Interreg NEXT Black Sea Basin

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EOL

ENVIRONMENTAL AND OCEAN LITERACY IN THE BLACK SEA BASIN

Education Manual

YUVA

Protection of Nature
HELLENIC SOCIETY FOR THE PROTECTION OF NATURE

GREEN BALKANS
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Environmental and Ocean Literacy in the Black Sea Basin Education Manual

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Interreg NEXT Black Sea Basin
Co-funded by the European Union
EOL

Environmental and Ocean Literacy in the Black Sea Basin (EOL)
BSB00432
Co-funded (90%) by the European Interreg NEXT Black Sea Basin Programme

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Project Summary

Protecting the Black Sea and its rich biodiversity begins with awareness. One of the biggest challenges in conserving this unique marine ecosystem is the general lack of understanding in society about the importance of such efforts.

The Environmental and Ocean Literacy in the Black Sea Basin (EOL) project [BSB00432] was developed to address this gap.

Co-funded by the Interreg NEXT Black Sea Basin Programme, EOL aims to strengthen environmental and ocean literacy, particularly among young people living in coastal areas of Turkey, Bulgaria, and Greece. Through a series of online and in-person workshops, educational events, and public discussions, the project seeks to build knowledge, develop green skills, and empower communities to become active stewards of the sea.

These activities, held across all three countries, are designed to help people see marine threats as personal concerns and understand that protecting ecosystems is a shared social responsibility. The collaborative international sessions provide space for open dialogue among different public representatives, encouraging the exchange of ideas and perspectives on how messages around marine conservation can better reach broader audiences.

This manual is part of that mission. It is intended to support educators, trainers, and facilitators in delivering meaningful and engaging learning experiences, ones that foster a deeper connection to the Black Sea and encourage lasting commitment to its protection.

The 18-month project is coordinated by the Yuva Association (Turkey), with the participation of the Hellenic Society for the Protection of Nature (HSPN) in Greece and the Green Balkans - Stara Zagora NGO in Bulgaria. It is co-funded at 90% by the European Interreg NEXT Black Sea Basin Programme.

YUVA Association

The YUVA Association (YUVA) works to support the out-of-school education and lifelong learning development of adults and youth, raise awareness about environmental issues, and contribute to the eradication of poverty.

YUVA was founded in 2010 with the aim of providing holistic and sustainable solutions to social issues related to environmental problems, poverty, and education. The association aims to support the development of adults and youth through formal education and lifelong learning, raise awareness in the field of ecology, and contribute to reducing poverty.

The areas of focus can be summarized as follows:

- Developing educational programs in the fields of ecology, human rights, and citizenship, and promoting intercultural learning,
- Establishing partnerships with relevant institutions to increase participation in lifelong learning across Turkey,
- Supporting disadvantaged individuals and communities in becoming self-sufficient and creating employment programs that enable them to build a better future.

The YUVA Association, with the awareness that all living beings are interconnected, works to spread a peaceful, inclusive, just, and solidarity-based way of life. It supports a culture of living together based on equality for both people and all other living beings in the community.

For more information, visit the website: https://yuva.org.tr

Hellenic Society for the Protection of Nature

The Hellenic Society for the Protection of Nature (HSPN), founded in 1951, is the first environmental NGO in Greece, and through its actions and initiatives it pursues the protection and sustainable management of the Greek natural heritage. It initiated the establishment of National Parks and Protected Areas, the modernization of environmental legislation, and the protection of habitats and endangered species of fauna and flora.

The HSPN represents the Foundation for Environmental Education (FEE) in Greece and is the national operator in Greece of all FEE's international programmes. It is a member of important international environmental organizations, such as the IUCN and MIO.

The five main areas in which the HSPN is currently active are:

- Environmental Intervention
- Nature Conservation Projects and Programmes
- Environmental Education
- Sustainable Management in the tourism sector
- Public Awareness

For more information, visit the website: https://eepf.gr/en/

Green Balkans – Stara Zagora NGO

"Green Balkans – Stara Zagora" NGO is one of the oldest and largest nature conservation civil society organizations in Bulgaria. It is the most recognizable organization in the field of conservation of rare species and habitats in the country. The organization is operating the only Wildlife Rescue Centre in Bulgaria. In addition to rehabilitating wild birds in distress, the Rescue Centre is an important captive breeding facility, fundamental to successful species recovery projects that brought back in the nature of Bulgaria extinct species of birds like the vultures, Lesser kestrel, and the Saker falcon. Identification and designation of protected areas is another important part of the organization's work.

Green Balkans played an important role in the development of the European ecological network, NATURA 2000, in Bulgaria during the European Union accession. Communication, environmental education, and public awareness raising are another key part of the organization's work.

For more information, visit the website: www.greenbalkans.org

Notes for trainers

Before the Training

- Share your mutual expectations with your team members and determine how you will work together and structure the training flow. Make sure to divide responsibilities and tasks.
- Plan with your team how to apply the sessions according to the number of participants. For example, decide how many groups will be formed in group activities, and how many participants should be in each group. Make these preparations in advance.
- Designate a suitable area to store your training materials, notes, and personal belongings. If a presentation will be used during the training, check the necessary technical equipment in advance.
- Review your training documents. If any documents are missing, make sure to complete them.
- Go through the applications and the program. Completing this preparation before the training is important; don't leave it to the last minute.
- You can use energizing and/or ice-breaking activities to focus the participants' attention during the training. If necessary, decide in advance which energizer/ice-breaking activity you will use.

Starting the Training

- At the beginning of the training, start by introducing yourself first. Emphasize that the training will be shaped by participants' thoughts and contributions, so it's important that both and they feel comfortable. Be friendly, and let them know that you look forward to have a fun and engaging time together.
- After briefly introducing yourself, thank the participants for attending and explain the purpose of the training.
- Give a brief overview of the Environmental and Ocean Literacy Project.
- Let them know that the training includes practical activities and will be enriched by their input and participation. Emphasize you value their engagement in discussions and their open expression of thoughts and ideas.

During the Training

- Clearly and explicitly communicate your expectations to the participants.
- Welcome and value everyone's contributions.
- Encourage active participation in all sessions to enhance the learning process. Give them space to share their thoughts and opinions at every opportunity.
- Keep in mind that negative emotions can trigger eco-anxiety, a deep sense of worry about the damage human activities cause to the environment. Instead, guide participants toward understanding ecological cycles and foster a connection with nature. The goal is to help them feel empowered to be part of the solution.

Environmental and ocean literacy education program overview

Sessions	Description	Duration
Session 1: Sea Breeze	An icebreaking activity is organized to create a friendly environment where participants can share their personal connections with the marine ecosystem.	30 min
Session 2: Find the Right Term	Basic and commonly known concepts about the environment, ocean literacy and marine ecosystem are introduced to the participants through a card-matching game.	35 min
Session 3: Discover the Black Sea	Participants learn about the ecosystem of the Black Sea by using a map.	60 min
	Tea Break	20 min
Session 4: Imagine the Future of the Black Sea	Participants become aware of marine issues and develop solutions to address them in the Black Sea Basin.	60 min
Session 5: Evaluation and Closing	Participants share their feedback by completing an evaluation form at the end of the education program.	15 min
Total Duration		220 min

Learning Objectives:

- Participants develop environmental awareness and a motivation of conservation motivation by learning about the structure and functioning of marine ecosystems in general, and the Black Sea ecosystem in particular.
- Participants recognize strengthen their personal connections to the sea in order to better understand its social importance.
- They analyze the problems facing oceans and marine ecosystems, explore their causes and consequences, and develop solution-oriented thinking skills.

- Participants develop a shared vision for a sustainable marine ecosystem and design action plans in line with this vision.
- They gain understanding of the causes of environmental problems affecting the Black Sea and identify concrete steps to address them.
- Through collaborative projects focused on protecting oceans and seas, participants enhance their communication, cooperation and social awareness skills.

Session 1: Sea Breeze

Session 1: Introduction - Sea Breeze

Objective: The purpose of this session is to help participants get to know each other by sharing their personal connection to the sea through a brief activity. This game sets the tone for the training while creating a warm and friendly atmosphere.

Duration: *30 min*

Session Flow:

- Trainers briefly introduce themselves and provide an overview of the project and the education program.
- Participants are then informed that they will play a game designed to help them express their personal connection to the sea.
- A sea-themed box is prepared, containing various objects that represent things related to the sea and ocean such as shells, stones, waves, piers, photos related to the sea/ocean, sounds from the sea, etc.
- Participants take turns selecting an object or photo from the box.
- They briefly introduce themselves by sharing their personal connection to the object or photo they have chosen. This may include what the object means to them, or any memories, feelings, or thoughts it evokes about the sea.
- Each participant is asked to share thoughts and emotions for about 1-2 minutes.

Materials:

- ✓ **Sea Box: A box is prepared containing various sea-themed objects and photographs. Suggested objects: Seashells, stones, photos of waves, pictures of sea animals, images of piers, etc.**

Note: If possible, this introductory session can be held outdoors, as doing so enhances participants' connection with the natural environment.

Key Learning Outcomes:

- Through marine objects and stories, participants explore how they individually connect to the sea, laying the foundation for awareness of marine ecosystems and motivation for conservation.
- Through shared stories, participants connect with one another by relating to common emotions and experiences, fostering a sense of community centered around the goal of protecting marine ecosystems.

Session 1: Sea Breeze – Notes for trainers

This session aims to build rapport among participants and help them explore their individual connections to the sea. Sharing personal stories and feelings about the sea not only deepens their emotional engagement but also fosters a shared sense of purpose. This process strengthens the emotional connection that forms the foundation of environmental education, such as ocean literacy.

- Keep in mind that participants may have very different backgrounds and experiences related to the sea. Some may have grown up near the coast, while for others, the sea might just be a natural element seen during holidays. All these connections are valuable. As a trainer, it is important to listen without judgment or comparison.

- The selected objects such as seashells, stones, wave sounds, etc. create a sensory experience that may evoke memories. These objects help participants build not only a mental, but also an emotional connection. The use of sensory stimuli (such as touch and hearing) can particularly enhance their learning process.

- Some participants may share emotional or nostalgic memories. It is important to approach these with empathy. To avoid making anyone feel obligated to speak, let them know they can simply introduce the object and offer a brief comment if they prefer. Be mindful not to put pressure on more reserved participants; if necessary, you can go first providing an example yourself as an example to model the activity.

- Since this is an introductory and relaxation session, it is beneficial to let the process unfold naturally. Emphasizing the diversity of connections to the sea ensures that everyone feels included. For those who may find it difficult to relate to the sea through an object, you can ask gentle guiding questions such as *"Why did you choose this object?"*

Session 2: Find the Right Term

Session 2: Find the Right Term

Objective: The objective of this session is to introduce participants to basic and commonly used concepts related to ocean literacy and marine ecosystems, and to match the terms with their meanings through discussion.

Duration: ***35 minutes (15 minutes group work-10 minutes discussion of the results of group work- 10 minutes end-of-session evaluation)***

Session Flow:

- The session begins with a brief introduction to the participants after which they are divided into four groups. Each group receives a set of concept and explanation cards.
- The task for each group is to match each concept with its correct explanation by pairing the concepts on the cards with the corresponding explanations.
- Groups are given 15 minutes to complete the task. Once all groups have finished, a group reflection takes place, guided by the following questions: *"Were there any concepts you encountered for the first time?" "Were there any concepts or explanations you found difficult to match?" "Were there any that surprised you?"*
- The trainer shares the correct concept-explanation matches with the participants.

Materials:

- ✓ Card sets containing basic concepts and terms that an ocean-literate person should know, along with their corresponding explanations.

Key Learning Outcomes:

Participants will learn the basic concepts of ocean literacy and marine ecosystems, gain a deeper understanding of the meaning of key terms, and develop greater awareness of marine ecosystems.

Participants will enhance their communication, collaboration, and critical thinking skills through group work and discussion.

Session 2: Find the Right Term – Notes for trainers

Why is the Ocean really important?

Around 70% of the Earth's surface is covered by ocean making it undeniably one of the planet's most significant features. The ocean plays an invaluable role both in Earth's ecosystems and in human society. Oxygen production, temperature regulation, support of biodiversity, food security and financial and economic values are some of the fundamental aspects of human prosperity the ocean provides for the planet and for the people living on it. It contributes to oxygen production, regulates global temperatures, supports biodiversity, and provides food security, as well as economic and financial value making it essential to both planetary health and human prosperity. Every action we take from the plastic we use to the seafood we consume impacts the ocean in some way. By becoming ocean-literate, we become part of a global effort to protect this vital marine ecological network.

So, the next time you walk along the shore, breathe in the ocean air, or enjoy seafood on your plate, remember: the ocean is more than just water. It's a force that shapes our lives, and in return, we have the responsibility to recognize it as a vital part of our natural world.

If you think the ocean isn't important, imagine Earth without it. Mars comes to mind. No ocean, no life support system.[1]

Sylvia Earle

[1] United Nations. (2021). The second World Ocean Assessment: World Ocean Assessment II (Vol. I). Division for Ocean Affairs and the Law of the Sea, Office of Legal Affairs, United Nations.

What is Ocean Literacy?

Ocean Literacy refers to an individual's understanding of the ocean's influence on them and their influence on the ocean. It involves knowledge of essential principles and concepts related to ocean systems, the interconnectedness between the ocean and human activities,[2] and ocean's critical role in sustaining life on Earth. Ocean literacy empowers individuals to make informed and responsible decisions regarding ocean stewardship and sustainability.[3]

The framework of ocean literacy is based on **seven essential principles**,[4] which include:

The Earth has one big ocean with many features

The ocean and life in the ocean shape the features of Earth

The ocean is a major influence on weather and climate

[2] Kelly, R., et al. (2021). Connecting to the oceans: Supporting ocean literacy and public engagement. Reviews in Fish Biology and Fisheries, 32. https://doi.org/10.1007/s11160-020-09625-9

[3] Cava, F., Schoedinger, S., Strang, C., Tuddenham, P., (2005). Science content and standards for ocean literacy: A report on ocean literacy. http://oceanliteracy.ca/wp-content/uploads/Science-Content-and-Standards-of-Ocean-Literacy.pdf

[4] Cava, F., Schoedinger, S., Strang, C., Tuddenham, P., (2005). Science content and standards for ocean literacy: A report on ocean literacy. http://oceanliteracy.ca/wp-content/uploads/Science-Content-and-Standards-of-Ocean-Literacy.pdf

The ocean makes Earth habitable

The ocean supports a great diversity of life and ecosystems

The ocean and humans are inextricably interconnected

The ocean is largely unexplored

These principles provide a foundation for understanding ocean science and its relevance to human society, guiding environmental education efforts.

The Seven Essential Principles About Our Ocean

Over time, scientists and educators have identified seven fundamental principles that define ocean literacy. These truths help us grasp the ocean's vast influence on our world:

1. **One World, One Ocean** – Though we name different seas and oceans, they are all part of one massive, interconnected system.[5],[6],[7]
2. **The Ocean Shapes Our Planet** – Waves, tides, and currents sculpt coastlines, carve landscapes, and impact weather patterns.[8]
3. **A Climate Regulator** – The ocean absorbs heat, influences winds, and drives climate patterns, making our planet habitable.[9]
4. **The Source of Life** – Without the ocean, Earth would not sustain life as we know it; marine plants generate much of the oxygen we breathe.[10],[11]
5. **A Hub of Diversity** – From tiny plankton to the giant blue whale, the ocean is home to an astonishing variety of life.[12]

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[5] McKinley, E., et al. (2023). The evolution of ocean literacy: A new framework for the United Nations Ocean Decade and beyond. Marine Pollution Bulletin, 186, 114467. https://doi.org/10.1016/j.marpolbul.2022.114467

[6] UNESCO. (2017). Ocean literacy for all: A toolkit. United Nations Educational, Scientific and Cultural Organization. https://unesdoc.unesco.org/ark:/48223/pf0000260721

[7] United Nations. (2021). The second World Ocean Assessment: World Ocean Assessment II (Vol. I). Division for Ocean Affairs and the Law of the Sea, Office of Legal Affairs, United Nations.

[8] Cava, F., Schoedinger, S., Strang, C., Tuddenham, P., (2005). Science content and standards for ocean literacy: A report on ocean literacy. http://oceanliteracy.ca/wp-content/uploads/Science-Content-and-Standards-of-Ocean-Literacy.pdf

[9] McKinley, E., et al. (2023). The evolution of ocean literacy: A new framework for the United Nations Ocean Decade and beyond. Marine Pollution Bulletin, 186, 114467. https://doi.org/10.1016/j.marpolbul.2022.114467

[10] Cava, F., Schoedinger, S., Strang, C., Tuddenham, P., (2005). Science content and standards for ocean literacy: A report on ocean literacy. http://oceanliteracy.ca/wp-content/uploads/Science-Content-and-Standards-of-Ocean-Literacy.pdf

[11] Ferreira, J. C., et al. (2021). Ocean literacy to promote sustainable development goals and Agenda 2030 in coastal communities. Education Sciences, 11(2), 62. https://doi.org/10.3390/educsci11020062

[12] McRuer, J., McKinley, E., et al. (2025). Human-ocean relationships: Exploring alignment and collaboration between ocean literacy research and marine conservation. Marine Policy, 171.

6. **A Human-Ocean Connection** – Whether through food, travel, or culture, human lives are deeply linked to the ocean.[13]
7. **Still a Mystery** – More than 80% of the ocean remains unexplored, holding secrets yet to be uncovered.[14]

Ocean Literacy milestones

The journey toward ocean literacy began in the early 2000s. Here's a glimpse into its key milestones.

- **2002** – The National Geographic Society (NGS) and the College of Exploration (CoE) began developing *Oceans for Life*[15] guide, a curriculum identifying ocean related topics that could be used in geography education
- **2004** – Around 100 Scientists, educators, and policymakers from across the U.S. gathered in a two-week online workshop in October 2004 and extensive follow-up communications were held among some 100 members of the ocean sciences and education communities.[16]
- **2005** - Building on the outcomes of the 2004 workshop and earlier work on *Oceans for Life*, a teacher's guide was produced. It included the essential principles and the fundamental concepts of ocean sciences.[17]

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[13] Kelly, R., et al. (2021). Connecting to the oceans: Supporting ocean literacy and public engagement. Reviews in Fish Biology and Fisheries, 32. https://doi.org/10.1007/s11160-020-09625-9

[14] Cava, F., Schoedinger, S., Strang, C., Tuddenham, P., (2005). Science content and standards for ocean literacy: A report on ocean literacy. http://oceanliteracy.ca/wp-content/uploads/Science-Content-and-Standards-of-Ocean-Literacy.pdf

[15] Cava, F., Schoedinger, S., Strang, C., Tuddenham, P., (2005). Science content and standards for ocean literacy: A report on ocean literacy. http://oceanliteracy.ca/wp-content/uploads/Science-Content-and-Standards-of-Ocean-Literacy.pdf

[16] UNESCO. (2017). Ocean literacy for all: A toolkit. United Nations Educational, Scientific and Cultural Organization. https://unesdoc.unesco.org/ark:/48223/pf0000260721

[17] Cava, F., Schoedinger, S., Strang, C., Tuddenham, P., (2005). Science content and standards for ocean literacy: A report on ocean literacy. http://oceanliteracy.ca/wp-content/uploads/Science-Content-and-Standards-of-Ocean-Literacy.pdf

- **2006** – The Seven Essential Principles of Ocean Literacy were formally introduced as an educational framework.[18],[19]
- **2011** – Ocean literacy gained global recognition, leading to its integration into curricula worldwide. The European Marine Science Educators Associations was also established.[20]
- **2012** - In 2012, the first international conference on Ocean Literacy in Europe was held in Bruges, Belgium.[21]
- **2015** – The launch of the first Horizon 2020-funded OL projects: SeaChange and ResponSEAble aimed at promoting public engagement with ocean issues.[22]

[18] Cava, F., Schoedinger, S., Strang, C., Tuddenham, P., (2005). Science content and standards for ocean literacy: A report on ocean literacy. http://oceanliteracy.ca/wp-content/uploads/Science-Content-and-Standards-of-Ocean-Literacy.pdf

[19] McKinley, E., et al. (2023). The evolution of ocean literacy: A new framework for the United Nations Ocean Decade and beyond. Marine Pollution Bulletin, 186, 114467. https://doi.org/10.1016/j.marpolbul.2022.114467

[20] Mokos, M., de-Bastos, E., Realdon, G., Wojcieszek, D., Papathanasiou, M., & Tuddenham, P. (2022). Navigating ocean literacy in Europe: 10 years of history and future perspectives. Mediterranean Marine Science, 23(2), 277–288. https://doi.org/10.12681/mms.26989

[21] Mokos, M., de-Bastos, E., Realdon, G., Wojcieszek, D., Papathanasiou, M., & Tuddenham, P. (2022). Navigating ocean literacy in Europe: 10 years of history and future perspectives. Mediterranean Marine Science, 23(2), 277–288. https://doi.org/10.12681/mms.26989

[22] Mokos, M., de-Bastos, E., Realdon, G., Wojcieszek, D., Papathanasiou, M., & Tuddenham, P. (2022). Navigating ocean literacy in Europe: 10 years of history and future perspectives. Mediterranean Marine Science, 23(2), 277–288. https://doi.org/10.12681/mms.26989

- **2021** – The UN declared 2021-2030 the Decade of Ocean Science for Sustainable Development , placing ocean literacy at the heart of global sustainability goals. [23],[24],[25]

Find The Right Term: Terms and Explanations

This section provides explanations for key terms used in ocean literacy and Black Sea environmental education. Trainers should use these definitions to facilitate discussions and ensure participants grasp fundamental concepts.

Ocean Literacy	**Understanding the ocean's role in supporting life, regulating climate, and influencing human activities. This knowledge empowers communities to make informed decisions regarding ocean stewardship.[26],[27]**

[23] Kelly, R., et al. (2021). Connecting to the oceans: Supporting ocean literacy and public engagement. Reviews in Fish Biology and Fisheries, 32. https://doi.org/10.1007/s11160-020-09625-9

[24] McRuer, J., McKinley, E., et al. (2025). Human-ocean relationships: Exploring alignment and collaboration between ocean literacy research and marine conservation. Marine Policy, 171.

[25] United Nations. (2021). The second World Ocean Assessment: World Ocean Assessment II (Vol. I). Division for Ocean Affairs and the Law of the Sea, Office of Legal Affairs, United Nations.

[26] Ferreira, J. C., et al. (2021). Ocean literacy to promote sustainable development goals and Agenda 2030 in coastal communities. Education Sciences, 11(2), 62. https://doi.org/10.3390/educsci11020062

[27] Kelly, R., et al. (2021). Connecting to the oceans: Supporting ocean literacy and public engagement. Reviews in Fish Biology and Fisheries, 32. https://doi.org/10.1007/s11160-020-09625-9

Basin	**An area defined by topographic boundaries where water, sediments, nutrients, and chemicals flow into a common stream. This system channels rainfall into rivers which eventually lead to seas or oceans.[28]**
Marine Protected Area (MPA)	**Specially designated ocean zones where human activities are managed to protect ecosystems, promote biodiversity, and sustain fisheries. In these areas, activities such as fishing, resource extraction and other human activities are restricted or prohibited.[29],[30]**
Ocean Acidification	**The absorption of CO2 from the atmosphere that dissolves in ocean water lowering pH levels and threatening marine organisms such as coral reefs and shellfish.[31],[32]**

[28] UNESCO. (2017). Ocean literacy for all: A toolkit. United Nations Educational, Scientific and Cultural Organization. https://unesdoc.unesco.org/ark:/48223/pf0000260721

[29] UNESCO. (2017). Ocean literacy for all: A toolkit. United Nations Educational, Scientific and Cultural Organization. https://unesdoc.unesco.org/ark:/48223/pf0000260721

[30] United Nations. (2021). The second World Ocean Assessment: World Ocean Assessment II (Vol. I). Division for Ocean Affairs and the Law of the Sea, Office of Legal Affairs, United Nations.

[31] UNESCO. (2017). Ocean literacy for all: A toolkit. United Nations Educational, Scientific and Cultural Organization. https://unesdoc.unesco.org/ark:/48223/pf0000260721

[32] United Nations. (2021). The second World Ocean Assessment: World Ocean Assessment II (Vol. I). Division for Ocean Affairs and the Law of the Sea, Office of Legal Affairs, United Nations.

Coastal Erosion	**The wearing away of coastlines due to natural events like waves, tides, as well as human activities like sand mining. It impacts local communities and marine ecosystems.[33],[34]**
Anoxic Layer	**Areas of water with severely depleted oxygen levels, often found in deep waters or eutrophic zones, creating "dead zones" harmful to marine life.[35]**
Eutrophication	**Excess nutrients–often from agricultural runoff or sewage– trigger algae blooms, oxygen depletion, and fish kills.[36]**
Marine Invasive Species	**Species introduced to new environments through human activities (e.g., shipping), which disrupt native ecosystems and reduce biodiversity.[37]**

[33] Cava, F., Schoedinger, S., Strang, C., Tuddenham, P., (2005). Science content and standards for ocean literacy: A report on ocean literacy. http://oceanliteracy.ca/wp-content/uploads/Science-Content-and-Standards-of-Ocean-Literacy.pdf

[34] United Nations. (2021). The second World Ocean Assessment: World Ocean Assessment II (Vol. I). Division for Ocean Affairs and the Law of the Sea, Office of Legal Affairs, United Nations.

[35] United Nations. (2021). The second World Ocean Assessment: World Ocean Assessment II (Vol. I). Division for Ocean Affairs and the Law of the Sea, Office of Legal Affairs, United Nations.

[36] United Nations. (2021). The second World Ocean Assessment: World Ocean Assessment II (Vol. I). Division for Ocean Affairs and the Law of the Sea, Office of Legal Affairs, United Nations.

[37] United Nations. (2021). The second World Ocean Assessment: World Ocean Assessment II (Vol. I). Division for Ocean Affairs and the Law of the Sea, Office of Legal Affairs, United Nations.

Climate Change	**Long-term shifts in temperature and weather patterns caused by natural processes and human activities, like greenhouse gas emissions.[38],[39]**
Bycatch	**The accidental capture of non-target species, including marine mammals, turtles, and juveniles, threatening marine biodiversity.[40],[41]**
Ballast Water	**Water carried in ships to maintain stability, often containing invasive species that can be released into new environments.[42]**

[38] McRuer, J., McKinley, E., et al. (2025). Human-ocean relationships: Exploring alignment and collaboration between ocean literacy research and marine conservation. Marine Policy, 171.

[39] United Nations. (2021). The second World Ocean Assessment: World Ocean Assessment II (Vol. I). Division for Ocean Affairs and the Law of the Sea, Office of Legal Affairs, United Nations.

[40] United Nations. (2021). The second World Ocean Assessment: World Ocean Assessment II (Vol. I). Division for Ocean Affairs and the Law of the Sea, Office of Legal Affairs, United Nations.

[41] Bellido, J. M., Santos, M. B., Pennino, M. G., Valeiras, X., & Pierce, G. J. (2011). Fishery discards and bycatch: solutions for an ecosystem approach to fisheries management? Hydrobiologia, 670(1), 317–333. doi:10.1007/s10750-011-0721-5

[42] United Nations. (2021). The second World Ocean Assessment: World Ocean Assessment II (Vol. I). Division for Ocean Affairs and the Law of the Sea, Office of Legal Affairs, United Nations.

Bottom Trawling and Dredging	**Destructive fishing practices that damage seabed habitats and reduce biodiversity.[43]**
Energy Balance in the Food Web	**The network of energy flow from producers to consumers in an ecosystem, essential for maintaining ecosystem health and stability.[44]**
Fish Discard	**The act of throwing unwanted catch back into the sea, often resulting in ecological waste and mortality of species.[45]**
Carbon Storage	**Sequestration of carbon in marine systems like seagrass beds, mangroves, and ocean sediments, helping mitigate climate change.[46]**

[43] United Nations. (2021). The second World Ocean Assessment: World Ocean Assessment II (Vol. I). Division for Ocean Affairs and the Law of the Sea, Office of Legal Affairs, United Nations.

[44] Ferreira, J. C., et al. (2021). Ocean literacy to promote sustainable development goals and Agenda 2030 in coastal communities. Education Sciences, 11(2), 62. https://doi.org/10.3390/educsci11020062

[45] Bellido, J. M., Santos, M. B., Pennino, M. G., Valeiras, X., & Pierce, G. J. (2011). Fishery discards and bycatch: solutions for an ecosystem approach to fisheries management? Hydrobiologia, 670(1), 317–333. doi:10.1007/s10750-011-0721-5

[46] United Nations. (2021). The second World Ocean Assessment: World Ocean Assessment II (Vol. I). Division for Ocean Affairs and the Law of the Sea, Office of Legal Affairs, United Nations.

Carbon Emmissions	**The release of gases such as CO_2 and methane into the atmosphere as a result of the burning of fossil fuels, deforestation, and other human activities. These gases significantly influence climate systems.[47]**
Fossil Fuel	**Non-renewable energy sources like coal, oil, and natural gas derived from decomposed organic matter which are major contributors to CO_2 emissions.[48]**
Mucilage (Sea Snot)	**Organic, jelly-like material produced by microorganisms during nutrient overload and warm temperatures, associated with eutrophication.[49]**

[47] United Nations. (2021). The second World Ocean Assessment: World Ocean Assessment II (Vol. I). Division for Ocean Affairs and the Law of the Sea, Office of Legal Affairs, United Nations.

[48] United Nations. (2021). The second World Ocean Assessment: World Ocean Assessment II (Vol. I). Division for Ocean Affairs and the Law of the Sea, Office of Legal Affairs, United Nations.

[49] Leppard, G. G. (1995). The characterization of algal and microbial mucilages and their aggregates in aquatic ecosystems. Science of The Total Environment, 165(1-3), 103–131. doi:10.1016/0048-9697(95)04546-d

Session 3: Discover the Black Sea

Session 3: Discover the Black Sea

Objective: The aim of this session is to provide basic information about the Black Sea ecosystem and raise awareness of its biodiversity and conservation status in an interactive, and collaborative learning environment.

Duration: ***60 minutes***

Session Flow:

- The session is briefly introduced to the participants. (5 minutes)
- Participants are divided into four groups. Each group is given a map of the Black Sea. Each group is also given 8 species cards, each containing a photo and information about the species.
- Each group places the species cards on the map in the appropriate marine environments (coast, deep sea, etc.) using sticky notes. (15 minutes)
- After placing the cards, each group presents what they have learned about their assigned species to the rest of the groups. (20 minutes)
- At the end of the session, a brief presentation is given about the species to reinforce the topic and consolidate learning. (15 minutes)
- At the end of the session, a few participants are invited to share their thoughts by answering questions such as, "How was this session for you?" and "What did you find most interesting?" (5 minutes)

Materials:

- ✓ Black Sea Map: This map is designed as a vertical cross-section. In this way, species cards can be placed by participants on the areas of the map where the species are found.
- ✓ Species Cards: Each species card includes a clear image of the species and information about its biological characteristics, natural habitat, role within the ecosystem, and more.
- ✓ Presentation: Contains general information about the Black Sea and details about the species.
- ✓ Patafix Adhesive: Used to attach the species cards to the map.

Key Learning Outcomes:

- ❖ Participants learn about the characteristics of the Black Sea ecosystem.
- ❖ Participants increase their environmental awareness by understanding the roles of living organisms in the marine ecosystem and their conservation status, reinforcing this knowledge by sharing it with the group.

Session 3: Discover the Black Sea – Notes for trainers

General Characteristics of the Black Sea

The Black Sea, covering an area roughly one-third the size of continental Europe, is one of the largest inland water basins in the world. Although almost entirely isolated from the world's oceans it reaches depths of over 2000 meters and receives river inputs from a vast catchment territory that spans parts of seventeen countries. Among the rivers feeding into it are the Danube, the Dnieper, and the Don–Europe's second, third, and fourth largest rivers, respectively.

The Black Sea connects to the Mediterranean only through the narrow and winding Bosphorus Strait, a 35-kilometer long natural channel that is just 40 meters deep and 700 meters wide at its narrowest point. From there, water flows into the Sea of Marmara and then through the Dardanelles into the Aegean Sea. This complex natural system makes the replenishment of seawater in the Black Sea very slow.

Every year the rivers pour an average of 350 cubic kilometers of water into the Black Sea. Because it receives more freshwater than it loses through evaporation, the average salinity of the Black Sea is relatively low, around 18‰, compared to about 36‰ in the Mediterranean Sea and the World Ocean. The surface outflow, a mixture of seawater and freshwater, from the Black Sea to the Aegean amounts to about 610 cubic kilometers annually. To compensate for this loss of water, the Black Sea receives an inflow from the Mediterranean with higher salinity but the volume is roughly twice smaller. It enters the sea as an underflow through the Bosphorus, which also carries the outflow. Since the two layers do not mix easily, the Black Sea has developed a surface layer about 100 meters deep, which contains significantly more freshwater than the denser, saltier waters below.

The replenishment of bottom waters of the Black Sea with new seawater from the Mediterranean takes hundreds of years. This very slow rate of replenishment and the large input of freshwater has led to a stratification of

the Black Sea that has now got a lighter and fresher upper layer and a denser underlying layer.

The slow replenishment, slow mixing of waters and limited oxygen supply, the process of decomposition is impaired and the bacteria consumes the remaining oxygen entirely creating anoxic conditions below a depth of about 180 metres, a boundary that continues to rise. In these anoxic layers, the metabolism of some bacteria generate hydrogen sulphide, a toxic, soluble gas with the distinctive smell of rotten eggs. Hydrogen sulphide is present in the entire lower layer of seawater in the Black Sea.

As a result the Black Sea is now considered the largest natural anoxic water basin in the world. Approximately 87 % of its volume is almost devoid of marine life, aside from specialized forms of bacteria. Despite these extreme conditions, the Black Sea is still comparatively rich in living resources. Its shelf areas and river deltas are important spawning grounds for sturgeon and other fish species. The coastal wetlands serve as vital migration and breeding areas for numerous rare and endangered European bird species. In addition, the warm coastal waters, and the natural beauty of the Black Sea's shorelines, plains, and mountains continue to attract millions of tourists every year.

An Overview of the Biodiversity of the Black Sea

Despite the varying conditions at different depths, the Black Sea is a single, interconnected ecosystem, operating in a tightly regulated and energy-defined cycle. The approximately 300 rivers flowing into the Black Sea deliver biogenic substances – including salts of nitrogen, phosphorus and other essential minerals for plants.These nutrients support the growth of algae and seagrasses, which, using sunlight, form the base of the food web. They nourish the herbivorous animals, which in turn serve as food for predatory invertebrates and fish.he latter, in turn, serve as food for birds and dolphins.

The Black Sea, is home to approximately 1 520 species of animals, including 164 species of fish and 3 species of mammals. It also hosts approximately 600 species of plants – algae and seagrass. Many animal species in the Black Sea arrived after its most recent reconnection to the Mediterranean. About 140 species are relicts from the freshwater Pontic Lake era, including autochthonous, Sarmatian, and Pontic species, often referred to as Caspian

species. These species mainly inhabit the brackish coastal zones, lakes, estuaries, and some river systems, particularly the Danube and the Dnieper.

Information about the species to be presented in this session:

The balance of every ecosystem is based on the full functioning of all its components - particularly the presence of each species native to that ecosystem. Due to the numerous rivers flowing into it, the Black Sea is rich in nutrients. However, due to its unique characteristics, such as significantly lower salinity, stratification, and limited water exchange compared to the global ocean, its species diversity is relatively low. This makes the Black Sea ecosystem highly vulnerable. For example, rich nutrients favor the development of invasive species especially when the natural balance among local species is disrupted. Also, ecosystems with low biodiversity tend to have weaker protective and restorative capabilities and are making them more susceptible to ecological catastrophes. To illustrate all this, below is a selection of representative species from the Black Sea biota organized by trophic level.

Yellow-legged gull: Found in coastal waters and lagoons, in inland water bodies and agricultural lands, as well as in urban areas.[50] It feeds on fish, mammals, bird eggs and chicks and also scavenges food scraps from garbage sites.[51] Typically the most numerous bird species along the coast.

Yelkouan shearwater: A medium-sized seabird, endemic to the Mediterranean Basin. A significant portion of the population winters in the Black Sea. During its annual migration to the Black Sea, large numbers pass through the Straits. It breeds in burrows, rocky cavities or big caves on rocky coastal and offshore islets, and on steep, inaccessible cliffs on the mainland. It feeds on fish and mollusks.[52] It follows fishing boats for discarded offal. Bycatch

[50] eBird. (2025). Yellow-legged gull. eBird. Retrieved from https://ebird.org/species/yelgul1

[51] Furtun, Ö. L., Erciyas Yavuz, K., & Karataş, A. (Eds.). (2021). Trakuş: Birds of Turkey. Istanbul, Turkey: İş Bank Cultural Publications, p. 170.

[52] Furtun, Ö. L., Erciyas Yavuz, K., & Karataş, A. (Eds.). (2021). Trakuş: Birds of Turkey. Istanbul, Turkey: İş Bank Cultural Publications, p. 73.

is one of the factors that threaten the species.[53] One of the few truly seabird species inhabiting the Black Sea region.

European shag: A species of cormorant that breeds in colonies along rocky shorelines. It is one of the cormorant species known for its deep diving ability (up to 45 meters). It feeds in the sea, and, unlike the great cormorant, is rarely found inland.[54] The shag is a pursuit-diving seabird that feeds predominantly in benthic habitats.

Mediterranean gull: A small to medium-sized seabird with a black head and dark red beak and legs. Commonly seen along coastal areas, or joining large gull roosts on inland lakes and reservoirs. The main breeding area for this beautiful gull is around the Black Sea. An opportunistic omnivore, it eats fish, worms, insects, eggs, young birds, offal and carrion.[55]

Sandwich tern: A very white tern, with a black cap on its head. Nesting colonies are located on dikes or islands, and the nest is basically a dimple in the ground, without any building material. Suitable nesting habitats for this species is rare in the Black Sea. It undertakes a very long migration, reaching South Africa. It feeds mostly on small fish, as well as shrimp, crustaceans and insects.[56]

Barrel jellyfish: A large translucent jellyfish with a huge mushroom shaped bell and eight frilly tentacles below. Blooms occur in the Black Sea from

[53] BirdLife International. (2025). Species factsheet: Yelkouan Shearwater Puffinus yelkouan. Downloaded from https://datazone.birdlife.org/species/factsheet/yelkouan-shearwater-puffinus-yelkouan on January 30, 2025.

[54] Furtun, Ö. L., Erciyas Yavuz, K., & Karataş, A. (Eds.). (2021). Trakuş: Birds of Turkey. Istanbul, Turkey: İş Bank Cultural Publications, p. 95.

[55] Furtun, Ö. L., Erciyas Yavuz, K., & Karataş, A. (Eds.). (2021). Trakuş: Birds of Turkey. Istanbul, Turkey: İş Bank Cultural Publications, p. 177.

[56] Furtun, Ö. L., Erciyas Yavuz, K., & Karataş, A. (Eds.). (2021). Trakuş: Birds of Turkey. Istanbul, Turkey: İş Bank Cultural Publications, p. 166.

September and November.[57] This species is a very mild stinger.[58] It plays a role in nutrient distribution by consuming plankton and enriching the surrounding water with waste containing essential elements. Moreover, their presence and interactions with other species can influence the structure and dynamics of marine communities.

Moon jellyfish: A carnivorous jellyfish that primarily feeds on plankton, crustaceans, and mollusks. Known a very mild stinger, it plays a key role in marine food webs. By feeding on smaller creatures such as fish larvae and eggs, jellyfish help to control species' populations and maintain the balance of the ocean's ecosystem.[59] As well as eating other animals, jellyfish are often prey themselves – even for other jellyfish! Moon jellyfish can serve as an indicator of marine ecosystems out of balance.

Comb jelly (Sea Walnut): This ctenophore (a stingless jellyfish-like animal) is native to the east coast of North and South America. It has been established as an invasive species in Black Sea. Ships carrying ballast water from the American coast transported this jellyfish to a port in the Black Sea. With few enemies in its new habitat, the comb jelly propagated at an alarming rate. Its predatory and competitive activity decreases fish and crustacean zooplankton populations.

Common shrimp: Typically found in fine sand or slightly muddy substrates but can also be found in areas with larger grains of sand. The young individuals live in seagrass meadows and bare sand flats. Thrives in areas with fluctuating water levels and low salinity. Feeds on small bottom-dwelling organisms like

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[57] ÖZTÜRK, B., TOPALOGLU, B., SÜMEN, S.G., TURAN, C., İŞİNİBİLİR, M., AKTAŞ, Ş., ÖZEN, Ş. 2018. Jellyfish of the Black Sea and Eastern Mediterranean Waters. Turkish Marine Research Foundation (TUDAV) Publication No. 48, Istanbul, Turkey. 75 pages.

[58] İşinibilir, M., Okyar, A., & Öztürk, N. (2017). TÜRKİYE DENİZLERİNDE ZEHİRLİ DENİZANALARI VE TOKSİK ETKİLERİ. Aquatic Sciences and Engineering, 32(3), 154-169. https://doi.org/10.18864/TJAS201714

[59] Öztürk, B., Aktan, Y., Topaloğlu, B., Keskin, Ç., Öztürk, A. A., Dede, A., & Türkozan, O. (2004). Marine life of Turkey in the Aegean and Mediterranean Seas. Turkish Marine Research Foundation (TUDAV) Publications. Marine Education Series. Number 10, Istanbul, Turkey, Uniprint Basım San. ve Tic.

crustaceans, worms, mollusks, and fishery waste.[60] Plays an important role in the food chain serving as an important food source for larger animals - from fish to birds.

Small hermit crab: Like other hermit crabs, uses empty mollusk shells to protect its soft abdomen. Common on flattish sandy beaches where the waves sweep up the shore. When exposed, they rapidly bury themselves in the sand. Hermit crabs represent a very important macrozoobenthic group. As a scavenger, it plays an important role in the marine trophic chain.

Bay barnacle: It is found in shallow coastal waters, estuaries and bays. It feeds by filtering suspended particles from the water. A filter feeder, they play an important role in the food chain, consuming plankton and dissolved detritus suspended in seawater, therefore essential in cleansing the water.[61] Also a key food source for fish, seabirds, and other marine animals.

Rapa whelk: A species of large predatory sea snail, native to the Northeast Pacific. It is an invasive alien species transported to the Black Sea via ballast water. In the Black Sea, it feeds primarily on bivalve mollusks. The invasion of the species severely affected the Black Sea, reducing populations of oysters, mussels, and clams.

Common prawn: Lives in shallow waters on rocky and muddy areas.[62] Along with many other species of prawns and shrimps in the sea, they are a vital part of the marine food chain, eaten by many fish. They are mostly scavengers feeding on detritus, algae and small benthic microorganisms, but they are predators, too. Their feeding habits help control algae growth and promote nutrient cycling, maintaining the balance of the ecosystems. Considered a bioindicator of environmental health.

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[60] SeaLifeBase. (n.d.). *Crangon crangon*. Retrieved January 29, 2025, from https://www.sealifebase.se/summary/Crangon-crangon.html

[61] SeaLifeBase. (n.d.). *Amphibalanus improvisus*. Retrieved January 29, 2025, from https://www.sealifebase.se/summary/Amphibalanus-improvisus.html

[62] SeaLifeBase. (n.d.). *Palaemon serratus*. Retrieved January 29, 2025, from https://www.sealifebase.se/summary/Palaemon-serratus.html

Marbled shore crab: A prevalent intertidal crab species, inhabiting coastal zones, as well as crevices in breakwaters, pier piles, and similar places. It has an omnivorous diet, feeding both on plants and animals.[63] It is an indicator of a stable and biodiverse ecosystem due to its contribution to ecological balance through its diverse feeding and regulation of prey populations. Shore crabs are eaten mainly by fish and birds (e.g. gulls, cormorants).

Mediterranean mussel: Lives in shallow calm waters, attaching to rocky substrates. They are suspension feeders, feeding on detritus and phytoplankton.[64] As filter feeders, they help remove pollutants from the water. These mussels reproduce by releasing eggs into the water during spawning. Fertilized eggs develop into larvae. Both eggs and larvae serve as food source for many marine animals. Plays important ecological roles such as habitat, food, water filtration and recreational fishing. Severely impacted by the Rapa whelk invasion that affected this important filtrator of the Black Sea ecosystem.

Striped venus clam: A small saltwater bivalve that lives buried in shallow sandy or muddy areas.[65] They feed on plankton that they obtain from water by filtering it. As a filter feeder, the species plays a vital role in maintaining water quality. By filtering out suspended particles, it supports the overall health of the marine environment.

Mediterranean limpet: A marine gastropod found in coastal zones. Their serving at different levels in the food chain makes them important for the functioning of marine ecosystems.[66] Limpets are considered a key species in

[63] SeaLifeBase. (n.d.). *Pachygrapsus marmoratus*. Retrieved January 29, 2025, from https://www.sealifebase.se/summary/Pachygrapsus-marmoratus.html

[64] SeaLifeBase. (n.d.). *Mytilus galloprovincialis*. Retrieved January 29, 2025, from https://www.sealifebase.se/summary/Mytilus-galloprovincialis.html

[65] Kosyan, A. R., & Divinsky, B. V. (2019). Chamelea gallina in the coastal waters of the Anapa bay bar (the Black Sea) as a carbonate sediment producer. Oceanologia, 61(4), 471-483.

[66] Hakenkamp, C. C., & Morin, A. (2000). The importance of meiofauna to lotic ecosystem functioning. Freshwater Biology, 44, 165-175. https://doi.org/10.1046/j.1365 2427.2000.00589.x

coastal ecosystems and are commonly collected for food and fishing bait.[67] Through their feeding behaviour as scraper, limpets regulate the density of benthic organisms, such as macroalgae and barnacles, thus influencing the benthic community structure and biodiversity. Used as a bioindicator for heavy metal pollution and is widely used in marine pollution monitoring programs.[68]

Cladophora: A green algae providing food and habitat or numerous organisms. It tolerates wide variations in salinity and temperature and grows on rocks, other plants, or sea animals. It is commonly found in the Black Sea. *Cladophora* growth is an important food for many fish and other aquatic animals, as a buffer for the sequestration of nutrients in the water body and for protection of some aquatic organisms from solar ultraviolet radiation. These plants are used in medicine due to their antibiotic and anti-tumor properties.[69]

Bonito: Bonito migrate from the Marmara Sea to the Black Sea during the warm season for feeding and reproduction and return to Marmara Sea in the cold season to overwinter. As a top predator[70], it feeds on anchovy, horse mackerel, and sprat. As a large schooling species, bonito provides an important food source to the Bottlenose dolphins. It holds a high economic value for the fisheries in the region.

Sprat: A shoaling fish that lives and reproduces both in fresh and in saline waters. It reaches sexual maturity at around two years of age, withspawning

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[67] Menge, B. A. (2000). Top-down and bottom-up community regulation in marine rocky intertidal habitats. Journal of Experimental Marine Biology and Ecology, 250, 257-289. https://doi.org/10.1016/S0022-0981(00)00200-8

[68] Storelli, M. M., & Marcotrigiano, G. O. (2005). Bioindicator organisms: Heavy metal pollution evaluation in the Ionian Sea (Mediterranean Sea, Italy). *Environmental Monitoring and Assessment, 102*(1–3), 159–166. https://doi.org/10.1007/s10661-005-6018-2

[69] Milchakova, N. A. (2011). Marine plants of the Black Sea. *An illustrated field guide*.

[70] Daskalov, G., Demirel, N., Ulman, A., Georgieva, Y., Zengin, M. Stock dynamics and predator–prey effects of Atlantic bonito and bluefish as top predators in the Black Sea, *ICES Journal of Marine Science*, Volume 77, Issue 7-8, December 2020, Pages 2995–3005, https://doi.org/10.1093/icesjms/fsaa182

occuring in spring. A single female may lay up to 20 000 eggs![71] It feeds on zooplankton. Adult sprats feed on copepods, while juveniles feed on the eggs and larvae of these crustaceans. Important food source for larger predators as Bonito and cetaceans and holds considerable economic value.

Anchovy: The anchovy holds important ecological role in the pelagic ecosystems acting as either a prey or a consumer, thus establishing a fundamental link between the lower and upper trophic levels. European anchovies eat plankton[72]. They are migratory, often travelling northwards in summer and south in winter. They form large schools, and may form "bait balls" when threatened. European anchovies are eaten by many species of fish, birds and cetaceans. Due to its abundance in pelagic environments, european anchovy is one of the most commercially important species in the Black Sea.

Short-snouted seahorse: A typical representative of the group that 'grazes' plankton. It prefers shallow, protected seagrass meadows, especially during breeding. After an elegant courtship ritual that resembles a ballet, the female lays her eggs in the male's pouch[73]. The male incubates the eggs for 4 to 5 weeks. After hatching, the baby seahorses are expelled from the pouch by intense contractions.

Spiny dogfish: The Black Sea spiny dogfish is the only species of shark constantly populating the Black Sea. It can live for 25 years and reach reproductive age comparatively late at 13-14 years. It mates at great depths and embryos develop inside the female's body and after a very long 'pregnancy' (18

[71] Golemansky, V. et al. (Eds). 2015. Red Data Book of the Republic of Bulgaria. Volume 2. Animals. BAS & MoEW, Sofia.

[72] Akalin, S., Sever, T.M., Ilhan, D., & Unluoglu, A. (2019). The Diet Composition of European Anchovy, Engraulis encrasicolus (Linnaeus, 1758) in İzmir Bay, Aegean Sea. *Turkish Journal of Fisheries and Aquatic Sciences*, *19*, 431-445. http://doi.org/10.4194/1303-2712-v19_5_08

[73] Short snouted sea horse, ret.Apr 23, 2025, https://www.nausicaa.fr/en/my-visit/animals/short-snouted-seahorse

months!) the fully developed-30cm-long tiny sharks are born[74]. Unfortunately, its slow reproduction cycle makes dogfish vulnerable to overfishing.

Black Sea turbot: A bottom-dwelling predator, known as *"kalkan"* in Turkish, meaning "shield", has a distinctive flat, shield-like shape. It is one of the most valuable commercial fish species in the Black Sea. However, its intense overfishing led to a collapse of its population in the 1980s[75]. Today its catch is limited by annual quotas.

Harbour porpoise: Harbour porpoises are the smallest marine mammals in the Black Sea, with lifespans of 7-10 years. They tend to avoid humans and boats. Like other cetaceans, they use ultrasound communication to locate one another and to hunt. Marine mammals are at the top of the food chain and play an important role in the overall balance of the marine environment. Due to its preference for bottom-feeding and reliance on high-frequency biosonar, it is highly susceptible to entanglement in bottom-set fishing nets, particularly those targeting turbot.

Bottlenose dolphin: Bottlenose dolphins are the largest marine mammals in the Black Sea, typically living 25-30 years, with some individuals reaching 50! They live in stable pods with complex social structures. Dolphins' use of biosonar in addition to ultrasounds provides that they make sounds that the human ear can hear. Dolphins unlike porpoises do not avoid boats but often swim close to their bows utilizing the water flow and minimizing energy use. Bottlenose dolphins are at the top of the food chain and play an important role in the overall balance of the marine environment. This species currently has the lowest population among Black Sea cetaceans.

Common dolphin: Common dolphins are smaller in size than the bottlenose and have a lifespan of 25-30 years. They form social groups that can number in the hundreds and are known for their agility and acrobatics preferring offshore

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[74]Secrets of the Black Sea: what amazing properties has the Black Sea spiny dogfish?, ret.Apr 23, 2025https://odessa-journal.com/public/secrets-of-the-black-sea-what-amazing-properties-has-the-black-sea-spiny-dogfish

[75] Hulak, B. et al. "The current state of the turbot, Scophthalmus maximus (Linnaeus, 1758), population in the northwestern part of the Black Sea" Fisheries & Aquatic Life, vol. 29, no. 3, Sciendo, 2021, pp. 164-175. https://doi.org/10.2478/aopf-2021-0018

waters. Common dolphins are at the top of the food chain and are estimated as the most numerous of the three Black Sea marine mammal species.

Common eelgrass: Eelgrass grows in shallow bays of the northwestern Black Sea in extensive underwater meadows. Eelgrass absorbs carbon dioxide - climate-warming greenhouse gas - and stores it. The eelgrass meadow is a bustling nursery, cradling the early stages of marine life. It offers shelter and sustenance to a myriad of creatures, from the tiniest invertebrates to juvenile fish. Migratory waterfowl also eat eelgrass. Eelgrass beds are natural fortresses against coastal erosion. By offering refuge and feeding grounds, eelgrass beds bolster fish populations, which in turn supports sustainable fisheries and, respectively, the coastal economy.

Green algae: Everyone who steps from the beach into the sea meets algae and seagrasses, those basic primary producers that account for the proper functioning of the coastal marine ecosystem. They create stable habitats for many types of food chains that support the goods and services of marine ecosystems. These marine plants also stabilize bottom sediments thus preventing coastal erosion, and support maintaining clear coastal waters. Microalgae living on their filaments are a very important component of the diet of invertebrates.

Phyllophora: *Phyllophora* is a genus of red algae that inhabits the floor of the Black Sea. It is considered highly valuable due to its rich iodine content. The *Phyllophora* fields located in the northwestern part of the Black Sea, are unique habitats characterized by a dense stand of red algae and a high diversity of associated fauna[76]. This algae form dense mats up to 15 cm thick, creating habitat for numerous associated organisms. As such, they serve as indicators for the status of the benthic ecosystems.

***Euglena*:** Photosynthetic organisms inhabiting the water column are called phytoplankton. Phytoplankton are the most important primary producers in the ocean, forming the base of the marine food chain, and serving as an important component of the global carbon cycle. They inhabit surface waters throughout the sea: from coast to coast, down to depths where sunlight can

[76] Milchakova, N. Marine plants of the Black Sea. An illustrated field guide. 2011. Digit Print Press, Sevastopol, 144 pp. https://www.marineagronomy.org/node/769

penetrate[77]. *Euglena* is a representative of this group. Its population can grow rapidly, after which it is grazed by zooplankton.

Copepod: Zooplancton refers to microscopic animals inhabiting the Black Sea water column. The largest are crustaceans of the Copepoda order. They are the main phytoplankton grazers – acting as the herbivores of the marine microworld. The copepods are key prey species for many fish in the Black Sea[78], forming a vital link in the marine food chain.

[77] Klisarova, D., and Gerdzhikov, D. Atlas of the phytoplankton of the Black Sea. https://phytoplanktonblacksea.com/en/

[78] Sakınan, S., Gücü, A. Spatial distribution of the Black Sea copepod, *Calanus euxinus*, estimated using multi-frequency acoustic backscatter, *ICES Journal of Marine Science*, Volume 74, Issue 3, March-April 2017, Pages 832–846, https://doi.org/10.1093/icesjms/fsw183

Session 4: Imagine the Future of the Black Sea

Session 4 (for 18-35 years old): Imagine the Future of the Black Sea

Objective: The objective of this session is to encourage participants to understand the causes and consequences of marine issues, particularly those affecting the Black Sea, and to inspire them to think in a solution-oriented way.

Duration: ***60 min***

Session Flow:

- A short presentation is given on the marine issues affecting the Black Sea. (10 min)
- Following the presentation, participants are asked the question, "What should the Black Sea of the future look like?" The answers are written on a flipchart by the trainer.
- After collecting several responses, a few key words that reflect the group's answers are used to form the trunk of the solution tree. (5 min)
- The trunk represents the commonly agreed vision for the future of the Black Sea.
- The roots of the tree represent the current problems of the Black Sea (e.g. pollution, overfishing).
- The branches represent the actions that need to be taken at different levels to address these problems (e.g. policy, local authorities, civil society, individual behaviour change, waste management).
- Participants are divided into 4 groups. Each group is given a worksheet. They develop a solution for the assigned issue and design it within the context of local governments or non-governmental organizations. (20 min)
- Each group presents their proposed solutions to others. (20 min)
- A brief presentation about the solution proposals is made by the trainers. (5 min)
- At the end of the session, participants are invited to share their thoughts for a general evaluation of the session.

Materials:

- ✓ Presentations prepared on the topic: one for use at the beginning and one at the end of the session.
- ✓ Paper, pens, large sheets of paper, or whiteboards.
- ✓ Worksheets for group activities.

Key Learning Outcomes:

- Participants understand the causes and consequences of major issues in ocean and marine ecosystems.
- Participants develop a sense of responsibility while creating individual and collective solutions to ocean and marine problems.

Session 4 (for local governments): Imagine the Future of the Black Sea

Objective: The objective of this session is to encourage participants to understand the causes and consequences of marine issues, particularly those affecting the Black Sea, and to inspire them to think in a solution-oriented way. In this session, participants will identify problems through mapping and design solutions based on these maps.

Duration: ***60 min (Group work: 40 minutes and group presentations & discussion: 20 minutes)***

Flow of the session:

- Participants receive a brief introduction to the marine problem mapping activity.
- As a group they discuss the marine issues observed and prioritized in the province being studied that day (e.g., Kırklareli).
- Participants then mark coastal and marine problems in their respective regions on the map, using the relevant colors to represent each type of issue.
- They analyze and observe the areas where problems are most concentrated.
- Participants are divided into small groups of 4-5 people, with each group assigned a different identified problem to focus on.
- Each group develops solutions to the problem they have been assigned.
- Groups present their proposed solutions to the rest of the participants. During the presentation, the solutions are marked on the map, and the working process of the solution is explained.
- Based on feedback from the other groups, teams have the opportunity to refine and improve their solutions.

Materials:

- ✓ **Color or Object Identification: A specific color or object is assigned to each issue topic. For example, pollution is represented by the color red.**
- ✓ **A map of the area where the training takes place that day will be provided.**

Key Learning Outcomes:

- Participants gain an understanding of the causes and consequences of major issues affecting ocean and marine ecosystems.
- Participants develop a sense of responsibility while creating both individual and collective solutions to ocean and marine problems.
- Participants share and visualize their vision for sustainable ocean and marine ecosystems.

Session 4: Imagine the Future of the Black Sea – Notes for trainers

Climate Change

Climate change refers to long-term shifts in temperature and weather patterns caused both by natural phenomena and human activities, particularly the greenhouse gas (carbon dioxide, methane, etc.) emissions. Since the 1800s, human activities have been the main driver of climate change, primarily due to the burning of fossil fuels like coal, oil, and gas. Burning fossil fuels generates greenhouse gases that act like a blanket around the Earth, trapping the sun's heat and causing temperatures to rise. THe energy, industry, transportation, building, agriculture and land-use sectors are among the main contributors to greenhouse gas emissions. As a result of human activity, the amount of carbon dioxide in the atmosphere has increased by 50% in less than 200 years.

The Direct Effects of Climate Change: Sea Level Rise, Global Temperature Rise, Sea Temperature Rise, etc.

Global mean sea level has risen by approximately 21–24 centimeters since 1880. This rise is mostly due to a combination of meltwater from glaciers and ice sheets and the thermal expansion of seawater as it warms. In 2023, global mean sea level was 101.4 millimeters above 1993 levels, making it the highest annual average in the satellite record (1993-present). The Black Sea's water level has been rising at an average rate of 1 mm/year from January 1993 to June 2023.

The average temperature of the Earth's surface is now about 1.2°C warmer than it was in the late 1800s, before the industrial revolution–and warmer than at any time in the last 100,000 years. The previous decade (2011-2020) was the warmest on record, and each of the last four decades has been warmer than any previous decade since 1850. While many people associate climate change primarily with warmer temperatures, temperature increase is just the beginning. Because Earth functions as an interconnected system, changes in one area can influence changes in all others.

About 90% of global warming is taking place in the oceans, increasing their internal heat content since modern record keeping began in 1955. The heat stored in the oceans causes water to expand, accounting for one-third to one-half of global sea level rise. Most of this excess energy is stored in the upper layers, between 0 to 700 meters in depth. The past 10 years were the warmest decade for the ocean since at least the 1800s. The year 2024 was the ocean's warmest year on record. Between 1991 and 2023, Black Sea's sea surface temperature increased by approximately 0.6°C per decade.

Pollution: Oil pollution, Marine Litter, Eutrophication, Noise Pollution

The main sources of oil pollution of the Black Sea include river runoff, direct discharges of domestic and industrial wastewater, atmospheric deposition, port operations in the sea ports, accidental spills, and unauthorized discharges from oil tankers. At present, the Black and Azov Seas are considered the marine regions under the highest anthropogenic pressure in Europe. According to statistics, from 0.1% to 0.5% of transported oil is discharged to the ocean as a result of washing and ballast water being released to open waters. Significant oil spills in recent history include the Novorossiysk disaster in November 1999, Kerch Strait spill in November 2007, and most recent spill in December 2024, again in the Kerch Strait which affected both the Black and Azov Seas.

Marine litter is one of the fastest growing threats to the marine environment. Every year, millions of tons of litter, primarily plastic, end up in the oceans and seas as a result of human activities. The problem is complex: a single plastic item can fragment into millions of microscopic particles, which degrade very slowly, making their removal extremely difficult. The continued accumulation of these persistent materials poses a significant risk to marine life, human health and the economy, and calls for urgent action. The Black Sea is particularly at risk due to marine litter and plastic pollution because of the high river discharge from multiple countries into this semi-enclosed basin.

The Black Sea, due to its semi-enclosed basin and a large water catchment which is more than four times larger than the sea's surface, is highly vulnerable to eutrophication. Additional factor that makes this basin more prone to eutrophication is the lower salinity and relatively high temperatures in the

sea's upper layers. Excess nutrients in the water lead to algal blooms, oxygen depletion, and fish kills.

Ocean noise pollution is a form of environmental pollution caused by human activities such as commercial shipping, oil exploration, seismic surveys, offshore wind turbine installation, and military sonar, all of which generate unnatural and excessive underwater noise. Over the past few decades, noise pollution in the ocean has increased dramatically. Since most marine species rely heavily on sound for their survival, this type of pollution is especially harmful to marine wildlife. Underwater noise can cause physical injuries, hearing loss, and behavioral changes in animals, masking critical sounds like mating calls and predator/prey signals.

Impact of Fisheries

Fisheries and aquaculture are among the most important direct benefits the World Ocean provides to humans. However, the Black Sea faces several serious threats, such as overfishing, IUU (illegal, unreported, unregulated) fishing, and habitat loss. Turbot is the most economically valuable fish species in the Black Sea. Its fishing is regulated through an annual quota and limited to a specific fishing method – bottom set gillnets. Despite being a passive fishing method, it is a well-documented cause of bycatch (entanglement in nets) of marine mammals – especially the endangered Black Sea harbour porpoise. Bottom trawling, commonly used in the Black Sea to harvest Rapana whelk and other demersal species, is known to be highly detrimental to marine life. It reduces the biomass, biodiversity and complexity of benthic communities, while the physical impact of trawl gear on the seabed causes severe mechanical and chemical alterations, compromising its functionality and productivity. Overfishing is another major problem caused by fisheries. Globally fish stocks used for food have declined by almost half over the past 40 years. The Black Sea is no exception, with 74% of its fish stocks classified as overexploited, fully exploited or destroyed.

Invasive Species

Marine invasive species can have devastating effects on biodiversity, ecosystems, fisheries, human health, tourism and coastal development. To date, over 900 non-indigenous species have been reported in the

Mediterranean Sea, and almost 300 non-indigenous species in the Black Sea. Among the most impactful is thenon-indigenous invasive comb jelly (*Mnemiopsis leidyi*) introduced in the late 1980s. It caused significant biodiversity loss and a decrease in fish stocks, particularly small pelagic species, such as the European anchovy. Another example is the Rapa whelk, a predatory sea snail introduced via ballast water from ships. It has heavily preyed on mussel beds, causing a significant decline in the population of these filter feeders.

Examples of Global Solutions

The most effective measures to address marine issues at a global scale are implemented through international agreements and protocols. These global frameworks which establish guidelines for ocean protection across countries help address ocean protection by fostering a shared global understanding and collective responsibility.

Paris Agreement: The Paris Agreement is the first truly global commitment to tackle the climate crisis. Signed in 2015 and entered into force in 2016, it is a key agreement under the United Nations Framework Convention on Climate Change (UNFCCC). It addresses mitigation, adaptation and finance. The Paris Agreement calls on all parties to set emission reduction targets, develop strategies to achieve these targets, and prepare and implement national adaptation plans. However, the Paris Agreement has limitations. For example, it does not impose legally binding commitments with penalties for specific greenhouse gas reductions or limits for individual countries.

Conference of the Parties (COP): 'COP' stands for the Conference of the Parties to the UNFCCC, which currently has 197 member countries. Each year a different country hosts the conference, which brings together delegates, decision and policy makers, civil society organisations, campaigners and journalists from each national government to prevent and mitigate the effects of climate change.

United Nations Decade of Ocean Science for Sustainable Development (2021-2030): The United Nations has declared 2021-2030 the Decade of Ocean Science for Sustainable Development to support efforts to reverse the decline in ocean health. This decade-long initiative aims to strengthen global cooperation and ensure the sustainability of ocean ecosystems. It also seeks to

enhance ocean science and raise global awareness of ocean conservation. The initiative is led by UNESCO's Intergovernmental Oceanographic Commission (IOC-UNESCO) which coordinates the global ocean community in making the necessary plans for ocean science and management throughout the decade.

Bucharest Convention (1992) - Convention for the Protection of the Black Sea against Pollution: Environmental problems and marine and coastal pollution in the Black Sea basin, home to approximately 160 million people, have reached critical levels, making international cooperation essential. In this context, the Bucharest Convention, prepared by the littoral states, was signed on 21 April 1992 and entered into force on 15 January 1994. The Convention was signed by Bulgaria, Georgia, Romania, the Russian Federation, Ukraine and Turkey.

The **Black Sea Commission**, the executive body of the Bucharest Convention, was established on 15 December 2000 to combat pollution and ecosystem degradation, prevent the loss of biodiversity and implement joint strategies, projects and activities among the riparian countries to protect the Black Sea ecosystem based on the Convention.

These global frameworks provide a strong foundation for the protection and sustainable management of our oceans. However, their success relies on collective action from all countries. Without strong political will and national prioritization, the binding force of these agreements will remain limited.

Examples of National Solutions

National-level action is crucial in addressing marine challenges. Countries can make significant progress through strengthening legislation, policies, and enforcement systems to ensure the sustainable use and protection of marine environments.

Sustainable Fisheries Management: Sustainable management of fisheries is critical to maintaining the health of marine ecosystems. National governments can implement regulations such as fishing quotas, seasonal fishing bans, species-specific protections, and zoning of fishing areas. In addition, fisheries monitoring and control systems should be developed and enforced.

Marine Protected Areas (MPAs): National governments can designate specific areas of the oceans and seas as Marine Protected Areas by restricting

or banning human activities in these regions. MPAs can be established to conserve biodiversity, restore ecosystems and ensure the sustainability of marine-based livelihoods like fishing and tourism. These areas help protect species and the health of marine ecosystems.

Legislation and Policy Changes: Governments can enact pro-environmental policy changes and legislation to combat marine pollution. Examples include regulations for waste management, marine pollution reduction, and carbon emission control. In addition, improved water quality standards and legislation can improve marine ecosystems.

Such measures at the national level are essential for countries to fulfil their responsibility in protecting marine ecosystems.

Examples of Local Solutions

Local governments and communities have a vital role to play in combating marine pollution, managing sustainable marine practices and protecting coastal and marine ecosystems. Here are some effective local-level solutions:

Improved Waste Management: Local governments can prevent plastic waste and other pollutants from entering the oceans by establishing effective waste collection and processing systems. Promoting waste separation and recycling projects and raising environmental awareness among local communities is essential.

Community Awareness Campaigns: Raising community awareness about marine pollution and ocean conservation is one of the most effective tools for local change. Municipalities and civil society organisations can organise educational programmes, seminars and campaigns in schools, in public spaces and on social media to promote ocean conservation and reduce plastic use Large-scale awareness campaigns can be conducted to encourage people to reduce the use of plastics and ensure the protection of local waterways.

Establishing Local Monitoring and Early Warning Systems: Local governments can monitor changes in marine ecosystems and detect potential hazards early. These systems track factors such as water quality and pollution levels, and provide early warnings of abnormal conditions. Early warning systems help local governments and communities to detect and respond to

threats before they escalate, allowing timely action to protect marine environments.

These local solutions help build a stronger sense of community responsibility and commitment to take effective action to protect marine ecosystems.

Examples of Individual Solutions

Individual choices and daily habits play a crucial role in protecting the oceans. Everyone can contribute through small, meaningful actions:

Reduce Plastic Use: Plastic is one of the most harmful pollutants in the oceans. Individuals can help by avoiding single-use plastics, using reusable water bottles instead of plastic ones, choosing products with plastic-free packaging and opting for plastic-free alternatives.

Adopt Sustainable Consumption Habits: Individuals can help protect the oceans by choosing sustainable and environmentally friendly products. Making environmentally conscious choices, such as buying seasonal, organic, and local food, and choosing sustainably sourced seafood (e.g., certified by MSC or ASC), can significantly reduce one's environmental footprint.

Participating in and Sharing Awareness Education: People can participate in awareness programmes to learn more about the oceans and seas. These programmes provide information on the ecological importance of the oceans, marine pollution and sustainable lifestyles. Taking the responsibility to share this knowledge and encouraging others to take action multiplies the impact at the community level.

These solutions can help protect marine ecosystems through small but effective actions that individuals can take in their daily lives. Everyone has a role to play in protecting our oceans and ensuring a sustainable future. Even small individual actions can collectively make a big difference.

🎓 Solution Design for the Black Sea - Worksheet

🟢 Group Name: _____

🔵 Group Members: _____

🟣 Group Spokesperson: _____

📌 Group's Activity Focus Topic: _____

✏️ GOAL SETTING

_____

_____

👥 WHO WILL IMPLEMENT IT?

_____

_____

🎯 TARGET AUDIENCE

_____

_____

🔨 ACTIONS / ACTIVITIES

1. _____
2. _____
3. _____

🕒 PROJECT DURATION

_____

_____

📦 NEEDS / RESOURCES

- _____

Evaluation and Closing

1. Before the training concludes, participants are informed that a written evaluation will be conducted to gather their thoughts and suggestions about the training.
2. Each participant receives an evaluation form and a pen. If the training evaluation is conducted via Google Forms, the link to the evaluation form will be shared by the participants.
3. After completing the evaluation form, participants are asked if anyone would like to share their feedback verbally. This provides an opportunity for anyone who wishes to express additional thoughts or suggestions aloud.
4. Participants are thanked for their participation, and the training session is concluded.

Session 5: Evaluation and Closure
Objective: To evaluate the implemented training program in light of the participants' feedback.
Duration: ***15 min***
Session flow: At the end of the training, participants will provide feedback both verbally and by completing a digital evaluation form.
Materials: ✓ Evaluation form

Environmental and Ocean Literacy in the Black Sea Basin Project - Ocean Literacy Training – Evaluation Form

Date and Location:

.....

This form is intended to evaluate the Ocean Literacy Training conducted within the scope of the Environmental and Ocean Literacy in the Black Sea Basin Project. The project is funded by the Interreg NEXT Black Sea Basin Programme. Your feedback will help us improve this and similar training programs. Thank you for your participation!

1. To what extent did the training meet your expectations?

(1 = Lowest, 5 = Highest)

Activity	1	2	3	4	5
Sea Breeze	○	○	○	○	○
Find the Right Term	○	○	○	○	○
Discover the Black Sea	○	○	○	○	○
Imagine the Future of the Black Sea	○	○	○	○	○

2. Do you think there were any missing elements in the training or anything that should be added to the content?

(Max 60 words)

.....

3. Please evaluate the training under the following headings:

(1 = Lowest, 5 = Highest)

Evaluation Criteria	1	2	3	4	5
Training venue	○	○	○	○	○
Duration and timing	○	○	○	○	○
Trainers' presentation & communication	○	○	○	○	○
Methods and techniques used	○	○	○	○	○
Content of the training program	○	○	○	○	○
Participation and group interaction	○	○	○	○	○

4. Overall, I would rate the quality of the training as:

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

5. Overall, the training improved my understanding of ocean literacy:

○ 1 ○ 2 ○ 3 ○ 4 ○ 5

6. Did the training program help you learn new things?

☐ Yes ☐ No

7. If yes, what did you learn? Please describe briefly.

(Max 30 words)

.....

8. What was the most positive aspect of the training program?

(Max 30 words)

.....

9. Is there anything else you would like to share that hasn't been covered above?

.....

Thank you!

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