Implementation of the ecosystem approach in the Adriatic through marine spatial planning

Towards an Integrated Marine Good Environmental Status (GES) Assessment for Montenegro

Assessment of the Marine Environment and the Sustainability of Ecosystem Values

UN environment programme
Mediterranean Action Plan Barcelona Convention
PAP/RAC
SPA/RAC
Montenegro Ministry of Ecology, Spatial Planning and Urbanism

Compiled and edited:	Ana Štrbenac (lead) Marina Marković, Carlos Guitart, Anis Zarrouk, Ivan Sekovski
Authors:	EO1 and EO2: Ana Štrbenac – lead author Vesna Mačić, Slavica Petović; Mirko Đurović, Dragana Drakulović, Branka Pestorić, Darko Saveljić, Ivana Stojanović, Milena Bataković, Anis Zarrouk EO5: Robert Precali – lead author Danijela Šuković EO7: Branka Grbec EO8: Željka Čurović EO9: Carlos Guitart – lead author Danijela Šuković, Aleksandra Ivanović, Darinka Joksimović, Ivana Stojanović, Ivan Sekovski, Marina Marković EO10: Milica Mandić – lead expert
Editing:	Cover design: swim2birds.co.uk Graphic design: Old School S.P. Proofreading: N. Yonow
Cover photograph:	Ghost nets in Montenegro; M. Mandić

This study was prepared by PAP/RAC, SPA/RAC, UNEP/MAP, and the Ministry of Ecology, Spatial Planning and Urbanism of Montenegro within the GEF Adriatic Project and supported by the Global Environment Facility (GEF).

Document citation:

UNEP/MAP-PAP/RAC-SPA/RAC and MESPU (2021). Towards an Integrated Marine Good Environmental Status (GES) Assessment for Montenegro. Assessment of the marine environment and the sustainability of the ecosystem values. By (alphabet order): Željka Čurović, Dragana Drakulović, Mirko Đurović, Carlos Guitart, Aleksandra Ivanović, Christos Ioakemidis, Darinka Joksimović, Vesna Mačić, Milica Mandić, Marina Marković, Branka Pestorić, Slavica Petović, Robert Precali, Darko Saveljić, Ivana Stojanović, Ivan Sekovski, Ana Štrbenac, Danijela Šuković, Anis Zarrouk. Eds: PAP/RAC, GEF Adriatic project. pp 110 + Annex

Table of contents

List of figures

List of tables

List of acronyms

ACCOBAMS	Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea, and contiguous Atlantic Area
ASI	ACCOBAMS Survey Initiative
Barcelona Convention	Convention for the Protection of the Mediterranean Sea against the pollution
BQE	Biological Quality Elements
BiOS	Biomodal Oscillating System
CARLIT	Cartography of littoral and upper-sublittoral rocky-shore communities
CBD	Convention of biological diversity
COP	Conference of (Contracting) Parties
CORMON	Ecosystem Approach Correspondence Group on Monitoring under Barcelona Convention
DPSIR	Drivers-Pressures-State-Impact-Responses framework
EcAp	Ecosystem approach
EMODNet	European Marine Observation and Data Network
EO	Ecological Objective
EU	European Union
GEF	Global Environment Facility
GES	Good Environmental Status
GFCM	General Fisheries Commission for the Mediterranean
ICZM	Integrated Coastal Zone Management
IMAP	Integrated Mediterranean Monitoring and Assessment Programme
IMBK	Institute of Marine Biology in Kotor
IPA	Instrument for Pre-accession Assistance
IPA Adriatic	Adriatic IPA Cross-border cooperation programme of the EU
IUCN	International Union for Conservation of Nature
LBS Protocol	Land-based Sources and Activities Protocol
MAP	Mediterranean Action Plan
MSP	Maritime Spatial Planning
MSFD	Marine Strategy Framework Directive
NEPA	Nature and Environmental Protection Agency
NETCET	Network for the Conservation of Cetaceans and Sea turtles in the Adriatic project
NIMP	National integrated monitoring programme
NIS	Non-indigenous species
PAP/RAC	Priority Actions Programme/Regional Activity Centre
SPA/BD Protocol	Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean, under Barcelona Convention
SPA/RAC	Regional Activity Centre for Specially Protected Areas
SST	Sea surface temperature
UNCLOS	United Nations Convention on the Law of the Sea
UNEP/MAP	Mediterranean Action Plan of the UN Programme for Environment
WTTC	World Travel & Tourism Council

Foreword

The seas and coastal areas are among the most valuable and vital components to sustain our life on planet Earth. At the same time, they are under exponentially increasing pressures by human activities, having already shown tangible negative consequences to our economy and society, beyond the impact in nature itself. To maintain, to protect, and to conserve the Mediterranean's coastal and marine environment in a healthy and productive state is the main premise upon which the marine environment regional policies and legislation are built.

The UNEP/MAP Barcelona Convention for the Protection of the Marine Environment and Coastal Region of the Mediterranean (the Barcelona Convention) and the European Union Regional Seas context (EU Regional Seas) are the two main science-policy frameworks with legal instruments involving all the Mediterranean riparian countries, either EU member states or Contracting Parties to the Barcelona Convention, on which the achievement of the Good Environmental Status (GES) of the Mediterranean Sea is dependent. This requirement also applies to the Adriatic Sea basin and the IPA countries, namely the Republic of Montenegro, as an integral part of the Mediterranean region.

The preparation of the *Towards an integrated marine GES assessment for Montenegro* report has been developed under the project "Implementation of Ecosystem Approach in the Adriatic Sea through Marine Spatial Planning" (i.e., the GEF Adriatic project), financed by the GEF and implemented jointly by PAP/RAC, SPA/RAC, and UNEP/MAP Coordinating unit in collaboration with relevant national institutional partners from Montenegro, as well as international collaboration. The document represents the first attempt to assess GES in the Montenegrin marine and coastal area in an integrated manner, based on principles and criteria set under the Barcelona Convention and its Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria (UNEP/MAP/IMAP). Other documents relevant for the GES assessment in the framework of the Barcelona Convention, including Common Regional Framework for ICZM and its Methodological Guidance for Reaching GES through ICZM, were used while preparing the document.

The objective of the document is to shed a light on the ecosystem's state and current pressures, through assessing as a whole a number of ecologically defined components and welfare processes of importance, such as biodiversity and non-indigenous species, eutrophication, hydrographic conditions, coastal ecosystems, contaminants, and marine litter to mention a few, as well as to identify shortcomings and existing gaps for future coastal and marine management improvements.

This assessment should be of particular use for the ongoing and future Montenegrin efforts to implement the UNEP/MAP/IMAP, as well as the European Marine Strategy Framework Directive (EU MSFD) at national level.

Summary

Preparation of the *Towards an integrated marine Good Environmental Status (GES) for Montenegro* document, one of the major outputs of the GEF-Adriatic project, is the first attempt to assess GES in Montenegro. This initial GES assessment was methodologically based on the Barcelona Convention's Integrated Monitoring and Assessment Programme (IMAP) for the Mediterranean. However, for the assessment of EO1 Biodiversity, some additions were made using the advantages of the latest MSFD criteria under the 2017 Commission's Decision (2017/848) and considering some national specificities.

The document was developed by the team of national and international experts under the supervision and guidance of UNEP/MAP, PAP/RAC and SPA/RAC. It consists of an initial overview of economic activities, such as drivers, pressures, and impacts to the marine and coastal environment; elaboration of initial GES assessment for the set of individual Ecological Objectives (EO1, EO2, EO5, EO7, EO8, EO9, EO10), including a baseline analysis; interrelations between EOs; GES assessment gaps; and needs and initial proposal of measures to achieve GES objectives.

Anthropogenic activities represent the main sources of **pressures and adverse impacts** to the marine and coastal environment. In Montenegro, the main economic activities related to that area are: tourism, maritime transport, fishery/aquaculture, and agriculture. Tourism alone generates one third of GDP and employment (UNEP/MAP-PAP/RAC MORT, 2020). On the other hand, most of the pressures and impacts are related to tourism, particularly marine litter, and physical loss of natural coastline. It should be stressed that pressures do not act alone, but rather combined, thus bringing cumulative and synergistic impacts.

Different pressures reflect on the state of biodiversity, assessed through **EO1 – Biodiversity**. However, due to limitations and lack of data, this state could only be assessed partially. Still, it appears that GES has been mostly achieved for both benthic and pelagic habitats in the coastal area, despite increased pressures. States of species could be measured partially, showing some initial positive indication for some parameters (e.g., population abundance and species distributional range of two groups of migratory species – cetaceans and marine turtles). GES characteristics of true seabirds, as summer visitors, migration, and wintering species in Montenegro, could not be fully assessed, while GES for breeding birds is mostly achieved for now. However, there are already some negative effects of lack of management of Ulcinj Salina, as the most important breeding site, which threatens the future of these species in Montenegro. Overall, more data, systematically collected over longer time periods, will enable better future understanding of GES.

One of the already present and ever-growing pressures to the biodiversity are the **Non-indigenous species** (NIS), with emphasis on invasive alien species, assessed through **EO2**. Although there are some records about NIS in Montenegro, this information is still not sufficient for GES assessment. Furthermore, thresholds at the Adriatic Sea level, which are needed as reference points for NIS GES assessment, are still unknown. The setting of thresholds requires a good and active transboundary cooperation.

Changes in **hydrography (EO7)** have been already recorded in the Adriatic Sea. The Adriatic, as the semi-enclosed sea, is particularly sensitive to climate change. Recent general climatology for the entire area, made by analysing a large amount of data (1911–2009) for temperature, salinity, and dissolved oxygen shows that the deepest part of the southern Adriatic becomes saltier and warmer. Due to a lack of systematic data on hydrographic conditions, it was not possible to assess GES in Montenegro. However, anthropogenic activities in Montenegrin waters, such as construction of near-shore infrastructure and sewers outflows, have a potential to permanently change hydrographic conditions near the coast, while in the open water, there are currently no such deteriorating activities. Recently initiated hydrocarbon investigation drilling should be carefully monitored in order to avoid significant hydrographic changes in the future.

Coastal ecosystems and landscapes (EO8) are increasingly altered by construction of human-made structures. According to the initial analysis undertaken in the scope of the GEF-Adriatic project, 32.51% of the coastal lengths of Montenegro is artificial coast, and 67.48% is natural. Most of the artificial structures are located in close proximity to the major settlements, particularly in the Boka Kotorska Bay. However, due to lack of relevant datasets to observe the trend, GES could not be assessed at the moment.

The initial assessment of **Pollution (EO9)** shows higher concentrations of contaminants in the coastal area, particularly Boka Kotorska Bay. Levels of legacy pollutants (heavy metals and organo-halogenated compounds), mercury in sediments in the open coastal areas of Budva and Bar, and cadmium and lead around Bar are above thresholds. This means that GES is not achieved in this respect, which may have negative impacts on biodiversity. Other parameters are either at levels that correspond to achievement of GES, or they are not assessed due to lack of data.

Marine litter (EO10) is one of the most serious threats to the marine and coastal environment at the moment. Based on the available data and adopted thresholds it can be concluded that GES for marine beach litter in Montenegro has not been achieved or could not be assessed due to lack of data. More specifically, the amount of beach litter is above set thresholds, while it was not possible to assess GES for floating litter or seabed litter. Still, based on the available data, it can be confirmed that the coastal part is under the greatest pressure, particularly Boka Kotorska Bay.

Understanding **interrelations between Ecological Objectives** and their common indicators is important for a comprehensive overview of GES. The results of the first attempt to assess GES in Montenegro, although challenged with limitations and/or lack of knowledge, indicate certain interlinkages between EOs. Overall, all assessed EOs (with the addition of EO5) affect the state of biodiversity (EO1), followed by EO2 NIS, whose spread may also be induced by EO5, EO7, EO9, and EO10. On the other hand, the EOs causing impacts on majority of EOs are EO5 and EO9. More data and better knowledge would enable more detailed elaboration in the future. In general, all these complex interactions should be in constant process of re-examination and discussion.

Main **gaps and needs** for carrying out the comprehensive GES assessments may be grouped:

- *Lack of legislative framework for GES assessment and some specific EOs related topics,* notably marine litter;
- *Lack or limitation of knowledge*, particularly long-term data series of all parameters, knowledge on biodiversity in open seas, species population demographics, NIS, hydrographic processes specific for Montenegrin waters and their impacts on ecosystems, toxicological effects, contamination of wild seafood species, and data on ballast waters;
- *Limited monitoring implementation*, notably the lack of systematic monitoring based on IMAP;
- *Limited institutional, human, and financial capacities*, particularly lack of experts in certain fields, such as physical oceanography, as well as limited national financial resources and high dependency on international funds, such as GEF and EU pre-accession funding;
- *Transboundary cooperation*, which already exists to some extent, but has a potential for improvement. It is particularly important for biodiversity (EO1), NIS (EO2), fisheries (EO3), marine litter (EO10), and noise (EO11).

In addition, there are a few methodological issues related to GES assessment, notably lack of elaboration of certain EOs (EO4 and EO6) and CIs under IMAP, as well as a lack of defined thresholds at national and regional levels.

Based on the results of the initial GES assessment, a number of preliminary **targets and recommendations** for measures are proposed in accordance with IMAP of Montenegro, with the overall aim to enable adequate future GES assessment and ensure maintenance and/or achievement of GES for all assessed components. In order to be able to fully implement all these measures, it is important to fulfil several structural pre-conditions, particularly focusing on ensuring adequate legislative framework for GES assessment, improving institutional and human capacities, and ensuring long-term financial capacities. Finally, a good transboundary cooperation for protection of marine and coastal environment is a must for the Adriatic Sea countries and further efforts are needed in that direction.

1 Introduction

This chapter briefly describes the marine policy frameworks at the Mediterranean Sea and European Seas level, emphasising the concept and requirements of the EcAp IMAP process under the MAP – Barcelona Convention system and its links with the European MSFD. It also provides a short overview of main features of the Adriatic Sea, thus recognising a need to consider a subregional context for national GES assessments. Finally, it explains the methodology and approach towards the integrated GES assessment.

1.1 GES assessment policy context

Mediterranean Sea level

Under the **UNEP/MAP Barcelona Convention** and its seven protocols, as a unique political and legal framework for the protection of the marine environment and the coastal areas of the entire Mediterranean Sea region, the Decision IG.17/6 on Ecosystem Approach Roadmap was adopted at COP 15 in 2008 by Contracting Parties and a process to achieve the Good Environmental Status of the Mediterranean Sea was initiated. Further, at COP 17 in 2012 under the vision of *A healthy Mediterranean with marine and coastal ecosystems that are productive and biologically diverse for the benefit of present and future generations*, Contracting Parties adopted a list of 11 Ecological Objectives and have been further broken down into Operational Objectives (COP 17 Decision IG.20/4), as well as GES definitions and associated targets (COP 18 Decision IG.21/3) established. In 2016, the Contracting Parties adopted the Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria (IMAP) (COP 19 Decision IG.22/7) a major component of the ecosystem approach implementation on the road for GES achievement. The steps undertaken from 2008 until 2016, with the publication of the *State of the Mediterranean marine and coastal environment report* in 2012 and the first *Quality Status Report 2017* (endorsed by COP 20 Decision IG.23/6) consolidated the implementation of the Ecosystem Approach and the initiation of the six-year cyclic IMAP for the Mediterranean Sea (Figure 1.1), in synergy and coherence with the implementation of the European MSFD. In order to assist the Contracting Parties to interpret what GES means in practice, the Integrated Monitoring and Assessment Programme and related Assessment Criteria (IMAP), elaborating 11 Ecological Objectives (EOs), specific GES definitions for each them, with common indicators (Table 1.1), was adopted together with a timeline and deliveries for the implementation of this Programme, which should cover the 2016–2021 period (Decisions IG.20/4, IG.21/3, IG.22/7).

The IMAP implementation has evolved with the establishment of national IMAPs, development of the IMAP centralised data collection and management infrastructure (within the InfoMAP System), refinement of technical specifications of IMAP common indicators and assessment criteria, further development and implemented candidate indicators, as well as the development of methodologies for integrated assessment. A specific roadmap is currently under implementation for the preparation of a fully-data based Quality Status Report in 2023 (2023 MED QSR) (Figure 1.1).

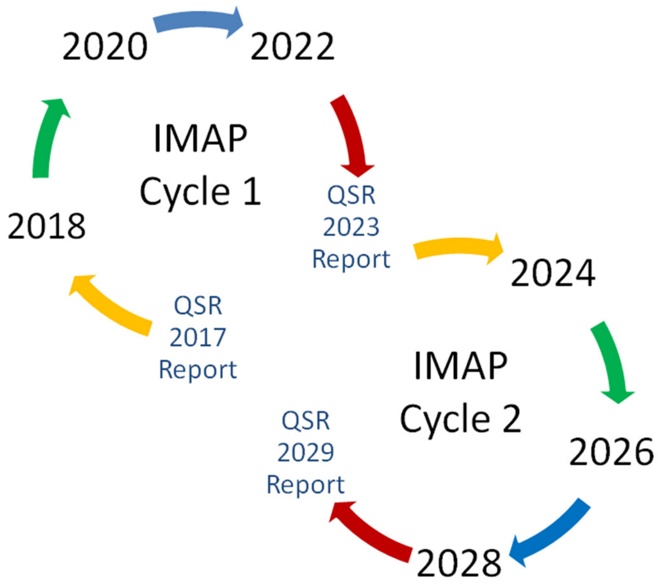


Figure 1.1. With the publication of the first ever Mediterranean Quality Status Report in 2017 (Initial Assessment) and the finalisation of the EcAp Roadmap; the formal IMAP 6-year management cycles have been initiated in order to achieve GES and inform both policy and decision makers

Table 1.1. List of IMAP Ecological Objectives (EOs) and Common Indicators (CIs)

Ecological Objective GES	IMAP Indicators	
EO1 Biodiversity		
Biological diversity is maintained or enhanced. The quality and occurrence of coastal and marine habitats and the distribution and abundance of coastal and marine species are in line with prevailing physiographic, hydrographic, geographic, and climatic conditions	Common Indicator 1:	Habitat distributional range (EO1) to also consider habitat extent as a relevant attribute
	Common Indicator 2:	Condition of the habitat's typical species and communities (EO1)
	Common Indicator 3:	Species distributional range (EO1, related to marine mammals, seabirds, marine reptiles)
	Common Indicator 4:	Population abundance of selected species (EO1, related to marine mammals, seabirds, marine reptiles)
	Common indicator 5:	Population demographic characteristics (EO1, e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates related to marine mammals, seabirds, marine reptiles)
EO2 Non-indigenous species		
Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem	Common Indicator 6:	Trends in abundance, temporal occurrence, and spatial distribution of non-indigenous species, particularly invasive, non-indigenous species, notably in risk areas (EO2, in relation to the main vectors and pathways of spreading of such species)
EO3 Harvest of commercially exploited fish and shellfish		
Populations of selected commercially exploited fish and shellfish are within biologically safe limits, exhibiting a population age and size distribution that is indicative of a healthy stock	Common Indicator 7:	Spawning stock biomass (EO3)
	Common Indicator 8:	Total landings (EO3)
	Common Indicator 9:	Fishing mortality (EO3)
	Common Indicator 10:	Fishing effort (EO3)
	Common Indicator 11:	Catch per unit of effort (CPUE) or Landing per unit of effort (LPUE) as a proxy (EO3)
	Common Indicator 12:	Bycatch of vulnerable and non-target species (EO1 and EO3)

Ecological Objective GES	IMAP Indicators	
EO4 Marine food webs		
Alterations to components of marine food webs caused by resource extraction or human-induced environmental changes do not have long-term adverse effects on food web dynamics and related viability	To be developed further	
EO5 Eutrophication		
Human-induced eutrophication is prevented, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algal blooms, and oxygen deficiency in bottom waters	Common Indicator 13:	Concentration of key nutrients in water column
	Common Indicator 14:	Chlorophyll *a* concentration in water column
EO6 Sea-floor integrity		
Sea-floor integrity is maintained, especially in priority benthic habitats	To be developed further	
EO7 Hydrography		
Alteration of hydrographic conditions does not adversely affect coastal and marine ecosystems	Common Indicator 15:	Location and extent of the habitats impacted directly by hydrographic alterations
EO8 Coastal ecosystems and landscapes		
The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved	Common Indicator 16:	Length of coastline subject to physical disturbance due to the influence of human-made structures
	Candidate Indicator 25:	Land cover change
EO9 Pollution Contaminants		
Contaminants cause no significant impact on coastal and marine ecosystems and human health	Common Indicator 17:	Concentration of key harmful contaminants measured in the relevant matrix (related to biota, sediment, seawater)
	Common Indicator 18:	Level of pollution effects of key contaminants where a cause and effect relationship has been established
	Common Indicator 19:	Occurrence, origin (where possible), extent of acute pollution events (e.g., slicks from oil, oil products, and hazardous substances), and their impact on biota affected by this pollution
	Common Indicator 20:	Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood
	Common Indicator 21:	Percentage of intestinal enterococci concentration measurements within established standards
EO10 Marine litter		
Marine and coastal litter do not adversely affect coastal and marine environment	Common Indicator 22:	Trends in the amount of litter washed ashore and/or deposited on coastlines
	Common Indicator 23:	Trends in the amount of litter in the water column including microplastics and on the seafloor
	Candidate Indicator 24:	Trends in the amount of litter ingested by or entangling marine organisms, focusing on selected mammals, marine birds, and marine turtles
EO11 Energy including underwater noise		
Noise from human activities cause no significant impact on marine and coastal ecosystems	Candidate Indicator 26:	Proportion of days and geographical distribution where loud, low, and mid-frequency impulsive sounds exceed levels that are likely to entail significant impact on marine animal
	Candidate Indicator 27:	Levels of continuous low frequency sounds with the use of models as appropriate

European level

In order to protect coastal and marine environment in Europe, the European Union adopted the **Marine Strategy Framework Directive (MSFD)** in 2008 (2008/56/EC). The MSFD aimed to achieve the Good Environmental Status (GES) of the EU's marine waters by 2020 and to protect the resources upon which relevant economic and social activities are based (ca. the European Regional Seas, including the Mediterranean Sea through few riparian EU members). The MSFD also applies the foundational ecosystem approach to management of human activities with impacts on the marine environment, balancing environmental protection, and sustainable use. Furthermore, the need for regional and sub-regional cooperation for conservation is recognised, including cooperation with countries beyond the EU borders. Thus, the MSFD recognises four European marine regions, including the Mediterranean Sea.

The achievement of GES was initially set for 2020 and the Member States were required to develop a strategy for its marine waters (the Marine Strategy) in 2008 and review them periodically. Other EU directives and regulations support the goals of the MSFD, including Maritime Spatial Planning (MSP) Directive, Birds and Habitat Directives, Water Framework Directive (WFD), and Common Fisheries Policy. The MSP in particular should ensure that human activities in the marine environment are implemented in a sustainable way. The EU-Mediterranean Member States are Contracting Parties of the Barcelona Convention; and therefore, the processes and approaches under IMAP and EU MSFD are shared, aligned, and optimised in order to be implemented by those countries effectively. Figure 1.2 shows the similarities between the two marine environmental policies in the Mediterranean Sea, in terms of Ecological Objectives and Descriptors of the marine ecosystem for the IMAP and EU MSFD, respectively.

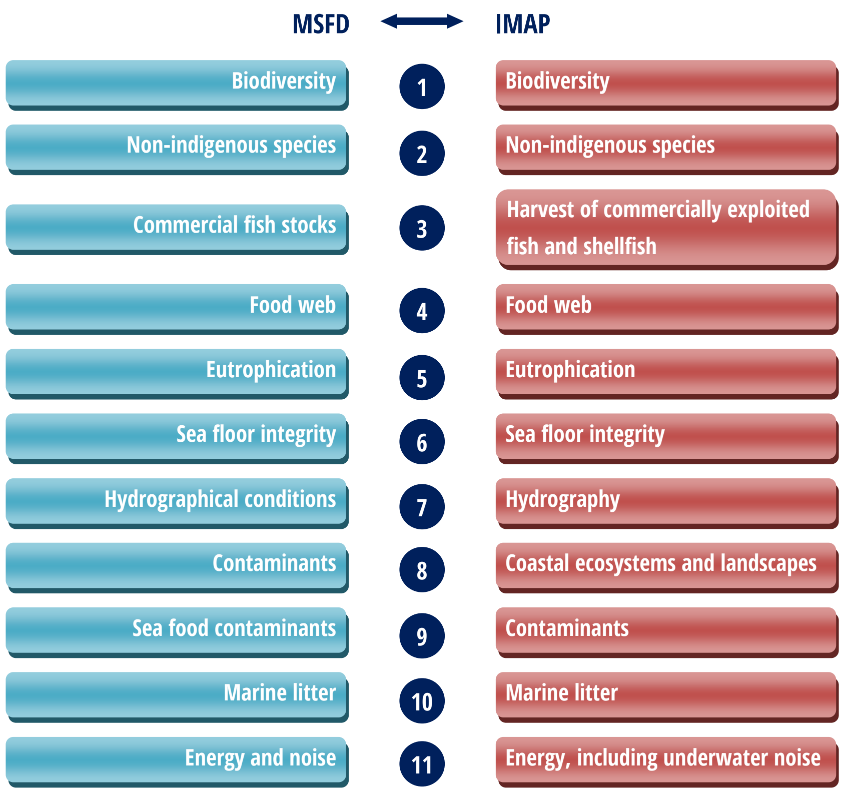


Figure 1.2. Similarities between the UNEP/MAP IMAP and the European MSFD. *Source: UNEP/MAP*

The Adriatic Sea

The Adriatic Sea is the northern semi-enclosed arm of the Mediterranean Sea. Based on hydrological conditions, three distinctive sub-areas can be observed (Figure 1.3): the shallow northern Adriatic; the central and middle Adriatic, featured by three depressions; and the deep southern Adriatic. The southern sub-basin consists of ca. 80% of the total volume of the Adriatic Sea.

The Adriatic Sea is bordered by Albania, Bosnia and Herzegovina, Croatia, Italy, Montenegro, and Slovenia. All Adriatic countries are Contracting Parties to the Barcelona Convention and follow the requirements under the UNEP/MAP IMAP to achieve GES in the Mediterranean Sea. In addition, the Adriatic Sea area affiliates predominantly to the European Union, since Croatia, Italy, and Slovenia are members of the EU. As such, these countries have harmonised their legislation with the EU *aqui,* including the MSFD and MSP.

All indicated features of the Adriatic Sea emphasise a need for strong cooperation and communication between the Adriatic countries in order to ensure the healthy environmental state of the Adriatic Sea.

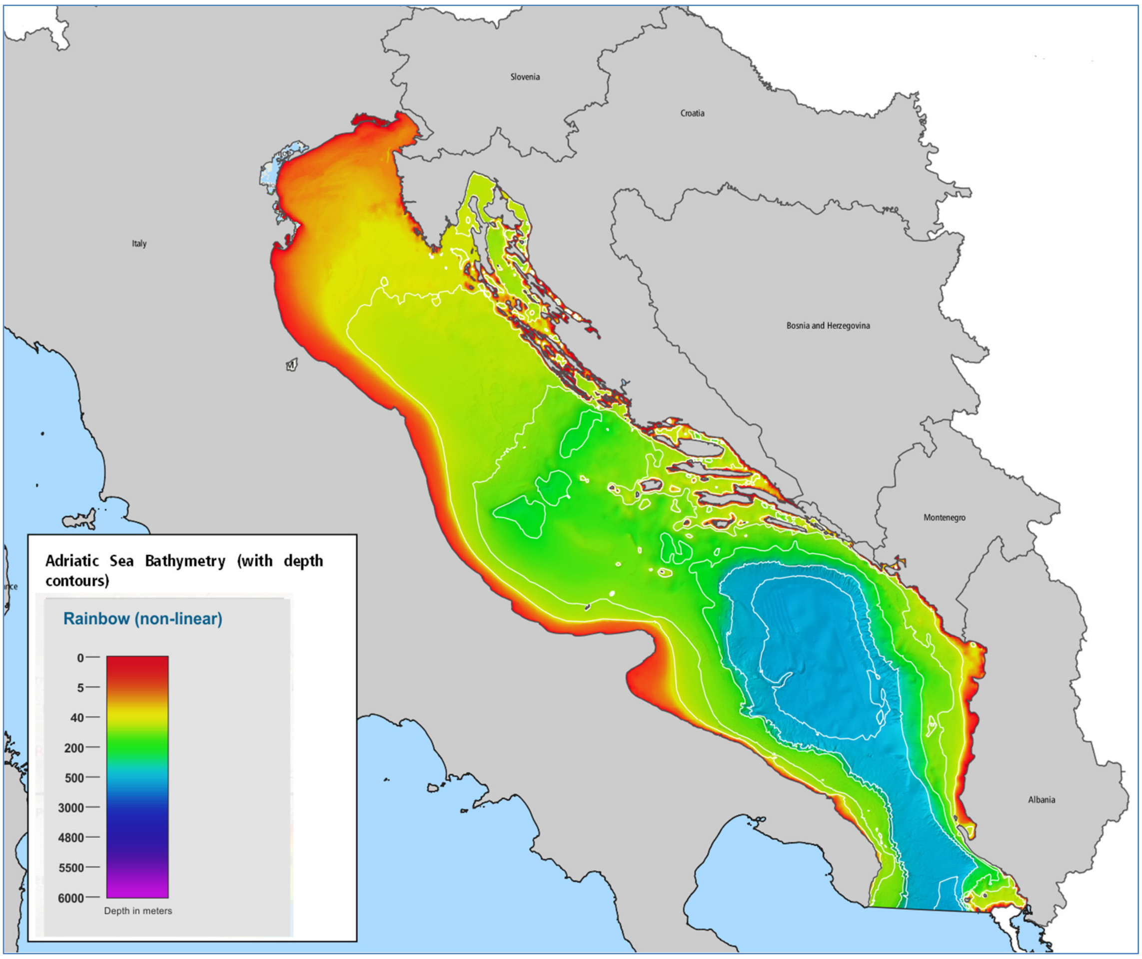


Figure 1.3. Adriatic Sea bathymetry, as a basis for division on sub-basins.
Prepared by Petra Štrbenac (Stenella consulting, Croatia) based on EMODnet Bathymetry Consortium, 2018: EMODnet Digital Bathymetry

1.2 Approach to integrated GES assessment preparation

The development of the *Towards an integrated marine GES assessment for Montenegro* document was coordinated by PAP/RAC and SPA/RAC and elaborated by the group of relevant international and national experts (more details in the *Impressum*).

The integrated assessment is based on the existing and available data on biodiversity (EO1), non-indigenous species (EO2), hydrographic conditions (EO7), eutrophication (EO5), contaminants (EO9), marine litter (EO10), and coastal artificialisation (EO8) through the integration of thematic IMAP EOs assessments elaborated under the GEF Adriatic by a number of coordinated national teams in Montenegro, together with international experts. The content of the document is aligned with the IMAP and it is based on the following elements:

- The initial overview of economic activities (chapter 2.1), being drivers of the predominant pressures and their impacts on the marine and coastal environment (chapter 2.2);
- Elaboration of initial GES assessment for the individual EOs, including a baseline analysis based on recent studies (chapter 3.1);
- Interrelations between Ecological Objectives (chapter 3.2);
- GES assessment gaps and needs (chapter 4);
- Initial proposal of measures to achieve GES targets (chapter 5).

The evidence base limits are particularly addressed through several sections of the document. Regional context has also been taken into account.

As mentioned, as part of the preparation of this document, the separate GES assessments per individual EOs were first undertaken (in publication). These thematic assessments contain detailed information on GES findings, methodologies, analysis of particular states and pressures, as well as proposed policy responses and further actions required to achieve GES. Where appropriate, the links with MSFD have also been highlighted.

The present document contains only the key summarised elements of the thematic GES assessments per individual EOs in order to establish interrelationships between them as an effort to produce an integrated evaluation of the marine environment in Montenegro.

The document places significant emphasis on the interlinks between different ecological objectives, status of marine biodiversity, predominant pressures, and their impacts on the overall marine and coastal environment in Montenegro. As such, it is the first attempt towards a national integrated GES assessment following the UNEP/MAP IMAP framework, despite the fact that a common harmonised, integrated, and methodological approach to assess GES as a whole in a fully integrated manner is still in debate by Contracting Parties of the Barcelona Convention at a regional level. Similarly, the initial MSFD framework was also revised in 2017 to improve the integrated GES assessment of the marine environment. Above all and bearing in mind that some information is lacking for some specific IMAP EOs, further national monitoring and assessment are needed to be able to have better understanding of the marine environment status as a whole.

2 Socio-economic drivers, pressures, and impacts existing in the marine and coastal environment of Montenegro

This chapter summarises economic and social uses of marine and coastal areas, pressures arising from these activities, and potential or actual impacts on the state of the environment. Identification of economic drivers, pressures, and impacts is an important step for their mitigation through adequate responses. All uses, pressures, and impacts in Montenegro are also viewed in a broader regional context. Furthermore, the integrated assessment of GES is based on the interrelationship between state, pressures, and impact based on the individual Ecological Objectives assessments and for which some of the drivers might be common. A more specific elaboration of pressures, state, and impacts related to specific Ecological Objectives are given in the thematic GES assessments.

2.1 Socio-economic drivers relevant for the state of the marine environment in Montenegro

The coastal zone of Montenegro is one of the most valuable national resources, which is characterised by complex relations between human activities and environment (e.g., tourism) that often result in pronounced pressures on natural resources.

The coastal area is relatively well developed and it is the most densely populated part of Montenegro, with an attractive, yet fragile, environment. Approximately 25% of the total Montenegro population live in the coastal area, with the highest population density (more than 1,000 inhabitants per square kilometre) in the cities of Tivat, Kotor, Budva, and Bar (Figure 2.1).

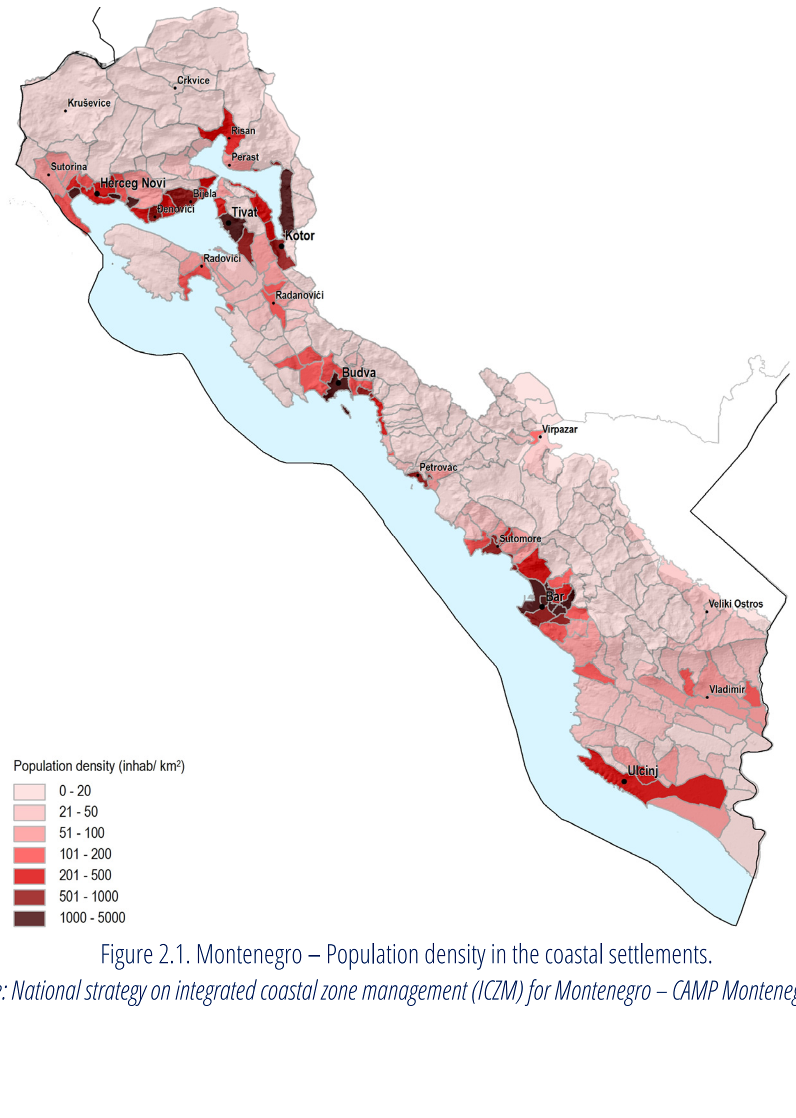


Figure 2.1. Montenegro – Population density in the coastal settlements.
Source: National strategy on integrated coastal zone management (ICZM) for Montenegro – CAMP Montenegro, 2015

Both land-based and sea-based anthropogenic activities represent the main sources of pressures and adverse impacts on the environment. Several economic sectors, among the most common in the Mediterranean region, challenge the health of the Adriatic Sea: urbanisation and industry, maritime transport, the energy sector, agriculture, fishery and aquaculture, and tourism. In Montenegro, the main economic activities related to the marine and coastal area are tourism, maritime transport, fishery/aquaculture, and agriculture (Table 2.1).

Tourism is one of the key economic sectors and growth generators in Montenegro. During the last decade, between 85% and 91% of the total number of arrivals and up to 97% of the total number of overnight stays were realised in coastal locations. In 2019, more than 2.3 million tourists, with more than 13.7 million overnights were concentrated in the coastal area; that is an increase of almost 80% compared to 2010 (UNEP/MAP-PAP/RAC i MORT, 2020).

However, the predominant type of tourism facility is still private accommodation that significantly contributes to urban sprawl and artificialisation of the narrow coastal area. Tourism is highly seasonal with beach tourism as the main product (UNEP/MAP-PAP/RAC i MORT, 2020); therefore, the full potential of sustainable tourism development is not yet achieved.

Maritime transport is highest in the northern and central Adriatic and along the Italian coast in the southern part of the Adriatic. However, there are several shipping routes passing the Montenegro coastal area (mainly passenger routes for liners and cruisers but also routes including cargo vessels for the transport of oil and gas), which have potential environmental impacts of concern in Montenegro's marine territorial waters and offshore area. It must be noted that several international ports are in operation (e.g., the ports of Bar, Kotor, Zelenika, and Risan – the latter three being located in the Bay of Boka), which implies intense use of marine space in the relatively small area of Boka Bay (more details in chapter 2.2).

With regards to **energy production**, Montenegro is not an oil or gas producer and therefore imports all oil products (Energy Charter Secretariat, 2018). Hydropower is the dominant source of electricity production, followed by coal and, recently introduced, wind. Energy production itself is concentrated in the terrestrial part of Montenegro. There are currently no major energy generation facilities in the coastal zone nor are there plans to build these infrastructures in the short term. However, offshore oil and gas exploration drillings were initiated in 2021 and plans for their continuation exist.

In Montenegro, **fisheries and mariculture** constitute activities with a negligible share in the national GDP (UNEP/MAP-PAP/RAC i MORT, 2020) but with an important sociological and cultural role. Fishing is one of the traditional sectors of Montenegro economy, which is conducted in fishing areas of the coastal zone and Skadar Lake. Marine fishery is the most important segment of the industry in Montenegro. Along the Montenegro coastline there are three main fishing ports: Bar, Budva, and Herceg Novi and one small port in Kotor important only for small-scale fisheries. Fishing activities include commercial (large-scale and small-scale commercial fishing) and sports-recreational events. In terms of foreign trade structure in fisheries products (including products of capture fisheries, farming, and processing), Montenegro is a relatively large importer. The foreign trade balance in fisheries products is negative, and the value of imports has been constantly growing during the last years.

Due to favourable natural conditions, **agriculture** represents a development potential of the coastal zone with good conditions for production of Mediterranean fruits, olives, and vegetables. However, in the coastal area agriculture is mostly an additional or temporary activity, and the number of those formally employed in the agricultural sector, forestry, and fishery is fairly low. Considering spatial specificities, traditional, and market demands, the three key agricultural sectors in the coastal zone are olive and citrus farming, and viniculture.

Table 2.1. Economic and social characteristics of the main human activities and anticipated future trends. *Source: UNEP/MAP-PAP/RAC i MORT, 2020; Monstat*

Human activities (sectors)	Economic and social characteristics	Anticipated future trends
Tourism	▪ Annual growth of tourism sector (6%) is double than the growth of GDP ▪ One third of the national GDP and employment are generated through activities which are directly or indirectly related to tourism and travel ▪ 50% of GDP of coastal municipalities comes from tourism ▪ 40% of tourism capacities are of low-category accommodation (below 2 stars) ▪ Annual occupancy of higher category hotels (4/5 stars) is only between 40–45% ▪ The recently built berth for mega yachts Porto Montenegro has become a new tourist symbol of the country ▪ Other important marinas are located in Bar, Budva, Luštica Bay, Portonovi, and the port of Kotor. In addition, there are number of smaller marinas, all located in Boka Kotorska Bay ▪ Numbers of visiting cruise ships tripled between 2007 and 2019	▪ Further increase of tourist visits and revenues from tourism is anticipated after the recovery from COVID-19 pandemics ▪ Increase of the nautical tourism sector ▪ Risk of further unsustainable development of tourism – more pressures to natural habitats and continued coastal artificialisation with economic consequences related to intangible assets
Urbanisation and industry	▪ Montenegro coastal area covers ca. 11.5% of the country's total territory, with 24% of total population ▪ 28.5–30% of Montenegro's GDP is generated in the coastal zone ▪ Constant migration from the north and central parts of the country towards the coast ▪ Industrial production contributes ca. 12% of national GDP	▪ Population growth is ca. 7% in the coastal zone ▪ Pronounced trend of depopulation of rural areas and concentration of populations in coastal settlements ▪ In general, further increase of urban population could be anticipated, accompanied with industrial development
Maritime transport	▪ The most important port is Bar with a capacity of ca. 5 million tonnes of freight. It is a transit centre of regional importance ▪ Other significant ports are Budva, Kotor, Tivat, Zelenika, and Kumbor-Portonovi ▪ The national maritime fleet has a modest capacity ▪ International maritime transport is of moderate intensity. It mainly flows towards the Italian coast	▪ Improved infrastructure in Central and Eastern Europe could lead to an increase in bulk cargo through Adriatic ports ▪ International traffic is likely to increase, particularly due to the energy sector (exploration and exploitation of oil and gas) ▪ It is projected that the number of cargo containers in Montenegrin ports will increase 2.4 times in 2030
Energy	▪ Hydropower is the dominant source of electricity production ▪ Electricity produced from renewable energy sources in 2018 was 38.8% (% of gross electricity consumption) (EUROSTAT) ▪ Limited oil and gas exploration drillings began in 2021	▪ Use of renewables is expected to increase due to obligations from Paris Agreement. However, at the same time, there is a potential increase in fossil fuels exploration and exploitation
Agriculture	▪ Only 24% of the total agricultural land in coastal municipalities is cultivated ▪ Agriculture, forestry, and fishery provide 8% of the national GDP	▪ Climate change is likely to pose a threat to agriculture in the future. It may result in a decrease of yield in the absence of relevant climate adaptation measures ▪ Increase in agricultural land use and investments in primary agriculture is anticipated
Fishery	▪ Total value of the fishery sector is ca. 7.4 million € ▪ Share of fishery in the national GDP amounts to not more than 0.5% ▪ Share of total pelagic species fishing effort of the Montenegrin fleet in the Adriatic is less than 1% ▪ In 2018, for the first time, the total catch in marine areas exceeded 1000 tons	▪ Support to strengthen and modernise the fishing fleet, and improvement of competitiveness and efficiency of aquaculture while preserving fisheries and other marine resources is envisaged under the current plans

2.2 Pressures and impacts in the marine and coastal environment

Different uses of marine and coastal areas lead to a range of pressures, which generate impacts on the environment. In addition, the same types of pressures often come from different activities; for example, the sources of litter are urbanisation and industry, maritime transport, fishery (e.g., ghost fishing gear), and tourism. Urbanisation and industry, as well as tourism development, contribute to deterioration of biodiversity, especially in coastal and marine habitats, distributional ranges, and populations abundance. In addition, they are, together with the energy sector, the major drivers of climate change, due to their dependence on fossil fuels (e.g., construction, transport, heating, etc.).

There are few pressures that may be emphasised as significant for the southern Adriatic, but they are mostly present outside the Montenegrin waters, which does not exclude their relevance and impacts of Montenegrin waters. For example, demersal fishing activity, although intensive in the Adriatic Sea, is not significantly destructive in Montenegro. Also, a part of the southern Adriatic area is identified as one of the hot-spot areas for possible oil spills, which is linked to intensive traffic of tankers containing oil and gas, but geographically it marginally challenges Montenegrin waters. Concerning the potential risks of oil spills, newly started initiatives for oil and gas drilling in Montenegrin marine waters are raising environmental concerns in the country.

Montenegrin waters are under pressure related to marine pollution. Recent assessment of contaminants, eutrophication, and marine litter (UNEP/MAP-PAP/RAC and MESPU, 2021) identified areas that are likely to be under greater pollution pressures (Figure 2.2). These are predominantly identified near the coastal areas, closer to urban and touristic centres.

The generic overview of pressures at a national level shows that geographically, the most extensive pressures in Montenegro are derived from the tourism sector (Table 2.2). Urbanisation and industry also contribute with pressures to some extent while other sectors contribute to a lesser extent.

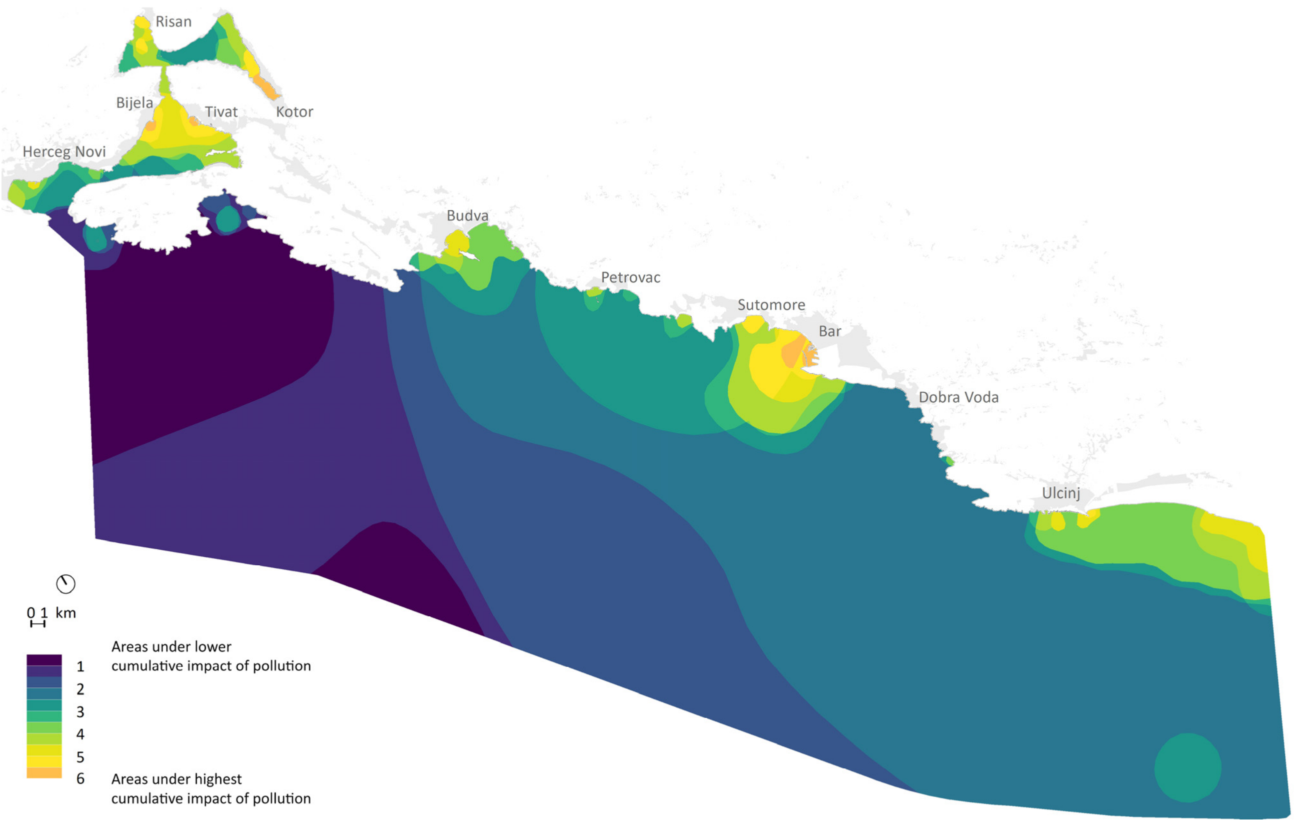


Figure 2.2. Areas with potential cumulative pressures from pollution in the marine area of Montenegro
Source: UNEP/MAP-PAP/RAC and MESPU, 2021; GEF Adriatic project

The increase of sea surface temperature is also not yet so significant, which is important information related to impacts of climate change and the spread of NIS. However, based on current levels of human activities and practices that cause climate change, more significant increase in temperature could be anticipated in the future.

It should be stressed that pressures do not act alone, but rather in a combined manner, which results in higher cumulative and synergistic impacts. At the Montenegrin level specifically, cumulative assessment of pressures was carried out, with the aim to determine the most impacted spatial units that should be restored and preserved from future degradation. This assessment considers different environmental segments, including biodiversity and fish resources. The results of the assessment showed higher impacts in the area of Boka Kotorska, at locations in Budva, Petrovac, Sutomore, Bar, and Ulcinj (Figure 2.3). This is particularly related to urbanisation and tourism, which is in line with assessments of geographical extents of pressures shown in Table 2.2.

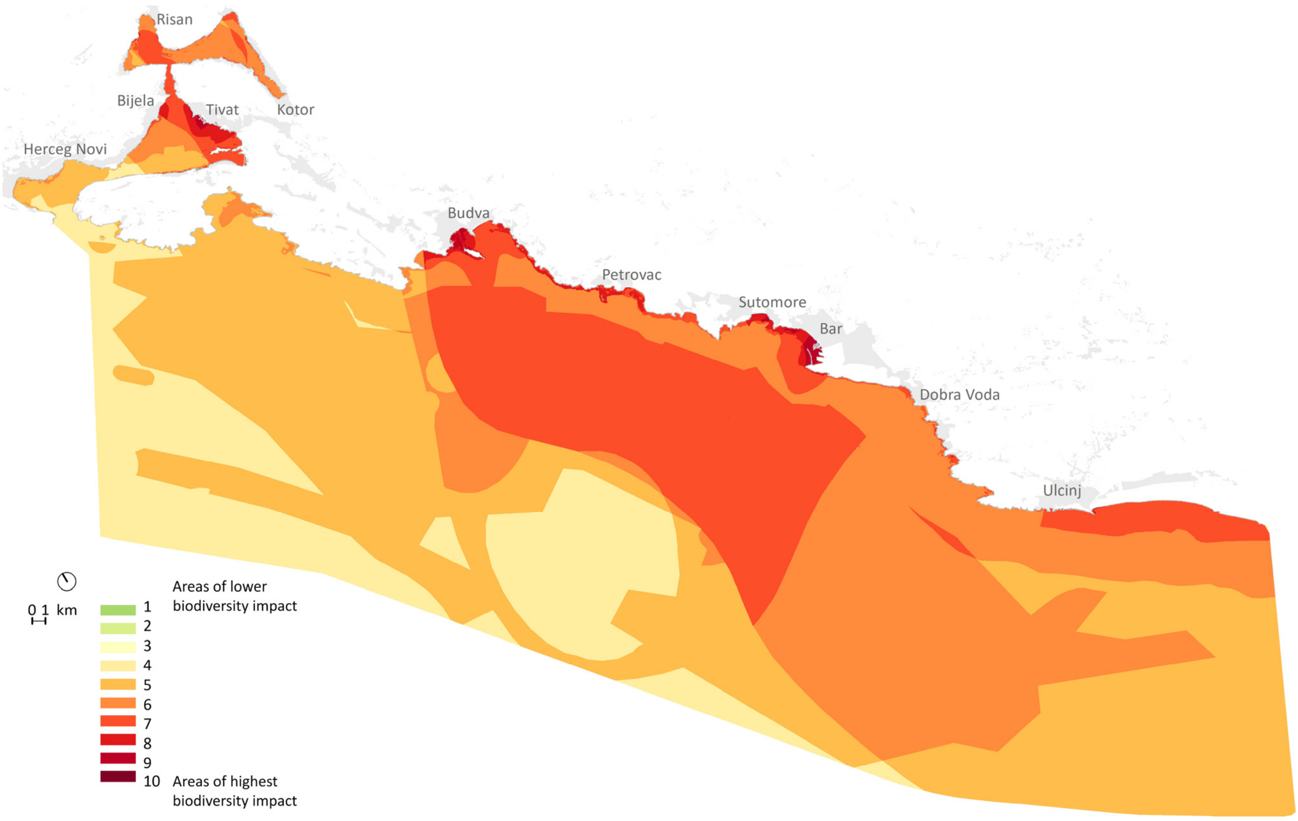


Figure 2.3. Areas with cumulative effects of pressures to biodiversity. *Source: UNEP/MAP-PAP/RAC and MESPU, 2021; GEF Adriatic project*

Table 2.2. Preliminary assessment of pressures' extent

Sector – Driver	Priority pressures (regional level)	Geographical extent of pressure in Montenegro*	Total per sector in Montenegro	Total of all sectors combined in Montenegro	Potential impacts (regional level)	Likely affected habitat types and species groups relevant for IMAP for Montenegro
Urbanisation and industry	Physical loss – Seafloor integrity (EO6)	Low	Medium – High	Medium	▪ Habitat loss and degradation (pelagic and benthic habitats) ▪ Species populations disturbance ▪ Incidental mortality ▪ Reduction of population abundances (for sedentary species) or population relocations ▪ Short/long term water quality impairment ▪ Coastal erosion ▪ Impacts on quality of life ▪ Long-term loss of revenues due to reduced and low-quality tourism development ▪ Increased pollution in sea/coastal area (marine litter, noise, light, etc.) ▪ Landscape degradation ▪ Littoralisation	▪ Photophilic algal communities ▪ Coralligenous assemblages ▪ *Posidonia* meadows ▪ Phytoplankton ▪ Zooplankton ▪ Marine mammals ▪ Marine turtles ▪ Seabirds
	Marine litter (EO10)	High	Medium – High	Medium		
	Nutrient and organic matter enrichment (EO5)	Medium	Medium – High	Medium		
	Contamination by hazardous substances (EO9)	Medium	Medium – High	Medium		
	Microbial pathogens (EO9)	Low	Medium – High	Medium		
	Physical loss – natural coastline (EO8)	Medium – High	Medium – High	Medium		
	Changes of local hydrographical conditions (EO7)	Low – Medium	Medium – High	Medium		
Maritime transport	Litter (EO10)	Low	Low – Medium	Medium	▪ Habitat loss and degradation (particularly pelagic habitats) ▪ Species populations disturbances ▪ Population relocations ▪ Incidental mortality (collisions) ▪ NIS transport and introduction ▪ Pollution (noise, debris, contaminants, etc.)	▪ Marine mammals ▪ Marine turtles ▪ Seabirds
	Noise (EO11)	Not known	Low – Medium	Medium		
	Non-indigenous species (EO2)	Not known	Low – Medium	Medium		
	Physical loss – Seafloor integrity (EO6)	Low	Low – Medium	Medium		
	Contamination by hazardous substances (EO9)	Low – Medium	Low – Medium	Medium		

Sector – Driver	Priority pressures (regional level)	Geographical extent of pressure in Montenegro*	Total per sector in Montenegro	Total of all sectors combined in Montenegro	Potential impacts (regional level)	Likely affected habitat types and species groups relevant for IMAP for Montenegro
Energy sector	Noise (EO11)	Not known	Low	Medium	▪ Habitat loss and degradation (pelagic and benthic habitats) induced by climate change ▪ Species populations disturbance	▪ Coralligenous assemblages ▪ *Posidonia* meadows ▪ Phytoplankton ▪ Zooplankton ▪ Marine mammals ▪ Marine turtles ▪ Seabirds
	Physical loss – Seafloor integrity (EO6)	Low	Low	Medium		
	Indirectly – focus on fossil fuels – promotor of climate change	Low	Low	Medium		
	Contamination by hazardous substances (EO9)	Low	Low	Medium		
Agriculture	Contamination by hazardous substances (EO9)	Low	Low	Medium	▪ Habitat loss and degradation (pelagic and benthic habitats), ▪ Reductions of species resilience to other threats ▪ Reduction of population abundance	▪ Photophilic algal communities ▪ Fish and cephalopods ▪ Coralligenous assemblages ▪ Posidonia meadows ▪ Phytoplankton ▪ Zooplankton ▪ Seabirds
	Microbial pathogens (EO9)	Low	Low	Medium		
	Nutrient and organic matter enrichment (EO5)	Low	Low	Medium		
Fishery (incl. aquaculture)	Removal of target and non-target species (lethal) (EO3)	Low	Low	Medium	▪ Habitat loss and degradation (particularly benthic habitats) ▪ Reduction of food resources ▪ Incidental mortality of non-targeted (threatened) species (bycatch, ghost net entanglement, entrapment in aquaculture cages, etc.) ▪ Reduction of population abundance	▪ Coralligenous assemblages ▪ Posidonia meadows ▪ Marine mammals ▪ Marine turtles ▪ Seabirds ▪ Fish and cephalopods
	Physical damage (abrasion) (EO6)	Low	Low	Medium		
	Litter (ghost nets) (EO10)	Low	Low	Medium		
	Non-indigenous species (EO2)	Low	Low	Medium		
	Contamination by hazardous substances (EO9)	Low	Low	Medium		
	Nutrient and organic matter enrichment (EO5)	Low	Low	Medium		
	Microbial pathogens (EO9)	Low	Low	Medium		

Sector – Driver	Priority pressures (regional level)	Geographical extent of pressure in Montenegro*	Total per sector in Montenegro	Total of all sectors combined in Montenegro	Potential impacts (regional level)	Likely affected habitat types and species groups relevant for IMAP for Montenegro
Tourism	Physical loss – Seafloor integrity (EO6)	Low	Medium	Medium	▪ Habitat loss and degradation (pelagic and benthic habitats) ▪ Species populations disturbance ▪ Incidental mortality (e.g., collisions) ▪ Reduction of population abundance ▪ Punctual (occasional) water quality alterations	▪ Coralligenous assemblages ▪ *Posidonia* meadows ▪ Marine mammals ▪ Marine turtles ▪ Seabirds ▪ Fish and cephalopods
	Litter (EO10)	High	Medium	Medium		
	Nutrient and organic matter enrichment (EO5)	Medium	Medium	Medium		
	Noise (EO11)	Not known	Medium	Medium		
	Microbial pathogens (EO9)	Low	Medium	Medium		
	Contamination by hazardous substances (EO9)	Medium	Medium	Medium		
	Physical loss – natural coastline (EO8)	Medium – High	Medium	Medium		
	Changes of local hydrographic conditions (EO7)	Low – Medium	Medium	Medium		
Climate change	Atmospheric changes, in particular variations in the air pressure in the northern hemisphere	Low	Low	Medium	▪ Habitat loss and/or degradation and/or changes ▪ Changes in phytoplankton, zooplankton, and pelagic fish biomasses ▪ Changes in species distributions ▪ Potential Impacts on livelihoods ▪ Increased costs for the beach nourishments and coastal infrastructure	▪ Coralligenous assemblages ▪ *Posidonia* meadows ▪ Marine mammals ▪ Marine turtles ▪ Seabirds ▪ Fish and cephalopods
	Sea level rise (EO7)	Low – Medium	Low	Medium		
	Stormy winds and/or occasional heavy rains	Low	Low	Medium		
	Changes of hydrographic conditions (EO7)	Low – Medium	Low	Medium		

3 Towards an integrated GES assessment

This chapter briefly describes the approach to GES assessment, including criteria and methodological standards for each Ecological Objective. Based on the criteria and elaborated methodology, this chapter provides the summarised assessment of GES for Ecological Objectives 1, 2, 7, 8, 9, and 10, to the extent allowed by the existing and available data. Major interrelations among Ecological Objectives are highlighted.

3.1 Overview of GES assessment

Assessment for each Ecological Objective is undertaken via defining specific GES targets and assessment criteria. In addition, a baseline assessment was carried out, using the most recent data. For the assessment of plankton (see 3.1.a), eutrophication, hydrography (see 3.1.c), and contaminants (see 3.1.e), results of the offshore survey undertaken within the framework of the GEF Adriatic project (2019) were used. This comprehensive survey, for the first time in Montenegro, was undertaken on 17 stations within five transects reaching from the shoreline to the external limits of the territorial sea (Figure 3.1). For the assessments of *Posidonia* and coralligenous communities, biodiversity survey results performed as part of the GEF Adriatic project (2019), in Boka Kotorska Bay and the open sea area, were also assessed (see 3.1.a). Analysis for the assessment of length of coastline subject to physical disturbance (CI17) as part of EO8, was also undertaken as part of the Project (2020; see 3.1.d).

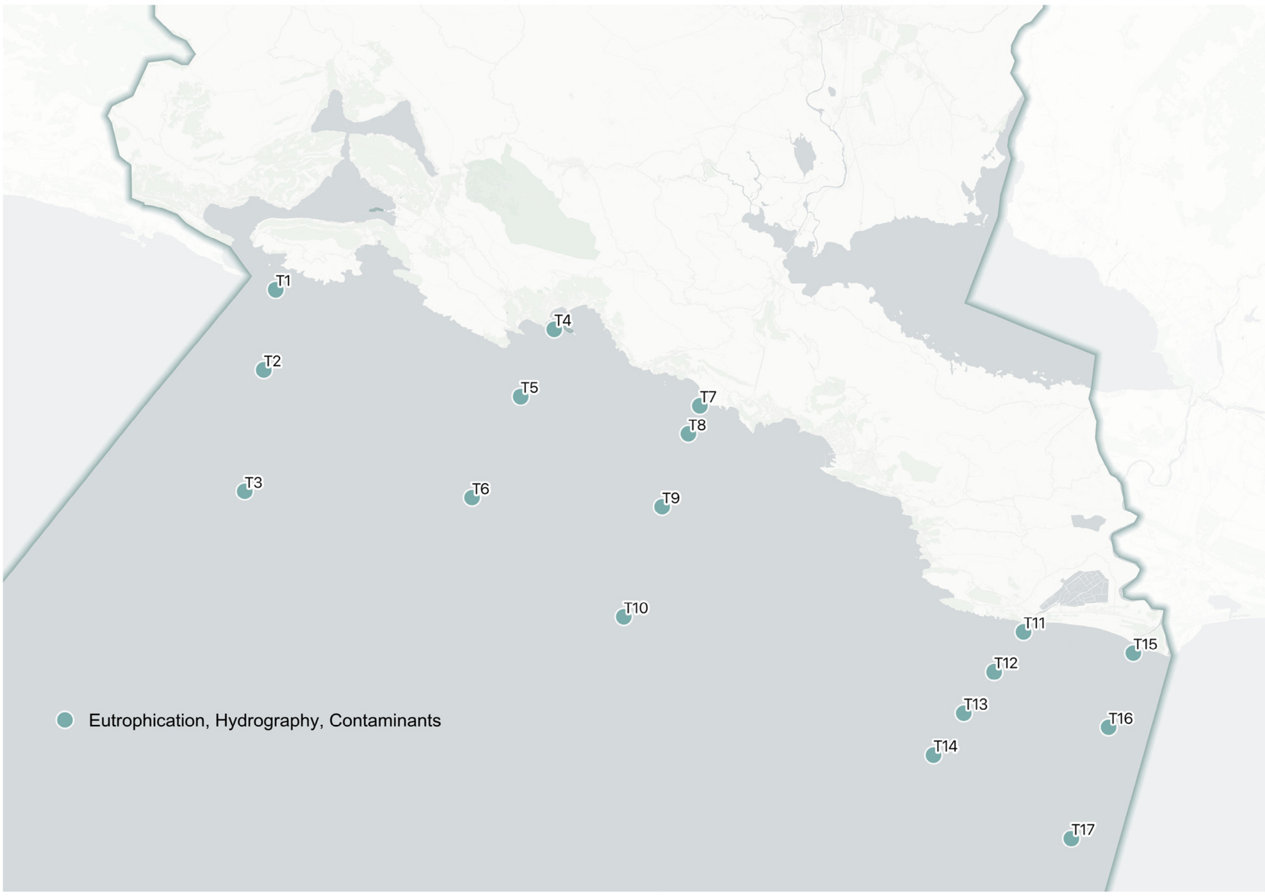


Figure 3.1. Survey stations for plankton, eutrophication, hydrography, and contaminants during 2019 survey

Based on those data, initial evaluation of GES status is presented. It must to be highlighted that detailed elaboration of GES per specific Ecological Objectives is given in the thematic reports available as supporting documents to this document.

3.1.a Biodiversity – (EO1)

GES criteria and definitions

The EO1 Biodiversity is a state-related objective, which is defined as: *Biological diversity is maintained or enhanced. The quality and occurrence of coastal and marine habitats and the distribution and abundance of coastal and marine species are in line with prevailing physiographic, hydrographic, geographic, and climatic conditions*. As such, it corresponds to the Descriptor 1 of the GES under MSFD. The main criteria for EcAp/IMAP's GES assessment of the state of biodiversity are five specific but common indicators, including habitat distribution and condition, species distribution, population abundance, and demographics (Table 3.1), with corresponding GES definitions. The focus of GES assessment are representative benthic and pelagic habitat types and groups of species, as listed in Table 3.2. It should be stressed that when choosing criteria for the preliminary Montenegrin EO1 GES assessment, few additions were made to the EcAp/IMAP's criteria, using the advantages of the latest MSFD criteria under the already mentioned 2017 Commission's Decision and considering some of the national specificities, as follows:

- Pelagic habitats are addressed due to their relevance for state of biodiversity, even though IMAP tackles them to some extent only under EO5 – Eutrophication;
- Although red coral (*Corallium rubrum*) is usually selected as a representative species of coralligenous assemblages, it has not yet been recorded in Montenegro, and as such could not be used as indicator species for GES assessment. Therefore, *Savalia savaglia*, as a representative species of coastal coralligenous assemblages of Montenegro, is selected instead. However, a search for *C. rubrum* is planned in the future;
- True seabird species, which are common selected species for GES assessment, are summer visitors, migratory, and wintering species only in Montenegro. Hence, the representative breeding species with habitats in coastal area are added to the list of selected seabirds;
- Monk seal (*Monachus monachus*) is not present in Montenegro, and hence, this specie, could not be a subject of GES assessment.

The most critical parts relate to selecting the appropriate methods to measure indicators and setting up the thresholds, providing a set of reference values for each indicator against which it would be possible to assess GES characteristics. Namely, it is difficult to quantify biodiversity, and hence, many thresholds are of a qualitative nature. In addition, identification of certain thresholds requires regional cooperation and harmonisation at the European level. In general, identification of thresholds for biodiversity is still an ongoing process, at both European and Mediterranean levels. However, for the purpose of the first Montenegrin GES assessment, an attempt was made to set thresholds, following requirements and guidance related to the implementation of IMAP as much as possible, as well as the MSFD and considering the proximity of Croatia, as the neighbouring country with the largest coastal area in the eastern Adriatic (more details in Table 3.3).

Table 3.1. Overview of common indicators on biodiversity under EcAp/IMAP's EO1.
Source: UNEP/MAP, IMAP Common Indicator Guidance Facts Sheets (Biodiversity and Fisheries), Greece, 2017

Ecological Objective	IMAP Indicators	Relevant GES definition
EO1 Biodiversity Biological diversity is maintained or enhanced. The quality and occurrence of coastal and marine habitats and the distribution and abundance of coastal and marine species are in line with prevailing physiographic, hydrographic, geographic, and climatic conditions	Common Indicator 1: Habitat distributional range (EO1) to also consider habitat extent as a relevant attribute.	The habitat is present in all its natural distributional range.
	Common Indicator 2: Condition of the habitat's typical species and communities (EO1).	The population size and density of habitat-defining species, and species composition of the community, are within reference conditions ensuring the long-term maintenance of the habitat.
	Common Indicator 3: Species distributional range (EO1 related to marine mammals, seabirds, marine reptiles).	Marine mammals: The species are present in all their natural distributional range. Seabirds: The distribution of seabird species continues to occur in all their Mediterranean natural habitat. Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic, and climatic conditions. (EO1, Biodiversity). Marine reptiles: The species continues to occur in all its natural range in the Mediterranean, including nesting, mating, feeding, and wintering and developmental (where different to those of adults) sites.
	Common Indicator 4: Population abundance of selected species (EO1, related to marine mammals, seabirds, marine reptiles).	Marine mammals: The species population has abundance levels allowing qualifying to Least Concern Category of IUCN Red List or has abundance levels that are improving and moving away from the more critical IUCN category. Seabirds: Population size of selected species (of seabirds) is maintained. The species population has abundance levels allowing to qualify to Least Concern Category of IUCN (less than 30% variation over a time period equivalent to 3 generation lengths). Marine reptiles: The population size allows to achieve and maintain a favourable conservation status taking into account all life stages of the population.
	Common indicator 5: Population demographic characteristics (EO1, e.g., body size or age class structure, sex ratio, fecundity rates, and survival/mortality rates related to marine mammals, seabirds, marine reptiles).	Marine mammals: ▪ *Cetaceans:* species populations are in good condition: low human induced mortality, balanced sex ratio and no decline in calf production. ▪ *Monk seal:* species populations are in good condition: low human induced mortality, appropriate pupping seasonality, high annual pup production, balanced reproductive rate, and sex ratio. Seabirds: Species populations are in good condition: natural levels of breeding success and acceptable levels of survival of young and adult birds. Marine reptiles: Low mortality induced by incidental catch; favourable sex ratios and no decline in hatching rates.

Table 3.2. Selected habitat types and species for the initial GES assessment for Montenegro.
Based on IMAP, 2016 and National integrated monitoring programme for Montenegro, 2020

Criteria element	Selected habitat types and species
HABITATS	
Benthic habitats	*Posidonia* meadows – *Posidonia oceanica* as representative species.
	Coralligenous assemblages – *Savalia savaglia* for Montenegro. For selection of more species, particularly in the open sea, more research is needed. This also applies to *Corallium rubrum*, which is not yet recorded in Montenegro.
	Photophilic algal communities and species belonging to genus *Cystoseira* – *Cystoseira amantacea* as representative species.
Pelagic habitats	Phytoplankton
	Zooplankton
SPECIES	
Marine mammals	*Tursiops truncates*
	Stenella coeruleoalba
Marine reptiles	*Caretta caretta*
Seabirds	*Calonectris diomedea (SMW)**
	*Larus audouinii (SMW)**
	*Phalacrocorax aristotelis (SMW)**
	*Puffinus yelkouan (SMW)**
	Charadrius alexandrinus (B)
	*Mycrocarbo pygmeus (*old name: *Phalacrocorax pygmeus*) (B)
	Phoenicopterus roseus (old name: *Phoenicopterus ruber)* (B)
	Sterna albifrons (B)

** True seabird species, SMW = summer visitors, migratory, and wintering species in Montenegro. B = breeding species*

Table 3.3. Criteria and methodological standards for GES assessment for EO1 Biodiversity in marine and adjacent coastal area of Montenegro.
Based on: Barcelona Convention 19th COP Decision IG.22/7 (IMAP), 2016; UNEP/MAP, IMAP Common Indicator Guidance Facts Sheets (Biodiversity and Fisheries), Greece, 2017; Commission Decision (EU) 2017/848; NIMP for Montenegro, 2020; Update on marine strategy documents in Croatia, 2019. EO = Ecological objective, CI = common indicator

Criteria elements	**Criteria** ***Indicator with related GES definition (minimum requirements for achieving GES)***	***Indicator measurement and thresholds***	**Methodological standards** ***Scale of assessment***	***Use of criteria***
Benthic habitats (relating to EO1 and EO6)				
Selected priority benthic habitats and relevant species: ▪ Photophilic algal communities and species belonging to the genus *Cystoseira – Cystoseira amantacea* ▪ Posidonia meadows – *Posidonia oceanica* ▪ Coralligenous assemblages – *Savalia savaglia* present only in Boka Kotorska Bay. *Corallium rubrum* is not recorded in Montenegro – further research required	Benthic habitat distributional range EO1, CI1 GES definition IMAP: The habitat is present in all its natural range.	*For photophilic algal communities:* What is measured: CARLIT index. Threshold: CARLIT index assessed as "very good", "good", or "moderate" conditions for coastal waters (as defined under the Water Framework Directive, 2000/60/EC, Annex V).	National level assessment	CARLIT index should be measured and assessed against indicated threshold. Values of "very good", "good", or "moderate" values are considered as GES.
		For Posidonia *meadows:* What is measured: Changed POMI index of Directive, 2000/60/EC. Threshold: Changed POMI index assessed as "very good", "good", and "moderate" conditions for coastal waters.	National level assessment	Changed POMI should be implemented (as it is in Croatia) and density of seagrass meadow, coverage, depth, and type of lower limit will be measured. Values of "very good", "good", and "moderate" thresholds are evaluated according to RAC SPA 2014 document.
		For coralligenous assemblages: What is measured: MAES[1] index for coastal assemblages. For the assemblages in the open sea, more research for evaluation of methods and thresholds are needed. Threshold: Montenegro – MAES status measured as "very good", "good", or "moderate" means GES.	National level assessment	MAES index should be measured and assessed against indicated threshold. Several parameters will be measured: no. of megabenthic species, cover of basal layer, density of erect species, height of dominant erect species, % necrosis, and litter density.
	Benthic habitat condition EO1, CI2 GES definition IMAP: The population size and density of the habitat-defining species, and species composition of the community, are within reference	*For photophilic algal communities:* What is measured: CARLIT index. Threshold: CARLIT index assessed as "very good", "good", and "moderate" conditions for coastal waters (as defined under the Directive, 2000/60/EC, Annex V).	National level assessment	

[1] MAES = Mesophotic Assemblages Ecological Status

Criteria elements	Criteria *Indicator with related GES definition (minimum requirements for achieving GES)*	*Indicator measurement and thresholds*	Methodological standards *Scale of assessment*	*Use of criteria*
	conditions ensuring the long-term maintenance of the habitat.	*For* Posidonia *meadows:* What is measured: Changed POMI tool of Directive, 2000/60/EC. Threshold: Changed POMI index assessed as "very good", "good", and "moderate" conditions for coastal waters.	National level assessment	
		For coralligenous assemblages: What is measured: MAES index for coastal assemblages. For the assemblages in the open sea, more research for evaluation of methods and thresholds is needed. Threshold: MAES measured as "very good", "good", or "moderate" means GES.	National level assessment	
Pelagic habitats (relating to EO1, EO4 and EO5)				
Selected priority pelagic habitats: ▪ *Phytoplankton* ▪ *Zooplankton*	Pelagic habitat condition EO1, CI2 GES definition IMAP: The population size and density of the habitat-defining species, and species composition of the community, are within reference conditions ensuring the long-term maintenance of the habitat.	*For phytoplankton:* What is measured: ▪ Composition (species groups), and abundance ▪ Composition and abundance trend (Box-whisker overview) ▪ Margalef, Shannon, Pielou, and Simpson indexes (MSPS) for diversity of phytoplankton (Box-whisker overview) ▪ Trend in blooming of plankton ▪ In general, 6-year data series would be most appropriate for GES assessment Thresholds: ▪ Composition and abundance trend as expected naturally ▪ MSPS indexes indicate relatively high phytoplankton biodiversity ▪ Low blooming rate, declining blooming trend	National level of assessment	All proposed elements should be measured per each selected group of pelagic habitats and assessed against the proposed thresholds, in each assessed area. Based on outcomes, it should be estimated whether the GES is achieved or not.
		For zooplankton: What is measured: ▪ Composition and abundance of meso-zooplankton ▪ Composition and abundance trends ▪ Ratio of holo- and mero-zooplankton (this ratio could be linked to impacts of climate change) ▪ Ratio of juvenile and adult individuals in copepods ▪ Biodiversity indexes of dominant group; Copepods	National level of assessment	

Criteria elements	Criteria *Indicator with related GES definition (minimum requirements for achieving GES)*	*Indicator measurement and thresholds*	Methodological standards *Scale of assessment*	*Use of criteria*
		In general, 6-year data series would be most appropriate for GES assessment. Thresholds: ▪ Composition and abundance trend as expected naturally ▪ Holoplankton dominated in holo-and mero-zooplankton ratio ▪ Juvenile individuals are in higher abundance in ratio juvenile/adults ▪ Number of Copepoda species, Margalef index, Shannon-Wienerov biodiversity index, Pielou index, and Simpson dominance index indicate relatively high biodiversity		
SPECIES				
Selected group of species: Marine mammals ▪ *Tursiops truncatus* ▪ *Stenella coeruleoalba* Marine reptiles ▪ *Caretta caretta* Seabirds ▪ *Calonectris diomedea (SMW)* ▪ *Larus audouinii (SMW)* ▪ *Puffinus yelkouan (SMW)* ▪ *Phalacrocorax aristotelis (SMW)* ▪ *Charadrius alexandrinus (B)* ▪ *Mycrocarbo pygmeus (B))* ▪ *Phoenicopterus roseus (B)* ▪ *Sterna albifrons (B)* *Note: Summer visitors, migratory, and wintering true seabird species are included (SMW) and coastal breeding species (B).*	Species distributional range EO1, CI3 GES definition IMAPMarine mammals: The species are present in all their natural distributional range. GES definition IMAPMarine reptiles: The species continue to occur in all its natural range in the Mediterranean, including nesting, mating, feeding, and wintering and nursery sites (where different to those of adults). GES definition IMAP and Seabirds: The distribution of seabird species continues to occur in all their Mediterranean natural habitats. Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic, and climatic conditions.	*For all selected species:* What is measured: Species distributional range and pattern. Thresholds: ▪ Species distributional range and pattern correspond to ones expected naturally ▪ For cetaceans and marine turtles in the Adriatic the reference values are those recorded during the 2010 and 2013 summer season aerial surveys	For cetaceans, marine turtles, and wintering seabirds – primarily Adriatic (sub-regional) level assessment should be made. For breeding birds – national level assessment.	In absence of certain sub-regional thresholds, baseline national overview could be made as a starting point for future sub-regional GES assessment.
	Population abundance EO1, CI4 GES definition IMAP Marine Mammals: The species population has abundance levels allowing to qualify for Least Concern Category of IUCN or has	*For all selected species:* What is measured: Population abundance trend. Thresholds:	For cetaceans, marine turtles and summer, visitors, migratory and wintering seabirds – primarily Adriatic	The population abundance should be assessed individually for each species at the Adriatic (sub-regional) level. In absence of sub-regional thresholds, baseline national overview could be made as

Criteria elements	Criteria *Indicator with related GES definition (minimum requirements for achieving GES)*	*Indicator measurement and thresholds*	Methodological standards *Scale of assessment*	*Use of criteria*
	abundance levels that are improving and moving away from the more critical IUCN category. GES definition IMAP Marine reptiles: Population size allows to achieve and maintain a favourable conservation status, taking into account all life stages of the population. GES definition IMAP Seabirds: Population size of selected species (of seabirds) is maintained. The species population has abundance levels allowing to qualify to Least Concern Category of IUCN (less than 30% variation over a time period equivalent to 3 generation periods).	▪ Population abundance has levels allowing to qualify to Least Concern Category of IUCN ▪ For cetaceans and marine turtles in the Adriatic the reference values are those recorded during the 2010 and 2013 summer season aerial surveys ▪ For the birds, reference numbers are of breeding pairs published in *Study of protection of Ulcinj salina,* (Sovinc *et al.* 2017) and monitoring of breeding birds of Bojana delta (Sackl *et al.* 2017)	level assessment (sub-regional) should be made. For breeding bird species – national level assessment.	a starting point for future sub-regional GES assessment.
	Population demographic characteristics EO1,CI5 EO3, CI12 GES definition IMAP Marine Mammals – Cetaceans: Species populations are in good condition: low human induced mortality, balanced sex ratio and no decline in calf production. GES definition IMAP Marine reptiles: Low mortality induced by incidental catch, favourable sex ratio and no decline in hatching rate. GES definition IMAP Seabirds: Species populations are in good conditions: natural levels of breeding success and acceptable levels of survival of young and adult birds.	Marine mammals and marine turtles What is measured: ▪ Trend in number of incidentally by-catch animals per group of species (at least a 6-year period) ▪ Sex ratio ▪ For mammals: calf production Thresholds: ▪ Mortality trend is stable or declining at national level ▪ Balanced sex ratio ▪ For mammals, no decline of calf production due to human influence	National level assessment	The extent to which GES has been achieved should be expressed for each area assessed as level of change of mortality trend per species. Any increase in mortality could be described as non-GES. The sex ratio and calf production (marine mammals), breeding success, and survival rate of young birds should be assessed for each species, on the basis of the criteria selected for use. If the proposed thresholds are achieved, it indicates GES.
		Seabirds What is measured: ▪ Trend in number of incidentally by-caught animals per group of species (at least a 6-year period) ▪ For breeding species only: survival of young and adult birds (breeding success) Thresholds: ▪ Mortality trend is stable or declining at national level ▪ Natural levels of breeding success	National level assessment	

EO1 GES assessment

Habitats: Benthic habitats

As already indicated, GES assessment is focused on three selected benthic habitat types: photophilic algal communities and species (*Cystoseira* as a typical genus), *Posidonia* meadows (*Posidonia oceanica* as a typical species), coralligenous assemblages (*Savalia savaglia* as a typical species) and for pelagic habitats – phytoplankton and zooplankton.

Stands of **photophilic algal communities and species** belonging to the genus *Cystoseira* inhabit the shallowest area of infralittoral exposed rocky areas and are widely distributed in the Mediterranean and the Adriatic Sea (*III.6.1. Biocenosis of infralittoral algae (upper horizon)* of RAC/SPA Reference List of Marine and Coastal Habitat Types in the Mediterranean; habitat type *1170 – Reefs* of the Annex I of the Habitats Directive 92/43/EEC (UNEP/MAP, 2017).

CARLIT is a method which allows rapid collection of different data on conditions of shoreline and shallow water species and communities. The surveys based on CARLIT (Cartography of littoral and upper-sublittoral rocky-shore communities) were carried out in 2018 and 2019 (Figure 3.2), with similar results. Namely, on four researched locations the CARLIT index ranged from "poor" to "high"; or an average "moderate". It should be stressed that at some particular sites, such as Petrovac, some parts of the coast are changed, as well as in some other parts that are not under monitoring. In Herceg Novi, there is almost no natural coast, but the state of the communities is not so bad.

However, the existing information is not yet sufficient to evaluate any trend.

It is also important to note that deeper parts of the habitat are not subject to the CARLIT methodology. This type of habitat is in many cases destroyed because of illegal fishing and in almost all parts of the coast severe changes of the ecosystem functioning are noted.

ES = 0,48

ES = 0,80

ES = 0,37

ES = 0,61

Figure 3.2. Ecological status (ES) of photophilic algal communities for four sections of the coast according to CARLIT methodology in 2019

The seagrass ***Posidonia oceanica*** is widely distributed throughout the Adriatic and the Mediterranean Sea and it is considered one of the priority habitats (III.5. Infralittoral *Posidonia oceanica* meadows of RAC/SPA Reference List of Marine and Coastal Habitat Types in the Mediterranean; habitat type 1120 – *Posidonia* beds (*Posidonia oceanica*) of the Annex I of the Habitats Directive 92/43/EEC (UNEP/MAP, 2017).

***Posidonia* meadows** are not very well studied in the Montenegro so far. First surveys with the aim of mapping *Posidonia* meadows, evaluation of meadows density, seasonal lepidochronology, anatomy of the leaves, and heavy metals pollution, were performed for Boka Kotorska Bay (Mačić, 2001). Later, several surveys were performed for mapping and evaluation of meadow density, especially in the open part of the coast (Katič, Platamuni, cape Ratac, Luštica, Stari Ulcinj, etc.). Density of the *Posidonia* meadows in Boka Kotorska Bay are lower than in the open sea, and that is in relation with the specific environmental conditions and anthropogenic pressures (mainly eutrophication). On the open part of the Montenegrin coast *Posidonia* meadows are mainly in good condition, in some areas occurring down to 30 m depth.

There is no possibility to evaluate trends for *Posidonia* due to lack of long-term monitoring based on the same methodology. Bearing in mind the cost and effort efficiency of POMI, a so called “modified POMI“ method, already applied in Croatia (Guala *et al.*, 2014), is tested and partially implemented in Montenegro. The first results on three locations – cape Crni, Buljarica, and Đeran, indicate good status, but more data are needed for full assessment.

Conservation index will be calculated in the future, based on these parameters. Furthermore, through this method, the presence of invasive and protected species (e.g., the pen shell *Pinna nobilis*) at the diving site will also be recorded.

Coralligenous assemblages are mainly developed on the hard substrate of the circalittoral step where light is limited. They are characterised by both calcified and non-calcified algae with an abundance of invertebrate species, with characteristic builders of coralligenous communities being sponges, anthozoans, and bryozoans.

Coralligenous habitats are very well developed in the inner part of Boka Kotorska Bay, where they start from 12 m depth down to 30 m, and are characterised by the presence of tube anthozoans.

The two very well studied locations inside Boka Kotorska Bay are Dražin vrt and Sopot (Figure 3.3). Dražin vrt is characterised by a submerged area which degrades rapidly and just a few meters from the shoreline the bottom reaches a depth of 5 m and degrades with greater steepness to 15–25 m.

On the hard substrate, coralligenous communities are developed down to 25 m depth. This area is rich with submerged springs. One of the most abundant species is *Savalia savaglia.* Its assemblages do not show epibiosis or necrosis in the distal branches, while high sedimentation is significantly present. According to UNEP/MAP-PAP/RAC-SPA/RAC and MSDT (2019) the value of MAES index for this site is 14 – Moderate.

Site Sopot is characterised by similar environmental conditions as Dražin vrt. The submerged area degrades rapidly and just a few meters from the shoreline the bottom reaches a depth of 7 m, where the first colonies of the zooanthid *Savalia savaglia* could be found. The bottom degrades with greater steepness down to 16–18 m. The coral blocks, mixed with huge assemblages and sparse colonies of *Savalia savaglia* end at 18 m on a bottom covered with a thin layer of sediments. It is characterised by scattered or grouped colonies of *Savalia savaglia*, scattered coral, and stony blocks. The biocenosis also consists of large sponges growing both on coral and stony blocks, as well as colonies of the soft corals *Leptogorgia sarmentosa* and the zoanthid *Parazoanthus axinellae.* The assemblages show epibiosis or necrosis in the distal branches of ca. 0.2%, and are characterised with a high amount of debris of anthropogenic origin. Calculated MAES index is 14 – Moderate (UNEP/MAP-PAP/RAC-SPA/RAC and MSDT, 2019).

Figure 3.3. Researched sites with presence of coralligenous habitats in Boka Kotorska

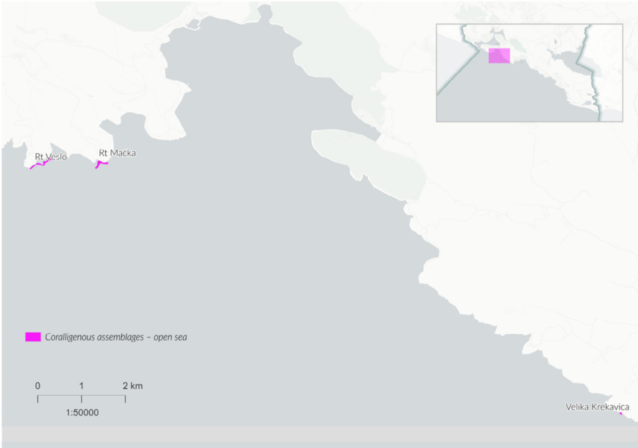


Figure 3.4. Researched sites with presence of coralligenous habitats in the open sea

Data for the open sea are not so comprehensive. There are two researched sites, capes Mačka and Veslo (Figure 3.4). Location Ponta Veslo is featured with hard rock in the shallow part and biogenic structures to 35 m depth, followed with a fine sediment substrate. Coralligenous assemblages are characterised by calcareous algae and sponges. The basal layer is very well developed, while the erect layer is absent. MAES index was not calculated. The main recognised pressures are sedimentation and fishing equipment. Rt Mačka is relatively close to the previous location. Hard bottom ends at 33 m and continues with fine sandy-muddy substrate; the rocky bottom is covered by algae. Similar to previous site, erect layer is missing. Community constructors are calcified algae and sponges. MAES index is not calculated (GEF Adriatic, 2019).

The evidence base for GES the assessment at the moment relies on literature data and some expert knowledge, which means sporadically collected data. Hence, it is possible to assess GES only partially (Table 3.4). In general, GES of photophilic algal communities could be better assessed than the coralligenous and *Posidonia* meadows. For assessed parameters, notably the state of photophilic algal and coralligenous communities in the coastal area, there is an indication that GES is achieved, despite increasing pressures such as construction of new infrastructure and water pollution, both particularly related to urbanisation and tourism. However, to obtain a full understanding of the state of benthic habitats, more systematic research needs to be done to address all knowledge gaps. In addition, there are no records on red coral (*Corallium rubrum*), which is a typical indicator species for GES assessment in the Adriatic, which requires further research of presence and abundance, as prescribed in the NIMP for Montenegro.

Table 3.4. Assessment of GES for benthic habitats in Montenegro, based on selected habitat types

Criteria		GES Assessment		
Indicator	**GES definition**	**Posidonia *meadows***	***Photophilic algae***	***Coralligenous assemblages***
Benthic habitat extent	The habitat is present in all its natural range.	Some maps of the *Posidonia* meadows distribution exist, but they are only detailed in some areas, like Boka Kotorska Bay and some locations in the open sea. POMI is measured only in few localities, and the first results indicate good environmental state. However, full GES assessment requires more data.	For the moment, CARLIT index measured in surveyed areas indicates that GES is achieved, despite the increasing trend of new infrastructure constructions on the coast. Still, on some particular sites, such as Petrovac GES is not achieved.	This type of coralligenous assemblages is confirmed only on three locations in Boka Kotorska Bay, with *Savalia savaglia* as the typical species; *Spinimuricea klavereni* was also found. There are no records of *Corallium rubrum*, a typical GES indicator species in the Adriatic. Calculated MAES index is "moderate", which means that they meet the minimum requirement for the GES for Boka Kotorska. GES for the open sea coralligenous assemblages is still unknown, due to lack of data.
Benthic habitat condition	The population size and density of the habitat-defining species, and species composition of the community, are within reference conditions ensuring the long-term maintenance of the habitat.	Typical density of the *Posidonia* meadows is maintained and it appears that the degradations in some parts, e.g. Perazića do, does not change the functions of this habitat in general sense. However, full GES assessment requires more data.	Compositions of the typical species is normal in most cases. Changes registered are consequence of the destruction of the coast or water pollution. There are no previous results with which to compare, but it appears that the function of this habitat is not changed. In addition, the deeper part of the habitat, which is not subject to the CARLIT methodology, is in many cases destroyed because of illegal fishing, and in almost all parts of the coast severe changes of the ecosystem functioning are noted.	As above.

Habitats: Pelagic habitats

Pelagic habitats, represented by phyto- and zooplankton, are crucial for functioning of marine ecosystem, particularly as a food base for number of species. Hence, even though pelagic habitats are not the focus of IMAP GES assessment of EO1 Biodiversity, they will be addressed in this document.

Phytoplankton

Phytoplankton is very sensitive to environmental changes. Algal growth is a result of the enrichment of water with nutrients (primarily nitrogen, silicon, and phosphorus compounds). Therefore, nutrients are important indicator of water quality before algae increase and result in intensive eutrophication (Brettum & Andersen, 2005). Phytoplankton composition together with physical and chemical parameters and chlorophyll concentration are the key elements for a good assessment of biological quality of the ecosystem (Toming & Jaanus, 2007). In some cases, the results of increased algal growth may also lead to an intensive growth of harmful-toxic species. Blooming of harmful algae can cause severe problems to an ecosystem and to human health.

Distribution of phytoplankton were analysed from June 2009 to June 2010 in Boka Kotorska Bay (may be referred to simply as Bay in text) at five locations.

Phytoplankton abundance recorded in the study area ranged from 10^4 cells/l to 10^6 cells/l and these values are characteristic for oligo-mesotrophic to eutrophic areas (Kitsiou & Karydis 2001, 2002). The highest abundance of phytoplankton was observed during summer period in July and August (3.59 x 10^6 cells/l and 3.05 x 10^6 cells/l).

Generally, growth of phytoplankton is characterised by bimodal cycles with maximum growth in colder periods of year (autumn, late winter ,and early spring) and minimum in summer periods. This trend is characteristic for the Mediterranean (Cushing, 1989) and the Adriatic Sea (Totti *et al.,* 2005). In the Bay, maximal values recorded during summer can be a result of still unregulated sewage waters and lower water dynamics.

The dominant phytoplankton groups were diatoms, the majority of which are typical species of zones with richness of nutrients (Revelante & Gilmartin, 1985; Pucher-Petković & Marasović, 1980); all observed species are quite common in the Adriatic Sea (Viličić *et al.,* 1995).

The highest value of dinoflagellates was recorded in September. Dinoflagellates are normally abundant during warmer period when lower supply of nutrients and lower turbulence favourable growth of dinoflagellates (Burić *et al.,* 2007). Drakulović *et al.,* 2017, confirmed higher values of dinoflagellates during warmer periods in Montenegrin water (Boka Kotorska Bay).

Coccolithophores also reached maximum in September.

The most recent data on phytoplankton were studied along the Montenegrin coast during 2018, 2019, and 2020. Analyses were performed on 12 locations in Boka Kotorska Bay, as well as in the open sea. The phytoplankton abundance was generally higher in the Bay than in the open sea, linked to the higher input of nutrients and lower water dynamics. The abundance at some locations in the Bay reached values of 10^5 cells/l while at certain locations abundance was 10^4 cells/l, which is, again, a characteristic of an oligo-mesotrophic to eutrophic area (Kitsiou & Karydis 2001, 2002).

The majority of frequent phytoplankton species observed during researches are indicators of areas rich in nutrients (Revelante & Gilmartin, 1980, 1985; Pucher-Petković & Marasović, 1980). The values of the diversity indexes were generally higher in the months when there was a lower number of dominant species (Table 3.5).

During the research, a lower number and diversity of toxic species of dinoflagellates (genera *Dinophysis*, *Gonyaulax, Lingulodinium, Phalacroma, Prorocentrum*) was recorded, while potentially toxic diatoms from the genus *Pseudo-nitzschia* were frequent and reached abundances of 10^4 cells/l. The presence of species that prefer areas rich in nutrients, along with the presence of toxic species, although still with a low abundance, indicate changes that should not be ignored. There is a necessity to carry out monitoring in order to be able to prevent possible negative consequences for the marine ecosystem and human health.

Table 3.5. Diversity indexes at investigation sites

Site with depth	Margalef index (d)		Shannon index (H')		Pielou index (J)	
	07.2019	10.2019	07.2019	10.2019	07.2019	10.2019
Rt Mačka, 0.5 m	2.0	2.0	2.18	2.32	0.72	0.75
Rt Mačka, 30 m	2.5	2.4	1.94	2.18	0.60	0.68
Katič, 0.5 m	1.6	2.3	2.19	1.94	0.79	0.61
Katič, 20 m	1.7	2.3	2.25	2.19	0.79	0.70
Rt Komina, 0.5 m	1.7	2.2	2.12	2.25	0.75	0.72
Rt Komina, 25 m	1.7	1.7	2.13	2.12	0.77	0.75

Analysis of phytoplankton were performed during 2019, in the scope of the GEF Adriatic project on 5 transects in the open sea from Mamula to Bojana River (Figure 3.1). In total, 94 taxa were recorded: 46 diatoms (48.94%), 39 dinoflagellates (41.49%), 6 coccolithophores (6.38%), 1 silicoflagellate (1.06%), and 2 taxa of chlorophytes (2.13%).

Diatoms dominated, while dinoflagellates were present in less abundance. The largest number of species that were dominant and recorded with the highest frequency of occurrence during the research prefer areas enriched with nutrients (Pucher-Petković & Marasović, 1980). This indicates slow changes that must be continuously monitored, all with the aim of avoiding possible negative effects in the increased productivity of these organisms.

Potentially toxic species were recorded, such as the diatom *Pseudo-nitzschia* spp and the potentially toxic dinoflagellates *Dinophysis acuminata, D. acuta, D. caudata, Lingulodinium polyedra, Phalacroma rotundatum, Prorocentrum cordatum,* and *P. micans.* The number of harmful organisms and pathogens (HAOP) has not yet increased, but indicate the need for monitoring to prevent possible negative consequences for the marine ecosystem and human health.

In general, existing data show that the recorded values for phytoplankton distribution are characteristic of oligo-mesotrophic to eutrophic areas. Some increased growth of phytoplankton appeared, but this growth was sporadic. Finally, it could be concluded that the composition and abundance of phytoplankton are in line with what is expected in the Adriatic, which indicate that GES is achieved. However, for full GES assessment, long-term data series are needed, based on systematic monitoring (preferably a 6-year period) (Table 3.6).

Table 3.6. Assessment of GES for pelagic habitats – phytoplankton in Montenegro

Criteria		GES Assessment
Indicator	**GES definition**	***Phytoplankton***
Pelagic habitat condition	The population size and density of the habitat-defining species, and species composition of the community, are within reference conditions ensuring the long-term maintenance of the habitat.	Considering the existing data from recent years, recorded values for phytoplankton distribution are characteristic of oligo-mesotrophic to eutrophic areas. These data indicate that composition and abundance of phytoplankton are in line with what is expected in the Adriatic, and that GES is achieved. However, for full GES assessment long-time data series is needed, collected systematically.

Zooplankton

Research of the zooplankton community in coastal and open sea waters in 2019 and 2020 recorded a total of 80 taxa from 12 groups. The number of taxa by months was diverse, ranging from 27 in September to 60 in February. Most taxa were recorded at the locations of Herceg Novi, Mamula, and Bar. The highest abundance of zooplankton was recorded in August at site Igalo and reached 28.138 ind m^{-3}, which is a consequence of high abundance of a cladoceran species *Penilia avirostris*. This is an indicator of highly eutrophic areas, noted in the inner part of Boka Kotorska Bay in 2009 (Pestorić *et al.*, 2017).

In general, the abundance was higher in the Bay than in the open sea (Budva, Bar, Ulcinj, Bojana sites). For the open sea, a small difference was observed for Bojana.

The most recent data were collected within the scope of the GEF Adriatic project in October 2019 at open sea stations. Copepods were the most numerous groups of zooplankton and generally represent the most abundant zooplankton; 56%–93%, followed by cladoceran species (average 9%), especially at transects D and C above the thermocline. Juvenile stages of copepods (calanoid and cyclopoid copepods) comprised 36%–68% of the total number of copepods. The analysis of the distribution of cladocerans by transects indicated that there was a statistically significant difference, which is consistent with the distribution of chlorophyll concentration, with highest determined value of 0.989 mgm^{-3}. The highest percentage of cladocerans is *Penilia avirostris*, a highly thermophilic species that feeds exclusively by filtration, indicating that a group of biological factors, i.e., the concentration of chlorophyll and the number of phytoplankton, is the one that enables the development and survival of this species in such numbers.

Diversity indices (Margalef, Pielou, and Shannon Wiener) showed that there are differences among locations in researched period. The highest values of Margalef and Shannon Wiener indexes were noted at Mamula. This is one of the deepest sites, with a visible influence of coastal waters as well as of the open sea. The highest richness was recorded in winter months, while the lowest diversity index value was observed in September, as consequence of a few dominant species, *Penilia avirostris* and small size fraction copepods, *Oithona* sp. and *Onceaidae*.

Analysis of the diversity index (Margalef and Shannon Wiener) of samples collected during field work in October 2019 in open sea showed that the maximum value of the Margalef index of 5.45 and 5.46 occurred at two locations in front of Mamula, which are also the deepest sites in this area (115 and 225 m), while the lowest diversity index value was recorded at the southernmost coastal location and was 2.8.

There is no concrete evidence that anthropogenic pressure affected habitat types; it was more a consequence of natural cycles and weather conditions as well as sea currents which caused specific environmental conditions (specially in 2009) and blooms of some species.

Non-indigenous species in zooplankton community were recorded, but this data is not published yet.

Data have been collected sporadically, with a more systematic approach since 2019. The research has been more complex and frequent in Boka Kotorska Bay then in the open sea. In general, the recorded values for zooplankton distributions coincided with data for the south Adriatic. It could be concluded that the composition and abundance of zooplankton are in line with what is expected in the Adriatic, which indicate that GES is achieved. However, for full GES assessment, long-time data series are needed, based on systematic monitoring (preferably a 6-year period) (Table 3.7).

Table 3.7. Assessment of GES for pelagic habitats – zooplankton in Montenegro

Criteria		GES Assessment
Indicator	**GES definition**	***Zooplankton***
Pelagic habitat condition	The population size and density of the habitat-defining species and species composition of the community are within reference conditions, ensuring the long-term maintenance of the habitat.	Considering the existing data from recent years, recorded values for zooplankton distributions coincided with data for the south Adriatic. These data indicate that composition and abundance of zooplankton are in line with what is expected in the Adriatic, and that GES is achieved. However, for full GES assessment, long-time data series is needed, based on systematic monitoring.

Species: Marine mammals – Cetaceans

Ten species of Cetaceans were recorded in Adriatic Sea, with four regulars in the southern Adriatic: bottlenose dolphin (*Tursiops truncatus*), striped dolphin (*Stenella coeruleoalba),* Cuvier’s beaked whale (*Ziphius cavirostris*), and Risso’s dolphin (*Grampus griseus*) (Table 3.8). There is no evidence of monk seal (*Monachus monachus*) presence in Montenegro.

Table 3.8. Cetacean species recorded and confirmed in the Adriatic Sea. *Source: Fortuna et al., 2015*

Species scientific name	Species common name	Current occurrence in the Adriatic
Tursiops truncatus	Common bottlenose dolphin (hereafter bottlenose dolphin)	Regular
Stenella coeruleoalba	Striped dolphin	Regular (southern Adriatic), occasional (northern and central Adriatic)
Delphinus delphis	Common dolphin	Rare visitor
Ziphius cavirostris	Cuvier's beaked whale	Regular
Grampus griseus	Risso's dolphin	Regular (southern Adriatic)
Balaenoptera physalus	Fin whale	Seasonally regular (central and southern Adriatic)
Physeter macrocephalus	Sperm whale	Rare visitor (all basin), potentially regular (southern Adriatic)
Pseudorca crassidens	False killer whale	Not occurring
Globicephala melas	Long-finned pilot whale	Not occurring
Megaptera novaeangliae	Humpback whale	Rare visitor or not occurring

Bottlenose and striped dolphins, the two selected cetacean species for GES assessment, are present in relatively large numbers and all year-round (Figures 3.5. and 3.6). The striped dolphin is considered the most abundant specie in the Mediterranean Sea, which appears to be the case in the Adriatic Sea, although it is regularly present only in the southern Adriatic, in the depths below 300 m (Fortuna *et al.*, 2015).

Based on combined results of the first two aerial surveys, carried out in the summers of 2010 and 2013, 5,700 specimens of bottlenose dolphin are estimated in the entire Adriatic, with 0.042 specimen per km^2, approximating 1,800 specimens in the southern Adriatic or 0.032 specimen per km^2. The relative density estimated in Montenegrin territorial waters is above the relative density in the southern Adriatic, as well as at the Adriatic (Table 3.9). Estimated abundance of striped dolphins in 2010 was minimally 15,343 individuals and 41,533 in 2013 survey (Fortuna *et al.*, 2015). A third aerial survey was carried out in 2018 in the scope of the ACCOBAMS Survey Initiative (ASI) project, but the data are still being processed. As for other data relevant for Montenegro, information is lacking on population demographics, particularly the incidental mortality rates. There was no assessment of conservation status of bottlenose dolphin and striped dolphins at the Adriatic Sea level, such as regional assessment based on the IUCN criteria.

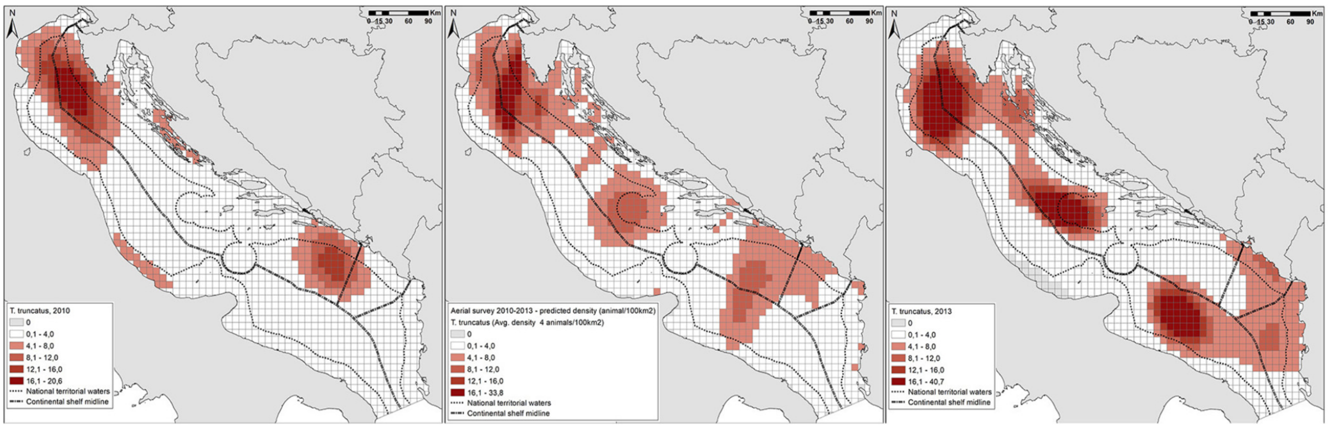


Figure 3.5. Bottlenose dolphin densities for the data from 2010 (left); 2010–2013 (centre), and 2013 (right). The scales represent below average (white), and then up to twice, up to three times, up to four times, and greater than four times the average (shades of dark red).
Source: Fortuna, Cañadas et al., 2018

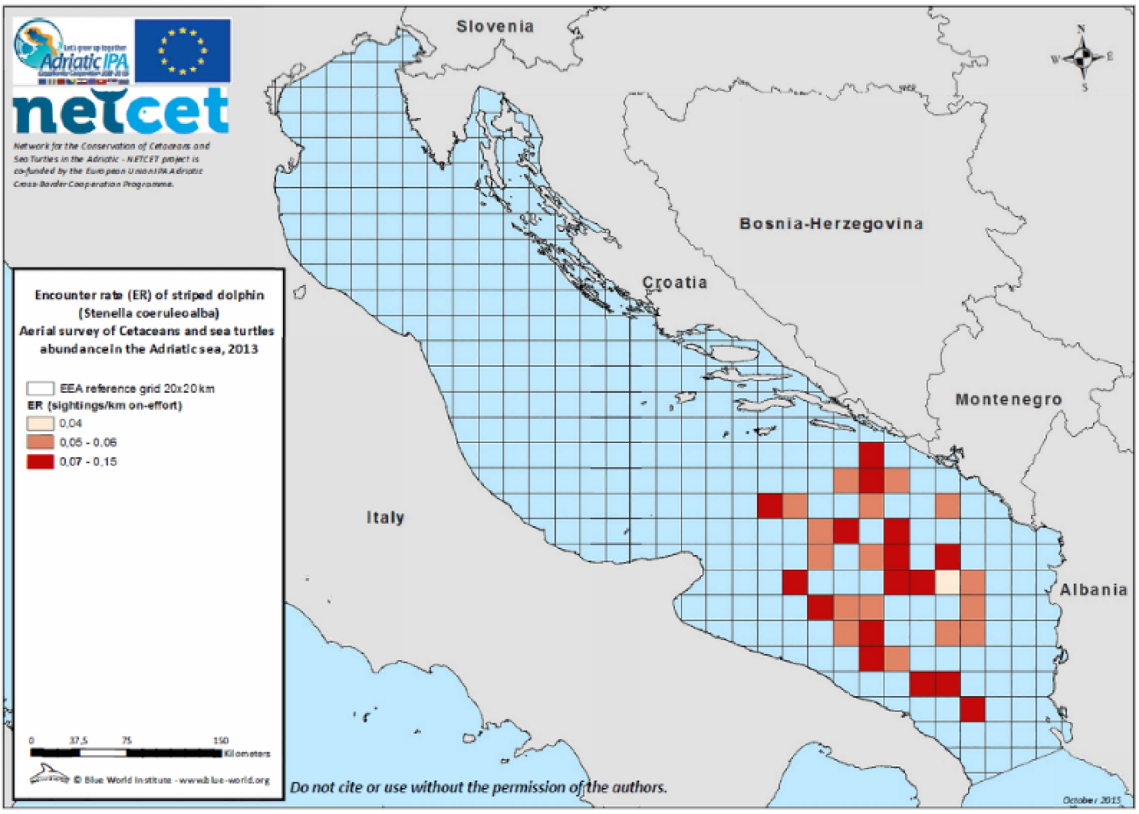


Figure 3.6. Striped dolphin encounter rates after aerial survey data from 2013. *Source: Holcer and Fortuna, 2015*

Table 3.9. Population abundance estimates of bottlenose dolphin (*Tursiops truncatus*) in the Adriatic Sea and in Montenegrin waters based on 2010 and 2013 summer aerial surveys. *Source: Fortuna, Canadas el al., 2018*

Stratum	***Tursiops truncatus***	
	Abundance (N) (CI = confidence interval)	**Relative density (ind/km^2)**
Adriatic	5,700 (CIs = 4,300 – 7,600)	0.042
North	2,600 (Cis = 2,200 – 2,900)	0.057
Central	1,100 (Cis = 800 – 1,500)	0.034
South	1,800 (Cis = 1,500 – 2,400)	0.032
Non-EU 12 nm – Montenegro	100 (Cis = 40 – 200)	0.049
Non-EU CSM* – Montenegro	200 (Cis = 100 – 300)	0.029

Continental shelf margin

The main pressures on cetaceans at the Adriatic level are interactions with fisheries – bycatch and marine litter (Table 3.10). Climate change is a powerful driver of negative impacts, with medium intensity in the southern Adriatic (UNEP/MAP RAC/SPA, 2015). Cumulative impacts of anthropogenic activities on species is also of concern. National level specificities regarding pressures and impacts are still unknown.

Table 3.10. Summary of main pressures and impacts to cetaceans and marine turtles in the Adriatic Sea. *Source: Fortuna, Holcer et al., 2015*

Pressure	Impact type	Significance	Species affected
Fishery – bycatch	Direct mortality	High	All cetaceans and marine turtle species
Marine litter	Direct mortality	Medium/High	All cetaceans and marine turtle species
Seasonal tourism	Behavioural changes	Medium	Bottlenose dolphin, low impact on marine turtles (still)
Oil and gas exploration	Behavioural changes, direct and indirect mortality	Medium	All cetaceans, possibly marine turtles
Chemical pollution	Indirect and direct mortality	Medium	All cetaceans and marine turtle species
Fishery – depredation	Behavioural changes, direct mortality	Low	Bottlenose dolphin
Biological pollution	Direct mortality	Low	Bottlenose and striped dolphins, sperm whale

For several indicators it was not possible to assess GES due to lack of or limited existing and available data (Table 3.11). For population abundances and species distributions specifically, data from two closely implemented aerial surveys show no decline or negative trends in general. However, in the absence of long-time data series, it is too early to draw conclusions about GES. The results of the ASI 2018 and future aerial surveys should enable future GES assessment.

Table 3.11. Assessment of GES for Cetaceans in Montenegro, based on selected species

Criteria		GES Assessment	
Indicator	**GES definition**	***Tursiops truncatus***	***Stenella coeruleoalba***
Species distributional range	The species are present in all their natural distributional range.	Not possible to assess GES. There is no long-time data series to allow measurement of species distributional range and patterns. Even if the data gathered in two closely implemented aerial surveys do not indicate any decline, it is too early to conclude that species distributional range meets the GES.	
Population abundance	The species population has abundance levels allowing it to qualify for Least Concern Category of IUCN or has abundance levels that are improving and moving away from the more critical IUCN category.	Not possible to assess GES. There is no long-time data series to allow measurement of population abundance trends. Even if the data gathered in two closely implemented aerial surveys do not indicate any decline, it is too early to assume this means that anthropogenic pressures have not significantly impacted the population abundance and whether GES is achieved.	
Population demographic characteristics	Species populations are in good condition: low human induced mortality, balanced sex ratio and no decline in calf production.	Not possible to assess GES due to lack of data on human-induced mortality, sex ratios, and calf production.	

Marine reptiles – marine turtles

Three species of marine turtles are recorded in the Montenegrin waters:

- the loggerhead turtle (*Caretta caretta*);
- the green turtle (*Chelonia mydas*); and
- the leatherback turtle (*Dermochelys coriacea*).

Due to its relatively high abundance and presence in almost all parts of the Adriatic Sea, as well as a species present in the list of protected species, the loggerhead turtle (*Caretta caretta*) is a suitable component for the assessment and monitoring of GES. The northern and central Adriatic represent some of the largest neritic habitats, and pelagic habitats are present in the parts of Ionian and southern Adriatic Sea (UNEP/MAP-RAC/SPA, 2015).

Furthermore, recent research showed that loggerhead turtles in the Adriatic predominantly belong to Greek nesting populations (75%). There are no records of nesting activity in Montenegro, but due to ongoing increase of temperature caused by climate change, there is a potential that this may change in the future. Combined data from the already mentioned 2010 and 2013 summer aerial surveys in the Adriatic Sea show that the northern Adriatic is the most abundant area for loggerhead turtles, with an estimated 18,200 of 27,000 specimens in the entire Adriatic (Fortuna, Canadas *et al.*, 2018) (Table 3.12), (Figures 3.7 and 3.8). Relative density in the southern Adriatic is below the Adriatic average, with 0.114 specimen/km^2, and measured relative density in Montenegrin territorial waters is lower, while on the continental shelf margin it is higher.

As already mentioned, the third aerial survey was carried out in 2018 in the scope of the ASI project, but the data are still being processed. In addition, knowledge about marine turtles should be improved through the implementation of the ongoing LIFE EUROTURTLES project.

Table 3.12. Population abundance estimates of loggerhead turtle (*Caretta caretta*) in the Adriatic Sea and in Montenegrin waters based on 2010 and 2013 summer aerial surveys. *Source: Fortuna, Canadas et al., 2018*

Stratum	*Caretta caretta*		
	Abundance (N) (CI = confidence interval)		Relative density (ind/km^2)
Adriatic	27,000	(Cis = 24,000 – 31,000)	0.203
North	18,200	(Cis = 17,700 – 20,000)	0.405
Central	1,900	(Cis = 1,600 – 2,200)	0.057
South	6,300	(Cis = 5,000 – 7,500)	0.114
Non-EU 12 nm – Montenegro	200	(Cis = 100 – 200)	0.078
Non-EU CSM* – Montenegro	1,200	(Cis = 800 – 1,400)	0.166

**Continental shelf margin*

As for other data relevant for Montenegro, information on population demographics and human-induced mortality is lacking. There was no assessment of conservation status carried out at the Adriatic Sea level, such as a regional assessment based on the IUCN criteria.

The main pressures to the marine turtles in the Adriatic Sea are fishery activities – bycatch and marine litter (Table 3.10). Whether this is also valid for Montenegro is unknown at the moment. Despite few records on loggerhead nesting, there are also potential pressures to the nesting sites, such as tourism-related disturbances and habitat loss. Climate change is a powerful driver to negative impacts, with medium intensity in the southern Adriatic (UNEP/MAP RAC/SPA, 2015). National level specificities regarding pressures and impacts are still not known.

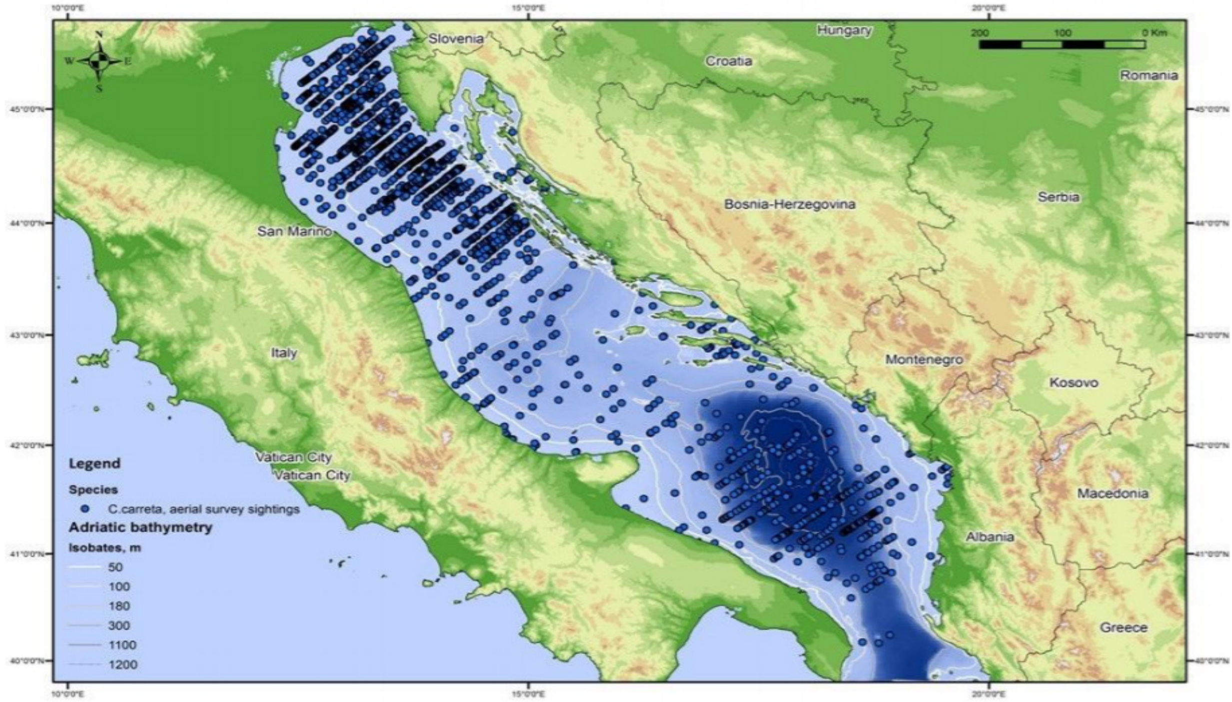


Figure 3.7. Map of sighting of (mostly) loggerhead turtles during 2010 and 2013 summer aerial surveys. *Source: UNEP-MAP-RAC/SPA, 2015*

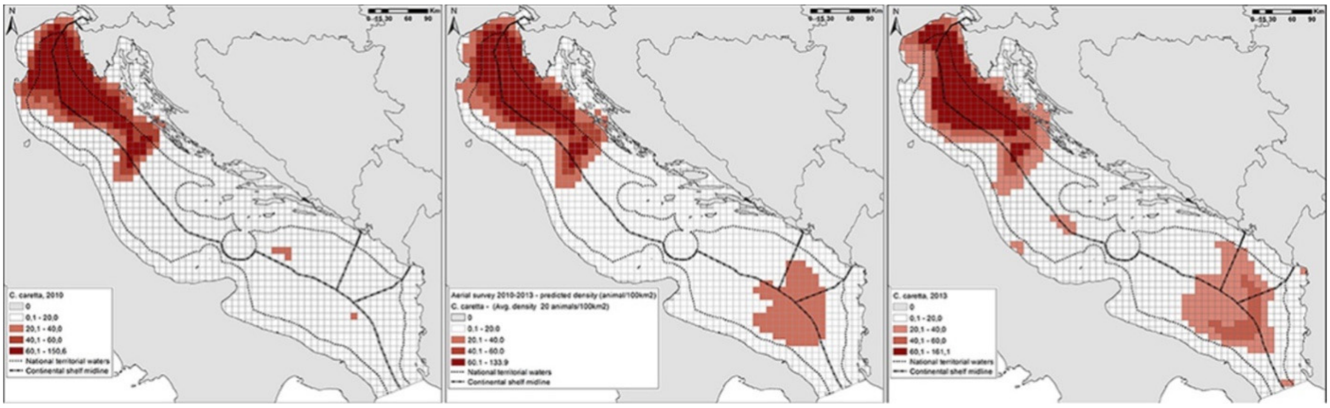


Figure 3.8. Loggerhead turtle densities for the data from 2010 (left); 2010–2013 (centre), and 2013 (right). The scales represent below average (white), and then up to twice, up to three times, up to four times and greater than four times the average (shades of dark red). *Source: Fortuna, Canadas et al., 2018*

For several indicators it was not possible to assess GES, due to lack of or limited existing and available data (Table 3.13). For population abundance and species distribution specifically, data from two closely implemented aerial surveys show no decline or negative trends in general. Still, in the absence of long-time data series, it is too early to draw conclusions about GES. The results of the ASI 2018 and future aerial surveys should give a better overview of the GES in the future assessments.

Table 3.13. Assessment of GES for marine turtles in Montenegro, based on selected species

Criteria		GES Assessment
Indicator	**GES definition**	***Caretta caretta***
Species distributional range	The species continues to occur in all its natural range in the Mediterranean, including nesting, mating, feeding, and wintering and developmental (where different to those of adults) sites.	Not possible to assess GES. There is no long-time data series to allow measurement of species distributional range and patterns. Even if the data gathered in two closely implemented aerial surveys do not indicate any decline, it is too early to conclude that species distributional range meets the GES.
Population abundance	Population size allows to achieve and maintain a favourable conservation status, taking into account all life stages of the population.	Not possible to assess GES. There is no long-time data series to allow measurement of population abundance trends. Even if the data gathered in two closely implemented aerial surveys do not indicate any decline, it is too early to assume whether this means that anthropogenic pressures have not significantly impacted the population abundance and whether GES is achieved.
Population demographic characteristics	Low mortality induced by incidental catch, favourable sex ratio, and no decline in hatching rate.	Not possible to assess GES due to lack of data on human-induced mortality, sex ratio, and balanced sex ratio.

Seabirds

The seabird community in the Adriatic only represents a small fraction of all the seabirds found in the Mediterranean. The small size and the absence of significant oceanographic features in the Adriatic explain the small size of its seabird populations (UNEP-MAP-RAC/SPA, (b) 2015).

True seabird species (*Calonectris diomedea*, *Puffinus yelkouan*, *Phalacrocorax aristotelis desmarestii,* and *Larus audouinii*) greatly depend on the good status of the marine environment, because they feed on the sea, mainly in large areas. Main habitats of true seabirds are located in the central and northern part of the Adriatic (Figure 3.9).

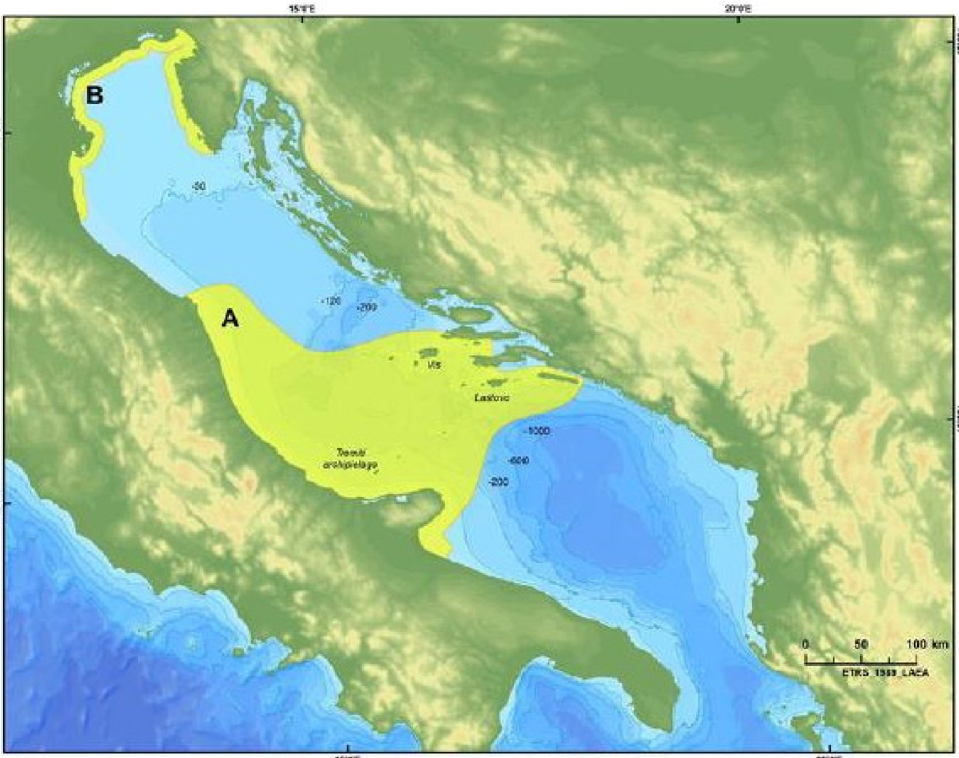


Figure 3.9. View of the study area (Adriatic Sea), showing the Important Areas for the conservation of seabirds proposed A: Central Adriatic Sea, B: Northern Adriatic Sea. *Source: UNEP/MAP – RAC/SPA by Requena and Carboneras, 2015 for RAC/SPA*

An overview of coastal and marine birds from Annex II of the Barcelona Convention in Montenegro shows that 18 species are regularly observed in Montenegro, including eight breeding species (Table 3.14). The occurrence of true seabird species is registered sporadically outside the breeding season, when they roam the Adriatic. These bird species have been recorded in the Bojana Delta, in the open sea, and there is one observation of *Larus audouinii* in the sea in front of the Special Ornithological Reserve Tivat Salina.

Table 3.14. List of coastal and marine birds of Montenegro from Annex II of the SPA/BD Protocol of Barcelona Convention. *Based on Saveljic, 2005 and Saveljic, 2015*

Species	No of breeding pairs	Wintering population	Trends	Remark
Calonectris diomedea	n/a	Unknown	Unknown	
Puffinus yelkouan	n/a	Unknown	Unknown	
Phalacrocorax aristotelis	n/a	Unknown	Unknown	
Microcarbo pygmeus	3,500	Up 7,000	Increasing	
Pelecanus onocrotalus	n/a	Up 10	Stable	
Pelecanus crispus	55	147 *Ulcinj salina	Increasing	
Phoenicopterus roseus	Up 170	Up 2,400 *Ulcinj salina	Stabile	Breeding success 0
Pandion haliaetus	n/a	n/a	Unknown	
Falco eleonore	Ex br *2 pairs	n/a	Unknown	
Numenius tenuirostris	n/a	n/a	Unknown	
Larus audouinii	n/a	1	Unknown	
Sterna sandwicensis	n/a	120	Decreasing	
Sternula albifrons	50–70	n/a	Stable	
Sterna caspia	n/a	Up 5	Stable	
Larus genei	Up 2	n/a	Unknown	
Larus melanocephalus	n/a	Unknown	Unknown	
Charadrius alexandrinus	Up 50	20 – 30	Stable	
Ceryle rudis	Ex br	n/a	Unknown	

Ulcinj Salina is the most significant breeding site and feeding and wintering ground, as well as a station during bird migration. It is a 15 km^2 large artificial ecosystem in which pool filling, salinity, and water level are human-made, and the breeding success of bird species is closely linked to water management. Due to the importance of this area for birds, it is declared a Nature park in 2019, as well as a Ramsar site.

Selected breeding species *Charadirus alexandrinus, Phoenicopterus roseus,* and *Sterna albifrons* regularly nest in the Ulcinj Salina, while *Larus genei* only occasionally. Breeding of some species in Ulcinj Salina has not been successful for years due to poor water management, e.g., *Phoenicopterus roseus*. This facility stopped working in 2013 and lack of management causes flooding of nests, eggs, and nestlings, resulting in a low breeding success for this species. However, for some species, such as *Sterna albifrons,* it is stable. Ulcinj Salina is also the main feeding ground for *Mycrocarbo pygmaeus*, whose colonies are located along the river Bojana (up to 250 pairs), while they rest on Skadar Lake (more than 3,000 pairs). Some bird species occur in very small numbers and occasionally in Tivat Salina, but they do not breed there.

Seabirds are most often registered in the sea in front of Ada Bojana or Velika plaža, which is partly related to the fact that the Bojana Delta has been the focus of attention of local and foreign ornithologists for more than 20 years. Bojana's estuary into the Adriatic Sea has been proposed twice as an area of international importance for birds (Saveljic et al 2006, Saveljic et al 2007) and after the first inventory related to the Natura 2000 establishment process, it was proposed as an SPA, Special Protected Area (Rubinic *et al.*, 2019).

The global IUCN status of the majority of species listed in Table 3.14 is LC (Least concern), except for *Pelecanus crispus* NT (Near threatened), and *Puffinus yelkouan* VU (Vulnerable).

Current data enabled GES assessment only for breeding bird species, although there are no data on incidental or human-induced mortality of adult birds. For the majority of these species, for the moment GES is achieved, but there are already some negative effects on bird populations in Ulcinj Salina, particularly for *Phoenicopterus roseus,* which breeds unsuccessfully for years (Table 3.15). Future prospects could only be worse if no actions are taken to properly manage Ulcinj Salina. GES could not be fully assessed for true seabirds, as open sea species, due to lack of data. Still, when it comes to population abundance and population demographic characteristics, there are positive indications that GES is achieved.

Table 3.15. Assessment of GES for seabirds in Montenegro, based on selected species

Criteria		GES Assessment	
Indicator	**GES definition**	**True seabirds (summer visitors, migration and wintering species):** ***Calonectris diomedea*** ***Larus audouinii*** ***Phalacrocorax aristotelis*** ***Puffinus yelkouan***	**Breeding species:** ***Larus genei*** ***Mycrocarbo pygmeus*** ***Phoenicopterus roseus*** ***Sterna albifrons***
Species distributional range	The distribution of seabird species continues to occur in all their Mediterranean natural habitats, thus biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.	For these species, there are no significant data on their occurrence in Montenegrin territorial waters, where they appear after the breeding season. Based on the data so far, it is only possible to acknowledge their regular occurrence, but not to assess GES.	All species mostly breed in the artificial ecosystem Ulcinj Salina. Hence, proper water management is of key importance for maintenance of this habitat, and the consequent survival of birds. At the moment, human negligence already affects this ecosystem, which is reflected in unsuccessful breeding of *Phoenicopterus roseus.* It could be concluded that, for now, GES is achieved for majority of the species, but with negative future prospects, if the *status quo* remains.
Population abundance	Population size of selected species (of seabirds) is maintained. The species population has abundance levels allowing to qualify for Least Concern Category of IUCN (less than 30% variation over a time period equivalent to 3 generation lengths).	Wandering populations outside the breeding season seem to be stable or increasing, which indicate that GES is achieved. However, more data are needed to be enable full GES assessment.	Breeding populations are still stable apart from unsuccessful breeding of *Phoenicopterus roseus.* It could be concluded that GES is achieved for the majority of species. However, situation with *Ph. roseus* and the *status quo* with Ulcinj Salina's lack of management are major reasons for concern.
Population demographic characteristics	Species populations are in good conditions: Natural levels of breeding success & acceptable levels of survival of young and adult birds.	Since species populations seem to be in good condition, it indicates that GES for population demographic is achieved. However, there are no precise data on incidental, human-induced, mortality of adult birds.	Populations are stable. Breeding success is optimal, apart from *Ph. roseus.* It could be concluded that, for now, GES is achieved for the majority of species. But, situation with *Ph. roseus* and the *status quo* with Ulcinj Salina's lack of management are major reasons for concern. In addition, there are no data on the incidental, human-induced mortality of adult birds.

3.1.b Non-indigenous species (NIS) – EO2

Invasive alien species (IAS) are regarded as one of the main causes of biodiversity loss in the Mediterranean Sea. According to the latest regional reviews, more than 6% of the marine species in the Mediterranean are now considered non-indigenous species (NIS), including 13.5% IAS (Zenetos *et al.*, 2012). NIS is a growing issue in the Adriatic Sea, which is particularly sensitive to impacts of this pressure due to its semi-enclosed geography. Spreading of NIS is facilitated through effects of climate change, notably in the increase of sea temperature.

Montenegro established a specific legislative framework to address NIS and IAS. Namely, in March 2019, Montenegrin Government adopted a law on alien and invasive plant and animal species and fungi (Official gazette of Montenegro, no. 18/2019).

GES criteria and definitions

The EO2 Non-indigenous species is a pressure-related objective, defined as: *Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem.* As such, it corresponds to Descriptor 2 under MSFD. Main criteria for GES assessment of the EO2 is Common Indicator 6, encompassing trends in abundance, temporal occurrence, and spatial distribution of non-indigenous species, particularly invasive, non-indigenous species, notably in risk areas (Table 3.16). As with assessing GES for biodiversity, the largest challenge is selecting an appropriate method to measure indicators and setting up the thresholds, providing a set of reference values for each indicator against which it would be possible to assess GES characteristics. The main obstacle for assessment for the entire Adriatic region is in limited available data and still-not-agreed threshold values at sub-regional levels, as the level of assessment for NIS considered in the MED QSR 2017 report. Hence, it is not yet possible to assess GES for NIS. However, a baseline, a national overview of existing and potential newly introduced NIS, was prepared as a starting point for future GES assessments.

Table 3.16. Criteria and methodological standards for GES assessment for EO2 Non-indigenous species in the marine area of Montenegro. *Based on: IMAP, 2016; Barcelona Convention 19th COP Decision IG.22/7, 2019; Commission Decision (EU) 2017/848; NIMP for Montenegro and Update on marine strategy documents in Croatia, 2019.* EO = Ecological objective, CI = common indicator

Criteria			Methodological standards	
	Indicator with related GES definition (minimum requirements for achieving GES)	**Indicator measurement and thresholds**	**Scale of assessment**	**Use of criteria**
Number of newly-introduced non-indigenous species, particularly invasive NIS	Trends in the abundance of introduced species, notably in risk areas EO2, CI6 GES definition IMAP: Decreasing abundance of introduced NIS in risk areas.	What is measured: ▪ Number of non-indigenous species newly introduced via human activity, in the 6-year assessment period ▪ Abundance trends of introduced species, particularly of IAS and in risk areas Thresholds: ▪ Thresholds should be agreed at the Adriatic level	Adriatic level (sub-regional)	In the absence of the Adriatic level thresholds, GES assessment could not be performed. However, a baseline, i.e. a national overview of existing and potential newly introduced NIS was prepared, as a starting point for the future GES assessments.

EO2 GES assessment

There are 23 NIS species recorded in the Montenegrin sea waters so far, and the predominant groups are the molluscs (10) (Table 3.17). The majority of NIS were recorded in the last 20 years; almost half the recorded species originate from Indo-West Pacific and were most likely transported through the Suez channel.

A first Horizon scanning exercise highlighted ten species that are most likely to be introduced in Montenegro in the near future (Table 3.18). They are characterised by high impact on biodiversity and/or economy and one fish species, *Pterois miles,* is dangerous for human health because of its poisonous spines, although at the same time, it could also be a food source.

GES of NIS could not be assessed, due to limited data on NIS in Montenegro and lack of thresholds set at the Adriatic level (Table 3.19).

Table 3.17. NIS species recorded in the Montenegrin waters. *Source: Petović, S., Marković, O., Đurović, M., 2019. Inventory of Non-indigenous and Cryptogenic Marine Benthic Species of the South-East Adriatic Sea, Montenegro. Acta zoologica bulgarica, 71 (1), 47–52*

Taxon	First record	Origin	Introduction pathway	Establishment success	Location	Reference and remarks
RHODOPHYTA						
Antithamnion amphigeneum	2016	Indo-Pacific	Shipping	Alien/Casual	Tivat	Mačić & Ballesteros, 2016
CHLOROPHYTA						
Caulerpa cylindracea	2004	Indo-West Pacific	Aquarium trade	Alien/Invasive/ Established	Žanjice, Mirišta, Rt Arza, Mamula, Strmac (between Žanjice and Dobreč), Zlatna Uvala, Rt Mačka, Rt Veslo, Rt Kočište, Uvala Žukovica, Uvala Žabica, Rt kod Uvale Velika Krekavica, Uvala Podrupice (Trsteno), Rt Jaz, island Sveti Nikola, Skočidjevojka, Crni rt. Žukotrlica, luka Bar	Mačić, 2005
Asparagopsis taxiformis	2006	Indo-West Pacific	Suez/shipping	Alien/Established	Herceg Novi	Zenetos *et al.*, 2011
Asparagopsis armata	1979/80	Western Australia	Aquaculture/shipping	Alien	Uvala Trašte	Špan & Antolić, 1987
Womersleyella setacea	2003	Indo-West Pacific	Shipping	Alien/Casual	Žanjice, Mirišta, Rt Arza, Mamula, Strmac (rt between Žanjice and Dobreč), Rt Mačka, Rt Veslo, Rt Kočište, uvala Žabica, Seka Kalafat, Rt Platamuni, island Sveti Nikola (south), uvala Kamenovo	Batteli & Rindi, 2008
PORIFERA						
Paraleucilla magna	2016	South West Atlantic	Shipping?	Alien/Established	Tivat, Kotor	Mačić & Petović, 2016

Taxon	First record	Origin	Introduction pathway	Establishment success	Location	Reference and remarks
MOLLUSCA						
Aplysia dactylomela	2011	Circumtropical	Shipping?	Alien/Established	Herceg Novi	Mačić & Kljajić, 2012
Bursatella leachii	2009	Circumtropical	Suez/shipping	Alien/Established	Herceg Novi	Zenetos *et al.*, 2011
Melibe viridis	2003	Indo-West Pacific	Suez/shipping	Alien/Established	Herceg Novi	Jančić, 2004
Thecacera pennigera	2017	Cosmopolitan	Shipping?	Cryptogenic	Tivat	Petović & Lipej in Gerovasileiou *et al.*, 2017
Anadara transversa	2015	West Atlantic	Shipping	Alien/Established	Kotor	Petović *et al.*, 2017
Arcuatula senhousia	2014	Indo-Pacific	Aquaculture/Shipping	Alien/Established	Port of Bar, Veliki pijesak	Petović *et al.*, 2017
Ruditapes philippinarum	2015	Indo-Pacific	Aquaculture/Shipping	Alien/Invasive	Bar, open sea	Petović *et al.*, 2017
Teredo navalis	1967	Circumtropical	Shipping	Cryptogenic	Kotor	Stjepčević, 1967
Pinctada imbricate radiatea	2016	Indo-West Pacific	Suez/shipping	Alien/Established	Tivat, Kotor	Petović & Mačić, 2017
Magallana gigas	1977	Indo-Pacific	Aquaculture	Alien/Established	Kotor	Stjepčević *et al.*, 1977
CRUSTACEA						
Penaeus aztecus	2013	North West Atlantic	Shipping?	Alien/Established	Tivat	Marković *et al.*, 2013
Callinectes sapidus	2006	West Atlantic	Shipping	Alien/Established	Jaz, marina Budva, uvala Kruče, Valdanos, Port Milena, Ada Bojana	Zenetos *et al.*, 2011
Amphibalanus eburneus	1983	West Atlantic	Aquaculture/Shipping	Alien/Established	Kotor	Igić, 1983
ANNELIDA						
Hydroides dirampha	2014	Circumtropical	Shipping	Alien	Bar	Spagnolo *et al.*, 2018
Palola valida	2014	Red Sea	Shipping	Alien	Bar	Spagnolo *et al.*, 2018
BRYOZOA						
Bugula neritina	2014	Unknown	Shipping	Cryptogenic	Port of Bar, islet Mamula	Spagnolo *et al.*, 2018
TUNICATA						
Styela plicata	2016	Western Atlantic	Aquaculture/Shipping	Alien	Tivat, uvala Trašte, port of Bar	Petović, 2018

Table 3.18. List of the most invasive species likely to invade Montenegro ranked according to their assessed impact in decreasing order (after Horizon Scanning methodology). *Source: NIMP for Montenegro, 2020*

Species	Name in English	Overall impact in ecosystem services	Overall impact on biodiversity
Plotosus lineatus	Striped eel catfish	625	125
Mnemiopsis leidyi	Warty Comb jelly	542	108
Pterois miles	Lion fish	542	108
Brachidontes pharaonis	Rayed Erythrean mussel	400	100
Anadara kagoshimensis	Clam	333	100
Rapana venosa	Rapa whelk	315	85
Codium fragile	Sponge seaweed	267	67
Charybdis japonica	Asian paddle crab	235	64
Fulvia fragilis	Cockle	191	55
Stylea clava	Asian Clubbed Tunicate	118	39

Table 3.19. Assessment of GES for NIS in Montenegro

Criteria		GES Assessment
Indicator		
Trends in the abundance of introduced species, notably in risk areas	Decreasing abundance of introduced NIS in risk areas.	Not possible to assess GES due to lack of systematic data on newly introduced NIS and population trends, particularly invasive NIS. In addition, there are no thresholds set at the Adriatic Sea level.

3.1.c Hydrography – EO7

Changes in hydrographic conditions caused by natural processes and anthropogenic activities, and their cumulative impact on maintaining GES, should be such that they do not harm the marine ecosystem. These changes are evident in the changing regimes of temperature, salinity, waves, and currents and sea water transparency. It should be emphasised that spatial and temporal changes of temperature, salinity, and transparency are the key parameters that determine the dynamics of ecosystems. These dynamics are also associated with the atmospheric processes on a scale larger than the Adriatic basin, i.e., with variations in air pressure in the northern hemisphere (Zore-Armanda, 1969; Grbec *et al.*, 1998, Supić *et al.*, 2004), also linked to climate change.

The Adriatic is very sensitive to climate change and hence, under this era of intensive climate change, we can expect significant responses in hydrographic conditions. Various climatic scenarios for the Adriatic region show changes in the frequency and intensity of bora events, which cause changes in the intensity of vertical convection, changes in the structure of temperature and salinity clines, and the formation of water mass.

Permanent hydrographic changes due to construction and maintenance of infrastructure in near-shore areas, maritime transport, sand extraction, tourism, and recreation have been observed in several locations along the coast of the Adriatic Sea. Therefore, the first step in achieving and preserving GES is to pay attention to such interventions at the local level. Their impact must be controlled by environmental impact studies, which are prescribed by local or state authorities. This reduces the cumulative impact of such interventions.

GES criteria and definitions

In IMAP, monitoring the changes in hydrographic conditions is carried out through the Ecological Objective EO7 and the Common Indicator 15 addressing location and extent of the habitats impacted directly by hydrographic alterations. The main obstacle for the EO7 assessment is limited data availability at national level. In addition, although environmental impact assessments (EIAs) are regularly undertaken, evaluations on the hydrographic alterations and impacts on habitats are scarce. Finally, there are no agreed threshold values at sub-regional level (Table 3.20). Hence, it is not yet possible to assess GES for EO7. However, a baseline overview of hydrographic conditions on the Adriatic and national level is presented as a starting point for future GES assessments.

Table 3.20. Criteria and methodological standards for GES assessment for EO7 hydrography in Montenegro. *Based on: IMAP Decision IG.22/7; Commission Decision (EU) 2017/848; NIMP for Montenegro and Update on marine strategy documents in Croatia, 2019. EO = Ecological objective, CI = common indicator*

Criteria			Methodological standards	
Parameters	**Indicator with related GES definition (minimum requirements for achieving GES)**	**Indicator measurement and thresholds**	**Scale of assessment**	**Use of criteria**
Selected hydrographic parameters: ▪ bathymetry, seabed substrate, morphology; ▪ temperature and salinity; ▪ tide/sea level (at least offshore conditions); ▪ currents; ▪ waves; ▪ water transparency; ▪ sediment transport. Location and extent of benthic habitats	CI15: Location and extent of the habitats impacted directly by hydrographical alterations. GES definition: Negative impacts due to new structures are minimal with no influence on the larger scale coastal and marine system.	What is measured: Hydrographic changes and links with extent of selected benthic habitats. Thresholds: Thresholds have not been defined.	Local level Adriatic level (sub-regional)	Area/habitat and the proportion of the total area/habitat where alterations of hydrographical conditions have occurred or are expected to occur (estimations by modelling or semi-quantitative estimation). Preferably these are made as part of EIA. In order to be able to identify hydrographic changes and its impacts to habitats, it is necessary to have continuous monitoring of basic hydrographic parameters.

EO7 GES assessment

In order to describe the current state of the hydrographic conditions in the southern Adriatic and in the waters of Montenegro, parameters with an adequate set of data were selected: sea temperature, salinity, and sea water transparency.

Sea temperature and salinity

The thermohaline properties of the Adriatic Sea are determined mainly by air-sea interactions, water exchange through the Otranto Strait, river discharge, mixing, currents, and the topography of the basin.

As a whole, the Adriatic is a warm temperate sea. Temperatures of even the deepest layer are almost above 10°C. The South Adriatic is 8–10°C warmer than its central and northern parts during winter. In other seasons the horizontal temperature distributions is more uniform.

The unavoidable fact is that the Adriatic Sea is very sensitive to climate change. The last few decades have seen an increase in surface temperatures in the Adriatic and the Mediterranean. In summer, i.e., in the warm part of the year, this increase is even more evident. Measurements of the surface temperatures of the sea (SST) in the area of the central Adriatic, from the coastal area to the open sea, show that since 1979 the SST has been rising, more precisely oscillating, around higher values. In the 1979–2015 period, the increase was 1.03°C, which is in line with the trend of warming of the sea surface in other Mediterranean areas (Grbec *et al.*, 2018). The positive trend was, however, more noticeable in recent decades. In the 2008–2015 period the SST increased by 1.25°C. This trend of strong warming continues, which does not mean that the episodes of cooling of the surface layer of the sea do not occur. Warming episodes become more frequent, stronger, and longer lasting.

The Adriatic belongs to those parts of the Mediterranean that have a positive difference between precipitation (including run-off) and evaporation. The influx of saline Mediterranean water through the Strait of Otranto increases, while precipitation and the run-off (the latter mostly in the north) decrease salinity of the Adriatic water. Overall, salinity of the Adriatic is relatively high. The largest part of its volume, i.e., its open southern part, has salinity values between 38.4–38.9. Salinity is lower, and more variable in the shallow northern part, close to the Po River mouth and in coastal zones. In the open South Adriatic waters, between the three clearly distinguished layers, the intermediate layer has the highest salinity. Changes in salinity along the eastern Adriatic coast have recently shown a positive trend in the entire water column (http://baltazar.izor.hr/azo/azoindex).

Recent general climatology for the entire Adriatic, made by analysing a large amount of data (1911–2009), temperature, salinity, and dissolved oxygen, shows that the deepest part of the southern Adriatic becomes saltier and warmer (Lipizer *et al.*, 2014). Unique thermohaline conditions in the Adriatic were observed in 2017: very high salinity values in the entire water column were recorded with an ‘inverse’ salinity profile in August and a maximum in the surface layer, recorded for the first time in the central Adriatic. Surface salinity of 39.02 recorded in August was 2.5 standard deviations above the long-term average (1961–2016). The observed salinity distributions are the result of both local and remote drivers, whereby the North Ionian cyclonic gyre controlled by the Adriatic-Ionian Bimodal Oscillating System (BiOS) has been responsible for the overall above-average salinities since 2011 (Beg Paklar *et al.* 2020). In the future, as the Adriatic Sea is sensitive to climate change, more such situations can be expected.

In terms of hydrographic conditions in **Montenegro**, two distinctive areas can be distinguished: Boka Kotorska Bay and the open sea area. The Bay is a eutrophic shallow closed basin, which differs significantly from the open sea due to its climatic, geomorphological, and physicochemical characteristics (Campanelli *et al*., 2009). This fact explains the large annual, seasonal, monthly, and daily changes in the physical and chemical parameters of seawater, which is significantly influenced by specific atmospheric processes. In addition, hydrodynamic processes within the Bay are quite different, which is reflected in slow rate of water exchange between Boka Kotorska Bay and the open sea, reaching a residence time of ca. 70 days during the period of minimum freshwater discharge. This slow circulation of seawater is characterised by surface outflow and bottom inflow. The other interesting feature is the anticyclone circulation in the central bay, Tivat Bay, which has residence time values of 25 days at the surface and 15 days in the deep layers (Bellafiore *et al.*, 2011). Some areas near to the open sea maintain residence time values of 5 days at the surface and lower values in the deep layers (Bellafiore *et al.*, 2011).

In the 1984–2017 period in the Bay, a positive trend of SST of 0.48°C per decade was recorded (Violić *et al.*, 2019). By analysing the average annual SST values along the Montenegrin coast, long-term variability was determined that coincides with the general trends in the Adriatic, in particular with the trend observed along the eastern Adriatic coast (Figure 3.10). For stations at Ulcinj and Bar, those with relatively long series of measurements, the increase is 1.28°C/40 years (Ulcinj) and 1.38°C/40 years (Bar).

Comparing the obtained trends shows that the corresponding linear trends are declining towards the south. This is not only a consequence of the marine environment influence but also of the action of the predominant mesoscale atmospheric processes as well as those on a larger scale than the Adriatic (Grbec *et al.*, 2009). Due to the geographical position of the Adriatic, much of its atmospheric variability is associated with hemispheric atmospheric processes such as the North Atlantic Oscillation (NAO), North Africa – West Asia (NAWA), and Eastern Atlantic (EA) which affect the Adriatic with varying intensities and durations (Matić *et al.,* 2011).

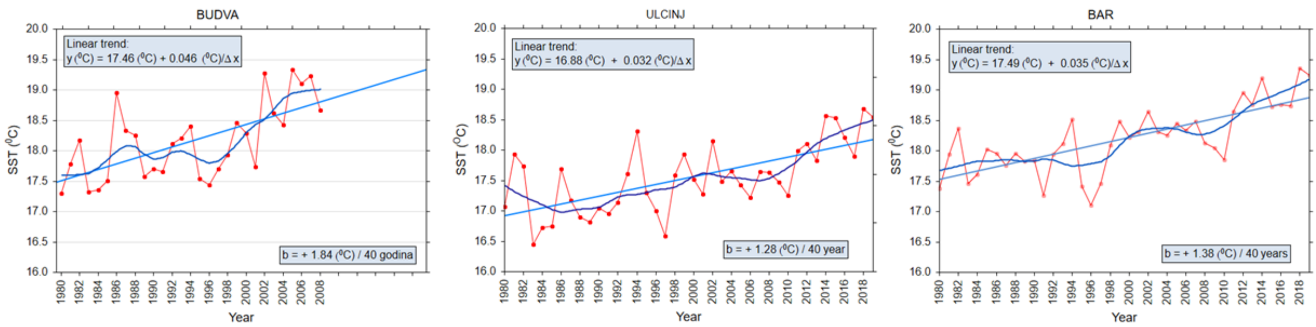


Figure 3.10. Long-term SST trend for selected stations along the Montenegrin coast. *Source: Grbec, 2019*

Recent surveys along the entire Montenegrin coast, undertaken as part of the GEF Adriatic project in October 2019 (Figure 3.1), demonstrated a significantly stratified water column for that time of year, as a result of prolonged summer conditions and the absence of the usual water column mixing, where the temperature and saline vertical gradients weaken. Moving from north to south along the coast of Montenegro, and from the coast to the open sea, the expected autumn characteristics were not observed due to the very particular warm and dry September and October. Such conditions resulted in the maintenance of the thermocline and the stability of the water column. Relatively high salinity values that were observed, even in the surface layer, originate in the specific Adriatic conditions, in which occasionally, due to local conditions and/or supported by non-Adriatic processes, salinity increases (Beg Paklar *et al.*, 2020).

Water transparency

Long term changes in transparency in the southern Adriatic (Morović *et al.*, 2010) indicate that the it is highest during the summer and lowest during the winter months. Sea water transparency has a high spatial variability depending on the influence of natural and/or anthropogenic factors. By moving away from the coast, transparency in the southern Adriatic, otherwise the most transparent area of the Adriatic, increases. The area of the southern Adriatic encompasses a wide range of optical types, but in the open sea it is mostly optical type I water, characteristic for oligotrophic areas. In areas where the impact of rivers is significant, the waters are more turbid, and if the circulation is weaker, light there penetrates to lower depths; they belong to coastal turbid waters of type IV-VII (Morović *et al.*, 2008).

Along the coast, the depth of light penetration into the sea depends on local specific conditions (location of the site, freshwater input from the land, proximity to anthropogenic and/or natural sources of fresh water, circulation). Due to anthropogenic impacts at some measuring stations, the transparency along the Montenegro coast does not have a notable annual sequence. Mean monthly values range from 6 to 15.5 m with considerable variability. The lowest transparency in the area of Boka Kotorska Bay was determined at locations near the port of Kotor and around Igalo in the Bay of Herceg Novi, where the median transparency of the entire research period was ca. 8 m (IA, 2019). However, from the range of transparency values in almost the entire investigated area it is evident that transparency occasionally falls below 4 m (Verige), which are extremely low values and it is quite certain that this is not solely due to the increase in phytoplankton biomass, but also due to the freshwater inflows are also likely to contribute to such low values.

A recent survey (October 2019) along the Montenegrin coast (Figure 3.1) showed the mean transparency of 17.2 m with a standard deviation of 4.51 m and a range of 7–25 m.

Conclusions

Achieving GES for EO7 primarily refers to the prevention of deterioration of those parameters that directly affect the weakening of the possibility of preserving GES for EO1, EO2, EO3, EO5, EO8, EO9, and EO10. These are primarily temperature and salinity, transparency, and waves and sea currents. Concerning climate change, it is important to mention that if the surface layer becomes warmer, stronger stratification is expected to occur.

Human activities undertaken in Montenegrin waters with the potential to permanently change hydrographic conditions mainly near the coast include construction or expansion of ports and marinas, and construction of wastewater treatment plants and sewers. At present, the situation in the coastal area is quite burdened by construction, marinas, and sewage outflow. For example, in Boka Kotorska Bay some parts of its coastal areas have reduced circulations and hydro-physiological quality which has led to the deterioration in ecological quality. Cumulative impacts of these modified areas largely represent locations where substantial coastal infrastructure activity has taken place, resulting in major modifications of the coastline and/or adjacent marine waters. In the open water, there are currently no activities leading to permanent hydrographical alterations. Recently initiated hydrocarbon investigation drilling should be carefully monitored in order to avoid significant hydrographic changes.

Table 3.21. Assessment of GES for Hydrography in Montenegro

Criteria		
Indicator	**GES definition**	**GES Assessment**
Location and extent of the habitats impacted directly by hydrographical alterations	Negative impacts due to new structures are minimal with no influence on the larger scale coastal and marine systems.	Not possible to assess GES due to lack of systematic data on hydrographic conditions. In addition, there are no thresholds set at either the Mediterranean or Adriatic Sea levels. However, observations at the local level indicate that there could be local changes of hydrographic conditions, mainly near the coast and in particular in Boka Kotorska Bay. As of yet, no significant permanent changes are observed.

3.1.d Coastal ecosystems and landscapes – EO8

Coastal zones are increasingly being altered by construction of human-made structures. These structures (e.g., ports, marinas, jetties, etc.) cause irreversible damage to landscapes, loss and fragmentation of habitats, loss of biodiversity, and have a strong influence on the configuration of the shoreline. Physical disturbances due to artificial structures on the coastal fringe can disrupt sediment transport, reduce the ability of the shoreline to respond to natural factors, and fragment the coastal space. Coastal defence infrastructures have been implemented to solve the problem, together with beach nourishment, but preserving the natural shoreline system with adequate sediment transport from rivers and dunes has proven to be the most preferred solution.

The closer the artificial structures are to a coastline, the more exposed they are to waves and storm surges, and sea level rise. Therefore, each further construction in coastal zones should be carefully thought through since it can create an additional financial burden of protecting and repairing such structures from the damage by climate hazards.

On the other hand, emerging climate hazards will require the construction of certain protective structures to tackle erosion/flooding and preserve the existing beaches. In Montenegro, coastal erosion caused by wave action is happening, for example on the islands of Mamula, Sveti Stefan and Sveti Nikola, Velika Plaža, and Jaz, while on Ada Bojana there occurs also aeolian erosion. Therefore, interventions will be necessary in order to protect and rehabilitate certain parts of the coast.

The key climatic pressures that affect coastal artificialisation (and consequently impact marine biota and seawater quality) are rising sea levels, storm surges, stormy winds, and heavy rains. From the aspect of vulnerability of the narrow coastal area due to sea level rise, an increase of 0.62–0.96 m in sea level (depending on different IPCC scenarios) is anticipated (National Strategy for Integrated

Coastal Zone Management of Montenegro, 2015). From this aspect, implementation of the ICZM Protocol and the coastal set-back is critical.

GES criteria and definitions

IMAP's Common Indicator 16, the common indicator belonging to EO8, addresses the length of coastline subjected to physical disturbance by human-made structures.

In 2019, at the meeting of the Ecosystem Approach Correspondence Group on Monitoring (CORMON) on Coast and Hydrography cluster, the Contracting Parties to the Barcelona Convention expressed the importance of defining the Good Environmental Status (GES) for Common Indicator 16. It was in particular emphasised that, due to national circumstances such as socio-economic, historic, cultural, and the like, unique targets and GES cannot be applicable to all Mediterranean countries and hence, cannot be specified quantitatively as a threshold value (UNEP/MED WG. 467/6). Therefore, the agreement was that the definition of GES and related targets and measures should be left to each Contracting Party, taking legal obligations of the Barcelona Convention into account, in particular the ICZM Protocol, Articles 8 and 16 in particular.

In Montenegro, the indicators grouped around the key planning targets of the coastal zone development were set by the National strategy on integrated management of the coastal zone of Montenegro (NS ICZM MNE, 2015). For narrow coastal strip, the extent to which the coastline will be built up in 2030 should be no higher than the baseline value (which is 31.9% – a share established – via orthophoto interpretation in 2011 (NS ICZM MNE, 2015)). There are also other indicators that concern the wider coastal belt such as share of construction areas of the total surface of coastal municipalities (not higher than 10% in 2030); share of construction areas in the 1 km-wide belt from the coastal line (not higher than 35% in 2030), and the extent to which the construction areas are used or built-up (not higher than 50% in 2030).

Table 3.22. Criteria and methodological standards for GES assessment for EO8 coastal ecosystems and landscapes in Montenegro.
Based on: IMAP Decision IG.22/7; NIMP for Montenegro. CI = common indicator

Criteria			Methodological standards	
Parameters	Indicator with related GES definition (minimum requirements for achieving GES)	Indicator measurement and thresholds	Scale of assessment	Use of criteria
Location and extent of artificial structures on the coastline Share of artificial and natural coastline in total coastline length	CI16: Length of coastline subject to physical disturbance due to the influence of human-made structures. GES definition: Physical disturbance to coastal areas induced by human activities should be minimised.	What is measured: The share of artificial coastline in total coastal length, with specified type of artificial structures. Thresholds: Although thresholds have not been officially defined by Montenegro, National ICZM Strategy indicates no further coastline urbanisation until 2030, compared to 2015 data (31.9%).	National level	For GES assessment a trend in share of artificial coastline should be observed (every 6 years).

EO8 GES assessment

In 2020 the spatial analysis on the length of Montenegro's coastline occupied by human-made structures was carried out within the GEF Adriatic project, i.e., the monitoring of the Common Indicator 16 was implemented.

The area of analysis was the coastline of Montenegro, from the border with Albania on the south to the border with Croatia on the north. Administratively, this area includes six coastal municipalities: Ulcinj, Bar, Budva, Kotor, Tivat, and Herceg Novi.

Primary input data for this analysis was digital orthophoto imagery, taken in 2018, performed with a spatial resolution of 0.2 m and provided by state Geodetic Administration of Montenegro. The minimum distance between coastal defence structures is set to 10 m in order to classify such segments as natural, i.e., if the distance between two adjacent coastal defence structures is less than 10 m, all the segment including both coastal defence structures is classified as artificial.

According to the analysis, the total length of Montenegro coastline is 330.46 km, of which 223 km is natural coast (or 67.48%) while the total length of artificial coastline is 107.46 km (or 32.51%) (Figure 3.11). It should be noted that this study did not take into account the area along the Bojana River, but only the line band of land/sea interaction (i.e., the area separating the mainland from the sea). This may be one of the reasons the total coastal length differs from other sources.

Most of the artificial structures on the coastline are located in close proximity to the major settlements with strong economic activities. A particularly large presence of artificial structures is observed in Boka Kotorska Bay. The reason for this is primarily the geological relief that descends steeply towards the sea and leaves a very narrow coastal belt for the development of settlements and hotel complexes accompanied by infrastructure and facilities such as beaches, marinas, promenades, etc. The small share sections of sandy beaches in the Bay and inaccessibility to bathing shores also contributed to increased construction of concrete beaches.

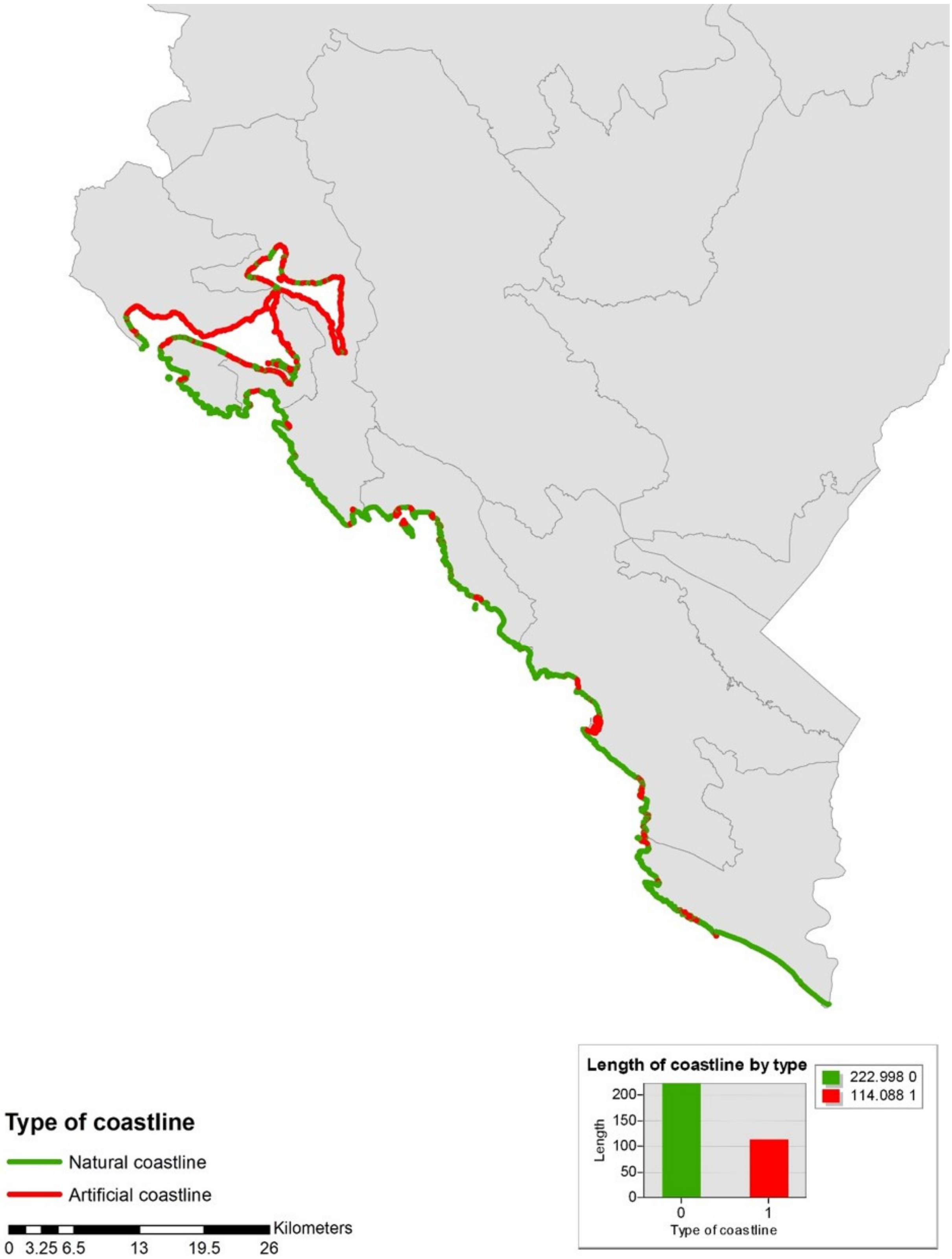


Figure 3.11. Spatial presentation of coastal delineation by type of coastline in Montenegro

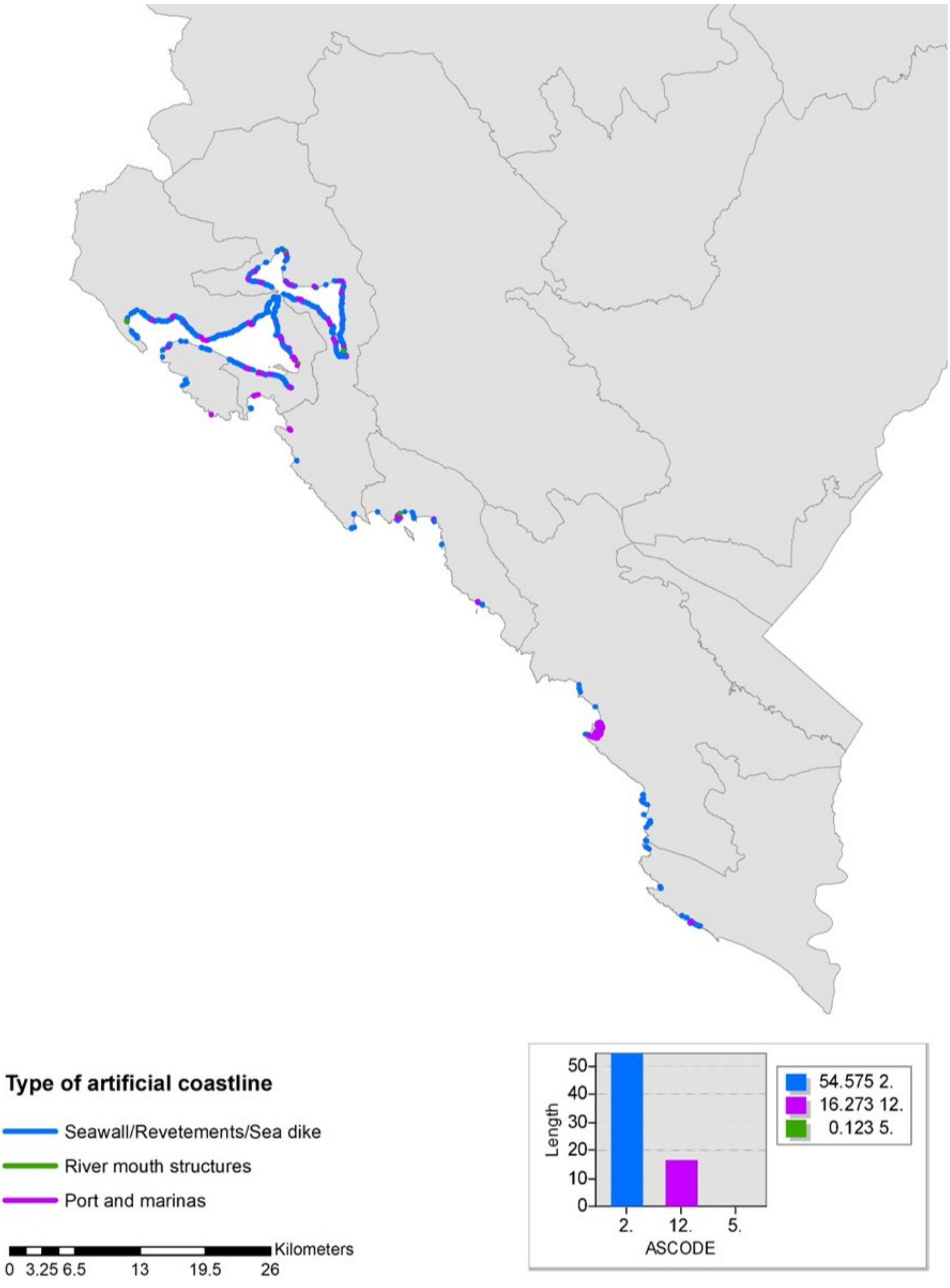


Figure 3.12. The length and type of artificial coastline in Montenegro

Spatial distribution of different types of artificial infrastructure is shown in Figure 3.12. The artificial structures are dominated by “Seawalls/ Revetments/Sea dikes“ category (54.58% of the total artificial coastline), “Ports and Marinas“ (16.27%), while significantly less represented are “River Mouth Structures“ (0.12%).

It is also important to note that significant part of the artificial structures (29.03%) does not belong to any of above-mentioned categories set by CI16 Indicator Guidance fact sheet. This “Other” category is mostly represented by coastal roads, parking areas, construction sites, shipyards, etc. (Figure 3.13). The “Breakwaters“ whose projection of the coastline coincided with the purpose of the seaports and nautical tourism ports, were designated as “Port and marinas“. Although there are several examples of natural sandy and pebble beaches in Boka Bay, coastline is generally rocky and difficult to access. Therefore, some units of local government and tourist resorts have decided to flatten and concrete the rocky coast in order to provide citizens and tourists with easier access to the sea. The aforementioned concrete beaches, i.e., as sea fronts typical of any seaside town, were coded under ”Seawalls/ Revetments/Sea dikes“. Although those manmade structures mainly serve as promenades, they are basically a defence against the waves.

Figure 3.13. Example of the construction site on the coastline (Kumbor-Porto Novi)

Since the GES regarding IMAP’s CI16 reflects in minimising negative impacts due to new structures with no influence on the larger scale coastal and marine system, it is essential to observe the temporal trends in coastal artificialisation. Although Montenegro had some similar assessment previously (findings of which are reflected the above-mentioned 31.9% baseline value from NS ICZM MNE in 2015), it was not carried out according to the exact methodology defined in IMAP’s Indicator Guidance Factsheet for CI16, so the establishment of the trend (i.e., comparison between states in two different time periods) would not be consistent and hence prone to faulty interpretations.

In other words, the GES for this indicator cannot be established at the moment (Table 3.23). New assessment should be carried out after six years (as set by the Montenegro's monitoring programme for CI16) to observe the trend, i.e., to estimate the GES for this indicator.

Table 3.23. Assessment of GES for Hydrography in Montenegro

Criteria		
Indicator	**GES definition**	**GES Assessment**
Length of coastline subject to physical disturbance due to the influence of human-made structures	Physical disturbance to coastal areas induced by human activities should be minimised.	GES for this indicator cannot be assessed at the moment because there are not enough relevant datasets to observe a trend. New assessments should be carried out after six years to observe a trend, i.e., to estimate the GES for this indicator. However, some observations from this assessment are indicative: more than a third of Montenegro's coastline is artificial, and Boka Kotorska Bay is the most urbanised area.

3.1.e Pollution – EO9

The Ecological Objective 9 (EO9) is related to the introduction of chemical contaminants and hazardous microbiological substances in the marine ecosystem from land-based and sea-based sources, thereby affecting the structure and function of marine ecosystems, as well as its ecosystem services. It is primarily monitored by means of pressure- and impact-based Common Indicators (CIs 17–21) allowing assessment of the Good Environmental Status (GES) against established regional standards and threshold criteria. The EO9 GES assessment provides, together with other pollution-related EOs (EO5 – Eutrophication and EO10 – Marine litter), inputs to the overall integrated GES assessment of the marine environment. As mentioned, the integrated GES is based on the achievement of the targets of all EOs set for the marine environment and structured within the UNEP/MAP/IMAP programme.

The current IMAP EO9 evaluations consider a selection of chemicals and groups of substances which should be revised periodically according the monitoring and assessment results of the consecutive IMAP six-year cycle implementation, as well as similarly updated in light of new research and monitoring findings. Information on chemical contaminants are based primarily in international available lists of chemicals of concern, such as:

- OSPAR and HELCOM Regional Seas conventions Priority List of Chemicals and Substances of concern;
- The European Commission WFD and MSFD Directives and the JRC "Watch List" of priority substances;
- The Stockholm, Rotterdam and Basel Conventions lists;
- The US Environmental Protection Agency (US EPA) lists.

GES criteria and definitions

The EO9 GES achievement in the Mediterranean Sea requires undertaking a review of the existing national monitoring networks according to both UNEP/MAP/IMAP and other international policies, such as EU WFD and EU MSFD, potentially including the links with drivers and pressures (see chapter 2). In Montenegro, the historical and updated MEDPOL biomonitoring network of stations provides a number of continuous monitoring datasets (2016–2020) for CI17 (chemical contaminants), as does the selected coastal and offshore stations grid (Figure 3.1) for the sediment sampling marine survey undertaken in October 2019. These are the primary sources of environmental datasets for EO9 (related to CI17, CI18, and CI20), as well as the national oil spill contingency plan (CI19) and the bathing water quality monitoring programme for CI21 (microbial pathogens).

The scale of monitoring and particulars for CI17 (chemical contaminants) and CI18 (toxicological effects) of the IMAP common indicators are found under IMAP guidelines, for which the parameters monitored for two types of matrices (biota and sediment) are chemical compounds (metals and organic compounds) and biological effects, respectively. With regards to CI19 (oil and HNS spills) and CI20 (seafood contamination), the operational area is the entire national marine waters of Montenegro and there is no predefined regular geographical monitoring network as such. The CI21 (microbiological pathogens / bathing water quality) comprises a network of more than 100 sampling sites along the coastline of Montenegro. The distinction is made between the operational areas and subareas selected to perform the present EO9 GES assessment according the rationale explained above, based on existing knowledge. The 2016–2020 period was taken into consideration to perform a research on existing datasets and information for each EO9 CI according to IMAP requirements to assess GES.

Some of the five CIs of the EO9 are multiparametric indicators. For example, CI17 should be integrated by observing the different groups of chemical compounds monitored and exhibiting a pressure on the marine ecosystems (organisms or habitats, namely targeted biota and sediments); before an upper level of integration / aggregation could be undertaken among CIs. It is similar for CI18 and CI20, but not for CI19 and CI21 which are based on a single parameter for its evaluation. Whether uniparametric or multiparametric, these CIs should be assessed according to the operational objectives and targets defined (for each) to examine the achievement of the defined GES and according to the scientific-based criteria established and agreed under the IMAP implementation processes in the Mediterranean Sea.

Of note, the Decision IG. 22/7 (COP19, February 2016) on IMAP included in its Annexes the Related Assessment Criteria to perform the CI17 and CI18 GES assessment, as well as for EO5. Since then, the main outputs during the initial phase of IMAP have refined those assessment criteria (UNEP(DEPI)/MED 439/15 Meeting of the MED POL Focal Points, Rome, Italy, 29–31 May 2017) initially communicated in Decision IG.23/6 (COP20, 2017) on 2017 Mediterranean Quality Status Report (http://www.medqsr.org) for the EO9 GES assessment.

Under EO9, and particularly for CI17 and CI18, these assessment criteria include Background Concentrations (BCs), Background Assessment Criteria (BACs) and Environmental Assessment Criteria (EACs), for hazardous chemical substances and biomarkers for the Mediterranean Sea. In the UNEP(DEPI)/MED 439/15 document, BCs and Mediterranean BACs were estimated at regional and sub-regional scales using the reference datasets provided by the Contracting Parties to this regard. The methodology and results can be found in the document UNEP(DEPI)/MED WG.427/Inf.3 containing all the detailed data / metadata information, datasets characteristics, statistical results, and scientific rationale of the performed analysis and estimation of IMAP Related Assessment Criteria for these CIs. In relation to CI20 (similarly to CI17), a multiparametric CI, the European criteria established for seafood chemical levels for human consumption should be observed along the IMAP methodologies to set thresholds (COMMISSION REGULATION (EC) No 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs) .

The CI19 is evaluated pursuant to the occurrence trends of oil and harmful and noxious substances (HNS) accidental pollution events, based on the number of pollution events of 50 cubic meters or higher per year according the IMAP CI Factsheets. The CI21 is evaluated according to the threshold values and methodology established by EU Bathing Water Quality Directive and also agreed by the Contracting Parties to the Barcelona Convention. For those two CIs, the evaluations and GES status elucidation were approached based on the communications and discussions with the responsible authorities, namely, the Maritime Safety and Ports Management Administration, the Ministry of Ecology, Spatial Planning and Urbanism, and Public Enterprise "Morsko dobro" respectively.

EO9 GES assessment

The initial assessment for EO9 considered an extensive evaluation of the monitoring datasets for CI17 for which the majority of datasets are available. The following Tables 3.24 and 3.25 show the results of the quantitative CI17 assessment for the main group of chemical contaminants over the 2016–2020 period and against the IMAP assessment criteria (see also the sectoral document Towards EO9 assessment for detailed information). The tables are divided by chemical groups and evaluated against the established thresholds (and colour scales) for either biota or sediment; namely, Background Concentrations (BC), Med BAC and EACs/ERLs according the IMAP Guidance Factsheets for EO9.

The following tables show a high percentage of sediment samples in which concentrations of Hg and Pb exceed the thresholds (ca. ERL, Effects Range Low assessment criteria) during the 2016–2020 period and where probable toxicological effects could be expected. The majority of these datasets correspond to Boka Kotorska Bay and few samples in the coastal stations of Luka Bar and Luka Budva in the middle part of the sea of Montenegro, where pressures from urbanisation and industry exist. The visual presentation of the assessment of 2016–2020 monitoring datasets of metals is shown in Figures 3.14 and 3.15.

Table 3.24. Assessment of metals monitoring datasets (averaged 2016–2020 by location) against IMAP EO9 assessment criteria for CI17 multiparametric indicator (units µg/Kg dry weight). As defined by IMAP CI17 assessment criteria, red colour cells indicate „concern" (concentration are at levels where probable toxicological effects to organisms can occur), blue and green/orange indicates „no concern", despite the later indicate concentrations above the background levels for the area.

C17 (Substance & Matrix) – Averaged 2016–2020			Cadmium		Mercury		Lead	
Operational Area	**Subarea**	**Location**	**Biota**	**Sediment**	**Biota**	**Sediment**	**Biota**	**Sediment**
Boka Kotorska Bay	TW1–TW4							
		Brodogradilište Bijela	673	225	111	408	1,204	80,000
		Dobrota – IBM	852	235	96	900	1,529	56,500
		Luka Herceg Novi	470	140	85	327	800	20,000
		Luka Kotor	756	398	75	910	5,117	77,667
		Luka Risan	824	180	112	497	993	31,500
		Luka Tivat	1,070	134	128	650	18,811	33,500
		Porto Montenegro	696	240	131	8,046	1,713	77,800
		Orahovac	825		110		1,140	
		Stoliv	1,167		117		1,583	
Northern part of the sea of Montenegro	CW1, CW2, and OW1							
		Luštica		280		140		6,500
		Luštica – Dobra luka		134		30		3,220
		Offshore transect (1)		135		21		18,750
Middle part of the sea of Montenegro	CW3, CW4, and OW2							
		Luka Bar	1,134	4,470	94	212	69,452	234,000
		Luka Budva	825	143		170		26,800
		Offshore transect (1)		100		14		14,600
		Offshore transect (2)		135		21		1,8750
Southern part of the sea of Montenegro								
		Ada Bojana		110		65		6,200
		Port Milena	408	52	89	39	1,381	6,567
		Offshore transect (1)		100		27		26,250
		Offshore transect (2)		107		28		20,667

Note: both station coordinates and yearly concentrations are provided in the Excel files

Table 3.25. Assessment of organic compounds monitoring datasets (averaged 2016–2020 by location) against IMAP EO9 assessment criteria for CI17 multiparametric indicator (units µg/Kg dry weight). Red colour cells indicate "concern", blue and green/orange indicates "no concern"

C17 (Substance & Matrix)			PCBs (sum 7 ICES congeners)		HCB, Lindane, DDTs		PAHs (BaP as reference)	
Operational Area	**Subarea**	**Location**	**Biota**	**Sediment**	**Biota**	**Sediment**	**Biota**	**Sediment**
Boka Kotorska Bay	TW1-TW4							
		Brodogradilište Bijela	24	675	< 0.5	< 0.1	1.3	1,372
		Dobrota – IBM	11	17	< 0.5	< 0.1	2.8	430
		Luka Herceg Novi	15	134	< 0.5	< 0.1	3.3	682
		Luka Kotor	10	85	< 0.5	< 0.1	3.3	1,592
		Luka Risan	11	37	< 0.5	< 0.1	2.2	400
		Luka Tivat	19	55	< 0.5	< 0.1	< 0.5	287
		Porto Montenegro	12	288	< 0.5	< 0.1	2.1	1,640
		Orahovac	5.9		< 0.5		< 0.5	
		Stoliv	< 2		< 1		< 3	
Northern part of the sea of Montenegro	CW1, CW2 and OW1							
		Luštica		< 2		< 5		10
		Luštica – Dobra luka		0.8		< 0.1		2
		Offshore transect (1)		0.17		< 0.05		2
Middle part of the sea of Montenegro	CW3, CW4 and OW2							
		Luka Bar	26.1	55	< 0.5	< 0.1	1.8	233
		Luka Budva	2.4	18	< 0.5	< 0.1	1.5	324
		Offshore transect (1)		0.20		< 0.05		0.70
		Offshore transect (2)		0.21		< 0.05		1.13
Southern part of the sea of Montenegro								
		Ada Bojana		5		< 0.1		< 5
		Port Milena	< 0.2	2	< 0.5	< 0.1	2.1	331
		Offshore transect (1)		0.10		< 0.05		1.65
		Offshore transect (2)		0.18		< 0.05		1.52

Note: both station coordinates and yearly concentrations are provided in the Excel files

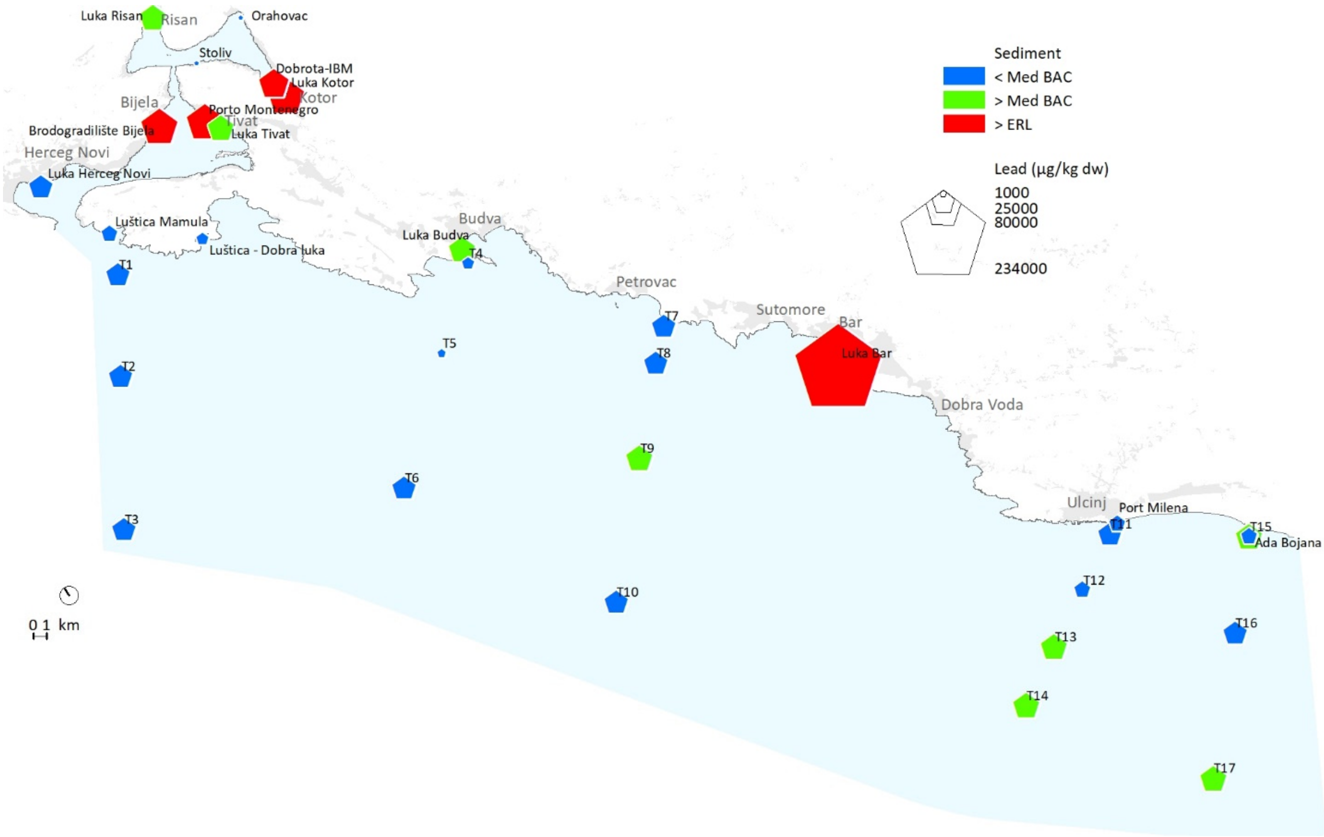


Figure 3.14. Visual presentation of assessment of 2016–2020 monitoring datasets for lead (in sediment). *Source: UNEP/MAP-PAP/RAC and MESPU, 2021*

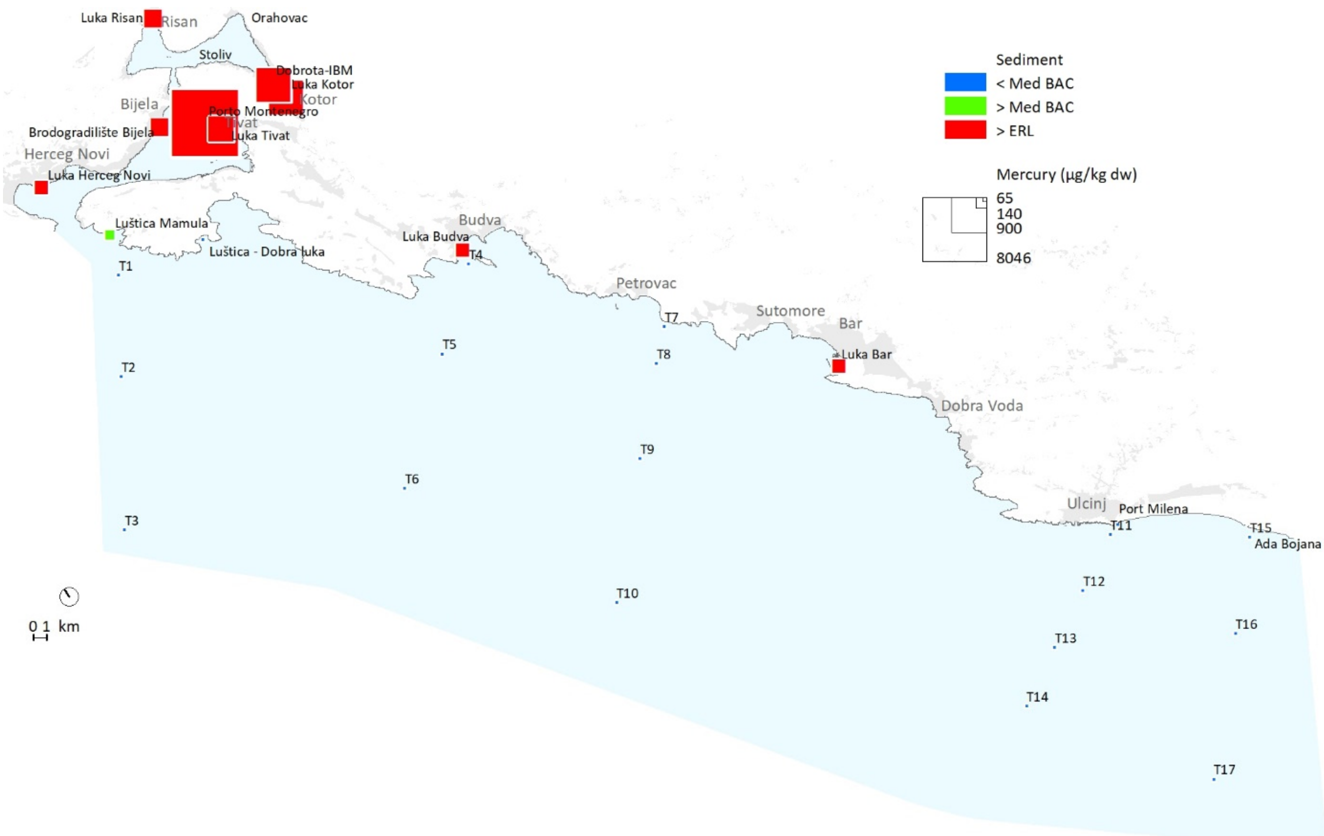


Figure 3.15. Visual presentation of assessment of 2016–2020 monitoring datasets for mercury (in sediment).
Source: UNEP/MAP-PAP/RAC and MESPU, 2021

It is important to highlight the Tables and Figures above, that the coastal belt is where high concentrations of chemicals are found, and particularly in Boka Kotorska.

Regarding organic compounds, similarly, a number of sediment samples exceed the levels of no-concern (environmental contaminants concern) in the same areas and locations for polychlorinated biphenyls (PCBs) and aromatic hydrocarbons in sediment.

Table 3.25 shows that all the datasets for HCB, Lindane, and DDTs are below the Background Assessment Criteria (BACs) and therefore pose no concerns. On the contrary, a significant percentage of PCBs (ICES 7 sum) appears to be of concern in sediments since the levels of almost 40% of the analysed samples are above ERLs thresholds with probable toxicological risks in Boka Kotorska Bay, Luka Bar, and Luka Budva. This can be also observed in the sediment samples analysed for polycyclic aromatic hydrocarbons (PAHs) as shown in Figures 3.16 and 3.17 below for biota and sediment matrices. The pollution concerns are focused in ca. 1/3 of the sediment samples, mainly form Boka Kotorska, Luka Budva, and Luka Bar.

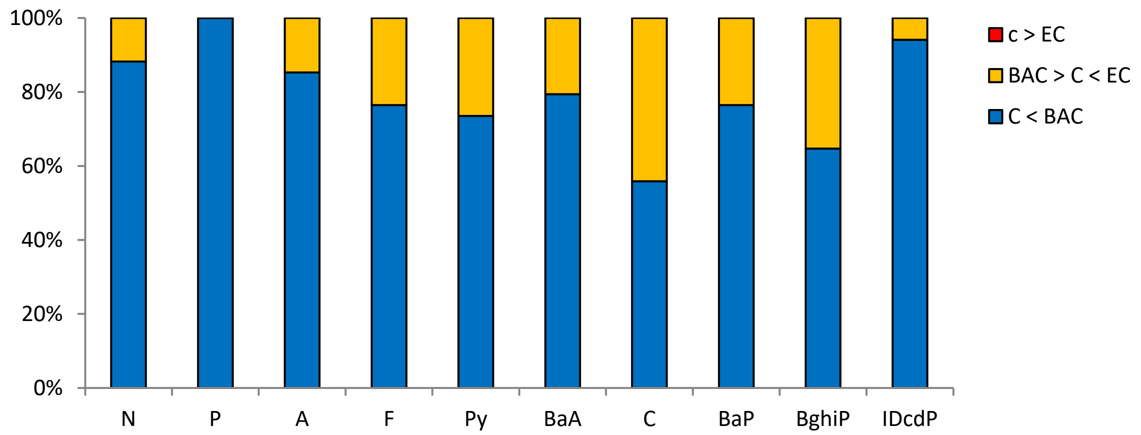


Figure 3.16. Polycyclic aromatic compounds in biota samples datasets between 2016–2020 for the complete Montenegrin marine environment

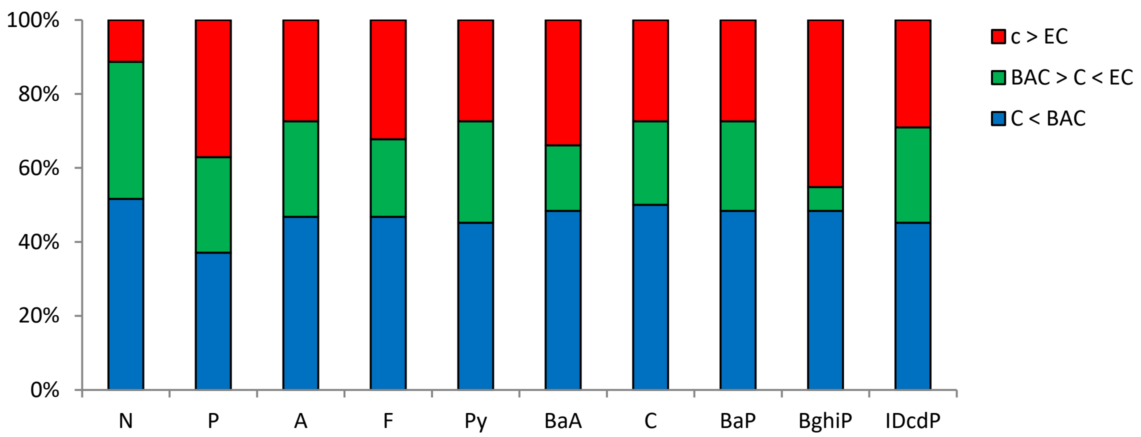


Figure 3.17. Polycyclic aromatic compounds in sediment samples datasets between 2016–2020 for the complete Montenegrin marine environment

The origin of the hydrocarbon contamination according the PAH congener ratios P/A, F/Py and BaA/C (not shown) point to both petrogenic and pyrolytic origins for biota and sediments, respectively, and should be related to a number of either ubiquitous or punctual inputs of oil related hydrocarbons in these areas. To this regard, in terms of CI18 data, it is worth highlighting that precisely in Boka Kotorska Bay the AchE and Micronuclei frequency in all mussel samples were inhibited at toxic levels and above the Med BAC values. The visual presentation of the assessment of monitoring datasets for 7CBs and Benzo(a)pyrene (BaP) is shown in Figures 3.18 and 3.19 below.

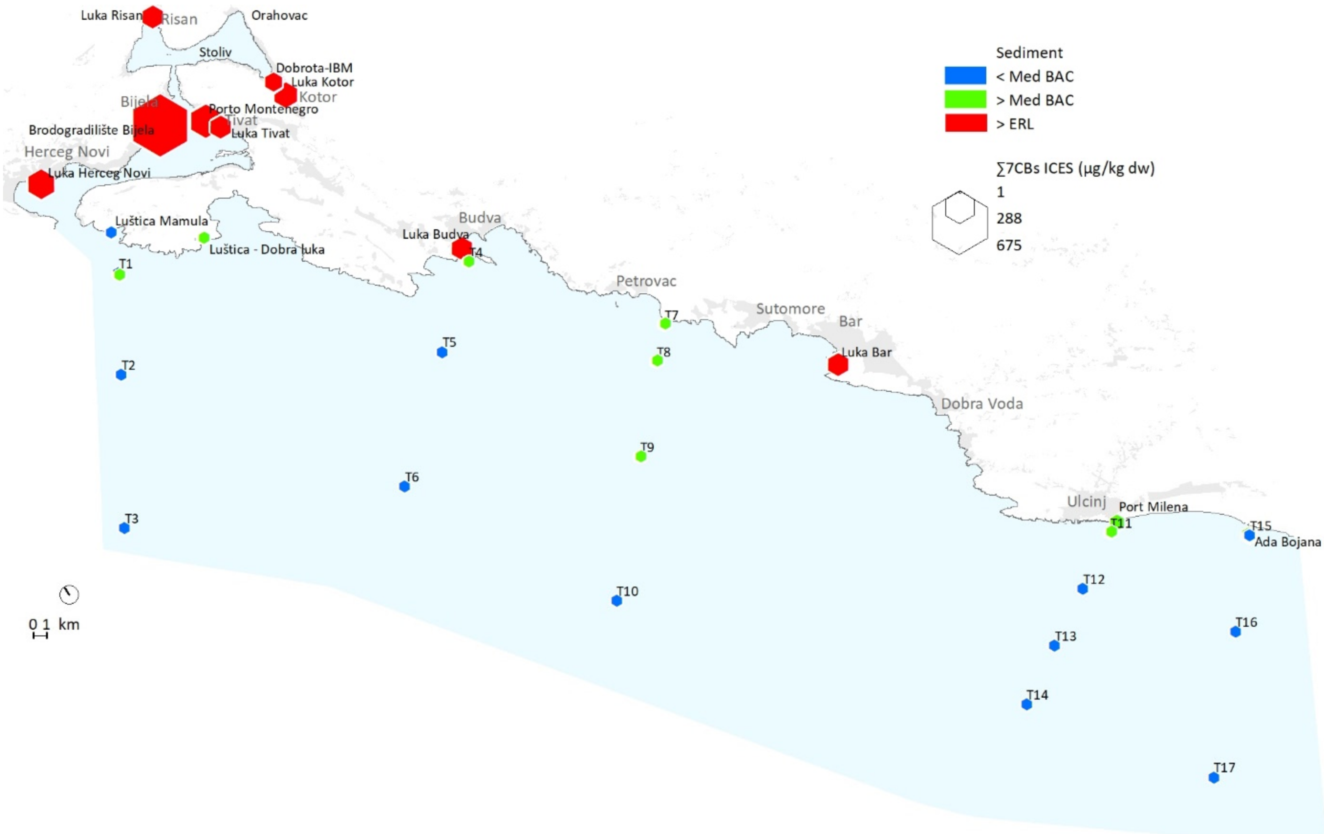


Figure 3.18. Visual presentation of assessment of 2016–2020 monitoring datasets for 7CBs (in sediment).
Source: UNEP/MAP-PAP/RAC and MESPU, 2021

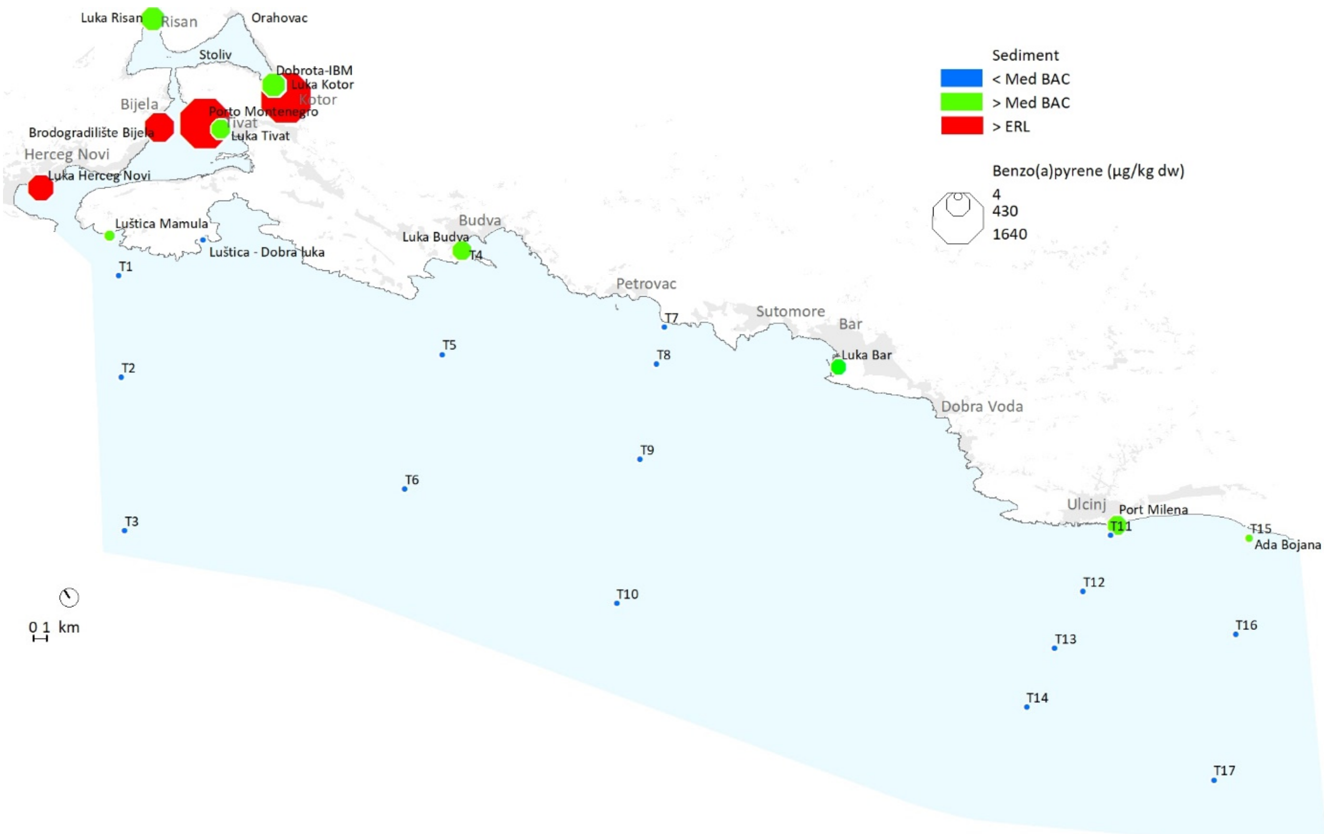


Figure 3.19. Visual presentation of assessment of 2016–2020 monitoring datasets for BaP (in sediment).
Source: UNEP/MAP-PAP/RAC and MESPU, 2021

Table 3.26. Assessment of GES for Contaminants in Montenegro

Criteria		GES Assessment
Indicator	**GES definition**	
Concentration of key harmful contaminants measured in the relevant matrix	Level of pollution is below a determined threshold defined for the area and species.	Some of the monitored and assessed groups of harmful chemicals pose a threat in Boka Kotorska Bay while in the open coastal and marine environment there is no concern. Mostly, legacy pollutants (heavy metals and organohalogenated compounds) are found in specific industrial locations (e.g., Bijela shipyard) and in most of the locations of the semi-enclosed Bay. In the coastal areas of Budva and Bar, facing the Adriatic Sea, high levels of mercury in sediments are a concern. Cadmium and lead are also a concern in Bar. These are levels above thresholds potentially impacting biodiversity. Overall, GES is not achieved.
Level of pollution effects of key contaminants where a cause and effect relationship has been established	Concentrations of contaminants are not giving rise to acute pollution events.	There are not enough continued monitoring evidences nor assessments to determine this indicator, although in locations with compounds above the threshold levels, potential toxicological effects are highly probable to occur (e.g., Boka Kotorska Bay).
Occurrence, origin (where possible), and extent of acute pollution events (e.g., slicks from oil, oil products, and hazardous substances) and their impact on biota affected by this pollution	Occurrence of acute pollution events is reduced to the minimum.	There have been no oil spillages of concern to be reported according to the definition of this indicator definition in the coastal and marine area of Montenegro so it can be concluded that GES is achieved.
Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood	Concentrations of contaminants are within the regulatory limits for consumption by humans. No regulatory levels of contaminants in seafood are exceeded.	GES cannot be assessed. There is no empirical scientific evidence of wild fishery stocks being affected by chemical compounds, and therefore concentrations of contaminants in seafood. The low representation of this sector in the Montenegrin economy makes sampling and assessment of this indicator a challenge. In fact, the GES is assessed by addressing wild populations of commercial fisheries and aquaculture species rather than controlled.
Percentage of Intestinal enterococci concentration measurements within established standards	Concentrations of intestinal enterococci are within established standards.	GES is achieved. A national monitoring programme established in Montenegro has reported no concerns for this indicator. Dedicated efforts are directed towards preserving the excellent standards of the bathing water quality, thus a key sector of the Montenegrin economy.

3.1.f Marine litter – EO10

Marine pollution as a consequence of human activity is to a large extent generated by various human activities. Marine litter increasingly impacts the health of marine ecosystems and biota, which creates additional pressures for already endangered organisms, habitats, and the overall ecosystem health. Of the seven protocols of the Barcelona Convention, the most relevant to marine litter is the Land-based Sources and Activities Protocol (LBS Protocol). The Protocol states that parties need to undertake action to eliminate pollution deriving from land-based sources and activities, in particular to phase out inputs of the substances that are toxic, persistent, and liable to bio-accumulate as listed in its Annex I, including litter. In addition, the Dumping Protocol has relevance to marine litter. It states that dumping of wastes and other matter is prohibited, except for dredged material, food waste, platforms and other human-made structures, and inert geological materials.

Montenegro has established the legislation framework related to the conservation of the environment, nature, coastal and sea management, and waste management. As part of the Law on the Protection of the Marine Environment, the following directives have been transposed: Directive

2008/56/EC of the European Parliament and Council establishing a framework for Community action in the field of marine environmental policy; 2017/845/EU of the European Parliament and the Council amending Directive 2008/56/EC and Commission Decision 2017/848/EU laying down criteria and methodological standards on Good Environmental Status (GES) of the marine environment.

Although there is no term “marine litter” mentioned in the Law, compliance with the mentioned directives will enable the implementation of the national monitoring programme, preventive and protective measures of the marine environment against marine litter pollution. Furthermore, there are several strategic documents addressing the issue. National Action Plan (NAP) for the implementation of the LBS protocol and its regional plans in the framework of the SAP-MED with the aim to achieve Good Environmental Status for pollution-related EcAp ecological objectives describes in detail all the requirements of international conventions and regulations that should be implemented in Montenegro related to marine litter. Document gives the timeframe proposal for the implementation of preventive measures and activities for the prevention, preservation, and improvement of marine environment. A certain part of the activities envisaged by NAP started with the realisation during 2019, but with a significant delay compared to the proposed timeframe. It is noteworthy that without recognising marine litter in the Montenegrin legislation, it is not possible to adequately implement the envisaged measures.

GES criteria and definitions

In order to contribute to the determination of a set of GES characteristics and enable assessment of the extent to which GES is being achieved, definition of baseline and threshold values are mandatory. In order to adequately assess trends and possibly correct the baseline and threshold values it is necessary to have a database including at least four years of data collection. For this reason, baseline and threshold values have not yet been agreed upon at the regional level for all marine litter indicators.

Therefore, the assessment of GES in this document was carried out in accordance with the previously defined and accepted baseline and threshold values, related only to beach litter (CI22). Values for floating and seabed marine litter (CI23) have only been proposed but not yet regionally agreed and therefore GES for these indicators was not assessed (Table 3.27).

Assessments for Montenegro as part of this document have been done at the national level (Table 3.27). Although marine litter is a problem that for the majority of cases cannot be observed only at the national level, as it knows no borders, the available data are presented only for the territorial sea and coast of Montenegro. In addition to the assessment at the national level, for each group of processed data (indicators), available data at the level of the Adriatic and the Mediterranean Sea were presented (depending on availability).

What appears as a problem for an adequate assessment of GES is the lack of a series of data (at least the six-year assessment cycle) on the basis of which trends would be determined. Nevertheless, for all indicators covered in this document, GES was assessed on the basis of available data and available baseline and threshold values.

Table 3.27. Criteria and methodological standards for GES assessment for EO10 Marine litter in Montenegro.
Based on: IMAP Decision IG.22/7; UNEP/MED WG.482/23, 2020; EO = Ecological objective, CI = common indicator

Criteria			**Methodological standards**	
Elements/Parameters	**Indicator with related GES definition (minimum requirements for achieving GES)**	**Indicator measurement and thresholds**	**Scale of assessment**	**Use of criteria / Target**
Marine litter related to EO10				
CI22 Beach litter: Trends in the amount of litter washed ashore and/or deposited on coastlines (EO10);				
Selected beaches in the area of Boka Kotorska Bay and open part of Montenegrin coast	GES definition IMAP: Number/amount of marine litter items on the coastline does not have negative impacts on human health, marine life, and ecosystem services.	What is monitored: ▪ Distribution of beach litter expressed as number of items/100 m and total weight/100 m of transect ▪ CCI (Clean Coastal Index). Baseline: Baseline on Mediterranean level 329 items/100 m of beach transects. Threshold: TV on Mediterranean level – 59 litter items/100 m beach length.	Adriatic level assessment (sub-regional) and national level	Amount of beach litter per main litter categories and its distribution (number of items/100 m of transect), and whether the threshold values set have been achieved (%decrease).
Floating litter and sea floor litter – Trends in the amount of litter in the water column including microplastics and on the seafloor (EO10)				
CI 23 Floating litter				
Selected transects in the area of Boka Kotorska Bay	GES definition IMAP: Number/amount of marine litter items in the water surface and the seafloor do not have negative impacts on human health, marine life, ecosystem services and do not create risk to navigation.	What is monitored: Distribution of floating litter at 3 transects in the area of Boka Kotorska Bay, expressed as N items/km^2 of sea surface Proposed baseline (44–47 items/km^2) and threshold values (5 items/km^2) are not yet adopted due to the scarcity of available data.	Adriatic level assessment (sub-regional) and national level (for Boka Kotorska Bay area)	Amount of litter items per main litter categories and its distribution (N items/km^2), and whether the threshold values set have been achieved (statistically significant % decrease).
CI23 Sea floor litter				
MEDITS surveys (10 transects in open sea), fisheries surveys (Boka Kotorska Bay area) and visual census (scuba diving)	GES definition IMAP: Number/amount of marine litter items in the water surface and the seafloor do not have negative impacts on human health, marine life, ecosystem services and do not create risk to navigation.	What is monitored: Distribution of sea floor litter at 10 transects in the open waters of Montenegro and 2 transects in Boka Kotorska Bay area, expressed as N items/km^2. Proposed baseline (161–464 items/km^2) and threshold values (64 items/km^2) are not yet adopted due to the scarcity of available data.	Adriatic level assessment (sub-regional) and national level (open sea and Boka Kotorska Bay area)	Amount of litter items per main litter categories and its distribution (N items/km^2), and whether the threshold values set have been achieved (statistically significant % decrease).

EO10 GES assessment

In accordance with the recommendations of Decision IG.22/7, for the estimation of GES of marine environment in Montenegrin waters, following data were used: available data for beach litter (in the area of Boka Kotorska Bay and for the rest of the Montenegrin coast), sea floor litter (the area of Boka Kotorska Bay and for the rest of Montenegrin coast), and floating litter (for the area of Boka Kotorska Bay). The assessment of GES was made on available data collected through different international projects (EU IPA DeFishGear project, MEDITS surveys and national fishery resources research and UNEP/MAP "Adopt-a-beach" project).

UNEP/MAP and the Italian Ministry for Environment, Land and Sea Protection (IMELS) signed in September 2016 a cooperation agreement for implementation of specific pilot projects such as the "Adopt-a-beach" project. This project aims, on the one hand, at keeping beaches clean, and, on the other hand, at raising awareness and educating citizens on marine litter in Albania, Bosnia, and Herzegovina and Montenegro. (UNEP/MED WG.452/5).

Beach litter CI22

Since the analyses of marine litter on Montenegro beaches refer to different years, different periods, and sampling dynamics, as well as different beaches, comparative data are presented in accordance with defined indicators.

Within the **IPA EU DeFishGear** project two beaches were monitored by seasonal dynamics during 2014 and 2015. In order to compare litter abundance in the Bay and open sea areas, two beaches were selected based on the influence of the open waters (Blatna beach in the area of Boka Kotorska Bay and Kamenovo beach which is located at open part of the Montenegrin coast – Figure 3.21).

Figure 3.20. Beach litter survey in Montenegro

Results from all four seasons showed that most dominant type of litter belongs to plastics with 75.30%, followed by metal 7.78%, paper 5.10%, glass/ceramics 4.05%, textile 3.34%, wood 2.90%, rubber 1.24%, and other 0.28%. **Average number of marine litter items for both beaches was 0.37 items/m² (374.2 items/100 m stretch).** The top 20 litter item categories accounted for 85.4% of the total recorded litter, with cigarette butts and filters being by far the most abundant litter item accounting for 40.8% of the sampled litter. According to clean coastal index (CCI) Kamenovo beach belong to "dirty" beaches (CCI = 10.5), while Igalo – Blatna beach belongs to "clean" beaches (CCI = 4.4). According to the CCI scale values from 0–2 indicate very clean beaches, 2–5 clean, 5–10 moderately clean, 10–20 dirty, and > 20 extremely dirty beaches (Alkalay *et al.*, 2007).

Within the **UNEP/MAP "Adopt a beach project"**, two beaches were monitored, Blatna and Jaz (Figure 3.22). These two beaches were chosen due to the proximity of the river mouths to the sea.

Results indicate a fairly high level of beach pollution by solid waste during all investigated seasons. On Jaz beach during all three seasons, in total 4,227 items/100 m with a total weight of 48.4 kg were found, while on Blatna beach a total of 3,831 items/100 m with a total weight of 85 kg were recovered. **Average abundance of marine litter during all three seasons was estimated to be 0.35 items/m² (350 items/100 m stretch) and 0.85 items/m² (850 items/100 m stretch) on Jaz and Blatna beaches, respectively.** According to CCI Jaz beach belong to moderately 2clean" beaches (CCI = 7), while Blatna beach belong to "dirty" beaches (CCI = 17.14).

The largest percentage share of marine litter belongs to APM on both beaches with cumulative percentage of 90.6% and 79.11% of total litter on Jaz and Blatna beach, respectively.

Available data on the amount of beach litter for the Adriatic-Ionian region (Table 3.29) indicate that in most countries the amount of beach litter is increasing. This indicates the fact that the issue of marine litter is unresolved and that GES is likely not achieved in all the countries if the values are compared with the defined baseline and threshold values.

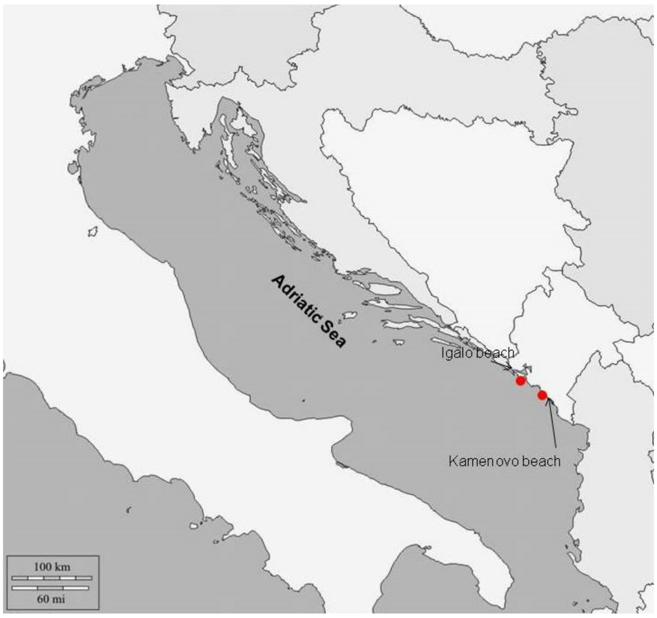


Figure 3.21. Two beaches (Igalo and Kamenovo) monitored for marine litter during the DeFishGear project

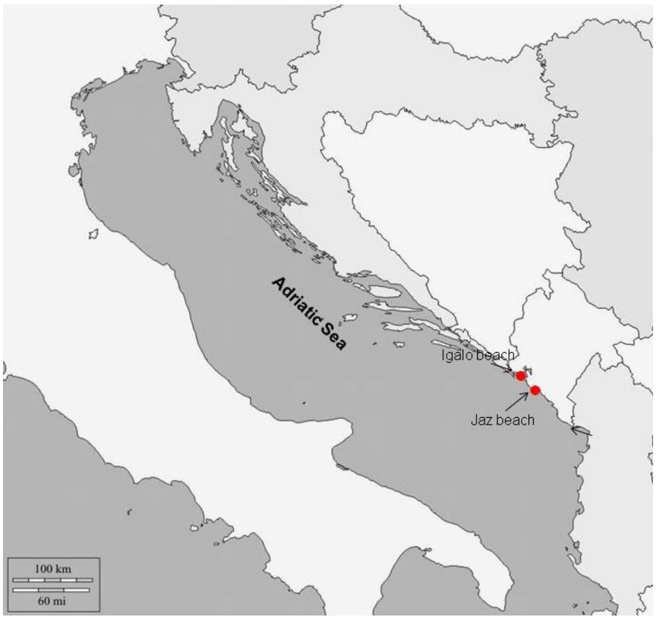


Figure 3.22. Two beaches (Igalo and Jaz) monitored for marine litter during UNEP/MAP Adopt a beach project

Table 3.28. Beach marine litter survey results

Area	Number of surveys	Min	Max	N of items[2]/100 m (average)	N of items[3] /100 m (median)	Baseline	Threshold
Boka Kotorska Bay Igalo beach	7	82	1,906	671.3	448	329	59
Open sea Kamenovo and Jaz beaches	7	193	3,533	842.9	412	329	59

Table 3.29. Comparative data of beach litter abundance (average N of items/100 m^2) in the Adriatic-Ionian region

Country	N of items/100 m^2 2014/2015 (average)	N of items/100 m^2 2017/2018 (average)	References
Albania	220	130	Vlachogianni *et al.*, 2017, Vlachogianni *et al.*, 2019
Croatia	2,920	3,350	Vlachogianni *et al.*, 2017, Mokos *et al.*, 2019
Italy	280	760	Vlachogianni *et al.*, 2017, Vlachogianni *et al.*, 2019
Greece	240	1,680	
Montenegro	370	600	
Slovenia	490	320	

Floating marine litter (CI23)

Since the data on floating macro-litter in Montenegro refer to only one year of seasonal surveys, comparative data for the Adriatic and Mediterranean Sea are also presented.

The first floating macro-litter survey was carried out in the area of Boka Kotorska Bay during October 2014, January 2015, April 2015, and July 2015. Those surveys were performed within the IPA EU DeFishGear project along three transects (Figure 3.24) using methodology developed under the project.

The average density of floating macro-litter during autumn 2014 was 75.06 items/km^2, during winter 2015 124.91 items/km^2, during spring 2015 it was 167.9 items/km^2 and during summer 2015 it was 156.43 items/km^2. **Average value of floating macro-litter abundance for all four seasons is 131.08 items/km^2.** The most abundant litter category was artificial polymer material (plastics) with a contribution of 81.99% over all investigated seasons.

Table 3.30. Assessment of floating marine litter in Montenegro

Area	N of surveys	Min	Max	N of items/100 m (average)	Baseline (not adopted)	Threshold (not adopted)
Boka Kotorska Bay	4	75.06	167.9	131.08	44–47	5

[2] Including cigarette butts.

Figure 3.23. Floating macro-litter

Figure 3.24. Three transects monitored for floating litter during the DeFishGear project

The semi-enclosed area of the Boka Kotorska Bay is isolated from the influence of open waters and litter items found are not expected to be related to major transportation mechanisms, fishery sector, or shipping. It is more likely that source of floating macro litter is consequence of shoreline, tourism, and recreational activities. In order to fully assess GES further monitoring is necessary (Table 3.35).

Available data on the amount of floating macro-litter in the Mediterranean (Table 3.31) indicate that the Adriatic Sea is one of the most polluted seas when it comes to marine macro-litter pollution.

Table 3.31. Comparative data of floating macro litter (average Number of items/km^2) in the Mediterranean

Country/area	Year	Minimum detectable size class	N of items/km^2 (average)	References
Western Mediterranean	2006 – 2015	> 1 cm	15 ± 23	Di-Méglio and Campana, 2017
Western Mediterranean	2013	2 – 10 cm	0 – 162	Suaria and Aliani, 2014
Adriatic Sea	2014 – 2015	2.5 – 5 cm	260 ± 596	Zeri *et al.*, 2018

Sea floor litter (CI23)

The data on sea floor litter in Montenegro presented here refer to the area of open waters of Montenegro and the area of Boka Kotorska Bay. Additionally, the available data for the Adriatic and Mediterranean Sea area are presented for comparative purposes.

Figure 3.25. Sea floor litter

Data on the amount, type, and spatial distribution of marine litter on the seabed for the open sea of the Montenegrin coast were collected during the monitoring of fishery resources (MEDITS research) on a total of ten transects during the three research years (2014, 2015, and 2016). The research was conducted by the research vessel “Pasquale e Cristina” at the same positions during the August each year using a specially designed bottom trawl net used by all other Mediterranean countries. In order to estimate the density of litter (expressed as the number of items/km^2 or kg/km^2), an analysis was performed using the “swept“ methodology. Marine litter was classified into six basic categories (plastic, rubber, textile, metal, glass / ceramics, other), while within each category a detailed classification was made in accordance with the MEDITS protocol (MEDITS-Handbook. Version no. 8, 2016).

A total of 454 items of marine litter was found, which was categorised in detail in accordance with the MEDITS protocol. Litter was found on all investigated transects. The total density of litter ranged from 10.8–1,407 items/m^2, with an **average value for all researched years of 290 items/km^2**.

Table 3.32. Assessment of sea floor marine litter in the open area of Montenegro

Sea floor	N of surveys	Min	Max	N of items/100 m (average)	Baseline (not adopted)	Threshold (not adopted)
Open sea area (10 transects)	3	10.8	1,407	290	51–61	4

In the context of weight, the most dominant category of litter belonged to plastic, with a percentage of 77.4%, 84.2%, and 69.05% for 2014, 2015, and 2016, respectively. The total weight of plastic litter ranged from 0.81–699 kg/km^2 (for 2014), 0.6–103.8 kg/km^2 (for 2015), and 1.41–498.8 kg/km^2 (for 2016).

The analysis of the mean values of the total litter by weight showed an average pollution of 89.64 kg/km^2, with the largest share belonging to the category of plastics (73.4%) and rubber (16.7%).

The largest amount of plastic, and at the same time total litter (“hot spots“) were found in the area between Petrovac and Sutomore and in the area between Bar and Ulcinj at depths between 50 and 65 meters. The category of rubber is present both in deeper parts up to 80 meters depth and in the bathymetric zone of 200–500 and more than 500 meters depth. The largest amount of rubber was found in the area between Petrovac and Bar in the zone up to 100 meters depth.

The available data on the amount of sea floor litter in the Mediterranean (Table 3.33) indicate that the Adriatic Sea is one of the most polluted seas when it comes to marine litter pollution.

Data on the amount, type, and spatial distribution of marine litter on the seabed were also processed for the area of the Bay. The monitoring was conducted as part of the research of fishery resources of the Institute of Marine Biology for the area of Kotor and Risan bays during June and July 2014. Namely, due to shallow waters in the Bay, trawling is not allowed, so this area could not form part of MEDITS survey. Although GES is usually assessed based on the data on the number of marine litter items found during trawling activities (MEDITS research), Decision IG. 22/7 indicates the possible use of data from other surveys, such as monitoring in marine reserves or programmes on biodiversity monitoring. For the area of Herceg Novi and Tivat bays, a rough expert assessment of the amount of litter was made, based on the analysis of data collected by trawling in the area of the entrance to Boka Kotorska Bay, combined with data from underwater clean-up actions and collection of abandoned fishing gears, and taking into account the amount of litter collected in Kotor–Risan Bay.

Unlike the MEDITS research, when monitoring the litter in Boka Kotorska Bay, only data on litter weight were taken, without monitoring the number of items of litter by the litter categories.

Table 3.33. Comparative data of sea floor litter abundance (average N of items/km^2) in the Mediterranean

Area	Average litter abundance	% plastics	Reference
South-eastern Adriatic	290 items/km^2, 89.64 kg/km^2	84.1%, 73.4%	This document
North and central Adriatic (western part)	85 kg/km^2	34%	Strafella *et al.*, 2015
North and central Adriatic (western part)	913 items/km^2, 82 kg/km^2	80%, 62%	Pasquini *et al.*, 2016
Sicilian channel	66 items/km^2	55%	Fiorentino *et al.*, 2015
Adriatic-Ionian	510 items/km^2, 65 kg/km^2	89.4%	Vlachogianni *et al.*, 2017
Sardinia (GSA[4] 11)	39 items/km^2	58%	Spedicato *et al.*, 2019
Lionski Zaliv (GSA[1]7)		99%	
Eastern Corsica (GSA[1] 8)	534 items/km^2	33%	
Cyprus (GSA[1] 25)	198 items/km^2	35%	
Aegean Sea (GSA[1] 19)	136 items/km^2	50%	
Northern and central Adriatic (eastern part) (GSA[1] 17)	112 items/km^2	45%	

In the context of weight, the most dominant litter category belongs to rubber, with a share of 38.38% for all transects. The total weight of rubber ranged from 402–723 kg/km^2. Of a total of five transects, no rubber was found on two. A slightly smaller share (36.29%) belongs to plastic litter, which was found on all research transects with a total weight in the range of 29–402 kg/km^2. It is followed by the category of metal with a percentage share of 24.27% and a weight in the range of 0.94–804 kg/ km^2. Metal was also found on all investigated transects.

The analysis of the mean values of sea floor litter in the context of weight, an average litter pollution in the area of the Bay was calculated to be 165.90 kg/km^2.

Significant amounts of litter were found on all transects, so it can be said that the entire research area is a hot spot in terms of marine litter pollution (Figure 3.26). However, the pollution of plastic and metal litter is greatest on the stretch from the Turski rt to Kostanjica and in the area of the Straits of Verige, where the dynamics of water masses is significant. The spatial distribution of rubber litter indicates the greatest pollution in the zone from Verige to the Bay of Kotor. The categories of glass and ceramics are more dominant in the narrow coastal part of the Boka Kotorska Bay.

It is important to note that during the trawling in the area of the Boka Kotorska Bay, only ”smaller“ items of litter were sampled, i.e., there is a significant amount of large litter items under the sea surface that cannot be sampled with trawl net. A significant amount of large litter was identified during the survey within the DeFishGear project in the Bay during October 2014 and September 2015.

The research of the amount, type, and spatial distribution of sea floor litter was also conducted using scuba diving on three transects in the area of Kotor and Tivat bays at the sites of Kostanjica, Strp, and Sveta Nedjelja. The research was conducted on a seasonal basis in the period from October 2014 to August 2015. At the locality of Strp, the depth of the transect ranged from 13–24 m, at Kostanjica from 15–21 m, and at Sveta Nedjelja from 9–22 m.

The methodology used in that research was developed in the framework of the DeFishGear project (Vlachogianni and Kalampokis, 2015) and was recommended as the most adequate for estimating the amount, type, and distribution of litter in shallow coastal zones (0–25 m depth) (Katsanevakis and Katsarou 2004).

The results of the research in the context of weight (kg/100 m^2) showed that the most dominant category is glass/ceramics with a total share of 43.26% for all researched seasons. It is followed by the metal category (21.49%) and the plastics category (19.25%).

[4] GSA – Geographical Sub-Area (Resolution GFCM/33/2009/2)

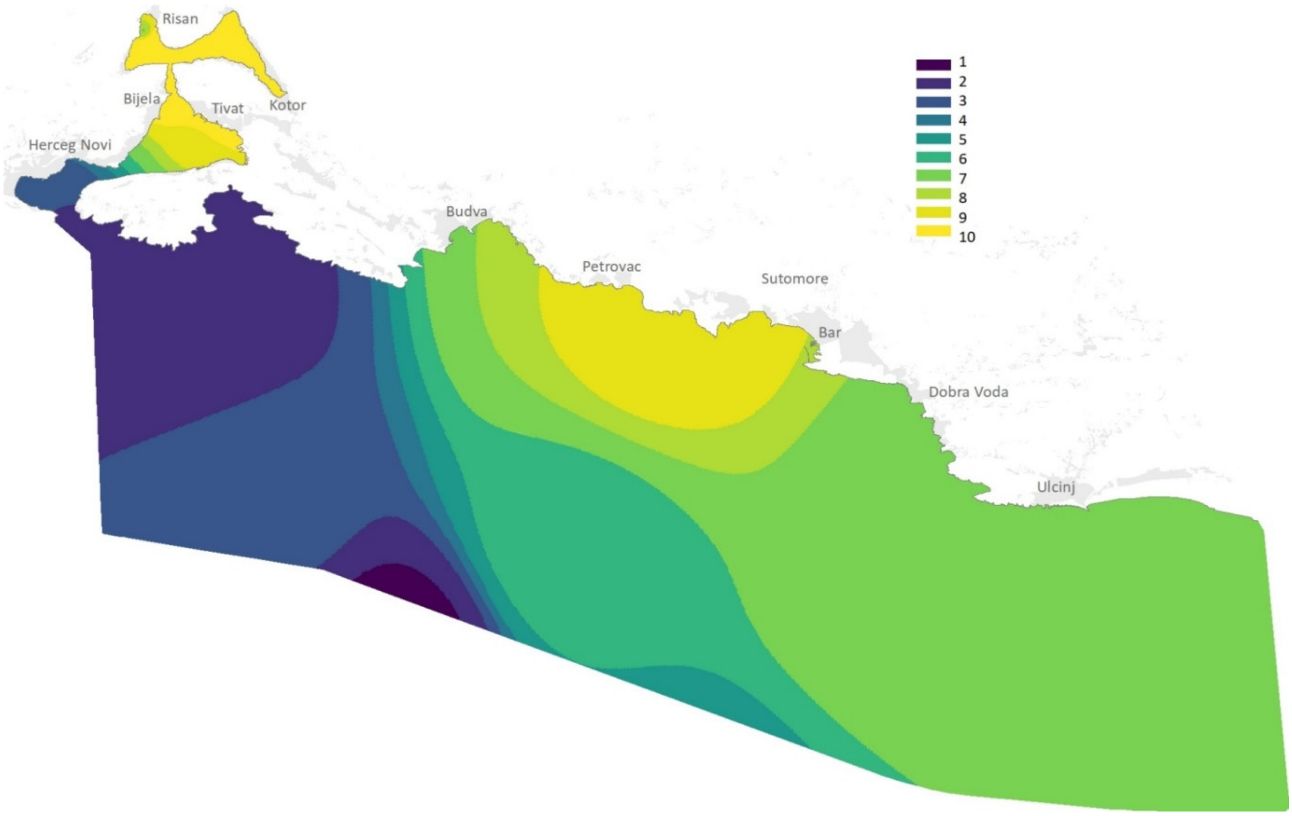


Figure 3.26. Spatial distribution of sea floor litter in Montenegro
(Key: 1 lowest pressures from sea bottom marine litter; 10 – highest pressures from sea bottom marine litter)
Source: State and Pressures of the Marine Environment of Montenegro (UNEP/MAP-PAP/RAC and MESPU, 2021; GEF Adriatic project)

When it comes to the number of items per 100 m^2, the dominant category of litter also belongs to glass/ceramics with a total percentage of 45.26% for all surveyed seasons. It is followed by plastics (30.51%) and metal (16.15%).

The largest number of litter items was found during the first sampling (October 2014) when the maximum number of items was collected (21 items/100 m^2), while the smallest number of items was found in August 2015 (3.9 items/100 m^2). The mean value for all surveyed seasons ranged from 0–6.47 items/100 m^2, with a total mean value of 1.35 items/100 m^2. During all research, the largest number of litter items was found at the Sveta Neđelja transect.

The results on sea floor litter in Montenegro indicate that the amount of marine litter in shallow coastal zones (such as Boka Kotorska Bay) is significantly higher than the amount recorded in open waters. The results in Montenegro are in line with the research undertaken in other areas of the Adriatic and the Mediterranean (Table 3.34).

Table 3.34. Comparative data of sea floor litter abundance (by visual surveys with scuba/snorkelling) in the Mediterranean

Area	Average litter abundance (items/100 m^2)	Average litter abundance (items/km^2)	Depth (m)	Reference
Montenegro – Boka Kotorska Bay (2014–2015)	1.35	13,500	0 – 20	This document
Montenegro (open sea and Boka Kotorska Bay)	0.25	2,500	0 – 40	Mačić *et al.*, 2017
Slovenia	0.68	6,800	2 – 17	UNEP, 2015
Greece	1.50	15,000	0 – 25	Katsanevakis and Katsarou, 2004
Central Mediterranean	0.11	1,100	5 – 30	Consoli *et al.*, 2019
Mediterranean Sea	43.55	43.500	< 30	Consoli *et al.*, 2020

Conclusions

Based on available data and adopted thresholds it can be concluded that GES for marine beach litter has not yet been achieved. However, more data are necessary for the full GES assessment.

Nevertheless, there are indications that pressures from marine litter are significant, both on sea floor and in the water column, similarly to other areas of the Adriatic and the Mediterranean Sea.

Based on the available data on marine litter in Montenegro, it can be confirmed with certainty that the coastal part is under the greatest pressure when it comes to marine litter pollution. In addition, the enclosed bay of Boka Kotorska is undoubtedly exposed to significant amounts of marine litter. Keeping in mind the relatively shallow depths of the area, but also the specificity of the bay in terms of relief, basin shape, relatively poor communication with the open sea, and the specifics of water mass dynamics, it can be concluded the origin of litter is from land, recreational activities, and poor municipal waste management. The same conclusion can be applied to the remaining coastal area in Montenegro.

Table 3.35. GEF assessment for marine litter in Montenegro

Criteria indicator	GES Definition	GES Assessment
Trends in the amount of litter washed ashore and/or deposited on coastlines (CI22)	Number/amount of marine litter items on the coastline does not have negative impacts on human health, marine life, and ecosystem services.	The existing data indicate that beach litter pollution is above the proposed baseline and threshold values (according to UNEP/MED WG.482/23), and for the amount of litter on the beaches, expressed as the number of items/100 m, the GES has not been achieved.
Trends in the amount of litter in the water column including microplastics and on the seafloor (CI23)	Number/amount of marine litter items in the water surface and the seafloor do not have negative impacts on human health, marine life, ecosystem services, and do not create risk to navigation.	The existing data indicate that the amount of floating litter in Montenegro (Boka Kotorska) is above the proposed threshold values. However due to the data scarcity on the basis of which regional baseline and threshold values could be agreed, the assessment of GES for floating litter is not possible at this stage. The existing data indicate that seabed litter amount in Montenegro (Boka Kotorska and the open sea) is above proposed threshold values. However due to the data scarcity on the basis of which regional baseline and threshold values could be proposed and agreed, the assessment of GES for seafloor litter is not possible at this stage.

3.1.g Eutrophication – EO5

Eutrophication is a process driven by enrichment of water by nutrients, especially compounds of nitrogen and/or phosphorus, leading to:

- increased growth, primary production, and biomass of algae;
- changes in the balance of organisms; and
- water quality degradation.

The consequences of eutrophication are undesirable if they degrade ecosystem health and/or the sustainable provision of goods and services. These changes may occur due to natural processes, but management concerns arise when they are attributed to anthropogenic sources. Although these shifts may not be harmful themselves, the main worries concern ‘undesirable disturbance’ – the potential effects of increased production, and related changes of the balance of organisms, on ecosystem’s structure, function, goods, and services.

GES criteria and definitions

In 2013, the initial GES definitions for Common Indicators within each IMAP Ecological Objective were defined and agreed at the Conference of the Parties (COP18) by Decision IG.21/3 [UNEP(DEPI)/MED IG.21/9 Annex II]. Since then, some of those definitions have been slightly updated and modified, namely in Decision IG 22/7 (COP19, 2016), IMAP Common Indicator guidance factsheets presented at the Meeting of the MED POL Focal Points in Rome in 2017 (UNEP(DEPI)/MED WG. 439/12).

The first step in this study was the establishment of water typology for Montenegro. The water typology is mainly focused on hydrological parameters, characterising water body dynamics and circulation, and is based on the introduction of the static stability parameter (derived from temperature and salinity values in the water column). Such a parameter, having a robust numerical basis, can describe the dynamic behaviour of a coastal system. Surface density is adopted as a proxy indicator for static stability as both temperature and salinity are relevant in the dynamic behaviour of a coastal marine system: both are involved in circulation and mixing and all information is then nested in the surface density parameter (Giovanardi *et al.*, 2006).

Based on surface density (σ_t) values three major water types with subdivisions have been defined:

- Type I: coastal sites highly influenced by freshwater input;
- Type IIA: coastal sites moderately influenced but not directly affected by freshwater input (Continent influence);
- Type IIIW: continental coast, coastal sites not influenced/affected by freshwater inputs (western basin);
- Type IIIE: not influenced by freshwater input (eastern basin);
- Type Island: coast (western basin).

Thus, it is recommended that to define the major coastal water types in the Mediterranean Sea research is needed to assess eutrophication (Table 3.36). This subdivision, based only on salinity, is comparable with the previous ones, based on density.

The major coastal water types and related criteria in the Mediterranean were defined following their calibration, applied for phytoplankton only, as provided in Decision IG.22/7 on IMAP (COP 19, 2016).

For Montenegro, as part of the Adriatic sub-region the relevant types are Type I, Type IIA Adriatic, and Type IIIW.

Table 3.36. Major coastal water types in the Mediterranean

	Type I	Type IIA Adriatic	Type IIIW	Type IIIE	Type Island-W
σ_t (density)	< 25	25 < d < 27	> 27	> 27	All range
S (salinity)	< 34.5	34.5 < S < 37.5	> 37.5	> 37.5	All range

GES thresholds and trends are recommended to be used in combination, according to data availability and agreement on GES threshold levels. In the framework of UNEP/MAP MED POL there is experience with regard to using quantitative thresholds. It is proposed that for the Mediterranean region, quantitative thresholds between "„good" (GES) and "moderate" (non-GES) conditions for coastal waters could be based as appropriate on the work carried out in the framework of the MEDGIG intercalibration process of the EU Water Framework Directive (WFD). It is recommended to rely on the classification scheme on chlorophyll *a* concentration (μg L^{-1}) in coastal waters as a parameter easily applicable and based on the indicative thresholds and reference values of chlorophyll *a* in Mediterranean coastal water types (according to 2013/480/EU), calling on reference conditions and boundaries of good/moderate status (G/M). The thresholds and reference values are presented in Tables 3.37 and 3.38. for Type I and Type IIA Adriatic (UNEP(DEPI)/MED WG. 463.Inf.13).

At the moment, integrative classification schemes based on CI13 key nutrients in the water column are under development. There are only the proposed values for the concentration of Total Phosphorous (TP) (Tables 3.37 and 3.38) and these are based on the preliminary documents accepted at the CORMON meeting in 2021 (UNEP(DEPI)/MED WG. 492.11).

Table 3.37. Reference conditions and boundaries of ecological quality classes for BQE phytoplankton expressed by different parameters for Type I coastal waters. The G/M boundary (orange) is also the accepted GES boundary.

Boundaries	TRIX	Chl-*a* annual *G_Mean* μg L^{-1}	TP annual *G_Mean* μmol L^{-1}
Reference Conditions	-	1.40	0.19
H/G	4.25	2.00	0.26
G/M	5.25	5.00	0.55
M/P	6.25	12.6	1.15
P/B	7.00	25.0	2.00

Table 3.38. Reference conditions and boundaries of ecological quality classes for BQE phytoplankton expressed by different parameters for Type IIA Adriatic coastal waters. The G/M boundary (orange) is also the accepted GES boundary.

Boundaries	TRIX	Chl-*a* annual *G_Mean* μg L^{-1}	TP annual *G_Mean* μmol L^{-1}
Reference Conditions	-	0.33	0.16
H/G	4	0.64	0.26
G/M	5	1.50	0.48
M/P	6	3.50	0.91
P/B	7	8.20	1.71

Table 3.39. Criteria and methodological standards for GES assessment for EO5 Eutrophication in Montenegro.
EO = Ecological objective, CI = common indicator

Criteria			**Methodological standards**	
Parameters	**Indicator with related GES definition (minimum requirements for achieving GES)**	**Indicator measurement and thresholds**	**Scale of assessment**	**Use of criteria**
CI13: Concentration of key nutrients in water column				
Concentration of Dissolved Inorganic Nitrogen (DIN) and ammonium Concentration of Total Phosphorous (TP) and orthophosphate N/P ratio	GES definition: Concentrations of nutrients in the euphotic layer are in line with prevailing physiographic, geographic and climate conditions.	What is measured: At the moment there are only proposed values for the concentration of Total Phosphorous (TP), which are based on the UNEP(DEPI)/MED WG. 492.11. Thresholds: Annual geometric mean of concentration of total phosphorus (TP) that separates the Good from Moderate state – for Type I – 0.55 µmol/L, for Type IIA – Adriatic – 0.48 µmol/L.	National level (12 stations in both Boka Kotorska Bay and the coastal sea throughout the Montenegrin coast)	GES assessment for the indicator concentration of nutrients in the water column is achieved if the average annual value (geometric mean) for individual nutrients is not higher than thresholds for total phosphorus (TP) (Good/Moderate threshold).
CI14: Chlorophyll-*a* concentration in water column				
Concentration of chlorophyll *a*	GES definition: Natural levels of algal biomass, water transparency and oxygen concentrations in line with prevailing physiographic, geographic, and weather conditions.	What is measured: Concentration of chlorophyll *a*. Thresholds: Annual geometric mean of concentration of total phosphorus (TP) that separates the Good from Moderate state – for Type I – 5.0 µg/L, Type IIA – Adriatic – 1.50 µg/L.	National level (12 stations in both Boka Kotorska Bay and the coastal sea throughout the Montenegrin coast)	GES assessment for the indicator concentration of chlorophyll *a* in the water column is achieved if the average annual value (geometric mean) is not higher than thresholds for chlorophyll *a* (Good/Moderate thresholds).

EO5 GES assessment

The data used for GES assessment were provided by IBM (2012–2016) and CETI (2017–2019).

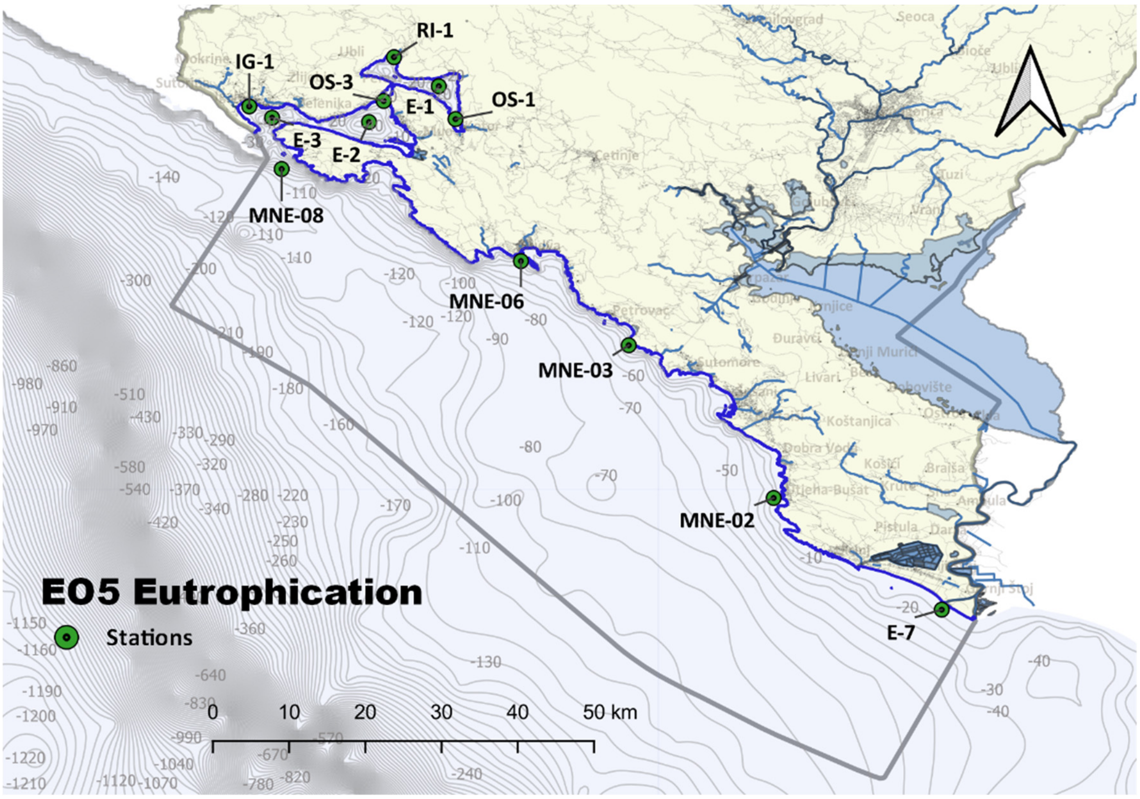


Figure 3.27. Station used for the baseline and GES assessment along the Montenegro coast in the 2012–2019 period

Table 3.40. Station code, station name, region, latitude, longitude, bottom depth, and water typology (C – Coastal, R – Reference) for the stations used for the baseline and GES assessment along the Montenegro coast in the period (2012–2019)

ID	Station	Station name	Region	Latitude	Longitude	Depth	Typology
1	E-1	Kotor		42.47515	18.74113	30	C
2	OS-1	Dobrota IBM		42.43638	18.76087	20	C
3	RI-1	Risan		42.50937	18.68835	23	C
4	OS-3	Sveta Neđelja	Boka Kotorska	42.45775	18.67618	30	C
5	E-2	Tivat		42.43293	18.65893	36	C
6	E-3	Herceg Novi		42.43805	18.54472	40	C
7	IG-1	Igalo		42.45132	18.51780	11	C
8	MNE-08	Mamula		42.37762	18.55597	75	R
9	MNE-06	Budva		42.26917	18.83793	29	C
10	MNE-03	Bar	Open waters	42.17005	18.96499	37	C
11	MNE-02	Ulcinj		41.99016	19.13572	14	C
12	E-7	Ada Bojana		41.85863	19.33378	13	C

Dissolved salts of inorganic nitrogen in natural waters occur in oxidised (nitrate, nitrite) and reduced forms (ammonium salts). Due to the relatively rapid oxidation and reduction processes of these compounds, their sum, i.e., **Dissolved Inorganic Nitrogen (DIN).** The concentration of DIN in the Boka Kotorska area ranged from 0.21–29.8 µmol L^{-1}. The highest value in the area was measured near Igalo (IG-1). The values do not show distinct patterns with a uniform distribution in the whole area. The highest average values were observed in front of Kotor (OS-1) 9.5 µmol L^{-1} in 2018. In general, the average values were between 2–6 µmol L^{-1}. No distinct interannual patterns were observed. The open waters values ranged from 0.21–22.12 µmol L^{-1}. The highest value in the area was measured near Ulcinj (MNE-02). The average values ranged from 1–6 µmol L^{-1} but higher average values were observed in 2016. At the station close to Bojana River mouth (E-7) the values were higher than along the other parts of the coast mainly due to fresh water input. No consistent interannual pattern was observed.

In Boka Kotorska the concentration of **Total Phosphorous (TP)** ranged from 0.02–1.70 µmol L^{-1}. The highest value was observed near Kotor (OS-1). The average annual values were ca. 0.3 µmol L^{-1} and never exceeded 0.4 µmol L^{-1}. The inter-annual variability was high with no clear pattern.

In the open waters the values ranged from 0.02–1.3 µmol L^{-1}. The highest value was observed near Bojana River mouth (E-7). The average annual values were in general lower than 0.26 µmol L^{-1} and never exceeded 0.4 µmol L^{-1}. The values were in general lower than in the Boka Kotorska area. The inter-annual variability was high with no clear pattern.

In Boka Kotorska the concentration of orthophosphate raged from 0.02–1.10 µmol L^{-1}. The highest value was observed near Herceg Novi (E-3). The average annual values were ca. 0.25 µmol L^{-1} and never exceeded 0.3 µmol L^{-1}. The inter-annual variability was high with no clear pattern.

In the open waters the values ranged from 0.02–0.9 µmol L^{-1}. The highest value was observed near Bar (MNE-03). The average annual values were in general lover than 0.2 µmol L^{-1} and never exceeded 0.26 µmol L^{-1}. The values were generally lower than in the Boka Kotorska area. The inter-annual variability was high with no clear pattern.

The calculation of the **N/P ratio** (DIN/PO_4^{3-}) is very important: the Redfield ratio or Redfield stoichiometry is the consistent atomic ratio of carbon, nitrogen, and phosphorus found in marine phytoplankton and throughout the deep oceans. Redfield empirically found the C : N : P ratio to be 106 : 16 : 1. The Redfield ratio has remained an important reference to oceanographers studying nutrient limitation and assist in determining which nutrients are limiting in a localised system if there is a limiting nutrient. The ratio can also be used to understand the formation of phytoplankton blooms and subsequent hypoxia. Controlling the N : P ratio could be a means for sustainable reservoir management.

The N/P ratio ranged from 1.3 to more than 100. Substantially higher values than 100 were observed but resulted as an artefact that always happens for values that were below detection limit. The data show that in most of the cases the values as annual averages were higher than 16 (Redfield ratio) indicating a limitation by phosphorous. Few values are below 16 and mainly appear in the open waters indicating that the processes are limited by nitrogen. This shifting between N or P limitation indicates that the input of phosphorous is very variable along the Montenegrin coast. Further investigation into the result is needed as data availability is relatively scarce.

Phytoplankton is one of the main biological elements utilised for water quality assessment due to its sensitivity to eutrophication processes as well as its rapid response to changes in the environment. The most common and simplest method for estimating phytoplankton biomass is to determine **the concentration of chlorophyll *a*** (the main photosynthetic pigment).

In Boka Kotorska the concentration of chlorophyll *a* range was < 0.1–11.40 µg L^{-1}. The highest value was observed Risan Bay (Ri-1). The average annual values (geometric mean – GM) in the inner part (E-1, OS-1, RI-1) were.04–1.39 µg L^{-1}. In the outer part of Boka the GM range was 0.35–1.71 µg L^{-1}. The inter-annual variability was high with no clear pattern.

In the open waters the values ranged from 0.10 to 4.60 µg L^{-1}. The highest value was observed near Bar (MNE-03). The average annual values (GM) not influenced by the Bojana River (MNE-08 – > MNE 02) ranged from 0.16 to 0.86 µg L^{-1}. At station E-7, under the direct influence of the Bojana

River the GM range was 0.33–0.69 µg L^{-1}. The inter annual variability was high with no clear pattern. In general, the highest concentrations of chlorophyll *a* were observed in the inner part of the Boka Kotorska which is under direct influence from substantial; but intermittent, springs (Mandić *et al.*, 2017).

The **GES assessment for EO5** was started with the water type definition for the Montenegrin monitoring stations. Because of the discontinuous data, the whole evaluation period (2012–2019) was used. The assessment showed that the dominant type along the Montenegrin coast is the type IIA Adriatic , i.e. salinity levels between 34.5 and 37.5 (stations MNE-03 – MNE-08) (Figure 3.28 and Table 3.39). The southernmost part of the coast is under the influence of Bojana River and is of Type I (salinity levels below 34.5). The Boka Kotorska area, due to specific geomorphological and hydrological characteristics, is an area heavily influenced by fresh water and belongs to Type I.

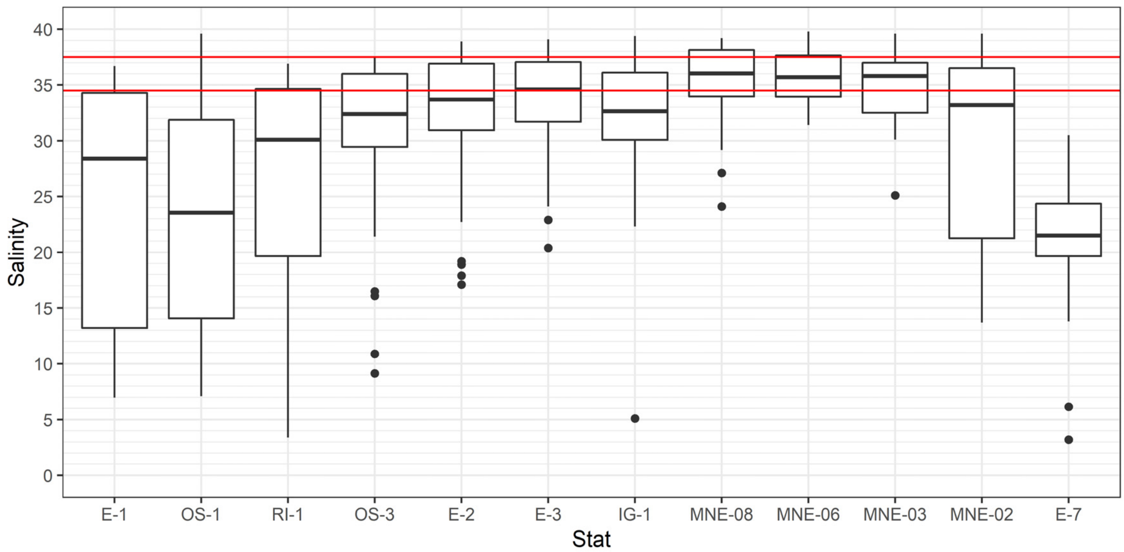


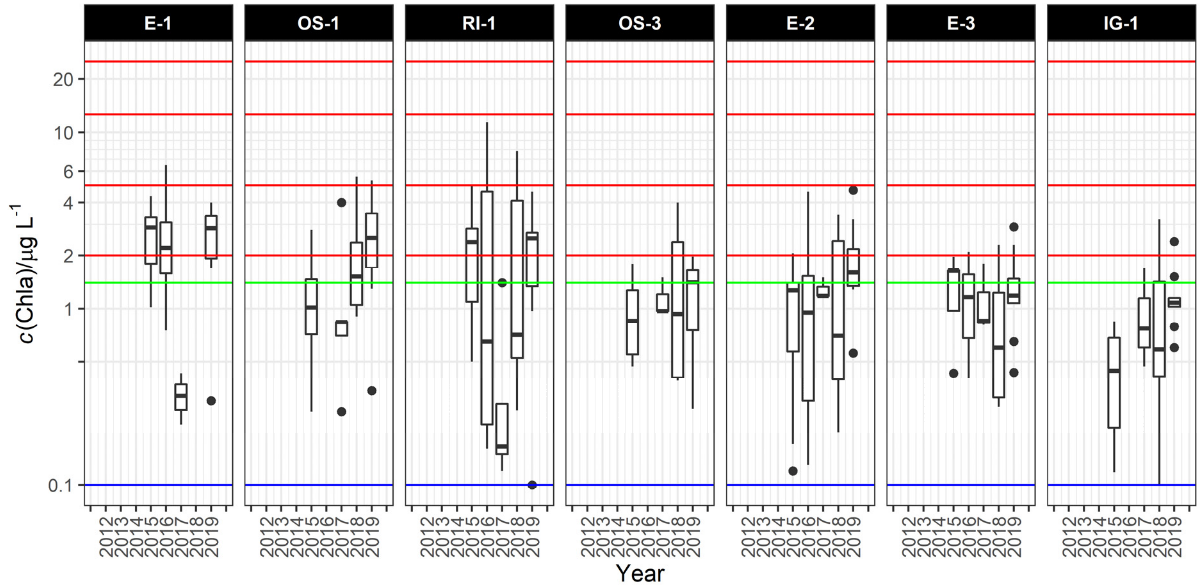
Figure 3.28. Boxplot of salinity by station in the surface layer (0–10 m) for the period 2012–2019. The mean value (bold line in each box) defines the type of water at each station. The red lines delimit the water type based on salinity levels (Type I < 34.5 – lower red line; Type IIA > 34.5 and < 37.5 – upper red line).

Table 3.41. Number of data (N), water type, and mean values of salinity by station in the surface layer (0–10 m) for the period 2012–2019

Station	Description	N	Mean salinity	Water type
E-1	Kotor	23	23.84	Type I
OS-1	Dobrota IBM	38	24.09	Type I
RI-1	Risan	37	25.74	Type I
OS-3	Sveta Neđelja	39	29.43	Type I
E-2	Tivat	37	32.08	Type I
E-3	Herceg Novi	35	33.50	Type I
IG-1	Igalo	43	32.82	Type I
MNE-08	Mamula	40	35.71	Type IIA Adriatic
MNE-06	Budva	50	36.58	Type IIA Adriatic
MNE-03	Bar	38	35.67	Type IIA Adriatic
MNE-02	Ulcinj	51	33.84	Type I
E-7	Ada Bojana	28	21.32	Type I

Applying the assessment criteria for GES as stated in Chapter 3 on Figures 3.29 and 3.30 are presented as annual boxplots for the concentration of chlorophyll *a* and total phosphorous for the areas of Boka Kotorska Bay and the open waters.

Type I



Open waters

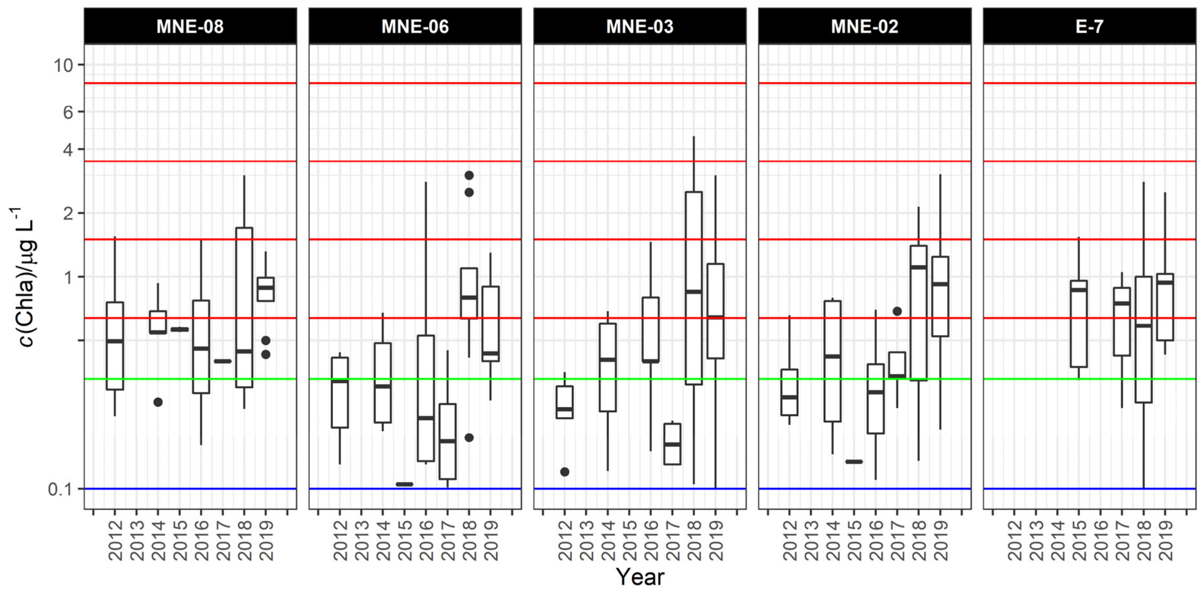
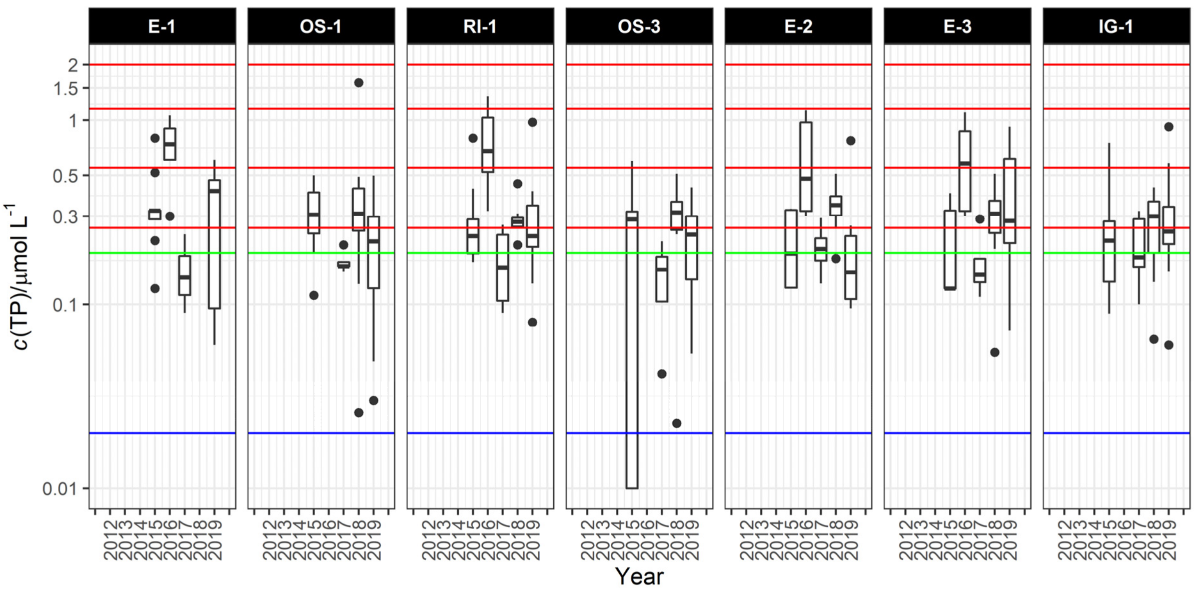


Figure 3.29. Boxplots of concentration (c) of chlorophyll *a* (Chla) by year in Boka Kotorska and open waters. The red lines represent the boundaries between classes progressively from bottom up (High/Good, Good/Moderate, Moderate/Poor, Poor/Bad). The green line represents the reference value. The blue line represents the detection limit of the method (0.1 ug L^{-1}).

Boka Kotorska



Open waters

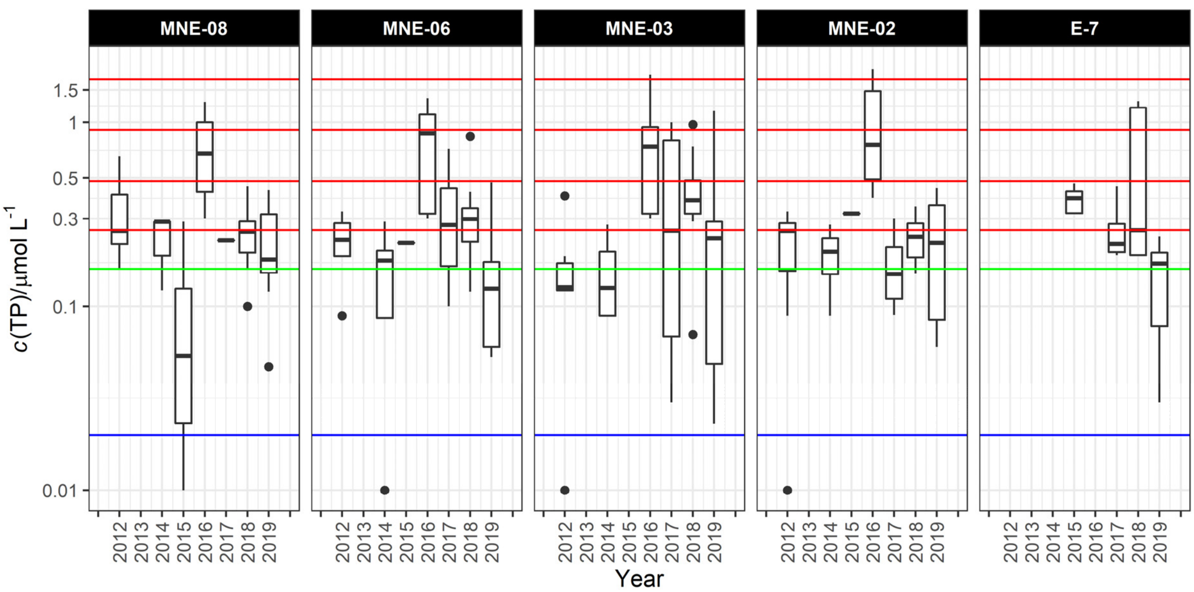


Figure 3.30. Boxplots of concentration (c) of Total phosphorus (TP) by year in Boka Kotorska and open waters. The red lines represent the boundaries between classes progressively from bottom up (High/Good, Good/Moderate, Moderate/Poor, Poor/Bad). The green line represents the reference value. The blue line represents the detection limit of the method (0.02 ug L^{-1}).

For both assessment parameters the mean values of the Boxplots (as the $\log_{10}$ scale is used) represent **the geometric mean of the annual aggregated data and for all stations they are always below the G/M boundary indicating that the GES is achieved for both eutrophication indicators for all Montenegrin coastal areas.** The difference exists between the Boka Kotorska area and the open waters where the first is mainly in mainly in good ecological status while the latter is in high ecological status.

Conclusion

Based on the data presented here, it can be concluded that for both assessment parameters (concertation of chlorophyll *a* and total phosphorus) the geometric mean of the annual aggregated data for all stations are always below the G/M boundary indicating that **the GES is achieved for the entire Montenegro coastal area**. The difference exists between the Boka Kotorska area and the open waters where the first is generally in a good ecological status while the latter is above the recommended levels.

The elaboration of data and assessment are fully compliant with the IMAP concept and demonstrate its applicability. The pressures and impact assessment demonstrated the low pressure footprint of Montenegro. Higher vulnerability to eutrophication of Boka Kotorska Bay, as a naturally enhanced system, deserve additional attention and a management strategy.

Table 3.42. GES assessment for EO5 Eutrophication in Montenegro

Criteria		
Indicator	**GES definition**	**GES Assessment**
Concentration of key nutrients in water column (CI13)	Concentrations of nutrients in the euphotic layer are in line with prevailing physiographic, geographic, and climate conditions.	Based on the existing data, the GES regarding CI13 is achieved for the entire Montenegrin coastal area.
Chlorophyll *a* concentration in water column (CI14)	Natural levels of algal biomass, water transparency, and oxygen concentrations are in line with prevailing physiographic, geographic, and weather conditions.	Based on the existing data, the GES regarding CI14 is achieved for the entire Montenegrin coastal area.

3.2 Interrelations between Ecological Objectives

The interrelations between ecological objectives and their common indicators are evident and they stress the need for an integrated approach to the overall GES assessment. Such need for an integrated approach was endorsed at the 7th meeting of the Ecosystem Approach Coordination Group of the UNEP/MAP in 2019 (UNEP MED WG. 467/7).

The results of the first attempt to assess GES in Montenegro, despite the lack of data and knowledge gaps, demonstrate certain interlinkages between EOs. However, it is not yet fully possible to estimate the degree to which certain EOs are interlinked.

For coastal benthic and partially pelagic habitats (EO1), it could be assumed that the strongest relations probably exist with EO5 (eutrophication), EO8 (physical loss of coastal ecosystems and landscapes), and E10 (marine litter). Eutrophication can cause severe impacts on habitats and the ecosystem as a whole through nutrient and organic matter enrichment. Furthermore, it is one of the principal causes of harmful algal blooms. The eutrophication-biodiversity relationship can be particularly relevant for semi-enclosed water bodies (e.g., Boka Kotorska Bay). In general, eutrophication can also be linked to fisheries decline that can occur indirectly by eutrophication-driven oxygen depletion. Food webs within the ecosystem will be altered by the higher inputs of nutrients. For link with marine litter, it could be anticipated to have certain impacts on marine mammals and marine turtles, through their entanglement in fishing gear, as well as suffocation through ingestion of plastics. In Montenegro, survey on benthic habitats in 2019 confirmed that important coralligenous communities in Boka Kotorska Bay are under significant pressure from marine litter. Microplastic is also problematic, entering the food-web and accumulating in shellfish and fish. However, such knowledge on marine litter-biodiversity links in Montenegro is not sufficient to draw firmer conclusions at present. Currently, there is not much evidence on the actual interrelationships between EO1 and EO2 (NIS) in Montenegro's sea either, although it is known that NIS may cause habitat degradation and destruction, the decline of certain species and the spread of diseases that may affect biodiversity.

Hydrographic characteristics (such as temperature, salinity, currents, waves, turbulence, etc.) play a crucial role in the dynamics of marine ecosystems and are therefore interlinked with all other EOs. Hydrographic changes can modify local conditions and negatively impact pelagic and benthic habitats (mainly through the altered sediment fluxes). Adriatic studies since 1970 show corelations between hydrographic changes with the composition of habitats, plankton, and fish species. Biological ecosystems will respond more or less synchronously in all its components to, e.g., long-term temperature increase, which has a significant impact on primary production and changes in the zooplankton community and the composition of community species, with an evident shift towards smaller cells or organism sizes, and a decline in demersal fish, major predators, and small pelagic fish. Furthermore, increased turbidity can affect primary production (due reduced inflow of sunlight) and consequently whole food webs. In addition, currents can favour redistribution of NIS (inflow from the southern/eastern Mediterranean), facilitate the spread of thermophilic species, and affect plankton communities that impacts demersal and pelagic fish species. Information on hydrographic conditions (such as temperature, salinity, and density) are particularly relevant for eutrophication assessment; these are also used for determination of the typology scheme for the Mediterranean coastal waters. Therefore, it is always advisable that the monitoring of these two EOs takes place at the same stations; full information on levels of such impacts in Montenegro is not available at the moment. Hydrography and bathymetry significantly affect the movement and accumulation of marine litter (EO10) and the formation of "hot spots". In marine areas where sea currents are strong, upwelling is present, and the bathymetry allows the accumulation and retention of litter; therefore, the impact on species and marine ecosystem may be most significant. In such parts, a larger accumulation of micro-particles is possible, which consequently causes a higher ingestion of litter by marine organisms. Contaminants can be redistributed or transported throughout the environment by hydrographic processes. Contaminants remain in the water and especially in the sediment, from which they can be re-suspended depending on the currents, waves, turbulence, etc.

The most relevant link of coastal ecosystems and landscapes (EO8) is with EO1 (Biodiversity) since coastal artificialisation affects primarily supra and medio littoral habitats and their typical species, as well as benthic habitats in near-shore shallow waters due to smothering by different materials used for construction. Such interaction in Montenegro could be relevant around larger coastal settlements and in almost the entirety of Boka Kotorska Bay, but more research is needed. Also, urbanised areas in the coastal zone are a source of nutrient enrichment in near-shore marine areas, in particular in the absence of the appropriate wastewater treatment (relevant for EO5). Different types of specific construction / near shore activities (such as shipyards) can lead to contamination (EO9), which could be relevant for some areas of Boka Kotorska (such as Tivat and Bijela) and around Bar municipality.

Pollution (EO9) may foremostly cause degradation and destruction of habitats. Toxicological effects of harmful chemicals and pathogens can affect the biodiversity, from individual specimens to entire communities (e.g., the "imposex" effect of TBT-organotin compounds). Chemical pollution and microbial pathogens can be linked to Eutrophication (EO5) via wastewater outflows. Recent research studies show that chemical plasticisers and other known persistent substances can leach from marine litter (both macro- and micro-litter items).

Contaminants can be transported/redistributed throughout the marine environment by hydrographic processes. They can remain in the water column and especially in the sediments, from which they can be re-suspended depending on the currents, waves, turbulence, and other environmental features. Furthermore, near-shore currents and the local hydrographic conditions can expand the pollution outbreaks in the marine environments both from diffuse and point sources. For coastal artificialisation (EO8), ports and port-related coastal construction are sources of marine contamination in Montenegro.

The impact of marine litter (EO10) on other EOs in Montenegro is only scarcely known, although marine litter is generally related to EO1, through the above-mentioned ingestion by and entanglements of marine species. In Montenegro, surveys on benthic habitats in Boka Kotorska confirmed that important coralligenous communities are under significant pressures from marine litter. For link between marine litter and EO2 (NIS), floating litter could be a favourable vector for the transmission of organisms to the most distant places, which means it can cause transportation of NIS to new locations (Rech *et al.,* 2016). There is a better insight on impacts on EO3 (Harvest of commercially harvested fish and shellfish): in Montenegro, 235 fish individuals were studied for macro-litter identification during 2015. Analysis of the gastro-intestinal tracts (guts) of the examined fish revealed that macro-litter was present in the guts 61 individuals, 25.9% of the total examined fish. Litter was found in five species (*Mullus barbatus*, *Sardina pilchardus*, *Solea solea*, *Trachurus trachurus,* and *Scomber japonicas*). All species examined had ingested litter in their guts; especially the pelagic and mesopelagic species *S. pilchardus*, *S. japonicu*s, and *T. trachurus* with quite high litter occurrence (50%, 43%, and 24%, respectively). The percentage of litter frequency of occurrence was 25.96%, with range between 4% and 50%, and with *S. pilchardus* showing the highest value (39% of total). The increased fish consumption with the constant increase of plastic production and the fact that fish constitute significant levels in food chains towards higher trophic levels also represent a concern for human health (Anastasopoulou *et al.*, 2018).

All these complex interactions (Figure 3.31) should be in a (constant) process of re-examination and discussion. A brief overview of interactions between Ecological Objectives and their indicators, grouped around clusters, is given in Annex 1.

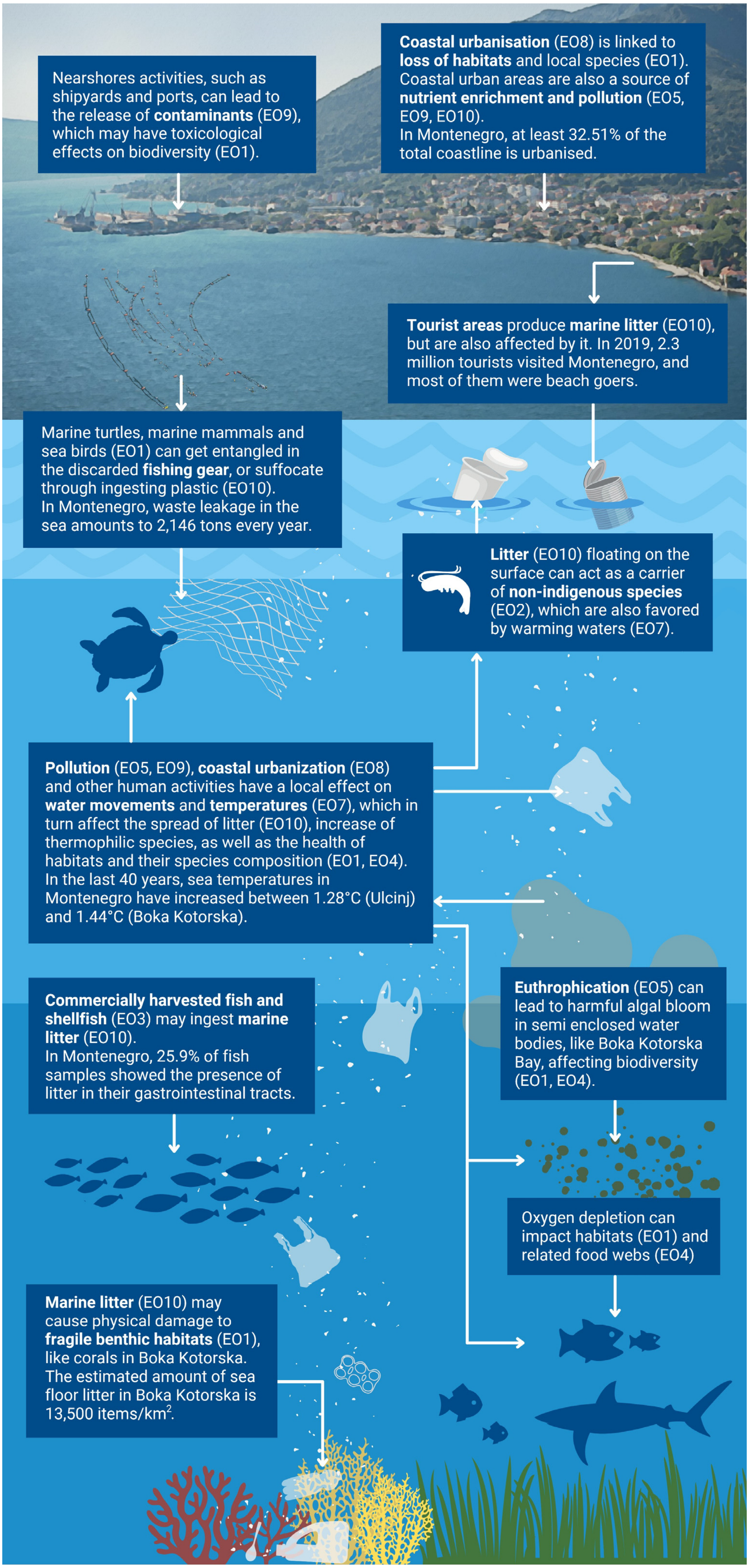


Figure 3.31. Interrelations between the marine environment and human activities in Montenegro

4 Integrated GES gaps and needs

This chapter explains challenges faced with carrying out the first GES assessment and needs that should be met to be able to enable future GES assessments.

4.1 Lack of legislative framework for GES assessment and some specific EOs related topics

It is important that GES assessment is an obligation stipulated in national legislation in order to provide strong support that all data are collected and processed regularly and punctually, with adequate human and financial capacities allocated to this effort. The relevant national legislation does not yet fully include provisions on GES assessment, although as a Contracting Party to the Barcelona Convention Montenegro is bound to carry out the GES assessment. The EU accession process is the main driver for making necessary amendments to national legislation. As an EU candidate country, Montenegro is currently in the process of harmonisation of its national legislation with the EU *acqui*, where full transposition of MSFD has been finalised.

Some specific legislation covering EOs topics need to be amended. Namely, analysis of the national legislation in Montenegro showed that the only instrument that prohibits the dumping of solid waste directly into the sea and on coasts is the Law on Prevention of Marine Pollution from Vessels (Official Gazette of Montenegro No. 20/11, 26/11, 27/14). Therefore, it is necessary to amend relevant legislation in Montenegro in order to reduce the amount of marine litter that reaches the sea and coastal areas, to protect the environment of the sea and preserve the natural values of the area.

More specifically, the term "marine litter" as a specific category of waste should be included in the Law on Waste Management (OG of Montenegro, No. 64/11 and No 39/16), as well as in the Law on Marine Fisheries and Mariculture (OG of Montenegro, No. 56/09, 47/15) and prohibit any disposal in the sea (notably used fishing gear). Adoption of a specific by-law (rulebook) under the Law on Waste Management could more closely define the conditions and measures for the implementation of marine litter management policies.

4.2 Lack or limitation of knowledge

The first attempt to assess GES in Montenegro showed a certain **lack and limitations of data and knowledge**, which enabled only partial GES assessment. The lack of knowledge is a multi-folded issue and requires addressing legislative and institutional gaps, human and financial capacities at national level, as well as improvement of transboundary cooperation at the Adriatic Sea level, particularly for data gathering and exchange, as well as identification of thresholds. These aspects are elaborated further in sections 4.3–4.6.

The assessment of state of biodiversity (EO1) particularly showed that:

- Open-sea area is the least researched for all biodiversity components, notably benthic habitat types and seabirds;
- There are no long-time data series for the majority of biodiversity components;
- There are no data on species population demographic characteristics, particularly for cetaceans and marine turtles.

Data on NIS (EO2) are also limited, particularly on trends, which is a result of the lack of systematic monitoring.

Similarly, there is scarcity of hydrological (EO7) parametric data resulting in the overall insufficient knowledge of hydrographic processes that are specific for the waters of Montenegro and their impacts on the ecosystem. In addition, there is a lack of knowledge on:

- The combined effects of thermohaline properties and pH trends on the conditions of Montenegrin waters;
- Long-term effect of acidification on the complete food web;
- Impact and resilience of the marine ecosystem to changes in river regimes due to anthropogenic and natural changes;
- Changes in seawater circulation regimes and consequences of dispersion from sewage discharges.

In order to fully assess impacts of contaminants (EO9) the following information are lacking:

- Toxicological effects (CI18), together with the appropriate laboratory methods to comply with IMAP Assessment Criteria;
- Contamination of wild seafood species (e.g., fish), beyond the national shellfish programme need to be collected through monitoring of wild species. Note that the mentioned programme currently consists of four stations in the Boka Kotorska Bay area and therefore it is not representative of the whole marine environment;
- Data on ballast water in order to assess different pressures linked with shipping.

Regarding the marine litter (EO10) there is a lack of data series, in particular for the floating and sea bed marine litter so the trends cannot be determined, and hence the determination of GES is limited.

4.3 Limited monitoring implementation

Nature and Environmental Protection Agency (NEPA Montenegro), as the main institution responsible for environmental monitoring in Montenegro, prepares the annual national environmental monitoring programme, which is further adopted by the Government of Montenegro. As part of the GEF Adriatic project an Integrated Monitoring Programme (IMP) based on UNEP/MAP IMAP, was developed and submitted for adoption. It is recommended that the annual monitoring for all EOs is undertaken based on developed IMP.

Overall, this would ensure that monitoring is being planned and implemented more systematically and adjusted to the requirements of the GES assessment. Furthermore, it is also important to ensure adequate data storage and availability through national information systems linked to the IMAP INFO System, also developed through the GEF Adriatic project.

4.4 Limited institutional, human, and financial capacities

The current institutional and human capacities in terms of the existing expert knowledge, experience, and overall expertise were sufficient for carrying out the first Montenegrin GES assessment. However, there is a limited number of experts in certain fields, which may be a challenge for future assessments. In particular the lack of experts in physical oceanography should be emphasised, as it forms a basis for comprehensive assessment of hydrographic conditions.

Having in mind an anticipated increase of monitoring intensity related to requirements of GES assessment, the situations with limited capacities should be addressed. Furthermore, monitoring requires adequate and stable funding. The existing monitoring is financed mostly through the state budget, and sporadically through the projects implemented with support from international funds, such as GEF or EU pre-accession funds. However, the available funding is limited, particularly if some rather costly research is considered, such as that of cetaceans through aerial survey, etc.

Hence, it is recommended that, linked to the adoption and effective implementation of IMAP/MSFD-related legislation, a comprehensive analysis of institutional, human, and financial capacities is made and that actual needs are identified. This endeavour would facilitate future GES assessments.

4.5 Transboundary cooperation

There is already a certain transboundary cooperation at the Adriatic level, but it needs to be further improved. Good examples, like the joint Adriatic level projects on conservation of cetaceans and marine turtles, should also be implemented for other transboundary-featured biodiversity components, as well as NIS. Transboundary cooperation is particularly important for fisheries (EO3), marine litter (EO10), and noise (EO11). Such collaboration is particularly imperative in identifying certain thresholds at sub-regional level (more details in section 5.5).

Cooperation should be extended not only to other Adriatic countries, but also to other countries with similar biodiversity issues and which have extensive knowledge on these issues. Joint meetings to improve national capacities, share data, and discuss thresholds among countries should be organised on regular basis, at least at the Adriatic level.

4.6 General methodological issues

There were several general methodological considerations necessary while preparing the GES document:

1. For a number of EOs, indicators and assessment criteria were fully missing EO 3, 4, 6, 11); where appropriate, these were partially substituted with latest MSFD GES assessment criteria.
2. Threshold values were not set for all the common indicators. For this assessment, GES was estimated mainly for those indicators where threshold values or approaches are regionally adopted .
3. Assessment of GES for EO8 was particularly challenging. However, due to the fact that similar assessment was done during CAMP project in Montenegro (2015) when ICZM Strategy was developed and indicator values for monitoring coastal urbanisation were set, orientation GES values were proposed.
4. At the regional level, there is still no agreed approach for integrated GES assessment. This document is the first attempt in that direction. However, it can easily be adapted and improved based on new criteria and guidelines.

Regarding the overall GES assessment, information technologies could be used to facilitate future GES assessments once all necessary data will be available, and increase the visibility to all relevant authorities and institutions through appropriate web tools. Hence, for the next GES assessments, such options should be explored.

5 GES targets and recommended measures

This chapter attempts to identify preliminary targets and recommended measures for achievement of GES, based on results of GES assessment elaborated in Chapter 3, and taking into account gaps and needs from Chapter 4.

The identified GES targets are mostly focused on ensuring sufficient levels of knowledge to be able to fully assess GES in the future. In addition, even if the GES for certain assessed parameters is achieved, a set of targets and general measures is proposed to address the identified threats to maintaining the GES.

It should be stressed that in order to be able to implement all measures, it is important to fulfil several structural pre-conditions, as already indicated in Chapter 4, particularly focusing on:

- ensuring adequate legislative framework for GES assessment;
- improving institutional capacities;
- ensuring long-term financial capacities.

In particular it is of paramount importance to fully implement the IMAP-based Integrated monitoring programme for Montenegro (further in text referred as IMP), in a way that all measured elements are collected in a systematic and standardised way. Furthermore, acquired information should be adequately managed, shared, and made available using information technology and web tools, primarily national database linked to regional databases and platforms, as developed within the GEF Adriatic project.

Table 5.1. Preliminary GES targets and recommended measures to achieve them in Montenegro, based on results of the first GES assessment of EO1 Biodiversity[5]

Indicator	GES definition	GES assessment	Preliminary GES target(s)	Recommendation(s)
HABITATS				
Benthic habitat extent (CI1)	The habitat is present in all its natural range.	GES of photophilic algal communities and coastal coralligenous assemblages has been mostly achieved in terms of presence in their natural range, despite intensive new infrastructure constructions in the coastal area. There is still a lack of data to assess the state of *Posidonia* meadows and open sea coralligenous assemblages.	The knowledge on abundance, distribution, and anthropogenic impacts on all selected benthic habitat types (*Posidonia* meadows, coralligenous assemblages and photophilic algae) is sufficient to enable full GES assessment.	▪ Continue monitoring of photophilic algal communities and coastal coralligenous assemblages, with necessary adjustments to be in line with Integrated Monitoring Programme for Montenegro (NIMP). ▪ Carry out inventory and monitoring of *Posidonia* meadows extent and open sea coralligenous assemblages, in line with IMP. ▪ Use and update national IMAP-related database linked with IMAP Info System.
			Anthropogenic pressures that threaten GES of benthic habitats are adequately mitigated, particularly new infrastructure construction in coastal areas, mostly related to tourism and urbanisation.	▪ Implement relevant measures as part of the National ICZM Strategy.
Benthic habitat condition (CI2)	The population size and density of the habitat-defining species and species composition of the community are within reference conditions ensuring the long-term maintenance of the habitat.	GES of photophilic algal communities and coastal coralligenous assemblages has been mostly achieved, which means their composition is normal in most cases, despite coastal destruction and water pollution. There are indications that the density of *Posidonia* meadows is also adequate, but full GES assessment requires more research. The state of open sea coralligenous assemblages is still unknown.	The knowledge on selected benthic habitat types condition and state of typical habitat species (*Cystoseira* spp, *P. oceanica, Savalia savaglia*, and possibly *Corallium rubrum*) is sufficient to enable full GES assessment.	▪ Continue monitoring of conditions of photophilic algal communities and coastal coralligenous assemblages, with necessary adjustments to be in line with NIMP. The emphasis should be also made on research of presence of *Corallium rubrum*, as a typical GED indicator species in the Adriatic. ▪ Carry out inventory and monitoring of composition and density of *Posidonia* meadows and open sea coralligenous assemblages, in line with NIMP. ▪ Use and update national IMAP-related database linked with IMAP Info System.

[5] For cetaceans and marine turtles specifically, measures are identified taking into account the Strategies on conservation of cetaceans and sea turtles on the Adriatic for the 2016–2025 period, developed in the scope of the EU IPA Adriatic NETCET project.

Indicator	GES definition	GES assessment	Preliminary GES target(s)	Recommendation(s)
			Anthropogenic pressures that threaten GES of benthic habitats are adequately mitigated, particularly new infrastructure construction and water pollution in coastal areas, mostly related to tourism and urbanisation.	▪ Implement relevant measures as part of the National ICZM Strategy.
Pelagic habitat condition (CI2)	The population size and density of the habitat-defining species and species composition of the communities are within reference conditions ensuring the long-term maintenance of the habitat.	The current data indicate that pelagic habitat condition is in line with GES requirements. However, for full GES assessment, long-term data series are needed.	The knowledge on condition of phytoplankton and zooplankton is sufficient to enable full GES assessment.	▪ Continue monitoring of plankton in line with IMP.
			Anthropogenic pressures that threaten GES of benthic habitats extent are adequately mitigated, particularly eutrophication in Boka Kotorska Bay, mostly related to tourism and urbanisation.	▪ Implement relevant measures as part of the National ICZM Strategy.
SPECIES				
Cetacean distribution range (CI3)	The species are present in all their natural distributional range.	There is no long-term data series to allow measurement of species distributional range and patterns, so it is not possible to assess GES. Even if the data gathered in two closely implemented aerial surveys do not indicate any decline, it is too early to conclude that species distributional range meets the GES.	The bottlenose and striped dolphin distributional range trend is known, based on regular monitoring at the Adriatic and national levels.	▪ Continue with monitoring of distribution range at the Adriatic level through aerial surveys and other methods, in cooperation with Adriatic countries, in line with IMP. ▪ Establish monitoring of distribution of local populations, in line with IMP. ▪ Use and update national IMAP-related database linked with IMAP Info System.
Cetacean population abundance (CI4)	The species populations have abundance levels allowing it to qualify for Least Concern Category of IUCN or has abundance levels that are improving and moving away from the more critical IUCN category.	There is no long-term data series to allow measurement of population abundance trends, so it is not possible to assess GES. Even if the data gathered in two closely implemented aerial surveys do not indicate any decline, it is too early to assume whether this means that anthropogenic pressures have not significantly impacted the population abundance.	The population abundance trends are known, based on regular monitoring at the Adriatic and national levels.	▪ Continue with monitoring of population abundance at the Adriatic level through aerial surveys and other methods, in cooperation with Adriatic countries, in line with NIMP. ▪ Establish monitoring of abundance of local populations, in line with IMP. ▪ Use and update national IMAP – related database linked with IMAP Info System. ▪ Assess the regional IUCN Red List status of bottlenose dolphin and regularly review it.

Indicator	GES definition	GES assessment	Preliminary GES target(s)	Recommendation(s)
Cetacean population demographic characteristics (CI5)	Species populations are in good condition: low human induced mortality, balanced sex ratio, and no decline in calf production.	Not possible to assess GES due to lack of data on human mortality, sex ratio and calf production.	The knowledge on human-induced mortality (by-catch) of cetaceans is sufficient to enable GES assessment.	▪ Establish a functional national stranding network, as elaborated in IMP. ▪ Assess by-catch rates, in line with IMP. ▪ Use and update national IMAP-related database linked with IMAP Info System.
			Anthropogenic pressures that cause mortality of bottlenose and striped dolphins are recognised and addressed through mitigation measures.	▪ Once the data on mortality are being monitored, further analyse the causes of mortality and propose concrete mitigation measures.
			The knowledge on sex ratio and calf production of bottlenose and striped dolphins is sufficient to enable GES assessment.	▪ Identify population structure, in line with IMP, as well as which population to conserve.
Marine turtle distributional range (CI3)	The species continues to occur in all its natural range in the Mediterranean, including nesting, mating, feeding, and wintering and developmental (where different to those of adults) sites.	There is no long-term data series to allow measurement of species distributional range and patterns, so it is not possible to assess GES. Even if the data gathered in two closely implemented aerial surveys do not indicate any decline, it is too early to conclude that species distributional range meets the GES.	The loggerhead turtle distributional range trend is known, based on regular monitoring at the Adriatic level. The distribution of potential and recorded nesting sites is known.	▪ Continue with monitoring of distribution range at the Adriatic level through aerial surveys and other methods, in cooperation with Adriatic countries, in line with IMP. ▪ Establish national level monitoring of potential and already recorded nesting sites, in line with IMP. ▪ Use and update national IMAP-related database linked with IMAP Info System.
Marine turtle population abundance (CI4)	Population size allows to achieve and maintain a favourable conservation status, taking into account all life stages of the population.	There is no long-time data series to allow measurement of population abundance trends, so it is not possible to assess GES. Even if the data gathered in two closely implemented aerial surveys do not indicate any decline, it is too early to assume whether this means that anthropogenic pressures have not significantly impacted the population abundance.	The population abundance trend of loggerhead turtle is known, based on regular monitoring.	▪ Continue with monitoring of population abundance at the Adriatic level through aerial surveys and other methods, in cooperation with Adriatic countries, in line with IMP. ▪ Establish monitoring of abundance of local populations, in line with IMP. ▪ Use and update national IMAP-related database linked with IMAP Info System. ▪ Assess the regional IUCN Red List status of loggerhead turtle and regularly review it.

Indicator	GES definition	GES assessment	Preliminary GES target(s)	Recommendation(s)
Marine turtle population demographic characteristics (CI5)	Low mortality induced by incidental catch, favourable sex ratio, and no decline in hatching rate.	Not possible to assess GES due to lack of data on human induced mortality, sex ratio, and balanced sex ratio.	The knowledge on human induced mortality (by-catch) of loggerhead turtle is sufficient to enable GES assessment.	▪ Establish functional national stranding network, in line with IMP (could be joint with the cetaceans stranding network). ▪ Use and update national IMAP-related database linked with IMAP Info System.
			Anthropogenic pressures that cause mortality of loggerhead turtle are recognised and addressed through mitigation measures.	▪ Once the monitoring of mortality rate is established, analyse the causes of mortality and propose concrete mitigation measures.
			The knowledge on sex ratio of loggerhead turtle is sufficient to enable GES assessment.	▪ Linked to monitoring of potential and already recorded nesting sites, monitor breeding and survival success.
Seabirds distributional range (CI3)	The distribution of seabird species continues to occur in all their Mediterranean natural habitats and biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic, and climatic conditions.	For breeding bird species, GES regarding distributional range is mostly achieved, but poor water management of Ulcinj Salina already threatens bird populations. Occurrence of true seabird species (as wintering species) is known, but there is not enough research to be able to assess GES.	The species distributional range trend of selected bird species is known and sufficient to enable full GES assessment.	▪ Continue with monitoring of distributional range of breeding bird species, with necessary adjustments to be in line with IMP. ▪ Establish monitoring of distribution of true seabird species, in line with IMP. ▪ Use and update national IMAP-related database linked with IMAP Info System.
			Management of Nature Park and Ramsar site Ulcinj Salina is improved and as such, this area supports long-term conservation of birds.	▪ Restore salt production and implement good water management.
Seabirds population abundance (CI4)	Population size of selected species (of seabirds) is maintained. The species population has abundance levels allowing to qualify to Least Concern Category of IUCN (less than 30% variation over a time period. equivalent to three generations).	For the moment, GES is achieved for majority of breeding species. The situation with *Ph. roseus* and the *status quo* with Ulcinj Salina management are main reasons for concern. GES could not be assessed for true seabirds (wintering), due to lack of data.	The population abundance trends of selected bird species are known and sufficient to enable full GES assessment.	▪ Continue monitoring of population abundance of breeding bird species with necessary adjustments to be in line with IMP. ▪ Establish monitoring of abundance of true seabirds, in line with IMP. ▪ Use and update national IMAP – related database linked with IMAP Info System. ▪ Assess the regional IUCN Red List status of selected seabirds and regularly review it.

Indicator	GES definition	GES assessment	Preliminary GES target(s)	Recommendation(s)
			Management of Nature Park and Ramsar site Ulcinj Salina is improved and as such, this area supports long-term conservation of birds.	▪ Restore salt production and implement good water management.
Seabirds population demographic characteristics (CI5)	Species populations are in good conditions: Natural levels of breeding success and acceptable levels of survival of young and adult birds.	GES regarding breeding bird population demographic characteristics is mostly achieved, although there is a threat for long-term maintenance of birds due to poor water management in Ulcinj Salina. There are indications that GES is achieved for true seabirds, but more data are needed for full GES assessment.	The knowledge of human-induced mortality (by-catch) of selected bird species is sufficient to enable GES assessment.	▪ Establish functional national stranding network (could be joint with the cetaceans/marine turtles stranding network). ▪ Use and update national IMAP-related database linked with IMAP Info System.
			The knowledge on breeding success and young birds' survival rate is sufficient to enable GES assessment.	▪ Continue monitoring of breeding colony species, with necessary adjustments to be in line with IMP.
			Management of Nature Park and Ramsar site Ulcinj Salina is improved and as such, this area supports long-term conservation of birds.	▪ Restore salt production and implement good water management.

Table 5.2. Preliminary GES targets and recommendations to achieve them in Montenegro, based on results of the first GES assessment of EO2 Non-indigenous species (NIS)

Indicator	GES definition	GES characteristics	Preliminary GES target(s)	Recommendation(s)
Trends in the abundance of introduced species, notably in risk areas (CI6)	Decreasing abundance of introduced NIS in risk areas.	Not possible to assess GES due to lack of data on newly introduced NIS and population trends, particularly invasive NIS. In addition, there are no thresholds set at the Adriatic Sea level.	The knowledge on newly-introduced non-indigenous species and their abundance is sufficient to enable measurement of introduction trends (in six years intervals).	▪ Assess presence of selected potential invasive alien species, in line with NIMP. ▪ Assess abundance and spatial distribution of selected IAS, in line with NIMP. ▪ Establish early-warning systems for NIS, particularly IAS. ▪ Establish standardised NIS information management, exchange and sharing.
			Adriatic level thresholds are identified to enable GES assessment.	▪ Engage in active cooperation with other Adriatic countries to set the Adriatic level thresholds for NIS.

Table 5.3. Preliminary GES targets and recommendations to achieve them in Montenegro, based on results of the first GES assessment for E07 Hydrography

Indicator	GES definition	GES characteristics	Preliminary GES target(s)	Recommendation(s)
Location and extent of the habitats impacted directly by hydrographic alterations (CI15)	Negative impacts due to new structures are minimal with no influence on the larger scale coastal and marine system.	Not possible to assess GES. However, observations at the local level indicate that there could be changes in hydrographic conditions, mainly near the coast and in particular in Boka Kotorska Bay.	Planning of new structures must take into account all possible mitigation measures in order to minimize the impact on coastal and marine ecosystems and its services integrity and cultural/historic assets.	▪ Implement yearly monitoring of key hydrographic data, as defined by Integrated Monitoring Programme. ▪ Create and continuously update the GIS database on all relevant hydrography-related parameters (temperature, salinity, currents, wind-waves statistics). Particular attention should be given to Boka Kotorska Bay. ▪ During any physical intervention, for which the permanent changes in hydrographic properties (more than ten years) are expected, the spread (in km^2) of the negative impact should be estimated using adequate hydrodynamic models for particular case. In addition, particular attention should be given on benthic habitats in vicinity of planned constructions. ▪ Wastewater discharges must be positioned in a such way that the stratification (summer thermocline) prevents the upwelling of contaminants/pollutants to the surface. ▪ An Environmental Impact Assessment (EIA), including measurements of thermohaline conditions, currents and hydrodynamic modelling should be performed for all planned waste water discharges. After construction, control monitoring should be carried out for each wastewater discharge.

Table 5.4. Preliminary GES targets and recommendations to achieve them in Montenegro, based on results of the first GES assessment for EO8 Coastal ecosystems and landscapes

Indicator	GES definition	GES characteristics	Preliminary GES target(s)	Recommendation(s)
Length of coastline subject to physical disturbance due to the influence of human-made structures (CI16)	Physical disturbance to coastal areas induced by human activities should be minimised.	2020 assessment of built-up coastline identified 32.7% of coastline being built upon. This indicates that GES is not being achieved. However, the assessment methodology for baseline and 2020 assessment was not identical to the previous one, and this could be the reasons for the observed change.	Urban sprawl in coastal areas minimised.	▪ Systemically monitor and assess the state and processes in the coastal zone, also using the spatial indicators identified in the National ICZM Strategy (2015). ▪ Use and further upgrade GIS for monitoring coastal and marine development, prepared as part of the GEF Adriatic project (and the CAMP project before). ▪ Implement specific measures identified in the National ICZM Strategy (2015) for limiting spatial development in the narrow coastal zone.

Table 5.5. Preliminary GES targets and recommendations to achieve them in Montenegro, based on results of the first GES assessment for EO9 Pollution

Indicator	GES definition	GES characteristics	Preliminary GES target(s)	Recommendation(s)
Concentration of key harmful contaminants measured in the relevant matrix (related to biota, sediment, seawater) (CI17)	Level of pollution is below a determined threshold defined for the area and species.	GES has been assessed in biota and sediment matrices as recommended by UNEP/MAP-IMAP and for the majority of harmful chemical compounds, namely heavy metals, organo-chlorinates, and hydrocarbons. Known "hot spots" have been reassessed. No trends can be assessed yet.	▪ Concentrations of specific contaminants below either Background Assessment Criteria or Environmental Assessment Criteria (BACs/EACs) or below reference concentrations (from other sources). ▪ No deterioration trends in contaminant concentrations in sediment and biota from human impacted areas statistically defined. ▪ Reduction of contaminants emissions from land-based sources.	▪ Further monitoring should continue to elucidate both concentrations and trends according the Integrated National Programme of Montenegro. ▪ Socio-economic measures should lead towards the reduction of contaminant emissions from land-based sources (and potentially from new sea-based economic activities).

Indicator	GES definition	GES characteristics	Preliminary GES target(s)	Recommendation(s)
Level of pollution effects of key contaminants where a cause and effect relationship has been established (CI18)	Concentrations of contaminants are not giving rise to acute pollution events.	GES for this common indicator has not been formally assessed due to lacking timely representative national datasets.	▪ Contaminants effects below thresholds. Levels of biomarkers identified comply with agreed Mediterranean Background Assessment Criteria or Environmental Assessment Criteria (BACs/EACs).	▪ To increase CI18 national monitoring activities will allow the assessment of the toxicological effects in biota (and habitats, e.g., sediments) at a national scale. ▪ Latest research developments in terms of toxicological tools should be considered as this scientific field advances rapidly. Therefore, improved and cost-efficient alternative toxicological tools should be considered.
Occurrence origin (where possible) and extent of acute pollution events (e.g., slicks from oil products and hazardous substances) and their impact on biota affected by this pollution (CI19)	Occurrence of acute pollution events is reduced to the minimum.	GES is achieved under IMAP reporting characteristics.	▪ Decreasing trend in the occurrences of acute pollution events (achieve the elimination of intentional pollution of the marine environment by oil and other Harmful and noxious substances (HNS) and the minimisation of accidental discharge of such substances).	▪ The national agencies in charge of oil spillages and maritime incidents should continue their efforts in collecting statistical data with regards to IMAP. ▪ To include future related parameters related to other descriptors, such as EO2 (invasive species), could be added in the framework of other regional and international policies, and therefore linked to IMAP EOs.
Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood (CI20)	Concentrations of contaminants are within the regulatory limits for consumption by humans. No regulatory levels of contaminants in seafood are exceeded.	GES has not been evaluated and there are no datasets.	▪ Concentrations of contaminants are within the regulatory limits set by legislation. ▪ Decreasing trend in the frequency of cases of seafood samples above regulatory limits for contaminants.	▪ Consider sampling alternatives to measure indicators due to the fact that the fisheries and aquaculture sectors in Montenegro do not represent a high economic asset, and therefore, the monitoring programmes are difficult to implement at present (with the exception of national food health programmes).

Indicator	GES definition	GES characteristics	Preliminary GES target(s)	Recommendation(s)
Percentage of intestinal enterococci concentration measurements within established standards (CI21)	Concentrations of intestinal enterococci are within established standards.	GES is achieved according to national statements with a national monitoring programme in place.	▪ Increasing trend in the measurements within established standards (levels of intestinal enterococci comply with established national or international standards, such as EU 2006/7 Directive).	▪ The datasets for this indicator (CI21) should be reported according IMAP (and EU MSFD) methodologies for regional and European harmonisation, as well as to benefit from further comparability and developments in this field.

Table 5.6. Preliminary GES objectives and recommendations to achieve them in Montenegro, based on results of the first GES assessment for EO10 Marine litter

Indicator	GES definition	GES characteristics	Preliminary GES target(s)	Recommendation(s)
Trends in the amount of litter washed ashore and/or deposited on coastlines (CI 22)	Number/amount of the marine litter items on the coastline does not have negative impacts on human health, marine life, and ecosystem services.	GES is not achieved.	Decreasing trend in the number of/amount of marine litter (items) deposited on the coast of at least 20%.	▪ Involve different stakeholder groups in the activities of beach cleaning and record keeping of types and quantities of marine litter on the beaches. ▪ Ensure appropriate waste disposal measures on the beaches. ▪ Organise activities addressing change of people's behaviour in terms of reducing marine litter.
Trends in the amount of litter in the water column, including microplastics, and on the seafloor (CI23)	Number/amount of the marine litter items in the water surface and the seafloor do not have negative impacts on human health, marine life, and ecosystem services and do not create risk to navigation.	GES cannot be assessed as there are not yet regionally agreed thresholds.	Decreasing trend in the number of/amount of marine litter (items) in the water column and on the seafloor.	▪ Prevent inflow and/or reduce the quantity of marine litter inflow via rivers and main torrent flows into the sea, in particular for Bojana and Sutorina rivers. ▪ Implement programmes on regular removal and safe disposal of accumulations/hotspots of marine litter. ▪ Development of scientific research projects to test microplastics in the water and its impact on the marine ecosystem. ▪ Organise activities addressing change of people's behaviour in terms of reducing marine litter.

Table 5.7. Preliminary GES targets and recommendations to achieve them in Montenegro, based on results of the first GES assessment for EO5 Eutrophication

Indicator	GES definition	GES characteristics	Preliminary GES target(s)	Recommendation(s)
Concentration of key nutrients in the water column (CI13)	Concentrations of nutrients in the euphotic layer are in line with prevailing physiographic, geographic and climate conditions.	GES is achieved.	▪ Reference nutrient concentrations according to the local hydrological, chemical, and morphological characteristics of the un-impacted marine region. ▪ Decreasing trend of nutrient concentrations in water column of human impacted areas, statistically defined. ▪ Reduction of BOD emissions from land-based sources. ▪ Reduction of nutrient emissions from land-based sources.	▪ Establish a coordinated system for monitoring the state of coastal and marine ecosystems and processes: ▪ coordinated implementation of the prepared national monitoring programme in accordance with IMAP and other national monitoring programmes implemented in the Adriatic waters under the sovereignty of Montenegro; and ▪ establish a trans-national (Adriatic) programme for monitoring the state of the marine environment. This would rationalise costs and manage the maritime area as efficiently as possible. This especially refers to the implementation of monitoring programmes in waters outside the external borders of the territorial sea of Montenegro. ▪ Additional care has to be given to monitor the use of mineral fertilisers as their use could rise in future due to intensive agriculture. Assessments on consumption of N-based and P-based fertilizers are needed, to enable interpretation of pressures from agricultural activities near the sea. ▪ Disproportionate and partially treated waste water disposal, specifically in the area of Boka Kotorska, an area naturally more sensitive to the problems of eutrophication, implementing the higher sampling frequency needed during monitoring. At the moment, the data used for that problem were insufficient.
Chlorophyll *a* concentration in the water column (CI14)	Natural levels of algal biomass, water transparency and oxygen concentrations in line with prevailing physiographic, geographic, and weather conditions.	GES is achieved.	▪ Chlorophyll *a* concentration in high-risk areas below thresholds. ▪ Decreasing trend in chlorophyll *a* concentration in high-risk areas affected by human activities.	

6 Conclusions

The first attempt to assess GES in Montenegro based on the criteria and methodologies developed under IMAP, implementing an integrated approach focused on EO1-Biodiversity, EO2-NIS, EO5-Eutrophication, EO7-Hydrography, EO8-Coastal ecosystems and landscapes, EO9-Pollution, and EO10-Marine Litter as far as possible. The main lesson learnt is that, at the moment, GES assessment could only be done partially, mainly due to the limitation or lack of data, including gaps in certain baseline information and long-term data series. Still, some **preliminary and indicative** conclusions could be made, namely, viewing the assessed components (those assessed partially under EO1, EO5, EO9, and E10), it appears that GES for most of them is achieved, except for some elements of EO9 and EO10. Interrelations between EOs and their Common indicators are indicative, as more precise conclusions require a better knowledge base.

In order to fully implement the IMAP of Montenegro in the future and be able to fully assess and achieve GES, it is important to improve legislative framework and the knowledge base, supported by human, institutional, and financial capacities. Finally, it is necessary to have a good and continuous transboundary cooperation with other Adriatic countries both in understanding and achieving GES.

The results of GES assessment are presented in Table 6.1, using the following colour scheme:

GES achieved (for the existing information)

GES not achieved

Not possible to assess

Table 6.1. Final table

EO	Indicator	Assessment		
EO1 – Benthic habitats		*Posidonia meadows*	*Photophilic algae*	*Coralligenous assemblages*
	Benthic habitat extent			
	Benthic habitat condition			
EO1 – Pelagic habitat condition		*Phytoplankton*	*Zooplankton*	
	The population size and density of the habitat-defining species and species composition of the community are within reference conditions ensuring the long-term maintenance of the habitat.			
EO1 – Species Marine mammals		*Tursiops truncatus*	*Stenella coerueloalba*	
	Species distributional range			
	Population abundance			
	Population demographic characteristics			
EO1 – Species Marine turtles		*Caretta caretta*		
	Species distributional range			
	Population abundance			
	Population demographic characteristics			
EO1 – Species Sea birds		*True seabirds*	*Breeding species*	
	Species distributional range			
	Population abundance			
	Population demographic characteristics			
EO2 – NIS	Trends in the abundance of introduced species, notably in risk areas			
EO5 – Eutrophication	Concentration of key nutrients			
	Chlorophyll *a*			
EO7 – Hydrography	Location and extent of the habitats impacted directly by hydrographical alterations			
EO8 – Coastal ecosystems and landscapes	Length of coastline subject to physical disturbance due to the influence of human-made structures			
EO9 – Contaminants	Concentration of key harmful contaminants measured in the relevant matrix			
	Level of pollution effects of key contaminants where a cause and effect relationship has been established			
	Occurrence, origin (where possible), and extent of acute pollution events (e.g., slicks from oil, oil products, and hazardous substances) and their impact on biota affected by this pollution			
	Actual levels of contaminants that have been detected and number of contaminants which have exceeded maximum regulatory levels in commonly consumed seafood			
	Percentage of Intestinal enterococci concentrations within established standards			
EO10 – Marine Litter	Trends in the amount of litter washed ashore and/or deposited on coastlines			
	Trends in the amount of litter in the water column including microplastics and on the seafloor			

7 Literature

Introduction

Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive)

Energy Charter Secretariat (2018). In-Depth Review of the Energy Efficiency Policy of Montenegro

UNEP/MAP-PAP/RAC i MORT (2020). Plava ekonomija u Crnoj Gori. Autorica: Marina Marković. Ur: PAP/RAC – GEF Adriatik projekat. 67 pp

UNEP(DEPI)/MED IG.20/8. Decision IG. 20/4. Implementing MAP ecosystem approach roadmap: Mediterranean Ecological and Operational Objectives, Indicators and Timetable for implementing the ecosystem approach roadmap

UNEP(DEPI)/MED IG.21/9. Decision IG. 21/3. on the Ecosystems Approach including adopting definitions of Good Environmental Status (GES) and targets

UNEP(DEPI)/MED IG.22/28. Decision 22/7. Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria

UNEP(DEPI)/MED IG.23/23. Decision IG. 23/6. 2017 Mediterranean Quality Status Report

MSDT and UNEP/MAP-PAP/RAC (2015). National strategy on integrated coastal zone management of the coastal zone of Montenegro

Biodiversity and NIS (EO1 and EO2)

Agencija za zaštitu prirode i životne sredine. 2019. Predlog programa monitoringa životne sredine Crne Gore za 2019. godinu (In Montenegrin language only). http://www. gov.me

BirdLife International. 2018. *Pelecanus crispus* (amended version of 2017 assessment). The IUCN Red List of Threatened Species 2018: e.T22697599A122838534. https://dx.doi.org/10.2305/IUCN.UK.2017-3.RLTS.T22697599A122838534.en. Downloaded on 04 July 2020.

BirdLife International. 2018. *Puffinus yelkouan*. The IUCN Red List of Threatened Species 2018: e.T22698230A132637221. https://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T22698230A132637221.en. Downloaded on 04 July 2020.

BirdLife International. 2015. *Numenius tenuirostris*. The IUCN Red List of Threatened Species 2015: e.T22693185A60033376. Downloaded on 04 July 2020.

BirdLife International. 2015. *Ceryle rudis*. The IUCN Red List of Threatened Species 2015: e.T22683645A59985727. Downloaded on 04 July 2020.

Brettum, P. & Andersen, T. 2005. The Use of Phytoplankton as Indicators of Water Quality (NIVA Rep. SNO 4818-2004), 33 pp.

Burić, Z., Cetinić, I., Viličić, D., Mihalić, C.K., Carić, M. & Olujić, G. 2007. Spatial and temporal distribution in a highly stratified estuary (Zrmanja, Adriatic Sea). Marine Ecology 28: 169-177. http://doi.org/ 10.1111/j.1439-0485.2007.00180.x.

Caroppo, C., Fiocca, A., Sammarco, P., Magazzu, G. 1999. Seasonal variations of nutrients and phytoplankton in the coastal SW Adriatic Sea (1995–1997). Bot. Mar. 42: 389–400.

Cavallo M., Torras X., Mascaró O., Ballesteros E. 2016. Effect of temporal and spatial variability on the classification of the Ecological Quality Status using the CARLIT Index. Mar. Pollut. Bull. 102(1): 122-127.

Commission Decision (EU) 2017/848 of 17 May 2017 laying down criteria and methodological standards on good environmental status of marine waters and specifications and standardised methods for monitoring and assessment, and repealing Decision 2010/477/EU

Cushing, D.H. 1989. A difference in structure between ecosystems in strongly stratified waters and in those that are only weakly stratified. J. Plankton Res. 11(1): 1–13.

Energy Charter Secretariat. 2018. Energy Charter Protocol on Energy Efficiency and Related Environmental Aspects, PEEREA, In-Depth Review of the Energy Efficiency Policy of Montenegro. 222 p.

EMODNET, The European Marine Observation and Data Network, Central Portal, https://www.emodnet.eu/

European Commission study. 2011. Exploring the potential of maritime spatial planning in the Mediterranean, Montenegro – Country report.

FAO. 2019. Country profile for Montenegro for fisheries: http://www.fao.org/fishery/countrysector/naso_montenegro/en

Fortuna, C.M., Holcer, D., Mackelworth, P. (eds.) 2015. Conservation of cetaceans and Sea turtles in the Adriatic Sea – status of species and potential conservation measures. 136 p. Report produced under WP 7 of the NETCET project, IPA Adriatic Cross-border Cooperation Programme.

Kitsiou, D., Karydis, M. 2001. Marine eutrophication: a proposed data analysis procedure for assessing spatial trends. Environ. Monit. Assess. 68: 297-312.

Kitsiou, D., Karydis, M. 2002. Multi- dimensional evaluation and ranking of coastal areas using GIS and multiple-criteria choice methods. Sci. Total Environ. 284: 1-17.

Mačić, V. 2001. Taxonomical, morphology-anatomical and physiological analysis of seagrasses *Posidonia oceanica* (L.) Del. and *Cymodocea nodosa* (Ucria) Asch. in the Bay of Boka Kotorska, in purpose of protection. MA degree of Environmental Engineering TEMPUS, University of Novi Sad, 97 pp. (in Serbian).

Maglio, A., Pavan, G., Castellote, M., Frey, S. 2016. Overview of the noise spots in the ACCOBAMS area – Part I, Mediterranean Sea. An ACCOBAMS report, Monaco, 44 pp.

Ministry of Agriculture and Rural development. 2015. Fisheries strategy of Montenegro 2015-2020 with an Action plan (for transposition, implementation and enforcement of EU acquis).

Ministry of Sustainable Development and Tourism of Montenegro. 2015. National Biodiversity Strategy of Montenegro with Action Plan 2016-2020.

Ministry of Sustainable Development and Tourism of Montenegro in partnership with UNEP/MAP, PAP/RAC. 2015. National strategy on integrated coastal zone management for Montenegro – CAMP Montenegro.

Perković, M, Harsch, R., Ferraro, G. 2016. Oil spills in the Adriatic Sea. In: Carpenter A., Kostianoy A. (eds.) Oil Pollution in the Mediterranean Sea: Part II. The Handbook of Environmental Chemistry, vol 84. Springer, Cham.

Pestorić, B., Drakulović, D., Hure, M., Gangai Zovko, B., Onofri. I., Lučić, P., Lučić, D. 2017. Zooplankton Community in the Boka Kotorska Bay In: A. Joksimovic´ *et al.* (eds.), The Boka Kotorska Bay Environment. Hdb. Env. Chem., DOI 10.1007/698_2016_35, Springer International Publishing Switzerland, 231-270.

Petović, S., Marković, O., Đurović, M. 2019. Inventory of Non-indigenous and Cryptogenic Marine Benthic Species of the South-East Adriatic Sea, Montenegro. Acta zoologica bulgarica 71(1): 47-52

Pucher-Petković, T., Marasović, I. (1980). Développement des populations phytoplanctoniques caractéristiques pour un milieu eutrophisé (Baie de Kaštela). Acta Adriatica 21: 79–93.

Revelante, N. 1985. A catalogue of phytoplankton reported for the Rovinj area of the northern Adriatic. Thalassia Jugoslavica 21: 139–169.

Rubinić, B.,Sackl, P., Gramatikov, M. 2019. Conserving of wild birds in Montenegro. The first inventory of potential Special protection Areas in Montenegro. AAM Consulting, Budapest, xiii + 328 pp.

Sackl, P., Bordjan, D, Basle, T., Božič, L., Smole, J., Denac, D., Stumberger, B. (ed.) 2017. Spring migration of ducks in the Bojana Buna Delta – a comparison of migration volumes and conventional count information for a key wetland site within the Adriatic Flyway. Euronatur Foundation. Radolfzell, 312 pp.

Saveljić, D. 2005. Status of Marine and Coastal Birds in Montenegro, 78-80 p. UNEP-MAP-RAC/SPA Proceedings of the First Symposium on the Mediterranean Action Plan on the conservation of marine and coastal birds (Vilanova i la Geltrú, Spain, 17-19 November 2005). RAC/SPA pub. Tunis.

Saveljić, D., Vizi, O., Dubak, N. (ed.) 2006. Birds of Montenegro and Their Important Habitats. Center for the Protection and Research of Birds of Montenegro, 48 pages

Saveljić, D., Dubak, N, Vizi, A., Jovićević, M. (ed.). 2007. Important Bird Areas in Montenegro. Center for Protection and Research of Birds of Montenegro. Monography CZIP No. 1. Podgorica, 50 pp.

Sackl, P., Schneider–Jacoby, M., Štumberger, B. 2014. Planbeobachtungen des sichtbaren Vogelzuges vor dem Bojana-Buna-Delta (Montenegro/Albanien) an der sudostilchen Adria im Marz 2010. Der Ornithologische Beobachter / Band 111 / Heft 3. 186-232 pp.

Saveljić, D. 2015. Status of marine and coastal birds of Montenegro: species listed under Annex II of the Barcelona Convention Protocol on specially protected areas and biological diversity in the Mediterranean. Conservation of marine and coastal birds in the Mediterranean. Proceedings of the UNEP-MAP-RAC/SPA Symposium, Hammamet, Tunisia, 20–22 February 2015, . 88-91 pp.

Sovnic *et. al.* 2017. Protection Study for Ulcinj Salina.

Svensen, C., Viličić, D., Wassmann, P., Arashkevich, E., Ratkovac, T. (2007): Plankton distribution and vertical flux of biogenic matter during high summer stratification in the Krka estuary (Eastern Adriatic). Est. Coast. Shelf Sci. 71: 381-390.

Štrbenac, A. (ed.) 2015. Strategy on the conservation of cetaceans in the Adriatic Sea for the period 2016 – 2025. Document produced under the NETCET project, IPA Adriatic Cross-border Cooperation Programme, 28 pp.

Štrbenac, A. (ed.) 2015. Strategy on the conservation of sea turtles in the Adriatic Sea for the period 2016 – 2025. Document produced under the NETCET project, IPA Adriatic Cross-border Cooperation Programme, 25 pp.

Toming, K. & Jaanus A. 2007. Selecting potential summer phytoplankton eutrophication indicator species for the northern Baltic Sea. Estonian Journal of Ecology 56(4): 297-311.

UNEP/MAP-PAP/RAC-SPA/RAC and MSDT (2019). Investigation of hard bottom habitats with special attention given to Anthozoa and their taxonomy in Boka Kotorska Bay, Montenegro. By: Egidio Trainito. Ed: PAP/RAC – GEF Adriatic project. 67pp

UNEP/MAP. 2019. Cross-Cutting Issues and Common Challenges: The Methodological Approach for Mapping the Interrelations between Sectors, Activities, Pressures, Impacts and State of Marine Environment for EO5 and EO9. Document prepared for the 7th meeting of the Ecosystem Approach Coordination Group of the UNEP/MAP in Athens.

UNEP/MAP. 2017. IMAP Common Indicator Guidance Facts Sheets (Biodiversity and Fisheries).

UNEP/MAP. 2016. Integrated Monitoring and Assessment Programme (IMAP) of the Mediterranean Sea and Coast and Related Assessment Criteria, Athens, Greece.

UNEP/MAP. 2017. 2017 Mediterranean Quality Status Report (2017 MED QSR).

UNEP/MAP. 2017. Review of proposed IMAP Common Indicator Guidance Facts Sheets (Biodiversity and Fisheries) IMAP Common Indicator Guidance Facts Sheets (Biodiversity and Fisheries). 6th Meeting of the Ecosystem Approach Coordination Group, Athens, Greece, 11 September 2017. UNEP(DEPI)/MED WG.444/6/Rev.1, 126 pp.

UNEP/MAP. 2012. State of the Mediterranean Marine and Coastal Environment. UNEP/MAP – Barcelona Convention. Athens, 92 pp.

UNEP/MAP-PAP/RAC. 2020. ”GEF Adriatic” Project, Blue economy in Montenegro, draft report, April 2020.

UNEP, RAC-SPA and Mediterranean Action Plan: Protocol concerning specially protected areas and biological diversity in the Mediterranean. Annex II. List of endangered or threatened species.

UNEP-MAP-RAC/SPA. 2015a. Adriatic Sea: Important areas for conservation of cetaceans, sea turtles and giant devil rays. By Holcer, D; Fortuna, C.M and Mackelworth, P.C. Edited by Cebrian, D. & Requena, S., RAC/SPA, Tunis, 69 pp.

UNEP-MAP-RAC/SPA. 2015b. Adriatic Sea: Status and conservation of Seabirds. By Carboneras, C. Edited by Cebrian, D. & Requena, S., RAC/SPA, Tunis, 17 pp.

UNEP/MAP – RAC/SPA. 2013. Fishery activities assessment in Montenegro: case study of five selected parts of Montenegrin coast. Document prepared by Mirko Djurović and Olivera Marković under the MedMPAnet Project, Tunis, 39p.

UNEP-MAP-RAC/SPA. 2010. Report presenting a georeferenced compilation on bird important areas in the Mediterranean open seas. By Requena, S. and Carboneras, C. Ed. RAC/SPA, Tunis, 39 pp.

UNEP/MAP-PAP/RAC-SPA/RAC and MESPU (2021). Integrated Monitoring Programme – Montenegro. By: Milena Bataković, Olivier Brivois, Daniel Cebrian, Luka Čalić, Željka Čurović, Dragana Drakulović, Mirko Đurović, Ivan Guala, Carlos Guitart, Draško Holcer, Zdravko Ikica, Aleksandra Ivanović, Christos Ioakemidis, Aleksandar Joksimović, Darinka Joksimović, Radovan Kandić, Yakup Kaska, Jelena Knežević, Nada Krstulović, Vesna Mačić, Milica Mandić, Marina Marković, Ivana Mitrović, Branka Pestorić, Slavica Petović, Robert Precali, Darko Saveljić, Ivana Stojanović, Ivan Sekovski, Danijela Šuković, Anis Zarrouk, Marco Zenatello, Argyro Zenetos, Vladimir Živković. Eds: PAP/RAC, GEF Adriatic project. pp130 + Annexes

UNEP/MED WG.482/25. Comparative Analysis undertaken with regard to IMAP and the European Commission GES Decision 2017/848/EU for Biodiversity. Report adopted at the CORMON meeting, December 2020.

UNEP/MED WG.482/Inf.13. Methodological Approaches for mapping interrelations between Pressures-Impacts and the Status of Marine Ecosystem Components for Biodiversity Cluster. Report presented as information document at the CORMON meeting, December 2020.

Vasilijević, M., Pokrajac, S., Erg, B. (eds.). 2017. State of Nature Conservation Systems in South-Eastern Europe. Gland, Switzerland and Belgrade, Serbia: IUCN Regional Office for Eastern Europe and Central Asia (ECARO) – IUCN SONC report

Viličić, D., Leder, N., Gržetić, Z., Jasprica, N.1995. Microphytoplankton in the Strait of Otranto (eastern Mediterranean) Marine Biology 123: 619–630.

Viličić, D., Terzić, S., Ahel, M., Burić, Z., Jasprica, N., Carić, M., … Olujić, G. 2008. Phytoplankton abundance and pigment biomarkers in the oligo-trophic eastern Adriatic estuary. Environmental Monitoring and Assessment 142: 199-218. http://doi.org. 10.1007/s10661-007-9920-y.

Vulnerability Assessment of the Narrow Coastal Zone, CAMP Montenegro – Summary. 2013. Document prepared under the CAMP MNE project commissioned by the Ministry of Sustainable Development and Tourism of Montenegro and UNEP-MAP PAP/RAC, 50 pp.

World Travel & Tourism Council. 2020. Montenegro – 2020 Annual research: Key highlights.

Zenetos, A., Çinar, M. E., Crocetta, F., Golani, D., Rosso, A., Servello, G. & Verlaque, M. 2017. Uncertainties and validation of alien species catalogues: The Mediterranean as an example. Estuarine, Coastal and Shelf Science 191: 171-187.

Hydrology (E07)

Beg Paklar, G., Vilibić, I., Grbec, B., Matić, F., Mihanović, H., Džoić, .T, Šantić, D., Šestanović, S., Šolić, M., Ivatek-Šahdan, S., Kušpilić, G. 2020.Record-breaking salinities in the middle Adriatic during summer 2017 and concurrent changes in the microbial food web // Progress in oceanography, 102345, 17 doi:10.1016/j.pocean.2020.102345

Bellafiore, D. *et al.* 2011. Study of hydrodynamical processes in the Boka Kotorska Bay with a finite element model. Dynamics of Atmospheres and OceansVolume 52, Issues 1–2, September 2011, 298-32. https://doi.org/10.1016/j.dynatmoce.2011.03.005

Buljan, M. 1953. Fluctuations of salinity in the Adriatic, Institut za Oceanografiju i Ribarstvo – Split (Croatia), Reports II(2): 64 pp.

Buljan, M. & M. Zore-Armanda. 1976. Oceanographic properties of the Adriatic Sea, Oceanogr. Mar. Biol. 14: 11–98.

Campanelli A., Bulatović, A., Cabrini, M., Grilli, F., Kljajić, Z., Mosetti, R., Paschini, E., Penna, P. and Mauro Marini, M. 2009.Spatial distribution of physical, chemical and biological oceanographic properties, phytoplankton, nutrients and Coloured Dissolved Organic Matter (CDOM) in the Boka Kotorska Bay (Adriatic Sea). Geofizika 26(2) 216-228.

Civitarese, G., Gačić, M., Lipizer, M., and Borzelli, G.L.E. 2010. On the impact of the Bimodal Oscillating System (BiOS) on the biogeochemistry and biology of the Adriatic and Ionian Seas (Eastern Mediterranean). Biogeosciences 7: 3987-3997.

Coll, M., Santojanni, A., Palomera, I. and Arneri, E. 2009. Food-web Changes in the Adriatic Sea over the last three decades. Marine Ecology Progress Series 381: 17-37.

Crise, A., Kaberi, H., Ruiz, J., Zatseoin, A.G., *et al.* 2015.A MSFD complementary approach for the assessment of pressures, knowledge and data gaps in Southern European Seas: The PERSEUS experience. Marine Poll. Bull. 95(1) DOI: 10.1016/j.marpolbul.2015.03.024

Dulčić, J., Grbec, B., Lipej, L., Beg Paklar, G., Supić, N. and SMIRČIĆ, A. 2004. The effect of the hemispheric climatic oscillations on the Adriatic Ichtyofauna. Fresenius Environmental Bulletin 13: 293-298.

Giani, M., Djakovac, T., Precali, R., Supić, N., Marić Pfannkuchen, and D.,Godrijan, J. 2015. Nutrients ratio trends in the northern Adriatic Sea and their potential effects on the ecosystem. Integrated Marine Biogeochemistry and Ecosystem Research – IMBER IMBIZO IV. Trst, Italija, 26-30 Oct 2015.

Grbec, B., and Morović, M. 1997. Seasonal thermohaline fluctuations in the middle Adriatic Sea. Nuovo Cim C 20: 561-576.

Grbec, B., Morović, M., and Zore-Armanda, M. 1998. Some new observations on the long-term salinity changes in the Adriatic Sea. Acta Adriatica 39: 3-12.

Grbec, B., Vilibić, I., Bajić, A., Morović, M., Beg Paklar, G., Matić, F., and Dadić, V. 2007. Response of the Adriatic Sea to the atmospheric anomaly in 2003. Ann. Geophys. 25: 835-846.

Grbec, B., Morović, M., Beg Paklar, G., Kušpilić, G., Matijević, S., Matić, F., and Gladan, Ž.N.2009. The relationship between the atmospheric variability and productivity in the Adriatic Sea area. J. Mar. Biol. Assoc. UK 89: 1549-1558.

Grbec, B., Bajić, A. and ViLab team. 2010. Virtual laboratory. Institute of Oceanography and Fisheries, Split. Meteorological and Hydrological Service, Zagreb.

Grbec, B., Morović, M., Matić, F., Ninčević Gladan, Ž., Marasović, I., Vidjak, O., Bojanić, N.,Čikeš Keč, V., Zorica, B., Kušpilić, G. and Matić-Skoko, Sanja. 2015. Climate regime shifts and multi-decadal variability of the Adriatic Sea pelagic ecosystem. Acta Adriatica 56 (2015), 1: 47-66.

Grbec, B., Matić, F., Beg Paklar, G., Morović, M., Popović, R. and Vilibić, I. 2018. Long-term trends, variability and extremes of in situ sea surface temperature measured along the eastern Adriatic coast and its relationship to hemispheric processes. In: Vilibić I., Horvath K., Palau J. (eds) Meteorology and Climatology of the Mediterranean and Black Seas. Pageoph Topical Volumes. Birkhäuser, Cham. https://doi.org/10.1007/978-3-030-11958-4_19

Grbec, B. 2019. Početna procjena hidrografskih uvjeta Crne Gore, a report from October 2019 field survey in Montenegro.

Krivokapić, S., Pestorić, B., Bosak, S., Grozdan Kušpilić, G. Wexels Riser, C. 2011. Trophic State Of Boka Kotorska Bay (South-Eastern Adriatic Sea). Fresenius environmental bulletin 20(8): 1960-1969.

Matić, F., Grbec, B., and Morović, M. 2011. Indications of climate regime shifts in the middle Adriatic Sea. Acta Adriatica 52: 235-246.

Matić, F., Kovač, Ž., Vilibić, I., Mihanović, H., Morović, M., Grbec, B. 2017. Oscillating Adriatic temperature and salinity regimes mapped using the Self-Organizing Maps method. Cont. Shelf Res. 132: 11-18.

Morović, M., Robert, P., Grbec, B. and Matijević, S. 2010.Spatial and temporal variability of transparency in the eastern Adriatic Sea (2010), Fresenius environmental bulletin 19(9 S.I.): 1862-1868.

Morović, M.,Grbec, B., Matić, F., Bone, M. and Matijević, S. 2008. Optical Characterization of the Eastern Adriatic Waters // Fresenius environmental bulletin 17(10B): 1679-1687.

Ninčević Gladan, Ž., Marasović, I., Grbec, B., Skejić, S., Bužančić, M., Kušpilić, G., Matijević, S.,Matić, F. 2010. Inter-decadal variability in phytoplankton community in the Middle Adriatic (Kaštela Bay) in relation to the North Atlantic Oscillation. Estuaries and coasts (1559-2723) 33 (2009) 2: 376-383

Orlić, M., Gačić, M., La Violette, P.E. 1992. The currents and circulation of the Adriatic Sea. Oceanol Acta 15: 109-124.

Redžić, A.,Krstulović, N., Šolić, M., Šantić, D. and Ordulj, M. 2015. Dynamics of prokaryotic community in Boka Kotorska Bay (South-eastern Adriatic Sea) Acta Adriatica (0001-5113) 56(2): 157-170.

Report on the implementation of the Marine Strategy Framework Directive 2008/56/EC, Brussels. 2020. 25.6.2020 COM, 259.

Rodionov, S.N., and J.E. Overland, J.E. 2005. Application of a sequential regime shift detection method to the Bering Sea ecosystem. ICES J. Mar. Sci. 62(3): 328-332.

Supić, N., Grbec, B., Vilibić, I. and Ivančić, I. 2004. Long-term changes in hydrographic conditions in Northern Adriatic and its relationship to hydrological and atmospheric processes. Ann. Geophys. 22: 733–745.

Šolić, M., B. Grbec, F. Matić, D. Šantić, S. Šestanović, Ž. Ninčević Gladan, N. Bojanić, M. Ordulj, S. Jozić, A. Vrdoljak. 2018. Spatio-temporal reproducibility of the microbial food web structure associated with the change in temperature: Long-term observations in the Adriatic Sea. Progress in Oceanography 161: 87-101. doi.org/10.1016/j.pocean.2018.02.003

Vilibić, I. and Supić, N. 2005. Dense water generation on a shelf: the case of the Adriatic Sea. Ocean Dyn. 55: 403-415.

Vilibić, I. and Supić, N. 2005. Dense water generation on a shelf: the case of the Adriatic Sea. Ocean Dynamics (1616-7341) 55(5-6); 403-415.

Violić, I., Kogovšek, T., Pestorić, B., Mačić, V., Milić Beran, I., Lučić, D. 2019. Recent changes (2013-2017) in scyphomedusan fauna in the Boka Kotorska Bay, Montenegro (Southeast Adriatic) // Acta Adriatica 60: 25-40. doi:10.32582/aa.60.1.2

Zore-Armanda, M. 1963. Les masses d'eau de la mer Adriatique. Acta Adriatica 10: 5-88.

Zore-Armanda M. 1969. Water exchange between the Adriatic and the eastern Mediterranean. Deep Sea Res. 16: 171-178.

Zore-Armanda, M. 1991. Natural characteristics and climatic changes of the Adriatic Sea. Acta Adriatica 32: 567-586.

Zore-Armanda M, Grbec B, Morović M. 1999. Oceanographic properties of the Adriatic Sea—a point of view. Acta Adriatica 40:3 9–54.

Coastal ecosystems and landscapes (EO8)

Special Purpose Spatial Plan for the Coastal Zone of Montenegro. 2018.

Study of landscape analysis, selection and mapping of landscape types for the needs of Spatial plan of the special purpose for Coastal area for the coastal area of Montenegro.

Pollution (EO9)

UNEP(DEPI)/MED WG.467/7. 2019. Cross-Cutting Issues and Common Challenges: The Methodological Approach for Mapping the Interrelations between Sectors, Activities, Pressures, Impacts and State of Marine Environment for EO5 and EO9. 7th Meeting of the Ecosystem Approach Coordination Group. Athens, Greece, 9 September 2019. https://wedocs.unep.org/bitstream/handle/20.500.11822/29729/19wg467_07_eng.pdf?sequence=1&isAllowed=y (accessed October 2020)

Decision IG. 21/3. UNEP(DEPI)/MED IG.21/9 Annex II – Thematic Decisions on the Ecosystems Approach including adopting definitions of Good Environmental Status (GES) and targets. https://wedocs.unep.org/bitstream/ handle /20.500.11822/6008/13ig21_09_annex2_21_03_eng.pdf (accessed October 2020)

Decision IG. 22/7. UNEP(DEPI)/MED IG.22/28 – Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria.https://mcc.jrc.ec.europa.eu/documents/Decision_IG.22-7_IMAP_FINAL.pdf (accessed October 2020)

UNEP(DEPI)/MED WG. 2017. 439/12 IMAP Common Indicator Guidance Facts Sheets (Pollution and Marine Litter). Meeting of the MED POL Focal Points. Rome, Italy, 29-31 May 2017.https://www.unenvironment.org/unepmap/meetings/reports

UNEP/MAP. 2016. National Action Plan (NAP) of Montenegro. Ministry of Sustainable Development and Tourism (MSDT).

UNEP/MAP-PAP/RAC and MESPU. 2021. The State and Pressures on the Marine Environment in Montenegro. By (alphabetical order): Bataković, Cigoj Sitar, N., M., Đurović, M., Jovičević, M., Mandić, M., Marković, M., Mišurović, A., Mlakar, A., Pešić, A. and Stojanović., I. Eds: PAP/RAC, GEF Adriatic Project.

Marine litter (EO10)

Alkalay, R., Pasternak, G., Zask, A. 2007. Clean-coast index—a new approach for beach cleanliness assessment. Ocean Coast. Manage. 50(5): 352–362.

Anastasopoulou,A., Kovač Viršek, M. Bojanić Varezić, D., Digkad, N., Fortibuoni, T., Koren, Š., Mandić, M., Mytilineou, C., Pešić, A., Ronchi, F., Šiljić, J., Torre, M., Tsangaris, M., Tutman, P. 2018. Assessment on marine litter ingested by fish in the Adriatic and NE Ionian Sea macro-region (Mediterranean). Marine Pollution Bulletin 133 (2018): 841–851.

Battaglia, P., Pedà, C., Musolino, S., Esposito, V., Andaloro, F., Romeo, T. 2016. Diet and first documented data on plastic ingestion of *Trachinotus ovatus* L. 1758 (Pisces: Carangidae) from the Strait of Messina (central Mediterranean Sea). Italian Journal of Zoology 83: 121–129. https://doi.org/10.1080/11250003.2015.1114157

Bo M., S. Bava, S. Canese, M. Angiolillo, R. Cattaneo-Vietti, G. Bavestrello. 2014. Fishing impact on deep Mediterranean rocky habitats as revealed by ROV investigation. Biological Conservation. 171: 167–176. 10. 1016/j.biocon. 2014. 01. 011.

Boucher, J. and Billard, G. 2020. *The Mediterranean: Mare plasticum*. Gland, Switzerland. IUCN, 62 pp.

Campani, T., Baini, M., Giannetti, M., Cancelli, F., Mancusi, C., Serena, F., Marsili, L., Casini, S., Fossi, M.C.2013. Presence of plastic debris in loggerhead turtle stranded along the Tuscany coasts of the Pelagos Sanctuary for Mediterranean Marine Mammals (Italy). Marine Pollution Bulletin 74: 225–230. https://doi.org/10.1016/j.marpolbul.2013.06.053.

Cedrian D. 2008. Seals-fisheries interactions in the Mediterranean monk seal (Monachus monachus): related mortality, mitigating measures and comparison to dolphin-fisheries interactions. Transversal Working Group on by catch/incidental catches. O Headquarters, Rome (Italy), 15-16 September 2008.

Cole, M., Lindeque, P., Halsband, C., Galloway, T.S. 2011. Microplastics as contaminants in the marine environment: A review. Marine Pollution Bulletin 62: 2588–2597. https://doi.org/10.1016/j.marpolbul.2011.09.025

Colmenero A., C.Barría, E.Broglio, S.García-Barcelona. 2017. Plastic debris straps on threatened blue. shark Prionace glauca. Mar. Poll. Bull. 115(1-2): 436-438.

Consoli, P., Falautano, M., Sinopoli, M., Perzia, P., Canese, S., Esposito, V., Battaglia, P., Romeo, T., Andaloro, F., Galgani, F., Castriota, L. 2019. Composition and abundance of benthic marine litter in a coastal area of the central Mediterranean Sea. Marine Pollution Bulletin 136: 243-247.

Consoli, P., Scotti, G., Romeo, T., Fossi, M.C., Esposito, V., D'Alessandro, M., Battaglia, P., Galgani, F., Figurella, F., Pragnell-Raasch, H., Andaloro, F. 2020. Characterization of seafloor litter on Mediterranean shallow coastal waters: Evidence from Dive Against Debris®, a citizen science monitoring approach. Marine Pollution Bulletin. Volume 150. https://doi.org/10.1016/j.marpolbul.2019.110763.

Derraik, J. G.B. 2002. The pollution of the marine environment by plastic debris: a review. Marine Pollution Bulletin 44: 842-852.

Deudero, S. and Alomar, C. 2015. Mediterranean marine biodiversity under threat: Reviewing influence of marine litter on species. Marine Pollution Bulletin 98: 58–68.

Di-Méglio, N., Campana, I.2017. Floating macro-litter along the Mediterranean French coast: composition, density, distribution and overlap with cetacean range. Mar. Pollut. Bull. 118: 155–166.

European Environment Agency (EEA). 1999. Environmental Indicators: Typology and Overview. Technical Report No. 25. http:// www.eea.europa.eu/publications/TEC25.

European Commission. 2018. Reporting on the 2018 update of articles 8, 9 & 10 for the Marine Strategy Framework Directive. DG Environment, Brussels, 71 pp (MSFD Guidance Document 14).

Fiorentino,F., Gancitano, V., Giusto, G.B., Massi, D., Sinacori, G., Titone, A., Vinci,A., Garofalo, G. 2015. Marine litter on trawlable bottoms of the strait of Sicily. Biol. Mar. Mediterr. 22(1): 225-228.

Fossi, M.C., Coppola, D., Baini, M., Giannetti, M., Guerranti, C., Marsili, L., Panti, C., de Sabata, E., Clò, S.2014. Large filter feeding marine organisms as indicators of microplastic in the pelagic environment: The case studies of the Mediterranean basking shark (*Cetorhinus maximus*) and fin whale (*Balaenoptera physalus*). Marine Environmental Research 100: 17–24.

Gari SR, Newton A, Icely JD. 2015. A review of the application and evolution of the DPSIR framework with an emphasis on coastal social-ecological systems. Ocean Coast Manag. 103: 63-77.

Geyer, R., Jambeck, J. R., and Law, K. L. 2017. Production, use, and fate of all plastics ever made. Sci. Adv. 3: e1700782. doi: 10.1126/sciadv.1700782.

Hanke G., Walvoort D., van Loon W., Addamo A.M., Brosich A., del Mar Chaves Montero M., Molina Jack M.E., Vinci M., Giorgetti A. 2019. *EU Marine Beach Litter Baselines*, EUR 30022 EN, Publications Office of the European Union, Luxemburg, ISBN 978-92-76-14243-0, doi:10.2760/16903, JRC114129.

Fossi, M.C., Marsili, L., Baini, M., Giannetti, M., Coppola, D., Guerranti, C., Caliani, I., Minutoli, R., Lauriano, G., Finoia, M.G., Rubegni, F., Panigada, S., Bérubé, M., Urbán Ramírez, J., Panti, C. 2016. Fin whales and microplastics: The Mediterranean Sea and the Sea of Cortez scenarios. Environmental Pollution 209: 68–78. https://doi.org/10.1016/j.envpol.2015.11.022.

Jambeck, J. R., Geyer, R., Wilcox, C., Siegler, T. R., Perryman, M., Andrady, A., *et al.* 2015. Plastic waste inputs from land into the ocean. *Science* 347, 768–771. doi: 10.1126/science.1260352.

JRC within the MSFD Technical Group on Marine Litter in close collaboration with EU Member States. 2019. Marine Beach Litter Baselines. Scenario analysis of a pan-European 2012-2016 beach litter dataset (Draft). Luxembourg: Publications Office of the European Union, 2019.

Katsanevakis, S., Katsarou, A. 2004. Influences on the distribution of marine debris on the seafloor of shallow coastal areas in Greece (eastern Mediterranean). Water Air Soil Pollut. 159: 325–337.

Lebreton, L.C.M., van der Zwet, J., Damsteeg, J.-W., Slat, B., Andrady, A., Reisser, J. 2017. River plastic emissions to the world's ocean. Nat Commun 8: 15611.

Mačić, V., Mandić, M**.,** Pestorić, B., Gačić, Z., Paunović, M. 2017. First assessment of marine litter in shallow south-east Adriatic Sea. Fresenius Environmental Bulletin 26(7): 4834-4840.

Maximenko, N., Corradi, P., Law, K. L., Sebille, E. V., Garaba, S. P., Lampitt, R. S., Galgani, F., Martinez-Vicente, V., Goddijn-Murphy, L., Veiga, J. M., Thompson, R. C., Maes, C., Moller, D., Löscher, C. R., Addamo, A. M., Lamson, M., Centurioni, L. R., Posth, N., Lumpkin, R., *et al.* 2019. Towards the integrated marine debris observing system. Frontiers in Marine Science 6: 1-447. https://doi.org/10.3389/ fmars.2019.00447.

Mokos M, Zamora Martinez I, Zubak I. 2019. Is central Croatian Adriatic Sea under plastic attack? Preliminary results of composition, abundance and sources of marine litter on three beaches. Rend. Fis. Acc. Lincei 30: 797–806.

Ness, B., S. Anderberg and L. Olsson. 2010. 'Structuring problems in sustainability science: The multi-level DPSIR framework'. Geoforum 41(3): 479-488.

Pasquini, G., Ronchi, F., Strafella, P., Scarcella, G., Fortibuoni, T. 2016. Seabed litter composition, distribution and sources in the Northern and Central Adriatic Sea (Mediterranean). Waste Manage. 58: 41–51.

PlasticsEurope. 2018. "Plastics – the facts 2018. An analysis of European plastics production, demand and waste data" in *Association of Plastics Manufacturers and EPRO* (Brussels: European Association of Plastics Recycling & Recovery Organisations, Association of Plastic Manufacturers and European Association of Plastics Recycling and Recovery Organizations), 18 pp.

Rech, S., Borrell, Y. and García-Vazquez, E. 2016. Marine litter as a vector for non-native species: What we need to know. Marine Pollution Bulletin 113(1-2): 40-43.

Rodríguez B., J. Bécares, A.Rodríguez, J.Manuel Arcos. 2013. Incidence of entanglements with marine debris by northern gannets (Morus bassanus) in the non-breeding grounds. Mar. Poll. Bull. 75: 259– 263.

Romeo, T., Battaglia, P., Pedà, C., Consoli, P., Andaloro, F., Fossi, M.C.2015. First evidence of presence of plastic debris in stomach of large pelagic fish in the Mediterranean Sea. Mar. Poll. Bull. 95: 358–361. https://doi.org/10.1016/j.marpolbul.2015.04.048

Romeo, T., Pedà, C., Fossi, M.C., Andaloro, F., Battaglia, P. 2016. First record of plastic debris in the stomach of Mediterranean lanternfishes. Acta Adriatica 57, 115–124.

Spedicato M.T., Zupa W., Carbonara P., Fiorentino F., Follesa M.C., Galgani F., García- Ruiz C., Jadaud A., Ioakeimidis C., Lazarakis G., Lembo G., Mandic M., Maiorano P., Sartini M., Serena F., Cau A., Esteban A., Isajlovic I., Micallef R., Thasitis I. 2019. Spatial distribution of marine macro-litter on the seafloor in the northern Mediterranean Sea: the MEDITS initiative. Sci. Mar. 83S1: 257-270.

Strafella, P., Fabi, G., Spagnolo, A., Grati, F., Polidori, P., Punzo, E., Fortibuoni, T., Marceta, B., Raicevich, S., Cvitkovic, I., Despalatovic, M., Scarcella, G.2015. Spatial pattern and weight of seabed marine litter in the northern and central Adriatic Sea. Mar. Pollut. Bull. 91: 120–127.

Suaria, G., Aliani, S.2014. Floating debris in the Mediterranean Sea. Mar. Pollut. Bull. 86(1–2): 494–504. https://doi.org/10.1016/j.marpolbul.2014.06.025.

Tubau X., M.Canals, G.Lastras, X.Rayo, J.Rivera, D.Amblas. 2015. Marine litter on the floor of deep submarine canyons of the Northwestern Mediterranean Sea: The role of hydrodynamic processes. Progr. in Oceanog. 134: 379-403.

UNEP. 2015. Marine Litter Assessment in the Mediterranean. 45 pp.

UNEP(DEPI)/MEDIG.22/Inf.7. 2016. Integrated Monitoring and Assessment Guidance (COP19, Athens, Greece, 9-12 February 2016).

UNEP/MED WG.452/5. 2018. Regional Plan on Marine Litter Management in the Mediterranean and Related Best Practices Adopt-a-Beach (Main Elements). Regional Meeting on Marine Litter Best Practices Izmir, Turkey, 9-10 October 2018.

UNEP/MED WG.476/3. 2019. Marine Litter Assessment: Updated Baseline Values and Threshold Values for IMAP Marine Litter Indicators. . UNEP/MAP, Athens, 2019, 25 pp.

UNEP/MED WG.467/7. 2019. Cross-Cutting Issues and Common Challenges: The Methodological Approach for Mapping the Interrelations between Sectors, Activities, Pressures, Impacts and State of Marine Environment for EO5 and EO9. 7th Meeting of the Ecosystem Approach Coordination Group. Athens, Greece, 9 September 2019.

UNEP/MED WG.482/23. 2020. Updated Baseline Values and Proposal for Threshold Values for IMAP Common Indicator 22. Integrated Meetings of the Ecosystem Approach Correspondence Groups on IMAP Implementation (CORMONs). Videoconference, 1-3 December 2020.

Van Loon, W., Fleet, D., Hanke, G., Werner, S., Barry, J., Eriksson J., Gräwe, D., Kinsey, S., Schulz, M., Vlachogianni, Th., Press, M. and Blidberg, E. 2019. Proposal towards a SMART Threshold Value for Beach Litter. MLWG UE 2019 (Draft).

Vlachogianni T. 2019. Marine litter in Mediterranean coastal and marine protected areas – How bad is it. A snapshot assessment report on the amounts, composition and sources of marine litter found on beaches, Interreg Med ACT4LITTER & MIO-ECSDE.

Vlachogianni T., Anastasopoulou A., Fortibuoni T., Ronchi F., Zeri C. 2017. Marine litter assessment in the Adriatic and Ionian Seas. IPA-Adriatic DeFishGear Project, MIO-ECSDE, HCMR and ISPRA, 168 pp.

Vlachogianni, T., Fossi M.C., Anastasopoulou, A., Alomar, C., Aparicio, A., Baini, M., Caliani, I., Campani, T., Casini, S., Consoli, P., Deudero, S., Galgani, F., Kaberi H., Panti, C., E. Romeo, T., Tsangaris, C., Zeri, C .2018. State-of-the-art methods to monitor marine litter and its impacts on biodiversity. Interreg Med Plastic Busters MPAs project. 62 p.

Vlachogianni, T., Kalampokis, V. 2015. Methodology for Monitoring Marine Litter on the Seafloor (Shallow coastal waters (0–20 m) Visual surveys with SCUBA/snorkelling. IPA DeFishGear project, 10 pp. http://mio-ecsde.org/wp-content/uploads/2014/12/Seafloor-litter_monitoring-methodology_scuba_snorkelling_final.pdf.

Vlachogianni, T., Somarakis, S. 2015.Methodology for Monitoring Marine Litter on the Seafloor (continental shelf) Bottom trawl surveys. IPA DeFishGear project. 7 pp. http://mio-ecsde.org/wp-content/uploads/2014/12/Seafloor-litter_monitoring-methodology_continental-selves_final.pdf

Vlachogianni, Th., Anastasopoulou, A., Fortibuoni, T., Ronchi, F., Zeri, Ch. 2017. Marine Litter Assessment in the Adriatic and Ionian Seas. IPA-Adriatic DeFishGear Project, MIO-ECSDE, HCMR and ISPRA. pp. 168.

Wright, S.L., Thompson, R.C. and Galloway, T.S. 2013. The physical impacts of microplastics on marine organisms: A review. Environmental Pollution 178: 483 – 492.

Wright, S.L., Thompson, R.C., Galloway, T.S.2013. The physical impacts of microplastics on marine organisms: A review. Environmental Pollution 178: 483–492. https://doi.org/10.1016/j.envpol.2013.02.031.

Eutrophication (EO5)

Council Directive 75/440/EEC of 16 June 1975 concerning the quality required of surface water intended for the abstraction of drinking water in the Member States.

Council Directive 79/869/EEC of 9 October 1979 concerning the methods of measurement and frequencies of sampling and analysis of surface water intended for the abstraction of drinking water in the Member States.

Council Directive 80/778/EEC of 15 July 1980 relating to the quality of water intended for human consumption.

Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources.

Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment.

Đurović, B., Đurović, I., Joksimović, A., Crnojević, V., Đukanović, S., Pestorić, B., 2018. Monitoring the eutrophication using Landsat 8 in the Boka Kotorska Bay Acta Adriatica 59(1): 17 – 34.

EEA (1999). European Environment Agency (EEA): Environmental Indicators: Typology and Overview. Technical Report No. 25. http:// www.eea.europa.eu/ publications/TEC25.

European Commission. 2018. Reporting on the 2018 update of articles 8, 9 & 10 for the Marine Strategy Framework Directive. DG Environment, Brussels, 71 pp (MSFD Guidance Document 14).

Mandić, S., Radović, I., Radović, D., 2017. Physical and Geographical Description of the Boka Kotorska. In: Joksimović *et al.* (eds.), The Boka Kotorska Bay Environment, Hdb. Env. Chem. 54: 43–68, DOI 10.1007/698_2016_27

Medenica, N., 2017. Izvještaj o stanju životne sredine u Crnoj Gori na bazi indikatora. Agencija za zaštitu prirode i životne sredine Crne Gore, 105. pp.

Mišurović; A., Đurašković., P., 2019. National emissions Inventory from land-based sources of pollution for the Montenegrin coast for 2018/2019, 176 pp.

Palerm, J., Dusík, J. Šarić, I., Golja, G., Slokar, M., 2015. Strateška procjena uticaja na životnu sredinu za Nacionalnu strategiju u oblasti klimatskih promjena u Crnoj Gori. EuropeAid/127054/C/SER/multi, 145 pp.

Swackhamer D.L., H.W. Paerl, S.J. Eisenreich, J. Hurley, K.C. Hornbuckle, M. McLachlan, D. Mount, D. Muir, and D. Schindler. 2004. Impacts of Atmospheric Pollutants on Aquatic Ecosystems. Issues in Ecology 12: 2-24.

UNEP(DEPI)/MED IG.21/9 Annex I – Integrated list of Mediterranean Good Environmental Status and related targets. (Istanbul, Turkey, 3-6 December 2013).

UNEP(DEPI)/MED IG.22/Inf.7 Integrated Monitoring and Assessment Guidance (COP19, Athens, Greece, 9-12 February 2016).

UNEP(DEPI)/MED WG. 463/Inf. 3 The Amendments of the IMAP Guidance Factsheets for Common Indicators 13, 14, 17, 18, 20 and 21, Podgorica, Montenegro, 2-3 April 2019.

UNEP(DEPI)/MED WG. 492/11 Assessment Criteria Methodology for IMAP Common Indicator 13: Pilot Application in Adriatic Sub-region, Videoconference, 26-28 April 2021.

Vollenweider, R.A., Giovanardi, F., Montanari, G., Rinaldi, A., 1998. Characterization of the trophic conditions of marine coastal waters with special reference to the NW Adriatic Sea: proposal for a Trophic Scale, Turbidity and generalized Water Quality Index. Environmetrics 9: 329-357.

Vukašinović-Pešić, V., Blagojević, N., Savić, A., Tomić, N., Pešić, V., 2020. The Change in the Water Chemistry of the Rivers of Montenegro over a 10-Year Period. In: Pešić., V., Paunović, M., Kostianoy, A. G. (eds.), The Rivers of Montenegro. Hdb. Env. Chem. 93: 83–110, DOI 10.1007/698_2019_417.

8 Annex 1: Interrelations between ecological objectives

Table 8.1. Interrelations between Biodiversity and NIS cluster (EO1 and EO2) and other Ecological Objectives

	EO1	EO2	EO5	EO7	EO8	EO9	EO10
EO1		NIS may cause habitat degradation and destruction; decline of certain species; and spread diseases that may affect biodiversity.	Eutrophication may significantly impact habitats via nutrient and organic matter enrichment in coastal environments (and subsequent hypoxic conditions near the seafloor).	Hydrographic alterations impact benthic habitats via altered sedimentation rates; primary production and pelagic habitats via turbidity; and species composition due to increase in temperature/salinity.	Tourism-driven urbanisation and construction of coastal area contributes to benthic habitats destruction.	Pollution may foremostly cause degradation and destruction of habitats.	Marine litter can affect marine biodiversity. Most evident cases relate to entanglement of marine turtles and marine mammals in fishing gear, as well as suffocation through ingestion of plastic. Microplastics is also problematic, entering food-webs and accumulating in shellfish and fish. Benthic habitats can also be severely impacted via physical damage by litter, such as to corals (observed in Boka Kotorska in 2019).
EO2	NIS may cause habitat degradation and destruction; decline of certain species; and spread diseases that may affect biodiversity.			Increasing sea temperature can favour the introduction of NIS and facilitate the spread of thermophilic species. Change in currents in certain environmental conditions can favour the inflow of NIS from southern/eastern parts of Mediterranean Sea.			Floating litter could be a favourable vector for the transmission of organisms to the distant places and it can cause transportation of NIS to new locations.

Table 8.2. Interrelations between Eutrophication and Pollution cluster (EO5, EO9 and EO10) and other Ecological Objectives

	EO1	EO2	EO5	EO7	EO8	EO9	EO10
EO5	Eutrophication can cause a severe impact on biodiversity of habitats and the ecosystem as a whole. It is considered one of the principal causes of harmful algal blooms and hypoxia in certain (benthic) areas, which can impact whole food web (and fisheries in particular). Particularly relevant for semi-enclosed bays (such as Boka Kotorska Bay).			Local (small scale) and mesoscale coastal currents can extend the eutrophication. Information on hydrographic conditions (e.g., temperature, salinity, and density) are particularly relevant for eutrophication assessment. it is always advisable that the monitoring of parameters belonging to these two EOs takes place at the same stations at the same time.	Urbanised areas in coastal zone are source of nutrient enrichment in near-shore marine areas, in particular in the absence of the appropriate wastewater treatment.	Eutrophication sources could be also related to other sources of pollution (e.g., chemical pollution and microbial pathogens) through WWTP outflows.	
EO9	Toxicological effects of harmful chemicals and pathogens can affect the biodiversity, from individual specimens to entire communities (e.g., TBT – organotin compounds).		Chemical pollution and microbial pathogens could be related to eutrophication sources through WWTP outflows.	Near-shore currents and the local hydrographic conditions can expand the pollution outbreaks in the marine environments both from diffuse and point sources.	Ports and port-related coastal constructions are source of marine contamination in Montenegro.		Recent research studies show that chemical plasticizers and other known persistent substances can leach from marine litter (both macro- and micro-litter items).
EO10	Entanglement of marine turtles and marine mammals in fishing gear, as well as suffocation through ingestion of plastic. Marine litter can severely impact benthic habitats via physical damage by litter, such as corals (observed in Boka Kotorska in 2019).	Marine litter can facilitate transmission of NIS.		Key hydrographic processes and parameters, e.g., bathymetry and currents, have significant impact on marine litter accumulation and transport.	Link between more urbanised areas and marine litter depositions is evident in Montenegrin marine areas.	Recent research studies show that chemical plasticisers and other known persistent substances can leach from marine litter (both macro- and micro-litter items).	

Table 8.3. Interrelations between Coast and Hydrography cluster (EO7 and EO8) and other Ecological Objectives

	EO1	EO2	EO5	EO7	EO8	EO9	EO10
EO7	Currents and other types of water movement directly influence sedimentation rates and can influence benthic habitats. Studies in the Adriatic since 1970s show correlations between oceanographic changes with composition of habitats, plankton, and fish species.	Increasing seawater temperatures facilitate the spread of thermophilic species; in recent decades an increasing number of non-indigenous species has been recorded. Currents can favour redistribution of NIS (inflow from the southern/eastern Mediterranean).	Information on key hydrographic parameters (T, S) are relevant for the interpretation of eutrophication results. Integrated Monitoring Programme for Montenegro envisages monitoring of EO5 and EO7 at the same locations. The concentration of wastewater outfalls in Boka Kotorska could result in reduced circulations and hydro-morphological quality. Local (small scale) and mesoscale coastal currents can extend the eutrophication.		Physical changes of the coastline in Montenegro probably affect near-shore hydrographic conditions.	Contaminants can be redistributed or transported throughout the environment by hydrographic processes. Contaminants remain in the water column and especially in the sediment, from which they can be re-suspended depending on the currents, waves, turbulence, and other environmental features.	Hydrographic conditions, in particular currents have significant impacts on accumulation, transport and distribution of marine litter.
EO8	Artificialisation occupies more than 30% of Montenegrin coastline, including 60% in Boka Kotorska Bay, and affects supra- and medio-littoral habitats and nearshore benthic habitats.		Urbanised areas in coastal zones are sources of nutrient enrichment in near-shore areas, in particular in the absence of appropriate wastewater treatment.	Human-made structures can have direct impacts on the changes of hydrographic conditions, which can in turn impact marine habitats and biodiversity.		Ports and port-related coastal construction are source of marine contamination in Montenegro.	Link between urban areas and marine litter depositions is evident in Montenegrin marine areas.

gef

ADRIATIC

Implementation of the ecosystem approach
in the Adriatic through marine spatial planning

The GEF-funded project “Implementation of the Ecosystem Approach in the Adriatic Sea through Marine Spatial Planning” (GEF Adriatic) is carried out across the Adriatic-Ionian region with focus on two countries: Albania and Montenegro.

The main objective of the project is to restore the ecological balance of the Adriatic Sea through the use of the ecosystem approach and marine spatial planning. Also, the project aims at accelerating the enforcement of the Integrated Coastal Zone Management Protocol and facilitating the implementation of the Integrated Monitoring and Assessment Program. Eventually, it will contribute to the achievement of the good environmental status of the entire Adriatic. The project is jointly lead by UNEP/MAP, PAP/RAC and SPA/RAC. In Montenegro, the project is being implemented with the coordination of the Ministry of Ecology, Spatial Planning and Urbanism. The project duration is from 2018 to 2021.

Ministry of Ecology, Spatial Planning and Urbanism
IV Proleterske brigade 19, 81000 Podgorica, Montenegro
E: ivana.stojanovic@mepg.gov.me