

Scientific Monitoring in Karaburun-Sazan National Marine Park



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Forewords

Albania is a Mediterranean country with a coastline length of approximately 427 km, with 273 km of coast in the west facing the Adriatic Sea and 154 km of coast in the southwest in the Ionian Sea. Since 2015, in order to protect and preserve the biodiversity values of the Albanian territory was created a network of marine and terrestrial protected areas managed by the National Agency of Protected Areas, represented in regional level by the Regional Administration of Protected Areas, which falls under the Ministry of Tourism and the Environment. According to IUCN, a protected area is a “clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values”.

Throughout the years this network has undergone several changes coming in nowadays where there are identified 790 protected areas (including national parks, natural parks, protected landscapes and PA with sustainable use of natural resources(natural monuments not included)) making up for a total surface of 624,137 ha up to 21.7% of the territory of the country. Protected areas remain the fundamental building blocks of virtually all national and international conservation strategies, supported by governments and international institutions such as the Convention on Biological Diversity. They provide the core of efforts to protect the world’s threatened species and are increasingly recognized as essential providers of ecosystem services and biological resources; key components in climate change mitigation strategies; and in some cases also vehicles for protecting threatened human communities or sites of great cultural and spiritual value (Dudley, N., 2008).

A majority of these protected areas include marine habitats. The total marine area of Albania is approximately 6,000 km², with internal waters representing 12% of it (RAC/SPA and IUCN, 2014), and around 308 km² of marine and coastal area is included in a marine protected area. In the Mediterranean level, only 8.33% of surface is covered by a protection status (Roadmap 2030), however due to lack of real management efforts many of these protected areas don’t achieve their conservation targets and objectives. Marine protected areas (MPAs) are recognized as one of the most powerful and effective tools for protecting marine life and the livelihoods of coastal communities (Grorud-Colvert et al., 2021).

They help protect threatened and endangered biodiversity, important marine and coastal habitats such as coralligenous assemblages, seagrasses and coastal lagoons, and they are invaluable in their role to restore degraded marine habitats and to replenish fish stocks. Having sustainable income for the marine protected areas is considered as crucial element to achieve sustainability of the MPA and management effectiveness and efficiency. Many protected areas in Albania secure their income through traditional ways such as the state budget or fee system; however, since 2018 a new sustainable income source is made available for Karaburun-Sazan, the first marine protected area in Albania.

Through The MedFUND, an environmental trust fund based in Monaco, specifically dedicated to the financing of marine protected areas in the Mediterranean, a new management approach is applied in Karaburun-Sazan MPA with mutual efforts from the official state managers of the MPA and a local NGO. Following the implementation of this three party agreement several management and conservation objectives have been met, opening the path to a sustainable management of this marine protected area. The replication of the same approach in other national and international protected areas is to be seen as a great management practice that ensures sustainability and achievement of the management objectives.

I. Karaburun-Sazan, the first national marine park in Albania

The National Marine Park "Karaburun-Sazan" lies on the border between the Adriatic Sea and the Ionian Sea and covers the marine area along the coastline of the peninsula of Karaburun and the island of Sazan in the Vlora Bay. The national park was proclaimed on April 28, 2010 by the Council of Ministers, with the proposal of the Minister of Environment, Forestry and Water Administration.

The total proclaimed area of the National Park "Karaburun-Sazan" in 2010, is 12,570.82 ha, where the marine area near Karaburun consists of 9,848.95 ha and the marine area near the island of Sazan consists of 2,721.87 ha. Based on decision no.59, date 26.01.2022 "For the approval of the changes in the status and the surface of ecosystems of national parks of environmental protected areas", the new area of the marine national park is 12,437.7 ha, 9712.95 ha around Karaburun Peninsula and 2724.75 ha around Sazan Island.

The park is divided into three management zones:

Core Zone (2229.59 ha)- This sub-zone includes water surface and is defined as an area with high and rare values for natural heritage and biodiversity and the highest degree of protection is applied to it, which ensures an undisturbed territory. Scientific research is allowed in this sub-zone. The development of the following activities is strictly prohibited within the CZ: diving, swimming and snorkeling/snorkelling (beaches and sunbathing), fishing, boating (excursions), anchoring, anchoring, sailing, sailing by kayak all types of water sports, marine traffic, all types of infrastructure development, mineral extraction, collection of plants, minerals, stones, paleontological findings, aquaculture development and all military activities. The following activities can be carried out after a special permit has been granted by the PA administration: scientific research (special permit and the number of scientists allowed is limited) and monitoring, waste disposal, only guided visits on itineraries determined under the leadership of the PA administration (strictly limited in terms of numbers and places).

Traditional Use and Sustainable Development Zone (9428.8 ha)- In this sub-zone, the second level of protection applies. The following activities can be carried out freely in this area without any prior authorization: sailing (some areas must be outside the border), such as areas designated for water sports; signs for boats must be posted, waste discharges are not allowed, PA administration (must determine boat carrying capacity), swimming and snorkeling, anchoring, kayaking and sightseeing. The development of the following activities is strictly prohibited within the TUSD zone: maritime traffic, mineral extraction, and the collection of plants, minerals, stones, paleontological findings, professional commercial fishing, aquaculture development and all military activities.

Recreational Zone (779.31 ha)- This area includes parts of marine habitats. The third level of protection is applied in it, which ensures a low-impact territory and control of tourist activities. The following activities can be carried out freely in this area without any prior authorization: sailing, swimming and diving with an air tube/snorkeling, diving anchoring, anchoring, kayaking, water sports (but not water skiing because they are not allowed in this area) and sightseeing. The development of the following activities is strictly prohibited within the RZ: maritime traffic, mineral extraction, and the collection of plants, minerals, stones, paleontological findings, professional commercial fishing, aquaculture development and all military activities.

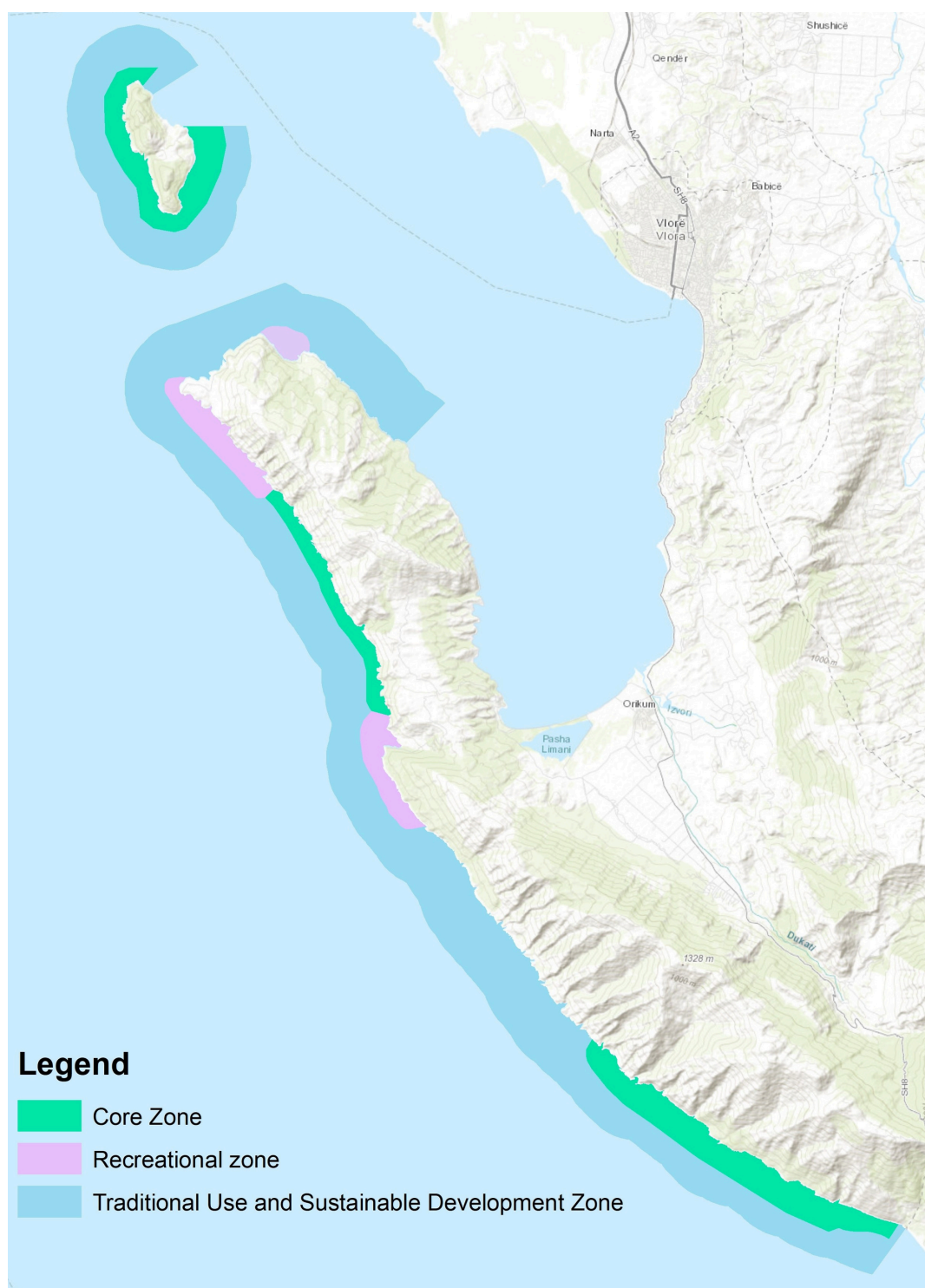


Figure 1. Zoning in Karaburun-Sazan MPA.

The Karaburun-Sazan MPA has a great importance regarding the biodiversity. The park has a rich biodiversity in habitats and species, including 75% of the species of the Red List of Albania and 36 species of high national and international importance such as the monk seal *Monachus monachus*, sea turtle *Caretta caretta* and *Chelonia mydas*, short-beaked common dolphin *Delphinus delphis* etc.. It is characterized by marine habitats as shown in the table below:

Table 1. Marine habitats present in Karaburun-Sazan MPA.

Littoral coastal areas	Subdivision of areas	Biocenosis
The mediolittoral zone	Mediolittoral hard rocks and beds	Biocenosis of the lower mediolittoral rocks
		Biocenosis of mediolittoral caves
Infralittoral zone	<i>Posidonia oceanica</i> meadows.	Biocenosis of <i>Posidonia oceanica</i> meadows (=Association with <i>Posidonia oceanica</i>)
	Infralittoral hard rocks and beds	Biocenosis of infralittoral algae
The circumlittoral zone	Hard circumlittoral rocks and beds	Corallogenic biocenosis
		Biocenosis of half dark caves

1.1 Mediollittoral

1.1.1 Biocenosis of the lower mediollittoral rocks

The mediollittoral is characterized by calcareous algae of *Lithophyllum sp.*, which are good biological indicators of superficial pollution and fluctuant sea levels. *Lithophyllum byssoides*, present in both Sazani island and Karaburuni peninsula, is a characteristic species of Western Mediterranean and Adriatic Sea, which grows slightly above mean sea level, in small caves, corridors and along cliffs. In this area it has created small cushions (hemispheric concretions) and rarely builds rims, usually known as “trottoirs”.

1.1.2 Biocenosis of mediolittoral caves

Another biocenosis in the mediolittoral is that of mediolittoral caves, which correspond to crevices or the entrances of caves that are partially out of the water. There are several of these places along the western side of peninsula, where species like *Catenella caespitosa*, *Hildenbrandia prototypus*, *Phymatolithon lenormandii*, etc. grow. Four underwater caves at the tip of the Karaburuni peninsula have been studied (Belmonte et al., 2006) and have shown very specific fauna different from the other side of the Adriatic. In particular a population of *Hypsichomus stichophthalmus* (Polychaeta) was present in the Haxhi Ali cave with abundant fishes, echinoderms, worms, crustaceans. At about 40 m deep, red cartilaginous algae *Faucheia* sp., are exuberant and very often seen with brightly coloured sponges. Some of these caves are monumental (up to 50 m high) with stalactites along the walls and hosting freshwater fauna (kingfishers, mosquitoes, bats), such as the one located in the bay of Veriu. Freshwater resurgence happens very often in the caves and along the canyons.

1.2 Infralittoral

1.2.1 Biocenosis of the *Posidonia oceanica* meadows

In the infralittoral stage the most important biocenosis is that of *Posidonia oceanica* meadows. *Posidonia oceanica* meadows (Association with *Posidonia oceanica*) are considered priority habitat by the EU Habitats Directive and are also listed in the Annex II of the Barcelona Convention (as an endangered or threatened species). Patches of *Posidonia oceanica* meadows occur at 6-10m depth and deeper in sheltered sites of the rocky coastline of Rreza e Kanalit-Karaburuni and Sazani island. On the eastern side of the island, *Posidonia* beds are found closer to the coast at shallower depths. On the western coast, *Posidonia oceanica* grows generally on rocky substrates and rarely on sandy seabeds, in front of small beaches. On the western side of Sazani island a rocky substrate is found prolonging the island, some patches of *Posidonia oceanica* are located in sheltered areas where the depth does not increase as much as along Karaburuni. Fragmented *Posidonia oceanica* meadows have been observed along the eastern coast of Karaburuni and these beds with coverage of 50% extend from 6 m to 15-18 m depth.

Along with the regression of the *Posidonia oceanica* beds, there is a mass growth of the invasive *Caulerpa racemosa*, which is developed mainly on “dead mattes” from 2 m to 15 m depth. After its first record in Albania in 2002, this invasive alga seems to be common in wide ranges of depths and substrata along the coast of Vlora bay (Kashta et al., 2005). In Vlora bay there is *Halophila stipulacea*, which originates from the Indian Ocean and is an invasive species in the Mediterranean (Kashta, 1992-93).

1.2.2 Biocenosis of infralittoral algae

In the hard beds and rocks of the infralittoral, perennial brown algae are dominant over extensive parts of shallow hard substrata in the western side of Karaburuni and Sazani. The most important group is that of the brown algae *Cystoseira*, represented with 5 species (*Cystoseira amentacea* var. *spicata*, *C. barbata*, *C. compressa*, *C. crinita* and *C. spinosa*). The *Cystoseira* communities together with the *Posidonia* meadows are the main supporters of biodiversity in shallow water. Association with *Cystoseira amentacea* var. *spicata* is located in the first meter of the infralittoral (from -20 to -30 cm) and creates belts in the photophilic biotopes, where there is a strong wave action and the rocky substrate is subvertical.

Cystoseira amentacea is an indicator of the upper limit of the infralittoral stage and represents a threatened species (Annex II of the Barcelona Convention). This association, including many strata, is characterized by big species richness; it shelters epibiont organisms and other benthic organisms mainly belonging to the algae, polychaetes, molluscs and crustaceans. Other important associations are those with *Cystoseira crinita*, *Dictyopteris polypodioides*, *Corallina elongata* and facies with *Cladocora caespitosa*.

1.3 Circalittoral

1.3.1 Coralligenous biocenosis

In the circalittoral zone, on hard substrata, the most important biocenosis is the coralligenous, with calcareous red seaweeds, gorgonians and bryozoans. This biocenosis is well developed on the western side of Sazani island and Karaburuni peninsula.

1.3.2 Biocenosis of semi-dark caves

Another important biocenosis is that of semi-dark caves, where the red coral *Corallium rubrum* and several species of sponges live. The red coral (*Corallium rubrum*), a species of great interest, is listed in the Annex III of the Barcelona Convention (as a species whose exploitation is regulated) and is also listed in the Annex III of the Bern Convention (as protected fauna species).

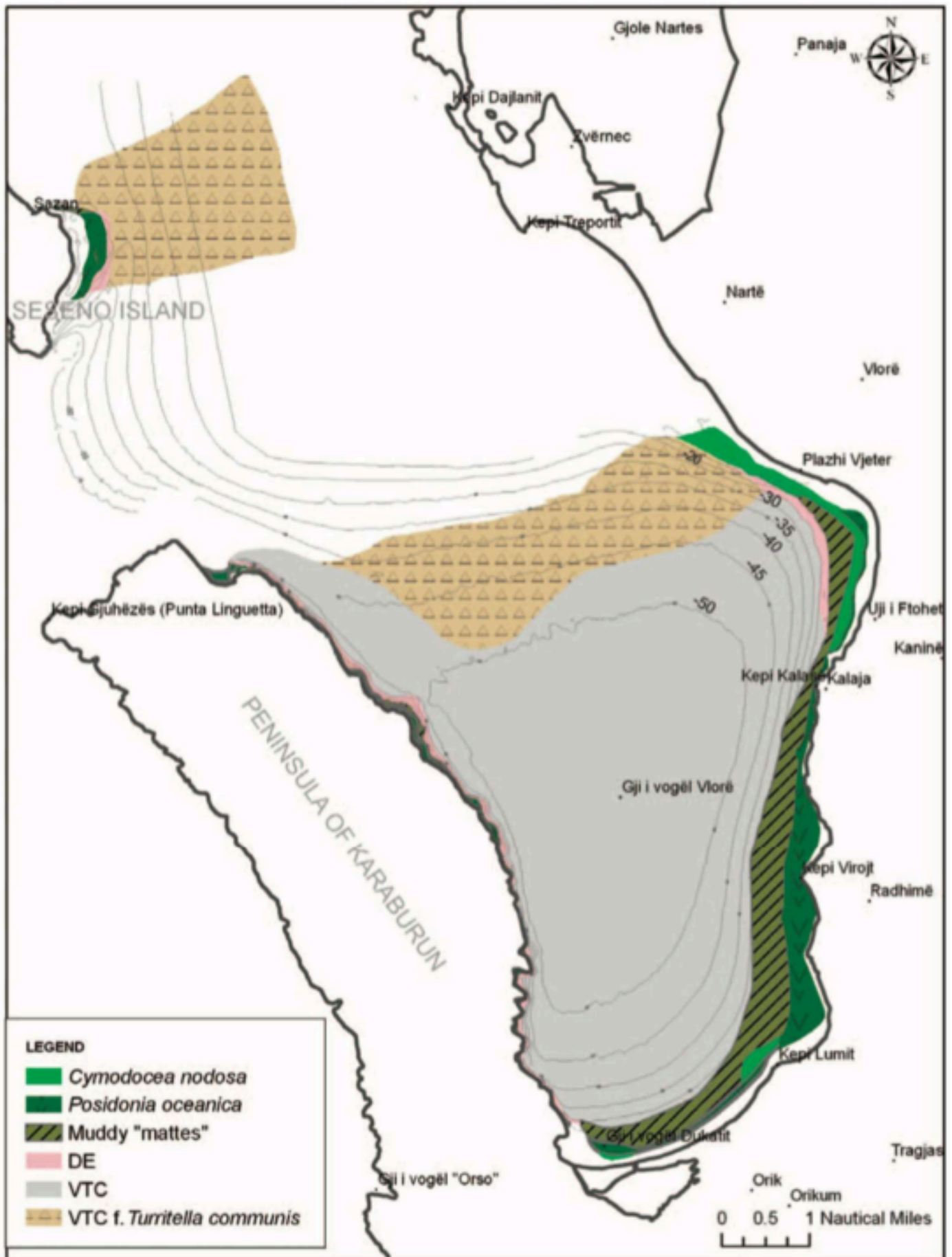


Figure 2. Map of main benthic habitats identified in Vlorë Gulf (Maiorano et al., 2011).

II. Scientific monitoring in Karaburun-Sazan MPA

Mediterranean MPAs are under growing pressure from anthropogenic activities, climate change and other issues, resulting in a need for managers that understand and are aware of the environmental changes that are occurring and affecting the MPA environment. Rare, endangered or threatened species or sites and habitats that hold large numbers of species might be particularly vulnerable, as species will need to move or adapt to the changing environmental conditions.

Table 2. Activities and their priority level according to the Management Plan of Karaburun-Sazan MPA.

Activity no.	Activity	Priority	Partners
AA1	Habitat mapping and then monitoring of Posidonia status	2	University of Tirana
AA2	Regulate and monitor number of boats in the MPA	1	Ranger Service, boat operators, diving centers
AA5	Regulate and monitor intensity of aquaculture, research impact of aquaculture and monitor it	2	University of Vlora
AB1	Habitat mapping and then monitoring of coralligenous status	2	University of Tirana
AC1	Collaboration of fishermen and military and monitoring (sightings) of charismatic species (large marine vertebrates – marine turtles, dolphins, whales and monk seals)	2	Ranger Service, fishermen, military
BA1	Monitor development of spatial planning documents and participate at meetings	1	Spatial planning authorities
BA2	Surveillance of illegal construction and informing inspection	1	Ranger Service
BB1	Update inventory of caves and cliffs and monitor their state (observation)	1	Scientists, experts, ranger service or conservation service
BC1	Baseline assessment of underwater archaeological remains and monitoring	1	University and CSOs
CB6	Introducing quality standards of touristic businesses (licensing system)	3	Tourist operators, CSOs, Agency of Tourism, Ministry of Tourism, local authorities
CB13	Surveillance and monitoring of diving activities, including number of divers per site	1	Ranger Service, diving centers
CC3	Monitor number of tourists of beaches during summer season	1	Ranger Service
CC4	Monitoring of sea water quality during summer season	2	Public Health Institute

Monitoring can be of assistance in identifying these adverse effects and providing early warnings and supporting decision making and undertaking of conservation measures. Monitoring activities prescribed by the 2015 Management Plan of Karaburun- Sazan MPA can be seen as the most prominent document defining and prescribing a set of activities related to monitoring. Those activities do not bear upon biodiversity only but on cultural heritage and landscape as well as sustainable use of natural resources.

The Table 2 summarizes activities related to monitoring and shows the level of priority according to the 2015 Management Plan. The management plan has initially set highest priority on monitoring of illegal construction, spatial planning, sea water quality as well as tourist activities such as boating, diving and occupation of beaches. Biodiversity related monitoring has been mainly classified under priority level 2. In addition to the provisions of the 2015 Management plan, the fulfillment of international obligations is becoming increasingly important. This is particularly true for the EU accession process and the associated implementation of both the Habitat and the Birds Directive. Those Directives, in turn, are interrelated with the Bern and the Barcelona Convention.

It is to be expected that the political demand for the implementation of those obligations will increase with the progress of Albania's EU accession. The obligation to implement the European Natura 2000 ecological network has been emerged with Albania's efforts in accessing the European Union. In this context, the National Agency for Protected Areas (NAPA) has been setting up a Wildlife monitoring system NAPA-WiMS and various activities have been started to determine and map NATURA 2000 habitats. Because of its legally binding character, NATURA 2000 should receive priority. In order to facilitate the process of prioritizing indicators and respective monitoring activities a list of previously defined criteria helps identify the most efficient and effective indicators. The following criteria have been agreed on for Karaburun-Sazan MPA: Human resources and capabilities; Equipment and infrastructure; Financial resources;; Time consumption; National/International obligations; Cross-sectoral collaboration; Threats and pressures.

Following the above analysis and based on a process of ranking and prioritizing six indicators have been identified for monitoring in Karaburun-Sazan MPA:

1. Biocenosis of infralittoral algae - Association with *Cystoseira amentacea*

2. *Posidonia oceanica* meadows

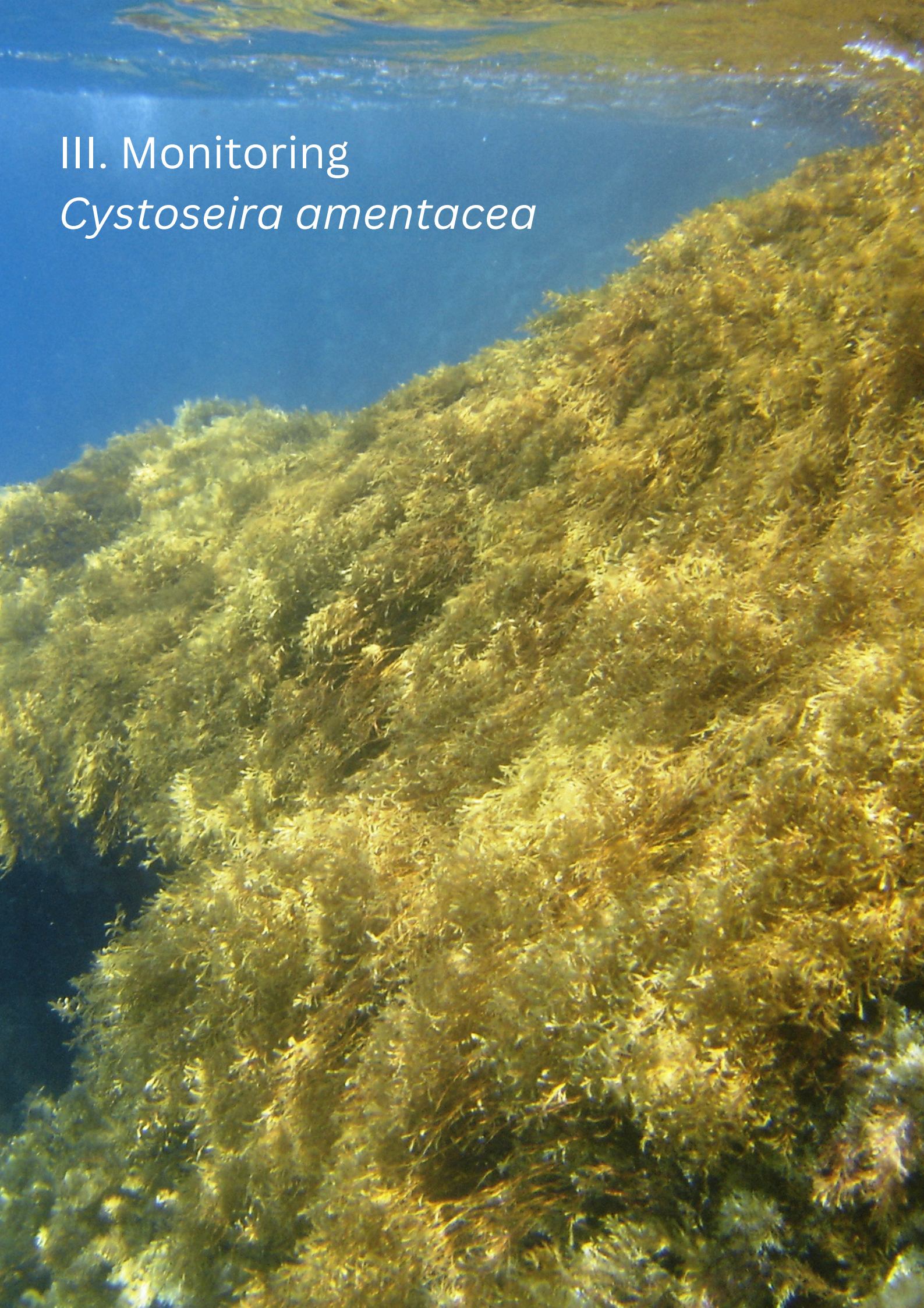
3. *Lithophyllum byssoides* rims

4. Monk seal *Monachus monachus*

5. Water quality

6. Common Indicator 16

III. Monitoring *Cystoseira amentacea*



3.1 Values of *Cystoseira amentacea*

Among the *Cystoseira* species, *Cystoseira amentacea* (previously referred to as *Cystoseira stricta* (Montagne) Sauvageau and *Cystoseira spicata* (Ercegović) is an endemic species widely distributed in the Mediterranean Sea. It is located in the first meter of the infralittoral and can form very long and dense belts in the photophilic biotopes, where a strong wave action predominates and where the rocky substratum is subvertical (Kashta et al., 2011).

Cystoseira amentacea is a type of brown algae, habitat-constructor, with important values for the development and survival of other organisms due to its important functional role insuring a complex food network and high biodiversity. In optimal conditions, the species form continuous belts known as *Cystoseira amentacea* forests.

Morphology: It is an algae rough to the touch with a height of 20-40 cm. From its base, originate some short vertical “stems” up to 5 cm long, called cauloid, which have branches covered by thorns. Reproductive organs are located in some structures called receptacle that are marginal, compact and with thorns. *C. amentacea* is perennial algae with seasonal development, which is maximal especially during spring, while in autumn and winter it is reduced.

Ecology, habitat: This is a helophyte species and grows in very shallow waters. It is locally dense and forms a brown band a few decimeters wide over exposed rocks, in the upper infralittoral, from the surface to about 1m depth.

Importance: *C. amentacea* forests are important because they produce oxygen and serve as a habitat for the reproduction and growth of many organisms. In addition, they export organic matter in other systems and serve as an indicator of the impacts affecting the rock bottom communities. *Cystoseira* species are some of the most important marine ecosystem-engineers, forming extended canopies comparable to land forests (Jones et al., 1994; Gianni et al., 2013; Cheminée et al., 2013). They play an important functional role in Mediterranean coastal ecosystems, especially for juveniles of many species (Cheminée et al., 2013), sustaining complex food webs and maintaining a high biodiversity (Gianni et al., 2013). *Cystoseira* assemblages are considered as habitats of critical importance for the EU (Directive 92/43/EEC; Annex I, included in “Rocky reefs”) and as indicators to assess ecological status in the context of the Water Framework Directive (WFD; Directive 2000/60/EC) (Fabbrizzi et al., 2020).

Well-structured communities of *Cystoseira amentacea* are bioindicators of sites with a high ecological status (Ballesteros & Pardo, 2004) and their loss has been defined as a good indicator of the anthropogenic effects associated with coastal urbanization (Mangialajo et al., 2008).

3.2 Materials and methods

The entire study area was divided in six monitoring zones and for the monitoring was used a small boat moving close to the shore at low speed. The status of *Cystoseira* belts in the infralittoral fringe was evaluated with linear transects as for the CARLIT index calculation, according to Guidelines for the conservation, monitoring and restoration of *Cystoseira* forests in Mediterranean Marine Protected Areas (Gianni & Mangialajo, 2016). The coastline was mapped and *Cystoseira* abundance was visually estimated and associated to a value corresponding to three categories according to Gianni & Mangialajo (2016) and Nikolić et al. (2013): 1- isolated individuals; 2- dense and numerous populations; 3- algal forests forming almost continuous or continuous belts. The symbols used in the distribution maps of the species or algal communities of the mid-littoral and upper levels of the upper infralittoral:

Orange lines █ isolated individuals

Light brown lines █ dense and numerous groups

Dark brown lines █ algal forests forming almost continuous or continuous belts

Apart the *Cystoseira* stands, other data were recorded such as the presence of biogenic formations of *Lithophyllum byssoides* algal rims as important habitat, and *Ellisolandia elongata* (*Corallina elongata*) and other species. All the observations were firstly drawn in maps of the monitoring zones (A3 formats) and later were entered in a Geographical Information System (GIS) database where as result was produced a full map of the distribution and status of *Cystoseira amentacea* in the MPA. The results were compared to other data gathered through previous monitoring and an analysis of the evolution of the habitat was made. More over data were gathered in 2021 regarding the coverage of the habitat, maximal length of the axis and its distribution on the substrate.



Figure 4. Photos taken during the monitoring of *Cystoseira amentacea* by Flag Pine and RAPA Vlore staff.

3.3 Results and discussions

The results of the monitoring show that the algal forests of *Cystoseira amentacea* are one of the most distributed habitats in the Karaburun-Sazan MPA (Figure 5, 6, 7, 8), situated in almost all the coastline of the MPA. Each monitoring zone, as results of various factors and pressures affecting it, has different status of *Cystoseira amentacea*, from isolated individuals to continuous belts. The monitoring zones are divided as below, same as the first monitoring of 2013 in order to avoid confusion.

Zone 1- Eastern side of Sazan Island;

Zone 2- Western side of Sazan Island;

Zone 3- From Cape of Gjuheza to Bay of Brisan;

Zone 4- From Cape of Galloveci to Cape of Gjuheza;

Zone 5- From Cape of Galloveci to Bay of Shen Vasil (eastern border of MPA);

Zone 6- From Bay of Brisan to Palasa (western border of MPA).

The species is considered as highly sensitive to anthropogenic pressures resulting in regression events that might be caused by the sensitivity of these macroalgae to increased water turbidity, eutrophication and pollution (Airoldi & Beck, 2007) caused by the increasing anthropogenic activity near the coastal areas. As result of the monitoring maps showing the distribution of *Cystoseira amentacea* forests were prepared using GIS during 2020, 2021, 2022, 2023.

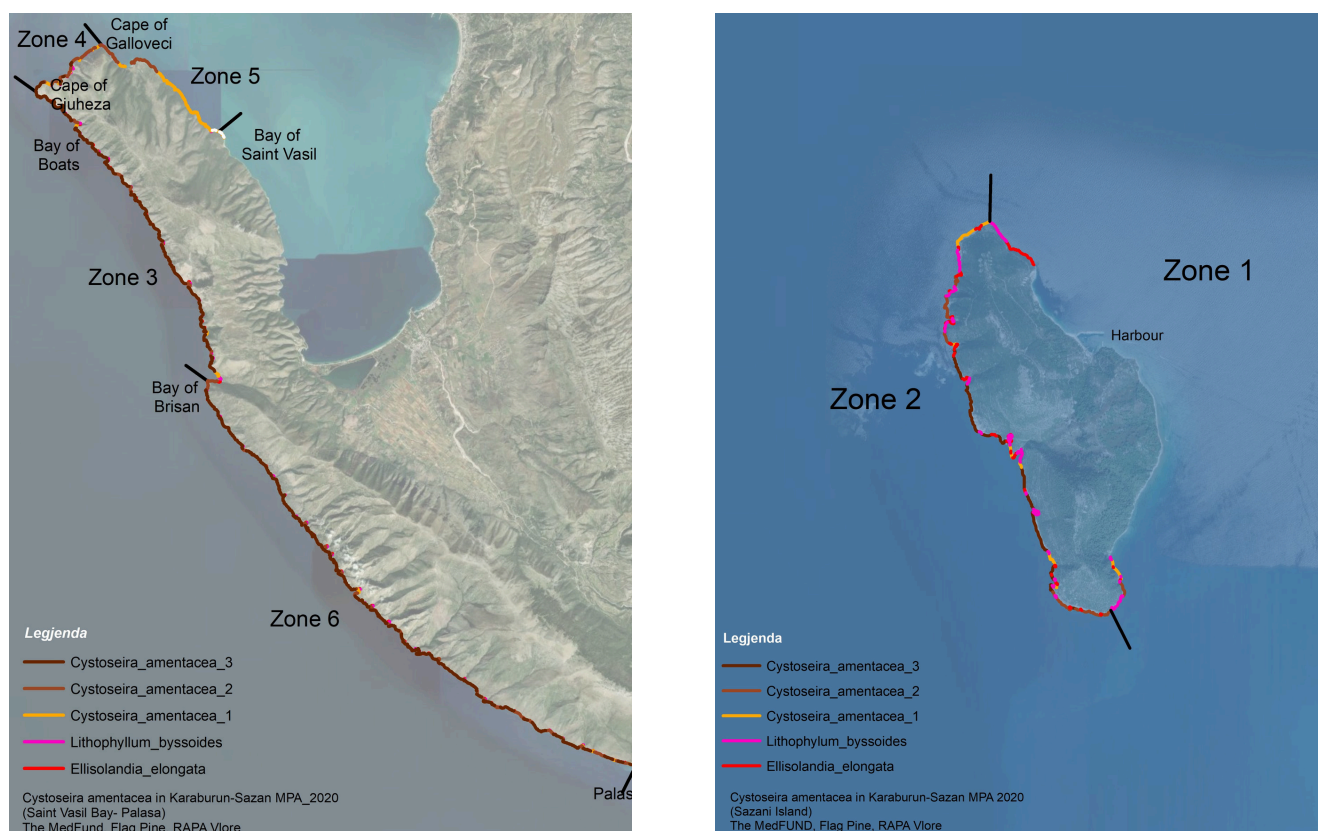


Figure 5. Map of the distribution and status of *Cystoseira amentanea* in Karaburun-Sazan MPA, 2020.

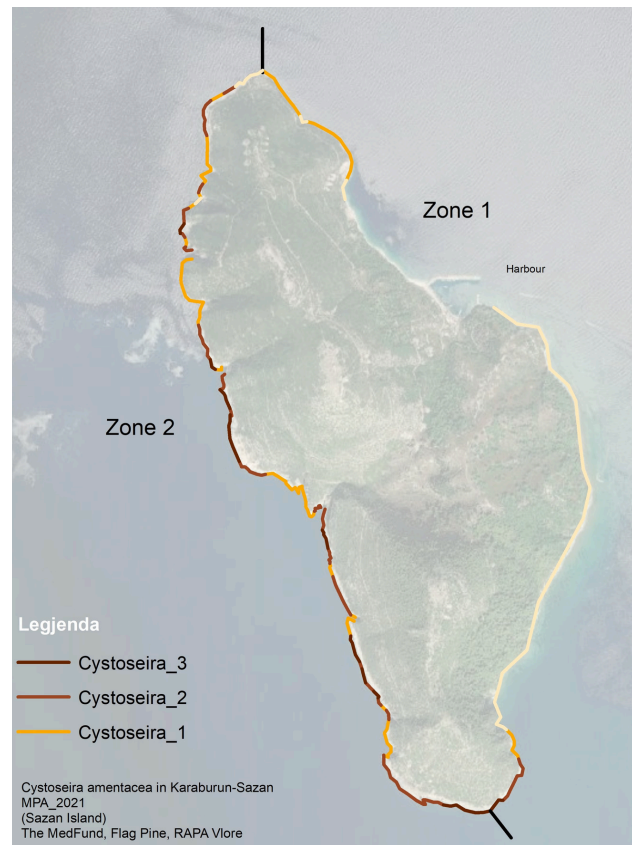


Figure 6. Map of the distribution and status of *Cystoseira amentacea* in Karaburun-Sazan MPA, 2021.

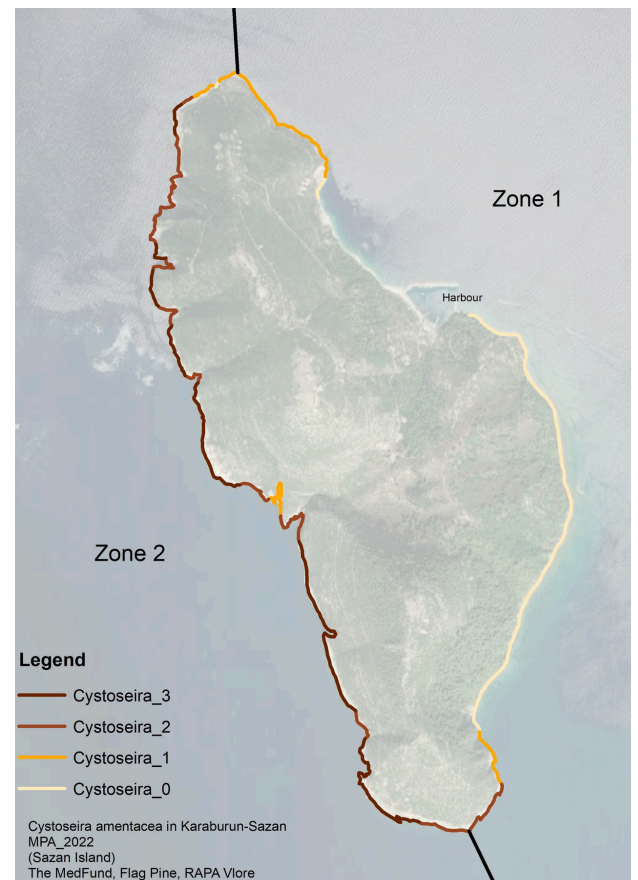


Figure 7. Map of the distribution and status of *Cystoseira amentacea* in Karaburun-Sazan MPA, 2022.

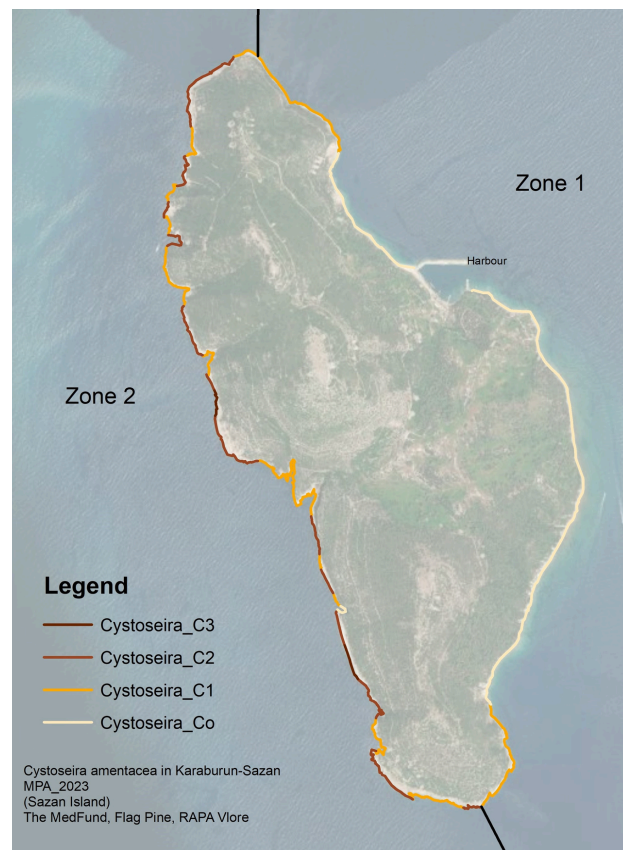


Figure 8. Map of the distribution and status of *Cystoseira amentacea* in Karaburun-Sazan MPA, 2023.

The eastern side of Karaburun Peninsula and Sazan Island and the area from Cape of Gjuheza to Cape of Galloveci shows the worst status for *Cystoseira amentacea* (Figure 9). These areas are the most affected from human activities such as tourism and illegal fishing activities (mainly date shell harvesting) and also from the presence of coastal artificialized areas. On this basis, a loss of relevant coastal habitats and a resulting extensive decrease in the ecological value of the coastal zone and marine habitats are expected (Airoldi and Beck, 2007).

In the other hand, the western side of Karaburun Peninsula, where there is no or less impact from human activities, shows the best status of the species and continuous or almost continuous belts are formed.

In some areas such as bays or not exposed coasts *C. amentacea* is missing due to natural factors. In this areas is noticed a presence of *Lithophylum byssoides* rims and presence of *Ellisolandia elongata*. During the monitoring have also been noticed associations with *Laurencia sp.* In other areas mainly in the eastern side of the MPA is noticed the presence of sea urchins.

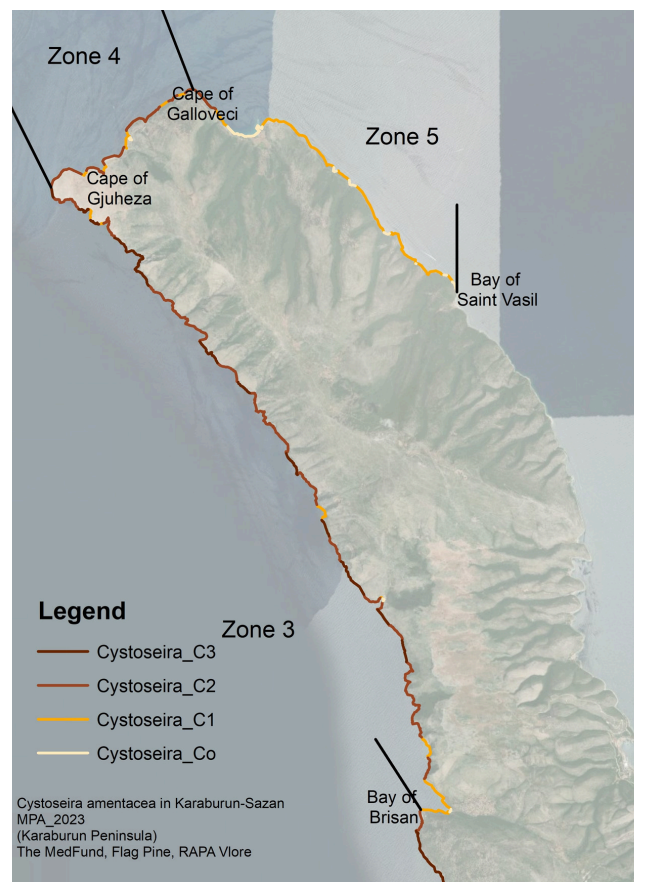
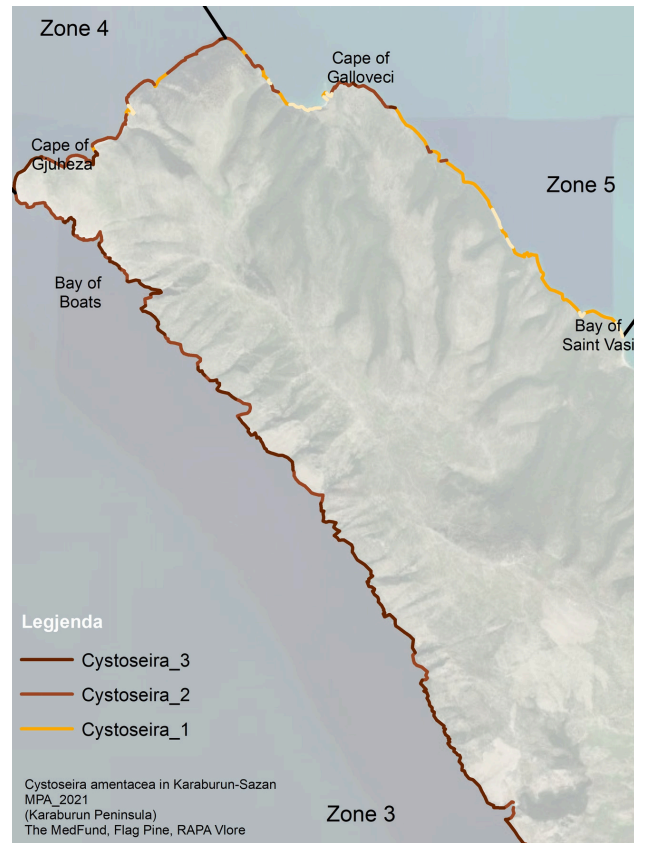
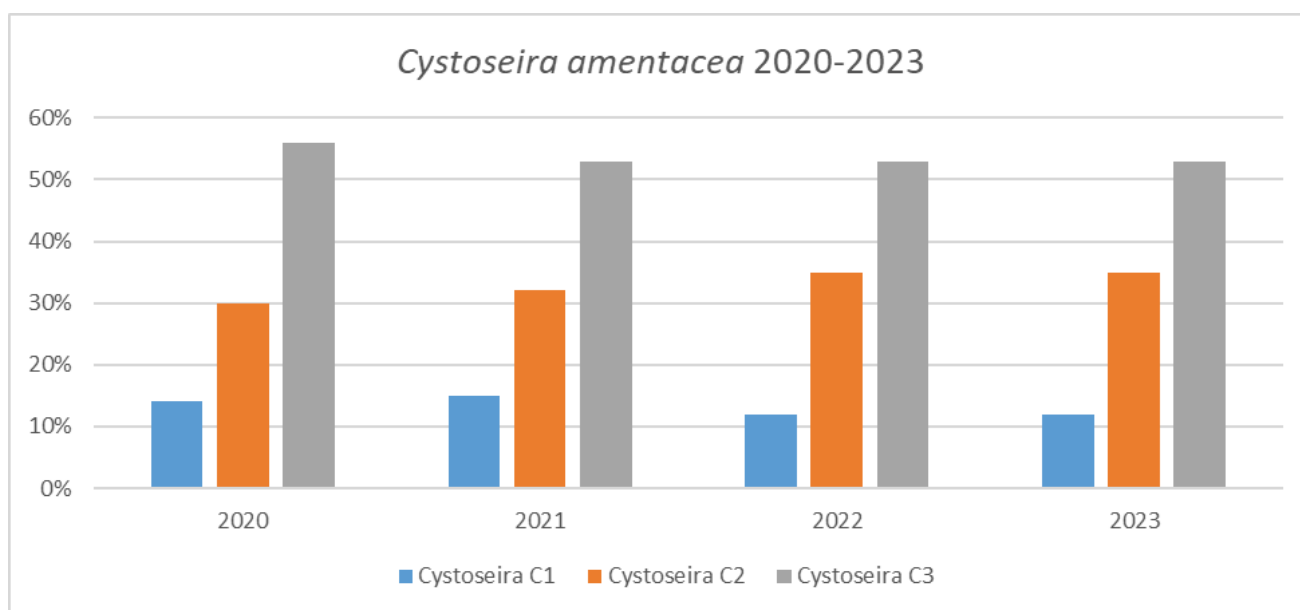


Figure 9. Distribution of *Cystoseira amentacea* in Eastern side of Karaburun Peninsula.

Following the analysis of the data regarding the status of the habitat in Karaburun-Sazan MPA From 2020 to 2023 the ratio of the status of the habitat C1, C2, C3 remains stable, respectively as the graph below (Graph 1) .



Graph 1. Ration of the status of *Cystoseira amentacea* in Karaburun-Sazan MPA.

As previously described another element of the monitoring is the gathering of data regarding the coverage of the habitat, maximal length of the axis and its distribution on the substrate. The monitoring was carried out in seven stations and the data gathered are presented in the Table 3.

Table 3. Data gathered from the monitoring transects of *Cystoseira amentacea*.

Location	Latitude	Longitude	Coverage	Axis length (cm)	Depth/ distribution (cm)
Moli i Veriut	40.4248378	19.2995219	14.6	10.5	112
Feneri i Gallovecit	40.43318	19.3275138	10.3	11	61
Dhimkushtë	40.4165696	19.3618623	5.2	10	43
Feneri Sazan	40.4737192	19.2853149	17.8	11.5	195
Gryka e Djallit-Sazan	40.4883176	19.2746194	16.5	13.6	330
Grame	40.215556	19.474167	20.2	13	87.5
Ali Can	40.3927778	19.325	15.2	11.6	70

IV. Monitoring *Posidonia oceanica*



4.1 Values of *Posidonia oceanica*

Posidonia oceanica is an aquatic plant, endemic to the Mediterranean Sea, belonging to the Posidoniaceae family (Monocote angiosperms). In our country, *Posidonia* is one of the main builders of underwater meadows, which extends along the entire Albanian coast up to 30m deep. Included in the Bern Convention (1993) and the Barcelona Protocol (1996), *Posidonia* meadows are on the red list as strictly protected ecosystems.

They have quite high productivity: 500-1300 gr/m²/year at a depth of 1 m, 150-300 gr/m²/year at a depth of 20 m. This productivity is comparable to that of an oak forest. About 30% of the primary productivity of meadows remains in the form of dead leaves in the deepest areas.

Valuable for marine biodiversity: *Posidonia* meadows are a reservoir of biodiversity; they host about 20-25% of Mediterranean species (400-500 species of algae and over 1,000 species of animals); many of these live exclusively in meadows.

They are oxygen producers: in 1 m² of meadow, as a result of the photosynthesis process, depending on the density, 4-20 liters of oxygen are produced per day, or on average about 14 liters. For this reason, they have been called the "green lungs" of the Mediterranean.

They are a place of shelter and food: meadows create microhabitats that serve as shelter and protection, for food and for reproduction for a large number of marine organisms. Among them there are groups of organisms of great economic importance such as fish, cephalopods and crustaceans.

They play an important role in sediment balance: the development of a strong root and stem system affects the stability of the seabed. The leaf mass of *Posidonia* meadows reduces the intensity of waves and affects the growth of sediments. In this respect, the meadows with *Posidonia* constitute a protective belt for the protection of the coasts from the erosive action of the waves. It reduces the force of sea waves up to 30%.

4.1.1 Morphology

Posidonia oceanica is made of creeping or erect stems usually buried in the sediment, called rhizomes. Creeping rhizomes are called plagiotropic, and erect rhizomes orthotropic. Leaves less than 5 cm long are called juveniles and those longer than 5 cm without basal sheath (=petiole) are called intermediate; when the growth is over, a petiole is formed and the leaf is said to be adult. The leaves drop, as they are formed, all year round. *Posidonia oceanica* flowers in the autumn (September- November). The flowers are hermaphrodite, i.e. both male and female at the same time; 4-10 flowers are grouped in an inflorescence at the tip of a 10-30 cm long stalk. It does not flower every year, especially in the relatively cold waters of the northwestern Mediterranean.

The fruits of *Posidonia oceanica* require 6-9 months to ripen. Between May and July, they drop off and float for a certain time. The leaves and rhizomes of *Posidonia oceanica* support many flora and fauna, some of which are calcified. When they die, their remains fall off and form an autochthonous sediment (debris of sea urchin spines or tests, mollusc shells, corallinales, etc.). *Posidonia oceanica* rhizomes grow in height, even in the absence of sedimentation. To resist being buried, they are capable of speeding up their growth. The “matte” is the whole mass composed of rhizomes, sheaths, roots and the sediment that fills the interstices. The rhizomes, sheaths and roots are not very putrescible and thus are conserved within the “matte” for several centuries or even thousands of years. The rising of the “matte” can bring the meadow near the surface. In exposed conditions, this rise stops 1 or 2 metres below the sea surface.

4.2 Monitoring methodology

Monitoring of structural variables (i.e. shoot density and cover percentage) was carried out to assess the conservation status of *Posidonia oceanica* as well as to identify changes in *Posidonia oceanica* meadows in the bay of Vlora. The monitoring of meadows with *Posidonia oceanica* was carried out during 2021 and 2023, in three study areas, two of which are inside the Bay of Vlora, and a control area, outside the bay, according to the maps and photos below (Figure 11).

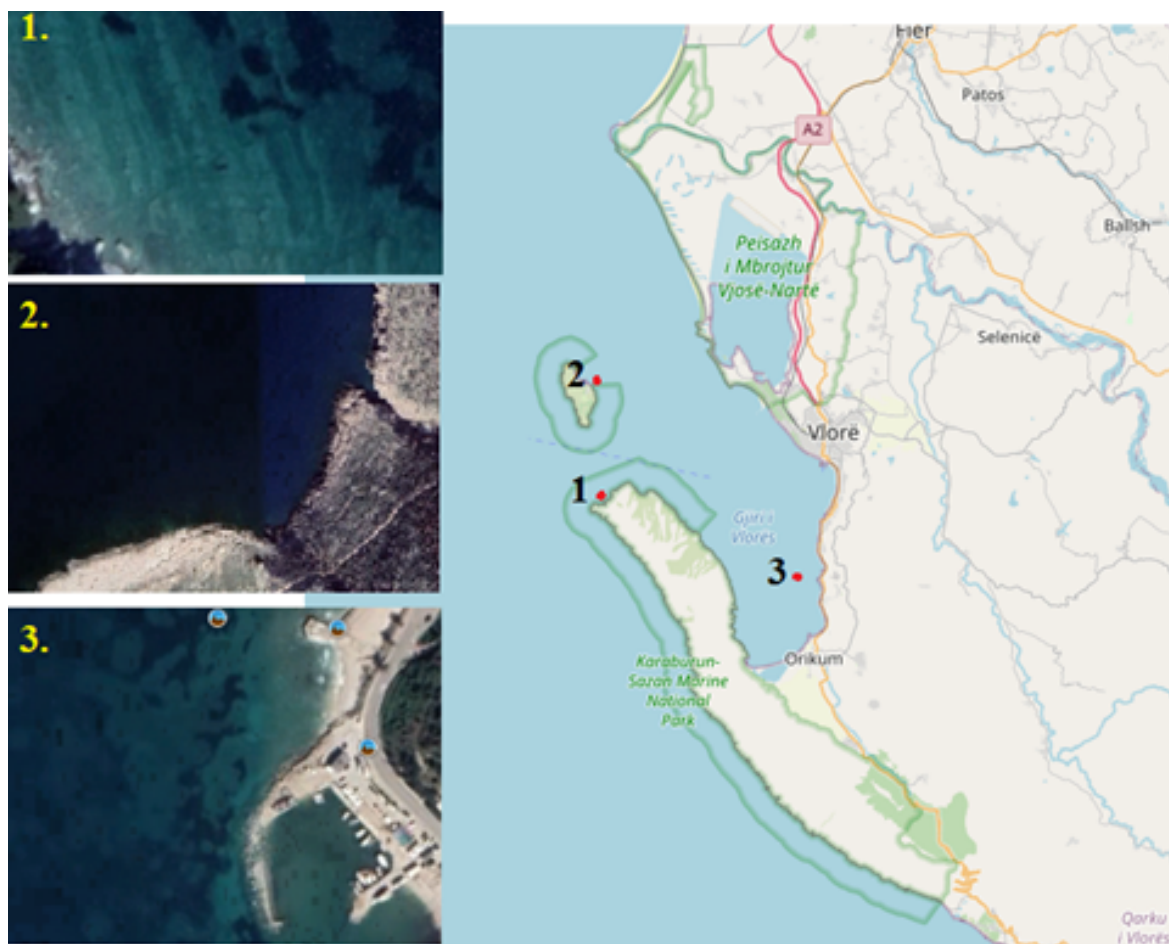


Figure 11. Map and photos of the monitoring sites of *Posidonia oceanica*.

As detailed cartographic data is lacking, sample designs are planned according to the knowledge of local MPA managers. In particular, sampling sites where *Posidonia oceanica* meadows colonize shallow water (depth range 3–16 m) and gentle slopes (i.e. horizontal or sub-horizontal bottoms) were selected; in fact these are the preferred conditions of recreational boats for mooring. Based on an empirical assessment of boat attendance, meadow density and continuity, meadows were designated as "impacted" or "reference" when attendance was high or negligible, respectively.

4.3 Results and discussions

4.3.1 First study area

A total of four polygons and four Lt were taken in the Karaburun meadow. Meadow density averaged 352 ± 10 (mean \pm standard error) shoots m^{-2} (-2 as exponent); the meadow belongs to the moderate level of development according to Pergent et al. (1995). This value reflects low disturbance conditions according to Buia et al. (2004). The depth of the meadow is 12-15 m. (Figures 12). Furthermore, a clear gradient in meadow density is visible from polygon 1 to polygon 4: the number of shoots decreases towards the south, independently of the depth that is almost unchanged (Table 3).

In some cases, the polygons present a healthy level of meadow with a normal density, but the presence of matte as well as the decrease in meadow density in the southeastern part clearly indicates the presence of a disturbing factor (Graph 2).

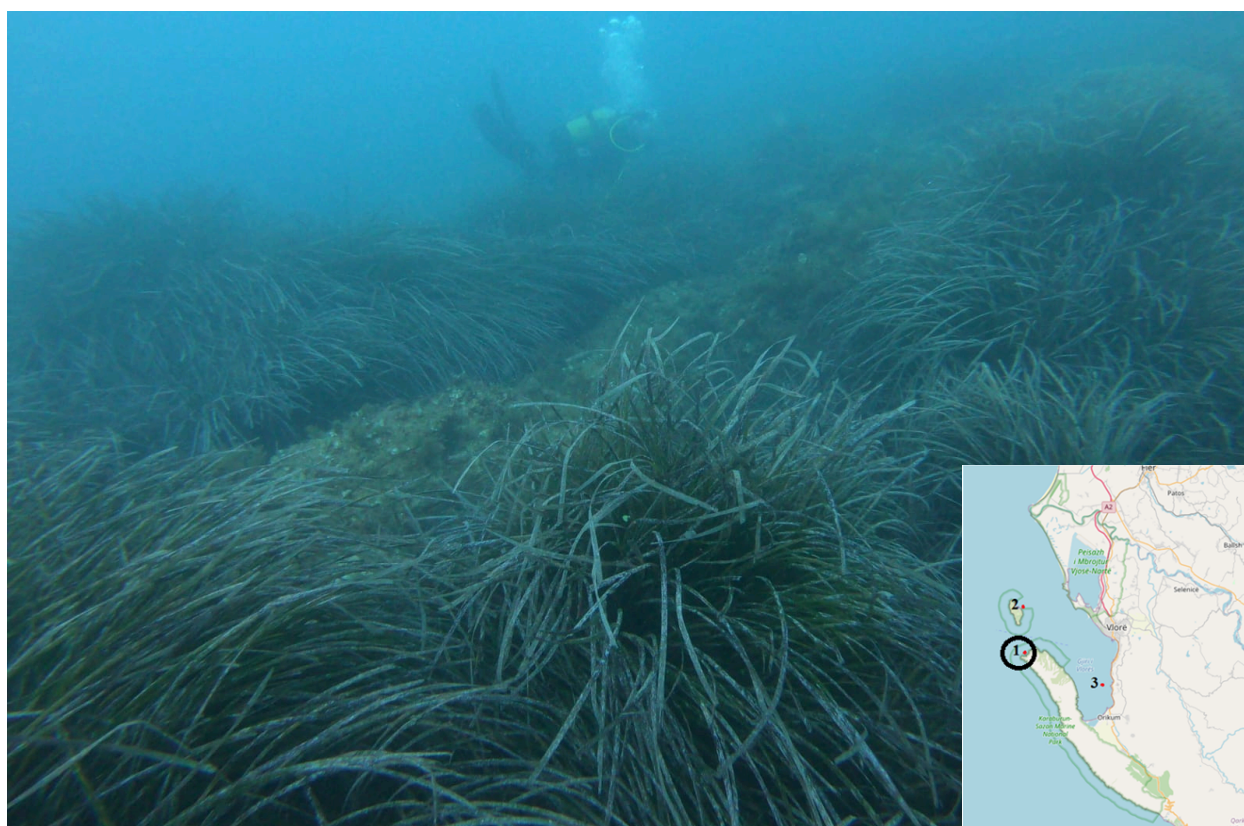
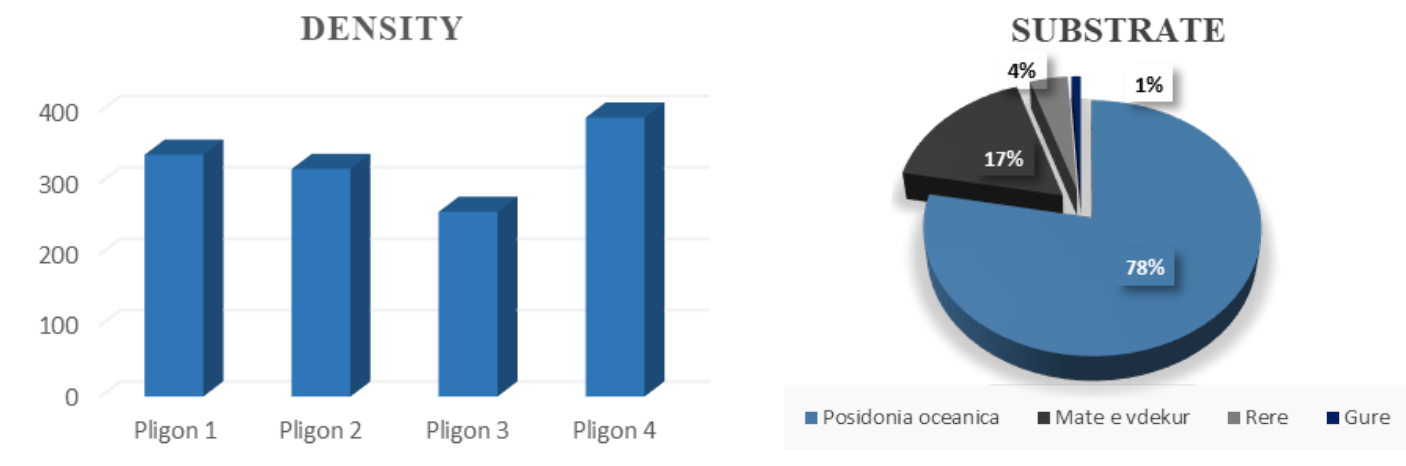


Figure 12. *Posidonia oceanica* meadow in Karaburun.



Graph 2. First study area. Meadow density chart by polygons, Substrate type – Brijuni. Percent cover of different substrates and live *Posidonia oceanica*.

Referring to the Graph 2 we can clearly see the difference in the level of cover between the polygons where the minimum level is represented by polygon 3 where there was the presence of a dead matte and the maximum level is represented by polygon 4 towards the east where its values correspond to the good status of the meadow. Regarding the percentage of substrate type, the entire monitoring area presents a level of 78% covered with *Posidonia oceanica* and only 17% of the cover consists of dead mattes. Referring to the conservation index for this study area, the value is 0.82, which belongs to good conservation status.

Table 4. The monitored values for each polygon in first study area.

Location	Coordinates	Polygon no.	Density		Length (cm)	Notes
Karaburun	40 25 39.2N 19 18 07.5E	Polygon 1	1	122	132	10% new growth
			2	113	127	
			3	98	125	
		Polygon 2	1	104	104	20% new growth
			2	115	110	
			3	100	108	
		Polygon 3	1	95	112	10% new growth
			2	106	96	
			3	112	106	
		Polygon 4	1	131	92	
			2	118	97	
			3	107	99	

4.3.2 Second study area

A total of four polygons and four Lits were taken in the Sazan Island meadow. Meadow density averaged 111 ± 14 (mean \pm standard error) shoots m^2 ; the meadow belongs to the poorly developed level according to Pergent et al. (1995). This value reflects conditions of high disturbance according to Buia et al. (2004). The depth of the meadow is 10-12 m. (Figures 13).

This value reflects conditions of high meadow disturbance according to Buia et al. (2004). Meadow represents an old matte that covers almost 50% of the total cover (Table 5). Polygons 1 and 4 represent the presence of a perennial dead matte which is reflected in squares with 0 cover density (Graph 3). Also the presence of young leaves but short in size, with an average of 52 cm indicates the presence of a short-leaved meadow, attacked by herbivores.

A concrete marker was placed at the border of the meadow for reference to observe the advance or regression in time of the meadow in future years.

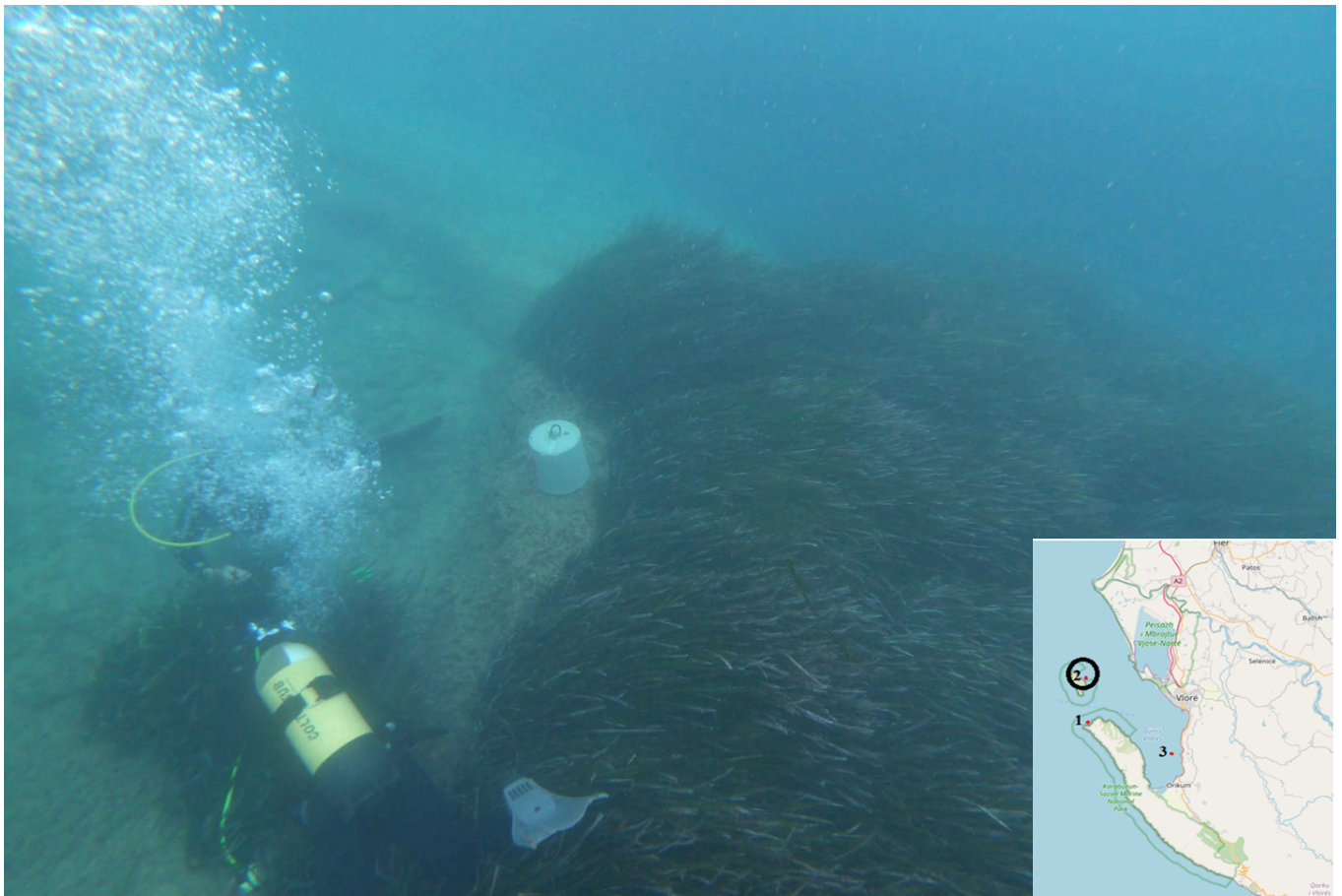
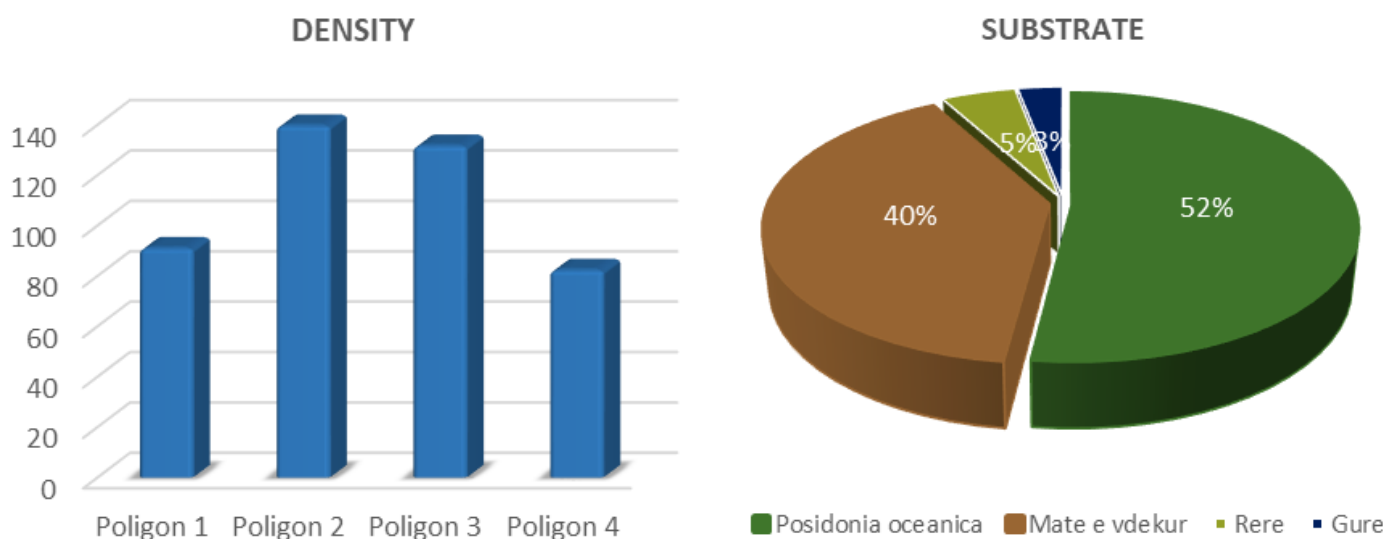


Figura 13. *Posidonia oceanica* meadow in second study area, Sazan.

Table 5. The monitored values for each polygon in second study area.

Location	Coordinates	Poligon no.	Density		Length (cm)	Notes
Sazan	40 30 00.5N 19 17 28.8E	Polygon 1	1	128	87	10% new growth
			2	92	93	
			3	90	90	
		Polygon 2	1	103	77	
			2	89	85	
			3	96	83	
		Polygon 3	1	117	72	5-10% new growth
			2	101	71	
			3	95	68	
		Polygon 4	1	87	79	
			2	103	85	
			3	93	88	

Referring to the Graph 3 we can clearly see the difference in the level of cover between the polygons, where the minimum level is represented by polygons 1 and 4, where the substrate was mainly covered by long-term dead matter, silt and clay, this sediment originating from the Vjosa River. Regarding the percentage of substrate type, the entire monitoring area presents a level of 52% covered with *Posidonia oceanica* and only 40% of the cover consists of dead matte. Referring to the conservation index for this study area, the value is 0.47, which belongs to the poor conservation status.



Graph 3. Second study area. Meadow density chart by polygons, Substrate type – Brijuni. Percent cover of different substrates and live *Posidonia oceanica*.

4.3.3 Third study area

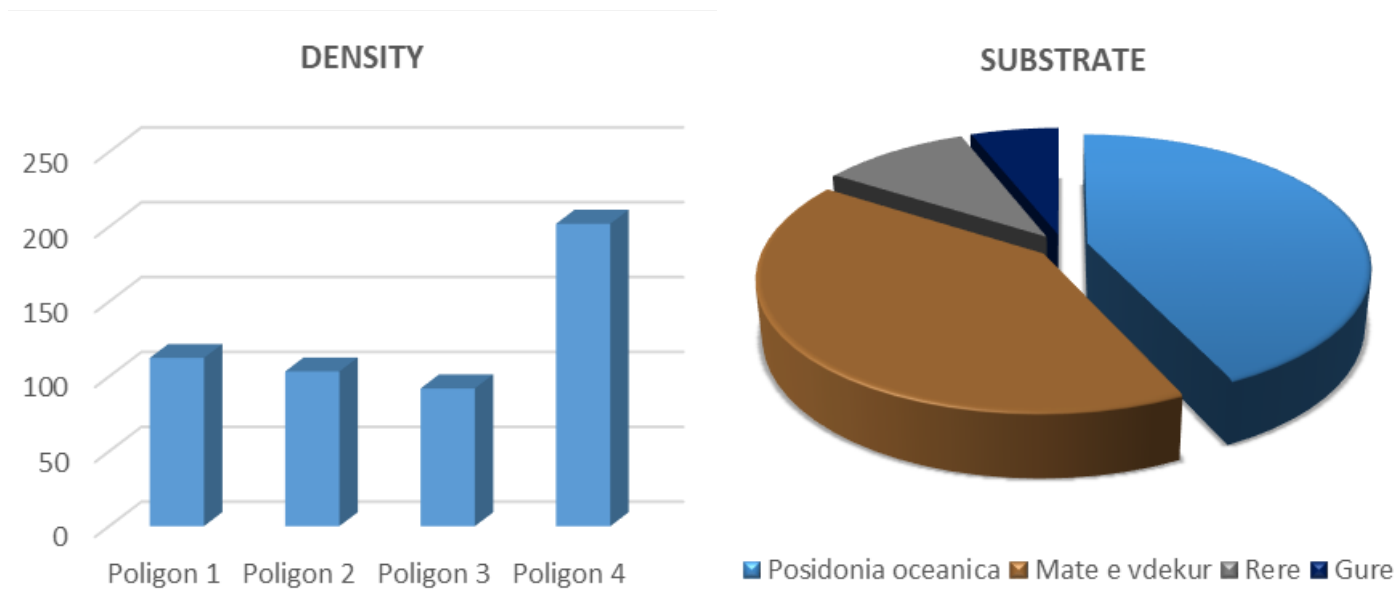
The third meadow studied is the meadow near the Karaburun-Sazan MPA Visitor Center in Radhima, in which a total of four polygons and four LIt were evaluated. Meadow density averaged 127 ± 12 (mean \pm standard error) shoots m^2 ; the meadow belongs to the poorly developed level according to Pergent et al. (1995). This value reflects conditions of high disturbance according to Buia et al. (2004). The depth of the meadow 10 - 13 m. (Figure 14).



Figure 14. *Posidonia oceanica* meadow in third study area, Radhima.

The meadow represents an old mat that covers almost 60% of the total cover. Polygons 2 and 3 present the presence of a perennial dead mat covered with clay cloud sand as well as stones and other sediments. A concrete marker was placed at the border of the meadow for reference to note the advance or regression in time of the meadow in future years. The meadow appears fragmented, with a high percentage of dead mat, where the shoots have leaves with an average length of 30 cm, where young leaves predominated, often eaten by herbivores. Such views of the meadow, the presence of herbivores and epiphytes as well as the lack of leaf growth indicate the constant presence of stressors in the health of the Radhima meadow.

Referring to the Graphs 4 we can clearly see the difference in the level of cover between the polygons, where the minimum level is represented by polygons 2 and 3, where the substrate was mainly covered by long-term dead matter, silt and clay, this sediment originating from the Vjosa River. Regarding the percentage of substrate type, the entire monitoring area presents a level of 43% covered with *Posidonia oceanica* and only 41% of the cover consists of dead mattes. Referring to the conservation index for this study area, the value is 0.361, which belongs to the poor conservation status.



Graph 4. Third study area. Meadow density chart by polygons, Substrate type – Brijuni. Percent cover of different substrates and live *Posidonia oceanica*.

Table 6. The monitored values for each polygon in third study area.

Location	Coordinates	Polygon no.	Density		Length (cm)	Notes
Radhima	40 2145.7N 19 28 43.8E	Polygon 1	1	59	44	
			2	72	41	
			3	77	37	
		Polygon 2	1	89	52	
			2	91	39	
			3	71	45	
		Polygon 3	1	96	51	
			2	99	44	
			3	103	42	
		Polygon 4	1	68	46	
			2	74	39	
			3	77	36	



V. Monitoring
Monachus monachus

5.1 General information regarding *Monachus monachus*

The Mediterranean monk seal *Monachus monachus* (Hermann, 1779), classified by the International Union for the Conservation of Nature (IUCN) as an endangered species, is the sole representative of the genus *Monachus* (Scheel, D. et al., 2014). The Mediterranean monk seal is among the largest phocid species and exhibits slight sexual dimorphism, with males slightly larger than females. Monk seals are considered opportunistic in their feeding, exploiting the most abundant resources in each place and time. Today seals generally use the beaches inside caves or beaches protected by cliffs (González, L.M. et al., 2006). The use of coastal, dry land territories exposed these species to anthropogenic impacts such as direct human disturbance and noise (Martin, M. et al., 2022). Interactions with fisheries represent one of the most important threats to marine mammals.

Historically, the distribution of the Mediterranean monk seal extended along the coasts of the Mediterranean and Black Sea, the eastern Atlantic and, along the African coast, from the Strait of Gibraltar to Mauritania, and along the oceanic islands of Macaronesia. (Archipelagos of Madeira, Azores, Canary Islands and Cape Verde). Likewise, there have been sightings of specimens in Atlantic France, Gambia and Senegal (Marchessaux, 1989).

Nowadays the species are located in three main subpopulations in the Cabo Blanco Peninsula and the Archipelago of Madeira in the Atlantic Ocean and in the eastern Mediterranean Sea where it is established in Greece and Turkey. Nevertheless, the establishment of the monks seal in the above locations, sightings of the species have been recorded even in other areas, (Karamanlidis, A.A. et al., 2019; Notarbartolo di Sciara, G. et al., 2016). The presence of the monk seals in Albania has been mentioned and taken into consideration since many years ago, even before the proclamation of Karaburun-Sazan MPA in 2010, but no scientific data were available to support these discussions, until 2020.

5.2 Monitoring methodology

The monitoring of the monk seal *Monachus monachus* by Flag Pine and RAPA Vlore within the MedFund project has started in 2022 and has continued the work and the efforts of RAPA Vlore and Archipelagos Italy done within the project “Sustainability, threats, presence and habitat use of the Mediterranean monk seal in Albania”.

Within the Archipelagos Italy project, in August 2019, a survey aimed to investigate suitable and potential habitats available for the Mediterranean monk seal was carried out along the coastline of the Karaburun-Sazan MPA. All caves along the coast were investigated, and the ones suitable for monk seal use were mapped and described (Bundone, L. et al., 2022). Among the surveyed and mapped caves, the ones showing the best characteristics for the use by the investigated species were equipped with infrared camera traps set on a motion detection mode.

The cameras were exchanged with a variable frequency to verify monk seal presence while keeping to the minimum any possible environmental disturbance to the specimens (Bundone, L. et al., 2022). The cameras were removed during the summer season and placed again after the season, in order to avoid being stolen or damaged by the presence of tourists.

5.3 Results

A total of eight suitable caves for the species were recorded, mapped, and described along the prospected Albanian coast. Two of the eight caves were equipped in 2020 with infrared camera traps to monitor their effective use by the monk seals. On 23 December 2020, about 1 year after the first installation of the infrared cameras in the caves, a seal was captured by the camera in one of the monitored caves (Figure 16). And on 14 February 2021, a seal was “captured” by the cameras installed in the other cave.



Figure 16. First photo of the monk seal *Monachus monachus* captured with camera traps.

The behavior of the specimens could not be confirmed due to the limited material recorded (Bundone, L. et al., 2022). In addition to the camera trap monitoring the presence of the monk seal in Karaburun-Sazan MPA and Vlora bay is documented also through citizen science. Photo and video materials acquired from fishers, tourists, boat operators and local community are kept in a database and analyzed in order to understand the dynamics of monk seal presence in the area.

In all the materials acquired during this period through camera traps and citizens science was seen only one individual, until 4 March 2022, when a camera trap in one of the monitored caves captured two individuals.

From 19 March 2019 until 13 December 2020 thirteen sightings were collected through citizen science, and from January 2022 to December 2023, the presence of the monk seal in Karaburun-Sazan MPA was documented in 45 occasions, 38 through camera traps and 7 through citizen science, showing one or two individuals (Figure 17abc).



Figure 17a.b.c. Photos of the monk seal *Monachus monachus* captured with camera traps.

On figure 18 is shown a map on the distribution of sightings of the monks seal in the territory of Karaburun-Sazan MPA and Vlora Bay. The low quality of the pictures from the citizen scientists along with the limited number of pictures from the camera traps and also lack of capacities for monk seal identification did not allow a proper individual identification.

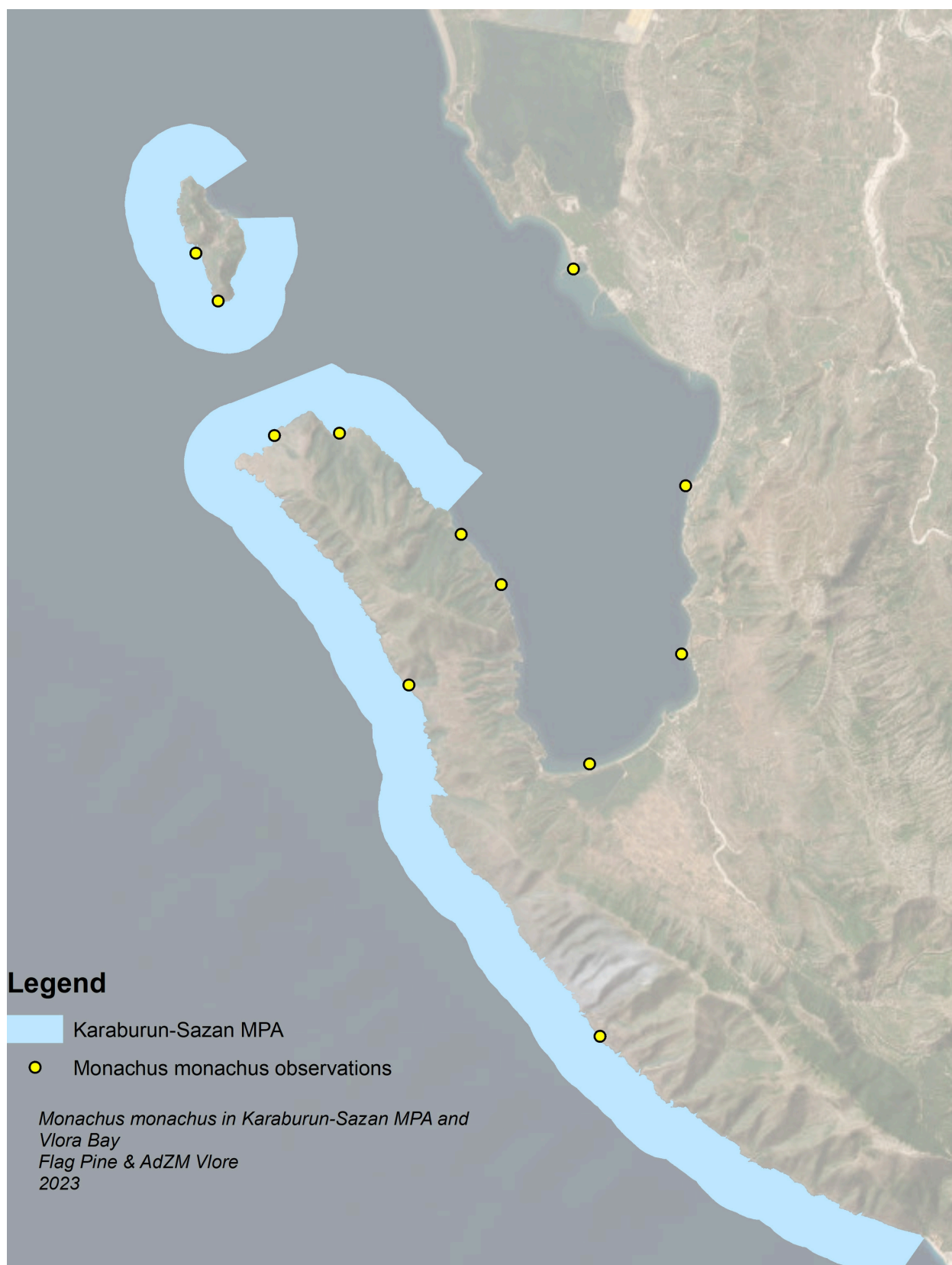


Figure 18. Locations of sightings of the *Monachus monachus* in Karaburun-Sazan MPA and Vlora Bay, 2023.



VI. Monitoring Water Parameters

6.1 Introduction

The following information presents the collected data on water quality and physical and chemical parameters of marine waters in Karaburun-Sazan MPA and Vlora Bay from August 2020 until December 2023. This data could be used to correlate how the surroundings affects the overall functionality of the marine ecosystems.

The main objectives of data collection are:

- **monitor**, through the adoption of a standardized data collection protocol, the changes in temperature along 14 different measurement sites within and in vicinity of the marine national park;
- **to evaluate** the effects of climate on coastal marine ecosystems, in order to collect useful data to develop adequate management and protection measures;
- **provide** periodic and constant data on physical and chemical parameters; process and compare the data recorded. These data will inform the decision makers and park managers
- **raise awareness** of agencies and public on the changes taking place, with the ultimate aim of stimulating the necessary interventions to address them;
- **lay the foundations** for the development of a national Albanian network for monitoring the impacts of climate change.

The overall number of monitored sites is 14 out of which 9 are located within protected areas and 5 located in Vlora bay (open sea) outside the protected area network. Two sites are located within “Vjose Narte” Protected Landscape, Vth category of protection according to IUCN, and seven are located within Marine National Park of “Karaburun- Sazan”, IIInd category of protection according to IUCN.

Monitored site were selected in such way that provides a better coverage of the entire Vlora bay but also an opportunity for data comparison within and outside protected areas. On purpose, few sites have been selected from the western part of Karaburun Peninsula (Recreation zone) where the anthropogenic impacts due to tourism or maritime traffic are minimal (P2, P3, P7, P8, P9) compared to other sites. Intentionally we have also selected a few sites in areas with high presence of tourism and maritime traffic usually during summer season (P4, P5, P6, P10). Meanwhile P0, P1, P11, P12 and P12.a are characterized by constant impact due to persistent economic or anthropogenic impacts occurring in these areas. Specifically, the sites are located and named as presented in Table 7 and Figure 20.

Table 7. Data on the monitored sites including site's name and coordinates

Site Code	Location	Coordinates	Notes
P0	Radhima	40°21'40.41"N 19°28'47.42"E	Small marine for artisanalfishery. Annual impact
P1	Raguza Bay	40°21'7.12"N 19°25'45.12"E	1 mile from aquaculture located in Raguza bay
P2	Gramma Bay	40°13'13.56"N 19°27'50.71"E	Western side of the MPA. Central sub zone
P3	Palasa	40° 9'59.57"N 19°34'9.76"E	Western side of the MPA. Traditional use and sustainable development sub-zone.
P4	Bay of Shen Vasil	40°24'10.74"N 19°22'54.91"E	Presence of tourism and maritime traffic during summer season
P5	Bay of Shen Jan	40°25'55.26"N 19°20'2.85"E	Located within “K-S” MNP. Presence of tourism and maritime traffic during summer season
P6	Haxhi Ali Cave	40°25'47.18"N 19°18'23.45"E	Located within “K-S” MNP. Presence of tourism and maritime traffic during summer season
P7	Bay of Boats	40°24'55.23"N 19°18'2.85"E	Located within “K-S” MNP. Recreation sub-zone
P8	Ali Cani	40°24'27.45"N 19°18'24.17"E	Located within “K-S” MNP. Recreation sub-zone
P9	Sazan-Lighthouse	40°28'24.86"N 19°17'12.87"E	Located within “K-S” MNP. Core zone
P10	Sazan- Port	19°17'12.87"E 19°17'16.39"E	Presence of tourism and maritime traffic during summer season
P11	Lungomare	40°26'59.00"N 19°29'21.18"E	Presence of tourism and maritime traffic during the summer season. Highly affected by sewage and increased urbanization.
P12	Small Dajlan-Bridge	40°30'50.63"N 19°23'41.90"E	Located within “Vjose Narte” PL. Lagoon and sea water mix together.
P12.a	Small Dajlan-Sea	40°30'52.66"N 19°23'43.99"E	Located within “Vjose Narte” PL. At the entrance of the canal, representing more the sea area.

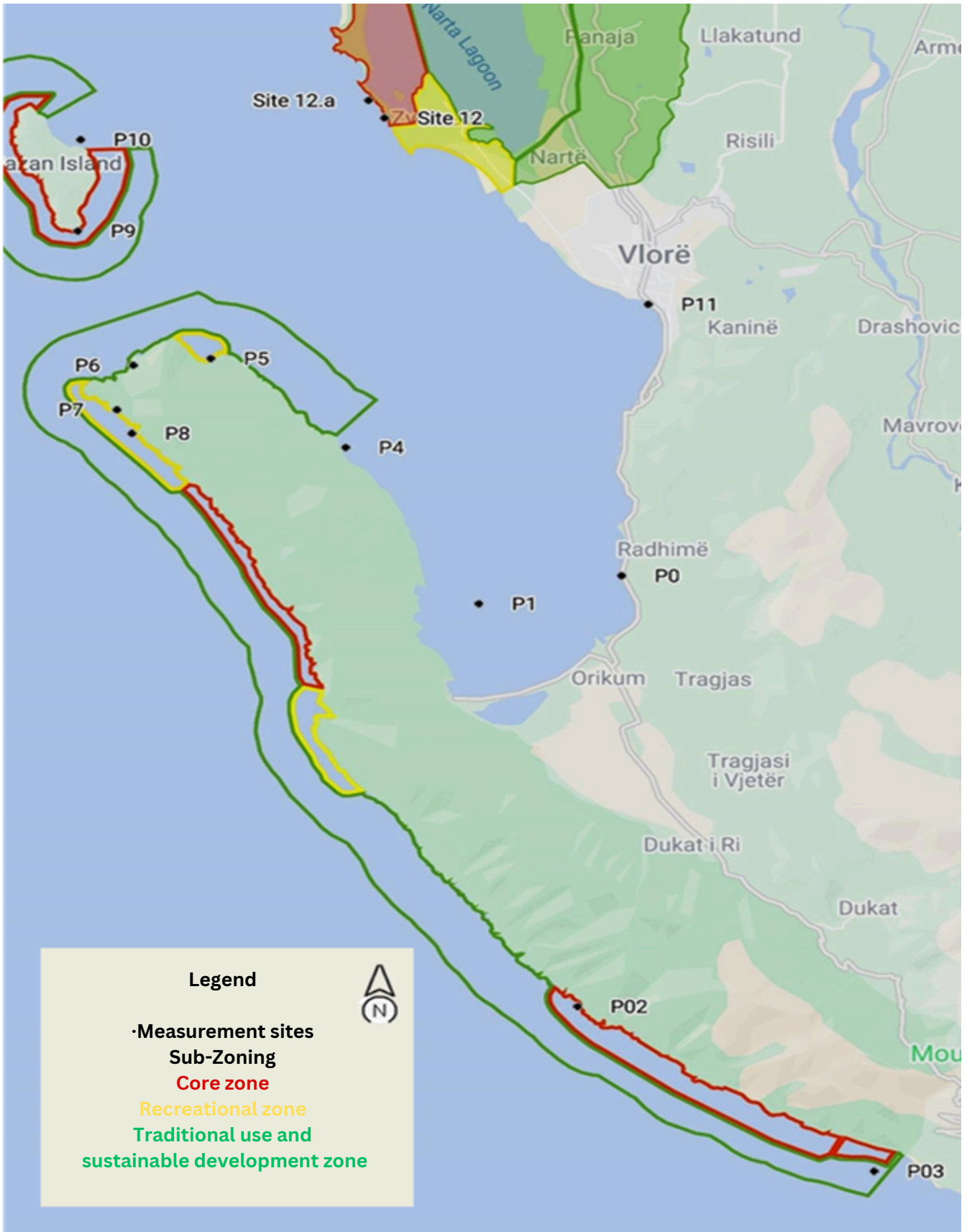


Figure 20. Map of monitoring sites in Marine National Park of “Karaburun-Sazan” and its surrounding. P2, P3, P5, P6, P7, P8, P9 are located within “Karaburun-Sazan” MNP. P12, P12.a are located within “Vjose-Narte” Protected Landscape. In red the core zone, in yellow, recreational zone, in green traditional use and sustainable development zone.

6.2 Methodology

To conduct the water quality measurement, Hanna Instrument HI98194 multiparameter for environmental and water treatment was used. Hanna Instrument is supplied with a multiparameter probe for pH/mV, ORP, EC, TDS, Resistivity, Salinity, Seawater σ , Dissolved Oxygen, Atmospheric Pressure and Temperature, TDS, EC, pH, DO. In total 13 Parameters have been measured specifically: Temp.[°C], pH, mV[pH], ORP[mV], EC[μ S/cm], EC Abs. [μ S/cm], RES[KOhm-cm], TDS [ppt], Sal.[psu], Sigma T[sT], Press.[psi], D.O.[%], D.O.[ppm]. For every site three different measurements were recorded, but only the last measurement was taken into account, assuming that the instrument's measurements after the second record would be more accurate. The data were collected at a depth of 5-6 meters for each point stations.



Figure 21. Technical detail for the HANNA multi-parameter probe. The key parameters measured are pH, ORP, Conductivity, Dissolved Oxygen, Temperature.



Figure 22. Photos from on the field data collection.

6.3 Results

Depending of the types of uses and activities, water quality criteria have been specified to determine its suitability for a particular purpose. Given that the study area covers Vlora bay and two protected areas, we will refer to the water quality standards that corresponds to ecologically sensitive areas, thus areas of high importance and sensitivity. Water quality criteria in that case would be as follows:

Table 8. Water quality criteria.

Parameter	Value range	Information
pH range	7.5-8.2	The average pH for sea water is 8.2 but can range between 7.5 and 8.5 depending on the local conditions. Human activities such as sewage overflows or run off, can cause significant short-term fluctuations in pH and long-term impacts can be extremely harmful to plants and animals. Extreme changes in pH, can stress local organisms and may ultimately lead many species to leave the area or die.
Dissolved Oxygen D.O. [%] or D.O. [ppm]	5.0 mg/l or 60 %	Not less than 3.5 mg/l at any time of the year for protection of aquatic lives
Temperature Temp.[°C]		Water temperature plays a substantial role in the aquatic system and can determine where aquatic life is found and the quality of the habitat. For example, water temperature can influence the metabolic rates of fish and the rate of photosynthesis of aquatic plants (and algae!). Water temperature also plays a significant role in ocean circulation patterns and influences the distribution and mixing of nutrients.
Salinity Sal. [psu]	30-40 psu	Measured in PSU (practical salinity units). The salinity of seawater is on average 35 psu, i.e., about 35 g/kg. Plants and animals are often sensitive to changes in salinity and salinity levels control local species composition. Changes in salinity can occur as a result of weather patterns, such as droughts or storms, or they can alert us to events such as increased urban runoff and sewer discharge. These events can change the condition of the water as the concentration of dissolved mineral salts typically increases with these types of events (which tend to decrease general water quality).
EC	50,000 uS/cm	Typical sea water has a conductivity value of about 50,000 uS/cm.

As suggested by the literature, water parameters change as a result of different natural processes and anthropogenic factors. For instance, marine organisms are affected by pH because most of their metabolic activities depend on the pH value (Wang W. et al., 2002). pH is also related to other water quality parameters such as CO₂, alkalinity and water hardness. At certain levels it may be toxic or may affect the toxicity of H₂S, cyanides, heavy metals and ammonium (Klontz, 1993). pH also affects fish. For the marine species the ideal pH varies between 7.5 and 8.5 (Boyd, 1990). At pH below 6.5, some species exhibit slow growth (Lloyd, 1992). At pH below 4.0 or above 11 many species die (Lawson, 1995).

As presented in Table 9, overall, the sites perform good pH parameters with the Ph values between 7.43 (P8, May 2022) and 8.47 (P11, January 2023), except the results obtained in May, June, July, November and December 2022 which indicate value outside the ideal range with a maximum of 11.92 in July 2022- P6 (Haxhi Ali Cave), 10.40 in July 2022- P5, 10.36 in November in P1, 9.18 in December-P4 (bay of Shen Jan) (Table 9).

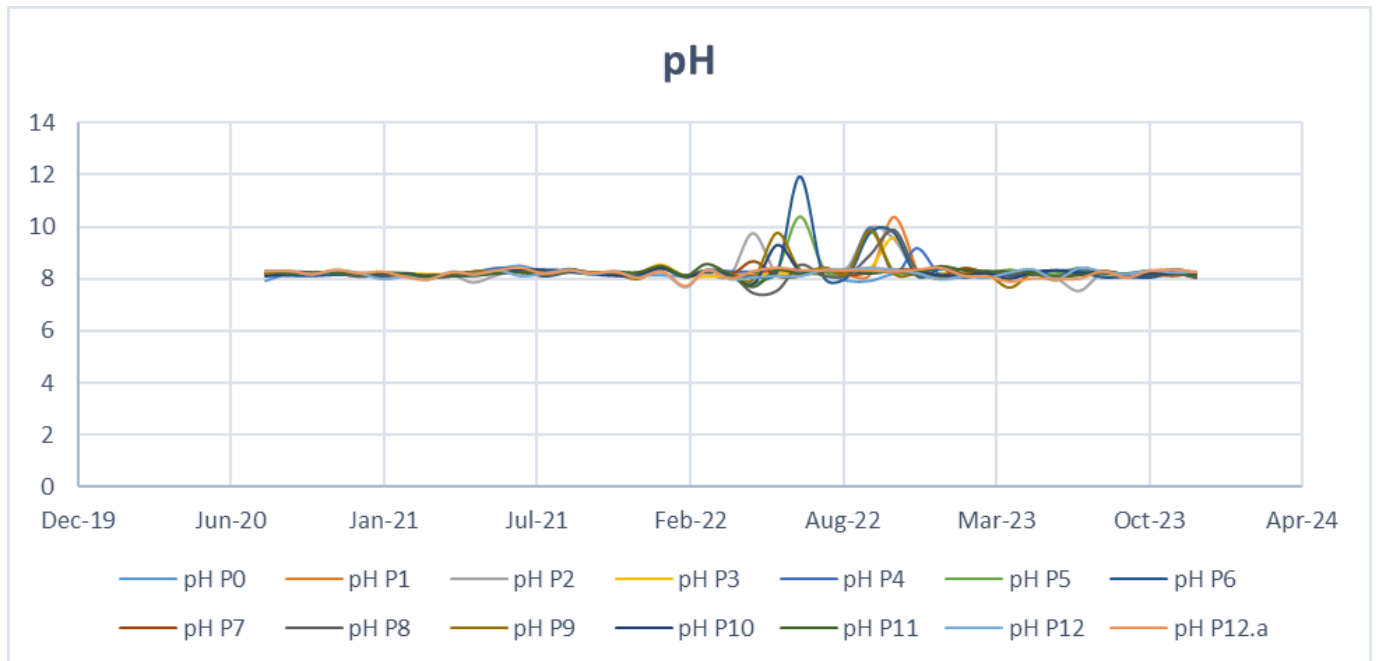
As the pH increases, the mV[pH] becomes more negative (Table 10). This reversed correlation is obvious if we look how the mV[pH] values in Table 10 decrease with the increase of pH and vice versa. Also referring to the graphs as presented in Graph 5, 6 we can realize how these two graphs are similar and reflect each other horizontally.

Table 9. Recorded data on pH level for the 14 monitored sites.

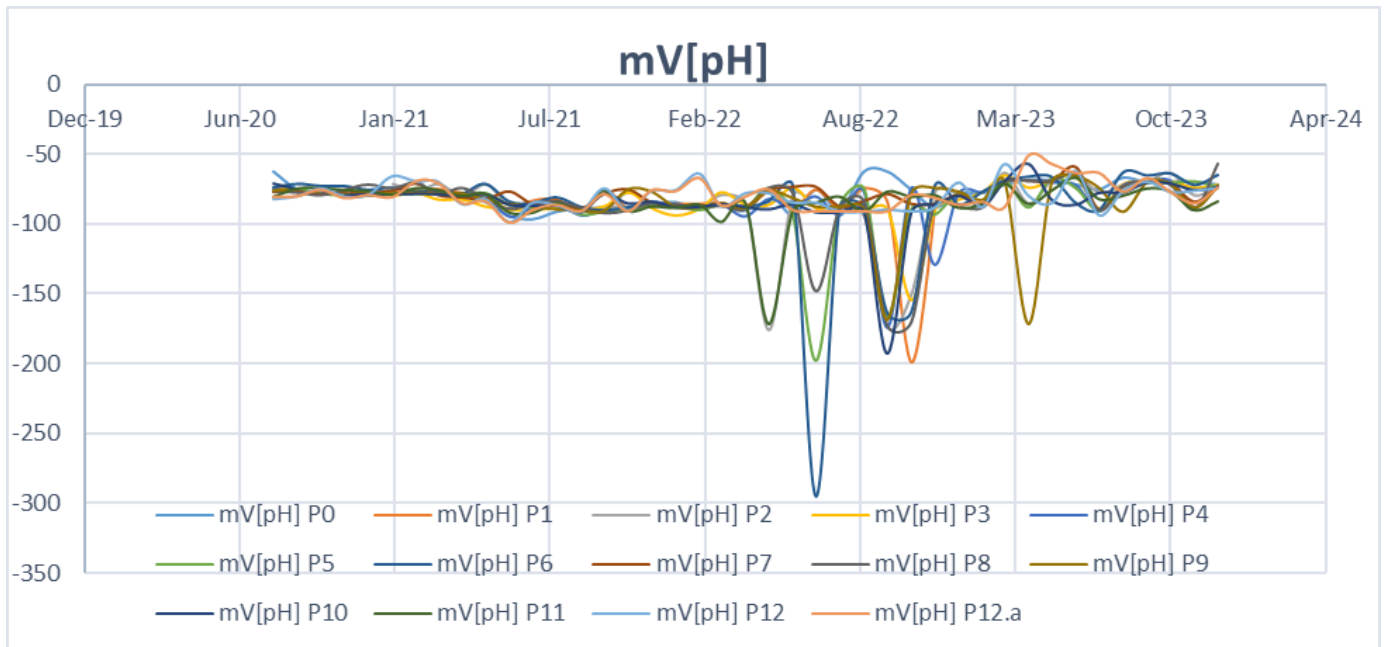
pH		P0	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P12a	
Aug-20		7.94	8.18				8.19	8.21	8.18	8.22	8.2	8.22	8.11	8.26	8.3	8.27
Sep-20		8.21	8.21				8.24	8.2	8.15	8.26	8.27	8.21	8.2	8.19	8.29	8.29
Oct-20		8.21					8.21	8.22	8.13	8.23	8.24			8.19	8.16	8.18
Nov-20		8.29	8.29				8.28	8.28	8.18	8.24	8.21	8.28	8.28	8.22	8.32	8.34
Dec-20		8.18	8.21				8.22	8.2	8.15	8.17	8.07	8.19	8.19	8.17	8.21	8.21
Jan-21		8.19	8.19	8.07	8.23		8.21	8.19	8.12	8.16	8.13	8.20	8.20	8.22	7.98	8.27
Feb-21		8.24	8.19	8.19	8.22		8.21	8.21	8.20	8.09	8.08	8.21	8.22	8.16	8.08	8.07
Mar-21		8.10	8.05	7.98	8.19		8.09	8.10	8.08	8.13	8.11	8.11	8.11	8.07	7.96	7.98
Apr-21		8.14	8.11	8.16	8.20		8.12	8.12	8.12	8.17	8.12	8.11	8.14	8.15	8.26	8.24
May-21		8.30	8.26	7.86	8.27		8.23	8.18	8.15	8.27	8.27	8.28	8.19	8.10	8.16	8.18
Jun-21		8.40	8.32	8.15	8.41		8.42	8.27	8.25	8.24	8.18	8.27	8.27	8.21	8.32	8.32
Jul-21		8.51	8.28	8.34	8.41		8.36	8.37	8.35	8.34	8.34	8.36	8.36	8.21	8.09	8.41
Aug-21		8.27	8.12	8.17	8.23		8.15	8.16	8.12	8.14	8.14	8.24	8.36	8.16	8.20	8.19
Sep-21		8.28	8.34	8.28	8.30		8.38	8.36	8.27	8.29	8.27	8.31	8.32	8.33	8.33	8.32
Oct-21		8.22	8.21	8.18	8.17		8.22	8.23	8.22	8.23	8.25	8.23	8.19	8.23	8.16	8.23
Nov-21		8.18	8.22	8.18	8.21		8.23	8.22	8.19	8.21	8.23	8.21	8.13	8.26	8.27	8.27
Dec-21		8.16	8.16	8.17	8.22		8.15	8.17	8.16	8.15	8.16	8.01	8.13	8.23	8.05	8.04
Jan-22		8.15	8.41	8.44	8.55		8.43	8.43	8.41	8.43	8.43	8.44	8.43	8.47	8.26	8.27
Feb-22		8.13	8.07	8.11	8.12		8.11	8.14	8.10	8.09	8.10	8.11	8.09	8.09	7.68	7.75
Mar-22		8.33	8.30	8.19	8.09		8.32	8.31	8.31	8.32	8.33	8.30	8.30	8.55	8.34	8.32
Apr-22		8.21	8.18	8.13	8.13		8.29	8.17	8.15	8.15	8.19	8.17	8.15	8.12	7.98	8.02
May-22		8.18	8.19	9.76	8.13		8.27	7.85	8.11	8.68	7.43	8.00	7.81	7.68	8.05	8.29
Jun-22		8.39	8.31	8.21	8.20		8.37	8.35	8.29	8.10	7.53	9.76	9.31	8.33	8.09	8.41
Jul-22		8.21	8.21	8.23	8.23		8.27	10.40	11.92	8.10	8.53	8.36	8.32	8.16	8.09	8.32
Aug-22		8.22	8.36	8.18	8.25		8.38	8.42	8.10	8.43	8.10	8.44	8.32	8.26	8.33	8.32
Sep-22		7.94	8.18	8.42	8.30		8.24	8.20	8.10	8.14	8.14	8.24	8.32	8.33	8.33	8.32
Oct-22		7.94	8.17	9.96	8.41		9.97	9.82	9.79	8.23	8.93	9.86	8.23	8.22	8.41	8.32
Nov-22		8.21	10.36	9.55	9.59		8.20	8.28	9.77	8.34	9.88	8.22	8.32	8.26	8.33	8.26
Dec-22		8.18	8.32	8.21	8.30		9.18	8.36	8.13	8.34	8.34	8.20	8.27	8.22	8.21	8.34
Jan-23		8.24		8.13	8.19		8.11	8.09	8.41	8.12	8.43	8.01	8.14	8.47	7.97	8.41
Feb-23		8.10		8.38	8.21		8.09	8.42	8.08	8.40	8.17	8.19	8.13	8.30	8.10	8.11
Mar-23		8.29		8.14	8.17		8.23	8.23	8.24	8.25	8.26	8.24	8.24	8.28	8.02	8.10
Apr-23		8.18		8.34	8.12		8.19	8.34	8.14	8.18	8.19	7.68	8.01	8.26	8.23	7.91
May-23		8.21		8.22	8.22		8.24	8.14	8.18	8.22	8.22	8.23	8.27	8.23	8.35	8.02
Jun-23		8.14		8.03	8.07		8.16	8.20	8.35	7.95	8.04	8.05	8.34	8.06	7.98	8.01
Jul-23		8.21		7.53	8.31		8.33	8.41	8.30	8.41	8.41	8.20	8.22	8.12	8.40	8.01
Aug-23		8.12		8.23	8.20		8.23	8.25	8.08	8.24	8.24	8.33	8.30	8.22	8.27	8.28
Sep-23		8.18		8.17	8.17		8.17	8.17	8.10	8.16	8.17	8.17	8.17	8.19	8.17	8.06
Oct-23		8.17		8.07	8.17		8.17	8.18	8.07	8.19	8.21	8.20	8.19	8.30	8.31	8.30
Nov-23		8.23		8.21	8.20		8.37	8.22	8.23	8.11	8.22	8.19	8.21	8.23	8.23	8.35
Dec-23		8.21		8.22	8.21		8.23	8.24	8.09	8.23	8.02	8.23	8.23	8.11	8.26	8.25

Table 10. Recorded data on mV[pH] for the 14 monitored sites.

	mV[pH]													
	P0	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P12.a
Aug-20	-62.8	-74.6			-75.2	-75.9	-74	-77.2	-76.4	-76.1	-70.6	-80.9	-82.5	-80.8
Sep-20	-75.7	-75.8			-77.4	-74.3	-71.6	-76.9	-77.6	-75.3	-74.7	-74.9	-80.3	-80.1
Oct-20	-77.8				-77.7	-78	-73.1	-78.6	-79.4			-74.8	-74.6	-75.6
Nov-20	-79.3	-79.3			-78.6	-79	-73.2	-76.8	-75.5	-78.9	-79	-76	-80.6	-81.6
Dec-20	-77.4	-79.5			-80	-78.7	-75.9	-77.4	-71.8	-78	-78.3	-76.8	-79.3	-79.3
Jan-21	-77.6	-77.6	-71.7	-80.1	-79.3	-78.1	-74.4	-76.2	-74.6	-78.4	-78.5	-79.2	-65.8	-80.8
Feb-21	-78.6	-76.2	-76.7	-78.2	-77.1	-77.8	-76.9	-71.2	-70.3	-77.5	-78	-74.7	-69.6	-69.4
Mar-21	-77.7	-75.3	-71.8	-82.8	-77.6	-77.9	-77.1	-79.4	-78.7	-78.5	-78.3	-76	-69.8	-70.8
Apr-21	-79.6	-78.1	-80.7	-82.8	-78.5	-78.6	-78.5	-81.1	-74.3	-78.2	-79.6	-80.3	-86.1	-85.2
May-21	-84.4	-81.7	-72	-87.8	-79.9	-77.5	-71.6	-82.5	-82.3	-82.7	-78.1	-78.9	-82.4	-83.9
Jun-21	-94.2	-89.6	-87.8	-90.1	-95	-85.9	-84.3	-76.8	-89.3	-85.8	-85.8	-92.2	-99.2	-99.1
Jul-21	-96.6	-83.6	-85.7	-90.1	-88.2	-87.3	-85.3	-85.7	-85.7	-87.5	-86.5	-92.2	-85	-90
Aug-21	-91.2	-82.6	-84.8	-88.8	-84.7	-85.3	-81.3	-83.6	-83.9	-89.7	-86.7	-85.3	-87	-86.3
Sep-21	-88.9	-92	-88.8	-90.2	-94.1	-92.9	-88.1	-89.1	-88.4	-90.6	-91.2	-91.4	-91.6	-90.9
Oct-21	-90.3	-75.8	-88.1	-87.4	-90.4	-90.9	-90.5	-78.6	-92.1	-90.6	-77.9	-76.3	-74.6	-78.6
Nov-21	-77.3	-89.2	-88.1	-77.8	-90.4	-89.6	-88.3	-75.3	-90.4	-75.3	-84.9	-91	-90.9	-90.9
Dec-21	-84.8	-85.1	-85.7	-88.9	-84.4	-85.5	-85.4	-84.6	-85.1	-76.9	-83.5	-87.9	-76.5	-76
Jan-22	-84.5	-86	-88.2	-94	-87.3	-86.9	-86.4	-87.6	-87.6	-87.8	-87.6	-88.9	-76	-76.6
Feb-22	-89.1	-85.9	-88.7	-89.2	-88.1	-89.7	-87.8	-87.5	-88.1	-88.2	-87.3	-86.5	-63.9	-67.3
Mar-22	-86.4	-85.1	-79.5	-77.6	-86.4	-85.7	-85.8	-86.5	-87.2	-85.4	-85.5	-98.9	-87.7	-86.8
Apr-22	-90.4	-89.3	-86.8	-86.4	-94.9	-88.2	-87.7	-87.8	-89.5	-88.4	-87.5	-85.3	-78.1	-80.5
May-22	-77.4	-77.6	-175.7	-86.4	-82.5	-73.9	-84.2	-75.9	-74.2	-76.3	-89.1	-172	-78.2	-75.3
Jun-22	-93.8	-89.1	-79.8	-74.3	-88.3	-92.7	-72.7	-73.5	-77.9	-81.5	-85.5	-91.4	-85	-90
Jul-22	-75.7	-75.8	-88.8	-88.8	-80.8	-197.5	-295.5	-73.5	-147.9	-87.8	-91.2	-85.3	-85	-90.9
Aug-22	-90.1	-89.1	-88.1	-91	-94	-86.8	-87.7	-87.6	-88.1	-87.7	-91.2	-80.9	-91.6	-90.9
Sep-22	-62.8	-74.6	-95	-90.2	-77.4	-74.3	-87.7	-83.6	-83.9	-89.7	-91.2	-91.4	-91.6	-90.9
Oct-22	-62.8	-84.8	-173.6	-90.0	-174.1	-165.8	-164.1	-78.6	-172.3	-168.9	-192.4	-77.2	-90.1	-90.9
Nov-22	-75.8	-199.1	-149.8	-154.1	-74.7	-88.9	-163.4	-85.7	-169.8	-78.0	-91.2	-80.9	-91.3	-79.3
Dec-22	-88.1	-89.6	-77.7	-90.2	-129.3	-92.9	-73.1	-85.6	-85.6	-74.3	-85.8	-79.7	-88.7	-81.4
Jan-23	-78.6		-79.2	-82.8	-78.4	-77.7	-86.5	-79.3	-87.6	-76.9	-79.5	-88.8	-70.4	-86.4
Feb-23	-78.0		-84.8	-77.4	-77.6	-86.8	-77.1	-85.9	-88.2	-82.8	-86.4	-85.4	-88.1	-84.2
Mar-23	-72.1		-63.8	-65.6	-68.9	-68.8	-69.4	-69.9	-70.2	-69.5	-69.1	-71.5	-57.0	-88.1
Apr-23	-68.6		-85.7	-74.3	-69.4	-87.7	-66.4	-69.0	-69.1	-172.0	-56.6	-86.1	-80.1	-51.2
May-23	-69.1		-69.1	-69.1	-70.6	-66.8	-66.7	-69.1	-69.1	-70.1	-82.3	-76.3	-85.3	-57.3
Jun-23	-71.9		-64.6	-66.6	-72.7	-74.0	-85.3	-59.2	-65.0	-65.9	-85.7	-67.3	-62.0	-63.7
Jul-23	-75.3		-77.9	-89.1	-91.4	-90.1	-90.2	-90.0	-90.0	-74.3	-77.2	-82.6	-94.2	-63.7
Aug-23	-67.2		-72.3	-71.7	-72.6	-73.0	-63.3	-73.0	-73.2	-91.4	-77.0	-80.0	-76.3	-76.9
Sep-23	-70.4		-70.1	-70.0	-70.1	-70.1	-65.5	-69.6	-69.8	-70.1	-69.7	-74.9	-69.8	-67.3
Oct-23	-69.8		-63.9	-69.7	-69.5	-70.3	-64.1	-70.9	-72.1	-71.5	-70.6	-77.1	-77.2	-77.1
Nov-23	-70.1		-79.8	-74.3	-88.3	-69.1	-72.3	-84.2	-89.6	-88.3	-75.3	-90.4	-76.3	-85.3
Dec-23	-71.9		-72.3	-72.2	-72.8	-73.5	-65.2	-72.8	-57.0	-73.2	-73.1	-84.2	-74.3	-74.0



Graph 5. Graph presentation of the recorded data on pH level for the 14 monitored sites.



Graph 6. Graph presentation of the recorded data on mV[pH] level for the 14 monitored sites.

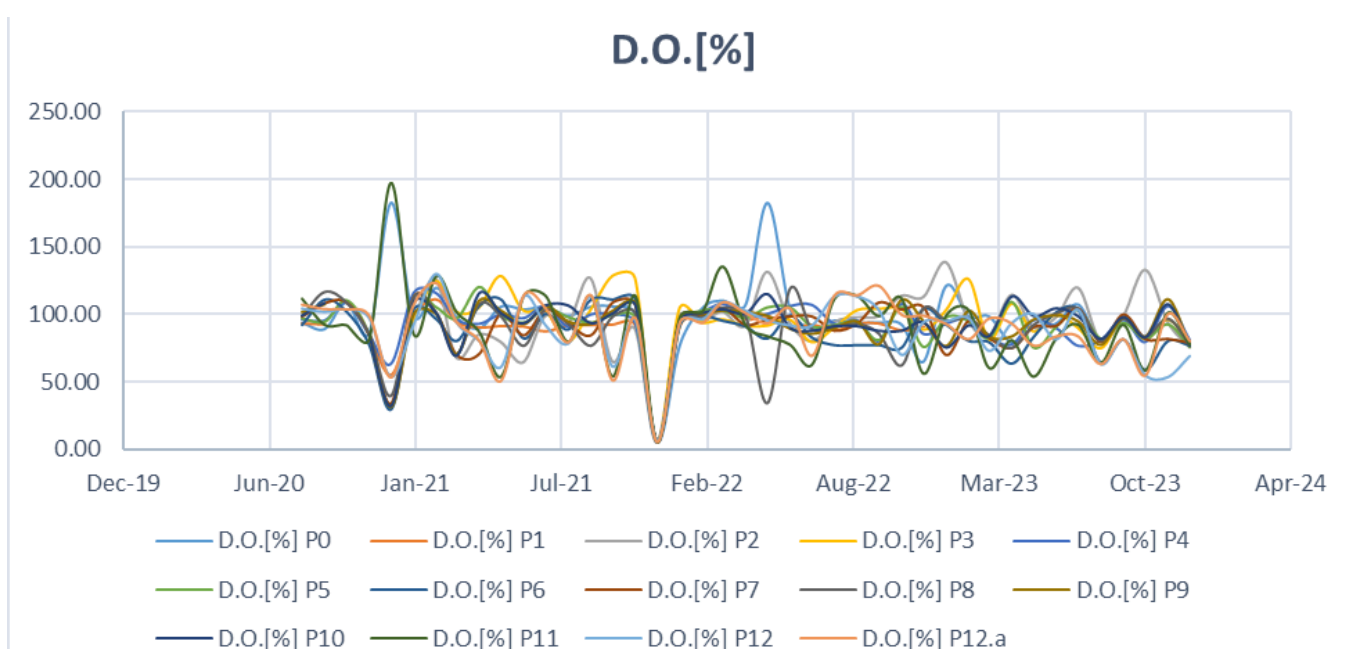
Dissolved oxygen or D.O. is one of the most important parameters necessary for fish respiration and a range of metabolic activities. The required D.O. value is above 5 mg / L (60.52 % or 5ppm), at lower values it can cause damage to fish and for 2 mg / L (24.21 % or 2ppm) it can cause death (for some species 3 mg / L or 36.31 % saturation). The D.O. value > 5.0 mg / L (60.52 % saturation or 5ppm) is set as the ideal value for marine waters.

In most of the monitored sites, the level of D.O. [%] is higher than 60.52%, thus lying within the ideal range of D.O.% for marine environments. In December 2020, nine of the monitored sites recorded below the ideal values (60.52 % or 5ppm) with the minimum value 29.4% or 2.16 ppm observed in P6. Low level of D.O. was recorded also in May 2022-P8 of 34.20%, March 2023-P11 of 59.9%, May 2023-P11 of 53.6%, October 2023-P6, P11, P12, P12.a and November 2023-P12 with values according to the Table 11. These values indicate high stress for the fish population in this area but also exposing all aquatic organisms at risk. Further research and analysis need to be conducted in order to identify if there is a certain pattern connecting these values with specific pollutants or impacts. Literature suggests that the reasons for D.O. decrease is often the wastewater and urban sewage. There is a positive correlation between pH and D.O. increase. The common feature of these water quality parameters, is their change according to a daily cycle, which relates to the intensity of photosynthesis development. The only source of dissolved oxygen in water is through the air and its content in water decreases with increasing temperature. D.O. is used by aquatic organisms to regulate metabolism and it is released in the form of CO₂ (during night breathing) which later is used by photosynthetic plants during the development of photosynthesis to produce oxygen within water (during day). In the same way as D. O. also pH has a daily pattern of change, which relates to the intensity of photosynthesis development.

Given that all organisms breathe, CO₂ is constantly produced, consequently lowers the pH of the water. Concentration of D.O. below 4.0 mg/l in marine waters is unacceptable, except when temporary natural phenomena cause this value to decrease. During summer D.O. values tend to decrease due to high temperatures. Data accumulated on dissolved oxygen indicated that the surface water of the study area is overall well oxygenated.

Table 11. Recorded data on D.O. [%] for the 14 monitored sites.

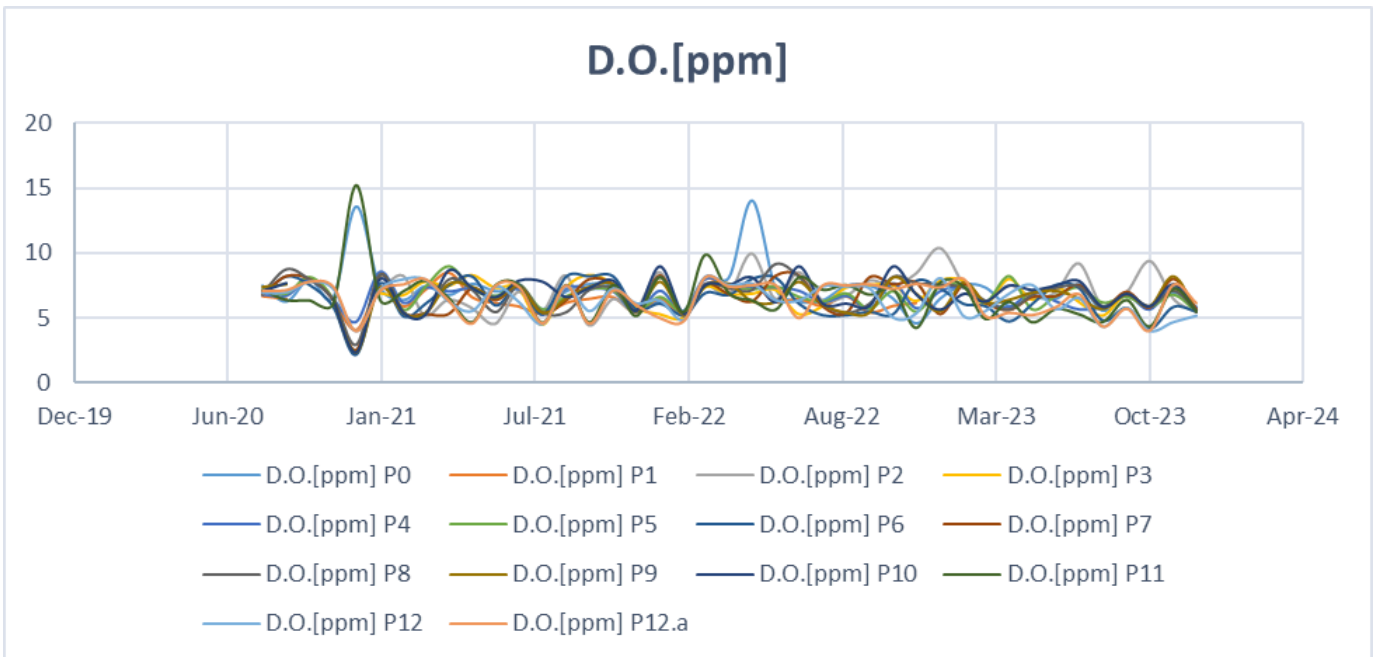
	D.O. [%]													
	P0	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P12a
Aug-20	93.80	93.20			96.70	97.20	92.20	98.50	99.20	101.50	99.00	111.30	104.50	107.50
Sep-20	89.20	92.40			96.00	94.60	111.00	108.50	117.10	107.30	108.30	91.90	102.10	104.20
Oct-20	108.90				109.10	110.60	102.00	109.10	109.10			91.60	104.00	104.00
Nov-20	86.60	85.70			85.30	85.00	77.30	84.70	85.40	85.40	85.10	81.30	97.40	99.40
Dec-20	182.40	55.30			64.00	30.80	29.40	33.90	39.70	31.20	31.80	197.10	53.80	53.80
Jan-21	98.70	98.70	93.10	93.80	116.50	112.80	103.60	113.10	113.00	99.90	108.70	84.90	92.70	107.50
Feb-21	119.60	110.80	126.80	125.00	116.20	105.30	96.40	101.10	101.40	99.90	100.60	128.10	130.30	123.40
Mar-21	97.50	94.10	68.30	102.30	96.60	97.30	80.30	70.10	70.90	70.40	69.20	101.20	94.20	94.60
Apr-21	89.60	90.30	84.80	105.00	93.60	120.50	106.40	70.90	108.20	110.00	115.60	86.60	80.50	80.80
May-21	105.80	91.30	79.70	128.70	100.50	99.50	111.00	100.90	98.70	102.50	100.60	53.60	61.30	51.40
Jun-21	103.60	90.90	64.50	103.30	97.80	94.00	82.10	84.70	77.00	92.60	93.30	113.30	113.60	114.40
Jul-21	105.50	87.40	98.60	103.30	106.80	104.70	100.50	103.80	104.30	105.90	106.50	113.30	92.00	104.70
Aug-21	99.00	92.00	93.10	80.10	91.40	98.00	88.80	93.50	93.40	94.50	106.40	79.30	78.60	79.70
Sep-21	105.60	91.90	126.80	103.30	100.50	94.00	111.00	84.70	77.00	92.60	93.30	113.30	113.60	114.40
Oct-21	105.80	92.40	65.20	128.70	100.50	99.50	111.00	109.10	98.70	102.50	100.60	53.60	61.30	51.40
Nov-21	99.80	91.30	89.20	127.50	93.60	97.20	111.00	107.30	100.90	107.30	106.50	113.30	96.10	97.60
Dec-21	5.81	5.39	5.57	5.78	5.43	5.49	5.65	5.53	5.46	5.48	5.53	5.17	6.14	5.99
Jan-22	77.60	91.80	98.70	104.70	94.20	92.80	92.50	96.50	96.10	97.30	94.30	97.50	94.20	94.60
Feb-22	104.80	99.40	94.80	94.20	102.20	102.90	98.80	100.00	97.30	99.70	100.90	101.80	96.60	94.00
Mar-22	110.20	107.90	101.80	96.60	108.10	102.90	95.20	105.10	105.30	102.70	103.50	135.00	109.40	109.20
Apr-22	107.00	96.30	91.50	91.80	99.40	97.50	91.00	92.50	98.70	101.60	100.50	91.60	102.90	101.20
May-22	182.40	98.70	131.40	91.80	100.90	105.30	82.00	96.60	34.20	98.60	114.90	83.50	95.70	93.60
Jun-22	103.90	90.10	94.00	96.50	106.70	105.20	99.30	98.70	119.50	89.20	90.00	77.20	92.00	104.70
Jul-22	89.20	92.40	80.10	79.70	107.50	91.20	82.80	98.70	89.50	85.50	87.70	62.40	92.00	69.70
Aug-22	95.50	88.00	94.40	90.40	93.60	92.20	77.20	88.20	91.50	89.60	91.00	111.30	113.60	114.40
Sep-22	93.80	93.20	97.80	103.30	96.00	94.60	77.20	93.50	93.40	94.50	91.00	113.30	113.60	114.40
Oct-22	93.8	93.1	98.7	104.3	80.7	81.0	77.2	109.1	85.9	77.8	87.6	98.5	103.3	121.4
Nov-22	92.4	88.0	113.6	104.3	108.3	105.6	75.3	103.8	62.4	110.6	87.7	111.3	70.2	100.0
Dec-22	65.2	90.9	112.7	88.9	86.0	76.0	104.2	105.5	104.9	94.6	94.0	55.7	94.5	99.4
Jan-23	121.1		138.4	103.3	93.7	97.9	92.5	70.0	96.0	76.4	75.2	98.9	95.3	93.2
Feb-23	98.4		95.1	126.4	97.2	95.1	80.3	95.4	97.5	102.3	91.8	102.7	97.3	82.0
Mar-23	98.4		84.1	81.3	83.5	82.6	79.3	82.7	84.6	83.2	83.8	59.9	73.2	97.3
Apr-23	79.0		114.3	108.2	78.3	109.4	63.4	75.1	75.4	83.5	113.1	80.5	93.8	93.5
May-23	90.4		90.2	87.6	96.3	75.4	83.3	90.9	92.7	96.0	98.7	53.6	100.5	77.2
Jun-23	93.3		97.9	100.4	90.3	91.0	101.5	91.8	100.9	98.9	104.3	81.9	81.7	84.1
Jul-23	107.3		119.5	90.1	77.2	103.3	103.3	104.7	104.7	94.6	98.5	92.0	103.6	84.1
Aug-23	80.1		80.2	75.1	81.5	82.2	64.2	79.6	80.7	77.2	81.6	64.0	63.4	63.6
Sep-23	96.9		98.8	97.0	96.4	93.8	81.3	100.2	97.1	97.3	97.8	91.9	81.6	81.9
Oct-23	81.6		132.8	81.5	80.1	82.3	58.7	82.0	83.7	83.1	82.8	58.2	55.0	55.2
Nov-23	96.0		94.0	96.5	106.7	92.7	80.2	82.0	97.2	111.0	107.3	100.9	53.6	100.5
Dec-23	79.8		75.5	78.1	81.5	76.0	76.9	79.1	77.4	76.5	76.4	77.2	69.3	80.6



Graph 7. Graph presentation of the recorded data on D.O. %.

Table 12. Recorded data on D.O. [ppm] for the 14 monitored sites.

	D.O. [ppm]													
	P0	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P12.a
Aug-20	7.47	6.65			6.81	7.07	6.78	6.82	6.87	7.38	7.04	7.2	6.94	7.09
Sep-20	6.23	6.45			6.7	6.84	8.2	8.22	8.73	7.57	7.66	6.4	7	7.15
Oct-20	7.96				7.97	8.11	7.55	7.99	7.94			6.38	7.81	7.8
Nov-20	6.55	6.48			6.45	6.41	5.86	6.36	6.41	6.45	6.44	6.1	7.27	7.43
Dec-20	13.59	4.08			4.71	2.26	2.16	2.48	2.9	2.29	2.33	15.27	3.97	3.97
Jan-21	7.34	7.34	6.89	6.9	8.54	8.26	7.64	8.31	8.31	7.32	7.96	6.43	7.2	7.09
Feb-21	6.36	5.88	8.22	6.71	6.16	5.58	5.11	5.39	5.4	5.31	5.35	7.1	8.02	7.6
Mar-21	7.42	7.13	5.17	7.74	7.32	7.35	6.08	5.29	5.36	5.31	5.22	7.89	8	8
Apr-21	6.74	8.44	6.34	7.43	7.04	8.94	7.52	5.3	7.96	7.61	8.65	6.54	6.27	6.3
May-21	7.6	6.58	5.75	8.26	7.28	7.2	8.2	7.28	7.14	7.39	7.29	4.68	5.54	4.55
Jun-21	7.02	6.13	4.49	7.3	6.66	6.65	5.96	6.36	5.42	6.5	6.58	7.56	7.46	7.51
Jul-21	7.16	5.88	6.95	7.3	7.22	7.56	7.57	7.44	7.47	7.44	7.84	7.56	6.24	7.4
Aug-21	5.65	5.3	5.42	4.47	5.25	5.61	5.28	5.39	5.37	5.37	7.76	4.65	4.52	4.58
Sep-21	7.03	6.15	8.22	7.3	7.28	6.65	8.2	6.36	5.42	6.5	6.58	7.56	7.46	7.51
Oct-21	7.6	6.45	4.4	8.26	7.28	7.2	8.2	7.99	7.14	7.39	7.29	4.68	5.54	4.55
Nov-21	7.45	6.58	6.4	7.59	7.04	7.07	8.2	7.57	7.28	7.57	7.84	7.56	7.29	7.12
Dec-21	5.81	5.39	5.57	5.78	5.43	5.49	5.65	5.53	5.46	5.48	5.53	5.17	6.14	5.99
Jan-22	6.23	6.45	8.47	5.29	7.09	6.58	6.1	8.27	8.15	7.77	8.94	8.16	6.37	4.98
Feb-22	5.53	5.24	5	5.01	5.39	5.41	5.23	5.27	5.13	5.26	5.32	5.5	4.85	4.74
Mar-22	8.16	7.97	7.43	7.32	7.98	7.46	6.92	7.59	7.6	7.44	7.51	9.9	8.17	8.15
Apr-22	8.11	7.2	6.79	6.83	7.45	7.31	6.82	6.82	7.29	7.61	7.52	6.92	7.55	7.42
May-22	14.05	7.6	9.91	6.83	7.28	7.17	8.01	6.28	7.13	6.26	8.09	6.38	7.67	7.52
Jun-22	7.17	6.21	6.43	7.13	7.34	7.38	8.08	8.27	9.15	6.21	6.2	5.66	6.37	7.53
Jul-22	6.23	6.45	8.47	5.29	7.09	6.58	6.1	8.27	8.15	7.77	8.94	8.16	6.37	4.98
Aug-22	6.33	5.91	6.33	5.88	6.21	6.24	5.21	5.87	6.03	6.03	6.08	7.2	7.46	7.51
Sep-22	7.47	6.65	6.66	7.3	6.7	6.84	5.21	5.39	5.37	5.37	6.08	7.56	7.46	7.51
Oct-22	7.47	5.42	7.84	7.50	5.71	5.68	5.46	8.14	6.07	5.39	5.90	6.82	7.30	7.61
Nov-22	6.45	5.91	7.46	7.50	7.66	7.03	5.29	7.58	8.16	8.11	8.94	7.22	5.02	7.24
Dec-22	4.54	6.13	8.38	6.29	5.74	5.44	7.86	7.71	7.65	6.84	6.77	4.25	5.37	7.64
Jan-23	6.46		10.34	7.81	7.05	7.41	7.28	5.28	7.56	5.48	5.62	7.75	8.10	7.35
Feb-23	7.52		7.56	7.83	7.36	7.40	6.08	7.58	7.31	7.74	6.83	7.44	5.13	8.01
Mar-23	7.32		6.26	6.04	6.23	6.15	5.90	6.16	6.29	6.18	6.24	4.94	5.54	5.13
Apr-23	5.90		7.47	7.96	5.84	8.17	4.73	5.60	5.62	6.38	7.46	6.27	6.90	5.39
May-23	6.54		6.56	6.37	6.98	5.62	6.08	6.61	6.75	6.93	7.14	4.68	7.57	5.21
Jun-23	6.44		6.94	7.33	6.27	6.67	7.55	6.67	7.29	7.06	7.47	5.71	5.67	5.84
Jul-23	7.57		9.15	6.21	5.66	7.30	7.30	7.53	7.40	6.50	7.82	5.30	6.55	6.84
Aug-23	5.52		5.85	5.18	5.85	6.14	4.79	5.81	5.84	5.66	5.82	4.71	4.32	4.33
Sep-23	6.74		6.92	6.79	6.74	6.58	5.77	7.01	6.79	6.82	6.84	6.40	5.79	5.71
Oct-23	5.79		9.34	5.74	5.65	5.83	4.15	5.78	5.89	5.88	5.87	4.36	3.99	4.00
Nov-23	6.93		6.43	7.13	7.34	6.75	5.85	8.01	7.07	8.20	7.57	7.28	4.68	7.57
Dec-23	5.81		5.39	5.57	5.78	5.43	5.49	5.65	5.53	5.46	5.48	5.53	5.17	6.14



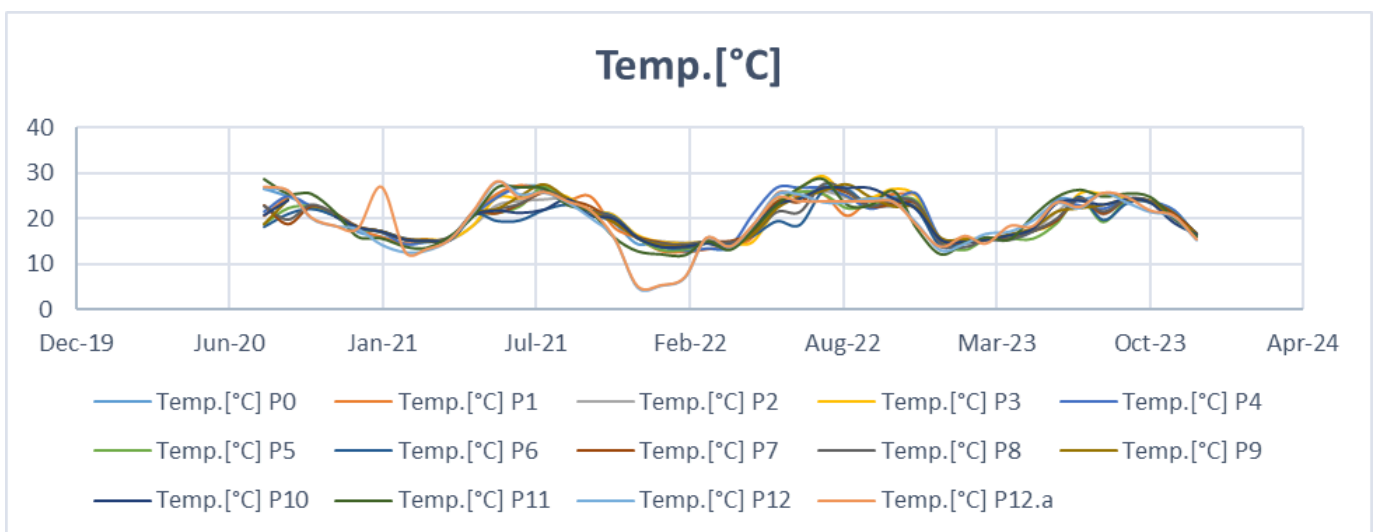
Graph 8. Graph presentation of the recorded data on D.O.ppm.

According to the data on the temperature for the 14 stations, from August 2020- December 2023 a normal pattern of temperature change was observed, with low temperatures during the winter time (min 4.91°C -12.31°C) and increasing during summer with the maximum value of 29.3°C in August 2022nd.

In 2021 the temperatures vary from 12.64°C in February (P 12.a) up to 28.18°C in June (P12.a). In 2022 the temperatures vary from 5.29°C in December (P12) up to 29.3°C in August (P.4). In 2023 the temperatures vary from 12.31°C in January (P11) up to 26.31°C in July (P.11). In Dec-21 the data were collected early in the morning and it was reported a low tide. Temperature fluctuations are more visible in January 2021 with a difference of 12.61 °C and December 2021 with a difference of 11.67°C.

Table 13. Recorded data on Temp.[°C]for the 14 monitored sites.

	Temp.[°C]													
	P0	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P12.a
Aug-20	26.76	20.67			21.63	18.85	18.18	22.96	22.91	18.83	20.83	28.61	26.62	26.94
Sep-20	25.06	24.97			25.06	22.3	21.02	18.79	19.91	24.19	24.06	25.48	26.21	26.13
Oct-20	22.81				22.86	22.67	22.14	22.73	23.17			25.47	20.24	20.28
Nov-20	20.66	20.73			20.74	20.88	20.67	21.2	21.18	20.76	20.64	21.53	18.46	18.42
Dec-20	17.12	17.81			17.84	17.94	18.14	18.26	18.28	18.14	18.14	16.14	17.79	17.79
Jan-21	16.01	16.01	17.23	17.22	17.02	17.2	17.24	17.18	17.22	17.24	17.23	15.78	14.33	26.94
Feb-21	14.48	14.59	15.85	15.66	14.36	15.48	15.56	15.44	15.45	15.46	15.47	13.97	12.66	12.64
Mar-21	14.79	15.05	15.24	15.53	14.99	15.23	15.16	15.28	15.18	15.17	15.26	13.71	13.02	13.29
Apr-21	15.84	15.89	15.44	15.68	15.49	15.56	15.24	15.57	16.22	15.47	15.5	16.28	15.52	15.45
May-21	21.61	21.11	18.51	18.46	20.79	20.73	21.02	21.08	20.9	21.09	20.78	20.59	21.52	21.73
Jun-21	25.37	25.54	23.03	24.55	24.81	21.31	19.48	21.2	22.22	22.18	21.78	26.81	28.16	28.18
Jul-21	27.31	27.41	24.02	24.55	27.06	22.77	19.63	23.24	23.41	24.97	21.31	26.81	25.4	24.52
Aug-21	27.11	26.31	24.38	25.9	26.46	26.96	21.94	25.79	26.14	27.51	22.02	26.63	25.83	25.84
Sep-21	24.29	24.22	24.49	24.86	23.59	23.76	23.08	24.21	24.51	24.39	24.27	23.04	23.68	23.76
Oct-21	21.37	24.97	21.96	21.93	21.79	21.71	21.72	22.73	21.81	21.72	20.74	21.53	20.24	21.73
Nov-21	19.01	18.12	20.96	20.83	20.26	20.05	20.43	19.19	20.25	19.19	19.96	15.96	15.72	15.73
Dec-21	14.42	15.83	15.96	16.58	15.78	15.91	15.91	15.98	16.05	15.83	15.89	13.01	4.91	5.2
Jan-22	14.81	12.93	15.18	15.06	13.69	13.26	13.8	14.72	14.72	14.19	13.89	12.31	5.29	5.39
Feb-22	12.58	12.72	14.86	14.74	12.87	13.31	13.51	13.9	14.54	13.84	13.97	12.11	7.03	7.14
Mar-22	13.33	13.27	14.88	14.99	13.4	14.72	14.53	14.98	15.09	14.77	14.66	15.21	15.76	15.76
Apr-22	13.37	14.23	14.98	14.98	13.92	13.86	14.54	15.04	14.93	13.98	13.99	13.27	13.88	13.88
May-22	17.12	16.01	17.06	14.98	21.08	17.44	16.17	17.19	16.57	16.61	18.08	17.65	18.66	18.63
Jun-22	25.37	25.5	23.42	22.34	26.97	23.77	19.42	23.74	21.58	22.27	23.09	23.04	25.4	24.52
Jul-22	25.06	24.97	25.9	26.48	26.94	25.88	18.6	23.74	21.58	24.77	24.41	26.8	25.4	23.78
Aug-22	27.36	25.47	26.21	29.3	26.96	25.37	26.26	26.89	27.73	26.12	26.76	28.61	23.68	23.76
Sep-22	26.76	20.67	24.81	24.86	25.06	22.3	26.26	25.79	26.14	27.51	26.76	23.04	23.68	23.76
Oct-22	22.76	24.38	22.90	24.54	22.29	23.15	22.88	22.73	22.82	24.72	26.72	22.96	24.55	23.76
Nov-22	24.97	25.47	22.86	26.54	24.06	24.29	23.57	23.24	24.38	22.67	24.41	26.00	23.71	23.61
Dec-22	21.96	25.54	23.03	24.86	25.51	23.76	22.14	23.26	23.44	22.30	22.02	17.78	18.98	18.45
Jan-23	14.48		15.46	15.53	15.55	15.08	13.79	15.30	14.72	15.83	15.49	12.31	13.06	13.79
Feb-23	14.48		14.72	15.83	14.99	13.25	15.16	14.73	13.86	15.53	14.98	14.77	14.54	16.17
Mar-23	15.63		15.46	15.57	15.54	15.56	15.43	15.43	15.46	15.53	15.48	15.98	16.73	14.54
Apr-23	15.61		15.41	16.22	15.72	15.76	15.47	15.57	15.64	16.65	16.44	15.52	17.22	18.38
May-23	17.88		17.33	17.32	17.47	15.68	17.19	17.32	17.33	17.99	17.90	20.53	19.63	18.33
Jun-23	24.23		21.58	19.40	23.52	19.01	19.63	19.53	20.08	21.52	23.41	24.69	23.53	23.54
Jul-23	24.19		24.58	25.50	23.04	24.55	24.86	24.52	24.52	22.30	23.96	26.31	22.37	22.54
Aug-23	25.39		21.13	25.37	22.28	19.33	19.70	21.16	21.68	23.04	23.12	24.84	25.67	25.65
Sep-23	24.91		24.40	24.39	24.49	24.16	23.41	24.37	24.42	24.24	24.36	25.48	23.62	24.69
Oct-23	23.62		24.08	24.06	23.92	23.71	23.77	23.90	24.02	23.66	23.60	24.79	21.57	21.79
Nov-23	21.99		21.42	21.34	21.97	21.33	21.13	21.17	20.05	20.43	19.19	20.25	20.53	20.63
Dec-23	16.22		16.64	16.64	16.09	16.67	16.73	16.64	16.73	16.66	16.65	16.17	15.34	15.43



Graph 9. Graph presentation of the recorded data on Temp.[°C]for the 14 monitored sites.

Table 14. Average temperature for every month for all monitoring sites.

Month	Average Temperature
Aug-20	22.81
Sep-20	23.59
Oct-20	22.48
Nov-20	20.48
Dec-20	17.78
Jan-21	17.41
Feb-21	14.79
Mar-21	14.77
Apr-21	15.65
May-21	20.70
Jun-21	23.90
Jul-21	24.45
Aug-21	25.63
Sep-21	24.01
Oct-21	21.85
Nov-21	18.97
Dec-21	14.09
Jan-22	12.80
Feb-22	12.65
Mar-22	14.66
Apr-22	14.20

Month	Average Temperature
May-22	17.37
Jun-22	23.60
Jul-22	24.59
Aug-22	26.46
Sep-22	24.81
Oct-22	23.65
Nov-22	24.27
Dec-22	22.35
Jan-23	14.64
Feb-23	14.84
Mar-23	15.56
Apr-23	16.12
May-23	17.83
Jun-23	21.82
Jul-23	24.09
Aug-23	22.95
Sep-23	24.38
Oct-23	23.57
Nov-23	20.87
Dec-23	16.35

Total dissolved Solids (TDS) represents the inorganic salts and small amounts of organic matter present in sea water such as calcium, magnesium, sodium, and potassium cations and carbonate, hydrogen carbonate, chloride, sulfate, and nitrate anions. The presence of ions in water will determine the sea water conductivity which is after converted into TDS values (World Health Organization, Geneva, 1996). This parameter is normally used for analyzing water quality for streams, rivers and lakes (freshwater ecosystems) where small differences on TDS will affect the aesthetic characteristics of drinking water or as an indicator of chemical contamination in freshwaters. TDS is directly proportional to the Electrical Conductivity (EC), therefore the higher the number of solids the greater the conductivity (Graph 10, 11, Table 15,16). Conductivity in our case is measured in microSiemens ($\mu\text{S}/\text{cm}$) and the seawater have a reading of approximately 50,000 $\mu\text{S}/\text{cm}$. Conductivity and salinity have a strong correlation. As conductivity is easier to measure, it is used in algorithms estimating salinity and TDS, both of which affect water quality and aquatic life.

A sudden increase or decrease in conductivity in a body of water can indicate pollution. Agricultural runoff or a sewage leak will increase conductivity due to the additional chloride, phosphate and nitrate ions. An oil spill or addition of other organic compounds would decrease conductivity as these elements do not break down into ions. In both cases, the additional dissolved solids will have a negative impact on water quality.

Table 15. Recorded data on TDS [ppt] for the 14 monitored sites.

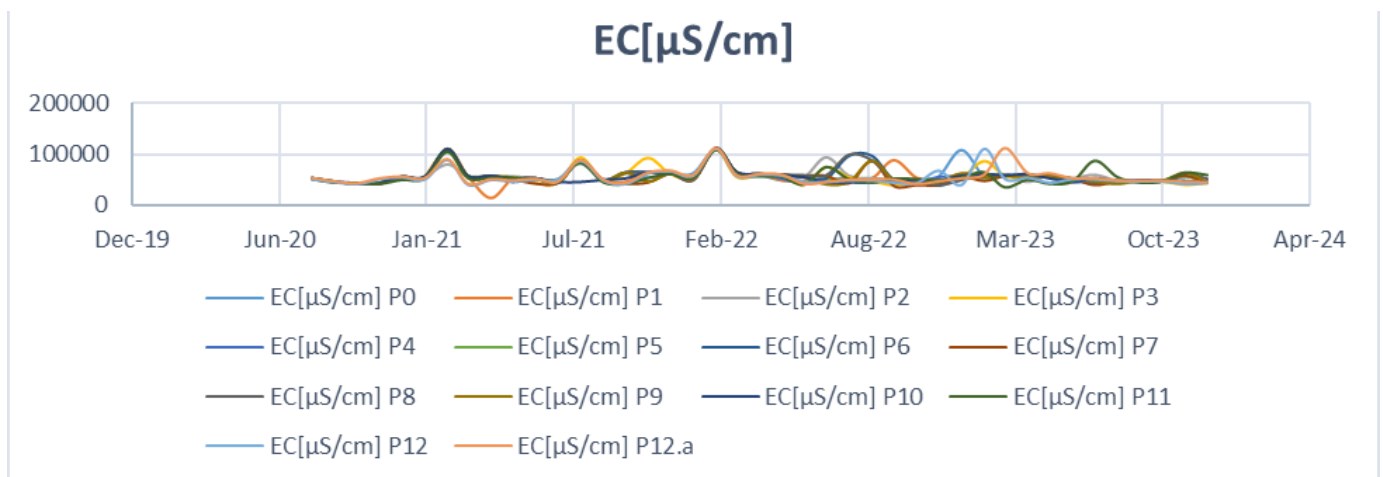
	TDS [ppt]														
	P0	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P12 a	
Aug-20			26.4			26.37	26.54	26.25	26.27	26.29	26.54	26.31	25.81	25.67	26.14
Sep-20	22.86	22.96				22.95	23.01	22.53	23.16	23.15	22.89	22.9	22.27	22.94	22.95
Oct-20	21.48					21.46	21.43	21.16	21.45	21.43			22.33	21.13	21.14
Nov-20	21.54	21.61				21.6	21.65	21.36	21.64	21.63	21.67	21.65	21.28	25.92	25.89
Dec-20	27.57	27.75				27.72	27.75	27.43	27.78	27.86	27.78	27.78	25.09	27.74	27.74
Jan-21	27.61	27.61	26.59	27.37		27.82	27.78	27.02	27.53	27.3	27.67	27.69	26.31	25.6	26.14
Feb-21	54.86	55.02	40.05	54.29	55.13	55.22	55.26	54.85	54.82	55.07	55.01	51.93	44.85	44.84	
Mar-21	28.09	28.23	28.22	27.5	28.37	28.39	28.13	28.42	28.4	28.5	28.48	26.77	20.38	20.4	
Apr-21	27.67	7.0773	28.66	28.22	28.22	28.67	28.43	28.67	27.24	28.77	28.76	27.04	25.19	25.04	
May-21	25.64	25.95	27.95	27.86	25.97	25.98	22.53	25.9	25.95	25.88	25.93	27.22	23.72	23.84	
Jun-21	25.71	25.94	26.37	22.44	26.08	26.44	26.23	21.64	26.34	26.17	26.2	25.67	25.45	25.44	
Jul-21	22.05	23.43	23.42	22.44	23.49	22.39	22.48	22.46	22.47	22.05	22.47	25.67	25.8	22.43	
Aug-21	43.63	43.42	43.95	47.22	43.63	43.49	43.62	43.9	43.88	43.78	22.41	40.88	43.93	44	
Sep-21	24.57	24.54	24.56	24.22	24.96	24.57	24.44	24.55	24.53	24.59	24.6	22.72	24.6	24.64	
Oct-21	31.68	22.96	31.79	31.71	31.89	31.9	31.89	21.45	31.94	31.89	25.97	21.28	21.13	21.45	
Nov-21	27.13	32.01	31.79	46.78	31.86	31.86	31.84	31.87	22.89	31.87	31.96	26.96	31.65	31.63	
Dec-21	31.18	31.52	31.45	31.3	31.53	31.53	31.48	31.31	31.41	31.21	31.25	30.78	33.68	33.51	
Jan-22	31.38	27.82	25.75	27.76	27.53	27.69	25.05	25.06	25.04	25.68	27.11	27.37	29.18	29.19	
Feb-22	55.35	55.28	55.7	55.17	55.3	55.63	55.24	55.61	55.8	55.62	55.66	53.88	55.77	55.62	
Mar-22	31.82	31.99	31.69	28.37	31.97	32.43	32.29	32.49	32.49	32.45	32.42	30.99	29.03	29.02	
Apr-22	29.85	30.34	30.16	30.02	30.38	30.42	30.32	30.73	30.69	30.41	30.43	28.34	30.24	30.24	
May-22	24.49	24.45	29.53	30.02	25.9	29.6	29.7	29.68	29.96	29.86	29.63	27.95	29.58	29.57	
Jun-22	23.28	23.5	27.65	20.7	21.34	22.14	27.06	29.41	29.63	27.13	27.18	20.48	23.37	20.28	
Jul-22	22.86	22.96	47.22	26.47	26.14	26.57	26.04	29.41	29.63	27.1	27.08	25.06	23.37	22.25	
Aug-22	24.53	26.71	25.09	23.82	25.1	25.19	24.14	24.87	24.65	24.72	24.56	25.81	24.6	24.64	
Sep-22	23.28	26.4	26.08	24.22	22.95	23.01	24.14	43.9	43.88	43.78	24.56	22.72	24.6	24.64	
Oct-22	23.28	43.95	24.93	20.28	25.48	25.17	24.73	19.32	24.92	24.32	24.87	26.27	22.44	24.64	
Nov-22	22.96	26.71	24.68	23.33	22.90	24.57	24.42	20.25	24.25	21.43	27.08	25.81	22.22	20.28	
Dec-22	28.58	25.94	19.21	21.91	27.36	22.18	19.02	20.25	20.26	23.01	23.57	24.66	34.26	23.06	
Jan-23	19.21		28.64	27.50	28.15	28.39	26.02	28.42	25.05	31.21	28.77	27.33	20.33	25.87	
Feb-23	28.15		24.22	43.72	28.37	27.47	28.13	24.30	30.42	27.50	30.02	32.45	55.80	29.70	
Mar-23	29.03		29.27	29.24	28.97	29.13	29.28	29.15	29.33	29.28	29.09	17.89	26.16	55.80	
Apr-23	27.96		22.47	27.24	28.11	29.03	28.24	28.26	28.31	27.95	30.25	25.19	27.37	30.93	
May-23	28.71		28.85	28.84	28.94	28.21	28.76	28.80	28.84	28.79	25.95	21.28	22.48	30.79	
Jun-23	25.58		26.23	26.21	25.83	26.18	22.48	26.32	26.20	25.73	22.47	23.62	25.90	25.89	
Jul-23	22.89		29.63	23.50	20.48	22.44	24.22	20.28	22.43	23.01	26.27	43.42	25.71	25.89	
Aug-23	23.72		23.70	23.71	23.76	23.73	23.25	23.66	23.72	20.48	23.11	27.72	23.84	23.88	
Sep-23	23.71		23.82	23.81	23.77	23.82	23.64	23.82	23.81	23.78	23.80	22.27	23.70	23.62	
Oct-23	23.70		23.83	23.78	23.85	23.85	23.78	23.85	23.88	23.83	23.83	23.72	23.74	23.72	
Nov-23	28.79		27.65	20.70	21.34	28.84	23.70	29.70	31.86	31.84	22.89	31.87	21.28	22.48	
Dec-23	22.16		22.24	22.21	22.18	22.23	22.13	22.23	26.16	22.23	22.24	29.70	22.19	22.27	

Conductivity is dependent on water temperature and salinity/TDS. Water temperature can cause conductivity levels to fluctuate daily. When water temperature increases, so will conductivity. TDS is directly proportional to the Electrical Conductivity (EC), therefore the higher the number of solids the greater the conductivity.

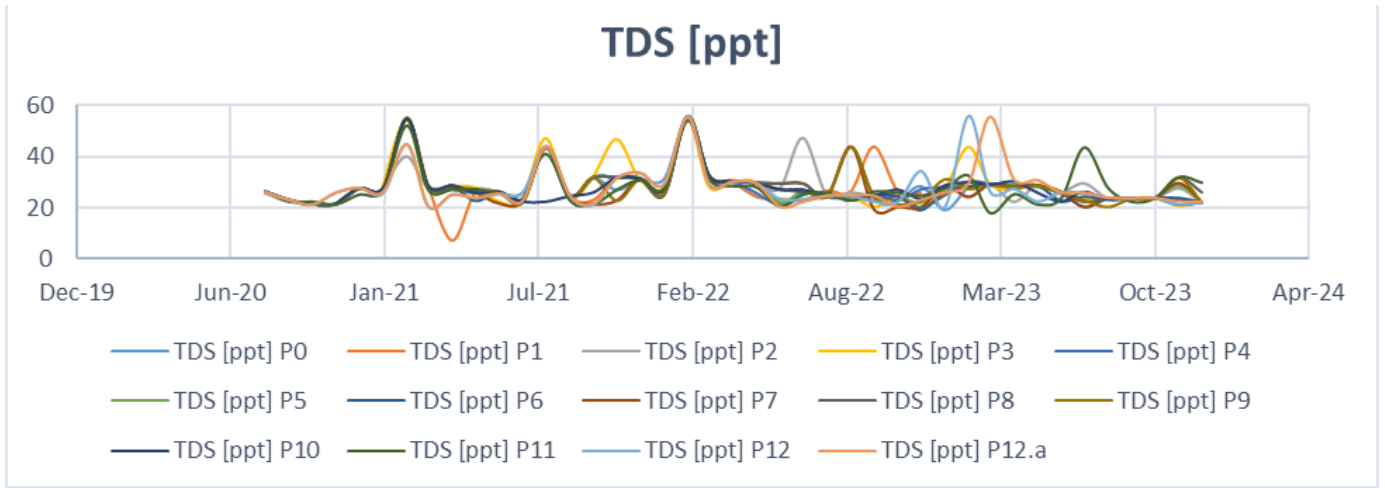
Most of the data present values within the ideal range of EC in sea waters, even though low levels were registered September- November 2020, July 2021 and September 2021, November and December 2022 and through out 2023. Conductivity pattern is still not clear and future data is required to further investigate the correlation between temperature level and EC.

Table 16. Recorded data on EC[$\mu\text{S}/\text{cm}$] for the 14 monitored sites.

	EC[$\mu\text{S}/\text{cm}$]													
	P0	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P12.a
Aug-20		52810			52740	53080	52500	52540	52590	53090	52630	51610	51340	52280
Sep-20	45720	45920			45900	46030	45060	46320	46310	45780	45800	44530	45890	45910
Oct-20	42970				42930	42860	42320	42910	42850			44660	42260	42290
Nov-20	43090	43220			43200	43310	42730	43280	43260	43340	43310	42560	51840	51790
Dec-20	55140	55500			55440	55500	54870	55560	55710	55570	55570	50180	55490	55490
Jan-21	55230.00	55230.00	53190.00	54740.00	55640.00	55560.00	54050.00	55060.00	54600.00	55340.00	55380.00	52630.00	51210.00	52280.00
Feb-21	109700.00	110000.00	80090.00	108500.00	110200.00	110400.00	110500.00	109700.00	109600.00	110100.00	110000.00	103800.00	89700.00	89680.00
Mar-21	58190.00	56470.00	56450.00	55010.00	56750.00	56780.00	56270.00	56840.00	56800.00	57010.00	56950.00	53550.00	40760.00	40800.00
Apr-21	55340.00	14150.00	57320.00	56450.00	56440.00	57350.00	56880.00	57340.00	54480.00	57540.00	57520.00	54090.00	50390.00	50080.00
May-21	51280.00	51910.00	55910.00	55720.00	51940.00	51970.00	45060.00	51800.00	51910.00	51770.00	51860.00	54440.00	47450.00	47690.00
Jun-21	51430.00	51880.00	52750.00	44890.00	52160.00	52880.00	52470.00	43280.00	52680.00	52350.00	52400.00	51350.00	50900.00	50880.00
Jul-21	44100.00	46870.00	46840.00	44890.00	46980.00	44790.00	44970.00	44920.00	44940.00	44110.00	44940.00	51350.00	51610.00	44870.00
Aug-21	87270.00	86850.00	87900.00	94450.00	87270.00	86980.00	87250.00	87800.00	87760.00	87570.00	44830.00	81770.00	87870.00	88010.00
Sep-21	49150.00	49080.00	49120.00	48440.00	49920.00	49150.00	48880.00	49110.00	49070.00	49190.00	49210.00	45450.00	49200.00	49290.00
Oct-21	63360.00	45920.00	63590.00	63420.00	63780.00	63810.00	63790.00	42910.00	63880.00	63780.00	51950.00	42560.00	42260.00	42910.00
Nov-21	54270.00	64020.00	63590.00	93560.00	63720.00	63720.00	63690.00	45780.00	63750.00	45780.00	63930.00	53930.00	63300.00	63260.00
Dec-21	62360.00	63050.00	62910.00	62800.00	63070.00	63060.00	62970.00	62630.00	62820.00	62430.00	62510.00	61560.00	67350.00	67030.00
Jan-22	62770.00	55650.00	51500.00	55520.00	55070.00	55380.00	50100.00	50120.00	50090.00	51360.00	54230.00	54750.00	58370.00	58390.00
Feb-22	110700.00	110500.00	111400.00	110300.00	110600.00	111200.00	110400.00	111200.00	111600.00	111200.00	111300.00	107700.00	111500.00	111200.00
Mar-22	63640.00	63990.00	63380.00	56750.00	63950.00	64860.00	64590.00	64990.00	64980.00	64900.00	64840.00	61980.00	58060.00	58050.00
Apr-22	59700.00	60680.00	60320.00	60050.00	60760.00	60850.00	60640.00	61470.00	61390.00	60830.00	60870.00	56680.00	60490.00	60490.00
May-22	48980.00	48900.00	59060.00	60050.00	51800.00	59210.00	59410.00	59360.00	59910.00	59730.00	59250.00	55910.00	59160.00	59140.00
Jun-22	46560.00	47000.00	55310.00	41410.00	42690.00	44280.00	54130.00	58830.00	59270.00	54260.00	54370.00	40960.00	46740.00	40570.00
Jul-22	45720.00	45920.00	94450.00	75510.00	52280.00	53140.00	52080.00	58830.00	59270.00	40150.00	44470.00	74680.00	46740.00	44510.00
Aug-22	56720.00	53420.00	57170.00	55940.00	45090.00	48220.00	97090.00	44200.00	98360.00	45220.00	44460.00	51610.00	49200.00	49290.00
Sep-22	46560.00	52810.00	52160.00	48440.00	45900.00	46030.00	97090.00	87800.00	87760.00	87570.00	44480.00	45450.00	49200.00	49290.00
Oct-22	46560	87900	49860	40560	50970	50340	49460	38650	49840	48650	49750	52540	44890	49290
Nov-22	45920	53420	49360	46670	45800	49150	48850	40500	48500	42860	44470	51610	44450	40570
Dec-22	57170	51880	38420	43820	54720	44370	38040	40500	40520	46030	47140	49320	68520	46120
Jan-23	109400		57290	55010	56300	56780	52050	56840	50110	62430	57540	54660	40660	51750
Feb-23	56310		48450	87450	56750	54950	56270	48600	60850	55010	60050	64900	111600	59410
Mar-23	58070		58540	58480	57940	56270	58560	58310	58660	58560	58190	35780	52320	111600
Apr-23	55920		44940	54480	56220	58060	56490	56530	56620	55910	60510	50390	54740	61860
May-23	57430		57700	57680	57880	56430	57530	57600	57680	57580	51910	42560	44970	61580
Jun-23	51170		52470	52420	51670	52360	44970	52650	52410	51470	44940	47250	51800	51780
Jul-23	45780		59270	47000	40960	44890	48440	40570	44870	48030	52540	86850	51430	51780
Aug-23	47440		47420	47530	47460	46510	47320	47450	47450	40960	46230	55440	47690	47770
Sep-23	47430		47640	47630	47560	47650	47650	47280	47640	47620	47560	47610	44530	47400
Oct-23	47400		47660	47560	47700	47700	47560	47710	47780	47660	47670	47450	47490	47250
Nov-23	57580		55310	41410	42690	57680	47400	59410	63720	63690	45780	63750	42560	44970
Dec-23	44320		44490	44430	44370	44460	44270	44460	52320	44460	44490	59410	44390	44540



Graph 10. Graph presentation of the recorded data on EC.

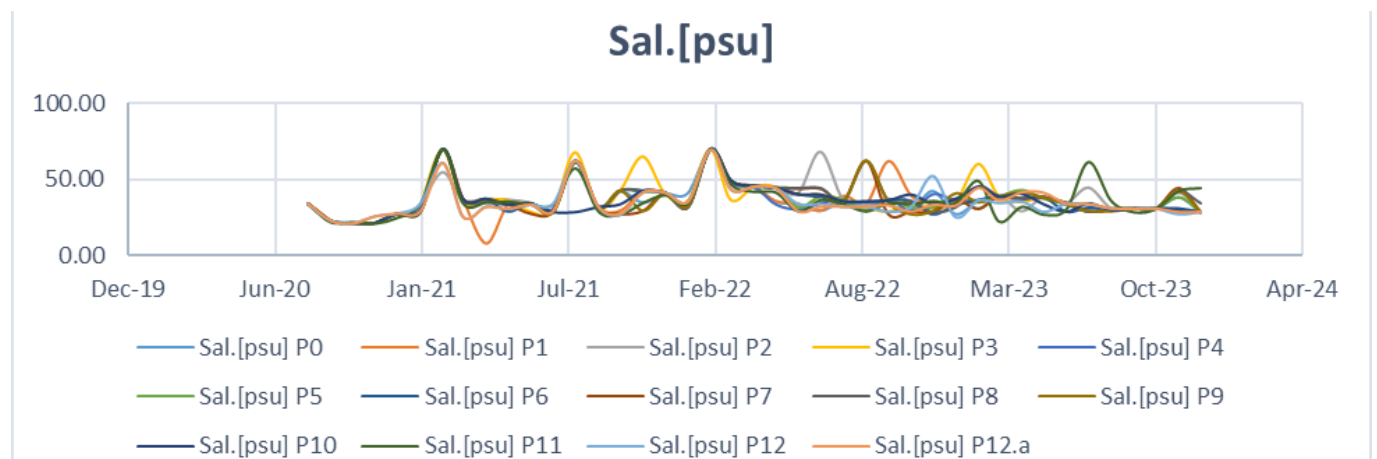


Graph 11. Graph presentation of the recorded data on TDS.

Salinity presents the total concentration of all dissolved salts in water usually of calcium and magnesium. In our case is presented in Practical Salinity Unit (PSU, 1PSU=1g/kg)16. Salinity of seawater is on average 35 psu, or about 35 g/kg, with lower values close to the river's mouth. Salinity is important in particular as it affects dissolved oxygen solubility. The higher the salinity level, the lower the dissolved oxygen concentration. In the Table 17, below all the records below 35 psu are colored in red-light red. Further data are necessary to understand the reasons for these outliers. Referring to Table 17 and Graph 12, overall salinity is close to the ideal range.

Table 17. Recorded data on Sal.[psu].

	P0	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P12.a	
Aug-20		34.53				34.55	34.56	34.08	34.50	34.53	34.57	34.41	34.08	33.80	34.51
Sep-20	22.86	22.96				22.95	23.01	22.53	23.16	23.15	22.89	22.90	22.27	22.94	22.95
Oct-20	21.48					21.46	21.43	21.16	21.45	21.43			22.33	21.13	21.14
Nov-20	21.54	21.61				21.60	21.65	21.36	21.64	21.63	21.67	21.65	21.28	25.92	25.89
Dec-20	27.57	27.75				27.72	27.75	27.43	27.78	27.86	27.78	27.78	25.09	27.74	27.74
Jan-21	28.53	30.54	30.39	29.00	30.62	28.84	28.78	28.96	28.99	28.46	28.87	33.81	33.95	28.99	
Feb-21	70.00	70.00	54.55	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	61.20	61.18
Mar-21	36.32	36.56	36.58	35.57	36.76	36.82	36.43	36.87	36.82	36.97	36.95	34.25	25.22	25.28	
Apr-21	35.86	36.06	37.24	36.64	36.61	37.28	36.88	37.27	35.41	37.41	37.40	35.01	32.25	32.02	32.02
May-21	33.48	33.90	36.60	36.46	33.90	33.92	28.94	33.82	33.89	33.80	33.84	35.72	30.69	30.87	30.87
Jun-21	33.81	34.15	34.65	28.99	34.53	34.33	34.63	34.18	27.68	34.55	34.3	34.32	33.81	33.53	33.52
Jul-21	28.53	30.54	30.39	29.00	30.62	28.84	28.78	28.96	28.99	28.46	28.87	33.81	33.95	28.99	
Aug-21	62.09	61.67	62.32	68.02	62.03	61.84	61.45	62.41	62.41	62.38	28.84	57.50	62.47	62.59	
Sep-21	32.09	32.03	32.08	31.59	32.61	32.06	31.82	32.05	32.04	32.11	32.12	29.34	32.09	32.16	
Oct-21	42.47	29.76	42.70	42.68	42.84	42.85	42.84	27.50	42.92	42.83	33.90	27.19	26.90	27.90	
Nov-21	35.11	42.59	42.70	66.92	42.63	42.61	42.63	29.63	42.65	29.63	42.76	34.95	41.69	41.65	
Dec-21	40.77	41.53	41.44	41.30	41.53	41.54	41.47	41.24	41.39	41.06	41.13	39.91	41.57	41.47	
Jan-22	41.14	35.63	33.01	35.88	35.34	35.49	31.82	31.96	31.93	32.77	34.77	34.87	35.57	35.62	
Feb-22	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00
Mar-22	48.10	48.39	47.95	36.76	48.37	49.22	48.98	49.35	49.34	49.26	49.20	46.76	43.43	43.43	
Apr-22	44.74	45.61	45.33	45.10	45.66	45.73	45.59	46.32	46.24	45.73	45.76	42.18	45.43	45.43	
May-22	35.88	35.80	44.31	45.10	33.82	44.45	44.59	44.57	45.03	44.87	44.49	41.65	44.41	44.39	
Jun-22	33.80	34.15	41.10	29.71	30.62	31.99	40.16	44.08	44.49	40.24	40.32	29.34	33.95	28.99	
Jul-22	29.62	29.76	68.02	39.03	34.51	39.33	38.45	44.08	44.49	40.14	40.12	36.68	33.95	32.17	
Aug-22	35.78	39.46	36.75	34.56	36.74	36.94	35.18	36.36	35.97	36.14	35.86	34.08	32.09	32.16	
Sep-22	33.80	34.53	34.33	31.59	29.75	29.71	35.18	62.41	62.41	62.38	35.86	29.34	32.09	32.16	
Oct-22	33.80	62.32	36.57	28.98	37.50	36.95	36.24	27.50	36.55	35.53	36.37	34.50	28.00	33.16	
Nov-22	29.76	39.46	36.15	33.86	29.63	32.09	35.72	28.96	35.41	27.48	40.12	34.08	32.12	29.01	
Dec-22	42.70	34.15	27.32	31.59	40.55	32.06	27.03	28.96	28.98	29.71	34.34	36.17	52.54	33.55	
Jan-23	27.32		37.22	35.58	36.51	36.79	33.20	36.87	31.95	41.06	37.41	34.81	26.16	32.99	
Feb-23	36.36		30.77	60.37	36.76	35.18	36.43	30.89	45.73	35.57	45.10	49.26	36.43	44.59	
Mar-23	38.81		39.16	39.12	38.71	38.96	39.17	38.98	39.25	39.18	38.90	22.65	34.54	36.43	
Apr-23	37.20		28.99	35.41	37.43	43.43	37.53	37.65	41.65	40.87	40.87	32.25	35.60	41.72	
May-23	38.36		38.56	38.55	38.69	37.59	38.43	38.49	38.55	38.48	33.89	27.10	28.78	41.51	
Jun-23	33.62		34.64	34.62	34.01	34.58	28.78	34.79	34.61	33.89	28.99	30.74	34.10	34.09	
Jul-23	29.63		44.49	34.15	29.34	29.00	31.59	28.99	28.99	29.71	34.50	61.67	33.81	34.09	
Aug-23	30.86		30.91	30.84	30.99	30.98	30.28	30.86	30.94	29.34	30.03	36.18	31.03	31.09	
Sep-23	30.87		31.03	31.02	30.96	31.04	30.79	31.03	31.01	30.97	31.01	28.78	30.87	30.74	
Oct-23	30.87		31.05	30.98	31.09	31.09	30.98	31.09	31.12	31.06	31.07	30.94	30.97	30.94	
Nov-23	38.48		41.10	29.71	30.62	38.55	30.91	44.59	42.61	42.63	29.63	42.65	27.19	28.78	
Dec-23	28.70		28.83	28.79	28.74	28.81	28.67	28.81	34.54	28.81	28.83	44.59	28.74	28.86	



Graph 12. Graph presentation of the recorded data on Sal.[psu].

VII. Monitoring Common Indicator 16



7.1 Introduction

Nowadays the urbanization of the cities has reached its peak and due to the high demand the focus is being shifted to coastal natural areas. Aiming to achieve more and more economic profit and also aiming to develop furthermore activities such as tourism, the artificialisation of coastal areas has taken place and new man-made structures are built such as marinas, docks, jetties etc. These coastal manmade infrastructures cause irreversible damage to landscapes, losses in habitat and biodiversity, and strongly influence the configuration of the shoreline. These artificial structures in the coastal fringe can disrupt the sediment transport, reduce the ability of the shoreline to respond to natural forcing factors, and fragment the coastal space. Around 40% of the coastal zone of the Mediterranean coastline is under some form of artificial land cover (UNEP/Mediterranean Action Plan), but yet there is still a deep lack of information regarding the actual level of this artificialisation. In order to assess the status of the Mediterranean coastline and understand the evolution of it and the impacts related to man-made structures, a monitoring protocol is compiled under the framework of Barcelona Convention.

Common Indicator 16, part of Ecological Objective 8 of IMAP, evaluates the length of artificial and natural coastline by measuring the length of coastline subject to physical disturbance due to the influence of man-made structures. There is no systematic monitoring in Mediterranean regarding coastal artificialization by now. The only country that has implemented the monitoring of the EO8 common indicator on a national level by this moment is Italy, with Montenegro and France performing similar inventories. Albania, as an under-development Mediterranean country, is currently facing the threats of the artificialisation of the coastline. Even though the impacts are seen and the consequences are obvious, there is still no official complete data on the level of the changes of the coastline, thus the implementation of the monitoring protocol of Common Indicator 16 is of major interests. An arising conflict is also the artificialisation of the coastline that is under protection regarding biodiversity, such as the system of natural protected areas in Albania, where there is a continuous pressure for building infrastructure as in the situation of Karaburun-Sazan MPA. In this case this indicator offers the possibility to evaluate through out the years the level of artificialisation and the consequences related to it thus it is recommended to perform this type of monitoring periodically in accordance with the monitoring protocol.

7.2 IMAP and Common Indicators

In 2016, Karaburun-Sazan National Marine Park was proclaimed a Special Protected Area of Mediterranean Importance (SPAMI) which falls under the Barcelona Convention. This convention derives from overarching principles and the overall structure of the Integrated Monitoring And Assessment Programme Of The Mediterranean Sea And Coast And Related Assessment Criteria (IMAP) that Contracting Parties of the Barcelona Convention are encouraged to coordinate within and between each other in order to use resources in an efficient way.

IMAP describes the strategy, themes, and products that the Barcelona Convention Contracting Parties are aiming to deliver, through collaborative efforts in the framework of the MAP Barcelona Convention. The ultimate goal is to assess the status of the Mediterranean sea and coast, as a basis for enhanced action. The main important aspects or the backbone of the IMAP are its Ecological Objectives and the respective Common Indicators. In the context of the Barcelona Convention, a common indicator is an indicator that summarizes data into a simple, standardized, and communicable figure and is ideally applicable in the whole Mediterranean basin, or at least on the level of subregions, and is monitored by all Contracting Parties. A common indicator is able to give an indication of the degree of threat or change in the marine ecosystem and can deliver valuable information to decision makers. The current IMAP covers the ecological objectives related to biodiversity (EO1), non indigenous species (EO2), eutrophication (EO5), hydrography (EO7), coast (EO8), contaminants (EO9), and marine litter (EO10).

7.3 Monitoring methodology

7.3.1 Monitoring protocol

The monitoring of this Common Indicator entails an inventory of the length and location of human-made coastline (hard coastal defense structures, ports, marinas). Soft techniques e.g. beach nourishment are not included. With regard to the coastline to be considered: the fixed reference official coastline as defined by responsible Contracting Party should be considered. The monitoring of this Common Indicator entails an inventory of:

- the length and location of manmade coastline (hard coastal defense structures, ports, marinas). Soft techniques e.g. beach nourishment is not included.
- land claim, i.e. the surface area reclaimed from the 1980's onward (ha); and
- the Impervious surface in the coastal fringe (100m from the coastline).

The optimal resolution should be 5 m or 1: 2000 spatial scale. Once a proper geographic scale has been established, monitoring should focus, in particular, on the location, the spatial extent and the types of coastal structures taking into account the minimum coastal length that can be classified as artificial or natural. The identification procedure of human-made structures should be carried on based on typical situations added to the indicator guidance factsheet, including the minimum size (length, width of human-made structures) to be taken into account. As monitoring should be done every 6 years, every CP should fix a reference year in the time interval 2000-2012 in order to eliminate the bias due to old or past human-made infrastructures. The length of artificial coastline should be calculated as the sum of segments on reference coastline identified as the intersection of polylines representing human-made structures with reference coastline ignoring polylines representing human-made structures with no intersection with reference coastline.

The minimum distance between coastal defense structures should be set to 10 m in order to classify such segments as natural, i.e. if the distance between two adjacent coastal defense structures is less than 10 m, all the segment including both coastal defense structures is classified as artificial. The total length of coastline influenced by human-made structures and the share of this coastline in total country's coastal length should be provided on a map showing the coastline subject to physical disturbance due to human-made structures (artificial segments) in red line and the rest (natural segments) in green line. The assessment output should be reported as a common shape file format with GRS as WGS84.

7.3.2 Monitoring in Karaburun-Sazan MPA

The monitoring was conducted during November-December 2022 in the territory of Karaburun Peninsula and Sazan Island. The base for the monitoring is the monitoring protocol compiled by IMAP and also the relevant Guidance Fact Sheet for Common Indicator 16. A field visit around Karaburun Peninsula and Sazan Island was conducted and also Ortophoto from the National Authority for Geospatial Information and satellite imagery were used in order to identify the man-made structures.

The study area was focused in the first 100m from the coast. An inventory of the manmade structures in the costal area in direct contact with the sea and land was realized and later on analyzed and reflected using GIS. The areas where these man-made structures were located are considered as artificial and the areas where the man-made structures are not present are considered natural. Structures located inside the sea are considered irrelevant and are not represented in the final product. The information regarding the artificial and natural areas are shown in maps produced using GIS and are shown with the below symbols.

Red lines  artificial coast area

Green lines  natural coast area

Blue lines  irrelevant structure

The monitoring was extended in three monitoring periods, 2007, 2015, 2022 and for each period was done an evaluation of the Common indicator 16 and a full inventory of the coastal infrastructure found. Photos from areas where changes were noticed were extracted with in 1:2000 spatial scale.

In addition, was completed a detailed inventory of man-made structures located with the 100m monitoring area, and were recorded data regarding the coordinates of this structures, surfaces and pictures for each of them.

The changes and the new infrastructure that is added along the 100m area throughout the years 2007, 2015, 2022 is reflected using areal images in 1:2000 spatial scale.

7.4 Results

7.4.1 Indicator 16. Natural and artificial zones

The study shows that the Karaburun-Sazan marine park in general remains a natural virgin area even though it is subject to the artificialisation of the coast. The process of the artificialisation has continued throughout the years, even though most of the artificial structures were already built in the reference year 2007. In Table 18 are shown the types of the artificial structures and the respective information regarding them.

Table 18. Information regarding artificial coastal area structures in Karaburun-Sazan MPA.

No.	Man-made structure	Location	Coordinates (Longitude)	Coordinates (Latitude)	Length (m)
1	Dock	Shën Vasil	19.38065575	40.40184246	8
2	Tunnel	Between Shën-Vasil Dhimkushtë	19.36272924	40.4159543	1
3	Tunnel	Between Shën-Vasil Dhimkushtë	19.36272924	40.4159543	1
4	Dock	Shën Jan	19.33600986	40.4315647	11
5	Dock	Shën Jan	19.32884808	40.43209447	9
6	Dock	Shën Jan	19.32884808	40.43209447	13
7	Dock	Moli i Veriut	19.29554052	40.42412477	9
8	Dock	Brisan	19.37755852	40.31480145	15
9	Dock	Gjiri i Inglezit	19.43656169	40.2440218	4
10	Dock	Gjiri i Inglezit	19.43656169	40.2440218	5
11	Dock	Gramë	19.47311251	40.21610399	14
12	Dock	Sazan	19.28539005	40.50198497	332
13	Dock	Sazan	19.28539005	40.50198497	8
14	Jettie	Sazan	19.28539005	40.50198497	20
15	Dock	Sazan	19.28527801	40.50194497	6
16	Dock	Sazan	19.28527801	40.50194497	3
17	Dock	Dhimkushtë	19.35705087	40.42210772	36

As shown in the Figure 24 the artificial structures, respectively, tunnel, docks, marinas and jetties for the year 2007 and 2015 are located in Shën Vasili Bay, the area between Shën Vasil and Dhimkushtë, Shën Jan Bay, Galloveci Cape, Moli i Veriut, Brisan Bay, Inglezi Bay, Grama Bay and Sazan Island. In 2022, there is another intervention in the coastal area of Dhimkushta where the rock was transformed for the placement of umbrellas and also a dock was built for the anchorage of boats.

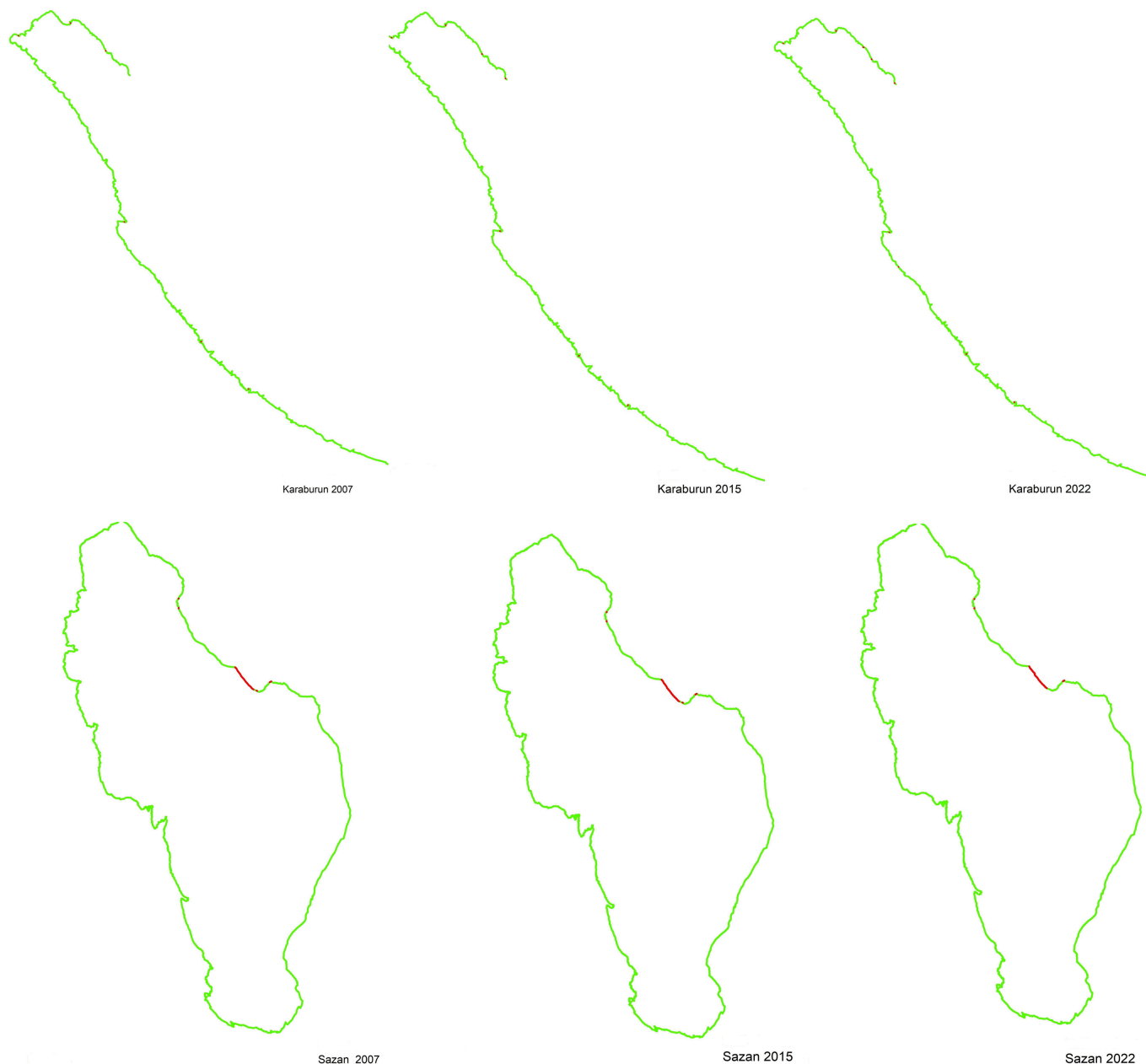


Figure 24. Indicator 16 in Karaburun-Sazan MPA for the year 2007, 2015, 2022.

In total, for the years 2007 and 2015 the entire natural coastline for Karaburun Peninsula and Sazan Island makes up for 116.32km and the entire artificial coastline makes up for 0.46 km. Meanwhile in 2022 there is seen a change in the ratio off natural and artificial coastline, respectively the natural coastline makes up for 116.28km and the artificial coastline makes up for 0.49km. The changes in 2022 show a trend for the artificialisation of the coastline of the marine park as result of the increase in the number of tourists and the higher request for relevant infrastructure.

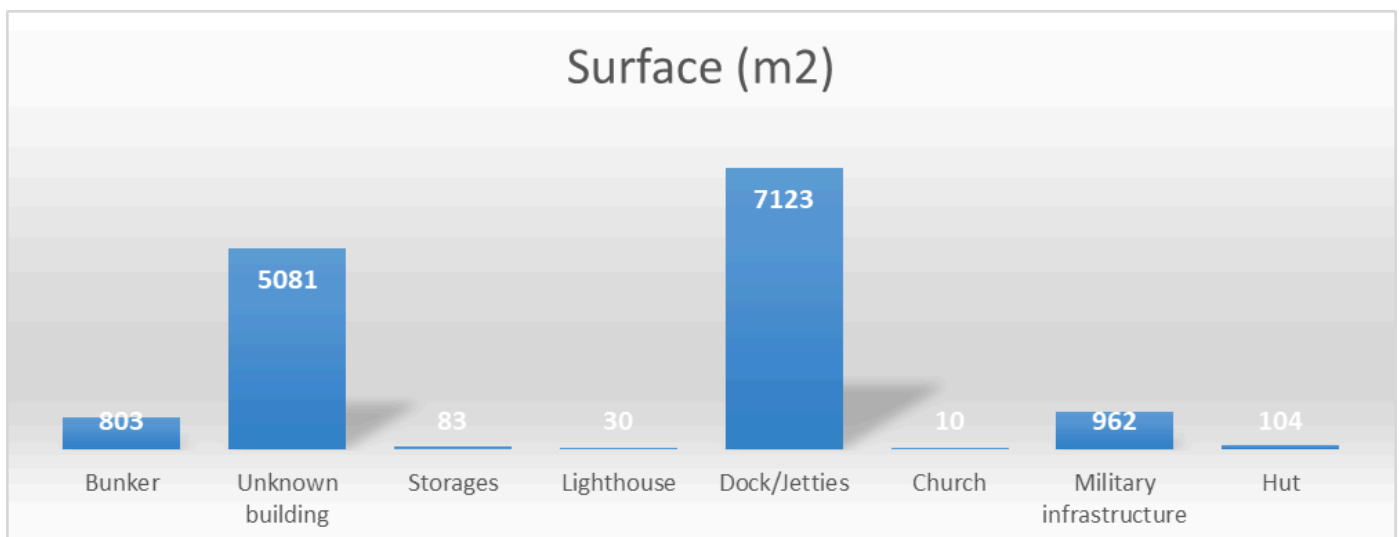
7.4.2 Man-made infrastructure

Other than the monitoring of the man-made structures in the first line of the coast was also monitored the structures present within the 100m area from the coast. The buildings present in the territory of Karaburun peninsula and Sazan Island are from different periods, but most of them are built during the communism period. These structures, 148 in total, include bunkers, tunnels, storage buildings, military buildings (Figure 25).



Figure 25. Photos of man-made structures inside the 100m area.

Respectively the number of bunkers is 84, the number of docks and jetties is 15, the number of unknown buildings is 47, storage buildings 1, lighthouse 2, church 1 and hut 2. The surface of the land covered by this structures is shown in Graph 13 where the most of the land is claimed by buildings whose function isn't known by 5081m², moreover the highest surface covered is by docks and jetties, respectively 7123m².



Graph 13. Surface of the land covered by the man-made structures.

Another element that shows the anthropogenic impact is also the existence of a terrestrial road that is being used by the military base and management authorities for patrolling. The road sometimes falls inside the 100m area and some times is out of it. All the man-made infrastructures are shown in the map in Figure 26.

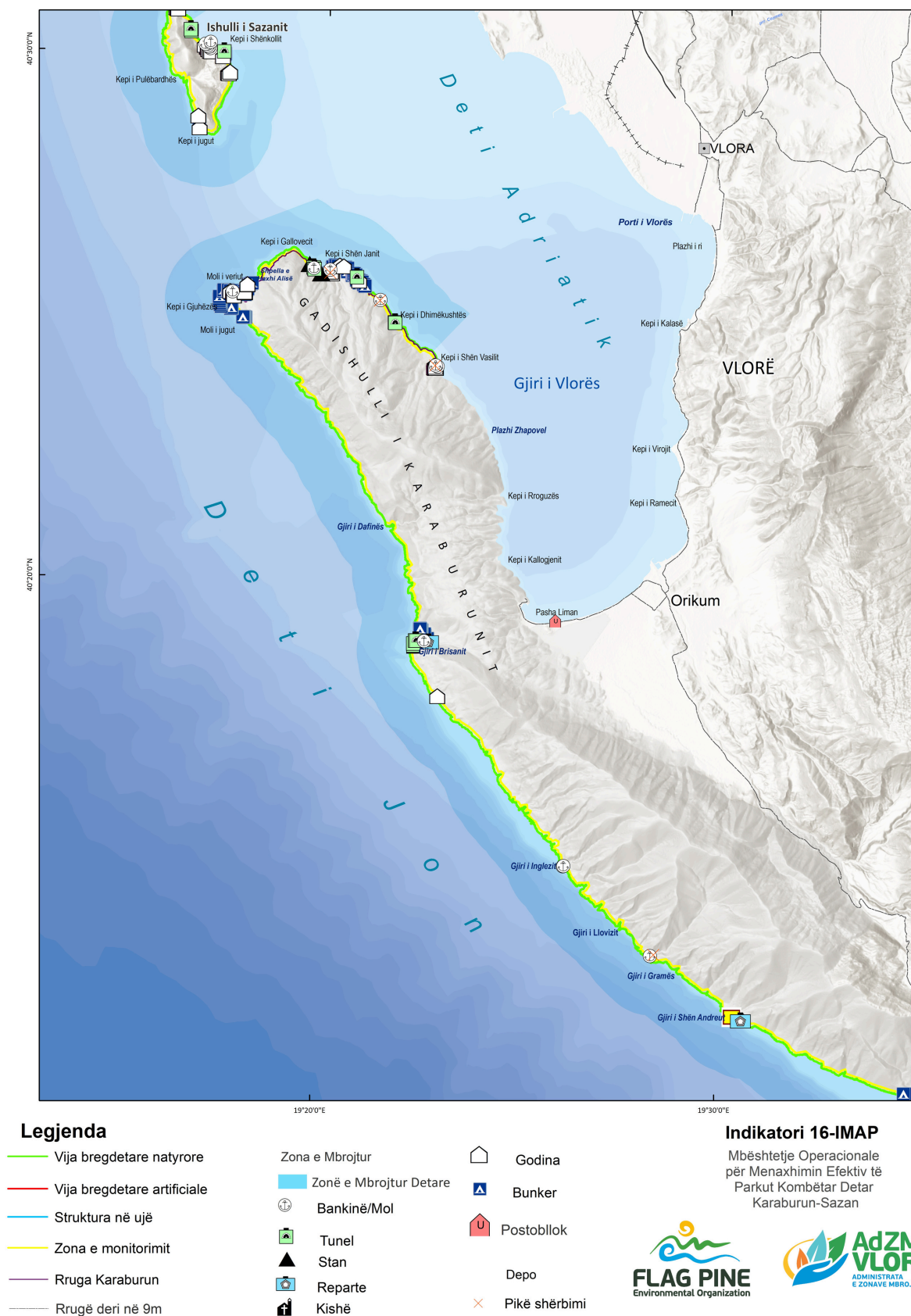


Figure 26. Map showing the distribution of all man-made structures inside the monitoring area.

In 2015, which marks also the year of the creation of RAPA Vlore, the interest of the area for tourism activities arise and as a result, four service points were built in Shën Vasil Bay, Dhimkushta Bay, Shën Jan Bay and Grama Bay. At the beginning, as shown in Figure 27 the infrastructure in this service points was quite minimal but in 2022 the situation is much more different.



Figure 27. Changes in the infrastructure of the beaches of Karaburun-Sazan MPA from 2007 (left) to 2022 (right). Shen Vasil in the first photos and Dhimkushta in the second photos.

Major changes are made in the beaches of Shën Vasil and Dhimkushtë meanwhile smaller changes are made in Grama Bay and Shën Jan Bay. Must be taken into consideration that Shën Vasil bay, located in the eastern side, is not part of Karaburun-Sazan MPA but due to its vicinity with the park it is taken into consideration within this monitoring.

In addition, another area that is located in the western border of the MPA, Palasa Bay has undergone major changes, shown in Figure 28. The changes noticed in these areas confirm even more the increased pressure for the artificialisation of the coastal areas.



Figure 28. Changes in the infrastructure in the coastal area of the western border of the MPA.

In the other bays of the MPA, located in the western side of Karaburun Peninsula, the situation remains the same as during the communism period apart from Brisan bay where small infrastructure has taken place, as shown in Figure 29. In Sazan Island also there are not made major changes apart from some small building in the upper area of the monitoring zone.



Figure 29. Situation in Sazan Island and the beaches in the western side of Karaburun-Sazan MPA (Shen Andre Bay in the bottom photos).

REFERENCES

- Airoldi L., Beck M.W. (2007): Loss, status and trends for coastal marine habitats of Europe. *Oceanogr Mar Biol Annu. Rev.* 45: 345–405.
- Albania and Marine Protected Areas: Legal and Institutional framework assessment for conservation of coastal and marine biodiversity and the establishment of MPAs. RAC/SPA and IUCN-Med. Ed. RAC/SPA - MedMPAnet Project, Tunis. 48pp
- ASIG Geoportal <https://geoportal.asig.gov.al/sq>
- Ballesteros E. and Pardo S. (2004). Los bosques de algas pardas. In: Luque, A. A. and Templado, J. (coords.). *Praderas y bosques marinos de Andalucía*, pp.223-236. Consejería de Medio Ambiente, Junta de Andalucía, Sevilla, 336 pp.
- Boyd Claude E. (1990): *Water Quality in Ponds for Aquaculture*. Birmingham, Ala.: AuburnUniversity Press
- Buia M.C., Gambi M.C., Dappiano M., 2004. Seagrass systems. *Biologia Marina Mediterranea* 11(suppl. 1), 133-183.
- Bundone, L.; Hernandez-Milian, G.; Hysolakoj, N.; Bakiu, R.; Mehillaj, T.; Lazaj, L.; Deng, H.; Lusher, A.; Pojana, G. First Documented Uses of Caves along the Coast of Albania by Mediterranean Monk Seals (*Monachus monachus*, Hermann 1779): Ecological and Conservation Inferences. *Animals* 2022, 12, 2620. <https://doi.org/10.3390/ani12192620>
- Cheminée A., Sala E., Pastor J., Bodilis P., Cottalorda J.-M., Thiriet P., Mangialajo L., Bianchimani O., Arceo H. and Francour P. (2013): Nursery value of *Cystoseira* forests for Mediterranean rocky reef fishes. - *Journal of Experimental Marine Biology and Ecology* 442: 70–79
- Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean
- Convention on the Conservation of European Wildlife and Natural Habitats in Europe
Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora
- Decision no. 57 “On the criteria and zoning of the territory of a protected area”
- Decision no. 60 “For the proclamation of natural ecosystems, natural managed reserve/natural park, and for the approval of the status change of existing surfaces of protected areas of these categories”
- Dinesh Kumar Y.S. Shivay, *Definitional Glossary of Agricultural Terms*, Vol I. 2008 I.K. International Publishing House Pvt.Ltd., New Dehli - 110016.
- Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds
- Dudley, N. (Editor) (2008). *Guidelines for Applying Protected Area Management Categories*. Gland, Switzerland: IUCN. x + 86pp. WITH Stolton, S., P. Shadie and N. Dudley (2013). *IUCN WCPA Best Practice Guidance on Recognising Protected Areas and Assigning Management Categories and Governance Types*, Best Practice Protected Area Guidelines Series No. 21, Gland, Switzerland: IUCN. xxpp.
- EcoAlbania Mapping of environmental issues along the Albanian coastline

Fabbrizzi E., Scardi M., Ballesteros E., Benedetti-Cecchi L., Cebrian E., Ceccherelli G., De Leo F., Deidun A., Guarnieri G., Falace A., Fraissinet S., Giommi C., Mačić V., Mangialajo L., Mannino A.M., Piazzini L., Ramdani M., Rilov G., Rindi L., Rizzo L., Sarà G., Souissi J.B., Taskin E. and Frascchetti S. (2020): Modeling Macroalgal Forest Distribution at Mediterranean Scale: Present Status, Drivers of Changes and Insights for Conservation and Management. *Front. Mar. Sci.* 7:20. doi: 10.3389/fmars.2020.00020

Gianni F. and Mangialajo L. (2016): Guidelines for the conservation, monitoring and restoration of *Cystoseira* forests in the Mediterranean Sea, pp 9-17. In: MMMPA Supervisory Board (Eds) *Monitoring Mediterranean Marine Protected Areas: A set of guidelines to support the development of management plans*. Deliverable of the MMMPA European project (FP7-PEOPLE-2011-ITN g.a. no.: 290056). Reef Check Italia onlus, Ancona, pp. 116. ISBN 978-88-906783-4-9

Gianni F., Bartolini F., Airoidi L., Ballesteros E., Francour P., Guidetti P., Meinesz A., Thibaut Th. & Mangialajo L. (2013): Conservation and restoration of marine forests in the Mediterranean Sea and the potential role of Marine Protected Areas, *Advances in Oceanography and Limnology*, 4:2, 83-101, DOI: 10.1080/19475721.2013.845604

González, L.M.; Fernández de Larrinoa, P.; Mas, J.; M'Bareck, H.; Cedenilla, M.A.; Moumni, A.; Idrissi, M.; Jiddou, A.M.; Araujo, A.; Costa-Neves, H.; et al. *El Plan de Acción Para la Recuperación de la Foca Monje del Mediterraneo (Monachus monachus) en el Atlántico Oriental; Naturaleza y Parques Nacionales; Series Especies Amenazadas; Servicio de Publicaciones del Ministerio de Medio Ambiente: Madrid, Spain, 2006;*

Goran Gugić (2019). Report on Defining Indicators to Monitor Natural Values of Karaburun-Sazan National Marine Park.

Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria UNEP/MAP Athens, Greece (2016)

Jones C.G., Lawton J.H., and Shachak M. (1994): Organisms as ecosystem engineers. *Oikos* 69: 373–386

Karamanlidis, A.A.; Adamantopoulou, S.; Tounta, E.; Dendrinou, P. *Monachus monachus* (Eastern Mediterranean subpopulation). The IUCN Red List of Threatened Species 2019: E.T120868935A120869697. 2019. Available online: <https://www.iucnredlist.org/species/120868935/120869697>

Kashta L., Beqiraj S., Tilot V., Zuna V., Dodbiba E. (2011): The first MPA in Albania, Sazani island – Karaburini peninsula, as a regional priority conservation area for marine biodiversity. *Varstvo Narave, Supl. 1*, 139-158.

Kirsten Grorud-Colvert et al. *The MPA Guide: A framework to achieve global goals for the ocean*. *Science* 373, eabf0861 (2021). DOI: 10.1126/science.abf0861

Klontz G.W. (1993): Epidemiology. In: Stoskopf, M.K. (ed.) *Fish Medicine*. W.B. Saunders, Philadelphia, US. pp. 210-213

Lloyd R. (1992): *Pollution and Freshwater Fish*. West Byfleet: Fishing News Books. 10
Lawson T. B. (1995): *Fundamentals of Aquacultural Engineering*. New York: Chapman and Hall
Management Plan of Karaburun-Sazan National Marine Park, 2015

Mangialajo L., Chiantore M. and Cattaneo-Vietti R. (2008): Loss of furoid algae along a gradient of urbanisation, and structure of benthic assemblages. *Marine Ecology Progress Series* 358: 63–74.

Martin, M.; Gridley, T.; Elwen, S.H.; Charrier, I. Assessment of the impact of anthropogenic airborne noise on the behaviour of Cape fur seals during the breeding season in Namibia. *J. Exp. Mar. Biol. Ecol.* 2022, 550, 151721.

MedPAN, SPA/RAC, WWF, Prince Albert II of Monaco Foundation. 2022. Post-2020 Mediterranean Marine Protected Areas Roadmap: The road to 2030. Edited by Charles Besancon, Susan Gallon, Asma Kheriji, Claudia Scianna, Marie Romani, Souha El Asmi, Pierre Vignes, Khalil Attia, Atef Limam, and Katy Mathias. 57p+annexe.

Nikolić V., Žuljević A., Mangialajo L., Antolić B., Kušpilić G. and Ballesteros E. (2013): Cartography of littoral rocky-shore communities (CARLIT) as a tool for ecological quality assessment of coastal waters in the Eastern Adriatic Sea. *Ecological indicators*, 34, 87-93.

Notarbartolo di Sciara, G.; Kotomatas, S. Chapter Twelve. Are Mediterranean monk seals, *Monachus monachus*, being left to save themselves from extinction? *Adv. Mar. Biol.* 2016, 75, 359–386. [CrossRef] [PubMed]

Pergent G., Pergent-Martini C., Boudouresque C.F., 1995. Utilisation de l'herbier à *Posidonia oceanica* comme indicateur biologique de la qualité du milieu littoral en Méditerranée: état des connaissances. *Mésogée* 54, 3-27.38

Plani i integruar ndërsektorial për brezin bregdetar, Shqipëria 2030

RAJKOVIC, Z. AND KROMIDHA, G. (2014): Management Plan For National Marine Park Karaburun-Sazan. UNDP, 11 pp. + annexes.

Scheel, D.-M., Slater, G. J., Kolokotronis, S.-O., Potter, C. W., Rotstein, D. S., Tsangaras, K., Greenwood, A. D. and Helgen, K. M. 2014. Biogeography and taxonomy of extinct and endangered monk seals illuminated by ancient DNA and skull morphology. *ZooKeys* 409: 1-33.

Sonila Kane. Studim i gjendjes mjedisore të gjirit të vlorës nëpërmjet parametrave kimikofizikë të tij.

Wang W., Wang A., Chen L., Liu Y. and Sun R. (2002): Effects of pH on Survival, Phosphorus Concentration, Adenylate Energy Charge and Na⁺-K⁺ ATPase Activities of *Penaeus chinensis* Osbeck Juveniles, *Aquatic Toxicology*, 60, 75-83

Table of Contents

I. Karaburun-Sazan, the first national marine park in Albania.....	1
1.1 Mediolittoral.....	3
1.1.1 Biocenosis of the lower mediolittoral rocks.....	3
1.1.2 Biocenosis of mediolittoral caves.....	4
1.2 Infralittoral.....	4
1.2.1 Biocenosis of the <i>Posidonia oceanica</i> meadows.....	4
1.2.2 Biocenosis of infralittoral algae.....	5
1.3 Circalittoral.....	5
1.3.1 Coralligenous biocenosis.....	5
1.3.2 Biocenosis of semi-dark caves.....	5
II. Scientific monitoring in Karaburun-Sazan MPA.....	7
III. Monitoring <i>Cystoseira amentacea</i>	9
3.1 Values of <i>Cystoseira amentacea</i>	10
3.2 Materials and methods.....	11
3.3 Results and discussions.....	12
IV. Monitoring <i>Posidonia oceanica</i>	17
4.1 Values of <i>Posidonia oceanica</i>	18
4.2 Monitoring methodology.....	19
4.3 Results and discussions.....	20
4.3.1 First study area.....	20
4.3.2 Second study area.....	22
4.3.3 Third study area.....	24
V. Monitoring <i>Monachus monachus</i>	26
5.1 General information regarding <i>Monachus monachus</i>	27
5.2 Monitoring methodology.....	27
5.3 Results.....	28

VI. Monitoring Water Parameters.....	31
6.1 Introduction.....	32
6.2 Methodology.....	35
6.3 Results.....	36
VII. Monitoring Common Indicator 16.....	48
7.1 Introduction.....	49
7.2 IMAP and Common Indicators.....	49
7.3 Monitoring methodology.....	50
7.3.1 Monitoring protocol.....	50
7.3.2 Monitoring in Karaburun-Sazan MPA.....	51
7.4 Results.....	52
7.4.1 Indicator 16. Natural and artificial zones.....	52
7.4.2 Man-made infrastructure.....	54
REFERENCES.....	55

Table of Figures

Figure 1. Zoning in Karaburun-Sazan MPA.....	2
Figure 2. Map of main benthic habitats identified in Vlora Gulf (Maiorano et al., 2011).....	6
Figure 3. <i>Cystoseira amentacea</i> forest in western side of Karaburun Peninsula.....	9
Figure 4. Photos taken during the monitoring of <i>Cystoseira amentacea</i> by Flag Pine and RAPA Vlore staff.	11
Figure 5. Map of the distribution and status of <i>Cystoseira amentacea</i> in Karaburun-Sazan MPA, 2020.....	12
Figure 6. Map of the distribution and status of <i>Cystoseira amentacea</i> in Karaburun-Sazan MPA, 2021.....	13
Figure 7. Map of the distribution and status of <i>Cystoseira amentacea</i> in Karaburun-Sazan MPA, 2022.....	13
Figure 8. Map of the distribution and status of <i>Cystoseira amentacea</i> in Karaburun-Sazan MPA, 2023.....	14
Figure 9. Distribution of <i>Cystoseira amentacea</i> in Eastern side of Karaburun Peninsula.....	15
Figure 10. <i>Posidonia oceanica</i> in Karaburun-Sazan MPA.....	17

Figure 11. Map and photos of the monitoring sites of <i>Posidonia oceanica</i>	19
Figure 12. <i>Posidonia oceanica</i> meadow in Karaburun.....	20
Figura 13. <i>Posidonia oceanica</i> meadow in second study area, Sazan.....	22
Figure 14. <i>Posidonia oceanica</i> meadow in third study area, Radhima.....	24
Figure 15. Photo of the monk seal taken in the vicinity of Karaburun-Sazan MPA Visitor Center in Radhima.....	26
Figure 16. First photo of the monk seal <i>Monachus monachus</i> captured with camera traps...28	28
Figure 17a.b.c. Photos of the monk seal <i>Monachus monachus</i> captured with camera traps..29	29
Figure 18. Locations of sightings of the <i>Monachus monachus</i> in Karaburun-Sazan MPA and Vlorë Bay, 2023.....	30
Figure 19. Monitoring of water quality in Karaburun-Sazan MPA.....	31
Figure 20. Map of monitoring sites in Marine National Park of “Karaburun-Sazan” and its surrounding. P2, P3, P5, P6, P7, P8, P9 are located within “Karaburun-Sazan” MNP. P12, P12.a are located within “Vjose-Narte” Protected Landscape. In red the core zone, in yellow, recreational zone, in green traditional use and sustainable development zone.	34
Figure 21. Technical detail for the HANNA multi-parameter probe. The key parameters measured are pH, ORP, Conductivity, Dissolved Oxygen, Temperature.....	35
Figure 22. Photos from on the field data collection.....	35
Figure 23. Man-made structure in the harbor of Sazan Island.....	48
Figure 24. Indicator 16 in Karaburun-Sazan MPA for the year 2007, 2015, 2022.....	53
Figure 25. Photos of man-made structures inside the 100m area.....	54
Figure 26. Map showing the distribution of all man-made structures inside the monitoring area.....	55
Figure 27. Changes in the infrastructure of the beaches of Karaburun-Sazan MPA from 2007 (left) to 2022 (right).....	56
Figure 28. Changes in the infrastructure in the coastal area of the western border.....	57
Figure 29. Situation in Sazan Island and the beaches in the western side of Karaburun-Sazan MPA (Shen Andre Bay in the bottom photos).....	57

Tables and Graphs

Table 1. Marine habitats present in Karaburun-Sazan MPA.....	3
Table 2. Activities and their priority level according to the Management Plan of Karaburun-Sazan MPA.....	7
Table 3. Data gathered from the monitoring transects of <i>Cystoseira amentacea</i>	16
Table 4. The monitored values for each polygon in first study area.....	21
Table 5. The monitored values for each polygon in second study area.....	23
Table 6. The monitored values for each polygon in third study area.....	25
Table 7. Data on the monitored sites including site's name and coordinates.....	33
Table 8. Water quality criteria.....	36
Table 9. Recorded data on pH level for the 14 monitored sites.....	37
Table 10. Recorded data on mV[pH] for the 14 monitored sites.....	38
Table 11. Recorded data on D.O. [%] for the 14 monitored sites.....	40
Table 12. Recorded data on D.O. [ppm] for the 14 monitored sites.....	41
Table 13. Recorded data on Temp.[°C]for the 14 monitored sites.....	42
Table 14. Average temperature for every month for all monitoring sites.....	43
Table 15. Recorded data on TDS [ppt] for the 14 monitored sites.....	45
Table 16. Recorded data on EC[μS/cm] for the 14 monitored sites.....	46
Table 17. Recorded data on Sal.[psu].....	47
Table 18. Information regarding artificial coastal area structures in Karaburun-Sazan MPA...52	
Graph 1. Ration of the status of <i>Cystoseira amentacea</i> in Karaburun-Sazan MPA.....	16
Graph 2. First study area. Meadow density chart by polygons, Substrate type – Brijuni. Percent cover of different substrates and live <i>Posidonia oceanica</i>	21
Graph 3. Second study area. Meadow density chart by polygons, Substrate type – Brijuni. Percent cover of different substrates and live <i>Posidonia oceanica</i>	23
Graph 4. Third study area. Meadow density chart by polygons, Substrate type – Brijuni. Percent cover of different substrates and live <i>Posidonia oceanica</i>	25
Graph 5. Graph presentation of the recorded data on pH level.....	38
Graph 6. Graph presentation of the recorded data on mV[pH] level.....	39
Graph 7. Graph presentation of the recorded data on D.O.%.....	40
Graph 8. Graph presentation of the recorded data on D.O.ppm.....	41
Graph 9. Graph presentation of the recorded data on Temp.[°C]for the 14 monitored sites..	42
Graph 10. Graph presentation of the recorded data on EC.....	46
Graph 11. Graph presentation of the recorded data on TDS.....	47
Graph 12. Graph presentation of the recorded data on Sal.[psu].....	47
Graph 13. Surface of the land covered by the man-made structures.....	54

