

Protecting Northeast Lemnos habitats

Final Progress Report

iSea, January 2024



ENVIRONMENTAL ORGANISATION FOR THE PRESERVATION OF THE AQUATIC ECOSYSTEMS

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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.

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Baseline information

In 2022, iSea selected Northeast Lemnos for Posidonia mapping, including all the coastal regions from the northeast cape to the southeast cape up to 40 km offshore, as well as the Natura 2000 site "[Limnos: Chortarolimni - Limni Alyki kai Thalassia periochi \(GR4110001\)](#)". The reason for pinpointing Northeast Lemnos was that it hosts the largest cohesive meadow of *Posidonia oceanica* in the Aegean Sea (Topouzelis et al., 2018) extending further than the limits of the Natura 2000 site of the region (Topouzelis et al., 2018; Traganos et al., 2018; iSea, 2022). In 2022, iSea with the support of Blue Marine Foundation produced the most detailed available mapping of the meadow in Northeast Lemnos summing to a total of 83.7 km². Among the other actions conducted, iSea documented the local ichthyofaunal biomass and abundance using visual census surveys. The preliminary results on the biodiversity, abundance and biomass of the local ichthyofauna, apart from being higher than in all areas examined that year, showed the importance of such an extensive habitat for the biodiversity of the area and natural resources. Furthermore, iSea documented several protected species including *Aplysina aerophoba*, *Axinella* spp. and *Cladocora caespitosa*.

During the surveys, iSea documented minimal pressures visually, however, there could be areas other than the ones visited considering the extended distribution of the seagrass meadow, while the health of the meadows was assessed as "good state" for most sampling locations. Regarding the blue carbon that is currently stored in the meadow's rhizomes, preliminary estimates show that this is more than 270,000 tons (Naasan Aga Spyridoulou et al., 2023).

Finally, the local community, mostly comprised of land workers and fishers, are rather sensitised towards the natural environment and were keen in actively participating in the two informative events, where the importance of the Posidonia meadows as well as other important habitats, such as the sand dunes and the lagoons, was discussed.

Overall, Northeast Lemnos is an area where engaging in research and community based actions should be prioritised, if the target is to set the roadmap for a Marine Protected Area (MPA) extending the limits of the Natura 2000 site, enhance the protection of marine ecosystems and finally promote ecosystem-based development. Improving our understanding on this vital ecosystem and consequently on the array of ecosystem services it provides will help advocate for its importance leading to protection and improved management. Furthermore, understanding the value of the carbon stock stored, will in turn, raise awareness on the matter and increase the support and participation of the local community, which should be the ultimate target for such projects based in rural locations.



Activities' progress report

A.1. Estimate fish biomass and species habitat affiliation using fisheries dependent data

A.1.1 Conduct seasonal onboard samplings with fishing vessels operating within the region of Northeast Lemnos.

The protocol for this action was finalised in collaboration with University of Patras and the onboard surveys were organised in collaboration with the president of the fishers' association in the area. Regarding the methodology of monitoring, it was decided that trammel nets were the most ideal gear to use for monitoring diversity, biomass and abundance as it represents the least selective gear compared to gillnets and longlines. The below results represent preliminary data, as there are still two remaining on board samplings to be completed. These were not completed as initially planned due to bad weather conditions at the survey location, and thus are postponed for early 2024. As agreed with BMF, the final results and complete analysis will be presented in 2nd of the project.

iSea team visited Northeast Lemnos in September from 31st of August to 3rd of September and in October from the 4th to the 14th of October to conduct the Autumn samplings aiming to collect information on species living in the three different habitats of the area, namely: Posidonia meadows (1120), Maerl and Rocky reefs (1170) using fisheries dependent data.

A total of 12 fishing operations were monitored 10 were carried out on Posidonia meadows, 1 was carried out on Maerl and 2 above the Rocky substrata. The observer recorded morphometric data for all the caught fish fauna. A total of 413 individuals were measured from 31 different species; 328 were caught above Posidonia, 46 above Maerl and 39 above the rocky reef. Figures 1-3 present the species composition of each habitat in detail.

Red mullets (*Mullus surmuletus*) and Annular Sea bream (*Diplodus annularis*) were the most abundant species on the Posidonia meadow, comprising 52% (N=168) and 21% (N=69) of the total fish caught, respectively. On Maerl, the most abundant species was the Comber (*Serranus cabrilla*) comprising 39% (N=18) and the Red Porgy (*Pagrus pagrus*) 24% (N=11). On the Rocky substrata, St Pierre (*Zeus faber*) comprised 23% (N=9) along with the Mediterranean parrotfish (*Sparisoma cretense*) accordingly.



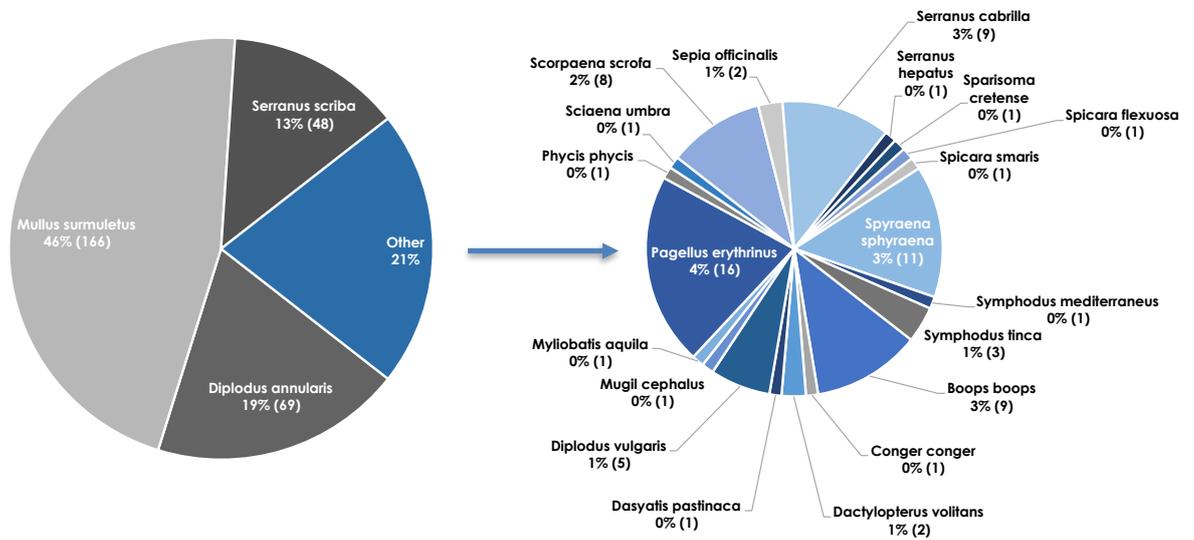


Figure 1. Species composition on the Posidonia meadow expressed in abundance, autumn sampling.

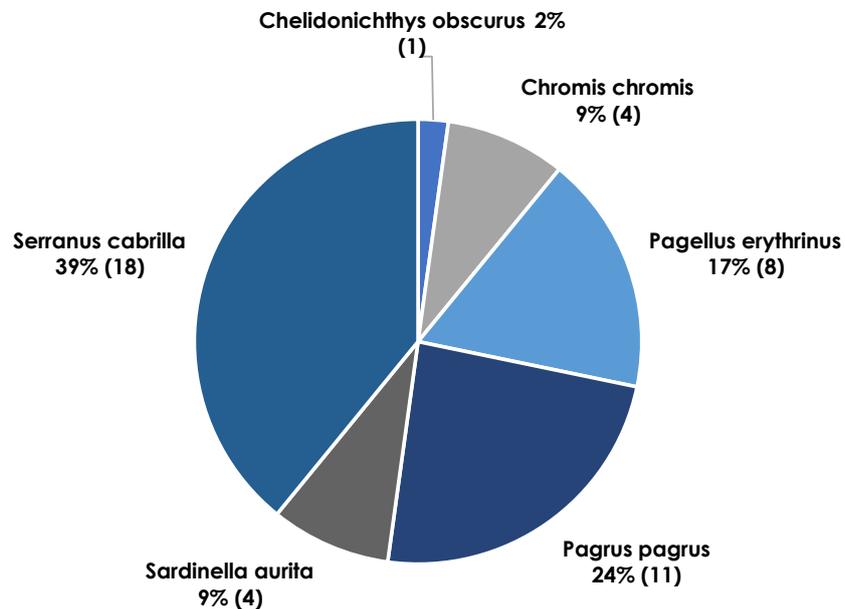


Figure 2. Species composition on Maerl expressed in abundance, autumn sampling.



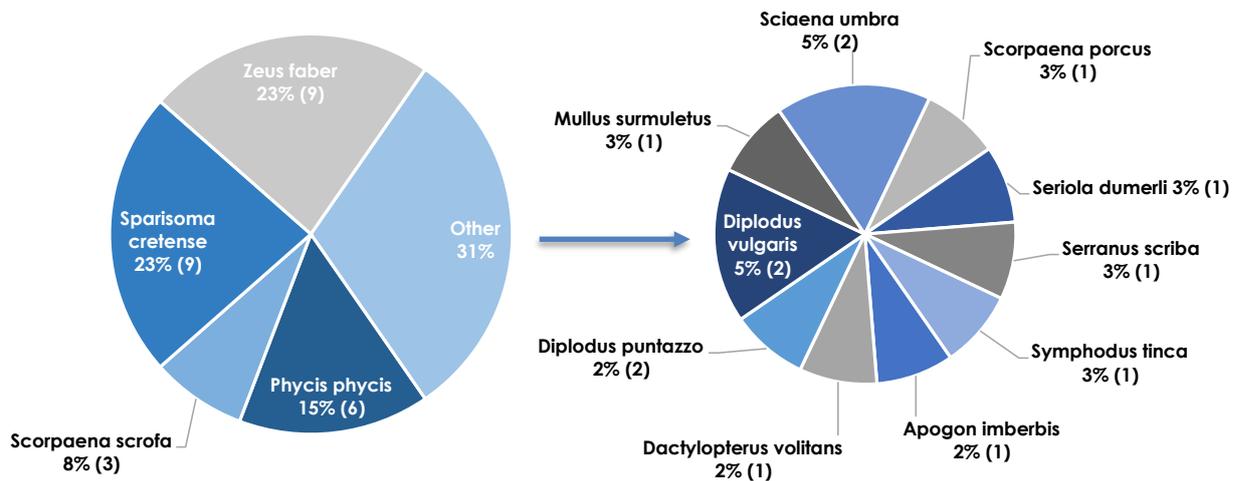
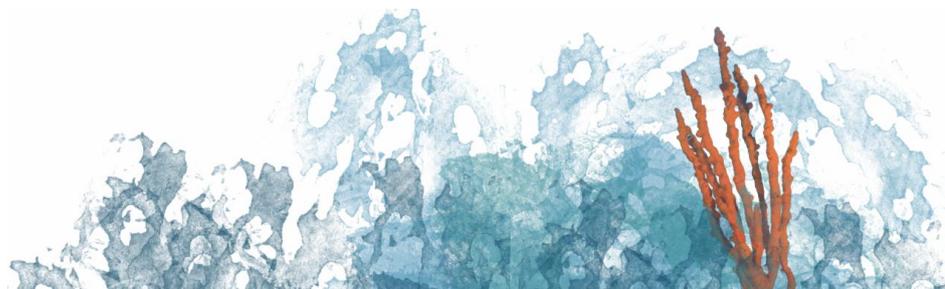


Figure 3. Species composition on the rocky reef expressed in abundance, autumn sampling.

Furthermore, the species composition on the different habitats was also expressed in biomass (Figures 4-6). The total biomass surveyed for all three habitats was 47kg specifically 33kg on Posidonia, 10kg on Rocky Reefs and 4tkg on Mearl. In terms of biomass on Posidonia meadows, European barracuda (*Sphyraena sphyraena*) held the highest percentage of the composition with 31% followed by Red mullet (*Mullus surmuletus*) with 24% and Common Eagle ray (*Myliobatis aquila*) with 9% (Figure 4). For Maerl the highest biomass was from Red Porgy (*Pagrus pagrus*) with 36% and Common pandora (*Pagellus erythrinus*) with 35% followed by the Comber (*Serranus cabrilla*) with 19% (Figure 5). For Rocky Reef the highest biomass was from Mediterranean parrotfish (*Sparisoma cretense*) with 27%, followed by the Forkbeard (*Phycis phycis*) with 21%, and Red Scorpionfish (*Scorpaena scrofa*) with 19% (Figure 6).



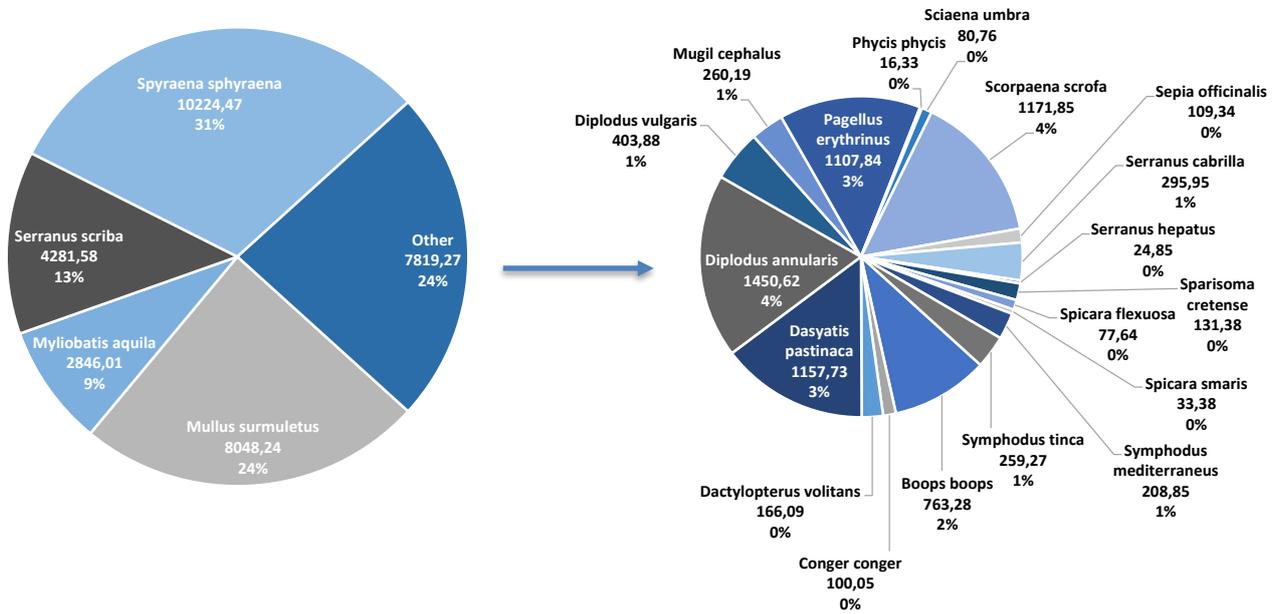


Figure 4. Species composition on the Posidonia meadows expressed in biomass (gr), autumn sampling.



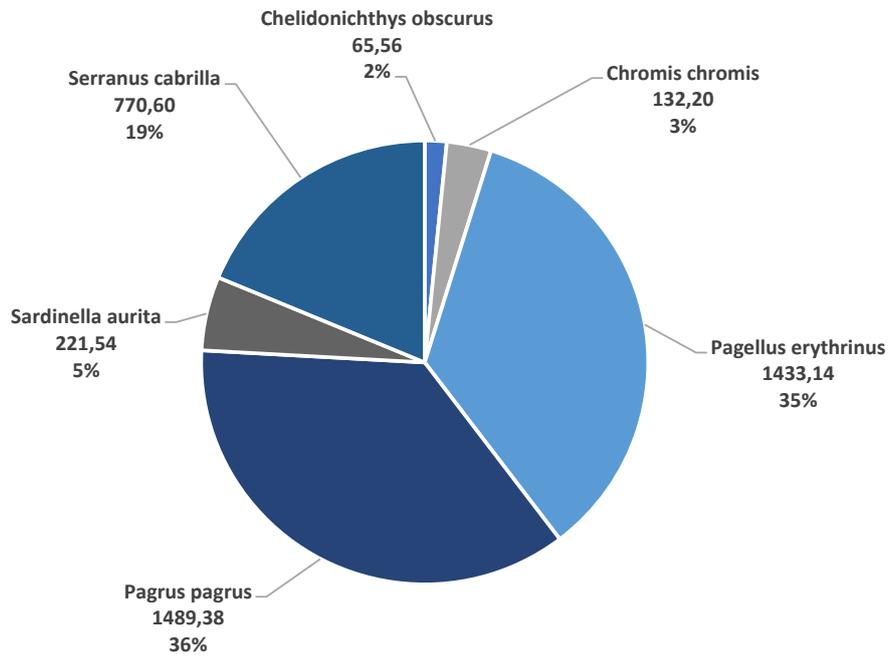


Figure 5. Species composition in Mearl habitat expressed in biomass (gr), autumn sampling.

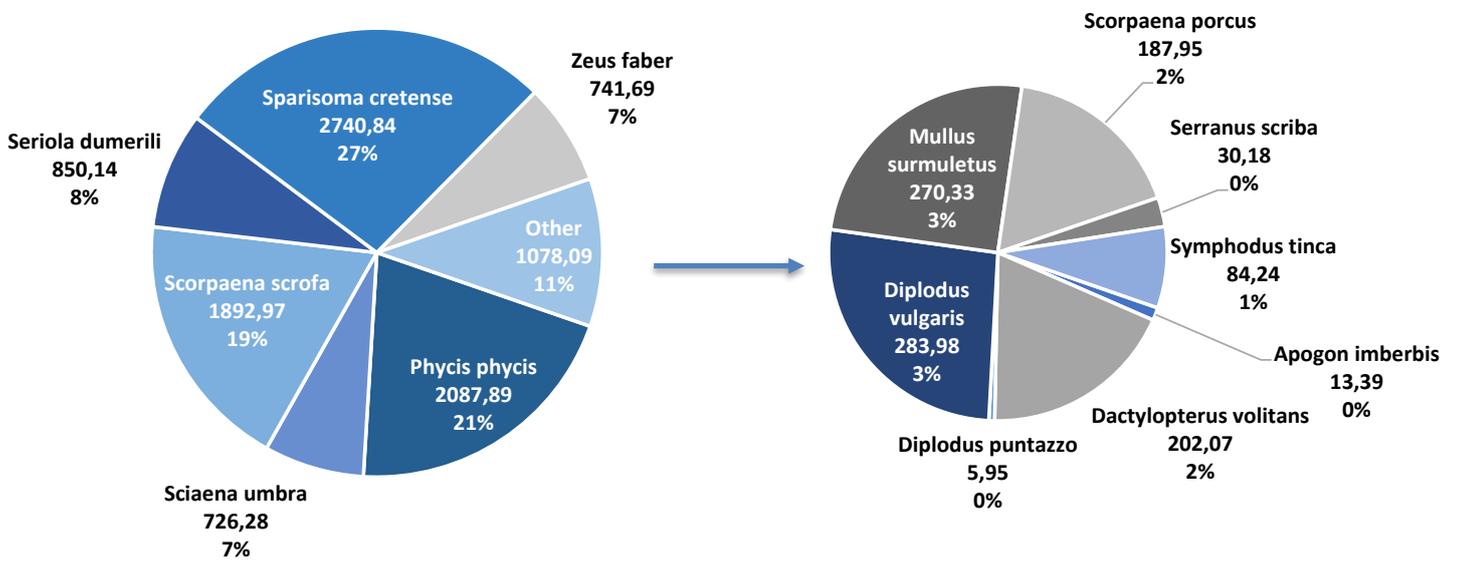
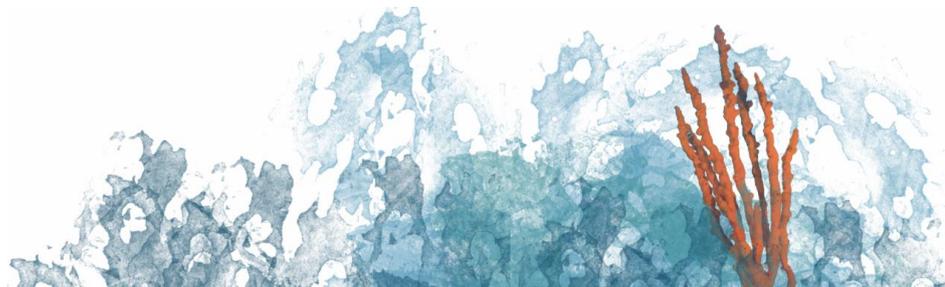


Figure 6. Species composition in rocky reef habitat expressed in biomass (gr), autumn sampling.





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The aforementioned are descriptive and probably influenced by seasonality. iSea will revisit Northeast Lemnos to conduct the winter samplings. The analysis will include the size distribution and maturity overview per habitat. An overview of the preliminary results, including catch per unit effort (CPUE) estimates between the three different habitat types can be seen in Appendix 1 and Appendix 2. These are not discussed in the present report as no conclusions can be drawn until a representative number of surveys have been completed over all three different habitats.

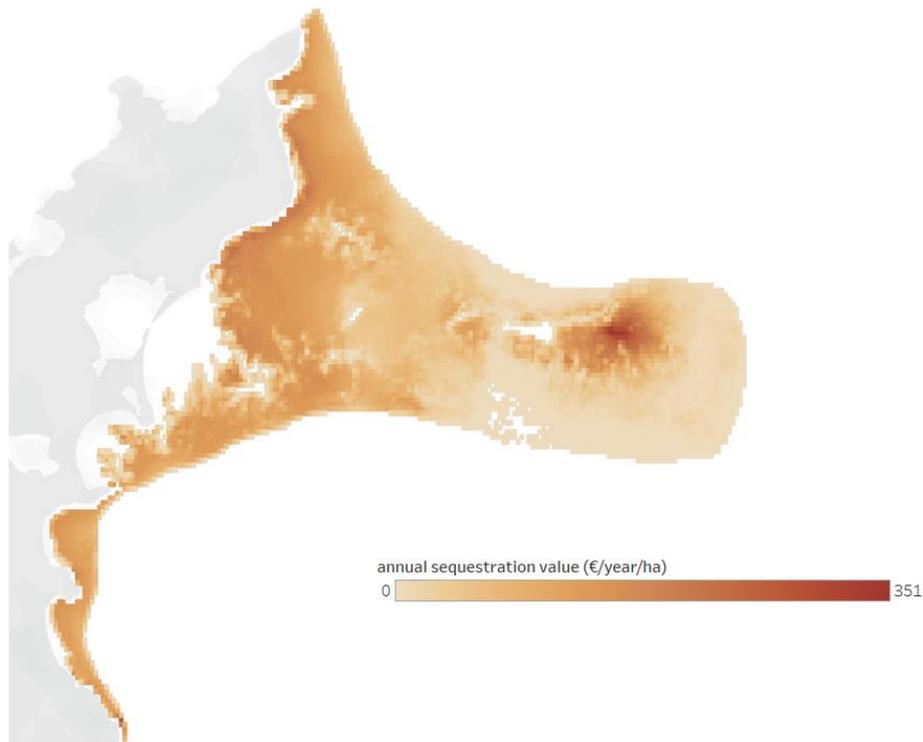
A.2. Evaluation of ecosystem services of the Natura 2000 site of Northeast Lemnos Island

A.2.1 Economic evaluation of blue carbon of the meadow hosted in the Natura 2000 site.

For the economic evaluation of the blue carbon of Northeast Lemnos, iSea teamed up with the School of Spatial Planning and Development of the Aristotle University of Thessaloniki, and the deliverable was undertaken by Dr. Dionysis Latinopoulos. The preliminary carbon data obtained from the area during the REPOSIDONIA project in 2022 acted as a basis to estimate the value of carbon sequestered every year as well as the value when maintaining the ecosystem in its current state based on the carbon stock. Apart from this, during the October visit in Lemnos, the team decided to collect additional corers from different sites than the ones visited in 2022, to improve study estimates as advised by BMF's Blue Carbon team. The combined data provide a better picture of the blue carbon stored in the Posidonia meadow of the area. A sensitivity analysis was also conducted, and the potential benefits of a blue carbon project investment based on conservation activities was explored. The detailed methodology can be found in Annex 3.

Figure 8 shows the spatially explicit estimates of the economic value of annual sequestration within the Natura 2000 site of NE Lemnos Island. The values depicted span from 0€/year/ha to 351€/year/ha, with a mean value of 71.32€/year/ha. The total annual estimate for the entire Natura site is calculated to be **1,089,129€**.



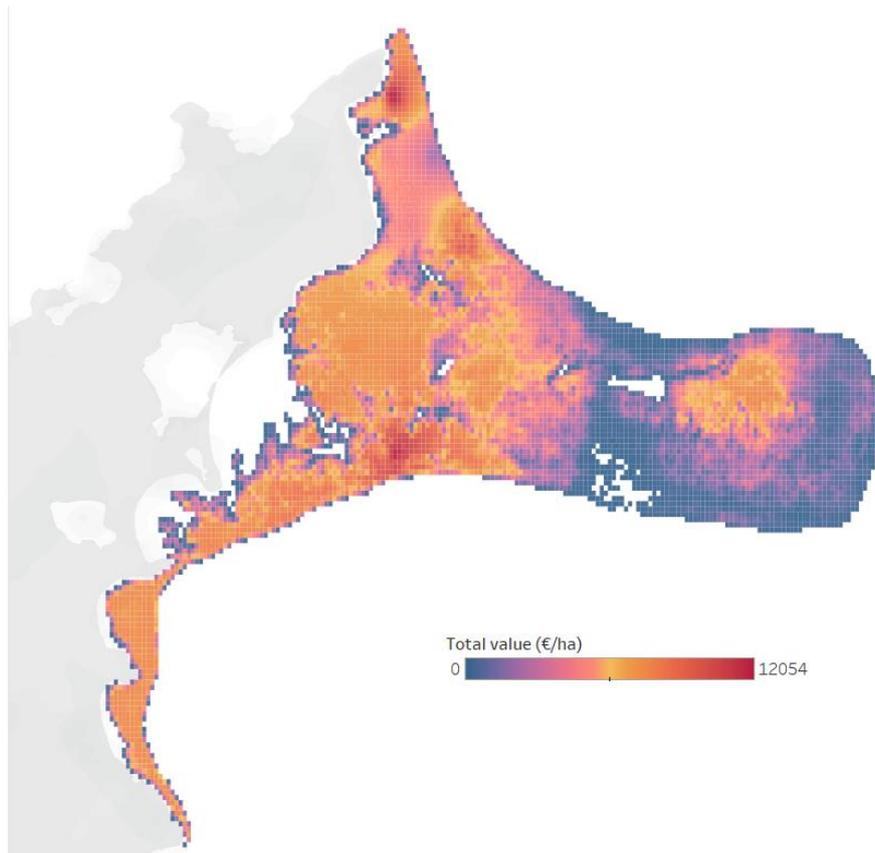


		min	max	mean	median	SD	sum
Annual sequestration (€/ha/year)	carbon value	0.0	351.0	71.32	60.00	58.63	1,089,129

Figure 8. Spatial representation of the annual sequestration value

Figure 9 illustrates the carbon stock values, representing the value of maintaining the ecosystem in its current state (for each grid cell). These values range from 0€ to 12,054€/ha, with a mean value of **4,179€/ha**. The total value estimate for the entire Natura site is computed to be **62,731,800€**.





	min	max	mean	median	std_dev	sum
Value of blue carbon per hectare (€/ha)	0	12,054	4,107.9	4,287.6	2,841.1	62,731,800

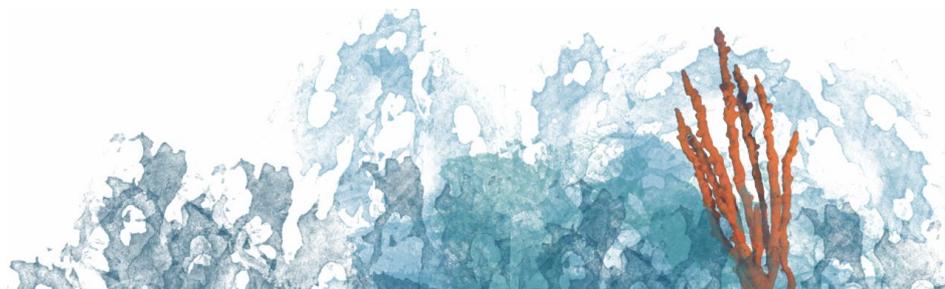
Figure 9. Spatial representation of the (blue) carbon stock value

Then, a sensitivity analysis was executed for different scenarios based on three hypothetical scenarios, as no factual data regarding measurable threats exist. Although this work is preliminary, we believe that is a very good basis and the first estimate for economic value of ES of *P.oceanica* in Greece. Within the next year, we aim to minimize uncertainty through additional core sampling. For this reason, during this fieldwork we collected additional samples after consulting with BMF's blue carbon team.

A.3. Posidonia meadows related research

A.3.1 Defining the deep limit of the meadow in Northeastern Lemnos and its typology.

During the fieldtrip in Northeast Lemnos in October, the team of iSea used a remotely operated vehicle (ROV) to define the deep limit of the Posidonia meadow in the area



and its typology. However, due to issues that occurred with the operation of the ROV; it became non-functional due to strong currents. As the area of the meadow is large, the deep limit was observed around the edges of the meadow at **18 points** by filming around the given points and defining the typology from screenshots of the videos and noting the succeeding habitats around the meadows (see Table 1, Figure 11, Figure 12). Maerl habitat was observed at depth of 54m but it is not included in the map (40.06917N, 25.45063E). The deep limit value obtained ranged from **27-33m** of depth with a 'Progressive typology' in observed cases indicating a high health status, as the meadow is growing towards deeper areas suggesting increased seagrass vitality and/or improvement of environmental conditions. Given this, the depth appears to be limited by natural conditions (e.g. hydrodynamic activity or geomorphology) instead of human disturbance. In 2024, iSea aims to collect more deep limit estimates around the area during the planned field visits for the fauna data collection. This is to collect better estimates that can be used for further analysis, as the meadows extent currently estimated with satellite images has been capped by depth (a known limitation of this type of approach) therefore these deep limits will aid in estimating the true extent of the deepest parts of the meadow.

Table 1. Overview of deep limits of the meadow in Northeastern Lemnos.

Site/ID	Y coordinates	X coordinates	Succeeding habitat	Depth (m)	Typology
1	39,89577	25,42813	Sand	31	Progressive
2	39,82294	25,36867	Caulerpa racemosa & Rock	27	Progressive
3	39,89537	25,42825	Sand	30,5	Progressive
4	39,90626	25,60171	Rocky reef	25,9	Progressive
5	39,90144	25,60548	Rocky reef	34,5	Progressive
6	39,90774	25,57712	Rocky reef	27	Progressive





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7	39,91108	25,53941	Sand	27	Progressive
8	40,03812	25,46552	Sand/Silt	33	Progressive
9	40,04536	25,45631	Sand/Silt	31,7	Progressive
10	40,04527	25,45435	Sand/Silt	31	Progressive
11	39,98723	25,4887	Caulerpa racemosa & Rock	27	Progressive
12	39,89415	25,61499	Sand	33	Progressive
13	40,04074	25,44641	Rocky reef	18	Progressive
14	39,95608	25,52858	Sand	23,7	Progressive
15	40,04466	25,45318	Hard substrate	30	Progressive
16	39,99379	25,47861	Caulerpa racemosa & Rock	27	Progressive
17	39,98774	25,48251	Caulerpa racemosa & Rock	27	Progressive
18	39,97974	25,48554	Caulerpa racemosa & Rock	24,5	Progressive

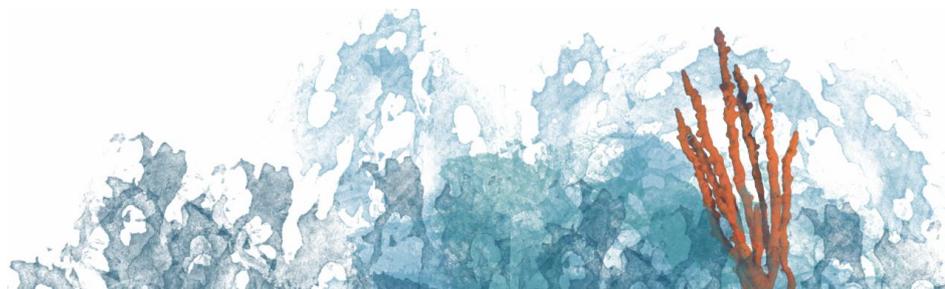




Figure 11. Images collected during the determination of the deep limit in Northeast Lemnos.



Fig 12: Deep limit points (measured in m) of the meadow and the habitats observed around the meadows.



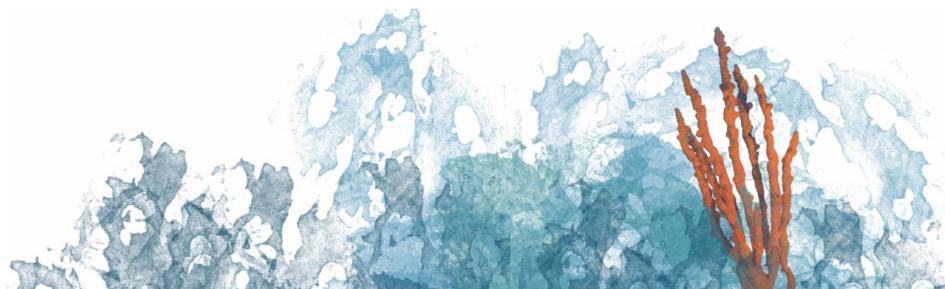
A.3.2 Collecting more information on the meadows' health applying specific indices in all sampling stations.

To avoid any restrictions regarding the implementation of this action, iSea obtained a research permit from the Ministry of Environment (Prot. No: ΥΠΕΝ/ΔΠΔ/44129/2657; ΑΔΑ: 97Μ54653Π8-Γ8Ρ) and the Forestry Directorate of Lesvos (Prot. No: ΥΠΕΝ/ΔΔΔ/44129/2657; ΑΔΑ: 97Μ54653Π8-Γ8Ρ) for the Natura2000 of interest to work on *Posidonia oceanica*. Finally, the Forestry Department of Lemnos and the Ephorate of Underwater Antiquities of Lesvos were informed on the dates of fieldwork and the types of activities conducted.



Figure 13. Sites where the health of the *Posidonia* meadow were assessed, following approach of Gerakaris (2017).

There were 4 sampling sites selected for the current project comprised of 3 sites in the Natura2000 site, and 1 outside of the protected area (Figure 13) following the methodology of Gerakaris (2017) to ensure comparability of results. What is particularly significant about the specific sites chosen (Figure 7) is that the meadow's conservation status has already been assessed by researchers, but the data used for their work were collected during 2013-2015 for the WFD and Natura2000 site inclusion



(Gerakaris, 2017). A total of 4 stations were sampled in 6 dives, in 15m of depth in the predefined sampling stations. In each sampling station 4 transects of 25m were performed noting the coverage of *Posidonia oceanica* to the nearest cm. From each station a total of 5, 40x40cm quadrats were used for counting the shoot density, plagiotropic rhizomes, leaf length, shoot burial and other remarks were noted. Finally, 4 orthotropic shoots were collected from each quadrat (N=80), to further examine the phenological features of the leaves, grazing signs and photosynthetic aera.

All 4 stations were assessed as "High conservation status" when considering the CI index, whereas when looking at the BiPo index, station 1 was assessed with a "High ecological status" while the other three with a "Good ecological status" status (Table 2).

Table 2: Defining the conservation status of *P. oceanica* in Northeast Lemnos using the Conservation Index (CI) and BiPo Index.

Station	CI	EQR Class	BiPo	EQR Class
1	1	High conservation status	0.83	High ecological status
2	1	High conservation status	0.75	Good ecological status
3	0.98	High conservation status	0.76	Good ecological status
4	1	High conservation status	0.72	Good ecological status

The BiPo results from previous estimates at the same points by Gerakaris (2017) were as follows: Station 1=0.857 (High), Station 2 =0.857(High), Station 3= 0.873(High). Data from station 4 are not publicly shared and so no comparison can be made. Comparing our results with the ones derived by Gerakaris (2017) show that stations 2 and 3 have a different EQR class, these were assessed as 'Good' while for the previous estimates they were assessed as 'High' meaning that the status of the meadows are in a lower health state compared to ten years ago.

The metric values of *P. oceanica* recorded during the fieldwork were summarized and the mean values for each station are subsequently presented in Table 3 bellow. The foliar surface (cm²) was estimated to be the highest on sampling station 1 with a value of 459.64 cm², whereas the lowest was in sampling station 2 with a value of 298.83 cm². Since the photosynthetic leaf surface of the meadow is related to the foliar surface, station 1 had the value of 408.41 cm², whereas station 2, a value of 254.97 cm², which is almost half of the station 1 value. The significance of grazing signs in the area is negligible, with 2.24% being the highest value, while on sampling stations 2 and 3 there was a complete absence of grazing signs. Coefficient A states the percentage of a leaf that lost its apex. Regarding this metric, sampling station 2 with 21.21% had the lowest value and thus was the station where *P. oceanica* had the most cut ends. Plagiotropic shoots were approximately the same throughout the surveyed area with



sampling station 1 showing a disparity of almost 14%. Due to the time of sampling, meadows were found to be in a very good state with an almost total absence of matte morte. Epiphytes were abundant throughout the site and were present almost on every leaf apart from the juveniles.

Table 3: Metrics observed and estimated for *P. oceanica* in the Northeastern waters of Lemnos.

Sampling station	Foliar surface (cm ²)	SD of Foliar surface (cm ²)	Grazing signs (%)	Photosynthetic leaf surface (cm ²)	SD of Photosynthetic leaf surface (cm ²)	Coefficient A (%)	Plagiotropic (%)	Matte morte (%)	Rhizome Stripping/ Burial (cm)
1	459.63	153.38	0.02	408.41	142.24	17.02%	1.32%	0.00%	4.52
2	298.83	148.64	0.00	254.97	128.75	21.21%	16.72%	0.00%	4.97
3	358.17	177.79	0.00	316.45	162.91	18.52%	15.13%	2.00%	5.47
4	345.27	138.62	0.02	311.09	129.85	16.42%	13.41%	0.00%	3.3

The results of the metrics agree with the estimated ecological status, indicating station 1 has the highest on ecological and conservation status. There is a need of further research and monitoring in order to reach a more comprehensive conclusion. Furthermore, as only a small number of deep limits were observed in this study.

A.3.3 Communication of the project in social media, iSea's website, etc.

A page dedicated to the project has been developed on iSea's website in order to communicate its objectives and outcomes to our network. The webpage is available in both [English](#) and [Greek](#), reaching out to a wide audience expanding beyond national borders. In addition, two posts on the organisation's social media accounts has been made, presenting our work for this year in Northeast Lemnos.

More systematic communication of the project will be conducted during the following months in 2024 where the results of the current work will be reported.

A.4. Coordination of the project

A.4.1 Monitoring the project actions, ensuring high-quality deliverables, and reporting.

Two project managers have been assigned to the project, who are closely monitoring its actions to ensure their timely implementation, while a broader team is also involved in some of the activities (e.g., diving, financial reporting). No declinations from the original timeline of the project have occurred up to the month delivering this report (October 2023), excluding the onboard samplings during summer which could not take place due to the late signature of the proposal and the unstable weather





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resulting in missing the seasonal sampling of summer. This sampling can be implemented by iSea during 2024, after the funder's agreement.

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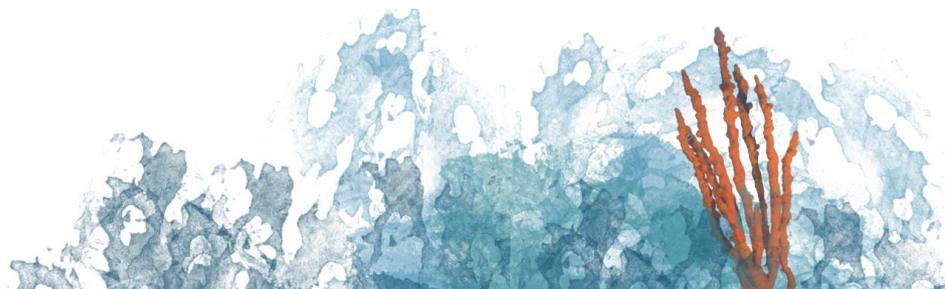
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APPENDICES

Appendix 1. Preliminary results of fish fauna sampling data in the three different habitats in northeast Lemnos.

Species & Habitat	Range of Total Length	Mean Total Length	Abundance (number of individuals)	Mean Biomass (g)
Maerl				
<i>Chelidonichthys obscurus</i>	19	19	1	66
<i>Chromis chromis</i>	13-15	14	4	33
<i>Pagellus erythrinus</i>	19-27	24	8	179
<i>Pagrus pagrus</i>	14-28	20	11	135
<i>Sardinella aurita</i>	3-24	16	4	55
<i>Serranus cabrilla</i>	5-18	15	18	43
Posidonia				
<i>Boops boops</i>	19-22	20	9	85
<i>Conger conger</i>	43	43	1	100
<i>Dactylopterus volitans</i>	14-24	19	2	83
<i>Dasyatis pastinaca</i>	55	55	1	1158
<i>Diplodus annularis</i>	9-14	11	69	21
<i>Diplodus vulgaris</i>	13-23	16	5	81
<i>Mugil cephalus</i>	36	36	1	260
<i>Mullus surmuletus</i>	7-29	15	166	48
<i>Myliobatis aquila</i>	92	92	1	2846
<i>Pagellus erythrinus</i>	13-24	17	16	69
<i>Phycis phycis</i>	13	13	1	16
<i>Sciaena umbra</i>	20	20	1	81



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<i>Scorpaena scrofa</i>	20-27	18	8	146
<i>Sepia officinalis</i>	7	7	2	55
<i>Serranus cabrilla</i>	11-18	14	9	33
<i>Serranus hepatus</i>	14	14	1	25
<i>Serranus scriba</i>	10-25	18	48	89
<i>Sparisoma cretense</i>	22	22	1	131
<i>Spicara flexuosa</i>	19	19	1	78
<i>Spicara smaris</i>	15	15	1	33
<i>Spyraena sphyraena</i>	15-81	63	11	929
<i>Symphodus mediterraneus</i>	26	26	1	209
<i>Symphodus tinca</i>	15-23	19	3	86
Rocky reef				
<i>Apogon imberbis</i>	10	10	1	13
<i>Dactylopterus volitans</i>	28	28	1	202
<i>Diplodus puntazzo</i>	15	15	1	6
<i>Diplodus vulgaris</i>	18-24	21	2	142
<i>Mullus surmuletus</i>	28	28	1	270
<i>Phycis phycis</i>	24-42	31	6	348
<i>Sciaena umbra</i>	26-35	30	2	363
<i>Scorpaena porcus</i>	23	23	1	188
<i>Scorpaena scrofa</i>	23-42	29	3	631
<i>Seriola dumerili</i>	37	37	1	850
<i>Serranus scriba</i>	14	14	1	30
<i>Sparisoma cretense</i>	19-33	28	9	305
<i>Symphodus tinca</i>	19	19	1	84
<i>Zeus faber</i>	15-20	18	9	82



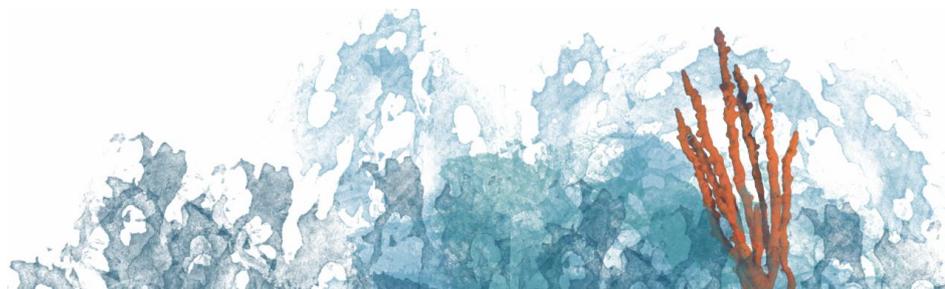
Appendix 2. Preliminary data of fish fauna catch per unit effort (CPUE).



Figure a: Map showing the location of the on-board fish fauna surveys along with the mean estimated catch per unit effort (CPUE) measured in kg per hour, for the three different habitats (Maerl, Rocky reefs and Posidonia meadows).

Appendix 3. Detailed Methodology of blue carbon stock value estimation.

The aim of this action was to estimate the economic value of blue carbon in the Natura 2000 site of Northeast Lemnos Island. *Figure b* below provides an overview of the developed methodology designed for assessing the blue carbon value within the study area. As shown in *Figure b*, two different paths were followed to obtain two





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different values: (1) the value of carbon sequestered every year, and (2) the value of maintaining the ecosystem in its current state based on the carbon stock. In both paths, the methodology involves the following steps: (a) leveraging the mapping results from the REPOSIDONIA project, specifically the delineation of the *Posidonia oceanica* meadow in the northeastern region of Limnos, conducted at a spatial resolution of 3 meters with an accuracy of 86%, (b) transforming the meadow map into a grid map aiming to estimate the spatial distribution coverage of the *Posidonia oceanica* ecosystem (following this method, the meadow cover estimates were found very close to the estimates of Gerakaris et al (2021)). Within this context, the Grid creation, Intersection, and Percentage Coverage tools in QGIS were applied.

Next, the first pathway aims to estimate the economic value of the annual carbon sequestration from the *P.oceanica* meadow. To determine the annual mean carbon sequestration of the meadow, the methodology outlined by Pergent-Martini et al. (2021) was adopted. This involved the utilization of their established function that correlate carbon sequestration (g C.m⁻²) with water depths, as evidenced in the case of Corsica Island.

Recognizing the inherent correlation between depth and (shoot) density impacting sequestration capacity, we refined this function based on the sampling points within the study area. The meadow depth and density data, as obtained (in 2022) from 19 frames across 7 sampling stations in the study area were used. This correction accounted for a minor adjustment of approximately 8%, addressing overestimated density values compared to those reported by Pergent-Martini et al. (2021). Consequently, employing this refined approach enabled us to estimate/approximate the annual carbon sequestration for the entire meadow area by means of Eq.1:

$$\text{Annual sequestration curve: } y=1.08*(-40.5\ln(\text{depth})+145.5) \quad (1)$$

Due to limited bathymetric data quality, we relied on EMODNET data, recognized as the most reliable source, for the area's bathymetry information (to estimate the depth in Eq.1). Based on this procedure, the annual carbon sequestration (rate) per grid cell was estimated. To transform these estimates to carbon sequestration values we used the EU-ETS carbon prices. Specifically, we utilized the average CO₂ value within the European Trading System from January 2020 to October 2023, which stands at 60.04€ per metric ton of CO₂ (as sourced from <https://www.sendeco2.com/es/precios-co2>). This (EU-ETS) price is considered as an average price/value, falling between the lower prices observed in the voluntary carbon market and the higher estimates of the social cost of carbon (SCC) (Zechter et al., 2017). By adopting this approach, we were able to estimate the spatial variability of the economic value associated with annual carbon sequestration, along with calculating the total economic value of carbon sequestration per year.



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As already mentioned, the second pathway seeks to approximate the value of preserving the ecosystem in its current state based on the carbon stock. The overall blue carbon potential within the meadow was determined by analyzing the total organic carbon (TOC) estimates derived from 17 core samples collected in August 2022. In order to create a continuous "surface" from the 17 sampling points (i.e. to estimate the per hectare total organic carbon in each grid cell), the Inverse Distance Weighting (IDW) interpolation method was used (in QGIS). Subsequently, the average 2020-2023 EU-ETS carbon price of €60.04/tCO₂ was once again applied to convert the TOC estimates into spatially varying carbon stock values. By multiplying these estimates to the total area of the meadow allows for the calculation of the total value of carbon stock within the Natura 2000 site area.

It is important to recognize that the results presented here are subject to a certain degree of uncertainty stemming from various factors such as: (a) the method used to interpolate total organic carbon estimates, (b) the adoption of the sequestration function derived from Pergent-Martini et al. (2021), and (c) reliance on an average value/price derived from the EU-ETS mechanism. Furthermore, it should be mentioned that the potential benefits of a blue carbon project investment (based on conservation activities) should not only consider the present state of the ecosystem but also explore future scenarios for carbon stocks. This exploration should consider current and future trends in carbon stock variations, under specific management practices (i.e. conservation actions) aimed at mitigating human-induced pressures. It is also worth noting that according to Gerakaris et al. (2021), no significant decline in the *P.oceanica* meadow was observed in study site. Therefore, the benefits of conservation activities should be modest enough to align with the current good quality status of the study area.

In this context, the sensitivity analysis will consider three different hypothetical scenarios (given the absence of current trend estimates), aimed at averting 5%, 10% and 20% loss/degradation of the ecosystemic service (carbon pool/sequestration), up to the year 2050 (through management actions). Beyond these scenarios, the sensitivity analysis also explored: (a) different discount rates (in a range for 1% up to 3%) and (b) different prices (values) of blue carbon, ranging from 30€/tCO₂ (a reasonable current price in the voluntary market of blue carbon) to 105€/tCO₂, which represents an acceptable estimate of the Social Cost of Carbon in 2050 (Montero-Hidalgo et al., 2023). It's important to note that these scenarios rely on average estimates and do not account for spatial variability, as there is currently no indication of the most vulnerable areas in NE Lemnos Island.

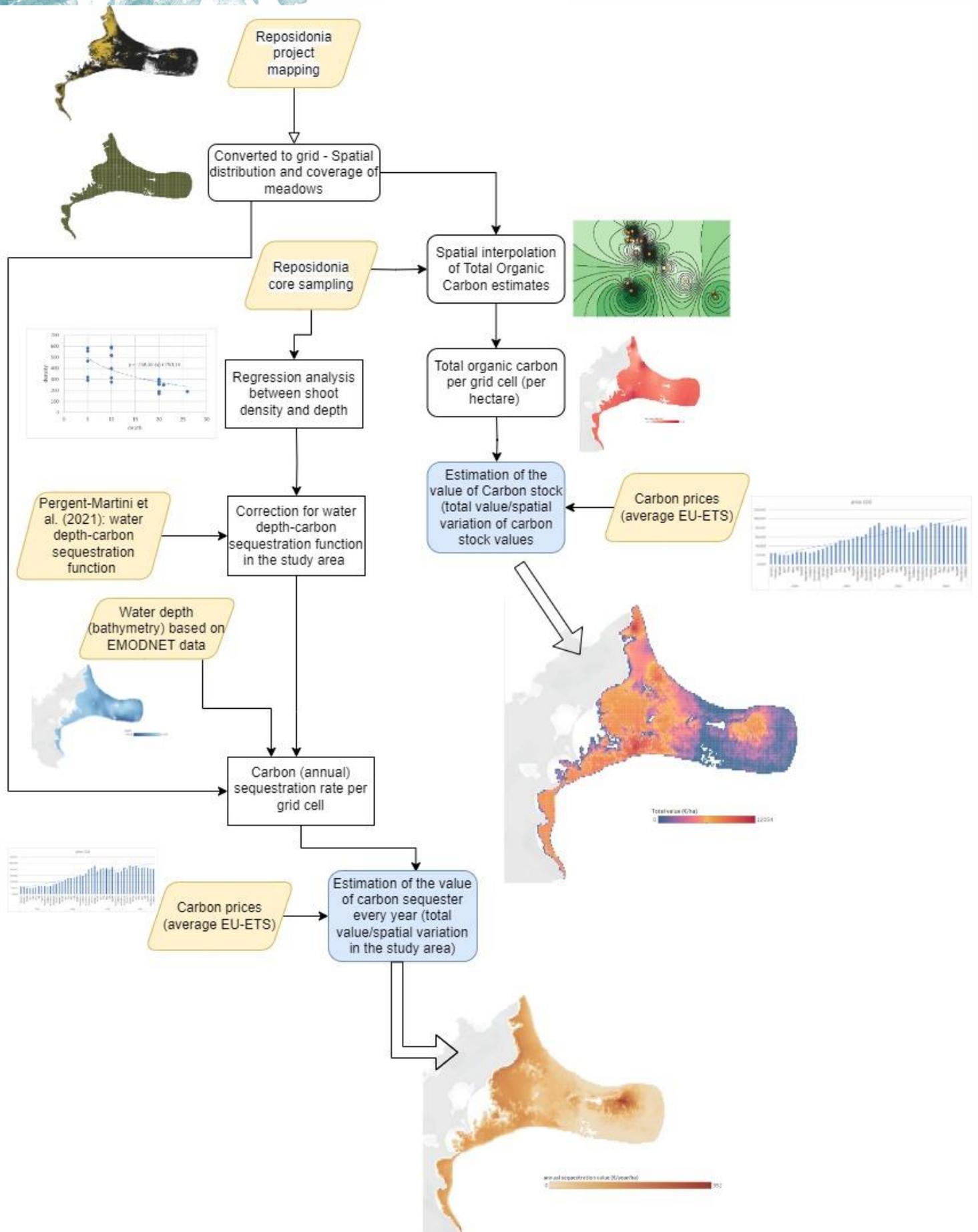
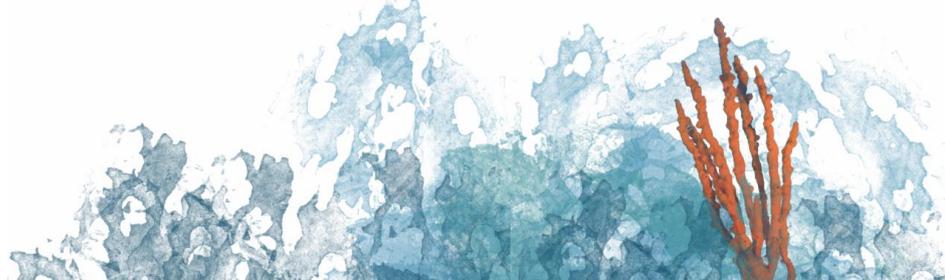
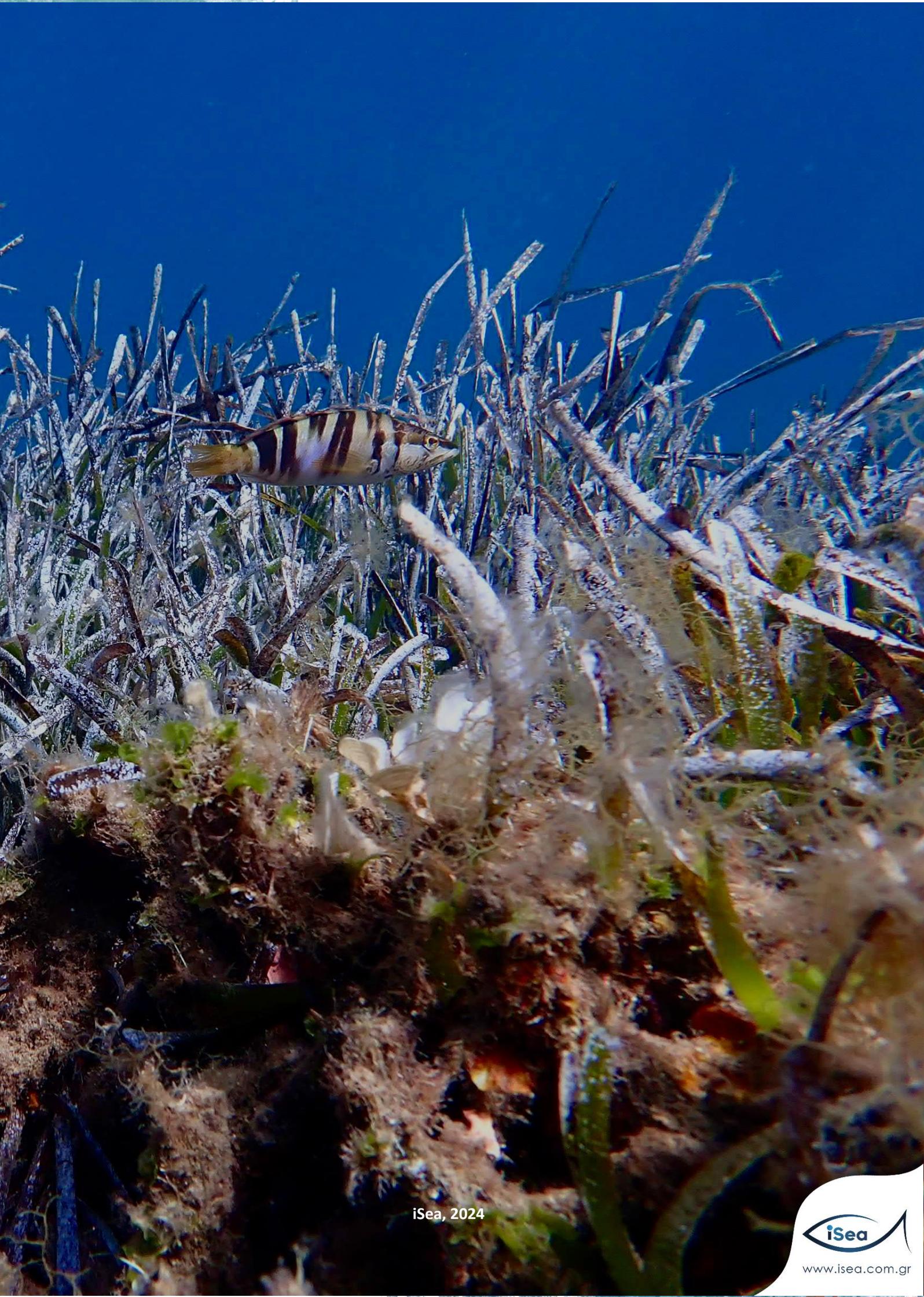


Figure a. Flowchart of evaluating the blue carbon of *P. oceanica* in the NE Limnos





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