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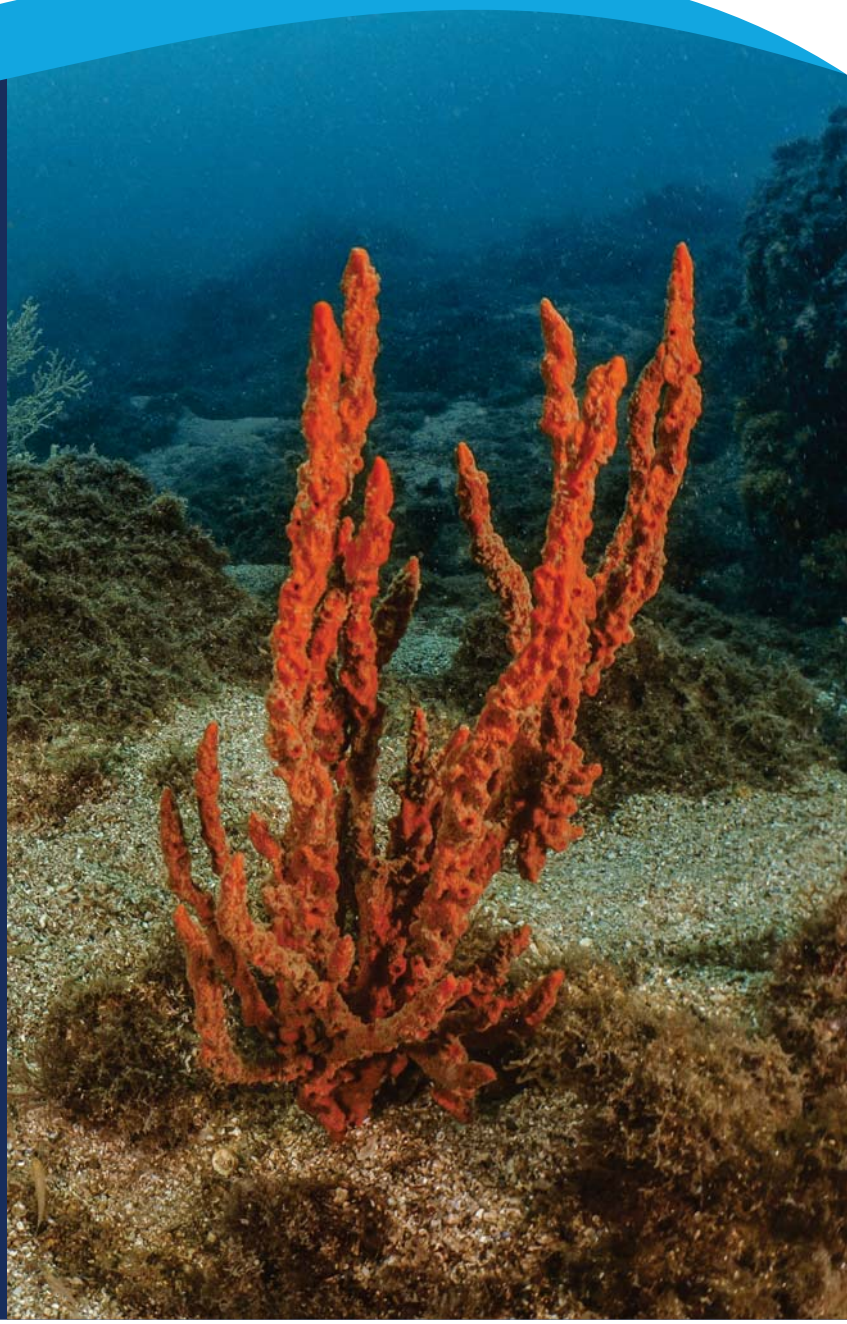
ADRIATIC

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

Integrated Monitoring Programme

Montenegro



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Impressum

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BAC	Background assessment concentrations
BC	Background concentration
CAMP	Coastal Area Management Programme
CI	Common indicator
COP	Conference of the Parties
CP	Contracting Parties
CPUE	Catch per unit of effort
CTD	Conductivity, temperature, depth
DCRF	Data Collection Reference Framework
PSIR	Drivers Pressures State Impact Response
EAC	Environmental Assessment Criteria
ECAP	Ecosystem Approach
EA	European Environment Agency
EEZ	Exclusive economic zone
EMSA	European Maritime Safety Agency
EO	Ecological Objective
EQV	Ecological Quality Value
FAO	Food and Agriculture Organisation of the United Nations
GEF	Global Environment Facility
GES	Good Environmental Status
GFCM	General Fisheries Commission for the Mediterranean
GPS	Global Positioning System
IMAP	Integrated Monitoring and Assessment Programme
IMO	International Maritime Organisation
IMP	Integrated Monitoring Programme
IUCN	International Union for Conservation of Nature
IUU	Illegal, unreported and unregulated fishing
IWC	International Waterbird Census
LSI	Land-Sea Interactions
MAP	Mediterranean Action Plan
MARPOL	International Convention for the Prevention of Pollution from Ships
MEDIAS	Mediterranean Acoustic Survey
MEDITS	Mediterranean Trawl Survey
MPA	Marine Protected Area
MSDT	Ministry of Sustainable Development and Tourism
MSFD	Marine Strategy Framework Directive
MSP	Marine Spatial Planning
MSY	Maximum sustainable yield
NIS	Non-indigenous species
PAH	Polycyclic aromatic hydrocarbons
PAP/RAC	Priority Actions Programme Regional Activity Centre
PCB	Polychlorinated biphenyl
POMI	Posidonia oceanica Multivariate Index
POP	Persistent organic pollutants
RAS	Rapid Assessment Survey
REMPEC	Regional Marine Pollution Emergency Response Centre for the Mediterranean Sea
ROV	Remote Operating Vehicle
SAC	Scientific and Advisory Committee
SAF	Stock assessment form
SAM	State-Space Assessment Model
SPA/RAC	Specially Protected Area Regional Activity Centre
SSB	Spawning stock biomass
TRIX	Trophic index
UN	United Nations
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
WGBS	Working Group on the Black Sea
WGSA	Working Group on Stock Assessment
QA	Quality assurance
QC	Quality control
XSA	Extended survivor analysis

BACKGROUND INFORMATION

INTRODUCTION

Montenegro has been a Contracting Party to the Barcelona Convention and its Protocols in the framework of UN Environment/MAP since 2008. UN Environment/MAP has committed to applying the ecosystem approach to assess the environmental status of marine waters and coasts. Contracting Parties to the Barcelona Convention (CP) have adopted the Integrated Monitoring and Assessment Programme (IMAP) based on eleven ecological objectives (Decision IG.22/7[1]), on the basis of which the Adriatic countries need to adjust their national monitoring programmes. However, it should be noted that the current IMAP includes elaborated and agreed common indicators and ecological objectives related to biodiversity, non-indigenous species, eutrophication, hydrography, coast, contaminants and marine litter. In addition, monitoring and assessment specifics for fisheries are those being developed by the General Fisheries Commission for the Mediterranean (GFCM).

The integrated monitoring programme for the marine environment in Montenegro (IMP) is based on the "Draft Integrated Monitoring and Assessment Guidance" (WG.420/4), "Technical guidance on monitoring for the Marine Strategy Framework Directive" (JCR, 2014) as well as monitoring plans or programmes developed by the EU Member States under the MSFD.

To avoid a sectoral approach, the IMP:

- Equally and in an integrated manner elaborates monitoring for all ecological objectives for which CPs have agreed on indicators and monitoring protocols: Ecological Objective for Biodiversity (EO1), Ecological Objective for Non-Indigenous Species (EO2), Ecological Objective for Fisheries (EO3), Ecological Objective for Eutrophication (EO5), Ecological Objective for Hydrography (EO7), Ecological Objective for Coastal ecosystems and landscapes (EO8), Ecological Objective for Contaminants (EO9) and Ecological Objective for Marine Litter (EO10). In addition, the Integrated monitoring includes pelagic habitats under EO1, even if those are not envisaged within the IMAP, due to its relevance and linkages with other EOs, such as eutrophication, invasive species, etc.
- Embraces and takes into consideration the existing national monitoring programmes for eutrophication and contaminants, a monitoring programme for fisheries, undertaken within MEDITS and MEDIAS surveys, monitoring undertaken as part of different relevant projects, such as DeFishGear for marine litter, etc.
- Where relevant, it adapts and upgrades the existing monitoring programmes according to the IMAP requirements. This is particularly relevant for monitoring of eutrophication and contaminants, where monitoring efforts are extended to offshore areas and changes in monitoring protocols are introduced. This includes defining the new codes for the monitoring stations, in line with the IMAP. Also, the systematic approach towards monitoring of hydrographic conditions is fully introduced.
- Supports appropriate integration with the EU-required monitoring programmes, in particular those that have been prepared under MSFD and WFD. Namely, as the accession to the European Union is a strategic priority for Montenegro, with recent opening and emphasis on the Negotiation Chapter 27 (Environment and Climate Change), preparation of IMP (based on the IMAP) almost in parallel with MSFD transposition allows a synergetic and compatible implementation of both processes in Montenegro, fulfilling the obligations both to the UN MAP system and the EU.

[1] "*Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria*" (IMAP) adopted by the 19th Meeting of the Contracting Parties to the Barcelona Convention in 2016 (COP 19, Athens, Greece, 9-12 February 2016)

The monitoring network is defined based on estimated representativeness of the priority areas for monitoring of marine environmental status in line with the overall risk-based approach, taking into consideration ecosystem characteristics, the spatial coverage of important habitats/ marine protected areas, as well as the presence of sources of pollution and hotspots. In addition, the IMP has been developed taking into consideration appropriate monitoring frequency and timing, also addressing interconnections and necessary integrations between different ecological objectives, notably in order to contribute to the cost-effectiveness of the Integrated monitoring.

In terms of spatial coverage, monitoring applies to the entire marine area of Montenegro. Having in mind the national competencies, it includes marine waters of Montenegro up to the outer limit of the territorial waters (Figure 1). However, for some of the ecological objectives (e.g. fisheries, marine litter) monitoring area extends up to the outer limit of the continental shelf (Figure 2), in line with the agreed coverage of the international survey expeditions. Therefore, monitoring includes not only coastal but also offshore stations for all ecological objectives.

Definition of monitoring network in line with risk-based approach enables obtaining an overview of the status and pressures on the marine and coastal area on a larger spatial scale while only monitoring a limited, yet representative number of locations.

In addition to the spatial coverage, applying sufficient sampling frequency is very important. Taking into consideration all the existing national capacities, monitoring frequency envisaged within the Integrated monitoring is to provide an adequate amount of information to ensure: determining GES (where it is lacking), monitoring trends towards GES as well as trends towards full implementation of the IMAP, including measures, without creating unnecessary financial strains.

Throughout the monitoring, it is important to carefully consider the timing, undertaking it in the appropriate yearly periods, with the minimum time lapse throughout the entire spatial coverage process.

More detailed elaboration of IMP, in line with the MSFD requirements and corresponding bylaws, shall be prepared and submitted for adoption by the end of 2021.

Having in mind the interconnectivity of marine area across the national borders, it is recommended to apply to the greatest extent possible the Integrated monitoring in coordination with other countries of the Adriatic. This is particularly important in monitoring marine species (EO1), NIS (EO2), fisheries (EO3), marine litter (EO10).

The implementation of the Monitoring programme is coordinated by the Ministry of Ecology, Spatial Planning and Urbanism (MESPU), together with the national Agency for Nature and Environment Protection, as the responsible administration authority (see Subchapter 11.1). Integrated monitoring is developed taking into consideration regional requirements of the IMAP INFO system, also harmonised with the EEA data requirements. All the information collected during monitoring shall be appropriately reported to NEA using the IMAP Info standards in order to be stored in the national database and subsequently reported to the IMAP INFO system. When entering data into the IMAP Info system, it is important that each monitoring station/site has its own unique code as a monitoring reference. Possible examples of such codes are given for the EO5, EO7 and EO9, where each code contains information on the monitoring area, name of the station, the type of station and station number. However, coding can be prepared in a simpler way, containing, as a minimum, the following information:

- Up to two letters referring to the station/site name;
- Ordinal number, corresponding to the station/site.

It should be highlighted that discussions are still ongoing with the Contracting Parties regarding monitoring guidelines related to some ecological objectives and common indicators. If the updated guidelines are published, they should be taken into account in the implementation of the present IMP document.

Integrated monitoring programme for Montenegro was prepared as part of the project "Implementation of Ecosystem Approach in the Adriatic Sea through Marine Spatial Planning" financed by the Global Environment Facility (GEF Adriatic) and implemented in Albania and Montenegro. The Project provides the framework enabling restoration of the ecological balance of the Adriatic Sea through the implementation of the ecosystem approach. By doing so, the aim is to integrate horizontal (sectoral) management approaches into a single, coherent one for the overall benefit of the marine resources.

MARINE AREA OF MONTENEGRO

Montenegro is a Mediterranean country with a total surface area of 13,812 km^2 with a population of about 625,000 and the population density of 45 inhabitants/km^2. The length of Montenegrin coastline is 294 km (out of which 105.5 km is in the area of Boka Kotorska Bay), and the total surface area of internal waters is 362 km^2, while the surface of territorial waters is 2,098.9 km^2.

Montenegro shares borders with Croatia in the northwestern part of the marine area and with Albania in the southeastern part (Figure 1).

Outside the territorial waters and surrounded by the depth of 200 m lies the area of the continental shelf in Montenegro (Figure 2). Continental shelf covers the area of 3,885 km^2, which is nearly 61% of the offshore (marine) area.

For the technical and organisational purposes, the marine area is divided into four monitoring areas: Boka Kotorska, northern area (from the island of Mamula up to Cape Platamuni), central area (from Cape Platamuni up to Cape Volujica), southern area (from Cape Volujica up to the Albanian border) (Figure 2).

These four areas do not correspond to reporting units. In addition, they do not necessarily correspond to assessment areas. However, having in mind that each area is composed of a set of monitoring stations for all ecological objectives, where appropriate, they could be used as preliminary assessment areas during the first monitoring cycle. Based on the findings, they could be further modified, also in line with ongoing regional activities for defining the scales of assessment within the IMAP implementation, as well as national MSFD and WFD processes.

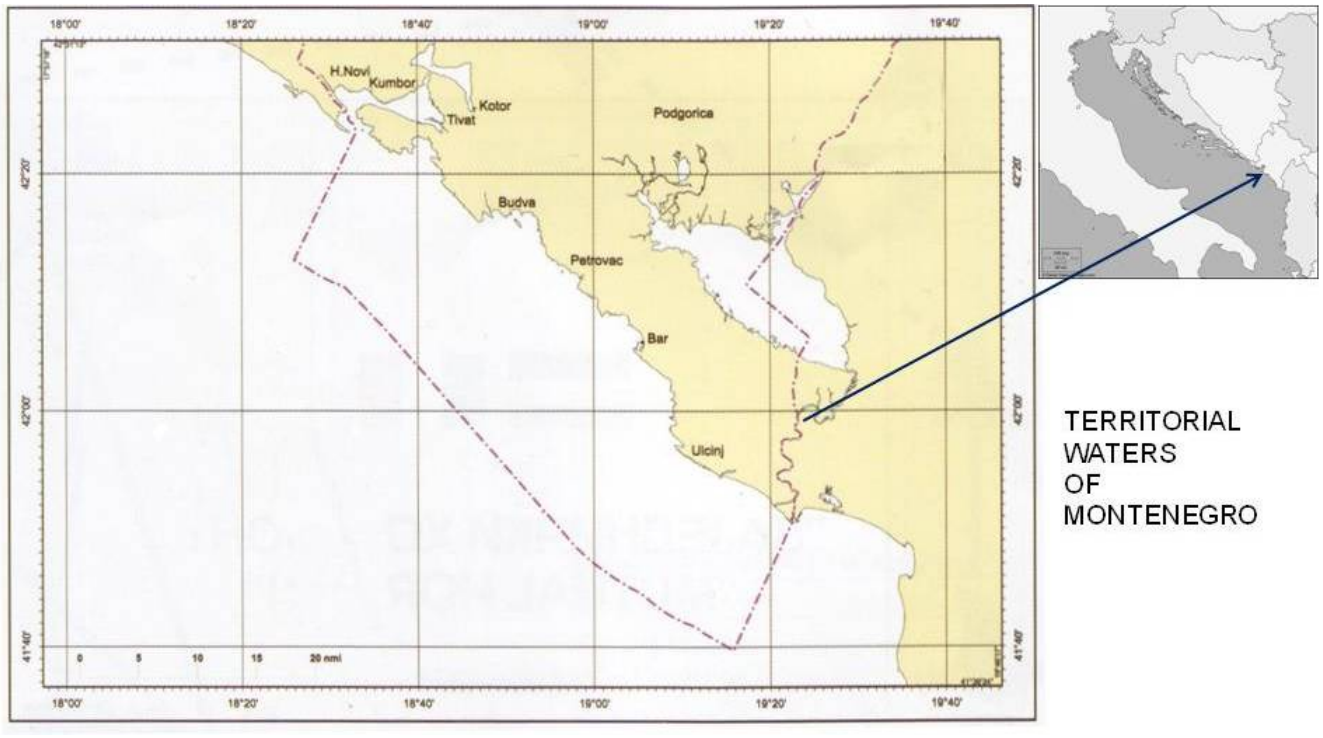


Figure 1: Marine border of Montenegro

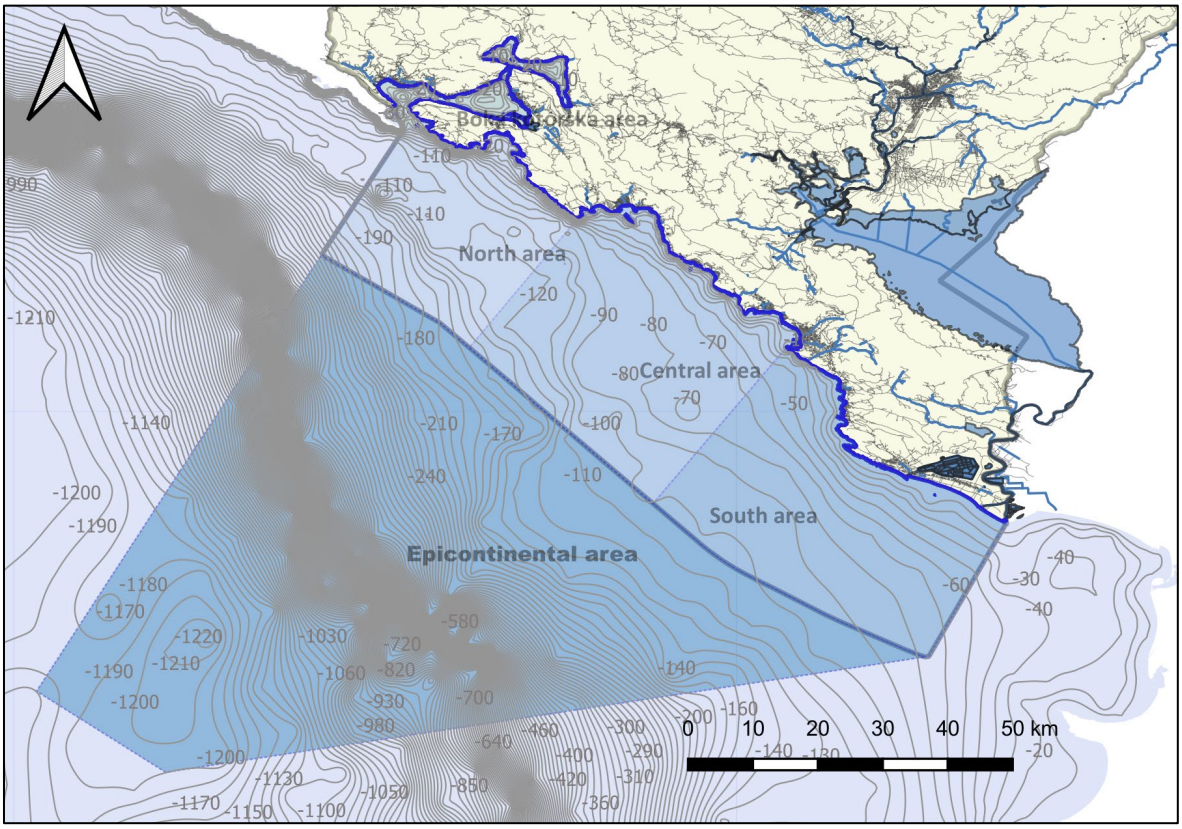


Figure 2: Montenegrin marine zone, with four monitoring areas within the outer limit of the territorial sea and epicontinental shelf

MONITORING PROGRAMME

1.
BIODIVERSITY (EO1)

The most widely agreed-upon definition of biodiversity is the one found in the Convention on Biological Diversity (CBD, 1992): "the variability among living organisms from all sources including, inter alia, [terrestrial,] marine [and other aquatic ecosystems] and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems". Marine biodiversity is undergoing rapid alteration under the combined pressure of climate change and human impact, but protection measures, either for species or ecosystems, are still scarce.

Characteristics of the biological diversity in the Montenegrin waters should be described according to the Components and agreed-upon Common Indicators proposed by the IMAP (Decision IG.22/7) which are mostly in coherence with Annex III of MSFD. Components to be monitored and assessed concerning biodiversity in Montenegrin waters are as following: predominant habitats (photophilic algae communities, *Posidonia oceanica* meadows and coralligenous assemblages) and biological communities associated with the predominant seabed and water column habitats (marine mammals, reptiles, seabirds, fish, phytoplankton and zooplankton communities), as well as non-indigenous and invasive species.

GES definition: Biodiversity 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.

Biodiversity monitoring highlighted in the following chapters is in line with the SPA/RAC Guidelines within the UNEP/MED WG 461.21 document[2] which include all the necessary complementary information and details to the present IMP document regarding Biodiversity.

1.1.
Component: Photophilic algae communities and *Cystoseira spp.*

Stands of photophilic algae communities and species belonging to genus *Cystoseira* inhabit the shallowest area of exposed infralittoral rocky areas and are widely distributed in the Mediterranean and the Adriatic Sea (*III.6.1. Biocenosis of infralittoral algae (upper horizon)* of SPA/RAC Updated Classification of Benthic Marine Habitat Types for the Mediterranean Region (SPA/RAC–UN Environment/MAP, 2019).

Photophilic algae communities represent a predominant habitat type which appears on the infralittoral rocky bottom of the Mediterranean and the Adriatic Sea. It is developing from the surface (average low tide level) to a depth of about 35 m. The photophilic algae communities are made up of numerous different species of photophilic algae. The settlements of algae are the most abundant in the upper infralittoral zone (from the surface to a depth of 6-8 m). On the exposed sites, the upper limit (0–1 m depth) is covered with algal belt based on brown algae species

Cystoseira amentacea. At a depth of more than 1 m, different Cystoseira species produce additional belts. Those species are mostly *C. compressa*, *C. crinitophylla*, *C. crinita*, *C. barbata*, *C. spinosa* and *Cystoseira foeniculacea*.

The presence of certain algal species is determined by natural and anthropogenic conditions. In polluted waters,

[2] Discussions are still ongoing with the Contracting Parties regarding the guidelines related to marine vegetation and coralligenous. If updated guidelines are published, it shall be considered during the implementation of the present IMP document.

due to waste or industrial water discharges, a special form of vegetation is developed in the infralittoral area. This kind of vegetation is based on species of the genera *Ulva* and *Enteromorpha* (green algae), *Pterocladia* and *Gigartina* (red algae) and *Dictyota* (brown algae).

1.1.1. Common indicators

According to the IMAP, two common indicators for assessing progress towards good environmental status are defined concerning biodiversity at the level of habitat:

Common indicator 1: Habitat distributional range considering also habitat extent as a relevant attribute	
This indicator is area-related, i.e. the proportion of the area of habitats that have been permanently or for a long time lost or subject to change in habitat type due to anthropogenic pressures.	
GES definition	The habitat is present in all its natural distributional range.
Operational objective	Coastal and marine habitats are not being lost.
GES target	The damaged or lost area per habitat type, especially for physically defined and not biogenic habitats, could be set as to not exceed an acceptable percentage of the baseline value.

Common indicator 2: Condition of the habitat's typical species and communities	
The concept of "typical species" emerges from the conservation status of natural habitats to their long-term natural distribution, structure and functions, as well as to the long-term persistence of their typical species within the territory.	
GES definition	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.
Operational objective	Coastal and marine habitats are not being lost.
GES target	No human-induced significant deviation of population abundance and density from reference conditions; The species composition shows a positive trend towards reference condition over an increasing proportion of the habitat (for recovering habitats).

1.1.2. Selection of parameters

Through coastline mapping, a standard set of data is gathered according to CARLIT (Cartography of littoral and upper-sublittoral rocky-shore communities) methodology that includes the length of each stretch of coast, defined by a specific geomorphological situation and by a specific community (Ballesteros *et al.*, 2007). The use of relevant geomorphological situations, species and communities and the sensitivity levels defined by Nikolic *et al.* (2013) is recommended, as it applies to the Eastern Adriatic Sea.

It should be noted that this methodology is very useful and it applies to the open part of the coast of Montenegro, but not to Boka Kotorska Bay, where the impacts of both freshwater and artificial change of the coastline are very strong. Furthermore, on the open part of the Montenegrin coast, the rocky areas near sandy beaches should be avoided because of the impact of the sand on the hard substrate benthic communities. Besides, the southern part of the coast from Cape Marjan to Cape Đeran is more demanding for the application of this method. In this area, due to the proximity to the transitional water body caused by the Bojana River, scientific investigations and tests should be conducted to identify the appropriate reference values for the GES in transitional waters of the Adriatic Sea.

1.1.3. Selected study sites

Given the recommendation to limit the artificial substrates (to make sure that they do not exceed 50% of the entire stretch of coast) and avoid the coastal stretches too close to sandy beaches and/or to large freshwater inflows, we can propose a list of obligatory areas for monitoring as shown in Table 1.1 and Figure 1.1.

Table 1.1: Selected Survey sites for Photophilic algae communities

Area	Survey Site					Main Pressures	Inside MPA	Monitoring Method
	Site Name	Starting Position	Ending Position	Max Depth	Site Code			
North	Cape Arza to Cape Platamuni (zone 1)	42.39118 18.56993	42.26726 18.78064	3 m	SA_1	Coastal construction erosion Eutrophication Urban and tourism pollution	YES- proposed MPA Platamuni	CARLIT
Central	Cape Platamuni to Cape Volujica (zone 2)	42.26726 18.78064	42.08889 19.06938	3 m	SA_2	Coastal construction erosion Eutrophication Urban and tourism pollution	Partial overlap with proposed MPA Katič	CARLIT
South	Cape Volujica to cape Marjan (zone 3)	42.08889 19.06938	41.97945 19.14081	3 m	SA_3	Coastal construction erosion Eutrophication Urban and tourism pollution	Partial overlap with proposed MPA Stari Ulcinj	CARLIT
	Cape Marjan to Cape Đeran (zone 4)	41.97945 19.14081	41.90816 19.23321	3 m	SA_4	Coastal construction erosion Eutrophication Urban and tourism pollution	Partial overlap with proposed MPA Stari Ulcinj	CARLIT

Sites 1 and 3 (Cape Azra to Cape Platamuni and Cape Volujica to Cape Marjan) are optimal for the application of CARLIT method because of the presence of continuous rocky substrate and a limited number of artificial substrates.

The second site (from Cape Platamuni to Cape Volujica) is situated between the two previously mentioned areas. The whole area stretching from Cape Arza to Cape Marjan is expected to be of the same water type and it is, therefore, appropriate to apply the methodology to the whole coastline, excluding the many beaches situated in this area, where is not possible to implement the CARLIT.

The monitoring programme based on the CARLIT method on the site 4 (from Cape Marjan to Cape Đeran) will be implemented only after an evaluation of species sensitivity levels for the transitional waters in the Adriatic Sea and definition of the reference values have been completed. The underlying rationale is that this area belongs to the transitional waters and the sensitivity levels defined by Nikolic *et al.* (2013) only apply to the open waters of the Eastern Adriatic Sea.

1.1.4. Methodology of sampling and measuring

CARLIT is a methodology that helps get a fast start on data collection in the sense of different data on the condition of shoreline and shallow water species and communities. The method has already been proven to work for WFD and will be used for several components of the Habitats Directive. CARLIT is based on detailed mapping of littoral communities to be conducted by a visual inspection from a small boat sailing along the coastline. The GPS position has to be marked each time when there is a discontinuity of the dominant community and/or of the geomorphological situation. Change of dominant communities and geomorphological situations can also be marked on orthophotos of the surveyed coast (using different colours to highlight different communities).

Data on the appearance of non-indigenous species (NIS) and physical damage of coastline and displacement of upper littoral communities must be collected for Ecological Objectives EO2 (non-indigenous species), EO6 (seafloor integrity) and EO7 (hydrography).

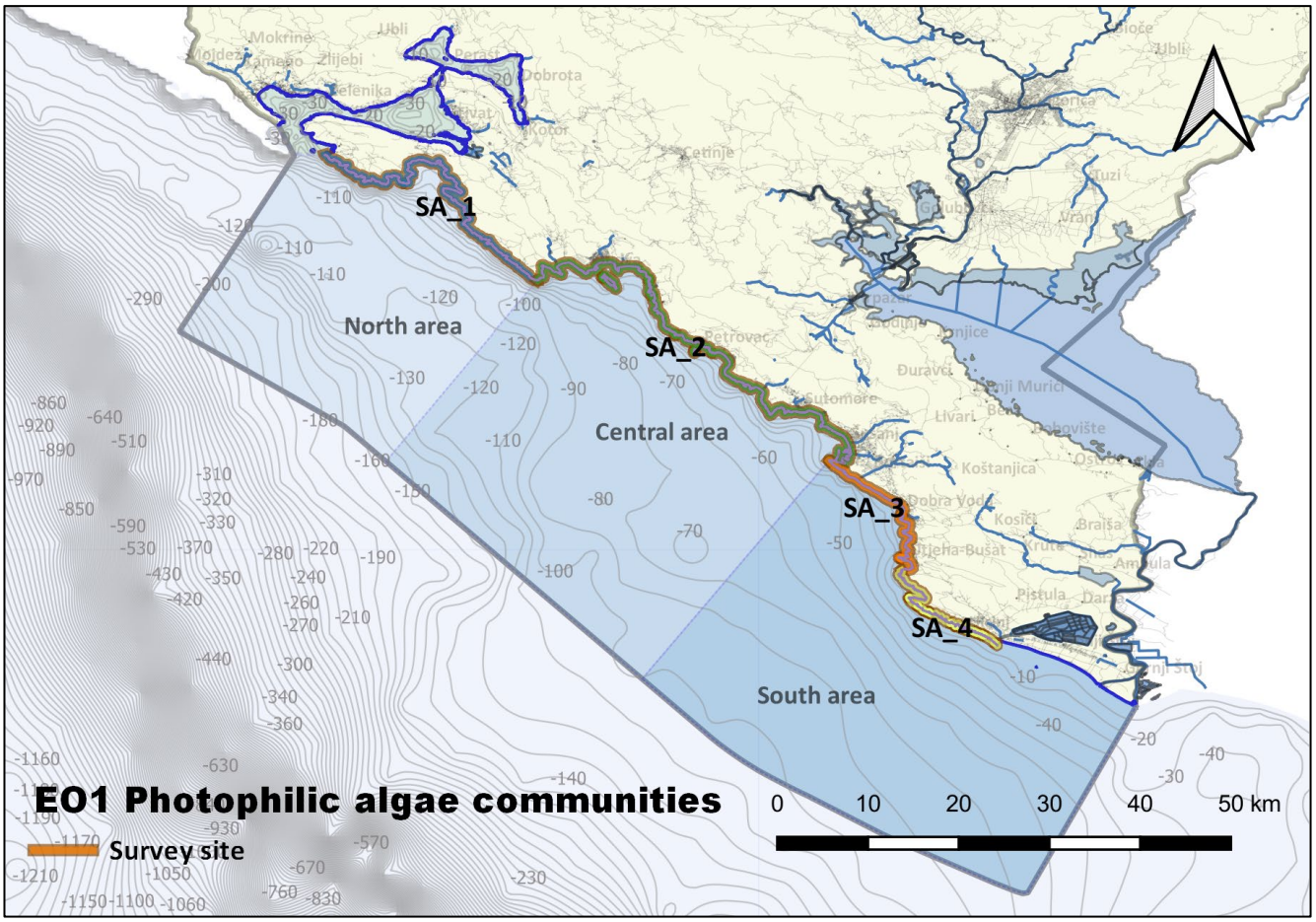


Figure 1.1: Monitoring sites proposed for CARLIT monitoring: 1. from Cape Arza to Cape Platamuni, 2. from Cape Platamuni to Cape Volujica, 3. from Cape Volujica to Cape Marjan, and 4. from Cape Marjan to Cape Đeran

1.1.5. Sampling frequency

CARLIT is to be performed every 3 years across all monitoring areas (Cavallo *et al.*, 2016). Having in mind that the area from Cape Marjan to Cape Đeran can be considered as transitional waters, priority shall be given to the three areas from Cape Arza to Cape Marjan. In practical terms, this can be organised in such a way that each area is monitored in a different year, within the 3-year cycle. Depending on the further analysis and the calibration of the CARLIT method for the transitional waters, it will be proposed how to deal with the remaining area (from Cape Marjan to Cape Đeran (Figure 1.1). In case further analysis shows that this area is also appropriate for CARLIT, it will be included in the monitoring every three years.

Due to the seasonality of the species considered, surveys will be conducted in the spring (from April to June).

1.1.6. Methodology for laboratory processing of samples

In general, there is no laboratory processing. In case of uncertain identification, samples of *Cystoseira* species should be collected for the identification by stereomicroscope and identification keys.

1.1.7. Data processing methodology

Every GPS waypoint is uploaded into Geographic Information System (GIS), and the length of each stretch of coast occupied by a specific community or characterized by a specific geomorphology structure is then calculated. A database including these elements and the sensitivity levels associated with each community (Ballesteros *et al.*, 2007), as well as a distribution map of the macroalgae communities, have been created for the entire rocky coastal area considered.

The Ecological Quality Value (*EQV*) is calculated using the formula (Ballesteros *et al.*, 2007):

$$EQV = \frac{\sum_i l_i \cdot SL_i}{\sum_i l_i}$$

where l_i is the length of the coastline occupied by the community "i" and SL_i is the sensitivity level associated with the "i" community.

The ecological quality of coastal waters facing the entire rocky coastal area considered is calculated using the formula (Ballesteros *et al.*, 2007):

$$EQR = \frac{\sum_i \frac{EQV_{ssi} \cdot l_i}{EQV_{rsi}}}{\sum_i l_i}$$

considering the ratio between the ecological quality values calculated in the study area (EQV_{ssi}) and the reference values (EQV_{rsi}) applicable to the study area (see Nikolić *et al.*, 2013) for each geomorphologically relevant situation along the entire coastline.

1.2. Component: *Posidonia oceanica* meadows

Seagrass *Posidonia oceanica* is widely distributed across the Adriatic and the Mediterranean Sea and it is considered one of the priority habitats (III.5. Infralittoral *Posidonia oceanica* meadows of SPA/RAC Updated Classification of Benthic Marine Habitat Types for the Mediterranean Region (SPA/RAC–UN Environment/MAP, 2019).

Given their wide distribution, their sedentary habit and susceptibility to changing environmental conditions, seagrasses are habitually used as biological indicators of water quality in accordance with the Water Framework Directive (WFD, 2000/60/EC) and of environmental quality in accordance with the Marine Strategy Framework Directive (MSFD, 2008/56/EC) (Montefalcone, 2009). Due to its recognized ecological importance, *Posidonia oceanica* is considered as the main biological quality element in monitoring programmes developed to evaluate the status of the marine coastal environment and particularly under the Integrated Monitoring and Assessment Programme (IMAP) of the Barcelona Convention (UNEP/MAP, 2016).

From the functional point of view, Posidonia meadows are considered as an 'essential fish habitat' for their role as a spawning and nursery area for many commercially important species of fishes and invertebrates (Francour, 1997; Procaccini *et al.*, 2003). *Posidonia* beds represent the most important ecosystem of the Mediterranean coastline for biodiversity, comprising 20 to 25% of Mediterranean plant and animal species (Boudouresque *et al.* 2006). They oxygenate coastal waters, producing net oxygen releases to the atmosphere above the meadows and are considered among the most efficient vegetated coastal systems for fixing CO_2 as organic matter (Duarte *et al.*, 2010; Pergent *et al.*, 2012).

On the other hand, *Posidonia* beds play a crucial role in the physical equilibrium of a large portion of the Mediterranean coasts: they attenuate waves and currents, reduce sediment resuspension, protect the beach from erosion and contribute to shoreline stabilization (Boudouresque & Jeudy de Grissac, 1983; Boudouresque *et al.*, 2006).

Contrary to many important characteristics of Posidonia meadows, they have not been studied as much as they should be in Montenegro so far. The first surveys intended to perform Posidonia meadows mapping, evaluation of meadows density, seasonal lepidochronology, anatomy of the leaves and heavy metals pollution were conducted for Boka Kotorska Bay (Mačić, 2001). At a later stage, several surveys were performed for mapping and evaluation of meadows density especially in the open part of the coast (Katič, Platamuni, Cape Ratac, Luštica, the island of Stari Ulcinj, etc.). Density of the Posidonia meadows in Boka Kotorska Bay is lower than that in the open sea and it can be attributed to the specific environmental conditions and anthropogenic pressures (mainly eutrophication). On the open part of the Montenegrin coast, Posidonia meadows are mainly in good condition and are found in some areas up to a depth of 30 m.

1.2.1. Common indicators

Common indicator 1:
Habitat distributional range considering also habitat extent as a relevant attribute

Common indicator 2:
Condition of the habitat's typical species and communities

Details regarding common indicators are shown in Section 1.1.1.

1.2.2. Selection of parameters

Mapping of *Posidonia oceanica*

In general, the methodology for mapping and map resolution are defined under the Habitat Directive. Once the mapping has been completed, sites for monitoring of *P. oceanica* distribution will be defined.

Monitoring of ecological status

In the Mediterranean, under the Water Framework Directive (WFD, 2000/60/EEC), several indexes have been developed by using *Posidonia oceanica* as a biological element for the definition of the ecological status of coastal water bodies (Romero *et al.*, 2007; Fernandez-Torquemada *et al.*, 2008; Gobert *et al.*, 2009; Lopez y Royo *et al.*, 2009; 2010a; Montefalcone, 2009).

The POMI (*Posidonia oceanica* Multivariate Index; Romero *et al.*, 2007; Mascarò *et al.*, 2012) that has been applied to the Croatian (Adriatic) coast (Nikolić *et al.*, 2009; UNEP/MAP-RAC/SPA, 2011; Mascarò *et al.*, 2012) is based on the combination of physiological, morphological, structural and community level seagrass metrics univocally related to environmental quality. POMI9 is one of the POMI versions that includes analyses of 9 selected parameters: shoot density, cover, leaf area, leaf necrosis, sucrose, nitrogen isotopic ratio, sulphur isotopic ratio, lead in rhizomes and nitrogen in epiphytes providing more detailed information on the state of the marine ecosystem and of *Posidonia oceanica* itself. Despite its effectiveness in assessing the ecological status of *P. oceanica* meadows, the POMI is methodologically demanding and could be very expensive, depending on the number of sites to be monitored.

Having in mind cost and effort efficiency of POMI method, we recommend the cost-effective approach "modified POMI" (RAC/SPA – UNEP/MAP, 2014) that has been developed for monitoring of *P. oceanica* meadows in Croatia and already tested and partially implemented in Montenegro (Guala *et al.*, 2014). The "modified POMI" method will help measure:

- lower limit type;
- shoot density;
- coverage of live plants and dead mat;
- lower and upper limit depth.

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

As soon as the appropriate conditions are established, it is recommended to apply the POMI as a method to monitor the ecological status of *Posidonia oceanica* in Montenegrin waters.

1.2.3. Selected study sites

Sites proposed for monitoring are shown in Table 1.2 and Figures 1.2 and 1.3).

Kotor is in the protected UNESCO site and, even if it is not a typical meadow, it should be monitored as a priority habitat under the strong anthropogenic impact (eutrophication, anchoring).

Herceg Novi is important as the site where *P. oceanica* is under regression, while on the other hand, this area is of very high importance for the health tourism (Igalo SPA centre) because of the peloids originated from *Posidonia*.

Four sites of Žukovica, the island of Katič and Buljarica, Cape Ratac and the island of Stari Ulcinj should be monitored because they are areas proposed for MPA designation. To the best of our knowledge so far, important and probably the largest *P. oceanica* meadows are found in Trašte Bay and in front of the town of Budva (Figure 1.3). Depending on the available funds and further results of the mapping, these two areas could be considered as potential sites for monitoring as well.

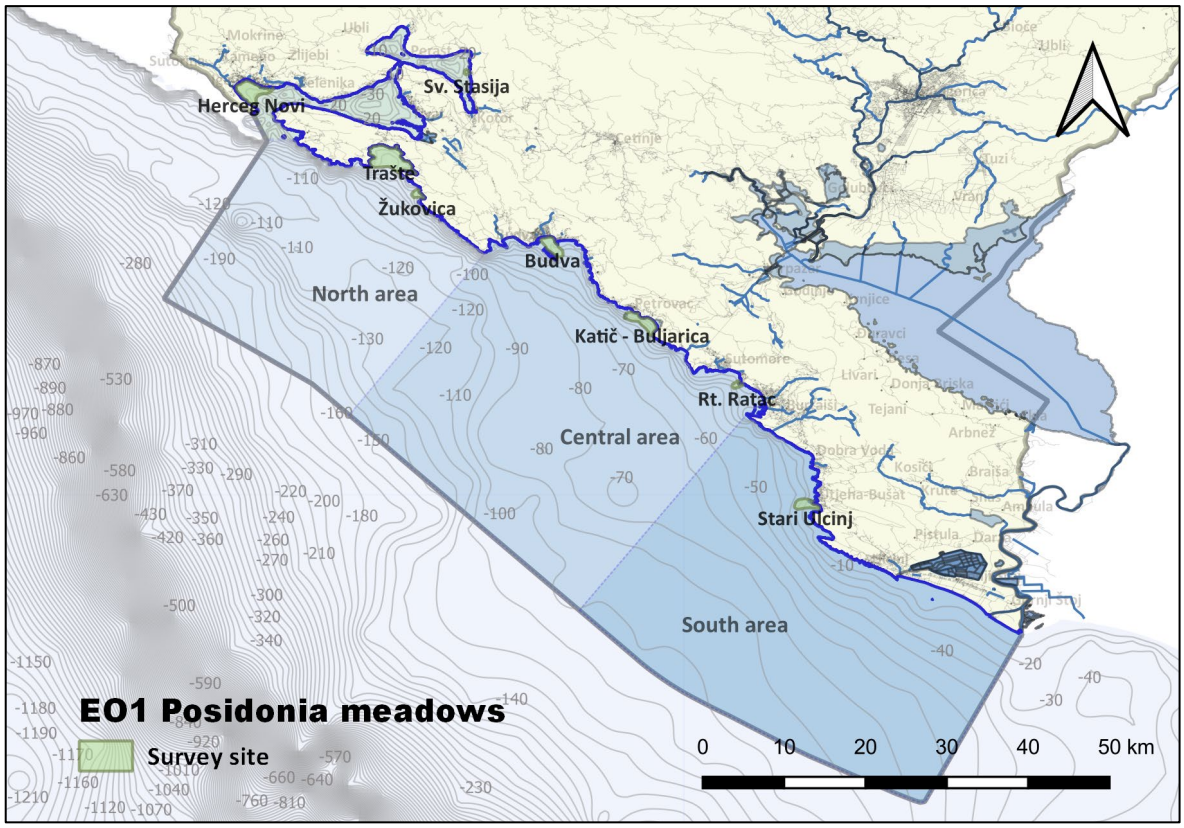


Figure 1.2: Monitoring sites proposed for *P. oceanica* monitoring: Sv. Stasija (Kotor), Herceg Novi, Trašte Bay, Žukovica, Budva, the island of Katič and Buljarica beach, Cape Ratac, the island of Stari Ulcinj

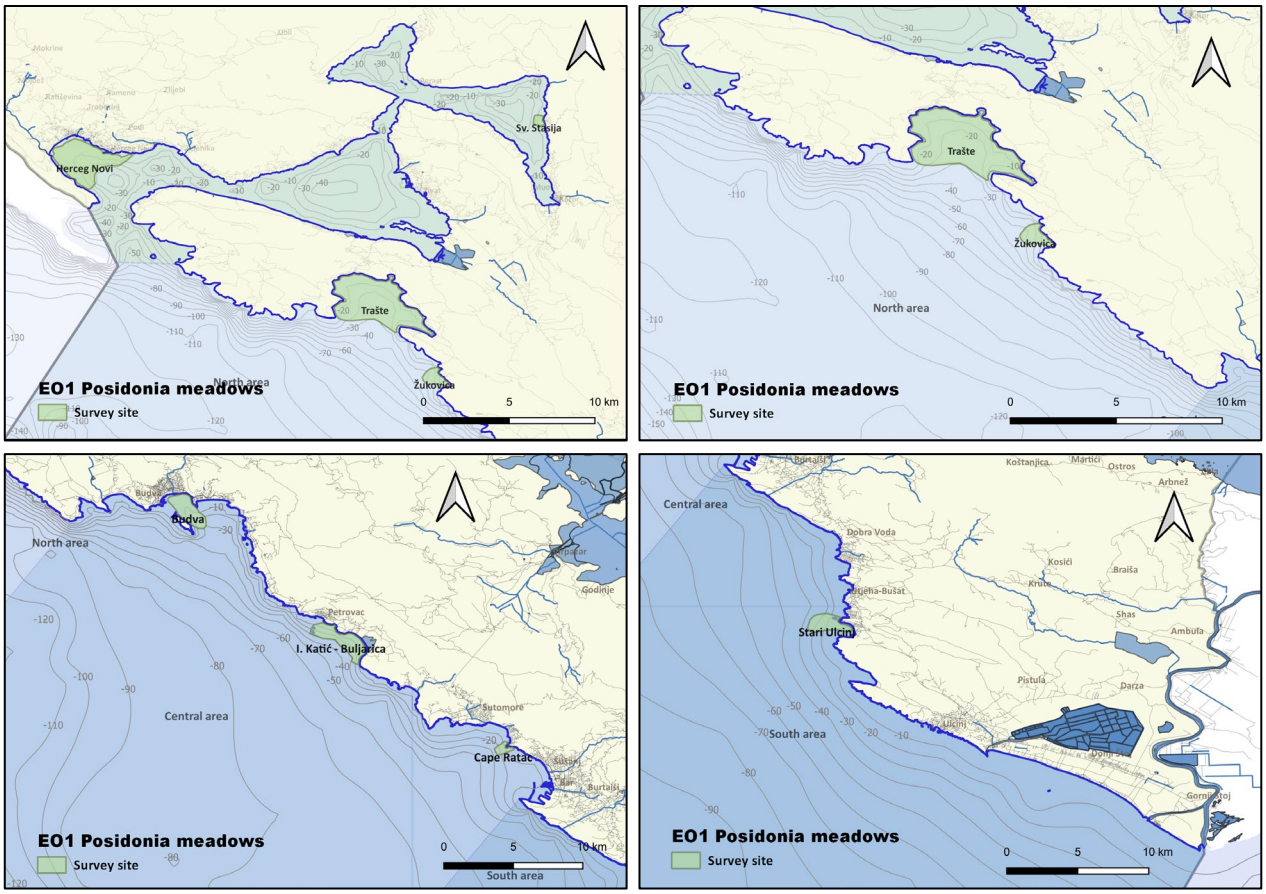


Figure 1.3: Detailed overview of *P. oceanica* study sites in Boka Kotorska, northern area, central area and southern area

Table 1.2: Selected monitoring sites for *Posidonia oceanica*

Area	Survey Site					Main Pressures	Inside MPA
	Site Name	Central Position	Min	Max	Max Depth		
Boka Kotorska	Sv. Stasija	42.46654 18.76063	42.46387 18.75754	42.46942 18.76351	15 m	Eutrophication, anchoring	Protected by UNESCO
	Herceg Novi	42.44524 18.52233	42.43029 18.50565	42.45715 18.54779	25 m	Eutrophication, anchoring	-
North	Trašte	42.36452 18.68645	42.35359 18.67323	42.37348 18.70513	30 m	Eutrophication, anchoring	-
	Žukovica	42.33158 18.70570	42.32711 18.69931	42.33698 18.71366	35 m	Fisheries, anchoring	Proposed MPA
Central	Budva	42.27388 18.85501	42.26241 18.84187	42.28453 18.86683	25 m	Eutrophication, anchoring	-
	Katič and Buljarica	42.19075 18.95399	42.17511 18.93399	42.20201 18.96975	30 m	Fisheries, anchoring	Proposed MPA
	Rt Ratac	42.12110 19.05881	42.11703 19.05313	42.12590 19.06598	25 m	Eutrophication, pollution	Proposed MPA
South	Stari Ulcinj	41.98914 19.13430	41.98372 19.12214	41.99559 19.15003	25 m	Fisheries, anchoring, eutrophication	Proposed MPA

1.2.4.
Methodology of sampling and measuring

At each sampling site, the depth and position of upper and lower limits (if any) could be recorded by mapping or direct measurement in the field by using depth gauge and GPS. The lower limit type has to be recorded in the field by conducting visual observations according to the characteristics (progressive, sharp, sparse, regressive) described in UNEP/MAP-RAC/SPA (2015).

Shoot density has to be assessed in the field by counting the number of shoots within 40x40 cm quadrats. Coverage of live plants and dead matte to be assessed (in %) in the field by visual assessment/photos/quadrats/transects.

1.2.5.
Sampling frequency

Frequency of monitoring activities should be defined after the mapping. Depending on the number of sampling sites and the budget available, two options are suggested: a) carry out monitoring of all sites every two years; b) sites are randomly divided into two sets and each year the sites within one set are monitored (Mayot *et al.*, 2006).

1.2.6.
Methodology of laboratory processing of samples

The methodology proposed for national monitoring protocol does not require any laboratory processing, but only data processing.

1.2.7.
Data processing methodology

Any method improves its accuracy by increasing the number of meadows used in the analysis. Moreover, assessing the spatial variability of selected variables at different spatial scales can provide a more detailed picture of the ecological status of each meadow. That is why for each of the proposed monitoring sites we recommend to perform data collection for selected variables on at least 3 depth ranges and at 3 stations within each depth.

The average number of leaf shoots detected in 40x40 cm frames is reported to the m^2 to assess the meadow density at each site and depth. Percentage cover of live plants and dead matte allows to calculate the conservation index (CI) of the meadows by the formula:

$$CI = \frac{P}{P + D}$$

where *P* is the percentage cover of living *P. oceanica* and *D* is the percentage cover of dead matte (Moreno *et al.*, 2001; Montefalcone *et al.*, 2006).

1.3.
Component: Coralligenous assemblages

Coralligenous habitat is insufficiently studied at the Adriatic level and there are neither precise historical nor recent data on its distribution and status. Cartography of coralligenous bottoms all over the Adriatic Sea is virtually non-existent. Little is known about the presence and abundance of species characteristic of the coralligenous habitat in different areas, but the available data indicate the high heterogeneity of the assemblages.

The inner part of Boka Kotorska Bay hosts rare and specific habitats known as "vrulja". These specific habitats are underwater freshwater springs that are creating a periodically strong inflow of freshwater and the connected currents, but more importantly, very specific coralligenous assemblages have developed there. Recent monitoring (Trainito, 2019) helps take one step forward in understanding the protected, endangered and rare benthic assemblages and at the same time offers indications on how future research activities may develop in the future and what measures can be implemented to reduce the impact of human activities.

Pressures and threats

Coralligenous assemblages are threatened by specific direct and indirect human activities, which affect the stability of this precious ecosystem and thus strongly compromise their future preservation. The effect of climate change, direct or indirect human-induced disturbances (mechanical damage), and the synergistic effects of these stressors (Cebrian *et al.*, 2012; Ballesteros, 2003; UNEP/MAP-RAC/SPA, 2008) are impacting the coralligenous assemblages mainly by:

- fishing practices interaction (mainly trawling and exploitation of the red coral), (fishing effort assessed within EO3 Monitoring);
- pollution (assessed within EO5 and EO9 Monitoring);
- sedimentation (assessed within EO7 Monitoring);
- biological invasions (assessed within EO2 Monitoring);
- impacts from divers.

1.3.1.
Selected common indicators

As biologically important, protected by different legislation, widespread and under significant human pressure, Coralligenous outcrops, including the species *Corallium rubrum*, might serve as good components for GES assessment under following common indicators:

Common indicator 1:
Habitat distributional range considering also habitat extent as a relevant attribute

Common indicator 2:
Condition of the habitat's typical species and communities

Details regarding common indicators are shown in Section 1.1.1.

Typical species

A list of species to be considered in the inventory and/or monitoring of coralligenous communities was provided in UNEP/MAP-RAC/SPA, 2011; Garrabou *et al.*, 2014; SPA/RAC, 2015.

1.3.2.
Selection of parameters

Some methods/indexes have been proposed for assessing the health status of coralligenous outcrops, for instance, the MAES (Cánovas-Molina *et al.*, 2016), the CBQI (Ferrigno et al 2017), CAI (Deter *et al.*, 2012), ESCA (Cecchi *et al.*, 2014), COARSE (Gatti *et al.*, 2015), EBQI (Ruitton *et al.*, 2015), INDEX-COR (Sartoretto *et al.*, 2015), OCI (Paoli *et al.*, 2016). Most of them include the assessment/measurement of structural and functional parameters:

- Species/Categories composition/abundance;
- Indicators on the degree of structural complexity;
- Indicators on coralligenous functioning: bioeroders and bioconstructors;
- Qualitative and semi-quantitative indicators on the impacts of different disturbances on coralligenous assemblages (e.g. presence of fishing nets, invasive species, sedimentation, strong diving pressure);

- The richness (α-diversity, i.e. the mean number of the taxa/groups per photographic sample);
- The β-diversity – as the mean distance of all photographic samples of each area from centroids calculated through PERMDISP.

An integrated and standardized procedure to evaluate the ecological status of coralligenous reefs (STAR) has been developed by Piazzi *et al.* (2018) for vertical substrates (85-90°) at a depth of around 35 m. The application of STAR procedure allows to apply most of the other indexes but in case of Montenegro, to the best of our knowledge, there are only two vertical coralligenous sites, while the majority is not on a vertical bottom. That is why, in this case, this methodology should be tested and possibly changed before implementation.

Due to the current gaps in the understanding of coralligenous assemblages in Montenegro, for this monitoring cycle, implementation of the monitoring protocol for coralligenous assemblage as implemented in Croatia (Garrabou *et al.*, 2014) is suggested.

Parameters that should be further elaborated are:

- Geographical and bathymetric distribution of coralligenous;
- State of colonies, abundance and size categories;
- If identified, red coral presence and abundance;

1.3.3. Selection of survey sites

The selection of the sampling sites depends on the spatial distribution of the assemblages and should take place once the mapping process has been completed. However, based on current knowledge and considering the particular geomorphological structure of the Montenegrin coast, sampling sites could be selected in three areas: inside Boka Kotorska Bay area, in the northern and central part of the open coast. In addition, if possible, the deep sea area could be included as well, but it is located outside the territorial borders. In each area, different sites are selected and an explanation of their main characteristics is provided because there are many differences between them.

Generally speaking, monitoring will take place at five sites (Table 1.3, Figures 1.4, 1.5).

Table 1.3: Selected survey sites for coralligenous assemblages

Area	Survey Site					Main Pressures	Inside MPA
	Site Name	Central Position	Min	Max	Max Depth		
Boka Kotorska	Dražin vrt	42.48265 18.71512	42.48201 18.71308	42.48385 18.71710	25 m	Marine litter, pollution, impact from divers	UNESCO, Preventive protection undergoing
	Strp (Sopot)	42.50975 18.68070	42.50802 18.67886	42. 51172 18.68249	27 m		UNESCO, Preventive protection undergoing
	Sv. Đorđe	42.48519 18.69112	42.48426 18.68979	42.48637 18.69220	30 m		UNESCO, Preventive protection undergoing
	Sv. Nedelja	42.45921 18.67461	42.45804 18.67213	42.46077 18.67722	34 m		-
South	Cape Rep	41.96882 19.14223	41.96122 19.13518	41.97836 19.15209	25 m		In the proposed MPA Stari Ulcinj

Four sites have been proposed in Boka Kotorska due to the exceptional environmental value and because of the differences between all of them. In Dražin vrt and Strp (Sopot), there are exceptionally large colonies of *Savalia savaglia* species of highest importance for the coralligenous (Mačić *et al.*, 2019). It is worth noting that these assemblages are found at very low depths, between 10 (15) and 25 m, which is extraordinary for this species (Giusti *et al.*, 2015). Their occurrence is likely linked to the presence of “vruljas” (underwater freshwater springs). These sites are considered as "a unicum in the Mediterranean" given that they could include almost half of all known populations of this species in the Mediterranean (Trainito, Baldacconi, 2016).

What makes Sv. Đorđe Island specific is the coral *Cladocora caespitosa* with many dead colonies of this species. In the Mediterranean, this species is among a few coral reef-building species and that is why it should be monitored.

Sv. Nedelja was selected because of the unique mix of different coralligenous species such as *Savalia savaglia, Leptogorgia sarmentosa, Axinela cannabina, Cladocora caespitosa, Spinimuricea klavereni*.

In the open sea, Cape Rep was proposed (Figure 1.5). Cape Rep was selected because of the outstandingly high density of protected sponge species *Axinella cannabina* and combination with coralligenous habitat. It is located in the future MPA Stari Ulcinj and it will be proposed for the highest level of protection.

1.3.4. Sampling frequency

Depending on the number of sampling sites and the budget available, it is suggested to:

1. Monitor coralligenous assemblages in Dražin vrt (or Sopot or both, depending on available resources) every year, due to its exceptional importance and unique nature, probably at the Mediterranean scale.
2. Monitor coralligenous assemblages on Sv. Đorđe and Sv. Nedjelja every year (or every two years, depending on available resources).
3. Monitor the coastal site Ponta Rep every two/three years.

Surveys should be planned from April to early October for scuba monitoring. In order to better observe these habitats and not to miss possible high events in one year (for example, because of high temperature), all selected locations could be randomly divided into two sets and each year the sites of one set are monitored. The only exception is Dražin vrt (or Sopot) that should be monitored every year.

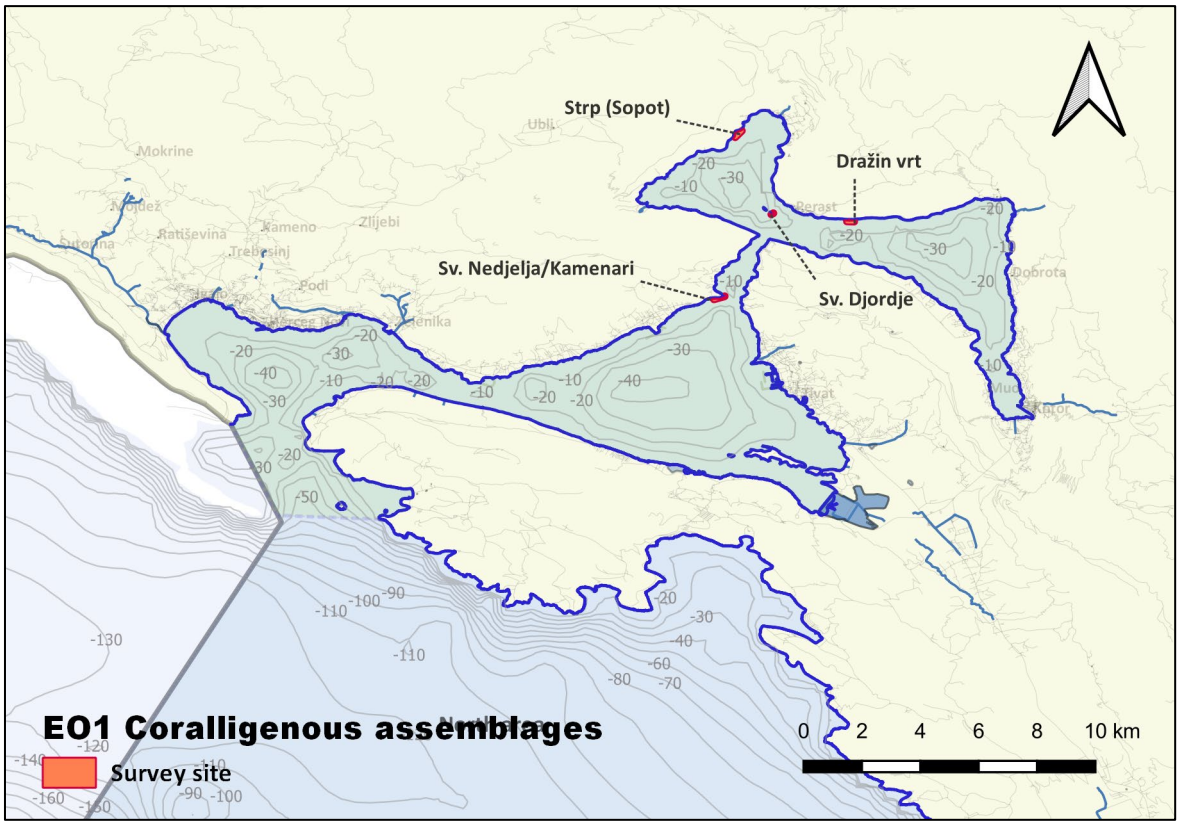


Figure 1.4: Sites proposed for Coralligenous assemblages monitoring in Boka Kotorska Bay: Dražin vrt, Strp, the Island of Sv. Đorđe and Sv. Nedjelja

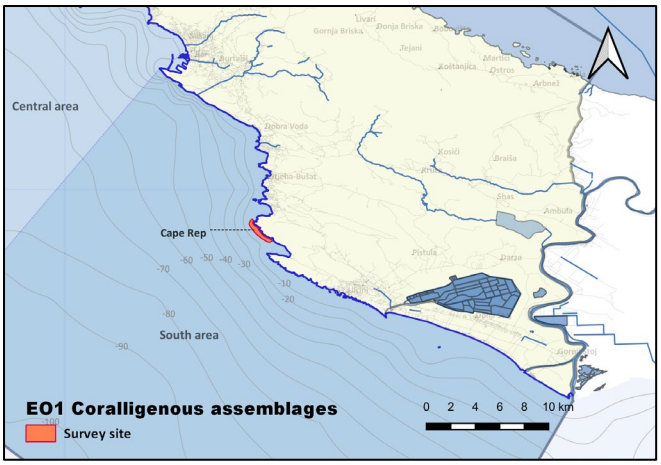


Figure 1.5: Site proposed for coralligenous monitoring in the open sea: Cape Rep

1.3.5. Methodology of sampling and measuring

Mapping and monitoring methods depend on the type of Coralligenous assemblage and depth range. For Coralligenous outcrops emerging from horizontal/sub-horizontal substrates that are predominant on deeper continental shelves (Cánovas-Molina *et al.*, 2016) acoustic data (e.g. SideScan Sonar and MultiBeam Sounder) are necessary to assess their distribution. Remote Operating Vehicles (ROVs) are the most common tools for ground truth and species/categories identification and abundance in deep water. For the coralligenous assemblages found on vertical or near-vertical walls *in situ* observation/ measurements are commonly used by scuba divers for

assemblages up to a depth of 40 m and by ROVs beyond this depth range (Garrabou *et al.*, 2014).

Since there is a lack of basic information on the coralligenous habitat, it is proposed to follow the basic methodological approach proposed for the Croatian Adriatic Sea coast (Garrabou *et al.*, 2014) and in line with the Standard methods for inventorying and monitoring coralligenous and rhodoliths assemblages (SPA/RAC, 2015).

The proposed methodology needs to be tested and possibly adjusted to become operational for this part of the Adriatic Sea. Furthermore, referential values have to be obtained and methodology for assessment and monitoring of red coral still has to be developed.

Sampling activities include:

- photo sampling;
- visual census along transects;
- visual census.

Photo sampling

A minimum of three areas of 2.5 m^2 (comprised of 10 contiguous photos of 50 x 50 cm quadrats to allow for species identification) should be photo sampled within the same depth range in each area. Photos will be further analysed in the laboratory and species at each study site will be identified to the lowest possible taxonomic level. For some taxa, voucher specimens should be collected to enable their identification.

Visual census along transects

Visual census along three 10 x 1 m horizontal transects should be conducted to assess the erect layer (by estimating the abundance of arborescent and massive species that can reach heights above 15 cm). Visual census along the same transects will also be conducted to estimate the abundance of macrobioeroders such as sea urchins *Sphaerechinus granularis* and *Echinus* sp. (by counting the total number of individuals of each species in each quadrat along the same transects) and to assess the cover of mucilaginous aggregates. The following classification was applied:

- Category 0 (Null): 0% cover of the transect;
- Category 1 (Low): low abundance in the basal-intermediate layers (composed of species below 15 cm in height) and/or in the erect layer;
- Category 2 (Medium): High abundance either in the basal-intermediate layers or in the erect layer;
- Category 3 (High): High abundance both in the basal intermediate layers and in the erect layer.

The thickness of the calcareous layer should be measured through a hand-held penetrometer with a minimum of six replicated measures per area. The size (mean height) and the percentage of necrosis and epibiosis in erect anthozoans should be assessed visually, measuring the height of the tallest colony for each erect species and estimating the percentage cover of the colonies showing signs of necrosis and epibiosis. The percentage cover of sediment in each sample should be estimated. The percentage cover of the conspicuous taxa/morphological groups should be evaluated for each sample. The overall SL should be calculated by multiplying the value of the SL of each taxon/group for its class of abundance and then summing up all the final values. Piazzi *et al.* (2018) propose to classify the cover values of each taxon/morphological group in eight classes of abundance:

1. 0 to ≤ 0.01%;
2. 0.01 to ≤ 0.1%;
3. 0.1 to ≤ 1%;
4. 1 to ≤ 5%;
5. 5 to ≤ 25%;
6. 25 to ≤ 50%;
7. 50 to ≤ 75%;
8. 75 to ≤ 100%.

The richness (α-diversity, i.e. the mean number of the taxa/groups per photographic sample) should be computed. The β-diversity could be evaluated as the mean distance of all photographic samples of each area from centroids calculated through PERMDISP.

Visual census

This method will be applied to assess the level of impact of disturbances such as fishing gear and mass mortalities of gorgonian populations. Direct observation of the presence and type of fishing gear at the study site should be conducted. If fishing net/long line is observed in the coralligenous habitat, its length will be estimated. The assessment of the conservation status of gorgonian populations (to provide estimates on the impacts of mass mortality on gorgonian populations), quantifying the percentage of affected colonies should be done at each

study site where gorgonians are present in well-developed populations. A colony will be considered as affected when the necrosis rate is above 10% of its total surface. For affected colonies, it should be noted whether the necrosis has appeared recently (approximately 1-12 months old injury, denuded axis or axis colonized by pioneering species such as hydrozoans, old (approximately ≥ 12 months, axis covered by long-lived species such as bryozoans, calcareous algae) or both types of necrosis have appeared.

To detect potential temperature anomalies, temperature data loggers should be set up along a vertical transect (placed at every 5 m down to a depth of 40 m) at the selected site within the region.

1.3.6. Data processing methodology

Coralligenous outcrops: Standard analyses and processing of data according to Garrabou *et al.* (2014), in line with the UNEP/MED WG 461.21.

Red coral (*Corallium rubrum*): Analysis of photo and video documentation to determine the distribution and demographic structure of red coral along each transect. Baseline value should be determined to monitor trends in red coral colony development in subsequent periods.

1.3.7 Monitoring interconnections of benthic habitats with other EOs

Interconnections and interactions between benthic habitats and other biodiversity components and ecological objectives are to be reflected in planning and undertaking monitoring programme. Proposals for overlapping monitoring stations are developed having in mind the relevance and distribution of the habitats, as well as locations of the (future) MPAs. For example, spatial interactions of *Posidonia oceanica* monitoring stations with eutrophication and contaminants are reflected in each of the four monitoring areas to enable integrated assessment of disturbance sources and impacts on the habitats. In addition and due to its relevance, information on non-indigenous species (EO2), basic hydrographic data (EO7) and amount of litter on the seafloor (EO10, CI23) should be recorded as well, even at the sites where there is no overlapping of monitoring stations.

Detailed information about the interconnections between benthic habitats and other EOs in Montenegro is provided in Annex 1. The rationale for interactions and interconnections between EOs is provided in Annex 2.

1.4. Pelagic habitat (relating to EO1)

In the Adriatic Sea, plankton community is generally characterized by the high diversity of both, phyto and zoo components. Within phytoplankton, there are more than 888 phytoplankton species recorded and the number is constantly increasing. The actual number of zooplankton species is more difficult to estimate, but current investigations point at 850 holoplanktonic and approximately 20 times as many meroplanktonic taxa. Therefore, phytoplankton and zooplankton are crucial for supporting the structure of the pelagic community, the pelagic food web and the marine ecosystem as a whole. Additionally, planktonic species have short life cycles and respond quickly to changing environmental conditions such as changes in salinity regime, in temperature, nutrients enrichment of marine ecosystems, and biological disturbance such as an introduction of non-indigenous species. Therefore, plankton is a good indicator of the trophic status and helps advance early detection of changes in the marine environment.

1.4.1.
Common indicators

Common indicator 1: Habitat distributional range considering also habitat extent as a relevant attribute	
This indicator is area-related, i.e. the proportion of the area of habitats that are permanently or for a long-lasting period lost or subject to change in habitat type due to anthropogenic pressures.	
GES definition	The habitat is present in all its natural distributional range.
Operational objective	Coastal and marine habitats are not being lost.

Common indicator 2: Condition of the habitat's typical species and communities	
GES definition	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.
Operational objective	Coastal and marine habitats are not being lost.

1.4.2.
Component: Phytoplankton

1.4.2.1. Selection of parameters

The composition and abundance of phytoplankton community and its temporal and:

- seasonal variability;
- Indices of diversity.

The ratios of the key functional groups of plankton

1.4.2.2. Selection of sampling sites

The sampling of plankton communities will be performed at the stations selected for eutrophication (see Subchapter 3.2.)

1.4.2.3. Sampling frequency

Phytoplankton community in the temperate seas where the Adriatic Sea belongs to are characterized by the pronounced seasonal cycle largely determined by the available amount of nutrients as well as the available light intensity. The bimodal seasonal cycle of the phytoplankton community causes the seasonal variation of zooplankton. The ratio of the most numerous taxonomic groups of diatoms and dinoflagellates also has a pronounced seasonal character caused by its different temperature optimum. Based on the above-mentioned seasonal variability in the plankton community, seasonal sampling, or sampling at least twice a year is recommended.

1.4.2.4. The methodology of sampling, measurement and laboratory work

See Section 3.5.2.

1.4.2.5. Data processing

The monitoring programme is designed to detect changes in the plankton community and connect them with anthropogenic influence using the correlation analysis. Assessment will be based on the grouping of planktonic organisms into functional groups, graphical representation of the abundance of each of these groups, the definition of seasonal changes and the tracking trends based on the difference in abundance and/or biomass of certain functional groups and life forms.

The goal of the monitoring is to determine changes in the plankton community caused by anthropogenic influence. The analysis of the above-mentioned indicators with the physicochemical characteristics of the water column as well as the analyses of ecological characteristics of the target species will be used to determine the changes in the community's response to climate, anthropogenic or natural driven changes in the environment.

Among the features listed in Annex III of the MSFD, the plankton monitoring programme will primarily contribute to determining the biological characteristics of the community, the description of the biological community concerning environmental conditions, including information on phyto- and zooplankton communities, as well as changes

in the composition and seasonal and geographical changes. The proposed monitoring will contribute to the collection of information on abundance and temporal and spatial distribution of introduced and invasive species.

1.4.3. Zooplankton Component

1.4.3.1. Selection of parameters

Within the framework of the zooplankton monitoring, it is necessary to analyse:

- the community composition;
- species distribution and seasonal variability;
- the abundance of selected zooplankton groups (radiolarians, tintinnids, copepods, cladocerans, gelatinous species and meroplanktonic larvae).

1.4.3.2. Selection of sampling sites

The sampling of zooplankton communities will be performed at the stations selected for eutrophication and phytoplankton community (see Subchapter 3.2).

1.4.3.3. Sampling frequency

For monitoring of zooplankton parameters, a seasonal sampling is proposed, alternatively, sampling needs to be done at least twice a year in different periods of stratification of the water column.

1.4.3.4. Sampling methods

Microzooplankton is sampled with 5L Niskin bottles at oceanographic depths (0, 5, 10, 20 m and 2 m above the bottom). The samples are preserved with 2.5% formaldehyde-seawater solution, previously buffered with $CaCO_3$. The abundance is expressed as the number of cells per litre (cells L^{-1}).

In shallow coastal areas, mesozooplankton samples are collected by vertical hauls from the bottom (1-2 m above) to surface using Nansen plankton net, 0.55 m diameter and 125 µm mesh size. At deeper sites (in the open sea), mesozooplankton is sampled in layers, from the thermocline to surface in one vertical haul and from the bottom (1-2 above) to the thermocline, with WP2 plankton net, 0.55 m diameter, 125 µm or 200 µm mesh size with the closing system. The samples are preserved in 2.5% formaldehyde-seawater solution, previously buffered with $CaCO_3$. The abundance is expressed as the number of organisms per cubic meter (ind. m^{-3}).

1.4.3.5. Laboratory processing of samples

Species identification and counting of microzooplankton organisms are performed using the inverted microscope at 100x and 400x magnifications. Both types of samples (bottle and net) are counted in a glass chamber (70 x 45 x 5 mm) and partially analysed. The total number of individuals is made from the count of aliquots: 1/4 for the bottle sample or ranging from 1/5 to 1/10 of the net catch. Whenever possible, taxonomic identification is performed at the species level. The entire sample is examined for a rare species. Abundances of specimens collected by Niskin bottle and Nansen net should be expressed as the number of organisms per litre (individuals L^{-1}) and cubic meter (individuals m^{-3}), respectively.

Mesozooplankton organisms are counted and classified in the subsamples obtained by "splitting" method (1/16 – 1/64 part of the sample). As a quantitatively representative subsample is accepted one in which at least 300 crustacean copepods, which are the most abundant part of this size fraction, are recorded. To record the rare species, it is necessary to examine the entire sample.

Counting and species identification of plankton material are performed using the inverted microscope at 40-400x magnifications. Abundances are expressed as the number of individuals per cubic meter (individuals m^{-3}). Radiolarians are identified based on their morphology skeleton using taxonomic keys Haeckel (Haeckel, 1887), Borgert (Borgert, 1906, 1911), Boltovskoy (Boltovskoy, 1999), Kling and Boltovskoy (Kling and Boltovskoy, 1999) and Kršinić and Kršinić (Kršinić F. and Kršinić A., 2012). Tintinnids are identified according to the lorica morphology and species description given by Kofoid and Campbell (Kofoid and Campbell, 1929, 1939), Balech (Balech (1959), Alder (Alder, 1999) and Kršinić (Kršinić, 2010). For the taxonomic determination of copepods and gelatinous organisms the following sources are used: Giesbrecht (1892), Nishida (1985), Sars (1918), Bradford-Grieve (1994), Frost and Fleminger (1968), Rose (1933), Wrobel and Mills (1998), Razouls and associates (Razouls *et al.*, 2005-2014 http://copepodes.obs-banyuls.fr/en).

1.4.3.6. Data analysis

For statistical data analysis, Microsoft Excel and PRIMER 5 for Windows programs are suggested. The biodiversity indices, Shannon-Wiener (H') and Pielou (J'), as well as the number of species (S) are used to analyse changes in the composition of the community of tintinnids, radiolarians and copepods at the spatial and seasonal scale.

Tintinnids determined to the genus level are counted only when no other species of the same genus occurred in the same sample. The Coxliella forms are not included in the species matrix. Cumulative (k-dominance curves) are used to compare the dominance of the species of the listed zooplankton groups against their numbers.

Method of non-metric multidimensional scaling (n-MDS) was applied to show the relationships of selected zooplankton groups at different stations. To reveal similarities between stations the Bray-Curtis similarity is computed on log(x+1) transformed average abundance data matrix of the above groups. Principal component analysis (PCA) is used to extract the stations based on the changes in abundance of the main zooplankton groups. The analyses are based on the correlation matrix of normalized variables.

1.4.4. Monitoring interconnections of pelagic habitats with other EOs

When conducting monitoring of pelagic habitats, linkages and interactions with other ecological objectives should be taken into consideration. The parameters of plankton communities are closely associated with changes in EO1, EO2, EO3, EO4, EO5 and EO7.

Monitoring of pelagic habitats shall be performed jointly (and at the same sampling stations) with EO5 and EO7.

Detailed information about the interconnections of pelagic habitats with other EOs in Montenegro is provided in Annex 1. The rationale for interactions and interconnections between EOs is provided in Annex 2.

1.5. Component: Marine mammals (Cetacea)

Ten species of Cetaceans were recorded in the Adriatic Sea. They include common bottlenose dolphin (hereafter bottlenose dolphin) *Tursiops truncatus*, striped dolphin *Stenella coeruleoalba*, short-beaked common dolphin (hereinafter common dolphin) *Delphinus delphis*, Cuvier's beaked whale, *Ziphius cavirostris* and Risso's dolphin, *Grampus griseus* considered native, fin whale, *Balaenoptera physalus* and sperm whale, *Physeter macrocephalus* considered as a regular visitor, and false killer whale, *Pseudorca crassidens*; long-finned pilot whale, *Globicephala melas* and humpback whale, *Megaptera novaeangliae* considered as a vagrant (Fortuna *et al.* 2015; Holcer *et al.* 2015).

Montenegro's sea has different physiography (depth, bottom type, slope, habitat, morphology etc.), which is why several species can find suitable habitat within the Montenegrin waters. According to the results of the aerial surveys in 2010 and 2013 (Holcer and Fortuna, 2015; Holcer *et al.*, 2015) coastal waters seem to be almost exclusively inhabited by bottlenose dolphins. Boat-based surveys carried out from May to September 2013 along the entire Montenegrin coast identified 74 distinct individual bottlenose dolphins, while the presence of juvenile animals point to the use of the coastal waters as breeding area (Miočić-Stošić *et al.* 2019). In the offshore areas, striped dolphins are the most abundant (Fortuna *et al.*, 2018). In addition, species distribution modelling indicate slope and abyssal parts as important habitats for Cuvier's beaked whale. Risso's dolphins have also been observed within the similar area, particularly over the slope.

Within the territorial waters, only bottlenose and striped dolphins are present in a relatively large number and according to the current knowledge, they are present year-round (Đurović *et al.*, 2016). Therefore, these two species should be considered relevant for monitoring as indicators.

1.5.1.
Common indicators

Common Indicator 3: Species distributional range	
This indicator is aimed at providing information about the geographical area in which marine mammal species occur. It is intended to determine the species range of cetaceans that are present in Montenegrin waters, with a special focus on the species selected by the Parties.	
GES definition	The species are present in all their natural distributional range.
Operational objective	Species distribution is maintained.
GES target	The distribution of marine mammals remains stable or expanding and the species that experienced reduced distribution in the past are in the favourable conservation status and can recolonize areas with suitable habitats.
Target evaluation method	Selected species distribution follows the expected distribution pattern. Target is monitored using standardized mapping method.
Common indicator 4: Species population abundance	
CI4 is aimed at providing information about the abundance of marine mammals population. It is intended to determine the abundance and density of cetaceans species that are present in Montenegrin waters, with a special focus on the species selected by the Parties.	
GES definition	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.
Operational objective	The population size of selected species is maintained, or, if depleted, it recovers to natural levels.
GES target	No human-induced mortality is causing a decrease in breeding population size or density. Populations recover towards natural levels.
Common Indicator 5: Population demographic characteristics	
This indicator is aimed at providing information about the population demographic characteristics of marine mammals in the Mediterranean Sea. Monitoring effort should be directed to collect long-term data series covering the various life stages of the selected species. This would involve the participation of several teams using standard methodologies and covering sites of particular importance for the key life stages of the target species.	
GES definition	Cetaceans: species populations are in good condition: low human-induced mortality, balanced sex ratio and no decline in calf production.
Operational objectives	Population condition of selected species is maintained.
GES Targets	Cetaceans: a preliminary assessment of incidental catch, prey depletion and other human-induced mortality cases followed by implementation of appropriate measures to mitigate these threats.
Target evaluation method	Natality rate within the selected species population is maintained, while mortality is not changing.

Apart from monitoring the CIs, it would be necessary to assess the anthropogenic impacts on Cetacean populations causing changes in the number, distribution and the status of the species include the shortage of prey due to:

- overfishing;
- incidental bycatch and mortality in fishing gear;
- pollution (toxic materials, junk) and the occasional intentional killing of individuals;
- cumulative impacts of anthropogenic activities on species are also a reason for concern (naval transit, fishing, seismic research, hydrocarbon exploitation, pollution, etc.).

1.5.2.
Selection of parameters

The following parameters, for respective indicators, are taken into consideration:

- Distributional range (CI3) – data on sighting locations of two species selected for monitoring, gathered as part of the aerial survey, is used to ascertain their distribution areas within the entire subregion;
- Population abundance (CI4) – abundance estimation is conducted for the two species selected for monitoring in the entire subregion as well as abundance estimations for local populations of common bottlenose dolphins;
- Population demographic characteristics (CI5) – one of the main demographic characteristics is the birth rate.

1.5.3. Selection of study sites

Subregional (Adriatic) approach

To achieve successful monitoring, the activities must be carried out across the Adriatic Sea through the joint efforts by all Adriatic countries. Based on the oceanographic characteristics of the Adriatic Sea and the existing knowledge of the presence, distribution and relative density of the target species – the bottlenose dolphin – the survey will be organised to cover one main stratum. The Adriatic Sea will be covered from north to south with a series of 53 parallel transects at 15 km spacing (Figure 1.6).

Territorial sea approach

Within the territorial sea, surveys should be organised covering the area in two parts – the first from Croatian-Montenegrin border to Petrovac, with the main base of operations located in the fishing village of Bigova, and the second one from Petrovac to the Bojana River estuary and the Albanian border, with the city of Bar as the main base of operation (Figure 1.7).

1.5.4. Measuring methodology

Several different methods for data collection and analysis should be applied to achieve coherent monitoring of the status and trends in abundance, distribution and health of populations of marine mammals. Using all of the methods and developing monitoring activities for all the species present within the Montenegrin waters would require substantial financial and human resources. Following the main aim of the ecosystem approach where selected indicators should provide enough data required for the assessment of the status of the marine environment and species, it is proposed to use the bottlenose dolphin and the striped dolphin as main indicators of the GES (good environmental status) related to biodiversity of marine mammals as a component of the ecosystem.

Due to the migratory nature and wide distributional range, monitoring of selected species would benefit from subregional approach and development of common monitoring methodology used at the level of south Adriatic, or even Adriatic in general. That is relevant for the offshore areas inhabited by striped dolphins and other cetaceans.

The following programme using different methodologies which would provide data needed for evaluation of the Common indicators is proposed:

A. Photo-identification method (mark-recapture)

Photo-identification as a method is successful in monitoring smaller, resident populations where individual animals can be observed repeatedly during a certain period. Following the same population over the years can provide necessary long-term monitoring data and provide insight into population status and parameters. This method is labour intensive but provides robust data for population monitoring. Photo-identification is carried out using small boat-based surveys regularly. Researchers follow the standard protocol for field data collection, including survey effort, environmental conditions and surveyed transects by using a GPS. When groups of dolphins are spotted, data collected include group size and group composition and animal behaviour. Additionally, researchers should make high-quality photographs of dorsal fins of each animal in the group as that serves as the basis for subsequent analysis. Photographs should document naturally occurring markings on their dorsal fins and bodies. Such records of scars, nicks, notches or colour patterns are later used to uniquely identify some individuals.

The surveyed area should be organised considering suitable habitat and animal distribution but also the logistics of survey organisation. Therefore, within the territorial sea, surveys could be organised covering area in two parts – the first part covering the area from border with Croatia to Petrovac n/m with the main base in Bigova or Budva and the second part covering the area from Petrovac n/m to the Bojana River and border with Albania with main base in Bar. The period from May to October needs to be covered in a survery providing equal coverage and enough sightings to be able to perform the necessary analysis of abundance, distribution and demographic parameters.

Initial boat-based surveying of the Montenegrin coast using photo-identification provided baseline information on the population of bottlenose dolphins inhabiting these waters.

Figure 1.6: Selected transects for monitoring of the abundance and distribution of common bottlenose dolphin and striped dolphin in the Adriatic Sea (Source: Proposal of the monitoring and observation system for future environmental assessments of Croatia, 2012)

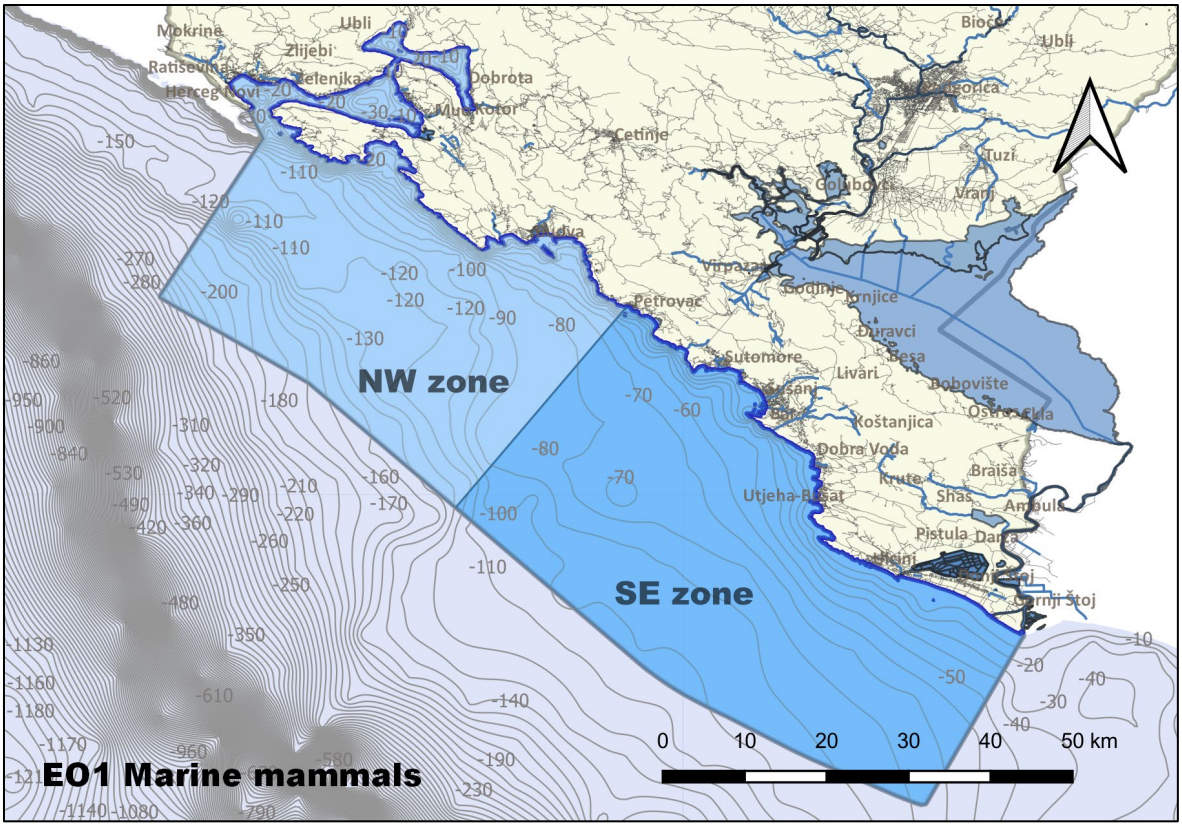


Figure 1.7: Survey sites for marine mammals national monitoring within Montenegrin marine waters

B. Aerial survey for abundance and distribution

To determine the distribution and population abundance, aerial survey using conventional distance sampling is a method of choice. Using such methods, aerial surveys have been used in the Adriatic and the Mediterranean Seas in the recent years, hence the need for expertise both in developing the surveys and in data analysis (see Fortuna and Holcer, 2013). Furthermore, within the ACCOBAMS, an international agreement ratified by Montenegro, the Aerial Survey Initiative project aiming to establish the Mediterranean wide information on cetacean distribution and abundance has been conducted in 2018, providing additional data and offering training to contracting parties.

The basic concept of the Distance Sampling method is that the perpendicular distance between an observer and all sighted "objects/animals/groups" along the transects can be used to estimate the effective strip width covered by observations (for more details see: Buckland *et al.*, 2001; Buckland *et al.*, 2004; Thomas *et al.* 2010). Therefore, the density of "objects/animals/ groups" $\widehat{D}$ can be estimated by using the following formula:

$$\widehat{D} = \frac{n\bar{s}}{2eswL}$$

Data processing after the aerial survey includes data quality checking and correction, effort and sighting layers development, calculation of the distance to observed animals and data testing. The analysis is performed using the software DISTANCE and a model for abundance estimate is produced by using CDS. Detailed methodology is presented by Buckland *et al.* 2001 and Buckland *et al.* 2004.

In addition to obtaining animal abundance, collected data are used for the analysis of distribution pattern using predefined grids and/or different data models like in Fortuna *et al.* (2018).

An aerial survey using the CDS method uses predefined area covered by several predefined transects, therefore, it can provide a standardised approach to monitoring of the CI3 and CI4 for both selected species.

C. Strandings and bycatch monitoring

Although monitoring of strandings and bycatch of marine mammals cannot provide substantial data needed to report on the indicators of GES, the data obtained through collection of stranded and bycaught animals can provide supplementary information needed to monitor population health and identify factors that could have a major impact on the populations of marine mammals. Through work of stranding network, the outbreak of infectious diseases potentially causing mass mortalities can be detected (reflecting on the population status of the entire population or its parts). Also, monitoring of bycatch can help identify the presence of particular interaction in some regions or interaction with a particular fishing tool enabling the evaluation of the population impact etc.

In addition to direct data, monitoring of stranding and bycatch can provide data needed for further analysis like a toxicological burden, genetic analysis, animal and population health status, etc.

To obtain the relevant data that would provide the most useful addition to monitoring of the status of marine mammals, the effective stranding network should be organised on the national level. A good policy and guidelines document have been prepared by RAC/SPA[3].

In addition to providing data on marine mammals, the stranding network can provide relevant information for monitoring of other animals, including sea turtles.

1.5.5. Measuring frequency

Given that marine mammals are long-living organisms, identifying changes in their abundance and distribution is not easy unless mass mortality events occur. Therefore, the required sampling frequency should be every third year. Such interval would ensure enough information for monitoring and identifying trends.

Monitoring by photo-identification method has to be organised every year, primarily because natural marking on the animals change during time, therefore, longer intervals could provide wrong identification and delayed, wrong population estimates.

[3] Guidelines for the Development of National Networks of Cetacean Strandings Monitoring, RAC/SPA Tunis, 2004

1.5.6.
Data processing methodology

After the aerial survey, data processing includes data quality checking and correction, effort and sighting layers development, calculation of the distance to observed animals and data testing. The analysis is performed using the software DISTANCE and a model for abundance estimate is produced using CDS. Detailed methodology is presented by Buckland *et al.* 2001, Buckland *et al.* 2004.

Processing of collected data during boat-based local surveys includes organisation and control of collected information, identification of photographed individuals and matching with other records, creation and subsequent update of a photo catalogue with identified individuals and the preparation of capture histories.

Individual dolphins encountered during surveys are associated with sighting data, like the location of observation, group size and composition as well as behaviour. Such data are analysed to provide information on habitat use, movements and life history characteristics of individual cetaceans and also estimates of other population parameters (survival rates, population viability, demographic characteristics, etc.).

Data collected during boat-based local surveys is also used for population abundance estimate using the mark-recapture method as each animal photographed and identified can be considered "marked" (Hammond *et al.* 1990). Methodology and mark-recapture analysis using MARK software package in the Adriatic has been described by a number of authors (Fortuna, 2006; Holcer, 2012; Pleslić *et al.*, 2013).

Data collected using this method can be used for monitoring of the CI3, CI4 and CI5 for bottlenose dolphin inhabiting territorial and coastal waters. The results of initial surveys carried out in 2013 (Đurović *et al.*, 2016; Miočić-Stošić *et al.*, 2019) can be used as the necessary baseline.

1.5.7.
Additional monitoring activities

The effectiveness of proposed monitoring methods should be regularly re-evaluated to refine and adjust the monitoring methodology.

Furthermore, the limits of organising monitoring during the warmer part of the year should be acknowledged given that data related to the winter period will not be available. Nevertheless, as monitored species are present in the Montenegrin waters throughout the year, the results of the monitoring should be enough to assess the GES.

To establish a finer population structure, the genetic analysis should be conducted on samples provided through stranding network and supplemented through biopsy of live animals (for example during photo-identification surveys). As shown by Gaspari *et al.* (2013), bottlenose dolphin population shows distinct structure across the Adriatic, therefore, understanding it on a local level would greatly improve monitoring and conservation.

Finally, photo-identification data should be further evaluated to help better understand the population demographics beyond the natality required for CI5.

1.5.8.
Monitoring interconnections of marine mammals with other EOs

Integration with the monitoring of other EO1 components, such as marine turtles, should be ensured. In addition, and mainly due to cost-effectiveness reasons, part of the marine mammals monitoring could be performed jointly with EO3 (and EO10) monitoring.

The rationale for interactions and interconnections between EOs is provided in Annex 2.

1.6.
Component: Marine reptiles

Three species of Sea turtles were recorded in Montenegrin part of the Adriatic Sea. They include loggerhead sea turtle (*Caretta caretta*), green turtle (*Chelonia mydas*) and leatherback turtle (*Dermochelys coriacea*) (Gvozdenović *et al.*, 2016). Loggerhead sea turtle is the most common species, while two others are very rare. Presence of the green turtle (*Chelonia mydas*) was observed twice during the implementation of the IPA Adriatic NETCET project in

2013 and 2104. Both specimens of green turtle were caught in fishing nets and released. Two records of the leatherback turtle (*Dermochelys coriacea*) were available from sources (Kosić B., 1896, 1899) and the video recorded by Hajrudin Šato from Ulcinj region in 2016 (Gvozdenović *et al.* 2016).

According to the available data, the loggerhead sea turtle is the most common turtle species in Montenegrin waters, while the two other species are very rare. Additionally, due to its relatively high abundance and presence in almost any part of the Adriatic Sea, especially in the open pelagic area and in the North Adriatic, as well as the species is listed on the main list of protected species, the loggerhead turtle (*Caretta caretta*) is a suitable component for the assessment and monitoring of GES and is recommended for the following commission criteria and indicators. Thus, the loggerhead sea turtle is the species to be considered for monitoring in Montenegro.

1.6.1. Common indicators

Common Indicator 3: Species distributional range	
The objective of this indicator is to determine the species range of sea turtles that are present in Montenegrin waters, especially the species selected by the Parties.	
GES definition	The species continues to occur in all its natural range in the Mediterranean, including nesting, mating, feeding and wintering and developmental (where they are different from those of adults) sites.
Operational objective	Species distribution is maintained.
GES target	No human-induced decrease in population abundance. Population recovers towards natural levels where depleted.

Common indicator 4: Species population abundance	
The objective of this indicator is to determine the population status of selected species by medium-to-long term monitoring to obtain population trends for these species. This objective requires a census to be conducted in breeding, migratory, wintering, developmental and feeding areas.	
GES definition	The population size allows to achieve and maintain a favourable conservation status taking into account all life stages of the population.
Operational objective	The population size of selected species is maintained.
GES target	Turtle distribution is not significantly affected by human activities. Turtles continue to nest in all known nesting sites. Pressure/Response. Protection of known nesting, mating, foraging, wintering and developmental turtle sites. Human activities having the potential to exclude marine turtles from their range area are regulated and controlled. The potential impact of climate change is assessed.

Common Indicator 5: Population demographic characteristics	
Demography is the study of various population parameters. Demography provides a mathematical description of how such parameters change over time. Demographics may include any statistical factors that influence population growth or decline, but several parameters are particularly important: population size, density, age structure, fecundity (birth rates), mortality (death rates), and sex ratio.	
GES Definition	Cetaceans: species populations are in good condition: low human-induced mortality, balanced sex ratio and no decline in calf production.
Operational objectives	Population condition of selected species is maintained.
GES Targets	Measures to mitigate incidental catches in turtles have been implemented.

1.6.2.
Selection of parameters

The following parameters should be taken into consideration during the monitoring:

- number/location of the loggerhead turtles counted during an aerial survey (CI3, CI4);
- number of the loggerhead turtles in bycatch (CI5);
- number of dead loggerhead turtles due to ingestion of marine litter (CI5);
- standard morphometric measurement (CI5).

1.6.3.
Selection of survey sites

Monitoring of marine reptiles should be applied in the area of the entire Adriatic (Figure 1.6). In addition, potential nesting of marine turtles shall be monitored on Velika Plaža in Ulcinj (Figure 1.8).

1.6.4.
Methodology of sampling and measuring

Due to the previous research from NETCET project and the individual attempts for collecting data for the CI3, CI4 and CI5, 4 different types of monitoring programmes could be applied:

1. Aerial survey;
2. Boat-based survey;
3. Beach monitoring: counting the number of nests during the nesting period and monitoring nest parameters;
4. Stranded monitoring programme and bycatch data obtained from the fisheries sector.

Aerial survey for abundance and distribution

Aerial survey methods applied can be the same as for marine mammals, described in Section 1.5.4.

Boat-based survey: capture-mark-recapture (CMR) method

In-water population monitoring is used to estimate the population size, abundance, and sex ratio of a population in a particular area. It is also very useful for collecting biological samples. A research area can be a breeding, feeding, overwintering ground or a mix of these three areas.

Due to the very low number and frequency of spotted marine turtles in the Montenegro territorial sea, this survey should only be performed in combination with other marine surveys (e.g. photo ID survey for marine mammals). Indeed, this would be cost-effective and more practical.

The rodeo technique could be used for capture-mark-recapture methods. Combining with other types of boat-based surveys could provide cost efficiency to this survey and show the possibilities to use this method after the survey period in Montenegrin marine area (up to 12 NM).

Figure 1.8: Velika plaža, Ulcinj

Beach monitoring: counting the number of nests during the nesting period and monitoring nest parameters

The only potential turtle nesting site is found on the longest sandy beach in Montenegro called Velika plaža. The 12 km long beach with very fine granulated sand is the potential area for nesting of marine turtles. However, up to the present time, no evidence of marine turtles' nests has been found. In 2010, the World Bank funded a study on the potential nesting sites on Velika plaža in Ulcinj from May to July, but the results were also negative.

Monitoring of the beach to identify turtle nests could be conducted by using the UAV (drones) supported with trained personnel for these activities. The drones could be used upon obtaining the licence from the Montenegro Civil aviation agency, free of charge. Having in mind the beach area, such a survey could be undertaken in two days, preferably early in the morning.

If the nests are found on the beach during the first year, night monitoring using human resources could be performed too by undertaking:

- Beach Monitoring during the hatching season;
- Hatched Nest Excavation;
- Calculation of Hatching and Incubation Period;
- Calculation of Hatching Success;
- Sand, Nest, Sea Surface Temperature.

Stranded monitoring programme and bycatch data obtained from the fisheries sector

Although monitoring of strandings and bycatch of sea turtles cannot provide substantial data needed to report on the target indicators, the data obtained through collection of stranded and bycaught animals can provide supplementary information needed to monitor population health and help identify factors that could have a major impact on the marine turtle populations. Through work of stranding network, the outbreak of infectious diseases, potentially causing mass mortalities can be identified (reflecting on the population status of the entire population or its parts). Also, monitoring of bycatch can help identify presence of particular interaction in some regions or interaction with particular fishing tool enabling the evaluation of the population impact etc.

In addition to direct data, monitoring of strandings and bycatch can provide data needed for further analysis like a toxicological burden, genetic analysis, animal and population health status, etc.

To obtain the relevant data that would provide the most useful addition to monitoring of the status of sea turtles, the effective stranding network should be organised on the national level. A good policy and guidelines document have been prepared by RAC/SPA[4].

The following information can be collected from stranded turtles:

- Spatio-temporal distribution of turtles;
- Tissue sampling for genetic and stable isotope;
- Size classes;
- Sex;
- Threats (causes of death);
- Marine pollution (marine litter ingestion; monitoring organic and chemical contaminants in the marine environment).

Regarding tissue sampling for genetic studies and bone sampling for skeletochronology, it could be recommended to identify and include in the research team a veterinarian who would be very helpful in obtaining and analysing this kind of data. Regional cooperation must be identified with some of the nearest active research team to get help in the early stages of these activities.

For genetic analyses from live turtles, skin sample from rear flipper of 1.5 to 2.0 cm and also tissue biopsy from the skin can be used. After sampling, the area must be cleaned with betadine to prevent a bacterial infection. The tissue sample must be placed in 70% ethanol. Single-use disposable sampling materials and gloves must always be used. If the same sampling materials are used, such as biopsy punch or scalpel, for different turtles, DNA may be transferred from one sample to another. For genetic analyses from dead turtles, it is also recommended to take a small amount of muscle from a dead turtle during necropsy. It is best to collect the same tissue for each research study, if possible.

[4] Guidelines for the Development of National Networks of Cetacean Strandings Monitoring, RAC/SPA Tunis, 2004

Fishing activities are one of the main threats to sea turtles, as they can be caught as bycatch in the various fishing gears. On the other hand, collaborating with fishermen can be an important monitoring tool. Such partnerships allow researchers to collect data from inaccessible areas, especially from pelagic areas. Montenegrin fishing fleet consists of 17 trawlers and approximately 150 small-scale fishing boats including mainly used gillnets and long lines. Due to the very good collaboration with fishermen on other activities, such as DCRF and National monitoring programme for collecting fisheries data, it could be very useful to prepare and distribute a questionnaire to the fishermen who would then fill in specific information on bycatch and entangled or found dead turtles during their activities. The following data could be obtained:

- GPS location;
- CCL measurement;
- Tag return information;
- Tagging;
- Photograph of entangled/stranded turtles.

A questionnaire-based marine turtle bycatch estimation can also be performed based on the data obtained from the fishermen.

More work needs to be done to allow for the definition of baselines and trends for these species and decide whether the proposed indicators and targets are appropriate or not.

1.6.5. Sampling frequency

Monitoring by the aerial survey: As marine turtles are long-living organisms, the required sampling frequency should be every third year. Such an interval would ensure enough information for monitoring and identifying (negative) trends.

Boat-based survey: Only if performed jointly with other marine surveys, such as photo ID survey for marine mammals, it is performed during the spring-summer period.

Beach monitoring: in the nesting period from May to August, the proposed monitoring method should be organized every 10 days. In case that turtle evidence is found on the beach, monitoring needs to be conducted every year. If no evidence of their presence at the nesting sites has been found in the first year of the monitoring, the next monitoring could be performed two years later.

1.6.6. Monitoring interconnections of marine reptiles with other EOs

Integration of monitoring of other EO1 components, such as marine mammals, should be ensured. Overall, when conducting a monitoring programme along the defined offshore transects, visual (and other) observation techniques for marine mammals should be applied.

The rationale for interactions and interconnections between EOs is provided in Annex 2.

1.7. Component: Seabirds

The presence of diverse marine birds has been observed in Montenegro. However, true seabird species (*Calonectris diomedea, Puffinus yelkouan*, *Phalacrocorax aristotelis desmarestii* and *Larus audouinii*), highly depend on the good status of the marine environment, as they feed on the sea, are not reported to breed in Montenegro. They appear rarely or sporadically in Montenegrin waters (Saveljić, Jovićević, 2015), also due to the lack of open seabird monitoring. Still, the fact that they breed on Croatian islands shows that these species are probably breeding in the Montenegrin part of the Adriatic.

Therefore, making more regular efforts in terms of national monitoring of seabirds will be an opportunity to gain more comprehensive knowledge of their status in Montenegro.

1.7.1.
Common indicators

Common Indicator 3: Species distributional range (Seabirds)	
The objective of this indicator is to determine the species range of the seabirds that are present in Mediterranean waters; especially the species selected by the Parties.	
GES definition	The 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 during a period equivalent to 3 generation lengths).
Operational objective	Species distribution is maintained.
GES target	No significant reduction in the population distribution in the Mediterranean in all indicator species. New colonies are established and the population is encouraged to spread among alternative breeding sites.

Common indicator 4: Species population abundance (Seabirds)	
The objective of this indicator is to determine the population status of selected species by medium-long term monitoring to obtain population trends for these species. This objective requires a census to be conducted in breeding, migratory, wintering, developmental and feeding areas.	
GES definition	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.
Operational objective	The breeding population size of selected species is maintained or, where depleted, it recovers to natural levels.
GES target	No human-induced decrease in breeding population size or density. Breeding populations recover towards natural levels where depleted. The total number of individuals is sparse enough in different spots. Local declines are balanced out by increases elsewhere so that overall numbers of breeding birds are maintained at the appropriate scale.

Common Indicator 5: Population demographic characteristics (Seabirds)	
Demography is the study of various population parameters and it is used in ecology (particularly population and evolutionary ecology) as the basis for population studies. Demography provides a mathematical description of how such parameters change over time. Demographics may include any statistical factor with a potential to influence population growth or decline, with several parameters being particularly important: population size, density, age structure, fecundity (birth rates), mortality (death rates), and sex ratios. When applied in population viability models, demographic parameters allow estimating the extinction risk of any given population.	
GES Definition	Species populations are in good conditions: Natural levels of breeding success & acceptable levels of survival of young and adult birds.
Operational objectives	Population condition of selected species is maintained.
GES Targets	Populations of all taxa, particularly those with IUCN threatened status are maintained long term and their average growth rate (λ) is equal or higher than 1 as estimated by population models. Incidental catch mortality is at negligible levels, particularly for species with IUCN threatened status.

1.7.2. Selection of parameters, sites, sampling frequency and methodology

Monitoring of the following summer visitors, vagrant, wintering or migrating seabird populations (out of which some are breeding) will be undertaken:

- *Calonectris diomedea* – Scopoli's Shearwater;
- *Puffinus yelkouan* – Yelkouan Shearwater;
- *Phalacrocorax aristotelis desmarestii* – European shag;
- *Microcarbo pygmaeus* – Pygmy Cormorant (it breeds in the Bojana River, 3-4 km upstream, up 240 bp);
- *Larus audouinii* – Audouin's gull;
- *Larus genei* – Slender-billed gull (it occasionally breeds in Ulcinj Salina with max registered 2 bp);
- *Larus melanocephalus* – Mediterranean gull;
- *Sterna albifrons* – Little tern (breeds in Ulcinj Salina with approximately 90-150 bp);
- *Thalasseus sandvicensis* – Sandwich tern;
- *Charadrius alexandrinus* – Kentish plover (it breeds in Ulcinj Salina with max 30 bp and few pairs on Velika plaža and Ada);
- *Pelecanus crispus* – Dalmatian pelican;
- *Pelecanus onocrotalus* – Great white pelican;
- *Phoenicopterus roseus* – Greater flamingo (it breeds in Ulcinj Salina with max 350 bp)
- *Pandion haliaetus* – fish hawk
- *Falco eleonore* – Eleonora's falcon (ex-breeding bird on Sv. Nikola);
- *Numenius tenuirostris* – Slender-billed curlew;
- *Ceryle rudis* – Pied kingfisher.

In addition, monitoring of some other bird species that share the same habitats as the species listed above could provide an added value to the monitoring of seabirds. These include Common Eider *(Somateria mollissima)*, Common Scoter (*Melanitta nigra)*, Velvet Scoter (*Melanitta fusca)*, Red-breasted Merganser (*Mergus serrator)*, Black-throated Diver (*Gavia arctica)*, Red-throated Diver (*Gavia stellata),* European Storm-petrel (*Hydrobates pelagicus melitensis)*, Slender-billed Gull (*Larus genei)*, Mediterranean Gull (*Larus melanocephalus)*, Little Tern (*Sterna albifrons)*, Sandwich Tern (*Thalasseus sandvicensis).*

1.7.2.1. At-sea distribution of breeding and non-breeding seabirds (CI3 and CI4)

At present, two approaches to survey seabirds at sea are normally considered: ship-based surveys and aerial surveys. Taking cost-effectiveness into account, monitoring can be performed in the following ways:

- Join the teams performing monitoring of other EOs, such as EO3, EO5, EO7, EO9, EO10.
- Use the regular ferry line Bar – Bari – Bar. This line operates twice a month during the winter months and from 4-8 times a month from June to November. It must be noted that this option is more expensive and also more limited, but has been used in practice by other countries.

For monitoring of the open sea species, it is necessary to use geo-positioned online bird monitoring platforms (for example, www.observation.org) which, in addition to the number and type of birds, dates and locations, have the option of entering additional data such as age, gender, etc. Details of monitoring methodology are explained on the following link.

Sampling method: Diurnal count of seabirds from a boat along the transects. Birds resting on the water and flying are identified and counted in 10 minutes counting intervals (snapshots) from a moving boat along a known path. It can be coupled with cetacean surveys, which use a similar protocol. Low-cost vessel-based counts on sample strips can be carried out from ferries crossing the Adriatic Sea (e.g. to/from Italy/Greece/Croatia); higher detail and complete spatial coverage of a given sector of the sea can be obtained from boats moving along a pre-defined path. The counting should ideally be done in the morning or the early afternoon, since in the late afternoon some species (notably gulls) may concentrate on the coast for evening roosts.

Suggested frequency and timing: one-two surveys/month.

Parameters to be recorded in a geo-positioned online bird monitoring platform are time, date, location, species, number of individuals, approximate distance from the boat. The results (abundance of species) are expressed as birds/km or birds/km^2.

1.7.2.2. Winter distribution and abundance of seabirds (CI3 and CI4)

Winter counting of birds in Montenegro has been taking place since 1991, based on the International Waterbird Census (IWC) programme, gradually including Skadar Lake, Ulcinj Salina and other relevant water habitats in the country. Since 2010, the IWC has been implemented along the coast, at the locations shown in Table 1.4 and Figure 1.9.

The methodology of collecting data from these points is the total census of species and number of birds on and above the seawater observed with binoculars or spy-glass. The IWC in Montenegro is working with already standardized protocol and in accordance with international standards. The data is sent regularly to Wetlands International. However, the project is addressing all land-based water habitats, but not the open sea, due to lack of human and financial capacities as well as information on behaviour patterns of birds at sea. It is recommended that this programme, implemented by several national institutions and organizations, also includes open sea monitoring.

For the IWC in the open sea, it is also recommended to use observation.org platform.

1.7.2.3. Monitoring of seabirds at the locations of Ulcinj Salina, Velika plaža and Ada Bojana (CI3 and CI4)

Ulcinj Salina, with Velika plaža and Ada Bojana is one of the most important breeding areas for seabirds in Montenegro.

Monitoring of breeding bird populations at Ulcinj Salina location has been actively conducted since 2002 in a standardized route every 15 days throughout the year. The data entry is done through the observation.org application, where it is automatically recorded, along with each entry, geolocation and time of entry. Unfortunately, due to poor water management, for most species, the success of breeding has been minimal or completely absent for some years. Therefore, it is very important to inform the Salina water management authorities during the monitoring if the water levels in the basins get too low or too high to prevent breeding failure.

Monitoring of breeding bird populations on Velika plaža and Ada Bojana dunes is carried out during the period from May to July. In addition to the birds' species listed in Section 1.7.2, *Burchinus oedicnemus* and *Haematopus ostralegus* can be further registered. Monitoring is conducted in the early morning by a line transect from the third kilometre of the western part of the beach (Velika plaža) to the mouth of Bojana (9 km). In mid-May, breeding pairs are reported, while the breeding success is recorded at the end of June. The same transect methodology is applied along the length of 3.5 km on Ada.

Frequency, timing and parameters to be recorded

During the monitoring period, the following parameters are recorded:

- At the very beginning of the nesting:
  - the species that nests;
  - number of breeding pairs with geolocated nests/ colonies;
  - the level of water in the pools (only for Ulcinj Salina);
  - disturbance, if it is present;
- Upon completion of incubation:
  - breeding success.

During breeding, basins are visited weekly and observed from embankment with scopes that ensure the absence of disturbance. Monitoring is done in the early morning hours, from sunrise (4:45 to 10:00 in the morning). Monitoring is performed by at least one ornithologist according to the previously determined route.

Since monitoring is conducted by the Centre for the Protection and Research of Birds, to ensure better monitoring, saving resources and a clear methodology, it is recommended that the person who wants to do the research should contact this organization for additional clarifications (www.czip.me).

In addition, monitoring of *Microcarbo pygmeus* should be specifically highlighted. The species breeds on the island of Paratuk on the Bojana River, but due to the vegetation degradation, it moved southward and formed a colony in Štoj, near Ada. The monitoring of this colony must be done from the mainland. Given that it is inaccessible and that nesting takes place high in the trees at the beginning of May, the breeding pairs should be counted in mid-June as well as the young birds in the nest.

This is the only breeding ground in the Montenegro offshore whose research requires additional effort in terms of searching for and monitoring colonies as they are usually inaccessible.

Table 1.4: Selected IWC sites

Area	Site	Geoposition	
Boka Kotorska	Herceg Novi	42.44954	18.53825
	Kumbor	42.43312	18.59812
	Kamenari	42.46004	18.67655
	Risan	42.50594	18.69302
	Ljuta	42.48498	18.76478
	Kotor	42.42711	18.76695
	Tivatska solila	42.39368	18.71461
	Rose	42.41408	18.54925
North	Veslo	42.36704	18.61066
	Bigova	42.35392	18.69522
Central	Jaz	42.28480	18.81526
	Budva	42.28324	18.85700
	Sveti Stefan	42.25736	18.89637
	Petrovac	42.20517	18.93719
	Buljarica	42.19056	18.97345
	Bar	42.08870	19.07018
South	Utjeha	41.99676	19.15334
	Ulcinj	41.92255	19.20167
	Bojana delta	41.87866	19.35405

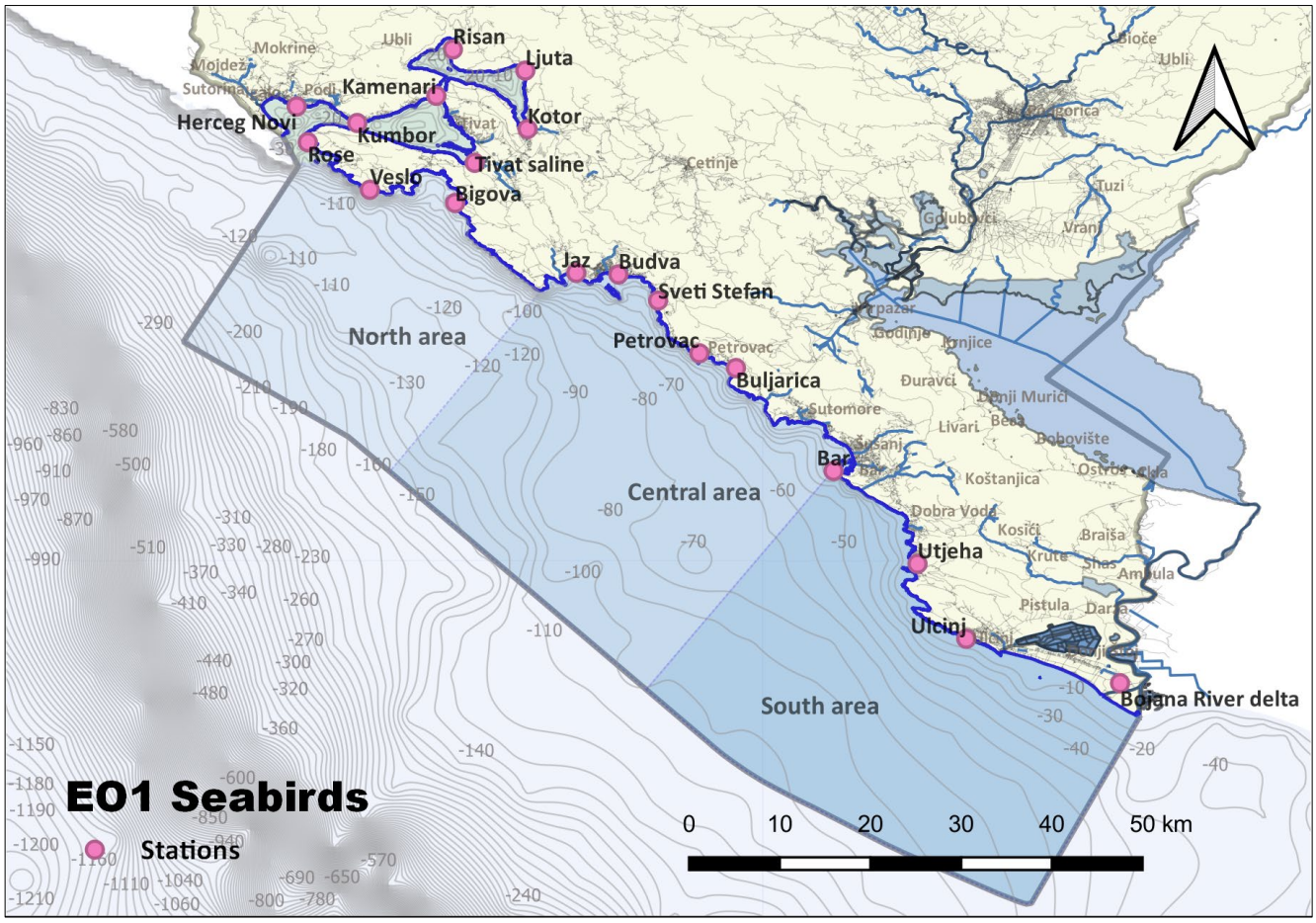


Figure 1.9: IWC sites on the coast

1.7.3.
Monitoring interconnections of marine birds with other EOs

Monitoring of seabirds at sea, mainly for cost-effectiveness reasons, could be conducted jointly with monitoring of marine mammals as well as monitoring of other EOs, applied across transects, such as EO3, EO5, EO7, EO9, EO10. Detailed information about the interconnections with other EOs is provided in Annex 1.

The rationale for interactions and interconnections between EOs is provided in Annex 2.

2.
NON-INDIGENOUS SPECIES (EO2)

Marine invasive alien species are regarded as one of the main causes of biodiversity loss in the Mediterranean, potentially modifying all aspects of marine and other aquatic ecosystems. They represent a growing problem due to the unprecedented rate of their introduction and the unexpected and harmful impacts that they have on the environment, economy and human health. According to the latest regional reviews, more than 6% of the marine species in the Mediterranean are now considered non-indigenous species as around 1000 alien marine species have been identified, while their number is increasing at a rate of one new record every 2 weeks (Zenetos *et al.*, 2012). Of these species, 13.5% are classified as being invasive in nature, with macrophytes (macroalgae and seagrasses) as the dominant group in the western Mediterranean and the Adriatic Sea, and polychaetes, crustaceans, molluscs and fishes in the eastern and central Mediterranean (Zenetos *et al.*, 2010, 2012). Even if the highest alien species richness occurs in the eastern Mediterranean, ecological impact shows strong spatial heterogeneity with hotspots in all Mediterranean sub-basins (Katsanevakis *et al.* 2016).

In the Adriatic Sea, there is a growing dynamic of non-indigenous species (NIS) introduction. Their impact on biological and ecological diversity as well as on the economy and human health has become more significant. Therefore, monitoring of NIS occurrence, spreading and impact is of major importance.

GES definition: Non-indigenous species (NIS) introduced by human activities are at levels that do not adversely alter the ecosystem.

Relevant pressure: Increase in maritime traffic, world trade including aquaria trade, aquaculture.

NIS monitoring highlighted in the following chapters is in line with the SPA/RAC Guidelines within the UNEP/MED WG 461.21 document[5] which include all the necessary complementary information and details to the present IMP document regarding NIS.

2.1.
Common indicator

Common indicator 6: Species population abundance	
Common indicator 6 is an indicator that summarizes data related to biological invasions in the Mediterranean into simple, standardized and communicable figures and can give an indication of the degree of threat or change in the marine and coastal ecosystem. Furthermore, it can be useful in assessing the effectiveness of management measures in the long run implemented for each pathway but also, indirectly, the effectiveness of the different existing policies targeting alien species in the Mediterranean Sea.	
GES definition	A decreasing abundance of introduced NIS in risk areas.
Operational objective	Invasive NIS introductions are minimized.
GES target	The abundance of NIS introduced by human activities reduced to levels giving no detectable impact.

[5] Discussions are still ongoing with the contracting parties regarding the guidelines related to marine vegetation and coralligenous. If updated guidelines are published, it shall be considered during the implementation of the the present IMP document.

Specifically, 3 metrics have been proposed as indicators based on the list of NIS which are newly introduced via human activity into the wild per assessment period (6 years). As a reference year, the year with the most comprehensive data should be used, as a basis for assessing:

- trends in the introduction at 6 year-intervals;
- trends in pathways at 6 year-intervals;
- CIMPAL indicator (cumulative impact) at any spatial level.

CIMPAL is a standardized, quantitative method for mapping the cumulative impacts of invasive alien species on marine ecosystems (Katsanevakis *et al.*, 2016).

2.2. Selection of the target species

In case REGULATION (EU) No 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species, has been adopted by the country, invasive species likely to invade the country should be prioritized. Targeted species are to be selected following the horizon scanning methodology (Roy *et al.*, 2018), see ANNEX A, among those listed in Karachle *et al.* (2017), see ANNEX B, preferably not species expected to be introduced unaided. The first Horizon scanning exercise, conducted by 3 independent evaluators has highlighted the ten species most likely to be introduced in Montenegro in the near future (Table 2.1). They are characterised by the high impact on biodiversity and/or economy and only one fish species, namely *Pterois miles*, is dangerous for human health because of its poisoning spines, although it can also be a food source).

Table 2.1: The list of the most invasive species likely to invade Montenegro ranked according to their assessed impact in descending order (based on Horizon Scanning methodology)

Species	Name in English	The overall impact on ecosystem services	The overall impact on biodiversity
Plotosus lineatus	Striped eel catfish	625	125
Mnemiopsis leidyi	Warty Comb jelly	542	108
Pterois miles	Lionfish	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
Styela clava	Asian Clubbed Tunicate	118	39

Six fish alien species were identified as priority ones by a Joint GFCM-UNEP/MAP working group for monitoring in the Eastern Mediterranean in relation to fisheries (GFCM-UNEP/MAP 2017). These are *Saurida lessepsianus* Russell, Golani, Tikochinski, 2015 [until recently misidentified as *S. undosquamis* (Richardson, 1848)]; *Fistularia commersonii* Rüppell, 1838; *Lagocephalus sceleratus* (Gmelin, 1789); *Plotosus lineatus* (Thunberg, 1787); *Siganus rivulatus* Forsskål & Niebuhr, 1775 and *Siganus luridus* (Rüppell, 1829) (treated here as one taxonomic unit *Siganus* spp.). Among these, only *Saurida lessepsianus* and *Plotosus lineatus* have not yet been recorded in Montenegro.

Timely recording of new NIS is very important, as well as further monitoring of those species that have already been classified as highly impacting in the region. In the

Mediterranean area, there are many records of new NIS, but unfortunately, there are not so many studies on the impacts of these species on local biodiversity and economy. For this reason, in addition to previous lists of NIS, we are proposing to include four of the NIS already present in Montenegrin waters in a monitoring programme that could have an important impact on biodiversity and/or economy: *Caulerpa cylindracea, Pinctada imbricata radiata, Paraleucilla magna* and *Callinectes sapidus.* These four species are proposed for monitoring because their abundance is significantly increasing in the last few years. *Caulerpa cylindracea* was among the first alien marine species reported for Montenegro in 2004 (Mačić, 2005) and since then its population has been constantly increasing. *Pinctada imbricata radiata* and *Paraleucilla magna* were recorded for the first time in marina Porto Montenegro (Tivat) in 2016 and now they are present in many locations, mostly on mariculture sites. The blue crab, *Callinectes sapidus*, was recorded for the first time in Montenegro in 2006 (Zenetos et *al.*, 2011), but its populations have seen exponential growth in the course of recent years. Considering the positive and negative impacts of *C. sapidus* (threat to local biodiversity, but also as a source of food), it would be interesting to monitor it.

Monitoring of the aforementioned four species found in Montenegro could be conducted annually and, depending on the results, it can be stopped or continued. Furthermore, for all new or already present NIS, all available data should be collected so that their distribution and abundance can be estimated more accurately.

2.3.
Selection of the sampling stations

Hotspot areas for NIS are ports such as Bar, marinas, lagoons and MPAs. Ports and marinas should be given the highest priority since the majority of NIS in Montenegro appear to be transferred from the vessel (including recreational boats). However, bays that host aquaculture facilities are prone to biological invasions and MPAs are not immune to NIS introduction.

Proposed locations are selected based on several characteristics. The Port of Bar (Figure 2.1) is the biggest in Montenegro and, because of the intensive vessel traffic (cargo, passengers and small private boats), presence of new NIS introduced mostly through ballast water and fouling, but also unaided from south Adriatic (because of the currents) can be expected.

Marina Porto Montenegro (Figure 2.2) is the biggest marina in the region and up to this point, several NIS were recorded there for the first time. Because of the very intensive traffic of yachts, the introduction of new species is expected primarily through fouling, but also possibly from anchors, diving and fishing equipment.

The Port of Kotor (Figure 2.2) is very frequently visited by big cruising vessels that are mostly navigating between important Adriatic and South-Eastern Mediterranean ports. That is why the transfer of NIS is very likely.

Table 2.2: Sampling stations for non-indigenous species

Area	Stations			Included in MPA or NIS Hotspot
	Station Name	Latitude N	Longitude E	
Boka Kotorska	Marina Porto Montenegro (Tivat)	42.43290	18.69153	NIS hotspot
	Mariculture site (preferable one of the locations with fish and molluscs): Cogi	42.48520	18.74396	NIS hotspot
	Sv. Stasija	42.46630	18.76223	UNESCO site
	Port Kotor	42.42525	18.76714	NIS hotspot
Central	Port Bar	42.09318	19.08206	NIS hotspot
	Katič	42.19619	18.93747	Proposed MPA
South	Rt Rep	41.96868	19.14323	Proposed MPA

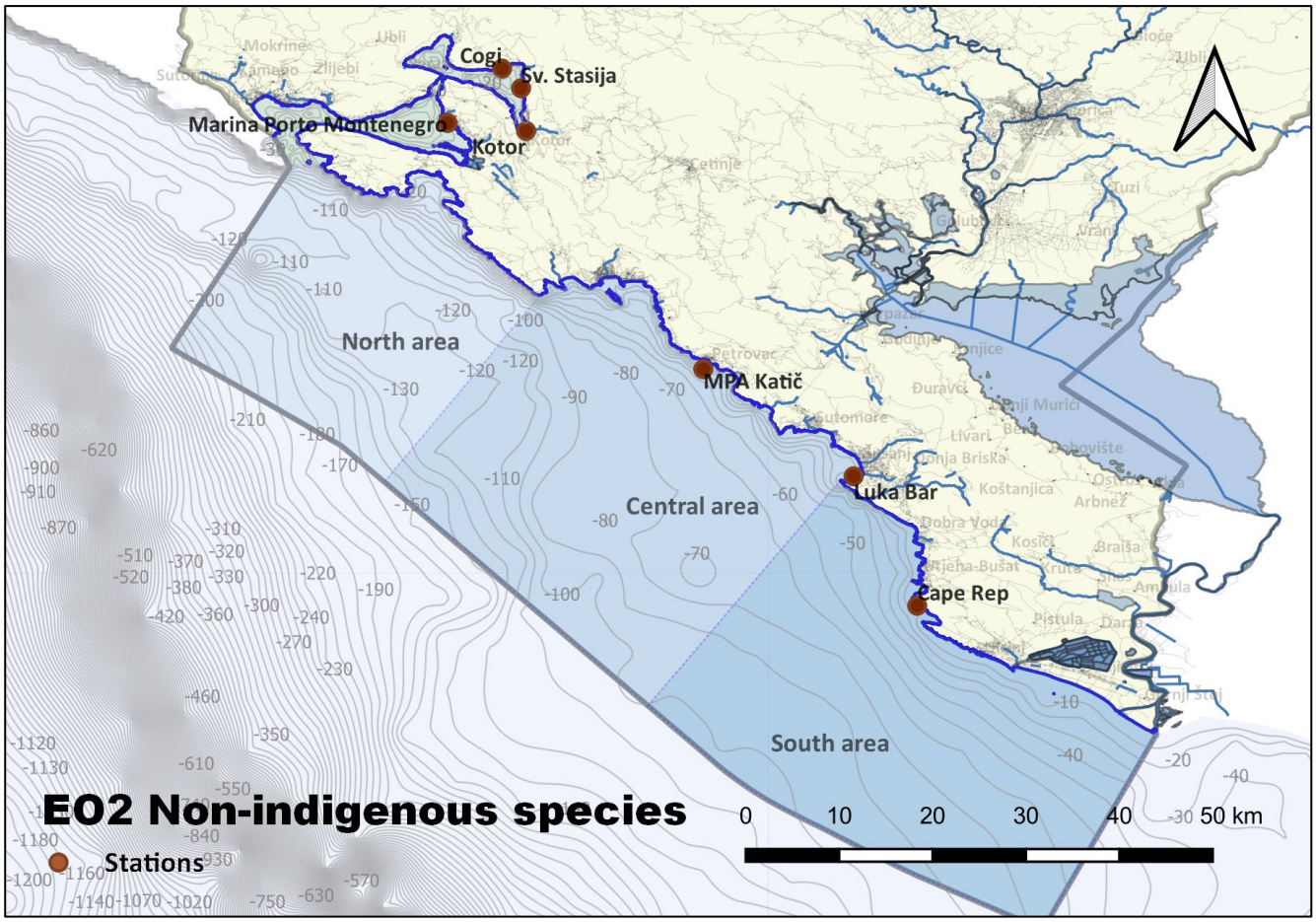


Figure 2.1: Monitoring stations for NIS

Furthermore, it is proposed to monitor one mariculture location, preferably one of two existing locations with fish and molluscs. At these sites, imported juveniles (mostly fish and rarely mollusc species) grow and that is a possible vector of transport for new parasites and other NIS.

Furthermore, two more areas are proposed. One is the future MPA Katič (Figure 2.1) and the other is Sv. Stasija (Figure 2.2), future Natura 2000 site. These two locations are also planned for monitoring of habitats (Posidonia), so this would contribute to reducing effort and cost and help monitor some of the protected areas at the same time.

Because of expected different vectors of transport for NIS in the situation of limited resources (both financial and human), we would suggest giving priority to the Port of Bar, marina Porto Montenegro (Tivat), mariculture site (fish and molluscs) in Kotor bay and future MPA Katič (Petrovac).

2.4. Selection of parameters

The measurement parameters depend on the risk related to the area and target species. Research should include at least:

- date of collection/detection;
- location of record (including depth and habitat);
- taxonomic identification;
- abundance data;
- assessment of the transport mechanism.

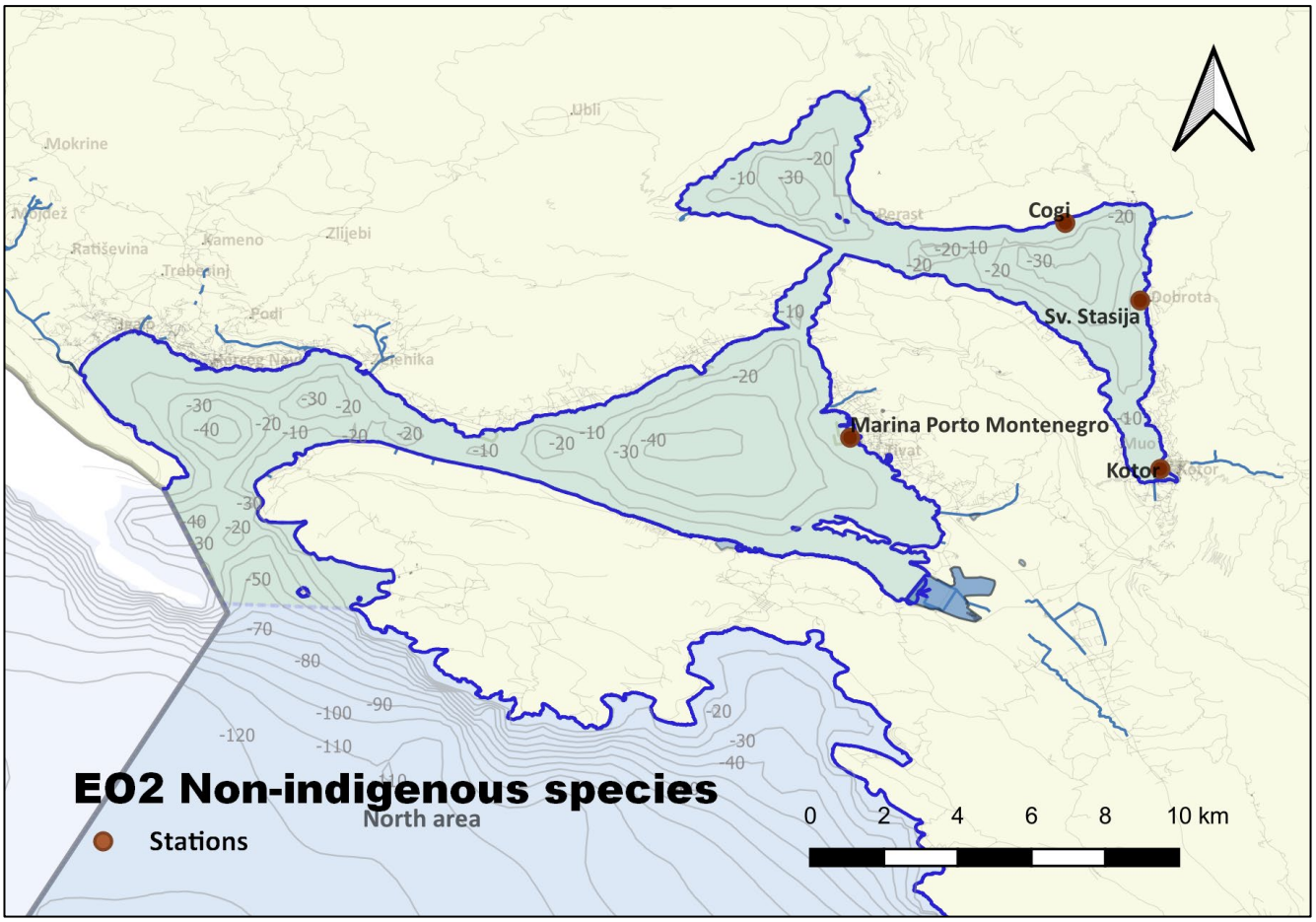


Figure 2.2: NIS stations in Boka Kotorska area

2.5. Sampling frequency

The first mandatory survey in hard and soft substrata (including marinas) will be conducted through the Rapid Assessment Survey (RAS). For more details on the RAS, see Katsanevakis *et al.* (2011); Ulman *et al.* (2017). Subsequent sampling needs to be done once a year.

For the development of NIS, specific environmental conditions are needed and most of the information will come not from targeted monitoring, but other surveys. This is why surveys in ports and other locations indicated for benthos surveys should be conducted continuously and. depending on the specific taxon's biology. at least once per year. Monitoring of NIS in the water column will be performed at the locations selected for the plankton biodiversity monitoring during the first year seasonally, and biannually (in the winter and in the summer) in subsequent years.

Further information on possible non-indigenous fish species will be collected through fisheries monitoring concerning their sampling frequency.

2.6. Methodology of sampling and measuring

For each location, a different methodology is applied and it is always site-specific. This means that sampling methodology and spatial scale of field research (size and depth of profile), highly depend on the specific location and cannot be completely standardized.

Fieldwork methodology is based on visual census, photo documentation and collection of samples.

Those activities need to be done by SCUBA diving, snorkelling or observation and collection from coastal areas, as well as plankton net. This is particularly so for:

- hard and soft substrata in marinas and ports: Rapid assessment survey, snorkelling, diving, wall scrape, settlement panels, benthic grab;
- water column: phytoplankton samples and zooplankton samples. Only for harbours, a modified CRIMP protocol is suggested as a standard methodology for NIS collection and assessment;
- vessels hulls (including recreational vessels), ballasts: Diving for target species (Peters *et al.*, 2019);
- MPAs: Snorkelling/diving for target species;
- fisheries surveys for target species: Boat-seine trammel nets. In addition, data can be collected from experimental fishing activities.

Most species are to be identified either *in situ* by the researchers or from *in situ* photos. Samples of small-sized species (< 1 cm) and species that are difficult to identify in the field (e.g. some polychaetes, bryozoans, and crustaceans) are to be collected for further laboratory analyses. When the collection is necessary for their identification, only a small part of an individual organism or only one individual among many will be collected, thereby minimizing the environmental impacts associated with the collection of live specimens. Samples must be stored in 90% ethanol.

Underwater photos/videos and data collected in the field on dive slates and logbooks (e.g. species, number and sizes of fish) need to be entered and saved before the end of each sampling day in an electronic format to be used for further statistical analyses.

Also, photos and samples of fish species caught by fishermen should be taken into account. In addition, local diving clubs and amateur shell collectors could provide potential new data on NIS (mostly fish, crustacean and molluscs). This can be achieved by sharing information on NIS through different networks and social media (most popular magazines, Facebook, TV, etc.).

2.7.
Methodology of laboratory sample processing

A laboratory analysis should be done by using standard laboratory methods e.g. identification under stereoscopes/ microscopes. High-quality photos are needed to ensure correct identification. In doubtful cases, photos will be sent to taxonomic experts among the network of NIS experts in the study area or the Mediterranean. Furthermore, in problematic cases, such as finding new species for the area, molecular analyses should be conducted. Voucher specimens of first NIS records in the country should be deposited in a museum or an institute's collection and be available to other scientists for examination on request.

2.8.
Data processing methodology

Validation of national lists of Alien species requires:

- thorough revision to exclude misidentifications, unconfirmed, cryptogenic species; and
- harmonisation considering taxonomic and/or nomenclatural issues. For more details on validation, see Recommendations on standardizing lists (Marchini et al 2015; Zenetos *et al.*, 2017).

Assessment of the impact at any spatial level will be based on the implementation of the CIMPAL index (Katsanevakis *et al.*, 2016), which requires georeferenced data. Therefore, precise georeferenced data is necessary for each species record.

Data collected using citizen science principle, involving the public in observation network, need to be quality controlled by taxonomic experts.

2.9.
Monitoring the interconnections between non-indigenous species and other EOs

Monitoring non-indigenous species is linked and interconnected primarily with habitats monitoring (EO1), particularly *Posidonia oceanica*. Monitoring NIS is therefore proposed in future MPAs.

In addition, NIS monitoring is relevant in the NIS hotspot areas, such as ports, and for EO9 monitoring. Interconnections are also established at selected EO5 and EO7 stations. Detailed information about the interconnections with other EOs is provided in Annex 1.

The rationale for interactions and interconnections between EOs is provided in Annex 2.

3.
FISHERIES (EO3)

Resources of small coastal, small pelagic and trawl fisheries on Montenegro's coast have been studied as part of national scientific and research projects led by the Ministry of Agriculture and Rural Development, since 1999, and the Ministry of Science, in the period 2008-2015.

In 2004, Montenegro joined the AdriaMed Project, a regional project encompassing countries surrounding the Adriatic Sea within the United Nations' Food and Agriculture Organisation. The Pilot study on biological and socio-economic data collection for fisheries was started in 2007/08, and, after a short break in 2008/09, continued until 2016. The pilot project was based on the biological sampling of economically important species in Montenegro.

AdriaMed Trawl Survey was performed twice, in 2004 and 2007. In 2008 Montenegro joined the Mediterranean Trawl Survey (MEDITS) programme, all through support by AdriaMed. The MEDITS expedition has been done annually ever since, except in 2009.

Acoustic survey for small pelagic biomass estimation started in Montenegro in 2002, followed by surveys in 2004 and 2005. Since 2008, and except 2009, the Eastern GSA 18 (Montenegro and Albania waters) was monitored. The acoustic survey is conducted according to a standardized methodology of MEDIAS surveys (MEDIAS Handbook, April 2017) revised annually. Along with the MEDIAS survey, the ichthyoplankton DEPM survey (Daily Egg Production Method) is conducted to determine the biomass of European anchovy (*Engraulis encrasicolus*).

Montenegro started with the GFCM – Data Collection Reference Framework (DCRF) in April 2017.

Based on the experiences from previous monitoring and scientific expeditions, and according to the DCRF programme, the following five species have been confirmed as the economically most important species in Montenegrin fisheries, and all are listed as the Group 1 Priority Species, according to Appendix A of the GFCM – Data Collection Reference Framework version 2017.1:

- European hake (Merluccius merluccius);
- Red mullet (Mullus barbatus);
- Deep-water pink shrimp (Parapenaeus longirostris);
- European anchovy (Engraulis encrasicolus);
- European pilchard (Sardina pilchardus).

Given the above, it is suggested that the following common indicators be estimated for those species.

Common Indicator 7: Spawning Stock Biomass	
This indicator is aimed at providing information about the SSB which is one of the most important stock status indicators and the primary indicator for the reproductive capacity of the stock. Achieving or maintaining good environmental status requires that SSB values are equal to or above SSBMSY (the level capable of producing Maximum Sustainable Yield-MSY).	
GES definition	Achieving or maintaining good environmental status requires that SSB values are equal to or above SSB_{MSY}, the level capable of producing maximum sustainable yield (MSY).
Operational objective	The Spawning Stock Biomass is at a level at which reproduction capacity is not impaired. State: $B > B_{thr}$.

Common Indicator 8: Total landing	
This indicator is aimed at providing information about the level of Maximum Sustainable Yield of commercial species in the Montenegrin territorial water, the level at which fisheries resources can be exploited without exhausting them and measuring the level of exploitation or total fishing pressure on an ecosystem (including IUU catch and discards). Based on scientific advice, fishing must be adjusted to bring exploitation to levels that maximise yields (or catch) within the boundaries of sustainability.	
GES definition	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.
Operational objective	The total catch of commercial species does not exceed the Maximum Sustainable Yield (MSY) and the bycatch is reduced.
GES target	▪ Long-Term High Yields ▪ Reduction of IUU catch ▪ Catch < MSY ▪ Minimization of discarding and incidental catch of vulnerable species

Common Indicator 9: Fishing mortality	
CI9 is an essential component of fishery stock status and a fundamental variable in stock assessment. In general, fishing mortality is defined as the instantaneous rate of mortality of the number of individuals that die due to fishing and can be defined in terms of either the number of fish or biomass of fish.	
GES Definition	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.
Operational objectives	Fishing mortality in the stock does not exceed the level that allows MSY.
GES Targets	Pressure -FMSY -F0.1 a proxy of FMSY (more precautionary).

Common Indicator10: Fishing effort	
CI10 aims to provide information about an *amount of fishing gear of a specific type used on the fishing grounds over a given unit of time*. It is an essential parameter in the assessment of fish stocks and their effective management. Effort information is needed to interpret changes in the amount of catch, and to regulate fishing efficiency to maximize profit and minimize overfishing.	
GES Definition	Total effort does not exceed the level of effort allowing the Maximum Sustainable Yield (MSY).
Operational objectives	Fishing effort should be reduced by using a multi-annual management plan until there is evidence for stock recovery.

Common Indicator 11: Catch per unit of effort	
This indicator aims to provide information on the catch per unit of effort (CPUE), expressed as the biomass captured for each unit of effort applied to harvest the stock. CPUE is extensively used by biologists to determine variations in biomass and by economists as a measure of the efficiency of the fleet.	
GES Definition	Catch per unit effort (CPUE) is an indirect measure of the abundance of target species. Changes in the catch per unit effort are inferred to signify changes to the target species' abundance.
Operational objectives	A stable or positive trend in CPUE. Declines in CPUE may mean that the fish population cannot support the level of harvesting. Increases in CPUE may mean that a fish stock is recovering and more fishing effort can be applied.

Common Indicator 12: Bycatch of vulnerable and non-target species (EO1 and EO3)	
This indicator aims to provide information on the catch of other commercial species that are landed, commercial species that cannot be landed (e.g. undersized, damage individuals), non-commercial species that are discarded, as well as the incidental catch of endangered or rare species. Incidental catch of vulnerable species is defined here as a subset of bycatch, which includes species that for some reason are considered vulnerable (i.e. long-lived vertebrates with low reproductive rates such as marine mammals, but also sea turtles, seabirds and elasmobranchs).	
GES Definition	The abundance/trends of populations of seabirds, marine mammals, sea turtles and sharks key species (selected according to their actual and total dependence on the marine environment, and to their ecological representativeness) are stable or do not seem to be on the decline in a statistically significant way, taking into account the natural variability compared to the current situation.
Operational objectives	Incidental catches of vulnerable species (i.e. sharks, marine mammals, seabirds and turtles) are minimized.

3.1.
Common indicator 7: Spawning stock biomass

3.1.1.
Methodology

The spawning stock biomass (SSB) is the combined weight of all individuals in a fish stock capable of reproducing. To calculate the spawning stock biomass, it is necessary to have estimates of the number of fish by length/age group, estimates of the average weight of the fish in each length/age group and an estimate of the number of mature fish in each length/age group. SSB and SSB_{MSY} need to be estimated from appropriate quantitative assessments based on the analysis of catch-at-age and/or catch-at-length (to be taken as all removals from the stock including discards). Where possible, reference points relative to SSB should be established for each stock.

Stocks of European hake (*Merluccius merluccius*), red mullet (*Mullus barbatus*), deep-water pink shrimp (*Parapenaeus longirostris*), European pilchard (*Sardina pilchardus*), and European anchovy (*Engraulis encrasicolus*)[6] are assessed at the Adriatic level at the annual GFCM Working Groups for Stock Assessment of Demersal and Small Pelagic Species. All data and results are submitted through relevant Stock Assessment Forms (SAF).

The status of stocks is ideally based on a validated stock assessment model, from which indicators of stock status (e.g. biomass, fishing mortality, recruitment) are obtained, and reference points are agreed for the selected indicators. When possible, analytical stock assessment models that incorporate both fishery-dependent (e.g. catches) and independent information (e.g. surveys) are used. Different stock assessment models are used in the GFCM area of application, but recently two methods have been used for stock assessment of demersal species in the Adriatic: a tuned version of virtual population models (extended survivor analysis – XSA) and statistical catch at age analysis (stock synthesis – SS3).

For the stock assessment of small pelagic species in the Adriatic, State-Space Assessment Model (SAM) has been used. Stock assessment is performed for anchovy and sardine at the Adriatic level, GSA 17 and GSA 18 together. Fishery-dependent data comes from official government statistics on landing, while fishery-independent data comes from MEDIAS survey. Reference points are determined during benchmark assessment sessions for small pelagics every 3 years. Reference points on biomass are *Blim* (the minimum midyear biomass value of the assessed time series) and *Bpa* (40% above B_{lim}) from the empirical approach, while reference points on fishing mortality have been assessed using analytical simulations based on the stock-recruitment relationship.

3.1.2.
Data collection and processing

Fishery-dependent data used in stock assessment is obtained through the Data Collection Reference Framework done in Montenegro, while fishery-independent data comes from the results of Mediterranean Trawl Survey (MEDITS) and Mediterranean Acoustic Survey (MEDIAS) conducted in Montenegrin waters.

The MEDITS survey is performed annually, usually during the summer period. The survey is supported by FAO AdriaMed, and there are 10 hauls performed in Montenegro, first by Italian vessel "Pasquale e Cristina", and by Italian vessel "Mizar" in 2018 and 2019.

Mediterranean Acoustic Survey (MEDIAS) is performed annually, during the summer period, along with DEPM survey, and is supported by FAO AdriaMed regional project. The survey is performed using the research vessel *G.F. Dallaporta* over a grid of transects perpendicular to the coastline between a depth of 20 meters (where possible) and a depth of 200 over the entire water column. The inter-transect distance is 10 nautical miles, and every 5 miles along DEPM and CTD station is determined. Four pelagic trawls are performed daily during the survey. Data is processed by Italian MEDIAS team at the regional level, the eastern part of GSA 18 (Montenegro and Albania), and submitted through AdriaMed WG SP and GFCM WGSP.

[6] All listed species are Group 1 Priority Species, according to Appendix A of the GFCM – Data Collection Reference Framework version 2017.1 (GFCM-DCRF, 2017)

3.1.3.
Suggestion for monitoring within the IMAP framework

At the moment, the Management Plan for Pelagic Stocks is in effect in the Adriatic Sea (Recommendation GFCM/42/2018/8), while the Management Plan for Demersal Stocks is currently under preparation.

Stocks of European hake (*Merluccius merluccius*), red mullet (*Mullus barbatus*), deep-water pink shrimp (*Parapenaeus longirostris*), European pilchard (*Sardina pilchardus*), and European anchovy (*Engraulis encrasicolus*)[7] are assessed at the Adriatic level at the annual meeting of the GFCM Working Groups for Stock Assessment of Demersal and Small Pelagic Species. Data will be collected through the National Programme for fishery data collection of Montenegro and scientific surveys MEDITS and MEDIAS.

It is suggested that the stock assessments of the listed species continue to be assessed on the regional, Adriatic level, and data collection will continue according to the GFCM DCRF manual.

3.2.
Common indicator 8: Total landings

The overall objective of the indicator is to address and contribute towards the reduction of:

- IUU catch;
- discarding and incidental catch of vulnerable species.

3.2.1.
Methodology

Reliable fishing data (i.e. landing and/or catch data), necessary to perform the assessment of the different stocks, may come from different sources and are usually derived from a combination of catch reports, logbooks, observers onboard, observers at the market and/or at the landing-place, market and/or landing survey, and landing statistics from port authorities. Landing/catch information can be measured and classified by species, area, fishing gear used, and other information that can be collected during the sampling process.

Several analytical methods, based on population dynamics of different stocks of demersal and small pelagic species, have been applied within the GFCM-WGSAs (Working Groups on Stock Assessment) and are also available in the literature. In the GFCM area, data for the assessment of stocks are collected through stock assessment forms (SAF), which also contain information on reference points and outcomes of the assessment (e.g. fishing mortality, exploitation rate, spawning stock biomass, recruitment etc.). Within the GFCM mandate, a series of stocks are already assessed on an annual basis. Every year, the Scientific and Advisory Committee (SAC) and the Working Group on the Black Sea (WGBS) will identify those species/stocks that should be assessed and for which stock assessment form should be provided.

Stocks of European hake (*Merluccius merluccius*), red mullet (*Mullus barbatus*), deep-water pink shrimp (*Parapenaeus longirostris*), European pilchard (*Sardina pilchardus*), and European anchovy (*Engraulis encrasicolus*)[8] are assessed at the Adriatic level at the annual meeting of the GFCM Working Groups for Stock Assessment of Demersal and Small Pelagic Species.

3.2.2.
Data collection and processing

Total landings data is available through the Data Collection Reference Framework performed in Montenegro (since April 2017). Data on total landings and catch (with discard amount added) are collected through logbooks (daily based for vessels of the large-scale fishery) and report on catches (monthly based for vessels of the small-scale fishery). Data are submitted to the Ministry of Agriculture and Rural Development – Directorate for Fisheries and stored in the Fishery Information System. Data are submitted according to the GFCM schedule through DCRF online platform as a total landing by relevant fleet segment, and total landings by main commercial species by fleet segment (task II).

[7] All listed species are Group 1 Priority Species, according to Appendix A of the GFCM – Data Collection Reference Framework version 2017.1 (GFCM-DCRF, 2017)

[8] All listed species are Group 1 Priority Species, according to Appendix A of the GFCM – Data Collection Reference Framework version 2017.1 (GFCM-DCRF, 2017)

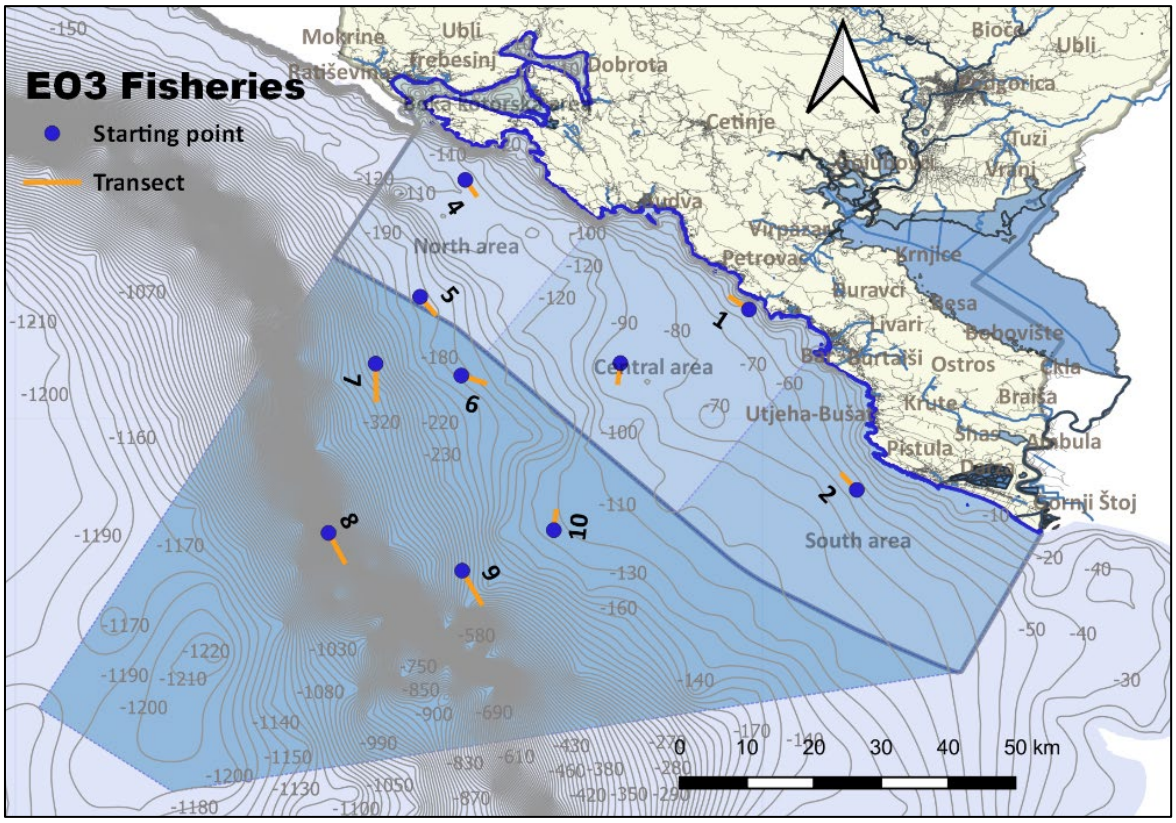


Figure 3.1: Fisheries monitoring along MEDITS transects in Montenegro

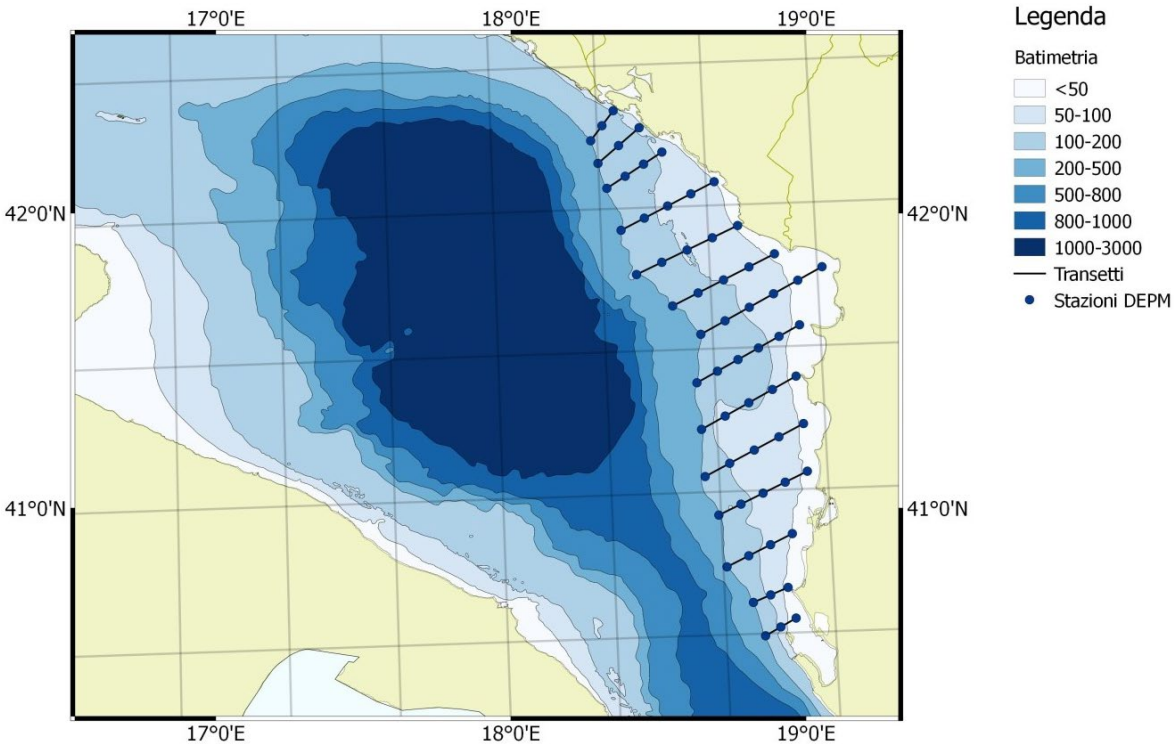


Figure 3.2: Fisheries monitoring along MEDIAS transects (DEPM and CTD stations) in Montenegro

MSY is extensively used as an indicator for fisheries management and it is probably the most important yield indicator of the landed catch over a specific period. The sustainable yield of any fish stock is the amount that can be fished annually without decreasing the stock's ability to yield fish in the future. This is determined by calculating the population weight or biomass that is added every year through recruitment and the growth of young fish and then deducting its natural mortality. Yield can be highly variable but is related to the growth of fish, stock size, the spawning stock biomass SSB, the recruitment, and to the proportion of the stock harvested by fishing (fishing mortality F).

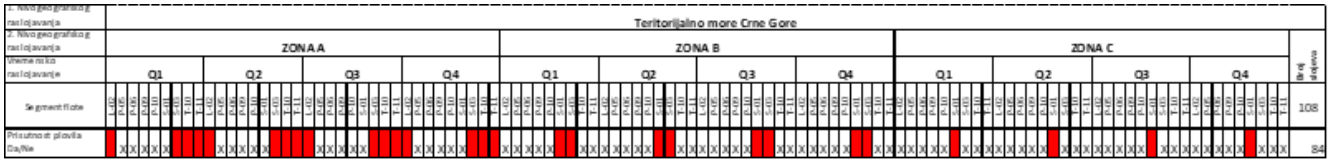
The Institute of Marine Biology – the University of Montenegro is responsible for the collection of biological data for DCRF, and submission of Task III and Task VII. Data is collected through onboard sampling by qualified and trained observers. Montenegro's Sea is divided into 3 zones:

- Zone A – Boka Kotorska Bay;
- Zone B – Open sea from the border with Croatia to municipalities Bar/Budva border;
- Zone C – open sea from municipalities Bar/Budva border to the border with Albania.

Fleet segments for sampling are selected based on the value of total landing of the fleet segment, value of that landing, fishing efforts in days, and fleet segments that generate 90% of cumulative value are selected for sampling. Following fleet segments are monitored:

- L-02: Small-scale vessels using set and/or drifted longlines 6-12 m;
- P-05 and P-06: Small-scale vessels using passive gears < 6 m and 6-12 m;
- P-09 and P-10: Polyvalent vessels < 6 m and 6-12 m;
- S-01 and S-03: Purse seiners < 6 m and 6-12 m;
- T-10 and T-11: Trawlers 6-12 m and 12-24 m.

Each of the fleet segments is monitored on a 3-month basis (4 times a year) from each zone. By the combination of the time variable, zone variable and presence of fleet segment in geographical zones, the following sampling scheme is used:



During each sampling, vessel data are collected (length, engine power, net characteristics), fishing trip data (fishing trip duration, fishing operation duration, haul coordinates). For fishing trips that involve only one haul (purse seines, fixed gears, etc.) the entire catch is processed, while for fishing trips that require more than one haul (bottom trawl fishery), hauls are sampled randomly to represent the entire fishing trip (1st and 3rd, or 2nd and 4th haul).

According to the GFCM regulation species that make up more than 2% of the total landings need to be sampled for biological data collection, and species that are listed in Appendix A of DCRF. By combining all this, a following list of species is sampled in Montenegro:

GFCM subregion	Adriatic Sea	
Country	MNE	
Reference year	2017	
Group 1 species	**Data to be collected (Y/N)**	**Notes**
Engraulis encrasicolus	Yes	
Merluccius merluccius	Yes	
Mullus barbatus	Yes	
Nephrops norvegicus	No	Species is not present in the country landings.
Parapenaeus longirostris	Yes	
Sardina pilchardus	Yes	
Group 2 species	**Data to be collected (Y/N)**	**Notes**
Boops boops	Yes	
Chamelea gallina	No	Species is not present in the country landings.
Eledone cirrhosa	No	Species accounts for 1.31% of total national landings (below the 2% threshold).
Eledone moschata	No	Species is not present in the country landings.
Octopus vulgaris	Yes	
Pagellus erythrinus	No	Species accounts for 1.63% of total national landings (below the 2% threshold).
Sepia officinalis	No	Species accounts for 1.9% of total national landings (below the 2% threshold).
Solea vulgaris	No	Species is not present in the country landings.
Spicara smaris	No	Species is not present in the country landings.
Squilla mantis	No	Species is not present in the country landings.
Group 3 species	**Data to be collected (Y/N)**	**Notes**
Anguilla anguilla	Yes	
Corallium rubrum	No	Species is not present in the country landings.
Dalatias licha	No	Species is not present in the country landings.
Dipturus oxyrinchus	No	Species is not present in the country landings.
Etmopterus spinax	No	Species is not present in the country landings.
Galeus melastomus	No	Species is not present in the country landings.
Hexanchus griseus	No	Species is not present in the country landings.
Mustelus asterias	No	Species is not present in the country landings.
Mustelus mustelus	No	Species accounts for 0.1% of total national landings (below the 2% threshold).
Mustelus punctulatus	No	Species is not present in the country landings.
Myliobatis aquila	No	Species accounts for 0.05% of total national landings (below the 2% threshold):
Prionace glauca	No	Species is not present in the country landings.
Pteroplatytrygon violacea	No	Species is not present in the country landings.
Raja asterias	Yes	
Raja clavata	No	Species is not present in the country landings.
Raja miraletus	No	Species is not present in the country landings.
ScySorhinus canicula	No	Species accounts for 0.09% of total national landings (below the 2% threshold).
Scyliorhinus stellaris	No	Species is not present in the country landings.
Squalus acanthias	No	Species is not present in the country landings.
Squalus blainvillei	No	Species is not present in the country landings.
Torpedo marmorata	No	Species is not present in the country landings.
Torpedo torpedo	No	Species is not present in the country landings.

For species that are not listed as main commercial species, the total weight of all sampled individuals is measured as well as the length of each individual, while for the main commercial species the entire set of biological data is collected (length, weight, sex, maturity, age) according to the DCRF manual. Species are also divided by subcategories, target or bycatch. Data on discard are collected from every sampled fishing trip for all the species present (number of individuals and total weight by species).

To collect more data on discard amount and composition in trawl fishery, Montenegro started with Pilot discard monitoring programme in august 2018, according to the methodology described and provided in the GFCM discard monitoring manual. Monitoring is conducted by observers on board, through self-sampling by fishermen and through interviews/questionnaires with fisherman. The fleet segments T-10 and T-11 are monitored every month. Data on the fishing vessel, fishing trip and fishing operation are recorded. Fishing hauls are sampled randomly to represent the entire fishing trip (1st and 3rd, or 2nd and 4th haul). Data on the retained part and discarded part of the catch are collected depending on time availability as the total amount of catch processed, or by subsampling which is chosen to represent the entire catch.

3.2.3. Suggestion for monitoring within the IMAP framework

Total landings data will be collected by the Ministry of Agriculture and Rural Development – Directorate for Fisheries based on the GFCM DCRF methodology and National Programme for fishery data collection of Montenegro, based on the data from logbooks and reports on catches. Data will be submitted through the DCRF online platform as a total landing by species by fleet segment.

The Institute of Marine Biology will continue to collect biological data according to the GFCM DCRF methodology and National Programme for fishery data collection of Montenegro. List of fleet segments and species to be sampled and monitored will be revised every 3 years based on data from previous years.

3.3. Common indicator 9: Fishing mortality

3.3.1. Methodology

The status of stocks is ideally based on a validated stock assessment model, from which indicators of stock status (e.g. biomass, fishing mortality, recruitment) are obtained, and reference points are agreed for the chosen indicators. When possible, analytical stock assessment models that incorporate both fishery-dependent (e.g. catches) and independent information (e.g. surveys) are used. Different stock assessment models are used in the GFCM area of application, but recently two methods have been used for stock assessment of demersal species in the Adriatic: a tuned version of virtual population models (extended survivor analysis – XSA) and statistical catch at age analysis (stock synthesis – SS3). For the stock assessment of small pelagic species in the Adriatic, the State-Space Assessment Model (SAM) has been used.

Stocks of European hake (*Merluccius merluccius*), red mullet (*Mullus barbatus*), deep-water pink shrimp (*Parapenaeus longirostris*), European pilchard (*Sardina pilchardus*), and European anchovy (*Engraulis encrasicolus*)[9] are assessed at the Adriatic level at the annual meetings of the GFCM Working Groups for Stock Assessment of Demersal and Small Pelagic Species.

3.3.2. Data collection and processing

Fishery-dependent data used in stock assessment is obtained through the Data Collection Reference Framework done in Montenegro, while fishery-independent data comes from the results of the Mediterranean Trawl Survey (MEDITS) and Mediterranean Acoustic Survey (MEDIAS) conducted in Montenegrin waters. Data is processed at the regional level during relevant AdriaMed and GFCM working groups meetings and submitted through Stock Assessment Forms.

[9] All listed species are Group 1 Priority Species, according to Appendix A of the GFCM – Data Collection Reference Framework version 2017.1 (GFCM-DCRF, 2017)

3.3.3. Suggestion for monitoring within the IMAP framework

Stocks of European hake (*Merluccius merluccius*), red mullet (*Mullus barbatus*), deep-water pink shrimp (*Parapenaeus longirostris*), European pilchard (*Sardina pilchardus*), and European anchovy (*Engraulis encrasicolus*)[10] are assessed at the Adriatic level at the annual GFCM Working Groups meetings for Stock Assessment of Demersal and Small Pelagic Species. Data will be collected through the National Programme for fishery data collection of Montenegro and scientific surveys MEDITS and MEDIAS (Figures 3.1 and 3.2).

It is suggested that the stock assessments of the listed species continue to be assessed on the regional, Adriatic level, and data collection will continue according to the GFCM DCRF manual.

3.4. Common indicator 10: Fishing effort

3.4.1. Methodology

The Ministry of Agriculture and Rural Development – Directorate for Fisheries is responsible for the collection and submission of fishing effort data. Data on fishing effort comes from logbooks and reports on catches in terms of time (number of fishing days, number of hours) and Fisheries information system in terms of capacity (GT and kW) based on the licences that are issued to fishermen.

3.4.2. Data collection and processing

Fishing effort is a measure of the amount of fishing activity deployed and it is calculated by multiplying the fishing capacity deployed by the period of time. Fishing effort is reported as a nominal effort by fleet segments. The nominal effort is calculated as a measure of GT of that fleet segment and a total number of fishing days of the relevant fleet segment. The fishing effort by gears is expressed as a number of fishing days (for gears that are used on polyvalent vessels, the number of fishing days is estimated based on the total number of fishing days of relevant fleet segments and number of gears used in that fleet segment).

3.4.3. Suggestion for monitoring within the IMAP framework

Effort data will be collected by the Ministry of Agriculture and Rural Development – Directorate for Fisheries based on the GFCM DCRF methodology and National Programme for fishery data collection of Montenegro, based on the data from logbooks and reports on catches and data from licences (GT, kW, number of nets in licences). Data will be submitted through the DCRF online platform as a fishing effort by fleet segment and fishing effort by gears.

3.5. Common Indicator 11: Catch per unit of effort

3.5.1. Methodology

The catch per unit of fishing effort (CPUE) is a relative measure of fish stock abundance and can be used to estimate relative abundance indices; it can also serve as an indicator of fishing efficiency, both in terms of abundance and economic value. In its basic form, the CPUE could be expressed as the captured biomass for each unit of effort applied to species/stock (e.g. total catch of a species divided by the total fishing effort: kg/number of fish per long line hook days). Declining trends of this estimator could indicate overexploitation, while unchanging value could indicate sustainable fishing.

The Ministry of Agriculture and Rural Development – Directorate for Fisheries is responsible for the collection and submission of CPUE data. CPUE is expressed as a ratio of total catch by gear and species and nominal effort by fishing gear (Appendix F.2 of DCRF manual 2019.1). CPUE is reported for the Group 1 and Group 2 priority species found in catches in Montenegro.

[10] All listed species are Group 1 Priority Species, according to Appendix A of the GFCM – Data Collection Reference Framework version 2017.1 (GFCM-DCRF, 2017)

3.5.2.
Data collection and processing

Fishery-dependent data used in CPUE estimation is obtained through the Data Collection Reference Framework done in Montenegro and through the data available via fishing logbooks and reports on catches submitted to the Ministry of Agriculture and Rural Development.

3.5.3.
Suggestion for monitoring within the IMAP framework

CPUE data will be collected by the Ministry of agriculture and rural development – Directorate for fisheries based on the GFCM DCRF methodology and National Programme for fishery data collection of Montenegro, based on the data from logbooks and reports on catches and data from licences (GT, kW, number of nets in licences). Data will be submitted through the DCRF online platform as a CPUE by gear and species.

3.6.
Common indicator 12: Bycatch of vulnerable and non-target species

3.6.1.
Methodology

Data on incidental catches of vulnerable species comes from logbooks and reports on catches (self-sampling of fisherman) and samplings by onboard observers. All available data (gear, fleet segment, measures of individual, dead or alive, etc.) is collected and submitted through the DCRF online platform.

3.6.2.
Data collection and processing

Data on the incidental catch of seabirds, sea turtles, seals, cetaceans, sharks and rays species (Appendix E.1) as identified in the GFCM recommendations (GFCM/35/2011/3, GFCM/35/2011/4, GFCM/35/2011/5, GFCM/36/2012/2 and GFCM/36/2012/3) and included in Annex II (List of Endangered or Threatened Species) and Annex III (List of species whose exploitation is regulated) of the Protocol concerning Specially Protected Areas and Biological Diversity SPA/BD in the Mediterranean of the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention), rare sharks and rays (Appendix E.2), are collected through onboard observers and/or self-sampling and transmitted to the GFCM through DCRF online platform (task III). All this information (measures of individuals, gears, fleet segment, etc.) is collected and submitted as a report.

3.6.3.
Suggestion for monitoring within the IMAP framework

All incidental catches of vulnerable species, the information on which is collected by observers on board or through self-sampling, will be reported through task III of DCRF online platform.

3.7.
Interactions with fisheries monitoring and other EOs under the IMAP

Fisheries monitoring is being implemented along the GFCM agreed transects. Mainly due to cost-effectiveness reasons, monitoring of EO10, and possibly EO1, is being implemented during the EO3 surveys as well.

Detailed information about interconnections and interactions between EO3 and other EOs is provided in Annex 1.

The rationale for interactions and interconnections between EOs is provided in Annex 2.

4.
EUTROPHICATION (EO5)

Definition: 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 nutrients causing changes to the balance of organisms; and water quality degradation. The direct and indirect consequences of eutrophication are undesirable when they degrade ecosystem health and/or the sustainable provision of goods and services, such as algal blooms, dissolved oxygen deficiency, declines in seagrasses, the mortality of benthic organisms and/or fish. Although these changes may also occur due to natural processes, the management concern begins when they are attributed to anthropogenic sources.

GES definition: Human-induced eutrophication is minimized, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algal blooms and oxygen deficiency in bottom waters.

Relevant pressures: Input of nutrients; Input of organic matter.

4.1.
Common indicators

Common indicator 13: Concentration of key nutrients in the water column	
GES definition	Concentrations of nutrients in the euphotic layer are in line with prevailing physiographic, geographic and climate conditions.
Operational objective	Human introduction of nutrients in the marine environment is not conducive to eutrophication.
GES targets	(1) Reference nutrients concentrations according to the local hydrological, chemical and morphological characteristics of the un-impacted marine region; (2) Decreasing trend of nutrients concentrations in the water column of human-impacted areas, statistically defined; (3) Reduction of BOD emissions from land-based sources; (4) Reduction of nutrients emissions from land-based sources.

Common indicator 14: Chlorophyll a concentration in the water column	
GES definition	Natural levels of algae biomass, water transparency and oxygen concentrations in line with prevailing physiographic, geographic and weather conditions.
Operational objective	Human introduction of nutrients in the marine environment is not conducive to.
GES targets	(1) Chlorophyll a concentration in high-risk areas below thresholds; (2) Decreasing trend in chl-a concentrations in high-risk areas affected by human activities.

4.2.
Selection of sampling stations

Sampling stations for the IMAP eutrophication monitoring programme were selected considering the results of the current national marine ecosystem monitoring programme and spatial variation in eutrophication for coastal areas as well as results of the vulnerability and pollution assessment given in the National Strategy on Integrated Coastal Zone Management of Montenegro (CAMP, Montenegro)[11].

The geographical scale of the monitoring programme was defined concerning the hydrological and morphological conditions of an area, particularly the freshwater inputs from rivers, the salinity, the general circulation, upwelling and stratification. Montenegro's sea consists of two substantially different areas in terms of their geographic, hydrographic and oceanographic characteristics: Boka Kotorska Bay and the open sea extending from the coastal line[12]. The total surface of the territorial sea is around 2,460.9 km^2 (of which 87.33 km^2 in Boka Kotorska Bay).

The strongest pressures that Montenegro's sea ecosystem is facing are generated by wastewater from many sewage outfalls, which function without wastewater treatment, and from absorbent cesspits, which introduce a great amount of dissolved and particulate nutrients and organic matter with contents changing throughout the year. There is also pressure from pollution coming from dumps close to the sea, wastewater from small plants and wastewater from ships, as well as the inflow of nutrients from the Bojana River.[13] The analysis of the Trophic index (TRIX) obtained from the monitoring conducted from 2008 to 2011 can give an overview of the relationship between potential pressure and eutrophication.

Considering the potential impacts of pressures related to eutrophication, the proposed sampling locations for the eutrophication monitoring programme are presented in Table 4.1. This proposal of sampling locations also considers the presumed water types needed for the classification of water based on the existing eutrophication monitoring data assigned to monitoring areas (i.e. transects) surrounding respective sampling locations as presented in Chapter 3.6. "Data elaboration. Stations". The name was obtained by merging for example O for open waters (offshore), Station type (C for Costal) and the monitoring areas abbreviated as B for Boka Kotorska. The next two characters represent the abbreviated sampling location name (MA for Mamula) and the two numeric characters stand for the progressive number of the station.

[11] National strategy of integrated coastal zone management of Montenegro (CAMP, Montenegro)"

[12] Information on harbors of national importance Government of Montenegro; Ministry of Transport and Maritime Affairs

[13] National Action Plan for the implementation of the LBS Protocol and its regionals plans in the framework of the SAP-MED with the aim to achieve GES for pollution related ECAP ecological objectives

Area	Area code	No.	Station code		Location	Type*	Longitude	Latitude	Depth (m)	Water Type
			New	Old						
Boka Kotorska	B	1	BCM-IG01	IG-1	Igalo	CM	18.51780	42.45132	11	Type IIA
		2	BCM-HN01	E-3	Herceg Novi	CM	18.54472	42.43805	42	Type IIA
		3	BCM-TI01	E-2	Tivatski zaliv	CM	18.65893	42.43293	38	Type IIA
		4	BCM-SN01	OS-3	Sveta Nedelja	CM	18.67618	42.45775	24	Type I
		5	BCM-RI01	RI	Risan	CM	18.68835	42.50937	16	Type I
		6	BCR-OR01		Orahovac-Ljuta	CR	18.76333	42.48563	/	Type IIA
		7	BCM-DI01	OS-1	IBM-Dobrota	CM	18.76087	42.43638	14	Type I
		8	BCM-KO01	E-1	Kotorski zaliv	CM	18.74113	42.47515	22	Type I
Open sea – North	N	9	NOR-MA01		Mamula 1	OR	18.55597	42.37762	74	Type IIA
		10	NOM-MA02		Mamula 2	OM	18.51480	42.31328	74	Type IIA
		11	NOM-MA03		Mamula 3	OM	18.45178	42.22216	74	Type IIA
		12	NCM-LU01		Luštica	CM	18.66362	42.36107	/	Type IIA ?*
Open sea – Central	C	13	CCM-BU01	MNE-06	Budva	CM	18.83793	42.26917	30	Type IIA
		14	CCR-KA01		Katič – MPA	CR	18.93828	42.19375		Type IIA ?*
		15	CCM-BL01		Buljarica 1	CM	18.96499	42.17005	/	Type IIA ?*
		16	CCM-BL02		Buljarica 2	CM	18.92221	42.13254	/	Type IIA ?*
		17	COM-BL03		Buljarica 3	OM	18.80908	42.02325	/	Type IIA ?*
		18	CCM-RA01	MNE-03	Ratac – Barski zaliv	CM	19.04502	42.11033	35	Type IIA
Open sea – South	S	19	SCR-SU01		Stari Ulcinj	CR	19.13572	41.99016	35	Type IIA
		20	SCH-PM01	OS-5	Port Milena	CH	19.23477	41.90157	10	Type IIA
		21	SCM-AB01	OS-6	Ada Bojana 1	CM	19.33378	41.85863	/	Type I
		22	SOR-AB03		Ada Bojana 3	OR	19.20173	41.72879	/	Type IIIW

* – Type, CM – Costal Master, CR – Costal Reference, CH – Costal Hotspot, OM – Offshore Master, OR – Offshore Reference

?*– new locations for which there is not enough data to determine the type of water

Table 4.1: Sampling stations for eutrophication

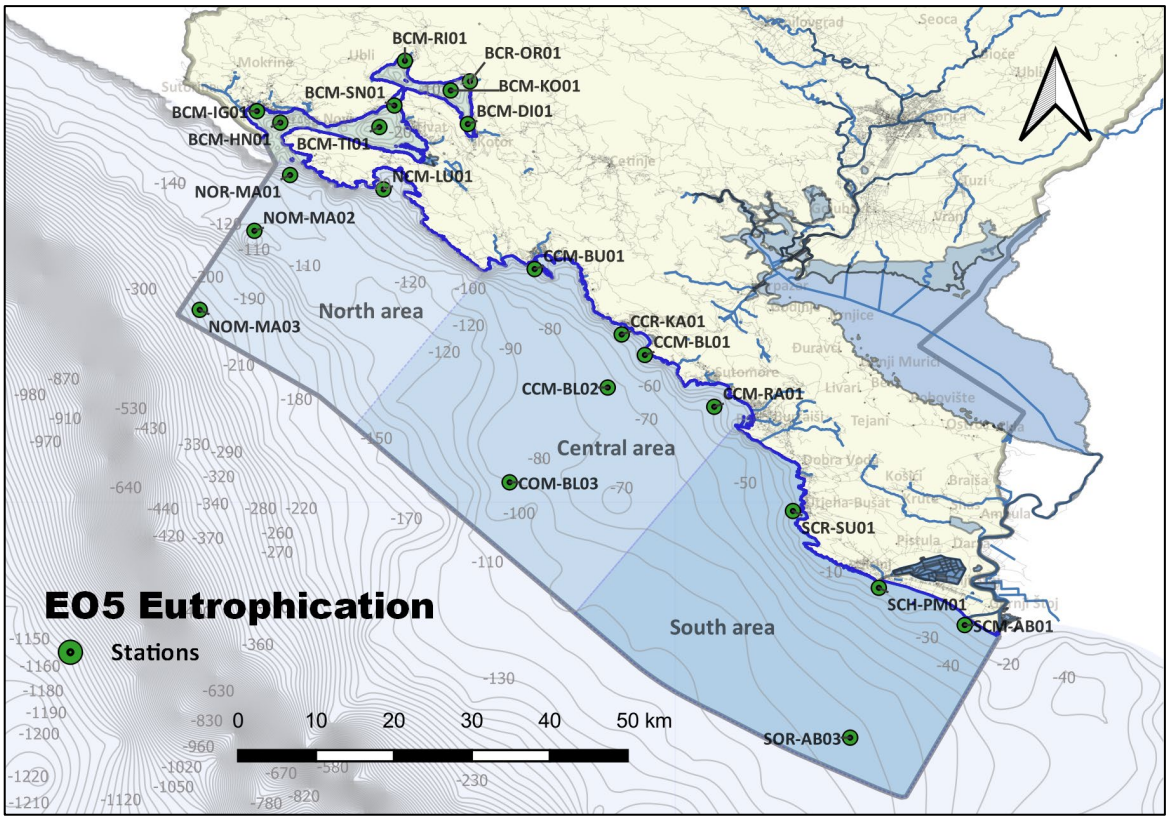


Figure 4.1: Map of stations for monitoring of physicochemical and biological parameters

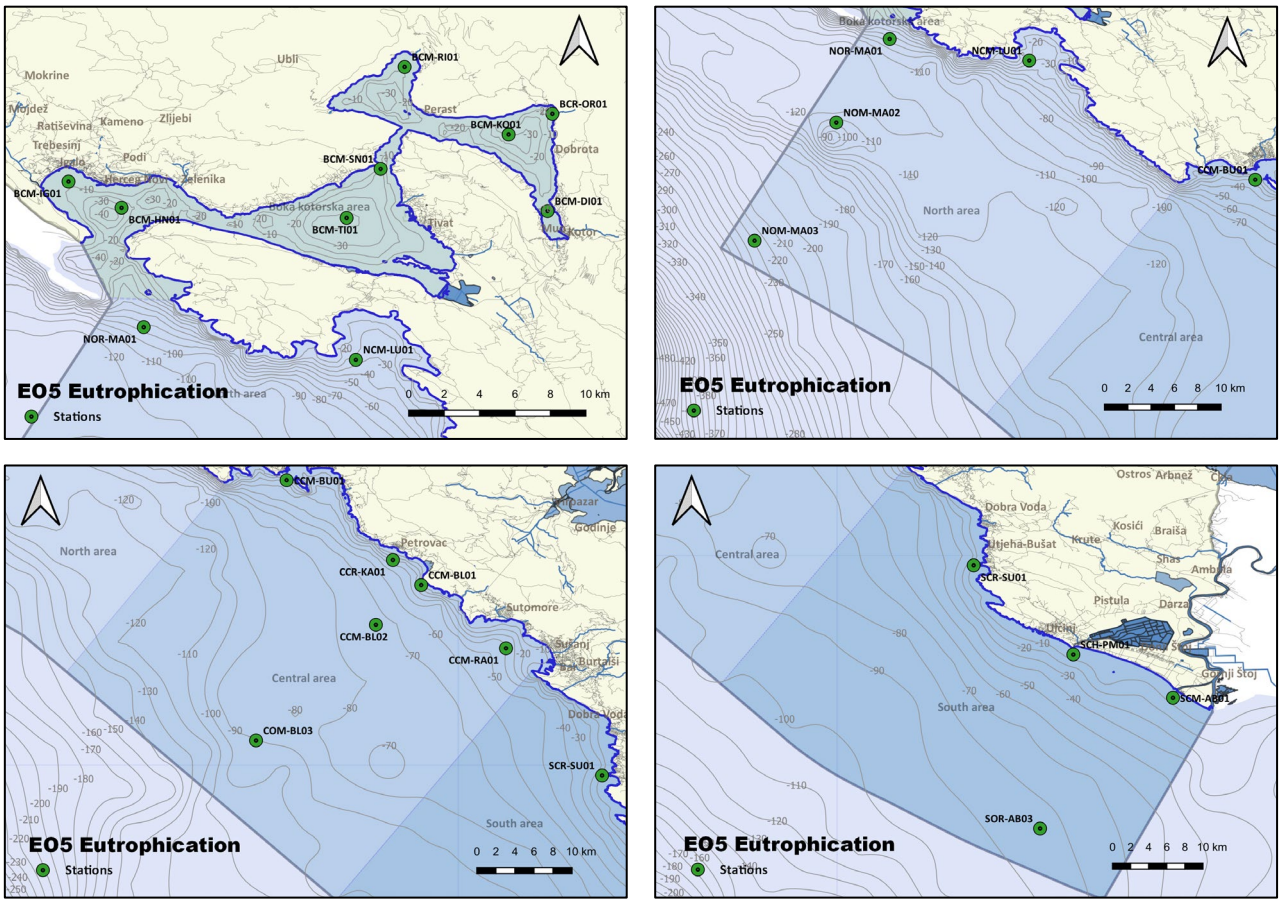


Figure 4.2: Map of stations in Boka Kotorska, northern area, central area and southern area

4.3.
Selection of parameters

Selection of parameters for assessment of eutrophication and achievement of GES are done according to IMAP Common Indicator Guidance Facts Sheets (UNEP (DEPI)/MED WG.444/5) and Integrated Monitoring and Assessment Guidance (UNEP (DEPI)/MED IG.22/Inf.7), as well as Commission Decision (EU) 2017/848.

Table 4.2: List of key parameters and sub-indicators according to IMAP Common Indicator Guidance Facts Sheets (UNEP (DEPI)/MED WG.444/5)

Common indicator 13: Concentration of key nutrients in the water column		
N_0	Key parameters	Sub-Indicators:
	Nitrate (NO_3-N) Nitrite (NO_2-N) Ammonium (NH_4-N) Total Nitrogen (TN) Orthophosphate (PO_4-P) Total Phosphorus (TP) Orthosilicate (SiO_4-Si)	Nutrient ratios (molar) of silica, nitrogen and phosphorus where appropriate: Si:N, N:P, Si:P
Common indicator 14: Chlorophyll *a* concentration in the water column		
N_0	Key parameters	Sub-Indicators:
	Chlorophyll *a* concentration in seawater	pH Water Transparency Dissolved oxygen and Saturation Temperature Salinity Abundance of phytoplankton Composition of phytoplankton community

4.4.
Sampling frequency

In general, eutrophication shows pronounced spatial variation in coastal regions. The frequency and spatial resolution of the monitoring programme should reflect this spatial variation in eutrophication status and pressures following a risk-based approach and the precautionary principle (UNEP(DEPI)/MED IG.22/Inf.7), as well as considering a need for ensuring cost-efficient monitoring.

The achievements and data generated through present national monitoring programme were used as a basis for defining the sampling frequency of new IMAP-based monitoring programme considering the necessity of both controlling the deviations of the known natural cycles of eutrophication and control of human-impacted areas.

Based on the above, the conclusion is that a particular area can be best assessed if we measure three relevant depths (typically 0, 5, 10 m) at one station at least once a month or one depth (0 m) at four stations. On an annual basis, 36 samples discriminate around 0.25 chla $\log_{10}$ unit for the mesotrophic – eutrophic area that is slightly more than half a difference between two classes as defined for the Adriatic Sea. Due to smaller standard deviation for an oligotrophic area, we achieve the same with half a frequency. The next measurement frequency is proposed:

- Eutrophic – mesotrophic: monthly;
- Mesotrophic – oligotrophic: monthly near the coast, bimonthly in open waters; and
- Oligotrophic: bimonthly near the coast, seasonally in open waters.

Considering all of the above, in Table 4.3 are shown the proposed sampling frequencies for the eutrophication monitoring programme, as well as the list of sampling depths. The sampling frequency for coastal locations, which are under the influence of coastal waters and other human impacts, will be 12 times per year and for open waters (offshore locations), which are not under the coastal influence, this frequency will be 4 times per year.

Considering the variability in the water layers caused by active hydrodynamic processes, the eutrophication monitoring programme will be achieved by sampling different seawater depths. All physicochemical, chemical and biological parameters, except temperature and salinity, will be sampled at four depths (0 m, 5 m, 10 m and 2 m above bottom - locations where the depth is more than 10 m). Temperature and salinity will be recorded by CTD for the whole water profile.

4.5.
The methodology of sampling, measurement and laboratory work

The following section provides detailed scientific and technical considerations related to the current practices in monitoring the marine environment, in accordance with the IMAP Guidance Factsheets for each of the parameters within the Common Indicators for Eutrophication, which are necessary for appropriate monitoring.

Table 4.3: Sampling frequency at depths of 0, 5, 10 and 2m above the seabed for the eutrophication

Area	Station Code	Physicochemical parameters*	Chemical parameters**	Biological parameters***
Boka Kotorska	BCM-IG01	12	12	12
	BCM-HN01	12	12	12
	BCM-TI01	12	12	12
	BCM-SN01	12	12	12
	BCM-RI01	12	12	12
	BCR-OR01	12	12	12
	BCM-DI01	12	12	12
	BCM-KO01	12	12	12
Open sea – North	NOR-MA01	12	12	12
	NOM-MA02	4	4	4
	NOM-MA03	4	4	4
	NCM-LU01	12	12	12
Open sea – Central	CCM-BU01	4	4	4
	CCR-KA01	12	12	12
	CCM-BL01	12	12	12
	CCM-BL02	12	12	12
	COM-BL03	4	4	4
	CCM-RA01	12	12	12
Open sea – South	SCR-SU01	12	12	12
	SCH-PM01	12	12	12
	SCM-AB01	12	12	12
	SOR-AB03	4	4	4

* Water Transparency, Temperature, Salinity, Dissolved oxygen and Saturation

** Nitrate, Nitrite, Ammonium, Total Nitrogen, Orthophosphate, Total Phosphorus, Orthosilicate

*** Concentration of Chlorophyll a, Abundance of phytoplankton, Phytoplankton community composition

Table 4.4: Key nutrients in the water column (CI13)

Monitoring CI13		Methodology and procedures
Sample collection		Water sampling is performed using Niskin or equivalent sampler in accordance with ISO guidelines for sampling, storage and handling of samples. EN ISO 5667-3, ISO 5667-14:1998, ISO 5667-3:2003
Sample processing		Nutrient determinations should be carried out as soon as possible after sampling. Ammonia should be determined immediately after sampling, while nitrate, phosphate, and silicate should be determined within a few hours after sampling, with samples protected from light and stored in a refrigerator. If the analysis is not possible within a few hours, then samples must be preserved. Commonly used preservation methods include freezing (for silicate, preferable temperatures are those between –18 °C and –20 °C). UNEP/MAP/MED POL, 2005, EN ISO 5667-3
Measurements	*Ammonium*	Method for the determination of ammonium is based on the formation of the blue coloured indophenol complex, by phenol and hypochlorite in the presence of the NH_4^+ and NH_3 species. The reaction requires an elevated temperature or a catalyst. The colour is measured at 630 nm and remains stable for at least 30 hours.
	Nitrite	The standard method for the determination of nitrite in seawater is based on the reaction of nitrite with an aromatic amine leading to the formation of a diazonium compound, which couples with a second aromatic amine. The product is an azo dye that is quantified by spectrophotometry. UNEP/MAP/MED POL, 2005 Strickland and Parsons, 1972
	Nitrate	Direct determination by UV spectrophotometric method.
	Orthophosphate	The present methods in the analysis of inorganic phosphate in seawater follow essentially the colourimetric method by Murphy and Riley (1962), which is based on the formation of a highly coloured blue phosphomolybdate complex. The modified procedure described here mainly follows the method outlined by Koroleff (1983).
	Orthosilicate	The determination of dissolved silicon compounds is based on the formation of a yellow silicomolybdic acid when an acid sample is treated with a molybdate solution. This silicomolybdic acid (occurring in two isomeric forms) is then reduced to an intensely blue-coloured complex by adding ascorbic acid as a reductant. The colour is formed within 30 minutes determined at 810 nm and remains stable for several hours.
	Simultaneous determination of *Total Nitrogen* and *Total Phosphorus*	The method for the determination of total nitrogen and total phosphorus is based on using a persulphate oxidizing reagent for the decomposition of organic material containing N and P. The oxidizing reagent breaks down organic components, releases phosphorus as phosphate and oxidizes nitrogen components to nitrate. In the simultaneous oxidation of samples, the reaction starts at about pH 9.7 and ends at 4-5. These conditions are established using a boric acid-NaOH system. Total nitrogen and total phosphorus are determined by spectrophotometer.
Reporting and Quality Assurance	*Ammonium:*	Symbol: $c(NH_4^+)$
	Nitrite:	Symbol: $c(NO_2^-)$
	Nitrate:	Symbol: $c(NO_3^-)$
	Total Nitrogen:	Symbol: c(TN)
	Orthophosphate:	Symbol: $c(PO_4^{3-})$
	Total Phosphorous:	Symbol: c(TP)
	Orthosilicate:	Symbol: $c(SiO_4^{3-})$
	Unit: µmol/L (micromole per litre)	
	Laboratories carrying out analyses of nutrients have to establish a quality management system according to EN ISO/IEC 17025. Accreditation by a recognized accreditation authority is also recommended. The quality assurance procedures must cover all steps of the nutrient determinations, including sampling, storage of samples, analytical procedures, maintenance and handling of the equipment as training of the personnel. The laboratory should also take part in interlaboratory comparisons and proficiency testing, e.g. QUASIMEME, to provide external verification of laboratory performance.	

Table 4.5: Chlorophyll *a* in the water column (CI14) and related parameters

Monitoring CI14 Concentration of Chlorophyll *a*	Methodology and procedures
Sample collection	Water sampling is performed using Niskin sampler or equivalent sampler in accordance with ISO guidelines for sampling, storage and handling of samples. EN ISO 5667-3, ISO 5667-14:1998, ISO 5667-3:2003
Sample processing	It is recommended that the sample drawn from the water sampler should be filtered immediately on board. However, samples may be stored for short periods in the dark and at ~4°C. If it is not possible to follow this procedure, the filters should be kept frozen at < -20 °C for no longer than 21 days. If stored longer, a temperature of < -80 °C should be maintained to avoid degradation of chlorophyll a. UNEP/MAP/MED POL, 2005
Measurement	Extraction of chlorophyll *a* from the filter residue into hot ethanol and spectrophotometric determination of the chlorophyll *a* concentration in the extract. Extraction procedures and measurements should be carried out in low light. UNEP/MAP/MED POL, 2005 Strickland and Parsons, 1968, ISO 10260 (1992)
Reporting and Quality Assurance	Symbol: *c*(Chl*a)* Unit: µg/L (microgram per litre) Data reporting to the IMAP database should follow the requirements of the latest reporting formats, together with QA information on methods used, detection limits, reference values, and any other comments or information relevant to an assessment of the data. It is recommended that laboratories carrying out analyses of Chlorophyll *a* have to establish a quality management system according to EN ISO/IEC 17025. Accreditation by a recognized accreditation authority is also recommended. The quality assurance procedures must cover all steps of the concentration of chlorophyll determination, including sampling, storage of samples, analytical procedures, maintenance and handling of the equipment as training of the personnel. The laboratory should also take part in interlaboratory comparisons and proficiency testing, e.g. QUASIMEME, to provide external verification of laboratory performance. Given that a Certified Reference Material (CRM) for chlorophyll is not available, the laboratories should regularly take part in interlaboratory comparisons. Internal methods should be properly validated. As a routine procedure for controlling systematic errors, the use of control charts is recommended. It is common practice in analytical laboratories to run duplicate analyses at frequent intervals as a means of monitoring the precision of analyses and detecting out-of-control situations in R-charts so-called Range (control) charts or Precision charts. This is often done for determinants for which there are no suitable control samples or reference materials available. For chlorophyll *a* analyses it is recommended to run at least one duplicate sample within every batch of samples. EN ISO/IEC 17025, EN 14996 (2006)
Temperature and Salinity (CI14)	**Methodology and procedures**
Sample collection	does not apply EN ISO 5667-3
Measurement	*Temperature* and *Salinity will be* measured *in situ* by modern CTD (*Conductivity, Temperature, Depth)* high-precision probe equipped with sensors for salinity and temperature. WOCE, 1991 UNESCO, 1994, UNEP/MAP/MED POL, 2005.
Reporting and Quality Assurance	*Temperature:* symbol: *t;* Unit: °C (degree Celsius) *Salinity:* Symbol: *S;* Unit: – (dimensionless) Data reporting to the IMAP database should be in accordance with the requirements of the latest reporting formats. It is recommended that laboratories carrying out analyses of salinity establish a quality management system according to EN ISO/IEC 17025.

pH (CI14)	Methodology and procedures
Sample collection	A variety of sampling bottles can be used for the collection of nutrient samples. These are commonly deployed on either a CTD -rosette or they are clamped to a hydrographic wire and lowered to the prescribed depth.
Sample processing	Subsamples for pH should be drawn from sampling bottles as early as possible (after samples for oxygen but before samples for nutrients and salinity) to avoid gas exchange between water and air. Samples should be collected in gas-tight bottles. Bottles should be rinsed thoroughly with sample water before filling. Bottles are filled with a laminar flow of sample water, allowing 2-3 bottle volumes to overflow before capping. Bottles should be completely filled, leaving no headspace. Avoid trapping bubbles of air when capping bottles. Samples should preferably be analysed as soon as possible right after sampling. HALCOM, 2017
Measurement	pH is measured using a glass/combined electrode. Determination of pH using a glass electrode is described in ISO 10523. The NBS pH scale should be used, although not ideal, the NBS scale has to this day been considered to be the best option for the wide range of salinity. Temperature is measured and recorded both during pH measurement and at sampling depth. A correction for *in situ* pH (Gieskes 1969) is sometimes applied. A better option is to report measured pH, temperature from pH measurement and *in situ* temperature. ISO 10523; HALCOM, 2017; Wedborg et al, 2007
Reporting and Quality Assurance	Symbol: pH Unit: – (dimensionless) Data reporting to the IMAP database should be in accordance with the requirements of the latest reporting formats. It is recommended that laboratories measuring pH have to establish a quality management system according to EN ISO/IEC 17025. An internal reference material (IRM) should be analysed daily.

Concentration of Dissolved Oxygen and Saturation (CI14)	Methodology and procedures
Sample collection	Water samples from specified depths are normally collected with water samplers. Various designs are commercially available. The non-reversing type sampler such as Niskin is the most widely used.
Sample processing	Oxygen in water samples for Winkler analysis must be fixed immediately after collection to eliminate the removal or production of oxygen in the sample. DO samples should be the first to be drawn from the sampling bottles. After fixation, samples should be stored in a dark place at a constant temperature – if possible, the same as the *in situ* temperature – for at least one hour. The fixed sample should be titrated within 24 hours after collection. In some cases, longer storage of the fixed sample is unavoidable, but storage conditions and handling procedures must be validated and clearly documented. Zhang *et al.* (2002) note that storage under seawater is advisable in such circumstances. For general requirements for sampling, preservation, handling, transport and storage of water samples see EN ISO 5667-3.
Measurement	*Determination of Oxygen by Winkler Titration Method* The reference method for the determination of DO is the Winkler titration to the iodine endpoint. The procedure according to ISO 5813:1983 is fully described in MAP Technical Reports Series No. 163 (UNEP/MAP/MED POL, 2005).
Reporting and Quality Assurance	Concentration of Dissolved Oxygen Symbol: $c(O_2)$ Unit: µmol/L (micromole per litre) Transformations: Unit A – Unit B – Transformation factor mg/L – mL/L – 0.7 mL/L – mg/L – 1.429 µmol/L – mL/L – 11.196 mL/L – µmol/L – 0.0893 mg/L – µmol/L – 0.06251 µmol/L – mg/L – 15.997 Saturation of Dissolved Oxygen Symbol: $\varphi(O_2/O_2')$ Unit: % (percent)

Concentration of Dissolved Oxygen and Saturation (CI14)	Methodology and procedures
	Saturation is calculated from tables of oxygen saturation values in Volume II of the International Oceanographic Tables (UNESCO, 1973). It has to be reported with Dissolved Oxygen Temperature and Salinity. Data reporting to the IMAP database should be in accordance with the requirements of the latest reporting formats, together with QA information on methods used, detection limits, reference values, and any other comments or information relevant to data assessment. It is recommended that laboratories carrying out analyses of oxygen establish a quality management system according to EN ISO/IEC 17025. Accreditation by a recognized accreditation authority is also recommended. There is no Certified Reference Material for oxygen in the water. The reference method is the properly performed Winkler method (Grasshoffet al, 1999). Several publications contain descriptions of how the calibration should be performed and quality assurance can be achieved (WOCE, 1994) The calibration of sensors is dependent on the Winkler method and therefore it is recommended to use internal laboratory procedures according to Grasshoffet al. (1999) for quality assurance of the chemical analysis.

Phytoplankton abundance and community composition (CI14)	Methodology and procedures
Sample collection	Water sampling is performed using Niskin sampler or equivalent sampler in accordance with ISO guidelines for sampling, storage and handling of samples. EN ISO 5667-3; ISO 5667-14:1998; ISO 5667-3:2003; ISO 5667-9: 1992
Sample processing	Preservation and storage of samples: The most commonly used fixatives are formaldehyde and Lugol's solution, but it is good practice to observe an alive subsample first. This would allow a better characterization of cells morphology, colour and motility. If the analysis is not possible within a few hours, then samples must be preserved. Acidic Lugol's solution is recommended since it is less toxic than formaldehyde. Fixed samples should be stored at room temperature, in the dark up to 12 months, but it is recommended to check the colour of the solution, that tends to become lighter with time due to the oxidation of iodine, thus reducing fixation.
Measurement	Quali-quantitative analysis of the subsamples should be performed using the inverted microscope method described by Utermöhl, 1958; Zingone *et al.*, 1990. in accordance with standard method MEST EN 15204:2014.
Reporting and Quality Assurance	Unit: N (number of cells)/L – cells Composition of the phytoplankton community

4.6. Data processing

In the Mediterranean, a considerable number of eutrophication experts have built a typology scheme for the Mediterranean coastal waters during the first inter-calibration phase for the EU Water Framework Directive implementation, which is still in use after their update according to Commission Decision 2013/480/UE and represents a very simple typology approach that could be easily applied across the Mediterranean for coastal waters, since these coastal waters have been intercalibrated. For eutrophication, it is accepted that surface density is adopted as a proxy indicator for the static stability of a coastal marine system. More information on typology criteria and the setting is provided in document UNEP(DEPI)/MED WG 417/Inf.15:

- Type I: coastal sites highly influenced by freshwater inputs;
- Type IIA: coastal sites moderately influenced not directly affected by freshwater inputs (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).

For Montenegro, I, IIA and IIIW types apply.

It is recommended to define the major coastal water types in Montenegro coastal waters for eutrophication assessment using the ranges presented in Table 4.6. Both density or salinity can be equally used. Data collected in five years in the surface layer (0-10 m) respecting the sampling frequency defined in Subchapter 4.4. must be used. Average values over the period (climatological) are used for the evaluation.

Table 4.6: Major coastal water types in the Mediterranean

	Type I	Type IIA, IIA Adriatic
σ_t (density)	< 25	25 < d < 27
Salinity	< 34.5	34.5 < S < 37.5

With the view to assessing eutrophication, it is recommended to rely on the classification scheme based on Chlorophyll *a* concentration (µg/L) in coastal waters as a parameter easily applicable by all Mediterranean countries based on the indicative thresholds and reference values presented in Table 4.7. In the Table, only values referred to the Adriatic Sea are presented as the ones that are the most applicable to the Montenegro coast. In future, when sufficient data to develop their national boundaries is available (five years at sampling frequency defined in Subchapter 4.4), the classification scheme adapted to the Montenegro coast must be developed or this one maintained.

Table 4.7: Coastal Water types reference conditions and boundaries for the Adriatic Sea

Coastal Water Typology	Reference conditions of Chl*a* (µg L^{-1})		Boundaries of Chl*a* (µg L^{-1}) for G/M status	
	G_mean	90th percentile	G_mean	90th percentile
Type I	1.4	3.93	6.3	17.7
Type II-A Adriatic	0.33	0.8	1.5	4.0
Type III-W Adriatic			0.64	1.7

This classification scheme relies only on the concentration of chlorophyll *a* data. At the moment, integrative classification schemes based on CI13 key nutrient in the water column are under development in the wider scientific European community.

4.7. Quality Assurance and Quality Control

Since important decisions will be taken based on the results obtained by the monitoring programme, the data generated must be of acceptable quality. The accuracy and comparability of the data collected is a key requirement for status assessment and description and the assessment of anthropogenic influences and required measures. Quality assurance (QA) and quality control (QC) measures ensure that monitoring results of stated quality are obtained at any time. QA/QC should help gain confidence in the whole analytical process, from sampling to reporting.

The integral quality assurance relies on different quality assured processes undertaken basically at the primary level (i.e. by National Laboratories), which should consider many different technical steps, such as data cleansing, standardization, laboratory data quality and control (QA/QC). Each process should be quality assured (i.e. technical check performed); namely, sample collection, sample processing, sample determination and data reporting. Thus, these are required to be performed and fully registered for each marine monitoring project by technical managers and/or involved staff. Therefore, the quality assurance at the first level requires high technical expertise referred to EO5 and EO9 within the IMAP to deliver the expected QA (i.e. data quality).

If marine monitoring activities at the first level are not performed by a single organization (i.e. sample collection, processing, analysis and reporting), the data flows might be separated, and additional integration will be necessary, such as the 'data quality' registry integration.

Table 4.8: Total Quality Assurance (Monitoring QA) at the primary organizational level (i.e. national laboratories) for each monitoring process under IMAP EO5 and EO9

QA flows versus monitoring processes	QA Requirements	Internal QA	External QA	Reporting/Registry QA
Sample collection	Protocols/Data Registry 1	YES	NO*	NO*
Sample processing	Protocols/Data Registry 2	YES	YES (i.e. IAEA/MEDPOL proficiency test)	YES (i.e. Laboratory Accreditation)
Analytical determinations	Protocols/Data Registry 3	YES	YES (i.e. IAEA/MEDPOL proficiency test)	YES (i.e. Laboratory Accreditation)
Reporting	Templates for Data Registry 1 + 2 + 3 (e.g. MED POL data format reporting)	(not applicable)	(not applicable)	YES

** Methodologies for Sample Collection are not externally QA, nor accredited, in general.

From Table 4.8., it could be observed that the fulfilment of the 'data quality' at the first level undertaken by National Laboratories requires a proper design of functions (as well as time and staff resources) to ensure a smooth monitoring process, which starts with the sample collection and ends with the data reporting in the appropriate format. The process from monitoring to reporting can take months or even years to be completed, and therefore, the information registration under reporting QA should be imperative.

ISO/IEC 17025 enables laboratories to demonstrate that they operate competently and generate valid results, thereby promoting confidence in their work, both nationally and globally. It also helps facilitate cooperation between laboratories and other bodies by generating wider acceptance of results between countries. Test reports and certificates can be accepted from one country to another without the need for further testing, which, in turn, improves international trade.[14]

Under Article 56 of the Law of the Environment ("Official Gazette of Montenegro", No. 052/16) for the implementation of certain monitoring tasks, the Agency shall designate one or more reference laboratories accredited according to the MEST EN ISO/IEC 17025 standard. In addition to the requirements of this Article, the Agency shall also consider the criteria relating to the inter-laboratory quality control of work and experience in carrying out specific monitoring tasks.

In accordance with Article 2 of the Rulebook on the criteria to be met by a reference laboratory for environmental monitoring ("Official Gazette of Montenegro", No. 011/17 of 20.02.2017), the reference laboratory for environmental monitoring should meet the following conditions:

1. The Annual plan for conducting interlaboratory/ proficiency testing;
2. Participation in interlaboratory testing carried out by certified organizers of the European Union member states in accordance with international standards (ISO / IEC 17043: 2010, ILAC P13: 10/2010, ISO / IEC 17011), as well as other relevant international organizations;
3. Interlaboratory/proficiency testing carried out by non-certified organizers if no interlaboratory testing have been organized by certified organizations of the EU Member States during the two-year period, where interlaboratory testing shall be carried out with legal entities accredited in accordance with MEST EN ISO / IEC 17025, as well as other relevant international ones;
4. The test results not older than two years for each measurement required for authorization;
5. Experience in carrying out specific monitoring tasks (prior experience and quality performance of the activity); and
6. The appropriate scope of accreditation.

[14] International Organization for Standardization

4.8.
Monitoring the interconnection between eutrophication and other EOs

Eutrophication monitoring shall be performed jointly with the monitoring of EO1-plankton and EO7. In addition, mainly due to cost-effectiveness reasons, most of the stations for EO5 are also used for EO9 (links with EO9 monitoring is presented in the information document *National Thematic Monitoring Programme for Contaminants)*. Also, whenever possible, interconnections with habitats monitoring, in particular within MPAs, are ensured.

Detailed information about the interconnections between EO5 and other EOs in Montenegro is provided in Annex 1. The rationale for interactions and interconnections between different EOs and Common Indicators is provided in Annex 2.

5.
HIDROGRAPHY (EO7)

GES definition: Permanent alteration of hydrographical conditions that does not adversely affect marine ecosystems.

Ecological Objective 7 ("Alteration of hydrographical conditions") addresses permanent alterations in the hydrographical regime of currents, waves and sediments due to new large-scale developments (permanent structure lasting more than 10 years) that have the potential to alter hydrographical conditions.

For permanent coastal structures (built mainly between 0 to 50 m depth), the habitats potentially impacted are:

- mediolittoral and infralittoral benthic habitats (rock and sand);
- coastal water pelagic habitats.

For permanent offshore structures (as marine/wind turbines, drilling/oil rigs, ...), the habitats considered will depend on the location of the structures. In that case, infralittoral, circalittoral, and possibly even bathyal benthic habitats could be potentially impacted, as coastal waters and shelf and oceanic waters pelagic habitats.

The pressures considered on benthic habitats are:

- Physical loss: a permanent change to the seabed (lasting more than 10 years), including changes in the substrate from the natural seabed substrate to an anthropogenic substrate (e.g. made of concrete or metal, such as the foundations of oil, gas or renewable energy installations) or a man-made structure on the coast or offshore (e.g. land claim, artificial island).
- Permanent changes to hydrological conditions:
  - changes in waves, currents and tidal regime;
  - changes in sediment transport processes, turbidity and morphology, for sandy sites or sites with natural sediment dynamic;
  - changes in salinity or temperature, if the new structure involves water discharge, water extraction or changes in freshwater movements (estuary).

Apart from the above, climate change certainly contributes to changing sea temperature and salinity and, consequently, to circulation on a time scale greater than a decade. Therefore, their effect, although not directly related to local human activity, should be taken into account since it can permanently change hydrographic conditions and, consequently, the ecosystem. In the era of climate changes, alteration of hydrographical conditions in the Adriatic Sea became important mainly because changes occurring during extreme winter will be more intense and more frequent in the future.

Based on historical data in combination with current observations and existing models, significant changes in the temperature, salinity and sea level in this part of the Adriatic have been observed, and hence the changes in water masses and thermohaline circulation. These changes are not uniform, they are different in the coastal area in relation to the open sea due to the diversity of hydrographic conditions, but they certainly have permanent consequences on the existing ecosystem and relationships in the food web.

5.1.
Common indicator

Common indicator 15: Location and extent of the habitats impacted directly by hydrographical alterations	
The EO7 Common Indicator reflects the location and extent of the habitats impacted directly by the alterations and/or the circulation changes induced by them: footprints of impacting structures. It concerns area/habitat and the proportion of the total area/habitat where alterations of hydrographical conditions are expected to occur (estimations by modelling or semi-quantitative estimation).	
GES definition	Negative impacts due to new structure are minimal with no influence on the larger scale coastal and marine system.
Operational objective	Alterations due to permanent constructions on the coast and watersheds, marine installations and seafloor anchored structures are minimised.
GES targets	Planning of new structures takes into account all possible mitigation measures to minimize the impact on the coastal and marine ecosystem and its services integrity and cultural/historic assets. Where possible, promote ecosystem health.

5.2.
Parameter selection

In order to monitor the alterations within EO7, the hydrographic parameters, which describe the spatial and temporal properties of the sea in the positions where long-term or short-term datasets already exist, have been selected, so it is possible to monitor and model the changes in their condition in a particular time interval. Therefore, depths and, in general, the seabed bathymetric model, waves, currents, sea level movement, temperature, salinity and turbidity have been taken as key parameters which define hydrographic alterations.

Parameters to be monitored concerning hydrography conditions:

- bathymetry, seabed substrate, morphology;
- temperature and salinity;
- tide/sea level (at least offshore conditions);
- currents;
- waves;
- transparency;
- sediment transport.

Parameters to be monitored concerning habitats (this information will finally be taken from EO1 – once it gets available there – under Habitats):

- Location and extent;
- Coastal and marine structures:
  - Location and extent;
  - Construction types and functions.

5.3.
Selection of sampling sites

In the coastal area of Montenegro, some of the hydrographic parameters (waves, transparency, conductivity) were assessed on sixteen coastal locations (Herceg Novi, Kumbor, Verige, Risan, Perast, Dobrota, Kotor, Tivat, Luštica, Budva, Sveti Stefan, Petrovac, Sutomore, Bar, Ulcinj, Donji Štoj). However, the main issue with data, in this case, is that it is usually not precise enough, qualitative and/or based on visual observations. Therefore, determination of EO7 monitoring stations (in particular for the basic hydrographic parameters of temperature, salinity, turbidity, transparency) is not based on the "existing" stations but optimal monitoring interconnected primarily with EO5, with additional stations across transects (Table 5.1, Figure 5.1, 5.2).

Table 5.1: Hydrographic sampling stations

Area	Area code	No.	Station code		Location	Type*	Longitude	Latitude	Depth (m)
			New	Old					
Boka Kotorska	B	1	BCM-IG01	IG-1	Igalo	H	18.51780	42.45132	11
		2	BCM-HN01	E-3	Herceg Novi	H	18.54472	42.43805	42
		3	BCM-TI01	E-2	Tivatski zaliv	H	18.65893	42.43293	38
		4	BCM-SN01	OS-3	Sveta Nedelja	H	18.67618	42.45775	24
		5	BCM-RI01	RI	Risan	H	18.68835	42.50937	16
		6	BCR-OR01		Orahovac-Ljuta	H	18.76333	42.48563	/
		7	BCM-DI01	OS-1	IBM-Dobrota	H	18.76087	42.43638	14
		8	M-Kotor		Kotor (mareograph)	M	18.76982	42.42400	
		9	BCM-KO01	E-1	Kotorski zaliv	H	18.74113	42.47515	22
Open sea – North	N	10	NOR-MA01		Mamula 1	H	18.55597	42.37762	74
		11	NOR-MAA1		Mamula 1A	I	18.53540	42.34610	
		12	NOM-MA02		Mamula 2	H	18.51480	42.31328	74
		13	NOM-MAA2		Mamula 2A	I	18.48460	42.26710	
		14	NOM-MA03		Mamula 3	H	18.45178	42.22216	74
		15	NCM-LU01		Luštica	H	18.66362	42.36107	/
Open sea – Central	C	16	CCM-BU01	MNE-06	Budva	H	18.83793	42.26917	30
		17	CCR-KA01		Katič – MPA	H	18.93828	42.19375	
		18	CCM-BL01		Buljarica 1	H	18.96499	42.17005	/
		19	CCM-BLA1		Buljarica 1A	I	18.94373	42.15146	
		20	CCM-BL02		Buljarica 2	CM	18.92221	42.13254	/
		21	CCM-BLA2		Buljarica 2A	I	18.86540	42.07790	
		22	COM-BL03		Buljarica 3	H	18.80908	42.02325	/
		23	CCM-RA01	MNE-03	Ratac – Barski zaliv	H	19.04502	42.11033	35
		24	M-Bar		Bar (mareograph)	M	19.07513	42.08793	
Open sea – South	S	25	SCR-SU01		Stari Ulcinj	H	19.13572	41.99016	35
		26	SCH-PM01	OS-5	Port Milena	H	19.23477	41.90157	10
		27	SCM-AB01	OS-6	Ada Bojana 1	H	19.33378	41.85863	/
		28	SCM-ABA1		Ada Bojana 1A	I	19.30745	41.83253	
		29	SOR-AB02		Ada Bojana 2	H	19.28097	41.80670	
		30	SCM-ABA2		Ada Bojana 2A	I	19.24168	41.76733	
		22	SOR-AB03		Ada Bojana 3	H	19.20173	41.72879	/

Type:

- H – Main hydrographic stations
- I – instrumental stations (CTD Sonde only)
- M – Mareographic stations

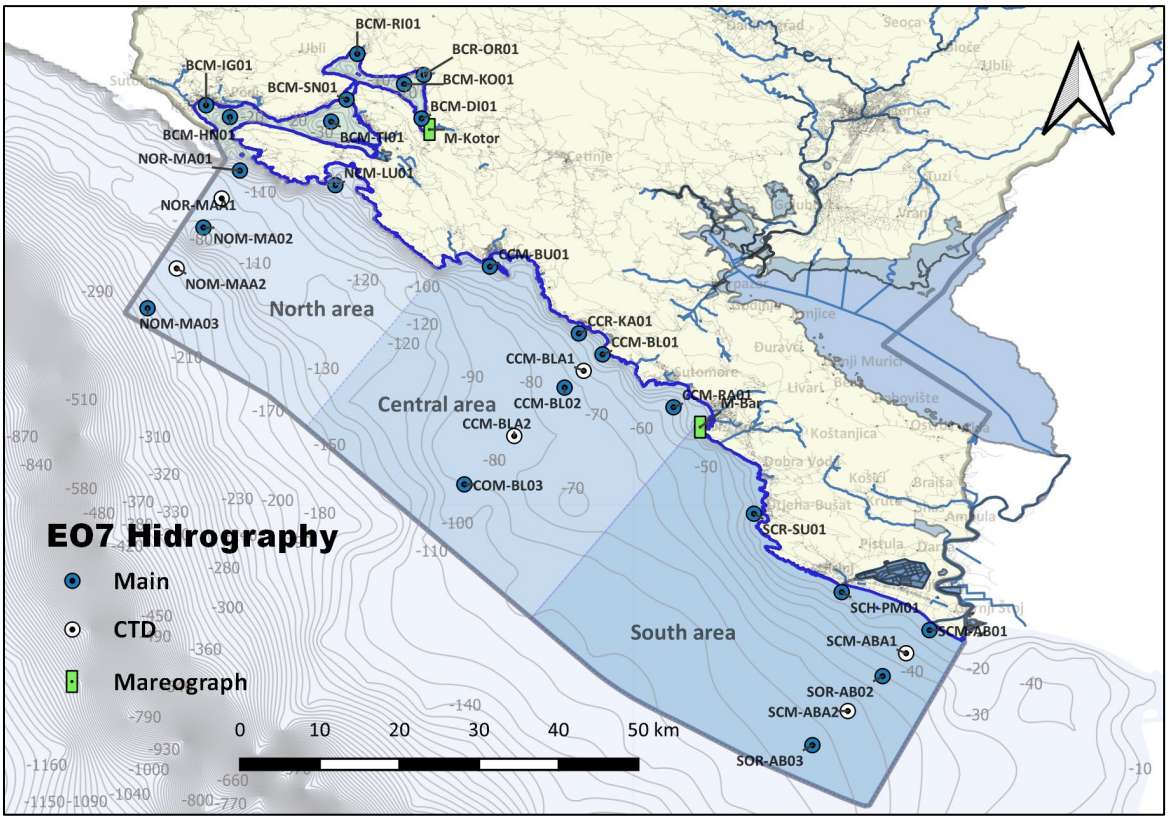


Figure 5.1: Hydrographic stations connected with EO5 stations (stations marked as CTD are only hydrographic ones)

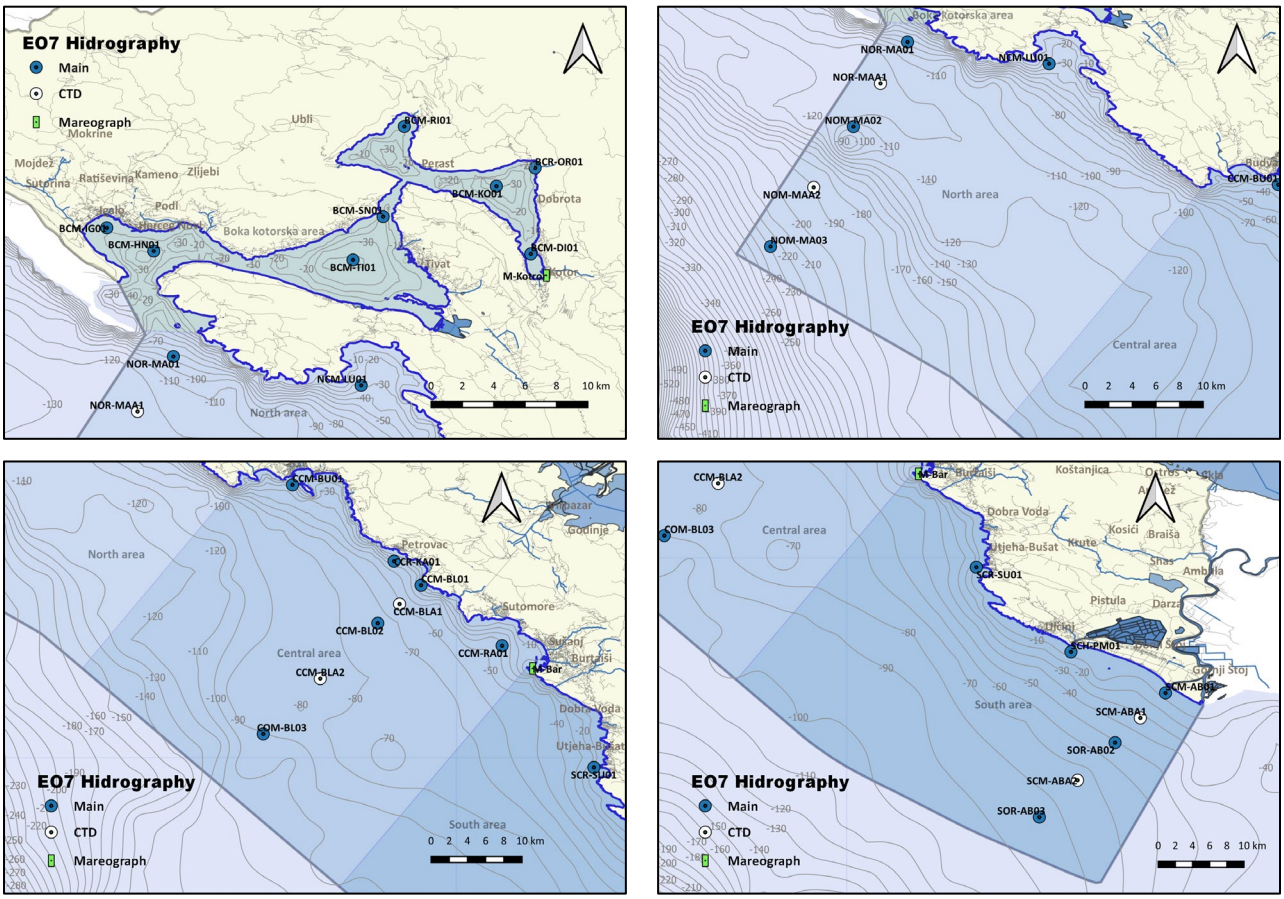


Figure 5.2: Detailed view on hydrographic stations in Boka Kotorska, northern area, central area and southern area four monitoring areas

Tide/Sea level

The sea-level monitoring will be carried out at two existing permanent stations in Kotor (42°25'26.39"N 18°46'11.36"E) and Bar (42° 5'16.53"N 19° 4'30.50"E) (see Table 5.1 and Figures 5.1, 5.2).

In addition, future monitoring of bathymetry, currents, waves and suspended materials shall be ensured in the following areas.

Bathymetry

The bathymetric survey of the whole Montenegrin aquatorium should be done to obtain a complete and up-to-date condition of the Montenegrin coast in terms of depths, which would serve as the baseline for determining all future changes (alterations).

Currents

For the future monitoring of currents, a network of at least five monitoring stations should be set up in the coastal area: at the entrance to Boka Kotorska Bay, Trašte Bay, at the access area to Budva Bay, at the access area to the Port of Bar, in the area from Ulcinj to the mouth of the Bojana River.

A model of currents for the open part of the Montenegrin part of the Adriatic can be taken and used as the baseline by the COPERNICUS Marine Environment Monitoring Service.

Waves

For the future monitoring of currents, a network of at least three automatic monitoring stations (wave buoys) should be set up, which would preferably constantly measure some of the above-mentioned parameters. The proposal for locations for these three stations would be the entrance area to Boka Kotorska Bay, the access area to the Port of Bar, the surroundings of the mouth of the Bojana River. Based on the collected measurements, a general model of waves for the coastal area would be developed.

A model of waves for the open part of the Montenegrin part of the Adriatic can be taken and used as the baseline by the COPERNICUS Marine Environment Monitoring Service.

Suspended materials

Monitoring of suspended materials along the coastline shall be planned, in particular at the mouth of the Bojana River, to determine the degree of erosion.

5.4. Sampling frequency

Monitoring frequencies depend a lot on the location to be considered (offshore/coastal), on its local conditions (rocky/sandy seabed, the intensity of hydrodynamic conditions) and natural evolution and the structure and its function.

Bathymetry: The complete coastal belt, which is most susceptible to changes, needs to be updated and measured at least once in two years. In the areas characterized by a constant change in the seabed morphology, such as the mouth of the Bojana River, or at the locations in the coastal part where the construction of anthropogenic structures (embankments, dams, collectors, luxury marinas and berths) is currently underway, a bathymetric survey should be carried out at least twice a year.

Temperature and salinity: at least 4 times a year

The sea level: monitoring will be carried at 6-minute intervals.

Currents: measurements should be constantly carried out at 10-minute intervals in order to obtain a sufficient amount of data to develop a single model of currents in the coastal area which would serve as the baseline for identifying any future changes.

Waves: constantly

Transparency and suspended materials: Measurements should be carried out at least 4 times a year. Furthermore, coastline should be observed and resurveyed every three months at these locations to determine the degree of erosion.

5.5.
Sampling and measurement methodology

Parameter	Methodology
Benthic habitats (see EO1)	Field campaign. Analysis of aerial images (depending on water transparency.
Coastal and marine structures	Public Enterprise for Coastal Zone Management is the national body which has a registry of all man-made structures in the coastal zone.
Hydrographical conditions	
Bathymetry	Bathymetric surveys, that is, depth measurements, will be carried out by using the latest hydrographic equipment, single-beam and multi-beam sonars (echo sounders), the SVP probe for measuring the sound speed propagation in water, and the panoramic side-scanning sonar for identifying the objects at the seabed. All bathymetric surveys will be carried out in accordance with the *S-44 IHO Special Order* standard.
Temperature and salinity	Temperature and salinity will be measured using the modern CTD high-accuracy multiparameter probe. Moreover, the surface temperature will be measured with standard alcohol thermometers, and surface salinity indirectly by using conductivity meters.
Tide/Sea level	Sea level movements will be observed by using automatic mareographic stations that operate on the principle of hydrostatic pressure.
Currents	Sea currents will be measured by using moored current meters (acoustic profilers). The current meters will be moored 2 meters above the seabed at depths no shallower than 20 meters, put in a protective metal frame case and anchored to a concrete block. Deployment and recovery of current meters will be conducted every 6 months.
Turbidity (and/or transparency) and suspended materials	Seawater turbidity will be measured with standard turbidity meters. Transparency is measured with Secchi disk. Regarding the determination of erosion, the coastline will be surveyed by using precise geodetic instruments, RTK GPS and total stations.

Important note: COPERNICUS Marine Environment Monitoring Service provide large scale modelling (or measurements) of several marine parameters (waves, currents, sea level, temperature, salinity, wind, turbidity). These resources should be considered (see: http://marine.copernicus.eu/services-portfolio/access-to-products/).

5.6.
Data processing methodology

The methodology to assess the indicator can be divided into three main steps:

1. Baseline hydrographical conditions characterisation (Monitoring and modelling of actual conditions without structure);
2. Assessment of hydrographical alterations induced by a new structure (Comparing baseline conditions and with structure conditions, using modelling tools);
3. Assessment of habitats impacted directly by hydrographic alterations (By crossing hydrographical alterations and habitat maps).

The data from COPERNICUS Marine Environment Monitoring Service will be used for assessing offshore baseline conditions in areas lacking national data or where those data are sparse.

Bathymetry

Data processing in a narrow hydrographic sense implies cleaning data from noise and reducing all measured and cleaned depths to a common reference level. In order to obtain a high quality and realistic representation of the bathymetry as the final result, it is necessary to clean the recorded data from incorrectly measured depths (noises) in special-purpose software.

When measuring depths with an echo sounder, noises and false reflections occur. Simply put, the ultrasonic beam is reflected from the first obstacle it encounters, the echo sounder determines the distance to that obstacle and shows it as depth. This obstacle is often not the desired seabed, but a useless noise; e.g. various suspended materials in water, gas bubbles, fish beneath the projector or the surface of seabed vegetation. All these noises need

to be cleaned to get accurate and usable data. Due to the action of tidal forces, the sea surface deviates from the vertical reference level all the time. It is necessary to reduce all depths measured at different levels to a common reference level. For the reduction of measured depths to the reference level, the data obtained by monitoring sea-level changes at permanent mareographic stations are used. All processed bathymetric data obtained by measuring with the echo sounder, cleaned from noises and reduced to the appropriate reference level, are used for the creation of a grid, that is, the creation of a 3D model of the seabed topography of the surveyed area in the appropriate software.

Temperature and salinity

The processing of data obtained by CTD measurements is not strictly defined and depends on the instrument being used (CTD instruments by various manufacturers). High accuracy CTD probes with well-developed software support which ensures reliable and accurate data on physical properties and sea parameters must always be used. The processing of CTD data consists of three steps:

- exporting of raw data involves converting all measured data and their customizing to specific formats for further processing;
- data processing involves the analysis of data obtained directly from measurements (temperature, conductivity, pressure) with those obtained by calculating the measured parameters;
- data visualization involves a graphical representation of all measured and benchmark values.

Tide/Sea level

The processing of data obtained through observation from permanent mareographic stations is done in the appropriate software for their analysis. Based on the obtained data, the analysis of sea level movements is performed and the reference vertical levels for a specific time cycle are determined, such as the mean sea level, the mean low water level, and the mean-high water level.

Currents

For the measurement of sea currents, current meters are used, which measure the direction and speed of currents, based on the Doppler effect, by profiles. This means that not only the direction of surface currents is obtained by using the professional equipment, but in the entire column of water, at the location where the instrument is installed. To create the general model, in addition to raw measurements, it is necessary to be familiar with other oceanographic and physical parameters, based on which the prediction of direction and speed of sea currents can be obtained.

The expected outputs of the CI15 monitoring are GIS data representing impacted habitats, used to assess:

- the area of impacted habitats (km^2);
- the proportion (%) of the impacted habitat area on the total habitat area distribution.

The extent of the habitats impacted directly by hydrographical alterations is assessed by interfacing (intersecting) a map of the distribution of benthic habitats with a map of pressures (permanent hydrographic alterations).

Indicator units

- km^2 of impacted habitat;
- proportion (%) of the total area/habitat impacted.

5.7. Quality assurance

The data which would ultimately constitute such a system would have the appearance of a more detailed marine chart, with a representation of the coastline, offshore topography, bathymetry, surface geology, direction and speed of currents, the wave propagation model in the coastal area, plotted cotidal lines, as well as the temperature and salinity model in the coastal area.

All data would be sorted out by layers, chronologically, which would help detect the change in an appropriate time interval.

The data that would be taken as the baseline must be issued by reference institutions that are accredited and qualified for specific types of research, where each parameter must have a professional technical description of the process of data collection and analysis.

Any physical change of the studied area must be updated within the optimal period so that an analysis of the impact on the change of hydrographic and hydrological conditions can be carried out afterwards, as well as the impact on the habitat in that area.

It is necessary to define a professional service which would have all of the above data at its disposal and which would be directly responsible for administering the spatial database, coordinating with the professional services, which form part of the overall system.

5.8.
Monitoring the interconnection between hydrography and other EOs

EO7 is strongly linked with EO5 and its monitoring will be fully integrated with it, also to contribute to the cost-effectiveness of the overall monitoring. In addition, hydrographic data are relevant for assessing EO1, EO2, EO3, EO9 and EO10, as hydrographical conditions play an important role in advection and dispersion phenomena.

Detailed information about the interconnections between EO7 and other EOs in Montenegro is provided in Annex 1. The rationale for interactions and interconnections between EOs is provided in Annex 2.

6.
COASTAL ECOSYSTEMS AND LANDSCAPES (EO8)

The inclusion of the Ecological Objective 8 as the only EO that focuses on the terrestrial part of the coastal zone is a particularity of the IMAP (compared to other regional monitoring and assessment programmes including MSFD). The monitoring under this EO reflects the Barcelona Convention's ICZM Protocol provisions, by addressing human activities causing coastal artificialization and thus impacting coastal ecosystems and landscapes.

The aim of this kind of monitoring is twofold: (i) to quantify the rate and the spatial distribution of the Mediterranean coastline artificialization and (ii) to provide a better understanding of the impact of this artificialization to the shoreline dynamics.

6.1.
Common indicator

The only common indicator of the Ecological Objective 8 "Coastal Ecosystems and Landscapes" is the Common indicator 16 "Length of coastline subject to physical disturbance due to the influence of manmade structures". The other indicator belonging to EO8 – "Land use change" still had a status of candidate common indicator at the time when this text was prepared.

Common indicator 16: Length of coastline subject to physical disturbance due to the influence of man-made structures	
Common indicator 16 is an impact indicator, which assumes that the coastlines occupied by man-made structures are potentially impacted areas.	
GES definition	Physical disturbance to coastal areas induced by human activities should be minimized.
Operational objective	The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved.
Proposed targets	Negative impacts of human activities on coastal areas are minimized through appropriate management measures.

In the IMAP Indicator fact sheet on CI16, it says that additional country-specific criteria should be taken into account for the definition of targets, measures and interpretation of results regarding this indicator due to strong socioeconomic, historical and cultural dimensions in addition to characteristic geomorphological and geographical conditions in each respective country (reflected in policy documents, strategies and other country-specific documents). Interpretation of results should be left to the countries taking the above criteria into account.

6.2.
Monitoring methodology

The monitoring of the Common indicator 16 entails an inventory of the length and location of all man-made structures on the coastline. This includes hard coastal defence structures (breakwaters; seawalls/revetments/sea dikes; groins; jetties; river mouth structures) ports and marinas. Soft techniques such as beach nourishment are not included in this inventory.

The identification procedure of man-made structures should take into account the minimum size, length, width of man-made structures, to be included into the inventory: the minimum distance between coastal defence structures should be set to 10 m to classify such segments as natural, i.e. if the distance between two adjacent coastal defence structures is less than 10 m, the whole segment including both coastal defence structures will be classified as artificial.

The length of artificial coastline should be calculated as the sum of segments on the reference coastline, identified as the intersection of polylines representing man-made structures with reference coastline. In addition, the share of this type of coastline in total country's coastline needs to be determined.

The coastline to be considered as reference coastline should be defined as fixed official national coastline by the responsible Contracting Party (in this case, Montenegro).

Space and airborne earth observation systems are the most suitable tool to conduct the monitoring strategy of the EO8 common indicator, i.e. very high resolution (VHR) satellite imagery, aerial photographs, laser scanners etc. Beyond earth observation data, identification techniques and procedures used through GIS tools also have to be described.

6.3.
Monitoring frequency (temporal resolution)

According to the IMAP, monitoring of Common indicator 16 should be carried out every 6 years. Montenegro, as every Contracting Party, should fix a reference year in more recent time interval to eliminate the bias due to old or past man-made infrastructures.

Monitoring of sandy coastline under anthropogenic pressure could be, if possible, repeated annually (at the same period of the year).

In Montenegro, public institutions that collect and manage spatial data shall be required to harmonize with spatial data and spatial data sets with the Law on spatial data infrastructure within three years from its entry to the force (January 1, 2019). Institutions shall be required to provide metadata and network services within two years from the date of entry into force of this Law.

In line with the medium-term programme, which introduced the practice to the territory of Montenegro, the cyclic aerial survey is performed every 5 years.

6.4.
Extent of monitoring area and spatial resolution

The optimal resolution for CI16 monitoring is 5 m or 1: 2000 spatial scale.

In Montenegro, there are following spatial data sets in the network of public services:

- orthophoto images for the territory of Montenegro from different periods of recording (resolution 0.2 m);
- digital map 1: 25,000;
- data on cadastral parcels and objects from the register of real property cadastre.

Scale (spatial resolution) in which coasts are monitored are 0.2 m for orthophoto and for spatial plans (1:100,000, 1:50,000, 1:25,000, 1:5,000, 1:2,500 and 1:1,000), which is in line with the IMAP requirements.

6.5.
Data processing and data format methodology

The total length of coastline influenced by man-made structures, and the share of this coastline in total country's coastal length should be provided on a map showing the coastline subject to physical disturbance due to man-made structures (artificial segments) marked with a red line and the rest (natural segments) marked with a green line.

The indicator units are:

- km of artificial coastline and % of a total length of coastline;
- percentage (%) of natural coastline on the total coastline length.

The assessment output should be reported as a common shapefile format with WGS 84 or ETRS 89 coordinate reference system. Shapefile with other reference systems will also be accepted if provided with a complete .prj file that allows transformations by standard GIS tools. The format for location and extent of artificial structures should be a polyline or a polygon, while for artificial/natural coastline the selected format should be a polyline.

The details on data submission and formats can be found in UNEP/MED WG.467/10 document "Data Standards and Data Dictionaries for Common Indicators related to Coast and Hydrography".

6.6.
Monitoring interconnection between coastal ecosystems and landscapes and other EOs

The results of EO8 monitoring could complement monitoring of EO1, EO5, EO7 and EO9, also to contribute to LSI assessment, relevant for marine spatial planning (MSP).

The rationale for interactions and interconnections between different EOs is provided in Annex 2.

7.
CONTAMINANTS (EO9)

The marine environment is particularly vulnerable to chemical pollution. A large number of different hazardous substances reach the marine environment through various input pathways (riverine, coastal, atmospheric and direct inputs through, e.g., ship traffic and offshore industries). Once introduced into the sea, contaminants can be redistributed or transported to the environment by human activity and natural physical and biochemical processes. Contaminants remain in the water and especially in the sediment, from which they can be resuspended. Many substances can also accumulate in biota and thus in the food web. From there they may reach the levels which not only pose a significant risk to marine organisms but also humans through the consumption of contaminated fish and seafood. Therefore, the knowledge and consideration of such processes in the marine environment are crucial in identifying input pathways which can lead to harm, in order to reduce or eliminate them. Monitoring the pressure deriving from chemical contaminants over time and space is a basic requirement for a quantitative assessment of the environmental status of the seas.

GES definition: Concentrations of contaminants are at levels not giving rise to pollution effects. Contaminants in fish and other seafood intended for human consumption do not exceed levels established by Community legislation or other relevant standards.

7.1.
Common indicators

The table below presents a short description of CIs of EO9 according to Fact Sheet: UNEP(DEPI)/MED WG.444/5.

Common indicator 17: Concentration of key harmful contaminants measured in the relevant matrix (related to biota, sediment, seawater)	
GES definition	Level of pollution is below a determined threshold defined for the area and species.
Operational objective	Concentration of priority contaminants is kept within acceptable limits and does not increase.
GES target	(1) Concentrations of specific contaminants below Environmental Assessment Criteria (/EACs) or below reference concentrations; (2) No deterioration trend in contaminants concentrations in sediment and biota from human-impacted areas, statistically defined; (3) Reduction of contaminants emissions from land-based sources.

Common indicator 18: Level of pollution effects of key contaminants where a cause and effect relationship has been established	
GES definition	Concentrations of contaminants are not giving rise to acute pollution events.
Operational objective	Effects of released contaminants are minimized.
GES target	Contaminants effects below threshold decreasing trend in the operational releases of oil and other contaminants from coastal, maritime and offshore activities.

Common indicator 19: Occurrence origin (where possible) extent of acute pollution events (e.g. slicks from oil products and hazardous substances) and their impact on biota affected by this pollution.	
GES definition	Occurrence of acute pollution events is reduced to the minimum.
Operational objective	Acute pollution events are prevented and their impacts are minimized.
GES target	Decreasing trend in the occurrence of acute pollution events.

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	
GES definition	Concentrations of contaminants are within the regulatory limits for consumption by humans.
Operational objective	Levels of known harmful contaminants in major types of seafood do not exceed established standards.
GES target	Concentrations of contaminants are within the regulatory limits set by the legislation.

Common indicator 21: Percentage of intestinal enterococci concentration measurements within established standards	
GES definition	Concentrations of intestinal enterococci are within established standards.
Operational objective	Water quality in bathing waters and other recreational areas does not undermine human health.
GES target	Increasing trend in the percentage of intestinal enterococci concentration measurements within established standards.

7.2. Methodologies and procedures

7.2.1. Common indicator 17: Concentration of key harmful contaminants measured in the relevant matrix (related to biota, sediment, seawater)

7.2.1.1. Selection of sampling sites and monitoring areas

Establishment of the new monitoring network for the implementation of the EO9 of the IMAP in Montenegro has been based on current national monitoring programme and the existing knowledge. The alignment of the existing national monitoring programmes of Montenegro to the IMAP requirements considers new spatial and temporal scales, as well as a need to correlate pressures, status and impacts (i.e., DPSIR framework). The main change in the spatial coverage for EO9 is related to the extension of monitoring efforts into offshore areas (including in all three matrixes biota, sediment and water column); as well as the reduction of available sampling locations in the narrow coastal strip to ensure the cost-effective monitoring programme. Overall, the selection of the sampling locations and monitoring areas is based on the following criteria:

- Areas of concern are identified based on the review of the existing monitoring stations and analysis of relevant trends in monitoring data collected in the period from 2008 to 2018.
- Areas of known past and/or present release of chemical contaminants and hazardous substances (i.e., host spot locations), as well as those defined in the NAP aimed at implementing the LBS Protocol.
- Offshore areas where risk warrants coverage is monitored (e.g. aquaculture, offshore oil and gas platforms, dredging and mining operations, dumping sites).
- Reference stations to ensure updated locations to both elaborate and support environmental assessment criteria within the IMAP (e.g. background concentrations/ background assessment concentrations, BC/BAC).
- The shift of focus towards Coastal Master, Coastal Hotspot, Open Master, Coastal Reference and Open Reference areas with the incentive to create the data which will show the clear picture of the quality of Montenegro's coastal area and the open sea.

To meet the IMAP criteria related to the expansion of monitoring efforts into offshore areas, a new national IMAP based monitoring programme includes sampling in 4 monitoring zones that include, wherever possible, the transects with 3 monitoring stations, at least one of which is an offshore station (Figure 7.1, 7.2). As it can be observed, 3 perpendicular monitoring zones of the coast from the north to the south cover the national marine waters of Montenegro up to 12 nm with 21 sampling stations in total. The monitoring stations are classified into 5 categories, respectively:

- CM – Coastal Master Station;
- CR – Coastal Reference Station;
- CH – Coastal Hotspot Station;
- OM – Offshore Master Station;
- OR – Offshore Reference Station.

Any station located beyond 1 nautical mile (nm = 1.6 km) with an average depth of 20 m assigned to this distance from the coastline is considered as an offshore station.

7.2.1.2. Parameter selection

The parameters to be monitored concerning IMAP Common indicator 17 are defined in accordance with IMAP Common Indicator Guidance Factsheet related to this indicator (UNEP (DEPI)/MED WG.444/5), as shown in Table 7.1. It also considers present monitoring efforts under the responsibility of the Ministry of Agriculture and Rural Development that are related to food safety in line with the provisions of the Directive 2000/60/EC (Water Framework Directive) and EC Regulations 853/2004 and 1881/2006 laying down specific hygiene rules for food of animal origin as shown in Table 7.7. Although according to the IMAP, the primary mandatory matrices for monitoring under CI17 are sediment and biota, Montenegro will also continue to monitor seawater for the purpose of integrated marine environment assessment.

In order to create the most effective monitoring programme and reduce overall costs of different monitoring efforts related to the implementation of the Barcelona Convention, MSFD, WFD and Food Safety Regulations, monitoring programmes under responsibility of the Ministry of Agriculture and Rural Development must be harmonized with the IMAP based monitoring programme along with future MSFD based monitoring programme under the responsibility of Ministry of Ecology, Spatial Planning and Urbanism and National Environmental and Nature Protection Agency.

Table 7.1: Contaminants to be monitored under IMAP Common Indicator 17 in line with UNEP(DEPI)/MED WG.444/5

Matrix	Chemical compounds/groups
Biota	Trace/Heavy Metals (TM): Total mercury (HgT), Cadmium (Cd) and Lead (Pb); Organochlorinated compounds (PCBs, Hexachlorobenzene, Lindane and ∑DDTs); Polycyclic aromatic hydrocarbons (US EPA 16 PAHs Compounds); Lipid content, flesh fresh/dry weight ratio for normalisation purposes
Sediment	In coastal and offshore sediments (<2mm particle size fraction): Trace/Heavy Metals (TM): Total mercury (HgT), Cadmium (Cd) and Lead (Pb); Organochlorinated compounds (PCBs, Hexachlorobenzene, Lindane and ∑DDTs); Polycyclic aromatic hydrocarbons (US EPA 16 PAHs Compounds) Aluminium (Al), Total Organic Carbon (TOC) in the <2mm particle size fraction for normalization purpose for TM and OCs, respectively. The<63µm sediment fraction is recommended to be complementary for metals. The lyophilisation ratio (dry/wet sediment ratio).
Seawater	Sub-indicators: other relevant chemicals (such as tributyltin, TBT) and emerging pollutants are recommended to be monitored on a country decision basis until a firm COP Meeting Decision has been taken.

Table 7.2: Monitoring network established with regard to IMAP Common Indicator 17

Zone	Zone Code	Old Stations		IMAP stations						Matrix			
		Name	Code	Name	Code	Longitude	Latitude	Dist. (nm)	Depth (m)	Bio.	Sed.	Wat.	Type*
Boka Kotorska	B	Port of Herceg Novi		Luka Herceg Novi	BCM-HN02	18.53265	42.44988	0.0	13		x	x	CM
		Brodograd. Bijela		Brodograd. Bijela	BCH-BB01	18.65233	42.44740	0.0	21	x	x	x	CH
		Port of Risan		Luka Risan	BCM-RI02	18.69400	42.51342	0.0	9	x	x	x	CM
		Orahovac-Ljuta		Orahovac-Ljuta	BCR-OR01	18.76333	42.48563	0.1	21	x	x	x	CR
		IBM-Dobrota	OS-1	IBM-Dobrota	BCM-DI01	18.76087	42.43638	0.2	22	x	x	x	CM
		Port of Kotor		Luka Kotor	BCH-KO02	18.76557	42.42512	0.1	15		x		CH
				Sveta Nedelja	BCM-SN01	18.67618	42.45775	0.2			x		CM
				Tivatski zaliv	BCM-TI01	18.65893	42.43293	1.2			x		CM
Open sea – Northern	N			Mamula 1	NOR-MA01	18.55597	42.37762	1.2	103		x		OR
				Mamula 2	NOM-MA02	18.51480	42.31328	5.8			x		OM
				Luštica	NCM-LU01	18.66362	42.36107	0.7	25		x		CM
Open sea Central	C	Port of Budva		Luka Budva	CCM-BU02	18.83883	42.27940	0.0	6		x		CM
				Budva	CCM-BU01	18.83793	42.25250	0.5	20		x		CM
				Katič	CCR-KA01	18.93828	42.19375	0.6	20	x	x	x	CR
				Buljarica 1	CCM-BL01	18.96660	42.17005	0.4	36	x	x	x	CM
				Buljarica 2	CCM-BL02	18.92220	42.13255	3.7	76		x		CM
		Port of Bar	OS-5	Luka Bar	CCH-BA02	19.08570	42.09073	0.0	13	x	x	x	CH
Open sea – Southern	S			Stari Ulcinj	SCR-SU01	19.13572	41.99015	0.4		x	x	x	CR
		Port Milena		Port Milena	SCH-PM01	19.23477	41.90157	0.2	8	x	x	x	CH
				Ada Bojana 1	SCM-AB01	19.33378	41.85863	0.5	11	x	x	x	CM
				Ada Bojana 2	SCM-AB02	19.28097	41.80670	5.0	59		x		CM

* Type: CM – Coastal Master; CR – Coastal Reference; CH – Coastal Hotspot; OM – Offshore Master; OR – Offshore Reference

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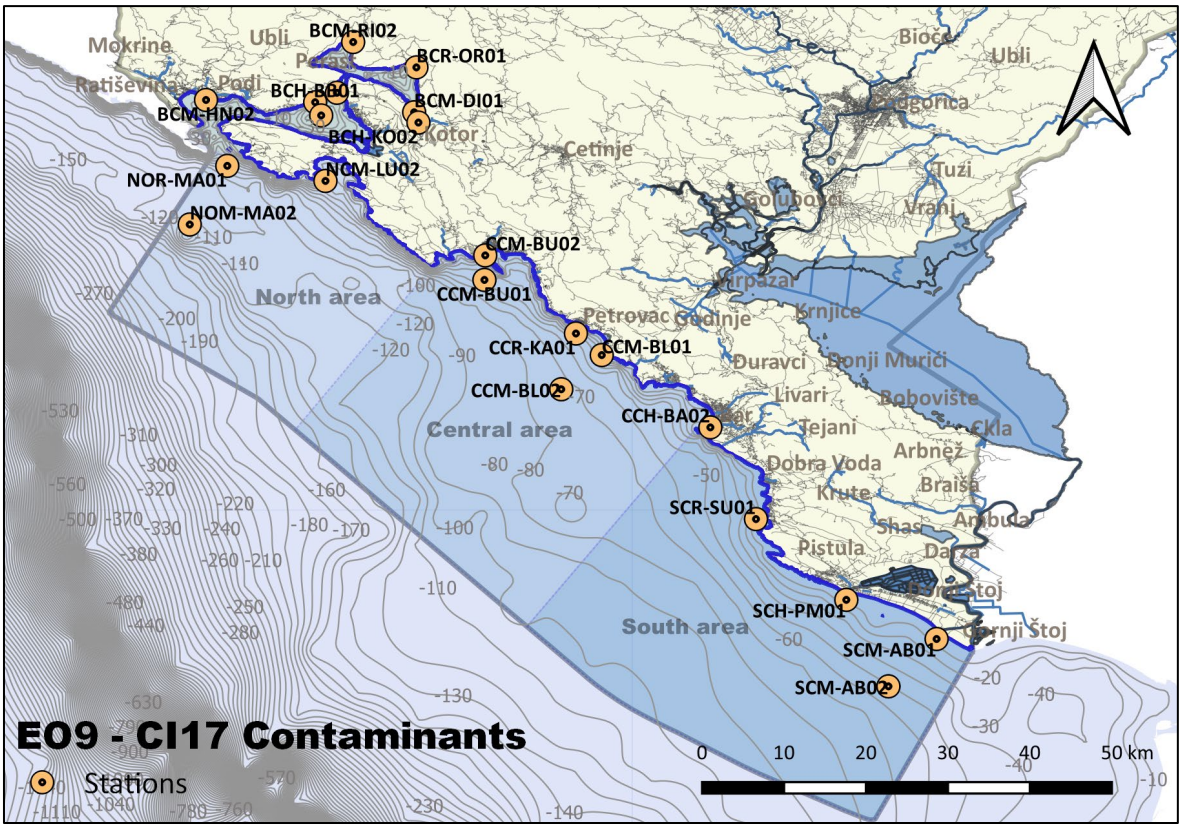


Figure 7.1: Monitoring stations for CI17

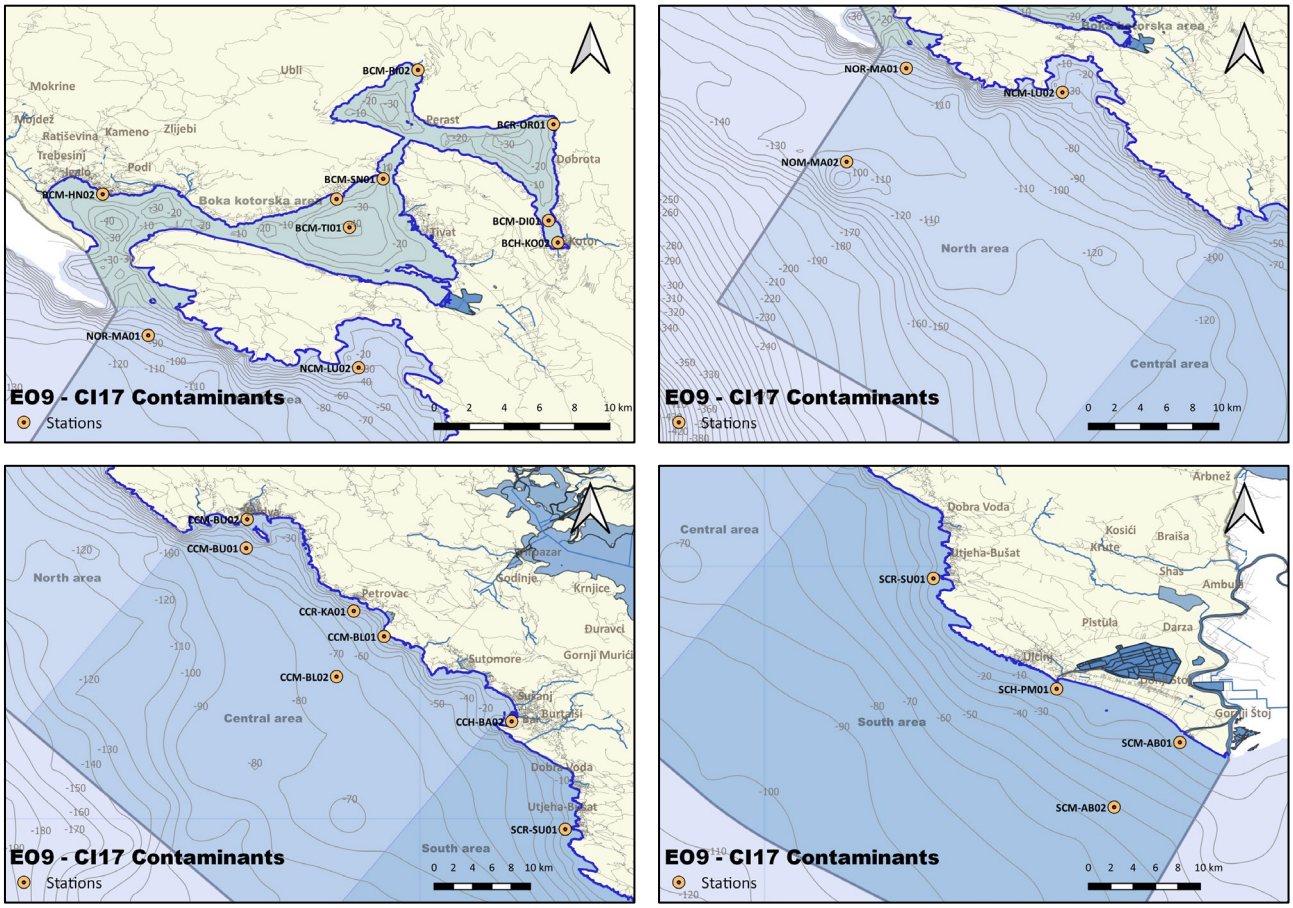


Figure 7.2: Detailed view of monitoring stations for CI17 in Boka Kotorska, northern area, central area and southern area

7.2.1.3. Sampling frequency

Sampling biota and sediment related frequencies is in line with the standard frequencies established by the IMAP, respectively, a minimum sampling frequency on an annual and biannual basis is foreseen.

Biota sampling

The sampling of fish species, including commercial species, is carried out initially once a year as a minimum standard.

For shellfish, the monitoring is performed before the spawning period during the spring season (April/May) on an annual basis as a minimum.

Sediment/seawater sampling

For the sediment and seawater, the sampling will be done biannually at all monitoring stations, as shown in Table 7.2.

Detailed scientific and technical considerations regarding marine monitoring practices reflect current national practices and capacities related to sample collection, sample processing, analytical determination of the contaminants, reporting and quality assurance.

7.2.2. Common indicator 18: Level of pollution effects of key contaminants where a cause and effect relationship has been established

The monitoring of the anthropogenic impact on marine species will be monitored through analysis of biomarkers as AChE activity and Micronucleus assay (MN). AChE activity is a biomarker of exposure to contaminants which are analysed in the scope of monitoring CI17 (PAHs, PCBs, metals, etc.). Micronucleus assay (MN) is used as a tool for assessing cytogenetic/DNA damage in marine organisms, suitable for the evaluation of the genotoxic activity of xenobiotic agents of environmental pollutants (PCB, pesticides, …).

The use of biomarkers in the monitoring of marine ecosystem together with information from the monitoring of contaminants will provide clearer information on the pollution effects in the marine environment. Bivalve molluscs (such as *Mytilus galloprovincialis* (4-5 cm)) will be used for the evaluation of the toxic effects of the marine contaminants.

7.2.2.1. Selection of sampling sites and monitoring areas

Monitoring of biological parameters in biota has been conducted as part of the national monitoring programme of the marine ecosystem since 2009 but the application has not been continuous. Sampling locations are mostly distributed across monitoring stations which are positioned at hotspot locations. In order to harmonize the monitoring programme of the marine ecosystem with the IPAM requirements for CI18, a new grid of monitoring stations for CI18 is established.

The selection of monitoring stations (i.e. sampling sites) for the monitoring of biological effects in the marine environment is provided considering the coverage of the following areas:

- Risk areas of concern identified based on the review of the existing information of the National monitoring programme (2016-2018);
- Vulnerable areas of known past and/or present release of chemical contaminants and hazardous substances defined in the framework of the Coastal Area Management Programme of Montenegro (CAMP) are considered;
- Offshore areas with risk warrants coverage;
- Reference sites looking to establish BAC and EAC.

The monitoring network related to the IMAP CI18 is defined in three monitoring zones extending from the mouth of the Bojana River in the south, to the Boka Kotorska Bay in the north. Each of three monitoring areas includes one reference, one coastal master station and one hotspot station.

An overview of sampling sites for the monitoring of biological effects in the marine environment is shown in Table 7.4.

Table 7.3: Monitoring of IMAP Common Indicator 17 in line with UNEP/MED WG.463/6 (2019)

CI17	Purpose/Rationale
Sample collection	To collect marine organisms, where the whole soft tissues or dissected parts are processed to perform analytical measurements of chemical contaminants (primarily, in bivalve species and/or fish). In the Mediterranean, the most common sample species are bivalves, (e.g. *Mytilus galloprovincialis*, *Donaxtrunculus*) and fish (e.g. *Mullus barbatus*). Further, sediment samples should be collected in coastal and marine areas, the continental platform and offshore by mechanical means (grab or corer) according to the sampling strategy. No 6. Rev. 1 UNEP/FAO/IOC/IAEA. No 12. Rev. 2. UNEP/FAO/IAEA. HELCOM-COMBINE, 2017. JAMP, 2018 (OSPAR). JRC, 2014. Rapport scientifique et politique du JRC. EUR 26499 EN.
Sample processing	Some additional parameters need to be recorded in biota are the biometrics (e.g. size/length, age), biological parameters such as condition index (e.g. mussels) and condition factor according to established protocols and scientific literature and knowledge. For sediments, the standard sieving fraction processed at the laboratory and analysed should be < 2 mm particle size fraction after freeze-drying (e.g. in-house mesh validated methods and/or geological sieving methods). The < 63µm sediment fraction is also recommended to be complementary for metals. The lyophilisation ratio (dry/wet sediment ratio) should be considered for datasets reporting and data should be reported in dry weight. No 71 UNEP/IAEA/IOC/FAO. León *et al.*, 2014.;Galgani *et al.*, 2014; Benedicto et al, 2011.
Measurements	Trace/Heavy Metals (TM) and Aluminium: Spectrometry, Mass Spectrometry (MS), Organic compounds: Gas or Liquid Chromatography (GC/LC) coupled to a variety of detectors, such as Flame Ionization Detector (FID) Electron Capture Detector (ECD) or Mass Spectrometry (MS) Guidance Document No. 33, 2014 – 084, ISBN 978-92-79-44679-5. León *et al.*, 2014.
Reporting and QA	▪ TM: ug/Kg (e.g. Cadmium), mg/Kg (e.g. Zinc), g/Kg (e.g. Aluminium) ▪ OC: ug/Kg (ppb) or mg/Kg (ppm) ▪ TOC: Elemental Analyser (as %) ▪ Particle fractions (as %) Selected analytical methods and measurements are subject to internal Quality Assurance through National Laboratories QA/QC Protocols and Laboratory accreditations, as well as external Quality Assurance by performing regional interlaboratory QA/QC exercises organized by the UNEP/MAP MED POL/IAEA MESL. No 7 Rev. 2 UNEP/FAO/IOC/IAEA. No 57 UNEP/IOC/IAEA

Table 7.4: Selected monitoring stations related to IMAP Common Indicator 18 in accordance with UNEP/MED WG.463/6 (2019)

Zone	Zone Code	Old Stations		IMAP Stations						Matrix	
		Name	Code	Name	Code	Longitude	Latitude	Dist. (nm)	Depth (m)	Bio.	Type*
Boka Kotorska	B	Brodograd. Bijela		Brodograd. Bijela	BCH-BB01	18.65233	42.44740	0.0	21	x	CH
		Port of Risan		Luka Risan	BCM-RI02	18.69400	42.51342	0.0	9	x	CM
		Orahovac-Ljuta		Orahovac-Ljuta	BCR-OR01	18.76333	42.48563	0.1	21	x	CR
		IBM-Dobrota		IBM-Dobrota	BCM-DI01	18.76087	42.43638	0.2	22	x	CM
Open sea – central	C			Katič	CCR-KA01	18.93828	42.19375	0.6	20	x	CR
				Buljarica 1	CCM-BL01	18.96660	42.17005	0.4	36	x	CM
		Port of Bar		Luka Bar	CCH-BA02	19.08570	42.09073	0.0	13	x	CH
Open sea – Southern	S			Stari Ulcinj**	SCR-SU01	19.13572	41.99015	0.4		x	CR
		Port Milena		Port Milena	SCH-PM01	19.23477	41.90157	0.2	8	x	CH
				Ada Bojana 1	SCM-AB01	19.33378	41.85863	0.5	11	x	CM

* The nearest locations to the locations included in the table

** Krš Đerane – an offshore small island

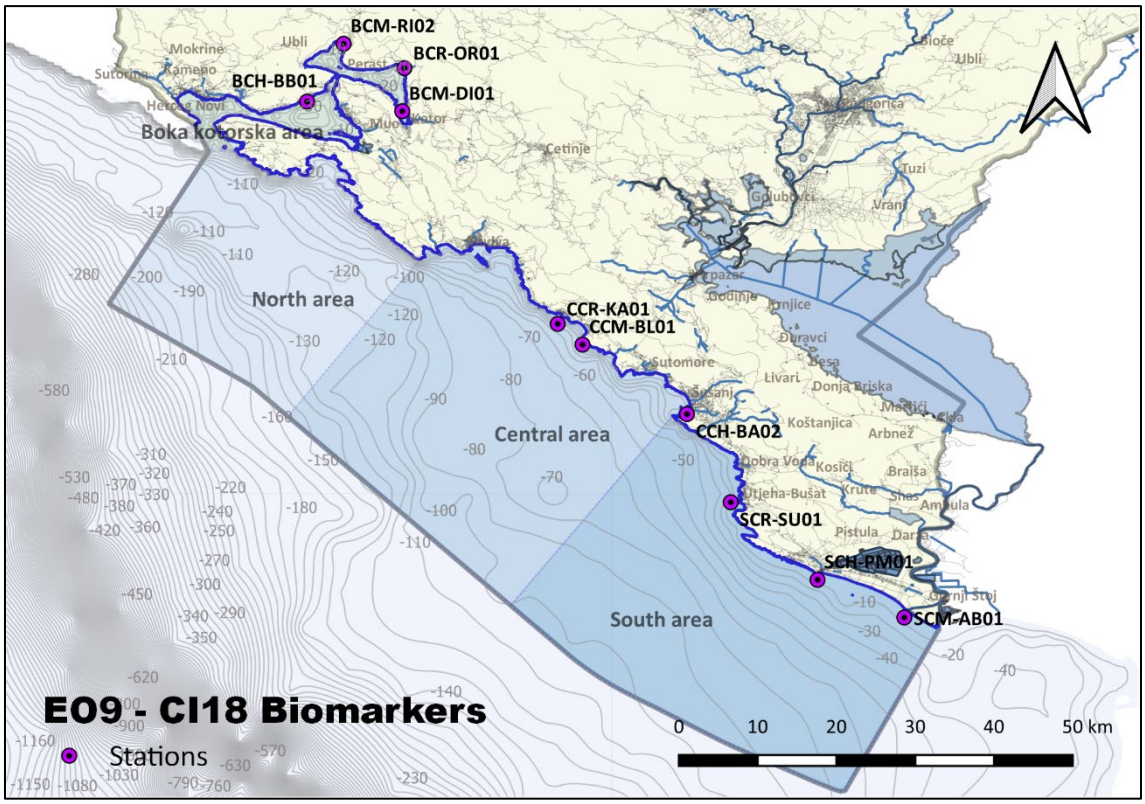


Figure 7.3: Monitoring stations for CI 18

7.2.2.2. Parameter selection

The parameters for the evaluation of the biological effects are selected in accordance with the IMAP Guidance Factsheets for IMAP Common Indicator 18 for marine bivalves (such as *Mytilus galloprovincialis*) and/or fish (such as *Mullus barbatus*):

- Acetylcholinesterase (AChE) assay as a method for assessing neurotoxic effects in aquatic organisms;
- Micronucleus assay as a tool for assessing cytogenetic/ DNA damage in marine organisms.

Additional sub-indicators could be measured as complementary biomarkers, bioassay and histology techniques and/or methods which are also recommended for monitoring at the national level (e.g. Comet assay, hepatic pathologies assessment, reduction of survival in the air by Stress on Stress (SoS), larval embryotoxicity assay, etc.).

Metallothionein needs to be measured in mussels. Ethoxyresorufin-O-deethylase (EROD) activity needs to be measured in fish as a biomarker for chemical exposures.

In the first phase of national IMAP-based monitoring implementation, Micronucleus assay and Acetylcholinesterase (AChE) assay will be monitored. Depending on further improvement of analytical laboratory capacities, the national IMAP-based monitoring implementation will be amended with other indicators and sub-indicators relevant for IMAP Common Indicator 18.

7.2.2.3. Sampling frequency

Sampling for IMAP Common Indicator 18 will be conducted twice a year in the periods April – June and September – November respectively during the post-winter months, but not during the spawning period, in mussels as the matrix.

7.2.2.4. The methodology of sampling, measurement and data processing

Table 7.5 shows detailed scientific and technical considerations related to the methodology of sampling, measurement and data processing for monitoring of CI 18 in accordance with the IMAP Guidance Factsheets.

Table 7.5: Methodologies for biomarkers (CI18) according to UNEP/MED WG.463/6 (2019)

CI18	Purpose/Rationale
Sample collection	The marine organisms collected to perform biomarker and toxicology evaluations should be collected exactly as those for CI17. In this way, the integrated chemical-biological assessments of the contaminant effects in the marine environment could better support the achievement of GES. As for chemical monitoring, sample collection should focus on selected locations such as hotspots and reference stations. PNUE/MEDPOL (1997). UNEP(OCA)/MEDWG.132/3. PNUE/RAMOGE (1999). ICES No.315 Rapport. I.M. Davies and D. Vethaak Eds., November, 2012.
Sample processing	Preservation, storage and transportation to the laboratory from remote locations are key factors to undertake toxicological measurements in live organisms (e.g. Lysosomal Membrane Stability-neutral Red Retention method). Further, dissections of the parts from marine organisms according to the standard methodologies for biochemical parameters and organism parts will also be undertaken (e.g. gills in *Mytilus galloprovincialis*). Additional parameters that need to be recorded in this step (in the field or at the laboratory) include biometrics (size/length, age), biological parameters such as condition index (mussels), condition factor, gonadosomatic index, hepatosomatic index (fish) and data on temperature, salinity and oxygen dissolved. I.M. Davies and D. Vethaak Eds., November 2012. Cenov *et al.*, 2018.
Measurements	In marine bivalves (such as *Mytilus galloprovincialis*) and/or fish (such as *Mullus barbatus*): ▪ Acetylcholinesterase (AChE) assay: Biochemical techniques, including spectrophotometry; ▪ Micronucleus assay: Biochemical techniques, including microscopy.
Reporting and QA	The main units for the agreed toxicological test under IMAP CI18 are (retention) minutes – Lysosomal Membrane Stability (LMS); nmol/min mg protein in gills (bivalves) for Acetylcholinesterase (AChE) assay; and, Number of cases, ‰ in haemocytes for the Micronucleus assay. ICES Cooperative Research Report. No.315. Integrated marine environmental monitoring of chemicals and their effects. I.M. Davies and D. VethaakEds., November 2012; Martínez-Gómez, C., 2017; Regoli et Giuliani, 2014.

7.2.3.
Common indicator 19: Occurrence origin (where possible), the extent of acute pollution events (e.g. slicks from oil products and hazardous substances) and their impact on biota affected by this type of pollution

The Maritime Safety Department of Montenegro is reporting to the EMSA and REMPEC, therefore, since REMPEC developed the CI19 Guidance Factsheet, this established reporting system covers the IMAP requirements. Taking this into account, we will reflect the basic EO9 IMAP needs, in terms of data flows, rather than include a specific monitoring programme for CI19 at present.

7.2.3.1. Selection of sampling sites and monitoring areas

The spatial scope for monitoring this indicator corresponds to the entire sub-regional area close to shipping harbours and petrochemical plants and offshore waters under the country's responsibility. The particular focus shall be given to the area of Boka Kotorska Bay, port of Bar and Ratac, as areas with an increased risk of acute pollution events.

7.2.3.2. Parameter selection

The occurrence of acute pollution events involving oil or HNS needs to be measured and possible impacts monitored. In 1996, a Joint Session of MEDPOL and REMPEC Focal Points Meeting agreed to report spillages over 50 cubic meters in the Mediterranean Sea, tightening the earlier recommendation to report spillages or discharges of oil above 100 cubic metres from 1987 and aligned with the revision of MARPOL 73/78 (IMO).

Furthermore, under the BCRS (Barcelona Convention Reporting System) formatting these parameters, the following should also be reported:

- accident location (latitude and longitude or the nearest coast location);
- accident type* (*cargo transfer failure, contact, collision, engine breakdown, fire/explosion, grounding, foundering/ weather, hull structural failure, machinery breakdown, other);
- vessel IMO number or vessel name;
- vessel flag;
- information on whether any product has been released or not. If yes, the type of product released should be

specified (Oil/Hazardous and Noxious Substances); and

- information on whether any actions have been taken or not. If yes, the actions taken should be specified.

7.2.3.3. Sampling frequency

As oil and HNS pollution incidents from ships occur unexpectedly (as a consequence of maritime casualties) or are random (MARPOL illicit discharges), the pollution monitoring will continue to be reported "in real time" when pollution incidents happen or are detected.

7.2.3.4. The methodology of sampling, measurement and data processing

In the case of oil and HNS acute pollution events, the indicator (reported spills over 50 cubic meters) will be obtained from the information of oil and HNS pollution events recorded and submitted annually to the REMPEC in the Mediterranean Sea.

In addition to monitoring pollution events occurrences against the target, it is recommended to carry out a trend analysis in order to measure performance against the target calculating a % increase or a % decrease in annual occurrences. The indicator units are, as stated earlier, cubic meters of spilled substances (and additional parameters accordingly, see above).

The data processing seeks the occurrence frequency and quantitative statistical analysis. The basis for aggregation would be a "nested approach" over the national marine area geographical scale. The trend analyses should calculate the evolution of oil and HNS incidents over a specific period. Summary of the monitoring approach for CI19 is given in the IMAP Factsheet UNEP/MED WG.463/6 (2019).

For details, please see the Thematic monitoring programme for EO9 CI 19.

7.2.4. Common indicator 20: Actual levels of contaminants that have been detected and number of contaminants that have exceeded maximum regulatory levels in commonly consumed seafood

The human exposure to chemical contaminants through commercial fish and shellfish species (i.e., fisheries and aquaculture, respectively) is one of the main concerns concerning the occurrence of pollutants in the marine environment. Wild and farmed marine species are exposed to environmental chemical contaminants through different mechanisms and pathways according to their tropic level, ranging from filter feeding to predatory species (bivalves, crustaceans, fish, etc.).

The National shellfish safety monitoring programme under the Ministry of Agriculture and Rural Development and Food Safety, Phytosanitary and Veterinary Affairs Directorate is in accordance with the requirements of Regulation 853/2004 as well as Regulation 1881/2006 and has been implemented since 2014. This monitoring programme serves as a quality source of data for IMAP Common Indicator 20 to get a clear picture of the level of contaminants in food which is consumed. This monitoring programme is in line with the IMAP requirement for CI20 data which can be provided from other relevant national monitoring programmes.

7.2.4.1. Selection of sampling sites and monitoring areas

Selection of monitoring station for CI20 is selected based on the risk-based assessments and to cover fisheries and aquaculture related activities. The approach must be primarily selected in fishing areas or aquaculture coastal areas through environmental monitoring (in line with CI17 in terms of samples), aboard fishing fleets or sampling within regular inspections by national authorities.

For monitoring of CI20, wild species at the same locations within CI17 monitoring which is in accordance with the IMAP request will be sampled. Furthermore, the results of the analyses of the commercial species from the farms are included within the current National food safety monitoring programme which is in accordance with Regulation 853/2004 and Regulation 1881/2006 will be included within CI20 monitoring. The National food safety monitoring programme "Monitoring programme in the production areas for shellfish farming" was adopted by the Ministry of Agriculture and Rural Development, while the Directorate for Food Safety, Veterinary and Phytosanitary Affairs and Centre for Ecotoxicological Research as an authorized laboratory are responsible for its implementation.

Table 7.6 shows the locations for the monitoring programme for CI 20.

Table 7.6: Overview of locations for sampling and analysis of CI20 according to UNEP/MED WG.463/6 (2019)

Zone	Zone Code	Old Stations		IMAP stations (Biota)						
		Name	Code	Name	Code	Longitude	Latitude	Dist. (nm)	Depth (m)	Type
Boka Kotorska	B	Ljuta	B1	Orahovac Ljuta*	BCR-OR01	18.76333	42.48563	0.1	21	CR
	B	Dražin Vrt	B2	Dražin Vrt	BCM-BDV01	18.72863	42.48317	0.1		CM
	B	Lipci	B3	Lipci	BCM-BLI01	18.66045	42.49820	0.1		CM
	B	Kalardovo	B4	Kalardovo	BCM-BKA01	18.71145	42.41258	0.1		CM
	B	Solila	B5	Solila	BCM-BSO01	18.70388	42.39622	0.1		CM
	B	Sveta Nedelja	B6	Sveta Nedelja*	BCM-SN01	18.67618	42.45775	0.1		CM
	B	Brodograd. Bijela		Brodograd. Bijela	BCH-BB01	18.65233	42.44740	0.0	21	CH
	B			Luka Risan	BCM-RI02	18.69400	42.51342	0.0	9	CM
	B	IBM-Dobrota		IBM-Dobrota	BCM-DI01	18.76087	42.43638	0.2	22	CM
Open sea-Central	C			Katič	CCR-KA01	18.93828	42.19375	0.6	20	CR
	C			Buljarica 1	CCM-BL01	18.96660	42.17005	0.4	36	CM
	C			Luka Bar	CCH-BA02	19.08570	42.09073	0.0	13	CH
Open sea-Southern	S			Stari Ulcinj	SCR-SU01	19.13572	41.99015	0.4		CR
	S			Port Milena	SCH-PM01	19.23477	41.90157	0.2	8	CH
	S			Ada Bojana 1	SCM-AB01	19.333783	41.858633	0.5	11	CM

* Coordinates of the “old station” were changed/replaced with coordinates of nearby station used for other CIs for EO9

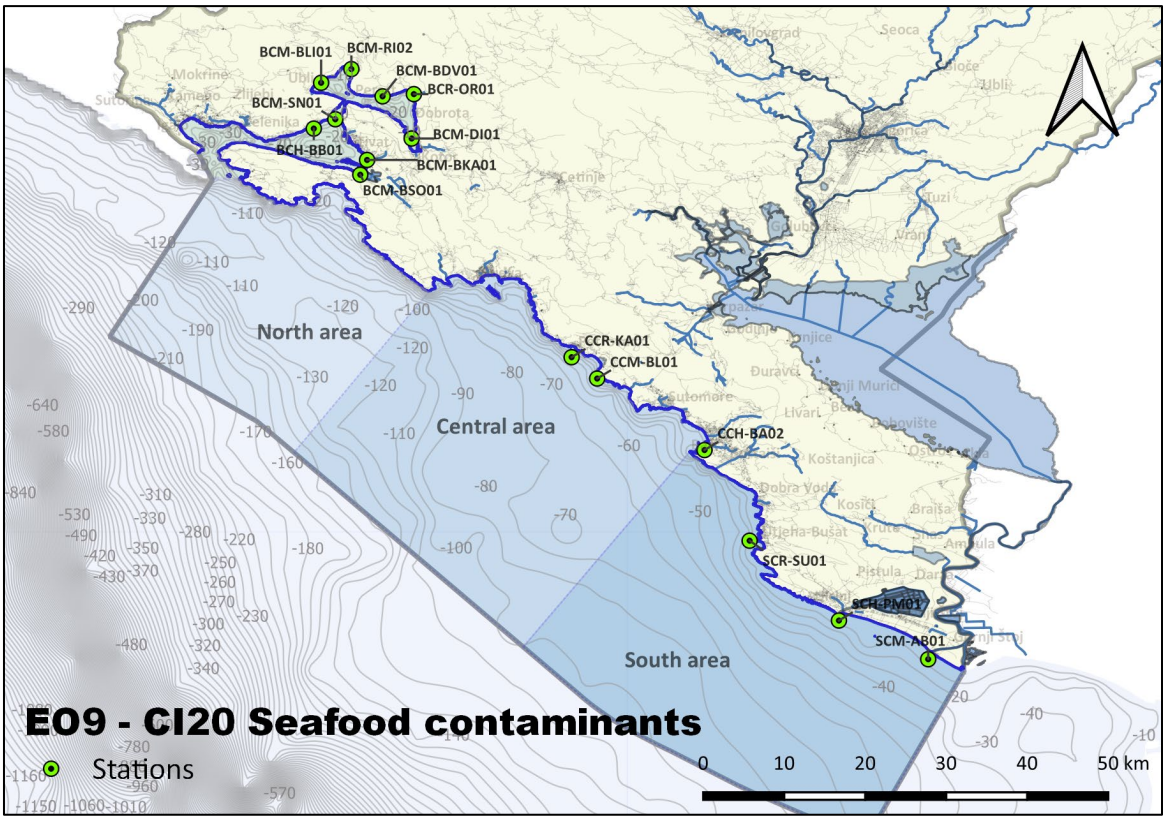
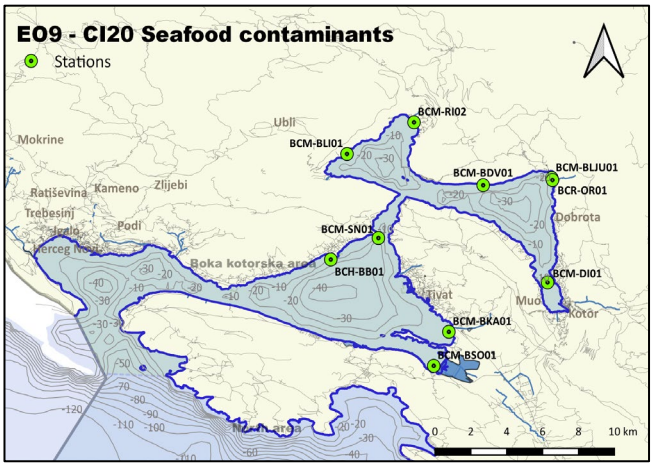
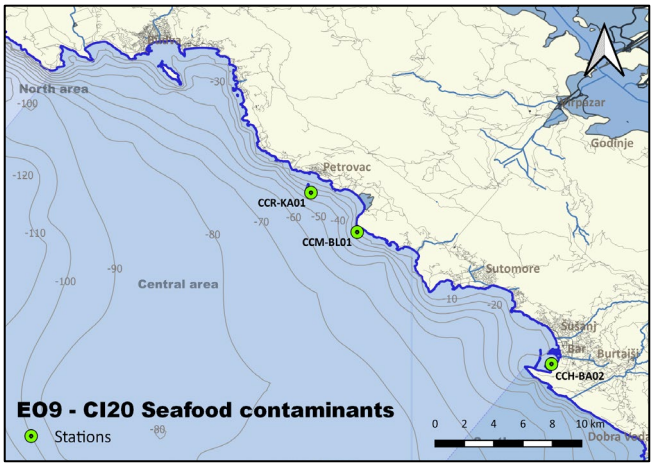


Figure 7.4: Monitoring stations for CI20





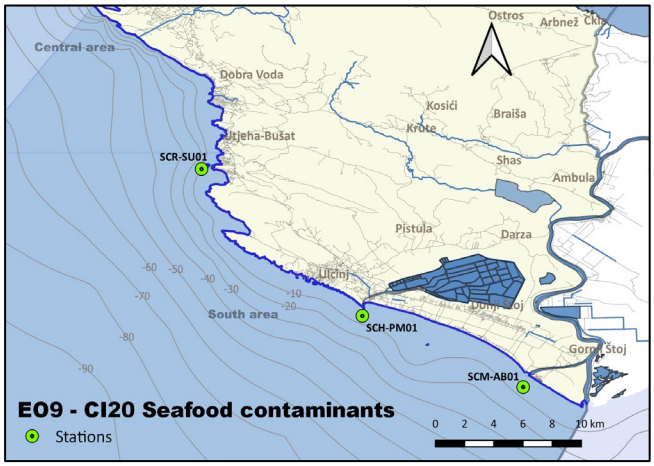


Figure 7.5: Monitoring stations for CI20 in Boka Kotorska, central area and southern area

7.2.4.2. Selection of parameters

Parameters for the CI20 will be harmonized with parameters for CI17, which include parameters that are in accordance with IMAP Common Indicator Guidance Facts Sheets and Food Safety Monitoring Programme which is in accordance with EC Regulation 853/2004 and Regulation 1881/2006. Therefore, the selected chemicals listed earlier in Section 7.2.1. related to the list of regulated contaminants will apply to this indicator. In addition to the Regulation required parameters (PAH, heavy metals, and biotoxins) organochlorine pesticides, PCBs, as well as new POPs chemicals (PFOS, PBDE), will be analysed too.

Table 7.7: Chemical compounds under different environmental legislation within Common Indicator 20 to be monitored within the IMAP National Monitoring Strategy

Matrix	Legislation	Chemical compounds/groups mandatory/non-mandatory substances;
Biota	UNEP(DEPI)/MED WG.444/5	Trace/Heavy Metals (TM): Total mercury (HgT), Cadmium (Cd) and Lead (Pb); Organochlorinated compounds (PCBs, Hexachlorobenzene, Lindane and ∑DDTs); Polycyclic aromatic hydrocarbons (US EPA 16 PAHs Compounds); Lipid content, flesh fresh/dry weight ratio for normalisation purpose
	EC Regulation 853/2004 and 1881/2006	Biotoxins (ASP,PSP, DSP), Pb, Hg, Cd, Dioxins and dioxin-like compounds, PCBs, PAHs

7.2.4.3. Sampling frequency

Initially, sampling will be carried out twice a year. For shellfish, the monitoring will be performed outside the spawning period, which means the periods of April/June and September/November.

7.2.4.4. The methodology of sampling, measurement and data processing

It is important to note that data interpretation will be done according to the maximum level for contaminants defined by Regulation 1881/2006. Taking into the account that the shellfish intended for consumption will be analysed using chemicals with exceptional property of bioaccumulation and biomagnification, the obtained results will be used to get a much clearer picture of the environmental status. This means that the contaminants in shellfish, which are not in compliance with regulatory levels and which exceed them, are also indicators of bad environmental status.

Detailed scientific and technical considerations related to CI20 monitoring practices, in accordance with the IMAP Guidance Factsheets, are given in Table 7.8. All the data presented in the following table correspond to national capabilities.

Table 7.8: Methodologies for Common Indicator 20 according to UNEP/MED WG.463/6 (2019

CI20	Purpose/Rationale
Sample collection	To collect marine organisms, mainly commercial species, and those similar to CI17. The sample collection for CI20 could be easily integrated with CI17 in terms of sample monitoring (e.g. from dedicated fish vessels or artisanal fleets at the port). It must be noted that, in any case, the origin (i.e. the area) of the fish captures should be known, including detailed field information (e.g. coordinates). No 6 Rev. 1 UNEP/FAO/IOC/IAEA: Guidelines for monitoring chemical contaminants in marine organisms. (25 p).
Sample processing	Sample processing refers to the dissection of the selected parts (e.g. liver, flesh fillet tissue, etc.) or the whole organism (e.g. soft parts) to be performed previously to the analytical determination of contaminants. Samples can be pooled to obtain sufficient sample material; however, this approach should be consistent over time and specific sample processing protocols should be recorded. Additional general parameters required might include sample identification, location, date and biometrics. Spada, L. *et al.* 2014.
Measurements	Trace/Heavy Metals (TM) and Aluminium: Spectrometry, Mass Spectrometry (MS). Organic compounds: Gas or Liquid Chromatography (GC/LC) coupled to a variety of detectors, such Electron Capture Detector (ECD) or Mass Spectrometry (MS). Maulvault, A.M. *et al.* 2015. Perello, G. *et al.*, 2015. Zaza, S. *et al.* 2015.
Reporting and QA	Percentages of occurrence of contaminants (e.g. number of detected regulated contaminants in commercial species, number of detected regulated contaminants exceeding regulatory limits (the European Regulation EU 1881/2006). Concerning analytical QA and determinations, the same approach for CI17 should be followed. Note: the assessment of this indicator should take advantage of the body of knowledge collected by the GFCM/FAO in the Mediterranean Sea, as well as off the methodologies developed for the EU MSFD (Descriptor 9). Maggi, C. *et al.*, 2014. Vandermeersch, G. *et al.* 2015.

7.2.5. Common indicator 21: Percentage of intestinal enterococci concentration measurements within established standards

The current Montenegrin Bathing Water Quality monitoring programme is fully compliant with the EU Bathing Directive, but the official reporting is still not in place because the legislation transposing the Directive has not been adopted yet. With regard to the IMAP CI21 implementation, the above is sufficient to report on CI21 under the IMAP. The World Health Organisation (WHO) has been concerned with health aspects of the management of water resources for many years and published various documents concerning the safety of the water environment, including marine waters, and its importance for health, as well as the US EPA that helped define IMAP CI21, and the EU.

7.2.5.1. Selection of sampling sites and monitoring areas

The Public Enterprise for Coastal Zone Management measures the required parameter (i.e. Intestinal enterococci, IE) at recreational bathing water sites from May to October in line with requirements of the EU Directive 2006/7/EC and the IMAP. Currently, sampling is more frequent than required by the Directive (twice per month), at locations shown in Table 7.9. It is important to note that not all of these locations are fixed, and some of them can change from one season to another. All monitoring stations and the results are publicly available at the PE Morsko dobro website. Sampling frequency was established by the relevant Decree which was changed in 2019 and aligned with the Directive.

Table 7.9: Locations managed by the Public enterprise for coastal zone management of Montenegro for Common Indicator 21

Municipality HERCEG NOVI				
Station code	Station name	Public beach	Longitude	Latitude
HN01	KAMENARI	Obala kod "Sv. Nedjelje"	18.67604443	42.45975904
HN02	BIJELA	"Delfin"	18.65996186	42.45374876
HN03	BAOŠIĆI	"Jedinica Damjanović"	18.62764128	42.43996406
HN04	ĐENOVIĆI	"Bambi"	18.61252431	42.43646184
HN05	KUMBOR	Kumbor (central beach)	18.58609969	42.43924878
HN06	ZELENIKA	"Zmijice"	18.57675706	42.44595104
HN07	MELJINE	Gradska plaža (central part)	18.56366167	42.45400782
HN08	SAVINA	"Vila Perla"	18.55304377	42.44947708
HN09	ĆOROVIĆA ŠPAŽA	Plaža Galija	18.54770873	42.44945815
HN10	TOPLA	"Yachting club"	18.53046213	42.41700465
HN11	TOPLA	"Sun Resort"	18.52550809	42.45441172
HN12	NOVOSADSKO KUPALIŠTE	Central part	18.51953753	42.45810078
HN13	IGALO	"Bay beach"	18.51554821	42.45848709
HN14	IGALO	"Palmon bay"	18.51242746	42.45703362
HN15	IGALO	Kupalište ispod Vile Galeb	18.50811669	42.45423002
HN16	BLATNA PLAŽA	Blatna plaža	18.50590118	42.45207299
HN17	NJIVICE	"Club hotel Riviera"	18.51736809	42.43434153
HN18	MIRIŠTA	Kupalište Mirišta	18.57904414	42.39474876
HN19	ŽANJICE	Žanjice (central part)	18.58019481	42.39903123
HN20	DOBREČ	Dobreč	18.55875679	42.41241707
HN21	ROSE	Rose	18.55596562	42.42847388

Municipality KOTOR				
Station code	Station name	Public beach	Longitude	Latitude
KO01	TRSTENO	Trsteno (central part)	18.78542135	42.28152204
KO02	TRSTENO	"Ploče"	18.78357197	42.26926304
KO03	STOLIV	Kod novog naselja	18.70113109	42.47482941
KO04	STOLIV	Markov rt (central part)	18.731	42.465
KO05	PRČANJ	"Tre Sorele"	18.7545223	42.44666238
KO06	BENOVO	Central part	18.76779039	42.42781659
KO07	DOBROTA	Žuta plaža	18.7676544	42.42967344
KO08	DOBROTA	Sveti Matija	18.76163372	42.44138513
KO09	DOBROTA	Sveti Stasija	18.76310671	42.46609034
KO10	ORAHOVAC	Orahovac (western part)	18.75602836	42.48965701
KO11	DRAŽIN VRT	"Bajova kula"	18.73514418	42.48373125
KO12	PERAST	Kupatilo I (ispod borova)	18.70581875	42.48401689
KO13	PERAST	Kupatilo II – "Pirate bar"	18.69442557	42.48861881
KO14	RISAN	"Teuta"	18.69106744	42.51571204
KO15	MORINJ	Morinj (central beach)	18.65149597	42.48844161

Municipality TIVAT				
Station code	Station name	Public beach	Longitude	Latitude
TI01	UVALA PRŽNO	"Plavi horizonti"	18.68311473	42.38552577
TI02	OBLATNO	"Almara beach"	18.65272845	42.38237511
TI03	KRAŠIĆI	"Anderba" and "Volat"	18.6447521	42.41186717
TI04	SOLILA	"Račice"	18.70458762	42.3936058
TI05	KALARDOVO	Kalardovo	18.71232579	42.40650405
TI06	GRADSKA PLAŽA	"Palma"	18.69876538	42.42798487
TI07	PONTA SELJANOVO	Kod svetionika	18.68430155	42.43900286
TI08	DONJA LASTVA	"Kamelija"	18.68778629	42.442165
TI09	OPATOVO	Opatovo	18.68147636	42.45960117

Municipality BUDVA				
Station code	Station name	Public beach	Longitude	Latitude
BU01	BULJARICA	Western part	18.96333257	42.19430429
BU02	LUČICE	Central part	18.9505765	42.20045963
BU03	PETROVAČKA PLAŽA	"Ponta Petrovac"	18.94261141	42.20293759
BU04	PETROVAČKA PLAŽA	Central part	18.94018749	42.20553721
BU05	DROBNI PIJESAK	Central part	18.90232409	42.23437923
BU06	CRVENA GLAVICA	"Galija"	18.89719793	42.24523484
BU07	SVETOSTEFANSKA PLAŽA	Eastern Sv. Stefan	18.89392073	42.25576884
BU08	SVETOSTEFANSKA PLAŽA	Western Sv. Stefan	18.89253805	42.25727561
BU09	PRŽNO	"Maestral"	18.89206866	42.26875493
BU10	KAMENOVO	Central part	18.88663853	42.27504255
BU11	RAFAILOVIĆI	Central part	18.87999068	42.28013789
BU12	BEČIĆKA PLAŽA	"The Queen of Montenegro"	18.8762412	42.28088692
BU13	BEČIĆKA PLAŽA	"Samsara" and "Bella Vista"	18.87402578	42.28074317
BU14	BEČIĆKA PLAŽA	"Sveti Toma"	18.87058714	42.28077843
BU15	BEČIĆKA PLAŽA	"Dolce Vita"	18.86466642	42.28038315
BU16	BEČIĆKA PLAŽA	"Bellevue"	18.86144455	42.27985735
BU17	SLOVENSKA PLAŽA	"Time out"	18.85463927	42.28442141
BU18	SLOVENSKA PLAŽA	"Sen Tropez"	18.85147611	42.28493516
BU19	SLOVENSKA PLAŽA	"Greco"	18.84017731	42.28286052
BU20	BRIJEG OD BUDVE	Central part	18.83634175	42.27768404
BU21	MOGREN	Mogren I	18.83246013	42.27687688
BU22	JAZ	Jaz (nudistička plaža)	18.81058399	42.28426663
BU23	JAZ	"Poseidon"	18.80641232	42.28363939
BU24	JAZ	"S&I beach life"	18.80512888	42.28332784
BU25	JAZ	"Blue beach" and "Escallera"	18.80348469	42.28262339
BU26	JAZ	"Sirena beach"	18.80114802	42.28115151
BU27	JAZ	Jaz – Svetionik	18.80037819	42.28056374

Municipality BAR				
Station code	Station name	Public beach	Longitude	Latitude
B01	UTJEHA	"Paradiso"	19.15065059	42.01070196
B02	VELIKI PIJESAK	Central part	19.14223381	42.03469635
B03	TOPOLICA	"Princess"	19.08982881	42.10110887
B04	ŠUMA LEKOVIĆA	Central part	19.08703722	42.10718858
B05	ŽUKOTRLICA	Central part	19.08418553	42.11173187
B06	ŽUKOTRLICA	Western part	19.08277025	42.11341805
B07	SUTOMORE	Eastern part	19.06061331	42.13392053
B08	SUTOMORE	"Korali"	19.058	42.135
B09	SUTOMORE	"Centar"	19.05243341	42.13716083
B10	ČANJ	"Biserna obala"	19.00238344	42.15805584
B11	ČANJ	Central part	18.99972813	42.15996136
B12	ČANJ	"Vela beach"	18.99726756	42.16096432

Municipality ULCINJ				
Station code	Station name	Public beach	Longitude	Latitude
U01	ADA BOJANA	Nudistička plaža	19.34200386	41.86243008
U02	VELIKA PLAŽA	"Copacabana"	19.30715392	41.88687567
U03	VELIKA PLAŽA	"Mar Buena"	19.29869155	41.89052876
U04	VELIKA PLAŽA	"Cabo beach"	19.28561959	41.89526855
U05	VELIKA PLAŽA	"MCM beach"	19.27515517	41.89913493
U06	VELIKA PLAŽA	"Tropicana"	19.26880369	41.90167733
U07	VELIKA PLAŽA	"Safari beach"	19.26521222	41.90275734
U08	VELIKA PLAŽA	"Pearl beach"	19.261838	41.90369061
U09	VELIKA PLAŽA	"Mojito"	19.25787235	41.90479754
U10	VELIKA PLAŽA	"White beach"	19.25611513	41.90528893
U11	VELIKA PLAŽA	"Evropa beach"	19.25287942	41.90602423
U12	VELIKA PLAŽA	"Miami"	19.249874	41.90677879
U13	VELIKA PLAŽA	"Tony grill"	19.24834246	41.90717303
U14	VELIKA PLAŽA	"Lido"	19.24193064	41.90880988
U15	MALA PLAŽA	Mala plaža	19.2045093	41.92360262
U16	VALDANOS	Central part	19.1653576	41.9516383

From 2020, monitoring will be conducted completely in line with the Directive requirements (including sampling frequency, selection of sampling location which will be done every year before the season and include calculation of both the 95th and 90th percentiles). The datasets obtained from this monitoring programme will be adequate for the IMAP reporting on CI21.

7.2.5.2. Parameters selection

Bathing water quality assessments shall be carried out based on intestinal enterococci concentration (CFU/100 ml).

7.2.5.3. Sampling frequency

According to Annex IV (EU Directive 2006/7/EC), the temporal scope guidance, for each site, is as follows:

"1. One sample is to be taken shortly before the start of each bathing season. Taking account of this extra sample and subject to paragraph 2 (below), no fewer than four samples are to be taken and analysed per bathing season.

2. However, only three samples need be taken and analysed per bathing season in the case of bathing water that either:

(a) has a bathing season not exceeding eight weeks; or

(b) is situated in a region subject to special geographical constraints.

3. Sampling dates are to be distributed throughout the bathing season, with the interval between sampling dates never exceeding one month.

4. *In the event of short-term pollution, one additional sample is to be taken to confirm that the incident has ended. This sample is not to be part of the set of bathing water quality data. If necessary, to replace a disregarded sample, an additional sample is to be taken seven days after the end of the short-term pollution".*

The sampling frequency is established by the relevant Decree which is expected to be changed in the course of 2019 and aligned with the Directive. Once the Decree has been aligned with the Directive, it will be adopted by the Government, and it will be obligatory that monitoring is conducted fully in line with the Directive requirements (including sampling frequency and calculation of both the 95th and 90th percentiles and categories of bathing water).

7.2.5.4. The methodology of sampling, measurement and data processing

All the steps described above have been applied during the implementation of current monitoring programmes by the Public Enterprise for Coastal Zone Management, but the reporting cannot be done in line with the Directive until the Decree is officially changed and adopted by the Government. Nevertheless, elaboration of data in line with the Directive has already been done, but not published for the mentioned reasons. The monitoring programme has already been fully aligned with the Directive, but it will be fully implemented once the Decree has been adopted.

Table 7.10: Methodologies for Common Indicator 21 according to UNEP/MED WG.463/6 (2019)

CI21	Purpose/Rationale
Sample collection	Sample collection in selected monitoring stations will be done in accordance with ISO 5667-1, ISO 5667-2 and Annex V of the Directive 2006/7/EC. UNE/MAP MED POL, 2010. Assessment of the state of microbial pollution in the Mediterranean Sea. MAP Technical Reports Series No. 170 (Amended). Directive 2006/7/EC
Sample processing	Preservation, handling and delivering of the water samples to the laboratory are done in accordance with ISO 5667-3 and Annex V of the Directive 2006/7/EC. Water samples must be protected at all stages of transport from exposure to light, in particular direct sunlight. The time between sampling and analysis is to be kept as short as possible. It is recommended that samples be analysed on the same working day. If this is not possible for practical reasons, then the samples shall be processed within no more than 24 hours. In the meantime, they shall be stored in the dark environment and at the temperature of 4 °C±3 °
Measurements	Detection and enumeration of intestinal enterococci will be performed by the membrane filtration method (ISO 7899-2).
Reporting and QA	Classification and quality status of bathing waters are based upon the 90th and 95th percentiles of the log10 normal probability density function of the CFU datasets measured at one single location according to established monitoring and assessment protocols and standards. A methodology has been proposed by Directive 2006/7/EC, as well as by UNEP(DEPI)/MED IG 20/8. WHO, 2003 Guidelines for safe recreational water environments. VOLUME 1: Coastal and fresh waters. WHO Library. ISBN 92 4 154580. World Health Organisation, 2003. Directive 2006/7/EC of the European Parliament and of the Council of 15 February 2006 concerning the management of bathing water quality and repealing Directive.

7.3. Quality Assurance and Quality Control

For more details, see Subchapter 5.4.

7.4. Monitoring interconnection between contaminants and other EOs

Integration of monitoring efforts for EO9 with the monitoring network defined for EO5 is fully ensured, mainly due to cost-effectiveness reasons.

Detailed information about the interconnections between EO9 and other EOs in Montenegro is provided in Annex 1. The rationale for interactions and interconnections between EOs is provided in Annex 2.

A detailed description of the EO9 monitoring, and its integration with EO5, is available in the information document National Thematic Monitoring Programme for Contaminants.

8.
MARINE LITTER (EO10)

Marine litter is defined as any solid, persistent, manufactured or transformed material which is dumped, abandoned or lost at sea or along the coastline. Therefore, marine litter are objects made and used daily and then abandoned or lost along the coastline or at sea, including those materials which, abandoned on land, eventually reach the sea pushed forward by the rivers, wind, runoff and urban wastewater.

The problem of waste at sea has grown to emergency proportions. The levels found along all the Adriatic beaches are considerable and continually increasing. To this can be added the waste present on the marine seabed and that floating on the sea's surface.

Marine litter poses a major threat to marine ecosystems in the Mediterranean Sea due to its environmental, economic, safety, health and cultural impacts. The regional approach to combating this type of pollution is a step to success since the issues of marine litter transcends national borders. The Adriatic region is facing a big gap when it comes to marine litter analysis, resulting in a lack of appropriate mitigation measures aimed at reducing this type of pollution evident in every country of the region.

Individuating and monitoring the sources is a difficult task, but what seems to be even more difficult is trying to reduce the quantity of waste in the sea because of the diversity of its sources, sometimes far from the coast as in the case of river transported waste, along with the objective difficulty of applying the rules of the legislation of each of the bordering states, which are often circumvented or not respected.

The most important projects that have been implemented or are currently being implemented in Montenegro are:

1. DEFISHGEAR
2. MEDITS (International bottom trawl survey in the Mediterranean)
3. UNEP Adopt a Beach
4. WELCOME

Even if data was collected during various projects, it is very important to note that most of the data is consistent with the IMAP requirements and that only minor harmonization of the existing monitoring methodology is needed.

8.1.
Common indicators

In accordance with the Integrated Monitoring and Assessment Programme of the Mediterranean Sea and Coast and Related Assessment Criteria (Decision IG.22/7), marine litter monitoring under the IMAP is based on the Regional Plan on Marine Litter Management (Decision IG. 20/10, the MLRP) and the agreed common and candidate indicators:

Common indicator 22: Trends in the amount of litter washed ashore and/or deposited on coastlines	
GES definition	Number/amount of marine litter items on the coastline does not have a negative impact on human health, marine life and ecosystem services.
Operational objective	The impacts related to properties and quantities of marine litter in the marine environment and coastal environment are minimized.
GES targets	State: A decreasing trend in the number of/amount of marine litter (items) deposited on the coast.

Common indicator 23: Trends in the amount of litter in the water column including microplastics and on the seafloor	
GES definition	Number/amount of marine litter items on the coastline does not have negative impacts on human health, marine life and ecosystem services.
Operational objective	The impacts related to properties and quantities of marine litter in the marine environment and coastal environment are minimized.
GES targets	State: A decreasing trend in the number of/amount of marine litter (items) deposited on the coast.

Candidate indicator 24: Trends in the amount of litter ingested by or entangling marine organisms focusing on selected mammals, marine birds, and marine turtles	
GES definition	Trends in the amount of litter ingested by or entangling marine organisms, especially mammals, marine birds and turtles.
Operational objective	Impacts of litter on marine life are controlled to the maximum extent practicable (10.2).
GES Targets	State: A decreasing trend in the cases of entanglement or/and a decreasing trend in the stomach content of the sentinel species.

Monitoring of marine litter ingested by marine turtles (*Caretta caretta*) should be conducted by following Protocols for monitoring interactions between marine litter and marine turtles (ingestion and entanglement) to harmonize methods of data collection for monitoring and assessment in the Mediterranean (UNEP/MED WG.464/6, 2019). Monitoring implies continuous sampling of dead sea turtles collected from beaches or at sea from accidental mortalities such as victims of long-line fishing (by-catch) or boat collisions.

Considering that previous studies on micro and macro litter in the fish stomach have shown that the pelagic fish species are more influenced by ingestion in the area of the Southern Adriatic Sea compared to demersal ones (Anastasopoulou, A. et al., 2018); monitoring of microplastics ingested by marine organisms in Montenegro is proposed for the following types of fish:

- *Sardina pilchardus;*
- *Boops boops;*
- *Scomber japonicus;*
- *Mullus sp.*

Analyses should be carried out by following the DeFishGear Protocol for macro litter ingested in fish stomachs (Anastasopoulou, A and Mytilineou Ch, 2015), and the Protocol included in "Monitoring Guidance for Marine Litter in European Seas" report (MSFD-TS, 2013).

8.2.
Beach Marine Litter (CI22)

8.2.1.
Selection of sampling sites and monitoring areas

The sampling sites are selected taking into consideration the following criteria. The selected beaches should be situated:

- In the vicinity of ports or harbours;
- In the vicinity of river mouths;
- In the vicinity of coastal urban areas;
- In the vicinity of touristic destinations;
- In relatively remote areas;
- On beaches where there are no regular clean-up activities.

In addition, the selected beaches should:

- Have a minimum length of 100 m;
- Be characterized by a low to moderate slope (~1.5-4.5 °), which precludes very shallow tidal mudflat areas that might be kilometres long;
- Have clear access to the sea (not blocked by breakwaters or jetties) in such a way that marine litter is not screened by anthropogenic structures;
- Be accessible to survey teams throughout the year;

- Ideally not be subject to cleaning activities. In case that they are subject to litter collection activities the timing of non-survey related beach cleaning must be known so that litter flux rates (the amount of litter accumulation per unit time) can be determined;
- Posing no threat to endangered or protected species, such as sea turtles, seabirds or shorebirds, marine mammals or sensitive beach vegetation; in many cases, this would exclude protected areas but this may vary depending on local management arrangements.

Based on the above-listed criteria and analysing the existing data collected through several projects, the following beaches are the subject of a national monitoring programme for marine litter (Table 8.1):

1. "Jaz" beach (open sea of Montenegrin coast);
2. "Velika " beach (open sea of Montenegrin coast);
3. "Blatna" beach (area of Boka Kotorska Bay).

Table 8.1: Coordinates and estimated area of proposed transects for CI22

Beach	Starting coordinates	Ending coordinates	Estimated area
Jaz	18.79969 42.27954	18.80010 42.28041	4,000 m^2
Blatna	18.50619 42.45297	18.50548 42.45224	1,500 m^2
Velika	19.33305 41.87016	19.33369 41.86918	5,000 m^2

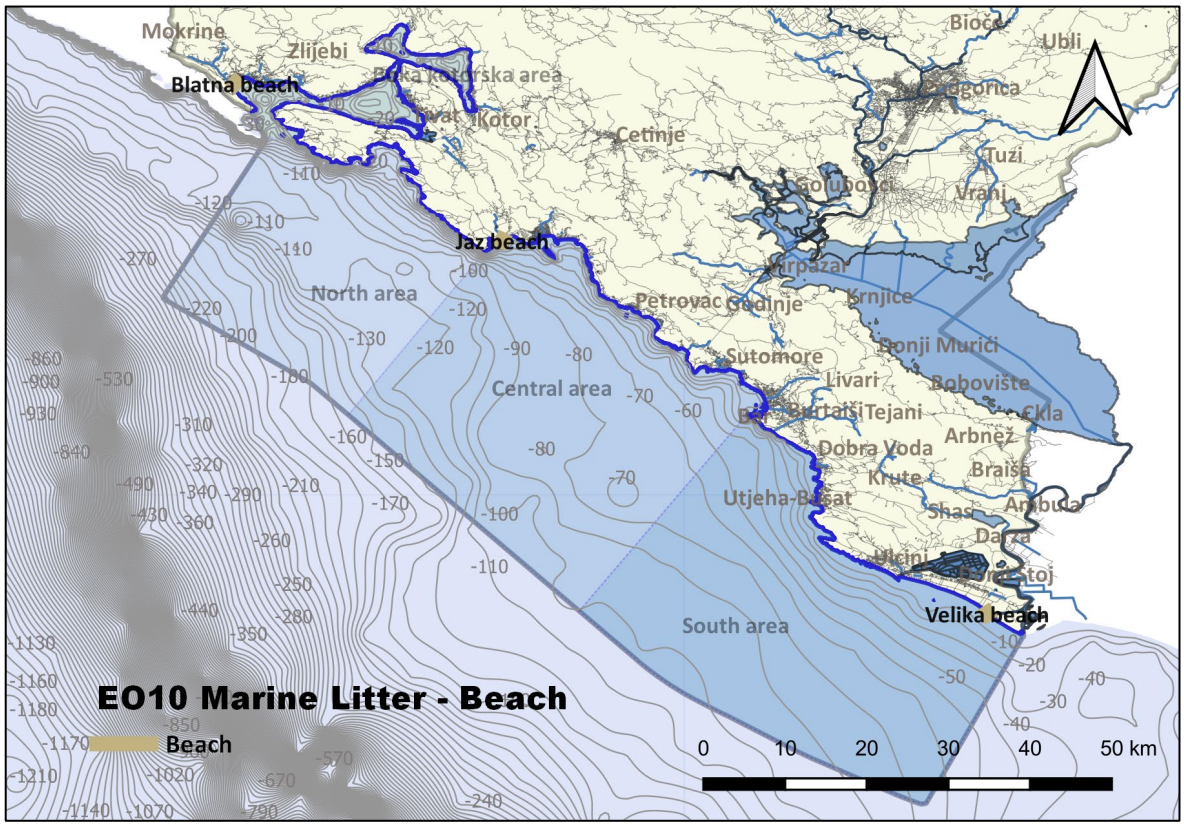


Figure 8.1: Monitoring stations for beach marine litter

8.2.2.
Frequency and timing of surveys

The survey will take place three times a year in the following dynamics:

- Winter: mid-December – mid-January
- Spring: May
- Summer-mid-June-mid-July

8.2.3.
Methodology for Monitoring Beach Marine Litter (> 0.5 cm)

The methodology for Monitoring Beach Marine Litter is based on the following methodological approaches and respective documents:

- EU MSFD TG10 "Guidance on Monitoring of Marine Litter in European Seas" (2013);
- OSPAR "Guideline for Monitoring Marine Litter on the Beaches in the OSPAR Maritime Area (2010)";
- UNEP/MAP MEDPOL Monitoring Guidance Document on Ecological Objective 10: Marine Litter (2014);
- IMAP Guidance Factsheets for Marine Litter: UNEP/MED WG.439/12;
- DeFishGear Methodology for Monitoring Marine Litter on Beaches Macro-Debris (> 0.5cm). 16 p.

Monitoring should be performed on a specific sampling unit, defined as a fixed section of a beach covering the whole area from the strandline to the back of the beach (Figure 8.2).

At least 1 section of 100 m on the same beach, or ideally 2 sections, is recommended for monitoring purposes, where possible. If two sections are monitored, it is necessary to have a minimum distance of 50 meters between them. The same sites should be monitored for all surveys. To identify the start and end points of each sampling unit, permanent reference points can be used and coordinates obtained by GPS.

Before any sampling begins, shoreline characterization should be completed for each 100m site with GPS coordinates of all four corners of the sampling unit, site ID name should be recorded and a sufficient number of digital photographs should be taken to document the physical characteristics of the monitoring site.

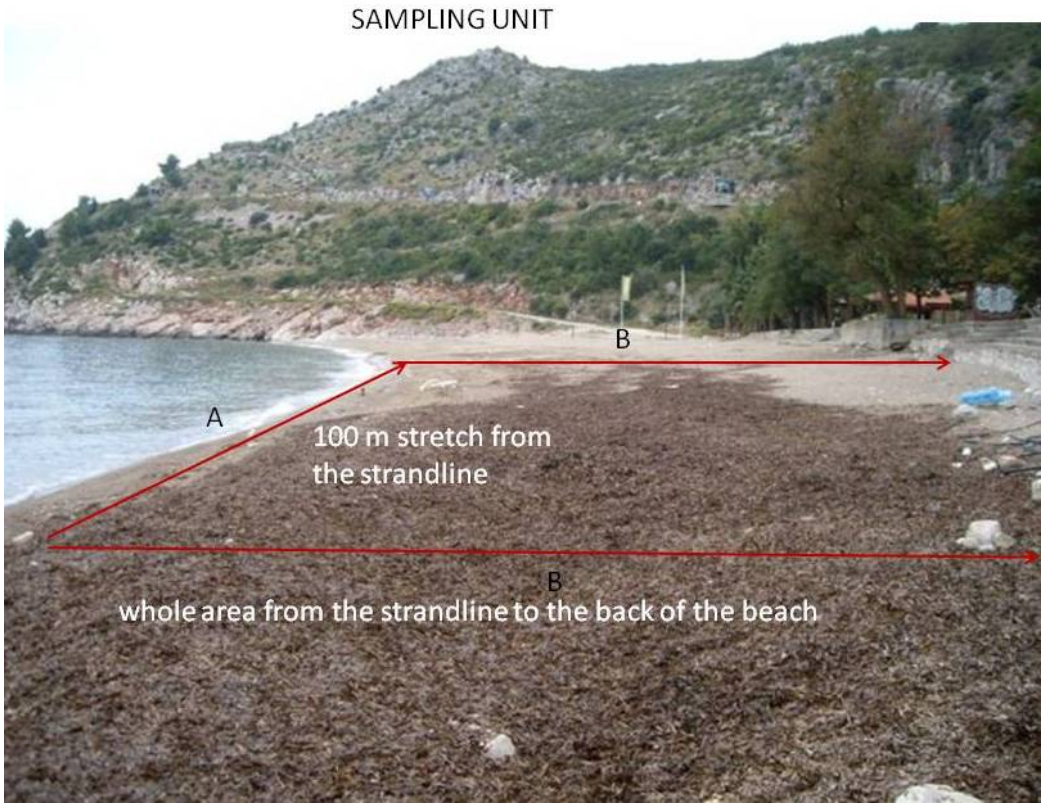


Figure 8.2: Sampling unit

Size limits and classes. There are no upper size limits to litter recorded on beaches. Litter items with a lower limit of 0.5 cm in the longest dimension will be monitored, ensuring the inclusion of caps, lids and cigarette butts. All items found on the sampling unit should be entered in the "MEDPOL Beach Litter Survey Form".

Quality assurance and quality control should be primarily targeted at the education of the field teams to ensure that litter collection and characterization are both consistent across surveys. Investment in communication and the training of the country/regional and local survey coordinators and managers is therefore critical for survey integrity.

8.2.4. Methodology for data processing

The basic analysis involves spreadsheet development, aggregations per category and type of marine litter items, mean values and corresponding standard deviation. Since there is no available long-term data at the moment, there is no statistical method recommended. Six years of monitoring is considered as the minimum to assess trends. Moreover, at present, there is no agreed statistical method for recommending a minimum number of sites that may be representative for a certain length of the coast. This depends greatly on the purpose of the monitoring, on the geomorphology of the coast and the number of available sites that meet the criteria described above. The representativeness of survey sites should be assessed in pilot studies, where initially a large number of beaches are surveyed. Subsequently, the selection of representative beaches from these sites should be made based on statistical analysis.

Expected assessment output includes information on:

- the abundance of beach marine litter with detailed information on densities (items/100 m transect and items/m2), different types of material and/or use;
- temporal and spatial distribution;
- identified sources;
- most frequent items list found at the regional and national level.

8.3. Seafloor Marine Litter (CI22)

The survey area for the seafloor marine litter is the entire continental shelf of Montenegro (see Figure 8.3), following the MEDITS survey approach. The MEDITS survey uses a depth stratified sampling scheme with a random selection of trawling sites (same positions each year) within each stratum. The sampling strata are the following depth zones: 20-50, 50-100, 100-200, 200-500 and 500-800 m. The number of stations in each stratum is proportional to the surface of these strata (Table 8.2).

Table 8.2: Surface area of depth strata and the corresponding number of stations in the MEDITS survey in Montenegro

GSA 18	Depth stratum	Area (km^2)	Proposed number of hauls
MNE	10-50 m	280	1
MNE	50-100 m	1100	2
MNE	100-200 m	1700	4
MNE	200-500 m	1150	2
MNE	500-800 m	770	1

8.3.1. Selection of seafloor sampling sites

Seafloor sampling sites should be selected in such a way as to ensure that they:

- Comprise areas with the uniform substrate (ideally sand/silt bottom);
- Take into account areas that might accumulate litter;
- Avoid areas of risk (presence of munitions), sensitive or protected areas;
- Do not exert impacts on any endangered or protected species.

They should be stratified according to sources (urban, rural, close to riverine inputs) and impacted offshore areas (major currents, shipping lanes, fisheries areas, etc.).

Based on the above, the locations for national monitoring of seafloor marine litter in the open sea of the Montenegrin coast are those that are monitored for the purpose of monitoring the demersal resources of the fish populations (in the framework of MEDITS the survey) (Figure 8.3., Table 8.3).

Additionally, two locations are added in the area of Boka Kotorska Bay (Figure 8.4, Table 8.4), as previous research activities have identified a high rate of marine litter pollution.

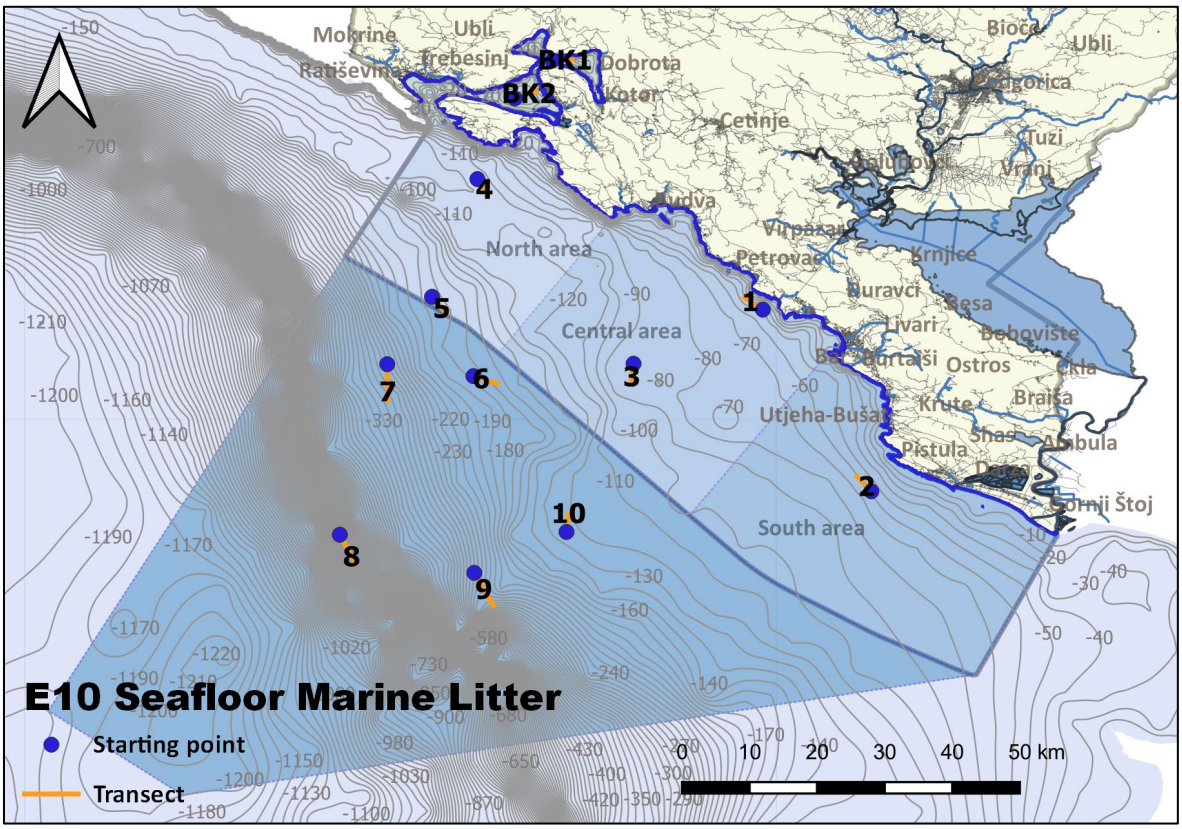


Figure 8.3: MEDITS hauls in Montenegro, transects for seafloor marine litter survey

Table 8.3: Geographical coordinates of the proposed location of seabed marine litter monitoring in the open sea of Montenegro (MEDITS survey). (SP – starting position, EP – ending position)

No. of haul	LATITUDE SP	LONGITUDE SP	DEPTH SP	LATITUDE EP	LONGITUDE EP	DEPTH EP
1	42.14583	18.98200	44	42.16217	18.95733	49
2	41.90433	19.12633	63	41.92433	19.10717	61
3	42.07400	18.81000	77	42.04833	18.80650	77
4	42.31950	18.60233	112	42.29950	18.61650	114
5	42.16300	18.54200	179	42.14033	18.56117	173
6	42.05750	18.59700	160	42.04750	18.62833	153
7	42.07333	18.48233	291	42.02483	18.48333	300
8	41.84667	18.41933	678	41.80800	18.44033	756
9	41.79600	18.59817	271	41.75233	18.62367	282
10	41.85033	18.72083	116	41.87517	18.72383	115

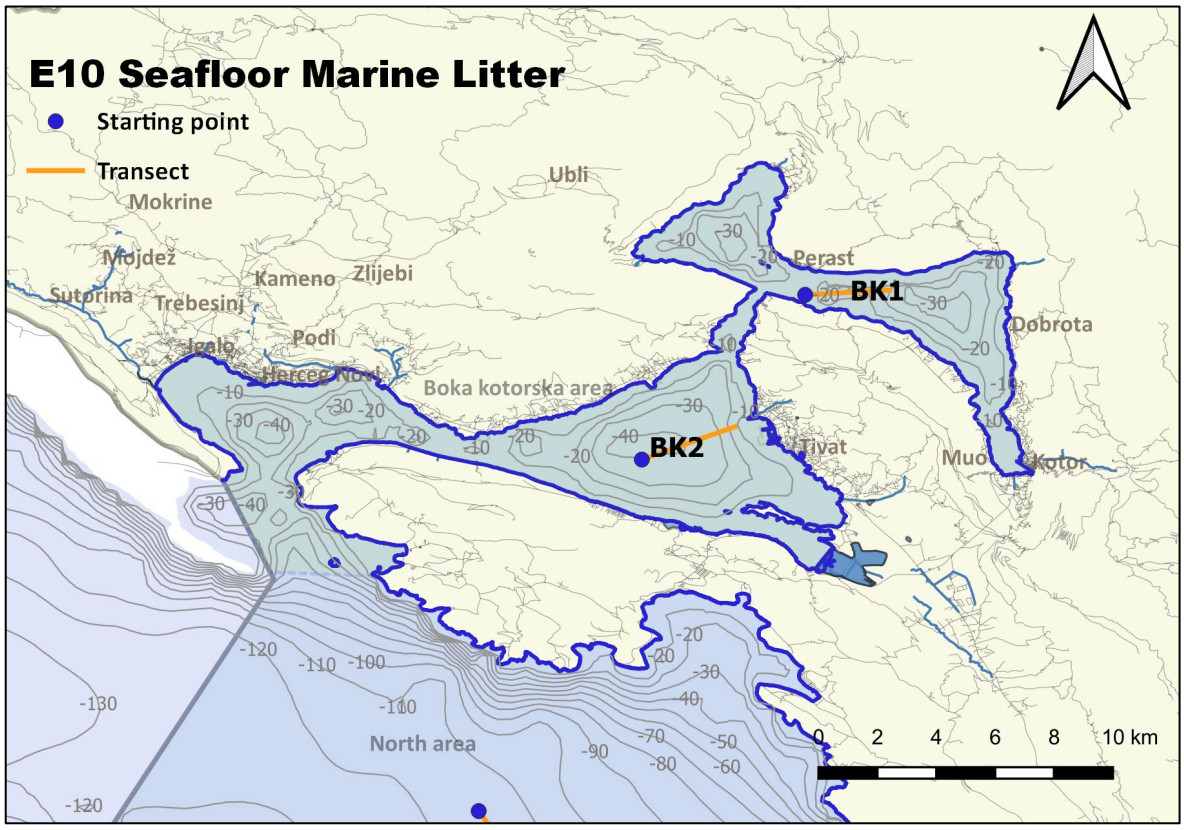


Figure 8.4: Proposed locations for sea litter survey in the area of Boka Kotorska Bay

Table 8.4: Geographical coordinates of the proposed location of seabed marine litter monitoring in the area of Boka Kotorska Bay. (SP – starting position, EP – ending position)

No. of haul	LATITUDE SP	LONGITUDE SP	LATITUDE EP	LONGITUDE EP	DEPTH
BK1	42.47695	18.70197	42.47838	18.72772	33
BK2	42.42670	18.65212	42.43673	18.68055	29

8.3.2.
Frequency and timing of surveys

The surveys are conducted once or twice per year, in the period July – August, depending on the available resources, during the same period for each year.

The timing of the surveys is fixed to:

- 30 minutes each for depths at less than 200 m; and
- 60 minutes for depths at more than 200 m.

In case during the fishing operations, the haul should be stopped before the completion of the standard duration, the haul can be considered valid if at least 2/3 of the time or the distance has been successfully attained.
Hydrographical and environmental information should be also taken into account.

Considering that the MEDITS research in Montenegro has been regularly conducted for more than a decade, to reduce the costs of monitoring and to align existing monitoring with the planned ones, we consider that the marine litter monitoring should be implemented only during the summer.

8.3.3.
Methodology for monitoring seafloor marine litter in the Continental Shelf (20–800 m)

The bottom trawling method is considered to be the most suitable for large scale evaluation and monitoring of benthic debris. Nevertheless, there are some sampling restrictions in rocky areas and soft sediments and the method may underestimate the quantities of litter present. As pointed out in the 2013 report of the MSFD Technical Subgroup on Marine Litter, international bottom trawl surveys, such as the MEDITS survey in the Mediterranean Sea, provide the most suitable means for broad-scale evaluation and monitoring of seafloor litter. In the MEDITS survey, a harmonized methodology is used as well as, specifically, a common gear and fishing operation and sampling scheme (GOV net, 20 mm mesh, 30-60 min tow, covering the entire 20-800 m depth zone). Most importantly, MEDITS provides the means (through the use of acoustic equipment) for monitoring the trawl geometry and the accurate estimation of the "swept area", a parameter required for recording litter as items per km^2.

The methodology applied for seafloor marine litter is based on the EU MSFD TG10 "Guidance on Monitoring of Marine Litter in European Seas (2013)", the "MEDITS International bottom trawl survey in the Mediterranean, Instructional Manual", "UNEP/MAP MEDPOL Monitoring Guidance Document on Ecological Objective 10: Marine Litter (2016)", as well as DEFISHGEAR Methodology for monitoring seafloor litter with bottom trawls.

Identification of seafloor marine litter takes into consideration the following categories:

- plastic;
- rubber;
- metal;
- glass/ceramic;
- textiles/natural fibres;
- processed wood;
- other, non-specified types of litter, based on categories with MEDPOL metadata templates.

The unit in which litter will be recorded is the number of items and it will be expressed as counts of litter items per square kilometre (litter items/km^2). The total weight of litter items per haul will be recorded, as well as the weight per each litter main category. In addition, the total weight of each haul should be recorded, as well as the weight of the commercial fish caught in it.

8.3.4.
Data processing methodology

Basic statistics can be applied during the analysis and aggregation of the results. The coefficient of variation (i.e. Standard deviation) should be included in the processed data for seafloor marine litter to couple the abundance/density figures (e.g. items/km^2).

The expected assessment output includes information on:

- marine litter found on the seafloor (if possible, comparison with the Mediterranean sea at the basin and sub-basin scale);
- abundance, density (items/ha or items/km^2), spatial and temporal distribution and types;
- sources to target prevention and reduction measures;
- map with existing information, in order to, among other things, assess marine litter accumulation areas on the seafloor of the entire Mediterranean Sea.

8.4.
Floating Marine Litter (CI23)

8.4.1.
Selection of Sea-Surface sampling sites and sampling frequency

To optimize and sustain the national monitoring programme for marine litter, for the monitoring of floating litter by visual observations, the same transects are used for the monitoring of seafloor marine litter too (MEDITS survey). Both monitorings should be synchronised over the same period and along the same transects (detailed coordinates are given in Table 8.3.2).

In addition, 3 transects in the area of Boka Kotorska Bay (Figure 8.5) are included for monitoring floating litter by visual observation and microplastics in the water column. Those transects were already used for the DEFISHGEAR project, and are part of the national monitoring programme on water quality in the production areas for shellfish farming.

The survey area is defined by the transect width and length. The transect width to be used is that of 10 m, however, verification should be made and the width of the observation corridor chosen in a way that all items along

that transect and within the target size range, can be seen. The table below provides a preliminary indication of the observation corridor width, with varying observation elevation and speed of the vessel.

Table 8.5: Observation width from different observation levels above the sea for a ship speed of 2 and 6 knots.

Observation level of the surveyor above the sea	Observation width (vessel speed 2 knots= 3,7 km/h)	Observation width (vessel speed 6 knots=11.1 km/h)
1 m	6 m	4 m
3 m	8 m	6 m
6 m	10 m	8 m
10 m	15 m	10 m

The transect length will be determined by taking latitude and longitude of transect start and end points obtained by GPS. The same areas should be monitored for all surveys.

The proposed survey periods are:

- Spring: April-May (for the area of Boka Kotorska Bay);
- Summer: July-August (for the open sea and area of Boka Kotorska Bay).

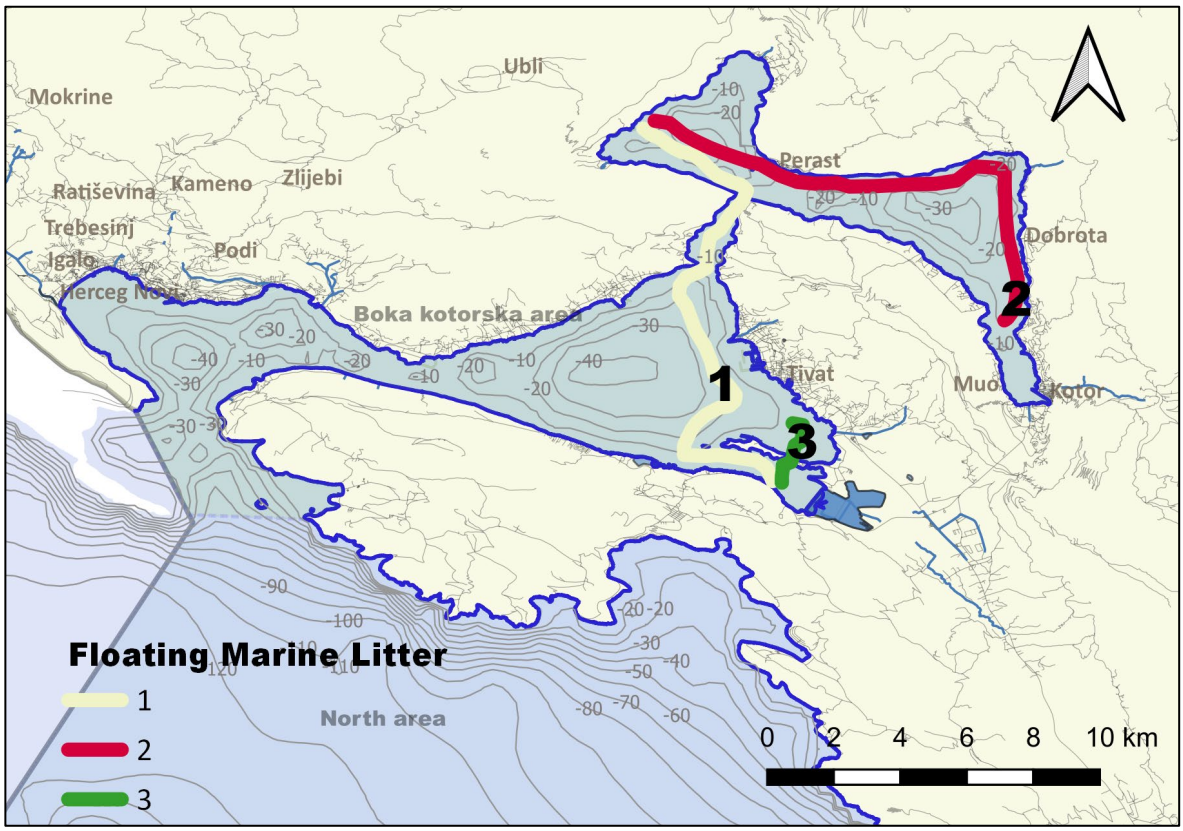


Figure 8.5: Monitoring of microplastics: transects in the area of Boka Kotorska Bay

8.4.2.
Methodology for monitoring floating marine litter

Monitoring floating marine litter is based on DeFishGear Methodology for Monitoring Marine Litter on the Sea Surface – Visual observation.

Visual observation is undertaken by vessels, ensuring the detection of litter items in the size range of 0.5 cm to 50 cm (items larger than 50 cm should also be recorded), along with the observation transect width of 10 m and with the speed of the boat not higher than 3 knots. All items observed in the survey area should be entered into the 'Floating Litter Monitoring Sheet', taking into consideration the following size ranges:

- A: 0.5 cm – 5 cm
- B: 5 cm – 10 cm
- C. 10 cm – 20 cm
- D: 20 cm – 30 cm
- E: 30 cm – 50 cm
- F: > 50 cm

The unit in which litter will be assessed on the sea surface will be the number of items and it will be expressed as counts of litter items per square kilometre (litter items/km^2). To compute the exact surveyed area, GPS coordinates must be recorded regularly (every min) to obtain an accurate measurement of the travelled transect.

Monitoring microplastics in the water column is based on the Sea surface sampling and microplastics separation Protocol (DeFishGear, 2015[15]), using a manta net attached to the vessel. Upon taking the samples, it is important to carefully separate all microplastic items from the samples. Microplastic particles need to be dried and weighed by each category separately by the use of analytical scale.

Finally, chemical identification of microplastics is performed using ATR-FTIR spectroscopy and micro ATR-FTIR spectroscopy.

8.4.3.
Expected results

No specific statistical tool is required for the analysis of the observed floating marine litter items. However, it is not uncommon that floating marine litter items appear grouped, either because they have been released together or because they accumulate on oceanographic fronts. The reporting system should acknowledge this and foresee a way to report such groups. The occurrence of such accumulation areas needs to be considered in the evaluation of data. Along with the litter occurrence data, a series of metadata should be recorded, including georeferencing (coordinates) and wind speed (m/s). This accompanying data shall allow the evaluation of data in the correct context.

Expected results of the evaluation should include identification of:

- accumulation zones for floating marine litter items;
- abundance, density and types of floating marine litter items in a more precise way.

8.5.
Monitoring the interconnection between marine litter and other EOs

Mainly due to cost-effectiveness reasons, whenever possible, EO10 monitoring shall be performed jointly with the monitoring of EO3. In addition, interconnections with EO1 monitoring (marine species) should be ensured where possible.

Detailed information about the interconnections of EO10 with other EOs in Montenegro is provided in Annex 1. The rationale for interactions and interconnections between EOs is provided in Annex 2.

A detailed description of the EO10 monitoring is available in the information document: National Thematic Monitoring Programme for Marine Litter.

[15] DeFishGear protocols for sea surface and beach sediment sampling and sample analysis. (2015). 27 p.

LEGAL FRAMEWORK

9.

RELEVANT LEGAL FRAMEWORK UNDER THE BARCELONA CONVENTION SYSTEM

The legal documents developed under the Barcelona Convention, relevant for the implementation of the national monitoring system, are presented in Table 9.1.

Table 9.1: Policy documents within the Barcelona Convention system

Ecological Objective	Barcelona Convention legislative framework
Biodiversity EO1	Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean (SPA/BD Protocol, 1995; Entry into force: 1999) Strategic Action Programme for the Conservation of Biological Diversity in the Mediterranean Region (SAP BIO, 2003) Regional Working Programme for the Coastal and Marine Protected Areas in the Mediterranean including the High Sea (adopted in 2009) Roadmap for a Comprehensive Coherent Network of Well-Managed MPAs to Achieve Aichi Target 11 in the Mediterranean (adopted in 2016) Regional Action Plans/Strategy on conservation of species and habitats, adopted in the framework of the SPA/BD Protocol: ▪ Action Plan for the management of the Monk Seal in the Mediterranean (adopted in 1987) ▪ Regional strategy for the conservation of Monk seal in the Mediterranean (adopted in 2013; updated in 2019) ▪ Action Plan for the conservation of marine turtles in the Mediterranean (adopted in 1989, last update in 2019) ▪ Action Plan for the conservation of cetaceans in the Mediterranean (adopted in 1991, last update in 2016) ▪ Action Plan for the conservation of bird species registered in annex II of the SPA/BD Protocol (adopted in 2003, last update in 2017) ▪ Action Plan for the conservation of Marine Vegetation in the Mediterranean Sea (adopted in 1999, last update in 2019) ▪ Action Plan for the conservation of the Coralligenous and other calcareous bio-concretions in the Mediterranean Sea (adopted in 2008, last update in 2016) ▪ Action Plan for the conservation of habitats and species associated with seamounts, underwater caves and canyons, aphotic hard beds and chemo-synthetic phenomena in the Mediterranean Sea (Dark habitats) (adopted in 2013) Updated Reference List of Marine Habitat Types for the Selection of Sites to be Included in the National Inventories of Natural Sites of Conservation Interest in the Mediterranean (2019) UNEP(DEPI)/MED WG.444/6/Rev.1. IMAP Common Indicator Guidance Factsheets (Biodiversity and Fisheries). UNEP/MED WG.467/16. Monitoring Protocols for IMAP Common Indicators related to Biodiversity and Non-Indigenous species: ▪ Guidelines for monitoring Cetaceans in the Mediterranean Sea ▪ Guidelines for monitoring Mediterranean monk seal ▪ Guidelines for monitoring seabirds in the Mediterranean ▪ Guidelines for monitoring marine turtles in the Mediterranean ▪ Guidelines for monitoring marine benthic habitats in the Mediterranean
Non indigenous Species EO2	Mediterranean Strategy on Ships' Ballast Water Management ▪ Action Plan concerning species introductions and invasive species in the Mediterranean Sea (adopted in 2003, last update in 2016) UNEP(DEPI)/MED WG.444/6/Rev.1. IMAP Common Indicator Guidance Factsheets (Biodiversity and Fisheries). UNEP/MED WG.467/16. Monitoring Protocols for IMAP Common Indicators related to Biodiversity and Non-Indigenous species:

Ecological Objective	Barcelona Convention legislative framework
	▪ Guidelines for controlling the vectors of the introduction into the Mediterranean of non-indigenous species and invasive marine species ▪ Guide for risk analysis assessing the impacts of the introduction of non-indigenous species ▪ Guidelines for monitoring non-indigenous species in the Mediterranean
Fisheries EO3	UNEP(DEPI)/MED WG.444/6/Rev.1. IMAP Common Indicator Guidance Factsheets (Biodiversity and Fisheries).
Eutrophication EO5	Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources and Activities (LBS Protocol) Strategic Action Programme to address pollution from land-based activities (SAP-MED) UNEP(DEPI)/MED WG. WG.439/12. IMAP Common Indicator Guidance Factsheets (Pollution and Marine litter) UNEP/MED WG.463/6. Monitoring Protocols for IMAP Common Indicators Related to Pollution: ▪ Monitoring protocols for eutrophication
Hydrography EO7	Protocol on integrated coastal zone management in the Mediterranean Common Regional Framework on ICZM Conceptual Framework for MSP UNEP/MED WG.467/6 Indicator guidance factsheets for EO7 and EO8 Coast and Hydrography Common Indicators 15, 16 and 25
Coastal ecosystems and landscapes EO8	Protocol on integrated coastal zone management in the Mediterranean Common Regional Framework on ICZM Conceptual Framework for MSP UNEP/MED WG.467/6 Indicator guidance factsheets for EO7 and EO8 Coast and Hydrography Common Indicators 15, 16 and 25
Contaminants EO9	Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources and Activities (LBS Protocol) Regional Strategy for the Prevention of and Response to Marine Pollution from Ship (2016-2021) UNEP(DEPI)/MED. Decision IG.20/9. Criteria and Standards for bathing waters quality in the framework of the implementation of Article 7 of the LBS Protocol UNEP(DEPI)/MED WG. WG.439/12. IMAP Common Indicator Guidance Factsheets (Pollution and Marine litter) UNEP/MED WG.463/6. Monitoring Protocols for IMAP Common Indicators Related to Pollution: ▪ Monitoring protocols for contaminants
Marine Litter EO10	Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources and Activities (LBS Protocol) UNEP(DEPI)/MED. Decision IG.20/10. Adoption of the Strategic Framework for Marine Litter management UNEP(DEPI)/MED IG.21/9. Decision IG.21/7. Regional Plan on Marine Litter Management in the Mediterranean in the Framework of Article 15 of the Land-Based Sources Protocol UNEP(DEPI)/MED WG. WG.439/12. IMAP Common Indicator Guidance Factsheets (Pollution and Marine litter) UNEP/MAP MEDPOL Monitoring Guidance Document on Ecological Objective 10: Marine Litter (2016) UNEP(DEPI)/MED WG.461/8 Defining the most Representative Species for IMAP Candidate Indicator 24 and related monitoring Protocol
IMAP	UNEP(DEPI)/MED IG.17/10. Decision IG.17/6. Implementation of the ecosystem approach to the management of human activities that may affect the Mediterranean marine and coastal environment 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. Ecosystems Approach including Adopting Definitions of Good Environmental Status (GES) and Targets UNEP(DEPI)/MED IG.22/28. Decision IG.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

10.
RELEVANT LEGAL FRAMEWORK UNDER THE EUROPEAN UNION AND GFCM (FOR FISHERIES)

The legal documents developed within the EU, relevant for the implementation of the national monitoring system, are presented in Table 10.1.

Table 10.1: Policy documents within the European Union, per ecological objective

Ecological Objective	MSFD and IMAP characteristics
Biodiversity EO1	Birds Directive (2009/147/EC) Habitats Directive (92/43/EEC) Water Framework Directive (2000/60/EEC) Commission Directive (EU) 2017/845 amending Directive 2008/56/EC) Commission Decision (EU)2017/848 Environmental Impact Assessment Directive (2011/92/EU) Strategic Environmental Assessment Directive (2001/42/EC) Common Fisheries Policy (1380/2013) Marine Strategy Framework Directive (2008/56/EC) Environmental Liability Directive (2004/35/EC) (as amended) Safety of Offshore Oil and Gas Operations Directive (2013/30/EU) Council Regulation (EC) No. 812/2004 laying down measures concerning incidental catches of cetaceans in fisheries
Non-indigenous Species (EO2)	Birds Directive (2009/147/EC) Habitats Directive (92/43/EEC) Water Framework Directive (2000/60/EEC) Commission Directive (EU) 2017/845 amending Directive 2008/56/EC) Commission Decision (EU) 2017/848 Council Directive (2006/88/EC) concerning animal health requirements for aquaculture animals (and products), the placing on the market and the prevention and control of certain diseases in aquatic animal Environmental Liability Directive (2004/35/EC) (as amended) EC, 2014, Regulation (EU) No. 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species Council Regulation (EC) No 708/2007 concerning the use of alien and locally absent species in aquaculture (as amended)
Fisheries (EO3) EC	Common Fisheries Policy (1380/2013) [including supporting Sea-Fisheries (Technical Conservation Measures) Regulations] Council Regulation (EC) No. 2347/2002 establishing specific access requirements and associated conditions applicable to fishing for deep-sea stocks Environmental Liability Directive (2004/35/EC) (as amended) Council Regulation (EC) No. 809/2007 as concerns drift nets Council Regulation regarding establishing measures for the recovery of the stock of European eel (Regulation No. 1100/2007)
Fisheries (EO3) GFCM	Recommendation GFCM/30/2006/3 on the establishment of fisheries restricted areas to protect deep-sea sensitive habitats Recommendation GFCM/30/2006/1 on the management of certain fisheries exploiting demersal and small pelagic species RES-GFCM/31/2007/3 40mm square mesh size in codend of trawl nets exploiting demersal resources Recommendation GFCM/33/2009/2 on the minimum mesh size in the codend of demersal trawl nets RES-GFCM/33/2009/1 On the management of demersal fisheries in the GFCM area Recommendation GFCM/35/2011/4 on the incidental bycatch of sea turtles in fisheries in the GFCM area of application

Ecological Objective	MSFD and IMAP characteristics
	Recommendation GFCM/35/2011/5 on fisheries measures for the conservation of the Mediterranean monk seal (Monachus monachus) in the GFCM area of application Recommendation GFCM/36/2012/2 on the mitigation of incidental catches of cetaceans in the GFCM area of application Recommendation GFCM/36/2012/3 on fisheries management measures for the conservation of sharks and rays in the GFCM area of application Resolution GFCM/37/2013/1 on area-based management of fisheries, including through the establishment of Fisheries Restricted Areas (FRAs) in the GFCM convention area and coordination with the UNEP-MAP initiatives on the establishment of SPAMIs Recommendation GFCM/37/2013/1 on a multiannual management plan for fisheries exploiting small pelagic stocks in geographical subarea 17 (northern Adriatic Sea) and on transitional conservation measures for fisheries exploiting small pelagic stocks in geographical subarea 18 (southern Adriatic Sea) Recommendation GFCM/39/2015/1 establishing further precautionary and emergency measures in 2016 for small pelagic stocks in the Adriatic Sea (geographical subareas 17 and 18) REC.DIR-GFCM/40/2016/2 on the progressive implementation of data submission in line with the GFCM Data Collection Reference Framework (DCRF) Recommendation GFCM/40/2016/3 establishing further emergency measures in 2017 and 2018 for small pelagic stocks in the Adriatic Sea (geographical subareas 17 and 18) REC.CM-GFCM/40/2016/5 establishing a minimum conservation reference size for European hake in the Mediterranean Sea REC.CM-GFCM/40/2016/5 establishing a minimum conservation reference size for European hake in the Mediterranean Sea RES-GFCM40/2016/3 on sustainable small-scale fisheries in the GFCM area of application Recommendation GFCM/41/2017/3 on the establishment of a fisheries restricted area in the Jabuka/Pomo Pit in the Adriatic Sea Resolution GFCM/41/2017/4 on a permanent working group on vulnerable marine ecosystems Resolution GFCM/41/2017/5 on a network of essential fish habitats in the GFCM area of application Recommendation GFCM/42/2018/2 on fisheries management measures for the conservation of sharks and rays in the GFCM area of application, amending Recommendation GFCM/36/2012/3 Recommendation GFCM/42/2018/8 on further emergency measures in 2019-2021 for small pelagic stocks in the Adriatic Sea (geographical subareas 17 and 18)
Eutrophication (EO5)	Water Framework Directive (2000/60/EC) Nitrates Directive (91/676/EEC) Urban Waste Water Treatment Directive (91/271/EEC) Industrial Emissions Directive (2010/75/EU) Water Framework Directive (2000/60/EEC) Commission Directive (EU) 2017/845 amending Directive 2008/56/EC) Commission Decision (EU)2017/848 Regulation (EU) No. 1305/2013 of the European Parliament and of the Council of 17 December 2013 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD)
Hydrography (EO7)	Environmental Impact Assessment Directive (85/337/EEC) (as amended) Strategic Environmental Assessment Directive (2001/42/EC) Maritime Spatial Planning Directive (2014/89/EU) Water Framework Directive (2000/60/EC) Marine Strategy Framework Directive (2008/56/EC) Commission Directive (EU) 2017/845 amending Directive 2008/56/EC). Commission Decision (EU)2017/848 Habitats Directive (92/43/EEC); Birds Directive (2009/147/EC); Environmental Liability Directive (2004/35/EC) (as amended).
Contaminants (EO9)	Water Framework Directive (2000/60/EC) Marine Strategy Framework Directive (2008/56/EC) Commission Directive (EU) 2017/845 amending Directive 2008/56/EC) Commission Decision (EU)2017/848 Biocidal Product Regulation (EU) No. 528/2012 Ship-source pollution and criminal penalties Directive 2005/35/EC (as amended) Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) Regulation (EC) No. 1907/2006

Ecological Objective	MSFD and IMAP characteristics
	Classification, Labelling and Packaging (CLP) Regulation (EC) No. 1272/2008 Persistent Organic Pollutants Regulation (EC) No 850/2004 as amended by Regulation (EU) No. 519/2012 (particularly Annex I) Priority Substances Directive 2013/39/EU amending the Directives 2000/60/EC and 2008/105/EC Sustainable Use of Pesticides Directive (2009/128/EC) Integrated Pollution Prevention and Control – Industrial Emissions Directive 2010/75/EU Dangerous Substances Directive (2006/11/EC) Control of major accident hazards involving dangerous substances Directive (2012/18/EU) EC Port Reception Facilities Directive (2000/59/EC, amended in 2002/84/EC, Directive 2007/71/EC Environmental Liability Directive (2004/35/EC) (as amended) Safety of Offshore Oil and Gas Operations Directive (2013/30/EU) Regulation (EC) No. 1881/2006 (as amended) setting maximum levels for certain contaminants in foodstuffs Regulation (EC) No. 178/2002 laying down the General Principles and requirements of food law, establishing the EFSA and procedures in matters of food safety Regulation (EC) No. 854/2004 laying down specific rules for the organisation of official controls on products of animal origin intended for human consumption Regulation (EC) No. 882/2004 on official controls performed to ensure the verification of compliance with feed and food law, animal health and animal welfare rules Animal health requirements for animals and products thereof, and on the prevention and control of certain diseases in aquatic animals Directive (2006/88/EC)
Marine Litter (EO10)	Waste Framework Directive (2008/98/EC) Marine Strategy Framework Directive (2008/56/EC Commission Directive (EU) 2017/845 amending Directive 2008/56/EC) Commission Decision (EU) 2017/848 Urban Waste-Water Treatment Directive (1991/271/EEC) Integrated Pollution Prevention and Control Directive (Directive 96/61/EC) Port Reception Facilities for Ship-generated Waste and Cargo Residues Directive (2000/59/EC) Waste Management (Waste Electrical and Electronic Equipment (WEEE) Directive (2012/19/EU) Restriction of Hazardous Substances (RoHS) Directive (2002/95/EC) Environmental Liability Directive (2004/35/EC) (as amended) Safety of Offshore Oil and Gas Operations Directive (2013/30/EU) Batteries and Accumulators Directive (2006/66/EC) End-of-life vehicles Directive (2000/53/EC)

11.
NATIONAL LEGAL AND INSTITUTIONAL FRAMEWORK

The legal basis for the implementation of the Integrated Monitoring and Assessment Programme in Montenegro (IMAP) is provided in:

- Law on ratification of the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean and its four Protocols: Protocol concerning Cooperation in Preventing Pollution from Ships and, in Cases of Emergency, Combating Pollution of the Mediterranean Sea; Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources and Activities; Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean; Protocol on the Prevention of Pollution of the Mediterranean Sea by Transboundary Movements of Hazardous Wastes and their Disposal (Official Gazette of Montenegro, 64/07).
- Law on the ratification of the Protocol on Integrated Coastal Zone Management, ratified in Montenegro in 2011. Out of seven, Dumping Protocol and Offshore Protocol are still pending ratification in Montenegro.

Apart from the national regulations ratifying and transposing Barcelona Convention, IMP implementation is based on the provisions of relevant national legal acts which regulate the protection of the coastal and marine environment, sustainable use of natural resources in coastal area and integrated coastal zone management, such as:

- Law on Environment (Official Gazette of Montenegro, 52/16);
- Law on Marine Environment Protection (Official Gazette of Montenegro, 073/19);
- Law on Nature Protection (Official Gazette of Montenegro, 054/16);
- Law on Waters (Official Gazette of Montenegro, 84/2018);
- Law of the Sea (Official Gazette of Montenegro No. 17/07, 06/08, 40/11);
- Law on integrated preservation and control of environmental protection (Official Gazette of Montenegro No. 80/05, 54/09, 40/11, 42/15, 54/16);
- Law on Strategic Environmental Assessment (Official Gazette of Montenegro, 80/05, 59/11, 52/16);
- Law on Environmental Impact Assessment (Official gazette of Montenegro, 080/05, 040/10, 073/10, 040/11, 027/13, 052/16);
- Law on marine fisheries and mariculture (Official Gazette of Montenegro, No. 56/09, 47/15) and related bylaws;
- Amendments agreement on the conservation of the Cetacea of the Black Sea and the Mediterranean Sea and contiguous Atlantic sea (Official Gazette of Montenegro No 04/14 International agreement);
- Law on the Prevention of Marine Pollution from Ships (Official Gazette of Montenegro 20/11, 26/11, 27/14).

Based on the laws listed above, and in accordance with the relevant EC regulatory documents, several by-laws are particularly relevant for the implementation of IMP:

- The Regulation on Maximum permissible amounts of contaminants in food (Official Gazette of Montenegro, 48/16);
- Rulebook on the manner and deadlines for determining the status of surface waters (Official Gazette of Montenegro, 25/19);
- Rulebook of measures to ensure the preservation, protection and improvement of the quality of bathing water (Official Gazette of Montenegro, 28/19) which

transposes Directive 2006/7/EC on bathing water quality management;

- Rulebook on technical requirements and places of the first landing of caught fish and other marine organisms (Official Gazette of Montenegro, 69/18);
- Rulebook on the maximum level of residues of plant protection products on or in plants, plant products, food or feed (Official Gazette MNE 21/2015), Regulation on Maximum permissible amounts of contaminants in food (Official Gazette CG 48/16);
- Amendments to the Order on the prohibition of fishing and marketing of fish juveniles, undersized fish and other marine organisms (Official Gazette of Montenegro 80/18);
- The Rulebook on technical requirements and places of the first landing of caught fish and other marine organisms (Official Gazette of Montenegro 69/18).

National strategic and action documents underlying the IMAP implementation in Montenegro include:

- National Strategy for Sustainable Development until 2030 (2016) which integrates the UN Agenda 2030 into the national context. It is an umbrella, long-term and horizontal development document of Montenegro, which defines guidelines for aligning conflicting sectoral policies, including their alignment with environmental policies;
- National Strategy for Integrated Coastal Zone Management of Montenegro (2015) which defined a strategic framework for sustainable development of Montenegrin coast through the integration of spatial and development solutions aimed at advancing economic, social and environmental performances of the coastal area. It defines measures relevant for the introduction and implementation of the IMAP in Montenegro;
- National Action Plan (NAP) for the implementation of the LBS Protocol and its Regional Plans in the framework of the SAP/MED to achieve good environmental status for pollution-related ecological objectives which set out the operational targets and related measures for the prevention and/or reduction of marine pollution from land-based sources in the time frame of its implementation, from 2015 to 2025. At the same time, the updated NAP assesses gaps and measures needed to provide national responses to statutory obligations arising from EcAp implementation, but also contribute to the introduction of the IMAP into the national programme for monitoring and reporting on the status of the marine environment.

The IMAP implementation is also compatible with the measures and actions from a significant number of national strategies, including those dealing with waters management, fisheries, biodiversity, waste management, chemicals management, and others.

11.1. Relevant national institutions

National institution responsible for the overall coordination of the marine environment-related activities is the Ministry for Ecology, Spatial Planning and Urbanism.

In line with the Law on marine environment protection, the IMP shall be implemented by the administrative authority responsible for the environment (Agency for Nature and Environmental Protection – the Agency). For conducting specific monitoring activities, the Agency may commission accredited legal entities for undertaking specific monitoring tasks. While doing so, the Agency should also consider all the relevant conditions for the reference laboratories. Reference institutions shall be designated based on the public call launched by the Agency, for a period of up to four years.

So far, in Montenegro, five institutions are responsible for collecting and assessing marine data relevant for IMP. These institutions are the Centre for Ecotoxicological Research (responsible for data on contaminants and partly eutrophication), the Institute for Hydrometeorology and Seismology of Montenegro (responsible for data on hydrography), the Institute for Marine Biology (responsible for data on marine biodiversity, non-indigenous species, fisheries and partly eutrophication), Marine Safety Department of Montenegro (of the Ministry of Transport and Maritime Affairs) (responsible for CI19) and Public Enterprise Morsko dobro (responsible for data related to CI21).

Based on the monitoring results, the Agency shall prepare the annual report on the state of the marine environment, as an integral part of the state of the environment report

and submit it to the Ministry of Ecology, Spatial Planning and Urbanism. The report on the state of the environment shall be prepared based on the National List of Environment Protection Indicators. The National List of Environment Protection Indicators shall be passed by the Government. The Agency shall communicate the report on the marine environment status to the European Environment Agency and the Barcelona Convention bodies, in line with the relevant legislation.

The national institution responsible for the overall coordination of the fisheries activities is the Ministry of Agriculture and Rural Development. Having in mind that EO3 is developed in collaboration with and based on GFCM standards, EO3 monitoring results are reported to the GFCM based on Data Collection Reference Framework.

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ANNEXES

Annex 1:
Spatial Interconnections between different Ecological Objectives

The integrated monitoring programme for Montenegro puts particular attention to the integration between different EOs and its CIs. Some stations, due to specific assessment needs as well as cost-effectiveness reasons, envisage monitoring for different CIs. For some CIs, monitoring is not envisaged in the same stations but within their vicinity, due to specific monitoring requirements. Nevertheless, these could be relevant for monitoring results' assessment and are therefore also considered fully interconnected. The most relevant spatial interconnections, including those in the vicinity between each other, are presented in an integrated manner in Table A1. All monitoring stations and interconnections between them are shown in Figures A1-A4.

Furthermore, the rationale for integrated monitoring and assessment per EOs is given in Annex 2.

Table A.1: The most relevant spatial interconnections between different EOs and their CIs

Area	Area Code	Survey Site		Main Pressures	Inside MPA	Interconnections between EOs[16]
		Site Name	Site Code			
Boka Kotorska	B	Sv. Stasija	KO09	Eutrophication, Anchoring	Protected by UNESCO	EO1: Posidonia oceanica EO2 EO8 EO9 (CI21) EO10 (CI23)
		Kotor/ Luka Kotor/ Dobrota IBM	BCM-DI01 BCH-KO02	NIS Anchoring/ recreational boating eutrophication	Protected by UNESCO	EO1: seabirds, plankton EO2 EO5 EO7 EO9 (CI17, CI18, CI20)
		Kotorski zaliv	BCM-KO01	Recreational boating, eutrophication		EO1: plankton EO5 EO7 EO9 (CI17, EO10 (CI23)
		Orahovac / Ljuta	BCR-OR01 KO10			EO1: seabirds, plankton EO5 EO7 EO8 EO9 (CI17, CI18, CI21) EO10 (CI23)
		Risan/ Luka Risan	BCM-RI01 BCM-RI02 KO14	Boating, eutrophication		EO1: plankton, seabirds EO5 EO7 EO9 (CI17, CI18, CI20, CI21)
		Sveta Nedelja/ Kamenari	BCM-SN01 HN01	Marine transport		EO1: coralligenous assemblages, plankton, seabirds EO2 EO5 EO7 EO8 EO9 (CI17, CI20, CI21) EO10 (CI23)
		Tivatski zaliv	BCM-TI01			EO1: plankton EO5 EO7 EO9 (CI17)
		Herceg Novi/ Luka Herceg Novi/ Igalo	BCM-IG01 BCM-HN01 BCM-HN02	Eutrophication, anchoring	-	EO1: Posidonia oceanica, plankton, seabirds EO5 EO7 EO9 (CI17)

[16] Monitoring of marine mammals and sea turtles is not specifically outlined; however, whenever possible, their monitoring will be implemented through aerial subregional surveys, thus it overlaps with all indicated stations

Area	Area Code	Survey Site		Main Pressures	Inside MPA	Interconnections between EOs[17]
		Site Name	Site Code			
North	N	Mamula	NOR-MA01 NOR-MA02 NOR-MA03			EO1: plankton EO5 EO7 EO9 (CI17)
		Lušticа	NCM-LU01 NCM-LU02			EO1: photophilic algae communities, coralligenous assemblages (nearby), plankton, EO5 EO7 EO8 EO9

Area	Area Code	Survey Site		Main Pressures	Inside MPA	Interconnections between EOs[18]
		Site Name	Site Code			
Central	C	Jaz and Budva	CCM-BU01 CCM-BU02 BU22-27	Eutrophication, Anchoring	-	EO1: photophilic algae communities, Posidonia oceanica, coralligenous assemblages (nearby), plankton, seabirds EO2 EO5 EO7 EO8 EO9 (CI17, CI21) EO10 (CI22)
		Katič and Buljarica	CCR-KA01 CCM-BL01 CCM-BL02 CCM-BL03 BU01	Fisheries, Anchoring	Proposed MPA	EO1: Posidonia oceanica, photophilic algae communities, plankton, seabirds EO2 EO3 EO5 EO7 EO9 (CI17, CI18, CI20, CI21) EO10 (CI22)
		Rt Ratac	CCM-RA01 B07-B09	Eutrophication, pollution	Proposed MPA	EO1: Posidonia oceanica, photophilic algae communities, plankton, EO5 EO7 EO8 EO9 (CI21)
		Bar/ Luka Bar	CCH-BA02	Eutrophication, contaminants, NIS		EO1: photophilic algae communities, plankton, seabirds EO2 EO9 (CI17, CI18, CI20)

[17] Monitoring of marine mammals and sea turtles is not specifically outlined; however, whenever possible, their monitoring will be implemented through aerial subregional surveys, thus it overlaps with all indicated stations

[18] Monitoring of marine mammals and sea turtles is not specifically outlined; however, whenever possible, their monitoring will be implemented through aerial subregional surveys, thus it overlaps with all indicated stations

Area	Area Code	Survey Site		Main Pressures	Inside MPA	Interconnections between EOs[19]
		Site Name	Site Code			
South	S	Stari Ulcinj	SCR-SU01 U01-U15	Fisheries, anchoring, eutrophication	Proposed MPA	EO1: Posidonia oceanica, photophilic algae communities, plankton, seabirds EO5 EO7 EO8 EO9 (CI17, CI18, CI20, CI21
		Velika plaža / Ada Bojana	SCM-AB01 SCM-AB02 SCM-AB03			EO1: photophilic algae communities, marine turtles, plankton, seabirds EO5 EO7 EO8 EO9 (CI17, CI18, CI20 EO10 (CI21)

[19] Monitoring of marine mammals and sea turtles is not specifically outlined; however, whenever possible, their monitoring will be implemented through aerial subregional surveys, thus it overlaps with all indicated stations

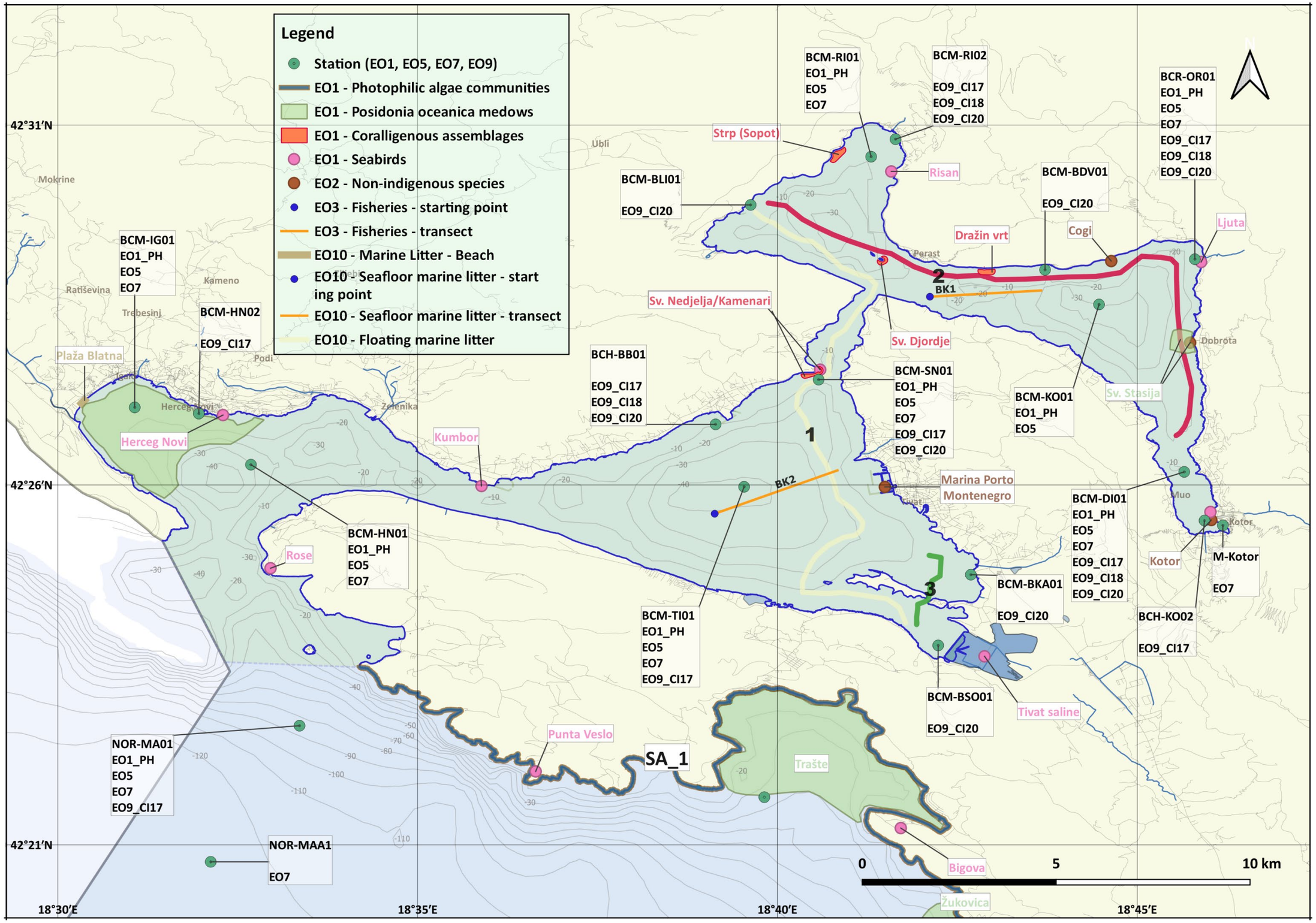

Figure A.1: Interconnections between EOs and their CIs in Boka Kotorska area

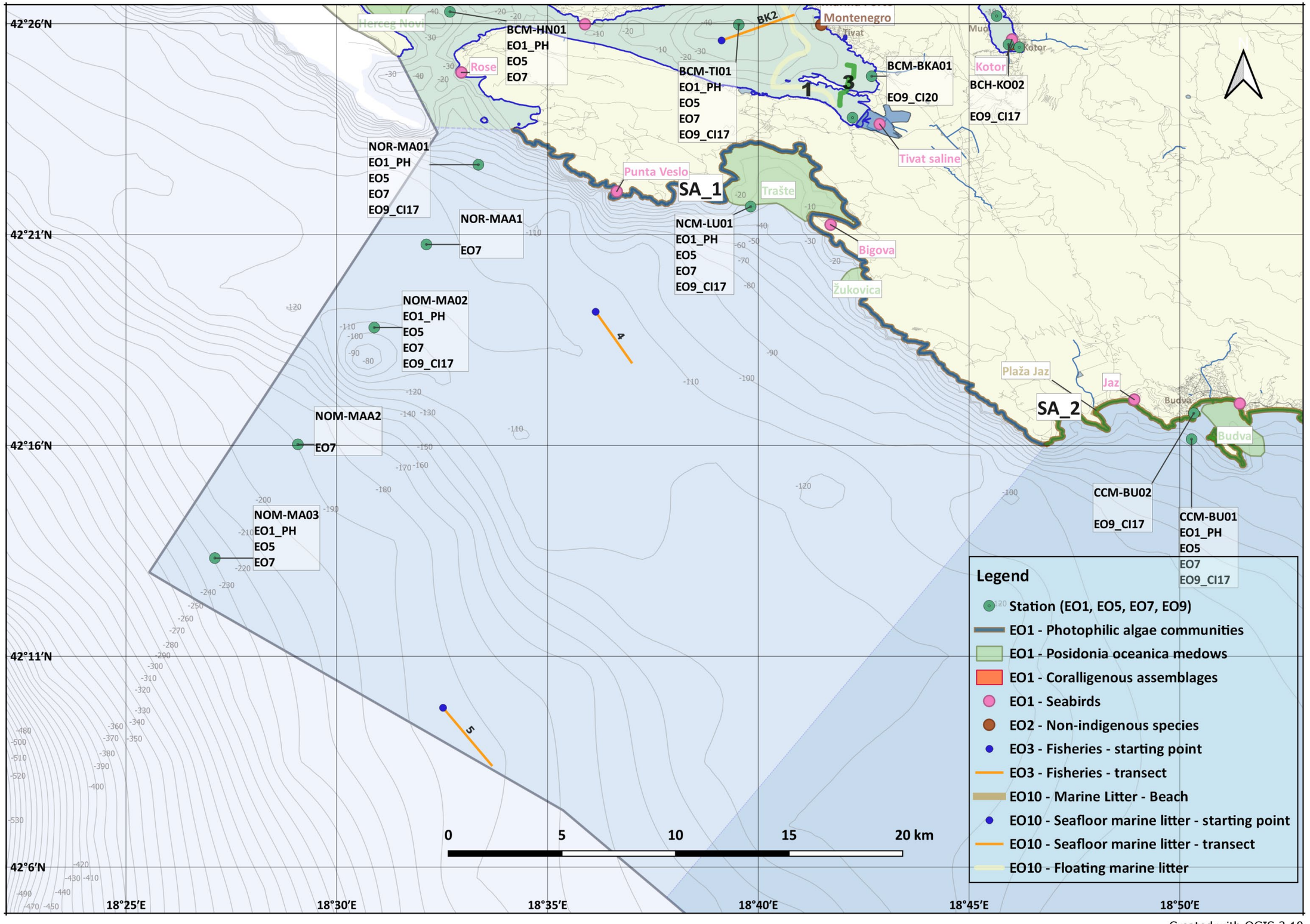

Figure A.2: Interconnections between EOs and their CIs in north area

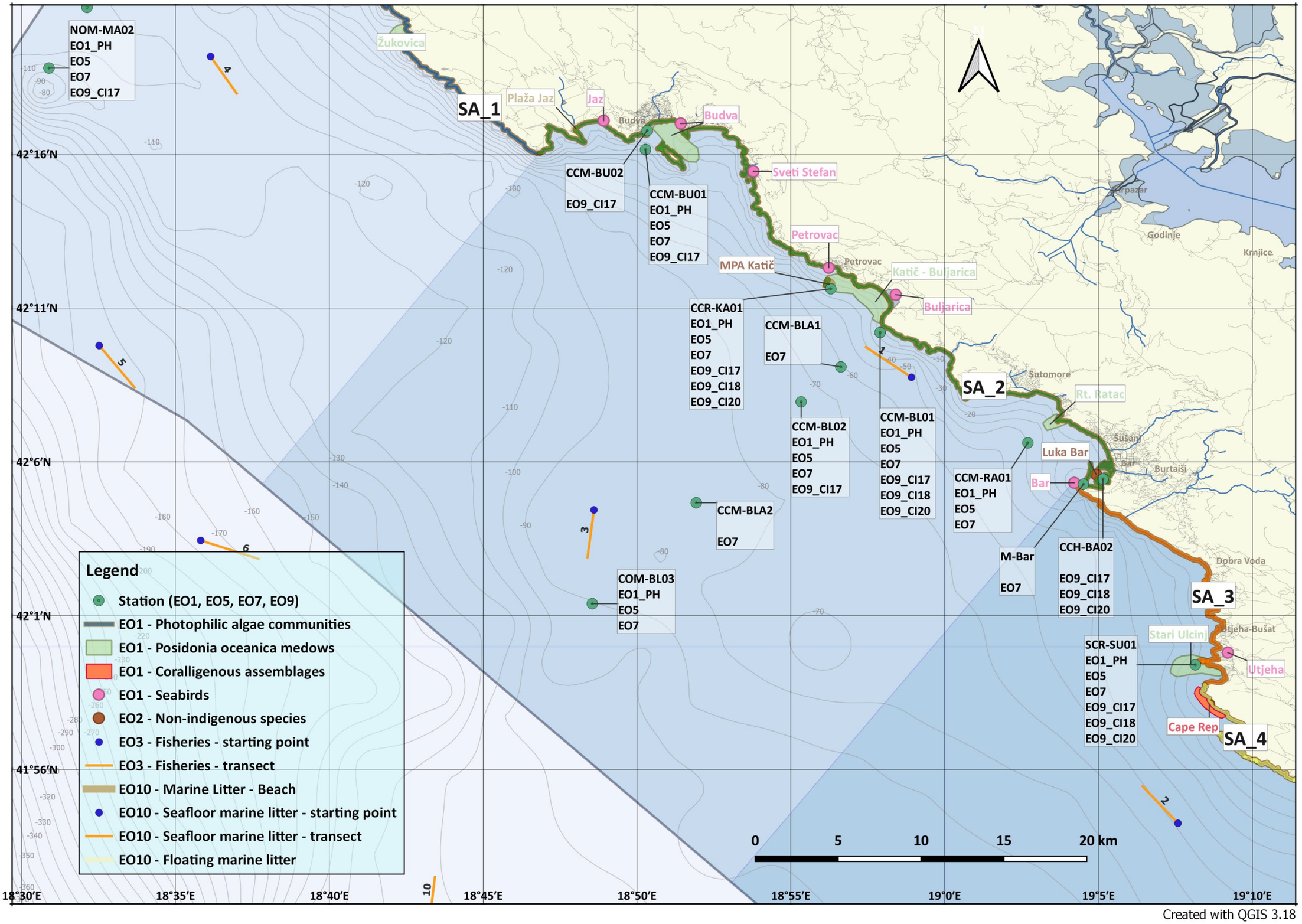

Figure A.3: Interconnections between EOs and their CIs in central area

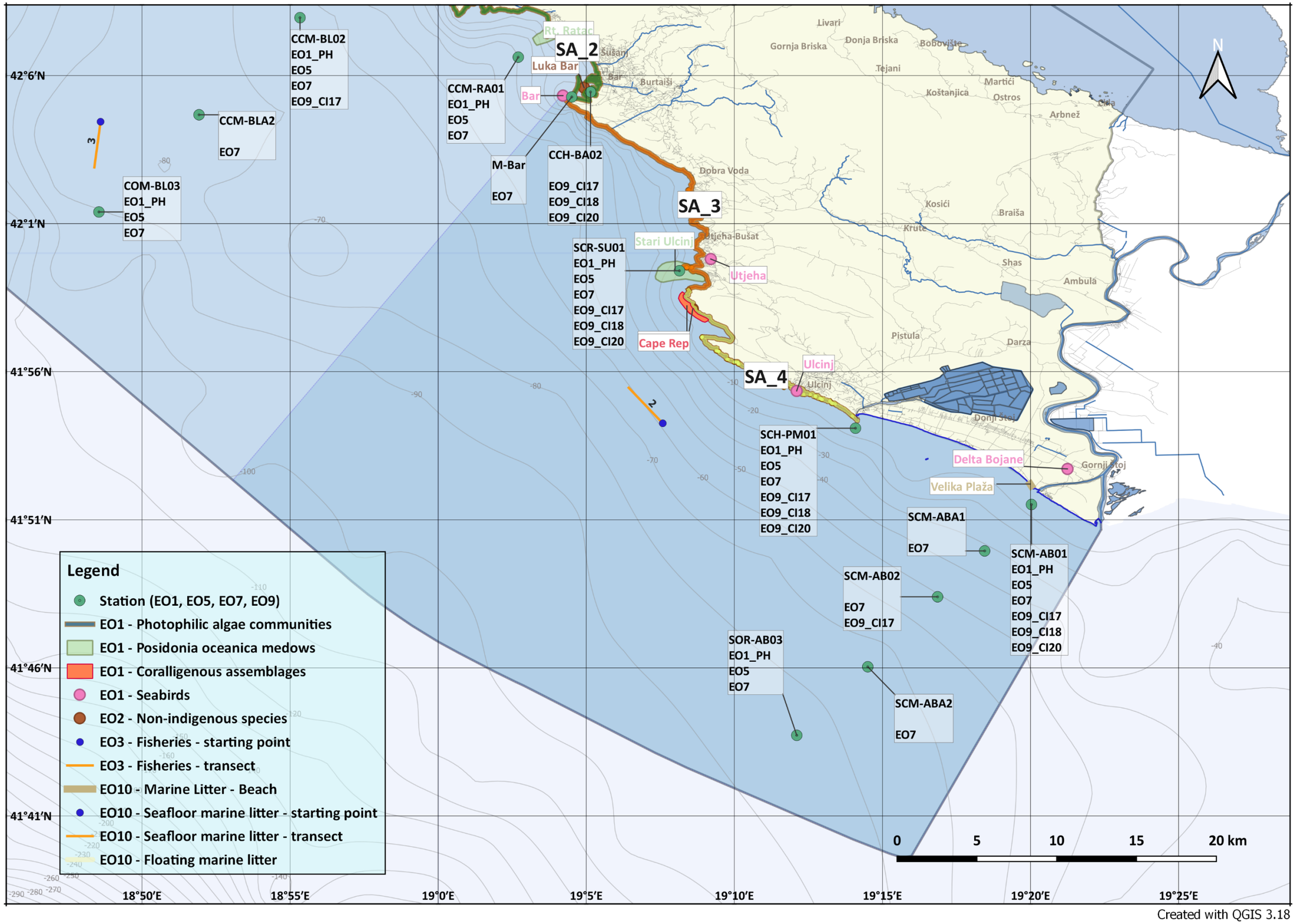

Figure A.4: Interconnections between EOs and their CIs in south area

Annex 2:
Interaction and Interconnection among Ecological Objectives

Interconnections and interactions between different ecological objectives and their common indicators are to be considered and addressed when planning and conducting monitoring programme.

In order to support the work of planning and implementing the IMAP entities towards ecosystem approach vision and matching good environmental status, the table below presents key interactions and interconnections among EOs that needs to be taken into considerations. In particular, the table reflects:

- Interactions and interconnections among key ecological components of the marine environment;
- Specific interconnections among different EOs that need to be considered during the planning and implementing the monitoring programme;
- As part of the latter, the table indicates interconnections that need to be identified and reported within the IMAP data standards, but also other interconnections that have not yet been reflected in data standards but could be helpful and possibly included in the national and/or future regional reporting system.

This presentation is the first attempt towards a comprehensive presentation of interconnections and interlinks between EOs. It should be further discussed at the expert level within the IMAP process and upgraded accordingly.

EO1 BIODIVERSITY

BENTHIC HABITAT

Ecological objective	Common Indicator	Interactions and interconnection with benthic habitats	Monitoring interconnections	
			IMAP Data standards	Additional information to be included
EO1 Marine Mammals	CI3: Species distributional range		Benthic habitat data that complement Marine Mammals Monitoring: ▪ presence of debris.	While Monitoring Benthic Habitat using a vessel, potential observed marine mammals may be, to the extent possible noted at genus species and approximate number (photo when possible).
	CI4: Population abundance of selected species			
	CI5: Population demographic characteristics (EO1, e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates)			
EO1 Marine Reptiles	CI3: Species distributional range	Benthic habitat coverage, composition and status may impact the temporal/seasonal/permanent presence of sea turtles. This refers mainly to sea turtle foraging areas and nesting sites.	Benthic habitat data that complement Sea Turtles Monitoring: ▪ habitat distribution (GIS maps); ▪ presence of debris.	If the monitored benthic habitat is located in areas close to or on nesting beaches and during the nesting and spawning period (June-October), record sea turtles' presence/absence. The abundance of female Sea turtles in the marine area close to identified nesting beaches increase during the nesting period.
	CI4: Population abundance of selected species			
	CI5: Population demographic characteristics (EO1, e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates)			
EO1 Sea Birds	CI3: Species distributional range	Benthic habitat coverage, composition and status within a feeding area for seabirds can impact seabird distribution.	Benthic habitat data that complement Sea Birds Monitoring: ▪ habitat distribution (GIS maps); ▪ habitat type; ▪ presence of debris on the beaches and the sea surface.	Benthos sampling below flocks and feeding sites of certain birds (e.g. seaduck, shags) could be done to have a better insight about the prey base. Technologies used may include sampling by bottom grabs, dredges, nets, SCUBA, cameras etc.
	CI4: Population abundance of selected species			
	CI5: Population demographic characteristics (EO1, e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates)			
EO2	CI6: Trends in abundance, temporal occurrence, and spatial distribution of non-indigenous species, particularly invasive, non-indigenous species, notably in risk areas.	Local and endemic species competition with NIS species for space (CI1) and/or food. Change in Habitat species composition (CI2) and particularly in dominant species composition within the habitat (*Posidonia, Caulerpa, Cymodocea, Coralliginous sp.*, etc.).	Benthic habitat data that complement NIS Monitoring, particularly if benthic habitat monitoring stations are within an area with a high frequency of shipping and/or anchoring activity (particularly commercial and touristic boats) or within an MPA: ▪ presence of invasive species.	Detailed recording of NIS species (genus/range). Pictures/videos of NIS while conducting the Benthic Habitat monitoring is highly recommended.

Ecological objective	Common Indicator	Interactions and interconnection with benthic habitats	Monitoring interconnections	
			IMAP Data standards	Additional information to be included
EO3	CI7: Spawning stock Biomass CI8: Total landings CI9: Fishing mortality			To the extent possible, link the identified high/low-frequency fishing activity areas, high/low fishing effort areas, and high/low spawning stock biomass areas to the composition, type and status of the benthic habitat in those areas. A particular focus should be on monitoring of impacts of trawling activities on Posidonia meadows and coralligenous.
	CI10: Fishing effort	Impact on benthic habitats/ communities/distribution (CI1 and CI2).		
	CI11: Catch per unit of effort (CPUE) or Landing per unit of effort (LPUE) as a proxy (EO3)			
	CI12: Bycatch of vulnerable and non-target species (EO1 and EO2)	Trawling activity impact on benthic macroinvertebrates, thus in habitat composition CI2 and possibly range CI1.		
EO5	CI13: Concentration of key nutrients in the water column	May cause: ▪ increased abundance of plant species (macroalgae) with consequent effects on other parts of habitat communities; ▪ chemical change with consequent effects on other parts of habitat communities. ▪ Coralligenous may be susceptible to eutrophication (although scientific studies show contradictory results)	At the selected monitoring stations for macroalgae, seagrass and Maerl/Rhodolith Habitat, EO5 monitoring could be included as well, in order to identify them. Physico-chemical data (Electrical conductivity, Dissolved oxygen, Oxygen saturation, pH, Chlorophyll a, Secchi disk depth, Nitrate, Nitrite, Ammonium, Total phosphorus, Orthophosphates, Total nitrogen Silicate). Benthic habitat data which may complement Eutrophication Monitoring: ▪ source of the disturbance	▪ The dominance of species with nitrophilic affinity or phosphorus affinity within the habitat; ▪ Magnoliophyta leaves with high coverage of epiphytic species and/or leaves showing signs of high degradation.
	CI13: Chlorophyll a concentration in the water column	May cause chemical and transparency change with consequent effects on other parts of habitat communities		
EO7	CI15: Location and extent of the habitats impacted directly by hydrographical alterations	▪ Destruction of nearshore benthic habitats; ▪ Change in turbidity and transparency of water; ▪ Change in nutrient and sediment intakes for habitat communities; ▪ Change in Habitat Structure/community composition and/or loss in distribution range due to hydrographical alteration.	At the selected monitoring stations for benthic habitats, EO7 monitoring could be included as well, in order to identify Water Temperature, Salinity, Secchi disk depth. Benthic habitat data which may complement Hydrology Monitoring: ▪ substratum type; ▪ sediment granulometry if monitored; ▪ artificialization if monitored.	
EO8	CI16: Length of coastline subject to physical disturbance due to the influence of man-made structures	Material from construction activities along the coastline can affect benthic habitats in nearshore shallow waters due to smothering		

Ecological objective	Common Indicator	Interactions and interconnection with benthic habitats	Monitoring interconnections	
			IMAP Data standards	Additional information to be included
EO9	CI17: Concentration of key harmful contaminants measured in the relevant matrix	Potential impact on benthic habitats (distribution and composition) due to concentration of contaminants on the sea bottom.	At the selected monitoring stations for Habitat, EO9 monitoring could be included as well, in order to identify contaminants concentrations in sediment and to the extent possible in biota. Benthic habitat data which may complement Contaminants Monitoring: ▪ sediment granulometry, if monitored; ▪ disturbance source; ▪ pollution source, if monitored.	▪ Rapid Change in Habitat Structure/community composition and/or loss in distribution range; ▪ High frequency of necrosis/degradation (magnoliophyta leaves, roots; corals mortality; cystoseira/Posidonia rapid distribution decrease).
	CI18: Level of pollution effects of key contaminants where a cause and effect relationship has been established			
	CI19: Occurrence origin (where possible), the extent of acute pollution events (e.g. slicks from oil products and hazardous substances) and their impact on biota affected by this type of pollution	Loss of key habitats with the potential impact of the regeneration potential of benthic habitat.		
	CI20: Actual levels of contaminants that have been detected and the number of contaminants that have exceeded maximum regulatory levels in commonly consumed seafood	Potential impact on benthic habitat community (Filter feeders, such as corals and anemones).		
EO10	CI23: Trends in the amount of litter in the water column including microplastics and on the seafloor	Potential damage on benthic habitats (change in water turbidity, suffocation and/or lack of light for non-mobile species within the habitat community). Microplastics pose a particular threat since it infiltrates into food webs, including animals inhabiting benthic habitats (e.g. sea filters such as mussels etc.).	Benthic habitat data which may complement Marine litter Monitoring: ▪ disturbance source; ▪ pollution sources, if monitored; ▪ debris types and abundance, if monitored.	▪ Record of a high density of debris trapped within non-mobile species or in the surrounding water column within the Benthic habitat monitoring stations may be noted; ▪ Species that grow on marine debris or become entangled in marine debris could be noted for future clean-up operations when needed.
	CI24: Trends in the amount of litter ingested by or entangling marine organisms focusing on selected mammals, marine birds, and marine turtles			

MARINE MAMMALS

Ecological objective	Common Indicator	Interactions and interconnection with marine mammals	Monitoring interconnections	
			IMAP Data standards	Additional information to be included
EO1 Benthic Habitat	CI1: Habitat distributional range to also consider habitat extent as a relevant attribute			
	CI2: Condition of the habitat's typical species and communities			
EO1 Marine Reptiles	CI3: Species distributional range		Marine Mammals data that complement Marine Reptiles Monitoring: ▪ aerial/boat survey of marine mammals may be used to provide data on sea turtles.	
	CI4: Population abundance of selected species			
	CI5: Population demographic characteristics (EO1, e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates)			
EO1 Sea Birds	CI3: Species distributional range		Marine Mammals data that complement Seabird Monitoring: ▪ a small boat-based survey using the photo-identification method as a common standard protocol for field data collection of birds and mammals may be used to provide data on seabirds (genus/number) or identification of seabird nesting areas. ▪ aerial surveys of marine mammals may be used to provide data on seabirds	
	CI4: Population abundance of selected species			
	CI5: Population demographic characteristics (EO1, e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates)			
EO2	CI6: Trends in abundance, temporal occurrence, and spatial distribution of non-indigenous species, particularly invasive, non-indigenous species, notably in risk areas.			Record of Marine mammals feeding on NIS species and particularly invasive ones should be communicated as it could increase knowledge of the species and its ecological important role and contribute to its protection.
EO3	CI7: Spawning stock Biomass	Possible identification of areas with an overlap: an important area for fisheries/ important area for marine mammals.	Marine Mammals data that complement Fishery Monitoring:	To the extent possible, link the identified areas including a high fishing activity with a high level of discard with the data related to the interaction of marine mammals with fisheries.
	CI8: Total landings			
	CI9: Fishing mortality			

Ecological objective	Common Indicator	Interactions and interconnection with marine mammals	Monitoring interconnections	
			IMAP Data standards	Additional information to be included
	CI10: Fishing effort	Possible loss of food resources. Lost fishing gear and nets (ghost nets) may cause ingestion and/or entanglement, which may cause mortality.	▪ data from animal strandings with evident fishing impact on its mortality; ▪ data from bycatch questionnaires/interview with fishermen according to the bycatch protocol.	
	CI11: Catch per unit of effort (CPUE) or Landing per unit of effort (LPUE) as a proxy (EO3)			
	CI12: Bycatch of vulnerable and non-target species (EO1 and EO2)	Incidental capture of marine mammals may be important.		
EO5	CI13: Concentration of key nutrients in the water column	May affect the prey base of marine mammals and consequently affect their distribution within the areas with high eutrophication.		
	CI13: Chlorophyll a concentration in the water column			
EO7	CI15: Location and extent of the habitats impacted directly by hydrographical alterations	May change the habitat of marine mammals and affect their distribution within the areas with hydrographical alterations.		
EO9	CI17: Concentration of key harmful contaminants measured in the relevant matrix	Potential ecotoxicological impacts on species. Alone or in combination with other factors, this may cause lesser resilience of marine mammal to environmental stressors (e.g. to microbial pathogens etc.) Possibly affects marine mammal distribution within the areas with high levels of contaminants.	Marine Mammals data which may complement Contaminants Monitoring: ▪ tissue analysis from stranded marine mammal species may provide additional data on contaminants.	
	CI18: Level of pollution effects of key contaminants where a cause and effect relationship has been established			
	CI19: Occurrence origin (where possible) extent of acute pollution events (e.g. slicks from oil products and hazardous substances) and their impact on biota affected by this pollution	Mass mortality of marine mammals species may occur.		
	CI20: Actual levels of contaminants that have been detected and number of contaminants that have exceeded maximum regulatory levels in commonly consumed seafood			

Ecological objective	Common Indicator	Interactions and interconnection with marine mammals	Monitoring interconnections	
			IMAP Data standards	Additional information to be included
EO10	CI23: Trends in the amount of litter in the water column including microplastics and on the seafloor	May cause high ingestion of microplastic while feeding/hunting: ▪ when ingesting microplastic or other debris, feeding/hunting activity may decrease, which usually causes mortality	Marine Mammals data which may complement Marine Litter Monitoring: ▪ stomach contents analysis from stranded marine mammals species may provide additional data on marine litter (CI24). ▪ marine mammals aerial surveys may also be used to collect data on large-sized marine litter (visible from the aircraft)	
	CI24: Trends in the amount of litter ingested by or entangling marine organisms focusing on selected mammals, marine birds, and marine turtles	May cause mortality of several marine mammal species due to strangling or ingestion regardless of the genus, sex, size.		

MARINE REPTILES

Ecological objective	Common Indicator	Interactions and interconnection with Marine reptiles	Monitoring interconnections	
			IMAP Data standards	Additional information to be included
EO1 Benthic Habitat	CI1: Habitat distributional range to also consider habitat extent as a relevant attribute	The possible attraction of well-conserved habitat to sea turtles for feeding or security (against predators) purposes (CI3 and CI4): ▪ presence of a large number of sea turtles may be linked to a good conservation status and composition of the marine habitat in the marine reptiles monitored areas. ▪ The presence of some habitat types (e.g. sandy beaches) may indicate actual or potential sea turtle nesting sites		
	CI2: Condition of the habitat's typical species and communities			
EO1 Marine Mammals	CI3: Species distributional range		Offshore Marine reptiles data may be complemented as Marine Mammals Monitoring is conducted, particularly if aerial/boat surveys are performed.	
	CI4: Population abundance of selected species			
	CI5: Population demographic characteristics (EO1, e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates)			
EO1 Sea Birds	CI3: Species distributional range	Some seabirds may feed on sea turtles barely hatched.		▪ Barely hatched sea turtle mortality due to hunting by seabirds may be observed and recorded.
	CI4: Population abundance of selected species			▪ While monitoring nests of sea turtles in the coastal area, seabird nests could be identified and should be recorded (particularly those that are known as sea turtle hatchlings predators).
	CI5: Population demographic characteristics (EO1, e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates)			

Ecological objective	Common Indicator	Interactions and interconnection with Marine reptiles	Monitoring interconnections	
			IMAP Data standards	Additional information to be included
EO2	CI6: Trends in abundance, temporal occurrence, and spatial distribution of non-indigenous species, particularly invasive, non-indigenous species, notably in risk areas.	Food resources composition may change due to the high abundance of invasive species. Marine Reptiles may prey/eat some NIS species such as blue crabs and non-indigenous jellyfish		Record of Marine reptiles feeding on NIS species and particularly invasive ones should be communicated as it could increase knowledge of the species and its ecological important role, and contribute to its protection.
EO3	CI7: Spawning stock Biomass		Marine Reptiles data which may complement Fishery Monitoring: ▪ analysis of data from stranded animals with evident fishing impact on its mortality (hook in mouth, stomach; entangled in a net, etc.); ▪ data from bycatch questionnaires/interview with fishermen according to the bycatch protocol.	Data on the alive release of incidentally caught individuals and data from the sea turtle rescue centre.
	CI8: Total landings			
	CI9: Fishing mortality			
	CI10: Fishing effort	Possible loss of food resources. Lost fishing gear and nets (ghost nets) may cause ingestion and/or entanglement, which may cause mortality.		
	CI11: Catch per unit of effort (CPUE) or Landing per unit of effort (LPUE) as a proxy (EO3)			
	CI12: Bycatch of vulnerable and non-target species (EO1 and EO2)	Incidental capture of marine reptiles may be important within several pelagic and bottom fishing gears.		
EO5	CI13: Concentration of key nutrients in the water column CI13: Chlorophyll a concentration in the water column	May change Marine reptiles distribution within the areas with high eutrophication: ▪ may decrease Marine reptiles distribution in a feeding area in case of increased eutrophication; ▪ may impact the reproduction/nesting activity of sea turtles if it occurs in an important area for sea turtles.		
EO7	CI15: Location and extent of the habitats impacted directly by hydrographical alterations	Possible loss of nesting areas ad nesting success (CI5) if the hydrographical alterations induce loss of suitable nesting sandy beaches.		
EO8	CI16: Length of coastline subject to physical disturbance due to the influence of man-made structures	Man-made structures and other physical disturbances (ex: light) may impact nesting areas of sea turtles.		The proximity of the sea turtle nest/nesting areas to coastal structures may be assessed and noted.

Ecological objective	Common Indicator	Interactions and interconnection with Marine reptiles	Monitoring interconnections	
			IMAP Data standards	Additional information to be included
EO9	CI17: Concentration of key harmful contaminants measured in the relevant matrix	Potential ecotoxicological impacts on species: ▪ may change Marine Reptiles distribution within the areas with high contaminant levels.	Marine Reptiles data which may complement Contaminants Monitoring: ▪ tissue analysis from animal strandings may provide additional data on contaminants.	
	CI18: Level of pollution effects of key contaminants where a cause and effect relationship has been established			
	CI19: Occurrence origin (where possible) extent of acute pollution events (e.g. slicks from oil products and hazardous substances) and their impact on biota affected by this pollution	Mass mortality of marine reptiles may occur.		
	CI20: Actual levels of contaminants that have been detected and number of contaminants that have exceeded maximum regulatory levels in commonly consumed seafood			
EO10	CI23: Trends in the amount of litter in the water column including microplastics and on the seafloor	May cause high ingestion of microplastic while feeding/hunting and ultimately may cause mortality.	Marine Reptiles data which may complement Marine Litter Monitoring: ▪ stomach contents analysis from stranding sea turtles may provide additional data on ingested marine litter (CI24).	During the identification of sea turtle nests on beaches, stranded marine litter may be assessed. Barely hatched sea turtle mortality due to the abundance of marine litter in the sand beaches should be noted and communicated. Beach clean-up programmes should consider the presence of the nesting area and the nesting period.
	CI24: Trends in the amount of litter ingested by or entangling marine organisms focusing on selected mammals, marine birds, and marine turtles	May cause mortality of several sea turtles species due to strangling or ingestion regardless of the genus, sex, size: When ingesting microplastic or other debris, marine reptiles feel no more hungry and decrease feeding/hunting activity which usually causes mortality		

SEABIRDS

Ecological objective	Common Indicator	Interactions and interconnection with seabirds	Monitoring interconnections	
			IMAP Data standards	Additional information to be included
EO1 Benthic Habitat	CI1: Habitat distributional range to also consider habitat extent as a relevant attribute	The possible attraction of wide distribution range and well-conserved habitat to a large number of sea birds (CI3 and CI4) due to food availability: ▪ if seabirds do not travel a long distance from nesting areas during the nesting period it may be linked to a favourable conservation status and composition of the marine habitat close to seabird nesting areas.		
	CI2: Condition of the habitat's typical species and communities			
EO1 Marine Reptiles	CI3: Species distributional range			
	CI4: Population abundance of selected species			▪ Boat survey of seabirds may be used to provide data on sea turtles when observed.
	CI5: Population demographic characteristics (EO1, e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates)	Some seabird groups may show interaction with hatchling/juvenile sea turtles (hunting). In such cases, it needs to be communicated.		
EO1 Marine Mammals	CI3: Species distributional range			At sea, observing the temporal abundance of seabirds hunting often indicates an abundance of fish and may be used to check the presence of marine mammals as they could target the same species for food. Boat survey of seabirds, particularly when done within fishing areas may be used to provide data on marine mammals (genus/presence).
	CI4: Population abundance of selected species			
	CI5: Population demographic characteristics (EO1, e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates)			

Ecological objective	Common Indicator	Interactions and interconnection with seabirds	Monitoring interconnections	
			IMAP Data standards	Additional information to be included
EO2	CI6: Trends in abundance, temporal occurrence, and spatial distribution of non-indigenous species, particularly invasive, non-indigenous species, notably in risk areas.	Seabirds may feed on some NIS species		Record of seabirds feeding on NIS species and particularly invasive ones should be communicated as it could increase knowledge on the species and its ecological important role, thus its protection.
EO3	CI7: Spawning stock Biomass	Possible identification of areas with an overlap: an important area for fisheries/ important area for sea birds.	Marine Seabirds data which may complement Fishery Monitoring: ▪ analysis of data from stranding animals with evident fishing impact on mortality; ▪ data from bycatch questionnaires/interview with fishermen according to the bycatch protocol.	
	CI8: Total landings			
	CI9: Fishing mortality			To the extent possible, link the identified areas including a high fishing activity with the high level of discard with the data related to the interaction of seabirds with fisheries.
	CI10: Fishing effort	Possible loss of food resources. Lost fishing gear and nets (ghost nets) may cause ingestion and/or entanglement, which may cause mortality.		
	CI11: Catch per unit of effort (CPUE) or Landing per unit of effort (LPUE) as a proxy (EO3)			
	CI12: Bycatch of vulnerable and non-target species (EO1 and EO2)	Incidental capture of seabirds (particularly longlines) may be important.		
EO5	CI13: Concentration of key nutrients in the water column	Seabird distribution changes within the areas with high eutrophication.		Dead fish due to eutrophication may provide temporary high food quantity for sea birds in the short term and loss of food in the long term; when observed, it needs to be monitored to the extent possible.
	CI13: Chlorophyll a concentration in the water column			
EO7	CI15: Location and extent of the habitats impacted directly by hydrographical alterations	Seabird distribution changes within the areas with hydrographical alterations particularly seabird nesting in coastal areas/beaches.		

Ecological objective	Common Indicator	Interactions and interconnection with seabirds	Monitoring interconnections	
			IMAP Data standards	Additional information to be included
EO9	CI17: Concentration of key harmful contaminants measured in the relevant matrix	Potential ecotoxicological impacts on species. The most sensitive seabirds to environmental changes may change the nesting site due to contamination in the surrounding area (loss of nesting areas).	Seabirds data that may complement Contaminants Monitoring: ▪ tissue and feathers analysis from stranded seabirds, dead juveniles and non-hatched eggs are important additional data on contaminants.	
	CI18: Level of pollution effects of key contaminants where a cause and effect relationship has been established			
	CI19: Occurrence origin (where possible) extent of acute pollution events (e.g. slicks from oil products and hazardous substances) and their impact on biota affected by this pollution	Mass mortality of seabird species or a large number of oiled individuals may occur.		
	CI20: Actual levels of contaminants that have been detected and number of contaminants that have exceeded maximum regulatory levels in commonly consumed seafood			
EO10	CI23: Trends in the amount of litter in the water column including microplastics and on the seafloor	May cause high ingestion of microplastic while feeding/hunting (causes mortality as animals do not feel hungry anymore).	Seabirds data that may complement Marine Litter Monitoring: ▪ stomach contents analysis from stranded seabird species may provide additional data on marine litter (CI24).	Analysis of sea birds rejects composition around nesting sites may provide additional data on marine litter as part of ingested debris is rejected by the species. Some Sea birds may be confused and use marine litter to design the nest. Thus, the frequency and abundance of debris within seabird nests may be relevant to highlight debris use by seabirds and assess the impact of artificialization on seabirds.
	CI24: Trends in the amount of litter ingested by or entangling marine organisms focusing on selected mammals, marine birds, and marine turtles	May cause mortality of several seabirds due to strangling or ingestion regardless of the genus, sex, size.		

EO2 NIS

Ecological objective	Common Indicator	Interactions and interconnection with NIS	Monitoring interconnections	
			IMAP Data standards	Additional information to be included
EO1 Benthic Habitat	CI1: Habitat distributional range to also consider habitat extent as a relevant attribute	Invasive species may compete with native (particularly endemic) species and replace them. They may also release toxins into the water column and physically change the habitats in general.	NIS data that complement Marine Habitat Monitoring: ▪ NIS coverage; ▪ NIS abundance.	Invasive species identified within hotspot station close to monitoring areas of marine habitat. NIS species feed on species that are within the local marine habitat community. The occurrence of some invasive species may serve as a warning of possible future degradation of the habitat around the NIS sampling station.
	CI2: Condition of the habitat's typical species and communities			
EO1 Marine Mammals	CI3: Species distributional range			
	CI4: Population abundance of selected species			
	CI5: Population demographic characteristics (EO1, e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates)			
EO1 Marine Reptiles	CI3: Species distributional range	Possible loss of some components of the marine reptiles ecological niche due to ecosystem alteration by NIS specie(s).		
	CI4: Population abundance of selected species			
	CI5: Population demographic characteristics (EO1, e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates)			

Ecological objective	Common Indicator	Interactions and interconnection with NIS	Monitoring interconnections	
			IMAP Data standards	Additional information to be included
EO1 Sea Birds	CI3: Species distributional range	Possible loss of some components of the seabird ecological niche due to ecosystem alteration by NIS specie(s).		
	CI4: Population abundance of selected species			
	CI5: Population demographic characteristics (EO1, e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates)			
EO3	CI7: Spawning stock Biomass	Possible alteration of spawning stock biomass in case of NIS species interaction (feeding, space competition, etc.).	NIS data that may complement Fishery Monitoring: ▪ abundance, temporal occurrence, and spatial distribution of non-indigenous species with commercial interest (fish and macroinvertebrate); ▪ abundance, temporal occurrence, and spatial distribution of non-indigenous species with dangerous impact on human health.	The abundance, temporal occurrence, and spatial distribution of non-indigenous species with a high identification confusion rate with local species may be recorded when possible. The abundance, temporal occurrence, and spatial distribution of non-indigenous species which feed on commercial species may be recorded when possible. The abundance, temporal occurrence, and spatial distribution of non-indigenous species with dangerous impact on human health may be recorded when possible.
	CI8: Total landings	Total landings may include NIS species with a commercial interest		
	CI9: Fishing mortality			
	CI10: Fishing effort	May be affected by the abundance of invasive species with no commercial interest or with commercial interest caught during fishing operations.		
	CI11: Catch per unit of effort (CPUE) or Landing per unit of effort (LPUE) as a proxy (EO3)	May be affected by the abundance of invasive species with no commercial interest or with commercial interest caught during fishing operations.		
	CI12: Bycatch of vulnerable and non-target species (EO1 and EO2)	NIS species abundance and occurrence during fishing operations may induce a change in fishing technique or fishing gears which may impact accidental catch of vulnerable species.		
EO5	CI13: Concentration of key nutrients in the water column	Chemical changes in the water column may favour some NIS species.	At the selected monitoring stations for NIS, EO5 monitoring could be included as well, in order to identify physico-chemical data (Water Temperature, Salinity, Secchi disk depth, Electrical conductivity, Dissolved oxygen, Oxygen saturation, pH, Chlorophyll a, Secchi disk depth, Nitrate, Nitrite, Ammonium, Total phosphorus, Orthophosphates, Total nitrogen Silicate).	The Presence of NIS species with nitrophilic affinity or phosphorus affinity whose abundance may increase in eutrophicated areas could be recorded.
	CI13: Chlorophyll a concentration in the water column	Chlorophyll a concentration in the water column may favour some NIS species.		

Ecological objective	Common Indicator	Interactions and interconnection with NIS	Monitoring interconnections	
			IMAP Data standards	Additional information to be included
EO7	CI15: Location and extent of the habitats impacted directly by hydrographical alterations	Hydrographical alterations may favour some NIS species. In particular changes (rise) in sea temperature.	At the selected monitoring stations for NIS, EO7 monitoring could be included as well, in order to identify Water Temperature, Salinity, Secchi disk depth.	The presence of NIS species witch expansion is highly linked to water currents should be communicated and highlighted particularly with environmental impact studies for new sea coastal structures.
EO9	CI17: Concentration of key harmful contaminants measured in the relevant matrix	Pollution alterations may favour some NIS species.	At the selected monitoring stations for NIS, EO9 monitoring could be included as well, in order to identify contaminant concentrations in sediment and biota to the extent possible.	
	CI18: Level of pollution effects of key contaminants where a cause and effect relationship has been established	Pollution alterations may favour some NIS species.		
	CI19: Occurrence origin (where possible) extent of acute pollution events (e.g. slicks from oil products and hazardous substances) and their impact on biota affected by this pollution	Possible impact if the regeneration rate of NIS species is higher than that of indigenous species following pollution accident.		
	CI20: Actual levels of contaminants that have been detected and number of contaminants that have exceeded maximum regulatory levels in commonly consumed seafood			
EO10	CI23: Trends in the amount of litter in the water column including microplastics and on the seafloor			Even if it happens rarely, some NIS species can grow on marine debris and spread around with debris circulating within water currents. Any data reported in this context may improve knowledge of this possible means of NIS intrusion and its link with marine litter.
	CI24: Trends in the amount of litter ingested by or entangling marine organisms focusing on selected mammals, marine birds, and marine turtles			

EO3 FISHERIES

Ecological objective	Common Indicator	Interactions and interconnection with fisheries	Monitoring interconnections	
			IMAP Data standards	Additional information to be included
EO1 Benthic Habitat	CI1: Habitat distributional range to also consider habitat extent as a relevant attribute	Bottom trawling impact on corals and coralligenous species. Lost gears, particularly nets (ghost nets).	Fishery data that may complement Habitat survey: ▪ spatial data of the fishing operations, particularly bottom trawling; ▪ fishing effort per area.	To consider discard composition (species) when performed.
	CI2: Condition of the habitat's typical species and communities			
EO1 Marine Mammals	CI3: Species distributional range	Some marine mammals may be attracted by fishing activity (Depredation and Discard) or be incidentally caught.	Fishery data which may complement Marine mammals survey: ▪ depredation data/observation; ▪ bycatch data (onboard/port questionnaires).	Interaction typology of the marine mammals with fisheries may be recorded.
	CI4: Population abundance of selected species			
	CI5: Population demographic characteristics (EO1, e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates)			
EO1 Marine Reptiles	CI3: Species distributional range		Fishery data that may complement Marine Reptiles survey: ▪ bycatch data (onboard/at port questionnaires).	
	CI4: Population abundance of selected species			
	CI5: Population demographic characteristics (EO1, e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates)			
EO1 Sea Birds	CI3: Species distributional range	Seabirds may be attracted by fishing activity (Discard) or be incidentally caught.	Fishery data that may complement Marine Reptiles survey: ▪ bycatch data (onboard/at port questionnaires).	Interaction typology of the seabirds with fisheries may be recorded.
	CI4: Population abundance of selected species			
	CI5: Population demographic characteristics (EO1, e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates)			
EO2	CI6: Trends in abundance, temporal occurrence, and spatial distribution of non-indigenous species, particularly invasive, non-indigenous species, notably in risk areas.	Discarding some caught invasive species may enlarge its expansion when it is done outside the area where these species are caught or in which they are already present.	Fishery data that may complement NIS survey: ▪ data on NIS species caught (macroinvertebrates and fish).	

Ecological objective	Common Indicator	Interactions and interconnection with fisheries	Monitoring interconnections	
			IMAP Data standards	Additional information to be included
EO5	CI13: Concentration of key nutrients in the water column	Possible lethal effect on fish stock related to the concentration level of some key nutrients in the water column.		
	CI13: Chlorophyll a concentration in the water column	Lethal effect on fish stock related to the concentration level of Chlorophyll a in the water column.		
EO7	CI15: Location and extent of the habitats impacted directly by hydrographical alterations			
EO9	CI17: Concentration of key harmful contaminants measured in the relevant matrix	Lethal effect on fish stock related to the concentration level of contaminants.		Mass fish mortality could be linked to alteration due to the high level of harmful contaminants. Fish quality (human health) may be impacted by bioaccumulation of contaminants.
	CI18: Level of pollution effects of key contaminants where a cause and effect relationship has been established			
	CI19: Occurrence origin (where possible) extent of acute pollution events (e.g. slicks from oil products and hazardous substances) and their impact on biota affected by this pollution	Physical smothering with an impact on physiological functions; ▪ chemical toxicity giving rise to lethal or sublethal effects or causing impairment of cellular functions; ▪ ecological changes, primarily the loss of key organisms from a community and the takeover of habitats by opportunistic species; and ▪ indirect effects, such as the loss of habitat or shelter and the consequent elimination of ecologically important species.	Fishery data that may complement Contaminants Monitoring: ▪ tissue analysis from caught species may provide additional data on contaminants if performed.	
	CI20: Actual levels of contaminants that have been detected and number of contaminants that have exceeded maximum regulatory levels in commonly consumed seafood			

Ecological objective	Common Indicator	Interactions and interconnection with fisheries	Monitoring interconnections	
			IMAP Data standards	Additional information to be included
EO10	CI23: Trends in the amount of litter in the water column including microplastics and on the seafloor	Lost nets and other fishing gears: ▪ ghost nets and other lost fishing gears may have an important negative impact on habitat and species.	Fishery data that may complement Marine litter survey: ▪ Composition/abundance of debris within discard when performed ▪ Position of lost fishing gears if performed ▪ Stomach contents analysis from caught species may provide additional data on marine litter (CI24)	Link with fishing effort and fishing areas should be done to the extent possible. Data from Fishingforlitter, litter monitoring programmes with fishing industries to be considered.
	CI24: Trends in the amount of litter ingested by or entangling marine organisms focusing on selected mammals, marine birds, and marine turtles			

EO5 EUTROPHICATION

Ecological objective	Common Indicator	Interactions and interconnection with eutrophication	Monitoring interconnections	
			IMAP Data standards	Additional information to be included
EO1 Benthic Habitat	CI1: Habitat distributional range (to also consider habitat extent as a relevant attribute)	Excessive concentrations of nutrients and chlorophyll a may cause chemical and transparency change with consequent effects on habitat communities.	Where possible, ensure overlapping of EO5 stations with the key locations of benthic habitats with plant species, preferably also within the MPA (as a reference station).	
	CI2: Condition of the habitat's typical species and communities	Concentrations of nutrients may cause an increased abundance of plant species (macroalgae) with consequent effects on other parts of habitat communities. Increased availability of nutrients can cause the proliferation of rapidly reproducing opportunistic species of marine plants (macroalgae) and animals. Excess of chlorophyll a indicates the increase of phytoplankton biomass. Phytoplankton, for example, can occur at sufficient densities to form blooms, which reduce light availability for marine plants such as seagrass.		
EO3	CI7: Spawning stock Biomass	May cause chemical and transparency changes with impacts on spawning conditions.		
EO7	CI15: Location and extent of the habitats impacted directly by hydrographical alterations	Temperature, salinity, depth, currents, waves, turbulence, and turbidity play a crucial role in maintaining marine habitats.	Basic hydrographic data (such as temperature, salinity, conductivity) should be collected and reported for all EO5 stations to define the major coastal water types for eutrophication assessment.	
EO8	CI16: Length of coastline subject to physical disturbance due to the influence of man-made structures	Urbanised areas could be a significant source of eutrophication in nearshore marine areas, in particular in the absence of the appropriate wastewater treatment.	The type of construction/infrastructure on the coastline is determined as part of EO8 monitoring. To some extent, it could contribute to identifying the type of pressure coming from human causes required for EO5 monitoring stations. In addition, information coming from EO5 monitoring could complement EO8 monitoring.	
EO9	CI17 – CI20		It is recommended to ensure integration of sampling locations for EO5 and EO9 due to cost-effectiveness.	

EO7 HYDROGRAPHY

Ecological objective	Common Indicator	Interactions and interconnection with hydrography	Monitoring interconnections	
			IMAP Data standards	Additional information to be included
EO1 Benthic Habitat	CI1: Habitat distributional range (to also consider habitat extent as a relevant attribute)	Water movement and temperature/salinity regimes directly influence sediment type/ changes.	Where possible, ensure the collection of key hydrographic parameters at the benthic habitats monitoring stations, at least water temperature, salinity, Secchi disk depth.	
	CI2: Condition of the habitat's typical species and communities	Water movement and temperature/salinity regimes play a significant role in determining the species composition of habitats/communities.		
EO2	CI6: Trends in abundance, temporal occurrence, and spatial distribution of non-indigenous species, particularly invasive, non-indigenous species, notably in risk areas.	Changes in the hydrographic regimes affect the occurrence and distribution of non-indigenous species. An increase in sea temperature facilitates the spreading of NIS, particularly from tropical regions.	Ensure collection of key hydrographic parameters at the EO2 monitoring stations, at least water temperature, salinity, Secchi disk depth.	
EO3	CI7: Spawning stock Biomass	Changes in the hydrographic regimes could affect trends in spawning stock biomass.		
EO5	CI13: Concentration of key nutrients in water column	Information on key hydrographic parameters is relevant for the interpretation of eutrophication results. Typology scheme for the Mediterranean coastal waters is based on the basic hydrographic data (temperature, salinity and density).	Hydrographic parameters such as temperature, salinity, pH, and transparency should also be measured at the EO5 monitoring stations.	
	CI14: Chlorophyll-a concentration in the water column			
EO8	CI16: Length of coastline subject to physical disturbance due to the influence of man-made structures	Physical changes of the coastline, due to man-made structures, could have a direct impact on the changes of thy hydrographic conditions, which can in turn lead to changes in marine habitats and biodiversity.	Monitoring of hydrographic conditions should take place in the areas with introduced changes of coastline. Therefore, these 2 sets of information should be jointly taken into consideration.	
EO9	CI17 – CI20	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 resuspended depending on the currents, waves and turbulence.	Where possible, ensure integration of EO7 and CI17 (EO9) locations.	
EO10	CI23: Trends in the amount of litter in the water column including microplastics and on the seafloor	Hydrographic conditions, in particular marine currents, have a significant impact on marine litter movements.		No particular hydrographic measurements of marine currents are envisaged during the marine litter survey. Nevertheless, water currents measurements could be an integral part of EO10.

EO8 COASTAL ECOSYSTEMS AND LANDSCAPES

Ecological objective	Common Indicator	Interactions and interconnection with coastal ecosystems and landscapes	Monitoring interconnections	
			IMAP Data standards	Additional information to be included
EO1 Benthic Habitat	CI1 – CI2	Constructions along the coastline affect primarily supra and medio littoral habitats and its typical species.	The results of the EO1 monitoring in combination with EO8 should be used to determine land-sea interactions, relevant for MSP.	
EO1 Marine Species	CI3 – CI5	In case that construction takes place near important bird/reptile habitats, such as beaches and coastal wetlands, it could seriously impact their distribution and abundance.		
EO5	CI13 – CI14 :	Increased urban construction could put further nutrient pressures on the marine environment, leading to overall eutrophication of the area, in particular in the absence of the appropriate wastewater treatment	Information on the type of construction near (EO5) monitored area could help determine the type and source of pressure present in the area (aquaculture facilities, wastewater coming from urban or industrial sources etc.	The type of operative function of the coastal infrastructure (linked to the type of man-made pressure) is not a priority in EO8 monitoring, but this type of information could be taken from spatial plans.
EO7	CI15: Location and extent of the habitats impacted directly by hydrographical alterations		Information coming from monitoring EO8 trends could complement EO7 monitoring.	
EO9	CI17 – CI20	Type of specific construction/nearshore activities (such as shipyards and marinas etc) could lead to contamination of the marine area.	Information on the type of construction near (EO9) monitored area could help to identify the sources of pressures, i.e. the (potential) source of contamination in the area.	
EO10	CI23: Trends in the amount of litter in the water column including microplastics and on the seafloor	It can be expected that urban areas could have larger quantities of marine litter deposits on the beaches or in the water. Nevertheless, due to water currents, litter washed ashore or found in the sea could have distant sources.		

EO9 CONTAMINANTS

Ecological objective	Common Indicator	Interactions and interconnection with contaminants	Monitoring interconnections	
			IMAP Data standards	Additional information to be included
EO1 Benthic Habitat	CI2: Condition of the habitat's typical species and communities	It can be expected that ecotoxicological pollution has impacts on species. The unwanted effects include harm to organisms at lower levels of the food chain and increased concentrations through food webs, resulting in higher concentrations and potential impacts at the top of the food chain.		No specific interlinks with the monitoring locations are required. Nevertheless, results of the EO9 monitoring could be taken into consideration to complement EO1 monitoring (in terms of identification of pressures).
EO1 Marine Species	CI3 – CI5	Oil spills can have significant impacts on species, in particular marine birds.		
EO5	CI13 – CI14		It is recommended to ensure integration of locations for EO5 and EO9 mainly due to cost-effectiveness.	
EO7	CI15: Location and extent of the habitats impacted directly by hydrographical alterations		Basic hydrographic data should be collected and reported for all EO9 stations, such as temperature and salinity.	
EO10	CI23: Trends in the amount of litter in the water column including microplastics and on the seafloor	Marine litter, in the form of microplastics, can carry and release chemical contaminants into the marine environment or transfer them directly to marine organisms after ingestion.		

EO10 MARINE LITTER

Ecological objective	Common Indicator	Interactions and interconnection with marine litter	Monitoring interconnections	
			IMAP Data standards	Additional information to be included
EO1 Benthic Habitat	CI1: Habitat distributional range (to also consider habitat extent as a relevant attribute)	Litter on the sea bottom damages benthic species and can affect the distribution of habitats.	Information on the type and amount of marine litter is relevant for the assessment of pressures put on the benthic habitats. Data from EO1 monitoring could complement the monitoring of seafloor marine litter. Also, the results of the EO10 monitoring could complement EO1 monitoring. No particular station overlap is necessary.	
	CI2: Condition of the habitat's typical species and communities			
EO1 Marine Species	CI3: Species distributional range	Marine litter could have a significant impact on marine mammals, reptiles and marine birds, through ingestion and/ or entangling. The unwanted effects include harm to organisms at lower levels of the food chain and increased concentrations through food webs, resulting in higher concentrations and potential impacts at the top of the food chain.		Data standards for monitoring trends in the amount of litter ingested by or entangling marine organisms have not yet been adopted. However, information/observations collected during monitoring of marine mammals, birds and turtles are particularly important for EO10 monitoring.
	CI4: Population abundance of selected species			
	CI5: Population demographic characteristics			
EO3	CI7: Spawning stock Biomass		In order to ensure cost-effectiveness, expeditions undertaken for EO3 monitoring could, at the same time, be used for EO10 (sea bottom and surface monitoring).	

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. Furthermore, the project aims to accelerate the implementation of the Integrated Coastal Zone Management Protocol and facilitate the implementation of the Integrated Monitoring and Assessment Programme. Just as importantly, it will contribute to the achievement of the good environmental status of the entire Adriatic. The project is jointly led by UNEP/MAP, PAP/RAC and SPA/RAC. In Montenegro, the project implementation is coordinated by the Ministry of Sustainable Development and Tourism. The project duration is from 2018 to 2021.

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