

**Carbon Binding Blue Black Sea (BlueC)
BSB00020**

**Trainers' Training Program
03-04 March 2025**

Tekirdağ Namık Kemal University

Syllabus

Interreg



Co-funded by
the European Union

NEXT Black Sea Basin



Content

1. Introduction
2. Course Overview
3. Training course structure
4. Learning objectives
5. Learning outcomes of the course
6. Content structure of the modules
 - 6.1. Module 1: The Ecological, Economic, and Climatic Importance of Seagrasses
 - 6.2. Module 2: Threats to Seagrasses
 - 6.3. Module 3: Conservation of Seagrass Ecosystems and Environmental Impact Assessment Studies in Mediterranean Countries
 - 6.4. Module 4: Mapping and Monitoring of Seagrasses: Fundamental Methods and Tools
 - 6.5. Module 5: Policy and Management Options for Seagrass Ecosystems
7. Learning profile or target groups
8. Training methodology
9. Prerequisites
10. Learning materials and resources
11. Assignment and assessment
12. Code on academic ethics and integrity

1. Introduction

The presented document contains a syllabus designed for a training course entitled "Carbon Binding Blue Black Sea Trainers' Training"

The course is specially created to answer the need for a training to support, up-skill and stimulate environmental professionals, marine biologists, coastal zone managers, and conservation practitioners. However, it is also suitable for the training of students studying in relevant departments of universities, environmental NGOs, and government officials to engage them in seagrass conservation and to build their capacity for climate change mitigation through blue carbon ecosystems.

The structure of the course allows its delivery as a blended mobility training (in-class and on-line learning).

Context

This course has been developed within the project Carbon Binding Blue Black Sea - BlueC (BSB00020), funded by the Interreg VI-B NEXT Black Sea Basin Programme. The project is led by Tekirdağ Namık Kemal University and focuses on the conservation and restoration of seagrass ecosystems in the Black Sea region as natural carbon sinks. A key objective of the project is to ensure that Environmental Impact Assessment (EIA) processes properly consider seagrass ecosystems, raise awareness about their importance, and implement activities with project partners throughout the region.

Climate change poses significant challenges to marine ecosystems worldwide, with the Black Sea region experiencing particular vulnerability due to multiple anthropogenic pressures. Seagrasses represent one of the most efficient natural carbon sequestration systems on the planet, capable of storing carbon at rates up to 35 times faster than tropical rainforests. Despite their ecological and climatic importance, seagrass meadows in the Black Sea region face numerous threats including coastal development, pollution, destructive fishing practices, and the impacts of climate change itself.

The Carbon Binding Blue Black Sea - BlueC project aims to address these challenges by building capacity among key stakeholders for the protection, monitoring, and restoration of these vital ecosystems. By enhancing knowledge and skills related to seagrass conservation, the project contributes to climate change mitigation efforts while simultaneously protecting marine biodiversity and supporting sustainable coastal livelihoods. This training program represents a cornerstone of the project's educational outreach, designed to create a network of informed trainers who can further disseminate knowledge and best practices throughout the region.

Course Overview

This course is intended to enhance understanding of seagrass ecosystems as blue carbon sinks and build capacity for their conservation and restoration in the Black Sea region. The specific aims are:

- To improve the level of knowledge and skills of participants on seagrass ecology, distribution, and ecosystem services with particular emphasis on carbon sequestration.
- To equip participants with practical tools and methodologies for mapping, monitoring, and assessing seagrass ecosystems.
- To develop understanding of the threats facing seagrass meadows and strategies for their conservation and restoration.
- To familiarize participants with relevant policy frameworks, international conventions, and management approaches for seagrass protection.
- To build capacity for stakeholder engagement and participatory approaches in seagrass conservation initiatives.

2. Training course structure

The course is composed of 5 training modules as follows:

Module 1: The Ecological, Economic, and Climatic Importance of Seagrasses

Module 2: Threats to Seagrasses

Module 3: Conservation of Seagrass Ecosystems and Environmental Impact Assessment Studies in Mediterranean Countries

Module 4: Mapping and Monitoring of Seagrasses: Fundamental Methods and Tools

Module 5: Policy and Management Options for Seagrass Ecosystems

The training has a total of 30 hours duration (Module 1: 6 h, Module 2: 6 h, Module 3: 6 h, Module 4: 6 h, and Module 5: 6 hours) as shown in the Tables below.

Module 1: The Ecological, Economic, and Climatic Importance of Seagrasses (6 hours)

Module No.	Module sub-title	Module workload (hours)	Out of which:		
			Guided training (Lectures, seminar, with the support of the training expert)	Self-learning (Individual learning based on the guidebook, bibliography and notes)	Assessment activities (not included in the total workload)
M 1.1	Definition of Seagrasses	(2 hours)	1.30	0.30	0.10
M 1.2	Global Distribution of Seagrasses	(2 hours)	1.30	0.30	0.10
M 1.3	Ecosystem Services of Seagrasses	(2 hours)	1.30	0.30	0.10
	TOTAL (hours)	6	4.30	1.30	0.30

Module 2: Threats to Seagrasses (6 hours)

Module No.	Module sub-title	Module workload (hours)	Out of which:		
			Guided training (Lectures, seminar, with the support of the training expert)	Self-learning (Individual learning based on the guidebook, bibliography and notes)	Assessment activities (not included in the total workload)
M 2.1	Land-based threats	(2 hours)	1.30	0.30	0.10
M 2.2	Sea-based threats	(2 hours)	1.30	0.30	0.10
M 2.3	Climate-related threats	(2 hours)	1.30	0.30	0.10
	TOTAL (hours)	6	4.30	1.30	0.30

Module 3: Conservation of Seagrass Ecosystems and Environmental Impact Assessment Studies in Mediterranean Countries (6 hours)

Module No.	Module sub-title	Module workload (hours)	Out of which:		
			Guided training (Lectures, seminar, with the support of the training expert)	Self-learning (Individual learning based on the guidebook, bibliography and notes)	Assessment activities (not included in the total workload)
M 3.1	Conservation of Seagrass Ecosystems	(3 hours)	2.30	0.30	0.15
M 3.2	Impact studies in Mediterranean countries	(3 hours)	2.30	0.30	0.15
	TOTAL (hours)	6	5	1	0.30

Module 4: Seagrass Mapping and Monitoring (6 hours)

Module No.	Module sub-title	Module workload (hours)	Out of which:		
			Guided training (Lectures, seminar, with the support of the training expert)	Self-learning (Individual learning based on the guidebook, bibliography and notes)	Assessment activities (not included in the total workload)
M 4.1	Techniques	(2 hours)	1.30	0.30	0.10
M 4.2	Technologies	(2 hours)	1.30	0.30	0.10
M 4.3	Data	(2 hours)	1.30	0.30	0.10
	TOTAL (hours)	6	4.30	1.30	0.30

Module 5: Policy and Management Options (6 hours)

Module No.	Module sub-title	Module workload (hours)	Out of which:		
			Guided training (Lectures, seminar, with the support of the training expert)	Self-learning (Individual learning based on the guidebook, bibliography and notes)	Assessment activities (not included in the total workload)
M 5.1	Policy Options	(3 hours)	2.30	0.30	0.15
M 5.2	Management options	(3 hours)	2.30	0.30	0.15
	TOTAL (hours)	6	5	1	0.30

The training uses a sequenced learning path, the learner having to complete the modules in a particular order. It is not allowed to proceed to the new module unless the previous module is successfully completed. The learner must complete all modules in order to complete the path.

3. Learning objectives

General objective

The general objective of the Carbon Binding Blue Black Sea - BlueC Trainers' Training is to build capacity among key stakeholders for the protection, monitoring, and restoration of seagrass ecosystems in the Black Sea region as a nature-based solution for climate change mitigation, with special emphasis on ensuring that Environmental Impact Assessment processes properly consider these vital ecosystems.

Specific objectives

M1	To enhance participants' understanding of seagrass ecology, distribution patterns, and ecosystem services with particular emphasis on carbon sequestration potential.
M2	To develop awareness of the various threats facing seagrass ecosystems in the Black Sea region and their implications for blue carbon storage.
M3	To familiarize participants with international conventions, EU directives, and other policy frameworks relevant to seagrass conservation.
M4	To build practical skills in mapping and monitoring seagrass ecosystems using various techniques and technologies.
M5	- To equip participants with knowledge of policy and management options for seagrass conservation. - To foster networking and knowledge exchange among professionals working on seagrass conservation in the Black Sea region.

4. Learning outcomes of the course

The specific intended learning outcomes are detailed according each training module of the Carbon Binding Blue Black Sea - BlueC Trainers' Training course:

M1	- Define seagrasses and identify their key biological and ecological characteristics - Describe the global distribution patterns of seagrass species with emphasis on the Black Sea region - Explain the role of seagrasses in marine ecosystems and their contribution to biodiversity - Quantify the carbon sequestration potential of seagrass meadows compared to other ecosystems - Calculate the economic value of ecosystem services provided by seagrasses - Articulate the importance of seagrass conservation for climate change mitigation
M2	- Identify and analyze land-based threats to seagrass ecosystems including coastal development, pollution, and agricultural runoff - Evaluate sea-based threats such as destructive fishing practices, boating activities, and invasive species - Assess climate-related threats including rising sea temperatures, ocean acidification, and sea level rise - Distinguish between acute and chronic threats to seagrass ecosystems - Identify the most significant threats to seagrass ecosystems in the Black Sea region - Propose preliminary measures to address key threats in specific case study locations

M3	- Describe various approaches to seagrass ecosystem conservation - Interpret the provisions of international conventions relevant to seagrass protection - Apply the requirements of the EU Water Framework Directive and Marine Strategy Framework Directive to seagrass conservation - Design appropriate environmental impact assessment methodologies for projects affecting seagrass habitats - Compare conservation strategies implemented in different Mediterranean countries - Adapt successful conservation approaches from the Mediterranean to the Black Sea context
M4	- Apply various techniques for seagrass mapping and monitoring including field surveys and remote sensing - Utilize appropriate technologies for seagrass assessment including GIS, satellite imagery, and underwater imaging - Demonstrate proper data collection, management, and analysis methods for seagrass monitoring - Design participatory monitoring programs involving multiple stakeholders - Interpret monitoring data to assess seagrass ecosystem health and resilience - Develop effective visualization methods for communicating seagrass distribution and status
M5	- Evaluate different policy options for seagrass protection at local, national, and international levels - Develop management strategies for sustainable use and conservation of seagrass ecosystems - Select appropriate restoration methods for different types of degraded seagrass habitats - Formulate policy recommendations for seagrass protection at local and national levels - Design communication strategies to raise awareness about seagrass importance among policymakers and the public - Integrate seagrass conservation into broader coastal management frameworks

5. Content structure of the modules

The training content is based on the integrative learning approach and covers a set of 5 training modules, with the following parameters:

5.1. Module 1: The Ecological, Economic, and Climatic Importance of Seagrasses

Module Code	Module title	
M1	The Ecological, Economic, and Climatic Importance of Seagrasses	
Training Content of the module:		
Topic No.	Training contents / Topic title	
1.1	Definition of Seagrasses	
1.1.1	This submodule covers the botanical classification of seagrasses as marine flowering plants, their evolutionary history, and unique adaptations to marine	

	environments.
1.1.2	Participants learn about the morphological characteristics of different seagrass species, their reproductive strategies, and physiological adaptations that enable them to thrive in submerged marine habitats.
1.1.3	The submodule also explores the ecological niche of seagrasses within coastal ecosystems and their relationships with associated flora and fauna.
1.2	Global Distribution of Seagrasses
1.2.1	This submodule examines the worldwide distribution patterns of seagrass species, with special emphasis on those present in the Black Sea region.
1.2.2	Participants learn about the environmental factors that determine seagrass distribution, including light availability, substrate type, water quality, temperature, and salinity requirements.
1.2.3	The submodule includes detailed mapping of seagrass habitats globally and regionally, highlighting biodiversity hotspots and areas of particular conservation concern. Historical changes in seagrass distribution are also analyzed to understand long-term trends.
1.3.	Ecosystem Services of Seagrasses:
1.3.1	This submodule explores the wide range of ecosystem services provided by seagrass meadows.
1.3.2	Particular attention is given to the carbon sequestration capabilities of seagrasses, explaining the mechanisms of carbon capture and long-term storage in both biomass and sediments. The concept of "blue carbon" is thoroughly examined, with comparative analysis between seagrasses and other carbon sink ecosystems.
1.3.3	The submodule also covers other ecosystem services including fisheries support, coastal protection, water quality improvement, and biodiversity enhancement. Economic valuation methodologies for these services are introduced, with case studies demonstrating successful approaches to quantifying both direct and indirect economic benefits.

List of general readings (Bibliography)

Dawes CJ (1981) Marine Botany. A WileyInterscience Publication. John Wiley & Sons, New York, Chichester, Brisbane, Toronto, Singapore. p.478

Den Hartog C (1970) The Seagrasses of the World. North Holland Publ. Co., Amsterdam.

de los Santos, C. B., A. Scott, A. Arias-Ortiz, B. Jones, H. Kennedy, I. Mazarrasa, L. McKenzie, L. M. Nordlund, M. de la T. de la Torre-Castro, R. K. F. Unsworth & R. AmboRappe, 2020. Seagrass ecosystem services: Assessment and scale of benefits. Out of the blue: the value of seagrasses to the environment and to people United Nations Environment 19–21.

European Commission. (2019). The EU Blue Economy Report 2019. Luxembourg: Publications Office of the European Union.

Fourqurean, J.W., Duarte, C.M., Kennedy, H., Marbà, N., Holmer, M., Mateo, M.A. et al. (2012). Seagrass ecosystems as a globally significant carbon stock. Nature Geoscience 5, 505–509.

Green EP, Short FT (2003) World Atlas of Seagrasses: Present status and future conservation. University of California Press.

- Hemminga MA, Duarte CM (2000) Seagrass Ecology. Cambridge Univ. Press, Cambridge, 298 pp.
- Jayatilake, D. R. M. & M. J. Costello, 2018. A modelled global distribution of the seagrass biome. Biological Conservation. 226: 120–126.
- Liquete, C., Piroddi, C., Drakou, E. G., Gurney, L., Katsanevakis, S., Charef, A., & Egoh, B. (2013). Current status and future prospects for the assessment of marine and coastal ecosystem services: a systematic review. PloS one, 8(7), e67737.
- McKenzie L.J., Nordlund L.M., Jones B.L., Cullen-Unsworth L.C., Roelfsema C., Unsworth R.K.F. (2020). The global distribution of seagrass meadows. Environmental Research Letters.
- Milchakova NA, Phillips RC (2003) Black Sea seagrasses. Marine Pollution Bulletin 46: 695-699.
- Nordlund, L.M., Unsworth, R.K.F., Gullström, M. and Cullen-Unsworth, L. C. (2018). Global significance of seagrass fishery activity. Fish and Fisheries 19, 399–412. <https://doi.org/10.1111/faf.12259>.
- Ondiviela, B., Losada, I.J., Lara, J.L., Maza, M., Galván, C., Bouma, T.J. et al. (2014). The role of seagrass in coastal protection in a changing climate. Coastal Engineering 87, 158–168. <https://doi.org/10.1016/j.coastaleng.2013.11.005>.
- United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) and Short, F.T. (2018). Global Distribution of Seagrasses (version 6.0). Sixth update to the data layer used in Green and Short (2003). Cambridge. <https://data.unep-wcmc.org/datasets/7>.
- World Bank and United Nations Department of Economic and Social Affairs. (2017). The Potential of the Blue Economy: Increasing Long-term Benefits of the Sustainable Use of Marine Resources for Small Island Developing States and Coastal Least Developed Countries. Washington D.C.: World Bank.

5.2. Module 2: Threats to Seagrasses

Module Code	Module title	
M2	Threats to Seagrasses	
Training Content of the module:		
Topic No.	Training contents / Topic title	
2.1	Land-based threats:	
2.1.1	This submodule examines threats originating from terrestrial sources that impact seagrass ecosystems. Topics include coastal development and its effects on seagrass habitats through increased sedimentation, habitat destruction, and altered hydrological regimes. The impacts of agricultural runoff, including nutrient loading and pesticide contamination, are analyzed in detail, with case studies demonstrating eutrophication effects on seagrass health. Industrial pollution, including heavy metals, petrochemicals, and emerging contaminants, is also covered, with discussion of bioaccumulation and biomagnification processes in seagrass ecosystems.	
2.1.2	The submodule concludes with an examination of watershed management approaches that can mitigate these land-based threats.	
2.2	Sea-based threats	
2.2.1	This submodule focuses on threats originating within the marine environment.	
2.2.2	Destructive fishing practices, including trawling and dredging, are examined for their direct and indirect impacts on seagrass beds. Boating and shipping activities are analyzed, including physical damage from anchoring, propeller scarring, and the	

	effects of shipping lanes on seagrass habitats.
2.2.3	The submodule also covers marine pollution sources such as oil spills, marine debris, and microplastics, with discussion of their specific impacts on seagrass physiology and ecosystem function. The introduction and spread of invasive species in seagrass habitats is explored, with case studies of particularly problematic invasions and their management.
2.3.	Climate-related threats
2.3.1	This submodule addresses the specific challenges posed by climate change to seagrass ecosystems.
2.3.2	Rising sea temperatures and their physiological effects on seagrass species are examined, including impacts on photosynthesis, respiration, and reproductive success.
2.3.3	Ocean acidification is analyzed for its effects on seagrass calcification processes and associated organisms.
2.3.4	Sea level rise and its implications for light availability in seagrass habitats are discussed, along with potential adaptation strategies.
2.3.5	The submodule also covers changing storm patterns and extreme weather events, examining how increased frequency and intensity of storms affect seagrass resilience and recovery.
2.3.6	The cumulative and synergistic effects of multiple climate stressors are emphasized, with discussion of threshold effects and tipping points in seagrass ecosystems.
List of general readings (Bibliography)	
Amone-Mabuto, M., Bandeira, S., da Silva, A. (2017). Long-term changes in seagrass coverage and potential links to climate-related factors: the case of Inhambane Bay, southern Mozambique. <i>Western Indian Ocean Journal of Marine Science</i> 16 (2), 13–25. Bester K (2000) Effects of pesticides on seagrass beds. <i>Helgoland Marine Research</i> 54: 95- 98. Duarte, B., Martins, I., Rosa, R., Matos, A.R., Roleda, M.Y., Reusch, T.B.H. et al. (2018). Climate change impacts on seagrass meadows and macroalgal forests: An integrative perspective on acclimation and adaptation potential. <i>Frontiers in Marine Science</i> 5, 190. https://doi.org/10.3389/fmars.2018.00190. Holon, F., Boissery, P., Guilbert, A., Freschet, E. and Deter, J. (2015). The impact of 85 years of coastal development on shallow seagrass beds (<i>Posidonia oceanica</i> L. (Delile)) in South Eastern France: A slow but steady loss without recovery. <i>Estuarine, Coastal and Shelf Science</i> 165, 204–212. Intergovernmental Panel on Climate Change (2019). Summary for Policymakers. In IPCC Special Report on the Ocean and Cryosphere in a Changing Climate. Abram, N., Adler, C., Bindoff, N.L, Cheng, L., Cheong, S.-M., Cheung, W.W.L. et al. (eds.). Koch, M., Bowes, G., Ross, C. and Zhang, X-H. (2013). Climate change and ocean acidification effects on seagrasses and marine macroalgae. <i>Global Change Biology</i> 19(1),103–132. https://doi.org/10.1111/j.1365-2486.2012.02791.x. Marbà N, Duarte CM, Cebrián J, Enríquez S, Gallegos ME, Olesen B, Sand-Jensen K (1996) Growth and population dynamics of <i>Posidonia oceanica</i> in the Spanish Mediterranean coast: elucidating seagrass decline. <i>Marine Ecology Progress Series</i> 137: 203-213. O'Brien, K.R., Waycott, M., Maxwell, P., Kendrick, G.A., Udy, J.W., Ferguson, J.P. et al. (2017). Seagrass ecosystem trajectory depends on the relative timescales of resistance, recovery and disturbance. <i>Marine Pollution Bulletin</i> 134, 166–176. https://doi.org/10.1016/j.marpolbul.2017.09.006.	

Serrano, O., Lavery, P., Masque, P., Inostroza, K., Bongiovanni, J. and Duarte, C. (2016). Seagrass sediments reveal the long-term deterioration of an estuarine ecosystem. *Global Change Biology* 22(4), 1523–1531. <https://doi.org/10.1111/gcb.13195>.

Unsworth, R.K.F, McKenzie, L.J., Collier, C.J., Cullen-Unsworth, L.C., Duarte, C.M., Eklöf, J.S. et al. (2019). Global challenges for seagrass conservation. *Ambio* 48(8), 801–815. <https://doi.org/10.1007/s13280-018-1115-y>.

Wolf, E., N. Arnell, P. Friedlingstein, J. M. Gregory, J. Haigh, A. Haines, E. Hawkins, G. Hegerl, B. Hoskins, G. Mace, I. C. Prentice, K. Shine, P. Smith, R. Sutton, C. Turley, H. Margue, E. Surkovic, R. Walker, A. J. Challinor, E. Dlugokencky, N. Gallo, M. Herrero, C. Jones, J. R. Porter, C. Le Quéré FRS, R. Pearson, D. Smith, P. Stott, C. Thomas, M. Urban, P. Williamson, R. Wood & T. Woollings, 2017. Climate updates: Progress since the fifth Assessment Report (AR5) of the IPCC Climate updates: what have we learnt since the IPCC 5th Assessment Report? The Royal Society, <https://eprints.whiterose.ac.uk/126326/>.

Yaakub, S.M., McKenzie, L.J., Erftemeijer, P.L., Bouma, T. and Todd, P.A. (2014). Courage under fire: seagrass persistence adjacent to a highly urbanised city-state. *Marine Pollution Bulletin* 83(2), 417-424. <https://doi.org/10.1016/j.marpolbul.2014.01.012>.

5.3. Module 3: Conservation of Seagrass Ecosystems and Environmental Impact Assessment Studies in Mediterranean Countries

Module Code	Module title	
M3	Conservation of Seagrass Ecosystems and Environmental Impact Assessment Studies in Mediterranean Countries	
Training Content of the module:		
Topic No.	Training contents / Topic title	
3.1	Conservation of Seagrass Ecosystems	
3.1.1	This submodule explores various strategies and frameworks for seagrass conservation. It begins with an examination of international conventions relevant to seagrass protection, including the Convention on Biological Diversity, the Ramsar Convention on Wetlands, and the Barcelona Convention for the Protection of the Mediterranean Sea.	
3.1.2	The EU Water Framework Directive and Marine Strategy Framework Directive are analyzed in depth, with particular focus on their requirements for monitoring and achieving good environmental status in coastal waters where seagrasses are present.	
3.1.3	The submodule also covers marine protected area design and management for seagrass conservation, including size considerations, zonation approaches, and enforcement challenges. Community-based conservation initiatives are presented as complementary approaches, with case studies of successful stakeholder engagement in seagrass protection.	
3.2	Impact studies in Mediterranean countries	
3.2.1	This submodule presents a comparative analysis of environmental impact assessment methodologies and outcomes in Mediterranean countries with relevance to seagrass conservation. It covers baseline survey techniques specifically adapted for seagrass habitats, including standardized monitoring protocols and indicator selection.	

3.2.2	Impact prediction methodologies for projects potentially affecting seagrasses are examined, including modeling approaches and uncertainty analysis. The application of the mitigation hierarchy (avoid, minimize, restore, offset) in the context of seagrass impacts is discussed, with emphasis on the challenges of seagrass restoration and offsetting.
3.2.3	The submodule includes detailed case studies from various Mediterranean countries, examining how different regulatory frameworks and assessment approaches have influenced seagrass conservation outcomes. Lessons learned from these experiences are discussed in terms of their applicability to the Black Sea context, with consideration of ecological, regulatory, and socioeconomic differences between regions.

List of general readings (Bibliography)

Asmala, E., Gustafsson, C., Krause-Jensen, D., Norkko, A., Reader, H., Staehr, P. A., & Carstensen, J. (2019). Role of eelgrass in the coastal filter of contrasting Baltic Sea environments. *Estuaries and Coasts*, 42(7), 1882-1895.

Björk, M., Short, F., Mcleod, E., Beer, S. (Eds.), 2008. *Managing Seagrasses for Resilience to Climate Change*. IUCN, Gland, Switzerland (56 pp.).

Bortone SA (2000) *Seagrasses - monitoring, ecology, physiology and management*. CRC Press. 318 pp.

Coles, R. and Fortes, M.D. (2001). Protecting seagrasses – approaches and methods. In *Global Seagrass Research Methods*. Short, F.T. and Coles, R.G. (eds.). Amsterdam: Elsevier. Chapter 23. pp. 445–463.

Herr, D., Agardy, T., Benzaken, D., Hicks, F., Howard, J., Landis, E. et al. (2015). Coastal "Blue" Carbon: A Revised Guide to Supporting Coastal Wetland Programs and Projects Using Climate Finance and Other Financial Mechanisms. Gland: IUCN International Union for Conservation of Nature. <https://doi.org/10.2305/IUCN.CH.2015.10.en>.

Hind-Ozan, E.J., and B.L. Jones. 2017. Seagrass science is growing: A report on the 12th International Seagrass Biology Workshop. *Marine Pollution Bulletin* 134: 223–227.

International Finance Corporation. (2016). *Climate Investment Opportunities in Emerging Markets*. Washington D.C. Intergovernmental Panel on Climate Change (2013). 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands. Switzerland.

Luque A, Templado JAy (2004) *Praderas y bosques marinos de Andalucía* Consejería de Medio Ambiente, Junta de Andalucía.

Martin, A., Landis, E., Bryson, C., Lynaugh, S., Mongeau, A. and Lutz, S. (2016). *Blue Carbon – Nationally Determined Contributions Inventory*. Norway: GRID-Arendal.

Turner, S. and Schwarz, A.M. (2006). Management and conservation of seagrass in New Zealand: an introduction. *Science for Conservation* 264.

United Nations Environment Programme World Conservation Monitoring Centre (2017). *Experimental Seagrass Ecosystem Accounts: A Pilot Study for One Component of Marine Ecosystem Accounts*.

Unsworth, R.K.F., Collier, C.J., Waycott, M., McKenzie, L.J. and CullenUnsworth, L.C.A (2015). framework for the resilience of seagrass ecosystems. *Marine Pollution Bulletin* 100, 34–46.

5.4. Module 4: Seagrass Mapping and Monitoring

Module Code	Module title	
M4	Seagrass Mapping and Monitoring	
Training Content of the module:		
Topic No.	Training contents / Topic title	
4.1	Techniques	
4.1.1	This submodule covers the range of techniques available for seagrass mapping and monitoring, from traditional field methods to advanced remote sensing approaches.	
4.1.2	Field survey techniques are examined in detail, including transect and quadrat sampling, biomass assessment, and shoot density counts. Underwater visual census methods are presented, with discussion of their advantages and limitations for different monitoring objectives.	
4.1.3	The submodule also covers participatory science approaches, including training protocols for volunteer monitors, data quality control mechanisms, and effective communication of monitoring results to different audiences. Standardized monitoring protocols such as SeagrassNet and Seagrass-Watch are introduced, with guidance on their implementation in the Black Sea context.	
4.2	Technologies	
4.2.1	This submodule focuses on technological tools for seagrass assessment and monitoring. Remote sensing applications are covered in depth, including satellite imagery analysis, aerial photography interpretation, and drone-based mapping techniques.	
4.2.2	Participants learn about spectral signatures of seagrasses, image classification methods, and accuracy assessment procedures.	
4.2.3	The submodule also examines underwater imaging technologies, including photogrammetry, side-scan sonar, and autonomous underwater vehicles for seagrass mapping. Geographic Information System (GIS) applications are presented, with practical instruction on spatial analysis techniques for seagrass distribution mapping, change detection, and habitat suitability modeling.	
4.3	Technologies	
4.3.1	This submodule addresses the collection, management, analysis, and interpretation of seagrass monitoring data. Data collection protocols are examined, with emphasis on standardization, quality assurance, and quality control procedures.	
4.3.2	Database design and management for seagrass monitoring programs are covered, including considerations for data sharing and interoperability.	
4.3.3	The submodule presents statistical analysis approaches for detecting change in seagrass parameters over time and space, including power analysis for monitoring program design. Data visualization techniques are explored, with guidance on creating effective maps, graphs, and other visual representations of seagrass status and trends.	
4.3.4	The integration of seagrass monitoring data with other environmental datasets is discussed, with examples of how such integration can enhance understanding of ecosystem dynamics and inform management decisions.	

List of general readings (Bibliography)

Flindt, M.R., Rasmussen, E.K., Valdermarsen, T., Erichsen, A., Kaas, H. and Canal-Vergés, P. (2016). Using a GIS-tool to evaluate potential eelgrass reestablishment in estuaries. *Ecological Modelling* 338, 122–134. <https://doi.org/10.1016/j.ecolmodel.2016.07.005>.

Goodchild, M., Huadong, G., Annoni, A., Bian, L., de Bie, K., Campbell, F. et al. (2012). Next-generation digital Earth. *Proceedings of the National Academy of Sciences* 109, 11088–11094. <https://doi.org/10.1073/pnas.1202383109>.

Gorelick, N., Hancher, M., Dixon, M., Ilyushchenko, S., Thau, D. and Moore, R. (2017). Google Earth Engine: planetary-scale geospatial analysis for everyone. *Remote Sensing of Environment* 202, 18–27. <https://doi.org/10.1016/j.rse.2017.06.031>.

McKenzie, L.J., Campbell, S.J. and Roder, C.A. (2003). *Seagrass-Watch: Manual for Mapping & Monitoring Seagrass Resources by Community (citizen) Volunteers*. Second edition. Cairns: Department of Primary Industries Queensland.

McMahon, K., van Dijk, K.-J., Ruiz-Montoya, L., Kendrick, G.A., Krauss, S.L., Maycott, M. et al. (2014). The movement ecology of seagrasses. *Proceedings of the Royal Society B* 281, 20140878. <https://doi.org/10.1098/rspb.2014.0878>.

Nahirnick, N.K., Reshitnyk, L., Campbell, M., Hessing-Lewis, M., Costa, M., Yakimishyn, J. et al. (2019). Mapping with confidence; delineating seagrass habitats using Unoccupied Aerial Systems (UAS). *Remote Sensing in Ecology and Conservation* 5, 121–135. <https://doi.org/10.1002/rse2.98>.

Phillips RC, McRoy CP (1990) *Seagrass research methods*. Monographs on oceanographic methodology. UNESCO, Paris. 210 pp.

Topouzelis, K., Makri, D., Stoupas, N., Papakonstantinou, A. and Katsanevakis, S. (2018). Seagrass mapping in Greek territorial waters using Landsat-8 satellite images. *International Journal of Applied Earth Observation and Geoinformation* 67, 98–113. <https://doi.org/10.1016/j.jag.2017.12.013>.

Traganos, D., Aggarwal, B., Poursanidis, D., Topouzelis, K., Chrysoulakis, N. and 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. *Remote Sensing* 10(8), 1227. <https://doi.org/10.3390/rs10081227>.

Veettil, B. K., R. D. Ward, M. D. A. C. Lima, M. Stankovic, P. N. Hoai & N. X. Quang, 2020. Opportunities for seagrass research derived from remote sensing: a review of current methods. *Ecological Indicators* 117: 106560.

5.5. Module 5: Policy and Management Options

Module Code	Module title	
M5	Policy and Management Options	
Training Content of the module:		
Topic No.	Training contents / Topic title	
3.1	Policy Options	
5.1.1	This submodule examines the range of policy instruments available for seagrass protection at different governance levels. International policy frameworks	

	relevant to seagrass conservation are analyzed, including multilateral environmental agreements and their implementation mechanisms.
5.1.2	Regional policies specific to the Black Sea are examined, with discussion of transboundary cooperation opportunities for seagrass protection. National policy options are presented, including legislative frameworks, regulatory approaches, and incentive mechanisms for seagrass conservation.
5.1.3	The submodule also covers the process of translating scientific knowledge into effective policies, engaging decision-makers, and advocating for seagrass protection. Policy evaluation frameworks are introduced, with methods for assessing the effectiveness of different policy instruments in achieving seagrass conservation objectives.
3.2	Management options
5.2.1	This submodule focuses on practical management approaches for seagrass conservation and sustainable use. Integrated coastal zone management frameworks are examined for their application to seagrass protection, including stakeholder engagement processes and conflict resolution mechanisms.
5.2.2	Ecosystem-based management approaches are presented, with emphasis on considering seagrasses within broader ecological and socioeconomic contexts.
5.2.3	The submodule covers seagrass restoration methods in detail, including seed-based approaches, transplantation techniques, and habitat modification, along with site selection criteria, donor material sourcing, and monitoring protocols. Adaptive management frameworks for seagrass conservation are introduced, with guidance on setting objectives, implementing actions, monitoring outcomes, and adjusting approaches based on results.
List of general readings (Bibliography)	
Björk, M., Short, F., Mcleod, E., Beer, S. (Eds.), 2008. Managing Seagrasses for Resilience to Climate Change. IUCN, Gland, Switzerland (56 pp.). Coles, R. and Fortes, M.D. (2001). Protecting seagrasses – approaches and methods. In Global Seagrass Research Methods. Short, F.T. and Coles, R.G. (eds.). Amsterdam: Elsevier. Chapter 23. pp. 445–463. European Commission. (2019). The EU Blue Economy Report 2019. Luxembourg: Publications Office of the European Union. Herr, D., Agardy, T., Benzaken, D., Hicks, F., Howard, J., Landis, E. et al. (2015). Coastal "Blue" Carbon: A Revised Guide to Supporting Coastal Wetland Programs and Projects Using Climate Finance and Other Financial Mechanisms. Gland: IUCN International Union for Conservation of Nature. https://doi.org/10.2305/IUCN.CH.2015.10.en. International Finance Corporation. (2016). Climate Investment Opportunities in Emerging Markets. Washington D.C. Intergovernmental Panel on Climate Change (2013). 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands. Switzerland. Martin, A., Landis, E., Bryson, C., Lynaugh, S., Mongeau, A. and Lutz, S. (2016). Blue Carbon – Nationally Determined Contributions Inventory. Norway: GRID-Arendal. Reynolds, L.K., Waycott, M., McGlathery, K.J. and Orth, R.J. (2016). Ecosystem services returned through seagrass restoration. Restoration Ecology 24(5), 583–588.	

Turner, S. and Schwarz, A.M. (2006). Management and conservation of seagrass in New Zealand: an introduction. *Science for Conservation* 264.

Unsworth, R.K.F, McKenzie, L.J., Collier, C.J., Cullen-Unsworth, L.C., Duarte, C.M., Eklöf, J.S. et al. (2019). Global challenges for seagrass conservation. *Ambio* 48(8), 801–815. <https://doi.org/10.1007/s13280-018-1115-y>.

van Katwijk, M.M., Thorhaug, A., Marbà, N., Orth, R.J., Duarte, C.M., Kendrick, G.A. et al. (2016). Global analysis of seagrass restoration: the importance of large-scale planting. *Journal of Applied Ecology* 53(2), 567–578. <https://doi.org/10.1111/1365-2664.12562>.

World Bank and United Nations Department of Economic and Social Affairs. (2017). *The Potential of the Blue Economy: Increasing Long-term Benefits of the Sustainable Use of Marine Resources for Small Island Developing States and Coastal Least Developed Countries*. Washington D.C.: World Bank.

6. Learning profile or target groups

The training is intended for environmental professionals, marine biologists, coastal zone managers, conservation practitioners, university students in relevant fields, environmental NGO representatives, and government officials responsible for marine resource management and conservation in the Black Sea region.

7. Training methodology

The educational material developed within the scope of the Carbon Binding Blue Black Sea - BlueC project can be taught to learners in three ways:

- In a classroom environment,
- in a virtual environment and
- In a hybrid environment.

The training employs a diverse range of teaching and learning methodologies to accommodate different learning styles and maximize knowledge retention and skill development:

- Interactive lectures with multimedia presentations
- Expert panel discussions and Q&A sessions
- Peer teaching and knowledge sharing

8. Prerequisites

It is recommended that learners who will take the training have basic knowledge of marine ecology, environmental science, or related fields. Familiarity with GIS concepts and basic underwater survey techniques would be beneficial but is not mandatory. It is assumed that the target group defined above has this background.

9. Learning materials and resources

The training content is made available on the Carbon Binding Blue Black Sea - BlueC platform in the form of:

- Carbon Binding Blue Black Sea - BlueC Syllabus (downloadable **PDF** file);

- Carbon Binding Blue Black Sea - BlueC Lecturer Notes with training content (downloadable **PDF** and **PPT** files);

The materials delivered as training content are considered required readings for the learners in the course. In addition, recommended readings could be found in the list of general readings and bibliography to each training module.

The materials are available in English Language.

10. Assignment and assessment

Assignment and assessment follow the internal rules of each delivering institution. Without prejudice to the internal rules of each institution, the following options of assessment shall be considered:

-
- regular class attendance and the associated in-class participation
- continuous assessment of the: (a) knowledge acquired by the learners, evidenced through successfully passed tests/quizzes, available on the Carbon Binding Blue Black Sea - BlueC learning platform for each training module and (b) results demonstrated by the learners in implementation of the assignments given for the different modules.

Proposed evaluation schemes:

- Regular attendance and participation in in-class activities – 70%
- Assessment of individual and/or group assignments and exercises – 30%
-
- Students who score 70% or above in overall are considered successful.

The scale can be converted to levels, points and percentages, depending on the grading systems of the countries where the course is delivered.

11. Code on academic ethics and integrity

Each institution implementing the course is encouraged to follow its own code or set of rules with regard to academic honesty, non-discrimination based on gender, ethnicity, religion or sexual orientation, open debate and respect for diverging opinions, plagiarism, etc.

Trainer Information

The Carbon Binding Blue Black Sea - BlueC (BSB00020) Trainers' Training program is delivered by Dr. Şevki DANACIOĞLU, Marine Coordinator of the Carbon Binding Blue Black Sea project. Dr. DANACIOĞLU brings extensive expertise in marine ecology, seagrass conservation, and blue carbon ecosystems to the training program. The training was conducted at Namık Kemal University on March 3-4, 2025.