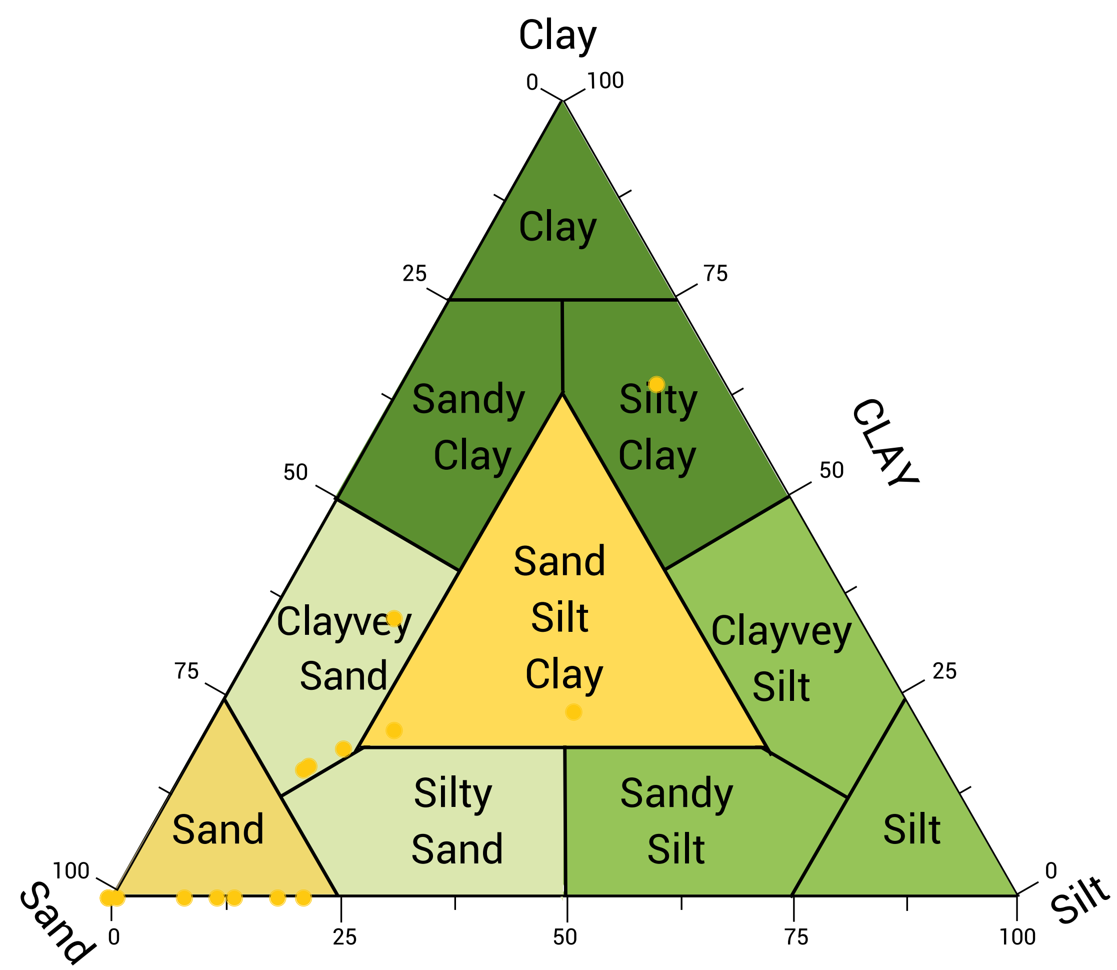


Figure 51
Fine sediment distribution at the study area (according to Shephard 1954)

Foça SEPA Sediment Classification

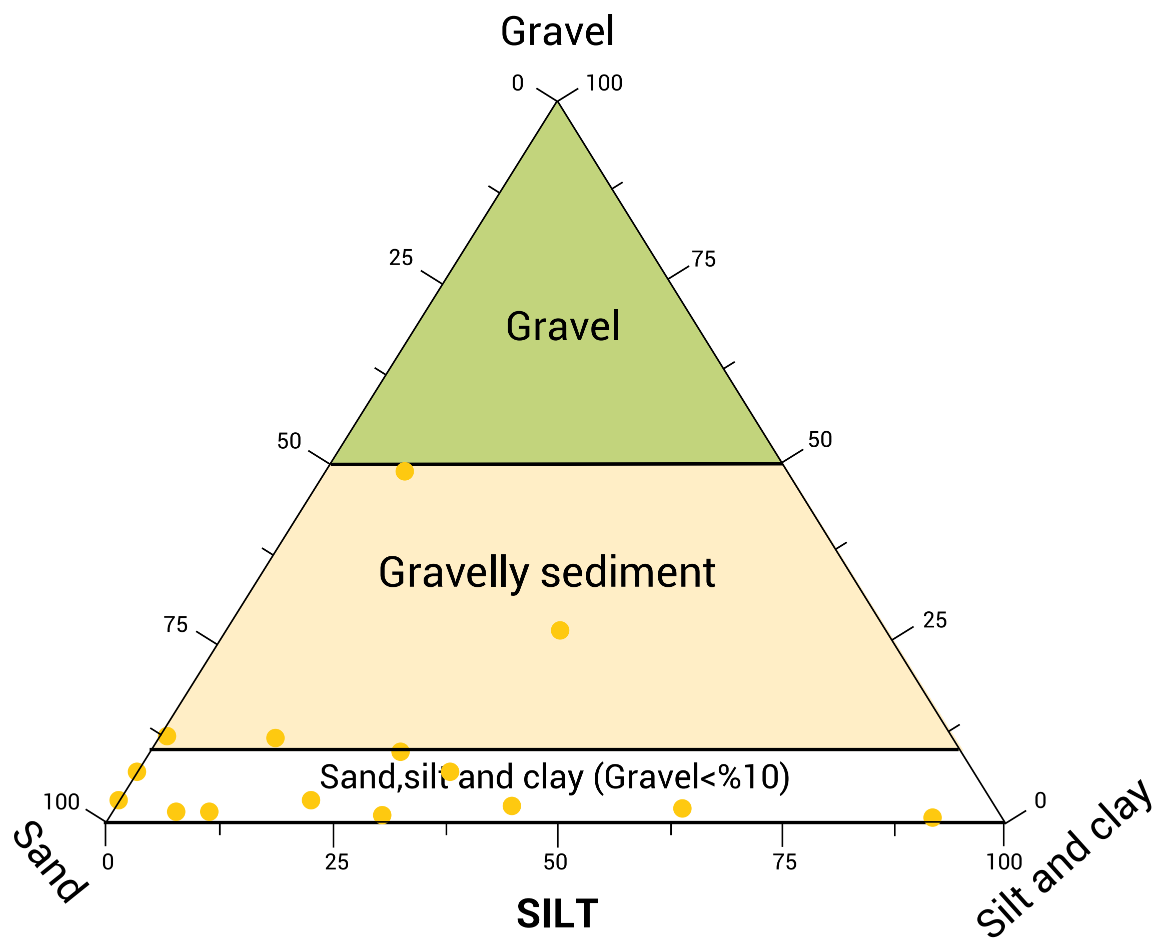


Figure 52
Coarse sediment distribution at the study area (according to Shephard 1954)

Despite the wide range between the stations, the distribution maps of the sediment classes give an opinion about the sediment characteristic of the study area. With this point of view, when we look at the sand distribution map, the offshore part and the north side of the study area has a higher sand content than the other parts (Figure-53). The silt and clay content (Figure-54) of the study area constitutes of the mud content. The mud percentages of the seabed sediments are increasing at the inshore and southern part of the study area. These two results are parallel with each other. However, when we look at the gravelly sediment distribution (Figure-55), especially the southern part and offshore of the study area has a bigger amount of gravelly content than the other parts.

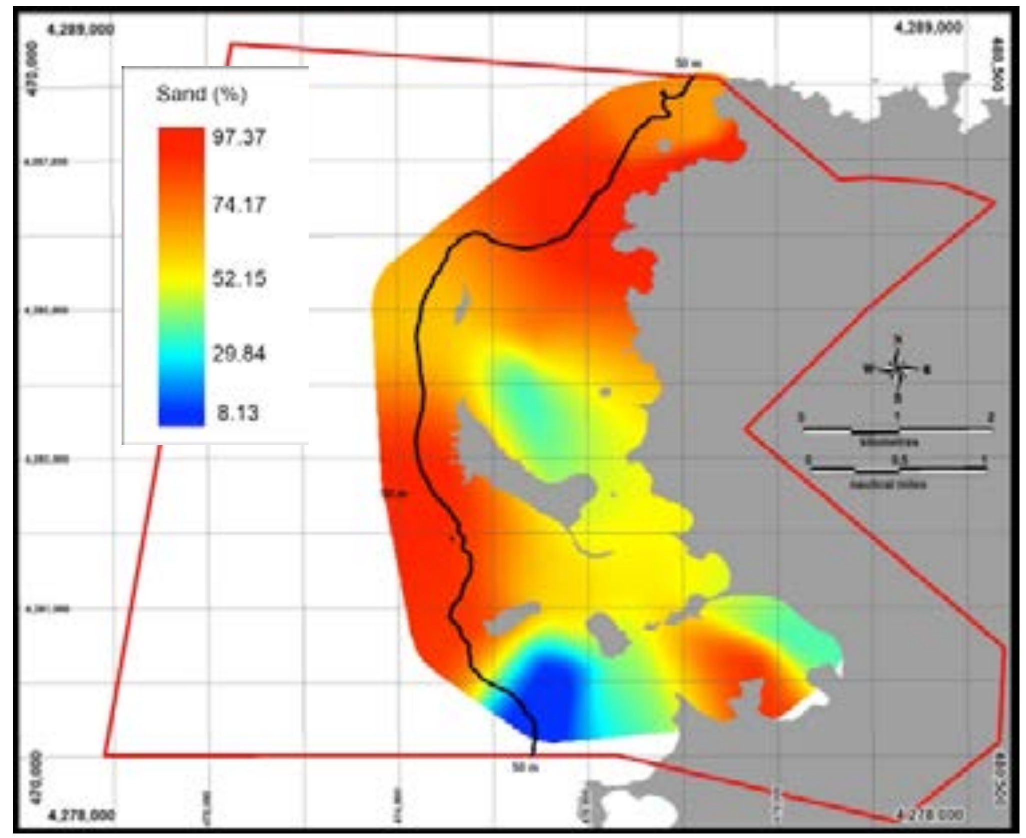


Figure 53
The distribution of sand in the study area

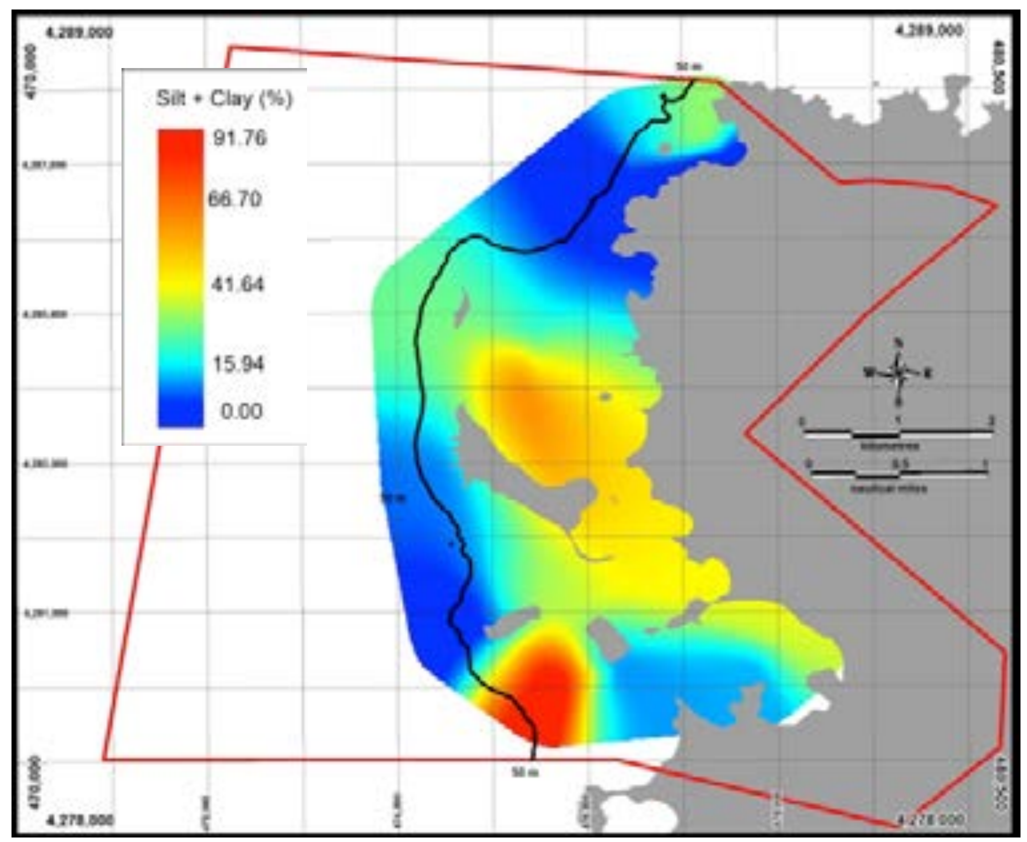


Figure 54
The distribution of silt and clay (mudy) sediment in the study area

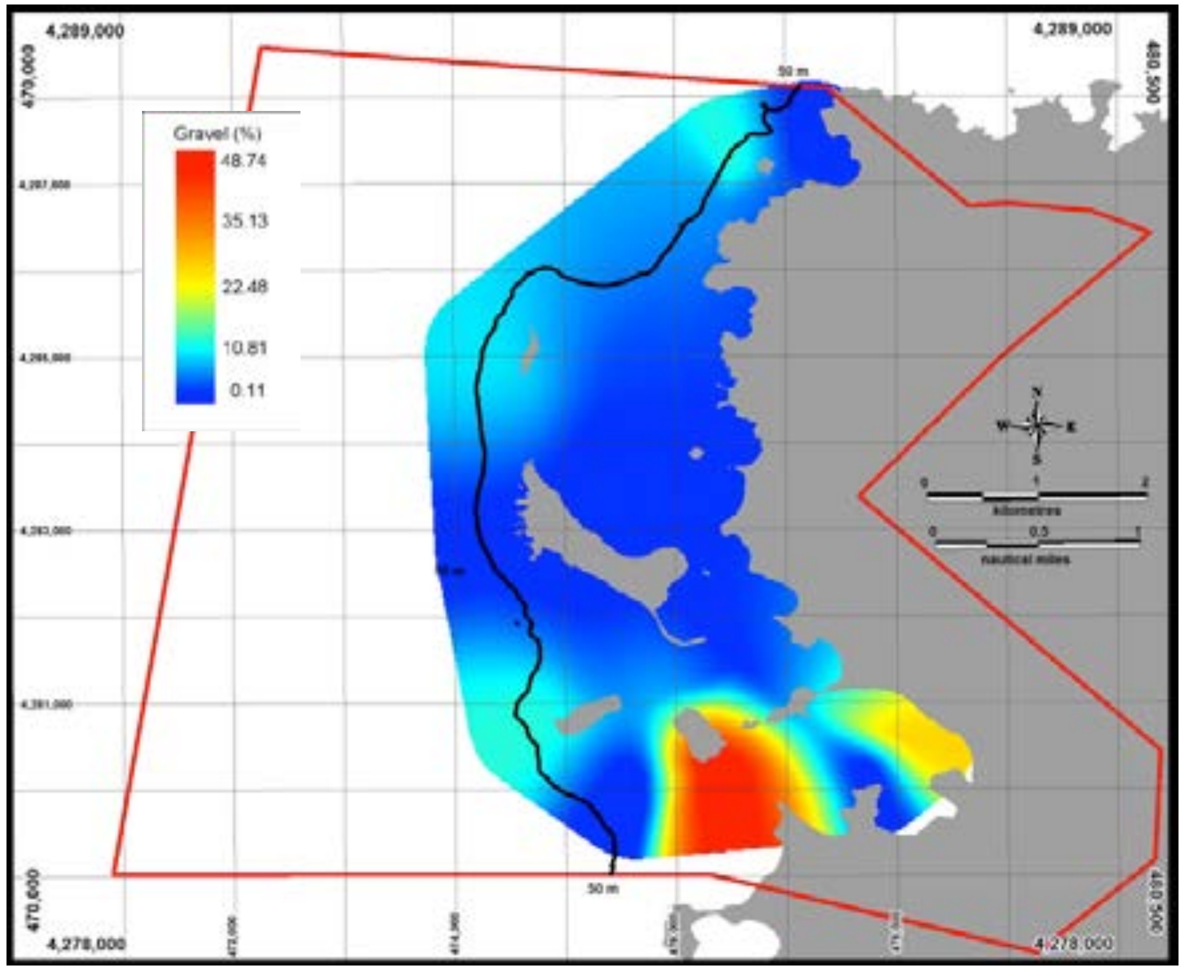


Figure 55

The distribution of gravelly sediment in the study area

4.3. Seabed Geomorphology of the Foça SEPA

There are four geomorphological units classified as 1) hard bottoms, 2) soft bottoms, 3) muddy bottoms, 4) *Posidonia oceanica* meadows using SSS mosaic and ground-truthing data. These classes were digitized as 568 polygon features in GIS.

Sandy bottoms have the majority in the distribution with 8.59 km^2 of surface coverage. It is followed by and *Posidonia oceanica* meadows (5.69 km^2) and muddy bottoms (2.25 km^2). Hard bottoms constitute to only 6.94% of the total area between 0-50 m depth interval with 1.23 km^2 in the area (Figure-56 & Table-6).

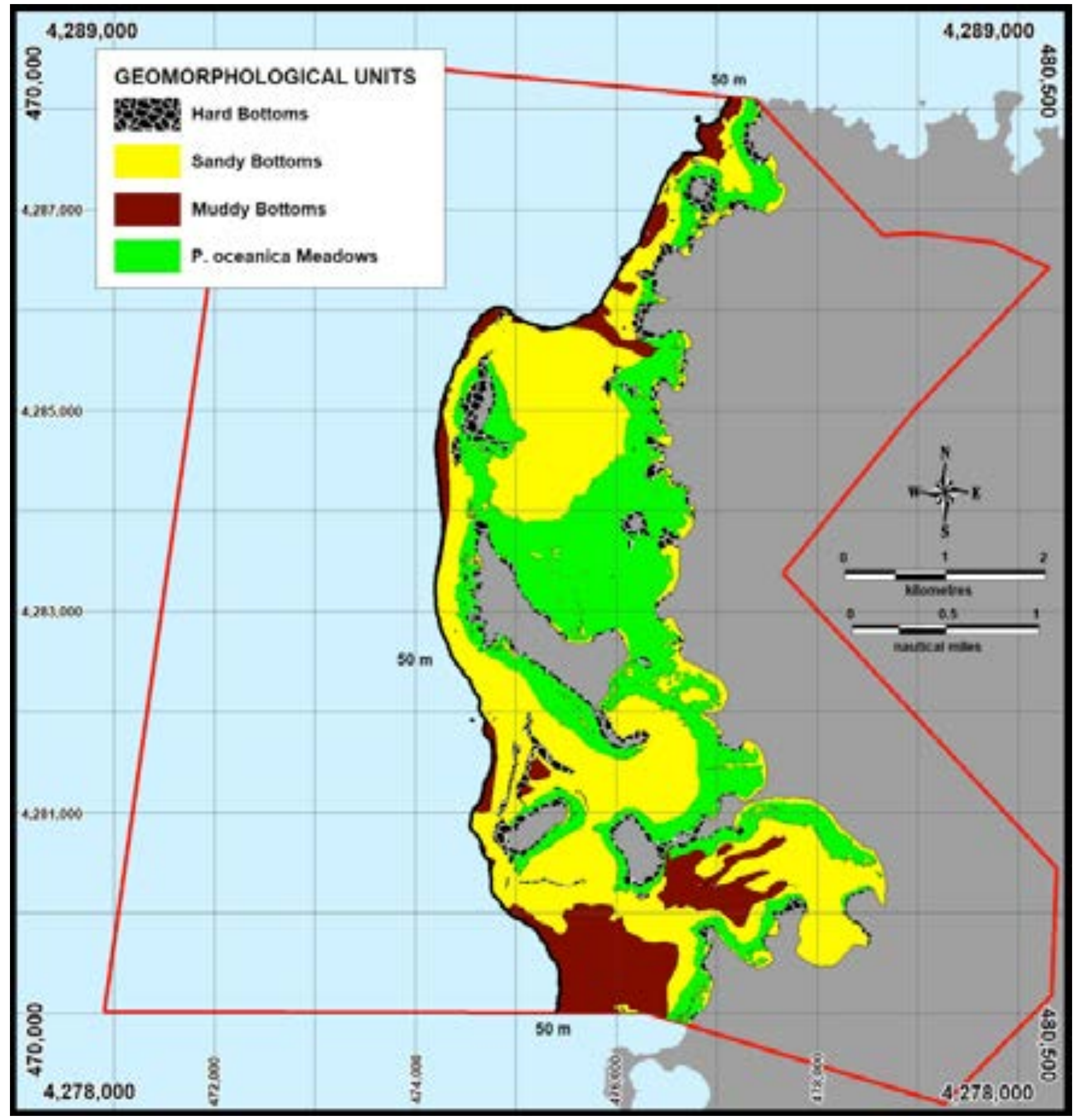


Figure 56

The map of geomorphological units

Table 6
Area coverages of geomorphological units in 0-50 m depth zone

GEOMORPHOLOGICAL CLASSES	A (km^2)	Percentage (%)	Feature N
Hard Bottom	1.232354	6.94	150
Sandy Bottom	8.593652	48.37	362
Muddy Bottom	2.251208	12.67	10
Posidonia oceanica meadow	5.690289	32.03	46
TOTAL	**17.767503**	**100.00**	**568**

5

5

OCEANOGRAPHIC PROPERTIES OF THE FOÇA SEPA

CTD (conductivity-temperature-depth) measurements were conducted as supplementary data for the study at 38 stations. The density, temperature and salinity profiles data are given in Figure-57.

These data were used for the physical characteristic definition of the study area. To understand the relationship between the bottom and the water column, the average values of the last 2 meters of the profiles were obtained. These values are presented in Table-7. On the other hand, the bottom values are evaluated with the distribution maps.

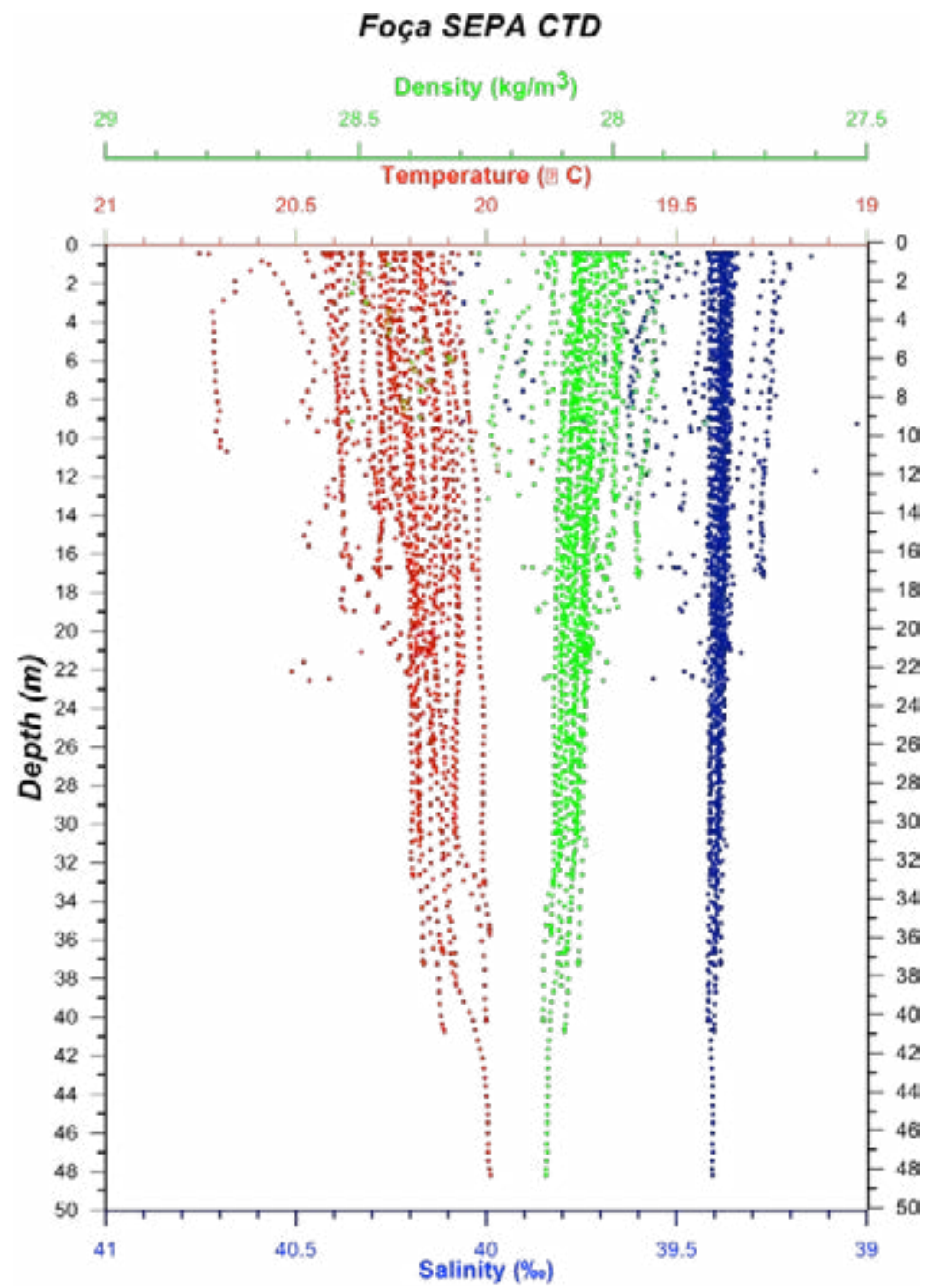


Figure 57

Density, temperature and salinity profiles of all stations

Table 7
Bottom (last 2 m) temperature, salinity and density average values of all stations

STATION CODE	Bottom CTD Parameters		
	Temperature (°C)	Salinity (PSU)	Density (kg/m³)
B4-S	20.354	39.375	28.008
B5-S	20.097	32.077	22.509
B6-S	20.195	39.410	28.078
B7-S	20.143	39.362	28.056
FC-02	20.282	39.274	27.950
SD-01	20.376	39.491	28.090
SD-02	20.008	39.393	28.117
SD-03	20.088	39.632	28.276
SD-04	19.998	39.395	28.121
SD-05	20.084	39.412	28.110
SD-06	20.123	39.397	28.088
SD-07	20.122	39.396	28.087
SD-08	20.176	39.386	28.066
SD-09	20.177	39.392	28.069
SD-10	20.267	39.430	28.073
SD-11	20.166	39.384	28.067
DDC-01	20.322	39.478	28.095
DDC-02	20.277	39.420	28.063
DDC-03	20.424	39.760	28.283
DDC-04	20.157	39.413	28.090
DDC-06	19.993	39.405	28.131
DDC-07	20.159	39.453	28.120
DDC-08 (TG-18)	20.115	39.414	28.103
DDC-09	20.081	39.399	28.101
DDC-10	19.962	39.295	28.053
DDC-11	20.002	39.417	28.137
DDC-12	20.431	39.451	28.045
DDC-13	20.401	39.355	27.980
DDC-14	20.582	39.555	28.082
TG-08	20.137	39.393	28.082
TG-09	20.140	39.396	28.082
TG-16	20.040	39.292	28.030
TG-24	20.176	39.392	28.070
TG-36	20.189	39.377	28.055
TG-37	20.117	39.400	28.093
TG-70	20.062	39.392	28.100
TG-71	20.210	39.577	28.201
TG-74	20.291	39.490	28.112

The distribution of the temperature, salinity and density bottom average values have little variations. The bottom density (Figure-58) and the salinity (Figure-59) show the highest values at the Kartdere region with the 28.28 kg/m³ and 39.76 psu respectively. The lowest values of the bottom density were observed at the north and the south of the Orak Island coast as about 27.95 kg/m3, while the lowest values of the salinity were seen at the north of the Orak Island coast and the area between the Orak Island and the main land. The temperature of the bottom water column has a different pattern. While the highest value of it was seen at the north coast of the Fener Island as 20.58 °C and the lowest value was observed at the area between the Orak Island and the mainland with 19.96 °C (Figure-60).

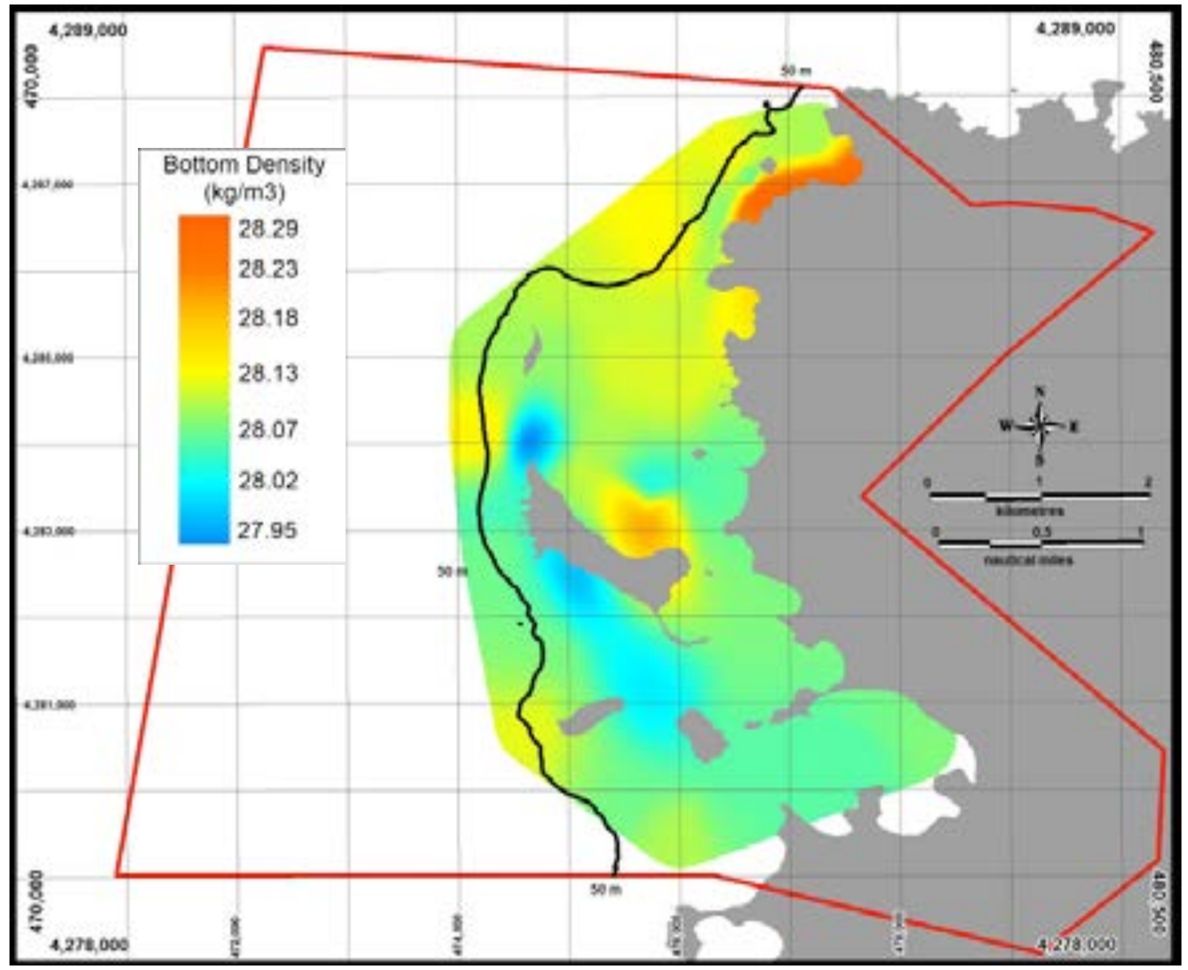


Figure 58
The distribution of sea bottom water density in the study area

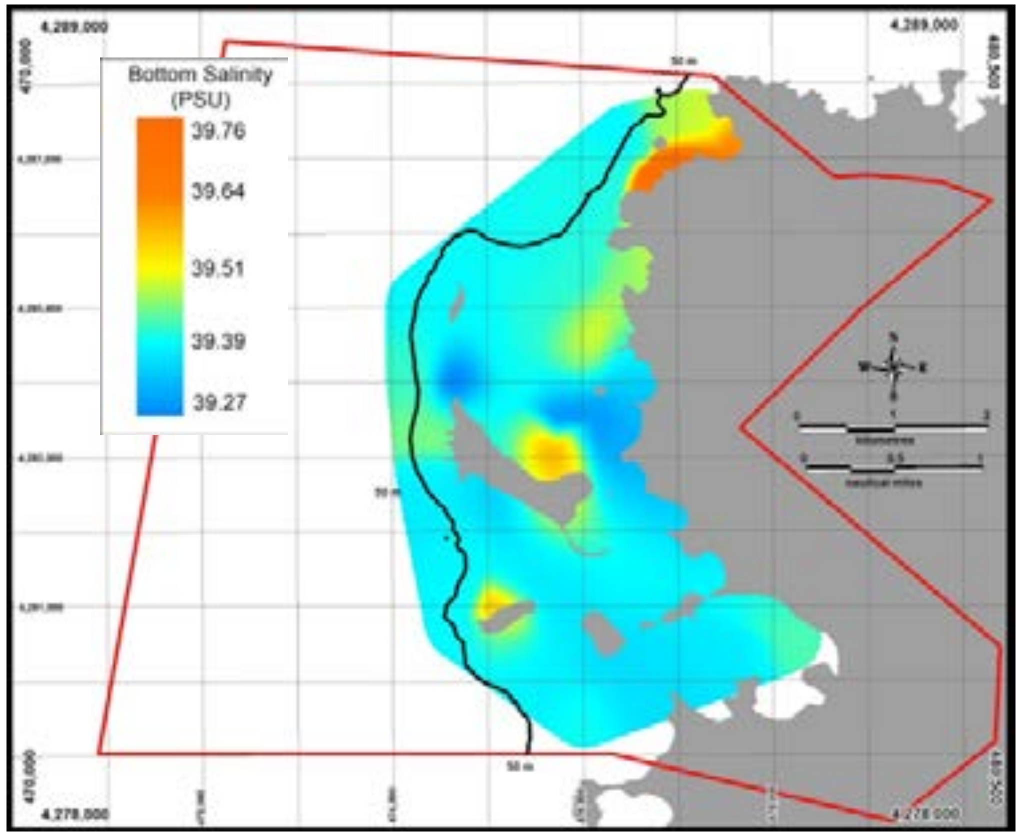


Figure 59

The distribution of sea bottom water salinity in the study area

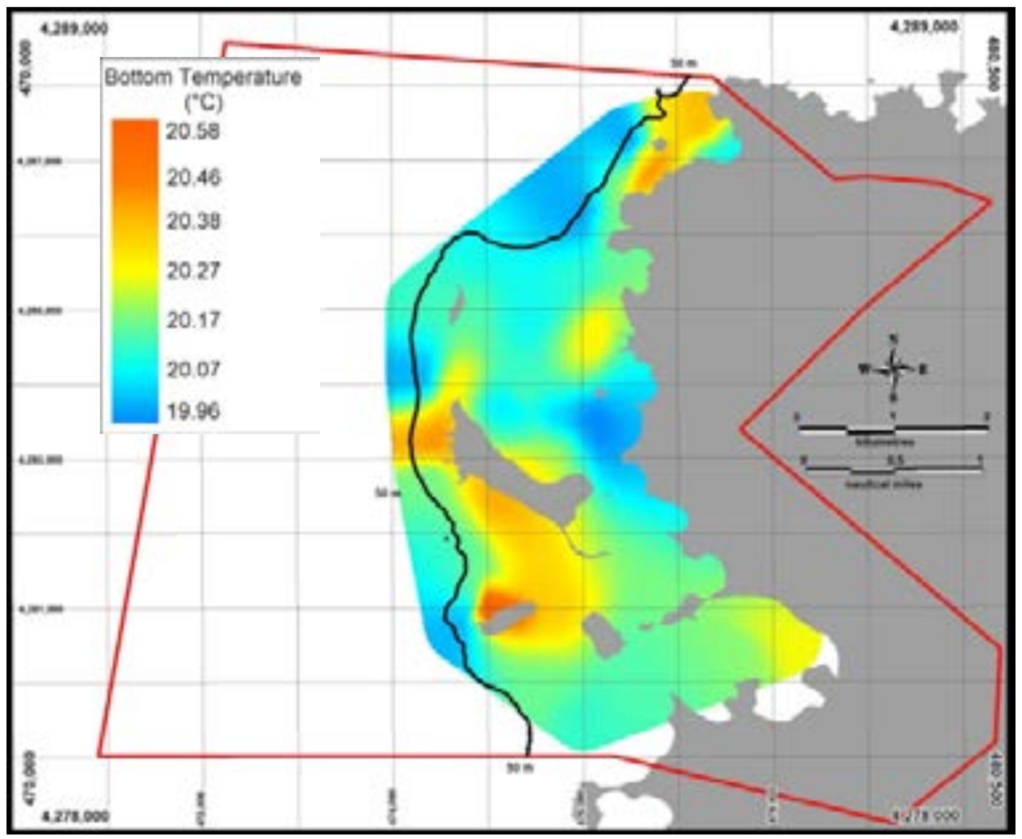


Figure 60

The distribution of sea bottom water temperature in the study area

6

6

BENTHOS OF THE FOÇA SEPA

6.1. Hard Bottom

The percentage cover of organisms found in the quadrate (0.25 m^2) at 7 randomly selected stations at 7.5-25 m depth in the study area were calculated using the photoQuad software program. According to the results of the analysis, species belonging to 7 taxonomic groups (Algae, Porifera, Cnidaria, Polychaeta, Mollusca, Echinodermata and Tunicata) were determined. Algae were the richest group in terms of species diversity in the sampling stations.

Epilithic algal community (56.3%) was the dominant group at HB-1 station. This group was followed by Corallinacea (spp.) (20.2%) and *C. bursa* (2.4%). Others category including *Liagora* sp., Tunicata (spp.), and Porifera (spp.) covered 1.1% of the total sampling area (**Figure-61 and 62**).

HB-1

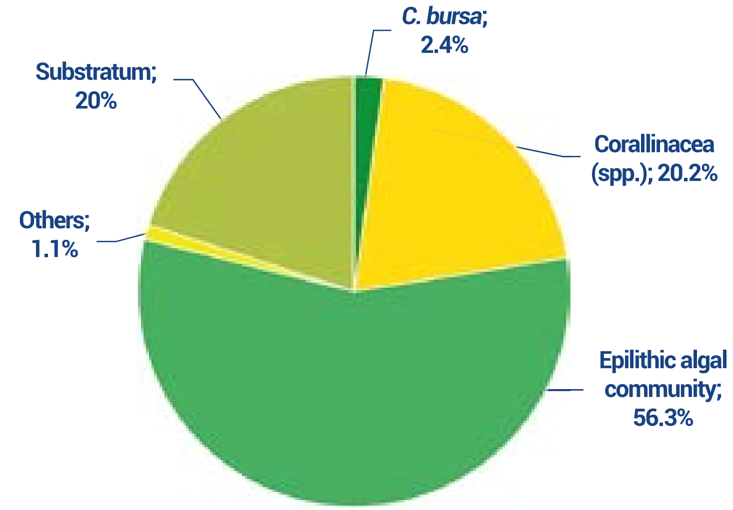


Figure 61
The percentage cover of benthic organisms on HB-1 (7.5 m)

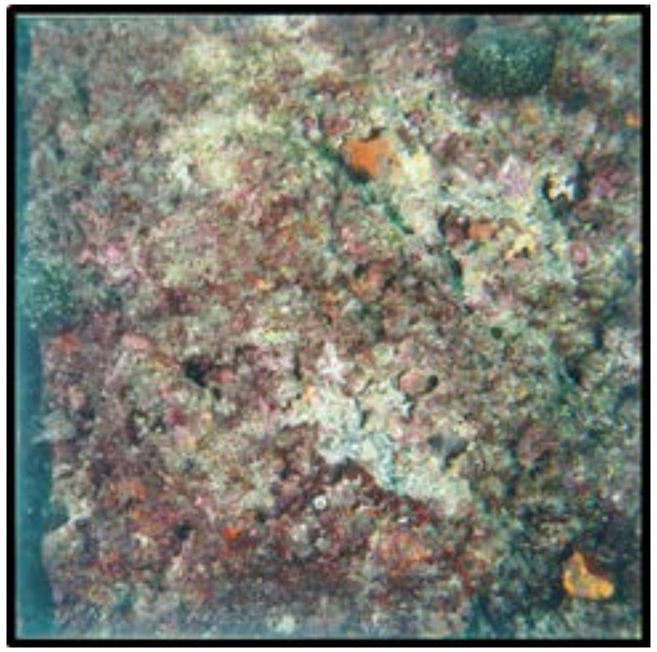


Figure 62
The image of hard substratum station HB-1

Epilithic algal community covered 81.1% of the total area. This group was followed by Corallinacea (spp.) (12.9%), *Codium bursa* (2%), Porifera (spp.) (1.1%) and different algal species (*Valonia* sp., *Halimeda tuna*, and *Liagora* sp.) in the Others category (0.9%) (Figure-63 and 64).

HB-2

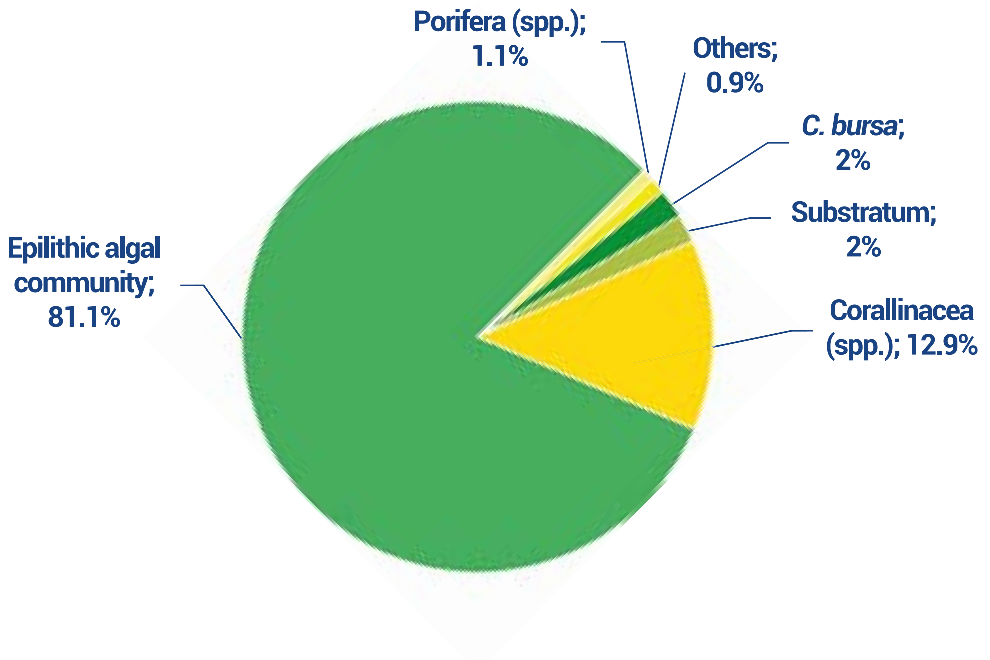


Figure 63
The percentage cover of benthic organisms on HB-2 (15 m)

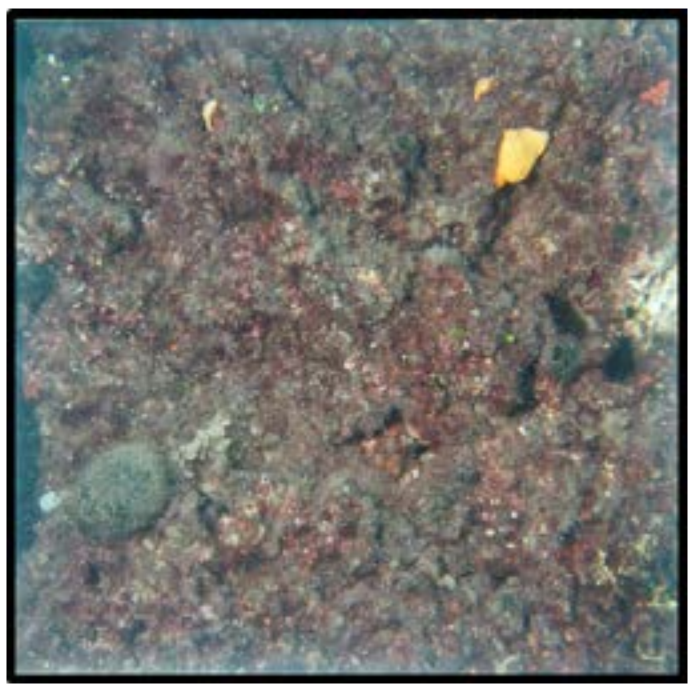


Figure 64
The image of hard substratum station HB-2

The percentage cover of epilithic algal community (48.8 %) was higher than the rest of the groups such as incrustant calcareous algae (10.2%), Porifera (spp.) (20.2%) and other species (1%- *H. tuna*, Polychaeta tube, and Nudibranch). No species was found in the 19.8% area of the quadrate (Figure-65 and 66).

HB-4

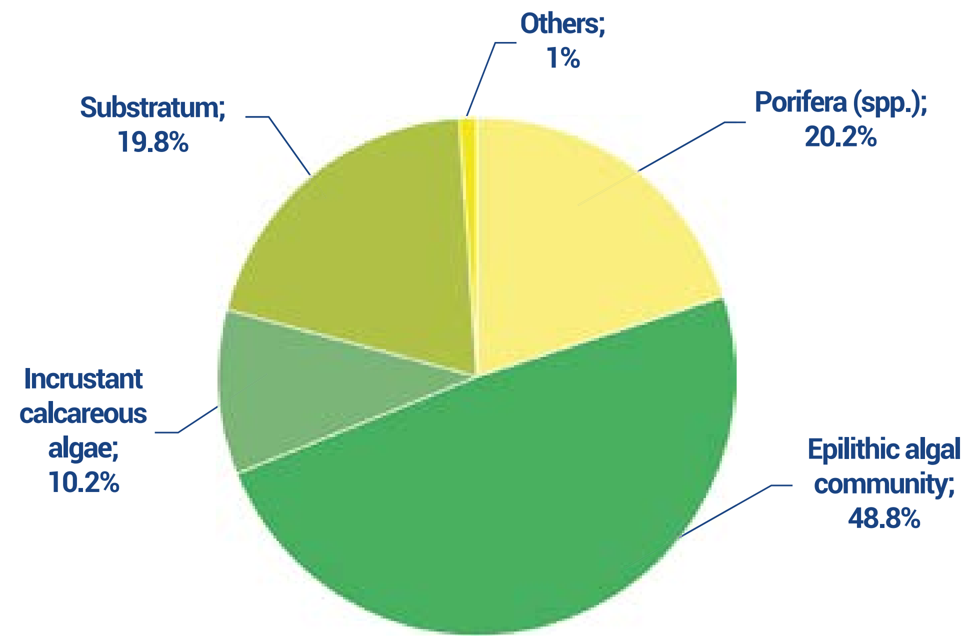


Figure 65
The percentage cover of benthic organisms on HB-4 (25 m)

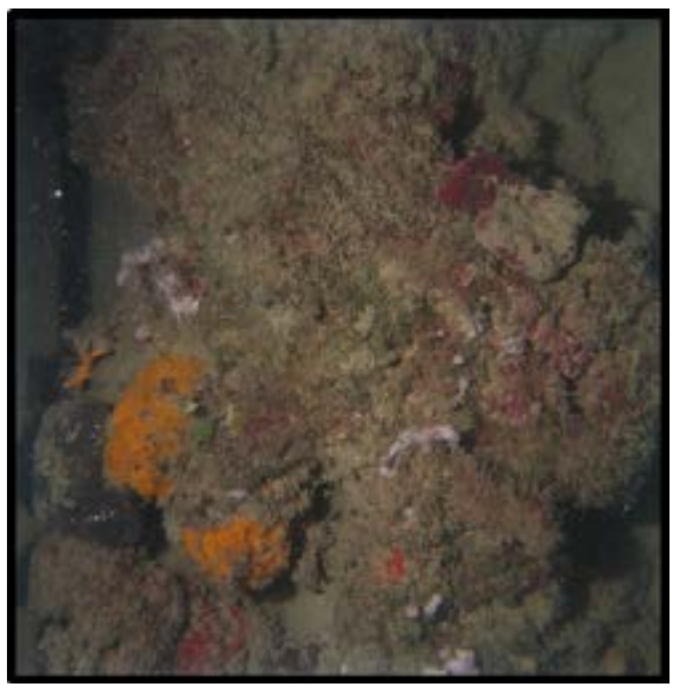


Figure 66
The image of hard substratum station HB-4

Epilithic algal communities (52.2%) and Incrustant calcareous algae (33.5%) had high coverage values at this station. Only a small portion (1.8%) of the sampling surface was covered by Other species including *Codium bursa*, *Halocynthia papillosa*, and serpulid polychaeta tube. Encrusting and erect forms of Porifera species covered 6.5% of the total area (Figure-67 and 68).

HB-7

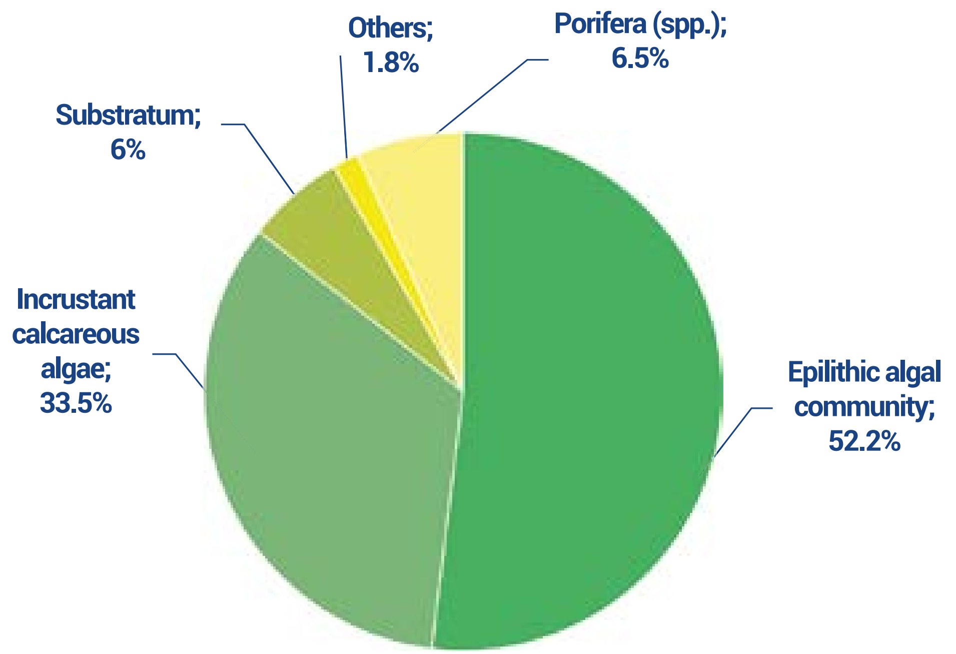


Figure 67

The percentage cover of benthic organisms on HB-7 (22 m)

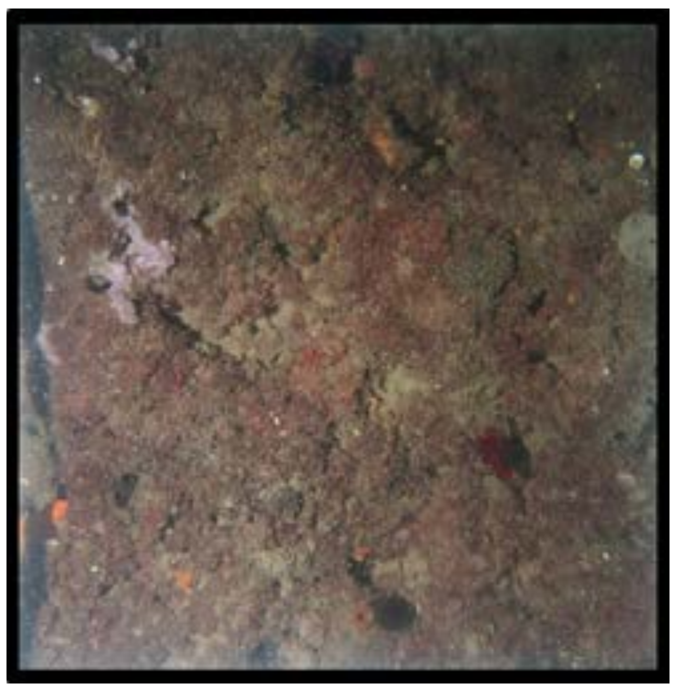


Figure 68

The image of hard substratum station HB-7

At this sampling station, the percentage cover of epilithic algal community (46%) was higher than those of other species. This group was followed by Corallinacea (spp.) (22.9%), C. bursa (7.1%), Peysonellia squamarina (6%) and Other category [4.9%-Algae sp. 1, Axinella polypoides, Porifera (spp.), H. tuna, and Anthozoa (sp.)] and Caulerpa racemosa var. cylindracea (2.7%) (Figure-69 and 70).

HB-8

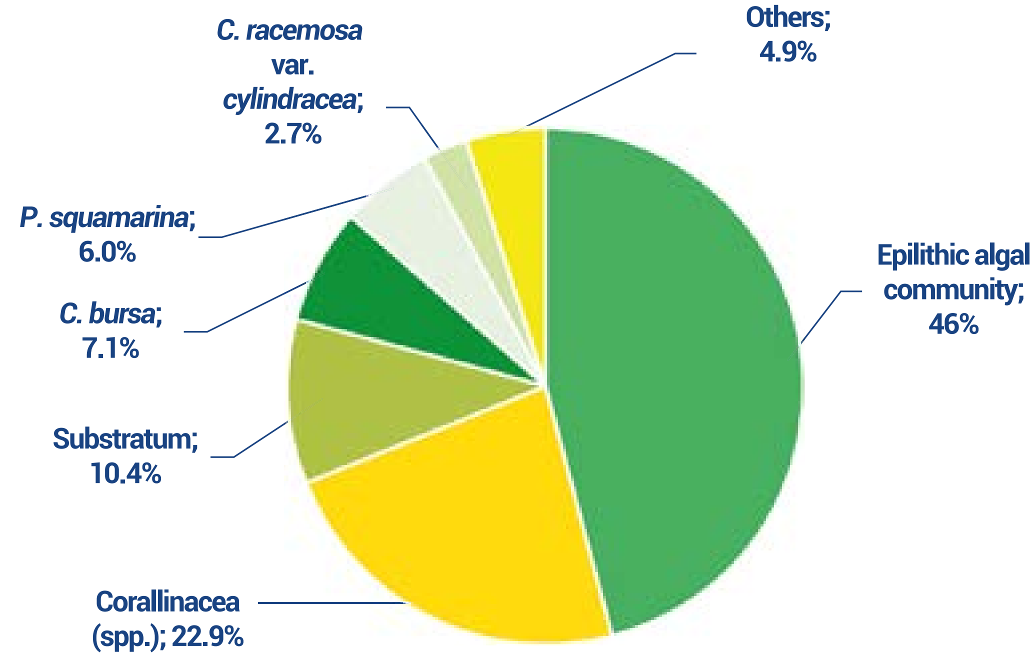


Figure 69

The percentage cover of benthic organisms on HB-8 (11 m)

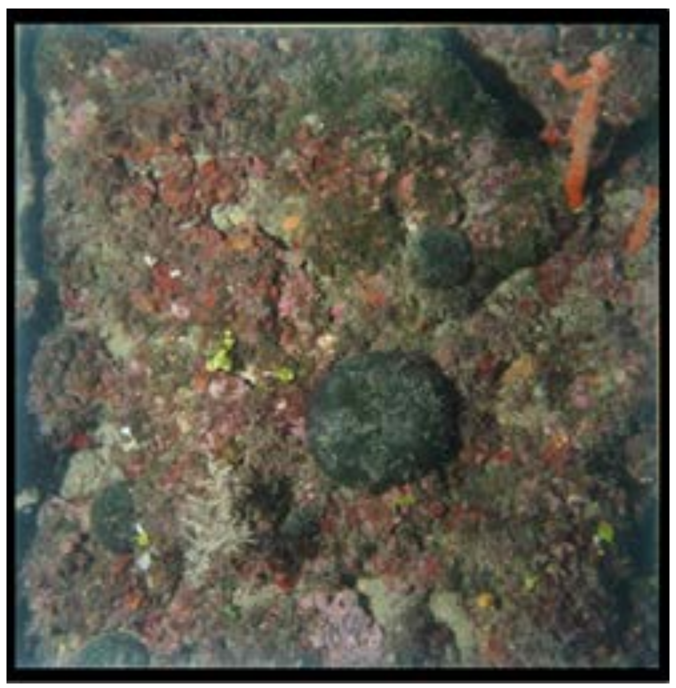


Figure 70

The image of hard substratum station HB-8

Epilithic algal community had the highest percentage cover value (31.8%) in this station. This group was followed by Corallinacea (spp.) (24.2%), C. bursa (22.4%), Rhodophyta (sp.) (7.6%), and Liagora sp. (4.2%). The percentage cover of Others including Halimeda tuna, Porifera (spp.), Echinaster sepositus, and turf algae were calculated as 6.7% of the total area (Figure-71 and 72).

HB-9

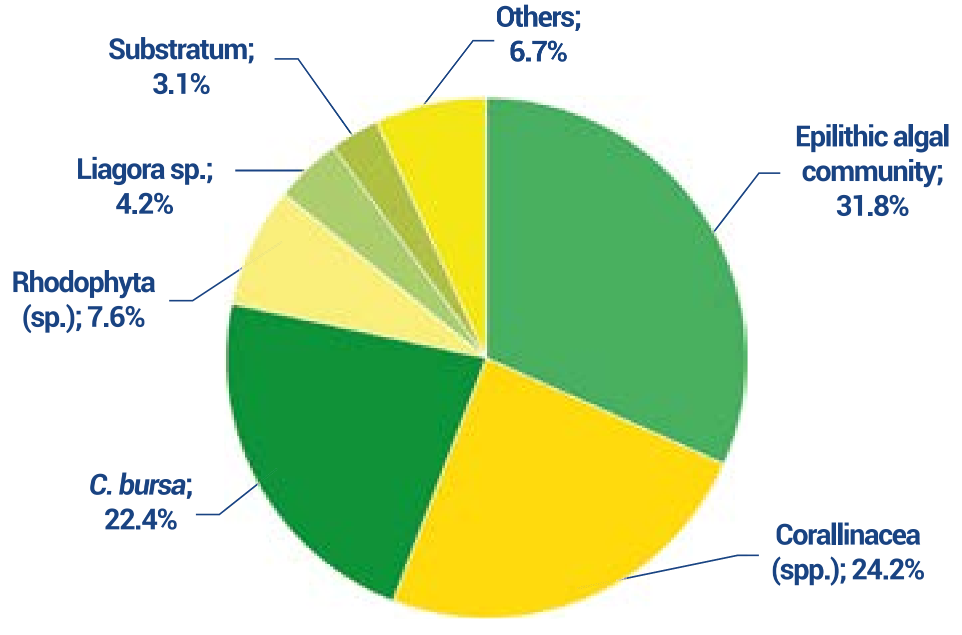


Figure 71
The percentage cover of benthic organisms on HB-9 (18 m)

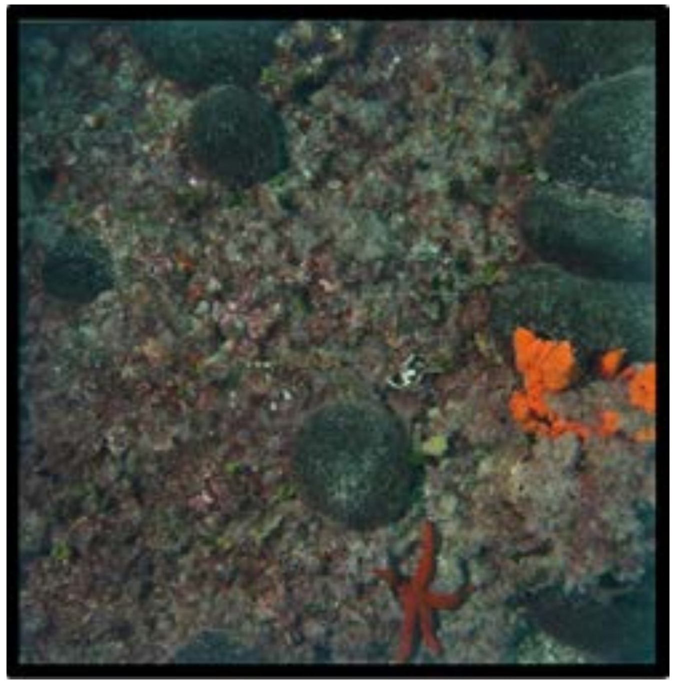


Figure 72
The image of hard substratum station HB-9

Corallinacea (spp.) covered 66.9% of the total area. Codium bursa (11.6%) was the second species represented with the highest coverage value in the sampling station. This species was followed by Porifera (spp.) (3.8%) and Others (0.6%-H. tuna and mollusc shell). In the station, 17.1% of the surface was not covered by any species (Figure-73 and 74).

HB-10

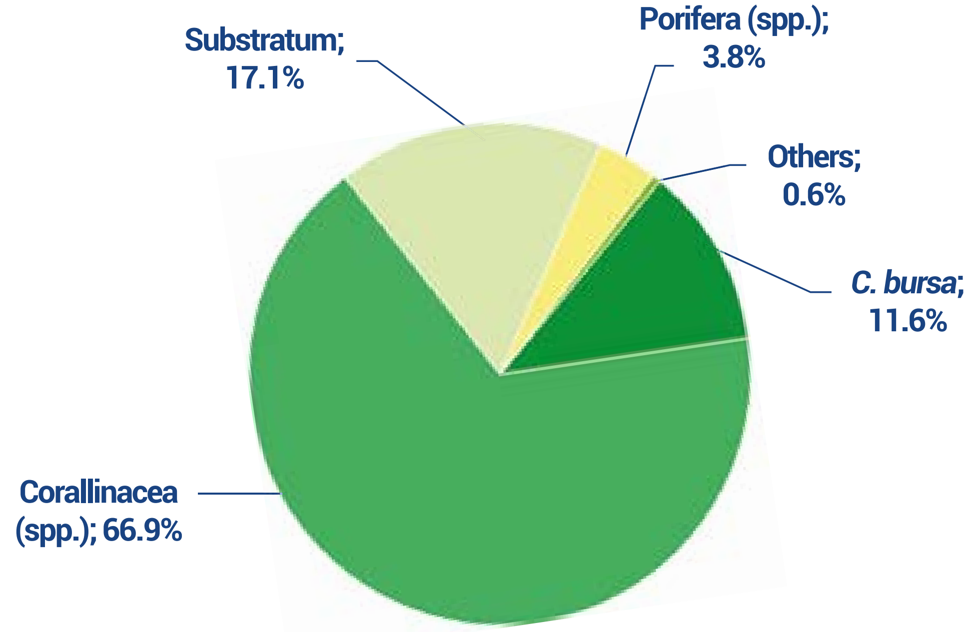


Figure 73
The percentage cover of benthic organisms on HB-10 (18 m)

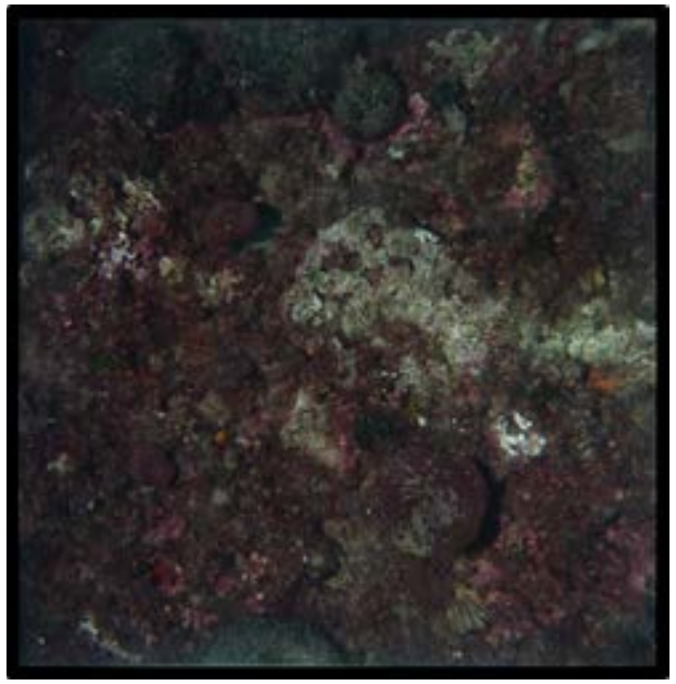


Figure 74
The image of hard substratum station HB-10

Sea star *Echinaster sepositus* which is the most abundant species reported from the coralligenous habitat in Mediterranean Sea (SAP BIO, 2003), was only recorded at station HB-9. The erect sponges, *Axinella polypoides* recorded at station HB-8, which is the most abundant species in the coralligenous from the eastern Mediterranean (SAP BIO, 2003) and is in the list of endangered or threatened species according to SPA/BD protocol (UNEP/MAP-SPA/RAC, 2018).

In the study area, three species, Clathrina sp., Agelas oroides and Axinella cannabina in Porifera, two species, Halocynthia papillosa and Aplidium tabarquense in Tunicata, and one species, Parazoanthus axinellae in Cnidaria were photographed outside of the examined quadrates (Figure-75 to 78). Axinella cannabina is considered in the endangered and threatened species according to the SPA / BD protocol (*UNEP/MAP-SPA/RAC, 2018*).

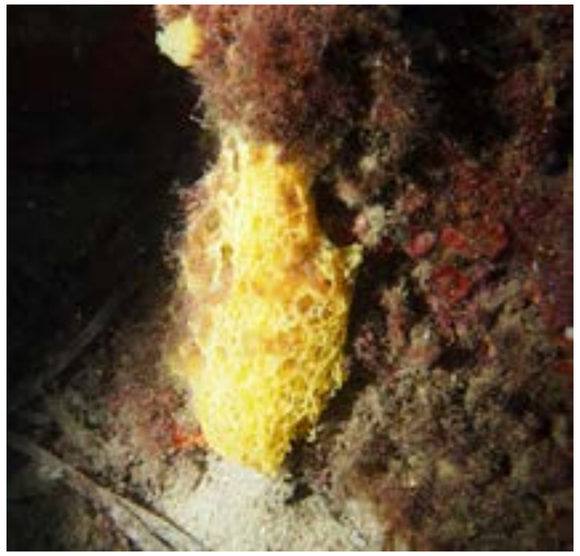


Figure 75

Clathrina sp.(Porifera), station HB-2

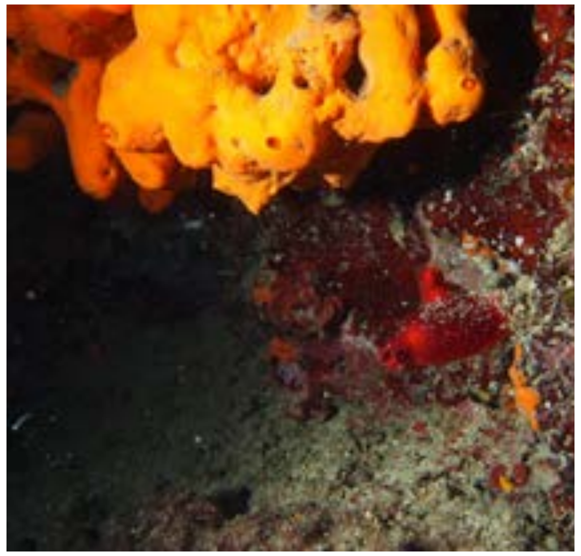


Figure 76

Halocynthia papillosa (Tunicata) and *Agelas oroides* (Porifera), station HB-2

Figure 77

Aplidium tabarquense (Tunicata), station HB-2

Figure 78

Parazoanthus axinellae (Cnidaria) and *Axinella cannabina* (Porifera), station HB-4

6.2. Soft Bottom

The faunistic analysis of the benthic samples collected from 8 stations (15-25 m) at the coast of Foça SEPA yielded a total of 303 species and 4821 individuals belonging to 12 systematic groups (Porifera, Cnidaria, Plathelminthes, Nemertea, Nematoda, Polychaeta, Sipuncula, Crustacea, Mollusca, Bryozoa, Echinodermata, and Tunicata). The species found in the stations and the number of individuals of the species was given in Table-8.

Table 8
Species found at the sampling stations in Foça Specially Protected Area (* established alien species; ** Protected species)

STATIONS SPECIES BELONGING TO THE SYSTEMATIC GROUPS	B1-P	B6-S	B3-P	B11-P	B4-S	B4-P	B7-S	B5-S
PORIFERA								
Porifera (spp.)	-	-	X	-	-	-	-	-
Sycon sp.	-	-	-	-	-	1	-	-
CNIDARIA								
Anthozoa (spp.)	-	-	-	1	-	-	-	-
Scolanthus callimorphus Gosse, 1853	-	-	-	-	-	-	1	-
PLATYHELMINTHES								
Platyhelminthes (spp.)	2	-	1	-	1	-	-	-
NEMERTEA								
Nemertini (spp.)	15	-	5	2	4	3	35	-
NEMATODA								
Nematoda (spp.)	-	4	83	125	5	2	68	16
POLYCHAETA								
Laetmonice hystrix (Savigny in Lamarck, 1818)	-	-	-	-	-	2	-	-
Pontogenia chrysocoma (Baird, 1865)	1	-	-	-	-	1	-	-
Harmothoe sp.	1	-	-	2	3	-	3	-
Malmgrenia lilianae (Pettibone, 1993)	-	-	1	-	4	-	-	-
Sigalion mathildae Audouin & Milne Edwards in Cuvier, 1830	-	1	-	-	-	-	-	-
Pholoe inornata Johnston, 1839	-	1	-	-	-	-	-	-
Chrysopetalum debile (Grube, 1855)	-	-	-	3	1	3	-	-
Amphinomidae (sp.)	-	-	4	-	-	-	-	-
Paralacydonia paradoxa Fauvel, 1913	-	1	-	-	2	-	1	1
Mysta picta (Quatrefages, 1866)	1	1	-	2	2	-	-	3
Phyllodoce sp.	9	-	3	6	-	4	1	-
Podarkeopsis galangaui Laubier, 1961	1	6	-	-	5	-	11	3
Syllidia armata Quatrefages, 1866	7	-	-	-	-	3	-	-
Sigambra tentaculata (Treadwell, 1941)	9	9	3	-	25	3	29	19
Exogone naidina Örsted, 1845	32	2	6	52	10	4	2	-
Exogone (Exogone) rostrata Naville, 1933	7	-	1	2	-	2	-	-
Sphaerosyllis sp.	20	2	-	30	-	11	5	2

STATIONS SPECIES BELONGING TO THE SYSTEMATIC GROUPS	B1-P	B6-S	B3-P	B11-P	B4-S	B4-P	B7-S	B5-S
Syllis garciai (Campoy, 1982)	23	8	33	36	6	5	4	6
Syllis variegata Grube, 1860	12	-	3	-	7	-	-	-
Syllis sp.	-	-	3	-	1	2	-	-
Leonnates sp.	-	-	-	-	2	2	-	2
Nereis sp.	-	11	-	-	-	-	-	9
Platynereis dumerilii (Audouin & Milne Edwards, 1833)	13	13	22	-	3	3	-	-
Glycera alba (Müller O.F., 1776)	-	-	1	2	2	-	7	1
Glycera capitata Örsted, 1843	2	6	2	5	-	-	-	3
Micronephthys longicornis (Perejaslavtseva, 1891)	-	-	2	2	-	-	1	3
Nephtys sp.	-	-	1	-	-	-	1	-
Sphaerodoridium minutum (Webster & Benedict, 1887)	-	-	-	-	1	-	-	-
Eunice vittata (Delle Chiaje, 1828)	-	-	2	2	3	3	-	5
Lysidice ninetta Audouin & Milne Edwards H., 1833	8	-	19	9	-	-	4	-
Lysidice unicornis (Grube, 1840)	10	3	16	4	8	1	6	1
Marphysa sanguinea (Montagu, 1813)	4	3	11	-	5	8	4	2
Lumbrineriopsis paradoxa (Saint-Joseph, 1888)	6	1	4	1	-	2	-	-
Lumbrineris sp.	1	4	2	-	-	-	2	-
Scoletoma sp.	3	9	-	-	3	-	3	4
Hyalinoecia tubicola (Müller, O.F., 1776)	-	1	-	-	12	-	15	15
Protodorvillea kefersteini (McIntosh, 1869)	1	-	6	-	1	-	3	-
Drilonereis filum (Claparède, 1868)	-	-	-	-	1	-	-	-
Aonides oxycephala (Sars, 1862)	-	-	-	-	-	-	1	3
Spio filicornis (Müller, 1776)	3	-	-	5	1	3	6	-
Aricidea (Acmira) cerrutii Laubier, 1966	-	15	-	-	-	-	-	4
Aricidea sp.	-	-	-	-	1	-	-	-
Levinsenia sp.	-	-	3	-	1	-	1	-
Paradoneis lyra (Southern, 1914)	26	-	7	5	3	10	3	1
Magelona sp.	1	-	-	1	2	-	3	5
Diplocirrus glaucus (Malmgren, 1867)	-	-	-	2	3	-	3	-
Flabelligera affinis Sars, M., 1829	-	-	-	-	-	3	-	-
Piromis eruca (Claparède, 1869)	-	-	6	-	4	-	5	-
Aphelochaeta sp.	1	1	2	1	-	4	-	1
Chaetozone sp.	1	-	-	-	-	1	-	-
Monticellina sp.	-	-	4	-	-	-	-	1
Cossura soyeri Laubier, 1964	1	-	-	-	-	-	-	-
Notomastus sp.	12	1	7	6	-	2	-	-
Euclymene lombricoides (Quatrefages, 1866)	-	2	-	3	12	-	5	-
Nicomache lumbricalis (Fabricius, 1780)	-	-	1	-	2	-	4	4

STATIONS SPECIES BELONGING TO THE SYSTEMATIC GROUPS	B1-P	B6-S	B3-P	B11-P	B4-S	B4-P	B7-S	B5-S
Petaloproctus terricolus Quatrefages, 1866	2	-	2	-	-	1	-	-
Praxillella praetermissa (Malmgren, 1865)	-	6	-	-	1	-	9	1
Polyophthalmus pictus (Dujardin, 1839)	5	-	3	6	-	-	-	-
Galathowenia oculata (Zachs, 1923)	-	-	-	1	1	-	1	-
Lagis koreni Malmgren, 1866	-	-	-	-	-	-	2	-
Petta pusilla Malmgren, 1866	-	-	-	-	1	-	-	-
Ampharetidae (sp.)	4	-	-	-	1	-	-	-
Pista sp.	1	-	1	-	-	-	2	2
Terebellides stroemii Sars, 1835	-	-	1	-	-	-	-	-
Branchiomma bombyx (Dalyell, 1853)	-	1	-	-	-	-	-	1
Euchone rosea Langerhans, 1884	-	-	-	-	1	-	1	1
Euchone sp.	-	1	-	-	-	-	1	-
Pseudofabricia aberrans Cantone, 1972	6	-	4	1	-	9	-	-
Sabellidae (sp.)	3	-	-	-	-	-	-	-
Serpula sp.	-	-	-	1	-	-	-	-
Vermiliopsis sp.	-	-	-	2	-	-	-	-
Polygordius appendiculatus Fraipont, 1887	-	6	-	-	-	-	-	16
SIPUNCULA								
Onchnesoma steenstrupii steenstrupii Koren & Danielssen, 1875	-	-	-	-	1	-	2	5
Golfingia (*G.*) *vulgaris vulgaris* (de Blainville, 1827)	-	-	3	-	-	-	-	-
Aspidosiphon (*A.*) *muelleri* Diesing, 1851	-	-	-	-	1	-	8	1
ARTHROPODA								
CRUSTACEA								
Pycnogonida (spp.)	-	-	2	5	-	1	-	-
Cirripedia (spp.)	-	-	3	-	2	-	13	-
Ostracoda (spp.)	33	13	-	30	18	19	20	32
Nebalia bipes (Fabricius, 1780)	-	-	-	-	-	-	2	-
Mysidacea sp.	-	-	-	-	-	-	-	1
Ampelisca brevicornis (Costa, 1853)	-	4	-	-	-	-	-	-
Ampelisca diadema (Costa, 1853)	-	-	9	1	-	-	-	-
Ampelisca pseudospinimana Bellan-Santini & Kaim-Malka, 1977	8	-	-	-	-	-	-	-
Ampelisca sp.	-	3	-	-	3	1	6	1
Ampithoe ramondi Audouin, 1826	-	-	-	6	-	-	-	-
Aora gracilis (Spence Bate, 1857)	-	-	-	5	-	-	-	-
Apolochus neapolitanus (Della Valle, 1893)	-	-	-	-	3	-	-	-
Caprella acanthifera Leach, 1814	3	-	-	-	-	-	-	-
Dexamine spiniventris (Costa, 1853)	-	-	-	1	-	-	-	-
Dexamine spinosa (Montagu, 1813)	2	-	1	1	-	3	-	-
Ericthonius argenteus Krapp-Schickel, 1993	-	-	-	8	-	3	-	-
Gammarella fucicola (Leach, 1814)	-	-	2	-	-	-	-	-

STATIONS SPECIES BELONGING TO THE SYSTEMATIC GROUPS	B1-P	B6-S	B3-P	B11-P	B4-S	B4-P	B7-S	B5-S
Gammaropsis maculata (Johnston, 1828)	-	-	-	-	6	-	-	-
Guernea (*Guernea*) *coalita* (Norman, 1868)	1	-	-	-	3	-	-	2
Harpinia dellavallei Chevreux, 1910	-	2	-	-	3	-	-	1
Lembos websteri Spence Bate, 1857	-	-	-	2	-	-	-	-
Leptocheirus guttatus (Grube, 1864)	-	-	-	6	-	-	-	-
Leptocheirus mariae Karaman, 1973	-	-	-	-	-	-	-	1
Leptocheirus pectinatus (Norman, 1869)	-	1	-	2	2	-	4	-
Leucothoe incisa Robertson, 1892	-	-	-	-	-	-	1	3
Liljeborgia dellavallei Stebbing, 1906	-	-	1	-	-	-	-	-
Lysianassa caesarea Ruffo, 1987	1	-	3	1	-	-	2	-
Lysianassa plumosa Boeck, 1871	-	1	-	-	-	-	-	-
Maera grossimana (Montagu, 1808)	-	-	1	-	3	-	-	-
Megamphopus cornutus Norman, 1869	-	1	-	-	-	-	-	-
Metaphoxus simplex (Spence Bate, 1857)	2	1	5	2	4	-	8	2
Microdeutopus algicola Della Valle, 1893	8	1	-	-	-	-	-	-
Perioculodes aequimanus (Kossman, 1880)	-	6	-	1	-	1	-	-
Perioculodes longimanus (Spence Bate & Westwood, 1868)	-	-	-	-	-	-	-	1
Phtisica marina Slabber, 1769	-	1	2	4	10	5	-	-
Synchelidium longidigitatum Ruffo, 1947	-	2	-	-	4	-	1	-
Tritaeta gibbosa (Spence Bate, 1862)	-	-	1	1	-	-	-	-
Urothoe elegans Spence Bate, 1857	-	2	2	-	-	-	-	-
Apanthura corsica Amar, 1953	-	-	11	-	-	3	-	-
Cymodoce truncata Leach, 1814	-	-	3	6	-	-	-	-
Gnathia sp.	5	-	5	-	-	-	-	-
Janira maculosa Leach, 1814	-	-	-	1	-	-	-	-
Limnoria sp.	3	-	-	1	-	4	-	-
Paranthura nigropunctata (Lucas, 1846)	3	-	5	1	-	1	-	-
Apseudopsis sp.	-	-	3	-	-	2	4	3
Chondrochelia savignyi (Kroyer, 1842)	64	2	31	16	16	10	-	-
Cumella limicola Sars, 1879	-	-	-	-	2	-	-	-
**Eocuma sarsii* (Kossmann), 1880	-	2	-	-	1	-	-	-
Iphinoe serrata Norman, 1867	-	1	-	-	1	-	2	3
Nannastacus longirostris Sars, G.O., 1879	4	-	3	-	2	-	-	-
Pseudocuma (*Pseudocuma*) *longicorne* (Bate, 1858)	-	1	-	-	-	-	-	-
Vaunthompsonia cristata Bate, 1858	-	-	1	2	2	1	2	-
Achaeus gracilis (Costa, 1839)	-	-	10	-	-	-	-	-
Athanas nitescens (Leach, 1813)	-	-	-	1	-	-	-	-
Callianassa subterranea (Montagu, 1808)	-	-	1	-	2	-	2	-
Cestopagurus timidus (P. Roux, 1830 [in P. Roux, 1828-1830])	-	1	-	1	1	-	1	-
Ebalia sp.	1	-	-	-	-	-	-	-

STATIONS SPECIES BELONGING TO THE SYSTEMATIC GROUPS	B1-P	B6-S	B3-P	B11-P	B4-S	B4-P	B7-S	B5-S
Eualus cranchii (Leach, 1817)	-	-	1	-	1	-	-	-
Liocarcinus depurator (Linnaeus, 1758)	-	-	-	-	-	-	1	-
***Maja squinado* (Herbst, 1788)	1	-	-	-	-	-	-	-
Processa macrophthalma Nouvel & Holthuis, 1957	-	-	-	1	-	-	-	-
Processa robusta Nouvel & Holthuis, 1957	1	-	-	-	-	-	-	-
Upogebia pusilla (Petagna, 1792)	-	4	-	-	-	-	-	-
MOLLUSCA								
Leptochiton bedullii Dell'Angelo & Palazzi, 1986	-	-	1	-	-	-	-	-
Lepidochitona cinerea (Linnaeus, 1767)	-	-	6	-	-	-	-	-
Jujubinus exasperatus (Pennant, 1777)	2	30	-	3	45	10	2	1
Jujubinus striatus (Linnaeus, 1758)	-	-	15	-	-	-	-	-
Bolma rugosa (Linnaeus, 1767)	-	-	-	-	1	-	-	-
Tricolia pullus pullus (Linnaeus, 1758)	-	-	1	-	-	-	-	-
Homalopoma sanguineum (Linnaeus, 1758)	-	34	-	-	-	-	-	-
Bittium reticulatum (da Costa, 1778)	2	372	250	10	160	9	21	20
***Cerithium vulgatum* Bruguière, 1792	-	7	-	-	1	-	2	-
Turritellinella tricarinata (Brocchi, 1814)	-	-	-	-	5	-	-	3
Marshallora adversa (Montagu, 1803)	-	12	21	-	9	-	-	3
Metaxia metaxa (Delle Chiaje, 1828)	-	3	3	-	-	-	-	-
Cerithiopsis minima (Brusina 1865)	-	-	8	-	-	-	-	-
Dizoniopsis coppolae (Aradas, 1870)	-	3	-	-	-	-	-	-
Aclis minor (Brown T., 1827)	-	-	-	-	2	-	-	-
Epitonium muricatum (Risso, 1826)	-	-	1	-	3	-	-	-
Eulima glabra (da Costa, 1778)	-	-	1	-	8	-	-	-
Parvioris ibizenca (Nordsieck, F., 1968)	-	1	22	-	-	-	-	-
**Sticteulima lentiginosa* (Adams, A., 1861)	-	2	-	-	-	-	-	-
Vitreolina perminima (Jeffreys, 1883)	-	-	-	-	-	-	1	-
Vitreolina philippi (de Rayneval & Ponzi, 1854)	-	-	24	-	4	1	-	-
Alvania aspera (Philippi, 1844)	-	4	-	-	-	-	-	-
Alvania cancellata (da Costa, 1778)	-	94	12	-	3	-	-	-
Alvania cimex (Linnaeus, 1758)	-	4	11	-	-	3	-	-
Alvania geryonia (Nardo, 1847)	-	49	90	-	10	-	-	1
Alvania hispidula (Monterosato, 1884)	-	27	-	-	1	-	-	-
Alvania mamillata Risso, 1826	-	9	-	-	4	-	-	-
Alvania punctura (Montagu, 1803)	-	-	-	-	4	-	-	-
Crisilla semistriata (Montagu, 1808)	-	17	-	-	-	-	-	-
Manzonia crassa (Kanmacher, 1798)	-	10	2	-	-	-	-	-
Pusillina inconspicua (Alder, 1844)	-	-	79	-	30	-	-	1
Pusillina lineolata (Michaud, 1830)	-	1	27	-	-	2	-	-
Pusillina marginata (Michaud, 1830)	-	3	-	-	16	-	-	-

STATIONS SPECIES BELONGING TO THE SYSTEMATIC GROUPS	B1-P	B6-S	B3-P	B11-P	B4-S	B4-P	B7-S	B5-S
Pusillina philippi (Aradas & Maggiore, 1844)	-	11	-	-	-	-	-	-
Pusillina radiata (Philippi, 1836)	-	15	72	-	32	8	-	1
Rissoa auriscalpium (Linnaeus, 1758)	-	4	35	-	-	-	-	-
Rissoa lia (Monterosato, 1884)	-	2	-	-	-	-	-	-
Rissoa monodonta Philippi, 1836	-	-	5	-	1	1	-	-
Rissoa ventricosa Desmarest, 1814	-	-	19	1	-	-	-	-
Rissoa violacea Desmarest, 1814	-	1	18	1	-	-	1	-
Rissoina bruguieri (Payraudeau, 1826)	-	8	-	-	-	1	-	-
Pisinna glabrata (Megerle von Mühlfeld, 1824)	-	1	-	-	-	-	-	-
Caecum auriculatum de Folin, 1868	-	-	2	-	-	-	-	-
Caecum subannulatum de Folin, 1870	-	-	5	-	-	-	-	-
Caecum trachea (Montagu, 1803)	-	-	2	-	-	-	-	-
Parastrophia asturiana de Folin, 1870	-	-	8	-	-	-	-	-
Hyala vitrea (Montagu, 1803)	-	-	-	-	4	-	-	-
Tornus subcarinatus (Montagu, 1803)	-	-	2	-	-	-	-	-
Truncatella subcylindrica (Linnaeus, 1767)	-	-	1	-	-	-	-	-
Vermetus triquetrus Bivona-Bernardi, 1832	-	-	2	-	-	-	-	-
Aporrhais pespelecani (Linnaeus, 1758)	-	-	-	-	3	-	-	-
Calyptraea chinensis (Linnaeus, 1758)	-	-	-	-	-	-	2	-
Euspira nitida (Donovan, 1804)	-	-	-	-	-	-	-	1
Bolinus brandaris (Linnaeus, 1758)	-	-	2	-	-	-	-	-
Muricopsis cristata (Brocchi, 1814)	-	-	1	-	-	-	-	-
Ocinebrina aciculata (Lamarck, 1822)	-	1	10	1	1	-	-	-
Pusia granum (Forbes, 1844)	-	1	-	-	-	-	-	-
Chauvetia turritellata (Deshayes, 1835)	-	14	8	-	-	-	1	-
Tritia incrassata (Strøm, 1768)	-	5	-	1	7	-	-	-
Fusinus pulchellus (Philippi, 1840)	-	2	-	-	-	-	-	-
Tarantinaea lignaria (Linnaeus, 1758)	-	4	-	-	-	-	-	-
Clathromangelia granum (Philippi, 1844)	-	1	-	-	-	-	-	-
Mitromorpha olivoidea (Cantraine, 1835)	-	-	3	-	-	-	-	-
Sorgenfreispira brachystoma (Philippi, 1844)	-	-	-	-	-	-	-	2
Bela zonata (Locard, 1891)	-	-	-	-	1	-	-	-
Bela nebula (Montagu, 1803)	-	-	-	-	-	-	1	-
Mangelia costulata Risso, 1826	-	-	-	-	1	-	-	-
Mangelia unifasciata (Deshayes, 1835)	-	3	3	-	-	-	-	-
Mangelia vauquelini (Payraudeau, 1826)	-	2	-	-	-	-	-	-
Raphitoma echinata (Brocchi, 1814)	1	1	-	-	1	-	-	-
Raphitoma linearis (Montagu, 1803)	-	3	4	-	2	-	-	-
Raphitoma philberti (Michaud, 1829)	-	-	-	1	-	-	-	-
Raphitoma purpurea (Montagu, 1803)	-	4	-	-	-	-	-	-
Folinella excavata (Philippi, 1836)	-	10	15	-	-	-	-	-

STATIONS SPECIES BELONGING TO THE SYSTEMATIC GROUPS	B1-P	B6-S	B3-P	B11-P	B4-S	B4-P	B7-S	B5-S
Chrysallida fenestrata (Adams, A., 1860)	-	-	1	-	1	-	-	-
Spiralinella incerta (Milaschewitsch, 1916)	-	-	8	-	4	-	-	-
Eulimella acicula (Philippi, 1836)	-	1	10	-	4	-	-	-
Megastomia conoidea (Brocchi, 1814)	-	2	9	-	9	-	-	4
Odostomella doliolum (Philippi, 1844)	-	2	6	-	3	-	-	
Odostomia acuta Jeffreys, 1848	-	-	-	-	-	-	-	1
Ondina vitrea (Brusina, 1866)	-	-	11	-	-	-	-	-
Ondina warreni (Thompson, W., 1845)	-	2	-	-	-	-	-	-
Parthenina monozona (Brusina, 1869)	-	4	5	-	-	-	-	-
Parthenina clathrata (Jeffreys, 1848)	-	-	6	-	-	-	-	-
Parthenina decussata (Montagu, 1803)	-	-	-	-	1	-	-	-
Parthenina terebellum (Philippi, 1844)	-	-	6	-	-	-	-	-
*_Syrnola fasciata_ Jickeli, 1882	-	-	-	-	1	-	-	1
Turbonilla gradata Bucquoy, Dautzenberg & Dollfus, 1883	-	-	20	-	-	-	-	-
Turbonilla jeffreysii (Jeffreys, 1848)	-	-	2	-	-	-	-	-
Turbonilla pusilla (Philippi, 1844)	-	-	7	-	3	-	-	-
Pyrgiscus rufus (Philippi, 1836)	-	4	1	-	11	-	-	6
*_Leucotina natalensis_ Smith, E.A., 1910	-	-	-	-	3	-	-	-
Ebala nitidissima (Montagu, 1803)	-	-	2	-	1	-	-	-
Ebala pointeli (de Folin, 1868)	-	-	2	-	-	-	-	-
Murchisonella mediterranea Peñas & Rolán, 2013	-	-	1	-	-	-	-	-
Acteon tornatilis (Linnaeus, 1758)	-	-	-	-	4	-	-	-
Ringicula conformis Monterosato, 1877	-	-	1	-	28	1	-	10
Haminoea hydatis (Linnaeus, 1758)	-	-	-	-	2	-	-	-
*_Pyrunculus fourierii_ (Audouin, 1826)	-	-	-	-	2	-	-	-
Pyrunculus hoernesi (Weinkauff, 1866)	-	-	2	1	-	-	-	-
Retusa crebrisculpta (Monterosato, 1884)	-	-	-	-	1	-	-	-
Retusa truncatula (Bruguière, 1792)	-	-	3	-	-	-	-	-
Volvulella acuminata (Brugière, 1792)	-	-	1	-	-	-	-	-
Nucula nitidosa Winckworth 1930	-	-	-	-	1	-	-	-
Striarca lactea (Linnaeus, 1758)	4	-	5	-	-	-	-	-
Modiolus barbatus (Linnaeus, 1758)	-	-	3	-	-	-	-	-
Musculus costulatus (Risso, 1826)	9	-	19	10	-	2	-	-
Musculus discors (Linnaeus, 1767)	-	-	-	-	2	-	-	-
*_Septifer cumingii_ Récluz, 1849	-	-	1	-	-	-	-	-
Anomia ephippium Linnaeus, 1758	2	-	-	-	-	-	-	-
Limaria hians (Gmelin, 1791)	-	-	-	-	-	-	1	-
Ctena decussata (Costa, O.G., 1829)	1	1	-	-	-	-	-	-
Loripinus fragilis (Philippi, 1836)	-	2	2	1	-	-	6	-
Lucinella divaricata (Linnaeus, 1758)	-	3	-	-	-	-	-	-
Myrtea spinifera (Montagu, 1803)	-	-	-	-	1	-	-	1

STATIONS SPECIES BELONGING TO THE SYSTEMATIC GROUPS	B1-P	B6-S	B3-P	B11-P	B4-S	B4-P	B7-S	B5-S
Thyasira flexuosa (Montagu, 1803)	-	-	-	-	3	-	-	-
Chama gryphoides Linnaeus, 1758	-	-	1	-	-	-	-	-
Kurtiella bidentata (Montagu, 1803)	10	-	2	-	-	-	-	-
Papillicardium papillosum (Poli, 1791)	-	-	3	-	-	-	-	-
Moerella pulchella (Lamarck, 1818)	-	-	-	-	3	-	-	2
Serratina serrata (Brocchi, 1814)	-	-	-	-	1	-	-	1
Gouldia minima (Montagu, 1803)	1	-	3	-	6	-	1	-
Pitar rudis (Poli, 1795)	-	-	2	-	-	-	1	-
Sphenia binghami Turton, W., 1822	-	-	-	1	-	1	-	-
Corbula gibba (Olivi, 1792)	-	-	-	-	-	-	3	1
Rocellaria dubia (Pennant, 1777)	-	-	1	-	-	-	-	-
Hiatella arctica (Linnaeus, 1767)	6	-	27	21	-	-	-	-
Antalis inaequicostata (Dautzenberg, 1891)	-	-	1	-	-	-	-	-
BRYOZOA								
Bantariella verticillata (Heller, 1867)	X	-	-	-	-	-	-	-
Amathia lendigera (Linnaeus, 1758)	X	-	-	X	-	-	-	-
Aetea truncata (Landsborough, 1852)	-	-	-	X	-	-	-	-
Copidozoum tenuirostre (Hincks, 1880)	X	-	-	X	-	X	-	-
Onychocella marioni (Jullien, 1882)	-	-	-	-	-	X	-	-
Calpensia nobilis (Esper, 1796)	-	-	X	X	-	X	-	-
Beania hirtissima (Heller, 1867)	-	-	X	X	-	-	-	-
Watersipora cucullata (Busk, 1854)	-	-	X	X	-	X	-	-
Escharoides mamillata (Wood, 1844)	-	-	X	-	-	-	-	-
Arthropoma cecilii(Audouin, 1826)	X	-	-	-	-	-	-	-
Smittina sp.	X	-	-	-	-	-	-	-
Fenestrulina malusii (Audouin, 1826)	X	-	-	-	-	-	-	-
Chorizopora brongniartii (Audouin, 1826)	X	-	-	-	-	-	-	-
Margaretta cereoides (Ellis & Solander, 1786)	-	-	-	-	-	X	-	-
Tubulipora sp.	-	-	X	-	-	-	-	-
ECHINODERMATA								
Asterina gibbosa (Pennant, 1777)	-	-	-	1	-	-	-	-
Amphipholis squamata (Delle Chiaje, 1828)	3	-	-	-	-	-	-	-
Amphiura chiajei Forbes, 1843	-	-	-	-	9	-	-	7
Amphiura filiformis (Müller, O.F., 1776)	-	-	-	-	26	-	-	1
Amphiura sp.	-	-	4	1	-	-	-	1
Ophiactis sp.	-	-	-	-	1	-	10	-
Ophiocten sp.	-	-	2	1	4	-	-	-
Echinocyamus pusillus (Müller, O.F., 1776)	-	3	-	-	-	-	-	-
Genocidaris maculata Agassiz, A., 1869	-	-	1	1	-	-	-	-
Psammechinus microtuberculatus (Blainville, 1825)	-	-	1	1	-	-	-	-
Spatangus sp.	-	-	-	-	2	-	-	-

STATIONS SPECIES BELONGING TO THE SYSTEMATIC GROUPS	B1-P	B6-S	B3-P	B11-P	B4-S	B4-P	B7-S	B5-S
TUNICATA								
Ascidia mentula Müller, 1776	1	-	1	1	-	-	-	-
Didemnum sp.	X	-	-	X	-	-	-	-
Microcosmus polymorphus Heller, 1877	1	-	-	-	-	-	-	-
Pyura dura (Heller, 1877)	-	-	1	-	-	-	-	-

Mollusca was the main group (128 species) in the area regarding number of species recorded at the sampling stations. This group was followed by Polychaeta (72 species) and Crustacea (63 species). Other systematic groups consisting of Porifera, Cnidaria, Platyhelmithes, Nemertea, Nematoda, Sipuncula, Bryozoa, Echinodermata and Tunicata were represented by 40 species (Figure-79).

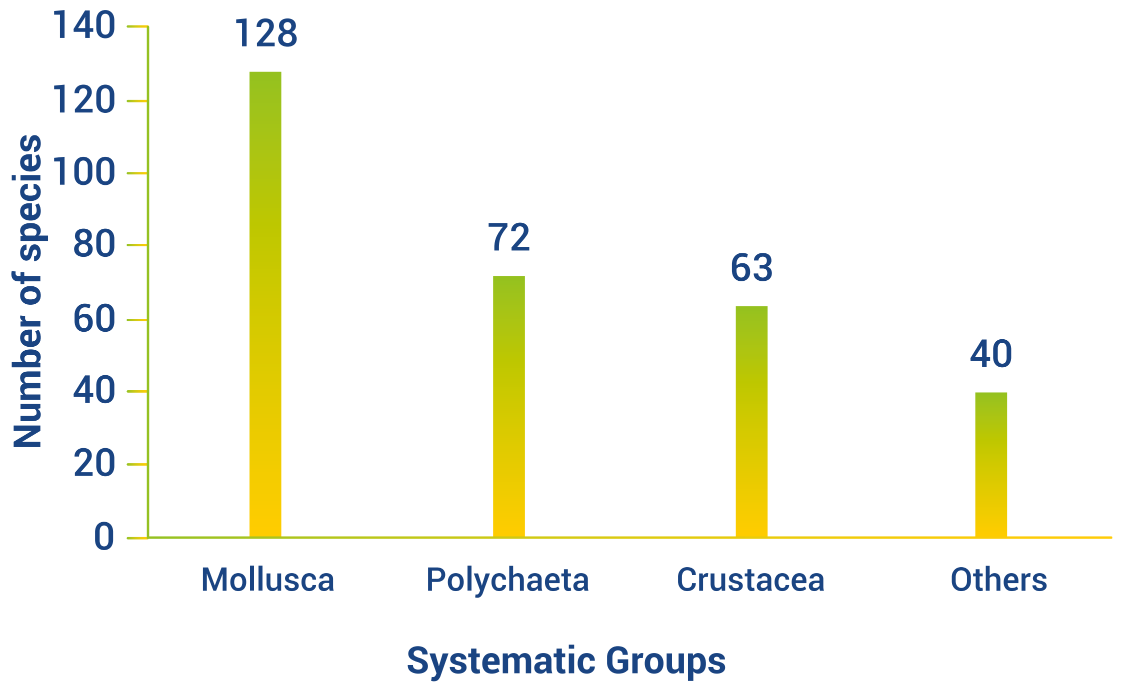


Figure 79
The number of species in the systematic groups

When systematic groups were compared in terms of the number of individuals, Mollusca (50.8%) was the first group with 2447 individuals. This group was followed by Polychaeta (1231 individuals, 25.5%), Crustacea (663 individuals, 13.8%), Nematoda (303 individuals, 6.3%), Echinodermata (80 individuals, 1.7%) and Nemertea (64 individuals, 1.3%). In the "Others" category, the highest number of individuals was determined in Sipuncula (21 individuals, 0.1%) (Figure-80).

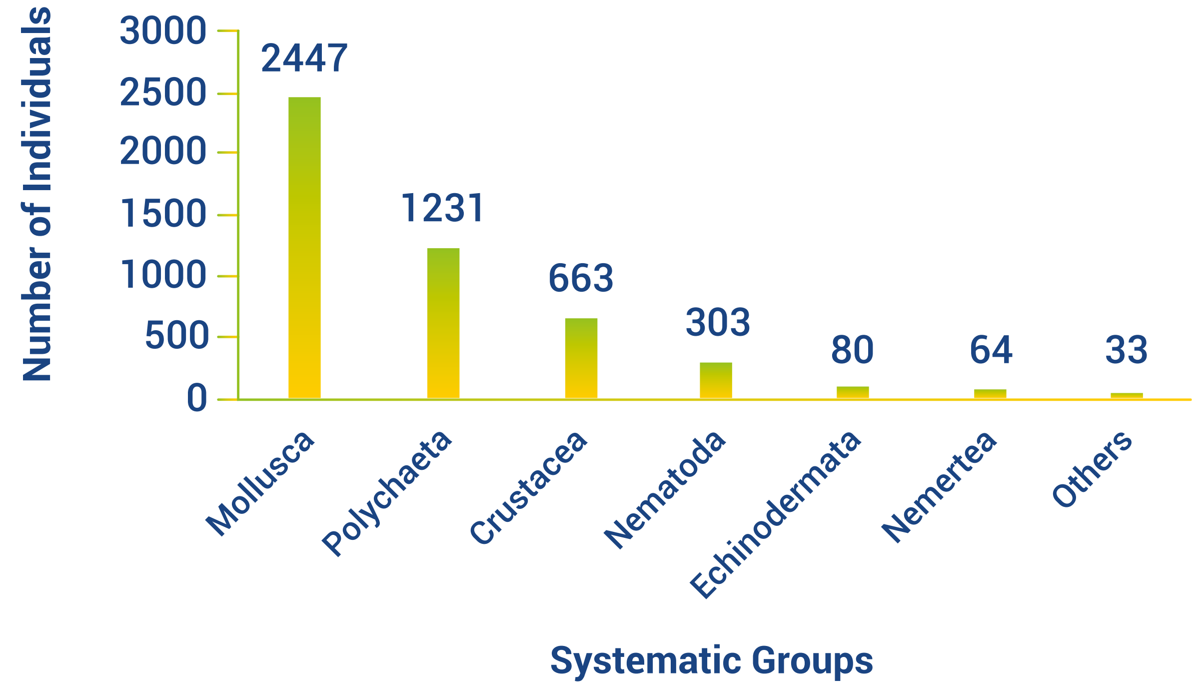


Figure 80
The number of individuals in the systematic groups

The highest number of species (142 species) in the study area was encountered at the station B3-P and the lowest number of species (57 species) at the station B4-P that collected from *Posidonia oceanica* meadows. The highest (117 species) and lowest (63 species) number of species was found at clayey sand station B4-S and sandy station B5-S, respectively (Figure-81).

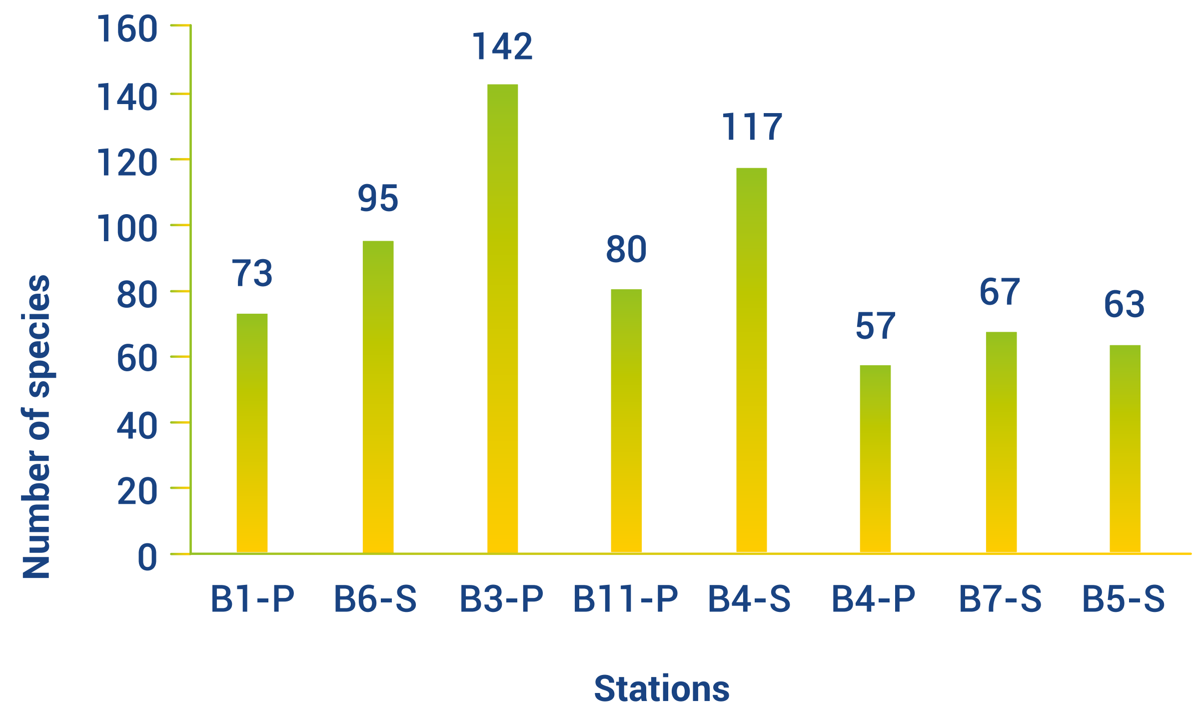


Figure 81
The number of species found in the stations

According to the number of individuals determined at the stations, the maximum number of individuals (1359 individuals) was determined at station B3-P, which Molluscan species *Bittium reticulatum* (250 individuals) had a high population density (Table 1). Another station represented by a high number of individuals (967 individuals) was station B6-S due to both number of individuals and species of Mollusca. The lowest number of individuals (191 individuals) was found at the station B4-P (Figure-82).

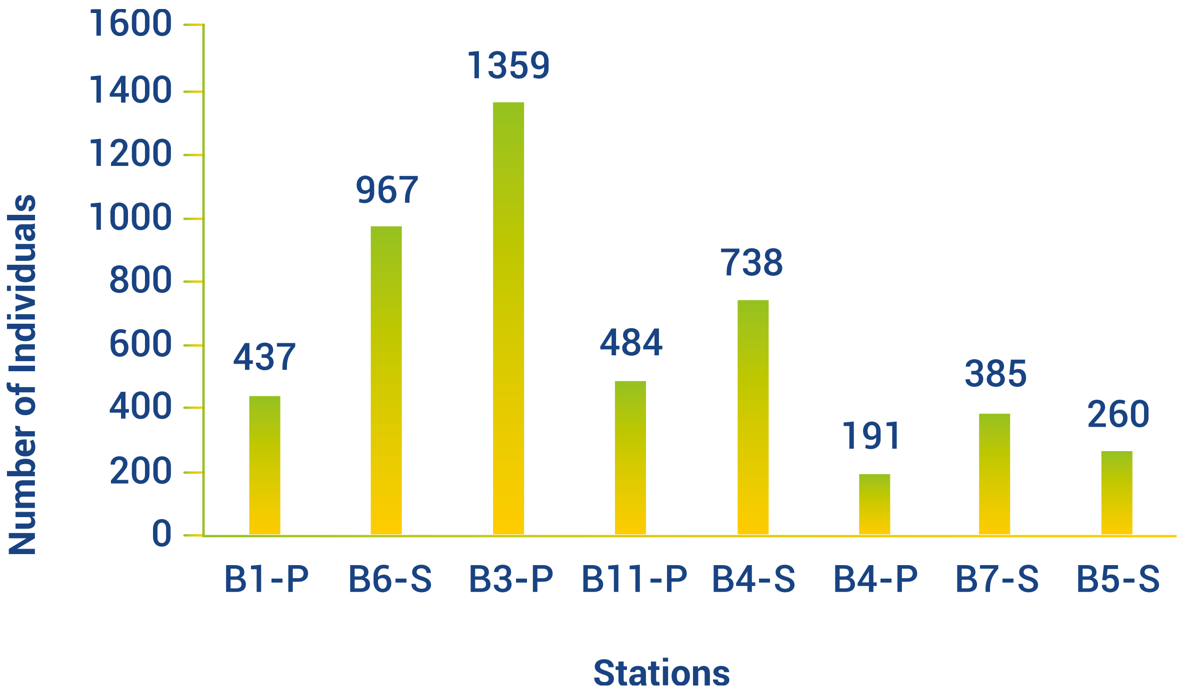


Figure 82

The number of individuals found in the stations

The dominant species and groups in the study area were *Bittium reticulatum* (Mollusca, 17.5% of the total number of individuals), Nematoda (spp.) (Nematoda, %6.3), Ostracoda (Crustacea, % 3.4), *Alvania geryonia* (Mollusca, %3.1), *Chondrochelia savignyi* (Crustacea, %2.9), *Pusillina radiata* (Mollusca, %2.7) and *Syllis garciai* (Polychaeta, %2.5) (Figure-83).

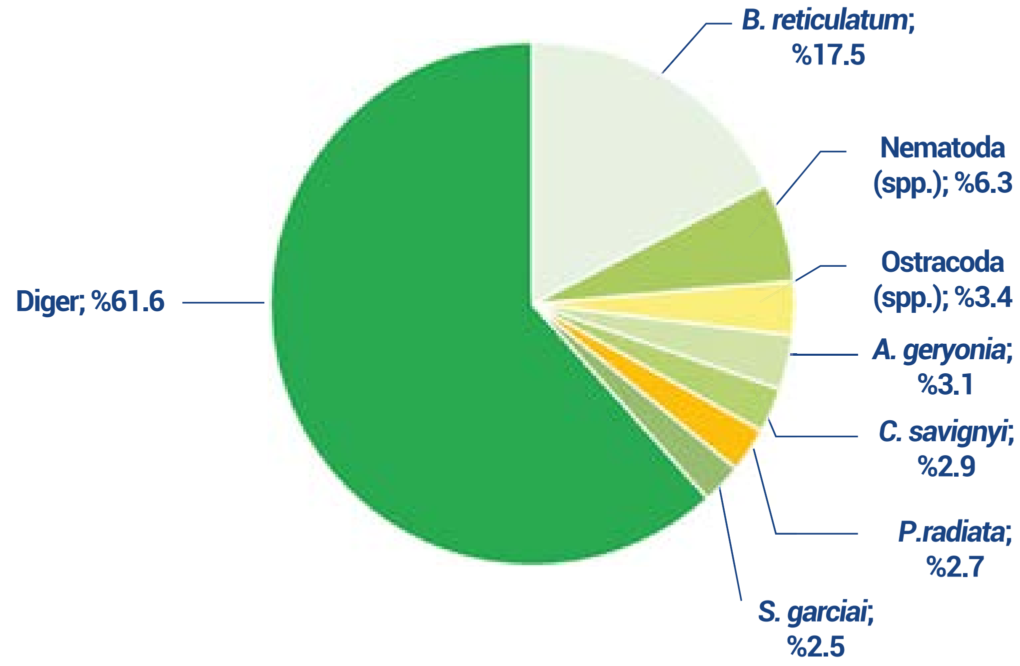


Figure 83

Dominant species found in the stations

According to the frequency index values, 139 species (46%) were classified as Rare, 105 species (35%) as Common and 59 species (19%) as Constant (Figure-84). *Syllis garciai* (Polychaeta), *Lysidice unicornis* (Polychaeta) and *Bittium reticulatum* (Mollusca) were observed at all sampling stations. The species with the highest frequency values in samples were Nematoda (spp.), *Syllis garciai* (Polychaeta), *Sigambra tentaculata* (Polychaeta), *Exogone naidina* (Polychaeta), *Marphysa sanguinea* (Polychaeta), *Paradoneis lyra* (Polychaeta), Ostracoda spp. (Crustacea), Ostracoda spp. (Crustacea), *Chondrochelia savignyi*, (Crustacea), *Metaphoxus simplex* (Crustacea) and *Jujubinus exasperatus* (Mollusca). The 135 species which were in the rare classification, observed only at one station.

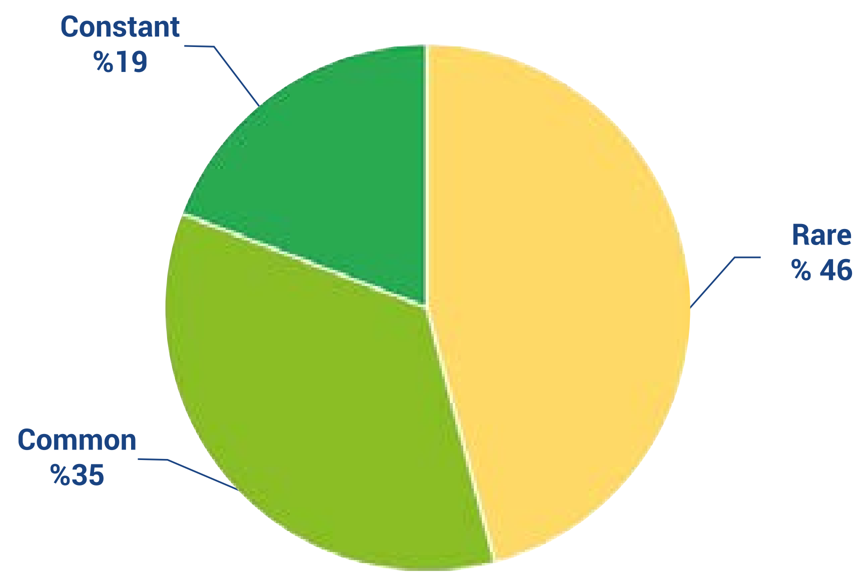


Figure 84

Distribution of the species into frequency index groups

In the results of Bray-Curtis Similarity Index, two main groups were distinct among stations (Figure-85). The first group composed of 4 soft bottom stations (B4-S, B5-S, B6-S and B7-S), has more than 30% of similarity value. The second group formed by stations (B1-P, B3-P, B4-P and B11-P) selected from *Posidonia oceanica* meadows. In this group, the stations B1-P and B11-P were linked to each other with highest similarity value (44%). According to SIMPER analysis, the highest similarity found between the stations B7-S and B5-S which were characterized by high densities of *Alvania geryonia*, *Pusillina inconspicus*, *Pusillina radiata*, *Risoa auriscalpium*. The similarity between B1-P and B11-P were contributed by *Alvania geryonia*, Nematoda (spp.), *Bittium reticulatum*, *Pusillina inconspicua* and *Pusillina radiata*.

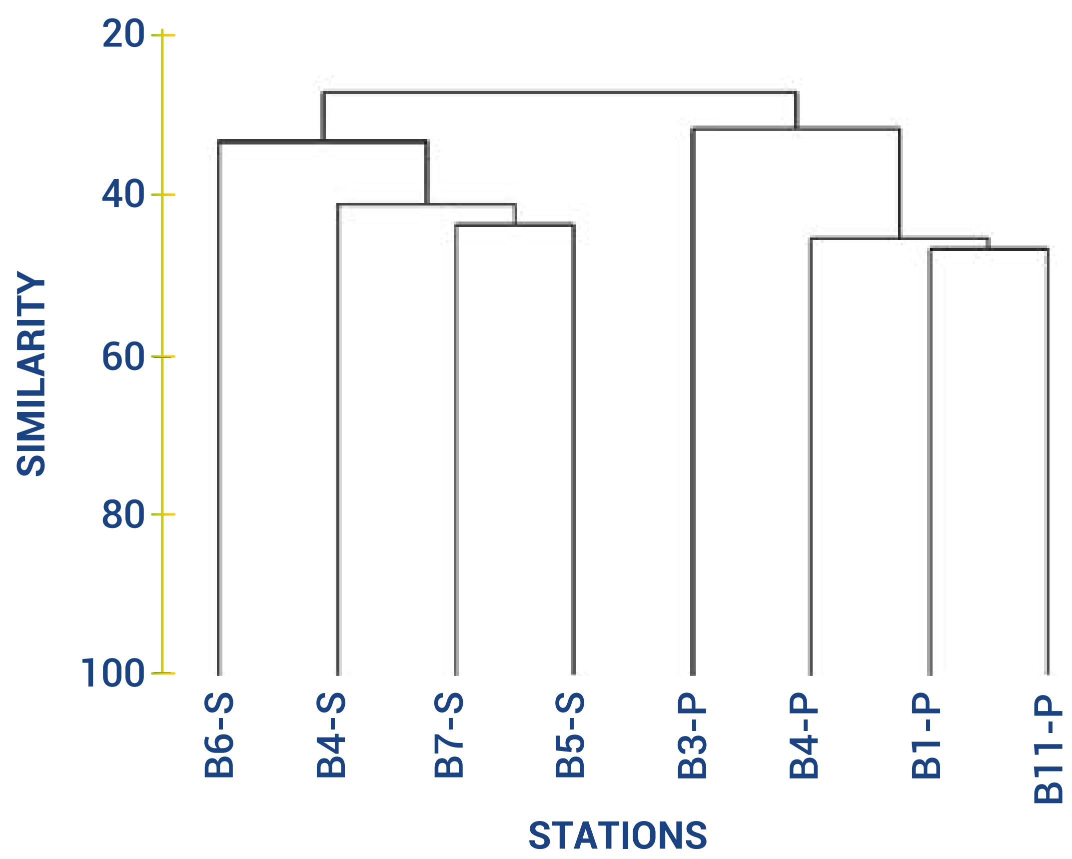


Figure 85

Dendogram showing the similarity among stations

Diversity index values were generally found above 3 for all stations. The lowest diversity index value (H'= 2.97) was calculated at B6-S while the highest value (H' = 3.81) was found at the station B3-P. Although B3-P represented with the highest diversity index value, low evenness index value (J '= 0.77) associated with high abundance of some species in the Mollusca group such as *Bittium reticulatum*, *Alvania cancellata*, *Alvania geryonia*. The evenness index values ranged from 0.65 (B6-S) to 0.91 (B4-P) (Figure-86).

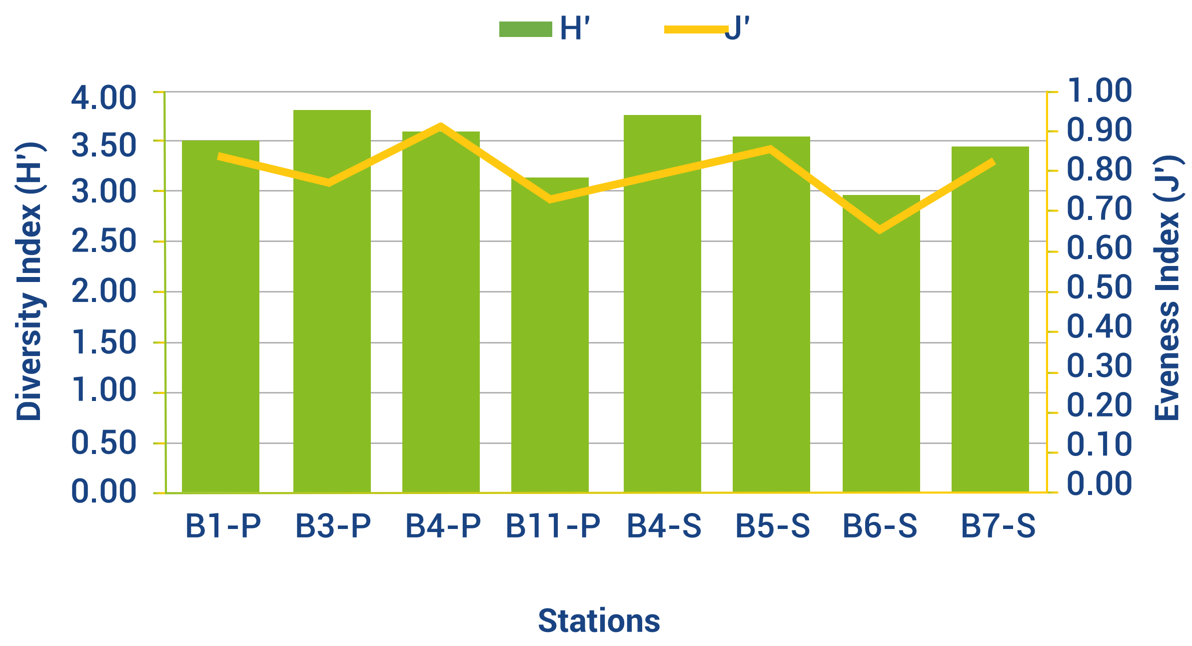


Figure 86

The Diversity Index and the Evenness Index values at the stations

A total of 1 alien Crusctacea (*Eocuma sarsii*) and 5 alien Molusca species (*Sticteulima lentiginosa*, *Syrnola fasciata*, *Leucotina natalensis*, *Pyrunculus fourierii* and *Septifer cumingii*) were recorded in the study area. *Sticteulima lentiginosa* and *S. cumingii* are classified as casual, while the other five alien species have become established in the area (Çinar et al., 2011). *Septifer cumingii* could have been introduced to the Mediterranean Sea by shipping, whereas five other alien species were the Lessepsian invaders (Çinar et al., 2011).

Cerithium vulgatum (Mollusca), which is protected species in the area according to national fishing regulation (Regulation No: 2016/35), was found at stations B4-S, B6-S and B7-S (Anonymous (2016a). *Maja squinado,* which is in the list of species whose exploitation is regulated (Annex III of the SPA/BD Protocol of the Barcelona Convention), was represented by only one individual at station B1-P (UNEP/MAP-SPA/RAC, 2012).

7

7.1. Acoustic Discrimination

SSS data was imported to the SonarWiz 7 software to analyse the seabed characterisation. Although the software processed automatically the sonar data, this process didn't seem adequate and bottom trace process was rearranged for all of the lines (Figure-87). After this operation, together with necessary filtering and arrangements mosaic map was produced.

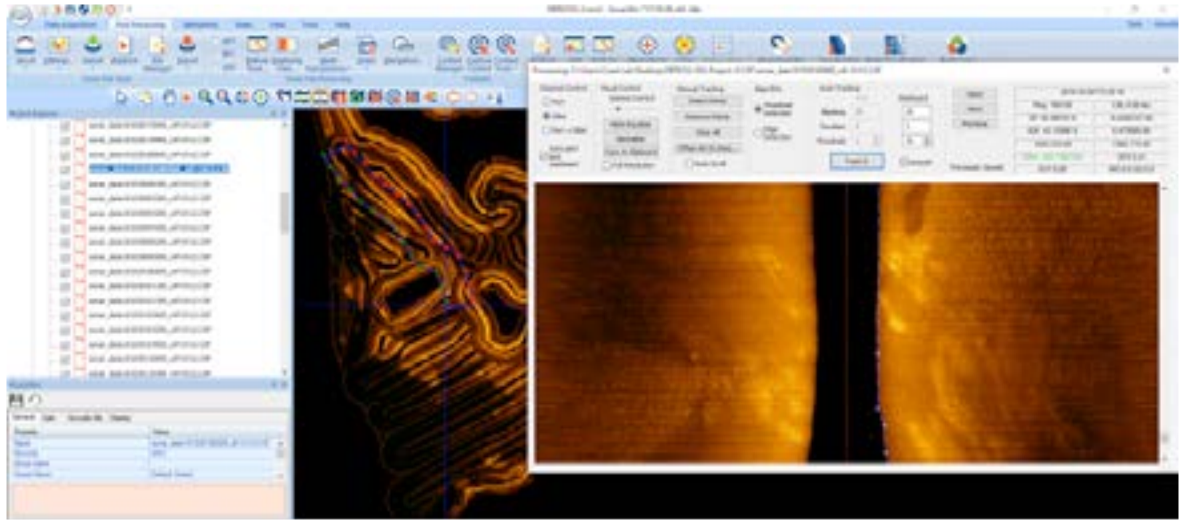


Figure 87

An example view from bottom track operation

Seabed classification operation was more complicated than the creation of the mosaic map. To carry out of this, the "Classification" tool was used in the SonarWiz software. The entropy and the intensity properties were chosen to train the classifier in first stage as suggested in seabed classification manual. This situation was tested with different training conditions by choosing different lines from the training panel. After these tests, other properties like GCLM contrast, GCML asimilarity, GCML homogeneity properties of the mosaic were used to classified the map. Eventually, the entropy and the intensity properties were chosen to classify the mosaic map. On the other hand, training the classifier with all lines did not give a good result. When several lines were selected to train the classifier, the results were better. However, the result didn't change much, when a random line was selected to train the classifier.

The other classification settings were also tested to obtain a good and satisfactory classes. The window size and step settings were used in different correlations to create the classes. On the other hand, the far and the nadir trim settings were chosen precisely to eliminate the side effect on the sonar data. With these setting and different correlations of these settings acoustic discriminations were made. Some of these classification results and the comparison information with current situation are given in Figure-88 to 93.

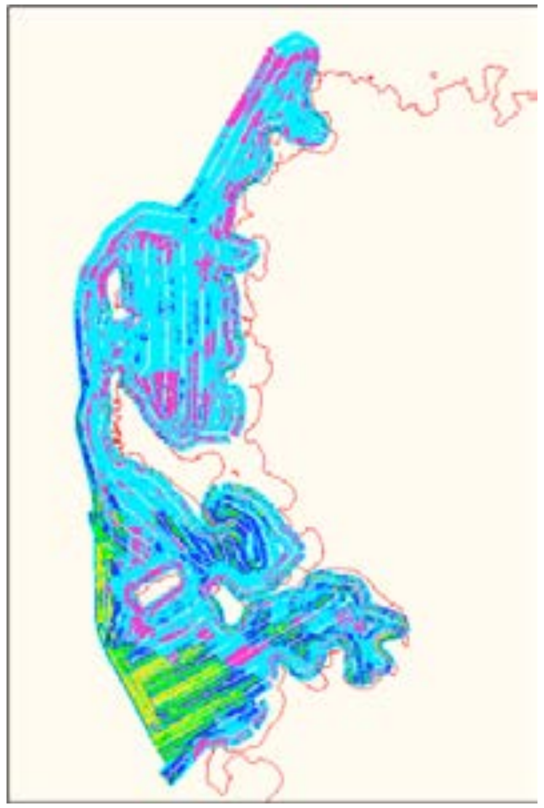


Figure 88

Trial one: good at some *Posidonia* and mud borders but bad at mixed and sandy sediment borders

Figure 89

Trial two: Better result to determine the mud and hard bottom but bad at sandy and mixed sediment borders

Figure 90

Trial three: good at some hard bottom and mud borders, but bad at *Posidonia* and sandy sediment borders

Figure 91

Trial four: good at some *Posidonia*, mud and hard bottom borders but bad at mixed and sandy sediment borders

Figure 92
Trial five: good at some mud and mixed sediment borders but bad at *Posidonia* and sandy sediment borders

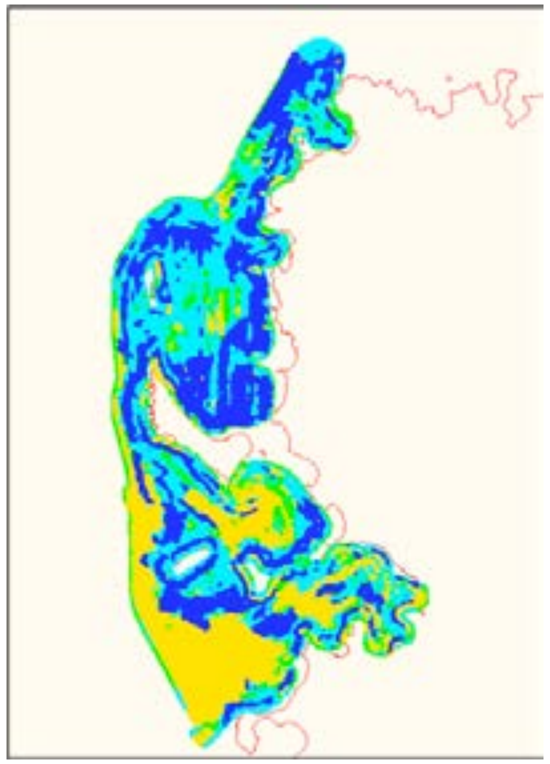


Figure 93
Trial six: good at mud, some *Posidonia* and mixed sediment borders but bad at hard bottom and sandy sediment borders

When the above results are considered, it was seen that seabed characterisation tool was successful in determining mud, some of the *Posidonia* and hard bottoms borders. It was unsuccessful in determining sand and mixed sediments and sand patches in the *Posidonia* borders due to the SSS data scattering in some areas. For this reason, onscreen digitizing was also performed in GIS using SSS mosaic as base map in addition to seabed characterization tool.

7.2. Ground-Truthing

Ground-truthing for habitat characterization was conducted via transects at shallow zones and DDC stations throughout all study area at varying depths. Habitat types were defined according to the "Draft updated classification of benthic marine habitat types for the Mediterranean region" (UNEP/MAP, 2019: UNEP/MED WG.468/10, Annex VI). These habitat definitions are based on the updated EUNIS habitat types for the Mediterranean region.

7.2.1. Habitats Determined Along the Transects

The habitat types determined in the transect survey are listed below (in bold) and the profiles and photographs of the determined habitat types are presented in Table-9 and Table-10. 15 habitat types at different hierarchical level of EUNIS were identified with the transect survey.

MA1.5 Littoral rock
- MA1.51 Supralittoral rock
  - **MA1.51a Supralittoral euryhaline and eurythermal pools (enclave of mediolittoral)**

MB1.5 Infralittoral rock
- **MB1.51 Algal-dominated infralittoral rock**
  - **MB1.51a Well illuminated infralittoral rock, exposed**
  - **MB1.51c Well illuminated infralittoral rock, sheltered**
- **MB1.52 Invertebrate-dominated infralittoral rock**
- **MB1.53 Infralittoral rock affected by sediments**
- **MB1.56 Semi-dark caves and overhangs**

MB2.5 Infralittoral biogenic habitat
- **MB2.54 *Posidonia oceanica* meadows**
  - **MB2.544 Dead matte of *Posidonia oceanica***

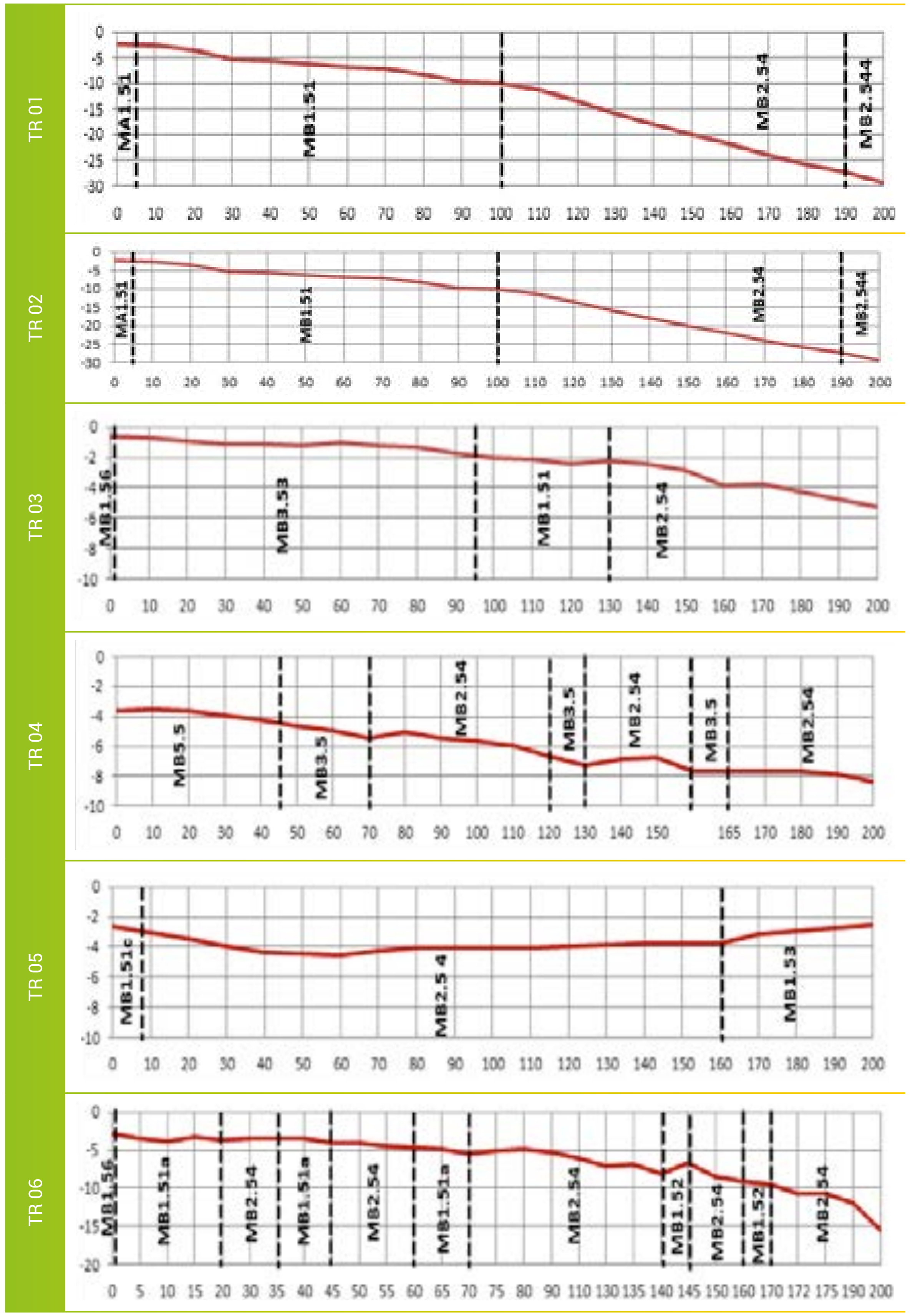
MB3.5 Infralittoral coarse sediment
- **MB3.53 Infralittoral pebbles**

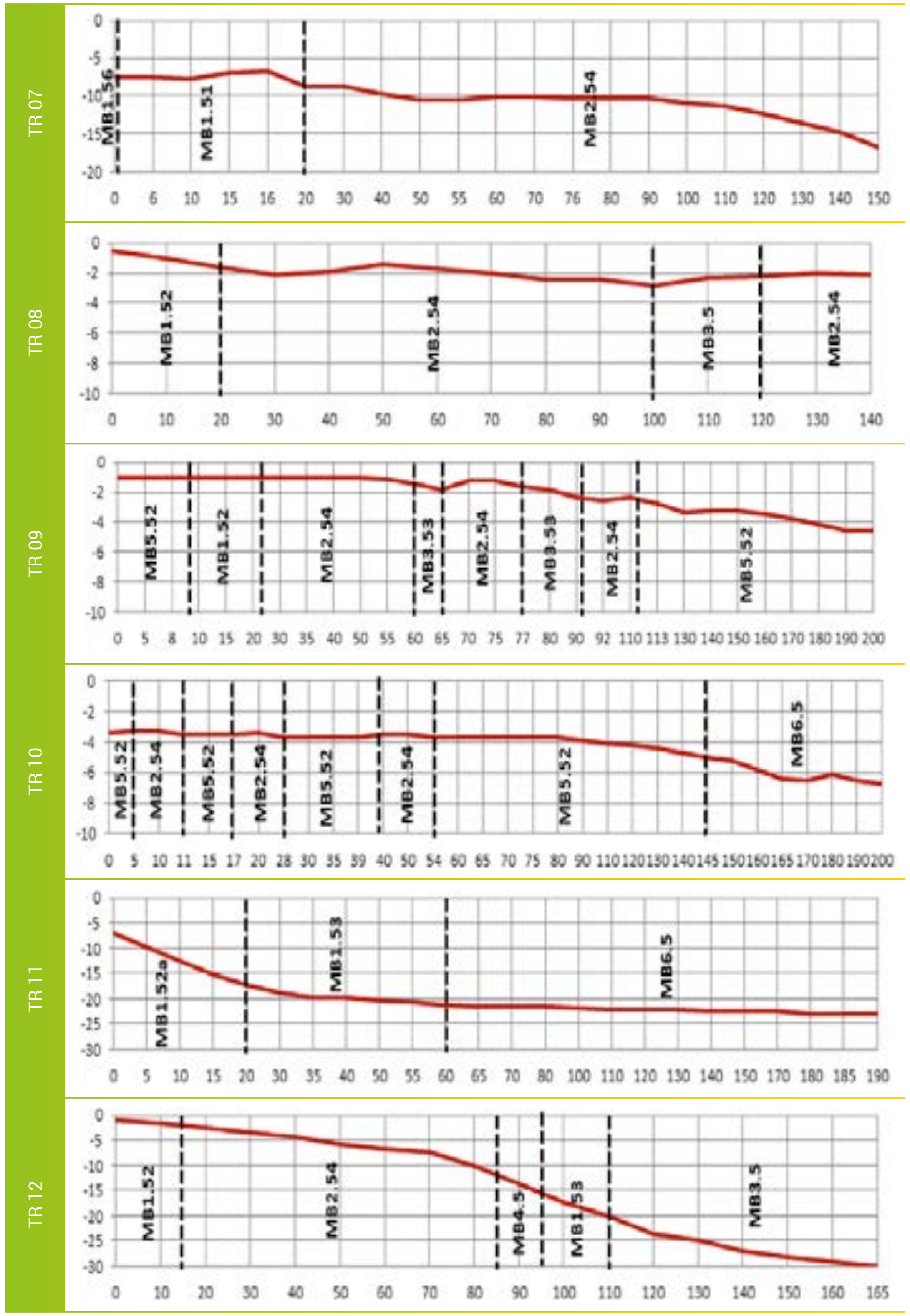
MB4.5 Infralittoral mixed sediment

MB5.5 Infralittoral sand
- **MB5.52 Well sorted fine sand**

MB6.5 Infralittoral mud sediment

Table 9
Habitat types along the transects





TR 13

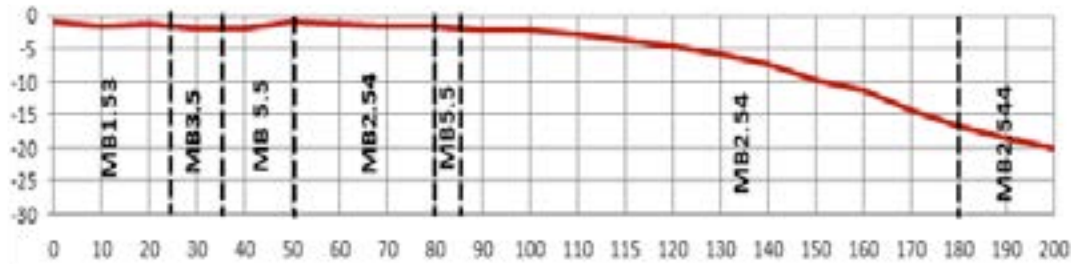
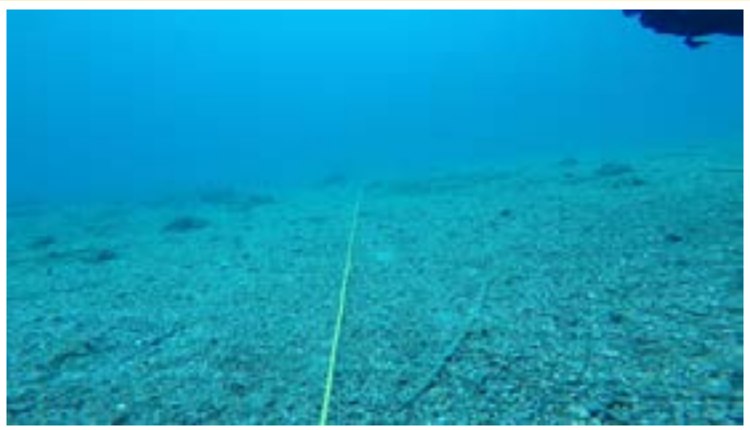
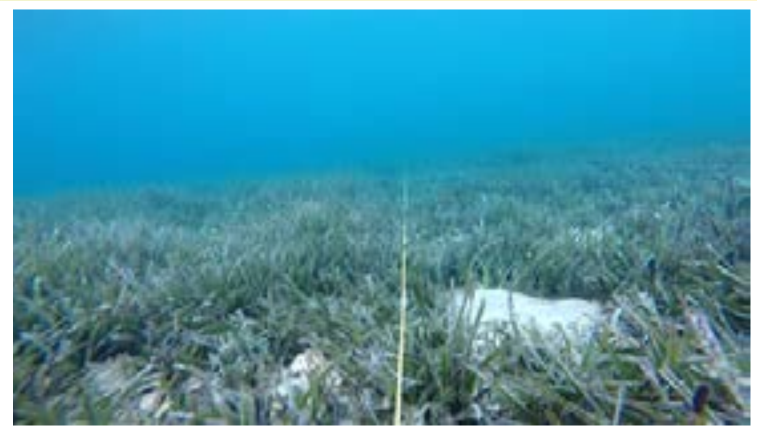


Table 10
Habitat types and images along the transects

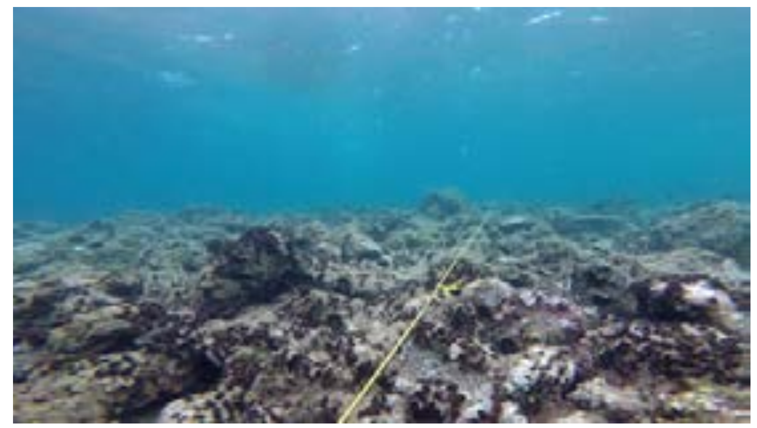
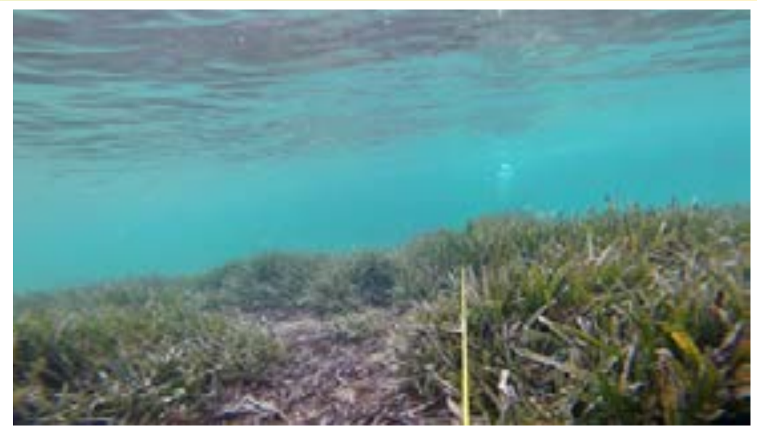
Transect	Habitat Types	Habitat Images
TR-01	MB 2.544	
TR-01	MB 2.54	
TR-01	MB 1.51	

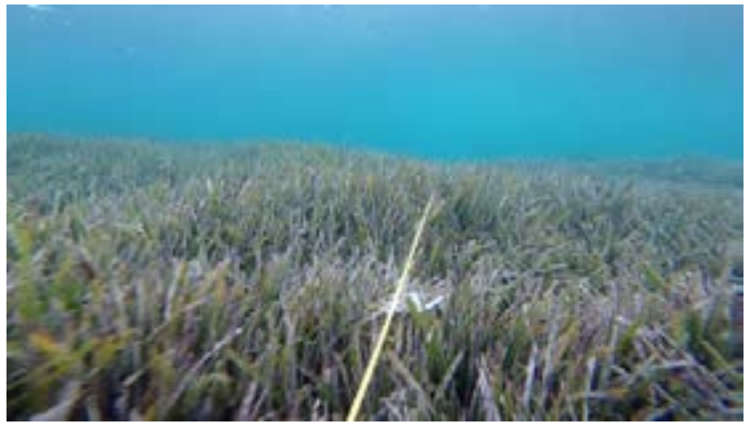
Transect	Habitat Types	Habitat Images
TR-01	MA 1.51a	
TR-02	MB 1.52	
TR-02	MB 2.54	
TR-02	MB 3.53	

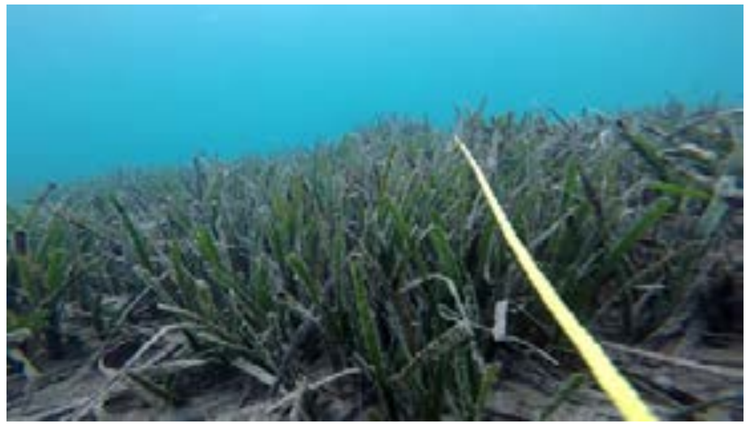
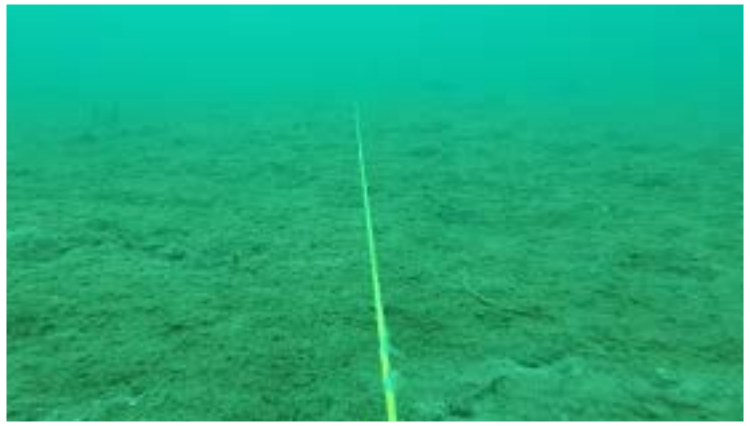
Transect	Habitat Types	Habitat Images
TR-03	MB 3.53	
TR-03	MB 1.51a	
TR-03	MB 2.54	
TR-04	MB 5.5	

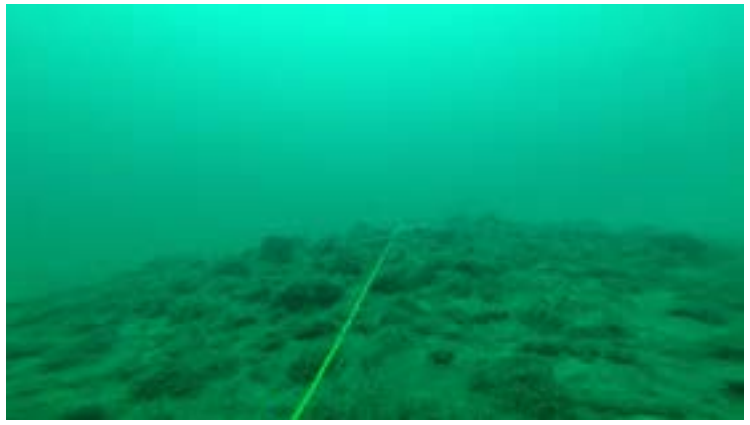
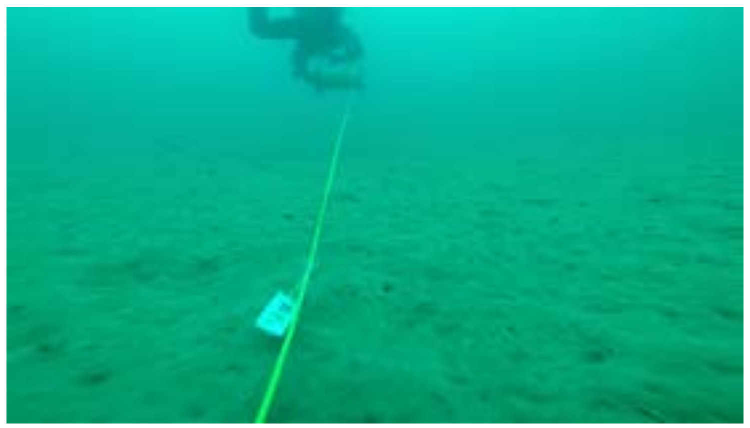
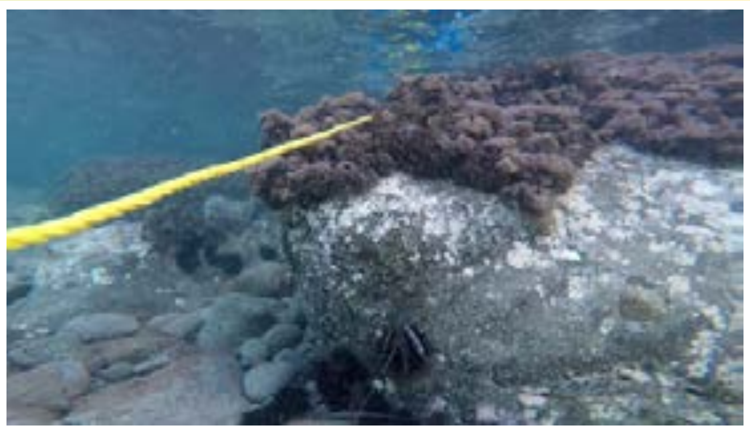
Transect	Habitat Types	Habitat Images
TR-04	MB 3.5	
TR-04	MB 2.54	
TR-05	MB 1.51c	
TR-05	MB 2.54	

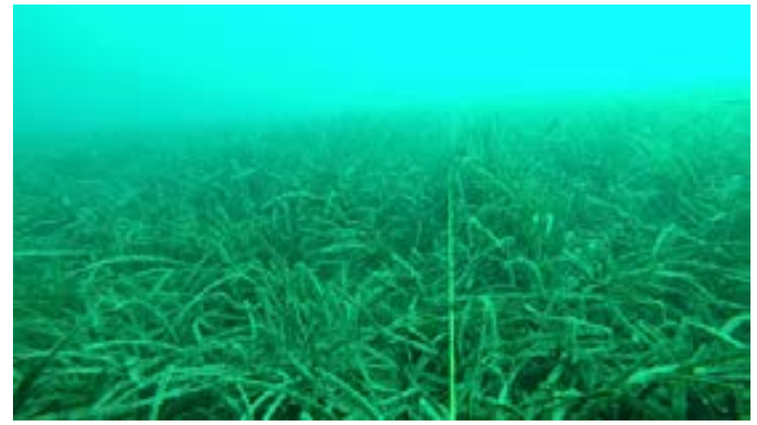
Transect	Habitat Types	Habitat Images
TR-05	MB 1.53	
TR-06	MB 1.51a	
TR-06	MB 2.54	
TR-06	MB 1.52	

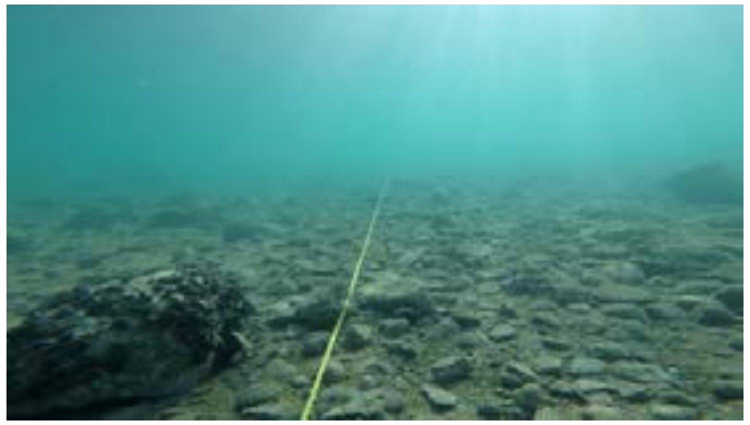
Transect	Habitat Types	Habitat Images
TR-07	MB 1.51	
TR-07	MB 2.54	
TR-08	MB 1.52	
TR-08	MB 2.54	

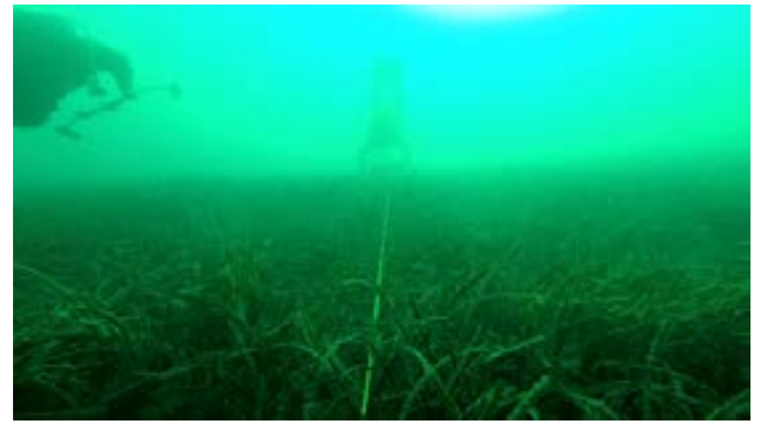
Transect	Habitat Types	Habitat Images
TR-08	MB 3.5	
TR-09	MB 5.52	
TR-09	MB 1.52	
TR-09	MB 2.54	

Transect	Habitat Types	Habitat Images
TR-09	MB 3.53	
TR-10	MB 5.52	
TR-10	MB 2.54	
TR-10	MB 6.5	

Transect	Habitat Types	Habitat Images
TR-11	MB 1.52a	
TR-11	MB 1.53	
TR-11	MB 6.5	
TR-12	MB 1.51	

Transect	Habitat Types	Habitat Images
TR-12	MB1.52	
TR-12	MB 2.54	
TR-12	MB 4.5	
TR-12	MB 1.53	

Transect	Habitat Types	Habitat Images
TR-12	MB 3.5	
TR-13	MB 1.53	
TR-13	MB 3.5	
TR-13	MB 5.5	

Transect	Habitat Types	Habitat Images
TR-13	MB 2.54	
TR-13	MB 2.544	

7.2.2. Habitats Determined at Dropdown Camera Stations

The habitat types determined in the DDC survey were as follows (**in bold**) and the photographs of the determined habitat types are presented in Table-11. 8 habitat types at different hierarchical level of EUNIS were identified with the dropdown camera survey.

MB1.5 Infralittoral rock

- **MB1.51 Algal-dominated infralittoral rock**
- **MB1.53 Infralittoral rock affected by sediments**

MB2.5 Infralittoral biogenic habitat

- **MB2.54 Posidonia oceanica meadows**

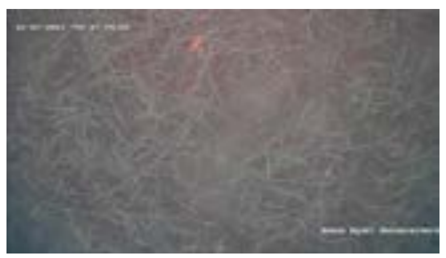
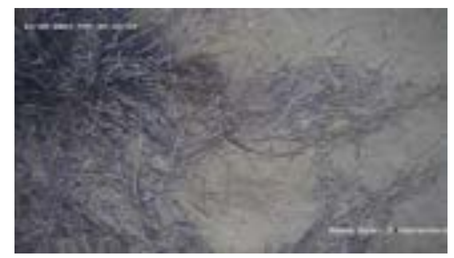
MB3.5 Infralittoral coarse sediment

MB4.5 Infralittoral mixed sediment

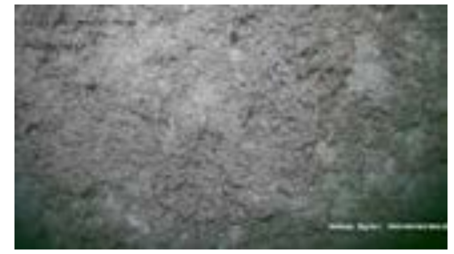
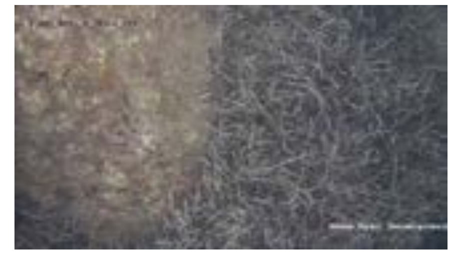
MB5.5 Infralittoral sand

MB6.5 Infralittoral mud sediment

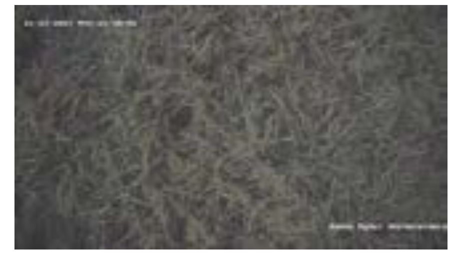
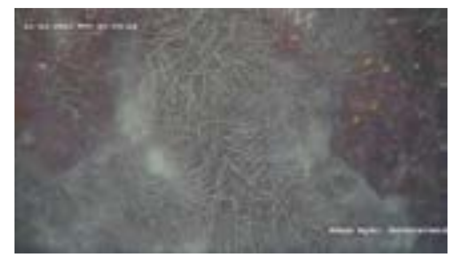
Table 11
Habitat types at DDC stations

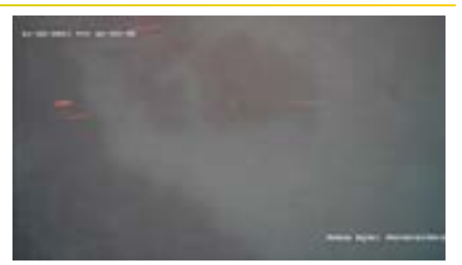
Station Code	Habitat Types	Habitat Images
B4-S	MB1.53	
B5-S	MB5.5	
B6-S	MB1.53	
B6-S	MB5.5	
B7-S	MB3.5	
FC-01	MB2.54	
FC-02	MB2.54	
SD-01	MB4.5	
SD-02	MB3.5	
SD-02	MB1.53	
SD-03	MB2.54	
SD-03	MB5.5	

Station Code	Habitat Types	Habitat Images
SD-04	MB3.5	
SD-05	MB5.5	
SD-06	MB5.5	
SD-07	MB2.54	
SD-08	MB3.5	
SD-09	MB4.5	
SD-10	MB4.5	

Station Code	Habitat Types	Habitat Images
SD-10	MB2.5	
SD-11	MB6.5	
DDC-01	MB2.54	
DDC-01	MB1.51	
DDC-02	MB2.54	
DDC-03	MB3.5	
DDC-03	MB2.54	

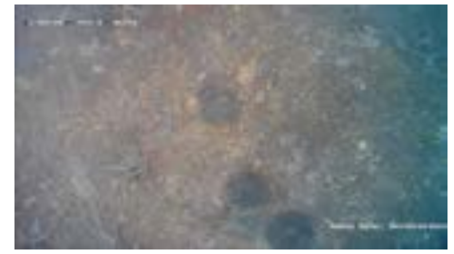
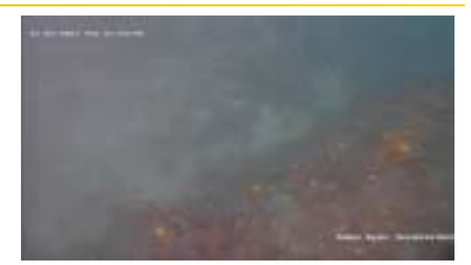
Station Code	Habitat Types	Habitat Images
DDC-04	MB2.54	
DDC-05	MB2.54	
DDC-05	MB4.5	
DDC-06	MB6.5	
DDC-07	MB2.54	
DDC-08 (TG-18)	MB3.5	
DDC-09	MB5.5	

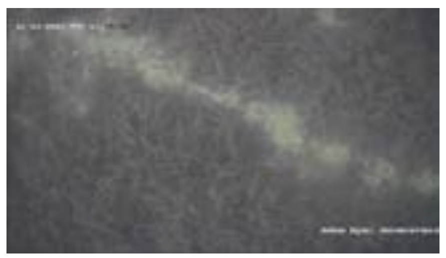
Station Code	Habitat Types	Habitat Images
DDC-10	MB2.54	
DDC-11	MB6.5	
DDC-12	MB2.54	
DDC-13	MB2.54	
DDC-14	MB2.54	
DDC-14	MB1.51	
TG-02	MB6.5	

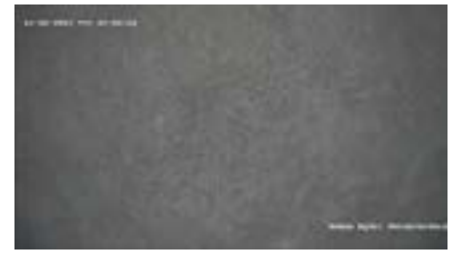
Station Code	Habitat Types	Habitat Images
TG-05	MB6.5	
TG-06	MB2.54	
TG-06	MB5.5	
TG-08	MB2.54	
TG-09	MB3.5	
TG-14	MB1.53	
TG-15	MB5.5	

Station Code	Habitat Types	Habitat Images
TG-16	MB2.54	
TG-24	MB3.5	
TG-26	MB6.5	
TG-32	MB4.5	
TG-32	MB1.53	
TG-35	MB6.5	
TG-36-1	MB4.5 Wreck	

Station Code	Habitat Types	Habitat Images
TG-36-2	MB4.5 Wreck	
TG-37	MB6.5	
TG-54	MB4.5	
TG-55	MB2.54	
TG-57	MB1.53	
TG-57	MB4.5	
TG-57	MB2.54	

Station Code	Habitat Types	Habitat Images
TG-61	MB4.5	
TG-61	MB2.54	
TG-64	MB6.5	
TG-64	MB1.53	
TG-65	MB6.5	
TG-69	MB1.53	
TG-69	MB2.54	

Station Code	Habitat Types	Habitat Images
TG-70-1	MB2.54	
TG-70-2	MB2.54	
TG-71	MB2.54	
TG-72-1	MB5.5	
TG-72-2	MB2.54	
TG-73	MB2.54	
TG-74	MB2.54	

Station Code	Habitat Types	Habitat Images
TG-75	MB1.51	
TG-75	MB2.54	
NTG-01	MB3.5	
NTG-02	MB6.5	
NTG-03	MB4.5	

7.3. Habitat Mapping

The spatial distributions of the habitat types were mainly determined by the acoustic (SSS and SBES) methods. Seabed characterization tool of SonarWiz and GIS on-screen digitizing techniques were applied to determine the border of different habitat types. Dropdown camera, sediment, CTD, benthos and fish counting stations data were used as ground-truthing information in defining the types within these boundaries.

However, there were gaps in the shallow zones of the study area, where acoustic measurements were not performed because of technical limitations. The GoogleEarth imagery was used in these shallow zones in order to obtain the spatial distributions of the shallow habitats. The digitizing was made focusing on determination of the hard, soft and meadow bottom boundaries. The transect survey lines, with a few dropdown camera stations, were then used as ground-truthing information in defining the types within these boundaries.

As a result of this combined approach, 17.7688 km^2 of marine area between 0-50 m depth contours was mapped. About 87.1% of the total area was mapped by using acoustic techniques whereas 12.9% of the total area was mapped using GoogleEarth and transects (Figure-94).

In assigning the EUNIS habitat types, the following criteria was followed:

1. If determined polygon had a ground-truthing information, that type was assigned.
2. If determined polygon didn't have a ground-truthing information but was close to a ground-truthed defined type, that type was assigned.
3. If determined polygon didn't have a ground-truthing information and wasn't close to a ground-truthed defined type, the higher level of habitat type was assigned.

Because of the criteria mentioned above, the resulting EUNIS hierarchical habitat type levels were not constant during the habitat mapping.

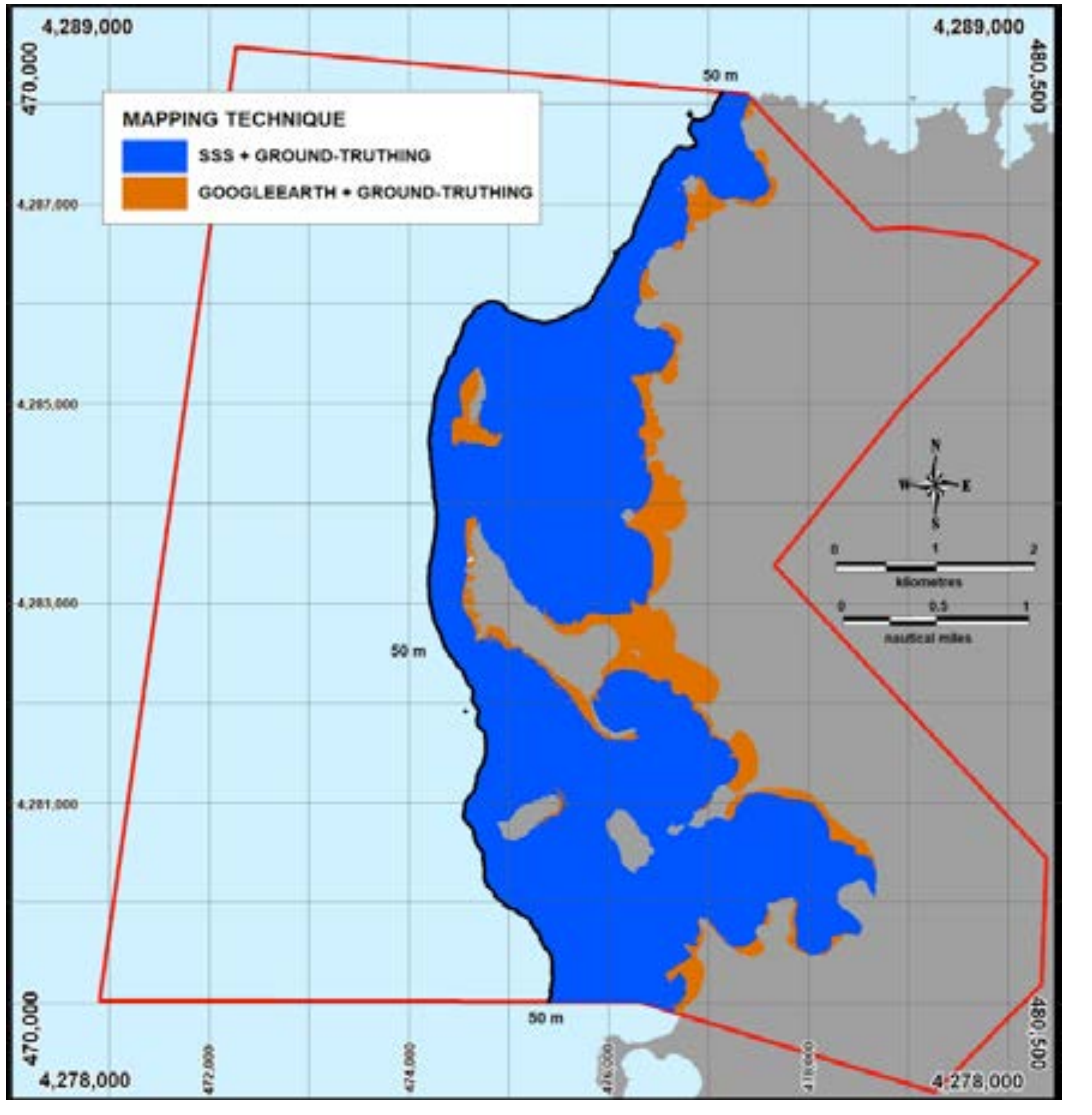


Figure 94
Mapped zones

7.4. Habitat Types and Distributions

The habitats were categorized under 15 classes at different EUNIS levels, using SSS and GoogleEarth imagery with ground-truthing data. A total of 571 polygon features were created in the categorization. The spatial distributions of these habitat types were obtained in GIS and their total area coverage is 17.77 km² (Table-12 & Figure-95).

Spatially defined habitat types in 0-50 m depth zone are the followings (**in bold**):

MB1.5 Infralittoral rock

- **MB1.51 Algal-dominated infralittoral rock**
  - **MB1.51a Well illuminated infralittoral rock, exposed**
  - **MB1.51c Well illuminated infralittoral rock, sheltered**
- **MB1.52 Invertebrate-dominated infralittoral rock**
  - **MB1.52a Moderately illuminated infralittoral rock, sheltered**
- **MB1.53 Infralittoral rock affected by sediments**
- **MB1.56 Semi-dark caves and overhangs**

MB2.5 Infralittoral biogenic habitat

- **MB2.54 *Posidonia oceanica* meadows**

MB3.5 Infralittoral coarse sediment

- **MB3.53 Infralittoral pebbles**

MB4.5 Infralittoral mixed sediment

MB5.5 Infralittoral sand

- **MB5.52 Well sorted fine sand**

MB6.5 Infralittoral mud sediment

Table 12
Habitat types and distributions

HABITAT TYPES	A (km²)	%	Polygon Feature N
MB1.5	0.451059	2.538	72
MB1.51	0.407043	2.291	55
MB1.51a	0.121125	0.682	6
MB1.51c	0.013745	0.077	1
MB1.52	0.068486	0.385	4
MB1.52a	0.018104	0.102	1
MB1.53	0.168097	0.946	33
MB1.56	0.000421	0.002	3
MB2.54	5.687530	32.009	46
MB3.5	1.959030	11.025	14
MB3.53	0.102870	0.579	4
MB4.5	2.358929	13.276	30
MB5.5	4.180935	23.530	289
MB5.52	0.015284	0.086	4
MB6.5	2.211338	12.445	5
Artificial (piers)	0.004806	0.027	4
Total	17.768800	100	571

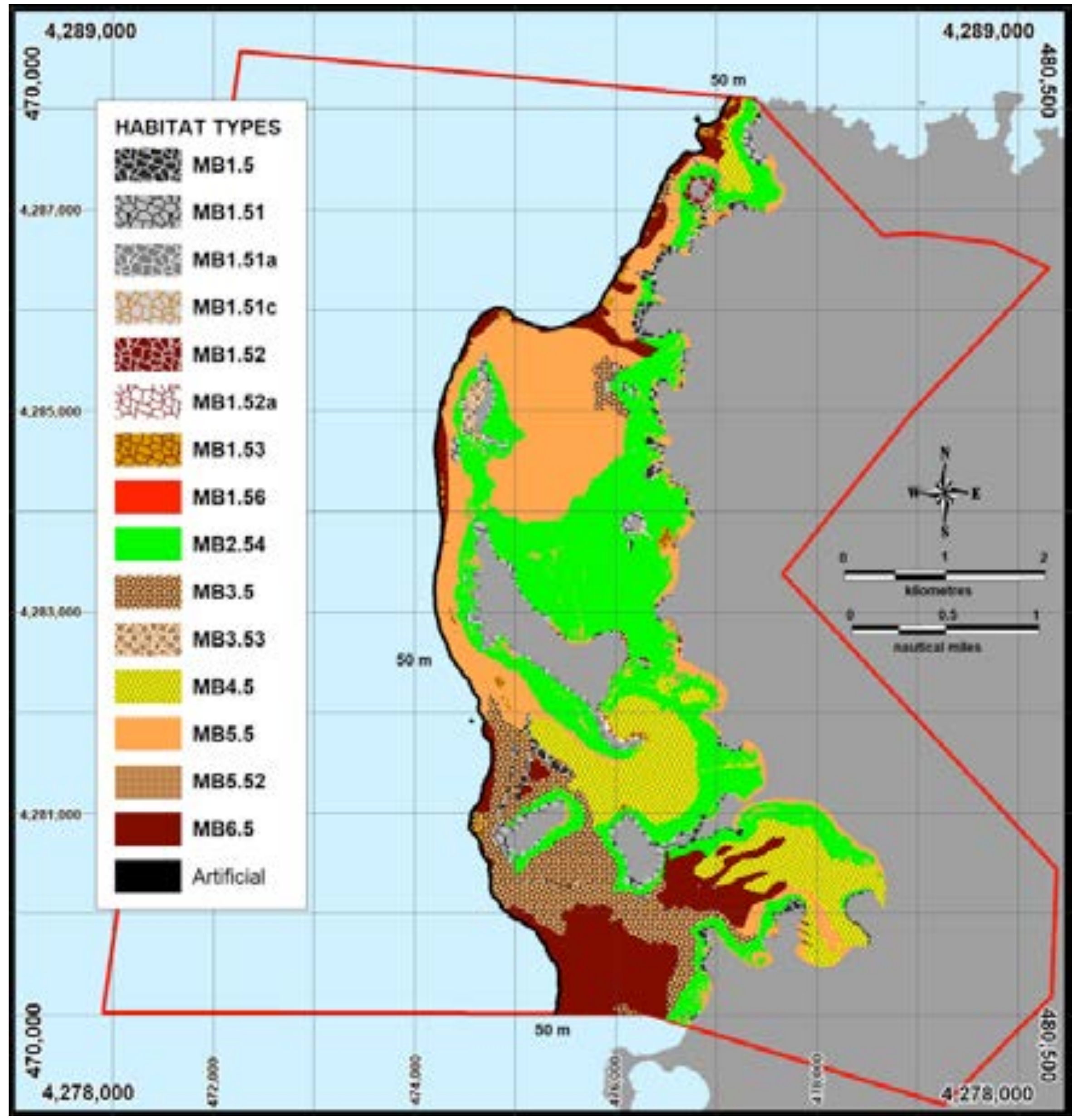


Figure 95
Spatial distribution of habitat types

8

8

MONITORING NETWORK OF THE FOÇA SEPA

In-situ measurements were made in all *Posidonia oceanica* Monitoring System-PoMS for the baseline state. Depth of the markers, the marker to marker and photo stick to marker angles, density, coverage, burial, and plagiotropgic rhizome percentage of the meadow are shown in Table-13 to 16. The characterization of the PoMS are given in Figure-96 to 99.

The two photos (right side and left side) which were taken from the frontal side of the blocks combined as a determinative one photo for monitoring (Figure-100-103). One photo was taken 2m above the blocks to determine the situation of the border for future monitoring (Figure-104 to 107).

The location of PoMS were demonstrated in Figure-18. The coordinates of these PoMS are as follows:

PM-01:

X (Longitude)= 474841.2

Y (Latitude)= 4282647.1

PM-02:

X (Longitude)= 475455.2

Y (Latitude)= 4280755.0

PM-03:

X (Longitude)= 476602.8

Y (Latitude)= 4285414.3

PM-04:

X (Longitude)= 477367.4

Y (Latitude)= 4287325.9

More detailed information on PM locations are given in the Digital Annex-I.

Table 13
PM-01 PoMS in situ measurements

Marker Number	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11
Depth (m)	5,2	5,4	5,5	5,6	5,7	5,7	5,7	5,3	5,5	5,6	5,5
Marker Plans (Orientations)											
Marker to Marker	B1->B2	B2->B3	B3->B4	B4->B5	B5->B6	B6->B7	B7->B8	B8->B9	B9->B10	B10->B11	B11->B10
Angle	150	140	90	140	130	110	40	60	90	120	300
Photo Stick to Photo Stick	P1->B1	P2->B2	P3->B3	P4->B4	P5->B5	P6->B6	P7->B7	P8->B8	P9->B9	P10->B10	P11->B11
Angle	205	270	170	205	225	200	155	100	190	175	220
Marker Number	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11
Cover (%)	100	70	90	95	95	80	45	70	40	85	95
Density (number of shoot/m^2)	408	483	517	575	483	517	517	583	475	483	333
Plagiotrophic Rhizome (%)	20%	29%	29%	19%	14%	10%	21%	14%	23%	19%	20%
Erosion/ Burial (cm)	3	3	6	3	3	3	5	4	4	2	3
Substrate	coarse sand	coarse sand	coarse sand	coarse sand	coarse sand	coarse sand	coarse sand	coarse sand	coarse sand	coarse sand	coarse sand
Limit Type	Sharp limit										
Remarks											

Table 14
PM-02 PoMS in situ measurements

Marker Number	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11
Depth (m)	17,0	17,7	17,7	16,5	16,6	17,4	17,7	17,3	17,6	17,4	17,6
Marker Plans (Orientations)											
Marker to Marker	B1->B2	B2->B3	B3->B4	B4->B5	B5->B6	B6->B7	B7->B8	B8->B9	B9->B10	B10->B11	B11->B10
Angle	50	50	10	55	75	60	45	45	55	60	240
Photo Stick to Photo Stick	P1->B1	P2->B2	P3->B3	P4->B4	P5->B5	P6->B6	P7->B7	P8->B8	P9->B9	P10->B10	P11->B11
Angle	320	315	310	310	340	340	340	335	340	335	315
Marker Number	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11
Cover (%)	25%	15%	20%	30%	15%	15%	20%	20%	20%	15%	10%
Density (number of shoot/m^2)	167	142	158	267	1583	125	125	117	117	150	133
Plagiotrophic Rhizome (%)	55%	71%	68%	47%	26%	80%	33%	50%	50%	67%	56%
Erosion/ Burial (cm)	2	-2	3	2	2	4	3	5	4	1	2
Substrate	Sand-mud	Sand-mud	Sand-mud	Sand-mud	Sand-mud	Sand-mud	Sand-mud	Sand-mud	Sand-mud	Sand-mud	Sand-mud
Limit Type	Sparse limit										
Remarks											

Table 15
PM-03 PoMS in situ measurements

Marker Number	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11
Depth (m)	6,8	6,9	6,8	6,8	6,7	6,6	6,7	6,6	6,9	6,9	6,9
Marker Plans (Orientations)											
Marker to Marker	B1->B2	B2->B3	B3->B4	B4->B5	B5->B6	B6->B7	B7->B8	B8->B9	B9->B10	B10->B11	B11->B10
Angle	200	170	125	140	100	135	130	200	165	95	275
Photo Stick to Photo Stick	P1->B1	P2->B2	P3->B3	P4->B4	P5->B5	P6->B6	P7->B7	P8->B8	P9->B9	P10->B10	P11->B11
Angle	290	285	195	160	190	195	220	230	335	230	200
Marker Number	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11
Cover (%)	65%	95%	100%	95%	95%	90%	100%	95%	95%	95%	90%
Density (number of shoot/m^2)	375	458	342	550	417	375	425	408	342	325	383
Plagiotrophic Rhizome (%)	31%	31%	20%	20%	18%	20%	22%	20%	34%	18%	17%
Erosion/ Burial (cm)	3	3	5	3	5	5	5	3	3	5	3
Substrate	coarse sand	coarse sand	coarse sand	coarse sand	coarse sand	coarse sand	coarse sand	coarse sand	coarse sand	coarse sand	coarse sand
Limit Type	Sharp limit										
Remarks											

Table 16
PM-04 PoMS in situ measurements

Marker Number	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11
Depth (m)	24,5	24,5	24,3	24,2	24,2	24,4	24,6	24,8	25,0	25,2	25,2
Marker Plans (Orientations)											
Marker to Marker	B1->B2	B2->B3	B3->B4	B4->B5	B5->B6	B6->B7	B7->B8	B8->B9	B9->B10	B10->B11	B11->B10
Angle	130	55	350	295	300	270	280	320	285	5	175
Photo Stick to Photo Stick	P1->B1	P2->B2	P3->B3	P4->B4	P5->B5	P6->B6	P7->B7	P8->B8	P9->B9	P10->B10	P11->B11
Angle	150	170	130	65	30	10	20	65	55	75	135
Marker Number	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11
Cover (%)	10%	30%	35%	25%	15%	40%	15%	15%	20%	15%	10%
Density (number of shoot/m^2)	67	83	117	92	75	125	50	50	92	75	67
Plagiotrophic Rhizome (%)	88%	90%	93%	91%	100%	73%	83%	83%	82%	100%	100%
Erosion/ Burial (cm)	0,5	0,5	0,5	0,5	0,5	0,5	0	0	-0,5	-0,5	-0,5
Substrate	sand-mud	sand-mud	sand-mud	sand-mud	sand-mud	sand-mud	sand-mud	sand-mud	sand-mud	sand-mud	sand-mud
Limit Type	sparse										
Remarks											

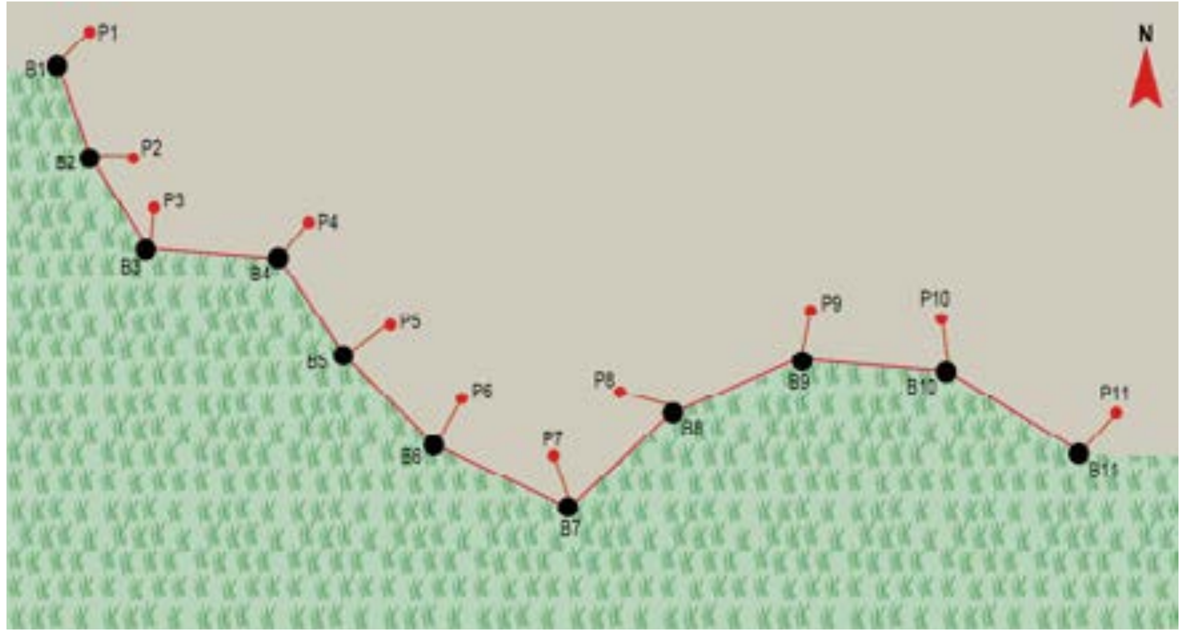


Figure-96

PoMS settlement at PM-01 station

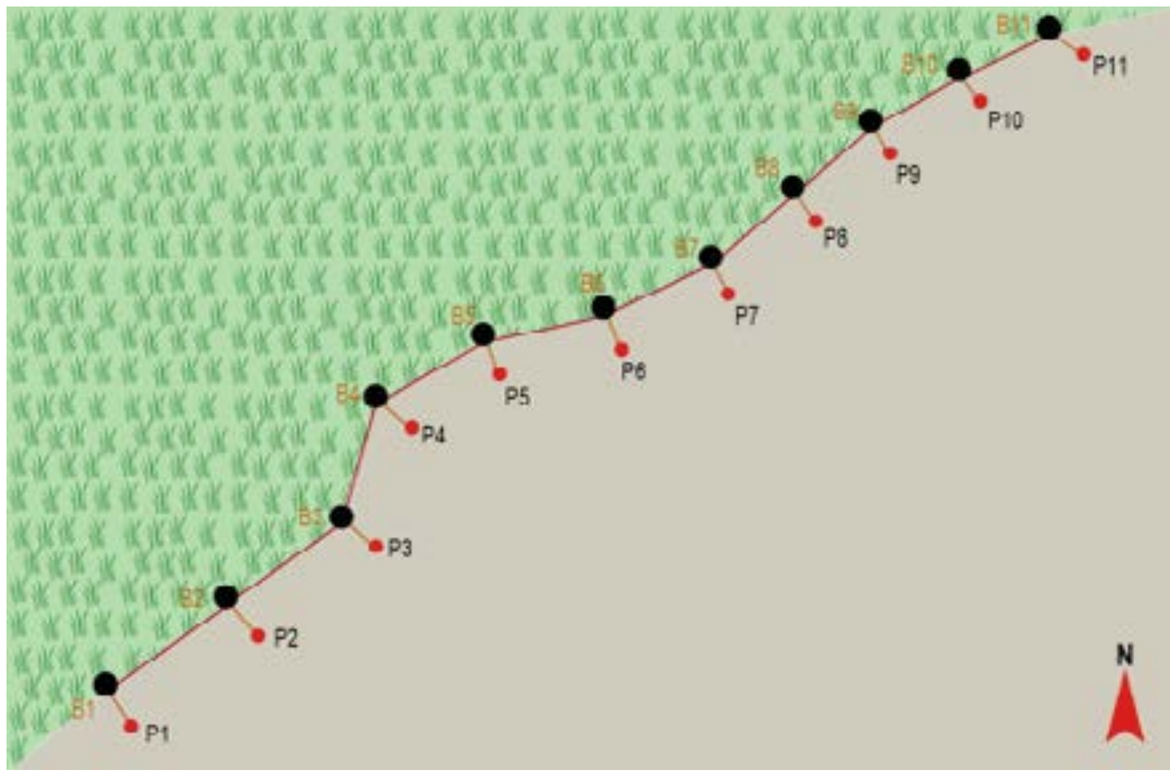


Figure-97

PoMS settlement at PM-02 station

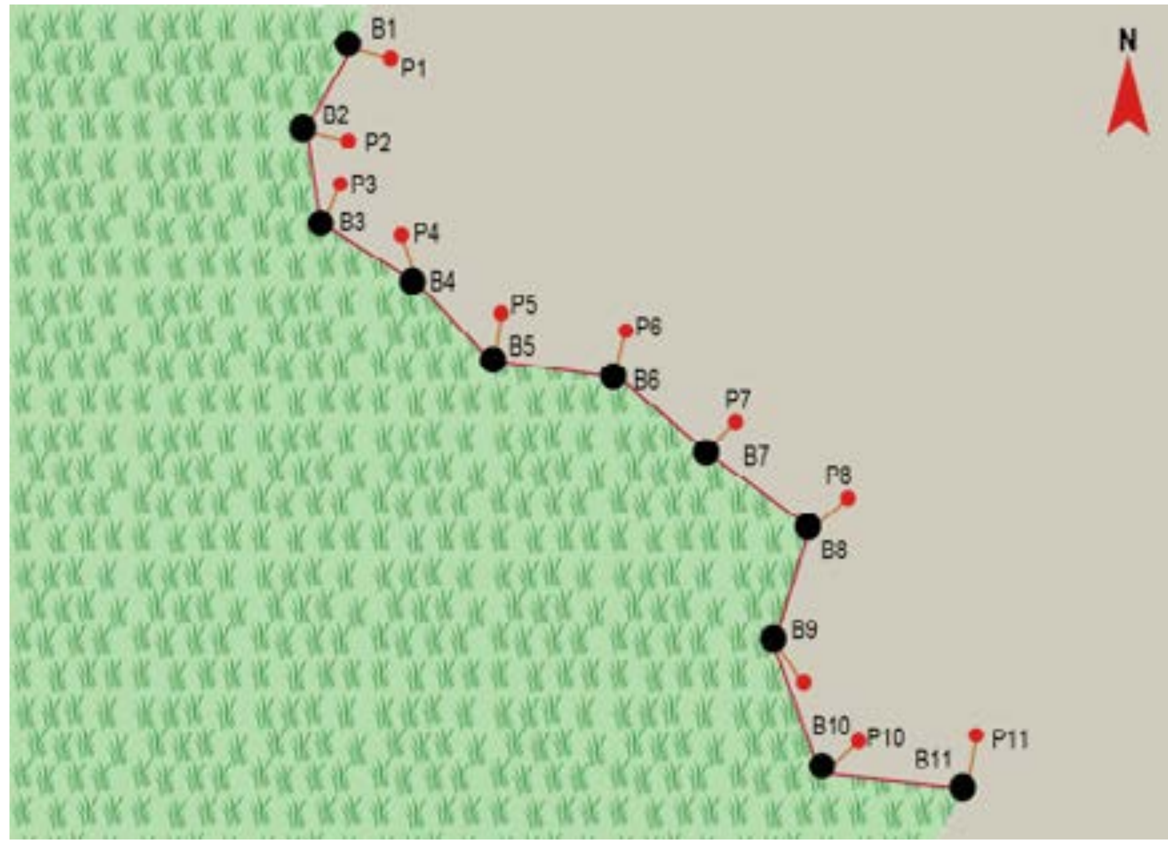


Figure-98

PoMS settlement at PM-03 station

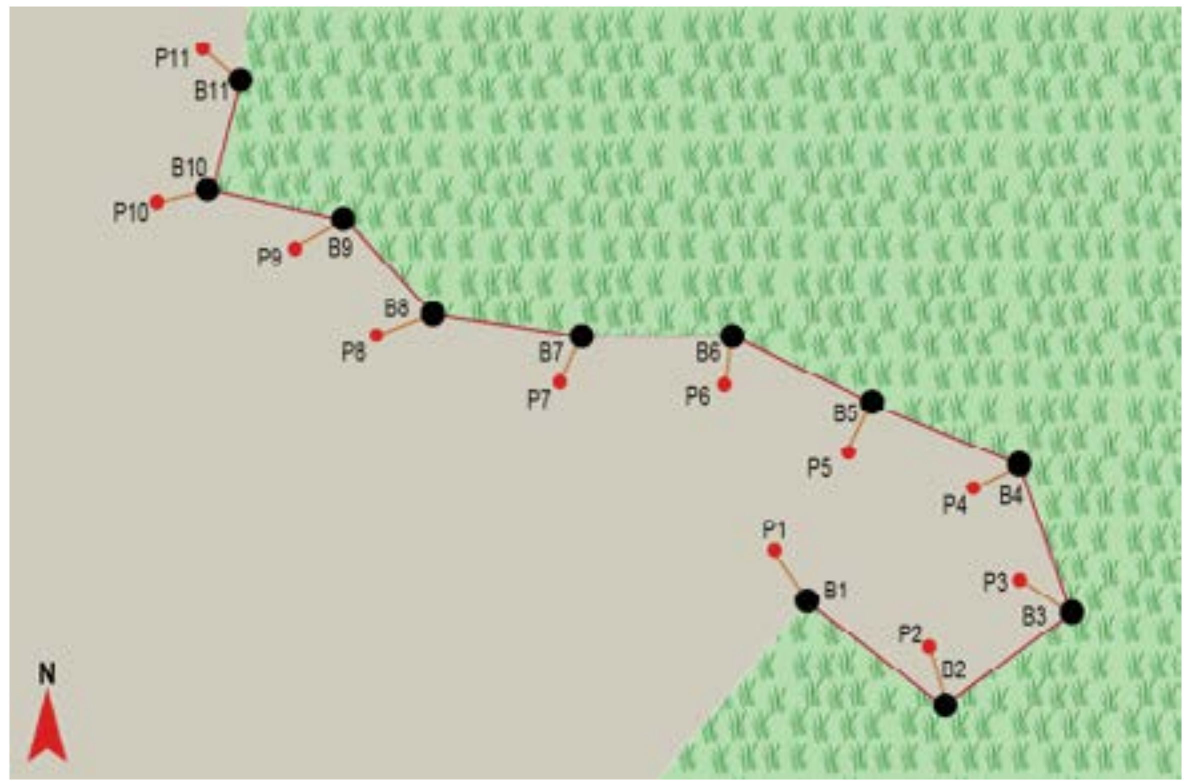


Figure-99

PoMS settlement at PM-04 station

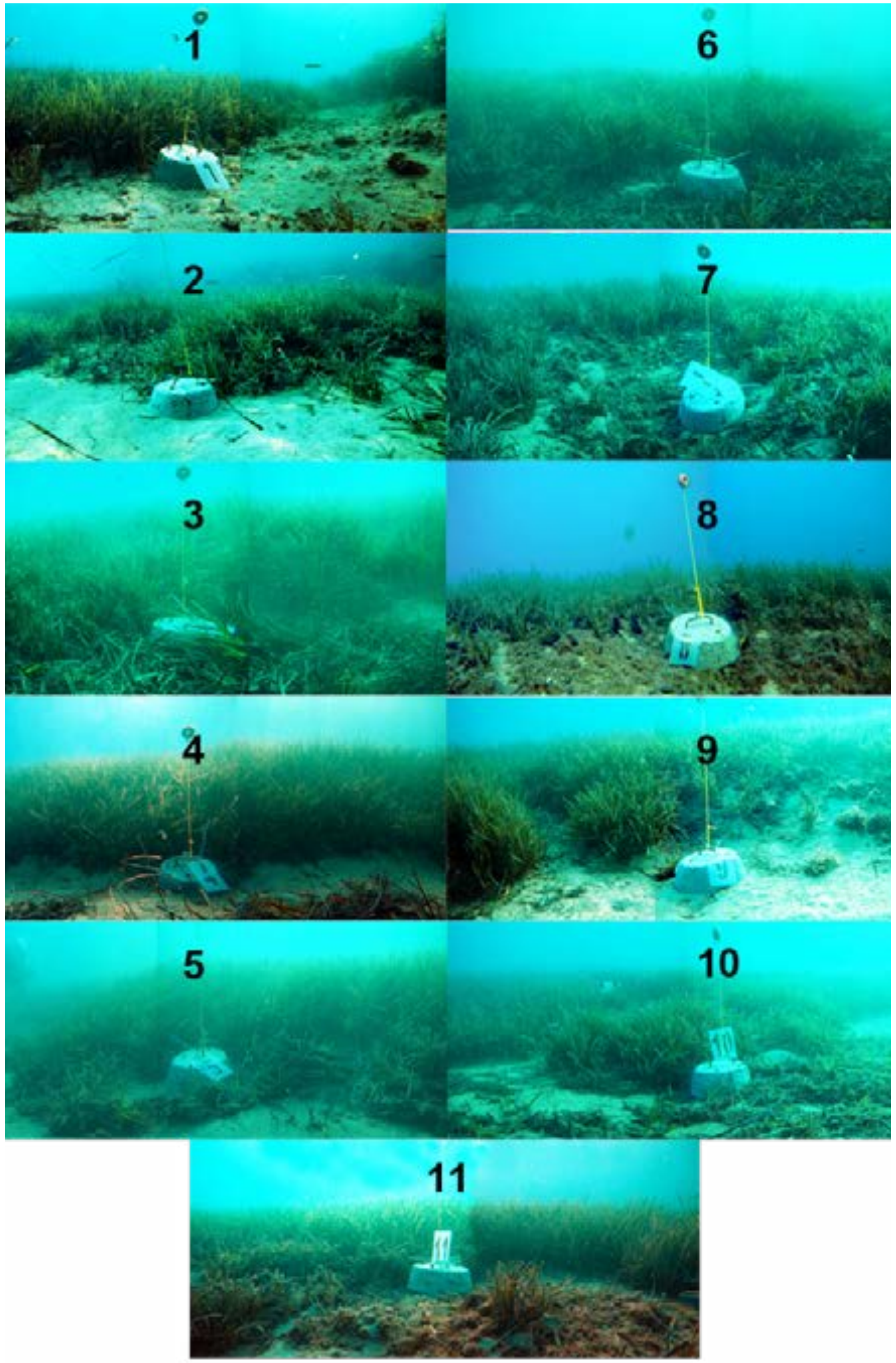


Figure-100

Combined photos taken infront of PM-01 PoMS markers

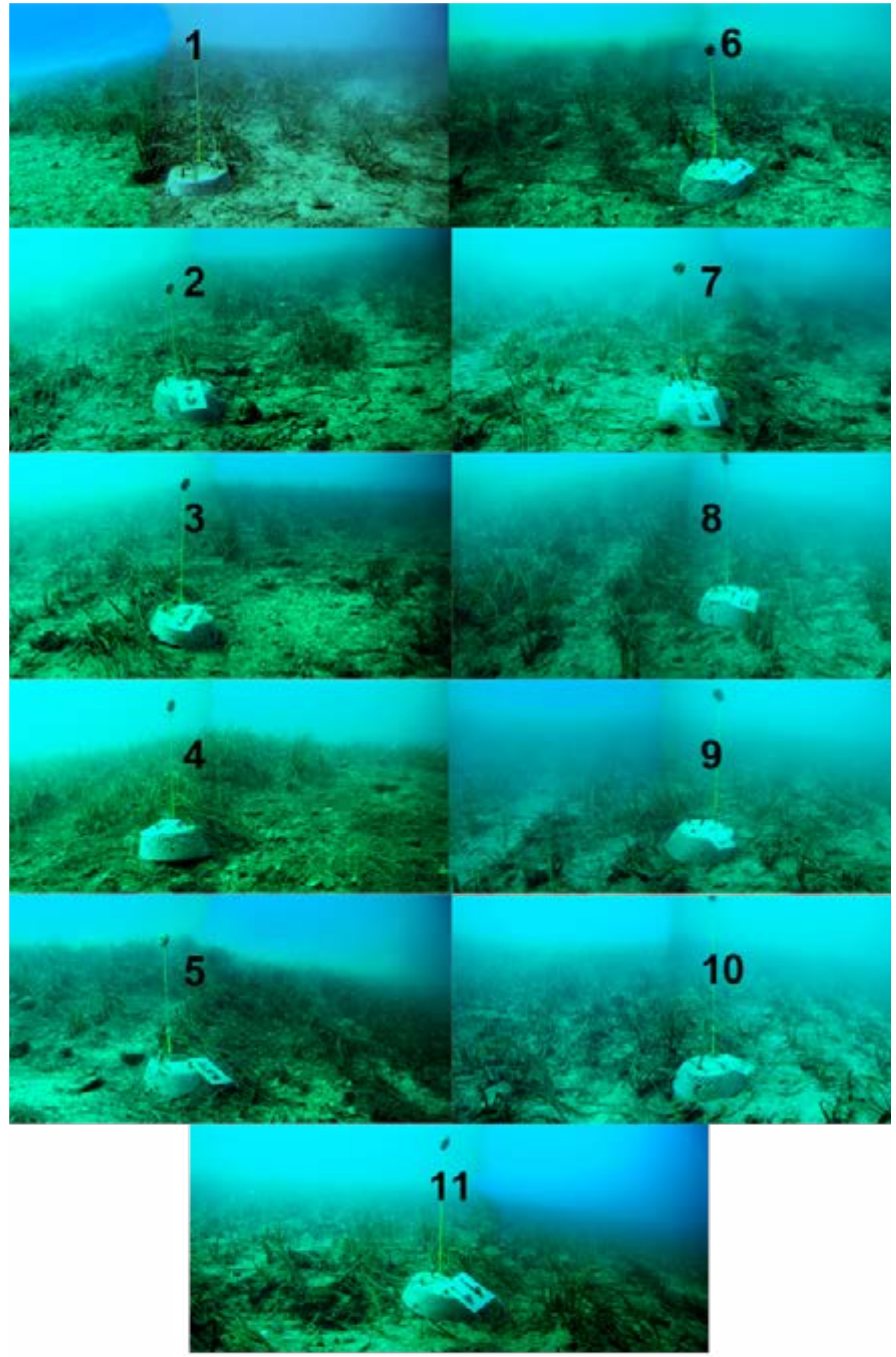


Figure-101

Combined photos taken infront of PM-02 PoMS markers

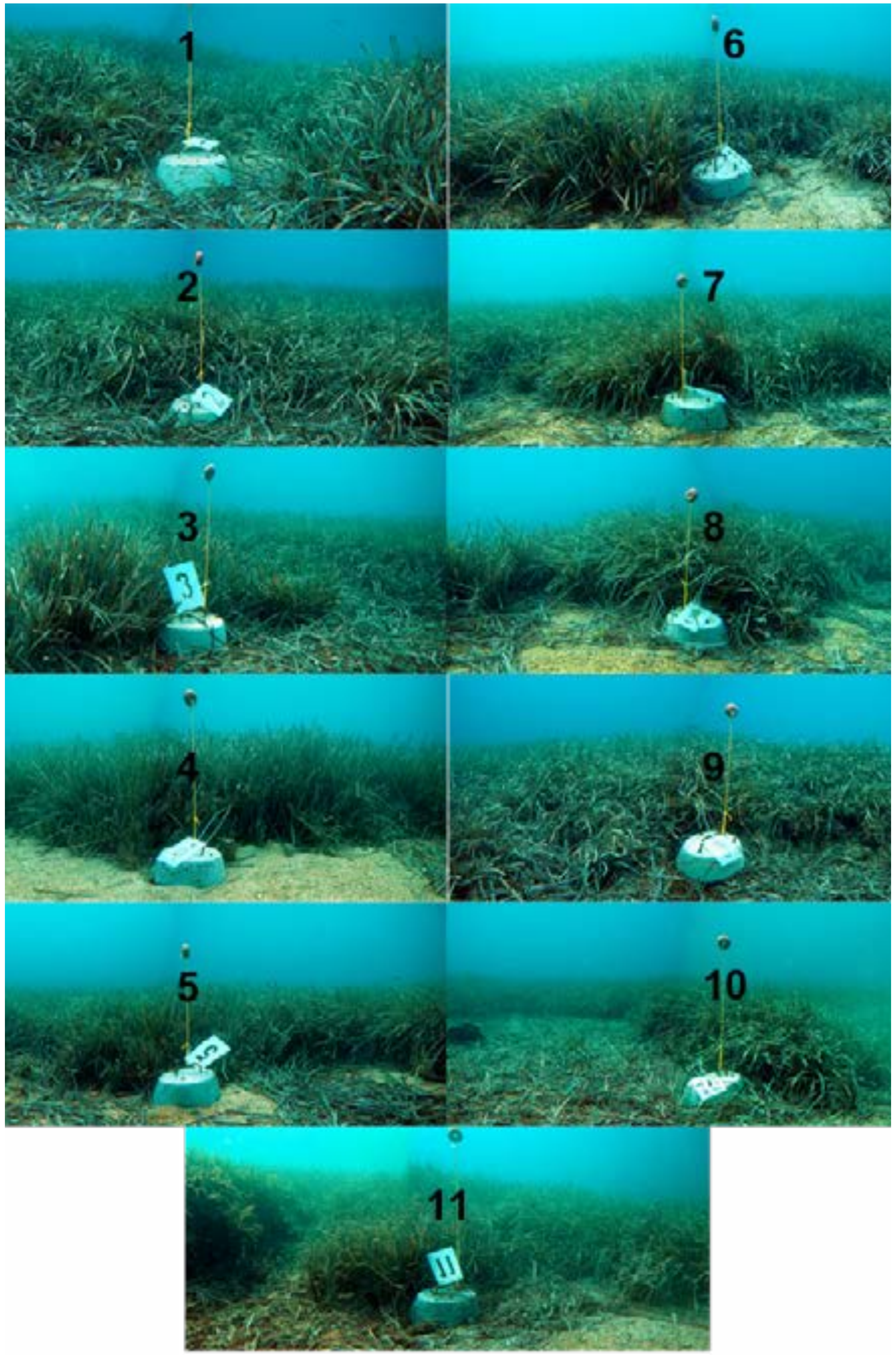


Figure-102

Combined photos taken infront of PM-03 PoMS markers

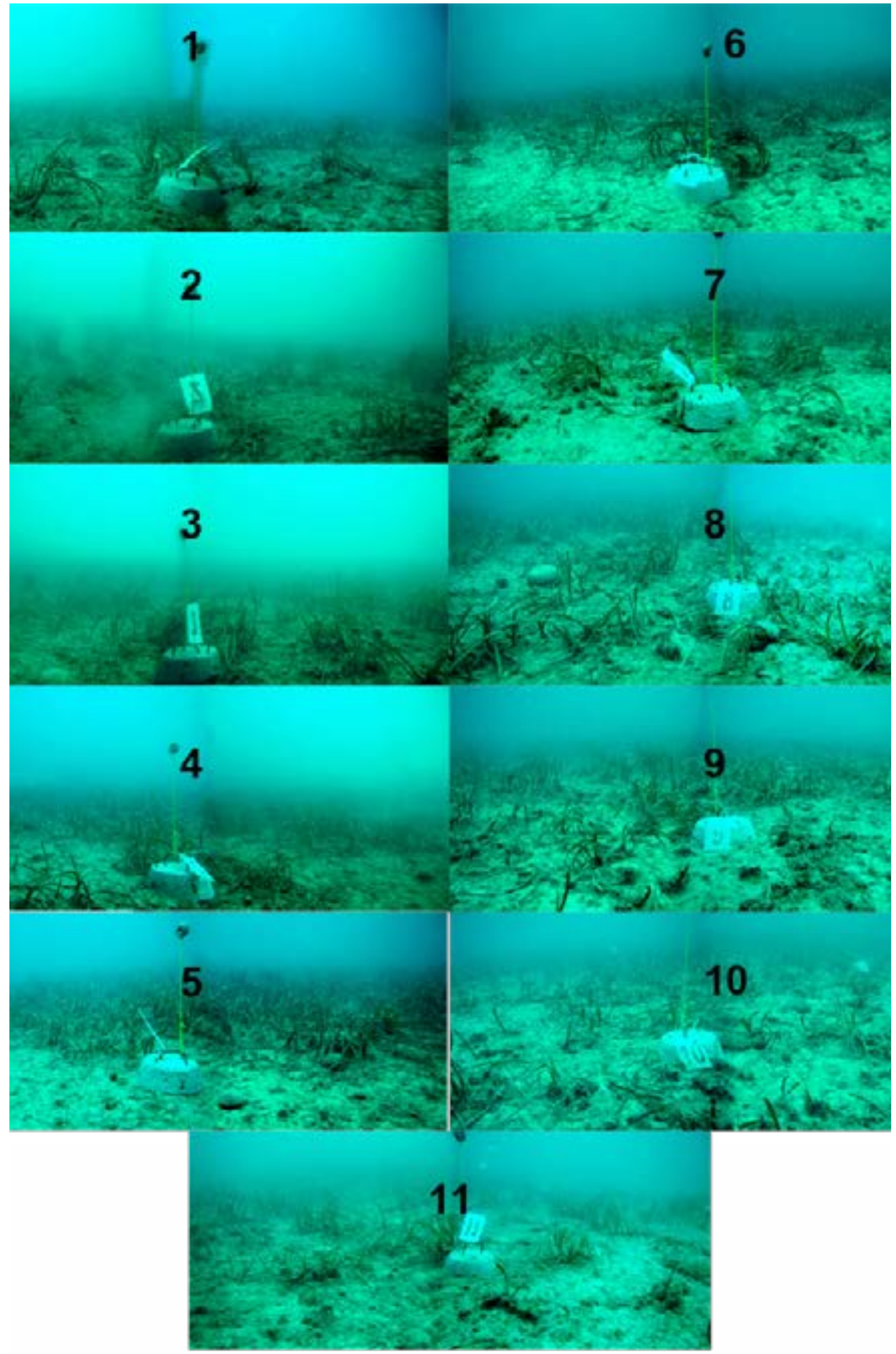


Figure-103

Combined photos taken infront of PM-04 PoMS markers

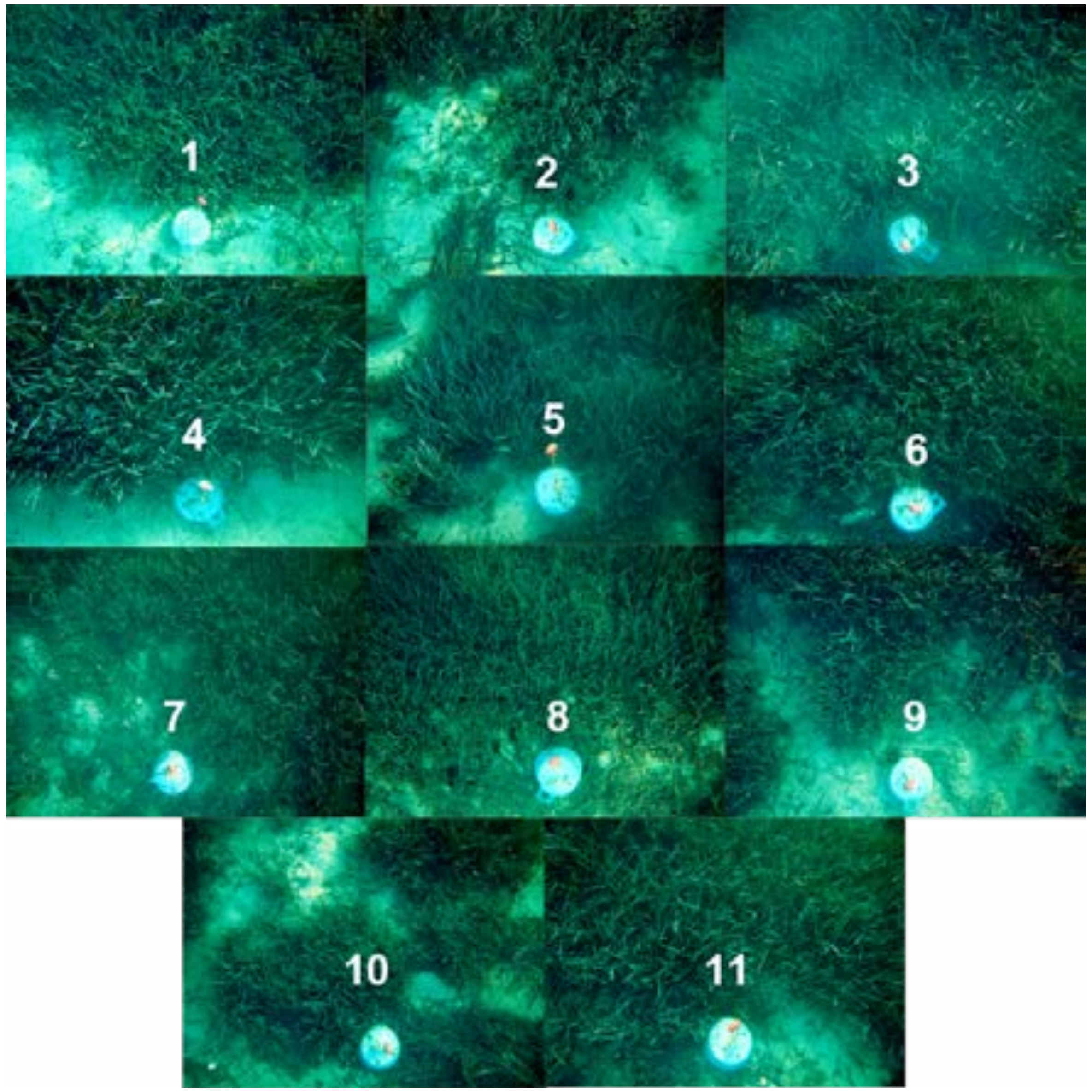


Figure-104

The photos taken above the PM-01 of PoMS markers

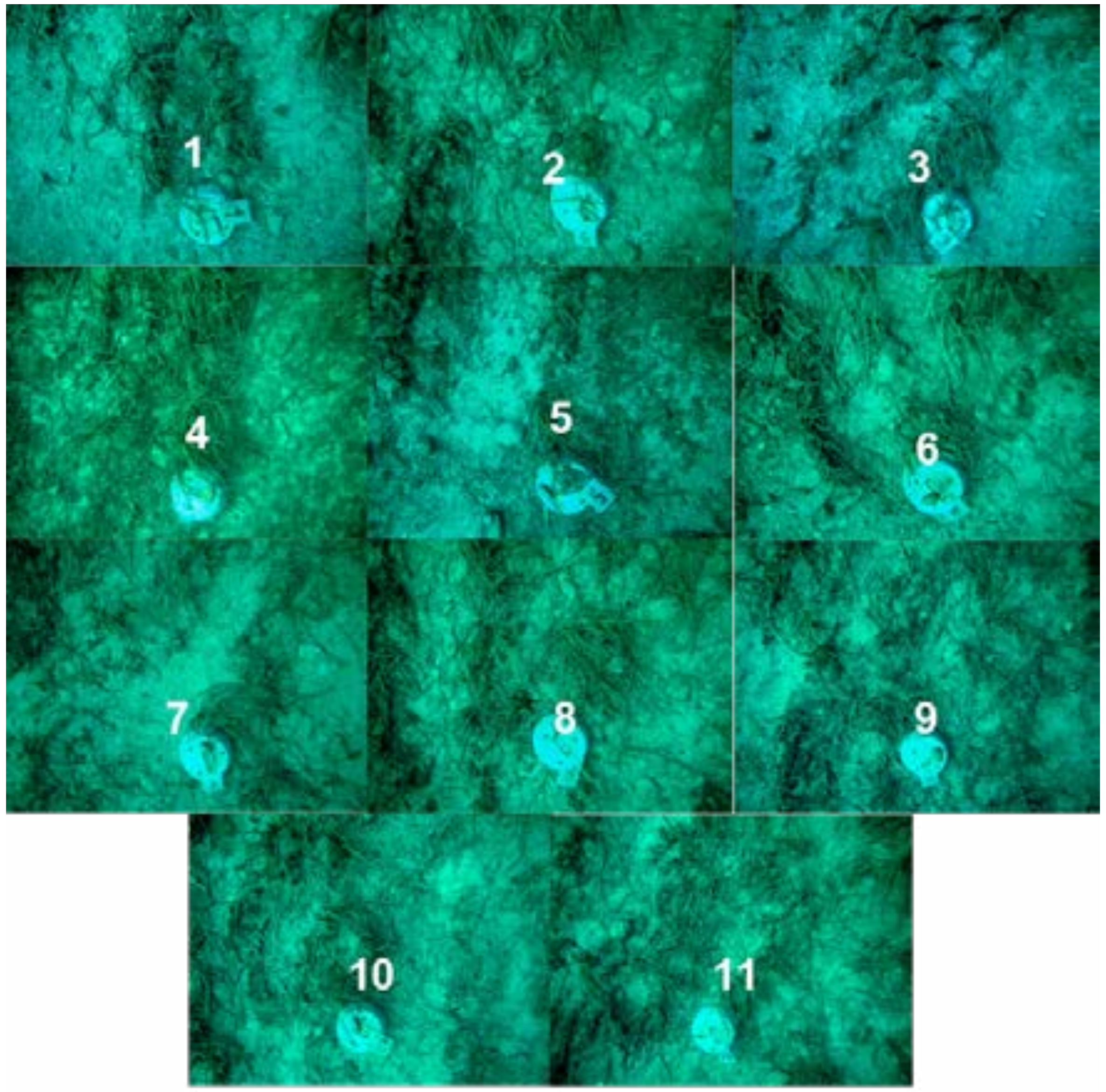


Figure-105

The photos taken above the PM-02of PoMS markers

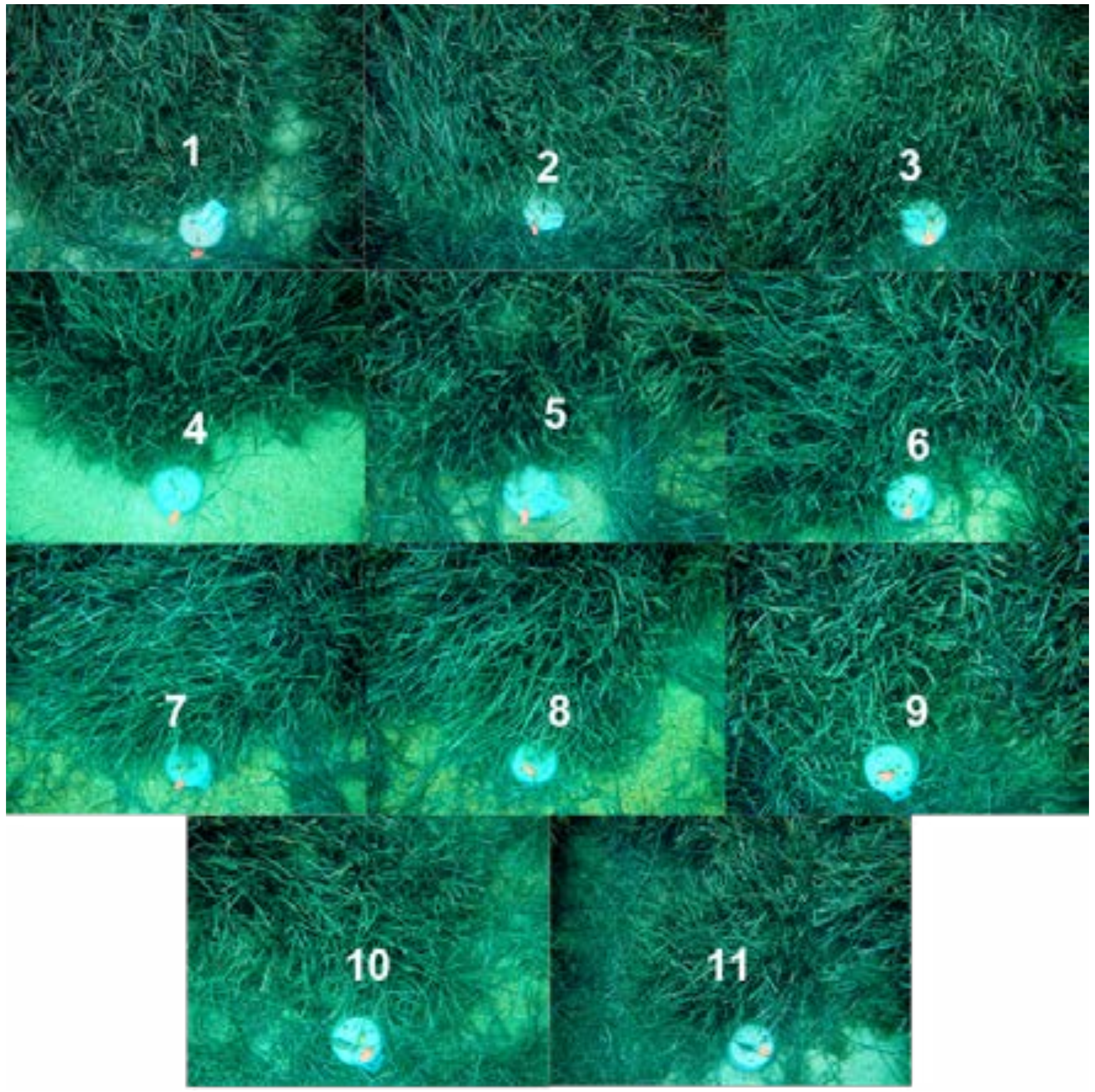


Figure-106

The photos taken above the PM-03 of PoMS markers

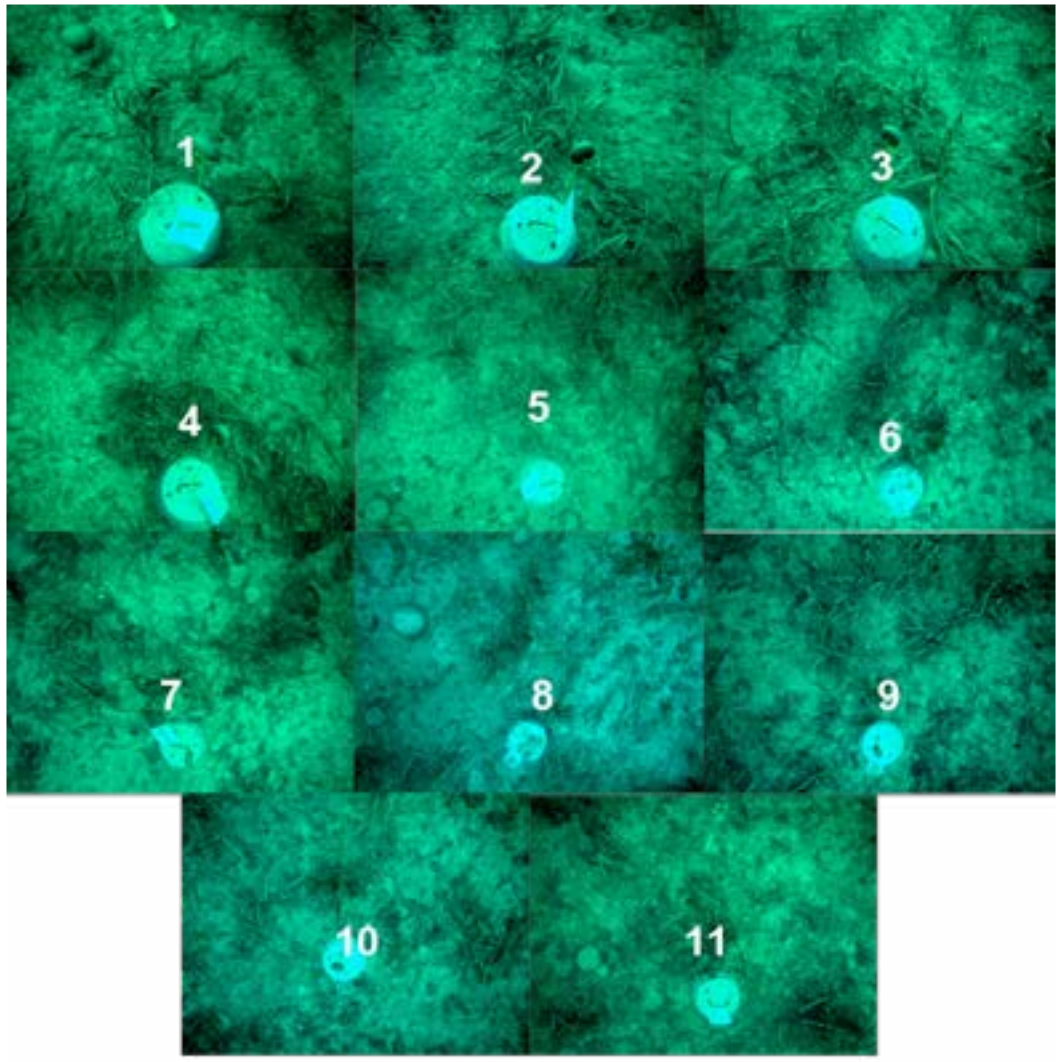


Figure-107

The photos taken above the PM-04 of PoMS markers

According to the protocol criteria of Med*Posidonia* 2011 (Annex V), the PM2 and PM4 stations are the lower limit stations. The lower limit depths of those two are 17.3 m and 24.6 m respectively (Table-17). Two stations were in poor situation. The lower limit type of those two stations are PM2 Sharp C- and PM4 sparse condition. Shoot densities are in poor condition (Figure-108). Plagiotropic rhizome percentage in lower limit stations are observed in high conditions (Figure-109). The coverage (%) of the two deep meadows were (PM2; 18.6%; PM4, 20.9%) moderate (Figure-110). The upper limit stations density situations were poor.

Table 17

Averages of parameters measured at *P. oceanica* monitoring stations in November 2019.

	PM1	PM2	PM3	PM4
Depth (m)	5.5±0.17	17.3±0.44	6.8±0.12	24.6±0.37
Density (number of shoot/m^2)	488.6±70.4	147.7±44.1	400.0±63.9	81.1±24.18
Cover (%)	78.6±0.20	18.6±0.06	92.3±0.03	20.9±0.10
Plagiotrophic Rhizome (%)	19.7±0.06	53.8±0.16	22.7±.0.6	88.8±0.09

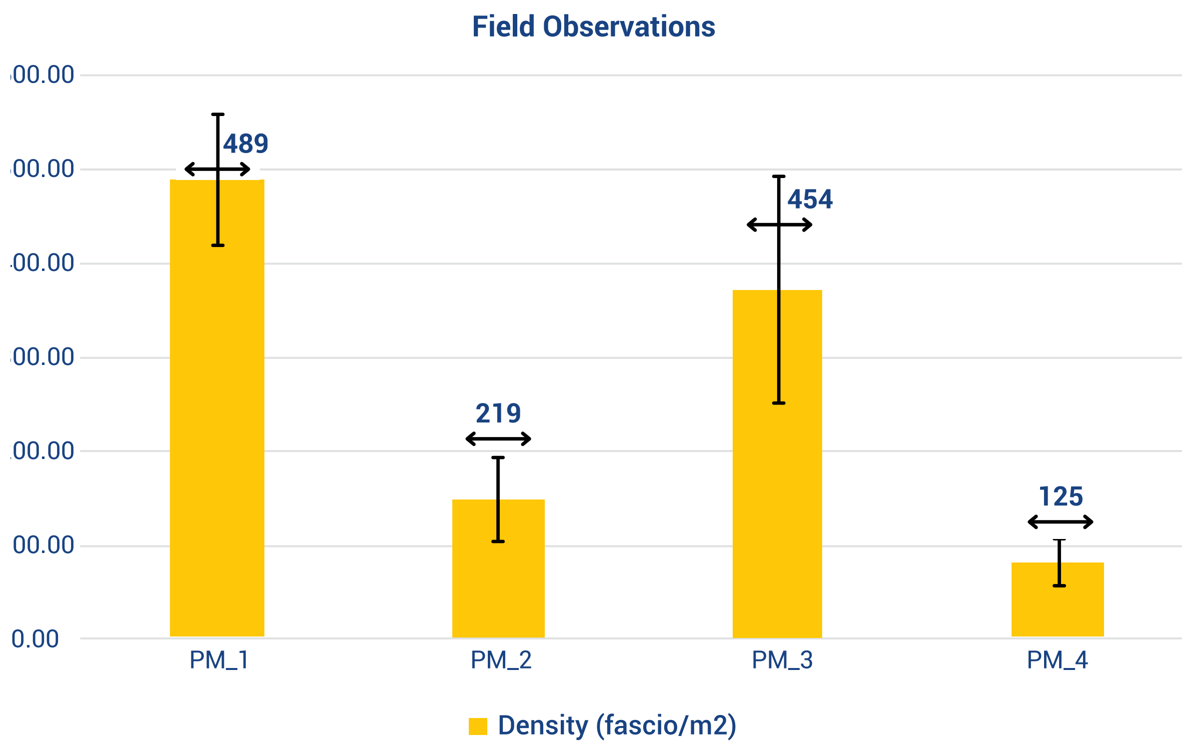


Figure-108

Shoot density of POMs at study site (red arrows represents the moderate situations)

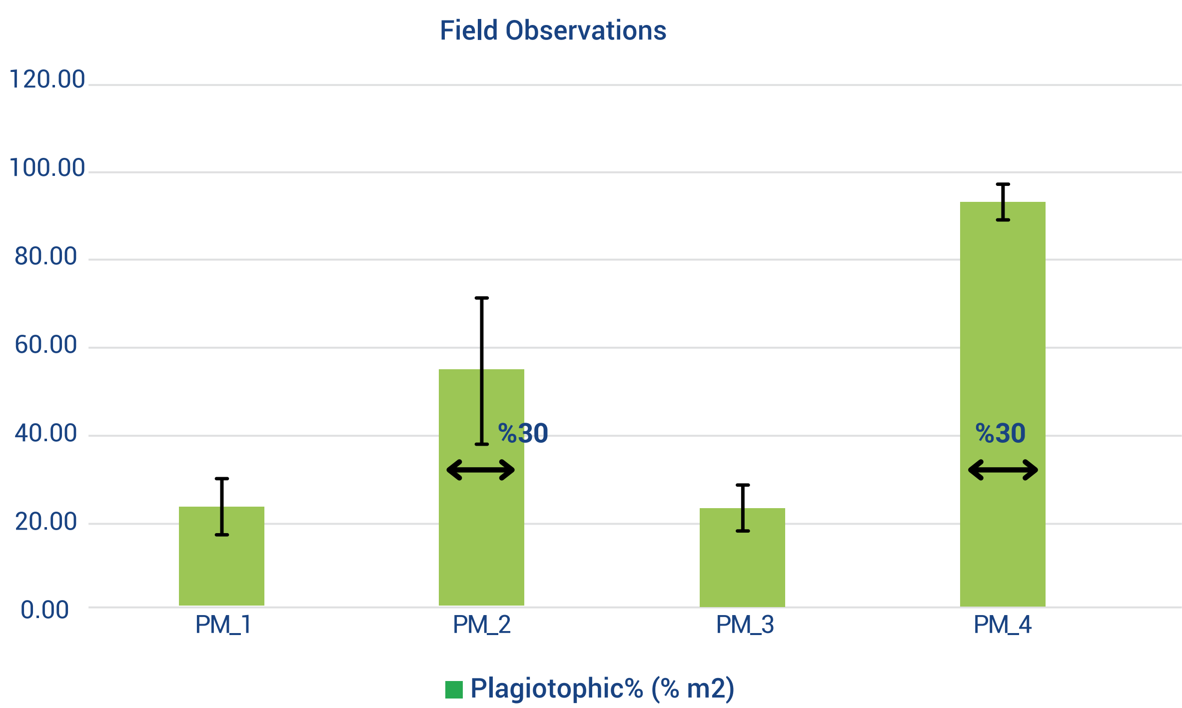


Figure-109

Plagiotrophic rhizome percentage at lower limit of POMs at study site (dark blue arrows represents the moderate situations)

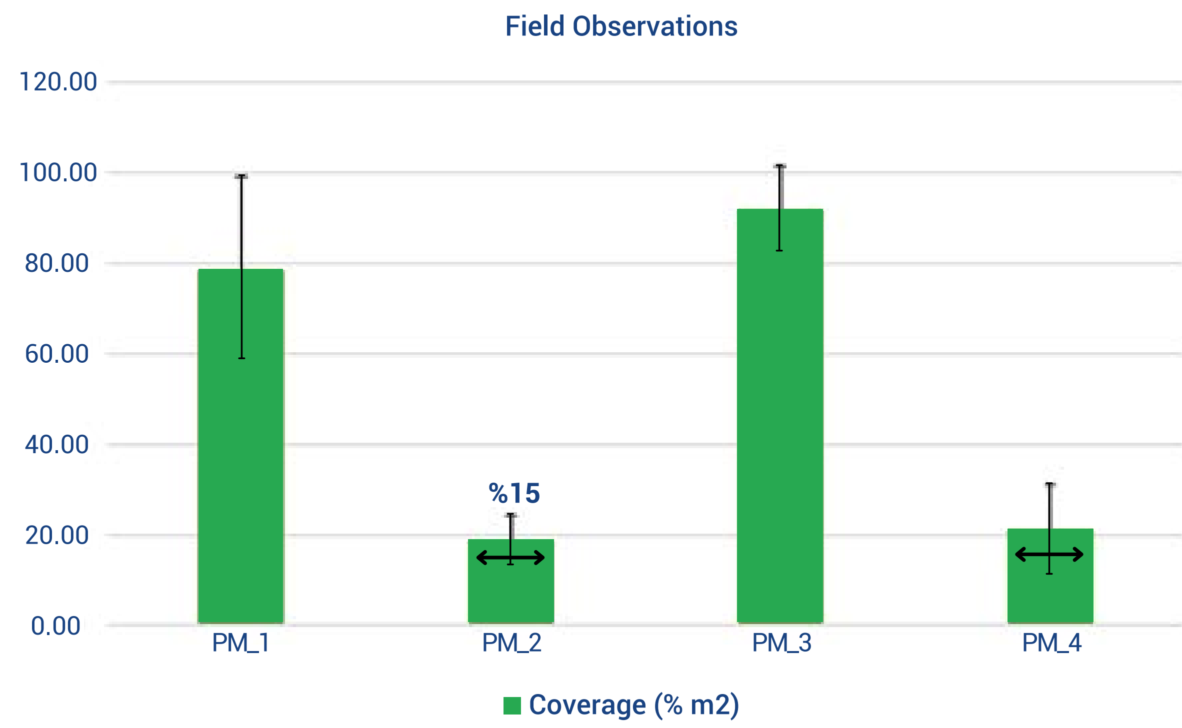


Figure-110

Leaf coverage percentage in m² at lower limit of POMs at study site (green arrows represents the moderate situations)

Phenological analysis consists in studying the plant's biometric parameters were given in **Tables-18-21.** The biometric parameters (number of leaves, total length, width) of each leaf are measured **(Figures 111-113)**. These different elements enable Leaf Area Index (LAI) per shoot to be determined **(Figure-114)**. It is also possible to calculate the Coefficient A that expresses the percentage of leaves that have lost their apex (broken or grazed leaves) (Figure-115).

Table 18

Phenological parameters of *P. oceanica* behind the lower limit in the PM1 station in November 2019 (average + 95% CI)

	Adult	Intermediary	All (Ad+Int)
Average no of leaves.shoots -1	2.6±0.8	2.9±0.6	5.4±1.0
Average length (mm.)	284.7±57.0	196.3±56.9	240.5±71.8
Average width (mm.)	8.4±0.6	8.1±0.5	8.3±0.6
Weighting A (% shoots -1)	%98.3±7.5	%22.1±25.4	%58.5±14.6
Foliar Index (sq.cm.shoots -1)	61.5±26.0	46.9±20.2	108.4±38.3
LAI (sq.m.m-2)	3.0±1.3	2.3±1.0	5.3±1.9

Table 19
Phenological parameters of *P. oceanica* behind the lower limit in the PM2 station in November 2019 (average + 95% CI)

	Adult	Intermediary	All (Ad+Int)
Average no of leaves.shoots -1	2.5±0.5	2.3±0.5	4.8±0.7
Average length (mm.)	448.2±69.1	204.2±40.0	326.2±135.5
Average width (mm.)	8.6±0.5	8.4±0.7	8.5±0.6
Weighting A (% shoots -1)	%64.2±36.4	%4.2±13.1	%36.0±18.6
Foliar Index (sq.cm.shoots -1)	97.0±29.4	39.1±9.6	136.1±30.0
LAI (sq.m.m-2)	1.4±0.4	0.6±0.1	2.0±0.4

Table 20
Phenological parameters of *P. oceanica* behind the lower limit in the PM3 station in November 2019 (average + 95% CI)

	Adult	Intermediary	All (Ad+Int)
Average no of leaves.shoots -1	2.4±0.7	2.6±0.5	5.0±0.9
Average length (mm.)	414.9±60.3	206.1±51.5	310.5±119.4
Average width (mm.)	9.1±0.7	8.8±0.7	8.9±0.7
Weighting A (% shoots -1)	%60.0±29.8	%8.3±17.5	%31.4±16.1
Foliar Index (sq.cm.shoots -1)	92.6±41.7	48.2±19.1	140.8±51.2
LAI (sq.m.m-2)	3.7±1.7	1.9±0.8	5.6±2.0

Table 21
Phenological parameters of *P. oceanica* behind the lower limit in the PM4 station in November 2019 (average + 95% CI)

	Adult	Intermediary	All (Ad+Int)
Average no of leaves.shoots -1	2.4±0.5	2.1±0.6	4.5±0.8
Average length (mm.)	412.7±111.7	194.1±57.2	303.4±141.1
Average width (mm.)	8.9±0.8	8.4±0.9	8.7±0.9
Weighting A (% shoots -1)	%58.3±32.7	%8.3±17.5	%34.8±20.6
Foliar Index (sq.cm.shoots -1)	92.2±38.9	37.3±19.3	129.5±48.5
LAI (sq.m.m-2)	0.7±0.3	0.3±0.2	1.0±0.4

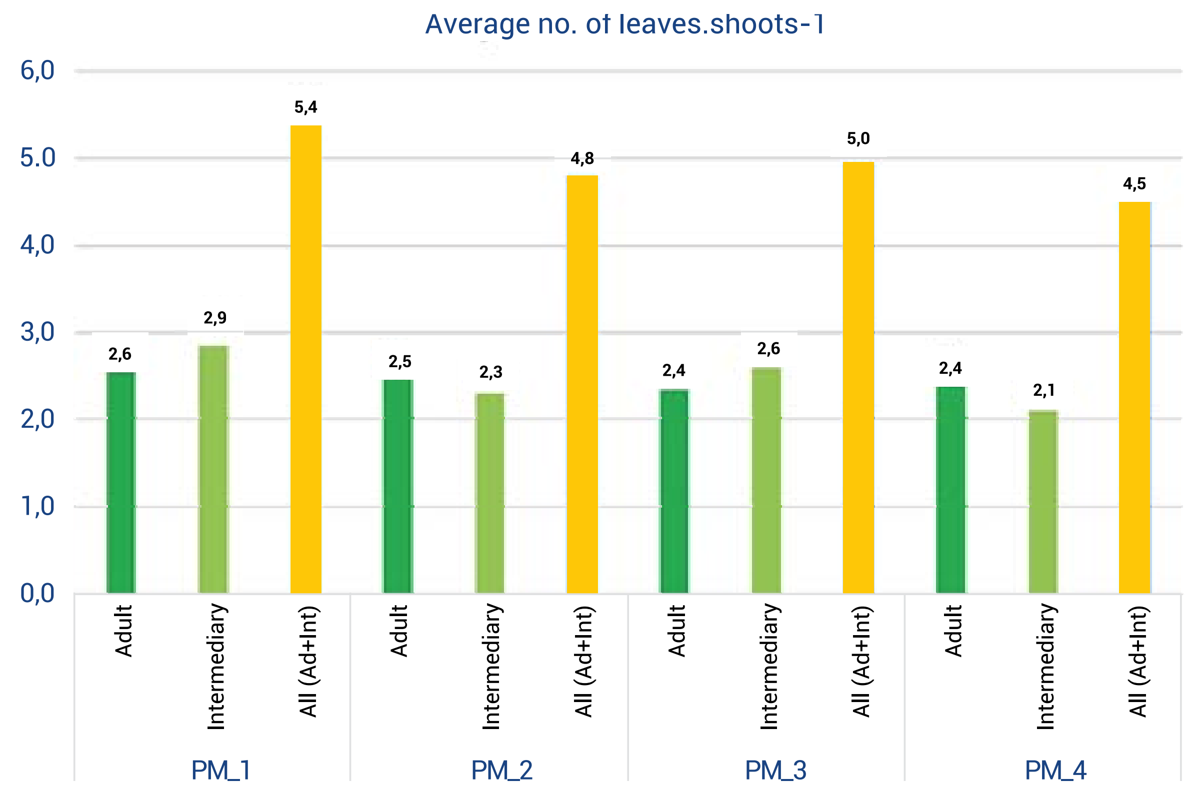


Figure-111
Average number of leaves in the shoot at PoMs in November 2019

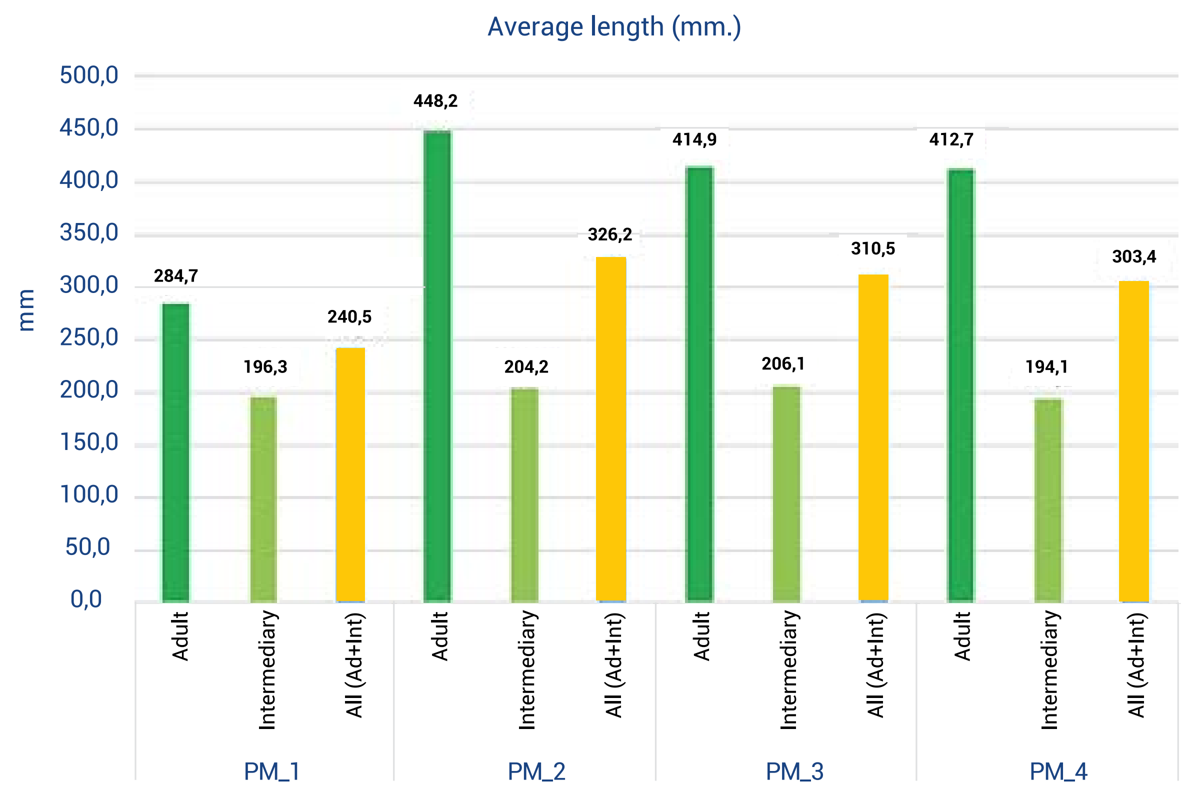


Figure-112
Average lenght of leaves in the shoot at PoMs in November 2019

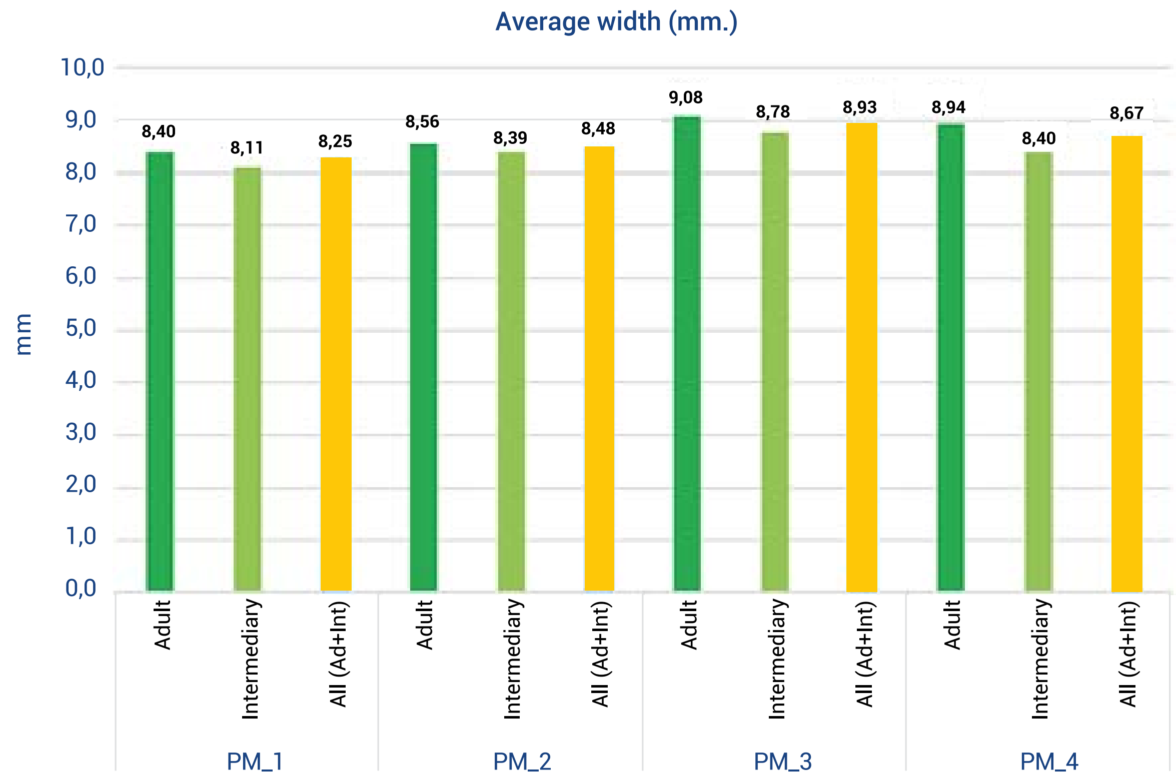


Figure-113

Average width of leaves in the shoot at PoMs in November 2019

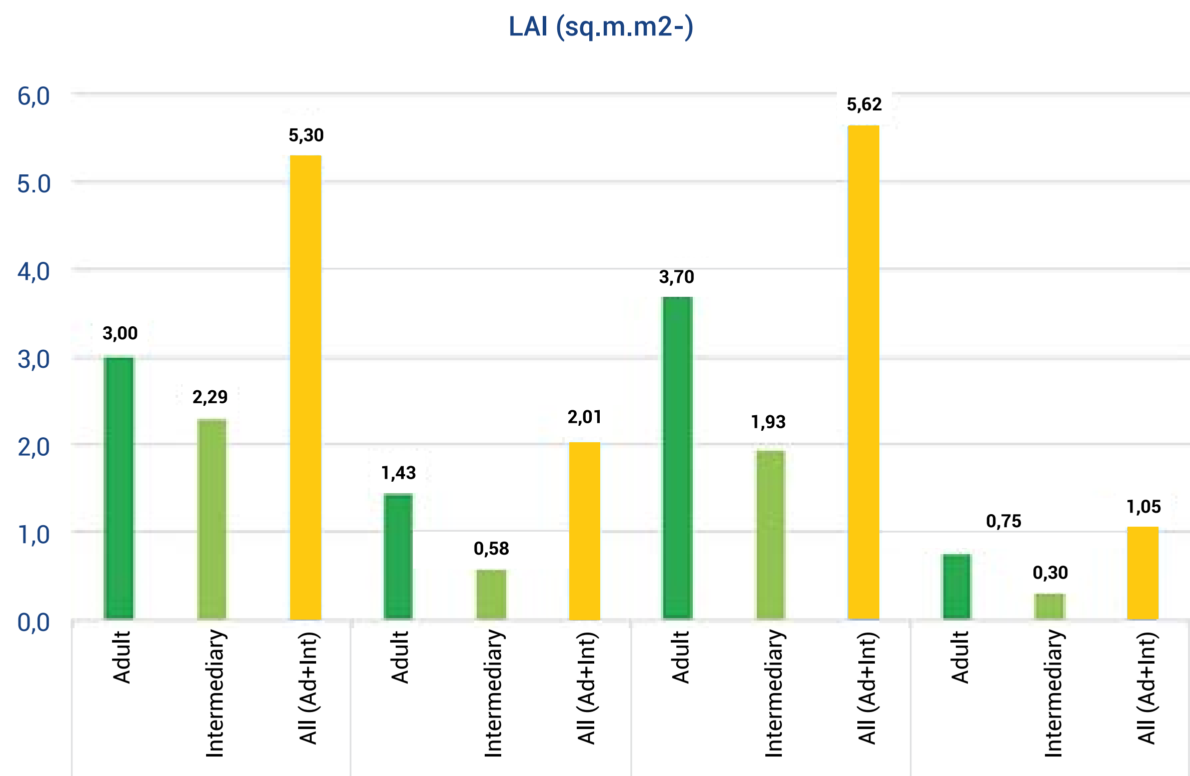


Figure-114

Leaf area index of leaves in the shoot at PoMs in November 2019

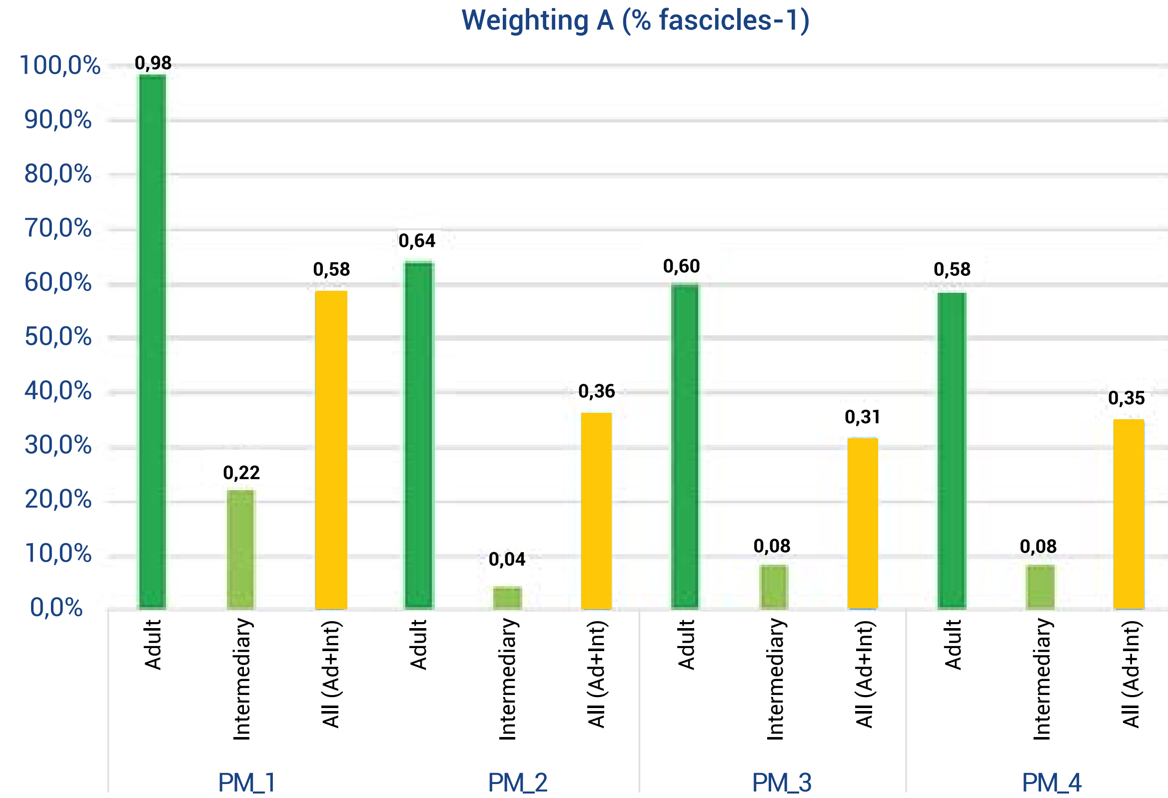


Figure-115

Coefficient A of (broken or grazed) shoot in the fascicle at PoMs in November 2019

Leaf surface area and epiphytic coverage factors are related in photosynthesize ability. The change of the leaf surface area and the coverage of leaf surface area covered by epipytic assemblages will show the surviving behaviours of the meadow. Increased epiphtic loads can cause shading effect on seagrass leaves and accordingly may reduce photosynthetic rate up to %65 (Sand-Jensen 1977; Tomasko and Lapointe 1991; Walker and McComb 1992; Tomasko et al. 1996; Frankovich and Fourqurean 1997; Ralph and Gademann 1999; Touchette 2000). High nutrient and/or organic matter levels cause high epiphytic biomass. Epiphyte biomass thus provides information concerning environmental quality and facilitates assessment of the range of impact of a natural or artificial discharges (outfall), aquaculture facilities, river mouth (Boudouresque *et al.*, 2007). However, due to its seasonal variations, comparisons must be restricted to measurements performed at an identical period of the year (Pergent-Martini et al., 1999). At the present study, the values of leaf surface area and epiphytes density show the relation between lower limit and depth. At the station PM2 and PM4 leaf surface area values are so close but epiphytic coverage is more affecting at PM2 on lower limit depth (Figure-116). The reason for this situation could be the wastewater treatment plant's discharge which is close to the PM2 station. High nutrient loads caused enhanced epiphytic coverages on the leaves (Borum 1985; Silberstein et al. 1986; Neckles et al. 1994; Balata et al. 2008). Because of the epiphytes and nutrient loads of the water column make change for the depth of lower limit though leaf surface area values are very close. Especially at the station PM2, epiphytes may play limiting role thanks to nutrient load for lower limit depth (Figure-117).

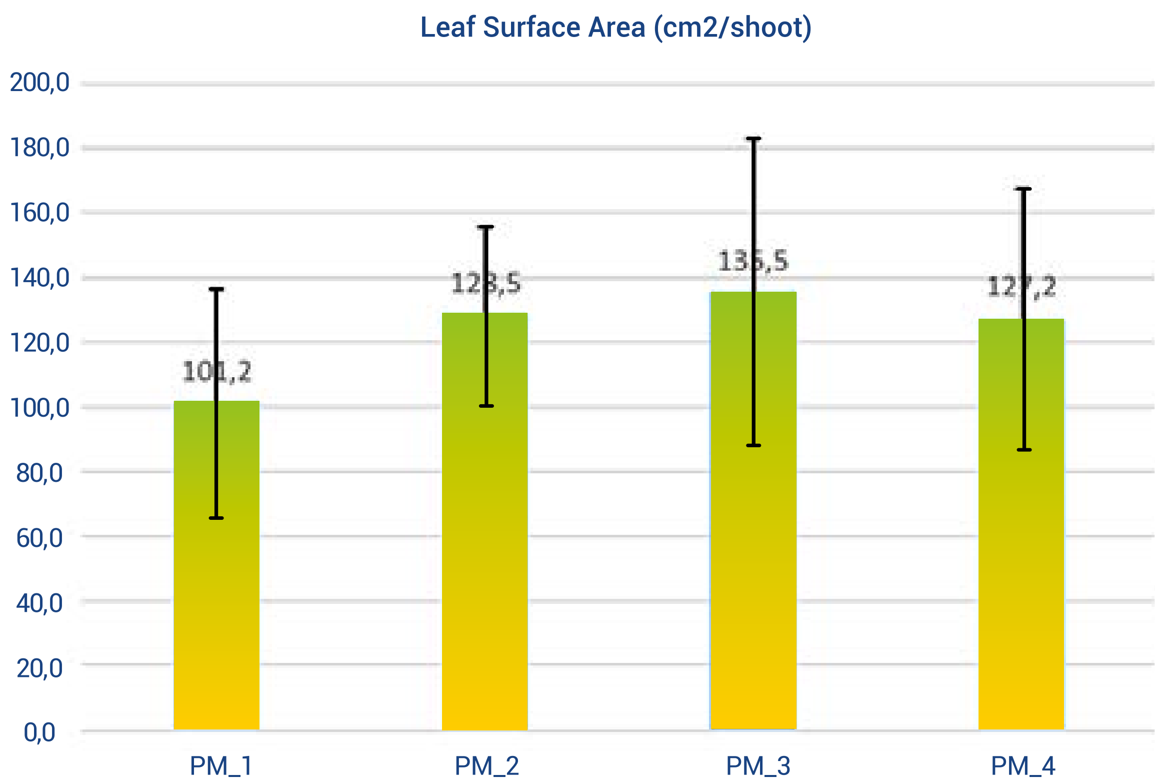


Figure-116

Average leaf surface area of the shoots at PoMs in November 2019

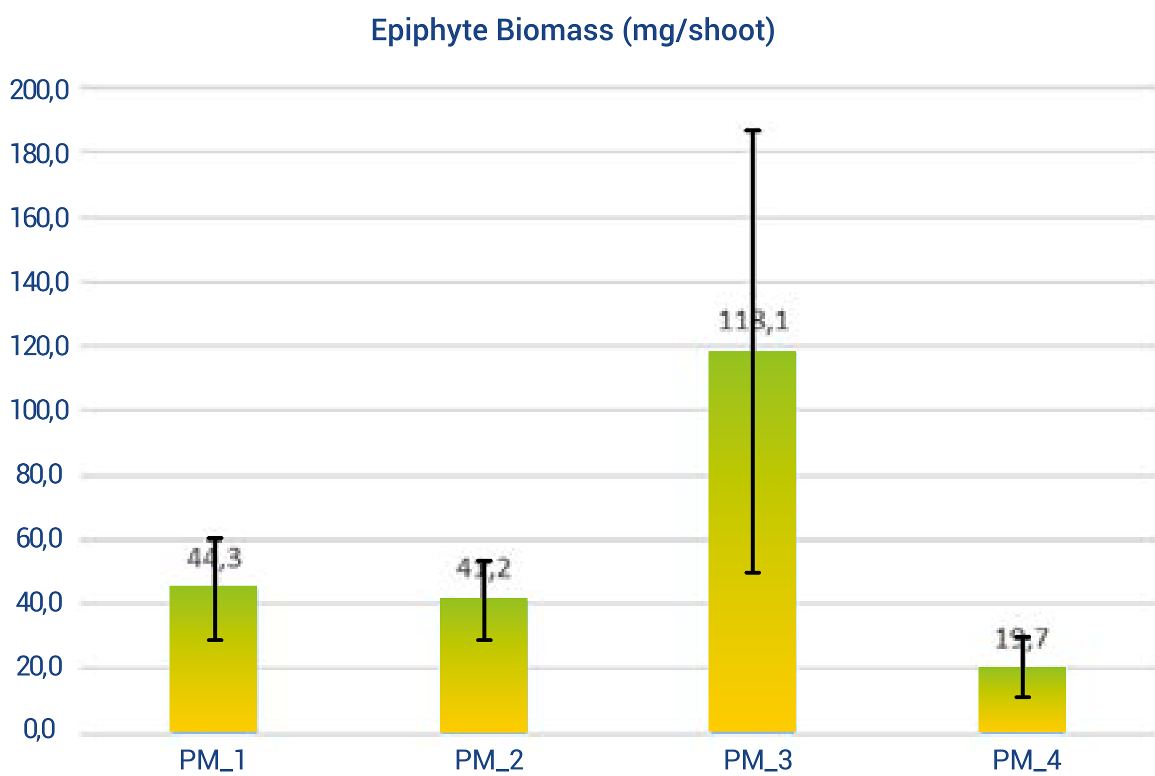


Figure-117

Average epiphytic biomass (dry weight) at PoMs in November 2019

For the lepidochronological analysis, number of scales per cycle and speed of growth of the rhizomes behind the lower limit in the monitoring stations were delivered in Figures 118-121.

In orthotropic rhizomes a number of annual cycles varying from 2.0 to 19.0 with an average of 6.4 ± 1.7 cycles per rhizome, was recorded. The average rhizome production of shoots (dry weight) in one cycle was 43.7±13.6 mg. shoot-1/year-1. The average rhizome length is 6.05±1.8 mm for all stations. The average number of leaves produced by one shoot per year was 8.06±0.49.

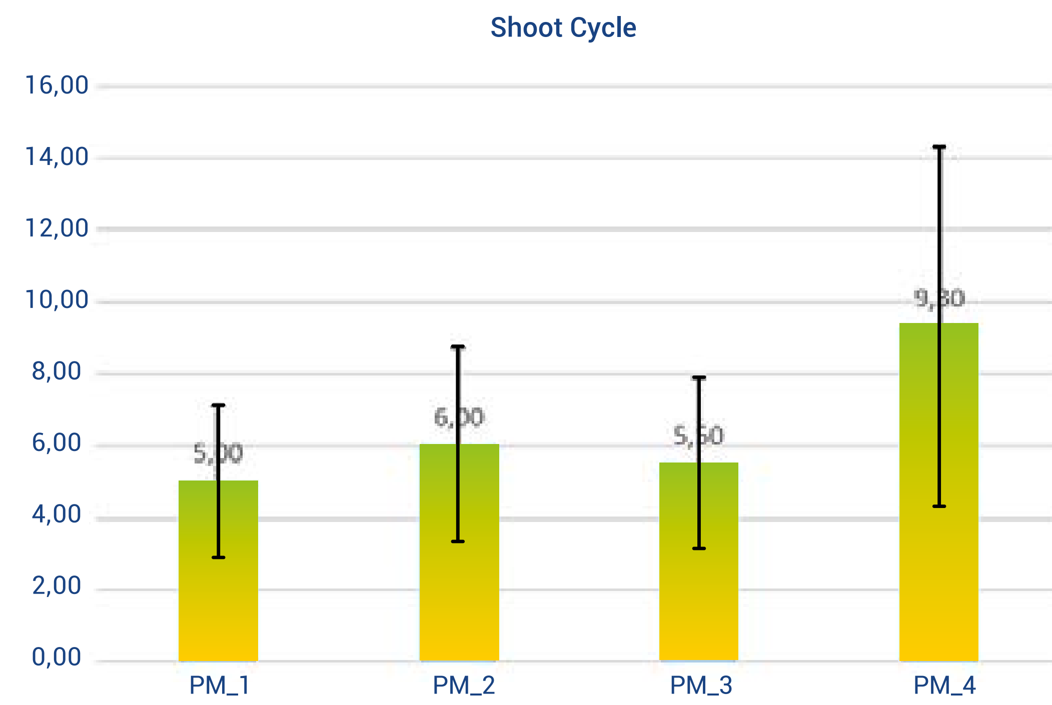


Figure-118

Average annual cycles of PoMs

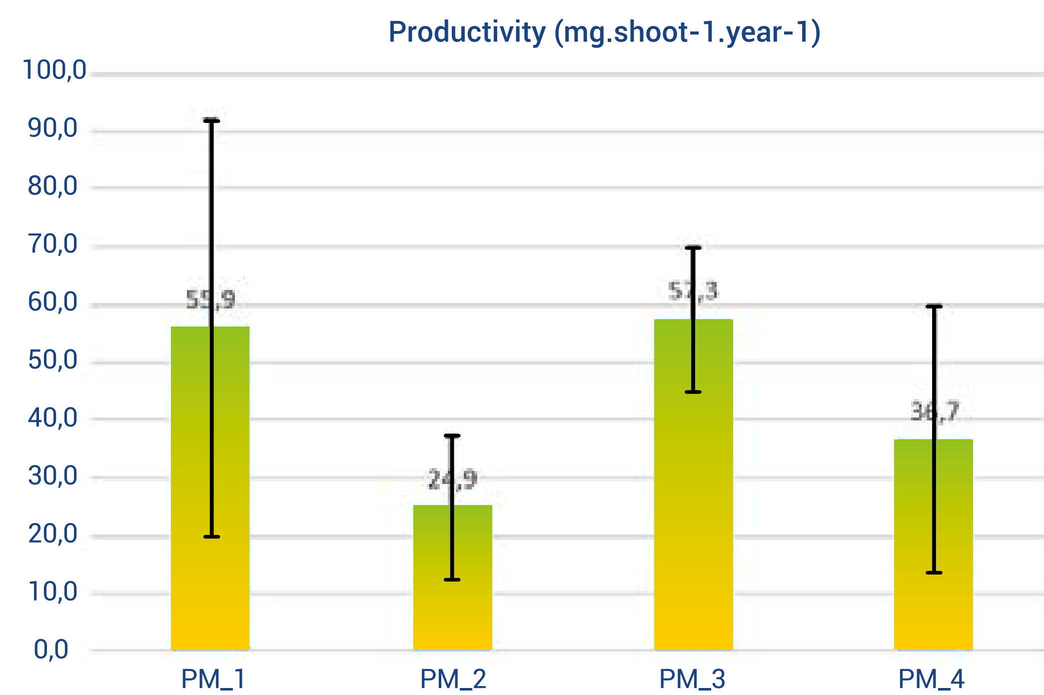


Figure-119

Average rhizome production (dry weight) per cycle of PoMs

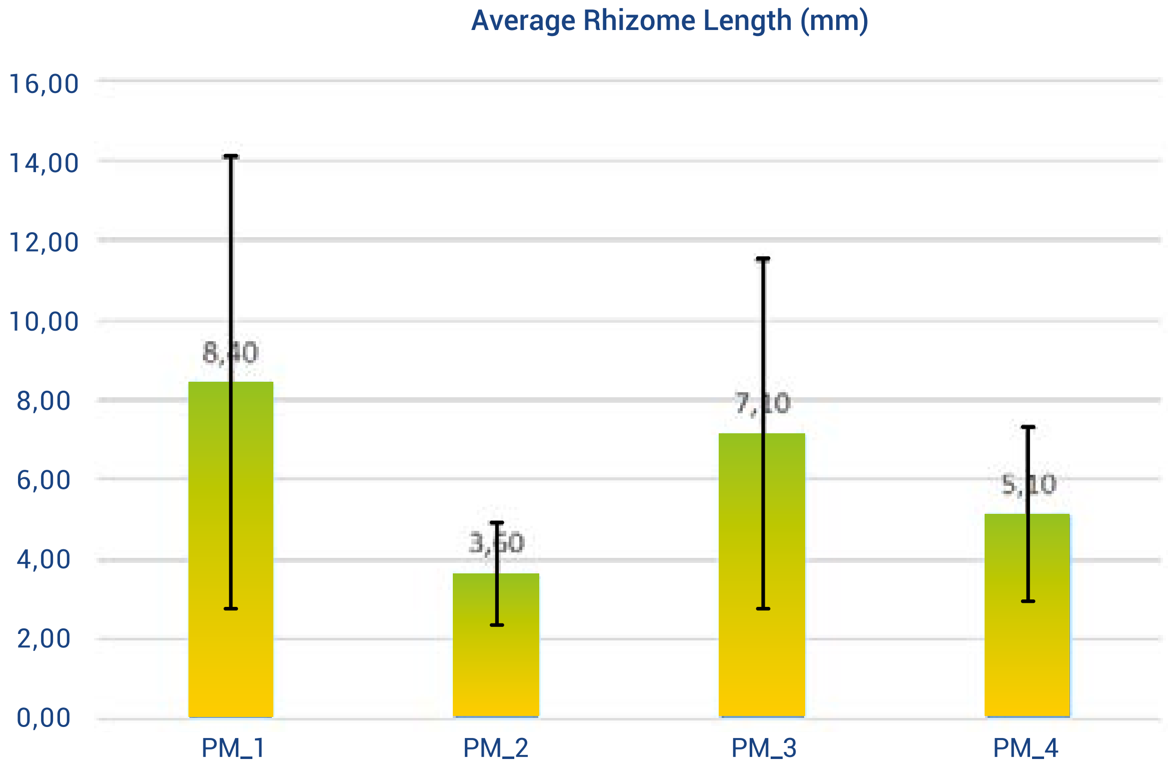


Figure-120

Average rhizome production (in length) per cycle of PoMs

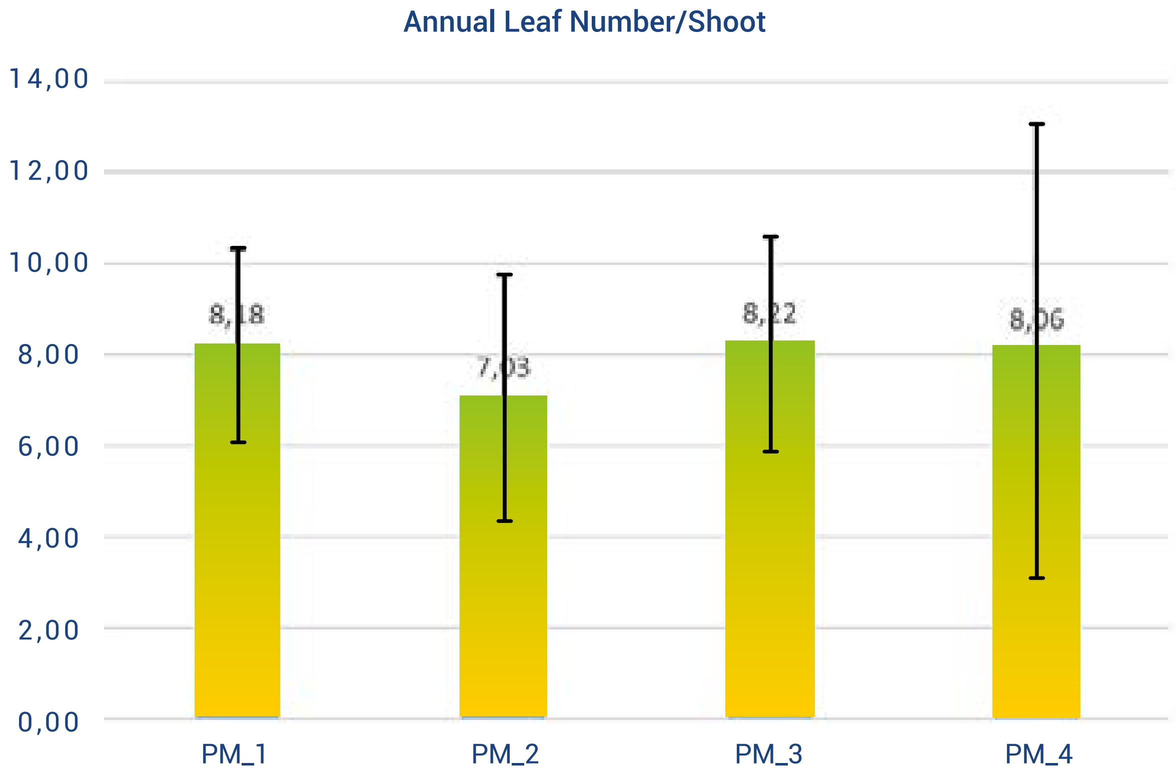


Figure-121

Average leaf production per shoot in PoMs

P. oceanica meadows are very sensitive to water and sediment enrichment with organic matter and nutrients. Meadow decline accelerates when organic matter and phosphorus benthic inputs surpass 1-2 g (dry weight) m-2 day-1 and 0.04 g m-2 day-1 respectively (Diaz-Almela *et al.,* 2008). This occurs through a series of cascade effects. When dissolved nutrients are high, epiphytic algae grow much faster and shadow the seagrass leaves, reducing seagrass light harvest and enhancing leaf grazing (Ruiz *et al.* 2001). Together with trawling, nutrient loading is the greatest cause of deterioration in seagrass beds. The source of organic matter is often the same as those for nutrient loading, but they usually do not spread as far a-field.

Labile organic matter increases sediment microbial activity, producing anoxia and increasing sulphate-reduction rates in the sediment. The excess hydrogen sulphide rapidly reacts with oxygen pumped through the seagrass roots, and may even penetrate the plant tissues, enhancing *P. oceanica* mortality (Frederiksen *et al.* 2007). Sediment hydrogen sulphide concentrations surpassing 10μM increase shoot mortality over 5% yr-1 (Calleja *et al.* 2007) Reduced sediment conditions persist years after the organic inputs have ceased, prolonging meadow regression (Delgado *et al.* 1999). Therefore, untreated sewage outlets, fish-farm effluents or runoff from fertilized agricultural areas are serious threats to neighbouring *P. oceanica* meadows. In bays with low water exchange, even small amounts of nutrient and organic input from houses or boats may induce seagrass decline (Marbà *et al.* 2002).

P. oceanica meadows can cope, through vertical rhizome growth, with sedimentation rates that do not exceed 4-5 cm yr-1 (Gacia and Duarte 2001), and are very sensitive to erosion. Coastline transformation, with the proliferation of roads and houses and the regulation of continental river-flow, sharply reduces sediment inputs to the submersed coastal habitats, thereby promoting meadow erosion in their area of influence. Piers and other coastal constructions destroy the underlying communities and may alter the pattern of coastal currents thus passing on the effects of siltation or erosion to other meadows. Dredging and sand reclamation activities close to meadows have a high risk of direct meadow removal and may produce bed siltation or erosion. Finally, beach re-filling (Medina *et al.* 2001) may change sediment conditions and produce long-term siltation of the adjacent underwater meadow, slowing seagrass recovery (González-Correa *et al.* 2007). On the other hand, removing the seagrass leaf litter from the beach may produce the reverse effect, enhancing shallow meadow erosion. (Diaz & Duarte, 2008). There are various factors like Gediz River, Foça waste water treatment plant, anchoring etc. that can affect the turbidity and nutrient concentrations in Foça SEPA. Besides, this is a region that people use extensively especially in summer season. For such reasons, *P. oceanica* meadows are adversely affected, the lower limit depth of *P. ocenica* at this area is 24-25 meters at northern part. However, this value decreases towards the city center to 15-17 meters.

According to Buia *et al.* (2004) the normal values of the leaf area index (LAI) of shallow meadows between 6.16 and 29 m^2/m^2 and for the deep meadows it is 1.1 and 2.6 m^2/m^2. LAI at PM1 and PM3 (upper limit) stations were 5,30 and 5.60 m^2/m^2 respectively. These results are close to normal values. The reason for the scarcity may be seasonal. The lower limit stations (PM2 and PM4) were in normal conditions.

The bottom cover is the mean percentage of substrate covered by the *P. oceanica* meadow with respect to the whole surface area. In shallow healthy meadows, the *Posidonia* cover can be high (80-100%). In contrast, at the lower limit of healthy meadows and in meadows subject to strong human impact, the cover usually ranges between 5 and 40% (Pergent *et al.*, 1995; Charbonnel *et al.*, 2000). The coverage of two lower limit stations (PM2-PM4) are close to %20. This situation indicates that meadows could be under human effect.

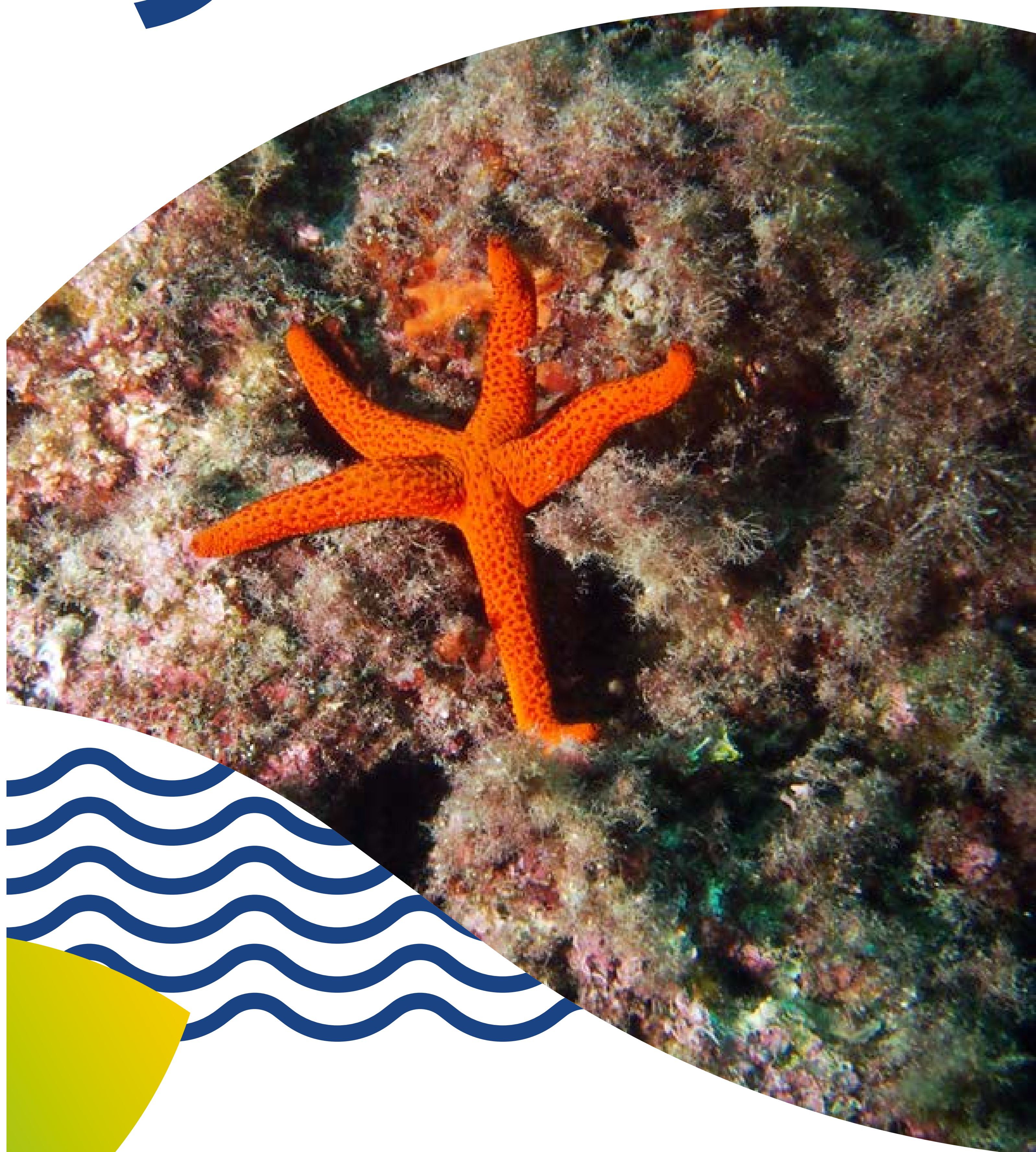
At the limit of the meadow and of *P. oceanica* patches, the occurrence of plagiotropic shoots is evidence of health, since it expresses a tendency to colonize (or re-colonize) neighboring areas (Charbonnel *et al.,* 2000).

Plagiotrophic rhizome percentages of PM2-and PM4 were about %54 and %93 respectively. This could be indicating that the meadows are healthy and try to colonize the area. However, the other parameters reflect that the meadows could be in stress and try to survive.

The state of apex provides information for a given site, the rate of predation by consumers (Velimirov 1984; Zupo, 1985; Verlaque 1987) and the action of the hydrodynamics (Mazzella *et al.,* 1981; Witman *et al.,* 1981). The state of the apex is determined by the coefficient "A" of (Giraud, 1977a), which is the percentage of the leaves having lost their apex. It depends on seasonal wave motion and predation on *P. oceanica* leaves by fish and other organisms. The Coefficient A measurements at lower limit stations (PM2-PM4) were similar and lower than upper limit stations (PM1and PM3). This situation is expected. The Coefficient A at PM1 was the highest percentage, the reasons for that could be, depth, waves and intensive use of pleasure boats.

When the measurement values of PM1 and PM2 stations (lower limit) are examined, they are considered to be under influence. Even if the coverage and plagiotrophic rhizome growth rates are of moderate quality, their density is in poor conditions. This region is negatively affected by the turbidity and nutrients brought by the Gediz river. In addition, the wastewater treatment plant close to the PM2 station has a deep water discharge. Other negative factors affecting the area are dense human settlement and industrial activities in the north of the region. The other two stations (upper limit) PM1 and PM3 are close to moderate conditions but even they are under effect of human impacts like anchoring, dredging etc.

9



9
FISHES OF THE FOÇA SEPA

In the present UVC study, a total of 25 fish species were observed and are listed in **Table-22** The maximum and average common length information is listed in **Table-23**.

Table 22
Familyalara göre gözlenen türler

Apogonidae	**Scaridae**
Apogon imberbis (Linnaeus, 1758)	*Sparisoma cretense* (Linnaeus, 1758)
Gobiidae	**Scorpaenidae**
Gobius bucchichi Steindachner, 1870	*Scorpaena scrofa* (Linnaeus, 1758)
Gobius geniporus Valenciennes, 1837	**Serranidae**
Labridae	*Serranus cabrilla* (Linnaeus, 1758)
Coris julis (Linnaeus, 1758)	*Serranus scriba* (Linnaeus, 1758)
Labrus merula (Linnaeus, 1758)	**Sparidae**
Symphodus cinereus (Bonnaterre, 1788)	*Boops boops* (Linnaeus, 1758)
Symphodus rostratus (Bloch, 1791)	*Diplodus annularis* (Linnaeus, 1758)
Symphodus tinca (Linnaeus, 1758)	*Diplodus sargus* (Linnaeus, 1758)
Symphodus mediterraneus (Linnaeus, 1758)	*Diplodus puntazzo* (Cetti, 1777)
Thalasoma pavo (Linnaeus, 1758)	*Diplodus vulgaris* (Geoffroy St. Hilaire, 1817)
Mullidae	*Oblada melanura* (Linnaeus, 1758)
Mullus surmuletus Linnaeus, 1758	*Sarpa salpa* (Linnaeus, 1758)
Muraenidae	*Spondyliosoma cantharus* (Linnaeus, 1758)
Muraena helena Linnaeus, 1758	
Pomacentridae	
Chromis chromis (Linnaeus, 1758)	

In addition to the species observed using the UVC technique, some other fish species were observed by the other underwater research team participating in the field study in the Foça SEPA. These were:

Belonidae	**Serranidae**
Belone belone (Linnaeus, 1761)	*Epinephelus marginatus* (Lowe, 1834)
Blenniidae	**Sparidae**
Blennius ocellaris Linnaeus, 1758	*Lithognathus mormyrus* (Linnaeus, 1758)
Parablennius rouxi (Cocco, 1833)	*Dentex dentex* (Linnaeus, 1758)
Centracanthidae	*Sparus aurata Linnaeus*, 1758
Spicara maena (Linnaeus, 1758)	**Syngnathidae**
Labridae	*Sygnathus sp.*
Symphodus roissali (Risso, 1810)	**Tetraodontidae**
Labrus bergylta Ascanius, 1767	*Lagocephalus sceleratus* (Gmelin, 1789)
Mugilidae	**Tripterygiidae**
Mugil spp.	Tripterygion melanurus Guichenot, 1850
Sciaenidae	**Xiphiidae**
Sciaena umbra Linnaeus, 1758	*Xiphias gladius* Linnaeus, 1758
Scombridae	
Auxis rochei (Risso, 1810)	

Table 23
Maximum and common size distributions of the species observed in the study from FISHBASE (https://www.fishbase.in)

SPECIES	Max Length (cm)	Common Length (cm)
Apogon imberbis (Linnaeus, 1758)	15	
Gobius bucchichi Steindachner, 1870	10	
Gobius geniporus Valenciennes, 1837	16	
Coris julis (Linnaeus, 1758)	30	20
Labrus merula (Linnaeus, 1758)	45	40
Symphodus cinereus (Bonnaterre, 1788)	16	8
Symphodus rostratus (Bloch, 1791)	14,3	
Symphodus tinca (Linnaeus, 1758)	44	25
Symphodus mediterraneus (Linnaeus, 1758)	18	12
Thalasoma pavo (Linnaeus, 1758)	25	20
Mullus surmuletus Linnaeus, 1758	40	25
Muraena helena Linnaeus, 1758	150	80
Chromis chromis (Linnaeus, 1758)	25	13
Sparisoma cretense (Linnaeus, 1758)	50	30
Scorpaena scrofa (Linnaeus, 1758)	50	30
Serranus cabrilla (Linnaeus, 1758)	40	25
Serranus scriba (Linnaeus, 1758)	36	25
Boops boops (Linnaeus, 1758)	40	20
Diplodus annularis (Linnaeus, 1758)	27,5	13
Diplodus sargus (Linnaeus, 1758)	45	22
Diplodus puntazzo (Cetti, 1777)	60	30
Diplodus vulgaris (Geoffroy St. Hilaire, 1817)	45	22
Oblada melanura (Linnaeus, 1758)	36,6	20
Sarpa salpa (Linnaeus, 1758)	51	30
Spondyliosoma cantharus (Linnaeus, 1758)	60	30

Biomass estimates and other related statistics for the observed species are given in Tables 24-26. Biomass (tonnes/km²) estimates were calculated as being approximately 16 tonnes in the 5-meter depth strata, 12 tonnes in the 10-meter depth strata and 26 tonnes in the 20-meter depth strata.

Damselfish *(Chromis chromis)* were found to have the highest biomass value at 5 m. This was followed by bogue (*Boops boops*) and sharpsnout seabream (*Diplodus puntazzo*) (Figure-122). In the 10-meter depth strata, damselfish made up almost 40% of the biomass value whereas bogue and Mediterranean rainbow wrasse (Coris julis) from the family of wrasses (Labridae) made up 23% and 10% respectively (Figure-123). Damselfish also had the highest biomass in the 20-meter depth strata and was followed by common two-banded seabream (Diplodus vulgaris), sharpsnout seabream, painted comber (Serranus scriba) and Mediterranean rainbow wrasse (Figure-124). Figure-125 presents the estimated total fish biomasses for each UVC station and depth strata.

Table 24
Biomass estimates for the species observed in 5-meter depth strata

UVC 5 m SPECIES	%	Mean kg	Variance	Biomass (kg/km²)	Variance	Standard deviation
Apogon imberbis	0.00	0.00	0.00	0.00	0.00	0.00
Gobius bucchichi	0.00	0.00	0.00	0.00	0.00	0.00
Gobius geniporus	0.00	0.00	0.00	0.00	0.00	0.00
Coris julis	7.98	0.21	0.01	2584.09	515407.18	717.92
Labrus merula	2.23	0.06	0.02	721.42	867405.82	931.35
Symphodus cinereus	0.03	0.00	0.00	8.11	109.74	10.48
Symphodus rostratus	0.03	0.00	0.00	10.66	88.36	9.40
Symphodus tinca	3.92	0.10	0.01	1269.82	400305.55	632.70
Symphodus mediterraneus	0.11	0.00	0.00	35.53	1398.97	37.40
Thalasoma pavo	2.60	0.07	0.01	843.16	330161.79	574.60
Mullus surmuletus	0.61	0.02	0.00	197.64	42649.74	206.52
Muraena helena	0.00	0.00	0.00	0.00	0.00	0.00
Chromis chromis	25.38	0.66	0.90	8219.10	46926278.05	6850.28
Sparisoma cretense	0.00	0.00	0.00	0.00	0.00	0.00
Scorpaena scrofa	0.38	0.01	0.00	121.61	24650.23	157.00
Serranus cabrilla	0.13	0.00	0.00	43.38	3136.34	56.00
Serranus scriba	8.27	0.21	0.07	2678.89	3497709.26	1870.22
Boops boops	14.72	0.38	0.73	4768.04	37890310.62	6155.51
Diplodus annularis	0.52	0.01	0.00	169.82	38017.88	194.98
Diplodus sargus	3.67	0.10	0.02	1187.76	864504.08	929.79
Diplodus puntazzo	14.56	0.38	0.27	4714.95	13931166.06	3732.45
Diplodus vulgaris	6.61	0.17	0.03	2140.56	1423338.79	1193.04
Oblada melanura	0.00	0.00	0.00	0.00	0.00	0.00
Sarpa salpa	5.69	0.15	0.08	1841.98	3985908.69	1996.47
Spondyliosoma cantharus	2.56	0.07	0.02	827.80	1142100.54	1068.69
TOTAL BIOMASS (km²)				**16192.17**		

Table 25
Biomass estimates for the species observed in 10-meter depth strata

UVC 10 m SPECIES	%	Mean kg	Variance	Biomass (kg/km²)	Variance	Standard deviation
Apogon imberbis	0.21	0.00	0.00	51.49	4418.27	66.47
Gobius bucchichi	0.01	0.00	0.00	3.11	16.16	4.02
Gobius geniporus	0.23	0.00	0.00	56.21	5266.82	72.57
Coris julis	11.46	0.23	0.04	2848.41	2071973.03	1439.43
Labrus merula	0.00	0.00	0.00	0.00	0.00	0.00
Symphodus cinereus	0.00	0.00	0.00	0.00	0.00	0.00
Symphodus rostratus	0.00	0.00	0.00	0.00	0.00	0.00
Symphodus tinca	0.80	0.02	0.00	199.49	36762.43	191.74
Symphodus mediterraneus	0.00	0.00	0.00	0.00	0.00	0.00

UVC 10 m SPECIES	%	Mean kg	Variance	Biomass (kg/km²)	Variance	Standard deviation
Thalasoma pavo	0.62	0.01	0.00	153.11	15628.25	125.01
Mullus surmuletus	0.04	0.00	0.00	10.86	196.59	14.02
Muraena helena	0.00	0.00	0.00	0.00	0.00	0.00
Chromis chromis	38.54	0.77	1.55	9582.25	80716471.92	8984.23
Sparisoma cretense	10.22	0.20	0.21	2540.37	10755758.48	3279.60
Scorpaena scrofa	0.49	0.01	0.00	121.61	24650.23	157.01
Serranus cabrilla	0.17	0.00	0.00	43.38	3136.34	56.00
Serranus scriba	2.42	0.05	0.01	601.75	279636.70	528.81
Boops boops	23.76	0.47	0.91	5906.825	47304209.62	6877.81
Diplodus annularis	2.80	0.06	0.00	697.12	236416.63	486.23
Diplodus sargus	0.00	0.00	0.00	0.00	0.00	0.00
Diplodus puntazzo	0.00	0.00	0.00	0.00	0.00	0.00
Diplodus vulgaris	7.57	0.15	0.04	1882. 80	2090758.27	1445.95
Oblada melanura	0.00	0.00	0.00	0.00	0.00	0.00
Sarpa salpa	0.00	0.00	0.00	0.00	0.00	0.00
Spondyliosoma cantharus	0.66	0.01	0.00	164.37	36692.12	191.56
TOTAL BIOMASS (km²)				**12431.58**		

Table 26

Biomass estimates for the species observed in 20-meter depth strata.

UVC 20 m SPECIES	%	Mean kg	Variance	Biomass (kg/km²)	Variance	Standard deviation
Apogon imberbis	0.00	0.00	0.00	0.00	0.00	0.00
Gobius bucchichi	0.00	0.00	0.00	0.00	0.00	0.00
Gobius geniporus	0.00	0.00	0.00	0.00	0.00	0.00
Coris julis	14.44	0.60	0.33	7558.55	17003831.23	4123.57
Labrus merula	0.00	0.00	0.00	0.00	0.00	0.00
Symphodus cinereus	0.00	0.00	0.00	0.00	0.00	0.00
Symphodus rostratus	0.00	0.00	0.00	0.00	0.00	0.00
Symphodus tinca	0.41	0.02	0.00	213.57	62447.79	249.90
Symphodus mediterraneus	0.13	0.01	0.00	68.47	7812.76	88.39
Thalasoma pavo	0.23	0.01	0.00	121.19	10810.20	103.97
Mullus surmuletus	1.05	0.04	0.00	550.31	202010.53	449.46
Muraena helena	1.60	0.07	0.02	839.14	1173600.87	1083.33
Chromis chromis	22.91	0.96	3.43	11998.39	1.79E+08	13371.73
Sparisoma cretense	0.00	0.00	0.00	0.00	0.00	0.00
Scorpaena scrofa	0.23	0.01	0.00	121.61	24650.23	157.00
Serranus cabrilla	0.08	0.00	0.00	43.38	3136.34	56.00
Serranus scriba	17.66	0.74	1.76	9246.36	91711160.33	9576.59
Boops boops	0.00	0.00	0.00	0.00	0.00	0.00
Diplodus annularis	0.31	0.01	0.00	163.06	38416.95	196.00
Diplodus sargus	1.09	0.05	0.00	568.82	251658.68	501.66

UVC 20 m SPECIES	%	Mean kg	Variance	Biomass (kg/km²)	Variance	Standard deviation
Diplodus puntazzo	18.35	0.77	2.95	9607.71	1.54E+08	12403.50
Diplodus vulgaris	21.16	0.89	1.35	11078.78	70440285.95	8392.87
Oblada melanura	0.00	0.00	0.00	0.00	0.00	0.00
Sarpa salpa	0.00	0.00	0.00	0.00	0.00	0.00
Spondyliosoma cantharus	0.35	0.01	0.00	181.86	55124.19	234.79
TOTAL BIOMASS (km²)				**26180.60**		

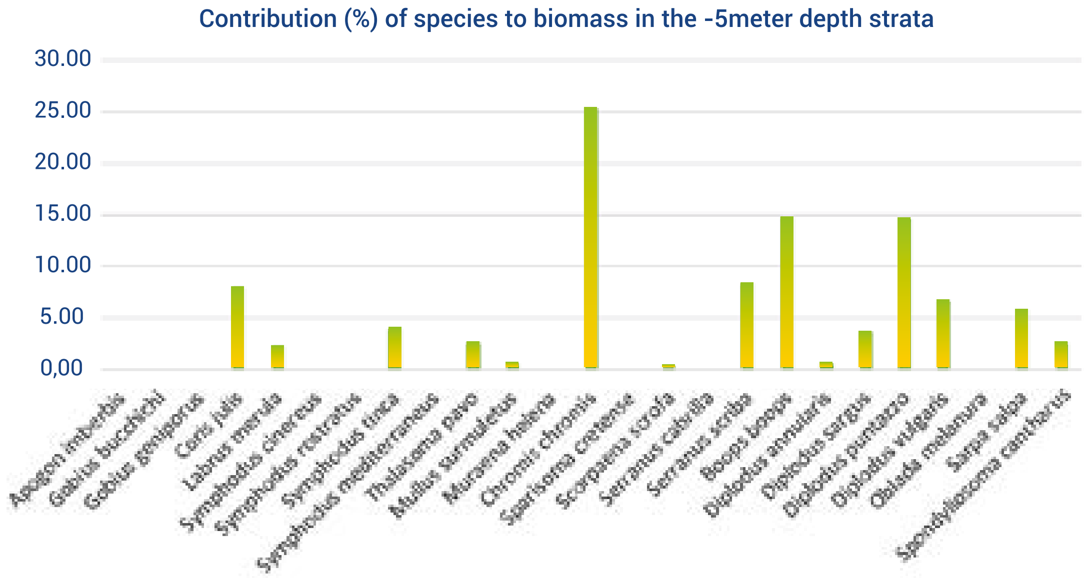


Figure-122

Percentage contribution of the observed species to biomass in the 5-meter depth strata

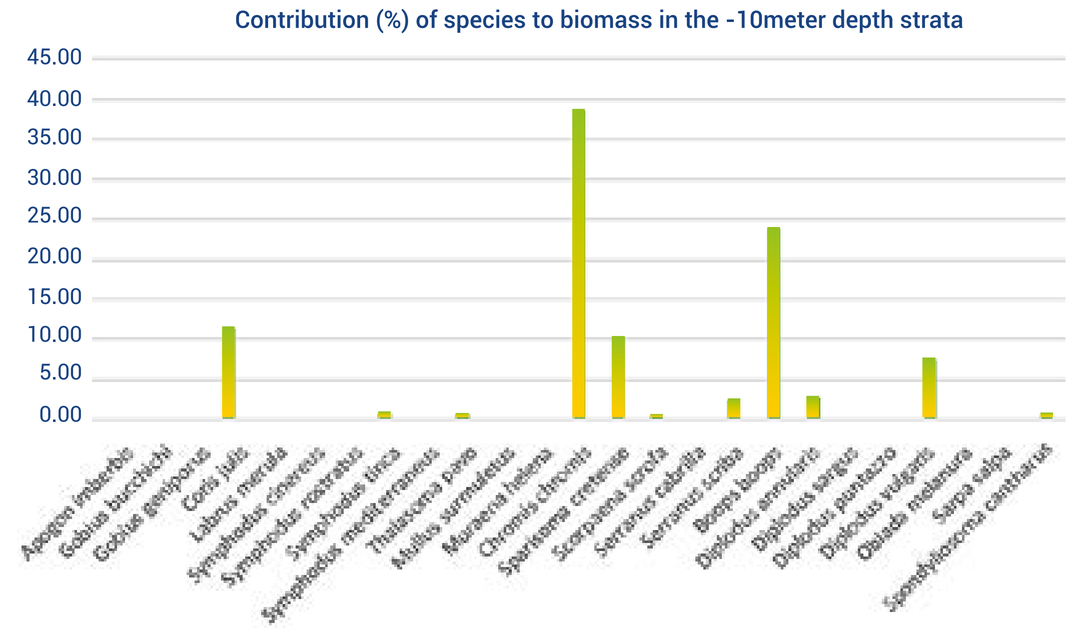


Figure-123

Percentage contribution of the observed species to biomass in the 10-meter depth strata

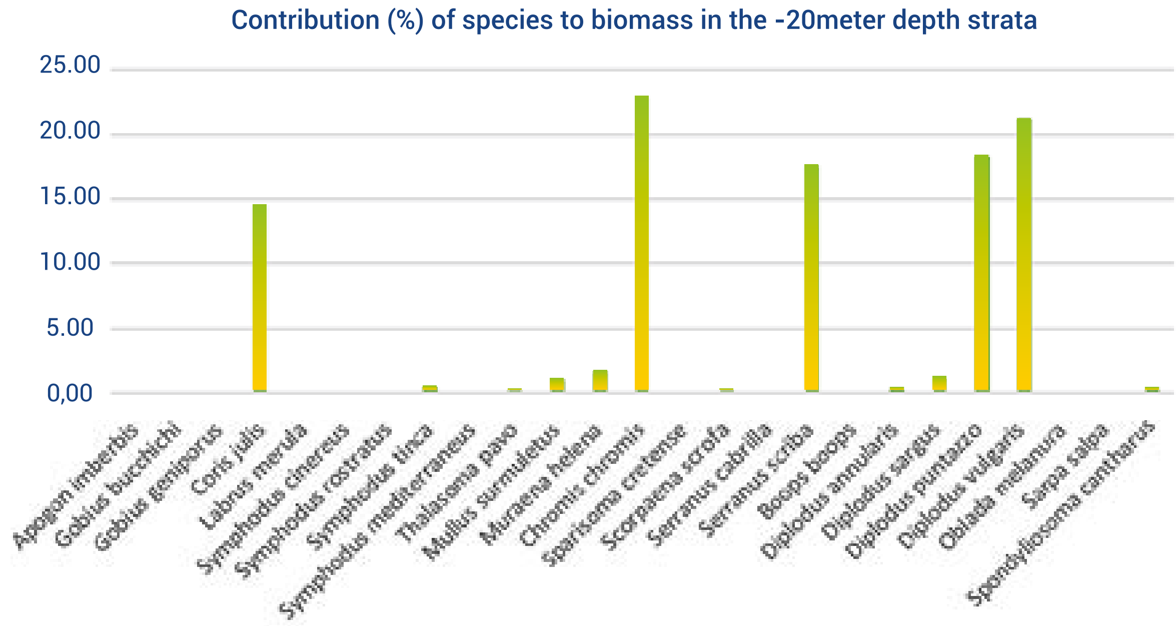


Figure-124

Percentage contribution of the observed species to biomass in the 20-meter depth strata

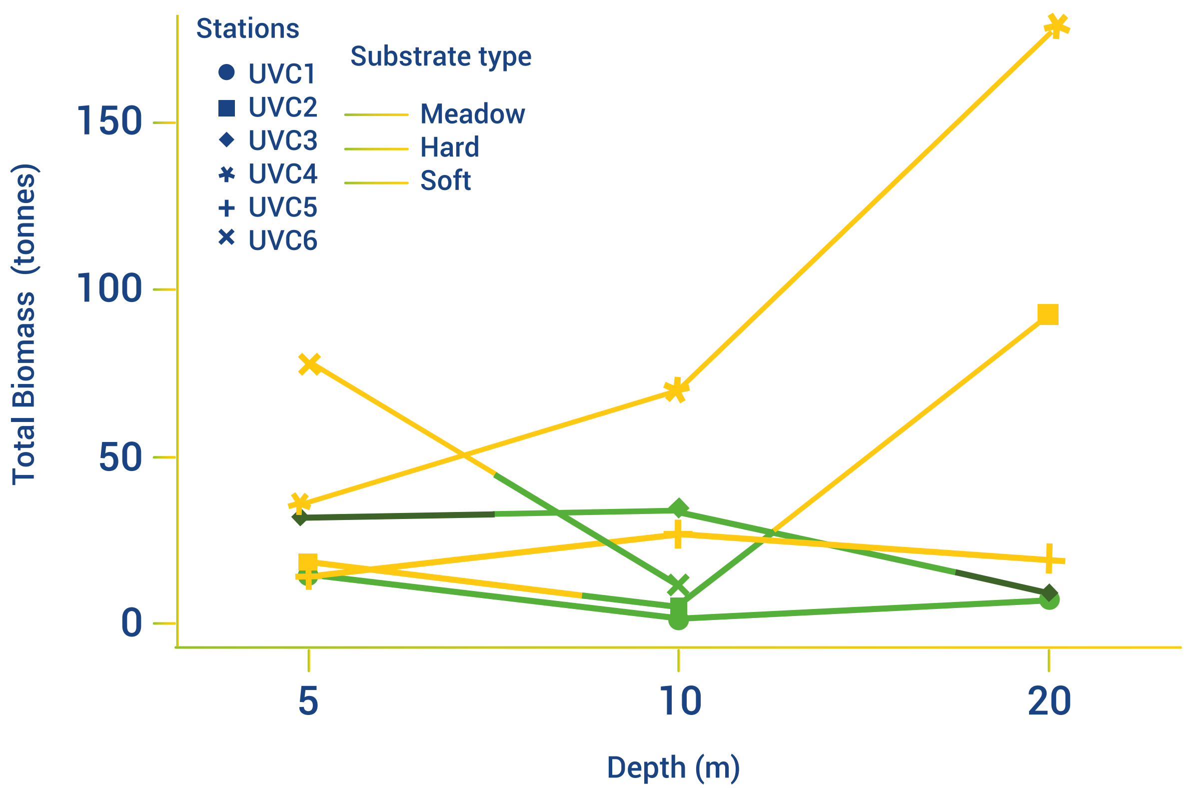


Figure-125

Estimated total fish biomasses for each underwater visual sensus (UVC) station and depth strata

9.1. Species Richness and Species Diversity

Table-27 presents fish species richness and fish species diversity observed at various stations during underwater visual census (UVC) in the Foça SEPA. Species richness (species density) is defined here as the total number of fish species per unit area (Krebs, 1998; Bakus, 2007). Species diversity differs from species richness in that both the number of species and the numbers of individuals of each species of fish are considered simultaneously (Krebs, 1998; Bakus, 2007). Two different non-parametric indices, Shannon Index (*H'*) and Simpson's Index (*S*), were used to measure fish species diversity. While Shannon Index is frequently used by aquatic ecologists, Simpson's Index is often preffered by terrestial ecologists (Bakus, 2007). By applying exponential transformation (Exponential *H'*), Shannon index may also be expressed in units of numbers of species as recommended by Hill (1973) and Krebs (1998). This index is also reffered to as Hill's Number 1 (N1). Reciprocal of Simpson's index or Simpson's Reciprocal Index also called Hill's Number 2 (N2) also measures species diversity measures in units of species numbers. In recent years, Hill's Numbers have become the preferred form of species diversity measures because they are in units of species numbers (Hill, 1973; Krebs, 1998; Jost et al., 2011). The UVC stations in the Foça SEPA are ordered according to the species diversity measure of Hill's Number 1 or Exponential *H'*. So the 5 m strata of UVC station 4 had the highest species richness and species diversity.

Table 27
Fish species richness and species diversity observed at various stations during underwater visual census in the Foça SEPA

Stations	Species richness	Shannon Index (H')	Simpson's Index (S)	Exponential H'	Reciprocal S
UVC4_5M	13	3.130	0.855	8.756	6.914
UVC5_20M	10	2.166	0.663	4.487	2.970
UVC2_5M	8	2.092	0.664	4.264	2.977
UVC5_5M	8	2.059	0.688	4.166	3.207
UVC2_20M	8	2.033	0.704	4.093	3.378
UVC5_10M	8	1.980	0.674	3.946	3.067
UVC6_10M	6	1.923	0.682	3.793	3.146
UVC6_5M	12	1.862	0.521	3.635	2.087
UVC4_20M	10	1.686	0.562	3.219	2.283
UVC1_10M	3	1.542	0.648	2.912	2.842
UVC1_5M	3	1.532	0.641	2.891	2.789
UVC3_5M	7	1.327	0.487	2.509	1.948
UVC4_10M	11	0.815	0.205	1.760	1.258
UVC3_10M	5	0.606	0.181	1.522	1.221
UVC1_20M	2	0.310	0.105	1.239	1.117
UVC2_10M	2	0.176	0.051	1.129	1.054
UVC3_20M	1	0.000	0.000	1.000	1.000
UVC6_20M	0	-	-	-	-

Table-28 presents the pairwise similarities among the underwater visual census (UVC) stations studied in the Foça SEPA, in terms of the percentage adjusted Jaccard Index of similarity coefficients (Chao et al., 2006; Jost et al., 2011) based on the species composition and numbers observed in each station. The 20 m strata of station 6 and again 20 m strata of station 3 are excluded from calculations because either no fish or only one species was observed at those strata. Since there were too many stations to evaluate simultaneously, a hierarchical cluster analysis was also carried out by applying group average linkage method (Bakus, 2007; Greenacre & Primicerio, 2013). The input data used for the cluster analysis were the adjusted Jaccard Index of dissimilarity coefficients (i.e. 1-Jaccard Index of similarity coefficients). **Figure-126** shows the resulting dendrogram from the cluster analysis, which visualizes the distances (dissimilarities) between the stations in a simpler way. The similar stations according to observed species composition and numbers are grouped in same clusters. As similarity between stations decreases, or in other words, dissimilarity increases the distance between them also increases.

Table 28

Pairwise percentage similarities among the underwater visual census (UVC) stations in the Foça SEPA. The adjusted Jaccard Index of similarity coefficients (Chao et al., 2006; Jost et al., 2011) are calculated from the species composition and numbers observed in each station

Stations	UVC1 5m	UVC1 10m	UVC1 20m	UVC 25m	UVC2 10m	UVC2 20m	UVC 35m	UVC3 10m	UVC4 5m	UVC4 1m	UVC4 20m	UVC5 5m	UVC5 10m	UVC5 20m	UVC6 5m
UVC1 10m	40.3														
UVC1 20m	65.5	71.6													
UVC2 5m	62.5	42.5	61.3												
UVC2 10m	30.2	38.5	92.1	51.4											
UVC2 20m	37.7	38.1	39.4	61.0	39.9										
UVC3 5m	23.5	28.7	27.0	24.6	25.8	28.7									
UVC3 10m	5.4	7.8	6.2	5.9	6.2	8.7	97.8								
UVC4 5m	50.0	21.1	28.6	88.9	15.3	61.5	25.0	6.2							
UVC4 10m	70.8	4.5	1.8	91.5	1.8	96.2	6.0	5.2	65.2						
UVC4 20m	76.4	12.8	14.5	82.3	12.8	91.2	18.0	7.7	89.3	90.5					
UVC5 5m	78.4	27.5	35.2	57.0	29.2	65.5	22.5	6.6	99.0	82.6	92.6				
UVC5 10m	73.1	22.3	25.0	77.3	22.9	89.0	21.3	6.6	99.4	92.8	98.6	96.1			
UVC5 20m	73.3	21.7	20.8	88.1	18.2	92.3	22.8	8.4	98.7	99.9	88.2	91.6	99.1		
UVC6 5m	53.1	3.0	1.4	43.5	0	50.6	3.5	3.1	74.3	80.7	83.6	66.0	66.0	68.9	
UVC6 10m	50.0	19.9	14.4	43.1	14.4	55.3	53.2	55.0	53.0	66.4	60.5	60.1	60.3	69.8	48.5

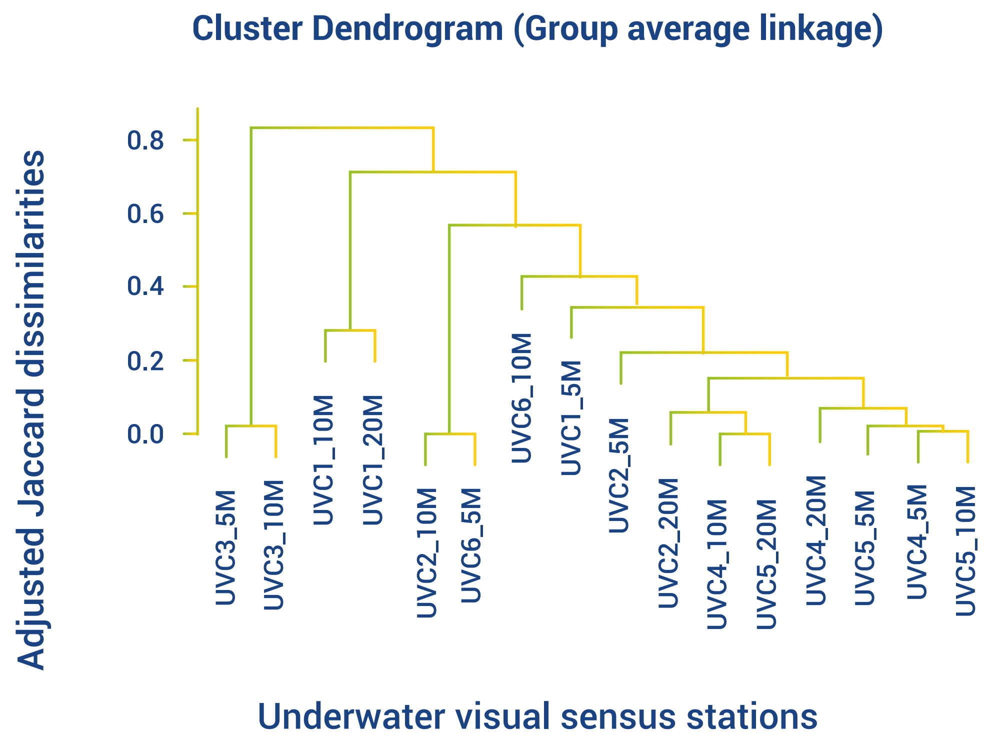


Figure-126

Dendrogram from the cluster analysis based on the adjusted Jaccard Index of dissimilarity coefficients calculated from the species composition and numbers observed in each station

9.2. Total Fish Biomass and Its Distribution

The total fish biomass between 0-50 m depth interval was estimated by using station fish biomass data and seabottom type distributions. This estimation depends on the assumption that the biomass of a unique seabottom type in each depth zone is the value of represented or closest station values. In order to assign biomass values to defined seabottom types, first the UVC observations in 5 m, 10 m and 20 m depths are assigned to 0-7.5 m, 7.5-12.5 m and 12.5-50 m depth zones, respectively. In order to apply this approach, the study area was divided into 3 depth zones (0-7.5 m, 7.5-12.5 m and 12.5-50 m), and then the distributions of all seabottom types within these depth zones were calculated in GIS (Figure-127). The calculated biomass for each depth zone and seabed type is given in Table-29.

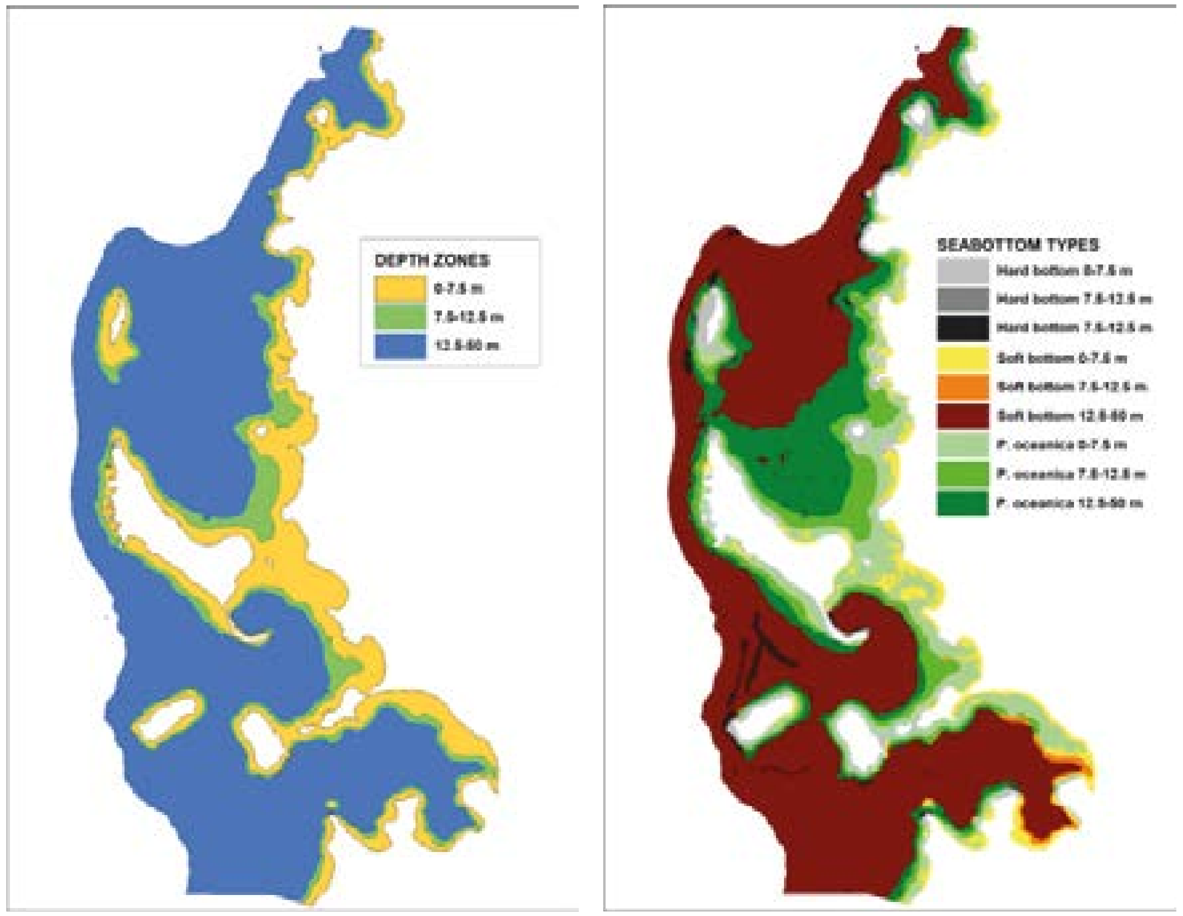


Figure-127
Depth zones (left) and seabottom type distribution in each depth zone (right)

Table 29
The calculated biomass for each depth zone and seabed type

Sea bottom type	Depth zone (m)	Average Biomass (kg/km^2)	Area (km^2)	Total Biomass (kg)
Hard Bottom	0 - 7.5	36824.0	0.875354	33895.75
Hard Bottom	7.5 - 12.5	48439.2	0.091939	4050.85
Hard Bottom	12.5 - 50	99091.7	0.265059	18494.60
Hard bottom total			**1.232352**	**56441.20**
Soft Bottom	0 - 7.5	32258.7	0.945035	30485.61
Soft Bottom	7.5 - 12.5	32258.7	0.198986	6419.04
Soft Bottom	12.5 - 50	32258.7	9.700838	312936.61
Soft bottom total			**10.844858**	**349841.25**
Posidonia oceanica meadow	0 - 7.5	23505.0	1.814394	27976.37
Posidonia oceanica meadow	7.5 - 12.5	13075.1	1.312915	9802.43
Posidonia oceanica meadow	12.5 - 50	8446.1	2.562977	19616.35
***P. oceanica* total**			**5.690286**	**57395.16**
Study area total			**17.767497**	**463677.60**

The calculation gave a total biomass of 463,677.6 kg in 17.77 km^2 of study area. The distribution of biomass in kg/km^2 in the study area is given in Figure-128.

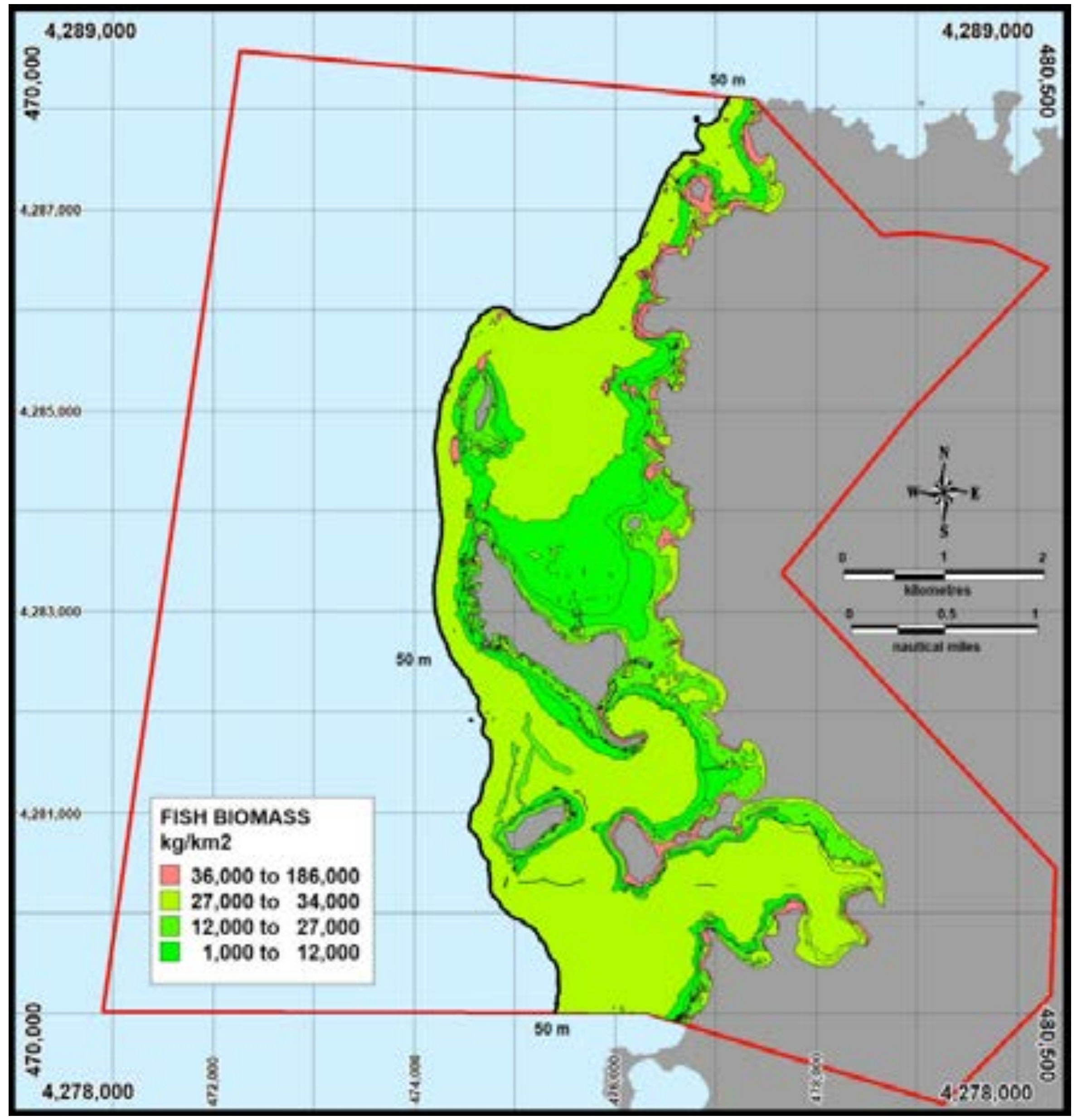
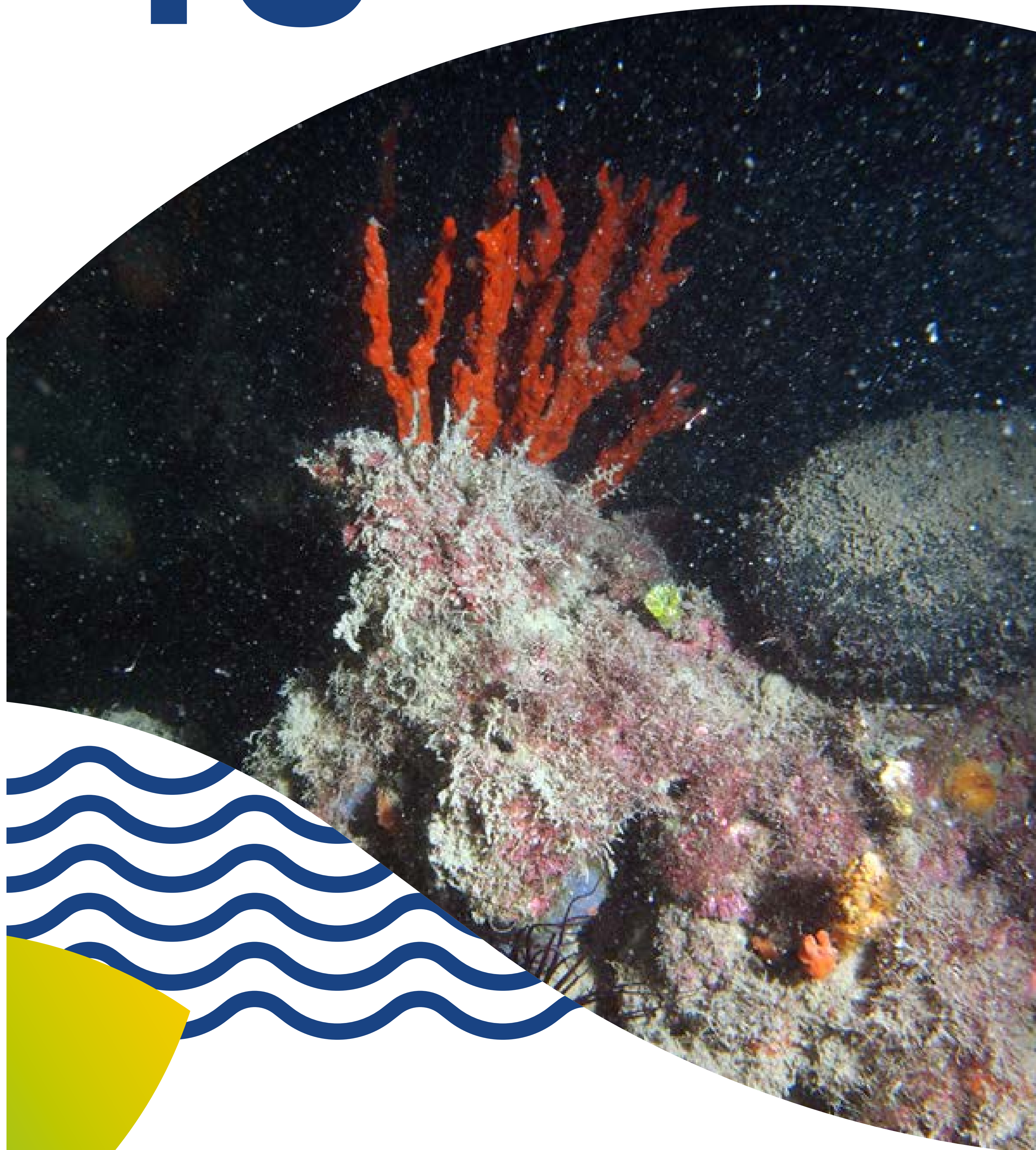


Figure-128
Fish biomass distribution

10



10

COMMERCIAL AND UNAUTHORISED FISHING IN THE FOÇA SEPA

10.1. Commercial (Rules-Based) Fishing Activities in the Foça SEPA

10.1.1. Basic Social and Economic Status of Small Scale Fishers in the Foça SEPA

Demography of fishers

The fishers who answered the questions in the questionnaire during the interviews were between 29 and 71 years old. The median age was 49 years. The age distribution of the fishers in Foça (Ages were pooled into 5-year classes) is presented in Figure-129. The fishers in the Foça SEPA were mostly middle aged and all men. The majority of fishers (67%) were in the 40-60 year range, only 3 fishers (12.5%) were younger than 40.

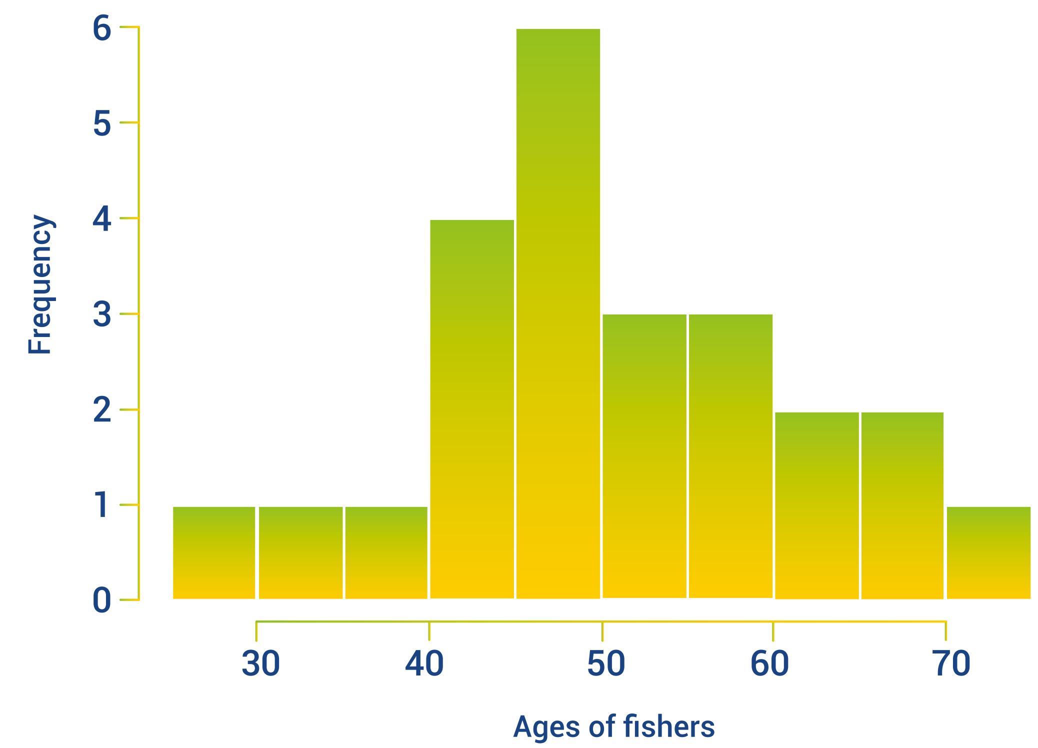


Figure-129

Age distribution of fishers in the Foça SEPA (Ages pooled into 5-year classes)

Education

Four of the fishers, i.e. approximately 17%, had completed middle school, the remaining ones (≈83%) boasted only primary school education (Figure-130a).

Housing

More than two-thirds of the fishers owned or rented their own homes. The remaining portion lived together with their families, i.e. in residences owned or rented by parents or other close relatives (Figure-130b).

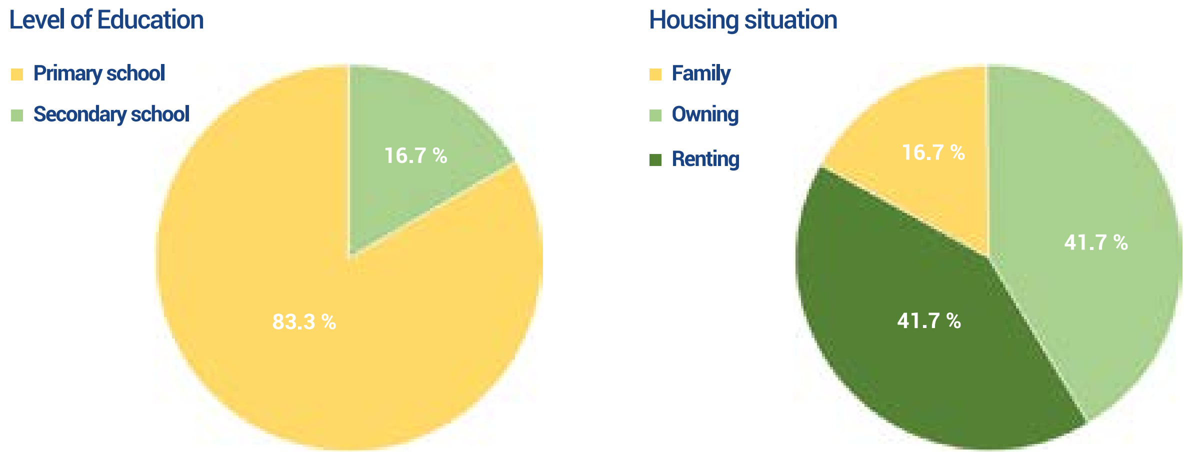


Figure-130
(a) Level of education and (b) housing conditions of the fishers in Foça Social security and additional income

Social security and additional income

Only 54% of the fishers had social security (Figure-131a). 25% of them were already retired and were receiving retirement benefits in addition to their income from fishing. 67% of the fishers declared that the income from fishing was not sufficient (Figure-131b) to make ends meet and that they had additional income from other employment in private (Agriculture, carpentry, tourism, diving, electrician, repairs) or in public (Municipality and military) sectors.

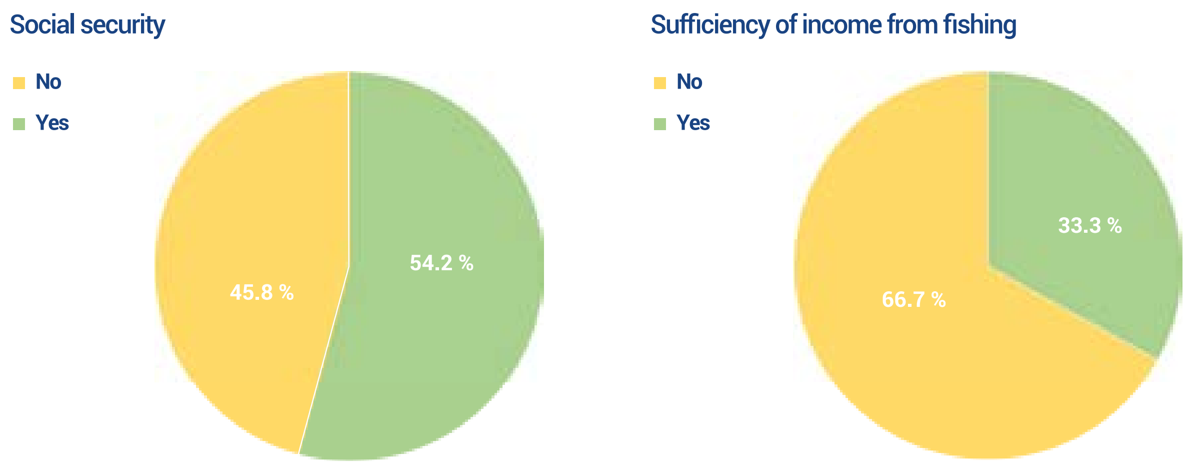


Figure-131
(a) Social security status and (b) sufficiency of income from fishing only

Fishing experience

All the fishers interviewed had been fishing for more than 10 years (Figure-132a) and 79% of them had fishing experience exceeding 20 years. Notably, 70% of them had been fishing in Foça for over two decades (Figure-132b). There were no newcomers at all into this fishery. The least experienced of the lot, a group that comprised only 7%, still had 6-10 years on the job.

A large majority of the fishers (88%) were members of the Foça Fisheries Cooperative. The remaining 12% had no affiliation with any cooperative.

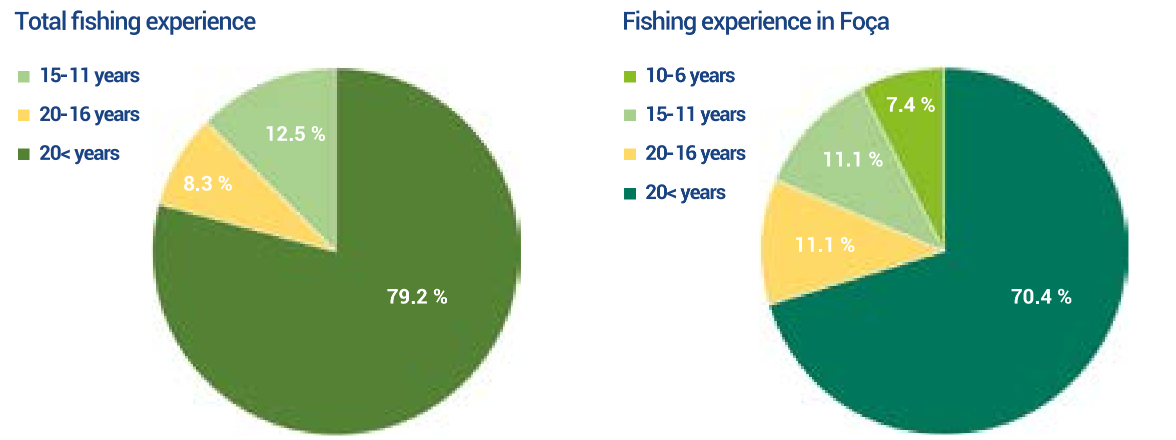


Figure-132
Fishing experience in total (a) and in the Foça SEPA (b) in years

Fishing boats

Over 90% of the interviewed fishers owned their own boats. The newest boat was little bit older than a year and the oldest boat was 50 years. The median age of the boats was 23. The age distribution of boats is presented in Figure-133a. Size distribution of fishing boats ranged between 5.6 and 8.8 m (Figure-133b). 43% of the boats was in the size category of 6.5-7 m. The minimum engine power was 6 hp and was associated with the smallest fishing boat (5.6 m) registered during the interview. The maximum engine power was 185 hp and belonged to the newest of the boats which was 8 m long. The majority of boats (≈44%) had engines with 9 hp and the median engine power was 20 hp.

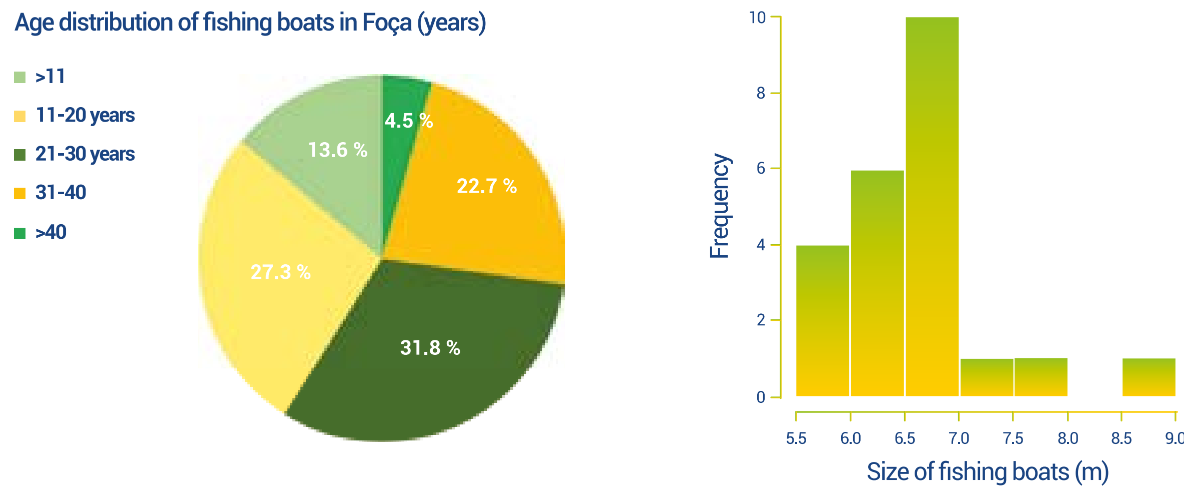


Figure-133
(a) Age and (b) size (total length) distribution of fishing boats in Foça

10.1.2. Fishing Gears and Practices for Rules-Based Commercial Fishing in the Foça SEPA

According to the fisheries questionnaire survey, the rules-based fishing gears used in the Foça SEPA can be broadly classified into four major categories: lines, longlines, gillnets and shore operated stationary lift nets. These main categories are presented in Table-30 with their specific ISSCFG (International Standard Statistical Classification of Fishing Gear) codes (Nédélec, & Prado, 1990; FAO, 2019). The lines category included handlines, pole-lines and troll lines using various sizes and shapes of hooks with or without baits targeting diverse fish and cephalopod species. Longlines used in Foça were set longlines. Similarly, the gillnets used in Foça were mostly stationary (set) gillnets and this category included mainly simple gillnets, but also trammel nets and combined gillnets-trammel nets. Encircling gillnets were also used by some fishers. The final category of gear comprised a special fishing gear and practice: the stationary lift nets. This gear had only been used in a specific grid "G9" in the Foça SEPA. 43% of the fishers in the area only employed gear from one category throughout the year whereas the remaining 57% used gear from at least two different gear categories in their fishing practices. Figure-134a presents the percentage composition of the main gear categories used in Foça. The gillnets were reported as being the most used gear category in Foça, almost 70% of the fishers chose various set gillnets for their fishing. This category was followed by lines (61%), longlines (22%) and shore operated stationary lift nets (%9) (Figure-134b). The spatial distribution of commercially used fishing gears in the Foça SEPA for each 1 km² grid is presented in Figure-135.

Table 30

Fishing gears used in the study area and their ISSCFG codes (Nédélec, & Prado, 1990; FAO, 2019)

	Gear	FAO name	ISSCFG code
Legally used gears	Line	Handlines and hand-operated pole-and-lines	09.1
	Longline	Set longlines	09.31
	Gillnet	Gillnets and Entangling Nets	07
	Shore operated stationary lift net	Shore-operated Stationary Lift Nets	05.3
Illegally used gears	Illegal trawling	Trawls	03
	Illegal beam trawling	Beam trawls	03.11
	Illegal spear fishing	Spears	
	Illegal sea cucumber collection (by diving)	Diving	10.8

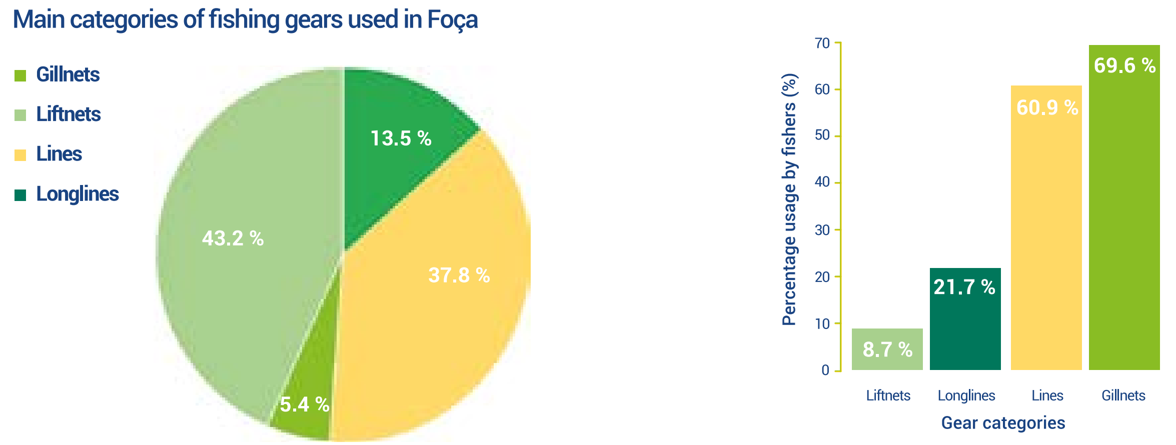


Figure-134

(a) The percentage composition of the main gear categories and (b) the percentage of fishers using these main gear categories in the Foça SEPA

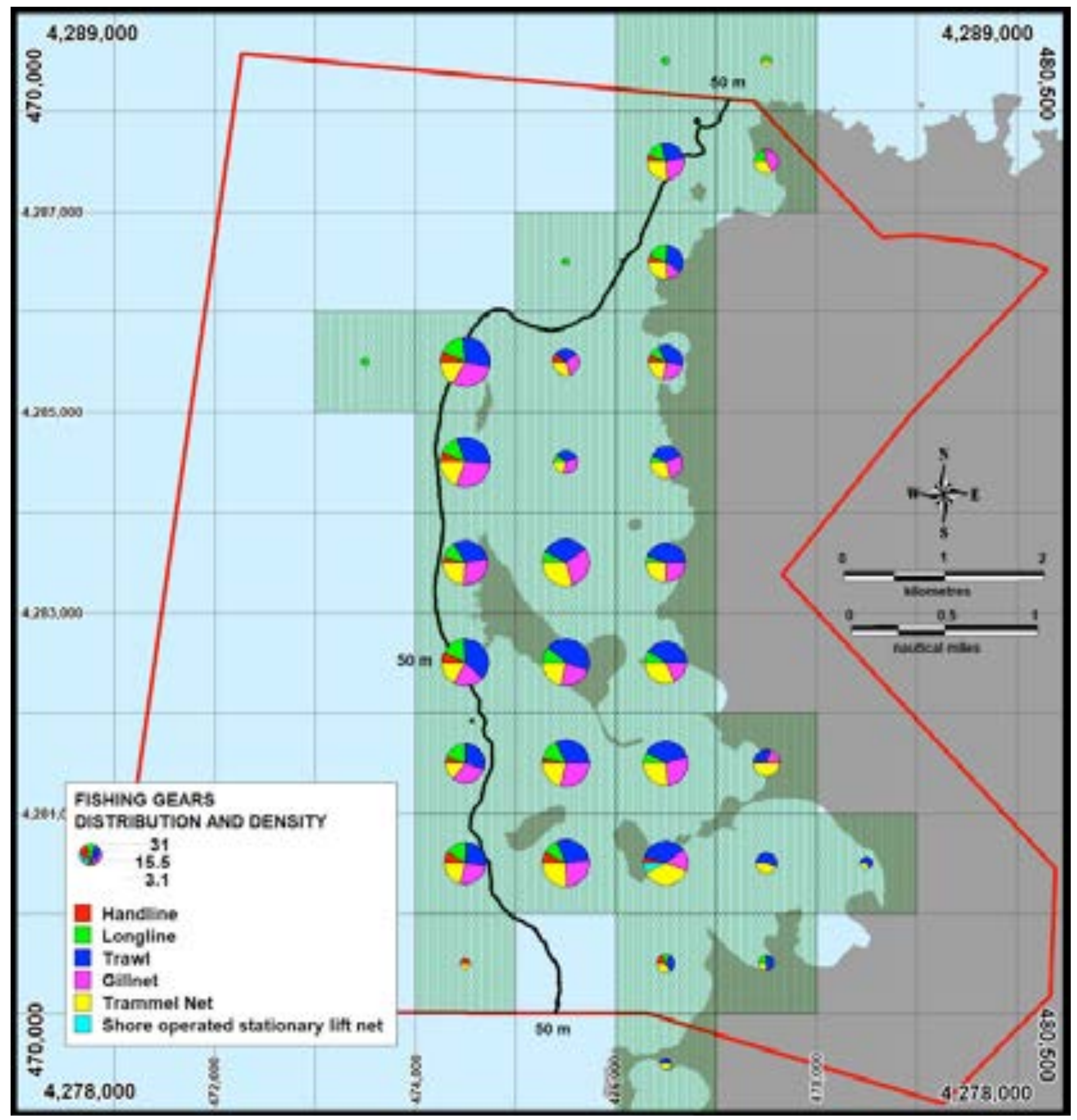


Figure-135

The spatial distribution of commercially used various fishing gears in the Foça SEPA for each 1 km² grid. Size of the pie in a grid is proportional to the intensity of utilization of gears in that particular area

10.1.3. Spatial and Temporal Distribution of Commercial Fishing Effort

This study measured fishing effort as days spent at sea for fishing. Through the interviews, fishers provided information about the frequency of fishing days spent at sea each month. It is very likely that the amount of time spent each day at sea differed among fishers as well as for the individual fisher in different seasons. Nevertheless, one fishing day at sea was considered to be an accepTable and representative unit for fishing effort. Figure-136 shows the variations in average monthly fishing effort together with standard errors estimated for each month. Wide standard error estimates are associated with a significant degree of variation within each month.

During the interviews, the fishers also gave information concerning the spatial distribution of their fishing activities by using the special maps dividing the marine area of the Foça SEPA into 1 km^2 grids. The annual distribution of fishing effort in each grid is presented in Figure-137. The monthly distribution of the fishing effort in each grid is shown in Figure-138. Figure-139 provides information about the preference of fishers for each grid throughout the year. The grids, E4 and E5 were the most preferred grids for fishing activities. They were followed by E6, E7 and F7 and G8.

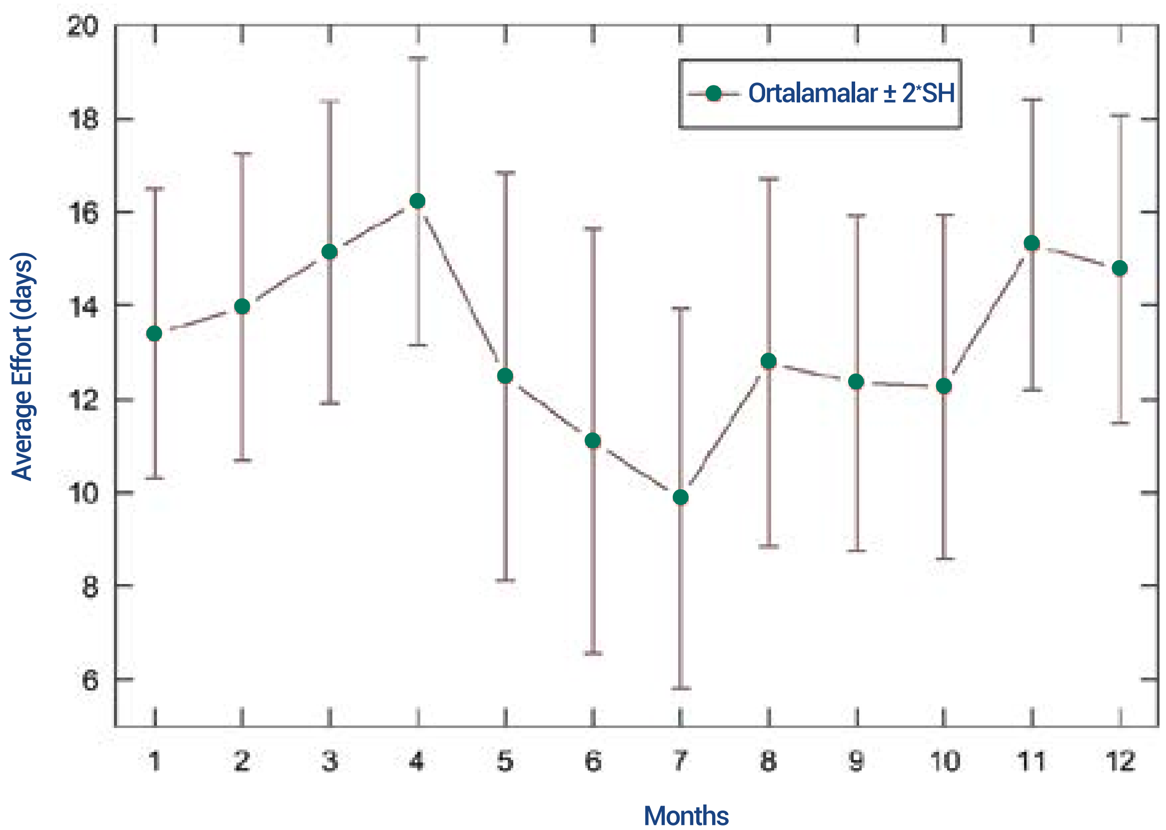


Figure-136

The average monthly fishing effort spent in the Foça SEPA. SE refers to the standard errors estimated for each month

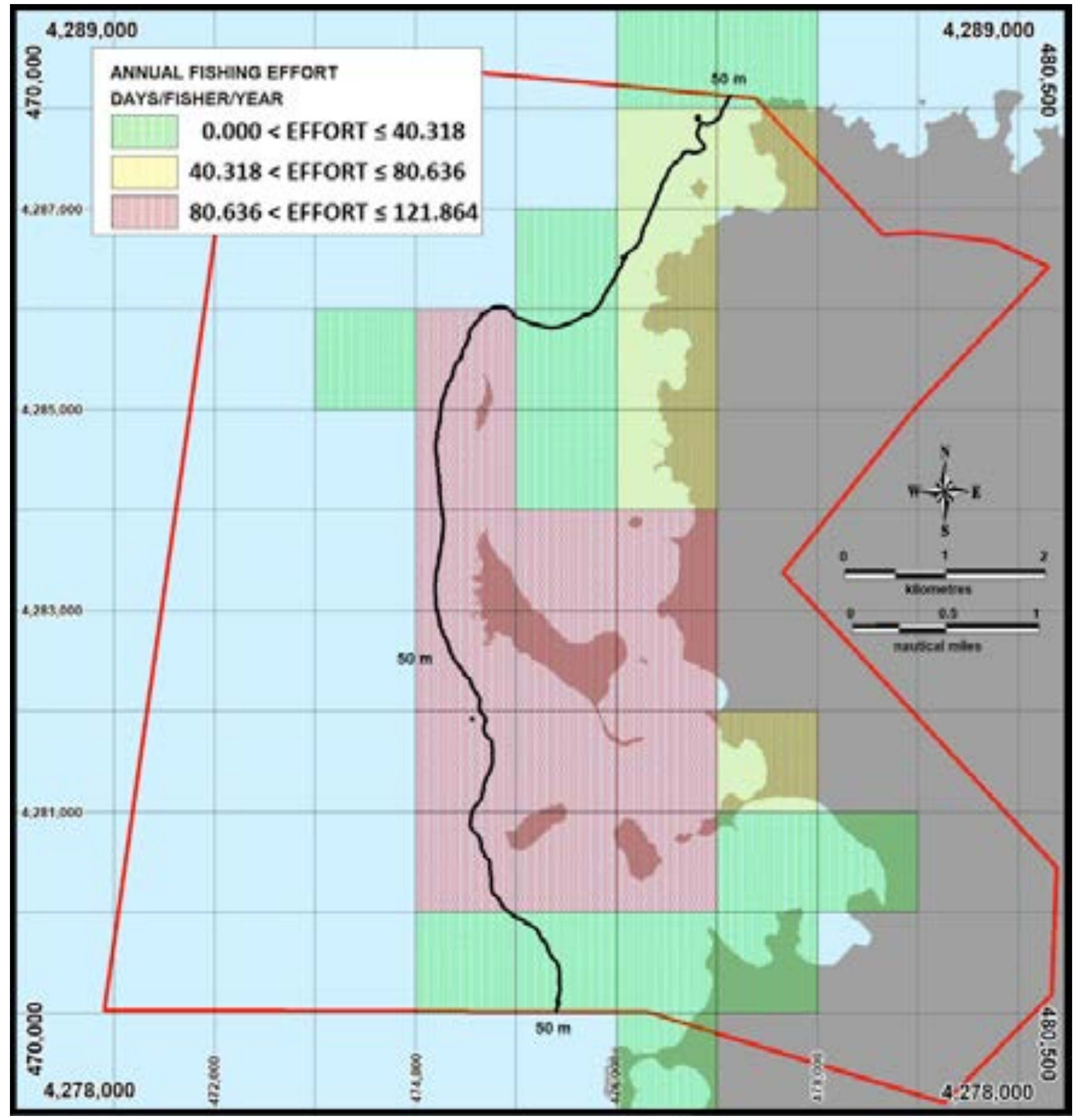


Figure-137

The annual distribution of fishing effort in the Foça SEPA for each 1 km^2 grid. The intensity of the effort is classified to three levels: low, moderate and high and appropriately color coded

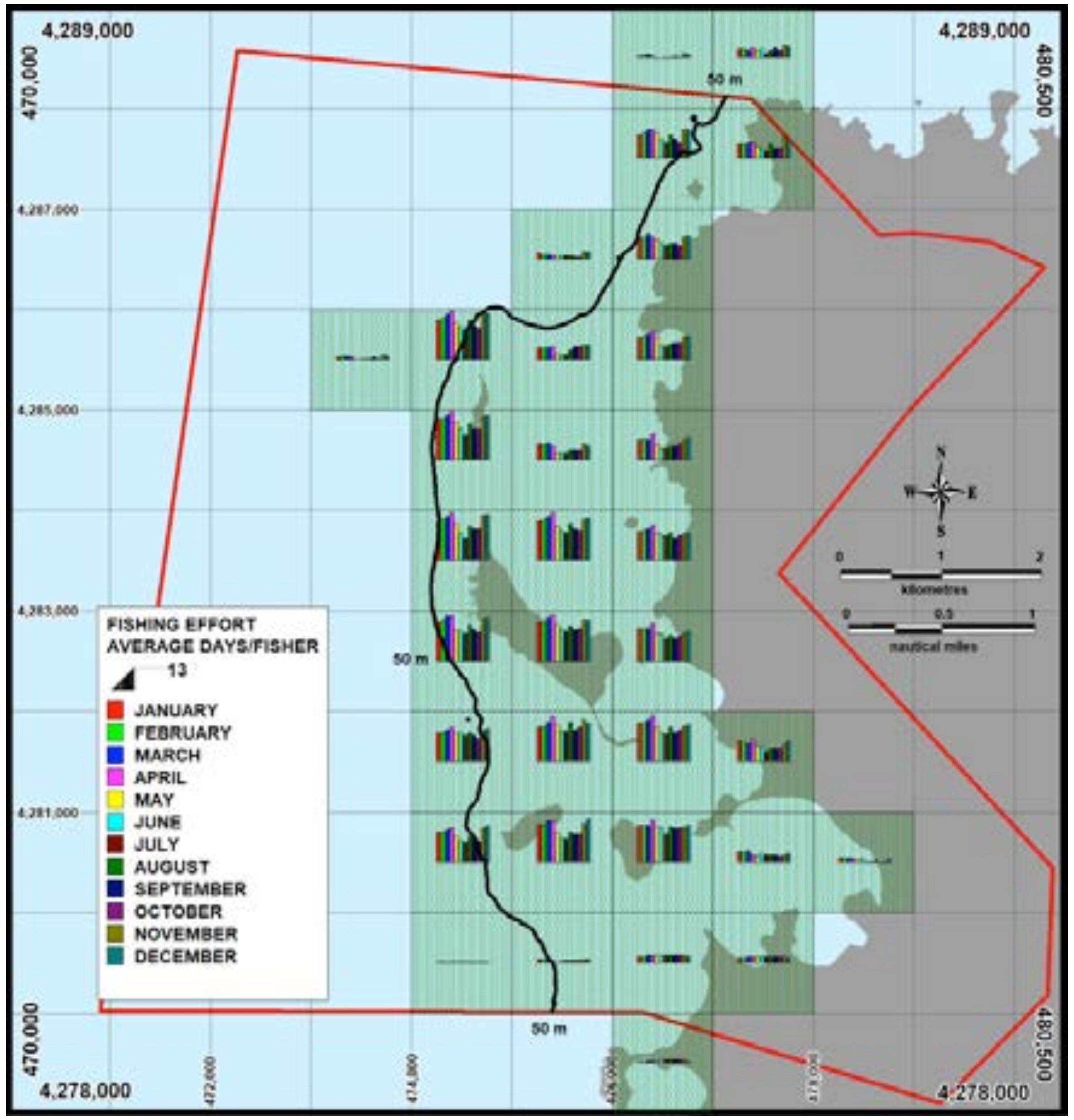


Figure-138

The monthly distribution of the fishing effort in the Foça SEPA for each 1 km^2 grid. Size of the histogram in a grid is proportional to the amount of fishing effort exercised in that particular area

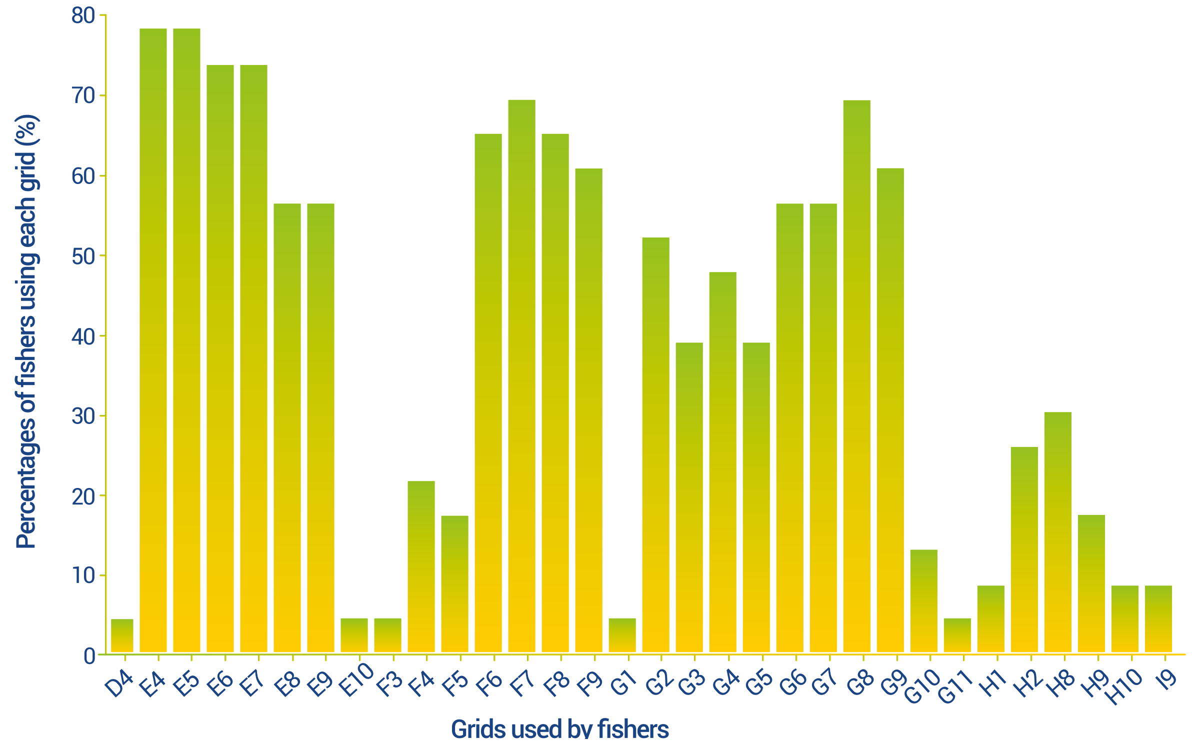


Figure-139

The preference of fishers for each grid throughout the year in Foça SEPA

10.1.4. Species Composition of the Commercial Fishery in the Foça SEPA

The list of fish and mollusk species targeted by the commercial fisheries in the Foça SEPA is presented in **Table-31**. The targeted species vary seasonally. In addition to the targeted species fishers occasionally caught other fish, mollusks or crustaceans. Some of these bycatch species have commercial value so fishers keep and sell them. The list of such species is given in **Table-31**. Another group of bycatch is composed of species with no commercial value. This group includes small sized individuals from otherwise commercially valued fish species, big sized individuals of non-markeTable species and also incidental catches of cartilaginous fish, sea turtles and sea birds (**Table-32**). 75% of the fishers interviewed declared that they always discarded the too-small commercial fish and noncommercial fish back into the sea. 10% declared that they sometimes threw the undesirable catch into the sea and sometimes brought it to shore. 15% of the fishers utilized these fish as bait whenever possible. The incidentally caught seabirds, turtles and cartilaginous fish were always released back into the sea. All the lists presented in **Tables 31, 32 and 33** were compiled from the data gathered through the interviews with fishers in the Foça SEPA.

Table 31
List of targeted fish and mollusk species by the fishers in the Foça SEPA by common (English and Turkish) and scientific (Latin) names

English name	Turkish name	Species name
European seabass	Levrek	*Dicentrarchus labrax*
Gilthead seabream	Çipura	*Sparus aurata*
Red porgy	Fangri	*Pagrus pagrus*
Common pandora	Kırma mercan	*Pagellus erythrinus*
Pink dentex	Trança	*Dentex gibbosus*
Common dentex	Sinarit	*Dentex dentex*
Common two-banded seabream	Karagöz	*Diplodus vulgaris*
White seabream	Sargoz	*Diplodus sargus*
Annular seabream	Isparoz	*Diplodus annularis*
Sand steenbras	Mırmır	*Lithognathus mormyrus*
Saddled seabream	Melanur	*Oblada melanura*
Salema	Salpa	*Sarpa salpa*
Bogue	Kupes	*Boops boops*
Grey mullets	Kefal	*A combination of species from genus Mugil, Chelon and Lisa*
Horse mackerel	İstavrit	*Trachurus spp*
Round sardinella	İri sardalya, tirsi	*Sardinella aurita*
Atlantic bonito	Palamut, torik	*Sarda sarda*
Bullet tuna	Tombik, gobene	*Auxis rochei*
Little tunny	Yazılı orkinoz	*Euthynnus alletteratus*
Atlantic mackerel	Uskumru	*Scomber scombrus*
Mediterranean chub mackerel	Kolyoz	*Scomber colias*
Leerfish	Akya, avcı	*Lichia amia*
Greater amberjack	Sarıkuyruk, kuzu balığı	*Seriola dumerili*
Meagre	Sarıağız, granyöz	*Argyrosomus regius*
Brown meagre	Eşkine	*Sciaena umbra*
Shi drum	Minekop, kötek	*Umbrina cirrosa*
Yellowmouth barracuda	Turna, ıskarmoz	*Sphyraena viridensis*
Black scorpionfish	Lipsoz	*Scorpaena porcus*
Common cuttlefish	Mürekkepbalığı, sübye	*Sepia officinalis*
European squid	Kalamar	*Loligo vulgaris*
Common octopus	Ahtapod	*Octopus vulgaris*

Table 32
List of bycatch fish, mollusk and crustacean species of commercial value with common (English and Turkish) and scientific (Latin) names. First 17 rows contain species from previous Table 31. Here these species are classified as bycatch because they were caught by fishers not targeting them.

English name	Turkish name	Species name
Gilthead seabream	Çipura	*Sparus aurata*
Common dentex	Sinarit	*Dentex dentex*
Common two-banded seabream	Karagöz	*Diplodus vulgaris*
Annular seabream	Isparoz	*Diplodus annularis*
Saddled seabream	Melanur	*Oblada melanura*
Salema	Salpa	*Sarpa salpa*
Bogue	Kupes	*Boops boops*
Horse mackerel	İstavrit	*Trachurus spp*
Round sardinella	İri sardalya, tirsi	*Sardinella aurita*
Atlantic bonito	Palamut, torik	*Sarda sarda*
Bullet tuna	Tombik, gobene	*Auxis rochei*
Leerfish	Akya, avcı	*Lichia amia*
Yellowmouth barracuda	Turna, ıskarmoz	*Sphyraena viridensis*
Black scorpionfish	Lipsoz	*Scorpaena porcus*
Common cuttlefish	Mürekkepbalığı, sübye	*Sepia officinalis*
European squid	Kalamar	*Loligo vulgaris*
Common octopus	Ahtapod	*Octopus vulgaris*
Swordfish	Kılıçbalığı	*Xiphias gladius*
White grouper	Lahos, grida	*Epinephelus aeneus*
Dusky grouper	Orfoz	*Epinephelus marginatus*
Combers	Hani, hanoz	*A combination of species from genus Serranus*
Wrasses	Lapin	*A combination of species from family Labridae*
Red mullet	Barbun	*Mullus barbatus*
John dory	Dülgerbalığı	*Zeus faber*
Tub gurnard	Kırlangıç	*Chelidonichthys lucerna*
Red scorpionfish	İskorpit, adabeyi	*Scorpaena scrofa*
Blackbellied angler	Fenerbalığı	*Lophius budegassa*
Grey triggerfish	Çütre	*Balistes capriscus*
Common sole	Dilbalığı	*Solea solea*
Smooth-hound	Adi köpekbalığı	*Mustelus mustelus*
Lobster	Istakoz	*Homarus gammarus*
Norway lobster	Böcek	*Nephrops norvegicus*

Table 33
List of bycatch species with no commercial value by common (English and Turkish) and scientific (Latin) names. The first 8 rows contain fish species also listed in Table 32 but included here because they are sometimes caught at a size deemed too small to sell.

English name	Turkish name	Species name
Annular seabream	Isparoz	*Diplodus annularis*
Saddled seabream	Melanur	*Oblada melanura*
Bogue	Kupes	*Boops boops*
Horse mackerel	İstavrit	*Trachurus spp*
Red scorpionfish	İskorpit, adabeyi	*Scorpaena scrofa*
Combers	Hani, hanoz	*A combination of species from genus Serranus*
Wrasses	Lapin	*A combination of species from family Labridae*
Grey triggerfish	Çütre	*Balistes capriscus*
Diverse small fish	Çeşitli küçük balık	
Picarel	İzmarit	*Spicara smaris*
European conger	Mığrı	*Conger conger*
Mediterranean moray	Müren	*Muraena helena*
Garfish	Zargana	*Belone belone*
Small unspesified sharks	Küçük köpekbalıkları	
Small-spotted catshark	Kedibalığı	*Scyliorhinus canicula*
Electric rays	Elektrikbalığı, çarpan	*Torpedo spp.*
Skates	Vatoz	*Raja spp.*
Common stingray	Rina, İğneli vatoz	*Dasyatis pastinaca*
Spiny butterfly ray	Kazıkkuyruk	*Gymnura altavela*
Common eagle ray	Çuçuna	*Myliobatis aquila*
Unspesified sea turtle	Deniz kaplumbağası	
Seagull	Martı	*Larus spp.*
Common cormorant	Karabatak	*Phalacrocorax carbo*

10.1.5. Interactions Between the Commercial Fishery and Other Marine Life in the Foça SEPA

Two ways of interactions can be classified between the commercial fishery and other marine life in Foça. The more usual interaction is the incidental catch of seabirds, turtles and cartilaginous fish, i.e. rays, skates and sharks by the commercial fishery. These species are already listed in Table-33. Since either most of these species are of no commercial value or not permitted to land (Anonymous, 2016a) they were almost always released back into the sea according to responses of fishers during the interviews. The second interaction is more limited to the encounters or sightings of some other marine life during fishing activities at sea. These include cetaceans, Mediterranean monk seals, seabird, turtles and big fish like bluefin tuna and large sharks and rays. Figure-140 presents the spatial distribution of interactions between the commercial fishery and other marine life in the Foça SEPA. Size of pies in grids are proportional to the frequency of interactions reported by interviewed fishers.

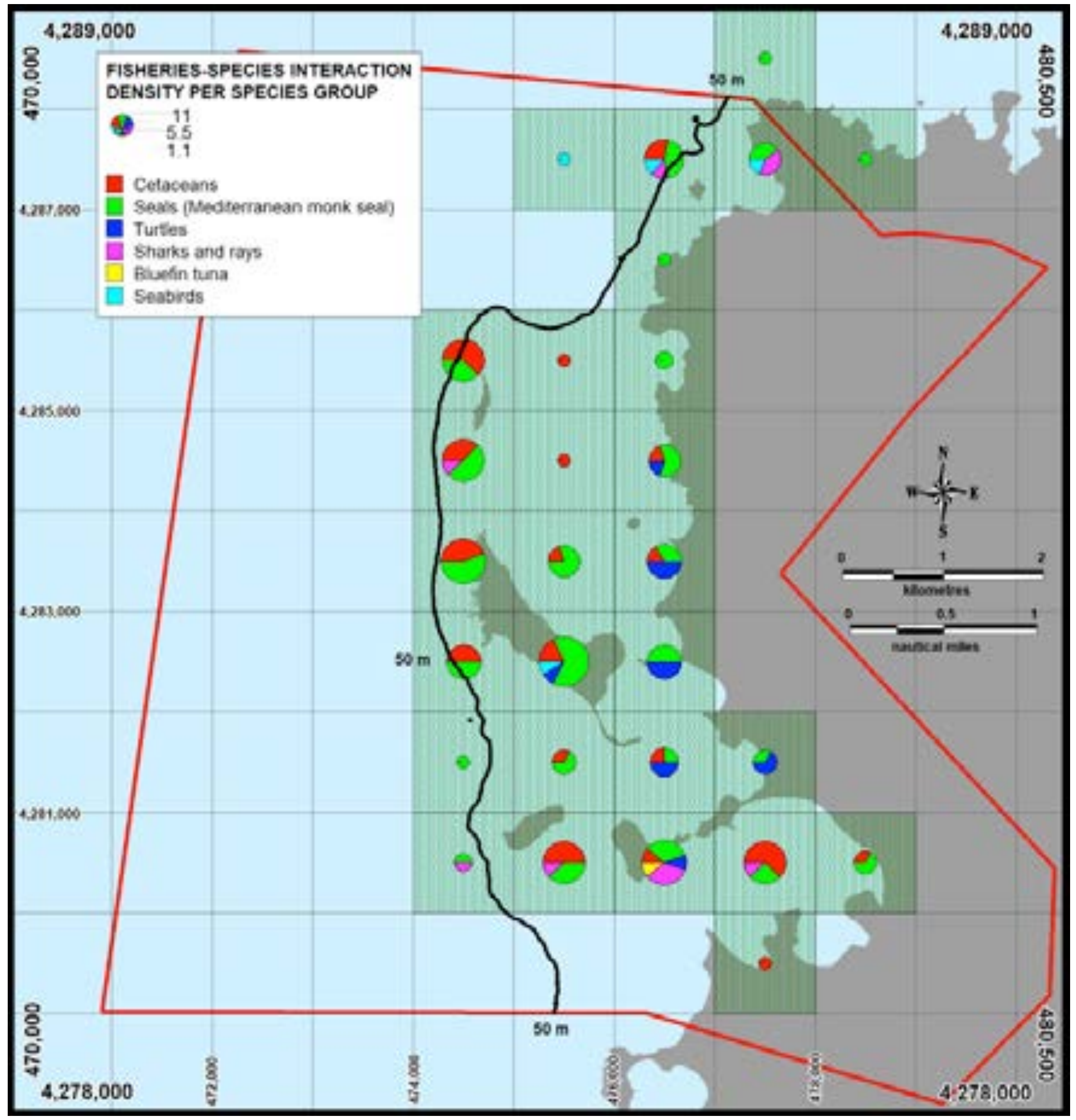


Figure-140
Spatial distribution of interactions between the commercial fishery and other marine life in the Foça SEPA. Size of a pie in a grid is proportional to the frequency of interactions in that particular area.

10.1.6. Professional Difficulties Experienced by Small Scale Fishers in the Foça SEPA

During the interviews, fishers also provided information on issues and difficulties routinely encountered in their profession. These issues ranged from problems with legislation, a strained economy, social and work security related worries, poor infrastructure, difficulties interacting with industrial fishers as well as concerns in connection with illegal fishing activities, tourism and challenges related to other marine life.

On the topic of fisheries legislation, a majority of the fishers (92%) stated that they were discontent. Present regulations were deemed unsatisfactory and not suiTable for keeping small scale fisheries sustainable. Some of the measures were considered of no practical value and control and surveillance activities were seen as being too infrequent to deter illegal (unauthorized) fishing activities or regulations violations by amateur or recreational fishers. The special protected area was in their view not at all well protected, especially from illegal fishing activities. Also, a few of them had (13%) experienced bureaucratic difficulties when renewing fishing licenses through a process see cumbersome and time-consuming.

The main financial issues encountered were cost related. Continuously rising prices of oil and lubricants (100% of the responses), new fishing gear, materials for maintenance and mending, boats and engines (79%) as well as for bait used in fishing (46%) were main concerns. Support and subsidies offered by the government were largely considered inadequate (79%) and many felt that reasonable banking loans to individual fishers or cooperatives were lacking (63%).

The main social issues considered by fishers included insufficient means to obtain social security within the range of general income from fisheries activities (63%), an insufficient level of organization among fishers including membership to cooperatives (54%) as well as a lack of professional educational opportunities for fishers (42%).

The infrastructural issues raised by fishers were the lack of adequate number of boatyards and slipways (75%), cold (freezing and refrigerated) storage capacity (71%) and fisher shelters (63%) in the Foça SEPA (63%). The absence of fish processing plants in the area was also of concern (42%).

Areal restrictions for fishing due to the naval base and other military installations in the Foça SEPA was an important issue for the fishers (83%). Tourism was also considered problematic in terms of spatial usage, and was seen as having an adverse impact on fishing activities particularly during high season. Hotels and holiday villages (67%), recreational areas (beaches) for swimming (58%), water sports (58%), scuba diving (42%) and daily tour boats (33%) were mentioned in this context. In addition, a scarcity of designated anchorage sites as well as restraints concerning the use of the harbour also troubled the fishers (29%).

Conflicts between rules-based commercial small scale fishers and other parties using the fisheries resources in the Foça SEPA were common. According to the interviewed fishers, the most important problem was the illegal fishing activities occurring in the area (100%). The second most important issue (92%) was amateur or recreational fishing violating legal limits and restrictions set forth in current fisheries regulations. Conflicts between small scale fishers and industrial fishers (i.e. trawlers and purse-seiners) came in third (75%) and some (46%) also mentioned small scale fishers from other areas occasionally turning up inside the SEPA as being a problem.

Unwanted interaction with other marine life during fishing operations was reported as another concern. Of the protected marine species or species groups that exist in the Foça SEPA, three were pointed out as being frequently encountered; the Mediterranean monk seal (58%), sea turtles (50%) and dolphins (42%). Fishers mentioned that seals feeding on fish caught in nets caused damage to their gears. Similarly, turtles and sea birds such as pelicans, shearwaters and cormorants feeding on fish or baits on longlines occasionally get caught by the gears or cause them damage. Some fishers (13%) also complained about the occasional occurrence of jellyfishes in the area. In addition, a possible expansion of invasive fish species such as rabbitfish, pufferfish and lionfish to the area was a concern for the fishers.

10.1.7. The Views of Fishers on the Foça SEPA

Via the questionnaire, fishers were presented with a group of items (questions) meant to reveal their personal view and contentment in relation to the Foça SEPA and they were required to respond according to a five point Likert scale (Strongly discontent, Discontent, No opinion, Content and Strongly content). The items were the presence of a Special Environmental Protection Area in Foça, the management of the Foça SEPA (administration, legislation, surveillance), fishers' involvement in the management process and the Foça SEPA's impact on commercial fishing. Figure-141 presents the contentment of individual fishers with the Foça SEPA.

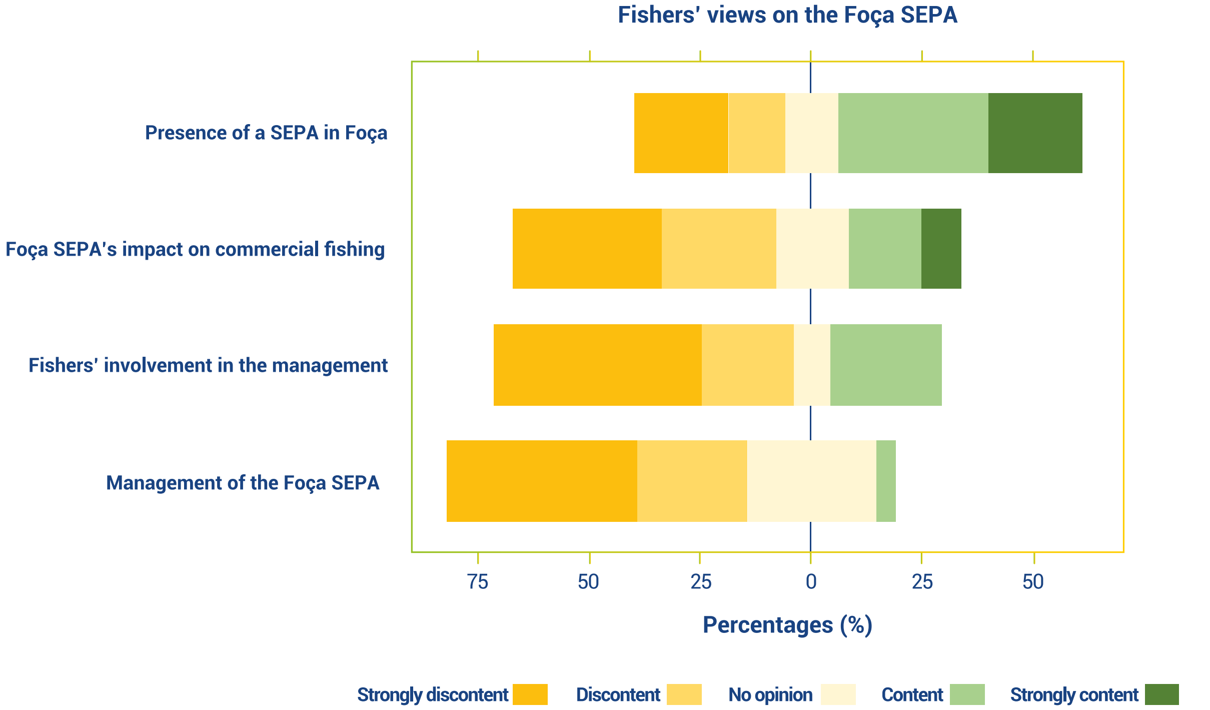


Figure-141

Fishers' view and contentment in relation to the Foça SEPA responses provided according to a five point Likert scale (Strongly discontent, Discontent, No opinion, Content and Strongly content)

10.2. Unauthorised Fishing Activities in the Foça SEPA

10.2.1. Fishing Gears and Practices Used in Unauthorized (Illegal) Fishing Activities in the Foça SEPA

According to the information collected through the fisheries questionnaire survey, the fishing gears used in unauthorized (illegal) fishing activities in Foça SEPA can be broadly classified into three major categories: trawls, beam trawls, and spears. The use of all of them is banned in the Foça SEPA. These main categories are presented in Table-30 with their specific ISSCFG (International Standard Statistical Classification of Fishing Gear) codes (Nédélec, & Prado, 1990; FAO, 2019). However, in terms of fishing practices, the unauthorized (illegal) fishing activities in the Foça SEPA can be classified to five main practices, i.e. fishing with trawls, beam trawls, spears, sea cucumber collection by diving, and amateur or recreational fishing beyond the legal limits and restrictions. Recreational fishing is another very common fishing activity taking place in the area and this may sometimes result in overexploitation of some species (i.e. catching fish above the allowed legal size and amount) and generation of illegal profits (i.e. violating the ban of selling fish caught in amateur fishing activity (Anonymous, 2016b)).

The spatial distribution of all sorts of illegal fishing practices and their density in the Foça SEPA for each 1 km^2 grid is presented in Figure-142. All data regarding illegal fishing practices in the Foça SEPA were compiled from the interviews with commercial fishers. The spatial distribution of each illegal fishing practice and its intensity (i.e. frequency of sightings of the particular illegal fishing practice by the commercial fishers) is provided separately in Figure-143 to 147.

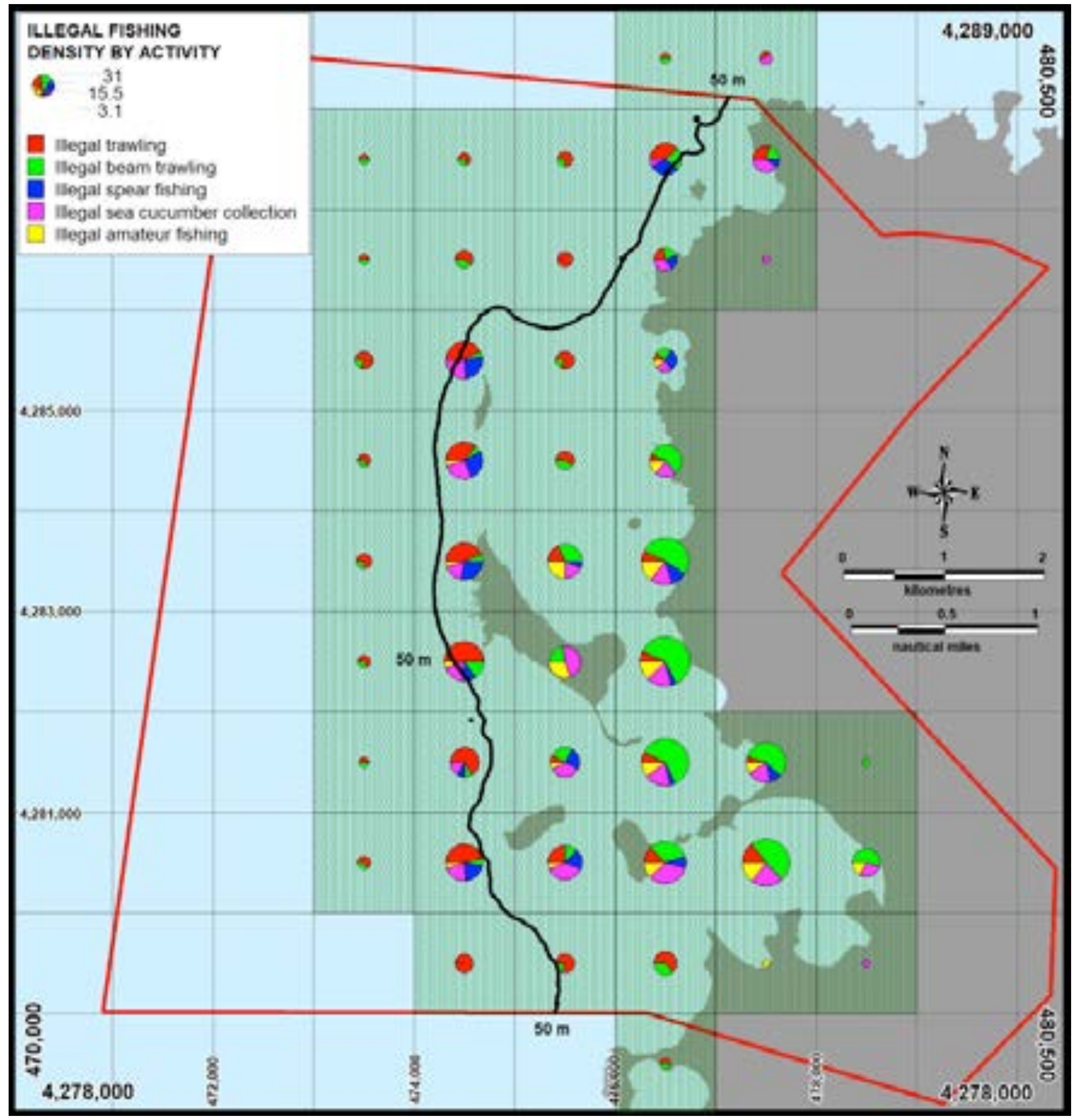


Figure-142

Spatial distribution of all sorts of illegal fishing practices in the Foça SEPA. Size of a pie in a grid is proportional to the frequency of sightings of these illegal fishing practices by commercial fishers for that particular area

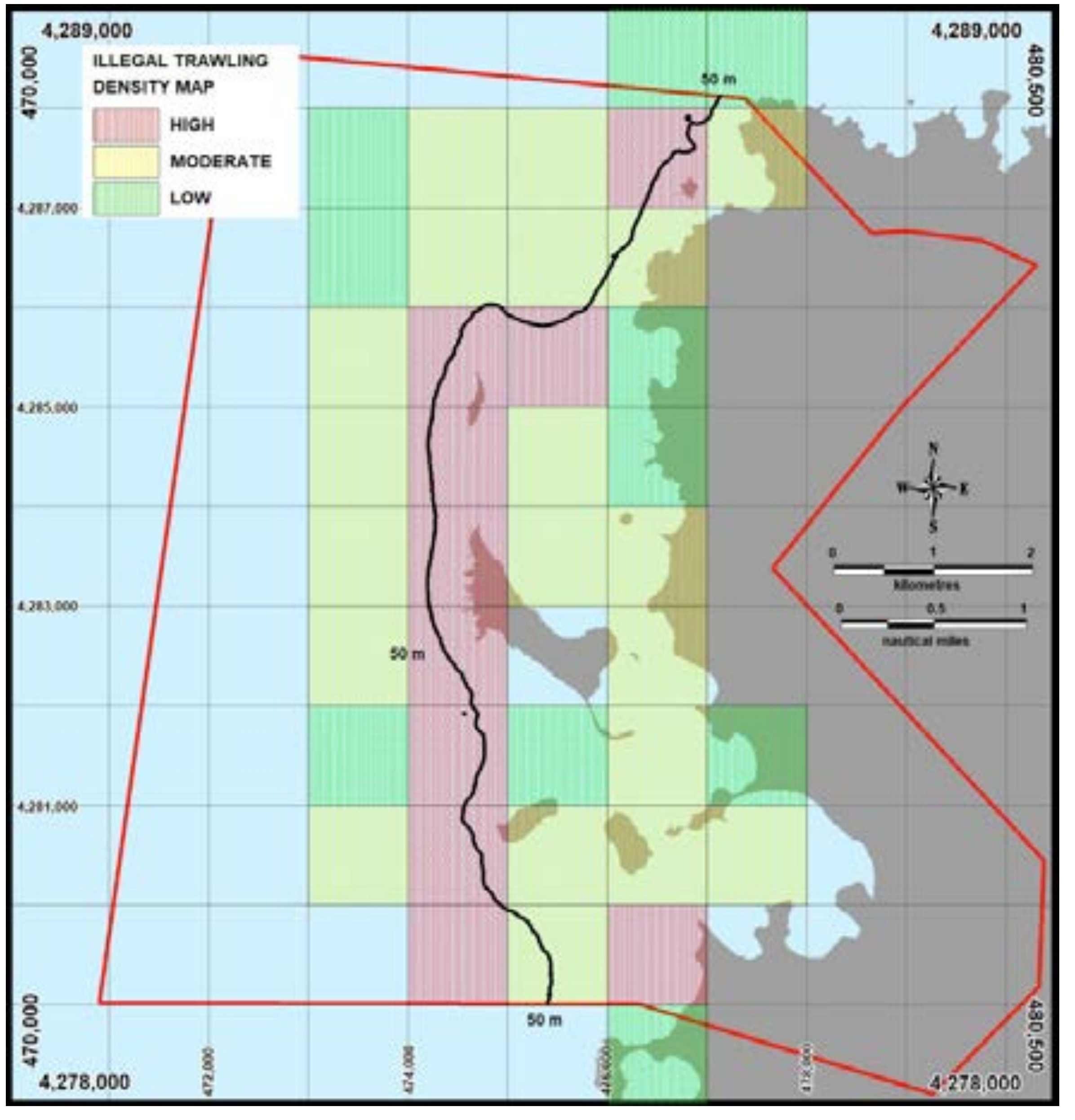


Figure-143

Spatial distribution of illegal trawling in the Foça SEPA. The density of this illegal fishing practice is based on the frequency of sightings by the commercial fishers for each grid. The density is classified to three levels: low, moderate and high and appropriately color coded

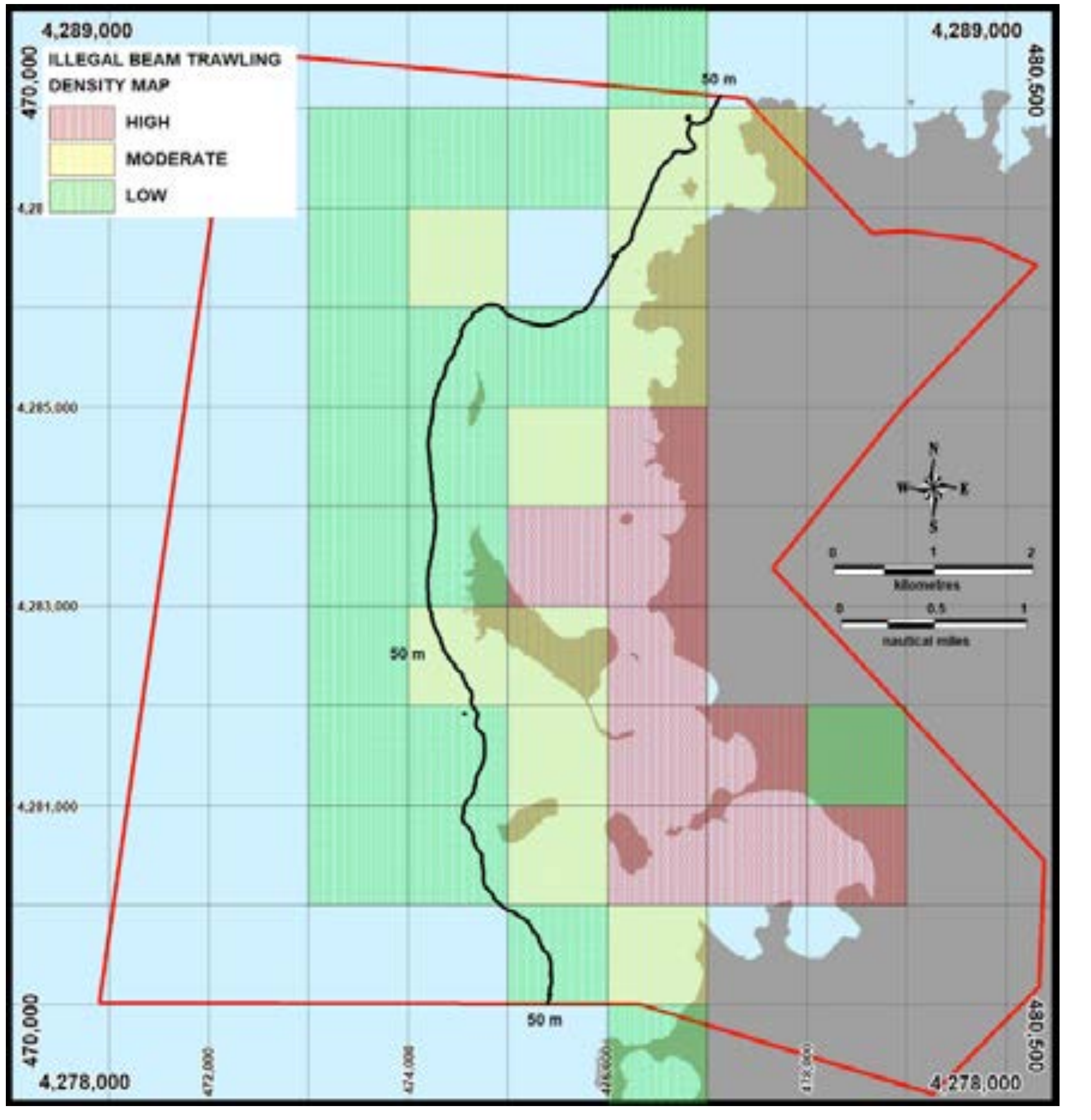


Figure-144

Spatial distribution of illegal beam trawling in the Foça SEPA. The density of this illegal fishing practice is based on the frequency of sightings by the commercial fishers for each grid. The density is classified to three levels: low, moderate and high and appropriately color coded

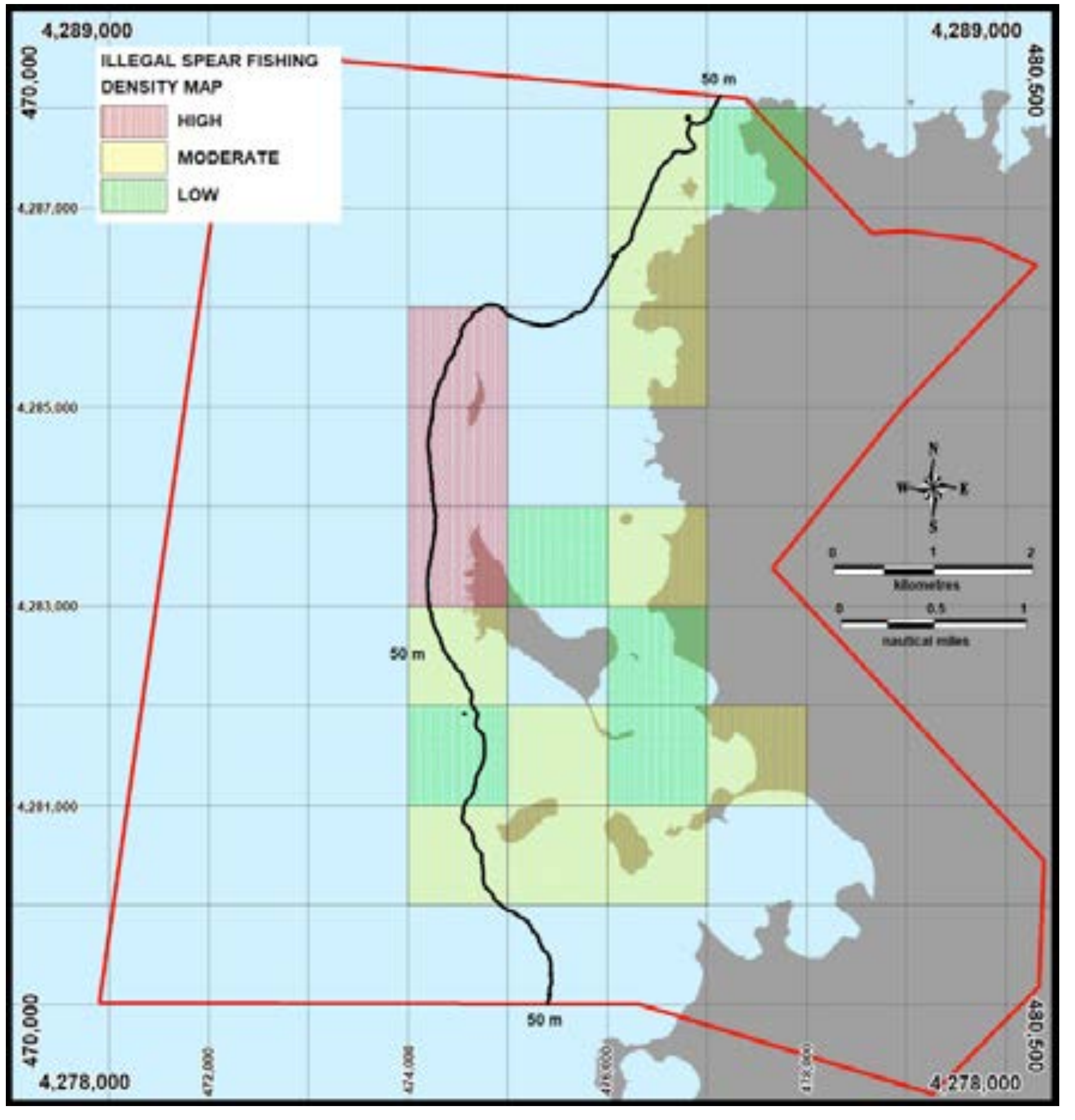


Figure-145

Spatial distribution of illegal spear fishing in the Foça SEPA. The density of this illegal fishing practice is based on the frequency of sightings by the commercial fishers for each grid. The density is classified to three levels: low, moderate and high and appropriately color coded

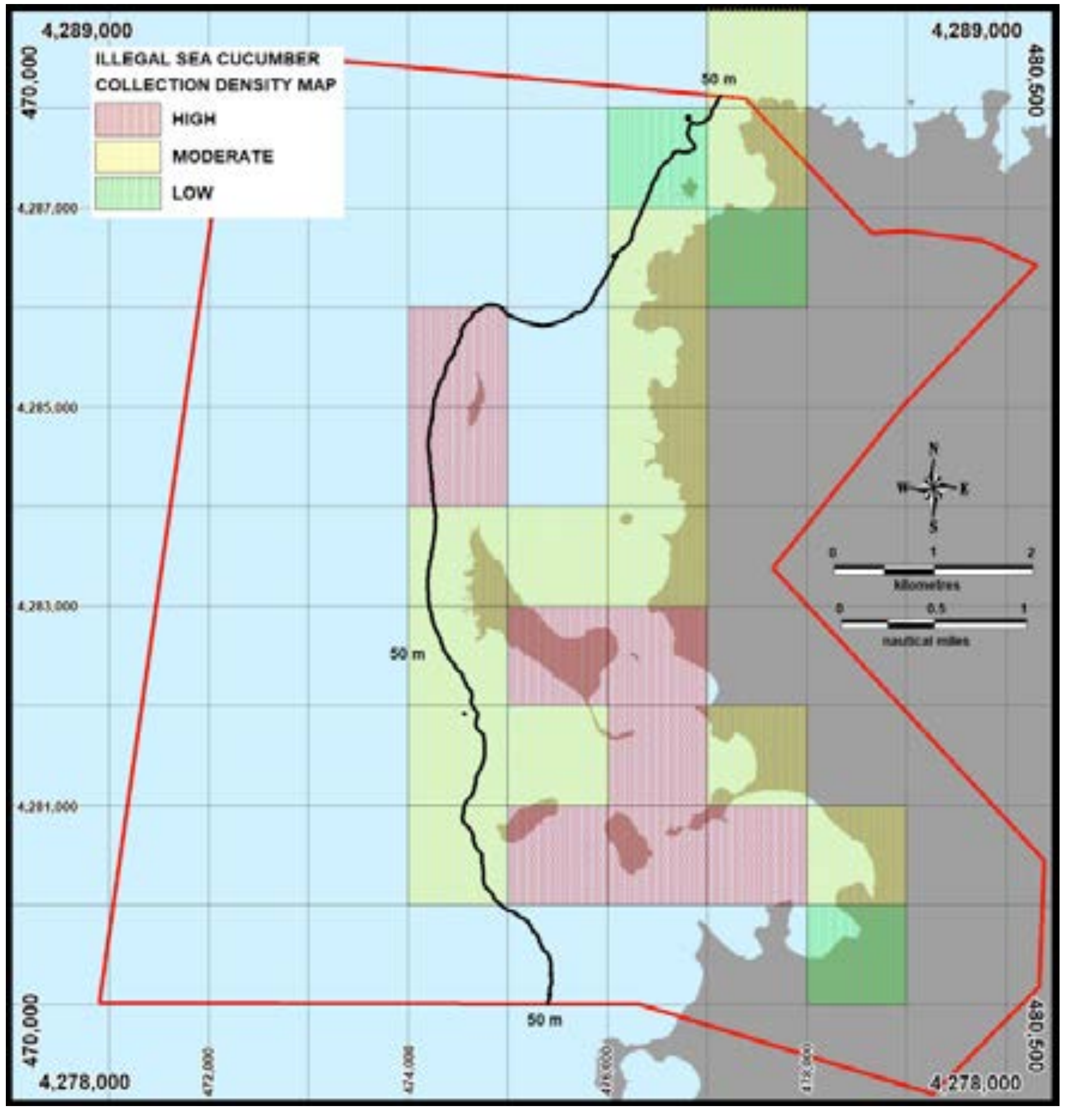


Figure-146

Spatial distribution of illegal sea cucumber collection by diving in the Foça SEPA. The density of this illegal fishing practice is based on the frequency of sightings by the commercial fishers for each grid. The density is classified to three levels: low, moderate and high and appropriately color coded

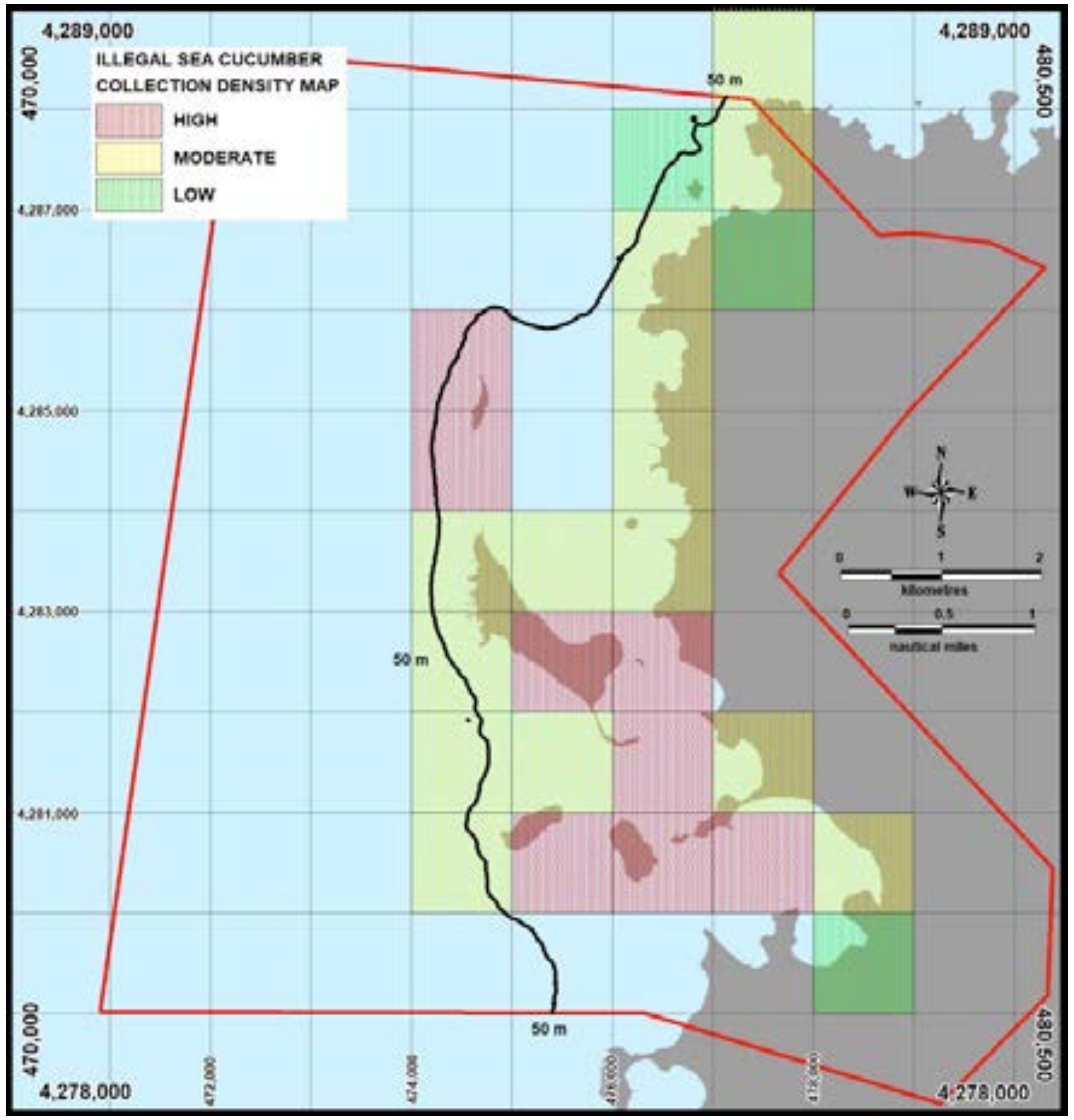


Figure-147

Spatial distribution of amateur or recreational fishing considered illegal by the commercial fishers because those amateur or recreational fishers catch fish beyond the legal limits and restrictions. The density of this illegal fishing practice in each grid in the Foça SEPA is based on the frequency of sightings by the commercial fishers for that particular area. The density is classified to three levels: low, moderate and high and appropriately color coded

10.2.2. The Views of Fishers on Illegal Fishing Practices in the Foça SEPA

In order to ascertain what the fishers themselves considered as illegal or unauthorized fishing, various definitions were offered and the fishers' preferences recorded. The definitions and the scores in terms of level of agreement (in percentages) are listed below.

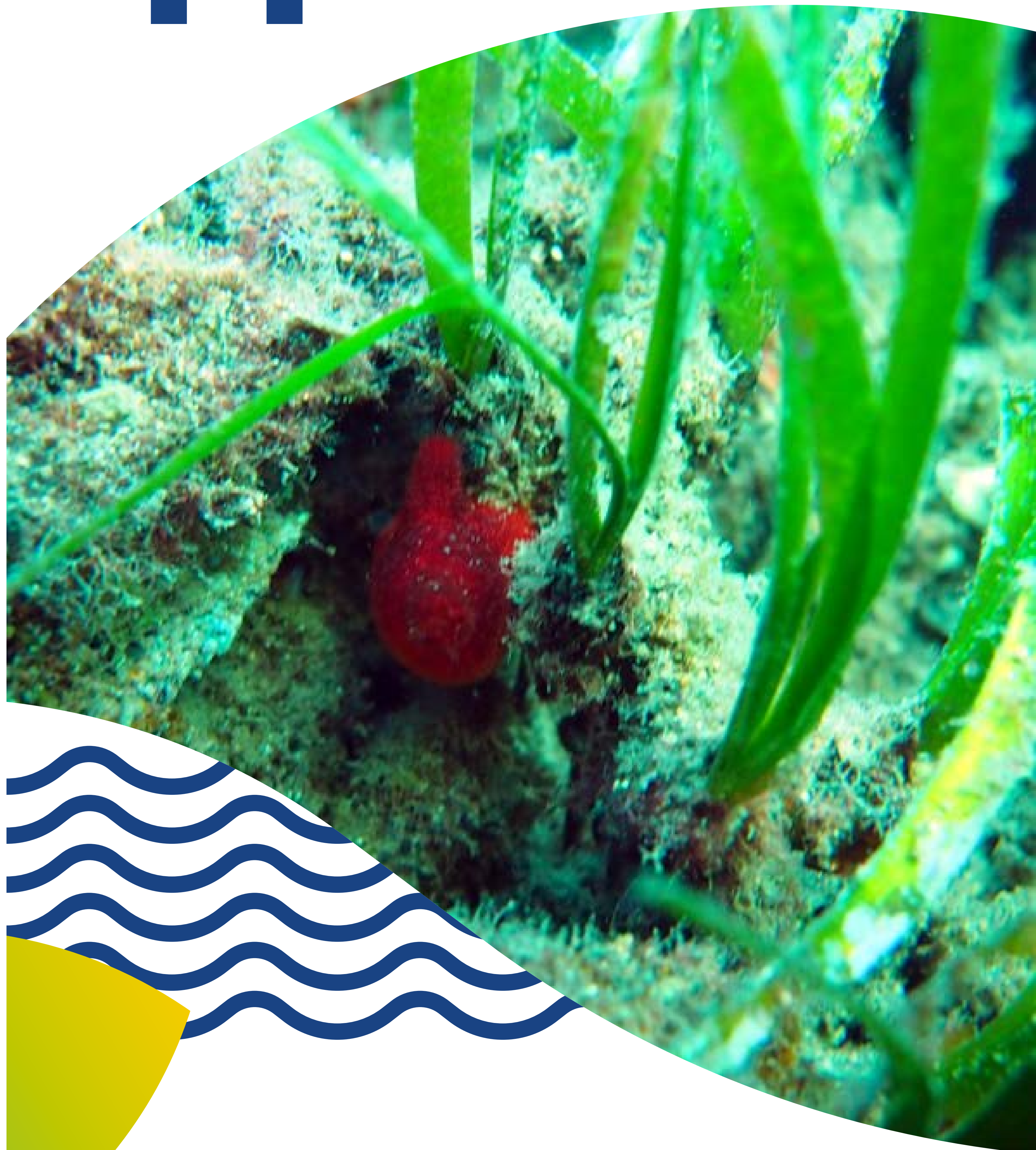
- Any fishing without appropriate license (100%)
- Fishing with unauthorized or illegal gear or methods (100%)
- Fishing outside the legal fishing seasons (during seasonal closures) (100%)
- Fishing of protected or prohibited species (96%)
- The targeting and retaining of fish specimens below legal size limits (96%)
- The catching of fish beyond the legally allowed limits by amateur or recreational fishers (96%)
- Fishing in closed off areas or areas where fishing activities are prohibited (87%)
- Violating depth restrictions during fishing (67%)

When fishers were asked to judge whether illegal fishing activities negatively impacted rule-based commercial fishing during the survey, they unanimously agreed. Adverse effects were listed as:

- Depleting commercial fisheries resources and destroying their habitat (92%)
- Causing a decrease in income for rules based commercial fishers (92%)
- Damaging the gears (various nets and longlines) utilized in rules based fishing activities (92%)
- Creating a negative public image of all commercial fishers in the area (71%)
- Constituting a threat or bodily danger for rules based fishers (67%).

In the fishers' opinion, it would be close to impossible to manage the fisheries resources in the Foça SEPA sustainably without stopping the illegal fishing activities.

11



11

THE IMPACTS OF RULES-BASED AND UNAUTHORISED FISHING ON THE MARINE KEY HABITATS IN THE FOÇA SEPA

The fisheries activities within the Foça SEPA are characterized by artisanal and recreational fishing. Fishing practices other than these activities (e.g. trawling, purse-seining) are forbidden in the area (Anonymous, 2016a). However, the meetings with the local authorities and the questionnaire survey performed during the project showed that unauthorised fishing is a crucial problem for the management of the Foça SEPA as well as fisheries management in the area. On the other hand, another outcome of the questionnaire survey was that recreational fishing is another dense fishing activity in the area, resulting in sometimes overexploitation of some fish species and some national illegal conditions (e.g. fishing over national quota for amateur/recreational fishing, or despite selling the fished products are forbidden by the Turkish Laws (Anonymous, 2016b), it is sometimes observed). Since the project scope was limited with the professional fishing, the effects of recreational fishing practices were only analysed within the illegal fishing practices during the assessments.

11.1. Commercial (Rules-Based) Fishing Activities in the Foça SEPA

Species considered

Five groups of marine species protected by the Natura 2000 network and listed on Annex II of the Directive: Cetaceans, Seals (Mediterranean monk seal), Turtles, Fish, Seabirds (Ref: N2K, 2015).

Fishing gears

1) Rules-based fishing gears: lines, longlines, gillnets and shore operated stationary lift nets

2) Unauthorised fishing gears/methods: trawling, beam trawling, spear fishing and sea cucumber collection by diving

Data source

The fisheries-species interaction is derived directly from the fisheries questionnaire data (Question #10).

11.1.1. Spatial Dimension of the Interactions

The fishermen provided that there were interactions with marine species in 27 grid cells for the total of 5 species groups. The interactions are quantified as low, moderate and high for each species group according to the interaction count numbers obtained for each grid cell (Table-34).

The fisheries-seal interaction is the most distributed (in 23 grids) and dense interaction, followed by fisheries-cetaceans interaction in 18 grids (Figure-148, 149, 150, 151 & 152)

Table 34
Fisheries-species interaction data from the questionnaire

Statistical Value	Cetaceans	Mediterranean monk seal	Turtles	Fish	Seabirds
Minimum	1	1	1	1	1
Maximum	5	7	3	4	1
Average	2.11	2.57	1.86	1.57	1
Standard Deviation	1.49	1.47	0.90	1.13	0
Variance	2.22	2.17	0.81	1.29	0
Count	18	23	7	7	4
Total grid	27				

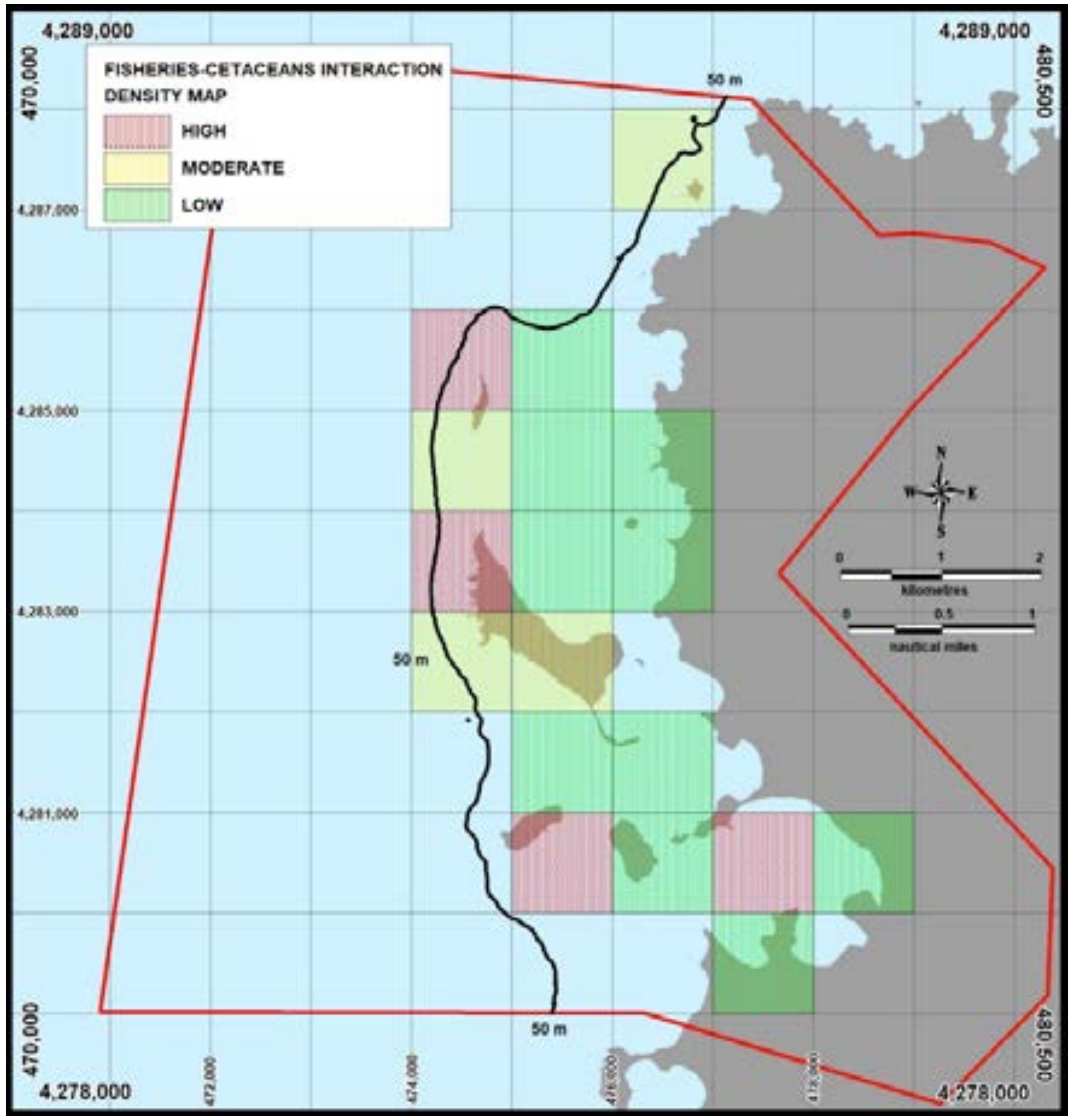


Figure-148
Map of fisheries-cetaceans interaction

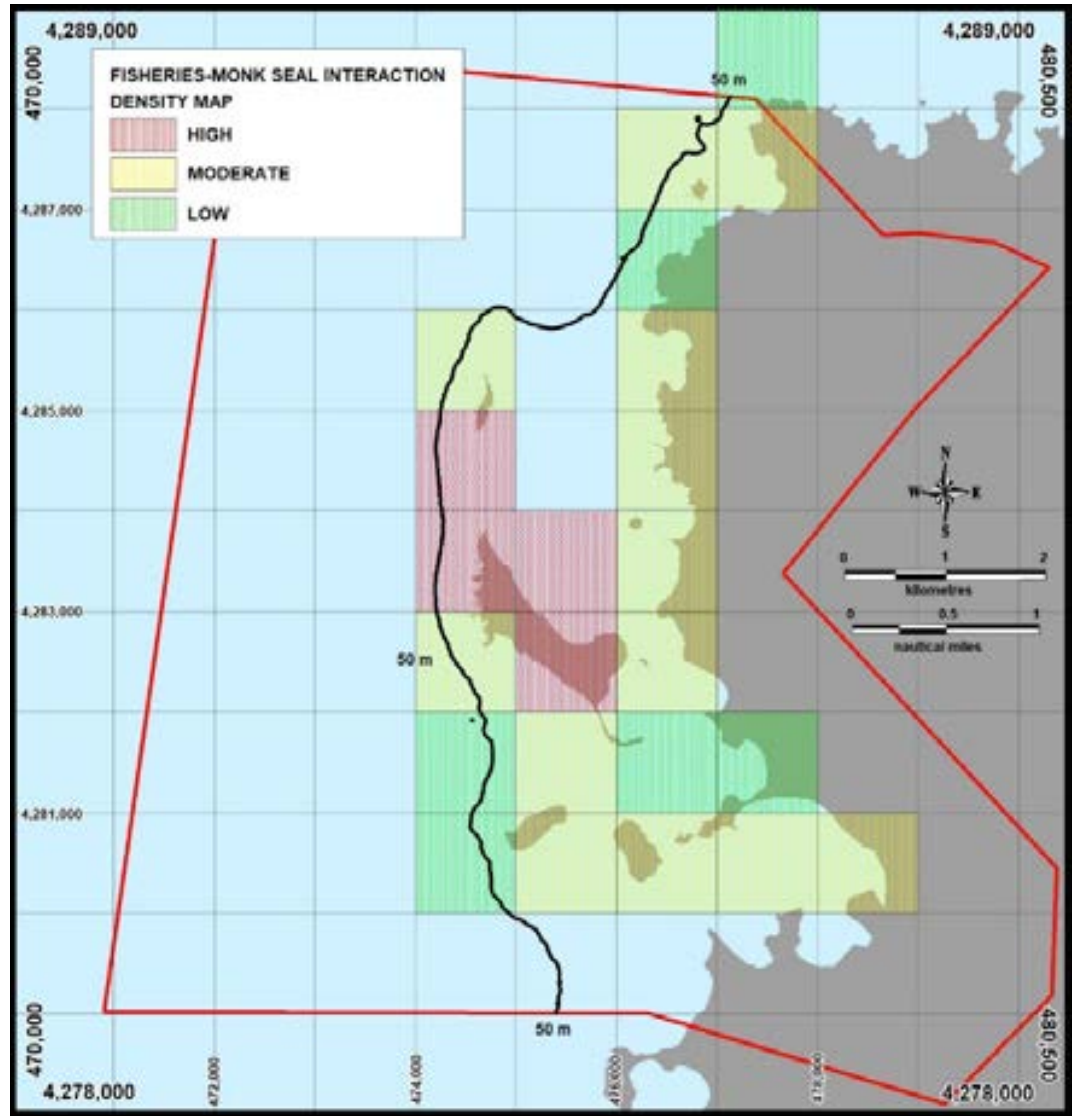


Figure-149
Map of fisheries-cetaceans interaction

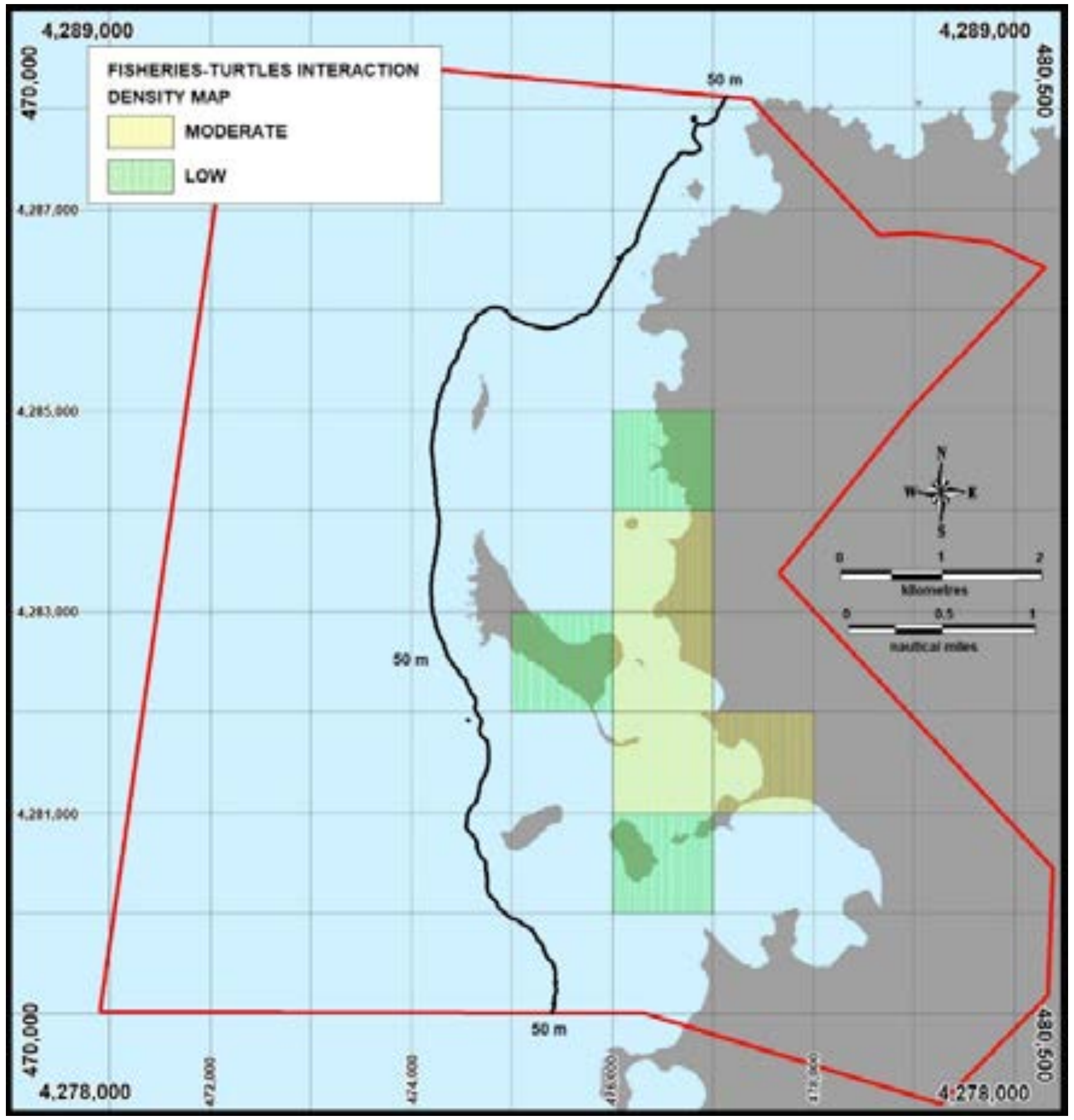


Figure-150

Map of fisheries-turtle interaction

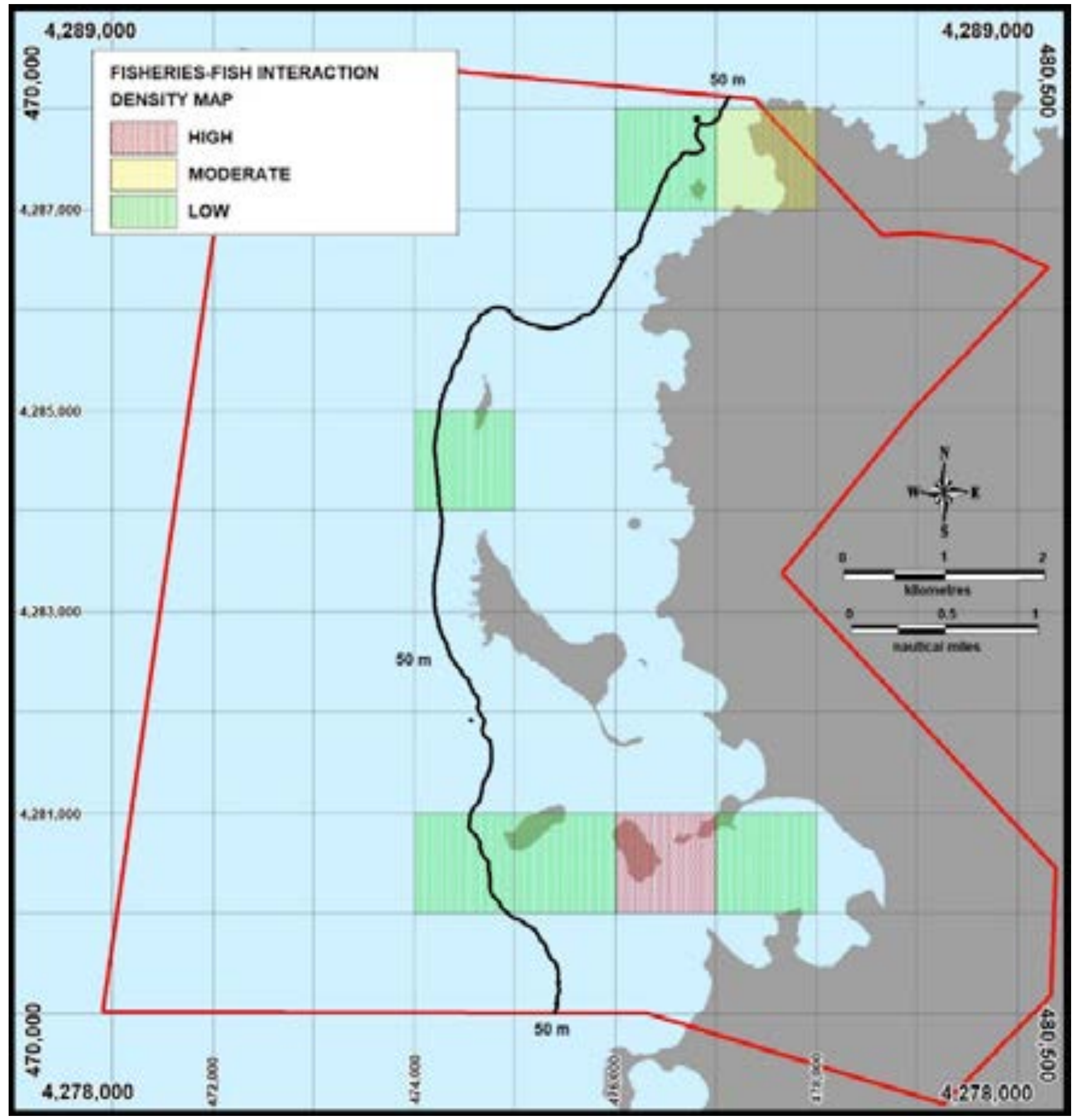


Figure-151

Map of fisheries-fish interaction

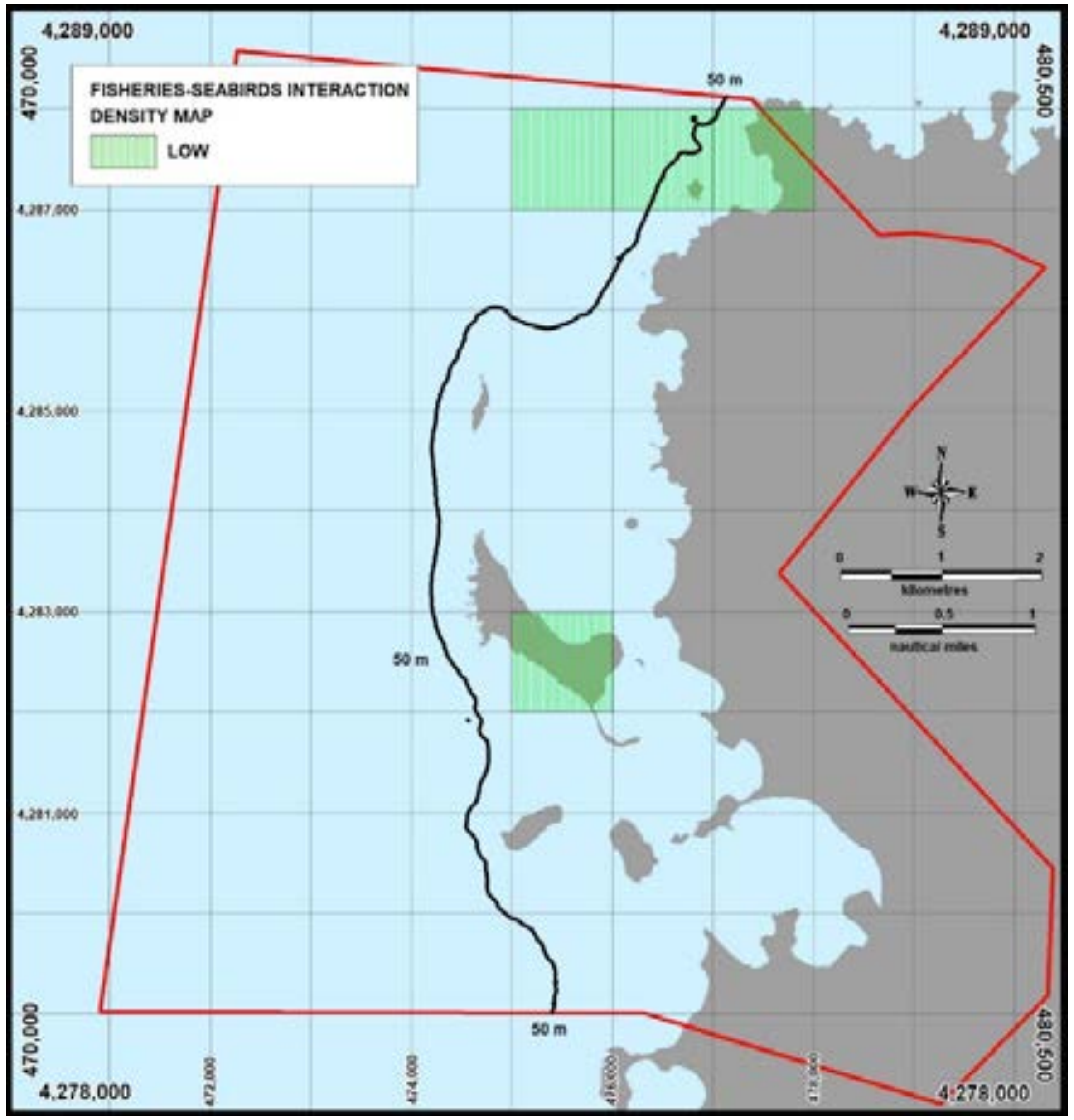


Figure-152
Map of fisheries-seabirds interaction

11.1.2. Potential Fisheries-Species Interactions

Using the gear and interactions fields of the fisheries questionnaire, a gear-species matrix was formed (Table-35). In the matrix, "Probable" entry means that fishermen mentioned an interaction with a species group in his fishing practice, thus the pressure is known to affect the species groups.

Table 35
Fisheries-species interaction data from the questionnaire

GEAR-SPECIES MATRIX		Species: Cetaceans	Seals	Turtles	Fish	Seabirds
Fishing gears	Line	Unlikely	Probable	Unlikely	Probable	Unlikely
	Longline	Possible	Possible	Probable	Probable	Probable
	Gillnet	Probable	Probable	Probable	Probable	Probable
	Shore operated stationary lift net	Unlikely	Probable	Unlikely	Probable	Probable
	Illegal trawling	Probable	Probable	Unlikely	Probable	Unlikely
	Illegal beam trawling	Probable	Probable	Unlikely	Probable	Unlikely
	Illegal spear fishing	Unlikely	Possible	Unlikely	Probable	Unlikely
	Illegal sea cucumber collection (by diving)	Unlikely	Possible	Unlikely	Possible	Unlikely

11.2. Fisheries-Habitat Interactions in the Foça SEPA

Habitats considered

The spatially defined 15 habitat types within this project (**bold ones**):

MB1.5 Infralittoral rock
- **MB1.51 Algal-dominated infralittoral rock**
  - **MB1.51a Well illuminated infralittoral rock, exposed**
  - **MB1.51c Well illuminated infralittoral rock, sheltered**
- **MB1.52 Invertebrate-dominated infralittoral rock**
  - **MB1.52a Moderately illuminated infralittoral rock, sheltered**
- **MB1.53 Infralittoral rock affected by sediments**
- **MB1.56 Semi-dark caves and overhangs**

MB2.5 Infralittoral biogenic habitat
- **MB2.54 *Posidonia oceanica* meadows**

MB3.5 Infralittoral coarse sediment
- **MB3.53 Infralittoral pebbles**

MB4.5 Infralittoral mixed sediment

MB5.5 Infralittoral sand
- **MB5.52 Well sorted fine sand**

MB6.5 Infralittoral mud sediment

Fishing gears

1) Rules-based fishing gears: lines, longlines, gillnets and shore operated stationary lift nets

2) Unauthorised fishing gears/methods: trawling, beam trawling, spear fishing and sea cucumber collection by diving

Data source

The fisheries-habitat interaction is derived directly from the fisheries questionnaire data (Question #3, 8 and 9).

11.2.1. Potential Fisheries-Habitat Interactions

Using the gear field of the fisheries questionnaire, a gear-pressure matrix was formed (**Table-36**). In this matrix, fishing gear techniques were evaluated according to their characteristics that may result in the defined pressures.

Table 36
Gear-pressure matrix

GEAR-PRESSURE MATRIX		Pressures					
		P1	P2	P3	P4	P5	P6
Fishing gears	Line	Unlikely	Possible	Probable	Unlikely	Unlikely	Probable
	Longline	Unlikely	Possible	Probable	Unlikely	Unlikely	Probable
	Gillnet	Possible	Possible	Probable	Possible	Unlikely	Probable
	Shore operated stationary lift net	Unlikely	Unlikely	Probable	Unlikely	Unlikely	Probable
	Illegal trawling	Probable	Probable	Probable	Probable	Probable	Probable
	Illegal beam trawling	Probable	Probable	Probable	Probable	Probable	Probable
	Illegal spear fishing	Unlikely	Unlikely	Probable	Unlikely	Unlikely	Possible
	Illegal sea cucumber collection (by diving)	Probable	Unlikely	Probable	Unlikely	Unlikely	Possible

Pressures	
P1	Benthic habitat destruction (fishing gear)
P2	Benthic habitat destruction (anchorage)
P3	Biomass removal (both targeted and non-targeted species)
P4	Marine litter produced by fishing activities
P5	Ghost fishing
P6	Interaction with species

The potential interactions of the fisheries and determined habitats were assessed in the habitat-pressure matrix (**Table-37**). All habitat types –except for semi dark habitats (MB1.56)– were assessed as likely to be impacted by fishing gears used.

Table 37
Habitat-pressure matrix

HABITAT-PRESSURE MATRIX		Pressures				
		P1	P2	P3	P4	P5
Habitats	MB1.5 Infralittoral rock	Probable	Unlikely	Probable	Unlikely	Probable
	MB1.51 Algal-dominated infralittoral rock	Probable	Unlikely	Probable	Unlikely	Probable
	MB1.51a Well illuminated infralittoral rock, exposed	Probable	Unlikely	Probable	Unlikely	Probable
	MB1.51c Well illuminated infralittoral rock, sheltered	Probable	Unlikely	Probable	Unlikely	Probable
	MB1.52 Invertebrate-dominated infralittoral rock	Probable	Unlikely	Probable	Unlikely	Probable
	MB1.52a Moderately illuminated infralittoral rock, sheltered	Probable	Unlikely	Probable	Unlikely	Probable
	MB1.53 Infralittoral rock affected by sediments	Probable	Probable	Probable	Unlikely	Probable
	MB1.56 Semi-dark caves and overhangs	Unlikely	Unlikely	Probable	Unlikely	Unlikely
	MB2.54 Posidonia oceanica meadows	Probable	Probable	Probable	Unlikely	Unlikely
	MB3.5 Infralittoral coarse sediment	Probable	Probable	Probable	Unlikely	Unlikely
	MB3.53 Infralittoral pebbles	Probable	Probable	Probable	Unlikely	Unlikely
	MB4.5 Infralittoral mixed sediment	Probable	Probable	Probable	Unlikely	Unlikely
	MB5.5 Infralittoral sand	Probable	Probable	Probable	Unlikely	Unlikely
	MB5.52 Well sorted fine sand	Probable	Probable	Probable	Unlikely	Unlikely
	MB6.5 Infralittoral mud sediment	Probable	Probable	Probable	Unlikely	Unlikely

11.2.2. Spatial Dimension of the Fisheries-Habitat Interactions

Gillnets and trammel nets, which are used in the commercial fishing (**authorized fishing**), were considered to have potential impacts on the seabed habitats. For this reason, their density was quantified as high, moderate and low within each grid cell (**Figure-153**). The map shows that there is a high concentration around the archipelago region, and a moderate density trough the northern coasts. After overlaying this grid data to the determined habitat types, the vulnerability of each habitat type to commercial fishing was determined in the same scale as high, moderate and low (**Figure-154**).

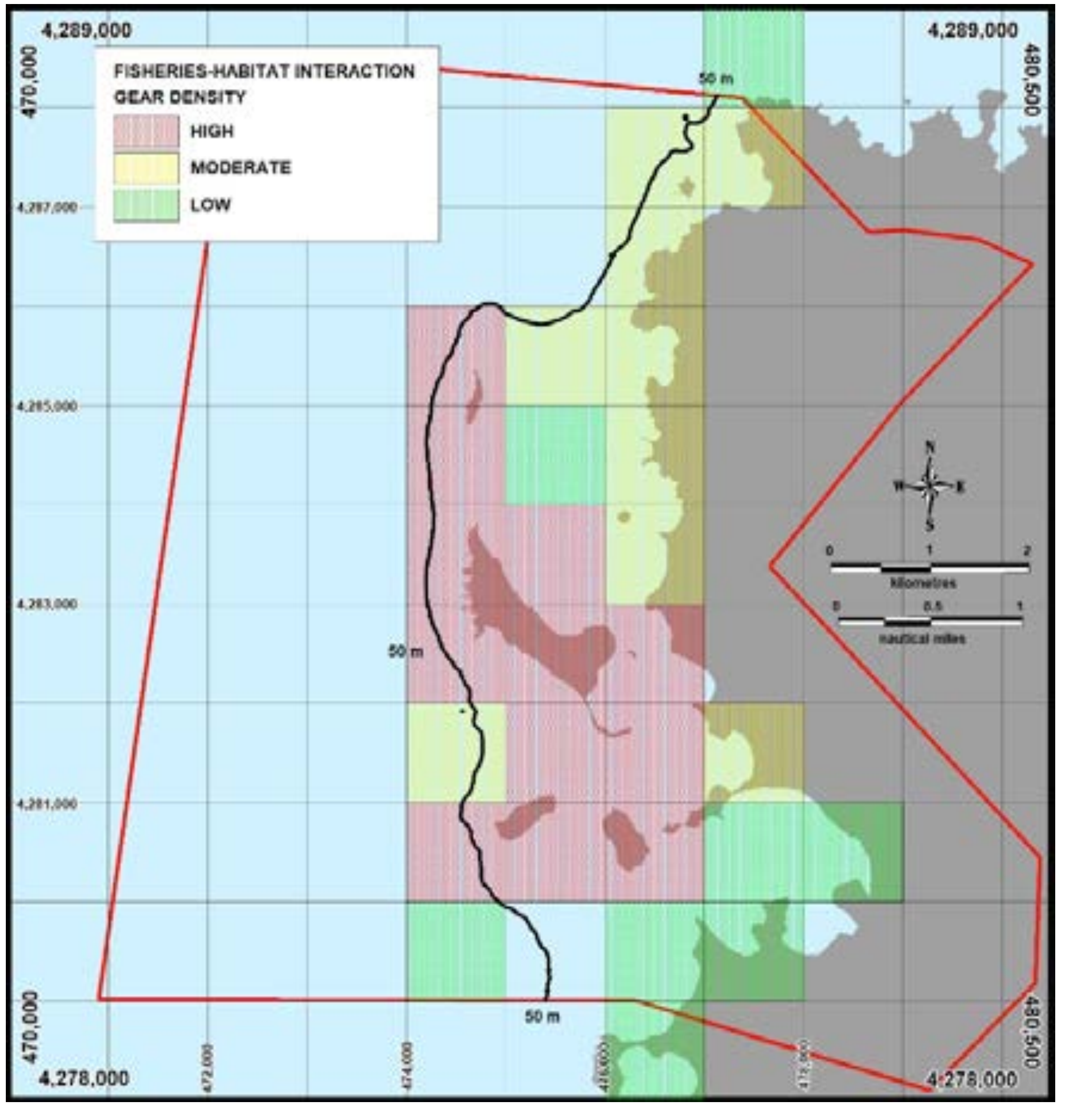


Figure-153
Map of gear density (commercial)

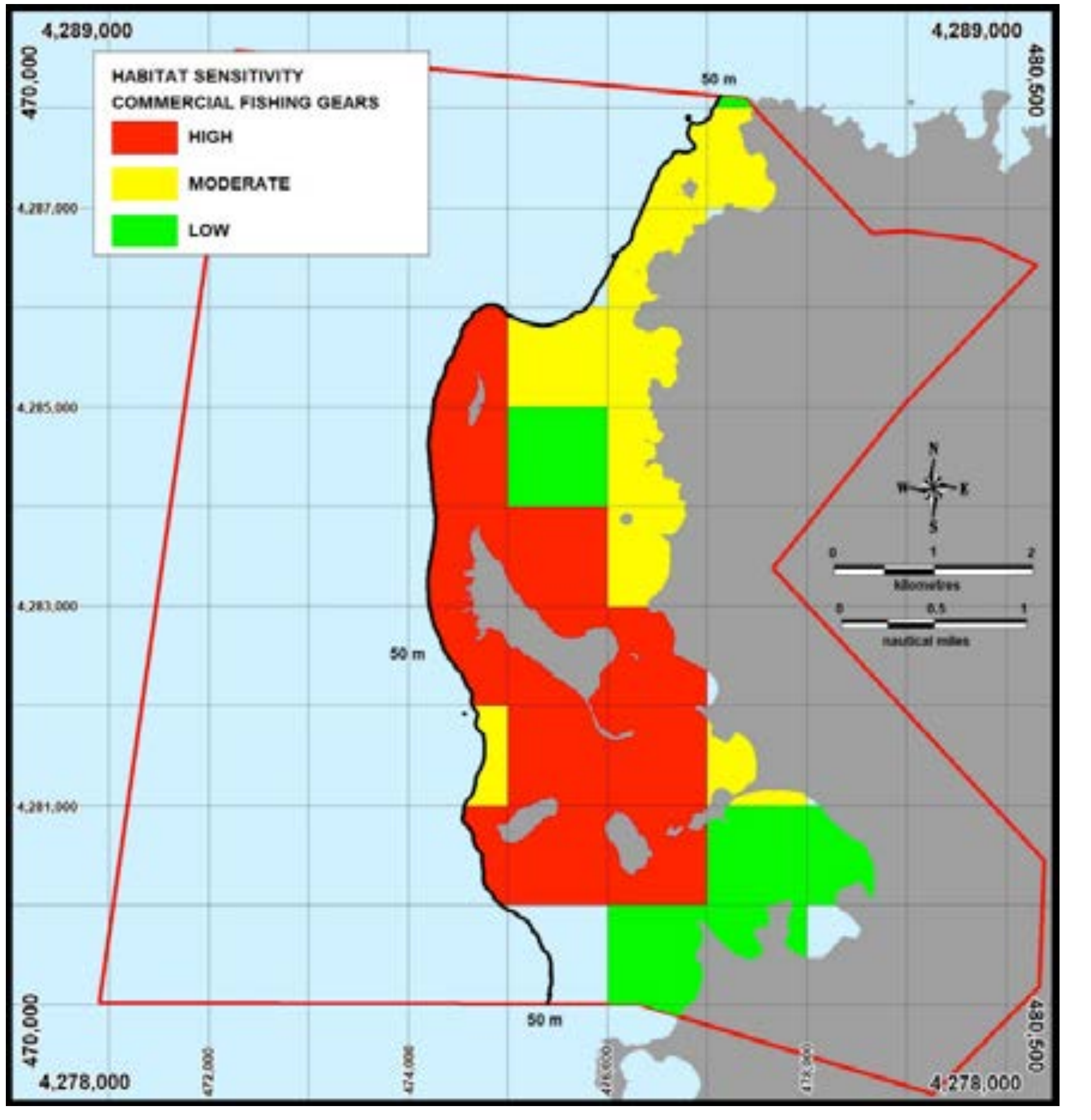
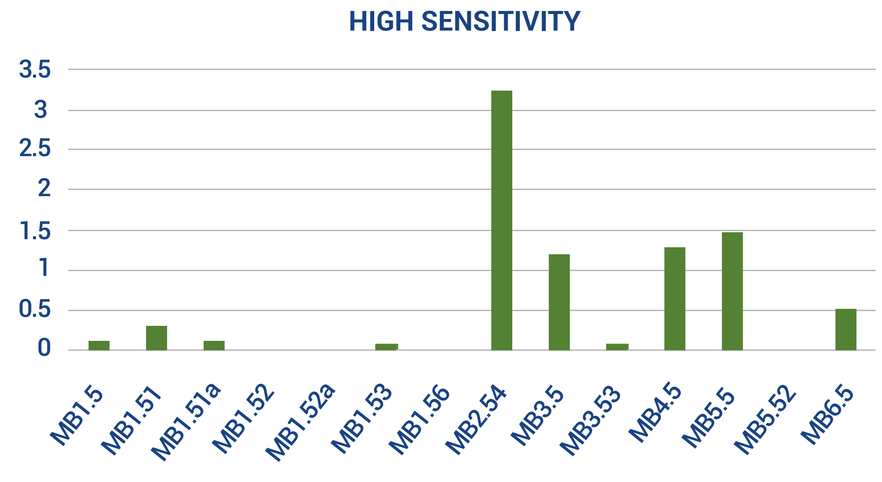
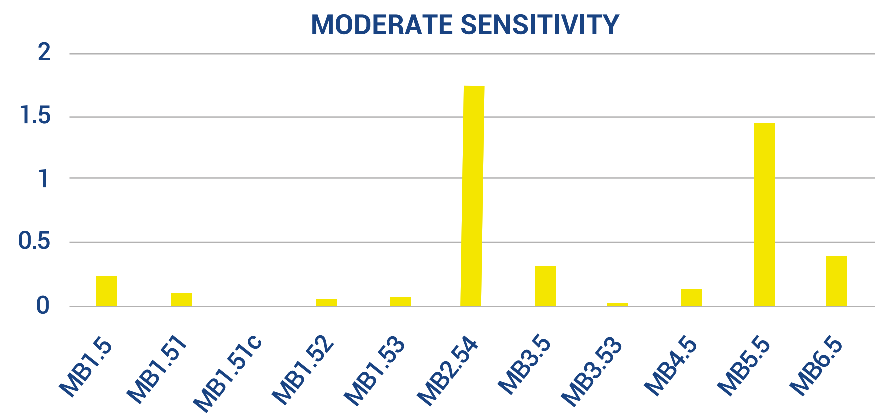


Figure-154
Habitat sensitivity to commercial gear use (legal)

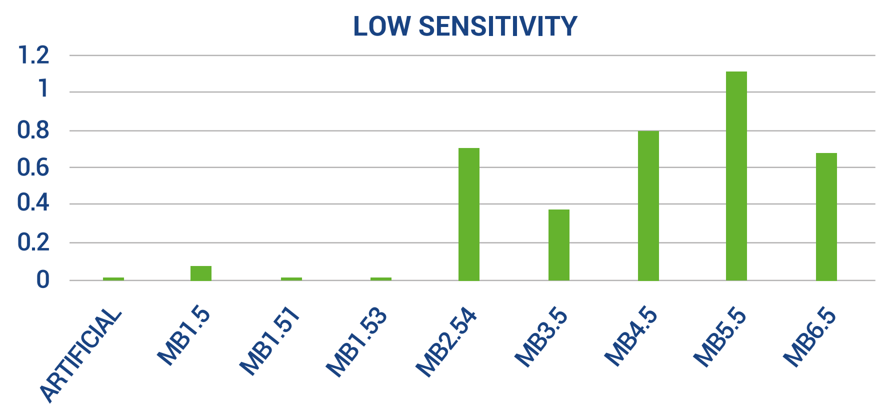
8.48 km² of habitats (14 types) have a high sensitivity, 4.57 km² of habitats (12 types) have a moderate sensitivity and 3.76 km² of habitats (8 types) have low sensitivity to commercial legal fishing activities in the area (Figure-155).



Habitat	A (km²)
MB1.5	0.123932
MB1.51	0.293971
MB1.51a	0.121125
MB1.52	0.011772
MB1.52a	0.018104
MB1.53	0.077154
MB1.56	0.000421
MB2.54	3.231294
MB3.5	1.209907
MB3.53	0.084367
MB4.5	1.289610
MB5.5	1.493313
MB5.52	0.015284
MB6.5	0.505944
Total	8.476197



Habitat	A (km²)
MB1.5	0.239563
MB1.51	0.107967
MB1.51c	0.013745
MB1.52	0.053719
MB1.53	0.075619
MB2.54	1.750284
MB3.5	0.324476
MB3.53	0.018503
MB4.5	0.141803
MB5.5	1.450545
MB6.5	0.398377
Total	4.574600



Habitat	A (km²)
ARTIFICIAL	0.004806
MB1.5	0.073431
MB1.51	0.005106
MB1.53	0.008742
MB2.54	0.702330
MB3.5	0.375712
MB4.5	0.801484
MB5.5	1.113528
MB6.5	0.676567
Total	3.761706

Figure-155

Habitat types, their sensitivity to legal fishing activities and coverages in km²

The same procedure was applied to illegal fishing practices trawling, beam trawling and sea cucumber collection and illegal fishing density (Figure-156) and sensitivity of habitats to these activities (Figure-157) were obtained. The sensitivity of habitats is found to be high in the southern part of the SEPA.

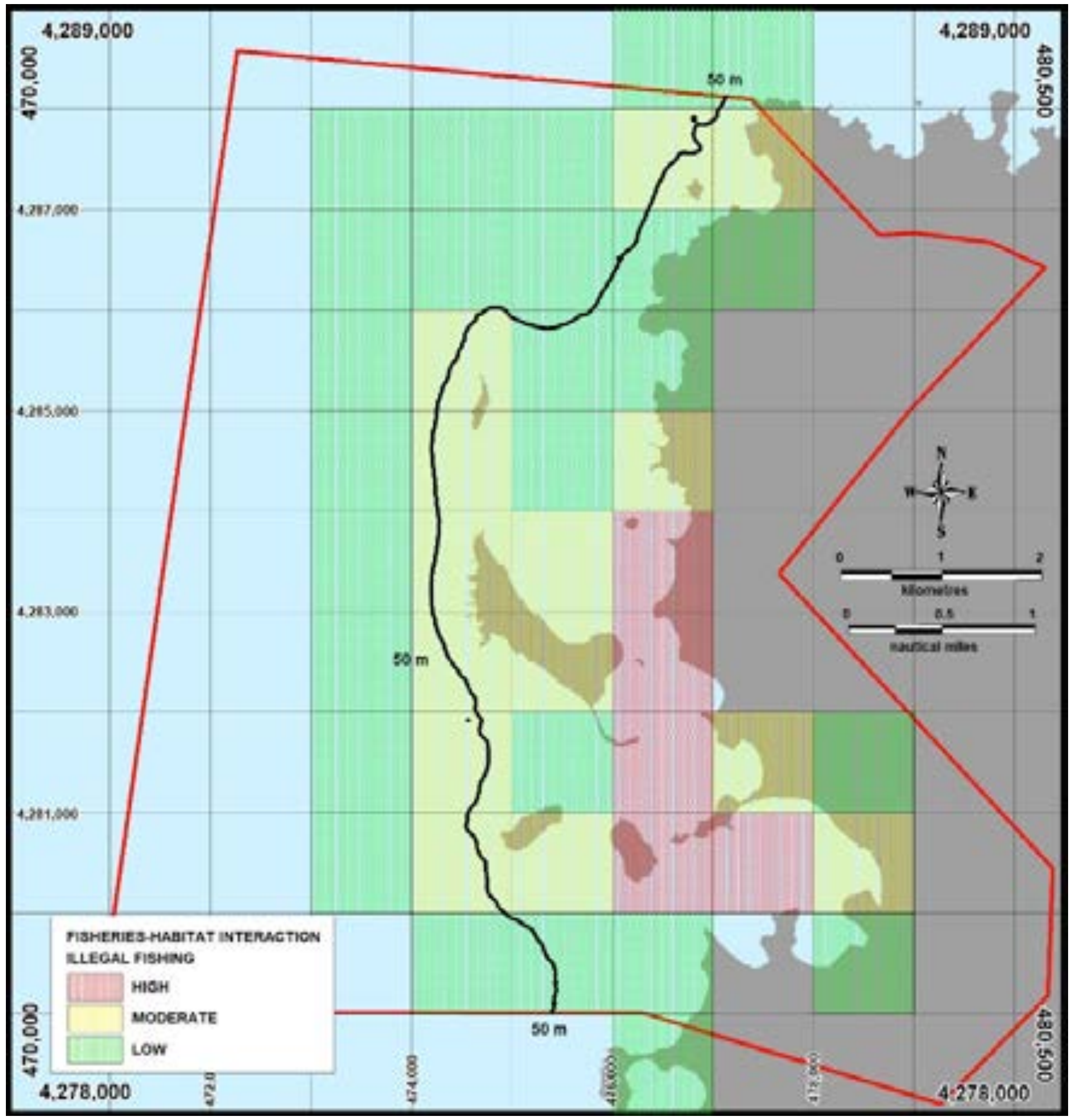


Figure-156

Map of illegal fishing density

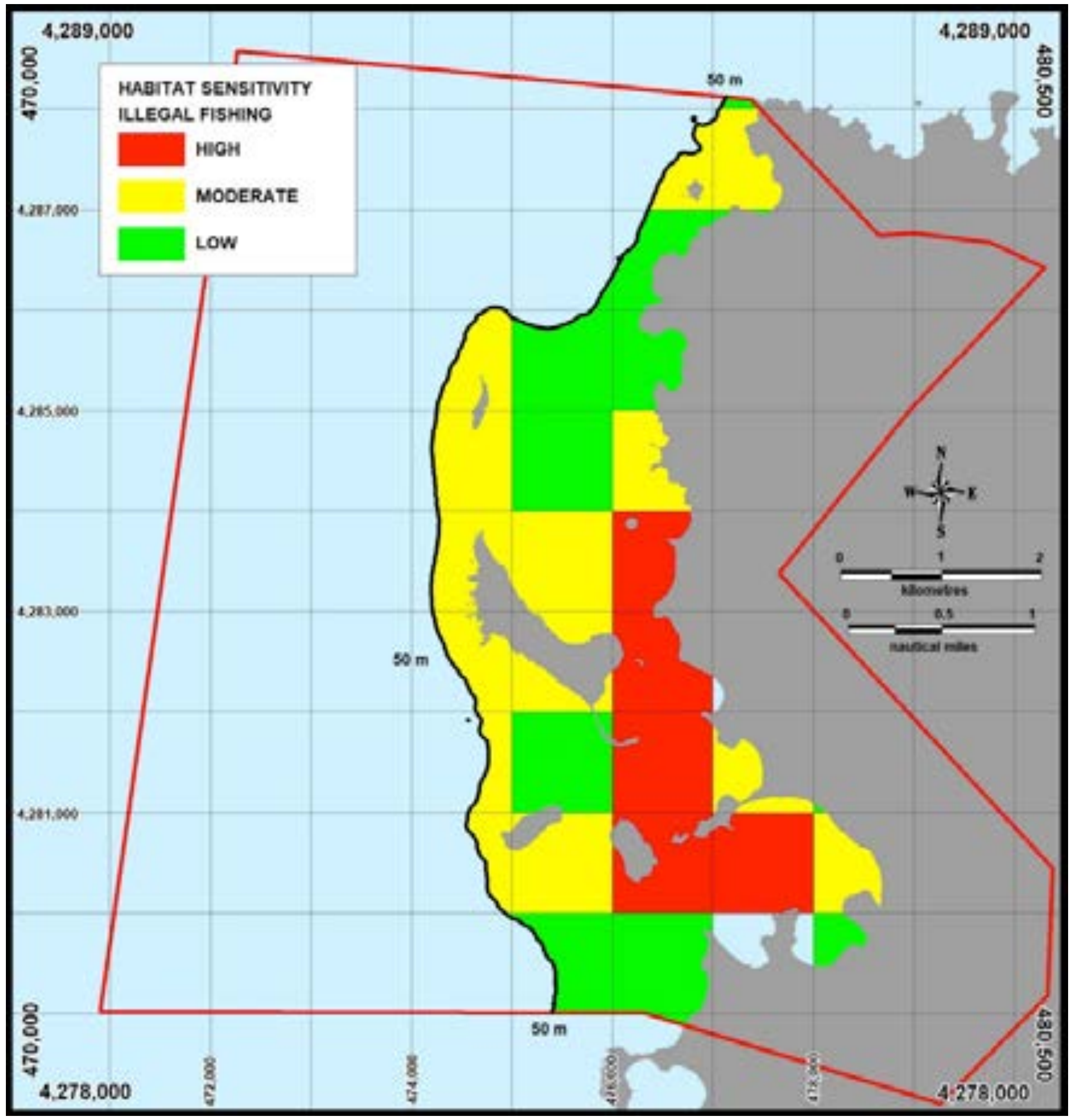
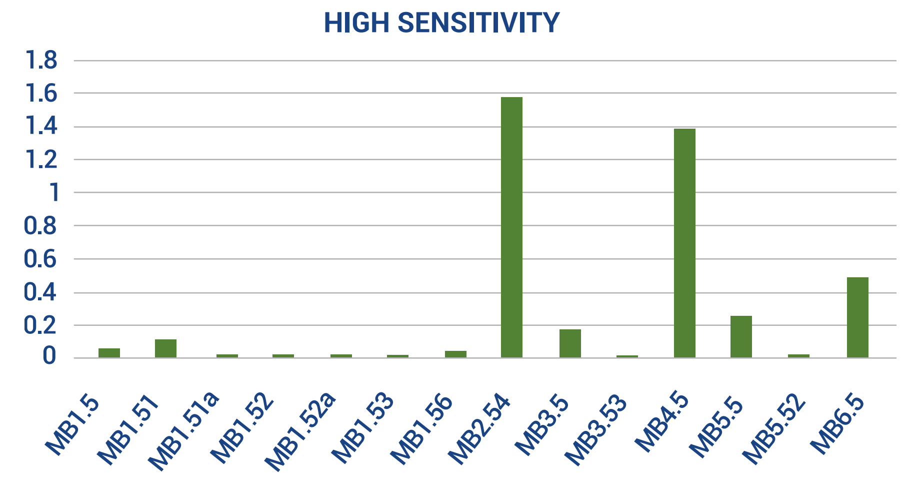


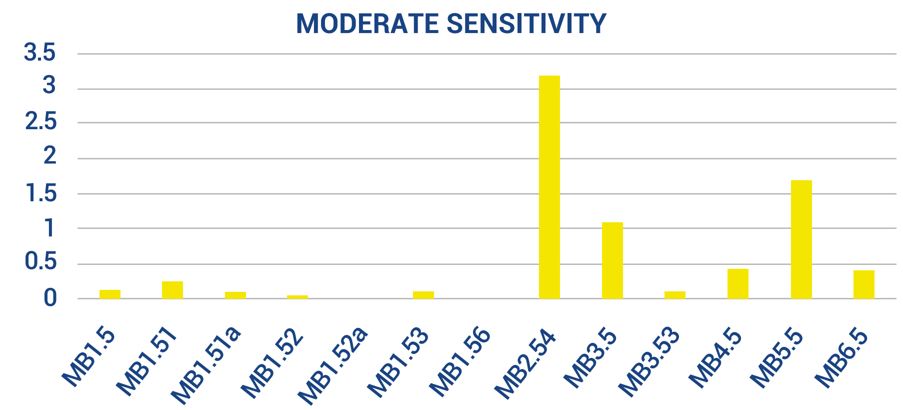
Figure-157

Habitat sensitivity to illegal fishing

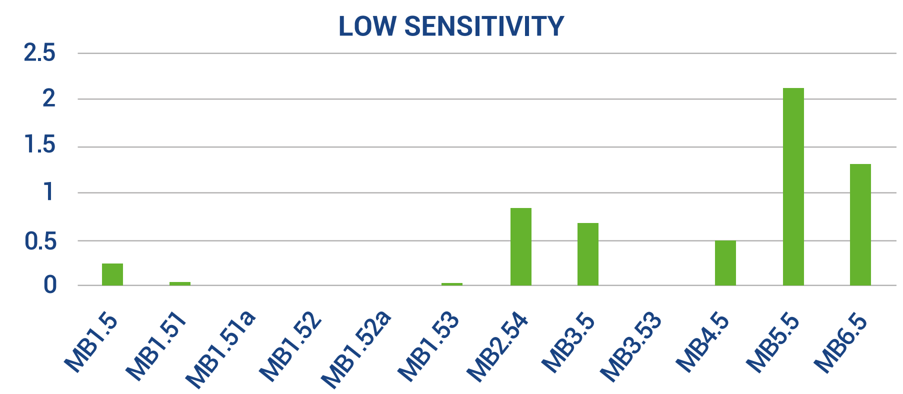
4.10 km² of habitats (14 types) have a high sensitivity, 7.47 km² of habitats (13 types) have a moderate sensitivity and 5.85 km² of habitats (12 types) have low sensitivity to illegal fishing activities in the area (Figure-158).



Habitat	A (km²)
MB1.5	0.076075
MB1.51	0.100407
MB1.51a	0.005702
MB1.51c	0.013745
MB1.52	0.011772
MB1.52a	0.007364
MB1.53	0.041578
MB2.54	1.570792
MB3.5	0.149958
MB3.53	0.001906
MB4.5	1.383877
MB5.5	0.246051
MB5.52	0.015284
MB6.5	0.476643
Total	4.101153



Habitat	A (km²)
MB1.5	0.118042
MB1.51	0.249196
MB1.51a	0.100777
MB1.52	0.053703
MB1.52a	0.000906
MB1.53	0.085367
MB1.56	0.000421
MB2.54	3.166766
MB3.5	1.080962
MB3.53	0.091949
MB4.5	0.432295
MB5.5	1.685076
MB6.5	0.399768
Total	7.465228

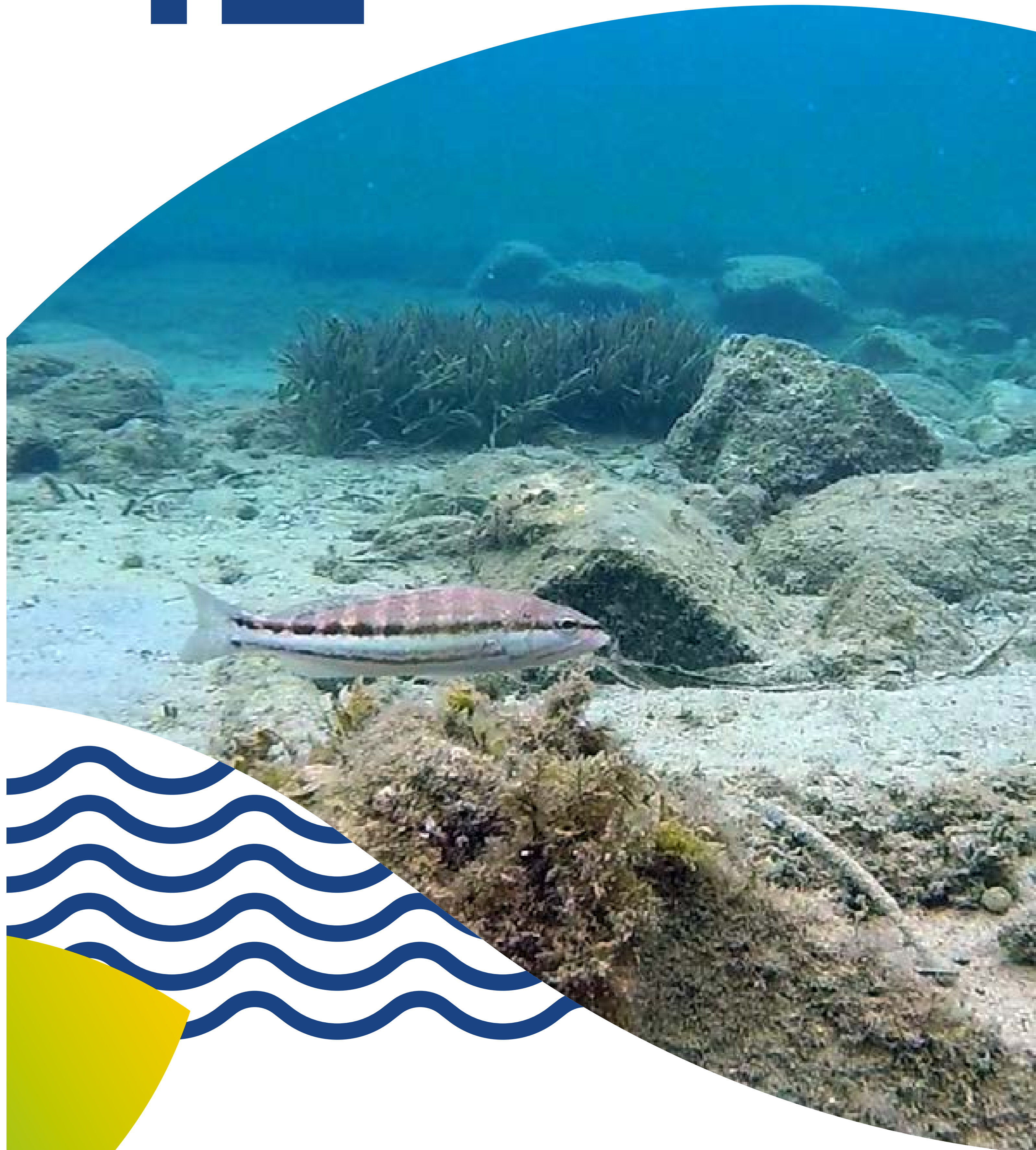


Habitat	A (km²)
MB1.5	0.254594
MB1.51	0.054312
MB1.51a	0.014646
MB1.52	0.003011
MB1.52a	0.009835
MB1.53	0.040436
MB2.54	0.850230
MB3.5	0.690502
MB3.53	0.009015
MB4.5	0.488181
MB5.5	2.117345
MB6.5	1.312913
Total	5.845020

Figure-158

Habitat types, their sensitivity to legal fishing activities and coverages

12



12 CONCLUSIONS AND RECOMMENDATIONS

12.1. Main Conclusions of the Study

Foça SEPA is one of the 12 coastal/marine Special Environmental Protection Areas of (Annex-3). Although it has typical Aegean coastal ecosystem features, it also has some site specific differrences. Its location is at the entrance of one of the largest bays of the Aegean Sea where the second largest river of the Aegean Sea –Gediz River– flows in. That's why historically it was once the one of the few spots in the Aegean Sea, where the longest food chain could be constructed up to the marine mammals, i.e., inhabited by once one of the largest monk seals colony. Today, it has still preserved most of its ecosystem components in spite of being exposed several anthropogenic pressures such as tourism, fisheries, agricultural effluents and maritime activities. It is therefore that the core part of the coastal ecosystem is proclaimed as SEPA.

Today, the monk seals have lost their capacity to maintain their population at a colony level, but they are still inhabiting in the Foça SEPA. The species and habitat diversity are fairly high relative to the similar ecosystems in the Aegean Sea, as demonstrated by the results obtained in this study. Thus, it still has specifications for being defined as one of the Key habitats of the Mediterranean Sea. Currently, the main challenge is to maintain, or even improve, its status, as much and long as possible. Moreover, it has a particular significance for contributing to scientific efforts on the protection of *P. oceanica* meadows in the Mediterranean since the existing meadows have been exposed to different degree of pressures at different sectors of the SEPA. Such differentiated pattern of meadow distribution offers opportunity for designing efficient monitoring activities, which enables to assess the impacts of pressures on meadows as well as the determination of best possible responses as one of the main pillar of the SEPA management plan. The meadows, together with their biological communities, provides the most representative indicators for achieving Good Envrionmental Status (GES). One other important complementary monitoring activity has to be focused on an obvious external threat, i.e., Non-indigenous Species (NIS). Their failures or successes to play a prominent role in the existing ecosystem of the Foça SEPA, is another important criterion for the evaluation of SEPA ecosystem with respect to GES, and they are not only limited with those competing with *P. oceanica*, but also the macrobenthic invertebrates and nectonic species have to be included.

12.1.1. Habitats

15 EUNIS marine habitat types, covering a total area of 17.77 km^2 between 0-50 m depth interval, were determined and mapped in the study. These habitats lay over a complex geomorphology of the archipelago structure within the Foça SEPA marine area. There are shallow zones (0-25 m depth) in the middle and southern parts of the SEPA, between Orak Island and the mainland. The slope of the seabed gets higher to the north and to the west of the islands. Consequently, this bathymetric structure involves various geomorphological units as hard, sandy, muddy bottoms with *P. oceanica* meadows.

The habitat types determined in the present study belong to infralittoral rock, infralittoral biogenic habitat (***Posidonia oceanica*** meadows), infralittoral coarse sediment, infralittoral mixed sediment, infralittoral sand and infralittoral mud sediments (Figure-159). The majority of the habitats mapped are ***P. oceanica*** meadows and infralittoral sand habitats, with around 32% and 23.6% distribution percentages, respectively. All determined habitat types, except for MB3.53 Infralittoral pebbles, are listed in the "Draft Updated Reference List of Marine Habitat Types for the for the Selection of Sites to be included in the National Inventories of Natural Sites of Conservation Interest in the Mediterranean" (UNEP/MAP, 2019). The piers of the Foça fishing port were assigned as artificial structures in the habitat classification since these areas were modified with coastal structures.

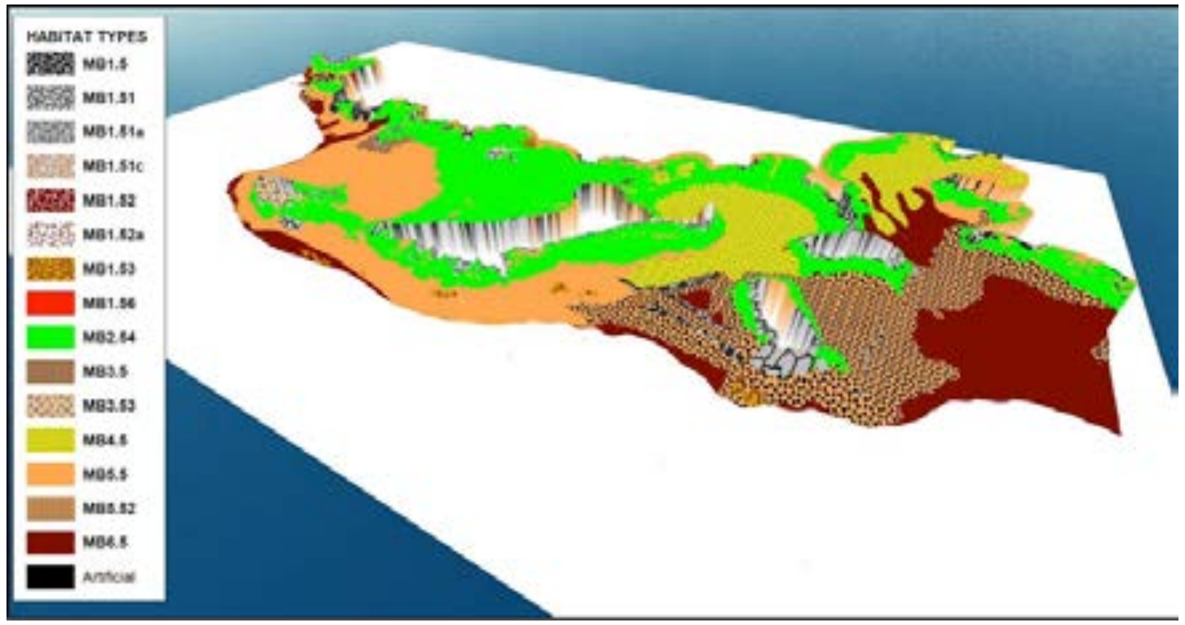


Figure-159
3D view of the habitats of Foça SEPA

There are important rocky habitats in the Foça SEPA, which are generally algal-dominated. In the deeper zones, there are rocky formations affected by sediments. These rocks in these sedimentary or hard bottom (whichever is higher in the area coverage in distribution) habitats were observed to host Axinella sponges and Brown meagre (***Sciaena umbra***) (e.g. between Fener and İncir Islands), other sponge and coralligene species (e.g. between Hayırsız and Orak Islands). The *Posidonia* meadows have a distribution throughout all coasts, except for the inner part of the port and western coast of the Fener Island. Other parts are formed by sedimentary structures such as sands, mixed sediments and muds. There are semi-dark habitats (caves) at the islands, which are also very important for the local Mediterranean monk seals.

The depth limit of the *Posidonia oceanica* increases to the north. In the fieldworks, the southern part (to the south down to Orak Island which are port and the marine discharge areas) were observed to have high turbidity. Long-term turbidity diminishes the light penetration, and this causes the decrease in photosynthetic activity. Nutrient enrichment triggers the phytoplankton blooms; this causes high epiphytic biomass on *P. oceanica* leaves. *P. oceanica* meadows are very sensitive to water and sediment enrichment with organic matter and nutrients. This occurs through a series of cascade effects. When dissolved nutrients are high, epiphytic algae grow much faster and shadow the seagrass leaves, reducing seagrass light harvest and enhancing leaf grazing (Ruiz et al. 2001). Together with trawling, nutrient loading is the greatest cause of deterioration in seagrass beds. Therefore, untreated sewage outlets, fish-farm effluents or runoff from fertilized agricultural areas are serious threats to neighboring *P. oceanica* meadows (Marbà et al. 2002).

P. oceanica is an endemic seagrass species in the Mediterranean Sea, which forms dense meadows. These meadows have high biodiversity and important ecological functions. They are under conservation of EU Habitat Directive (Dir 92/43/CEE) and adopted as a priority habitat (Diaz & Duarte, 2008). Their decline was started since 1970s because of pollution, eutrophication, sedimentation, coastal construction, trawling, anchoring, NIS and nowadays climate change. Sedimentation also have negative effects on *Posidonia* meadows because of burial of the rhizome and the root system. Besides, producing anoxia and increasing sulphate-reduction rates in the sediment. The excess hydrogen sulphide rapidly reacts with oxygen pumped through the seagrass roots, and may even penetrate the plant tissues, enhancing *P. oceanica* mortality (Frederiksen et al. 2007). Trawling is one of the most important causes of large-scale degradation of *P. oceanica* meadows, particularly in deep meadows (Ardizzone and Pelusi 1984, Erftemeijer and Robin Lewis 2006). This fishing technique can pull up *P. oceanica* leaves and rhizomes (100,000 to 360,000 shoots hour^{-1}) (Martín et al. 1997), largely reducing plant density and cover.

In general, the shallow habitats (between 0-10 m depth) were observed to be damaged by the human activities. In other parts of the Foça SEPA, the habitats were observed to be healtier. The damaged areas are densely used by marine vessels for sheltering and therefore anchoring is one of the pressure on the marine habitats.

Coastline constructions and river-flows, increases the sediment inputs to the submersed coastal habitats, thereby promoting meadow erosion in their area of influence. Piers and other coastal constructions destroy the underlying communities. In sites frequently visited by pleasure boats, there is significant removal of seagrasses by boat anchors (Francour et al. 1999). Also, moorings consisting of a dead weight lowered to the seabed, attached to a partially crawling chain form characteristic bare circle in *P. oceanica* meadows. These clearings persist for many years. If the anchoring density and frequency are too high, the subsequent erosion may be accelerated by enhanced hydrodynamics (Diaz & Duarte, 2008).

The distribution of NIS shows a great acceleration due to reasons such as increased transportation and opening channels, aquaculture activities, climate change etc. These species have negative effects on native species. 100 non-indigenous macrophytes have been introduced to the Mediterranean Sea in last decades, which at least 10 were invasive (Ballesteros, 2007). *Caulerpa taxifolia* and *C. cylindracea* have affected *P. oceanica* meadows. They couldn't compete with healthy *P. oceanica* meadows. However, if the situation deteriorates, they immediately substitute. Also, some mucous forming invasive algae creates dense populations on *P. oceanica* meadows for 1 to 3 months and reduce the light intensity (Lorenti et al., 2005).

Conservation management is mainly focused on protective measures through the installation of artificial reefs and seagrass-friendly moorings for boats, in order to reduce the erosive pressure of otter-trawling and free anchoring in shallow meadows. The control of invasive especies (*Caulerpa taxifolia*, *C. racemosa*) has also been performed recurrently in some *P. oceanica* beds. There is a need to further develop regulations for activities that have a negative impact on the *Posidonia* beds and other coastal ecosystems (e.g. pollutants level limits and allowed minimum distances of impact sources to meadows) and to implement it through the setting of a vigilance system. Such system could be coordinated with the seagrass monitoring networks already in place. Seagrass monitoring is a fundamental tool for measuring the status and trends of meadows and is also essential to assess the effectiveness of any protective or recovery initiatives. The number of monitoring programmes on *P. oceanica* meadows has increased in recent years. Monitoring of the upper and lower meadow limits delivers robust indicators of overall meadow distribution as most stresses will usually be detected first along meadow borders (water clarity affects the limit of depth and erosion or burial affects the upper limit).

The deep meadow limit is a comprehensive indicator and has a high priority in monitoring programs as it can help assess the effects of eutrophication and siltation on *P. oceanica* meadows. However, when meadows reach their deepest species range (45m in the clearest Mediterranean waters), monitoring may require the use of professional divers (Diaz & Duarte, 2008).

It also worths to mention that there are two unique features in the Foça SEPA, one in the south of the Hayırsız Island and one in the south of the Orak Island, which also gives its Turkish name to this island with its "sickle" shape (Figure-160). These features are important not only for the habitats they include, but also for their geomorphological formations.

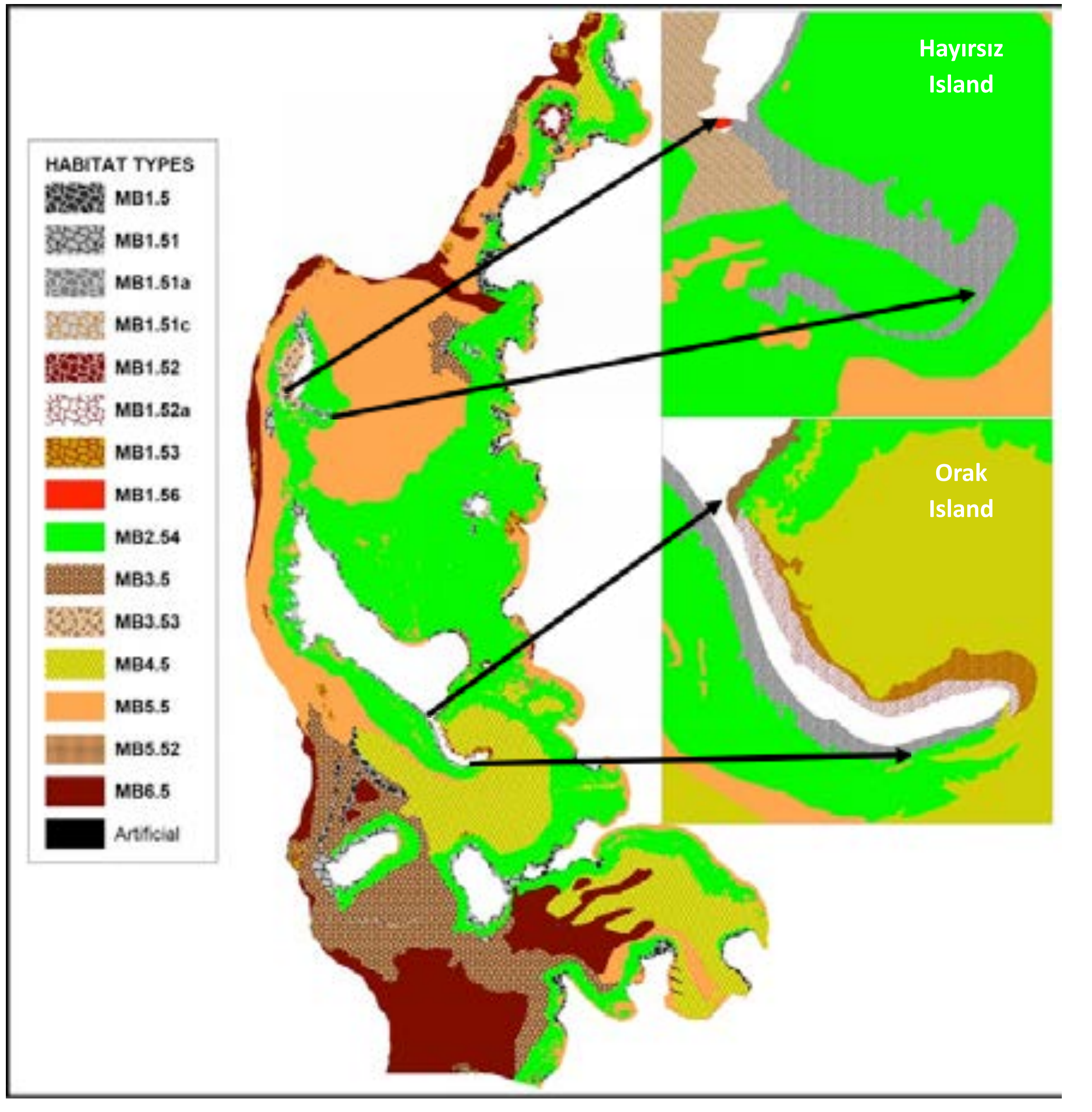


Figure 160

The unique geomorphological features in Hayırsız and Orak Islands

12.1.2. Benthos

The faunistic analysis of the benthic samples collected from 8 soft bottom stations (15-25 m) at the coast of Foça SEPA yielded a total of 303 species and 4821 individuals belonging to 12 systematic groups (Porifera, Cnidaria, Plathelminthes, Nemertea, Nematoda, Polychaeta, Sipuncula, Crustacea, Mollusca, Bryozoa, Echinodermata, and Tunicata). Mollusca had the highest number of species (128 species) and individuals (2447 individuals, 50.8%) on the soft bottom samples. The highest number of species and individuals in the study area was encountered at the station B3-P (142 species, 1359 individuals); the lowest number of species and individuals at the stations B4-P (57 species, 191 individuals) and B5-S (63 species, 260 individuals).

The dominant species and groups in the study area were *Bittium reticulatum* (Mollusca, 17.5%), Nematoda (spp.) (Nematoda, %6.3), Ostracoda (Crustacea, % 3.4), *Alvania geryonia* (Mollusca, %3.1), *Chondrochelia savignyi* (Crustacea, %2.9), *Pusillina radiata* (Mollusca, %2.7) and *Syllis garciai* (Polychaeta, %2.5). *Syllis garciai* (Polychaeta), *Lysidice unicornis* (Polychaeta) and *Bittium reticulatum* (Mollusca) were observed at all sampling stations.

In the results of Bray-Curtis Similarity Index, two main groups were distinct among stations. The first group composed of 4 soft bottom stations (B4-S, B5-S, B6-S and B7-S), has more than 30% of similarity value. The second group formed by stations (B1-P, B3-P, B4-P and B11-P) selected from *Posidonia oceanica* meadows.

Diversity index values were generally found above 3 for all stations. The lowest diversity index value (H'= 2.97) in the area was calculated at B6-S while the highest value (H' = 3.81) was found at the station B3-P. The evenness index values ranged from 0.65 (B6-S) to 0.91 (B4-P).

A total of 6 alien species (*Eocuma sarsii*, *Sticteulima lentiginosa*, *Syrnola fasciata*, *Leucotina natalensis*, *Pyrunculus fourierii* and *Septifer cumingii*) were recorded in the study area. *S. lentiginosa* and *S. cumingii* are classified as casual, while the other five alien species have become established in the area (Çinar et al., 2011). *Septifer cumingii* could have been introduced to the Mediterranean Sea by shipping, whereas five other alien species were the Lessepsian invaders (Çinar et al., 2011).

Cerithium vulgatum (Mollusca), which is protected species in the area according to national fishing regulation (Regulation No: 2016/35), was found at stations B4-S, B6-S and B7-S (T.R. Official Gazette, 13.08.2016, No: 29800). *Maja squinado,* which is in the list of species whose exploitation is regulated (Annex III of the SPA/BD Protocol of the Barcelona Convention), was represented by only one individual at the station B1-P (UNEP/MAP-SPA/RAC, 2012).

The percentage cover of organisms found in the quadrate (0.25 m^2) at 7 randomly selected hard bottom stations (7.5-25m) in the Foça SEPA were calculated using the photoQuad software program. According to the results of the analysis, species belonging to 7 taxonomic groups (Algae, Porifera, Cnidaria, Polychaeta, Mollusca, Echinodermata and Tunicata) were determined.

In the study area, epilithic algae was the dominant group in terms of the percentage cover of hard substrate organisms at all selected stations except HB-10. The percentage cover of this group which was followed by Corallinacea (spp.), changed between 31.8 % (HB-9) and 81.1 % (HB-2) at the stations. However, the coverage value of Corallinacea species reached to 66.9 % at HB-10 station where epilithic algal communities were not recorded. Almost at all stations (except HB-4) parts of the quadrate which were not covered by any organism or surfaces in the quadrate that were covered by muddy sediments were named as substratum. The coverage values of bare substratum at the stations, HB-1, HB-4, HB-10, HB-8 and HB-7, were quite high and changed between 6 % and 20 %.

Sea star *Echinaster sepositus* which is the most abundant species reported from the coralligenous habitat in Mediterranean Sea (SAP BIO, 2003), was only recorded at station HB-9. The erect sponges, *Axinella cannabina and A. polypoides* recorded at station HB-4 and HB-8, which is the most abundant species in the coralligenous from the eastern Mediterranean (SAP BIO, 2003) and is in the list of endangered or threatened species according to SPA/BD protocol (UNEP/MAP-SPA/RAC, 2018).

12.1.3. Fish & Fisheries

Within the boundaries of the Foça Special Environmental Protection Area, 25 fish species were observed by the underwater visual census method (UVC) at three (5-10-20 m) different depth strata. However, around 60 fish species have previously been reported from this region, as mentioned in the current project summary report (knowledge and gap analysis). According to Bilecenoğlu et al. (2014), around 450 species exist in the Aegean Sea and the diversity of fish species is in the range of 63-95 around Izmir Bay, where Foça is also located, and 30-41 species along the coast of Foça (Figure-161). In comparison, the number of species observed in the present study is low. This may be because all of the observations were made during a short time period of only three days. In addition, the diving depth was restricted to 20 meters, and there was a limited number of stations. All of these factors may have contributed to the non-observation of a number of species. However, overfishing pressure via illegal spear fishing may also have affected the Foça Special Environmental Protection Area. Species that are "popular" among spear fishers, such as grouper and common dentex, were notably missing from observations and this may be a strong indicator of overfishing.

Only a single grouper was observed during the three-day period and the observation was made by the team that was carrying out other underwater studies in the same area. The intense amateur fishing pressure on the coast of Foça is well known. Therefore, it is prudent and urgent that measures are taken to ensure sustainability by controlling the pressure caused by both commercial and amateur fishing.

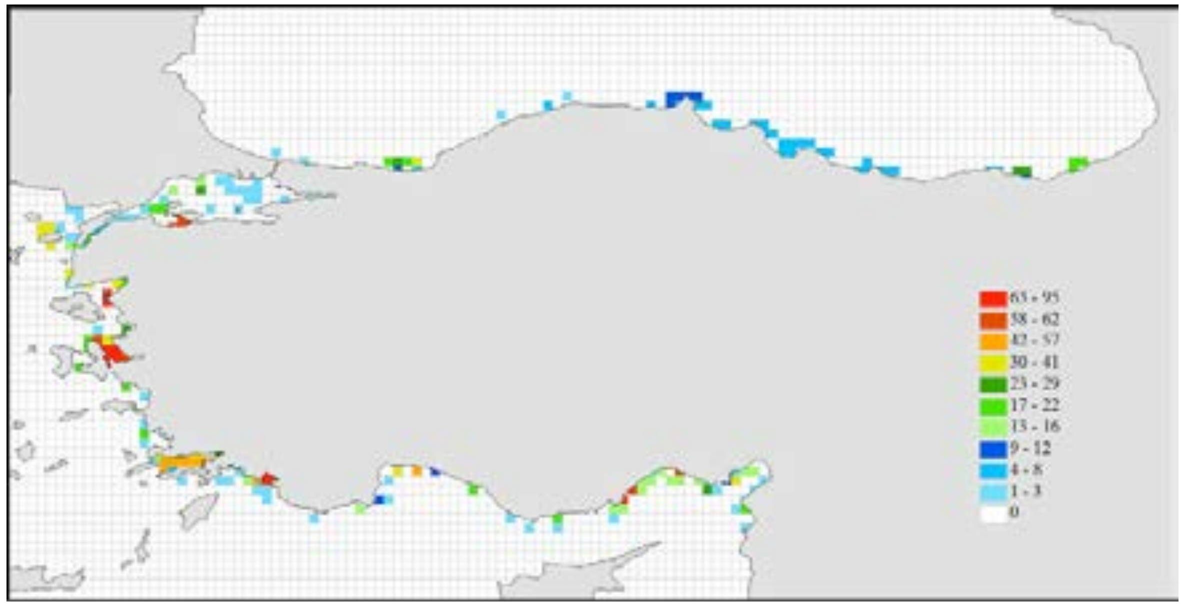


Figure-161

Numerical distribution of fish species recorded in coast (Source: Bilecenoğlu et al., 2014)

12.1.4. Fisheries Socio-Economics

The fishers in the Foça SEPA were mostly middle aged and all were men. Their level of education was generally quite low. More than two-thirds of the fishers owned or rented their homes. Only 54% of the fishers had social security. About a fourth of them owed this fact to already being retired. Those fishers were also receiving retirement benefits in addition to their income from fishing. The remaining fishers stated that their income from fisheries activities was insufficient to obtain social security. 67% of the fishers said that the income from fishing was insufficient to make ends meet and that they had to get additional income from other employment in the private (Agriculture, carpentry, tourism, diving, electrician, repairs) or in the public (Municipality and military) sectors. Financial struggles were generally due to the continuously rising prices of oil and lubricants, new fishing gear, maintenance and mending of gears, boats and engines as well as for bait used in fishing. Support and subsidies offered by the government were largely considered inadequate and many felt that reasonable banking loans to individual fishers or cooperatives were lacking.

The small scale fishing fleet in the Foça SEPA consists of small boats between 5.6 and 8.8 m long, typically (83%) smaller than 7 m in length and commonly equipped with (≈50%) small engines of less than 10 hp. A great majority of boats are older than 10 years. The fleet uses both active and passive fishing gears. The active gears make up ≈38% of the total gears used in rules-based fishing in the area and include several types of lines; handlines, pole-lines and troll lines using various sizes and shapes of hooks with or without baits targeting diverse fish and cephalopod species.

The passive gears (62%) are set longlines, mostly stationary simple gillnets, but also trammel nets and combined gillnets-trammel nets. Encircling gillnets were also used occasionally by some fishers. In addition, a special fishing gear and practice, the stationary lift nets, is also used. 57% of fishers report the use of gear from at least two different gear categories in their fishing practices.

The size of the area used by the fishing fleet in the Foça SEPA resembles that of most other typical small scale fisheries practices in the Mediterranean. The fleet hardly exceeds 50 m depths and mainly concentrates on fishing close to the main land as well as around the small islands of Hayırsız in the north, Orak in the middle, and Fener and İncir Islands in the south.

12.1.5. Illegal Fishing

Illegal fishers in the Foça SEPA use three categories of fishing gear all of which are banned inside the SEPA: trawls, beam trawls, and spears. In addition, Sea cucumber collecting by diving does not involve any prohibited fishing gear but is only allowed with special permission from the Ministry of Agriculture and Forestry. Most kinds of illegal fishing activities are carried out covertly and are only occasionally observed by small scale fishers practicing rules-based fishing activities. In contrast, amateur or recreational fishing of fish beyond the legal limits and restrictions is no less illegal but is usually carried out in full view and is often a topic of complain among the small scale fishers in the Foça SEPA. Recreational fishing is very popular in the area and this may sometimes result in the overexploitation of some species and the generation of illegal profits (by violating the ban of selling fish caught through amateur fishing). The area used for illegal fishing practices are more or less the same as that used by rules-based fishing activities. Since the description of the distribution and intensity of illegal fishing activities provided in this study is based solely on information given by the small scale fishers, and since that information is limited to observed coincidences it is reasonable to assume that the amount of illegal fishing practices happening is significantly underestimated.

The adverse effects of illegal fishing referred to by the fishers in the SEPA included the depletion of commercial fisheries resources and the destruction of their habitat as well as damage to gears and a decrease in income for rules based commercial fishers. Also mentioned in this connection was the negative public image being formed concerning commercial fishers as well as the occasional threat of bodily harm directed towards rules based fishers.

According to the questionnaire survey, one of the major problems is the illegal fishing in the area. Illegal trawling is concentrated on the 50 m depth contour, whereas illegal beam trawling is dense in the area between Orak Island, Incir Island and the mainland. Illegal spear fishing is generally performed on the coasts away from the center (e.g. Hayırsız and Orak Islands). Illegal sea cucumber collection is another activity in the area and it is performed almost at all coasts of the SEPA. The fishermen of the Foça SEPA believe that although the existence of the protected area should be beneficial, they are not satisfied with the management of the SEPA.

12.1.6. Fishing-Species Interactions and Fishing Impacts on the Marine Habitats

An important conclusion of the questionnaire survey performed within the project was that fishing practices have interactions with cetaceans, Mediterranean monk seals, turtles, fish and seabird species in the Foça SEPA. Among these, cetacean and monk seal interactions are the most common and distributed ones. This shows that the previous pressure (Kaboğlu, 2007; Kaboğlu et al., 2016) continues on the endangered Mediterranean monk seal in the area.

The gear density of the commercial rules-based fishing is high around the islands resulting in a high sensitivity of the marine habitats in these areas. 8.48 km^2 of habitats (14 types) have a high sensitivity, 4.57 km^2 of habitats (12 types) have a moderate sensitivity and 3.76 km^2 of habitats (8 types) have low sensitivity to commercial legal fishing activities in the area. On the other hand, illegal fishing is dense between Orak and İncir Islands and the mainland, and the port area. 4.10 km^2 of habitats (14 types) have a high sensitivity, 7.47 km^2 of habitats (13 types) have a moderate sensitivity and 5.85 km^2 of habitats (12 types) have low sensitivity to illegal fishing activities in the area. This situation results in a distributed total pressure of the legal and illegal fishing among the habitats in the area.

When the sensitivity of habitats types to fisheries activities are considered, following outstanding conclusions are obtained for rules-based (legal) and illegal fishing practices:

- 51.8% of the hard bottom habitats (all MB1.5 classes) have high sensitivity, 39.3% of these habitats have moderate sensitivity to legal fishing.
- 56.8% of the *Posidonia oceanica* habitat (MB2.54) have high sensitivity, 30.8% of this habitat have moderate sensitivity to legal fishing.
- 47.5% of the coarse sediment to sandy habitats (MB3.5, MB4.5 and MB5.5 classes) have high sensitivity, 22.5% of these habitats have moderate sensitivity to legal fishing.
- 22.9% of the muddy habitats (MB6.5) have high sensitivity, 18% of this habitat has moderate sensitivity to legal fishing.
- 20.6% of the hard bottom habitats (all MB1.5 classes) have high sensitivity, 48.7% of these habitats have moderate sensitivity to illegal fishing.
- 27.6% of the *Posidonia oceanica* habitat (MB2.54) have high sensitivity, 55.7% of this habitat have moderate sensitivity to illegal fishing.
- 20.9% of the coarse sediment to sandy habitats (MB3.5, MB4.5 and MB5.5 classes) have high sensitivity, 38.2% of these habitats have moderate sensitivity to illegal fishing.
- 21.6% of the muddy habitats (MB6.5) have high sensitivity, 18.1% of this habitat has moderate sensitivity to illegal fishing.

Another important conclusion about the fisheries impacts on the marine habitats was the trawling damage observed on the seabed from SSS images. This has a correlation with the information on illegal fishing obtained from the questionnaire survey (Figure-162).

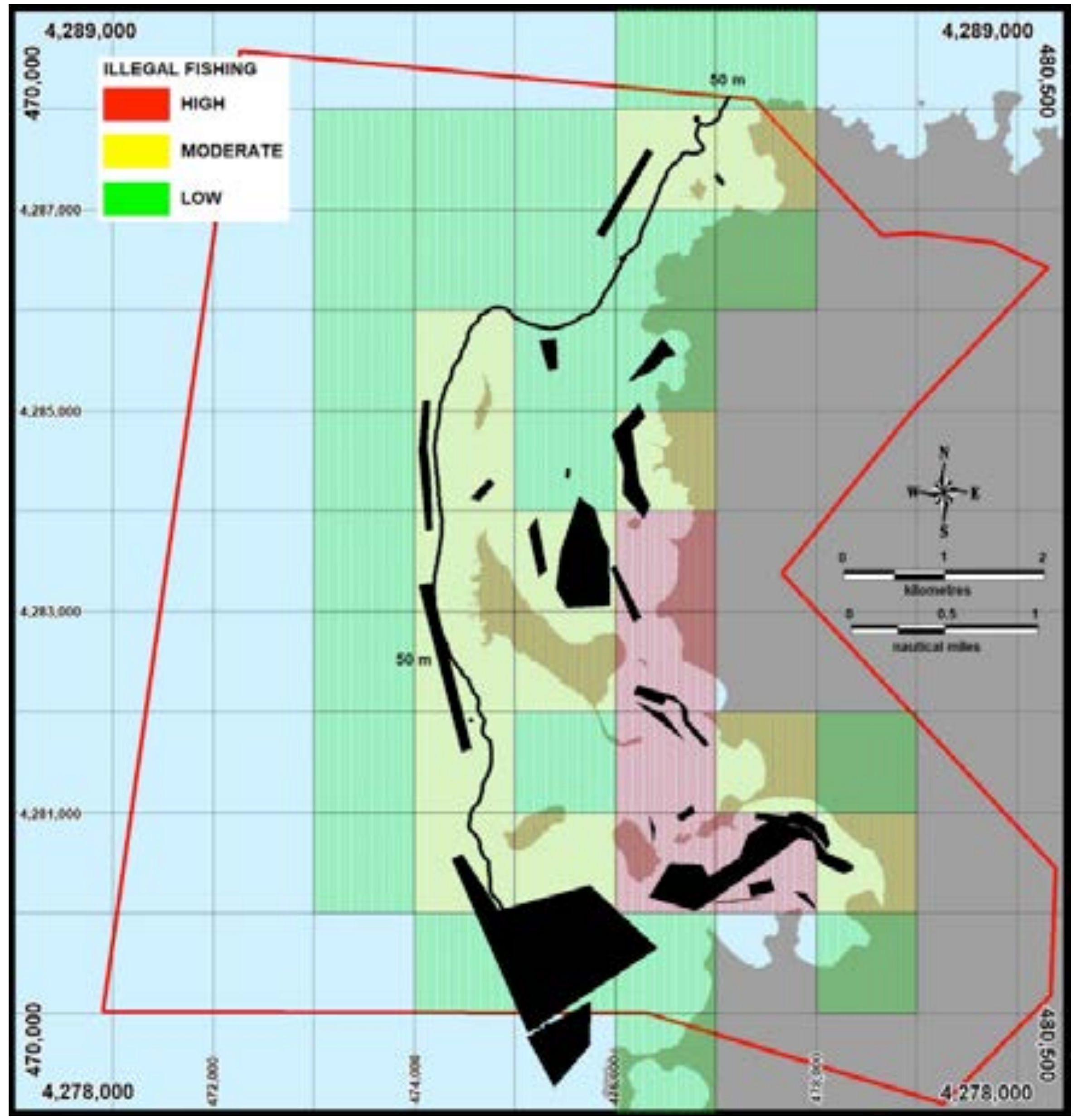


Figure 162

Trawling scars (black areas) on the seabed obtained from SSS images

12.2. Recommendations for the Protection and Management Measures to be Introduced in the Foça SEPA

- Monitoring activities should be planned and conducted within a programme in the Foça SEPA. The programme should be designed in accordance with the IMAP directives to monitor ecosystem elements (both ecological and social systems) in the area so as to detect both spatial and temporal trends. There are important hard bottom, semi-dark and *Posidonia oceanica* habitats at the Foça SEPA. These different habitat types should be monitored within a programme.
- It will be beneficial to maintain the controls and measurements of the established *P. oceanica* monitoring system. Four data loggers were placed upward at the 6th marker of each PoMS. Those loggers will collect temperature and light data in every hour. However, they have to be checked, data should be downloaded and they have to be cleaned at least every two months because of the light sensor. Otherwise, the fouling organisms could block the light sensor so the recorded data by the sensor could inaccurate. The first baseline measurements were done in November 2019. The long term monitoring plan should be programmed for further periods. The temperature and light loggers have to be checked and cleaned at least every two months to operate functionally and also download the data that they recorded. It is advised that, the measurements of the *P. oceanica* monitoring stations could be done at least yearly. The monitoring systems based upon *P. oceanica* are able to provide the decision makers useful, relatively inexpensive and easy to use tools to provide overall assessment of the quality of the marine environment. There were 2 monitoring stations established in 2008 (SAD, 2008; Akçalı et al., 2008). Unfortunately, these PoMS were not monitored in the following years. The PoMS set up in this project should not face the same fate with the previous ones.
- The source of high turbidity in the southern part should be determined. The anticipated sources are the Gediz River, the discharge and the port activities. After determination of the sources and their contributions to the total turbidity, appropriate management measures (e.g. to check the stability of the discharge, to monitor Gediz River flow, to monitor port activities) should be taken.
- Although Corallinacea species are more extended in the circalittoral zone, it can also develop in the infralittoral zone where there is enough dim light allowing them to grow. The main Corallinacea species are Lithophyllum (spp.), Mesophyllum (spp.), Neogoniolithon (spp.) and Peyssonnelia spp (UNEP-MAP, 2009; SAP BIO, 2003). The quality of coralligenous reefs, which are bioherm of the Mediterranean Sea and considered as biodiversity hotspots with numerous sessile and sedentary species (David et al., 2014), is accepted as an indicator of seafloor integrity according to the Marine Strategy Framework Directive (MSFD, 2008/56/EC). Therefore, the distribution of coralligenous habitat and associated species in the study area needs long term and wide range monitoring studies to assess the effects of different threats such as waste water, high sedimentation rate and invasive alien species.
- Erect species growing in coralligenous habitat such as *Axinella* spp. are fragile. The reduction of this kind of species due to physical damage such as fishing line, fishing net, anchoring and SCUBA diving cause biodiversity loss. This situation should be considered in conservation activities.
- The impacts of alien species on benthic communities should be monitored.
- The distribution of the protected species should be monitored.
- The harbors and islands are the regions that are under the over pressure of amateur fishing. In this context, fish populations appear quite worn out due to angler and spear fishing. The low individual number and small size of the existing species confirms this phenomenon. In a marine protected area like Foça, it is ineviTable to impose a quota and a ground ban on amateur fishing activities. According to the present (Notification of Amateur Fisheries) regulations, an amateur fisherman has the right to fish on a daily basis of 5 kg per day or limited number of according to target species. In the present regulation, there is no indication for the amateur fishing ground ban (except for the port-shelter) for Foça.
- Certain locations around the islands should be completely closed to amateur fishing activities.
- Period fisheries bans should be introduced with the thought that the species around the Foça are mostly "Spring spawners".
- In sites frequently visited by pleasure boats, there is significant removal of seagrasses by boat anchors (Francour et al., 1999). The permanent mooring systems can be used in the bays that are used extensively by daily cruising boats and yachts.
- *P. oceanica* meadows are also negatively affected by climate changes besides human effects. Another source that may affect the *P. oceanica* meadows in the Foça SEPA is the Gediz River. Especially in the periods when the wind of the southwester blows, it is seen in the satellite images that it brings a high amount of suspended solid matter.
- While planning coastal construction, distribution areas of *Posidonia* meadows should be taken into consideration.
- Additional monitoring and control for the fishing activities by scraping the seabed, such as illegal trawling, should be provided in the Foça SEPA. Related inspections should be carried out meticulously.
- Unique geomorphological features at Hayırsız and Orak Islands should be protected and monitored.
- As for effective monitoring, this should be done over a period of time even if it means limiting the number of sites being monitored and the number of parameters. The parameters should be adequate enough to avoid errors of interpretation but sufficiently reduced in numbers to ensure permanent monitoring.
- The overriding objective of this project is the mapping of marine key habitats and assessing their vulnerabilities to fishing activities in order to achieve long term protection of the Foça SEPA marine ecosystem. Given the complicated

and complex set of sometimes conflicting societal interests in the area, this can, in our view, best be achieved by adopting a strategy which considers all stakeholders' interests and strives to strike a balance between human and ecological well-being through transparent and competent governance. The ecosystem approach is ideally suited for this task as it is an adaptive management strategy rooted in the principles of the International Convention on Biological Diversity (CBD, 2004). The first logical step in the process of achieving a holistic management of the entire Foça SEPA, is the preparation of a fisheries management plan based on the ecosystem approach to fisheries (EAF). The EAF management plan for the Gökova SEPA in , prepared with the support of the FAO and with the participation of all pertinent stakeholders (Ünal et al., 2018; 2019) may serve as a model here.

- The final aim in the Foça SEPA should be the achieving of ecosystem-based management (EBM) in the long term. Since EBM "recognizes ecological systems for what they are: a rich mix of elements that interact with each other in important ways", it means "managing them in a way that acknowledges the complexity of marine and coastal ecosystems, the connections among them, their links with land and freshwater, and how people interact with them" (UNEP, 2011). For this purpose, the principles of both EBM and EA (UNEP/GPA, 2006; UNEP, 2011; Long et al., 2015) should be well recognized. The knowledge and experience gained through this project will support this process in the interpretation of EBM and EA to the Foça SEPA.
- It should be noted that the abovementioned recommendations are limited to the conclusions of this project, with determined marine habitats, their benthic communities, fisheries research and the assessment of the sensitivity of the habitats to fishing practices. Beyond these, the Foça SEPA is important for other marine species such as Mediterranean monk seals (Güçlüsoy & Savaş, 2003; Kaboğlu, 2007; Kıraç & Veryeri, 2012; Saydam, 2016), cetaceans (Alan et al., 2017) and avifauna (Güçlüsoy et al., 2006; Döndüren, 2007). Thus, protection measures should consider these and other coastal/marine components of biodiversity as well.
- The major recommendations, which are the establishment of a monitoring programme, control mechanism and zonation in the Foça SEPA, all need funding. The budget and staff shortfall is still a major problem for MPA funding in . "A financially sustainable protected area" should be one of the intermediate-term management goals for the Foça SEPA.
- Beyond all the abovementioned conclusions and recommendations, illegal fishing in the area stands in front of the success of any future management and conservation initiative. For this reason, one of the short-term aim in the Foça SEPA must be to overcome illegal fishing, which has impacts on the species and habitats in the area, as well as the income of the artisanal fishermen of the Foça SEPA.

12.3. Proposals for Recommendations for the Management and Conservation of the Habitats in the Foça SEPA

The Foça SEPA has been attracted many conservation efforts since its establishment in 1990. The local authorities, local public and NGOs have a high awareness on the environmental problems as a result of these initiatives. However, the human pressure continues to increase on the marine environment of this marine-coastal protected area (MPA & MCPA): fishing activities are still intense (Kaboğlu, 2007; SAD, 2008; Kaboğlu et al., 2016), the marine vessel carrying capacity of the SEPA is full since 2008 (SAD, 2008; Kaboğlu et al., 2012), endangered Mediterranean monk seal is under pressure (Güçlüsoy & Savaş, 2003; Kaboğlu, 2007; Kıraç & Veryeri, 2012; Kaboğlu et al., 2016; Saydam, 2016), *Posidonia oceanica* meadows suffer from a variety of risks from anchorage to turbidity (SAD, 2008; Akçalı et al., 2008), etc.

The continuation of the anthropogenic pressure in the Foça SEPA is mainly due to the lack of a protected area zonation and control mechanisms. There have been several zonation approaches and recommendations in the previous years (e.g. Kaboğlu, 2007; SAD, 2008; TVKGM, 2011; TVKGM, 2016). Despite the fact that 2011 and 2016 management plans of the Foça SEPA included zonation, any progress wasn't observed through their implementation.

Zonation is an important task in protected area designation and it is important to select core and buffer areas appropriate for each specific protected area (Salm & Clark, 1984; Kelleher, 1999). Natural value of ecological attributes is the main criteria in defining core and buffer zones and the aim of this approach is to determine no-entry and no-take zones where any activity involving the extraction of natural resources is prohibited (Kelleher, 1999; IUCN, 2003; Day et al., 2012) as a result of precautionary principle, and to regulate human activities in the surrounding buffer zones.

The most outstanding of this study was the determination of the seabed habitats in the Foça SEPA for the first time, which in turn revealed the marine wealth of the area, and this is the main difference from those previous studies. Although other marine components (e.g. Mediterranean monk seal, sea birds, etc.) weren't assessed within this project, the variety and distribution of marine habitats were identified and some important hard bottom habitats/features were observed in the area, which are concluded to be of importance to conserve. For this reason, two categories of zones are proposed in the area:

1. Core Zone (CZ): All human activities, except for scientific research and monitoring, are forbidden. The CZs are determined to guarantee the continuity of the important marine habitats. Marine habitats should be monitored in all these areas.
2. Buffer Zone (BZ): Human activities are regulated in time and user domains. Marine habitats should be monitored in all these areas. Marine activities (fishing, tour boating, recreational fishing, etc.) should be limited in these areas since BZs are defined in order to decrease and distribute the existing human pressures.

As a result, 5 core zones and 7 buffer zones, all of which are also habitat monitoring areas, are proposed (Figure-163).

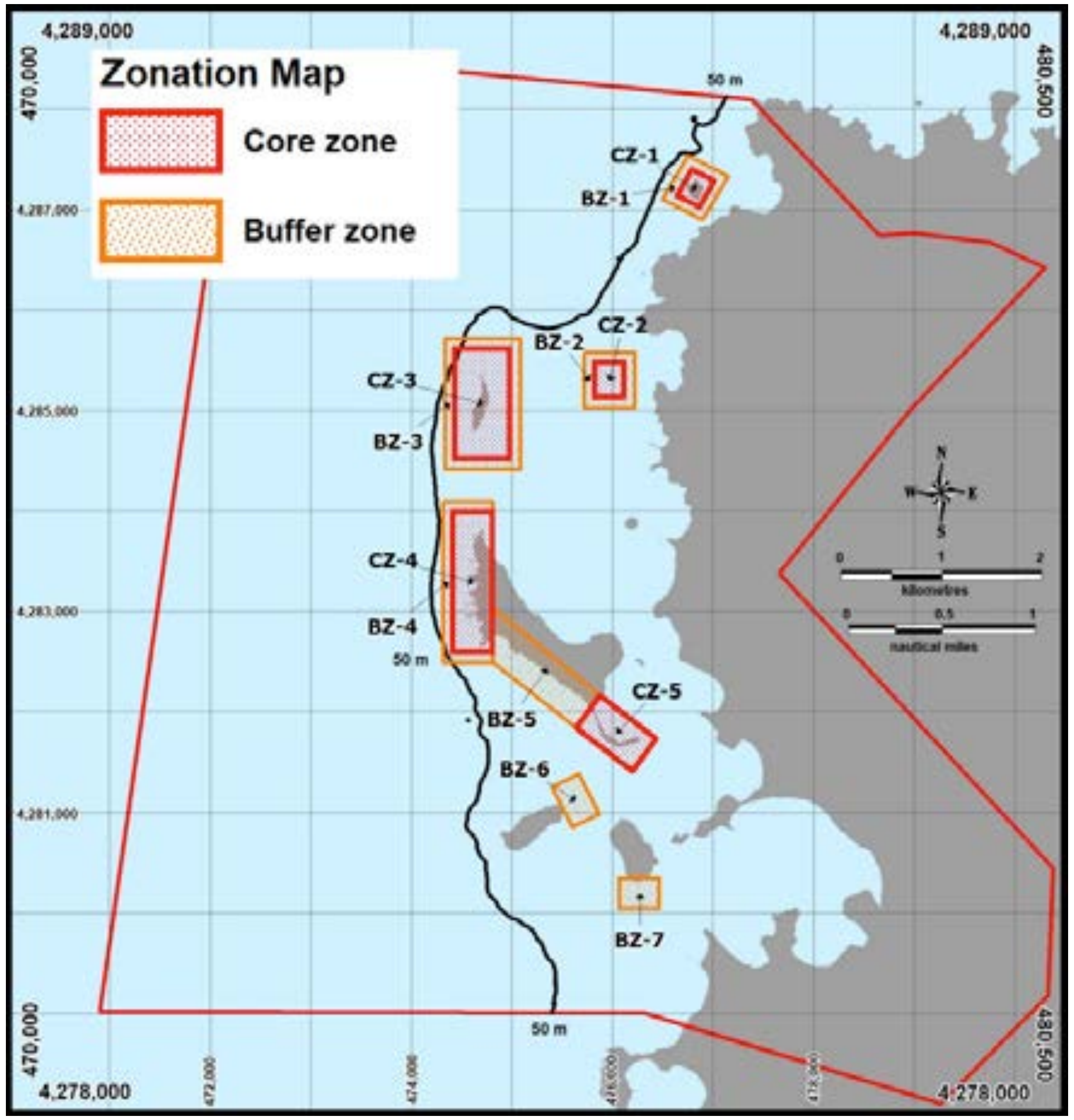


Figure 163

Zonation for the Foça SEPA: proposed core zones (CZ) and buffer zones (BZ)

Additionally, 23 oceanographic monitoring stations are recommended in order to monitor turbidity and other oceanographic properties (Figure-164 & Table-38). 8 of these oceanographic monitoring stations (3, 6, 7, 10, 11, 12, 15 & 18) are in the core and buffer zones for habitat monitoring purposes.

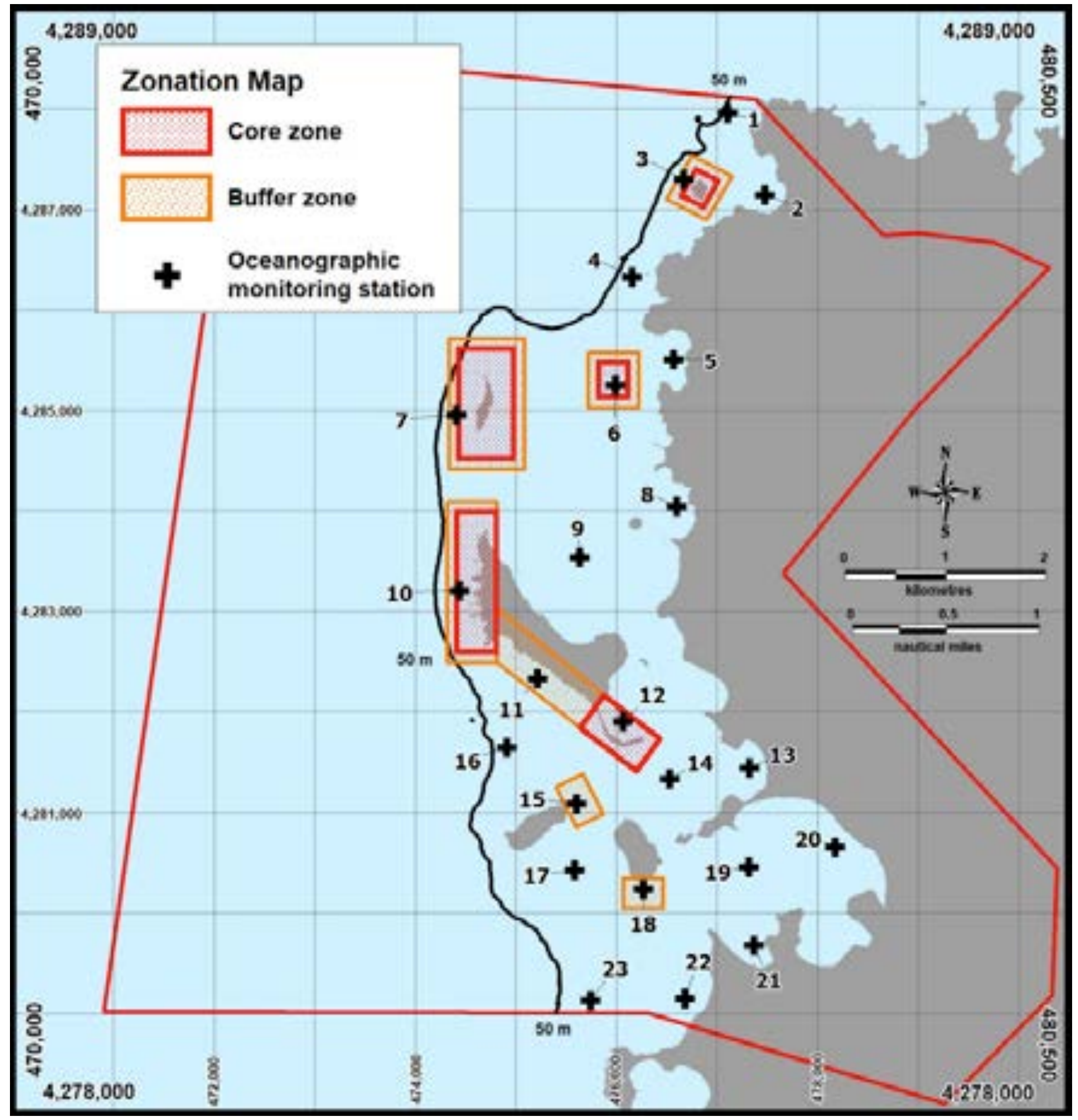


Figure 164

Proposed oceanographic monitoring stations in the Foça SEPA

Table 38
The UTM WGS84 coordinates of the proposed oceanographic monitoring stations

Station Code	X	Y
1	477106	4287958
2	477474	4287147
3	476668	4287295
4	476151	4286328
5	476569	4285510
6	475991	4285254
7	474410	4284957
8	476601	4284048
9	475633	4283537
10	474441	4283211
11	475214	4282330
12	476066	4281908
13	477320	4281444
14	476528	4281337
15	475601	4281091
16	474909	4281645
17	475579	4280428
18	476269	4280234
19	477317	4280458
20	478171	4280656
21	477369	4279681
22	476684	4279149
23	475740	4279135

The proposed oceanographic monitoring stations are located in order to determine the physical properties of the sea water column in high resolution in the Foça SEPA. Additionally, these stations may serve in detecting the anomalies or long term trends in the area for

1) Monitoring marine pollution source from the north (from Aliağa region): stations 1, 2, 3, 4

2) Discharge pipeline breakdown: stations 13, 14, 15, 16

3) Gediz River effect: stations 17, 18, 22, 23

4) Port use effects: stations 19, 20, 21

This monitoring activity is recommended to be performed monthly in order to detect any environmental risk in the Foça SEPA as immediately as possible. The monitoring parameters must involve turbidity in addition to the standard CTD parameters at minimum.

12.3.1. Proposed Core Zones

Core Zone 1 (CZ-1): Figure 165 & Table-39

Habitats: MB1.52 Invertebrate-dominated infralittoral rock, MB2.54 *Posidonia oceanica* meadows, MB5.5 Infralittoral sand (includes Kartdere Island)

Dimensions: 300 x 250 m

Area: 0.075 km^2 (includes Kartdere Island land)

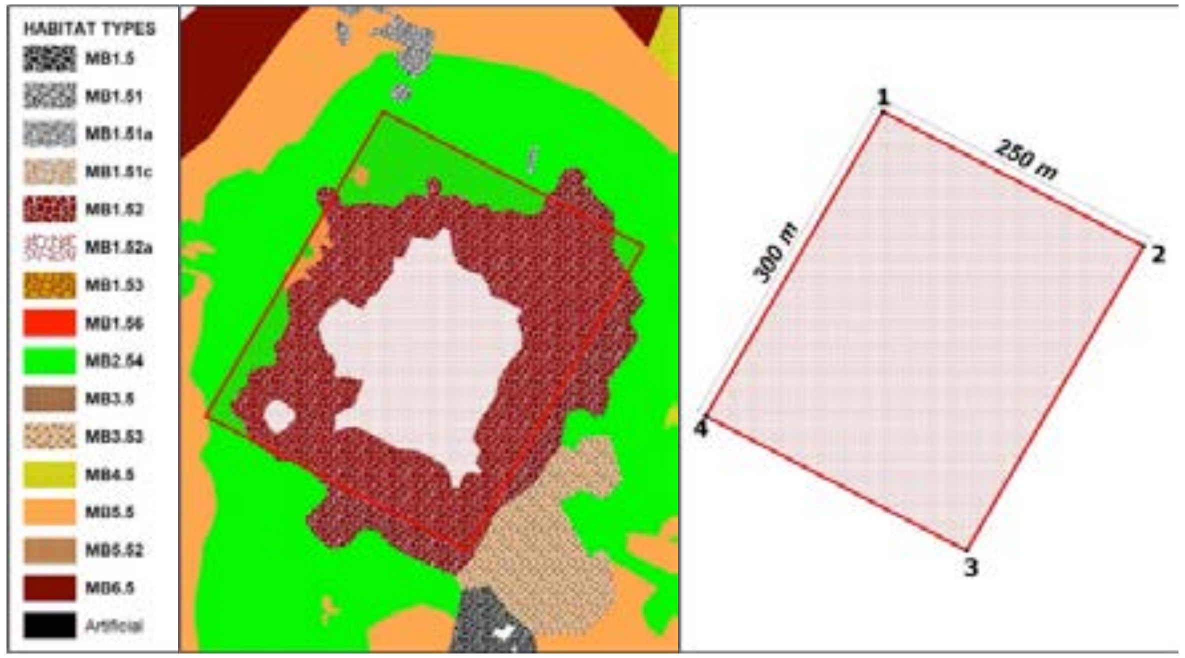


Figure 165
Proposed CZ-1 and its dimensions

Table 39
The UTM WGS84 coordinates of the CZ-1 borders

POINT ID	X	Y
1	476791	4287402
2	477013	4287287
3	476862	4287028
4	476640	4287142

Core Zone 2 (CZ-2): Figure-166 & Table-40

Habitats: MB1.51 Algal-dominated infralittoral rock, MB2.54 *Posidonia oceanica* meadows, MB3.5 Infralittoral coarse sediment, MB5.5 Infralittoral sand

Dimensions: 300 x 350 m

Area: 0.105 km^2

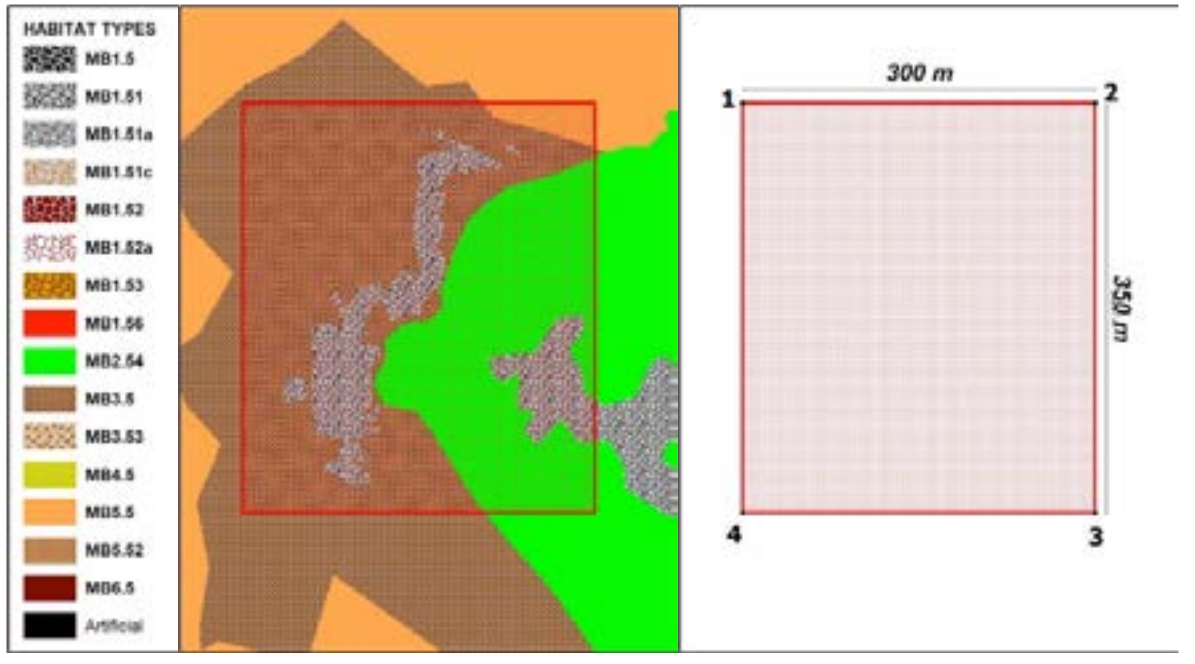


Figure 166

Proposed CZ-2 and its dimensions

Table 40
The UTM WGS84 coordinates of the CZ-2 borders

POINT ID	X	Y
1	475822	4285475
2	476123	4285475
3	476123	4285126
4	475822	4285126

Core Zone 3 (CZ-3): Figure-167 & Table-41

Habitats: MB1.51 Algal-dominated infralittoral rock, MB1.56 Semi-dark caves and overhangs, MB2.54 *Posidonia oceanica* meadows, MB3.53 Infralittoral pebbles, MB5.5 Infralittoral sand (includes Hayırsız Island)

Dimensions: 550 x 1100 m

Area: 0.605 km^2 (includes Hayırsız Island)

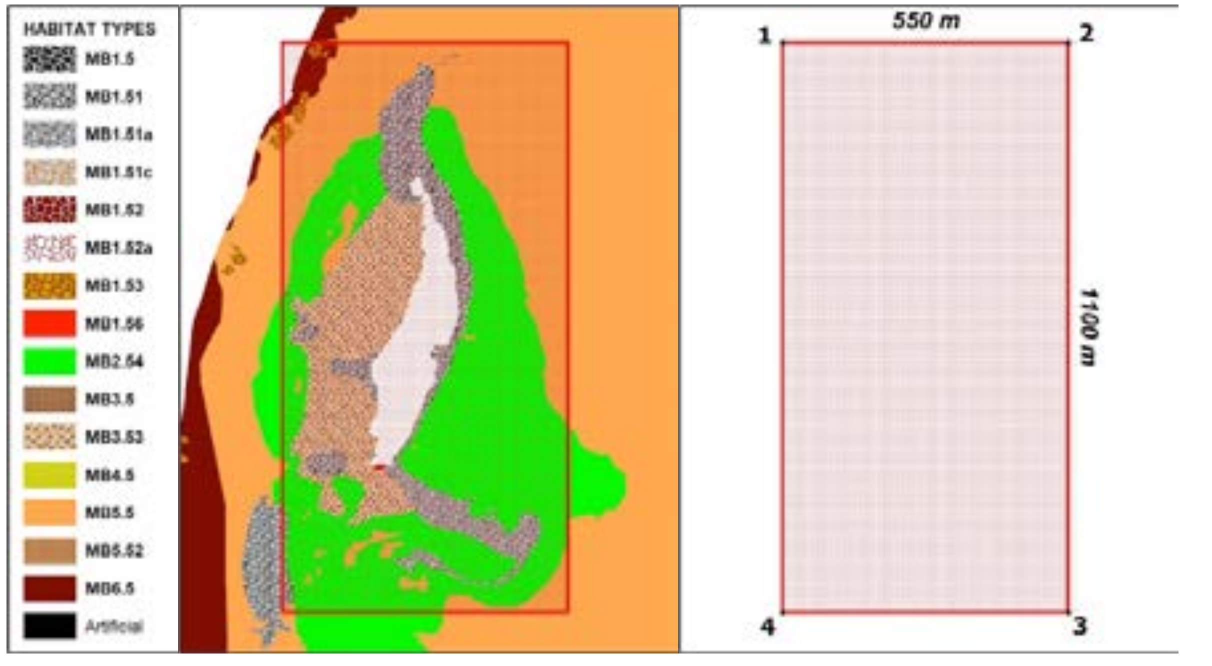


Figure 167

Proposed CZ-3 and its dimensions

Table 41
The UTM WGS84 coordinates of the CZ-3 borders

POINT ID	X	Y
1	474435	4285615
2	474986	4285615
3	474986	4284517
4	474435	4284517

Core Zone 4 (CZ-4): Figure-168 & Table-42

Habitats: MB1.51 Algal-dominated infralittoral rock, MB1.51a Well illuminated infralittoral rock, exposed, MB1.53 Infralittoral rock affected by sediments, MB1.56 Semi-dark caves and overhangs, MB2.54 *Posidonia oceanica* meadows, MB5.5 Infralittoral sand (includes part of Orak Island)

Dimensions: 400 x 1400 m

Area: 0.560 km^2 (includes part of Orak Island)

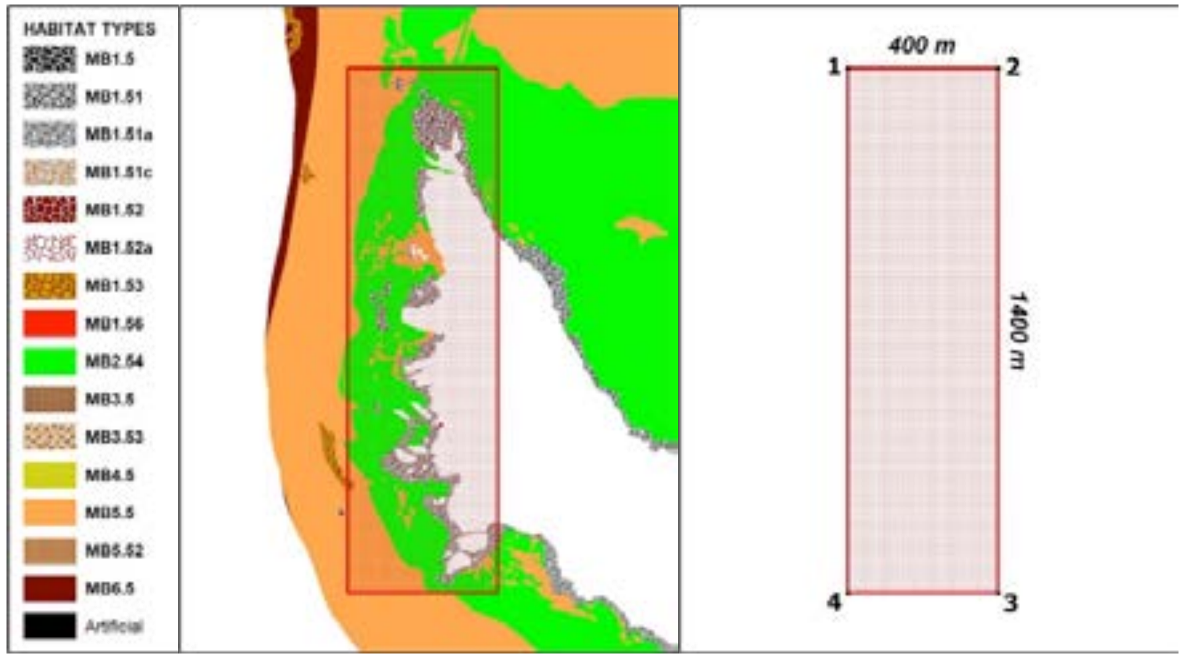


Figure 168

Proposed CZ-4 and its dimensions

Table 42
The UTM WGS84 coordinates of the CZ-4 borders

POINT ID	X	Y
1	474416	4283987
2	474817	4283987
3	474817	4282590
4	474416	4282590

Core Zone 5 (CZ-5): Figure-169 & Table-43

Habitats: MB1.51a Well illuminated infralittoral rock, exposed, MB1.52a Moderately illuminated infralittoral rock, sheltered, MB1.53 Infralittoral rock affected by sediments, MB2.54 *Posidonia oceanica* meadows, MB3.5 Infralittoral coarse sediment, MB4.5 Infralittoral mixed sediment, MB5.5 Infralittoral sand (includes part of Orak Island)

Dimensions: 400 x 700 m

Area: 0.280 km^2 (includes part of Orak Island)

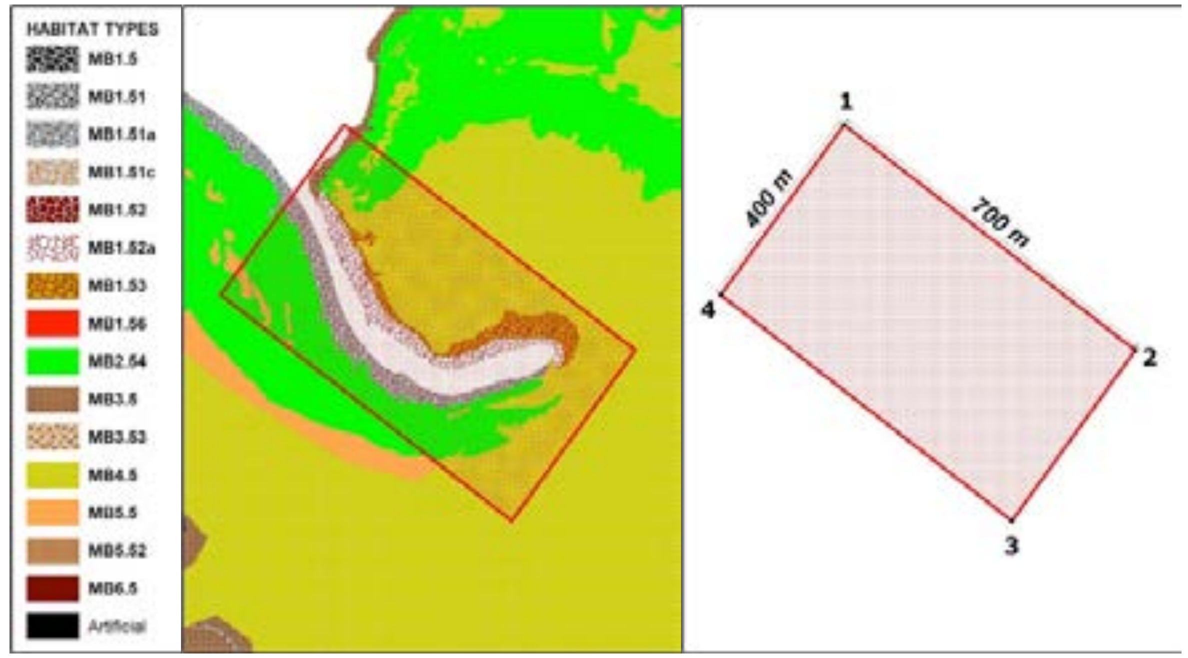


Figure 169

Proposed CZ-5 and its dimensions

Table 43
The UTM WGS84 coordinates of the CZ-5 borders

POINT ID	X	Y
1	475877	4282167
2	476430	4281738
3	476196	4281414
4	475642	4281843

12.3.2. Proposed Buffer Zones

Buffer Zone 1 (BZ-1): Figure-170 & Table-44

Habitats: MB1.5 Infralittoral rock, MB1.51 Algal-dominated infralittoral rock, MB1.52 Invertebrate-dominated infralittoral rock, MB2.54 *Posidonia oceanica* meadows, MB3.5 Infralittoral coarse sediment, MB3.53 Infralittoral pebbles, MB4.5 Infralittoral mixed sediment, MB5.5 Infralittoral sand, MB6.5 Infralittoral mud sediment

Dimensions: 450 x 500 m-100 m width (100 m buffer around CZ-1)

Area: 0.150 km^2

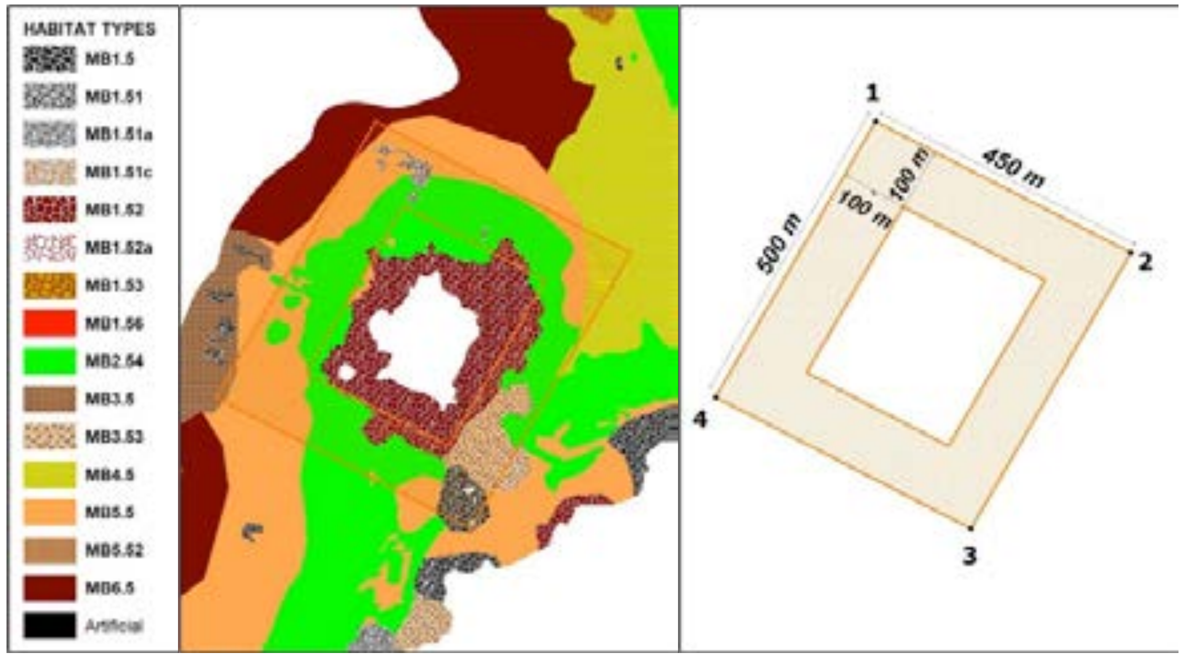


Figure 170
Proposed BZ-1 and its dimensions

Table 44
The UTM WGS84 coordinates of the BZ-1 borders

POINT ID	X	Y
1	476747	4287536
2	477147	4287330
3	476897	4286898
4	476497	4287104

Buffer Zone 2 (BZ-2): Figure-171 & Table-45

Habitats: MB1.51 Algal-dominated infralittoral rock, MB2.54 *Posidonia oceanica* meadows, MB3.5 Infralittoral coarse sediment, MB5.5 Infralittoral sand, MB6.5 Infralittoral mud sediment

Dimensions: 500 x 550 m-100 m width (100 m buffer around CZ-2)

Area: 0.170 km^2

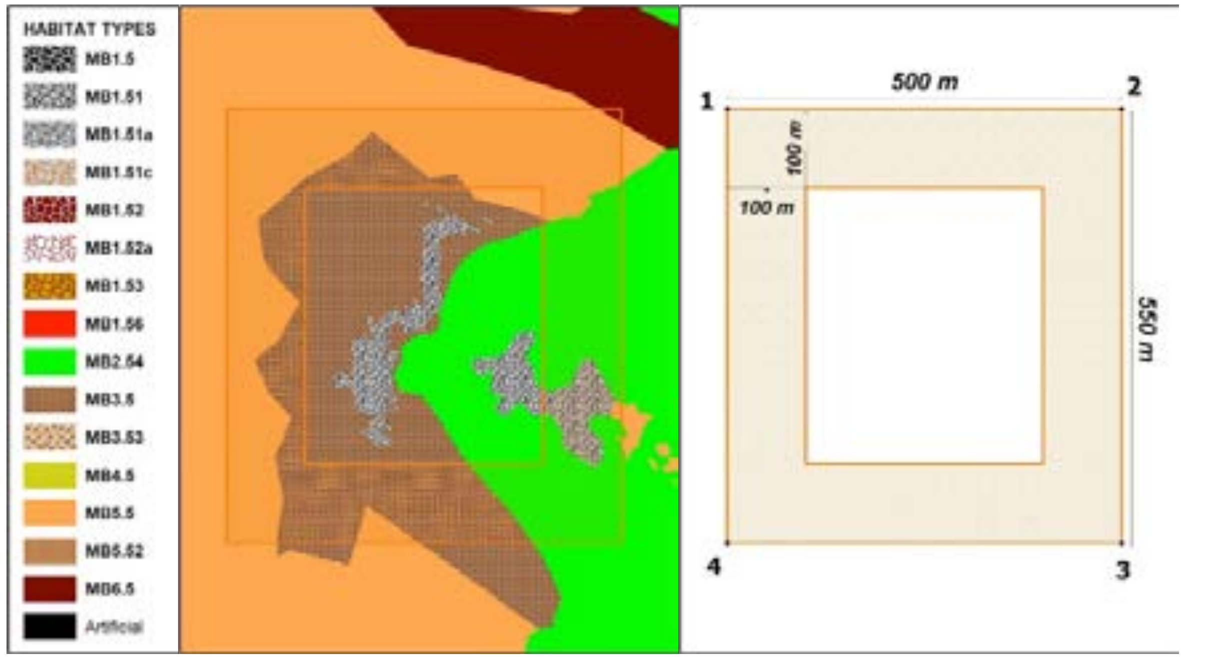


Figure 171
Proposed BZ-2 and its dimensions

Table 45
The UTM WGS84 coordinates of the BZ-2 borders

POINT ID	X	Y
1	475722	4285575
2	476222	4285575
3	476222	4285026
4	475722	4285026

Buffer Zone 3 (BZ-3): Figure-172 & Table-46

Habitats: MB1.51 Algal-dominated infralittoral rock, MB1.53 Infralittoral rock affected by sediments, MB2.54 *Posidonia oceanica* meadows, MB5.5 Infralittoral sand, MB6.5 Infralittoral mud sediment

Dimensions: 750 x 1300 m-100 m width (100 m buffer around CZ-3)

Area: 0.370 km^2

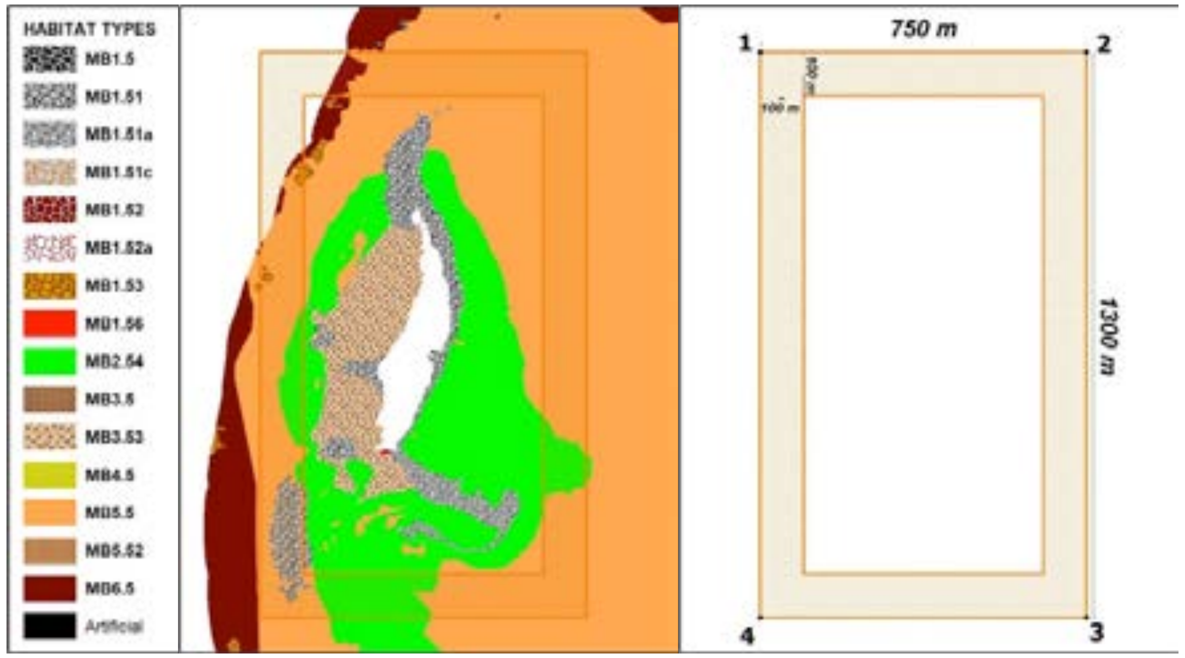


Figure 172

Proposed BZ-3 and its dimensions

Table 46
The UTM WGS84 coordinates of the BZ-3 borders

POINT ID	X	Y
1	474335	4285716
2	475086	4285716
3	475086	4284417
4	474335	4284417

Buffer Zone 4 (BZ-4): Figure-173 & Table-47

Habitats: MB1.5 Infralittoral rock, MB1.53 Infralittoral rock affected by sediments, MB2.54 *Posidonia oceanica* meadows, MB5.5 Infralittoral sand, MB6.5 Infralittoral mud sediment

Dimensions: 500 x 1600 m-100 m width (100 m buffer around CZ-4)

Area: 0.240 km^2

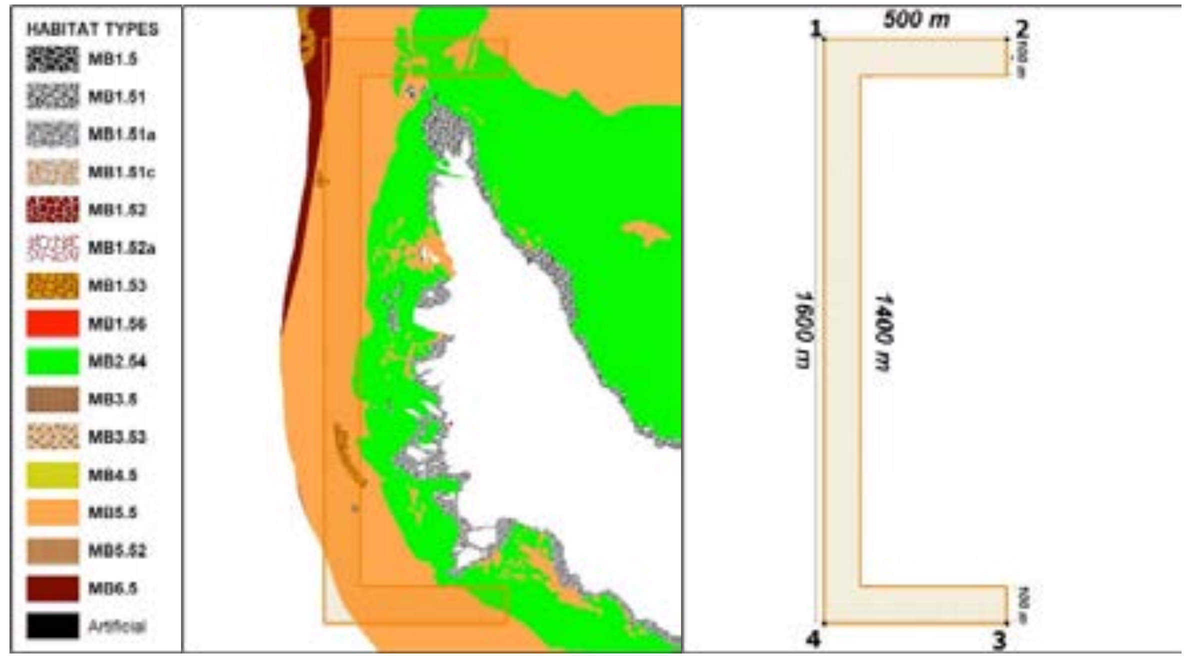


Figure 173

Proposed BZ-4 and its dimensions

Table 47
The UTM WGS84 coordinates of the BZ-4 borders

POINT ID	X	Y
1	474316	4284089
2	474817	4284089
3	474817	4282490
4	474316	4282490

Buffer Zone 5 (BZ-5): Figure-174 & Table-48

Habitats: MB1.51a Well illuminated infralittoral rock, exposed, MB2.54 *Posidonia oceanica* meadows, MB5.5 Infralittoral sand

Dimensions: 273 x 1153 m

Area: 0.317 km^2

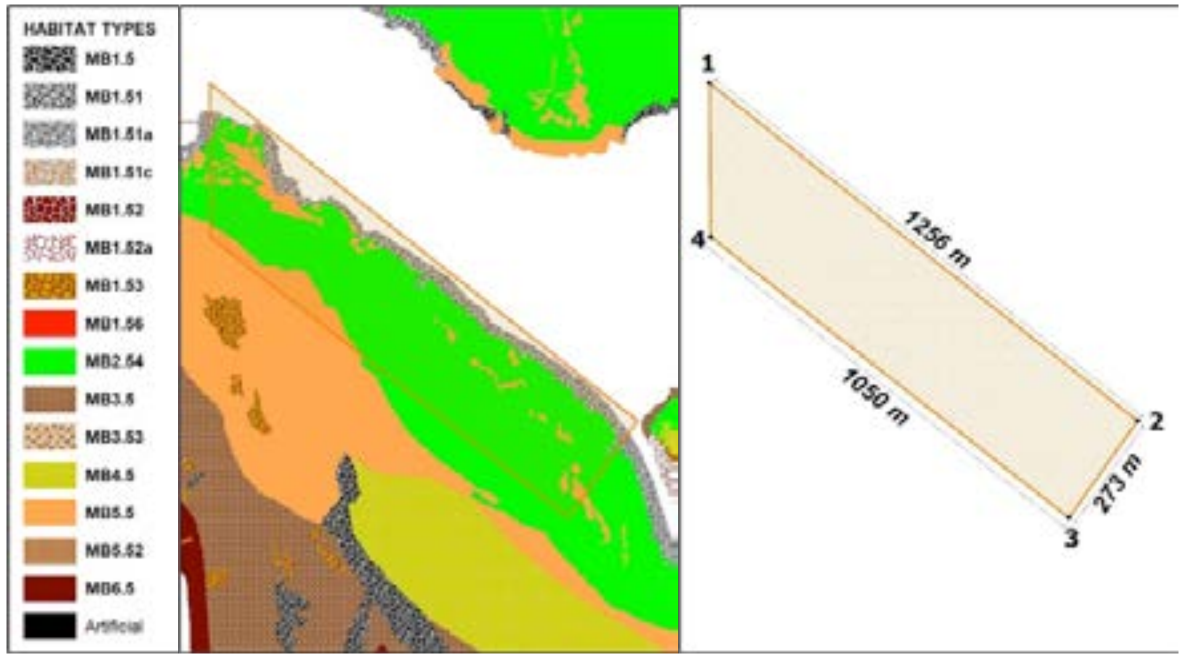


Figure 174

Proposed BZ-5 and its dimensions

Table 48

The UTM WGS84 coordinates of the BZ-5 borders

POINT ID	X	Y
1	474814	4282845
2	475800	4282067
3	475642	4281843
4	474817	4282490

Buffer Zone 6 (BZ-6): Figure-175 & Table-49

Habitats: MB1.51 Algal-dominated infralittoral rock, MB1.53 Infralittoral rock affected by sediments, MB2.54 *Posidonia oceanica* meadows, MB3.5 Infralittoral coarse sediment, MB4.5 Infralittoral mixed sediment, MB5.5 Infralittoral sand

Dimensions: 300 x 450 m

Area: 0.135 km^2

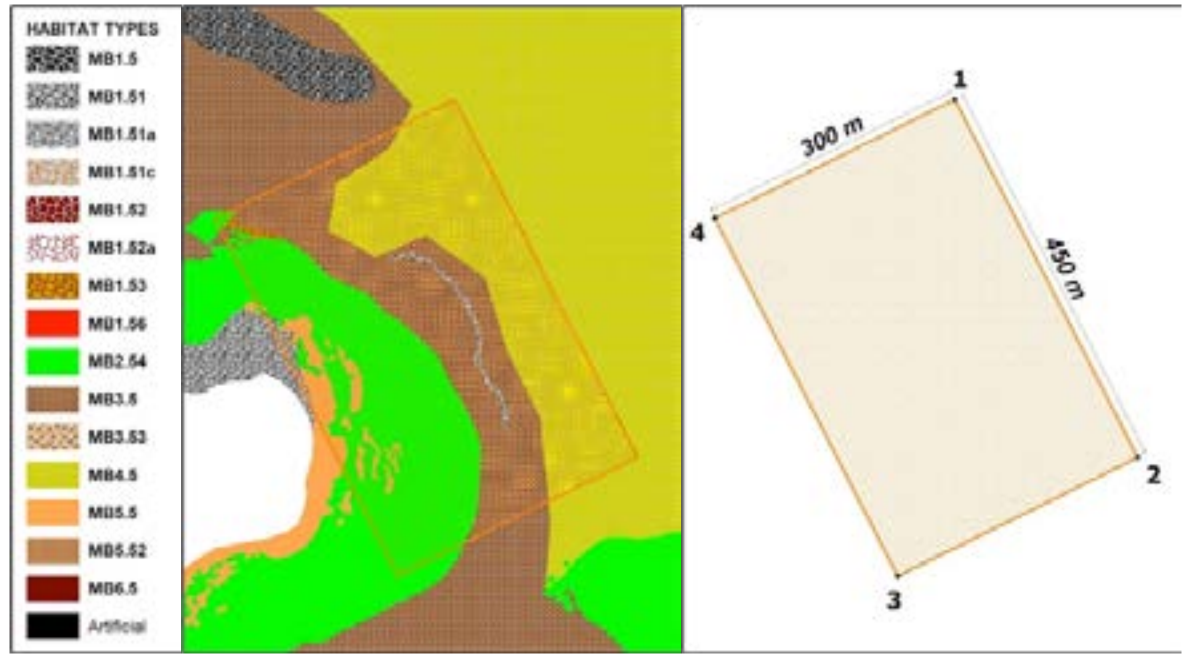


Figure 175

Proposed BZ-6 and its dimensions

Table 49

The UTM WGS84 coordinates of the BZ-6 borders

POINT ID	X	Y
1	475664	4281389
2	475869	4280988
3	475600	4280855
4	475395	4281255

Buffer Zone 7 (BZ-7): Figure-176 & Table-50

Habitats: MB1.51 Algal-dominated infralittoral rock, MB2.54 *Posidonia oceanica* meadows, MB3.5 Infralittoral coarse sediment, MB5.5 Infralittoral sand, MB6.5 Infralittoral mud sediment

Dimensions: 303 x 400 m

Area: 0.121 km^2

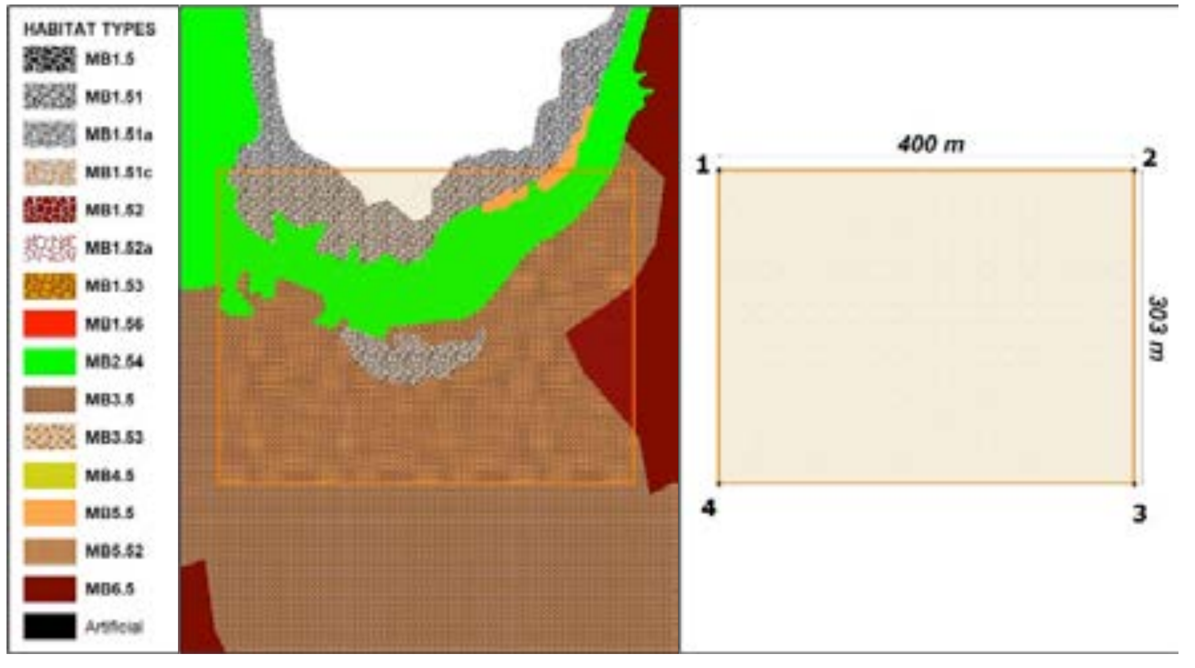


Figure 176

Proposed BZ-7 and its dimensions

Table 50
The UTM WGS84 coordinates of the BZ-7 borders

POINT ID	X	Y
1	476070	4280346
2	476472	4280346
3	476472	4280043
4	476070	4280043

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SPA/RAC WORKING AREAS

SPA/ RAC, the UNEP/ MAP ***Specially Protected Areas Regional Activity Centre****, was created in 1985 to assist the Contracting Parties to the Barcelona Convention (21 Mediterranean contries and the European Union) in implementing the Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean (SPA/BD Protocol).*

POST-2020 SAPBIO

Strategic Action Programme for the **Conservation** of **Biodiversity** and **Sustainable Management** of **Natural Resources** in the **Mediterranean Region**

Marine turtles

Cetaceans

Mediterranean Monk Seal

Cartilaginous fishes
(Chondrichtyans)

Marine and coastal bird species
Listed in Annex II of the Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean

SPAMI

Specially Protected Areas of **Mediterranean Importance**

Specially Protected Areas

Monitoring

Coralligenous and other calcareous bio-concretions

Marine vegetation

Dark Habitats
Habitats and species associated with seamounts, underwater caves and canyons, aphotic hard beds and chemo-synthetic phenomena

Species introduction and invasive species

UN environment programme
Mediterranean Action Plan Barcelona Convention
SPA/RAC The Mediterranean Biodiversity Centre

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MAVA FONDATION POUR LA NATURE
This publication has been prepared with the financial support of the MAVA foundation