



***Posidonia oceanica* (Linnaeus) Delile, 1813 meadows of northeast Corfu Island**



Suggested citation:

Naasan Aga Spyridopoulou, R., Gkikas, R., Giovos, I., *Posidonia oceanica* (Linnaeus) Delile, 1813 meadows of northeast Corfu., iSea 2021, Greece, 14pp.

Declaration of conflict of interest:

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this report.

Funded by:



Supported by:



Introduction

CREPOSIDONIA

The project REPOSIDONIA, is one of the main projects, that falls under the scope of the Vulnerable Species pillar of iSea, it is an umbrella project that aims at the protection and the preservation

of the habitat that *P. oceanica* constitutes to the point it fulfils its ecological role in a healthy marine ecosystem. The main focus of REPOSIDONIA is the contribution to management, protection and status improvement of the seabeds covered with *Posidonia oceanica*, as it is an important habitat forming species and provides habitat for many species (Pergent *et al.* 2016). In the context of the project, the grant “*Posidonia oceanica* meadows of northeast Corfu” was given from the Ionian Environment Foundation, to map the *P. oceanica* in the Erimitis peninsula and record the composition of the marine biodiversity in the area.

P. oceanica (Linnaeus) Delile, 1813



Fig.1: *P.oceanica* meadow in Erimitis bay (October, 2021).

Biology

Posidonia oceanica, is a species of seagrass (Magnoliophyta) endemic to the Mediterranean Sea. Also known as Neptune Grass, it is one of the most common species of seagrass in the region, along with *Cymodocea nodosa*, and *Zostera marina* (Traganos *et al.* 2018). The length of its leaves can reach up to 1.2 meters, the density of the meadows up to 10,000 per square meter while it is observed in the infralittoral zone on rocky to sandy bottoms where it can root. In Greece, Neptune Grass is present along the majority of the mainland coasts and the Greek islands. In the Northern Aegean Sea its meadows can extend down to 25 meters, while in the South Aegean Sea to 35 meters, depending on many factors but primarily water clarity. In the Ionian Sea, a highly oligotrophic area, the meadow can reach depths of 45 m depth (Traganos *et al.* 2018).

Importance

The endemic species *Posidonia oceanica* is the most important seagrass in the Mediterranean Sea (Boudouresque *et al.* 2006) in fact along with the Coralligenous habitats is the most important Mediterranean marine ecosystem (Giakoumi *et al.* 2013). The role of *Posidonia oceanica* meadows in marine coastal environments is often correctly compared to that of the forest in terrestrial environments, as they constitute the basis of the richness of coastal waters in the Mediterranean Sea. By producing enormous quantities of vegetal biomass, the meadows form the basis of many food webs (McRoy and McMillan, 1977). This primary production is comparable to or greater than that of other high - production environments, whether terrestrial or oceanic (Fergusson *et al.* 1980). In addition, *P. oceanica* meadows constitute a spawning ground, a nursery or a permanent habitat for a lot of species (over 400 different plant species and several thousand animal species populate the meadows of which many commercially important species; Pergent *et al.* 2016), making these underwater meadows a unique biodiversity hotspot (Boudouresque *et al.* 2012). Furthermore, *P. oceanica* is considered a “ecosystem engineer” as it stabilises the sediment with its roots and changes the hydrodynamic status of the sublittoral zone and protects from erosion (Pergent *et al.*, 2012). Besides, it serves as a purifier as it improves the water quality by reducing particle loads (Hemminga and Duarte, 2000). Moreover, it serves as long-term carbon storage (Pergent *et al.* 2012). Finally, their rhizomes concentrate radioactive, synthetic chemicals and heavy metals, recording the environmental levels of such persistent contaminants. Hence the importance, *Posidonia oceanica* is also used as a ‘biological quality element’ in the long-term monitoring programmes of the Water Framework Directive (WFD 2000/60/EC) as an indicator for assessing the ecological status of coastal water bodies.

Protection status

Posidonia oceanica meadows are a protected habitat in the EU through a variety of Conventions, Directives and Regulations, at union or state level (See Table 1). Under most frameworks, fishing with dynamic gears is prohibited, in order to prevent physical damage to the meadows (Pergent *et al.* 2016). Yet more protection legally binding measures should exist as more than half percent of the threats is associated with other human activities apart from fishing, such as coastal development and the impacts it might induce to these precious ecosystems.

Table 1: Legal Frameworks in the European Union (Pergent *et al.* 2016)

Region	Legal Framework
EU legislation	Habitat Directive (92/43/EEC)
EU legislation	Barcelona Convention, Annex II (2102/2015/EC)
EU legislation	Bern Convention Annex I (Council Decision 98/746/EC)
EU legislation	Fisheries policy regulation: 1967/2006/EC
EU legislation	UNEP-MAP-RAC/SPA 2009 (strictly protected in Mediterranean EU MPAs)

Threats

Although it is a long-living plant with an extended Area of Occupancy (AOO) and Extent of Occurrence (EOO) and hence listed as Least Concern by the latest IUCN assessment (Pergent *et al.* 2016), its extremely slow growth rate makes it highly vulnerable to external disturbances, thus making it very difficult to recover if degraded. In the Mediterranean basin, there has been a decrease in *P. oceanica*, up to 10% in the last 100 years, but recent analysis of its coverage shows an even steeper decrease of 34% of the area covered by it, in the last 50 years (Boudouresque *et al.* 2009). The main threat to these meadows is habitat degradation by human activities, such as: Water pollution, Construction of coastal infrastructure, Modification of marine currents (hydrography), Fishing, Invasive species, and shipping (Fig.2) (Boudouresque *et al.* 2012). In Greece, conservation actions are limited in local projects and in the two Greek MPAs (Zakynthos and North Sporades islands) (Pasqualini *et al.* 2005; Ladakis *et al.* 2003). In Corfu Island, information about the spatial extent of the seagrass meadows is poor with only two areas been model mapped: Between Othonoi island and Mathraki and from Perama to Ag. Ioannis, whereas there is no available information about their health status (EUNIS Marine Habitat Classification, 2019).

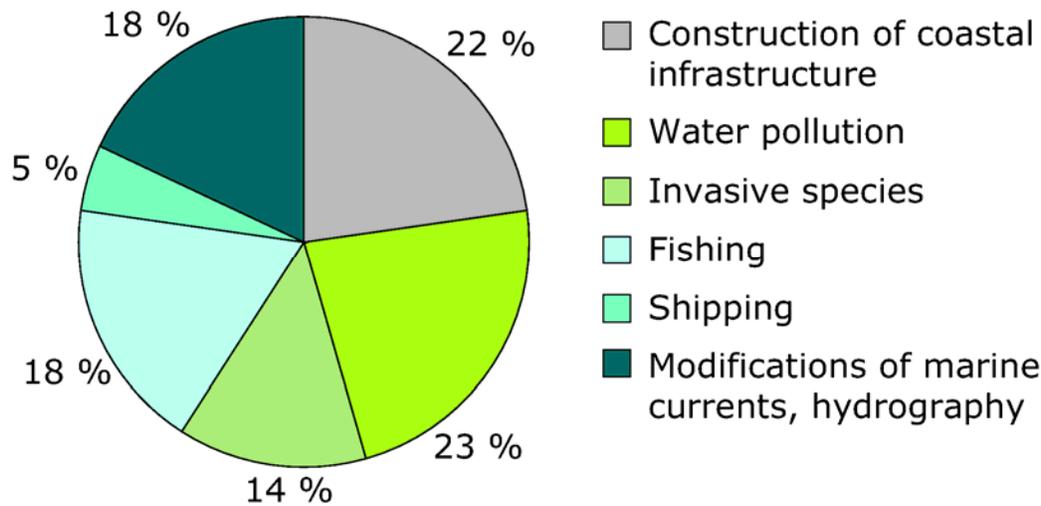


Fig 2: Grouped threats to *Posidonia oceanica* beds as reported by Mediterranean EU Member States under the EU Habitats Directive - eps

Study area

Erimitis peninsula is located in the Straits of Corfu, a narrow body of water between the coasts of Albania and Greece (Northeast Corfu), that separates the two countries. The channel is a passage from the Adriatic Sea on the north to the Ionian Sea. It is worth mentioning that the mainland area across Erimitis shores is the Butrinti National Park, an UNESCO World Heritage Site. According to the Butrinti National Park report in 2010, the *P. oceanica* meadows there cover 374.8 hectares, comprising 3.98% of the area and hosting a variety of fish species and marine megafauna (Zotaj, 2010). The region of Erimitis includes seven beaches that are intact from human disturbances from the land, as the beaches can only be approached by trails or from the sea. The study area in the context of this project has a total surface of 25.4 hectares with a maximum depth of 43 meters and is characterized by an extended rocky shore, with isolated small sandy beaches (Fig. 2). The bottom of the study area is a mixture of rocks, gravel and sand.

Methodology

Posidonia oceanica mapping

In order to develop a methodology specific for the area and inspect the whole extent of the meadow in the study area, two preliminary visits were conducted. In total, five dives were conducted, with two divers swimming along the meadow borders, with a buoy attached and the line stretched in order to always be vertical to the sea surface. The boat was following the buoy and the principal investigator of the team was marking the edges of the meadow by taking points in a Garmin eTrex® 22x GPS, with an accuracy of 3 meters.

The GPS points were then inserted to ArcGIS software and the points were overlaid with bathymetric isobath lines, retrieved from Navionics. The points were then merged to compile a polygon and minor corrections were made. Additional routes were made for mapping patches where *P. oceanica* was absent. GPS coordinates were retrieved for the centre of each patch and their area was measured by the divers. These data were also overlaid with the total range polygon of the meadow borders and were excluded from the total mapped meadows.

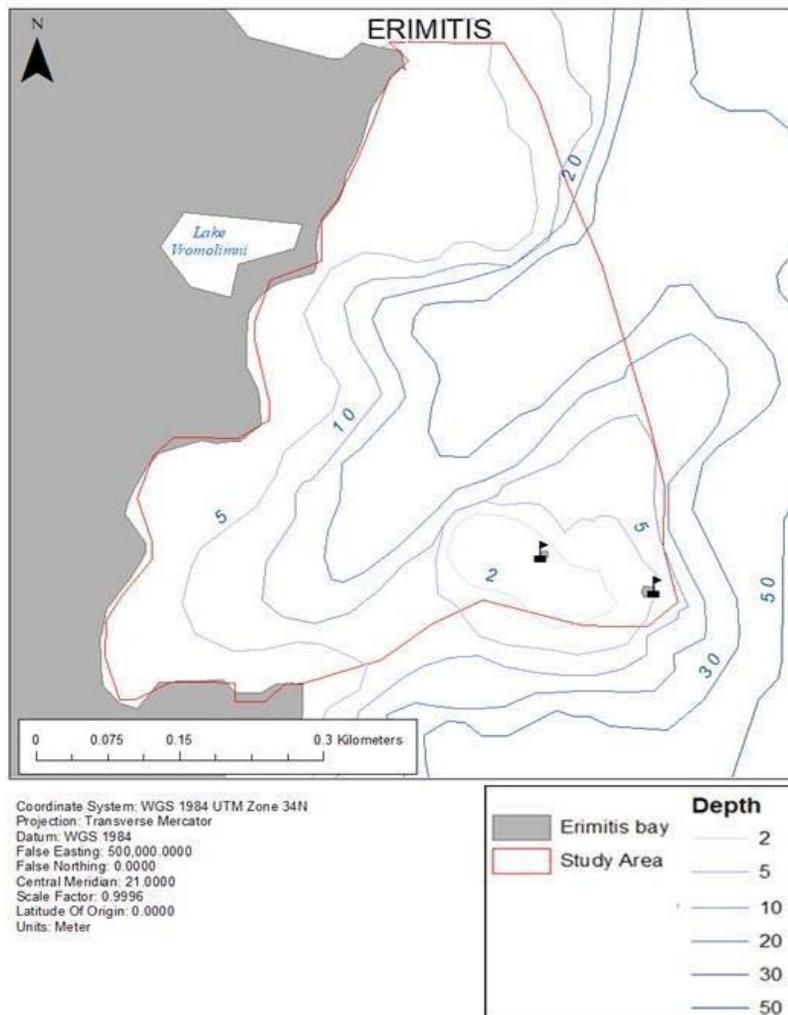


Fig. 3: The study area within the Erimitis Region (red line) with bathymetric isobath lines (in meters)

Biodiversity monitoring

For this work, visual census surveys were conducted with the purpose of creating a marine species list for the study area. A screening of the area was conducted prior to the selection of the transects, and promising sites above, not only, the *P. oceanica* meadow, but also rocky and sandy substrate were

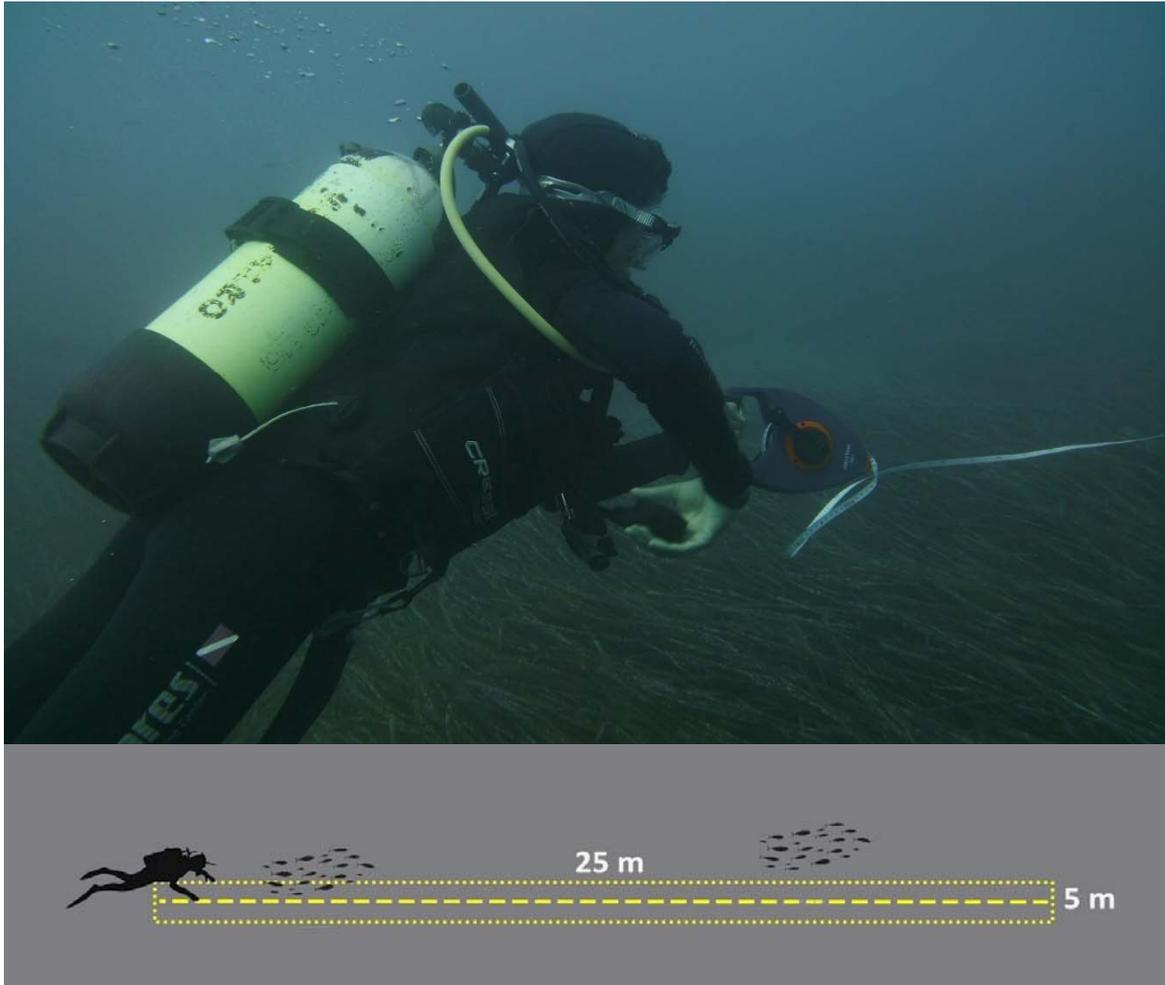


Fig.4: Diver measuring the transect (top). Schematic representation of the methodology used for the biodiversity surveys (bottom)

selected. The dimensions of each transect were 25 x 5 m. Strip transect sampling is widely applied for marine community studies (Samoilys & Carlos, 2000) The divers/researchers were moving along a 25-m diving line, defining the centreline of each strip, and recording all marine species within 2.5 m from the centreline in each direction (Fig.4).

Results

P. oceanica mapping

The total area covered with *P. oceanica* meadows is presented in Fig. 5. The mapping output was a polygon of a total 15.7465 hectares, covering 61.84% of the study area (Fig.3), although it is worth mentioning that the meadows expanded well beyond the northern and southern borders of the study area. The shallowest borders started at 0.2m and the deepest borders reached depths of 42m, in the central part of the study area, albeit most edges reached the 20 meter bathymetric contour, likely due to limited light availability.

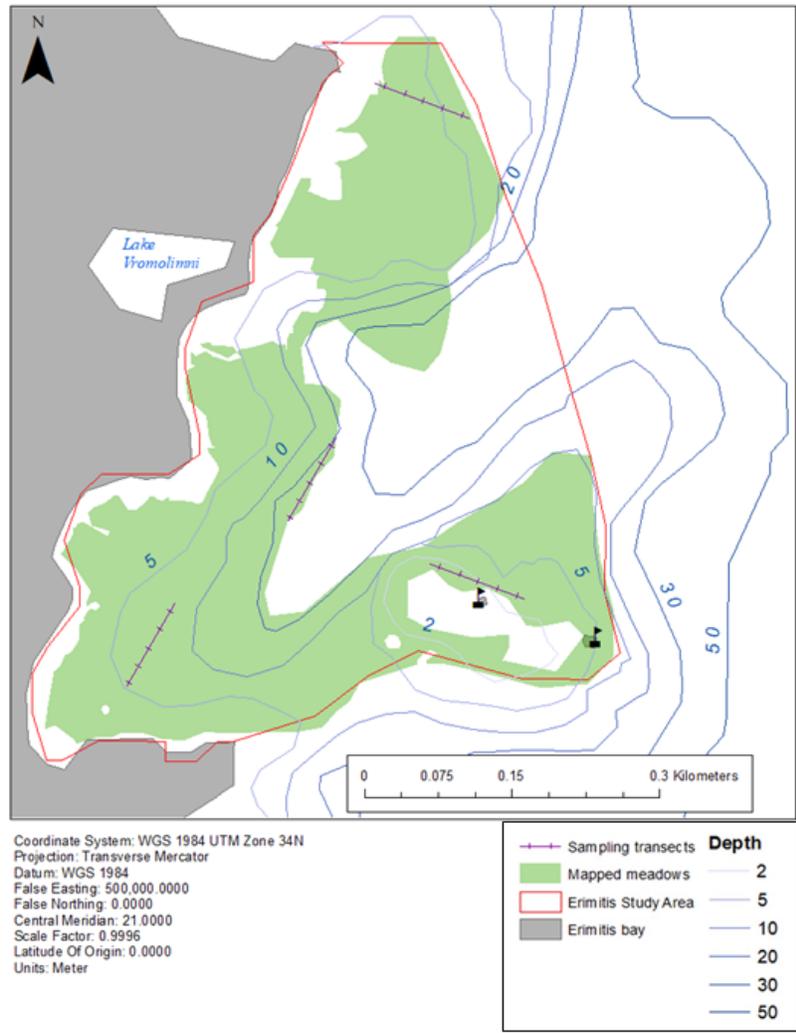


Fig. 5: *Posidonia oceanica* meadows within the study area (green)

As expected, the meadows' upper layer near the lake (Fig. 5) started from greater depths than neighbouring meadows, probably due to the lower salinity levels caused by underground water exchange between the lake and the sea.

The length of the leaves varied from 26 cm (in the upper layer of the meadow) to 70cm (in the deeper layer of the meadow). Both vertical and horizontal rhizomes were observed in all the locations of the

biodiversity surveys, suggesting that the meadows are growing and expanding (Larkum *et al.* 2006). The sediment varied in the study area with the southern part being mostly covered with gravels, until the middle part and up to the lake with mixture of sand and small gravels, while the northern part was covered with bigger gravels and rocks. Inside the meadows three big (~1m²) rocks were recorded disrupting the extensive meadow.

Biodiversity monitoring

The biodiversity surveys resulted in the observation of 82 different species, belonging in 10 different Phylum. More specifically, 43 species of fish (Actinopterygii) were observed, along with 10 species of plants (Chlorophyta and Tracheophyta) and 29 other animal species (Table 2). The species list created was crossed with the list of a previously available survey of the same area, conducted in June 2020 (Papadopoulou, 2020). The final list (presented below) includes 107 species. The Mediterranean Conservation Status of each species was extracted from the IUCN 'Red List of Threatened Species'. The vast majority falls under the Least Concern and Not Evaluated categories. Notable exceptions are: *Serranus cabrilla* (Endangered), *Sciaena umbra* (Vulnerable) and *Epinephelus marginatus* (Near Threatened).

Table 2: The list of the species observed during the biodiversity monitoring, sorted by Phylum. The asterisk (*) indicates data obtained from the survey of E. Papadopoulou in 2020.

Number of species	Species observed	Mediterranean Conservation Status by the IUCN
	Chlorophyta	
1	<i>Codium fragile</i>	NE
2	<i>Codium bursa</i>	NE
3	<i>Colpomenia sinuosa</i>	NE
4	<i>Cystoceira spp.</i>	NE
5	<i>Dasya corymbifera</i>	NE
6	<i>Jania rubens</i>	NE
7	<i>Liagora viscida</i>	NE
8	<i>Lithophyllum incrustans</i>	NE
	Tracheophyta	
9	<i>Cymodocea nodosa</i>	LC
10	<i>Posidonia oceanica</i>	LC
	Bryozoa	
11	<i>Electra posidoniae*</i>	NE
12	<i>Reptadeonella violacea*</i>	NE
	Porifera	
13	<i>Hemycale columella</i>	NE
14	<i>Crambe crambe</i>	NE
15	<i>Aplysina Aerophoba</i>	NE



16	<i>Oscarella lobularis</i>	NE
17	<i>Petrosia ficiformis</i>	NE
18	<i>Chondrosia reniformis</i>	NE
19	<i>Ircinia spinosula</i>	NE
20	<i>Ircinia spp.</i>	NE
21	<i>Chondrilla nucula*</i>	NE
22	<i>Cliona rickardus*</i>	NE
23	<i>Cliona schmidtii*</i>	NE
24	<i>Cliona viridis*</i>	NE
25	<i>Ircinia variabilis*</i>	NE
26	<i>Sarcotragus spinulosus*</i>	NE
27	<i>Spirastrella cunctatrix*</i>	NE
	Cnidaria	
28	<i>Actinia equina</i>	NE
29	<i>Anemonia viridis</i>	LC
30	<i>Thecocalanus sp.</i>	NE
31	<i>Balanophyllia europaea*</i>	LC
	Annelida	
32	<i>Hermodice carunculata</i>	NE
33	<i>Spirorbis spirorbis</i>	NE
34	<i>Protula intestinum</i>	NE
35	<i>Protula tubularia*</i>	NE
36	<i>Sabella spallanzanii*</i>	NE
37	<i>Serpula vermicularis*</i>	NE
	Arthropoda	
38	<i>Balanus perforatus*</i>	NE
39	<i>Maja crispata*</i>	NE
40	<i>Pachygrapsus marmoratus*</i>	NE
	Echinodermata	
41	<i>Ophioderma longicauda</i>	NE
42	<i>Paracentrotus lividus</i>	NE
43	<i>Sphaerechinus granularis</i>	NE
44	<i>Holothuria forskali</i>	LC
45	<i>Echinaster sepositus</i>	NE
46	<i>Ophidiaster ophidianus</i>	NE
47	<i>Coscinasterias tenuispina</i>	NE
48	<i>Arbacia lixula*</i>	NE
	Mollusca	
49	<i>Lepidochitona cinerea</i>	NE
50	<i>Callochiton laevis</i>	NE



51	<i>Diadora spp.</i>	NE
52	<i>Patella vulgata</i>	NE
53	<i>Haliotis tuberculata</i>	NE
54	<i>Octopus vulgaris</i>	LC
55	<i>Spondylus gaederopus*</i>	NE
56	<i>Osilinus turbinatus*</i>	NE
57	<i>Hexaplex trunculus*</i>	NE
	Chordota	
	Tunicata	
58	<i>Halocynthia papillosa</i>	NE
	Actinopterygii	
59	<i>Conger conger</i>	LC
60	<i>Muraena helena</i>	LC
61	<i>Synodus saurus</i>	LC
62	<i>Belone belone</i>	LC
63	<i>Atherina boyeri</i>	LC
64	<i>Scorpaena scrofa</i>	LC
65	<i>Dactylopterus volitans</i>	LC
66	<i>Dicentrarchus labrax</i>	LC
67	<i>Anthias anthias</i>	LC
68	<i>Epinephelus marginatus</i>	NT
69	<i>Epinephelus costae</i>	LC
70	<i>Serranus cabrilla</i>	EN
71	<i>Serranus scriba</i>	DD
72	<i>Seriola dumerili</i>	LC
73	<i>Apogon imberbis</i>	LC
74	<i>Trachinotus ovatus</i>	LC
75	<i>Mullus surmuletus</i>	LC
76	<i>Sarpa salpa</i>	LC
77	<i>Oblada melanura</i>	LC
78	<i>Boops boops</i>	LC
79	<i>Diplodus annularis</i>	LC
80	<i>Diplodus puntazzo</i>	LC
81	<i>Diplodus vulgaris</i>	LC
82	<i>Diplodus sargus</i>	LC
83	<i>Spicara maena</i>	LC
84	<i>Chromis chromis</i>	LC
85	<i>Mugil cephalus</i>	LC
86	<i>Chelon labrosus</i>	LC
87	<i>Labrus turdus</i>	LC
88	<i>Labrus bimaculatus</i>	LC

89	<i>Labrus merula</i>	LC
90	<i>Sparisoma cretense</i>	LC
91	<i>Symphodus ocellatus</i>	LC
92	<i>Symphodus mediterraneus</i>	LC
93	<i>Symphodus tinca</i>	LC
94	<i>Symphodus rostratus</i>	LC
95	<i>Symphodus roissali</i>	LC
96	<i>Thalassoma pavo</i>	LC
97	<i>Coris julis</i>	LC
98	<i>Uranoscopus scaber</i>	LC
99	<i>Tripterygion tripteronotus</i>	LC
100	<i>Parablennius gattorugine</i>	LC
101	<i>Parablennius zvonimiri</i>	LC
102	<i>Gobius luteus</i>	LC
103	<i>Lithognathus mormyrus*</i>	LC
104	<i>Sciaena umbra*</i>	VU
105	<i>Scorpaena notata*</i>	LC
106	<i>Symphodus melanocercus*</i>	LC
107	<i>Tripterygion melanurus*</i>	LC

Discussion

Although, pristine environments do not exist today especially in coastal areas due to anthropogenic pressures (Montefalcone *et al.* 2019), the study area was almost intact by anthropization. During the 5-day fieldwork, (2 days preliminary visit in May and 3 days of surveying in October 2021) only the following activities were recorded in the area:

- 1) Fishing with set gill nets and spearfishing,
- 2) Recreational activities (swimming and hiking),
- 3) Sailing boats and speed boats

Other than the above the area was intact with a completely natural scenery. Meadows are known to be affected by several disturbances as mentioned in the introduction of this study, yet the case was different for the study area. Species competition was high and the surveys yielded most of the species associated with *P. oceanica* meadows. It is worth mentioning that no alien species were observed, unlike most parts of the Greek seas, adding to the assumption that the meadow is healthy and intact. The meadow was in a very good condition with little to no fragmented meadows in the most of its area of extend. The upper limit of the meadow was extremely close to shoreline starting from 0.2m depth, in which case is an indication of good health (Montefalcone *et al.* 2010). Although seagrass meadows may be naturally fragmented by waves, currents and colonization processes into patches of different size and form (Pace *et al.* 2017), the monitored meadow seemed compact with only 4 patches without *P. oceanica* in the southern bay of the study area. Furthermore, the density of the leaves was high, throughout most of the meadow.

To sum up, the study area mostly consists of a healthy and undisturbed meadow, hosting a high number of different species. Since *P.oceanica* meadows are characterized as one of the most productive ecosystems in the Mediterranean, it becomes apparent that the protection of Erimitis bay and the management of its threats and disturbances should be highly prioritized. Last but not least, more research is needed in order to assess the situation of the broader and mostly understudied area, since the meadows expand well beyond the location of Erimitis bay.

Bibliography

- Boudouresque, C.F., Bernard, G., Pergent, G., Shili, A. and Verlaque, M. 2009. Regression of Mediterranean Seagrasses caused by natural processes and anthropogenic disturbances and stress: a critical review. *Botanica Marina*, 52: 395-418.
- Boudouresque, C.F., Bernard, G., Bonhomme, P., Charbonnel E., Diviacco, G., Meinesz, A., Pergent, G., Pergent-Martini, C., Ruitton, S. and Tunesi, L. 2012. Protection and conservation of *Posidonia oceanica* meadow. *Ramoge publication*: 1-202.
- Boudouresque, C. F., Mayot, N., & Pergent, G. 2006. The outstanding traits of the functioning of the *Posidonia oceanica* seagrass ecosystem. *Biol Mar Medit*, 13(4), 109-113.
- EUNIS habitat classification 2007 (Revised descriptions 2012) d
Davies, C.E, Moss D. & O Hill, M (2004). EUNIS habitat classification revised 2004. Report to EEA, ETC/BD
Evans, D & contributors (2016). Revising the marine section of the EUNIS Habitat classification - Report of a workshop held at the European Topic Centre on Biological Diversity, 12 & 13 May 2016
- Janssen, J & co-authors & contributors (2016). European Red List of habitats - Part 1. Marine habitats
- Fergusson, R.L., Thayer, G.W., Ricet, R. 1980. Marine primary producers. Functional adaptations of marine organisms. *Academic Press*: 9-69.
- Giakoumi, S., Sini, M., Gerovasileiou, V., Mazor, T., Beher, J., Possingham, H.P., Abdulla, A., Cinar, M.E., Dendrinou, P., Gucu, A.C. and Karamanlidis, A.A., 2013. Ecoregion-based conservation planning in the Mediterranean: dealing with large-scale heterogeneity. *PloS one*, 8(10), p.e76449.
- Hemminga, M.A. and Duarte, C.M., 2000. *Seagrass ecology*. Cambridge University Press.
- Ladakis, M., Skoullou, M., Dassenakis, M. 2003. Water quality in a Mediterranean marine protected area (North Sporades Islands, Greece). *Chemistry and Ecology*, 19(1): 47-57.
- Larkum, A. W., Orth, R. J., & Duarte, C. M. (2006). Seagrasses: biology, ecology and conservation. *Phycologia*, 45(5), 5.
- McRoy C.P., McMillan C., 1977. Production ecology and physiology of seagrasses. *Seagrass ecosystem a scientific perspective*: 53-87.
- Montefalcone, M., Parravicini, V., Vacchi, M., Albertelli, G., Ferrari, M., Morri, C. and Bianchi, C.N., 2010. Human influence on seagrass habitat fragmentation in NW Mediterranean Sea. *Estuarine, Coastal and Shelf Science*, 86(2), pp.292-298.
- Montefalcone, M., Vacchi, M., Archetti, R., Ardizzone, G., Astruch, P., Bianchi, C. N., ... & Ferrari, M. (2019). Geospatial modelling and map analysis allowed measuring regression of the upper limit of *Posidonia oceanica* seagrass meadows under human pressure. *Estuarine, Coastal and Shelf Science*, 217, 148-157.
- Pace, M., Borg, J.A., Galdies, C. and Malhotra, A., 2017. Influence of wave climate on architecture and landscape characteristics of *Posidonia oceanica* meadows. *Marine Ecology*, 38(1), p.e12387.



- Pasqualini, V., Pergent-Martini, C., Pergent, G., Agreil, M., Skoufas, G., Sourbes, L. and Tsirika, A., 2005. Use of SPOT 5 for mapping seagrasses: An application to *Posidonia oceanica*. *Remote sensing of environment*, 94(1): 39-45.
- Pergent, G., Bazairi, H., Bianchi, C.N., Boudouresque, C.F., Buia, M.C., Clabaut, P., Harmelin-Vivien, M., Mateo, M.A., Montefalcone, M., Morri, C., Orfanidis, S., Pergent-Martini, C., Semroud, R., Serrano, O. and Verlaque, M. (eds). 2012. Mediterranean Seagrass Meadows: Resilience and Contribution to Climate Change Mitigation. A Short Summary / Les herbiers de Magnoliophytes marines de Méditerranée: resilience et contribution à l'atténuation des changements climatiques, *Résumé*: 40.
- Pergent, G., Gerakaris, V., Sghaier, Y.R., Zakhama-Sraier, R., Fernández Torquemada, Y., Pergent-Martini, C. 2016. *Posidonia oceanica* (errata version published in 2018). *The IUCN Red List of Threatened Species 2016*: e.T153534A135156882.
- Samoilys, M.A., Carlos, G. 2000. Determining Methods of Underwater Visual Census for Estimating the Abundance of Coral Reef Fishes. *Environmental Biology of Fishes* 57, 289–304.
- Traganos, D., Aggarwal, B., Poursanidis, D., Topouzelis, K., Chrysoulakis, N., Reinartz P. 2018. Towards global-scale seagrass mapping and monitoring using Sentinel-2 on Google Earth Engine: The case study of the aegean and ionian seas, 10(8):1227.
- Zotaj, A. 2010. Butrint National Park Management Plan. *The Albanian Society for the Protection of Birds and Mammals*
- Παπαδοπούλου, Ε., 2020. Το θαλασσιο περιβαλλον του Ερημιτη και μια καταστροφικη λιμενικη εγκατασταση.



+30 231 309 0696



info@isea.com.gr
www.isea.com.gr



Kritis 12 | 54645
Thessaloniki | Greece

