Interreg NEXT Black Sea Basin

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Establishing and Operating an Innovative Marine Technology Transfer Network for Enhancing the Transition to a Sustainable Blue Economy in the Black Sea Basin

Assess benthic habitats health in relation to environmental conditions and human impacts

8/2026

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1. Introduction

Effective management of coastal ecosystems requires a reliable assessment of their ecological status. Over the past decades, studies have demonstrated that the analysis of marine ecosystems provides a robust means of detecting the extent of anthropogenic pressures on the environment (Crowe et al., 2000). This principle was adopted by the European Union in the Water Framework Directive (2000/60/EC), which recognized ecosystems as key indicators of the ecological condition of water bodies. The Directive establishes a framework that includes water body typology, reference conditions, and the classification of ecological status classes, based on measurable indicators of all relevant quality elements. In coastal waters, these elements specifically include phytobenthos, zoobenthos, and phytoplankton (EC, 2000).

Marine macroalgae and angiosperms serve as reliable bioindicators for assessing the ecological condition of coastal and transitional waters. In the North Aegean Sea, extensive meadows of key seagrass species, such as Posidonia oceanica and Cymodocea nodosa, provide essential habitats that support nearshore benthic ecosystems. These meadows play central roles in maintaining biodiversity, stabilizing sediments, and enhancing water quality. Given the environmental pressures acting on coastal zones, evaluating the current condition of these habitats and monitoring their spatial changes across multiple North Aegean locations is a priority for effective marine ecosystem management in Greece.

For the Greek pilot site, surveys and habitat-health assessments will be conducted using the NEMOSENS micro-AUV provided by RTsys. This platform will enable high-resolution mapping of seagrass distribution, canopy condition, and benthic vegetation patterns. Quantification of coverage ratios for key benthic flora species will be integrated with in situ measurements of shoot morphology, density, and biomass, following a harmonized protocol shared across partners in Greece, Bulgaria, Romania, and Turkey.

To interpret the status and trends of benthic habitats in relation to natural drivers and human pressures, a suite of environmental and ecological indices will be applied. Quantitative metrics derived from EfxINNOs field data, including species abundance, distribution, richness, diversity, and density, will be computed along the transects surveyed by the NEMOSENS micro-AUV. Indices such as the Shannon-Wiener diversity index, evenness, species richness, and the Simpson concentration index will be used to characterize community structure and detect spatial or temporal shifts in benthic assemblages.

The ecological quality status for this study area will be evaluated using the Ecological Evaluation Index (EEI; Orfanidis et al. (2001)), which provides a structured and widely applied framework for classifying the condition of benthic habitats based on the composition and functional characteristics of macrophyte communities. To strengthen the assessment and ensure that the full range of coastal and transitional environments in the North Aegean is appropriately represented, the Transitional Waters Quality Index (TWQI) will also be applied. The TWQI integrates ecological attributes specific to transitional systems, such as species tolerance, community composition, and the relative dominance of key functional groups, offering complementary insights into ecosystem status in systems with pronounced hydrological and environmental gradients.

By combining EEI and TWQI, the evaluation will capture both habitat-level ecological integrity and broader system-level responses to environmental pressures. This dual-index approach enhances the robustness of status classification and supports the identification of subtle changes in seagrass meadow condition, benthic community structure, and functional diversity.

Seasonal variability and long-term trends derived from both indices will be analyzed to track temporal dynamics, detect early signs of degradation or recovery, and distinguish between

natural fluctuations and anthropogenic impacts. This expanded analytical framework will provide a comprehensive understanding of ecosystem health across the North Aegean sites and will serve as a solid foundation for ongoing monitoring and management actions.

In parallel, the proximity and influence of human activities, including fisheries, aquaculture, port infrastructure, submarine cables, and pipelines, will be assessed to determine their direct or indirect impacts on seagrass meadows and associated benthic habitats. These assessments align with Greece's commitments under the Marine Strategy Framework Directive (MSFD) and will contribute to evidence-based planning and optimized management of marine space within the framework of Marine Spatial Planning.

2. Methodology

The methodological approach for the Greek study areas focuses on integrating detailed habitat mapping with quantitative ecological assessment to evaluate the condition of benthic communities in the North Aegean. Field data will be collected through systematic surveys using the NEMOSENS micro-AUV sensors, enabling high-resolution characterization of seagrass distribution, canopy structure, and associated benthic assemblages. Along these transects, metrics such as species abundance, richness, diversity, and density will be recorded and used to calculate a series of ecological indices, including the Shannon–Wiener diversity index, evenness, species richness, and the Simpson concentration index.

To assess broader habitat quality, two established macrophyte-based indices will be applied: the Ecological Evaluation Index (EEI) and the Transitional Waters Quality Index (TWQI). Together, these indices provide a comprehensive classification of ecological status across both coastal and transitional environments. This combined framework will allow for an integrated evaluation of seagrass meadow condition, benthic community structure, and the spatial and temporal patterns that reflect environmental pressures and human impacts.

In the subsequent sections, each index to be applied will be presented in detail, including its theoretical basis, calculation methodology, and relevance for assessing benthic habitat condition in the North Aegean. Particular attention will be given to the ecological parameters underpinning the Shannon–Wiener diversity index, evenness, species richness, the Simpson concentration index, as well as the structure and diagnostic criteria of the EEI and TWQI. Their combined use will be contextualized within the specific environmental characteristics of the study areas, ensuring clarity on how these tools contribute to an integrated evaluation of ecological status and habitat health.

2.1. Shannon Diversity Index (H')

Among the biodiversity metrics applied in this study, the Shannon Diversity Index (H') will be used to quantify the diversity of benthic communities within the North Aegean seagrass meadows.

The **Shannon Diversity Index** (Shannon, 1948) is one of the most widely used diversity indices in ecological studies, and it is also referred to as Shannon index or Shannon–Wiener index. The index was designed to quantify the entropy, or uncertainty, in sequences of symbols, commonly known as Shannon entropy, which is closely related to the concept of information content. The underlying idea is that the greater the number of distinct symbols and the more even their relative abundances, the harder it becomes to predict the next symbol in the sequence. In ecological terms, this translates to higher uncertainty or "entropy" when predicting the identity of a randomly selected individual from a community with many species that are evenly represented.

The Shannon index combines both species evenness and richness and is calculated using the following formula:

$$H' = -\sum_{i=1}^{S} p_i \ln\left(p_i\right) \tag{2.1}$$

where H' is the species diversity index, S is the number of species and p_i is the proportion of individuals of each species belonging to the i^{th} species of the total number of individuals.

Higher Shannon index values indicate more diverse and evenly structured communities, reflecting a healthier ecosystem, while lower values may signal dominance by a few species

and potential ecological stress. A value of H = 0 indicates a community that only has one species.

In addition, the **Shannon Equitability Index**, also known as **Species evenness**, will be calculated to assess how evenly individuals are distributed among the species within a community. "Evenness" reflects the relative similarity in species abundances, with higher values indicating a more balanced community structure. This index can be computed using the following formula:

$$E = H / \ln(S) \tag{2.2}$$

where E is the Species evenness, H is the Shannon-Wiener index and S is the Species richness.

This index ranges from 0 to 1, where a value of 1 represents complete evenness (species has an equal proportion of individuals) while 0 indicates that the community is dominated by one or a few species.

In order to overcome the shortcomings of biodiversity indices that cannot display the relative role different variable plays in the calculation a Rank – Abundance Curve or the Whittaker plot will be created to visualize species richness and evenness on each of the sites of North Aegean (Whittaker, 1965).

2.2. Simpson's Index of Diversity (D)

Another index that will be calculated is the Simpson concentration index, also known as **Simpson's Index of Diversity (D)** introduced by Simpson (1949) to measure the degree of concentration when individuals are classified into types. This index is a measure of biodiversity in a given area that quantifies the probability of two randomly selected individuals being of the same species. The formula for the calculation of the index is the following:

$$D = \sum_{i=1}^{S} \left(\frac{n_i}{N} \right)^2 \tag{2.3}$$

where S is the richness (the total number of types in the dataset), n_i is the total number of organisms in a particular species, and N is the total number of organisms of all species.

A higher value of D indicates a lower level of biodiversity and a higher concentration of dominance, while a value closer to 0 represents infinite diversity.

2.3. Ecological Evaluation Index (EEI)

The Ecological Evaluation Index (EEI) is a robust and widely adopted biotic index specifically designed to assess the ecological quality of coastal and transitional marine waters within the framework of the European Water Framework Directive (WFD). Developed to monitor the impacts of anthropogenic pressures, particularly eutrophication, the EEI leverages the sensitivity of marine benthic macrophytes as effective bioindicators.

The index operates on a straightforward principle: it classifies macrophyte species into two distinct Ecological State Groups (ESGs) based on their life history strategies. ESG I comprises late-successional species such as thick, perennial algae and resilient seagrasses (e.g., *Posidonia* and *Cymodocea*), which thrive in high-quality, stable environments. Conversely, ESG II includes opportunistic, fast-growing, sheet-like, and filamentous species that rapidly colonize disturbed or nutrient-rich environments. The final index score is derived from the relative abundance and coverage of these two groups; high EEI values (up to 10) signify pristine conditions dominated by ESG I species, while low values indicate environmental degradation and dominance by

opportunistic ESG II species. Water management authorities rely on the EEI's continuous formula (EEI-c) to quantitatively monitor water body status, compare the ecological health of different coastal areas, and set essential thresholds for restoration and conservation efforts.

The EEI methodology involves both an original matrix-based numerical system and a more precise continuous formula (EEI-c).

Each ESG was valued differently within the main groups, ESG I and II (Table 1). For ESG I, the criteria were phenotypic plasticity and light adaptation (e.g., Cystoseira crin*ito-phylla* < *C. compressa* < *Corallina* spp.), whereas for ESG II the criterion was growth rate (e.g., *Gracilaria* spp. < *Ulva* spp.).

The mean group coverage (%) for an assemblage was estimated using the following weighted formulas:

$$\begin{aligned} ESG\ I\ \left(\%\ \text{coverage}\right) &= \left[\left(IA\ *\ 1\right)\ +\ \left(IB\ *\ 0.8\right)\ +\ (IC\ *\ 0.6)\right] \\ ESG\ II\ \left(\%\ \text{coverage}\right) &= \left[\left(IIA\ *\ 0.8\right)\ +\ (IIB\ *\ 1)\right] \end{aligned} \tag{2.4}$$

The latter, the continuous formula, uses a hyperbolic model to provide continuous numerical values, avoiding abrupt jumps between ecological status classes. More specifically, this model approximates the index values based on the calculated absolute percentage coverages of the two Ecological State Groups (ESG I and ESG II). The specific formula for the continuous EEI-c is:

$$p\left(x,y\right)=a+b\cdot\left(\frac{x}{100}\right)+c\cdot(\frac{x}{100})^2+d\cdot\left(\frac{y}{100}\right)+e\cdot(\frac{y}{100})^2+f\cdot\left(\frac{x}{100}\right)\cdot\left(\frac{y}{100}\right) \tag{2.5}$$

where $p(x,y)$ is the resulting continuous EEI value, x is the absolute abundance (percentage coverage) of **ESG I** (late-successional species), y is the absolute abundance (percentage coverage) of **ESG II** (opportunistic species), a, b, c, d, f are empirically derived coefficients ($a = 0.4680$, $b = 1.2088$, $c = -0.3583$, $d = -1.1289$, $e = 0.5129$, $f = -0.1869$).

However, an inherent property of these polynomials is that they can exceed the theoretical limits required for the index. To constrain the intermediate values between 0 and 1, the formula is redefined using a minimum function:

$$f\left(x,y\right)=\min\left\{1,p\left(x,y\right)\right\} \tag{2.6}$$

Finally, since the desired Ecological Evaluation Index (EEI or ESI) values are scaled to range between 2 (bad ecological status) and 10 (high ecological status), the final Ecological Status Index (ESI) is defined by a linear transformation:

$$ESI(x,y)=2+8\cdot\min\left\{1,p\left(x,y\right)\right\} \tag{2.7}$$

For compliance with the Water Framework Directive (WFD), the EEI value is often transformed into an **Ecological Quality Ratio (EQR)**, which normalizes the score from 0 (bad status) to 1 (high status) based on the following formula:

$$EEI_{EQR}=1.25\times\left(\frac{EEI_{value}}{RC_{value}}\right)-0.25 \tag{2.8}$$

where EEI_{value} is the value obtained from the continuous EEI-c formula and RC_{value} is the reference condition value for a specific pristine site (typically 10 for coastal waters in Greece).

***Table 1**. An indicative classification of coastal water Mediterranean upper infralittoral benthic macrophyte taxa into Ecological Status Groups.*

No.	Taxon	ESG	No.	Taxon	ESG	No.	Taxon	ESG
1	*Acetabularia*	IC	64	*Drachiella*	IIA	127	*Padina*	IB
2	*Acinetospora*	IIB	65	*Dudresnaya*	IIB	128	*Pedobesia*	IIB
3	*Acrochaetium*	IIB	66	*Ectocarpus*	IIB	129	*Penicillus*	IIB
4	*Acrodiscus*	IIA	67	*Entocladia*	IIB	130	*Petalonia*	IIB
5	*Acrosorium*	IIA	68	*Erythrocladia*	IIB	131	*Peyssonnelia*	IC
6	*Acrothamnion*	IIB	69	*Erythroglossum*	IB	132	*Phaeophila*	IIB
7	*Aglaothamnion*	IIB	70	*Erythropeltis*	IIB	133	*Phyllophora*	IIA
8	*Aglaozonia*	IB	71	*Erythrotrichia*	IIB	134	*Pleonosporium*	IIB
9	*Ahnfeltiopsis*	IIA	72	*Falkenbergia*	IIB	135	*Plocamium*	IB
10	*Alsidium*	IIA	73	*Feldmannia*	IIB	136	*Pneophyllum*	IC
11	*Amphirhoa*	IC	74	*Flabellia*	IC	137	*Polysiphonia*	IIB
12	*Anadyomene*	IC	75	*Fosliela*	IC	138	*Porphyra*	IIB
13	*Anotrichium*	IIB	76	*Ganonema*	IC	139	*Porphyrostromium*	IIB
14	*Antithamnion*	IIB	77	*Gastroclonium*	IIA	140	*Posidonia*	IA

2.4. Transitional Waters Quality Index (TWQI)

The **Transitional Waters Quality Index (TWQI)** is a multi-metric index developed to assess the trophic status and overall ecological health of shallow transitional water ecosystems, such as lagoons and estuaries. It was developed by Giordani et al. (2009) to integrate information from both abiotic and biotic variables and address the significant temporal variability often found in these environments, providing a more reliable annual mean, than individual metrics alone. In this pilot area, the TWQI will be supported by abiotic data collected using multiple sources: the second payload of the NEMOSENS AUV (a CTD sensor), satellite-derived data from the Copernicus program, and in situ measurements using handheld devices. These combined approaches allow for a comprehensive assessment of environmental conditions influencing benthic communities and improve the accuracy of the index calculations.

The TWQI considers six measured variables: relative cover of benthic phanerogams (Ph) and opportunistic macroalgae (Ma), concentrations of dissolved oxygen (DO), phytoplankton chlorophyll-a (Chl-a), dissolved inorganic nitrogen (DIN = $NO3^-$ + $NO2^-$ + $NH4^+$) and dissolved inorganic phosphorus (DIP).

Based on the methodology proposed by Bonometto et al. (2019), the calculation process for the TWQI involves transforming each of the six raw data parameters into a common, dimensionless scale (Quality Value or QV) that typically ranges from 0 (low quality) to 100 (high quality) using non-linear functions.

Each Quality Value (QV) is then multiplied by a weighting factor to account for the relative contribution of the corresponding variable to the overall water quality score. The weighting factors, as defined by Giordani et al. (2009), were based on the ecological significance of each parameter. Benthic vegetation receives the highest weighting (0.23), reflecting its primary role in driving lagoon water quality and trophic status (Viaroli et al., 2008). In contrast, phytoplankton chlorophyll-a has a lower weighting (0.15), as its influence on water quality is considered less critical than that of macrophytes in these shallow environments.

Dissolved oxygen (DO) receives a weighting factor of 0.15, reflecting its dependence primarily on benthic vegetation and phytoplankton production. The lowest weighting (0.12) is given to dissolved nutrients, as they act more as causal factors influencing vegetation status rather than as direct indicators of trophic status and water quality.

To calculate the overall TWQI, the Quality Value (QV) for each parameter is first determined and then multiplied by its corresponding weighting factor to obtain a weighted quality value. This process is repeated for all categories considered in the index, including benthic vegetation, phytoplankton, dissolved oxygen, and dissolved nutrients. In the following sections, the specific formulas used to calculate the QVs for each category are presented in the tables below:

***Table 2**. Phytoplankton Chlorophyll-a (Chl-a in µg/L).*

Condition	Formula
Chl-a < 6 µg/L	$QV_{Chl\text{-}a} = 100$
6 µg/L < Chl-a < 12 µg/L	$QV_{Chl\text{-}a} = -7 \times Chl\text{-}a + 140$
12 µg/L < Chl-a < 18 µg/L	$QV_{Chl\text{-}a} = -5 \times Chl\text{-}a + 120$
18 µg/L < Chl-a < 24 µg/L	$QV_{Chl\text{-}a} = -3 \times Chl\text{-}a + 90$
24 µg/L < Chl-a < 30 µg/L	$QV_{Chl\text{-}a} = -2 \times Chl\text{-}a + 50$
Chl-a > 30 µg/L	$QV_{Chl\text{-}a} = 0$

***Table 3**. Dissolved Inorganic Phosphorus (DIP in µM).*

Condition	Formula
0 µM < DIP < 1.2 µM	$QV_{DIP} = -33 \times DIP + 100$
1.2 µM < DIP < 1.8 µM	$QV_{DIP} = -25 \times DIP + 90$
1.8 µM < DIP < 2.4 µM	$QV_{DIP} = -17 \times DIP + 75$
2.4 µM < DIP < 3.0 µM	$QV_{DIP} = -13 \times DIP + 67$
3.0 µM < DIP < 3.6 µM	$QV_{DIP} = -12 \times DIP + 62$
3.6 µM < DIP < 6 µM	$QV_{DIP} = -8 \times DIP + 50$
DIP > 6 µM	$QV_{DIP} = 0$

***Table 4**. Dissolved Inorganic Nitrogen (DIN in µM).*

Condition	Formula
0 µM < DIN < 20 µM	$QV_{DIN} = -2 \times DIN + 100$
20 µM < DIN < 30 µM	$QV_{DIN} = -1.5 \times DIN + 90$
30 µM < DIN < 40 µM	$QV_{DIN} = -1.0 \times DIN + 75$
40 µM < DIN < 50 µM	$QV_{DIN} = -0.8 \times DIN + 67$
50 µM < DIN < 60 µM	$QV_{DIN} = -0.7 \times DIN + 62$
60 µM < DIN < 100 µM	$QV_{DIN} = -0.5 \times DIN + 50$
DIN > 100 µM	$QV_{DIN} = 0$

***Table 5**. Dissolved Oxygen Saturation (DO in % saturation).*

Condition	Formula
0% < DO < 25%	$QV_{DO} = 0.4 \times DO$
25% < DO < 50%	$QV_{DO} = 0.8 \times DO - 10$
50% < DO < 75%	$QV_{DO} = 1.6 \times DO - 50$
75% < DO < 100%	$QV_{DO} = 1.2 \times DO - 20$

100% < DO < 125%	$QV_{DO} = 100$
125% < DO < 150%	$QV_{DO} = -0.4 \times DO + 149$
150% < DO < 200%	$QV_{DO} = -1.2 \times DO + 270$
200% < DO < 225%	$QV_{DO} = -0.8 \times DO + 190$
225% < DO < 250%	$QV_{DO} = -0.4 \times DO + 100$
DO > 250%	$QV_{DO} = 0$

***Table 6**. Macroalgal Cover (Ma in % coverage).*

Condition	Formula
0% < Ma < 10%	$QV_{Ma} = -3.0 \times Ma + 100$
10% < Ma < 20%	$QV_{Ma} = -2.0 \times Ma + 90$
20% < Ma < 30%	$QV_{Ma} = -1.5 \times Ma + 80$
30% < Ma < 60%	$QV_{Ma} = -1.0 \times Ma + 65$
60% < Ma < 70%	$QV_{Ma} = -0.3 \times Ma + 23$
70% < Ma < 90%	$QV_{Ma} = -0.1 \times Ma + 9$
90% < Ma ≤ 100%	$QV_{Ma} = 0$

***Table 7**. Benthic Phanerogam Cover (Ph in % coverage).*

Condition	Formula
0% < Ph < 50%	$QV_{Ph} = 1.5 \times Ph$
50% < Ph < 70%	$QV_{Ph} = 1.0 \times Ph + 25$
70% < Ph < 80%	$QV_{Ph} = 0.5 \times Ph + 60$
80% < Ph ≤ 100%	$QV_{Ph} = 100$

The overall TWQI for a site is then calculated as the sum of all weighted quality values, producing a final score ranging from 0 (poor conditions) to 100 (excellent conditions) based on this formula:

$$\mathrm{TWQI} = \sum_{i=1}^{n} \left(\mathrm{QV}_i \times w_i \right) \tag{2.9}$$

Based on this methodology, as the number of surveys increases, we will assess the temporal variability of the TWQI and the individual parameters that comprise the index. These calculations will be carried out using the formulas presented below:

$$\Delta QV_{i,j} = \mathrm{abs} \frac{QV_{i,j\ \mathrm{survey1}} - QV_{i,j\ \mathrm{survey2}}}{\max QV_i} \times 100 \tag{2.10}$$

$$\Delta TWQI_j = \mathrm{abs} \frac{TWQI_{j\ \mathrm{survey1}} - TWQI_{j\ \mathrm{survey2}}}{\max TWQI} \times 100 \tag{2.11}$$

3. Benthic Habitat Assessment in Turkey

During this reporting period, comprehensive analyses of ROV video imagery collected from the three pilot sites (BS1, BS2, and BS3) were carried out to support the assessment of benthic habitat health and the development of harmonized monitoring methodologies. The recorded video footage was systematically examined to identify the presence, distribution, and coverage of seagrass meadows, macroalgal communities (e.g. Ulva spp., Cystoseira spp., other filamentous species), and marine litter observed on the seabed (Figure 1 and 2). All observations were linked to their corresponding geographic coordinates and organized into a georeferenced database.

Based on these observations, coordinate-based labeling of benthic habitat types was completed by spatially matching habitat records extracted from ROV imagery with GPS coordinates acquired during field surveys. The resulting labeled dataset was transferred into a Geographic Information System (ArcGIS), where habitat classification layers were generated, and spatial analyses were performed to map the distribution and extent of seagrass meadows and associated benthic communities. These georeferenced datasets provide an important basis for future AI- and machine-learning-based habitat classification and automated image analysis.

In parallel, methodological studies continued to establish an operational framework for assessing the health status of phytobenthic habitats using ROV observations. A preliminary ROV-based Seagrass Status Index (SSI) was developed by adapting conventional diver-based monitoring metrics to video-based assessments suitable for the shallow and turbid conditions of the Black Sea (Table 8). The proposed methodology incorporates semi-quantitative evaluation criteria derived from video imagery, including seagrass cover, meadow continuity, lower depth limit, epiphyte and opportunistic macroalgal abundance, and sediment stability. A simplified scoring system was designed to facilitate standardized habitat health assessments and support future harmonized monitoring across the project's pilot sites.

Each habitat health criterion is assigned a score and a corresponding weight, and the individual weighted scores are summed to obtain the Total Score, ranging from 0 to 15. This Total Score is then converted into a percentage value, the Seagrass Status Index (SSI%), which is used to classify the ecological status of each site according to the scheme presented in Table 8:

- $SSI = \sum (Score_i \times Weight_i)$
- $SSI\% = (Total\ Score / Max\ Score) \times 100$

Based on this classification, sites scoring in the 0-3 range are classified as Bad, 3-6 as Poor, 6-9 as Moderate, 9-12 as Good, and 12-15 as High (Table 9).

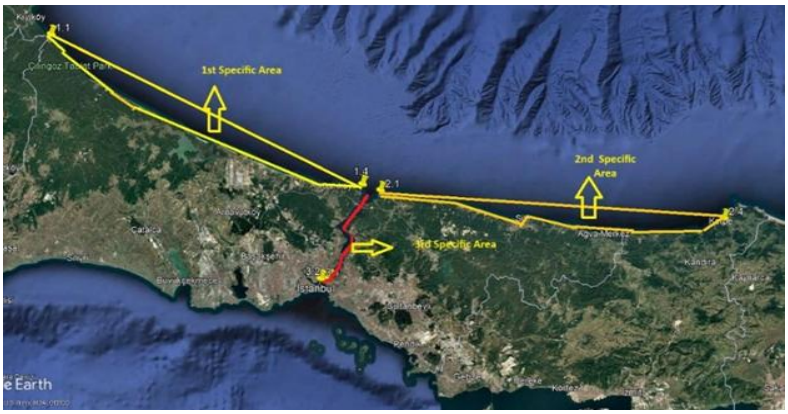
The activities carried out during this reporting period directly contribute to the project's objectives: developing interoperable methodologies for benthic habitat monitoring, producing spatial habitat maps, establishing a harmonized habitat health assessment framework, and creating high-quality, labeled datasets for future AI-supported ecological monitoring applications. The generated outputs will also provide a solid basis for calculating ecological indicators and evaluating habitat quality in subsequent reporting periods.



Pyrot 25.6.25/13-34-26 (lighthouse)						
Latitude	Longitude	Depth (m)	Habitat type	meadow upper limit depth	meadow lower limit depth	Litter
41.1489334	29.0459796	8.0	*Ulva* - sand- mussels	4.2	6.2	
41.1488942	29.0459832	6.9	*Ulva* - sand- mussels			
41.1489309	29.0458121	5.4	*Ulva* - pebble -sand			Tire x1
41.1490136	29.0457514	4.2	*Zostera-broken mussel shells*			
41.1490113	29.0457241	4.5	*Zostera -Ulva*			
41.1490802	29.0456895	4.9	*Zostera -Ulva*			
41.1490935	29.0457218	5.5	*Zostera -Ulva -sand*			
41.1490945	29.0456112	5.5	*Continuous Zostera*			
41.1491281	29.045629	6.5	*Ulva* - sand- mussels			
41.1491042	29.045591	5.9	*Zostera -Ulva -sand*			
41.1491099	29.0454644	5.6	*Ulva* facies			
41.1491503	29.0455085	6.0	Pebble -sand			
41.149196	29.0455767	7.8	Pebble -sand			
41.1491966	29.0455765	7.9	Pebble -sand			
41.1492306	29.0454523	5.2	*Ulva* - broken mussel shells			
41.1493082	29.0453957	5.3	*Ulva* facies			
41.1493097	29.0453916	5.2	*Ulva* facies			
41.1493215	29.045407	5.2	*Zostera -mucilageous aggregates*			Tire x3
41.1493444	29.0454276	6.5	sand -pebble			
41.1494175	29.045353	6.0	*Zostera*			
41.1494215	29.0453592	6.0	*Zostera -sand*			
41.149449	29.0453502	5.6	*Zostera -sand -Ulva*			
41.1495225	29.0453516	5.5	*Zostera -sand- Ulva*			
41.1495628	29.0453432	5.1	*Zostera -Ulva -mucilagenous aggregates*			
41.1496082	29.0453686	5.1	*sand -Zostera*			
41.149615	29.0453547	4.9	*Zostera -mucilageous aggregates*			



Figure 1*. ROV Imagery & Data Labeling for Benthic Habitat Classification.*



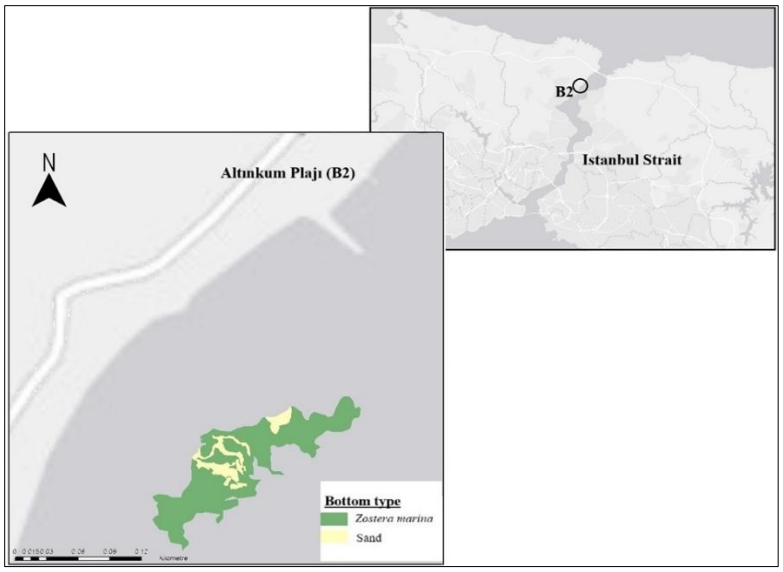


***Figure 2**. Representation of data from a single station (B2) imported into ArcGIS illustrating the extent and spatial distribution of seagrass meadows.*

***Table 8**. Draft of a simplified five-component scoring structure in order to develop the seagrass status index (SSI).*

	0	1	2	3
Meadow cover	0-25%	26-50%	51-75%	76-100%
Meadow Continuity	Absent	Patchy	Semi-continuous	Continuous/dense
Lower Limit	Clear regression	Fragmented/ unstable boundary	Stable and continuous	Expanding
Epiphytes / Opportunistic	Dense filamentous leafy dominance	High	Moderate	Low
Sediment Stability	Highly unstable -Extensive rhizome exposure -Strong mat erosion -Disturbed sediment	Unstable -Clear rhizome exposure -Moderate erosion -Partially disturbed sediment	Moderatelly stable -Limited rhizome exposure -Low erosion -Mostly stable sediment	Stable -Rhizomes burried -No erosion -Compact sediment

***Table 9**. Ecological status classification scheme based on the ROV-based Seagrass Status Index (SSI), showing quality score ranges and corresponding status categories from Bad to High.*

Quality scores	SSI	Ecological Status Classification
0-3	..	Bad
3-6	..	Poor
6-9	..	Moderate
9-12	..	Good
12-15	..	High

4. References

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