MONTENEGRO
MINISTRY OF SUSTAINABLE DEVELOPMENT AND TOURISM

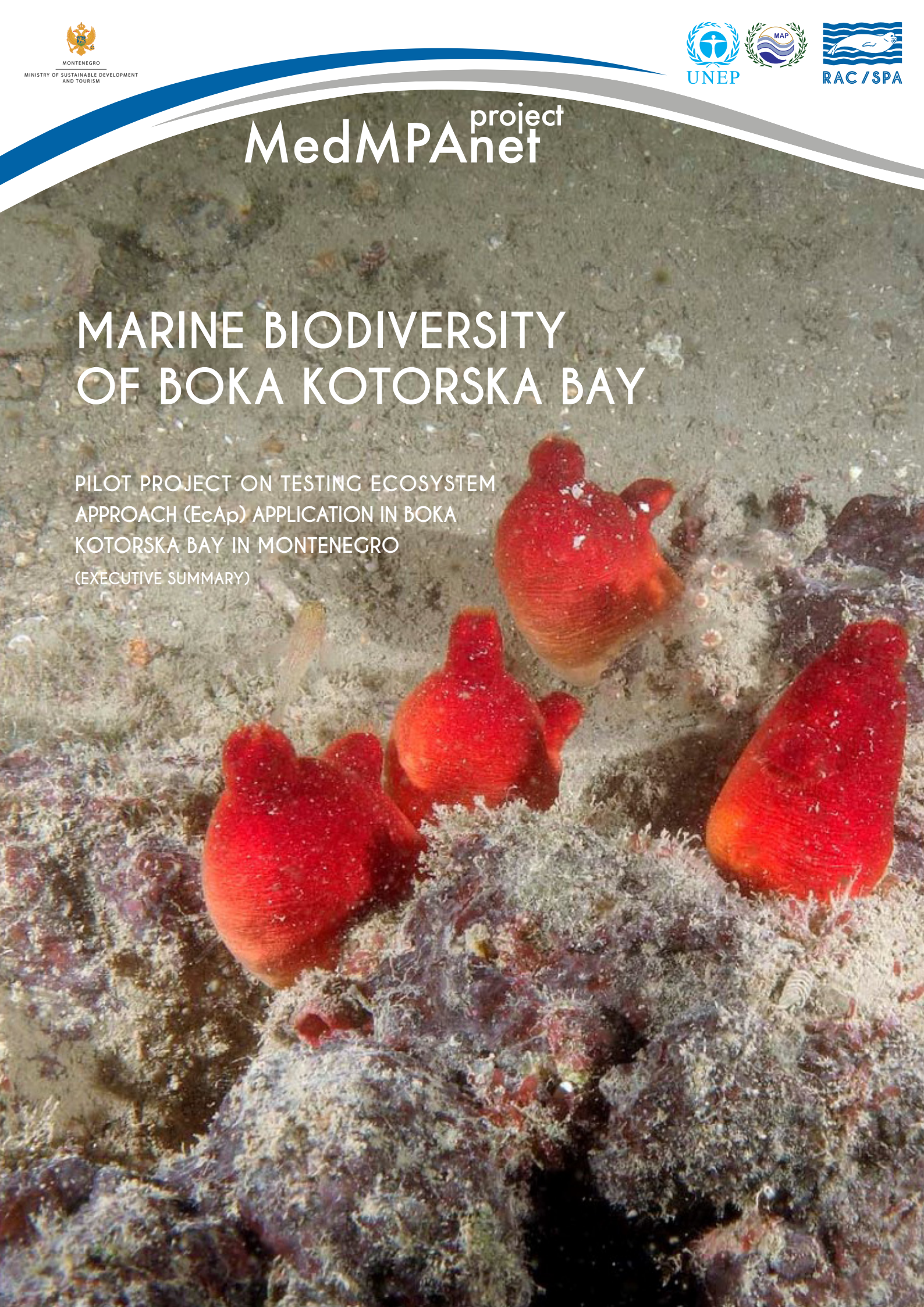
UNEP MAP RAC/SPA

MedMPAnet project

MARINE BIODIVERSITY OF BOKA KOTORSKA BAY

PILOT PROJECT ON TESTING ECOSYSTEM APPROACH (EcAp) APPLICATION IN BOKA KOTORSKA BAY IN MONTENEGRO

(EXECUTIVE SUMMARY)



Published by: RAC/SPA

For bibliographic purposes, this volume may be cited as:
RAC/SPA - UNEP/MAP, 2014. Marine biodiversity of Boka Kotorska bay - Pilot project on testing Ecosystem Approach (EcAp) application in Boka Kotorska bay (Montenegro) - Executive summary. By Petovic S. and Batakovic M. Ed. RAC/SPA - MedMPAnet Project, Tunis. 25 pages.

Layout: Zine El Abidine MAHJOUB and Asma KHERIJI.

Cover photo credit: Golder Associates.
Photos credits: Golder Associates.

This document has been elaborated within the framework of the Regional Project for the Development of a Mediterranean Marine and Coastal Protected Areas (MPAs) Network through the boosting of Mediterranean MPAs Creation and Management (MedMPAnet Project).

The MedMPAnet Project is implemented in the framework of the UNEP/MAP-GEF MedPartnership, with the financial support of EC, AECID and FFEM.

MARINE BIODIVERSITY OF BOKA KOTORSKA BAY

PILOT PROJECT ON TESTING ECOSYSTEM APPROACH (EcAp) APPLICATION IN BOKA KOTORSKA BAY IN MONTENEGRO

(SUMMARY REPORT)

MedMPAnet project

Regional Project for the Development of a Mediterranean Marine and Coastal Protected Areas (MPAs) Network through the boosting of MPA creation and management

Study required and financed by:

MedMPAnet project

Regional Activity Centre for Specially Protected Areas (RAC/SPA)
Boulevard du Leader Yasser Arafat
B.P. 337
1080 Tunis Cedex - Tunisia

In charge of the study:

Atef LIMAM, MedMPAnet Project, RAC/SPA

Daniel CEBRIAN, SAP BIO Programme Officer, RAC/SPA

Milena BATAKOVIC, Senior adviser. Department for nature protection, monitoring, analysis and reporting. Environmental Protection Agency of Montenegro (Montenegro)

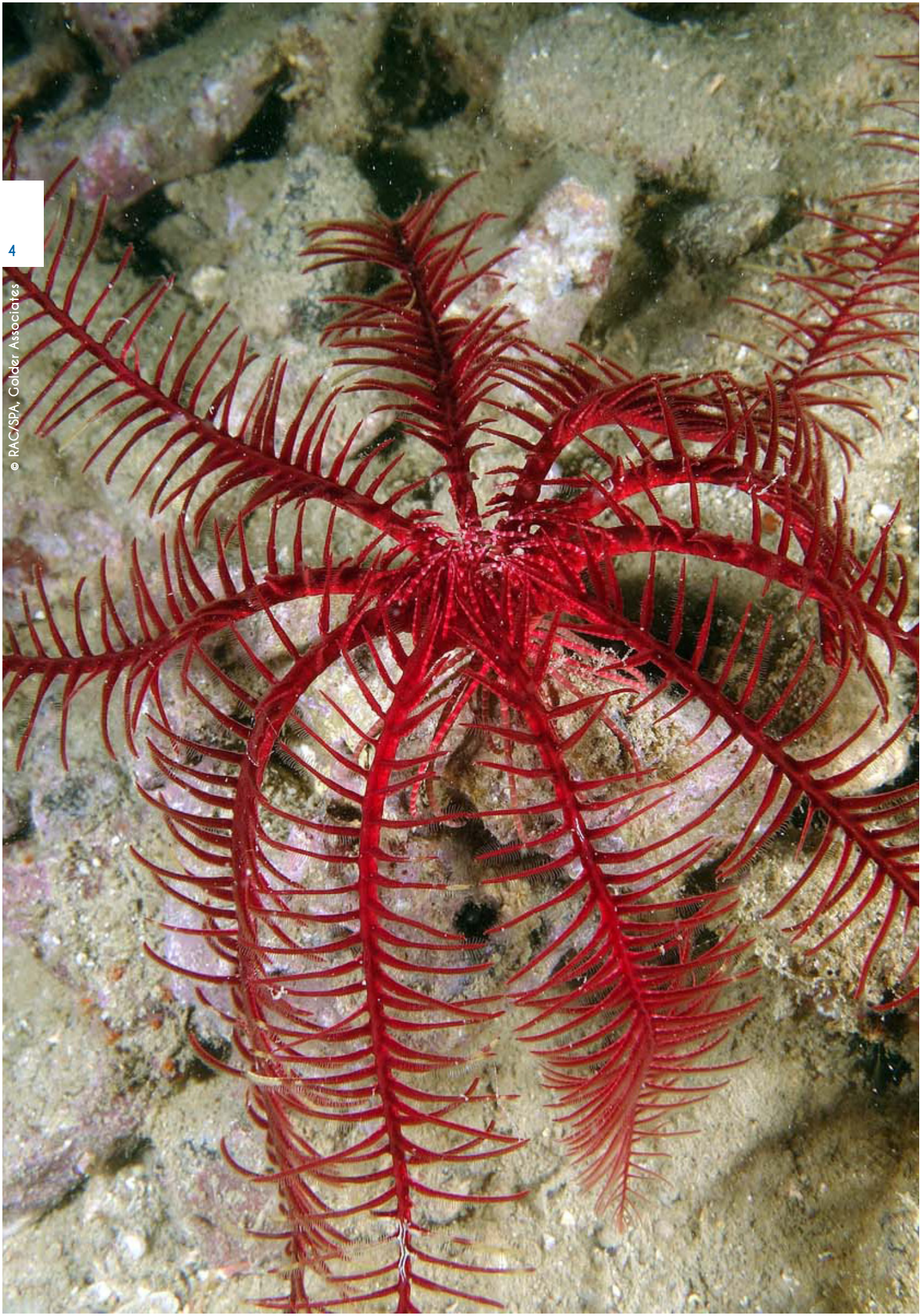
Scientific responsible of the study:

Slavica PETOVIC, Expert on Marine Environment (Montenegro)
Milena BATAKOVIC, Senior adviser. Department for nature protection, monitoring, analysis and reporting. Environmental Protection Agency of Montenegro (Montenegro)

Reference of the study:

MoU N° 12/MedMPAnet/2012

CONTENT



I. REVIEW OF DATA AVAILABILITY BY ECOSYSTEMS APPROACH GOALS AND INDICATORS

The pilot project aimed at testing the Ecosystem Approach (EcAp) in Boka Kotorska Bay is implemented within the Coastal Area Management Programme of Montenegro (CAMP-MNE) by supporting the development of the national Coastal Area Management Strategy. At the same time, testing of the EcAp, developed by UNEP/MAP under its Roadmap, is an attempt to understand data availability issues, current monitoring practices, and possibilities of following this approach for not only setting the goals for attaining good environmental status, but also drafting pertinent implementing measures.

In this regard and given that the data availability analysis is the starting point for implementing the Ecosystem Approach, based on the reviewed available literature for the pilot area against the set goals and objectives, and EcAp indicators, we reviewed the available data, as shown in Table 1 below, while the detailed presentation of the data is given in the section on Description of Current Status - Marine Biodiversity of Boka Kotorska Bay, describing the current status based on available literature and the most recent studies around the topics relevant for EcAp goals and indicators.

Table 1. Review of data availability by Ecosystems Approach goals and indicators

Ecological objective	Objective	Indicator	Data availability
Biological diversity is maintained or enhanced. The quality and occurrence of coastal and marine habitats and the distribution and abundance of coastal and marine species are in line with prevailing physiographic, hydrographic, geographic and climatic conditions.	Species distribution is maintained	Distributional range	Data available only for some species
		Area covered by the species (for sessile/ benthic species)	The data presented in Ecological Quantification of Boka Kotorska Bay, RAC/SPA study
	Population size of selected species is maintained	Population abundance	The data presented in Ecological Quantification of Boka Kotorska Bay, RAC/SPA study for macroalgae, zoobenthos, fish
		Population density	
	Population condition of selected species is maintained	Population demographic characteristics (e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates)	Data available for pilchard and anchovy
	Key coastal and marine habitats are not being lost	Potential / observed distributional range of certain coastal and marine habitats listed under SPA protocol	Data available for the bays of Kotor and Risan Ecological Quantification of Boka Kotorska Bay, RAC/SPA
		Distributional pattern of certain coastal and marine habitats listed under SPA protocol	Data available for the bays of Kotor and Risan Ecological Quantification of Boka Kotorska Bay, RAC/SPA
		Condition of the habitat defining species and communities	Descriptive
Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem	Invasive non indigenous species introductions are minimized	Spatial distribution, origin and population status (established vs. vagrant) of non-indigenous species	Data available on the number of species and the descriptive general influence, but not the population status
		Trends in the abundance of introduced species, notably in risk areas	No
	The impact of non-indigenous particularly invasive species on ecosystems is limited	Ecosystem impacts of particularly invasive species	Only a brief descriptive general influence of the recorded species may be given
		Ratio between non-indigenous invasive species and native species in some well studied taxonomic groups	No

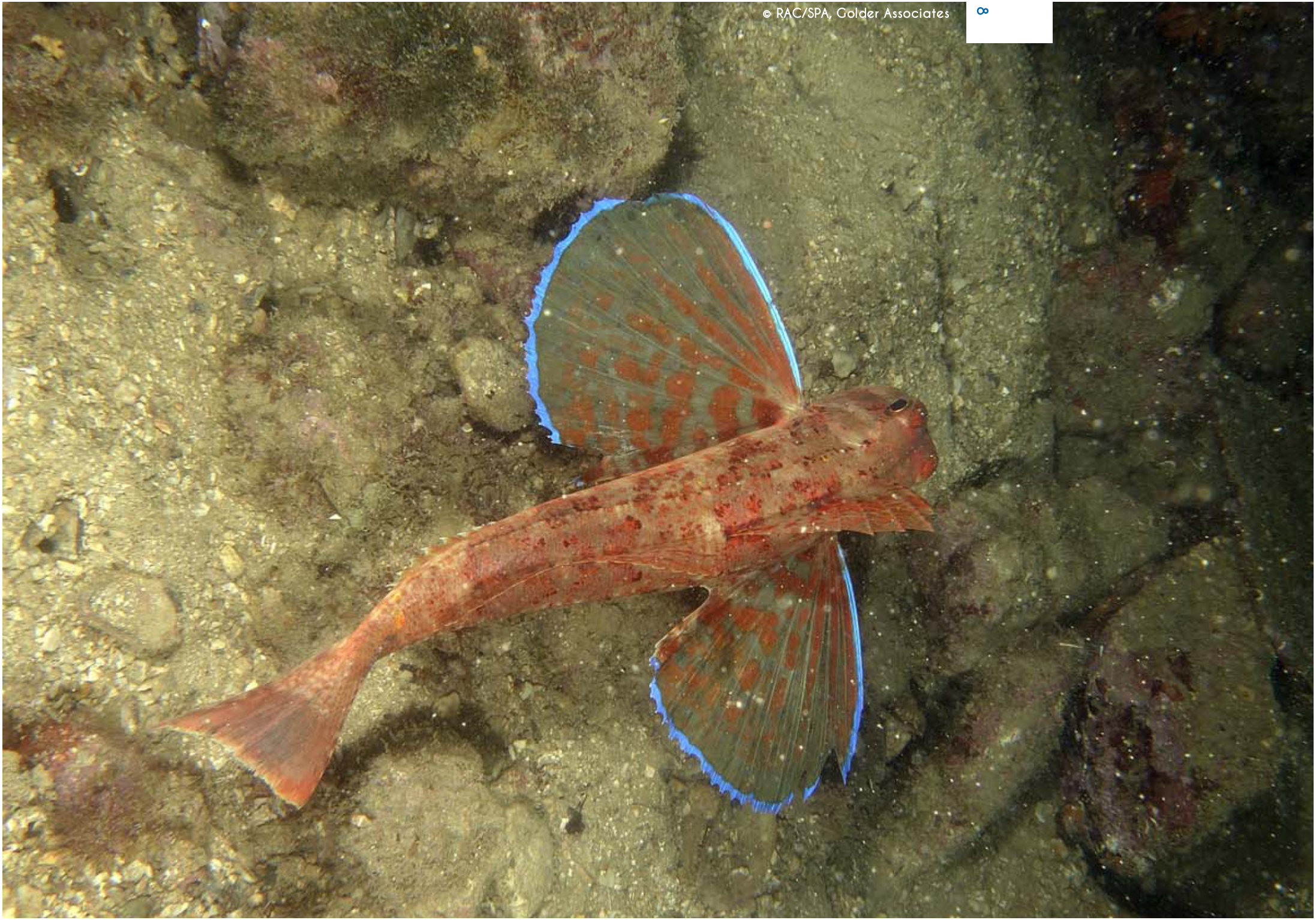
Ecological objective	Objective	Indicator	Data availability
Populations of all fish, crustaceans and shellfish are within biologically safe limits, exhibiting a population age and size distribution that is indicative of a healthy stock	Level of exploitation by commercial fisheries is within biologically safe limits	Total catch by operational unit	The Ecological Quantification of Boka Kotorska Bay, RAC/SPA gives assessment of catch, total catch and catch per unit effort for the Kotor and Risan bays. Some data available in previous research databases (2000 and 2005)
		Total effort by operational unit	
		Catch per unit effort (CPUE) by operational unit	
		Ratio between catch and biomass index (hereinafter catch/biomass ratio).	The Ecological Quantification of Boka Kotorska Bay, RAC/SPA gives assessment of catch, total catch and catch per unit effort for the Kotor and Risan bays. Some data available in previous research databases (2000 and 2005)
		Fishing mortality	No
	The reproductive capacity of stocks is maintained	Age structure determination	Yes
		Spawning Stock Biomass (SSB)	No
Alterations to components of marine food webs caused by resource extraction or human-induced environmental changes do not have long-term adverse effects on food web dynamics and related viability	Ecosystem dynamics across all trophic levels are maintained at levels capable of ensuring long-term abundance of the species and the retention of their full reproductive capacity	Production per unit biomass estimates for selected trophic groups and key species	No
	Normal proportion and abundances of selected species at all trophic levels of the food web are maintained	Proportion of top predators by weight in the food webs	
		Trends in proportion or abundance of habitat-defining groups	
		Trends in proportion or abundance of taxa with fast turnover rates	

Note: There are no data available for birds, and the detailed presentation and the list of species is given below in the section describing the current status

It is certainly worth mentioning the absence of any systemic monitoring of biodiversity components in Montenegro, which is not included in the national Environmental Monitoring Programme implemented by the Environmental Protection Agency (EPA) in cooperation with the relevant institutions. The Marine Ecosystem Monitoring Programme has been implemented since 2008 and is designed to suit the MEDPOL requirements, while the biodiversity component is missing. In 2010, a certain degree of monitoring for phyto- and zoobenthos was carried out at 5 locations. It was not extended to cover biodiversity due to limited funding. Therefore, the data available for the pilot area were obtained through project-based initiatives and activities.

Based on the review of the data available, the following descriptive objectives were selected:

- Species distribution is maintained ;
- Population size of selected species is maintained ;
- Key coastal and marine habitats are not being lost ;
- Level of exploitation of fish stock by commercial fisheries is within biologically safe limits.



II. CURRENT STATUS

2.1. Physical and geographic features of Boka Kotorska Bay

The area of Boka Kotorska Bay includes the locations from Cape Oštro to Cape Mirište. This area is, both geographically and oceanographically, a closed basin, which, given the climate, geomorphologic and physical-chemical characteristics of its sea area, differs substantially from the open sea. This fact accounts for huge annual, seasonal, monthly and daily changes in the physical and chemical parameters of the sea water; hence, establishing any patterns of changes and processes is very complex. Here, the sea penetrates deep into the mainland and creates a coast of about 105.5 km, with the total water surface area of 87.33 km or 0.06 % of the total sea surface area of the Adriatic Sea. The total volume of Boka Kotorska Bay is 2.4 x 10^9 m^3. Based on its geographical and hydrographical characteristics, the Bay could be divided into 3 parts: Kotor and Risan Bays (the inner part), Tivat Bay (the central part) and Herceg-Novi Bay (the outer part). The sea bed is very complex and not always symmetrical. In each bay the profundity increases towards the central part, except in Kotor Bay where the maximum depth is near the northern coast (Perast). The average depth of Boka Kotorska Bay is 27.6 m, and its maximum profundity is 64 m (Kotor Bay). Boka Kotorska Bay is surrounded by steep mountains, often causing substantial decrease in temperature, at times even with ice being formed on the sea surface in wintertime. This is an area of intensive precipitation, resulting in large amounts of fresh water entering the Bay, particularly its inner parts, between November and April.

2.2. Biodiversity features

Biodiversity analysis included a compilation of literature data taken over from many scientific papers, doctoral thesis, and the expert literature or studies, research papers and reports dealing with different locations within Boka Kotorska Bay.

The phytoplankton studies within the Bay area show maximum mean population abundance for diatoms recorded in the inner part of the Bay, or Kotor Bay area, while the minimum mean value was recorded in the outer part of the Bay, in Herceg Novi, which is to be expected given the strong influence of the open seas. The analysis of the dinoflagellate population abundance shows that the greatest mean value was also recorded at the sites within Kotor Bay in summertime, as is to be expected for this group.

Zooplankton analysis shows the highest value of the total mesozooplankton recorded in July 2011 at the Dobrota site, while the minimum was recorded in June 2011 at the Mamula site. Unlike the previous years, when the algal bloom of Protozoa was recorded in Boka Kotorska Bay, this research shows it to be at a much lower level reaching maximum presence of 15 % in Tivat Bay in April. The fact that in 2011 lower percentage-wise presence of Cladocera was recorded and there was no *Noctiluca scintillans* bloom points to the conclusion that Boka Kotorska Bay is exposed to lower level of human impact. Nevertheless, the presence and frequency of occurrence of the indicator species of *Penilia avirostris*, *Oithona nana* and *Noctiluca scintillans* indicate that Boka Kotorska Bay is still a eutrophic area, but to a much lesser degree compared to the previous years for which study data are available. The 1971 data show that 63 copepod species were recorded within the area of Boka Kotorska Bay.

Studying the benthic organisms within the area of Kotor and Risan Bays (Figs 1-2), it is possible to differ the *biocenosis of the coastal terrigenous* mud (accounted for by more than 87 % of the total area), and the elements of other biocenosis on the shifting and solid substrate: elements *of biocenosis of coastal detritic seabed* (accounted for by 2 % of the total area) and *biocenosis of muddy sands* accounted for by the rest of the seabed, *coraligenic biocenocis* (some 2 % of seabed in Kotor and Risan Bays) on the solid substrate of the circalittoral zone, on the shaded part below the seaweed meadows, and in much shallower parts of the seabed in Boka Kotorska Bay), *biocenosis* of *Posidonia*, *biocenosis of Zostera*, *biocenosis of Cymodocea* (on the shifting substrate of infalittoral with the area of some 0.15 %) and *biocenosis of photophilic algae* (on the solid substrate of infralittoral steps) (Karaman & Gamulin-Brida, 1970).

The research of communities in the area of Kotor and Risan Bays conducted in 1980s show the presence of the following types of communities:

1. Pure sandy seabed next to the shore, partly modified by human impact ;
2. Sandy seabed, partly covered in rocks and overgrown with algae ;
3. Rocky and pebble seabed for most part disturbed by human impact ;
4. Muddy seabed with smaller or larger traces of detritus and sand, brown or grey in colour ;
5. Discontinued elements of the coral plateau -*Cladocora caespitosa ;*
6. Seabed with photphilic algae ;
7. Seabed overgrown with *Cistoseire* ;

8. Seabed with Vidalia *volubilis* ;
9. Undersea meadows with seagrass (*Zostera* and *Cymodocea*);
10. Undersea *Posidonia* meadows ;
11. Areas of the *Amphiura chiajei* biocenosis ;
12. Biocenosis characterised by the abundance of *Tanaidacei*;
13. Area characterised by the presence of *Ocnus planci* latent;
14. Biocenosis characterised by *Holothuria impatiens* ;
15. Area characterised by the *Pinna nobilis* communities ;
16. A narrow zone characteristic for *Lapidoplax digitata* ;
17. Biocenosis of *Mytilus galloprovincialis uncinatus*.

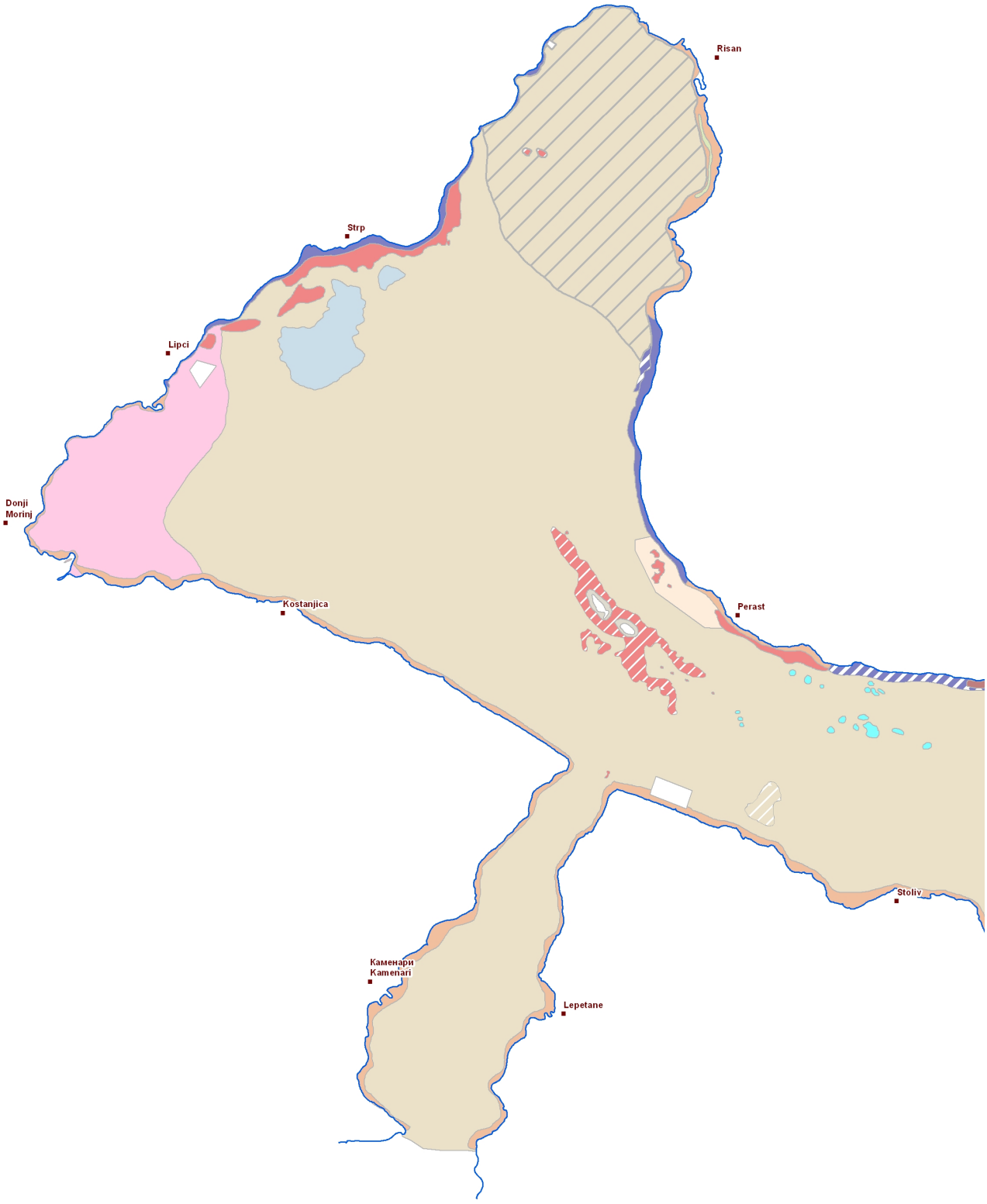
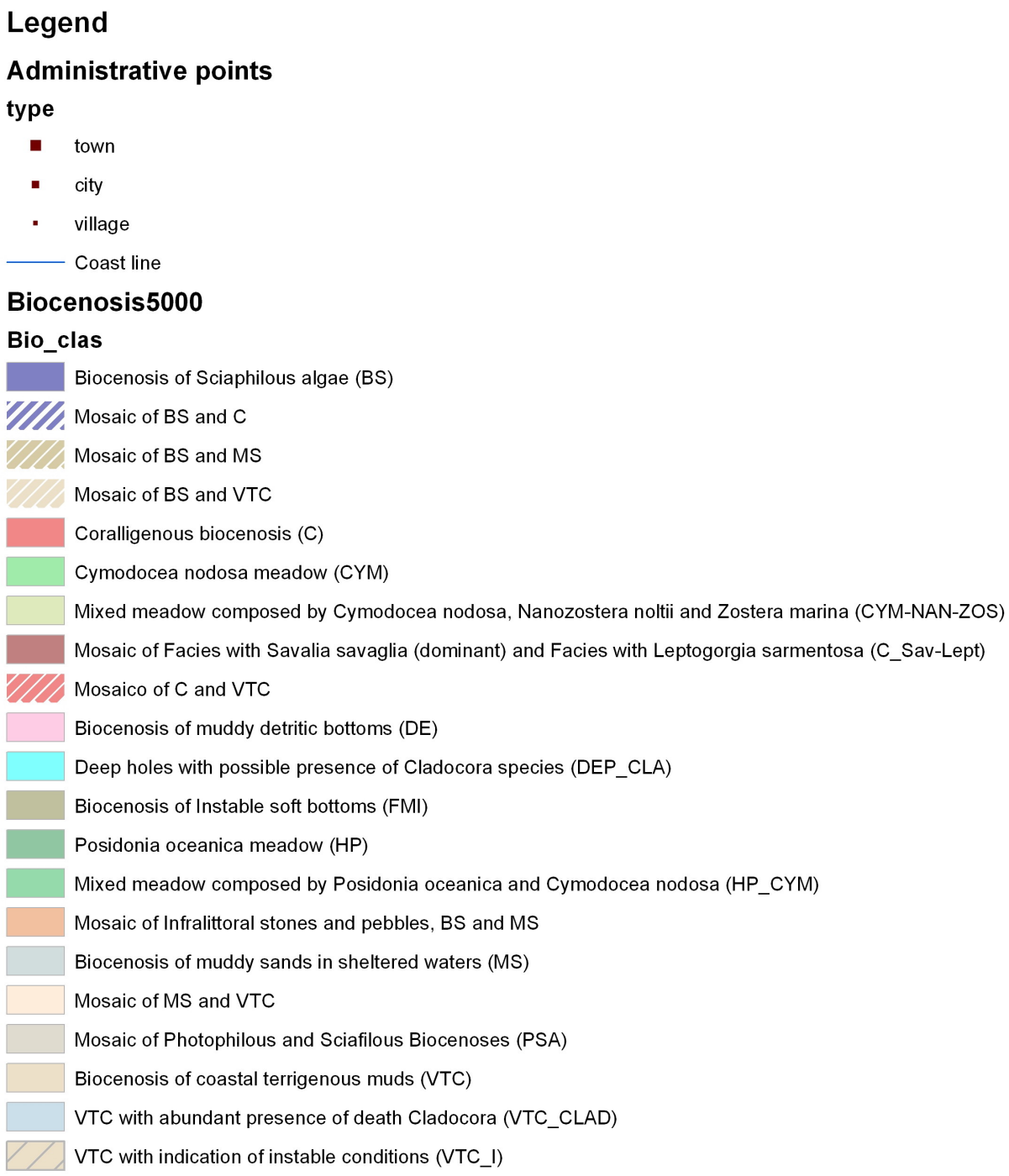


Figure 1. Habitat distribution within the area of Kotor and Risan Bays

Figure 2. Habitat distribution within the area of Kotor and Risan Bays (cont.)



More recent research of the same area identified the presence of 21 types of habitats. The area is dominated by the biocenosis of coastal terrigenous mud, but coral groups are also noteworthy, covering some 2 % of the total seabed of the bay, and seagrass meadows present in 4 locations, covering in total 0.15 % of the total seabed.

The study of phytobenthos shows that there are 4 types of marine flowering plants. The most important among them is *Posidonia oceanica* whose habitats are threatened. The total number of identified algae is 56, with 49 of them registered in the Kotor and Risan Bays.

Kotor and Risan Bays have abundant fauna. This primarily involves solid substrates where the total of 124 species were recorded, with another 77 species inhabiting shifting substrates. Comparing the results obtained with the literature data referring to the whole of Boka Kotorska Bay, the literature data show a much greater number of molluscs in the whole Bay area compared to its inner part, while the number of other benthic organisms is almost identical to the literature recorded data for the whole Boka Kotorska Bay area. This is indicative of the fact that two outer bays (Tivat and Herceg-Novi Bays) are under-researched, with the exception of the Mollusca group.

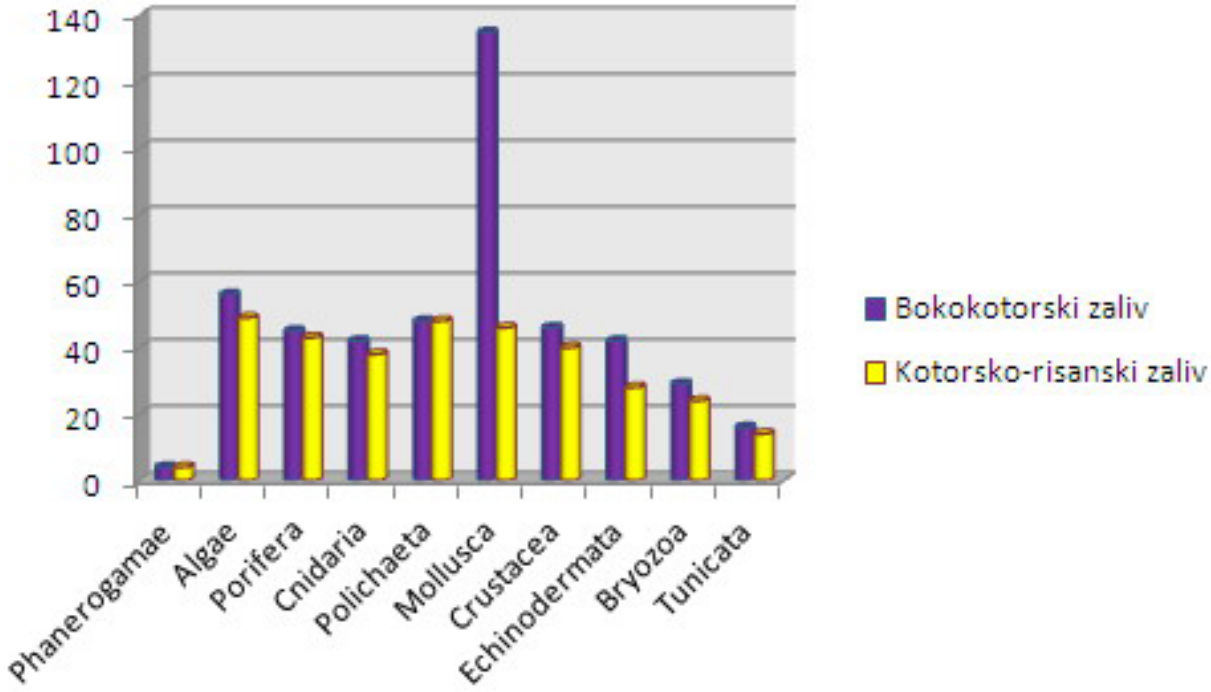


Figure 3. Comparison of zoo-benthic species recorded within the inner part and the whole of Boka Kotorska Bay

The species of the sea turtle *Caretta caretta*, and the common bottlenose dolphin *Tursiops truncates* have been observed within Boka Kotorska Bay.

The topography of Boka Kotorska Bay is very suitable for many activities: this is a large protected sea area deeply penetrating into the mainland; it is a natural spawning area and feeding area for fish progeny, and offers excellent conditions for mariculture. The ichthyoplankton research shows that a large number of fish species of commercial importance choose the waters of the Bay for spawning. Among them, the largest number of individuals belongs in summertime to the *Engraulis encrasicolus,* then *Diplodus annularis, Coris julis, Diplodus puntazzo, Gaidropsaurus mediterraneus, Serranus hepatus, Sardinella aurita,* while the species *Sardina pilchardus* is predominant in wintertime.

Studying the biodiversity of the Kotor and Risan Bays, the total of 59 fish species from 24 families were recorded. The specificity of small pelagic fishing in Boka Kotorska Bay are reflected in the use of (pilchard) seines, coming second in their total number, preceded only by single set nets, and followed by triple set nets, shore seines, long lines, then purse seiners and harpoons.

When it comes to invasive species, the total of 11 such species have been registered to date, 3 flora species and 8 fauna species, although this is not a finite number since it is to be expected to detect further new species from other areas during subsequent research.

Table 2. List of species introduced in the coastal zone of Montenegro

Species	Origin	Possible methods of introduction
ALGAE		
Chlorophyta		
***Caulerpa racemosa* var. *cylindracea* (Montagne) Weber-van Bosse**	Pacific	With ships
Rhodophyta		
***Womersleyella setacea* R.E. Norris**	Pacific	Through the Suez canal and with ships
***Asparagopsis taxiformis* (Delile) Trevisan de Saint-Leon**	Pantropical	With ships
CRUSTACEA		
Decapoda		
***Callinectes sapidus* Rathbun, 1896.**	Atlantic	With ships
***Farfantepenaeus aztecus* Ives, 1891**	Atlantic	With ships
MOLLUSCA		
Gastropoda		
***Melibe viridis* Kelaart 1858.**	Pacific	With ships
***Bursatella leachi* De Blainville 1817.**	Circumtropical	Through the Suez canal and with ships
***Aplysia dactylomela* Rang 1828.**	Circumtropical	Through the Suez canal and with ships
Bivalvia		
***Crassostrea gigas* Thunberg 1793.**	Pacific	Mariculture
PISCES		
***Fistularia commersonii* Ruppell 1835.**	Pacific	Through the Suez canal
***Sphoeroides pachygaster* Muller & Trochel 1848**	Atlantic	Through the Suez canal

Fishing is based on the exploitation of renewable biological resources (organisms of economic importance which inhabit coastal waters and the seas), and provided the exploitation is done sensibly (within the limits of possible natural restoration), it establishes a dynamic balance among the factors conducive to population restoration and increase, and the ones affecting its reduction (fishing mortality).

In August 2005 echo-sounding was carried out within the territory of Boka Kotorska Bay in the transect 14 Nm in length.

The biological data from August 2005 used to assess biomass of pelagic resources in Boka Kotorska Bay are as follows:

- medium size pilchard = 7.67 cm; percentage of catch = 66.0 %
- medium size anchovy = 7.60 cm; percentage of catch = 29.3 %
- other pelagic species of medium size = 26.01cm; percentage of catch 4.7 %

Based on these and the acoustic data, the following results were obtained for the seas of Boka Kotorska Bay, at the 14 Nm ship route:

- pilchard biomass = 324.9 t,
  with mean density of 23.2 t/ Nm^2 ;
- anchovy biomass = 144.4 t,
  with mean density of 10.3 t/ Nm^2 ;
- biomass of other pelagic species = 23.2 t,
  with mean density of 1.7 t/ Nm^2.

There are few species at the level of the whole Bay for which the population size and dynamics have been established. In the second half of 20th century, an estimate of the size of Cephalopoda in the Bay was done by calculating catch per unit effort, i.e. during one hour of trawling. The data obtained show that the greatest population size of the species covered was located within the Tivat Bay area.

As regards fish species, the greatest attention was devoted to the most present species in the Bay: anchovy, pilchard and common pandora.

Based on the average number of anchovy eggs per m^2 during the daylight, biomass was separately calculated for each bay separately. Although no strict line may be drawn to separate the bays, it is still possible to conclude that the largest biomass was found in Kotor Bay, and the smallest in Risan Bay. Anchovy egg distribution is under a huge impact of the environmental factors (particularly temperature and salinity), as well as the oceanographic conditions, such as the sea currents, nutrients, etc.

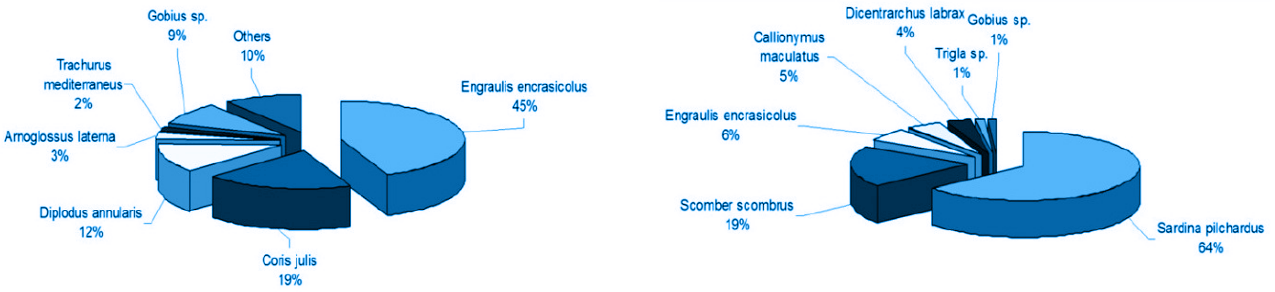


Figure 4. Percentage-wise share of the total ichthyoplankton species in July 2006 (left) and December 2006 (right) (taken from Mandić *et al.*, 2013)

As for common pandora (*Pagellus erythrinus*), surveys show that the estimated biomass from 10 m contour line up for the Kotor and Risan Bays is 62.98 t ± 51.52%.

The percentage of *Sardina pilchardus* by weight in the total catch of pelagic species in Boka Kotorska Bay is approximately 59 %, and mean Catch per Unit Effort (CPUE) is at about 150 kg haul; hence, this species comes first, before anchovy, in Boka Kotroska Bay. The size frequency distribution diagram shows that the caught fish ranged between 4.4 and 16 cm with mean value of 9.46 cm, and two modal values, at 7-7.5 cm and 9.5-10 cm. The difference between size frequency for pilchard within the Bay and in the open sea was noted.

The percentage share of pilchard, anchovy and other pelagic species, by different sites in Kotor Bay, show certain patterns. Namely, the pilchard is the species that prefers somewhat colder water of increased salinity compared to anchovy that prefers sea water mixed with fresh water. The currents from the open sea bringing colder water of high salinity enter the Bay and move along the coast counter-clockwise, i.e. in Kotor Bay these waters go along the left-hand side. At the same time, the greatest number of undersea fresh water springs is located in the vicinity of Orahovac, Ljuta and Dobrota. The shares of these species in the total catch show that pilchard is more abundant in the areas of colder and more salty water, i.e. at the sites of Markov rt, Muo and Marine Biology Institute, while anchovy is more abundant in the area with undersea springs, i.e. Sveti Matija, Ljuta and Orahovac. It was only at the site of Dražin vrt that both species had almost equal share in the catch (pilchard 50 %, anchovy 47 %, OPS 3 %).

Nutrients in the sea water play an important role. Nutrients enter the marine environment through various routes: fresh water inflow, the type of seabed has an impact as well, and in the water basin itself the regeneration of nitrogen salts takes place through the process of decomposition of organic matter near the bottom. Surveys show that between April and November 2012 nitrate concentration values ranged between 1 - 14.584 µmol/l. The results show the values to be highest in April and May at the sites of Dobrota and Orahovac, and the single highest measured concentration was at the site of Orahovac in May and amounted to 14.584 µmol/l. Even the year before the highest concentration of nitrates within the Bay was measured at the Orahovac site.

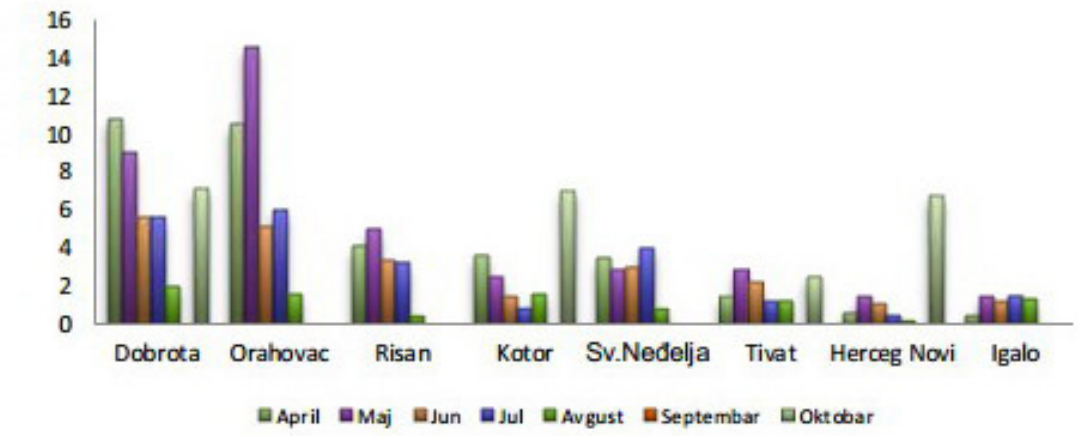


Figure 5. Nitrate concentration (µmol/l) at different sites in Boka Kotorska Bay (taken from 2013 Environmental Status Report)

Nitrite concentrations ranged between 0.019 and 0.396 µmol/l. The lowest value 0.019 µmol/l was recorded at the Mamula site, at 10m of depth. The maximum nitrite concentration value 0.396 µmol/l was measured at two sites, in Kotor and Tivat, on the surface, in October.

Ammonia concentration values ranged between 0 and 0.133 µmol/l. The maximum value was recorded within the Bay at the Risan site in July.

Total nitrogen values ranged between 3.677 µmol/l in October at the Herceg Novi site and 17.099 µmol/l, measured on the surface at the Risan site in May. The data shows that the highest concentration of phosphate was at surface layer in Dobrota site (0,578 µmol/l) in May.

The concentration of photosynthetic pigments is used as an indicator for phytoplankton biomass, since all green plants contain chlorophyll a, accounting for 1-2 % of plankton algae dry mass.

The chlorophyll a concentration is an indicator of the degree of eutrophication in marine ecosystems. High chlorophyll a values indicate increased organic production.

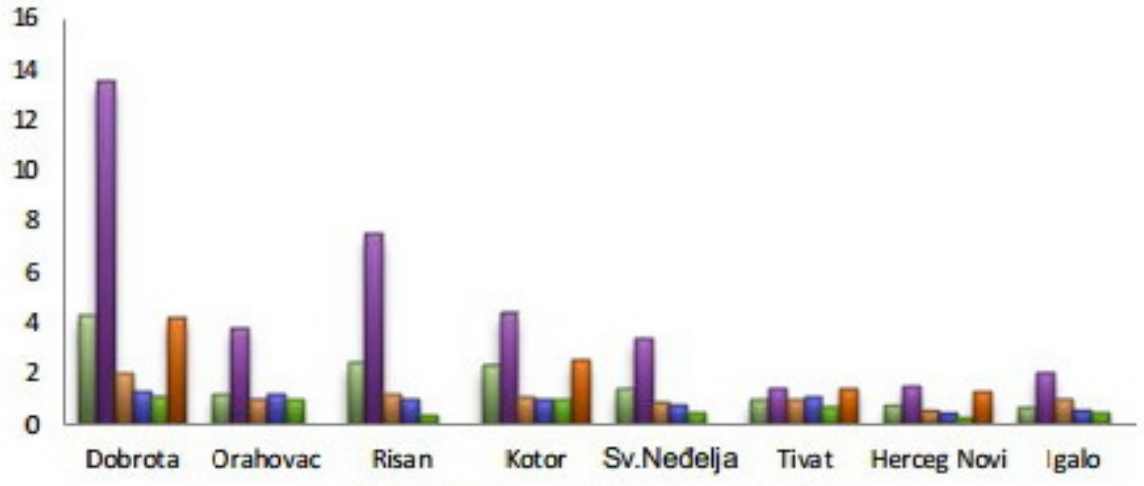


Figure 6. Chlorophyll a concentrations (mg/m^3) different sites in Boka Kotorska Bay (taken from 2013 Environmental Status Report)

The greatest chlorophyll a concentrations were recorded in May at the sites of Dobrota (13.553 mg/m^3), Risan (7.514 mg/m^3) and Kotor (4.41 mg/m^3), while the lowest concentration measured during the monitoring period was at the Herceg Novi site in August and amounted to 0.323 mg/m^3. Based on the data obtained, chlorophyll a concentrations ranged between 0-2.6 mg/m^3 at most sites and the sea is oligotrophic at these sites, indicative of insignificant eutrophication.

As regards heavy metal concentrations in the sea water, it is noteworthy mentioning the existence of a large number of methodologies and as many limit values. The results obtained show that heavy metal values at the sites within Boka Kotorska Bay are within the mean value ranges measured in other seas and oceans. The results of analyses show that sediments from the Shipyard Bijela and the Ship Repair in Tivat are burdened with spent sandblasting grit. Grit combined with sediments introduces in the marine environment a high content of both metal and organic components with long-lasting consequences for the living environment, starting from the problems that may be caused by organic tin compounds.

The biological indicator monitoring programme covers two sites in Boka Kotorska Bay: Kotor - in the vicinity of the Marine Biology Institute, and Bijela - shellfish farm near Sveta Nedjelja church. The survey conducted in November determined the response of biomarkers to pollution. Mussel (*Mytilus galloprovincialis*) was used as a bio-indicator. The heavy metal analyses in the soft tissue of mussels (*Mytilus galloprovincialis*) show the correlation with the contents of heavy metal in the sediments, with the exception of Zn, and the linkages with human influence.

The sanitary quality of water within Boka Kotorska Bay varied over the sampling period since it is in direct correlation to weather conditions, hence, only the current status of water quality may be inferred from the data.

III. ASSESSMENT OF ENVIRONMENTAL STATUS OF BOKA KOTORSKA BAY TO PROMOTE BLUE AND GREEN ECONOMY - BIODIVERSITY

No.	SECTOR-SITE	EcAp descriptor	EcAp Indicator	Description of status-pressures	Main pressures-influences	Objective to attain GES	Actions
1	**Boka Kotorska Bay**	Species distributions is maintained	Area covered by the species (plankton, benthic and nekton organisms)	Identified habitats of *Posidonia oceanica* and other sea grass with the receding trend due to pressures from land and the sea. Population size unknown; only the sites where such species are registered are known	Land-based human influence; increasing population and tourism visits; construction in the coastal zone; development of nautical and cruising tourism; uncontrolled fishing and scuba diving practices; global warming	Species abundance and population density does not recede and is maintained at the minimum established by base values. Preservation of habitats where species were recorded. Improvement of physical and chemical environmental features	- Minimize, limit and control construction activities and tourism development; - Protect vulnerable and endangered species and habitats characteristic for the Bay area by their listing; - Promotion and support to eco tourism; - Address the issue of waste waters; - Regulate recreational fishing and stricter fishing controls; - Control over disposal of construction waste within the Bay area; - Control of scuba-diving; - Control and limit the presence of cruise vessels; - Adjust routes and mooring places to avoid damages to sensitive species and habitats; - Monitoring, more intensive control and sanctioning of illicit fishing practices.
		Population size of selected species is maintained	Population density	Sea turtle: (*Caretta caretta*): 3 turtles recorded in the Bay	Irresponsible actions by fishermen; increased intensity of maritime traffic	Species abundance does not decline significantly due to human actions and activities are undertaken to increase this population	- Control and limit the number of cruise ships in the Bay; - Adjust routes and mooring places to avoid damages to sensitive species and habitats; - Monitoring, more intensive control and sanctioning of illicit fishing practices.
				Dolphin (*Tursiops truncatus*) occasionally visits the Bay	Irresponsible actions by fishermen; increased intensity of maritime traffic	The species distribution does not decline significantly due to human actions and activities are undertaken to increase this population	- Control and limit the number of cruise ships in the Bay; - Adjust routes and mooring places to avoid damages to vulnerable species and habitats; - Monitoring, more intensive control and sanctioning of illicit fishing practices.

				Engraulus engrasicolus: Anchovy biomass estimated at 144.4 t and 29.3 % share in catch, mean size 7.6 cm	Excessive and illegal fishing, and use of illicit means; change of physical and chemical parameters of water caused by human influence; climate change	Maintain biomass at the current level or increase in a way indicative of fish population sustainability	- Monitoring, more intensive control and sanctioning of illicit fishing practices.
				Sardina pilchardus Pilchard biomass estimated at 342.9 t, 66.0 % share in catch, mean size 7,6 cm	Excessive and illegal fishing, and use of illicit means; change of physical and chemical parameters of water caused by human influence; climate change	Excessive and illegal fishing, and use of illicit means; change of physical and chemical parameters of water caused by human influence; climate change	- Monitoring, more intensive control and sanctioning of illicit fishing practices.
		Key coastal and marine habitats are not being lost	Distributional pattern of certain coastal and marine habitats listed under SPA protocol	Biocenosis of coastal terrigenous mud covers more than 87 % of the total area of Kotor and Rsan Bays, while its coverage in Tivat and Herceg Novi Bays is unknown	Land-based human impact, such as disposal of waste and debris into the sea, embankment, reclamation of the sea; increased population pressures in the coastal zone; discharge of municipal waste waters into the sea	Distribution of coastal terrigenous mud biocenosis is stable and/or increasing and not lower than the base value (87 % of the total area of Kotor and Risan Bays)	- Minimize, limit and control construction activities and tourism development; - Address the issue of waste waters.
				Biocenosis of the coastal detritic seabed covers about 2% of the total area of Kotor and Rsan Bays, while its coverage in Tivat and Herceg Nov Bays is unknown	Land-based human impact, such as disposal of waste and debris into the sea, embankment, reclamation of the sea; increased population pressures in the coastal zone; discharge of municipal waste waters into the sea	Distribution of coastal detritic seabed biocenosis is stable and/or increasing and not lower than the base value (2% of the total area of Kotor and Risan Bays)	- Minimize, limit and control construction activities and tourism development; - Address the issue of waste waters.
				Coralligenic biocenosis covers about 2% of the total area of Kotor and Risan Bays, while its coverage in Tivat and Herceg Nov Bays is unknown	Land-based human impact; excessive and uncontrolled fishing; uncontrolled scuba diving; climate change; invasive species	Distribution of coraligenic biocenosis is stable and/or increasing and not lower than the base value (2% of the total area of Kotor and Risan Bays)	- Address the issue of waste waters; - Minimize, limit and control construction activities and tourism development; - Control and limit the presence of cruise vessels in the Bay; - Control scuba diving; - Monitoring, more intensive control and sanctioning of illicit fishing practices.
				Sea grass biocenosis covers about 0.15% of the total area of Kotor and Risan Bays, while its coverage in Tivat and Herceg Nov Bays is unknown	Land-based human impact; discharge of municipal waste waters; moorings and increased maritime traffic	Distribution of sea grass biocenosis is stable and/or increasing and not lower than the base value (0.15% of the total area of Kotor and Risan Bays)	-Address the issue of municipal waste waters; - Minimize, limit and control construction activities and tourism development; - Control and limit the presence of cruise vessels in the Bay.

1	**Boka Kotorska Bay**	Level of exploitation by commercial fisheries is within biologically safe limits	Ratio between catch and biomass index	Reducing fish stock biomass, especially commercial species	Uncontrolled fishing	Maintain biomass at the current level or increase in a way indicative of fish population sustainability	- Monitoring and more intensive control and implementation of sanctioning policy in fishing.
1	Boka Kotorska Bay	Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem	Spatial distribution, origin and population status (established vs. vagrant) of non-indigenous species	The total of 11 species registered so far, 3 flora species and 8 fauna species, although this is not a finite number since it is to be expected to detect further new species from other areas during the subsequent research.	Competition with native species and disturbance in the food webs, but this influence still under-researched Boka Kotorska Bay	Control of spreading of already registered species and introduction of new non-indigenous species	- Monitoring populations of registered species and their impact; - Control of the main means and routes for introduction of new species.

IV. REFERENCES

AdriaMed Pilot Study, 2007-08.

Babin, M., Morel, A., Gentili, B., 1996. Remote sensing of sea surface sun-induced chlorophyll fluorescence: consequences of natural variations in the optical characteristics of phytoplankton and the quantum yield of chlorophyll a fluorescence. International Journal of Remote Sensing 17, p. 2417-2448.

Badalamenti, F., Treviño-Otón, J., 2012. Development of Marine and Coastal Protected Areas (MPAs) in the Republic of Montenegro. Contract n° 05/ RAC/SPA /2011 MedMPAnet. 57 pp.

Batteli, C., Rindi, F., 2008. The extensive development of the turf-forming red alga *Womersleyella setacea* (Hollenberg) R. E. Norris (Rhodophyta, Ceramiales) in the Bay of Boka Kotorska, Montenegro (southern Adriatic Sea). Plant Biosystems 142 (1), p.120-125.

Benović, A., Lučić, D., Onofri. V., 2000. Does change in an Adriatic hydromedusan fauna indicate an early phase of marine ecosystem destruction? P.S.z.N.: Mar. Ecol., 21, p. 221-231.

Boero, F., Bouillon, J., Gravili, C., Miglietta, M. P., Parsons, T., Piraino. S., 2008. Gelatinous plankton: Irregularities rule the word (sometimes). Mar. Ecol. Prog. Ser., 356, p. 299–310.

Drakulović, D., Vuksanović, N., Joksimović, D., 2011. Dynamics of phytoplankton in Boka Kotorska bay. Studia Marina, 25(1), p. 1-20.

Drakulović, D., Vuksanović, N., Krivokapić, S., Pestorić, B., 2010. Phytoplankton Community as indicator of Eutrophication in the BokaKotorska Bay, http://balwois.com/balwois/administration/full_paper/ffp-1697.pdf.

Ecologycal study to strengthen the creation processes and the management of marine protected areas in Montenegro-Report, 2013. Report No. 12508420857.

Galil, B. S., 2007. Loss or gain? Invasive aliens and biodiversity in the Mediterranean Sea. Marine Pollution Bulletin 55(7-9), p. 314-322.

Gamulin-Brida, H., 1962. Biocenoze dubljeg litorala u kanalima srednjeg Jadrana = Biocoenoses du littoral plus profond (Circalittoral) dans les canaux de l'Adriatique moyenne. Acta Adriatica, 9, p. 1-196.

Gamulin-Brida, H., 1974. Biocoenoses benthiques de la mer Adriatique – Bentoske biocenoze Jadranskog mora. Acta Adriatica, 15(9), p. 1-102.

Giovanardi F. and Tromellini, E.,1992. Statistical assessment of trophic conditions. Application of the OECD methodology to the marine environment, in Marine Coastal Eutrophication, by Vollenweider R.A., Marchetti R. and Viviani R. (eds), Elsevier, London, p. 211-233. Godišnji izvještaj monitoringa kvaliteta voda za marikulturu za 2013 Godinu, MPiRR CG.

Informacija o stanju životne sredine Crne Gore za, 2009. godinu, 2010, Ministarstvo održivog razvoja i turizma Crne Gore, Agencija za zaštitu životne sredine.

Informacija o stanju životne sredine Crne Gore za, 2010. godinu, 2011, Ministarstvo održivog razvoja i turizma Crne Gore, Agencija za zaštitu životne sredine.

Informacija o stanju životne sredine Crne Gore za, 2011. godinu, 2012, Ministarstvo održivog razvoja i turizma Crne Gore, Agencija za zaštitu životne sredine.

Informacija o stanju životne sredine Crne Gore za, 2012. godinu sa Prijedlogom mjera, 2013, Ministarstvo održivog razvoja i turizma Crne Gore, Agencija za zaštitu životne sredine.

Joksimović, A., 2000. Stanje, struktura i stepen ugroženosti populacije arbuna (rombuna), Pagellus erythrinus, na području Crnogorskog primorja. Magistarska teza. Prirodno-matematički fakultet, Univerzitet u Kragujevcu, 73st.

Joksimović, D., Tomić, I., Stanković, R. A., Jović, M., Stanković, S., 2011. Trace metal concentrations in Mediterranean blue mussel and surface sediments and evaluation of the mussels quality and possible risks of high human consumption. Food Chemistry 127, p. 632–637.

Jukić, S.,1983. Kočarska naselja Crnogorskog primorja i dozvoljeni nivo iskorišćavanja. Studia marina, 13-14, p. 155-166.

Karaman, G., Gamulin-Brida, H., 1970. Contribution aux recherches des bicenoses benthiques du Golfe de Boka Kotorska. Studia Marina, 4, p. 3-42.

Karlovac, O., 1957. Stations list of the M.V. 'Hvar' fishery-biological cruises 1948-49. In: Reports, Split, vol. I No 3.

Krivokapić, S., Vuksanović, N., Stanković, Ž., 2009. Seasonal variation of phytoplankton biomass and environmental conditions in the inner Boka Kotorska Bay (eastern Adriatic Sea). Acta Bot. Croat. 68 (1), p. 45–55.

Lepetić, V., 1965. Sastav i sezonska dinamika ihtiobentosa i jestivih avertebrata u Bokokotorskom zalivu i mogućnosti njihove eksploatacije. Studia Marina, 1, p. 164.

Lokalni Akcioni plan za biodiverzitet Opštine Tivat za period od 2013. do 2018. godine, 2012.

Lučić, D., Pestorić, B., Malej, A., Lopez, L., Drakulović, D., Onofri, V., Miloslavic, M., Gangai, B., Onofri I., Benović, A., 2012. Mass occurrence of the ctenophore *Bolinopsis vitrea* (L. Agassiz, 1860) in the nearshore southern Adriatic Sea (Kotor Bay, Montenegro). Environ. Monit. Assess., 184, p. 4777-4785.

Mačić, V., 2008. Novo nalazište invazivne alge *Womersleyella setacea* (Hollenberg) R. E. Norris u crnogorskom podmorju. Vode 2008, Mataruška banja 3-6. jun 2008. p. 293-296.

Mačić, V., 2013. Contribution to the knowledge of *Bursatella leachii* (de Blainville, 1817) distribution and reproduction in the Boka Kotorska Bay (Montenegro). Studia Marina 26 (1), p. 119-128.

Mačić, V., Boža, P., 2001. Naselja morskih cvjetnica u Bokokotorskom zalivu (Seagrasses meadows in the Bay of Boka Kotorska) "Zasavica 2001", Zbornik radova, Sremska Mitrovica, p. 109-114.

Mandić, M., Đurović, M., Pešić, A., Joksimović, A., Regner, S., 2013. Boka Kotorska Bay-spawning and nursery area for pelagic fish species. Studia Marina 26(1), p.33-46.

Mandić, S., Joksimović, A., Joksimović, D., Mačić, V., Kašćelan, S., Đurović, M., 2007. Report 1. Estimate of environmental impact - Marine Ecology CUW-UK.

Marković, O., Gokoglu, M., Petović, S., Mandić, M., 2014. First record of the Northern brown shrimp, *Farfantepenaeus aztecus* (Ives, 1891) (Crustacea: Decapoda: Penaeidae) in the South Adriatic Sea, Montenegro. Medit. Mar. Sci., 15/1, p. 165-167.

Mihajlović, R., Joksimović, D., 2002. Heavy metals in sediments from Boka Kotorska Bay. Studia Marina 23 (1), p. 49-56.

Mihajlović, R., Joksimović, D., Mandić, S., Mihajlović, Lj., 2002. Macro i micro elements in sea water of Boka Kotorska Bay. Studia Marina 23(1), p. 41-48.

Mills, C. E., 2001. Jellyfish blooms: Are populations increasing globally in response to changing ocean conditions? Hydrobiol., 451, p. 55–68.

Pérès, J. M., Gamulin-Brida, H., 1973. Biološka oceanografija. Školska knjiga, Zagreb, 493 pp.

Pestorić, B., Krpo-Ćetković, J., Gangai, B., Lučić, D., 2012. Pelagic cnidarians in the Boka kotorska Bay (Montenegro, South Adriatic) ACTA ADRIATICA, 53(2): 289 - 300, 2012.

Pešić, A., 2011. Ribarstveno _ Biološka istraživanja juvenilne srdele (*Sardina pilchardus* Walbaum 1792.) U Kotorskom zalivu. Doktorska teza. Prirodno-matematički fakultet, Univerzitet u Kragujevcu, 73st.

Rijavec, L., 1975. Biology and dynamics of *Pagellus erythrinus* (L.) in the Boka Kotorska Bay and off the coast of Montenegro. Studia Marina 8, p. 3-109.

Seed, R. 1968. Factors influecting shell shapes in the mussel *M. galloprovincialis*. Mar. Biol. Ass. UK, 1968, p. 561-584.

Solazzi, A. 1971. Reperti algologici delle Bocche di Cattaro. Thalassia Salentina, 5.

Stjepčević et al., 1977.

Stjepčević, J. 1967. Biologija i tehnološki proces uzgoja jadranske kamenice (*Ostrea edulis* L.). Poljoprivreda i šumarstvo XIII, 4, p.33–48.

Stjepčević, J., Parenzan, P., 1980. Il Golfo delle Bocche di Cattaro – condicioni generali e biocenosi bentoniche con carta ecologica delle sue due baie interne. Studia Marina, 9-10, p. 3-149.

Streftaris, N., Zenetos, A., 2006. Alien Marine Species in the Mediterranean -the 100 'Worst Invasives' and their impact. Mediterranean Marine Science Volume 7/1,p. 87-118.

Vukanić, 1971., Kopepodi Bokokotorskog zaliva. Studia Marina Vol. 5. p. 21-62.

Vuksanović, N., 2003. Procjena količine fitoplanktona u području Crnogorskog primorja kao posljedica eutrofikacije. »Zaštita voda 2003« Zbornik radova, 383-385.

Zenetos A, Gofas S, Verlaque M, Çinar ME, García Raso E, Bianchi CN, Morri C, Azzurro E, *et al.,* 2010. Alien species in the Mediterranean Sea by 2010. A contribution to the application of European Union's Marine Strategy Framework Directive (MSFD). Part I. Spatial distribution. Mediterranean Marine Science 11(2), p. 381-493.

Županović, Š., 1963. Contribution a la conaissance de la biologie du *Mullus barbatus* (L) dans l'Adriatique moyene. Rapp. Com. int. Mer Medit., 17(2), p. 346-362.

Županović, Š., Rijavec, L., 1980. Biology and population dynamics of *Pagellus erythrinus* (L) in the insular zone of the middle Adriatic. Acta Adriat. 21(2), p. 203-226.

Regional Activity Centre
for Specially Protected Areas (RAC/SPA)

Boulevard du Leader Yasser Arafat
B.P. 337 - 1080 Tunis Cedex - TUNISIA
Tel. : +216 71 206 649 / 485 / 765
Fax : +216 71 206 490
e-mail : car-asp@rac-spa.org
www.rac-spa.org