Interreg

Co-funded by the European Union

NEXT Black Sea Basin

EfxINNOs

ROV-Based Monitoring of Benthic Habitats in EfxINNOs: Experience from Türkiye Pilot Sites

EfxINNOs 3rd Joint Open Workshop 16-17 April 2026

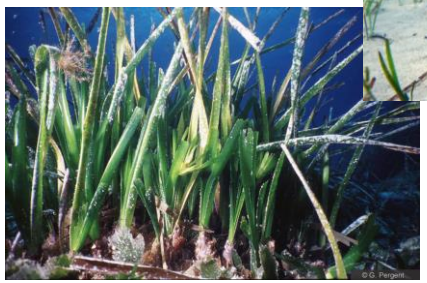
Yelda AKTAN
Istanbul University

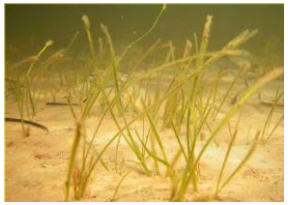
15 April 2026
Tbilisi, Georgia

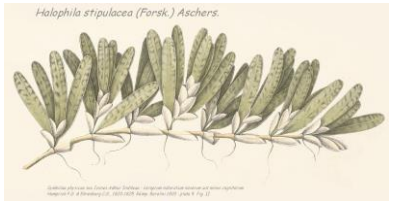
Seagrass

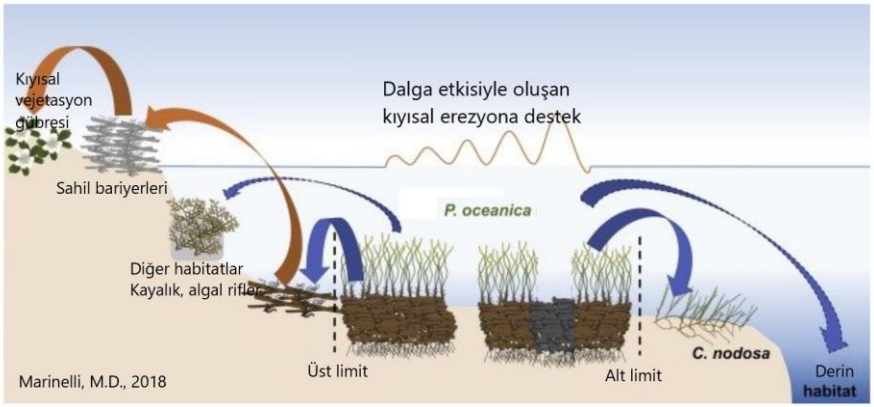
4 genus, 5 species

- *Cymadocea nodosa*
- *Zostera noltii*
- *Zostera marina*
- ***Posidonia oceanica***
- *Halophila stipulacea*









Surface

50 m Lower limit

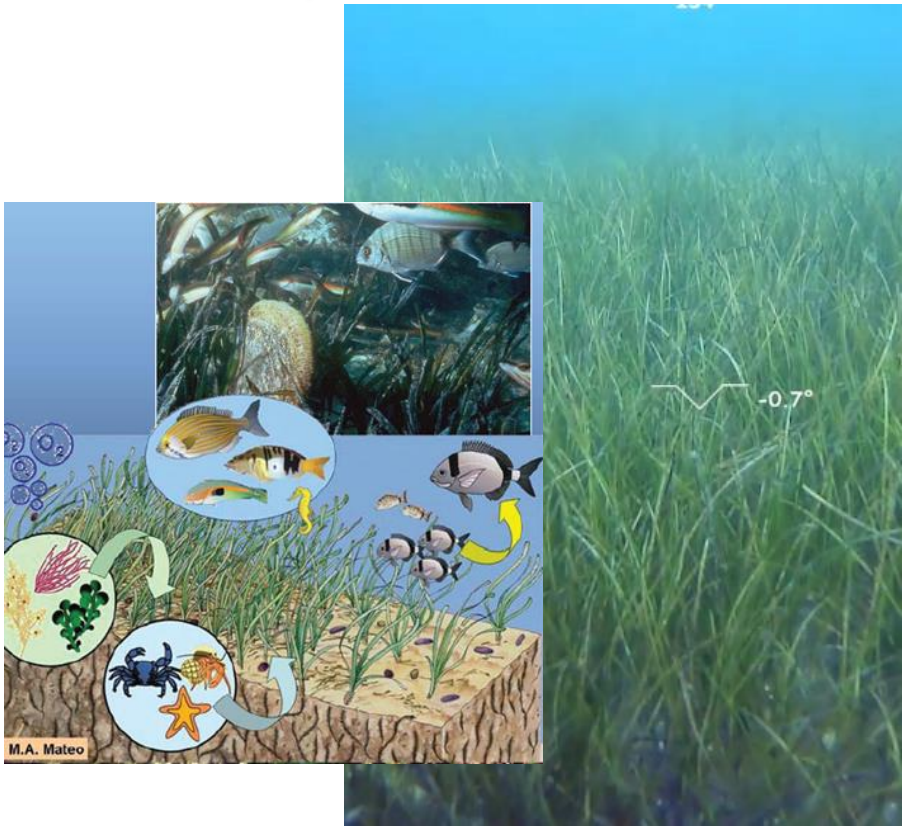
Interreg

Co-funded by the European Union

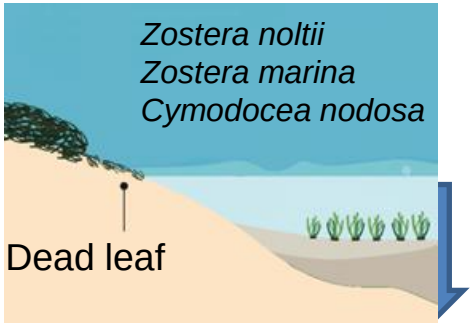
NEXT Black Sea Basin

EfxINNOs

Seagrass Meadows in the Black Sea Basin



- Key primary producers
- Areas of high biodiversity
- Shelter and breeding grounds for benthic invertebrates and fish species
- Carbon sinks «*blue carbon*»
- Coastal erosion reduction, wave attenuation, nutrient balance, etc.



Human impacts on the Black Sea Basin

General threats on seagrass habitats

- Physical damage: coastal construction and modification, fishing activities, anchoring




- Pollution: eutrophication, deep-sea discharge, uncontrolled aquaculture practice







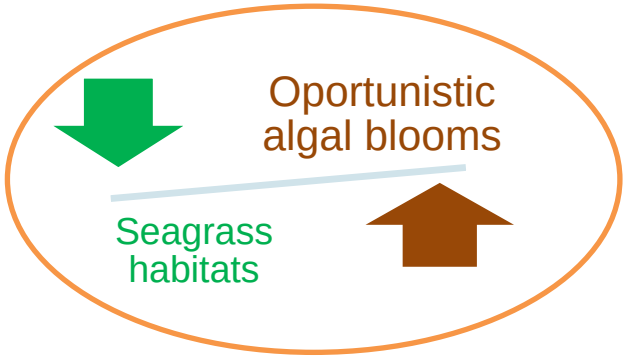
Interreg

Co-funded by the European Union

NEXT Black Sea Basin

EfxINNOs

- Algal blooms



- Invasive species

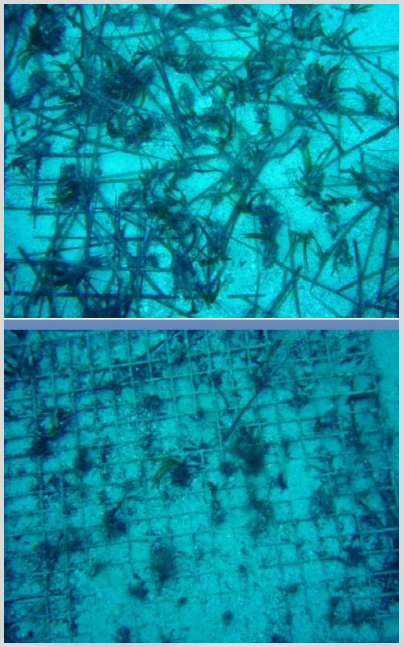
Seagrass transplantation

Transplanted cuttings of Posidonia

- Survival ratio: 30-70%
- Growth: 2 to 6 cm/year
- Cost: 60000 Euro/ha

Pergent et al., 2008 from France

- 2 years after



TURMEPA., 2024 from Türkiye, Göcek

MONITORING & PROTECTING

Interreg

Co-funded by the European Union

NEXT Black Sea Basin

EfxINNOs

*«**The starting point for the project** is the need to establish a sustainable and comprehensive marine monitoring network in the Black Sea and Northern Aegean marine ecosystems.»*

Data gaps and fragmented monitoring activities

Limited, inconsistent and incompatible data across countries in the Black Sea basin...

Climate change and increasing human pressure

urbanisation, tourism, maritime transport, fishing and pollution

Need for technological & scientific innovation

AUVs, ROVs, sensor networks, remote monitoring tools, innovative, low-cost and sustainable technologies

Strengthening regional cooperation

Common standards, data sharing and capacity building

Interreg

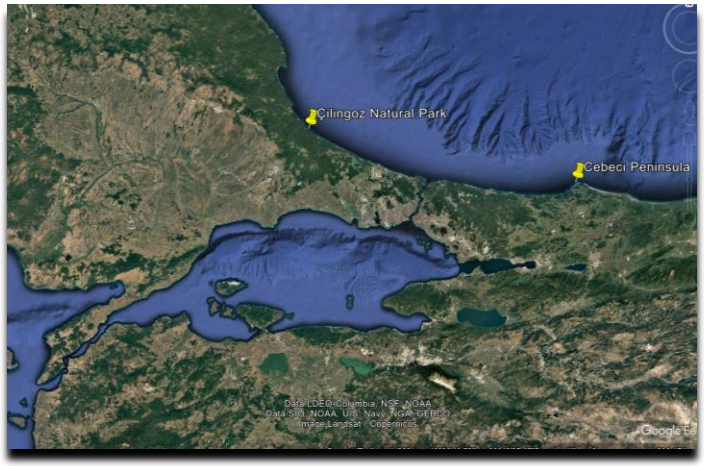
Co-funded by the European Union

NEXT Black Sea Basin

EfxINNOs

EfxINNOs in TR

- Main activity: monitor & map seagrass meadows with ROV, semi-quantitative, non-destructive, fast
- Verification: SCUBA diving
- Studying marine biodiversity & human impacts on the seafloor.
- Coastal human activities will be evaluated in relation to benthic ecosystems.



- Underwater monitoring will also reveal obtain the impact of marine activities on sensitive habitats,
- Public awareness will be raised through training materials, workshop and seminars.

Destructive fishing activities,
Mooring ,
Coastal filling, etc

Non-indigenious species
Marine litter

Interreg Co-funded by the European Union

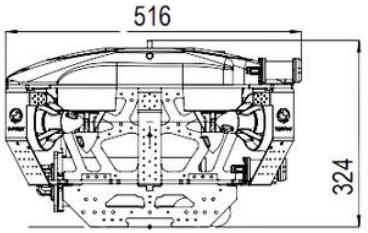
NEXT Black Sea Basin

EfxINNOs

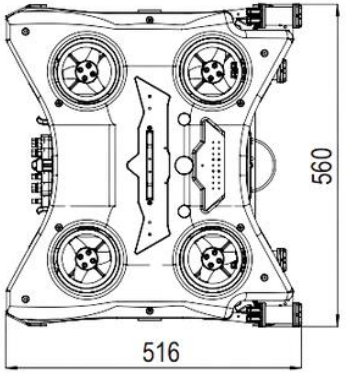
ROV (Remotely Operated Vehicle)

GENERAL SPECIFICATIONS

Width : 560 mm, **Length :** 324 mm
Weight (in air) : 21 kg
Body Material : Anodized Machined Aluminum, POM, & Buoyancy Foam
Window Material : Acrylic
Depth Rating : 500 m
Operating Temp : -10 to 50 °C



ROV Electrical System
Battery Voltage : 14.8 v 250 Wh Li-ion
Battery Run Time : 2 - 3 Hours (30-sec Battery Change)
Thruster Control : 100% Reversible



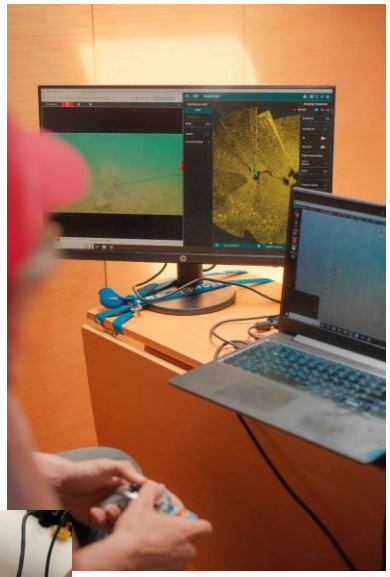
SONAR SYSTEMS
Sonoptix ECHO Multibeam Sonar
The Oculus M-Series Multibeam Sonar
Cerulean Omniscan450

NAVIGATION
The SeaTrac USBL
WaterLinked Underwater GPS G2
Cerulan Mark III ROV Locator
WaterLinked A50 & 125

AUXILLARY CAMERA
DVL Low Light Camera
4k Camera Optic ZOOM

MANIPULATORS&TOOLS
Newton Gripper
Reach Robotics Manipulators
Sediment Sampler
Swappable Jaws

ADDITIONAL SENSORS
Altimeter
Dissolved Oxygen
pH Sensors & ORP Sensors



Interreg

Co-funded by the European Union

NEXT Black Sea Basin

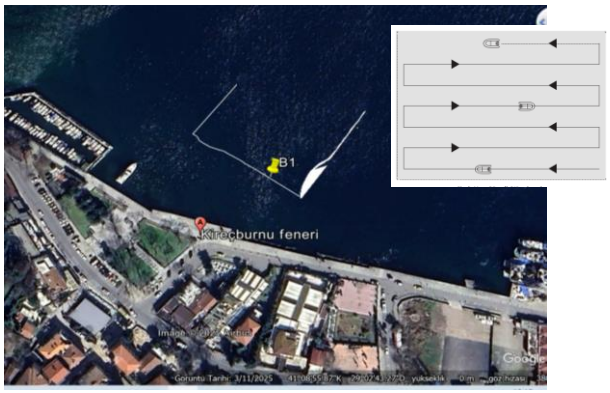
EfxINNOs

FIELD STUDY

For each site:

- Acquisition of aerial imageries from Google Earth.
- Determination of the pilot sites according to the presence of benthic macrophytes.
- **Monitoring the critical habitats & marine litter:** Capturing the photogrammetric imagery by manta-towing the ROV in linear pattern
- **Groundtruthing the optical methods with georeferenced diving:** Detect the outlines of macrophytic communities by GPS coordinates.
- **Estimation of macrophytic cover (%):** X replicated photoquadratic vertical projection (20x20 cm) in a standart depth.
- Measure **key environmental parameters**: temperature, salinity, pH, conductivity, oxygen, turbidity
- Assess **human impacts** using the Land Use Simplified Index (LUSI).

Linear pathern



Interreg NEXT Black Sea Basin

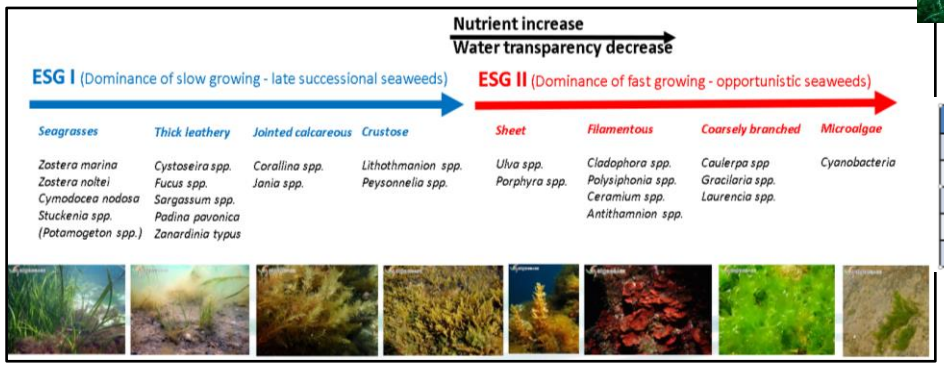
Co-funded by the European Union

EfxINNOs

Methodology followed during the data processing

- **Calculation** of the Ecological Evaluation Index (EEI) after sorting and estimating the cover of ecological status groups (ESGs).

Ground-truthing step
Quadrat-based field observations



EEI	EQR EEI	Status
10 ≥ EEI > 8	1 ≥ EQR > 0.75	High
8 ≥ EEI > 6	0.75 ≥ EQR > 0.5	Good
6 ≥ EEI > 4	0.5 ≥ EQR > 0.25	Moderate
4 ≥ EEI > 2	0.25 ≥ EQR > 0	Low
2	0	Bad

Genus	ESG	Cover on quadrat (%)
Acetabularia	I	
Acanthophora	II	
Amphiroa	I	
Anadyomene	I	
Antithamnion	II	
Bryopsis	II	
Calithamnion	II	
Caulerpa	II	
Ceramium	II	
Chaetomorpha	II	
Champia	II	
Chondria	II	
Cladophora	II	

Functional characteristics of marine benthic macrophytes

Ecological State Group	Functional form group	Morphology	Longevity (Succession)	Genera
ESG II	A. Sheet	Foliose	Annual (Opportunistic)	Ulva, Enteremorpha, Dictyota, Scystosiphon
ESG II	B. Filamentous	Delicately branched	Annual (Opportunistic)	Chaetomorpha, Cladophora, Polysiphonia, Ceramium, Spyridia
ESG II	C. Coarsely Branched	Coarsely branched upright	Annual (Mid-successional)	Acanthophora, Caulerpa, Chordaria, Gracilaria, Laurencia, Liagora
ESG I	D. Thick Leathery	Thick blades and branches	Perennial (Late-successional)	Cystoseira, Chondrus, Fucus, Laminaria,Padina, Sargassum, Udotea

Interreg

Co-funded by the European Union

NEXT Black Sea Basin

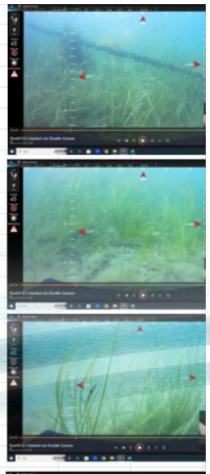
EfxINNOs

ROV Imagery & Data Labeling for Benthic Habitat Classification

- Coordinates
- Photogrammetric images: upper&lower limit depth
- Image labeling from videos for habitat type and marine litter

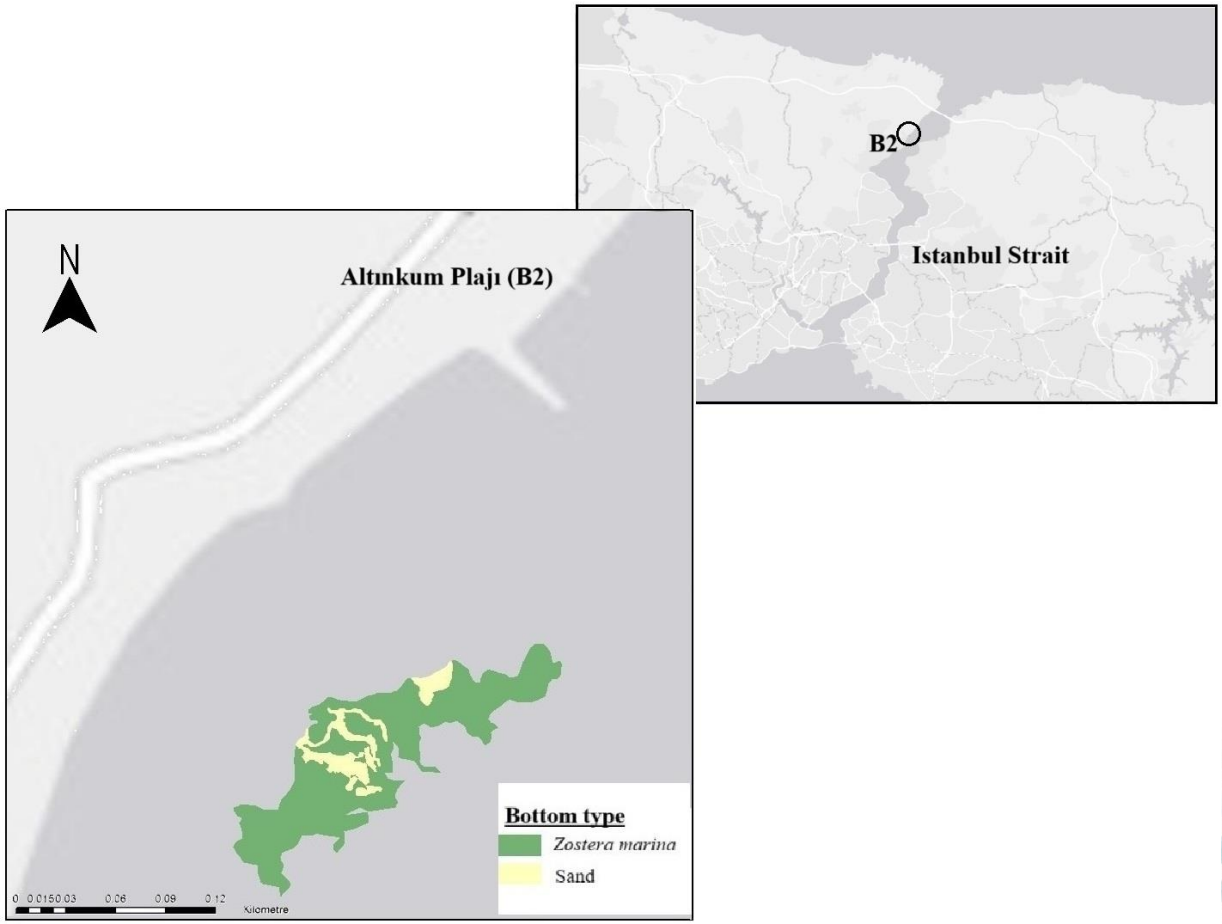
-

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*			



BSB00193 – EfxINNOs

- **Integration** of collected data to ArcGIS for **Mapping**.



Interreg NEXT Black Sea Basin

Co-funded by the European Union

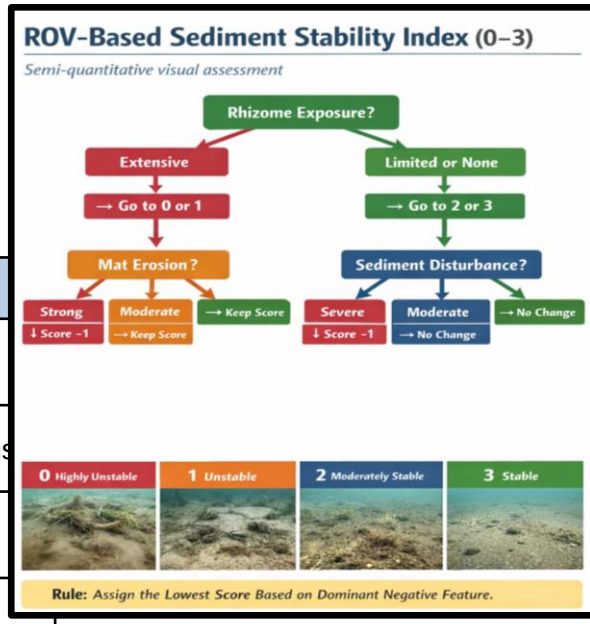
EfxINNOs

Preliminary Approach:

ROV-Based Seagrass Status Index (ROV-SSI)

Methodological Basis:

- Adapts diver-based ecological indices into an ROV-based operational monitoring framework
- Depth gradient & lower depth limit as primary reference
- Transect-based habitat labeling (*Zostera* meadows / foliose algae / filamentous algae)
- Video-derived semi-quantitative scoring



	0	1	2	3
Meadow cover	0-25%	26-50%	51-75%	76-100%
Meadow Continuity	Absent	Patchy	Semi-continuous	Continuous/dens
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

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

Interreg

Co-funded by the European Union

NEXT Black Sea Basin

EfxINNOs

Results/Expected impact

Environmental and Social impact

- «Conservation and monitoring» of Key Ecosystems

Functioning of critical habitats (EU Habitat Directive (92/43/EEC) in the BSB, provide significant information for the development of sustainable practices on climate change limitation

- Environmental awareness
- Blue economy

Healthy ecosystem → Resilient environment → Productive sea

Contributions to EU Policies

- Marine Strategy Framework Directive (MSDF)
- Marine Spatial Planning (MSP)
- Biodiversity Strategy
- Climate Change Action
- Black Sea Integrated Monitoring Assessment Programme (BSIMAP)

Thank you