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RAPID ASSESSMENT SURVEY OF COASTAL HABITATS TO HELP PRIORITIZE THE SUITABLE NEW AREAS NEEDING A STATUS OF PROTECTION FOR THE DEVELOPMENT OF A NETWORK OF MARINE AND COASTAL PROTECTED AREAS IN MONTENEGRO

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RAPID ASSESSMENT SURVEY OF COASTAL HABITATS TO HELP PRIORITIZE THE SUITABLE NEW AREAS NEEDING A STATUS OF PROTECTION FOR THE DEVELOPMENT OF A NETWORK OF MARINE AND COASTAL PROTECTED AREAS IN MONTENEGRO

MedMPAnet project

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Contents

1. INTRODUCTION

This report is part of the pilot activities for the on-site implementation of the project "Development of a Mediterranean Marine and Coastal Protected Areas (MPAs) Network through the boosting of Mediterranean MPAs creation and management in areas within national jurisdiction of third countries", with support to RAC/SPA by the EC and the Spanish Agency for International Cooperation to Development, AECID.

The report includes the findings of three different marine biodiversity survey missions to Montenegro carried out in 2008 (20-29 July 2008) principally in the northern coast of the country, in 2011 (25 October-03 November 2011) in the southern coast and in the Bay of Kotor, and in 2012 (12 – 20 June) in the following selected sites: Bay of Boka Kotorska (o. Sv. Đorđe and Strp), Mamula island and surroundings (o. Mamula and u. Ploča), island Sv. Nikola in front of Budva town (several locations including cape Mogren) and Trašte bay (Seka Kočište, Kamenolom Oblatno and Maslinada).

The report includes the assessment of benthic and fish assemblages and of human activities along the Montenegrin coast and is aimed at supporting the definition of specific protection/management measures for the Montenegro coast.

The report includes two series of data, one on the benthic habitats collected by Dr Fabio Badalamenti and the other on the fish assemblages, collected by Dr Jose Antonio García Charton and Mr Jorge Treviño Otón. Notes on the human activities and related socio-economic aspects were gathered by all the consultants.

Data on benthic habitats from the three missions (2008, 2011 and 2012) were merged, a common analysis was performed and a general discussion about the state of the benthic habitats provided.

Fish data from 2008, 2011 and 2012 were merged and analysed to extract a general view of the status of fish populations along the coast of Montenegro.

GPS coordinates and extension of the sites explored were provided by Dr Vesna Mačić, from the Institute of Marine Biology in Kotor and Dr Daniel Cebrian from the UNEP/MAP-RAC/SPA.

2. METHODS

2.1. Study Area

The coast of Montenegro is small, with about 300 km long shoreline. This report covers the whole Montenegro coastline, from Mamula Island in the North, at the entrance of the Bay of Kotor, to Ulcinj in the South of the country. The report also includes a survey inside the Bay of Kotor. The coastal habitat of Montenegro is characterized by calcareous rocky shores with sub-vertical (Fig. 1) and vertical cliffs (Fig. 2) sloping abruptly down to 20-30 m depth on a mosaic of gravel, sand and mud, intermingled with generally small pebble/gravel beaches or creeks (Fig. 3) with gentler slopes. Two exceptions are the large sandy beaches close to the border with Albania (Annex I; Fig. 21), the Velika Plaza south of Ulcinj, and the Bay of Kotor (Annex I; Fig. 32), which is a distinct system.

Along the rocky shore the lower part of the infralittoral is often covered by well-preserved *Posidonia oceanica* meadows (Fig. 4) with lower limits from 16 (in the south) to 33 (in the north) m depth. The upper part of the infralittoral is rocky. In some areas the habitat structure is very complex (characterized by outcrops and large-sized boulders) (Fig. 5). Algal coverage is generally scanty because most of this zone is characterized by a coralline barren dominated by sea urchins and encrusting algae (Fig. 6).

Areas with dense coverage of *Cystoseira* spp. or other brown algae are rare and generally located in the very upper infralittoral or in the infralittoral fringe where *Cystoseira amentacea* dominates the algal assemblage. The barren area (Fig. 7) extends on average from 0.5 to 10-12 m depth. Only at Seka Albaneze, Seka Kočište and Mamula Island does the barren area appear very small; the sea bottom is covered by algae, in particular by different species of *Cystoseira* and *Sargassum*, and *Padina pavonica* (Fig. 8). Another exception is the Bay of Kotor, where the barren is absent, possibly because of a lack of large rocky areas. Here, the upper infralittoral is rich in brown algae.

The midlittoral was not investigated thoroughly during our missions. It is often characterized by the presence of *Mytilus* spp. (Fig. 9), with a rich assemblage of predators, including the starfish *Coscinasterias tenuispina* and the mollusc *Stramonita haemastoma* (Fig. 10). Close to the surface, clear signs of biotope damaging owed to date-fishing (*Lithophaga lithophaga)* are present (Fig. 11). Between Bar and Ulcinj, mud is quite often found at the bottom of the cliff, with the remarkable presence of Axinella cfr *cannabina* (finding a also common in the Boka Kotorska). The small bays and inlets are generally dominated by *P. oceanica* and sand or gravel and pebbles closer to the surface. The small bays, such as those of Budva, Petrovac and Trašte, are dominated by *P. oceanica* and sand or gravel and pebbles closer to the surface.

The Bay of Kotor, Boka Kotorska, (Fig. 12), is a distinct system. The Boka Kotorska is a semi-enclosed bay. Owing to its peculiar shape and origin it is sometimes defined as the southernmost fjord. Since the middle of the 20th century a number of researchers have begun to study its fauna and have contributed greatly to improving knowledge of the Boka Kotorska. The most extensive study is probably that by Stjpčević and Parenzan (1980) carried out in 1970.

General description of the Bay

The sea passes through the strait between Cape Ostro (Rt Ostro) and Punta Miriste, first entering the Bay of Herceg-Novi (Hercegnovski zaliv) then turning towards the east, crossing a narrower channel (Kumborski tjesnac) then widening again into the Bay of Tivat (Tivatski zaliv). From here the sea heads north to the inner bays through the narrow Verige Strait, widening to the west in the Bay of Risan (Risanski zaliv) and to the east in the Bay of Kotor (Kotorski zaliv), which bends sharply while narrowing towards the south.

Between the Verige Strait and Perast lie the two small islands of St. George (Sveti Djordje) and Our-Lady-of-the-Reef (Gospa od Skrpjela).

The deep inlet of the Boka Kotorska is particular, due to its geographical situation, its orographical configuration and hydrographic characteristics, which influence the biotic and abiotic factors. All of this determines a very specific physiognomy due to the enclosed waters, which present notable differences to the open sea.

Origin of the Bay

The first hypothesis regarding the origin of the Boka Kotorska was that of Savicki (1924), who considered the morphological configuration to be of fluvial origin and pointed out that the straits have fluvial forms. The existence of terraces along the straits suggest that a tectonic predisposition should not be excluded. Cvijic (1924) supported Savicki’s opinion and added that the Verige Strait is an erosion point, a similar one being present at Capo Ostro. The Bay is accepted to be a drowned valley shaped during the Pliocene period and continued later by tectonic down-warping (Campanelli *et al.* 2011).

Hydrographic conditions

Five small watercourses are present in the Boka Kotorska area: Škurda, Ljuta, Široka rijeka, Gradiosnica and Sutorina. The whole area is also characterized by karstic rivers and underwater springs, which influence temperature, salinity and species distribution.

The larger watercourses, coastal and underwater sources/springs are present mostly in the Bays of Kotor and Risan. All the rivers, streams and torrents originate in the Lovcen and Orjen mountain ranges, where there are vast areas of karst which take in water in the rainy season and feed the underground water system.

From November to April, when precipitation is higher, the sea surface of the Bays of Kotor and Risan, especially close to Orahovac and Morinj, shows very low salinity. Precipitation in the Boka Kotorska reaches a maximum of 5480 mm due to the enormous mass of freshwater flowing into the basin of Risan, which is relatively small and closed (Stjepcevic and Parenzan, 1980). Precipitation varies greatly throughout the year. After the rainy season, there is a period of summer drought, with no rainfall for 3-4 months (July-September).

Throughout the year there is wide variation in surface water temperature in the Bay of Kotor. The mean maximum temperature is in July (26.9° C) and the minimum in February (8.3 °C). Mean seafloor temperatures ranged from 19.5 °C to 14.4 °C (Stjepcevic and Parenzan, 1980).

Salinity

The lowest level of salinity, 26.27 ppm, is found in the Bay of Risan at 11m depth. This low value is influenced by the great inflow from underwater freshwater sources/springs. The highest level of salinity is 39 ppm in the Bay of Kotor (Stjepcevic and Parenzan, 1980).

Benthic assemblages along the slopes

The megafaunal benthic assemblages within the first 20 metres depth are characterized by the presence of massive cnidarian with madrepores (notably *Cladocora caespitosa*) and gorgonians (*Leptogorgia* cfr *sarmentosa* and *Savalia savaglia*) and sponge (*Axynella* spp., *Geodia cydonium*, *Aplysina aerophoba*) assemblages (Fig. 13 a-h).

Figure 1: Calcareous rocky shores are one of the most common Montenegrin coastal habitats (Mendra)

Figure 2: Calcareous vertical cliffs are one of the common Montenegrin coastal habitats (Valdanos)

Figure 3: Small pebble/gravel beaches are another typical habitat of the Montenegrin coast (stari Ulcinj)

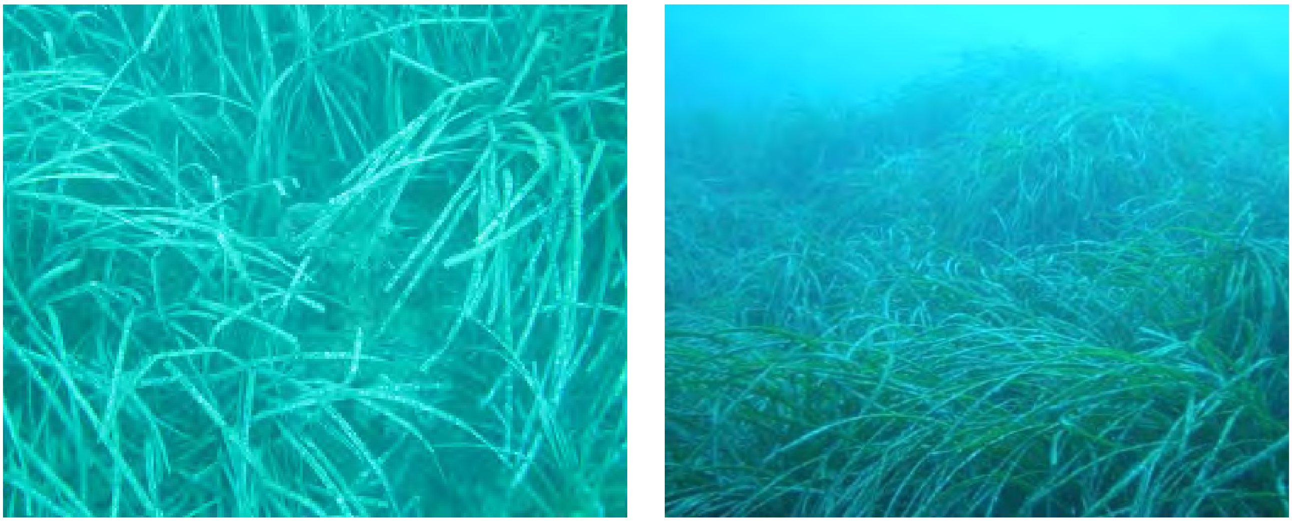


Figure 4: The lower part of the infralittoral along the rocky shore is often covered by well preserved *Posidonia oceanica* meadows with lower limits from 16 to 33 m depth (Rep)

Figure 5: In some areas the habitat structure is very complex (characterized by outcrops and large-sized boulders (Obala Strai Ulcinj)

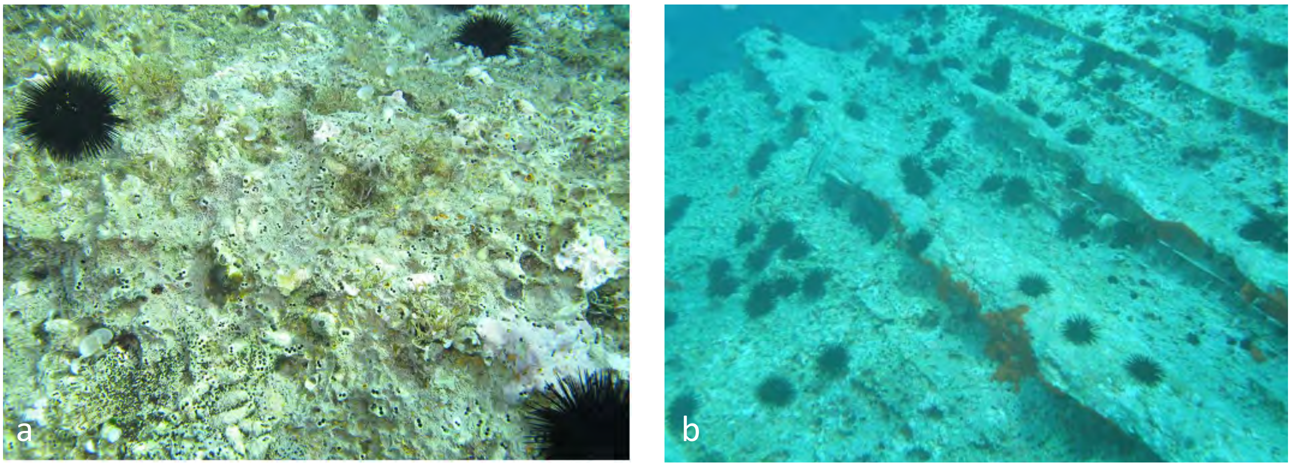


Figure 6: Algal coverage in the infralittoral is generally scanty because most of this zone is characterized by a coralline barren dominated by sea urchins and encrusting algae

Figure 7: Typical barren area at Rep

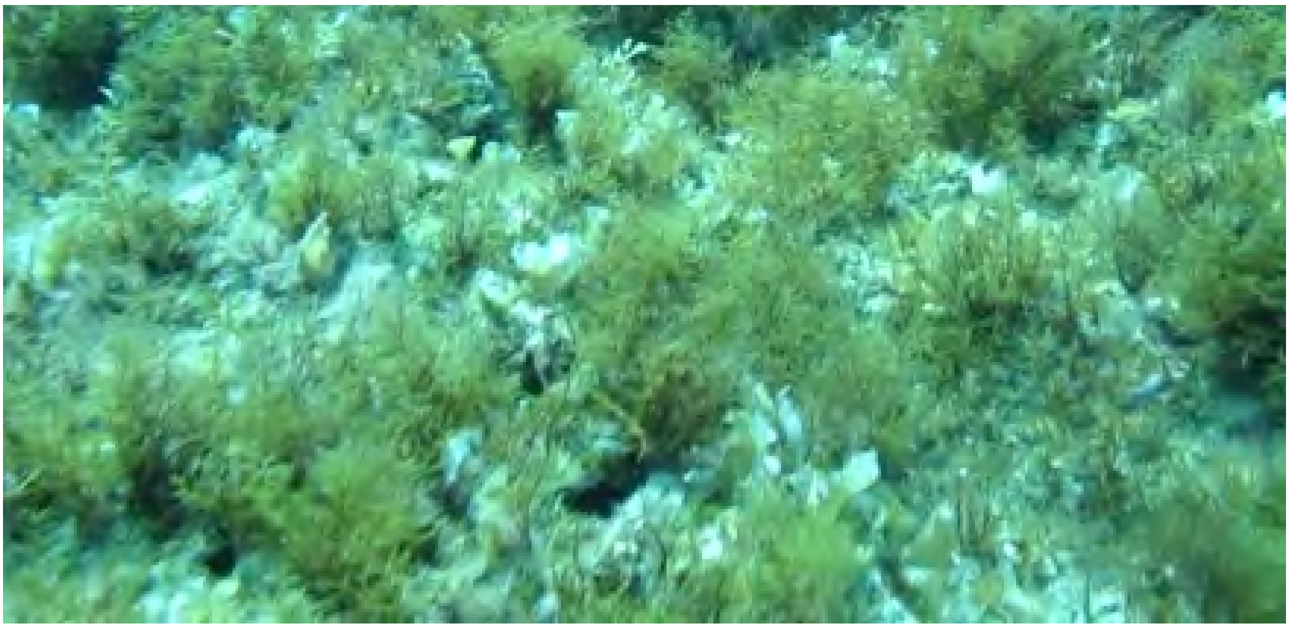


Figure 8: In the open sea at Seka Albaneze the barren area is very small and the sea bottom is covered by algae, in particular by different species of *Cystoseira, Sargassum* and *Padina pavonica*

Figure 9: The midlittoral could not be investigated thoroughly during our mission. It is often characterized by the presence of *Mytilus* spp.

Figure 10: *Coscinasterias tenuispina*, a common predator of Mytilidae

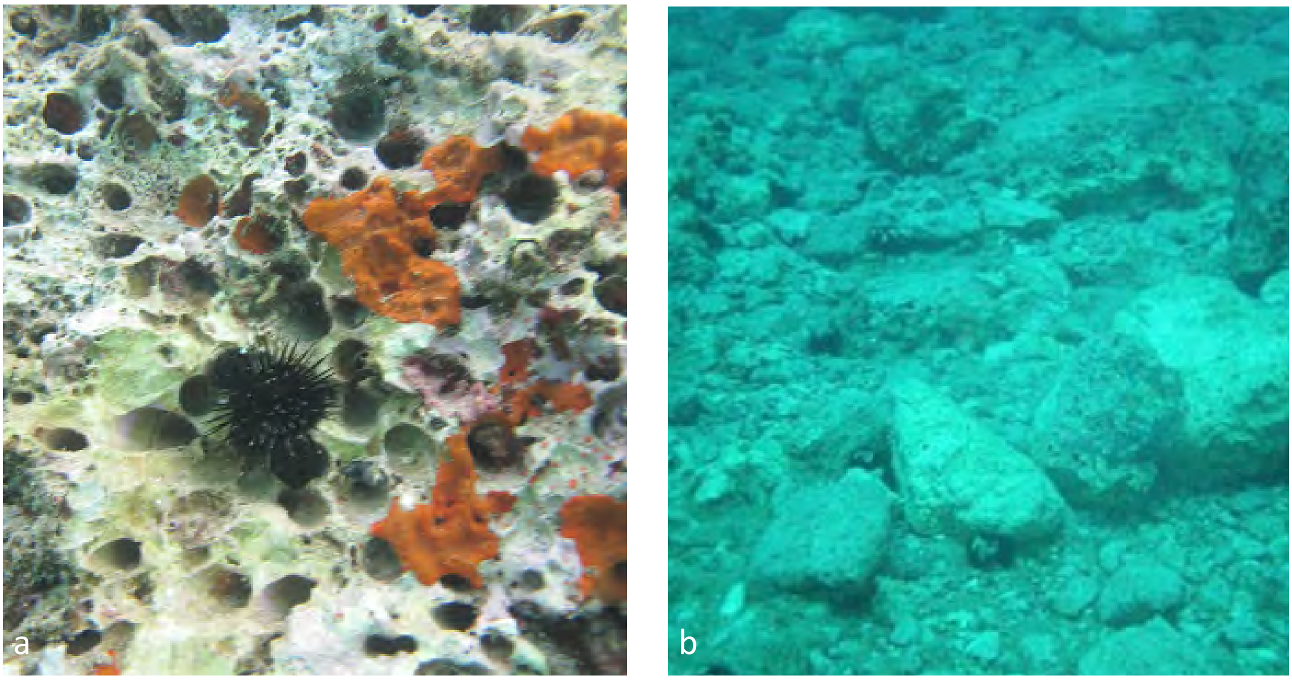


Figure 11: Close to the surface, clear signs of date-fishing are present

Figure 12: Bay of Kotor, close to Dražin Vrt

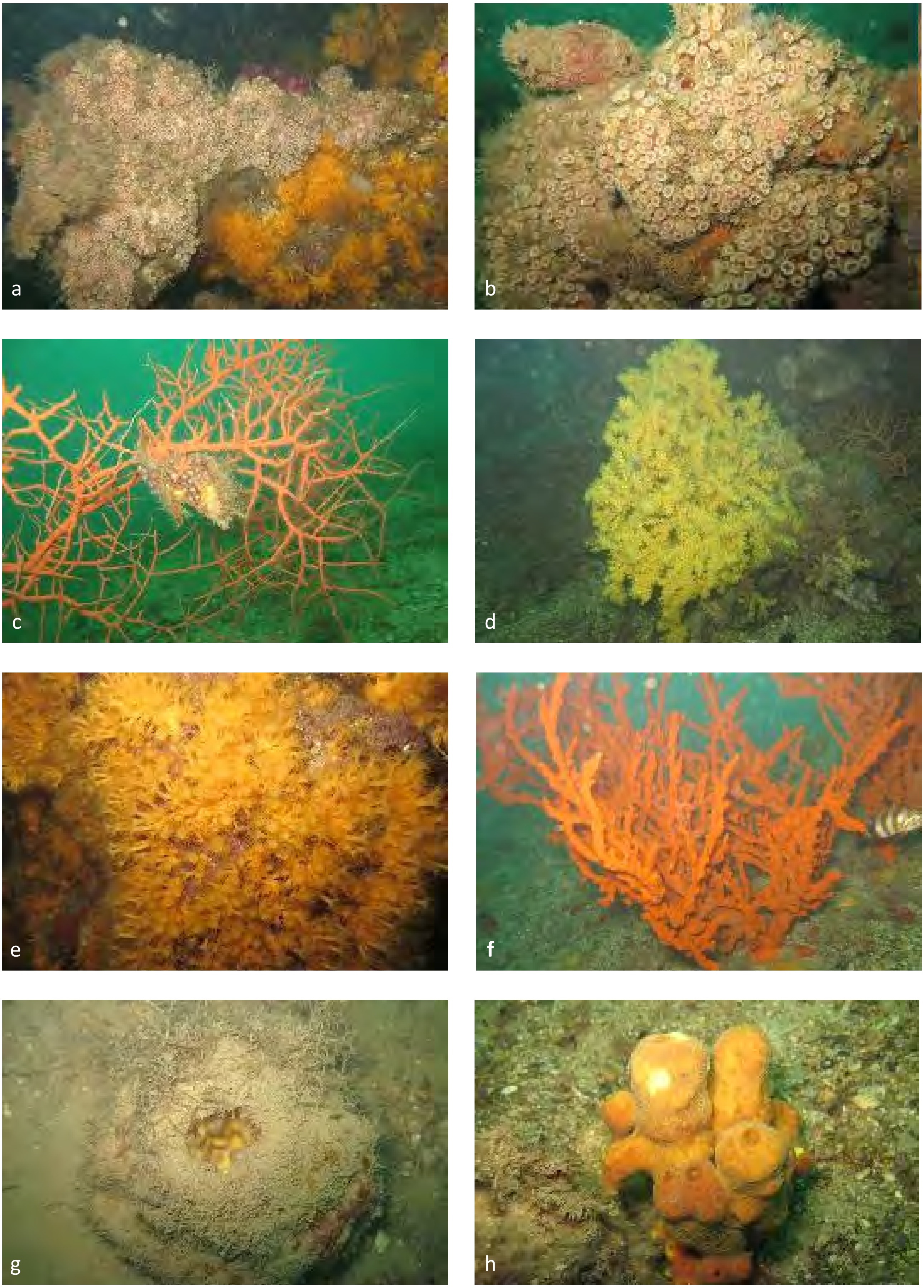


Figure 13: a) Madrepores, *Cladocora caespitosa*, b) and gorgonians, *Leptogorgia* cfr *sarmentosa* c) and *Savalia savaglia* d), *Parazoanthus axinellae* e) and *sponge Axynella* cfr *cannabina* f), *Geodia cydonium* g), *Aplysina aerophoba* h) characterize the mega benthic assemblages in the surveyed sites of Kotor Bay

2.2. Pre-survey

Pre-survey activities mainly consisted of gathering information on the area, in particular on the benthic and fish assemblages and the human activities along the Montenegrin coast and the Bay of Kotor and, during the second and third mission, reviewing the work carried out during the previous missions. Some important references were found in the Kotor Marine Laboratory library, others were gathered after meeting with local experts from the Laboratory or from the literature. Following the indications provided by the RAC/SPA contract and the suggestions of the Kotor researchers the following sites were chosen to carry out the surveys; 12 sites were surveyed both in 2008 and 2012 and 11 in 2011 (Table 1).

In 2008 at Dražin Vrt, in the Bay of Kotor, only a qualitative survey was carried out due to the shortage of time. In 2011 at O. Sv. Đorđe only a qualitative survey was carried out. This was because *Cladocora caespitosa* reefs had been reported in this site but we found none.

In 2012 at island Sv. Đorđe and Strp in the Bays of Kotor and Risan and Školj (offshore of island Sv. Nikola) only a qualitative survey was carried out. In the site at Kotor Bay, because diving was aimed at confirming the observation made in 2011 and to collect photos, školj was a qualitative replicate of island Sv. Nicola. Kamenolom Oblatno and Maslinada were used to describe the *Pinna nobilis* population of Trašte Bay.

All the other surveys included a quantitative assessment of the benthic and fish assemblages. A list of the most frequent and abundant benthic species was also collected, together with photographic documentation.

Table 1: Sites surveyed in Montenegro coast in 2008, 2011 and 2012

Site	Latitude	Longitude	Year of mission
1. Drazin Vrt	N 42° 29’ 0.56’’	E 18° 44’ 55.81’’	2008
2. Dubovac Cliff	N 42° 09’ 7.67’’	E 18° 59’ 04.17’’	2008
3. Formica islets	N 42° 10’ 3.68’’	E 18° 57’ 51.90’’	2008
4. Katic islets	N 42° 11’ 3.35’’	E 18° 56’ 05.04’’	2008
5. Mala Krekavica	N 42° 16’ 2.38’’	E 18° 45’ 35.31’’	2008
6. Mamula	N 42° 23’ 8.20’’	E 18° 33’ 32.24’’	2008
7. Posejdonov Grad	N 42° 22’ 4.89’’	E 18° 36’ 00.57’’	2008
8. Rt Kostovica	N 42° 18’ 4.99’’	E 18° 43’ 47.52’’	2008
9. Rt Platamuni	N 42° 16’ 0.67’’	E 18° 46’ 41.85’’	2008
10. Seka Albaneze	N 42° 19’ 1.23’’	E 18° 41’ 58.32’’	2008
11. Sveti Nikola	N 42° 16’ 4.49’’	E 18° 46’ 10.81’’	2008
12. Velika Krekavica	N 42° 17’ 6.21’’	E 18° 44’ 55.81’’	2008
13. Dražin Vrt	N 42° 29’ 00.6’’	E 18° 42’ 54.3’’	2011
14. Iza Perasta	N 42° 29’ 45.3’’	E 18° 41’ 25.5’’	2011
15. O. Stari Ulcinj	N 41° 59’ 30.8’’	E 19° 08’ 29.5’’	2011
16. O. Sv. Đorđe	N 42° 29’ 07.1’’	E 18° 41’ 27.8’’	2011
17. Obala Stari Ulcinj	N 41° 59’ 29.2’’	E 19° 08’ 28.3’’	2011
18. Opaljike	N 41° 55’ 50.3’’	E 19° 11’ 04.4’’	2011
19. Rt Kruče	N 41° 58’ 47.7’’	E 19° 08’ 26.4’’	2011
20. Rt Mendra	N 41° 56’ 59.8’’	E 19° 08’ 56.9’’	2011
21. Rt Rep	N 41° 58’ 37.2’’	E 19° 08’ 20.6’’	2011
22. Seka Albaneze	N 42° 19’ 41.6’’	E 18° 41’ 58.8’’	2011
23. Valdanos	N 41° 57’ 36.2’’	E 19° 09’ 20.8’’	2011
24. O. Sv. Đorđe	N 42° 29’ 07.0’’	E 18° 41’ 28.4’’	2012
25. Strp	N 42° 30’ 17.1’’	E 18° 40’ 24.4’’	2012
26. O. Mamula	N 42° 23’ 38.5’’	E 18° 33’ 31.7’’	2012
27. U. Ploča	N 42° 25’ 01.6’’	E 18° 32’ 53.3’’	2012
28. O. Sv. Nikola (west)	N 42° 15’ 35.7’’	E 18° 51’ 21.6’’	2012
29. O. Sv. Nikola (east)	N 42° 15’ 36.9’’	E 18° 51’ 31.8’’	2012
30. Hrid Galiola (o. Sv. Nikola west)	N 42° 15’ 37.8’’	E 18° 51’ 11.7’’	2012
31. Školj (o. Sv. Nikola west)	N 42° 15’ 43.7’’	E 18° 51’ 01.3’’	2012
32. Seka Kočište	N 42° 21’ 59.8’’	E 18° 39’ 54.2’’	2012
33. Kamenolom Oblatno	N 42° 22’ 31.7’’	E 18° 39’ 21.1’’	2012
34. Maslinada	N 42° 22’ 41.6’’	E 18° 41’ 17.2’’	2012
35. Rt Mogren	N 42° 16’ 26.2’’	E 18° 49’ 47.4’’	2012

2.3. Assessment of the benthic assemblages

The aim of this task was to report information on the most important benthic assemblages, including a list of dominant mega-fauna and mega-flora species and on the habitat structure of the infralittoral zone of the selected sites.

A protocol for data collection by SCUBA diving was finalized before starting the field activities (Annex 3). We decided to collect data along replicated (generally three per site) 10 m wide transects running perpendicular to the coast from the foot of the cliff up to the infralittoral fringe. Typically a transect ran from 20-25 m up to 0.5-2 m depth.

The following 23 benthic assemblages were selected *a priori* and mapped as percentage of cover within each transect:

1. Barren = encrusting coralline algae and sea urchins *Arbacia lixula* and *Paracentrotus lividus*
2. Boulders_barren = same as above plus large boulders
3. *Caulerpa racemosa* assemblage
4. *Cladocora caespitosa* reefs = *Cladocora caespitosa* assemblage
5. Coralligenous assemblages = Large boulders and vertical walls with dominance of *Halimeda tuna, Parazoanthus axinellae* and sponges
6. Infralittoral algal turf assemblages
7. Infralittoral gravel assemblages
8. Infralittoral mud assemblages
9. Infralittoral mud and gravel assemblages
10. Infralittoral pebble assemblages
11. Infralittoral sand assemblages
12. Large sponge assemblage with Geodia, Aplysina and Petrosia
13. Mussel bed assemblage
14. Photophilic algae assemblage with *Cystoseira* spp. and *Halopteris* spp.
15. Photophilic algae assemblage with *Cystoseira* spp.
16. Photophilic algae assemblage with *Padina pavonica*
17. *Posidonia oceanica*
18. Rubble and turf assemblage with *Codium* sp.
19. Sciaphilic algae assemblages on hard substrata = Rocky substrates dominated by *Codium bursa* and *Flabellia petiolata*
20. Sciaphilic algae assemblages on hard vertical/subvertical substrata with *Flabellia petiolata* and *Halimeda tuna*
21. Sciaphilic algae assemblages on hard substrata with *Flabellia petiolata* and *Peyssonnelia* spp.
22. Submerged canyon
23. Submerged caves

To facilitate graphic visualization, these assemblages were reduced to the following 10:

- Barren, including assemblages 1 and 2 ;
- Coralligenous including assemblages 4, 5, 12 and 23 ;
- Mussel bed ;
- Pebbles ;
- Photophilic algae, including assemblages 3 and 14-16 ;
- Posidonia ;
- Rubble and turf with *Codium* sp. ;
- Sciaphilic algae including assemblages 19-22 ;
- Soft bottom, including assemblages 7-11 ;
- Turf.

Pie charts were drawn for those 10 assemblages and non Metric Multidimensional Scaling (nMDS) calculated.

The following variables were collected while diving and reported on pre-constructed polyamide sheets: habitat complexity, depth and sea bottom slope, percentage cover of the most important assemblages and list of species. From land, the position of each transect (GPS coordinates), the existence of human activities, the geological nature and slope of the coast were recorded. Complexity was visually estimated by assigning different parts of transects with a value of 1 to 4, where 1 = low; 2 = medium; 3 = high and 4 = very high complexity. During the first survey in 2008. no data were collected from the midlittoral because of poor weather conditions and rough sea surface. For the next two surveys is decided to avoid more detailed survey of midlittoral in order to provide more compatible methodology and data compatibility with the previous survey. Also, we had idea to finish more difficult and more expensive survey of the deeper areas, considering that possible future survey of midlittoral could be easier to organize and to perform.

2.3.1. Assessment of *Pinna nobilis*

Pinna nobilis is the largest bivalve mollusc of the Mediterranean Sea, with records of individuals larger than 100 cm maximum shell length measured from the apex. It is endemic to this sea and inhabits subtidal soft bottoms, mainly *Posidonia oceanica* and *Cymodocea nodosa* meadows, sand, mud, biodetritic and maërl beds. Large-sized populations of *Pinna nobilis* have been spotted in the bay of Trašte. It was decided to dedicate a day in the area to locating at least two of these spots and performing a quantitative assessment of this threatened species listed in Annex II of the SPA/BD Protocol.

2.4. Assessment of fish assemblages

Underwater visual census (UVC) technique is a standardised method, not destructive and performed by SCUBA diving, that allow to collect data on fish richness, size structure and density data of fish assemblage. This method was used at the three campaigns in Montenegro with the aim to estimate rocky reef fish assemblages. 28 of the total sites selected were quantitatively surveyed, being Seka Albaneze done twice (2008 and 2011) (Table 2), while a qualitative observation was done in the other sites.

Table 2. List of sites surveyed each campaign grouped, by proximity, on zones within localities.

Year	Locality	Zone	Site
2008	PLATAMUNI	Eastern Grbalj	Rat Platamuni
			Sv. Nikola
		Western Grbalj	Seka Albaneze
			Rat Kostovica
		Krekavica	Velika Krekavica
			Mala Krekavica
	PETROVAC	Katic Islets	Katic Is.
			Sv. Nedjelja
		Dubovica	Dubovac Cliff
			Formika Is.
2011	KOTOR	Perast	Drazin Vrt
			iza Perasta
	PLATAMUNI	Western Grbalj	Seka Albaneze
	ULCINJ	Stari Ulcinj	Stari Ulcinj Is.
			o. Stari Ulcinj
		Rep	rt Kruce
			rt Rep
			Valdanos
		Ulcinj	rt Mendra
			Opaljike
2012	MAMULA	Mamula	Mamula Is.
			Ploca
	PLATAMUNI	Traste	Seka Kociste
		Sveti Nikola	Nikola East
			Nikola West
			Hrid Galiola
			Skolj
			Mogren

Underwater visual census (UVC) technique was used at each site in three replicates of transects 50 x 5 m.

Measuring tape of 50m length was layed on sea bottom, parallel to the coast line and trying to keep an average depth of 15 m. Observations along the 50m lenth and 5m wide transects were recorded in situ on a underwater-notebook estimating the size (in classes of 2 cm) and abundance of all species detected. Each fish observation was assigned to one of the nine predetermined abundance classes (1, 2-5, 6-10, 11-30, 31-50, 51-100, 101-200, 201-500, >500), the limits of which match up the terms of a base (approximately) 2 geometric series. Small-sized, cryptic species (belonging to families Gobiidae, Callyonimidae, Bleniidae, Gobioesocidae and Tripterygidae) were excluded from the censuses to avoid biases due to inappropriate size of sampling unit. Censuses were done between 10 and 15 h, when water conditions were optimal.

Along with the census of fish assemblages, habitat characteristics were also studied. In each transect, values of the deepest and shallowest points were recorded. From these values, average depth and verticality (difference between maximum and minimum depth) were calculated. Substrate types were also recorded as the percentage cover of rocky matrix, Posidonia meadow, sand bed or pebbles at each 10 x 5 m segment inside each transect. Surveys were followed by a short briefing were all divers comment theirs observations to complete the species list.

2.5. Data analysis

2.5.1. Benthic assemblages

Each transect was divided a posteriori into Units. A Unit was selected according to one of the following two criteria: a) change in the dominant assemblage and/or b) abrupt change in the slope (> 15°). Each Unit included one or more patches of the assemblages selected a priori. Units were named using the name of the dominant assemblage followed by the slope degree (i.e. flat 0°-10°, low 10°-30°, moderate 30°-60°, high 60°-80° and vertical wall 80°-90°). Overall, a total of 115 Unit was possible from the combination of the 23 assemblages x 5 slope degrees.

Total and average number of Units per site, average number of assemblages per Unit, average habitat complexity per site and the overall frequency of occurrence of assemblage per site were calculated.

The length of each unit was calculated *a posteriori* according to its depth range and slope. By summing the length of each unit the total length of each transect was calculated, and by multiplying length by width the unit and the overall transect surface area were obtained. From the percentage cover of each assemblage recorded within Units the surface area of each assemblage per transect was calculated and was then standardized as percentage cover of the whole transect.

A matrix, sites per assemblages, was constructed and a nMDS was calculated on the Bray-Curtis similarity matrix of untransformed data.

2.5.1.1 *Pinna nobilis*

Stripe sampling was used to assess *Pinna nobilis* density at two sites selected within Trašte Bay: Kamenolom Oblatno and Maslinada. Four 10 x 50 transect were carried out at Kamenolom Oblatno and one at Maslinada. Individuals observed within thetransects were counted and measured. Unburied length (UL) and corresponding minimum width (w) of individuals were measured underwater (Figure 14). Maximum shell length (Ht) of each *Pinna nobilis* was estimated using the equation (Ht = UL + 1.79w +0.5).

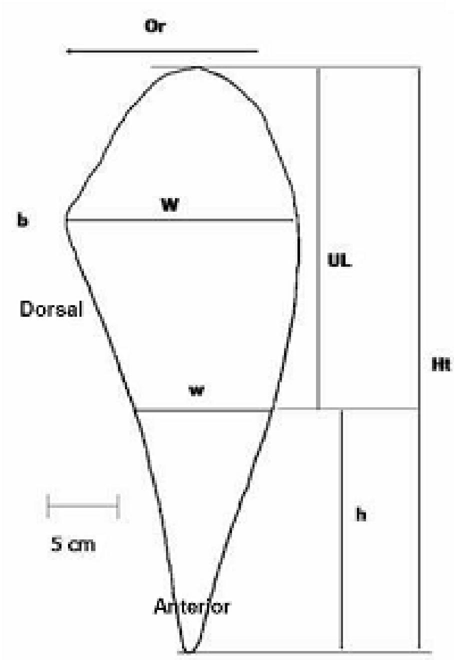


Figure 14: Standard measurements in *Pinna nobilis* individuals

2.5.2. Fish assemblages

Data from the three campaigns were merged in order to evaluate globally the spatial variation of fish assemblages along the coast of Montenegro. To this aim sites surveyed were grouped by proximity in zones and, equally, zones were organized in five localities (Table 2). Being one of them the Kotor bay, with peculiar characteristics and four localities placed outside the bay, from south to north, Ulcinj, Petrovac, Platamuni and Mamula. For data analysis geometric mean of each fish abundance class were extracted. Three parameters were used to evaluate the community structure, species richness and total and "reduced" abundance. Being the "reduced" abundance the total abundance excluding all pelagic and shoaling species occupying the water column and those species particularly cryptic or hidden, because they could not be accurately censused in a multi-species visual survey. We also examined differences at individual species but only on those non-pelagic taxa sufficiently present throughout the study, establishing the threshold on species with a frequency of occurrence ≥ 30%.

A three factor nested PERMANOVA (sites nested in zones and zones in localities) was done to evaluate differences from small to large scale (considering the factor Locality and as fixed). PERMANOVA analyses were done with the entire community, with the three parameters obtained (species richness and total and “reduce” abundance) and individually with those species with a frequency of occurrence ≥ 30%. PERMANOVA analyses were also completed with habitats variables in order to compare them with those obtained with fish population.

As a multivariate approach to evaluate the differences at community level between sites we performed, using transformed abundance data (log x + 1), a non Metric Multidimensional Scaling (nMDS) based on the Bray-Curtis similarity matrix and a Principal Component Analysis (PCA). We did the analysis with the entire community and repeated it with a “reduced” one after removing the shoaling and very abundant species which resulted determinant in the first ordination. We completed these analyses using PRIMER v6.

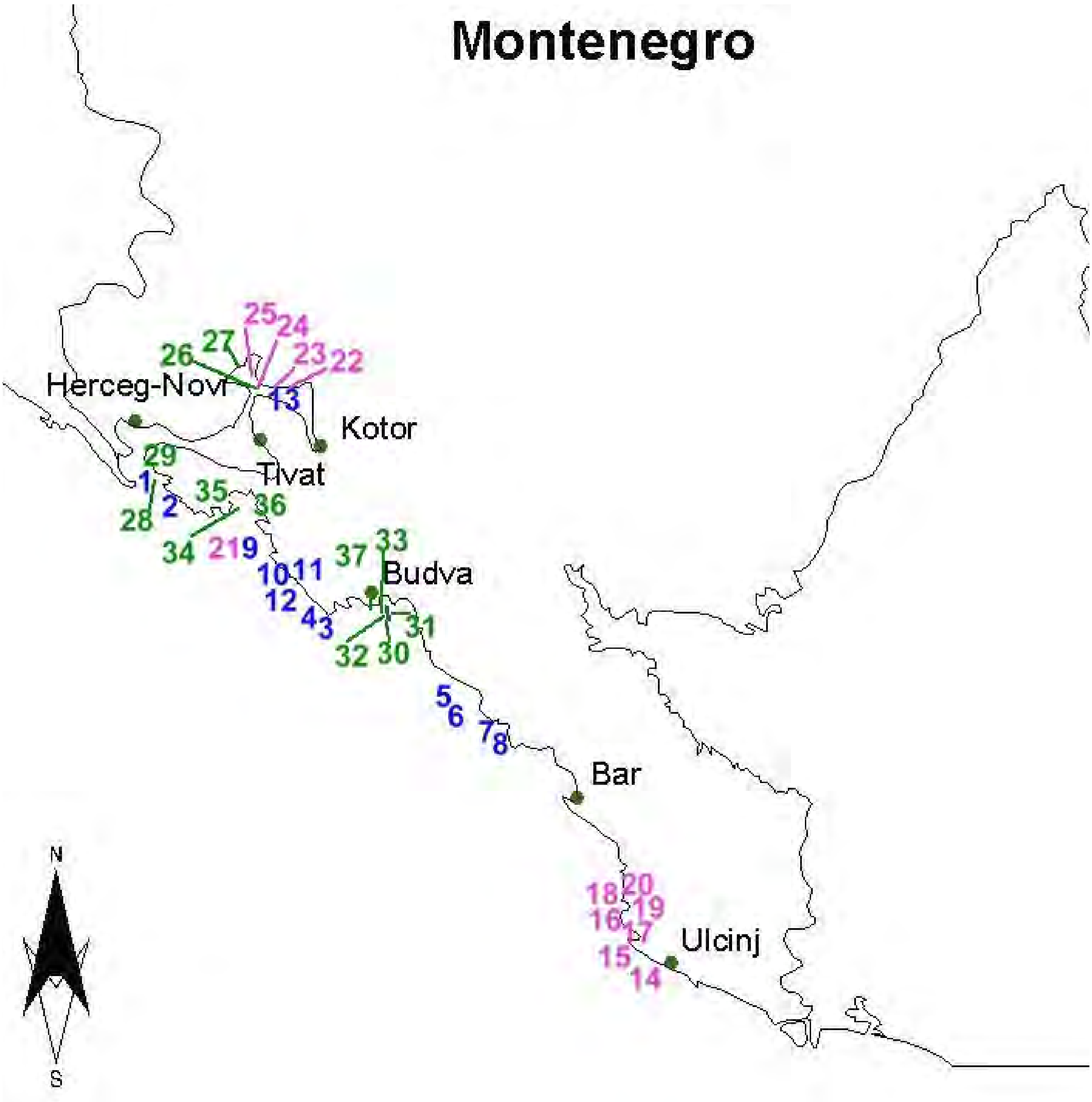


Figure 15: Map of the Montenegro coast and of the study sites. Numbers 1- to 13 refer to the first survey, numbers 14 to 25 to the second survey and numbers 26 to 37 to the third survey.

1 Mamula, 2 Posejdonov Grad, 3 Rt Platamuni, 4 Sveti Nikola, 5 Katič islets, 6 Dokova seka, 7 Formica islets, 8 Dubovac Cliff, 9 Seka Albaneze, 10 Rt Kostovica, 11 Mala Krekavica, 12 Velika Krekavica, 13 Dražin Vrt, 14 Opaljike, 15 rt Mendra, 16 rt Rep, 17 Valdanos, 18 o. Stari Ulcinj, 19 Rt Kruče, 20 obala Stari Ulcinj, 21Seka Albaneze, 22 Dražin Vrt, 23 Dražin Vrt, 24 O. Sv. Đorđe, 25 iza Perasta, 26 O. Sv. Đorđe, 27 Strp, 28 O. Mamula, 29 u. Ploča, 30 O. Sv. Nikola (west), 31 O. Sv. Nikola (east), 32 hrid Galiola (O. Sv. Nikola west), 33 školj (O. Sv. Nikola west), 34 Seka Kočište, 35 Kamenolom Oblatno, 36 Maslinada, 37 Rt Mogren.

3. RESULTS

3.1. Assessment of benthic assemblages

The coast surveyed is mainly composed of vertical or sub-vertical calcareous cliffs. Some of the sites are small islets or outcrops (e.g. Katič islet, O. Stari Ulcinj, Sveti Nikola, etc.) and in two cases offshore reefs were also surveyed (Seka Albaneze and Seka Kočište) (Table 3). Land use in the area surveyed is moderate (Table 3) but expansion of tourism is very likely in the whole area. Overall, 80 quantitative transects were explored in the sites visited and 70 Units identified (Table 3). Some further sites, (e.g. Dražin Vrt, Školj, O. Sv. Đorđe, Strp) were explored qualitatively.

Open sea sites

Katić islets was the site with the highest number of units (13), while Opaljike and Posejdonov Grad, showed the lowest (4 units) values (Table 3). The average number of Units per site ranged between 8.00 (Mendra) and 2.50 (Posejdonov Grad). The number of assemblages per site varied between the maximum recorded at Hrid Galiola (13) and the minimum recorded at Opalijke (5). The average number of assemblages per Unit varied between 3.38 (Seka Kočište) and 1.20 at Mala Krekavica (Table 3). Average habitat complexity was between 2.94 (Rt Kostovica) and 1.30 (Opaljike) (Table 3).

Boka Kotorska

Two quantitative surveys, Dražin Vrt and Iza Perasta, and three qualitative ones were carried out within the Bays of Kotor and Risan. Overall, 6 units were found at both Dražin Vrt and Iza Perasta, with an average of 5.33 and 4.33 units per site respectively. The total number of assemblages per site was the same at Dražin Vrt and Iza Perasta, but the average number of assemblages per unit was higher at Iza Perasta (2.08) than at Dražin Vrt (1.71). Average complexity showed the opposite trend (Table 3).

Overall, Barren, *Posidonia oceanica*, Soft bottoms and Turf were the dominant assemblages along the Montenegrin coasts, both as percentage cover and frequency of occurrence (Table 4 and 5 and Figure 3-4). Barren resulted the assemblage with the highest frequency of occurrence in the area (89%) followed by Turf and the Soft bottom assemblages (86%) and *Posidonia oceanica* (82%) (Table 4 and 5). The assemblages with the lowest frequency of occurrence in the area was *Cladocora caespitosa* (4%) (Table 4 and 5).

In terms of % cover, Barren assemblages (i.e. Barren + Boulders_Barren) were dominant in 11 sites, with values ranging between 24,3% and 61,8% (Barren only in 6 in the complete list of assemblages), *Posidonia oceanica* in 8 sites, with values ranging between 29,6% and 64,2% (11 sites in the complete list of assemblages) and soft bottoms in 5 sites, with values ranging between 27,6% and 95,0% (Table 4 and 5; Fig. 16 a-c).

Coralligenous assemblages were important within the Bay of Kotor (14,3% at Dražin Vrt and 12,7% at Iza Perasta) and, notably, was present also in Hrid Galiola, Mogren and Seka Kočište but with lower percentages (Table 4; Fig. 16 a-c). Rubble and Turf with Codium (28,1% at Dražin Vrt and 19,9% at Iza Perasta) resulted exclusive of the Bay of Kotor. The complex of Sciaphilic algae reaches higher values at Seka Kočište (58,1%) while Photophilic algae reaches higher values at Mamula (60,5%) and Seka Albaneze II (45,2%). Turf is the most important assemblage at Velika Krekavica (33,3%) (Fig. 16 a-c)

Table 3: Main characteristics of the sites studied.

Site	N. of transects	Total N. of Units per site	Average N. of Units per site	ds	Total N. of Assemblages per site	Average N. of Assemblages per Unit	ds	Average Habitat complexity	ds	Coast Typology	Slope° (Land)	Land Use	Date of dive
Dražin Vrt			Qualitative survey									i	29Julj 2008
Dražin Vrt	3	6	5,33	0,58	6	1,71	0,47	2,47	0,80	CC	40	i	31 October/01 November 2
Duvovac Cliff	3	6	4,33	0,58	6	1,23	0,44	1,85	1,07	CVC	90	a	26 July 2008
Formica Islets	3	6	4,00	0,00	7	2,33	0,65	2,42	1,24	CVI	80	a	26 July 2008
Hrid Galiola (Sv Nikola)	4	12	5,0	0,0	13	2,20	1,06	2,25	1,21	CVC	90	l	16 June 2012
Iza Perasta	3	6	4,33	1,15	6	2,08	0,95	1,46	0,78	CC	na	k	2 November 2011
Kamenolom Oblatno			Pinna nobilis survey									Quarry dumping	17 June 2012
Katić islets	5	13	5,80	1,92	13	1,69	0,76	2,45	1,06	CVI	50	b	25 July 2008
Kruče	3	9	6,33	1,15	10	2,42	0,84	2,32	1,16	CC	30	none	28 October 2011
Mala Krekavica	3	5	3,33	0,58	3	1,20	0,42	1,90	0,57	CVC	90	none	28 July 2008
Mamula	2	9	5,50	0,71	9	2,55	0,93	2,36	0,81	CC	45	b	22 July 2008
Mamula II	3	6	4,0	1,7	10	3,08	0,67	2,17	1,27	CC	45	b	14 June 2012
Maslinada			Pinna nobilis survey									none	17 June 2012
Mendra	3	8	3,33	0,58	7	1,90	0,88	1,70	0,48	CC	30	Light house	26 October 2011
Mugren	2	7	8,0	1,4	12	2,94	1,39	2,63	1,09	CVC	90	Very close to Budva	18 June 2012
o. Sv. Đorđe			Qualitative survey									j	13 June 2012
Obala Stari Ulcinj	3	10	6,33	1,15	13	2,37	0,90	1,95	1,13	CVC	70	none	29 October 2011
Opaljike	3	4	3,33	0,58	5	1,40	0,52	1,30	0,48	CC	30	g	26 October 2011
Posejdonov Grad	2	4	2,50	0,71	5	2,80	1,30	2,60	1,34	CVC	30	none	22 July 2008
Rat Kostovica	3	10	5,33	0,58	9	2,88	1,59	2,94	1,29	CC	70	c	27 July 2008
Rat Platamuni	3	6	4,00	1,73	8	2,18	0,98	2,00	0,77	CC	30	Light house	24 July 2008
Rep	3	9	6,00	1,00	9	2,28	1,13	2,00	1,03	CC	20	h	27 October 2011
Seka Albaneze	2	8	6,00	1,41	7	1,83	0,94	1,83	0,58	OU	na	d	27 July 2008
Seka Albaneze	1	5	na	na	9	3,17	1,33	2,50	0,84	OU	na	d	30 October 2011
Seka Kočište	3	8	4,3	0,6	9	3,38	1,80	2,38	0,77	OU	na	A quarry very close	17 June 2012
Školj (o. Sv. Nikola west)			Qualitative survey									l	16 June 2012
Stari Ulcinj	3	6	4,00	0.00	13	2,42	0,79	2,42	1,24	CVI	90	Holiday homes	28 October 2011
Strp			Qualitative survey									i	13 June 2012
Sv Nikola (Budva) inshore	3	9	4,7	1,2	9	2,00	0,88	1,93	1,00	CC	45	l	15 June 2012
Sv Nikola (Budva) offshore	3	6	4,3	0,6	6	2,15	0,69	2,08	0,86	CVC	90	l	15 June 2012
Sveti Djordje			Qualitative survey							CC	40	j	01 November 2011
Sveti Nikola	3	5	3,67	0,58	6	1,73	0,79	2,09	0,83	CVC	80	e	24 July 2008
Uvalla Ploča	3	7	5,3	0,6	9	2,44	1,09	1,44	0,96	CC	40	A small marine nearby	14 June 2012
Valdanos	3	10	5,33	1,53	10	2,00	0,97	1,88	1,09	CC	90	d	27 October 2011
Velika Krekavica	2	11	5,50	0,71	10	1,90	0,99	2,10	0,88	CC	70	f	28 July 2008

Total N. Transects	80
Total N. Units in the first survey	37
Total N. Units in the second survey	48 (7 exclusive of Kotor)
Total N. Units in the third survey	30
Total N. Units in the three surveys	70

CC = Calcareous Cliff; CVC = Calcareous Vertical Cliff; CVI = Calcareous Cliff on Islet; OU = Offshore reef.
a = None but close to a protected beach and saltmarsh;
b = None but crowded beaches inland
c = A tiny beach reachable on foot by land
d = A tiny village made up of holiday homes. Plans for coastal development exists.
e = Nothing but a small church on the top of one of the islets
f = A small beach reachable by land
g= None but a few houses scattered on the mountain. Not far from Ulcinj
h= Urban solid waste disposal on the mountain
i = Main Road mussel farm
j = Two tiny islets with monastry
k = Main Road and Perast town
l = A small tourist resort on the island which is very close to the busy town of Budva

Table 4: Percentage contribution of different assemblages to sites.

	Barren	Boulders_ barren	Caulerpa racemosa	Cladocora caespitosa reef	Coralligenous	Gravel	Large-sized sponges	Mud	Mud and gravel	Mussel bed	Pebbles	Photophilic algae Cystoseira and Halopteris	Photophilic algae Cystoseira spp.	Photophilic algae with Padina pavonica	Posidonia oceanica	Rubbles and turf with Codium	Sand	Sciaphilic algae Codium and Flabellia	Sciaphilic algae Flabellia and Halimeda	Sciaphilic algae Flabellia and Peyssonnelia	Submerged canyon	Submerged caves	Tur
Dražin Vrt				5,1	8,1		1,1		**55,6**							28,1							1,9
Duvovac Cliff	31,1	19,8													**48,5**								0,6
Formica Islets	27,1	5,5												5,7	28,8		**31,6**	1,4					
Hrid Galiola (Sv Nikola)	0,7	1,7	0,5		9,8	17,4					1,2	1,7	7,4	6,8	**29,6**			4,8			0,8	1,8	16,
Iza Perasta					7,4	11,0	5,3		**46,8**				9,6			19,9							
Katić islets	21,0	0,2										0,1		15,4	**54,0**		0,3		4,7	2,1			2,1
Kruče	15,4	16,7						17,1		2,9			0,3		**26,6**			0,9	2,5	12,6			5,0
Mala Krekavica	**61,8**					8,4																	29,
Mamula	1,7	1,5				13,4						6,4	**33,4**	20,7	12,6			10,4					
Mamula II	0,2		2,5			**27,6**						3,0	10,5	9,5	21,3			0,3	2,4	3,7			19,
Mendra	30,4	26,4								2,9		2,6			0,5			2,5					**34,**
Mugren	11,6	0,3				1,7					3,1	1,3		6,1	**31,0**			15,8		0,3	2,7	5,4	20,
Obala Stari Ulcinj	6,7	2,8				13,3		3,3		0,6	6,3		3,1	0,6	**45,2**			2,3	2,5	0,4			10,
Opaljike	1,2									0,8							**95,0**			0,3			2,8
Posejdonov Grad	**44,1**	4,8				8,3						12,5	0,3				4,2	4,9	20,8				
Rat Kostovica	**24,3**					8,5					2,2	2,9	7,1	1,2	23,8		2,5			4,1			23,
Rat Platamuni	36,5	3,6				1,3						7,6	1,3	0,2	10,0								**39,**
Rep	13,3	7,3				0,3					2,4	1,1			**61,5**		5,7	1,3					7,1
Seka Albaneze	**38,5**												20,0	0,7	18,5		2,2	1,3	11,4	2,5			5,0
Seka Albaneze II	4,6												23,4	21,8	**26,8**		1,0	6,8	1,2	11,4			1,2
Seka Kočište			1,5		3,7								9,9	1,2	16,7			**39,3**	13,3	5,5			8,9
Stari Ulcinj	**29,6**	12,8			0,4	4,1				2,4	11,1		4,1	1,3	6,9		3,3	13,4		8,1			2,6
Sv Nikola (Budva) inshore	9,0	4,9				3,0					1,3	2,1		0,7	**64,2**					2,4			12,
Sv Nikola (Budva) offshore	1,3	3,5				22,0					1,9				**38,9**								32,
Sveti Nikola	**53,3**														1,1				5,7				39,
Uvalla Ploča	0,4					33,8							4,0	1,9	**42,3**			0,2	1,5	0,2			15,
Valdanos	4,8	12,9							**60,3**	1,7	6,0		0,4	1,3	6,6			4,2					1,8
Velika Krekavica	31,2					23,8							2,8		5,6		3,4						**33,**
Frequency of occurrence of the identified assemblages along the Montenegrin coast	89	57	11	4	18	57	7	7	11	21	32	39	57	57	82	7	36	57	36	46	7	7	86

Table 5: Percentage contribution of the reduced number of assemblages to sites.

	Barren	Coralligenous	Mussel beds	Pebbles	Photophilic algae	Posidonia oceanica	Rubble and turf with Codium sp.	Sciaphilic algae	Soft bottoms	Turf
Dražin Vrt	0,0	14,3	0,0	0,0	0,0	0,0	28,1	0,0	**55,6**	1,9
Duvovac Cliff	**50,9**	0,0	0,0	0,0	0,0	48,5	0,0	0,0	0,0	0,6
Formica Islets	**32,6**	0,0	0,0	0,0	5,7	28,8	0,0	1,4	31,6	0,0
Hrid Galiola (Sv Nikola)	2,4	11,6	0,0	1,2	16,3	**29,6**	0,0	5,6	17,4	16,0
Iza Perasta	0,0	12,7	0,0	0,0	9,6	0,0	19,9	0,0	**57,8**	0,0
Katić islets	21,3	0,0	0,0	0,0	15,5	**54,0**	0,0	6,8	0,3	2,1
Kruče	**32,0**	0,0	2,9	0,0	0,3	26,6	0,0	16,1	17,1	5,0
Mala Krekavica	**61,8**	0,0	0,0	0,0	0,0	0,0	0,0	0,0	8,4	29,8
Mamula	3,2	0,0	0,0	0,0	**60,5**	12,6	0,0	10,4	13,4	0,0
Mamula II	0,2	0,0	0,0	0,0	25,4	21,3	0,0	6,4	**27,6**	19,0
Mendra	**56,7**	0,0	2,9	0,0	2,6	0,5	0,0	2,5	0,0	34,8
Mugren	11,9	5,4	0,0	3,1	7,4	**31,0**	0,0	18,8	1,7	20,8
Obala Stari Ulcinj	9,5	0,0	0,6	8,3	3,7	**45,2**	0,0	5,3	16,6	10,8
Opaljike	1,2	0,0	0,8	0,0	0,0	0,0	0,0	0,3	**95,0**	2,8
Posejdonov Grad	**49,0**	0,0	0,0	0,0	12,8	0,0	0,0	25,7	12,5	0,0
Rat Kostovica	**24,3**	0,0	0,0	2,2	11,2	23,8	0,0	4,1	11,0	23,3
Rat Platamuni	**40,1**	0,0	0,0	0,0	9,0	10,0	0,0	0,0	1,3	39,5
Rep	20,6	0,0	0,0	2,4	1,1	**61,5**	0,0	1,3	6,0	7,1
Seka Albaneze	**38,5**	0,0	0,0	0,0	20,7	18,5	0,0	15,1	2,2	5,0
Seka Albaneze II	4,6	0,0	0,0	0,0	**45,2**	26,8	0,0	21,3	1,0	1,2
Seka Kočište	0,0	3,7	0,0	0,0	12,7	16,7	0,0	**58,1**	0,0	8,9
Stari Ulcinj	**42,3**	0,4	2,4	11,1	5,4	6,9	0,0	21,5	7,4	2,6
Sv Nikola (Budva) inshore	13,9	0,0	0,0	1,3	2,8	**64,2**	0,0	2,4	3,0	12,4
Sv Nikola (Budva) offshore	4,8	0,0	0,0	1,9	0,0	**38,9**	0,0	0,0	22,0	32,4
Sveti Nikola	**53,3**	0,0	0,0	0,0	0,0	1,1	0,0	5,7	0,0	39,9
Uvalla Ploča	0,4	0,0	0,0	0,0	5,9	**42,3**	0,0	1,9	33,8	15,8
Valdanos	17,8	0,0	1,7	6,0	1,7	6,6	0,0	4,2	**60,3**	1,8
Velika Krekavica	31,2	0,0	0,0	0,0	2,8	5,6	0,0	0,0	27,2	**33,3**
Frequency of occurrence of the reduced assemblages along the Montenegrin coast	89	21	21	32	79	82	11	75	86	86

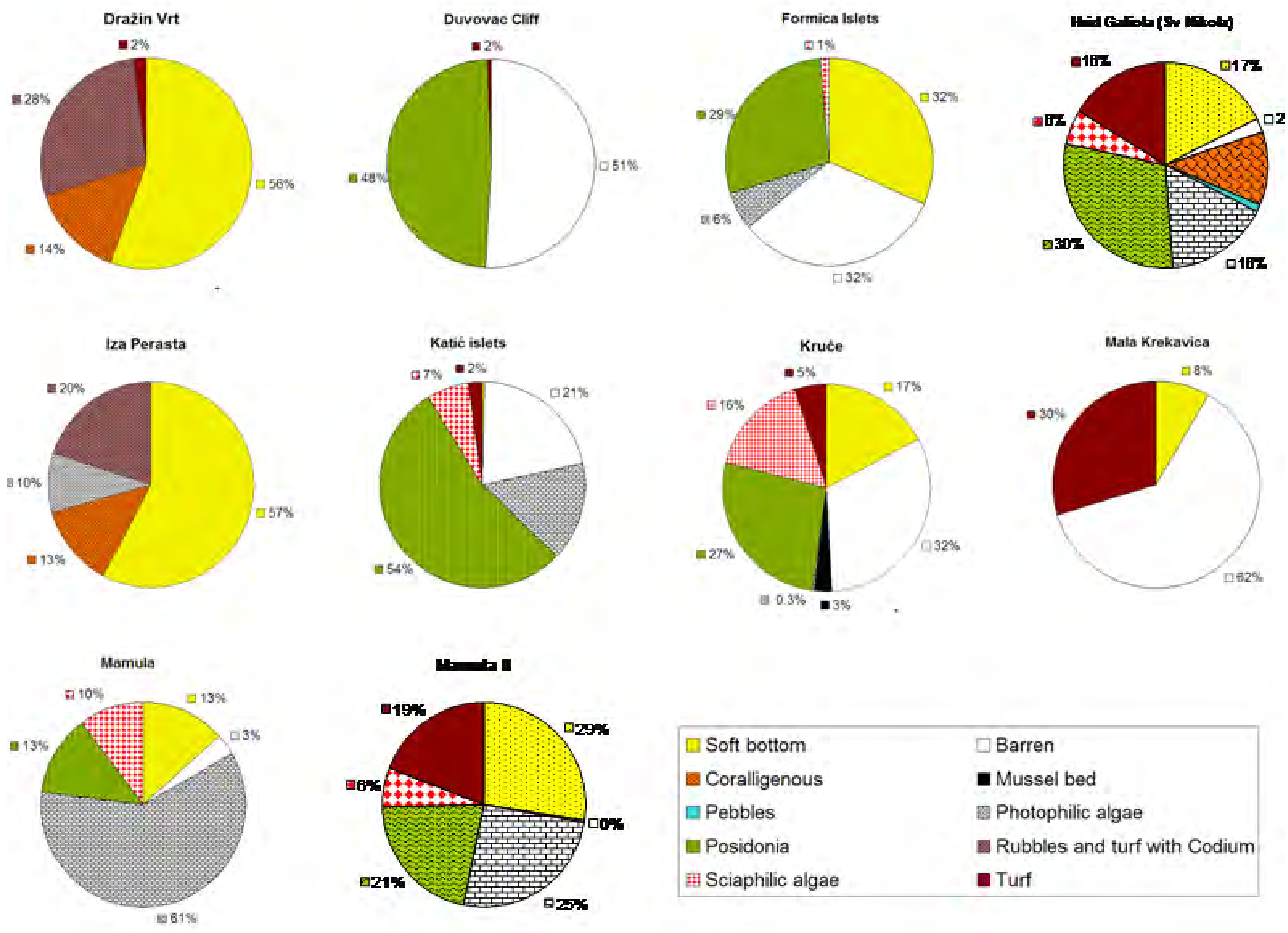


Figure 16 (a): Percentage cover of the 10 «reduced» assemblages in the surveyed sites

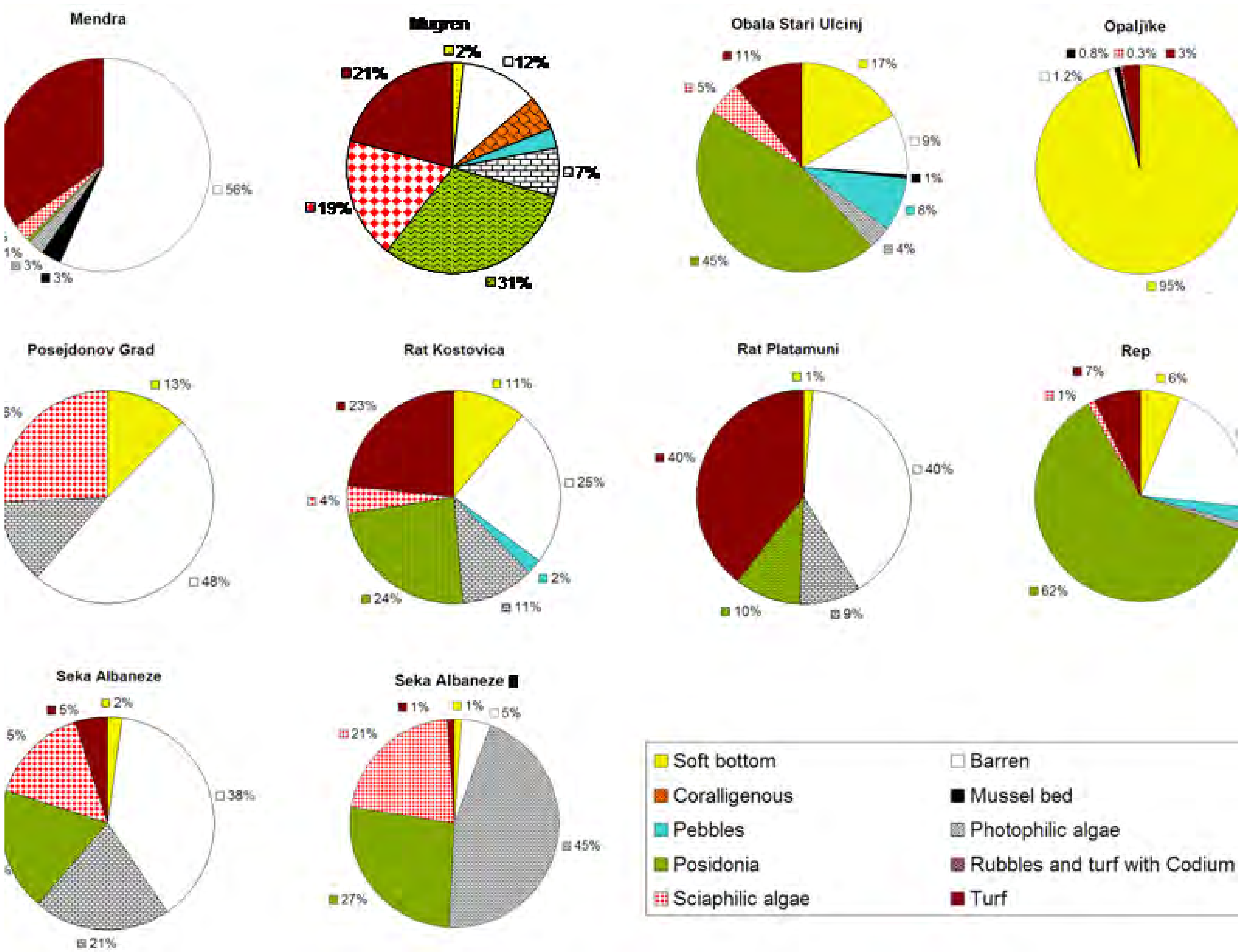


Figure 16 (b): Percentage cover of the 10 «reduced» assemblages in the surveyed sites

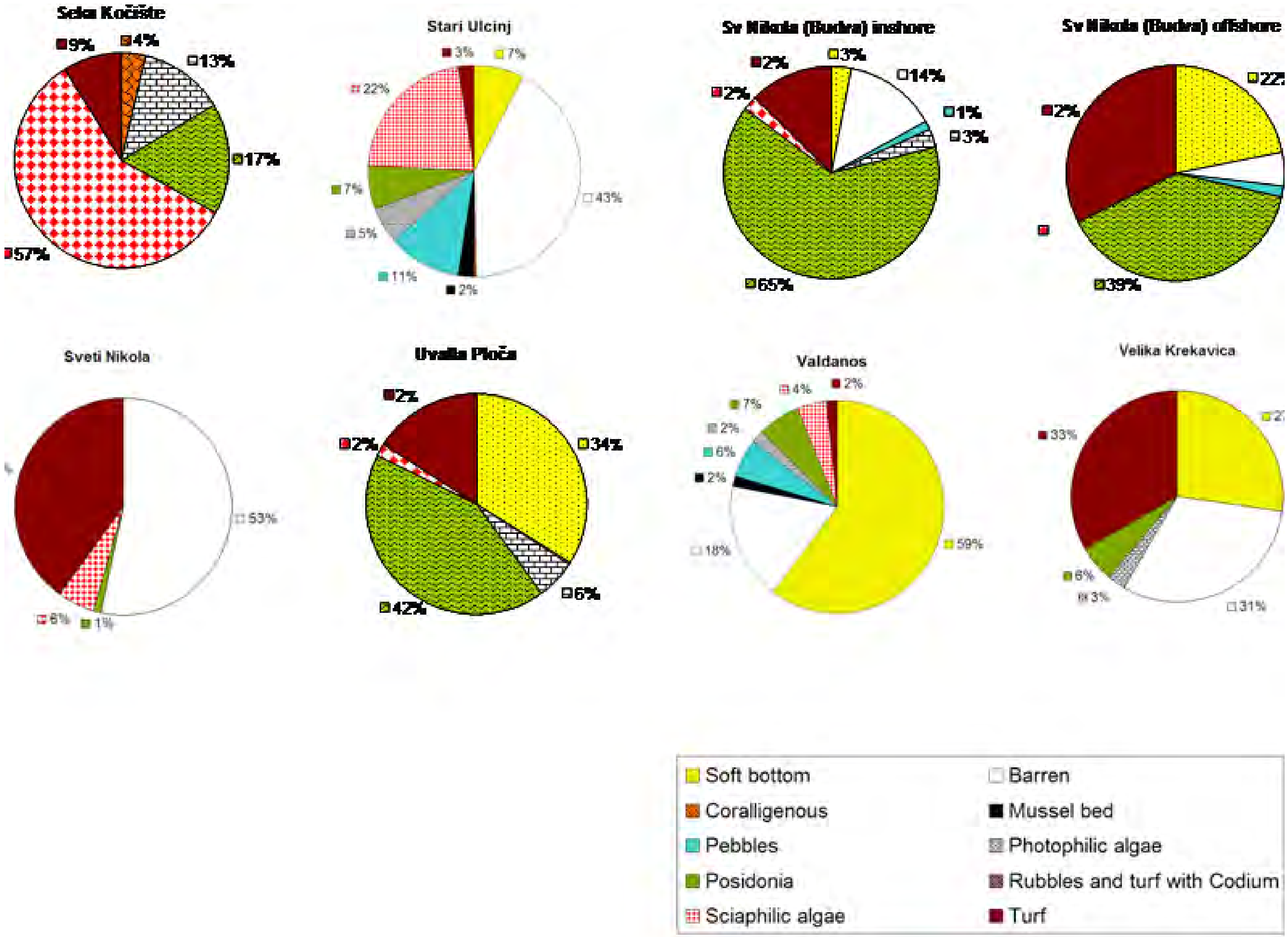


Figure 16 (c): Percentage cover of the 10 «reduced» assemblages in the surveyed sites

The nMDS segregated sites characterized by important coverage of soft bottom assemblages such as Dražin Vrt and Iza Perasta inside Kotor Bay, and Opaljike in the open sea, from those characterized by a large proportion of *Posidonia oceanica*, such as Katić islets, Obala Stari Ulcinj, Rep and Sv Nikola (Budva) inshore and offshore, or by Photophilic algal assemblages such us Mamula, Seka AlbanezeII and Seka Kočište (Fig. 17 a-m). Kruče, Mala Krekavica, Rat Patamuni, Stari Ulcinj and others showed large percentages of Barren and Mussel beds, while Mendra added Turf assemblages to the two previous ones (Fig. 17 a, c and l). Valdanos had a heterogeneous and balanced mixture of all the main assemblages. Coralligenous assemblages were almost exclusive to sites in Kotor Bay (Fig. 17 b). Coralligenous in Boca Kotorska was found in its best form at Dražin Vrt between 12 and 30m depth (Fig. 18).

Large colonies of *Parazoanthus axinellae* started at about 12 m depth, covering isolated boulders on the seaward side of each boulder (Fig. 18). Deeper, down to about 17 m depth, isolated colonies of *Leptogorgia* cfr *tormentosa*, *Savalia savaglia*, *P. axinellae* and large-sized sponges were found. These isolated colonies were followed by massive colonies of *Cladocora caespitosa* down to about 30 m depth. Colonies were spherical or egg-shaped. Length ranged from 0.5 to 8 m, width was between 0.5 and 3 m and height reached 3 m. Between *C. caespistosa* colonies, very large colonies of *S. savaglia* were found with *L.* cfr *tormentosa* intermingled between them. On the seaward surface of *C. caespitosa*, colonies of *P. axinellae* and several large-sized sponges were found, together with ascidians. Both isolated and massive colonies were close to freshwater springs (Fig. 18).

Results showed quite clearly that sites inside the Boca Kotorska were distinct from the others because of a) the large percentage of soft bottom assemblages and b) the exclusiveness of Rubble and Turf with Codium and c) the importance of Coralligenous assemblages (Fig. 16 a-c and Fig. 17 b, g, i and m). Another two sites, Valdanos and Opaljike were characterized by large percentages of soft bottom assemblages (Fig. 16 b-c), both close to the southernmost part of the country (Fig. 15) and are linked. This distribution is due to the effects of the Bojana river. *Posidonia oceanica* resulted the most important feature of Katic Islet, Rep and Sv Nikola (Budva) inshore (Fig. 16 a-c and Fig. 17 f and m). *P. oceanica* was important also at Seka AlbaneseII, Seka Kočište and Mamula, where, however, the best conserved algal, Photophilic and Sciaphilic, assemblages in the country were found (Fig. 16 a-c and Fig. 17 e, h and m) and at Obala Stari Ulcinj, where coralligenous assemblages are important (Fig. 16 b) and Hrid Galiola, MamulaII, Sv. Nikola (Budva) Inshore and Uvalla Ploča, where soft bottom assemblages were also important (Fig. 16 a-c and Fig. 17 i).

All the other sites were strongly characterized by a large proportion of barren (Fig. 16 a-c and Fig. 17 a and m). The possible causes of the extensive presence of barren (i.e. overfishing with the use of explosives and date harvesting) are discussed in the next section.

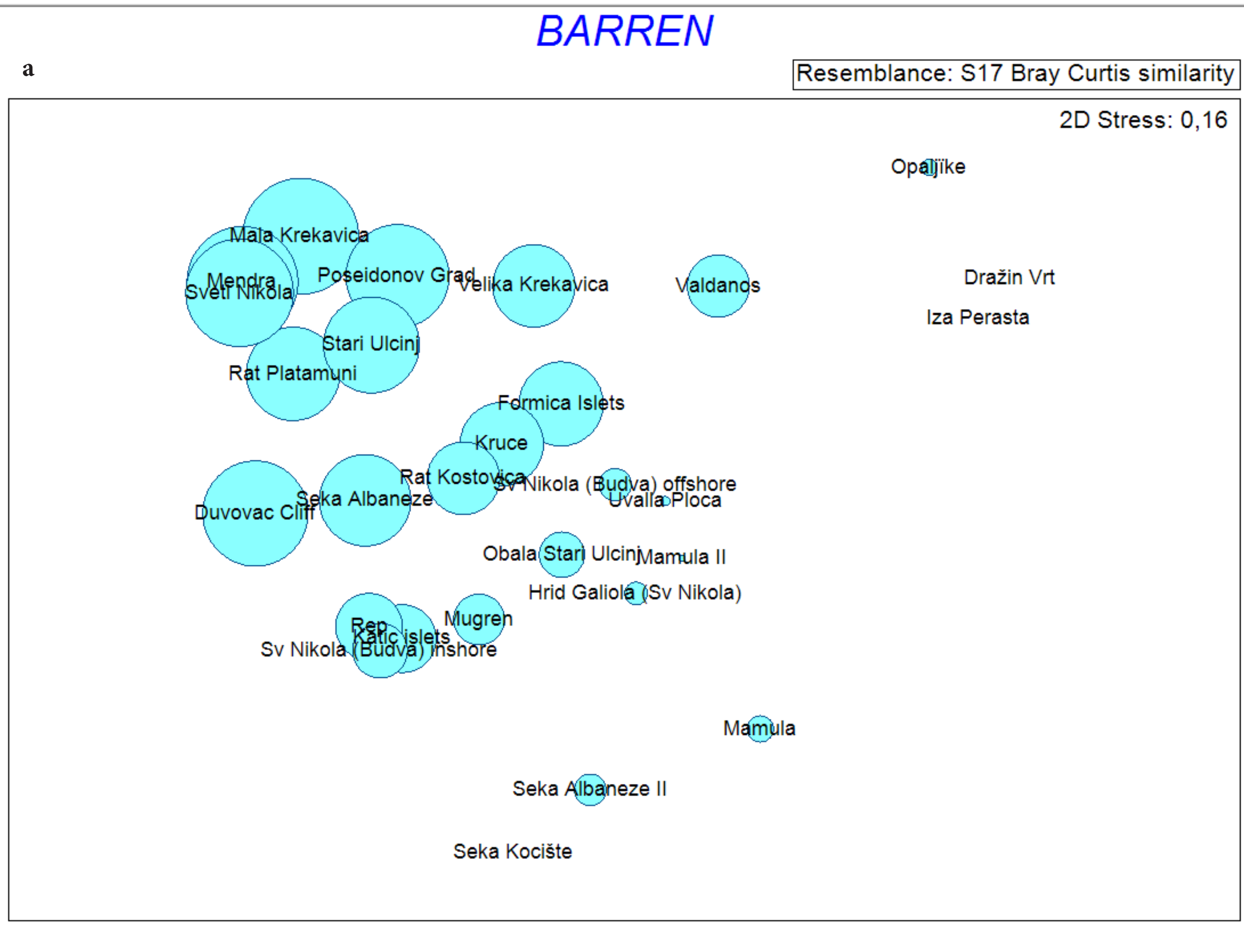
Finally, it is worth noting that mussel beds were more developed in the southern sites, from Obala Stari Ulcinj to Opaljike (Fig. 16 a-c and Fig. 17 c).

As far as species distribution is concerned, *Ophidiaster ophidianus* was almost absent from the southern sites. Instead, large-sized *Axinella* cfr *cannabina* were found there, in particular at the foot of the cliffs, and the infralittoral fringe was dominated by mussel beds which extended, in some cases, down to 2.5 m depth. *Pinna nobilis* is abundant in the north at Trašte Bay.

Overall, 119 different taxa, including invertebrates, algae and phanerogames, were identified underwater at the investigated sites (Annex 2).

Assessment of *Pinna nobilis*

Data from two sites (Kamenolom Oblatno and Maslinada) were merged for this analysis. Overall, 63 individuals were found within the 6 transects, with an average of 2,13 (±0.95) individuals/100 m^2. Average length of the shell (Ht) was 54,42 cm (±7,21). No significant differences were found in the Ht among the 6 transects ($F_{5,58}$ =1,29; P = 0,28).



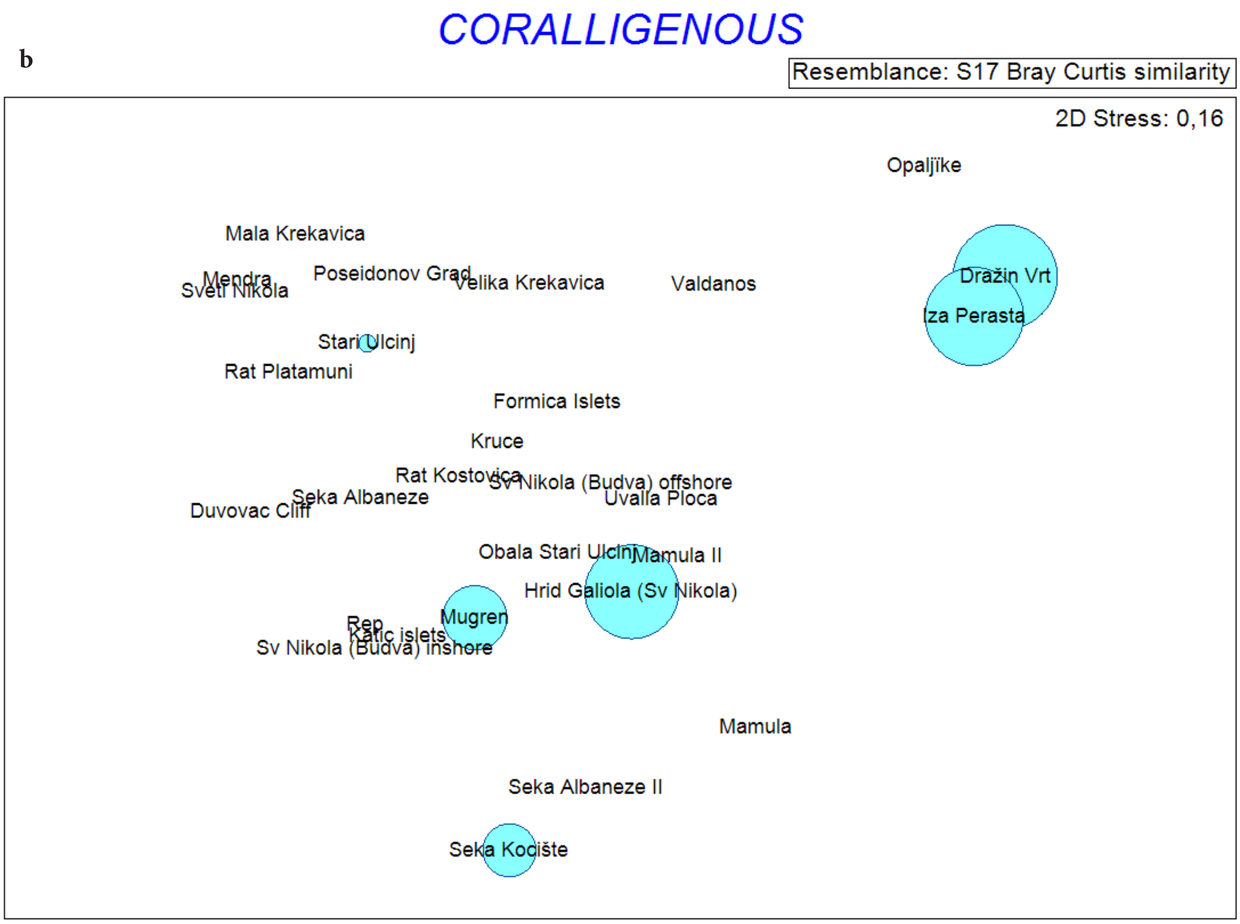


Figure 17 (a-b): nMDS bubble plots constructed on the sites per assemblages matrix. The Bray-Curtis similarity index of untransformed data was used to perform the analysis. Bubble size is proportional to the importance of the assemblage at each site.

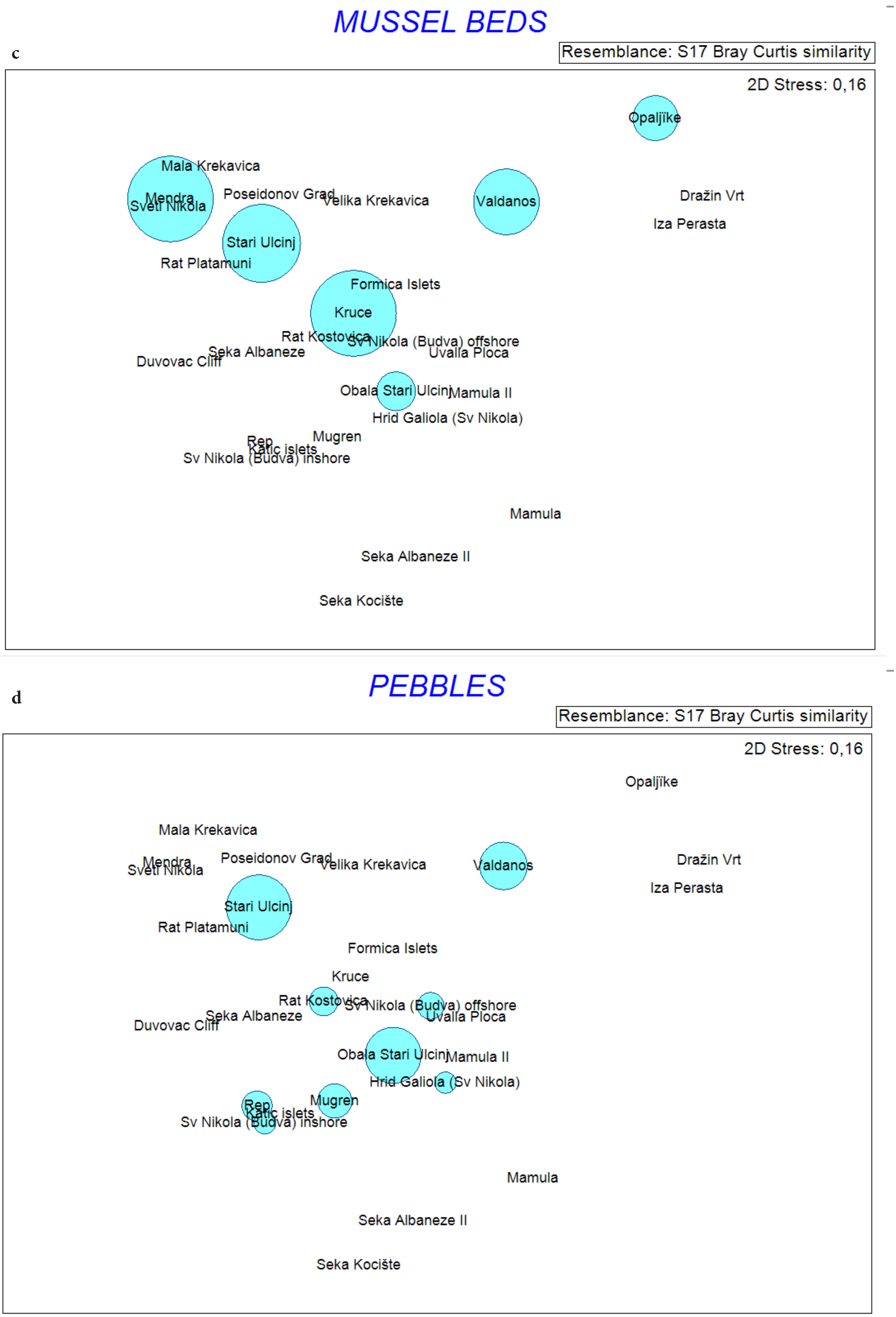
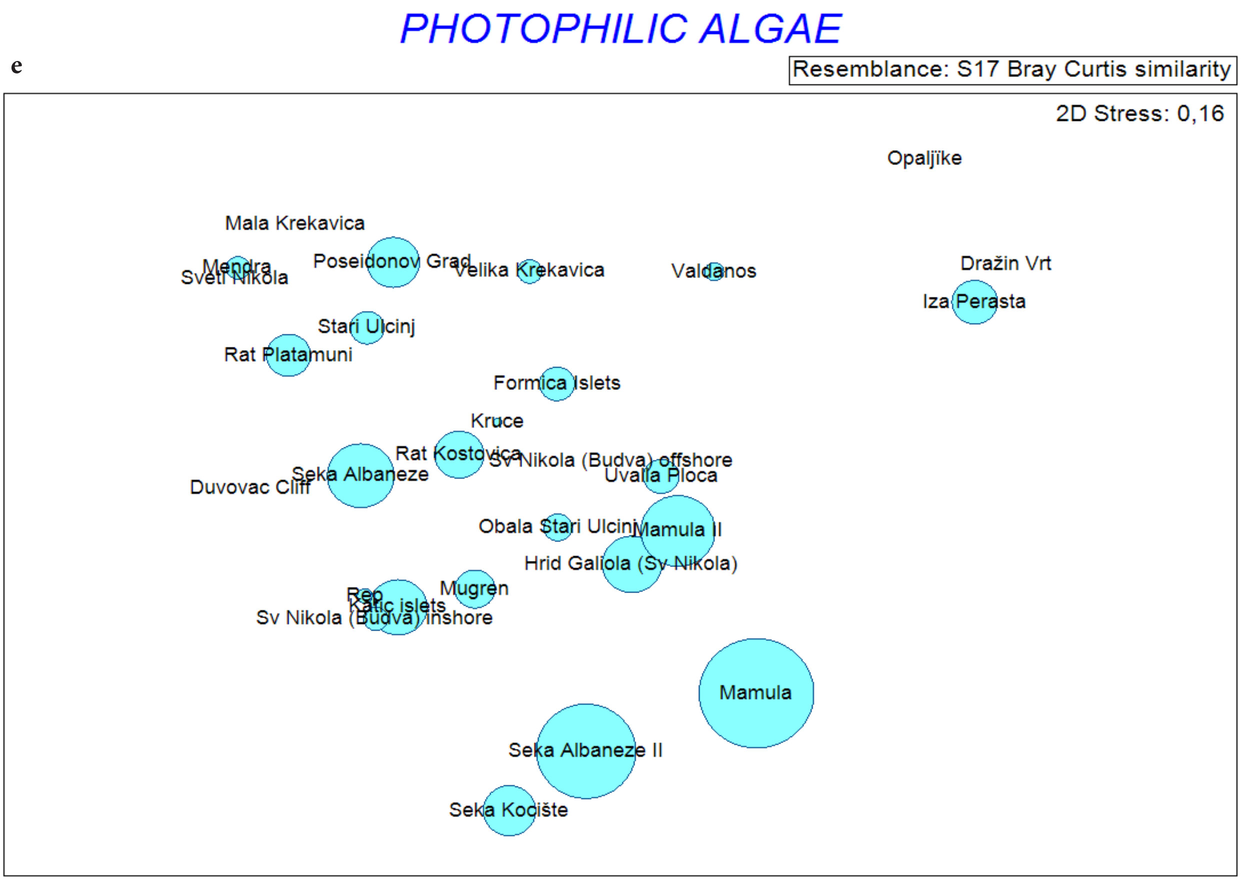


Figure 17 (c-d): nMDS bubble plots constructed on the sites per assemblages matrix. The Bray-Curtis similarity index of untransformed data was used to perform the analysis. Bubble size is proportional to the importance of the assemblage at each site.

e



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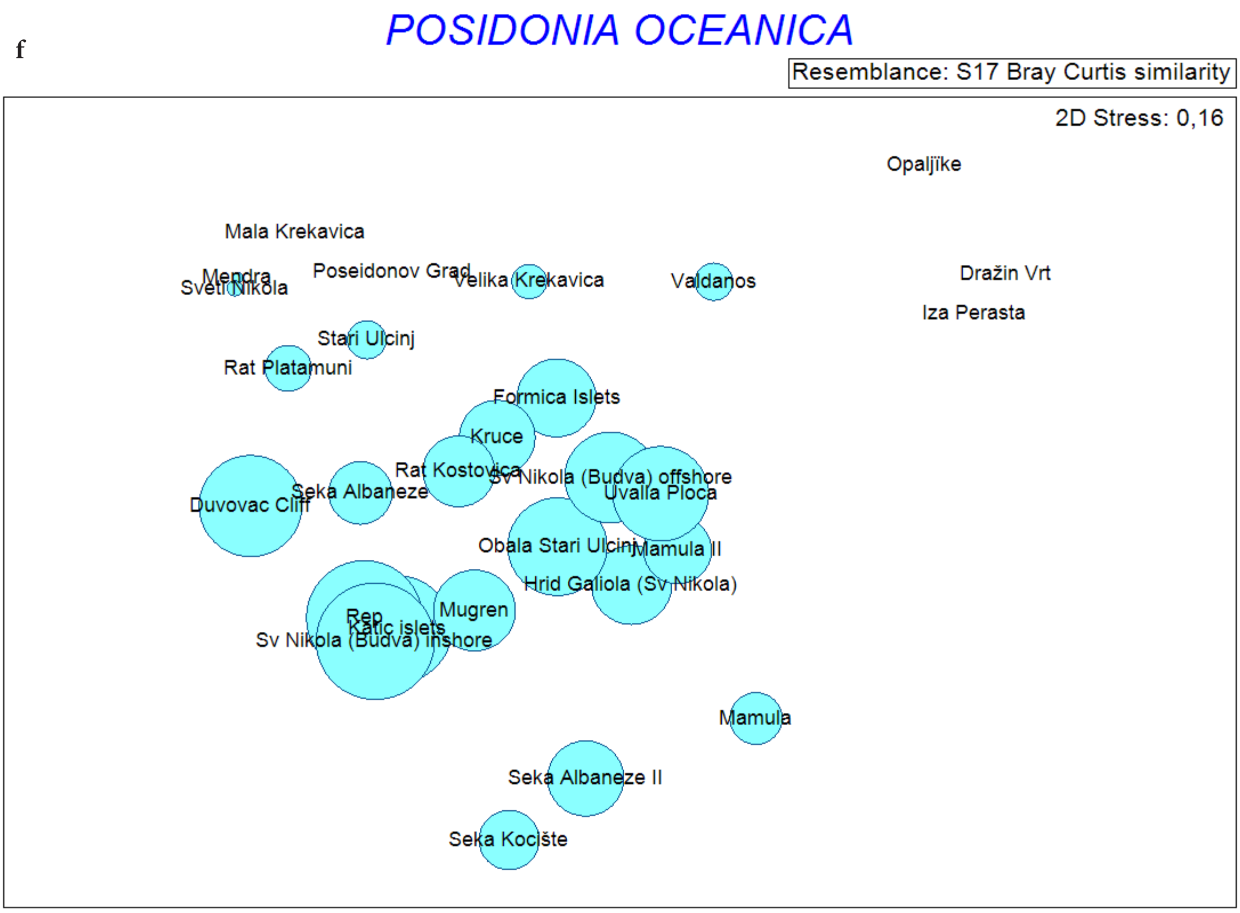
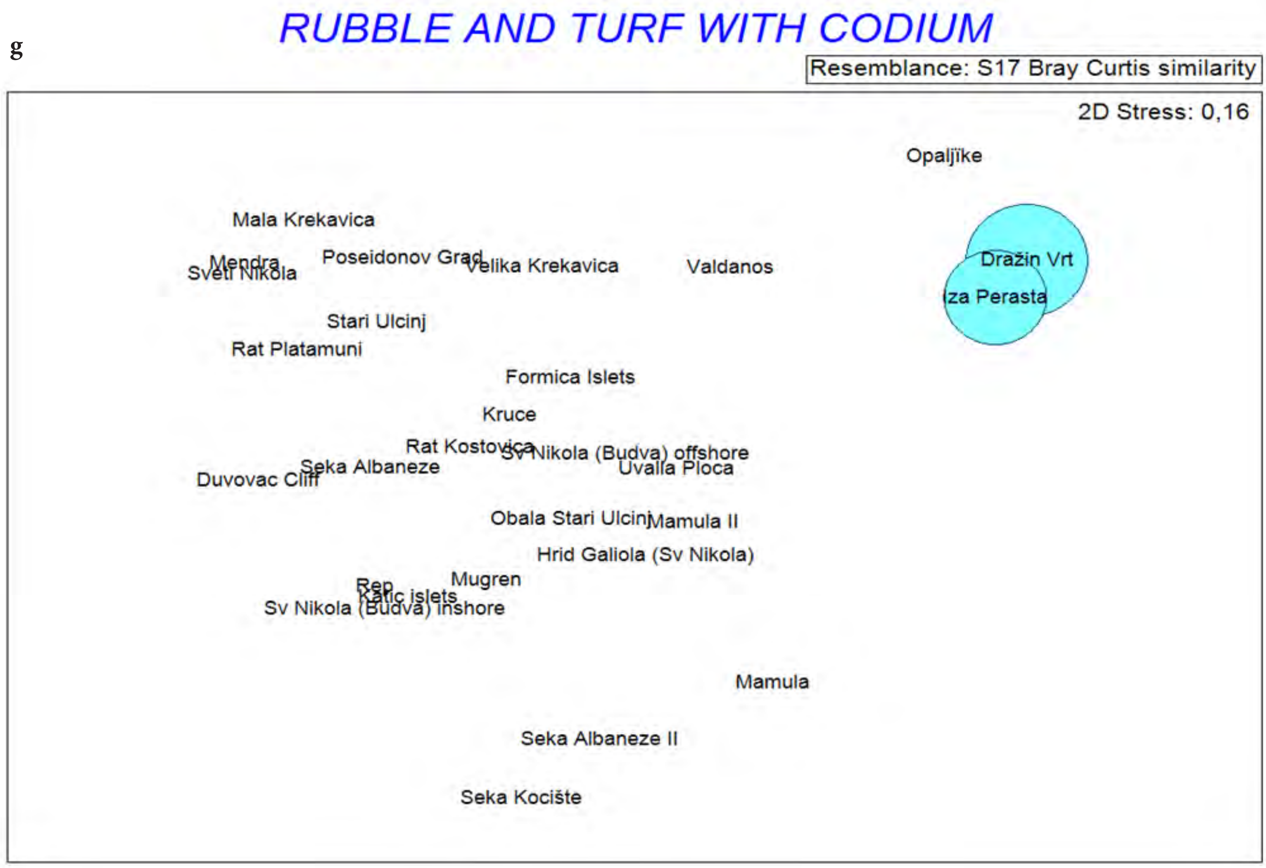


Figure 17 (e-f): nMDS bubble plots constructed on the sites per assemblages matrix. The Bray-Curtis similarity index of untransformed data was used to perform the analysis. Bubble size is proportional to the importance of the assemblage at each site.

g



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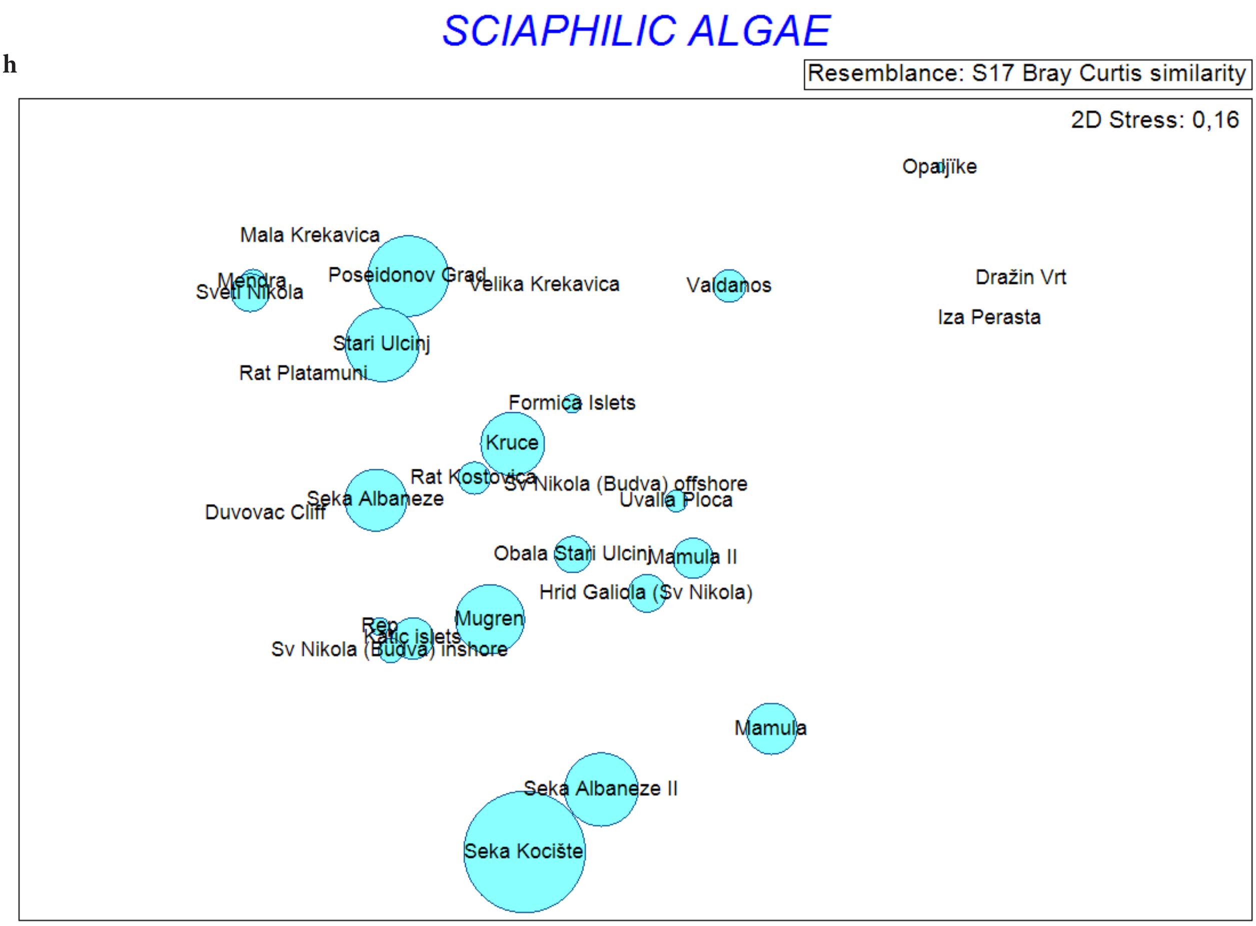
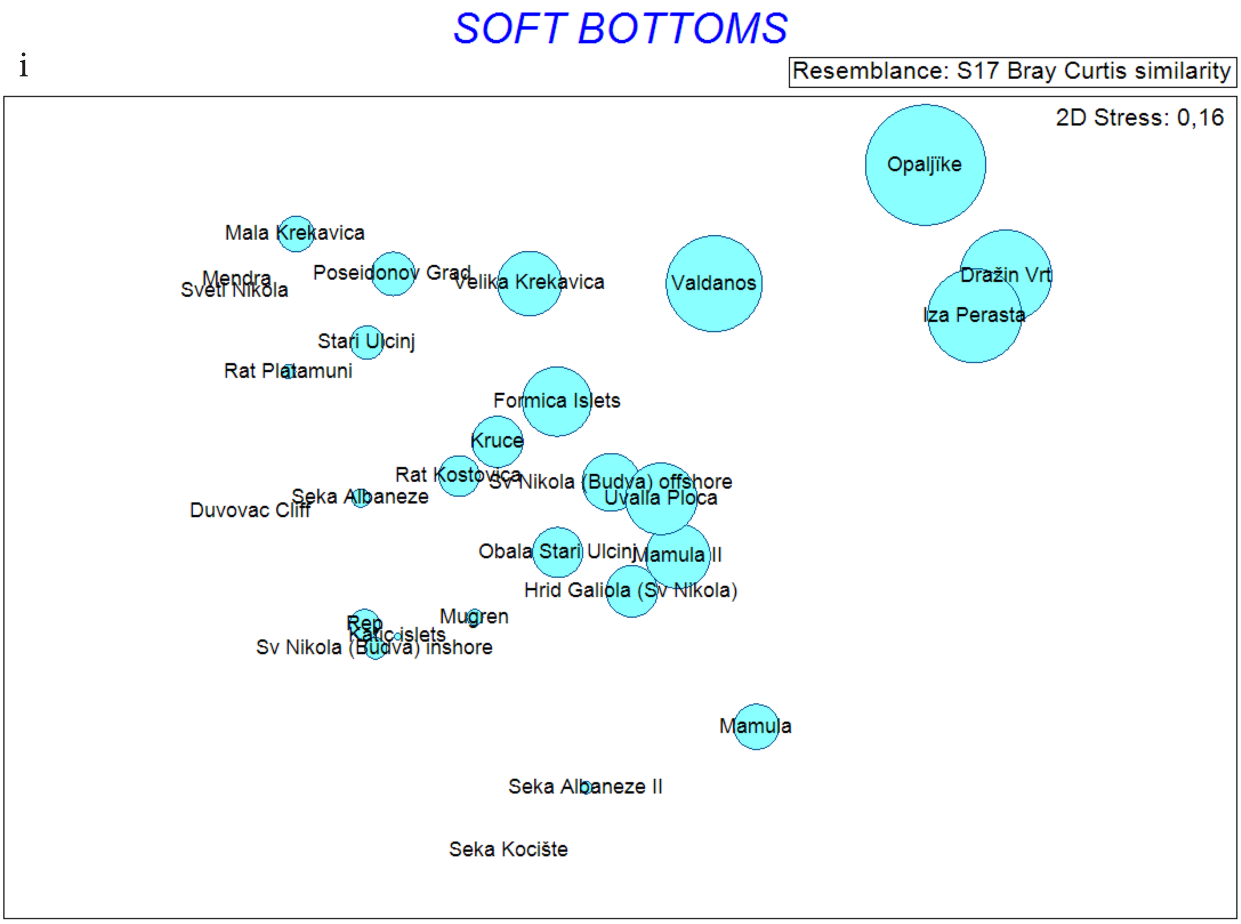


Figure 17 (g-h): nMDS bubble plots constructed on the sites per assemblages matrix. The Bray-Curtis similarity index of untransformed data was used to perform the analysis. Bubble size is proportional to the importance of the assemblage at each site.



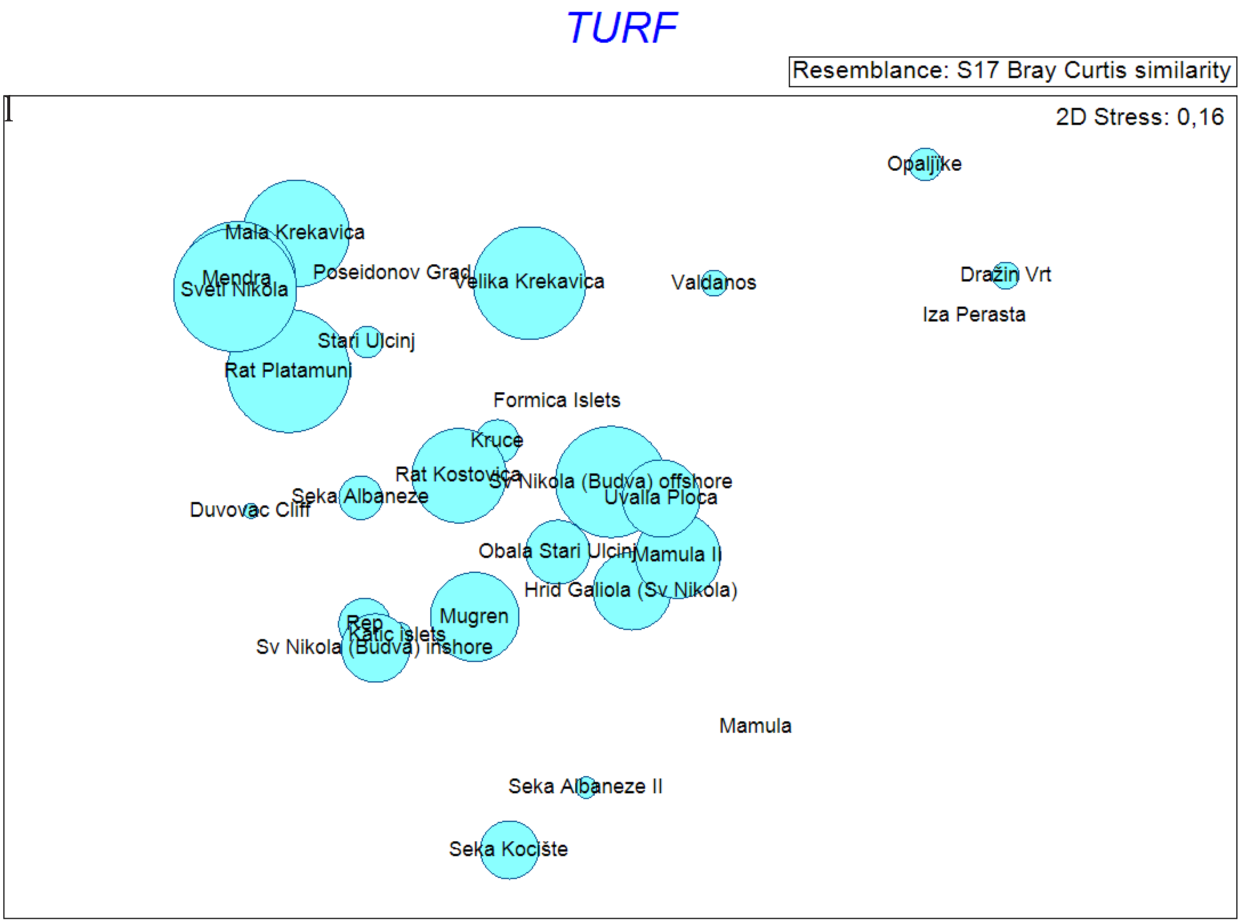


Figure 17 (i-l): nMDS bubble plots constructed on the sites per assemblages matrix. The Bray-Curtis similarity index of untransformed data was used to perform the analysis. Bubble size is proportional to the importance of the assemblage at each site.

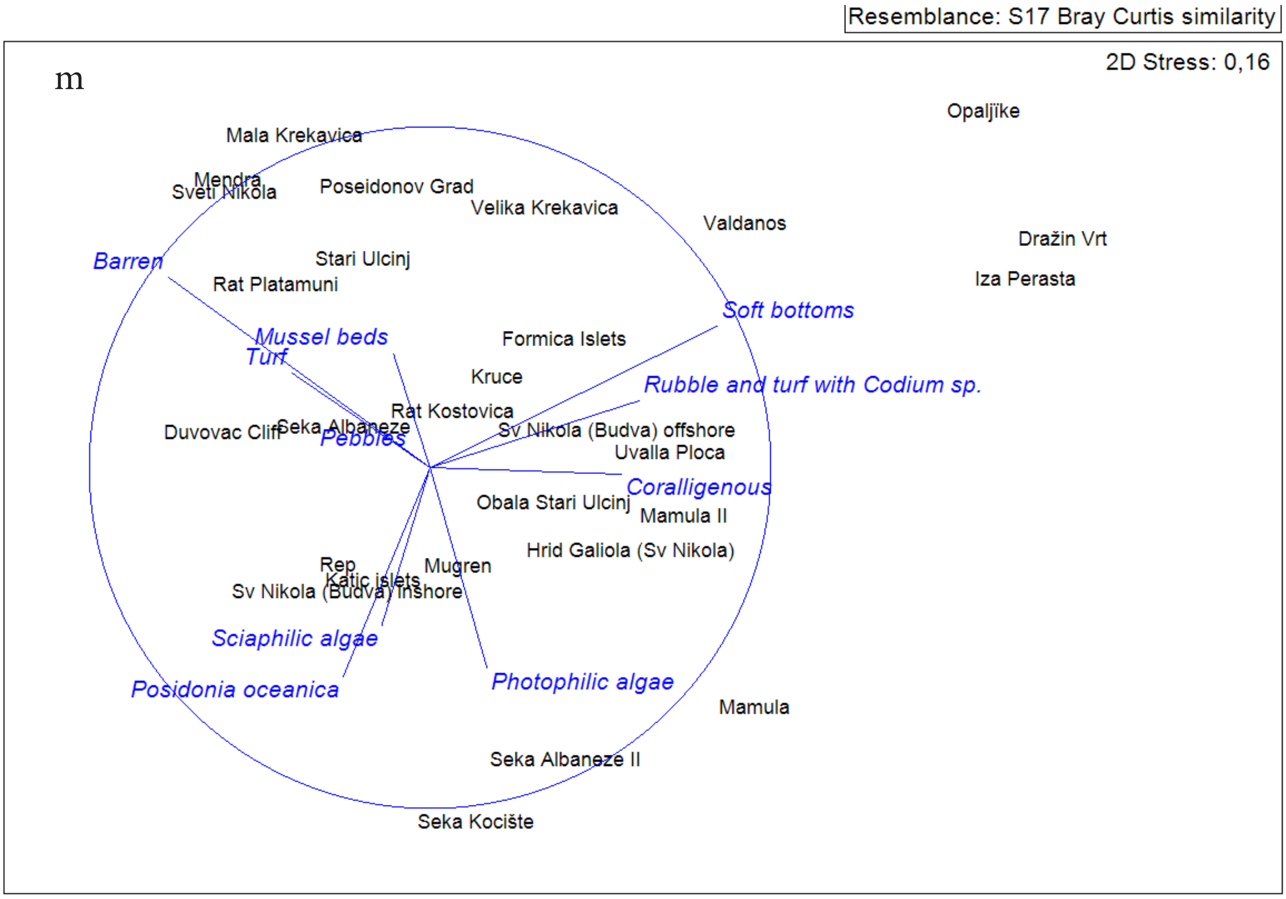


Figure 17 (m): nMDS constructed on the sites per assemblages matrix. The length of the blue line represents the degree of correlation of the investigated sites with the ten “reduced” assemblages. The Bray-Curtis similarity index of untransformed data was used to perform the analysis. Bubble size is proportional to the importance of the assemblage at each site.

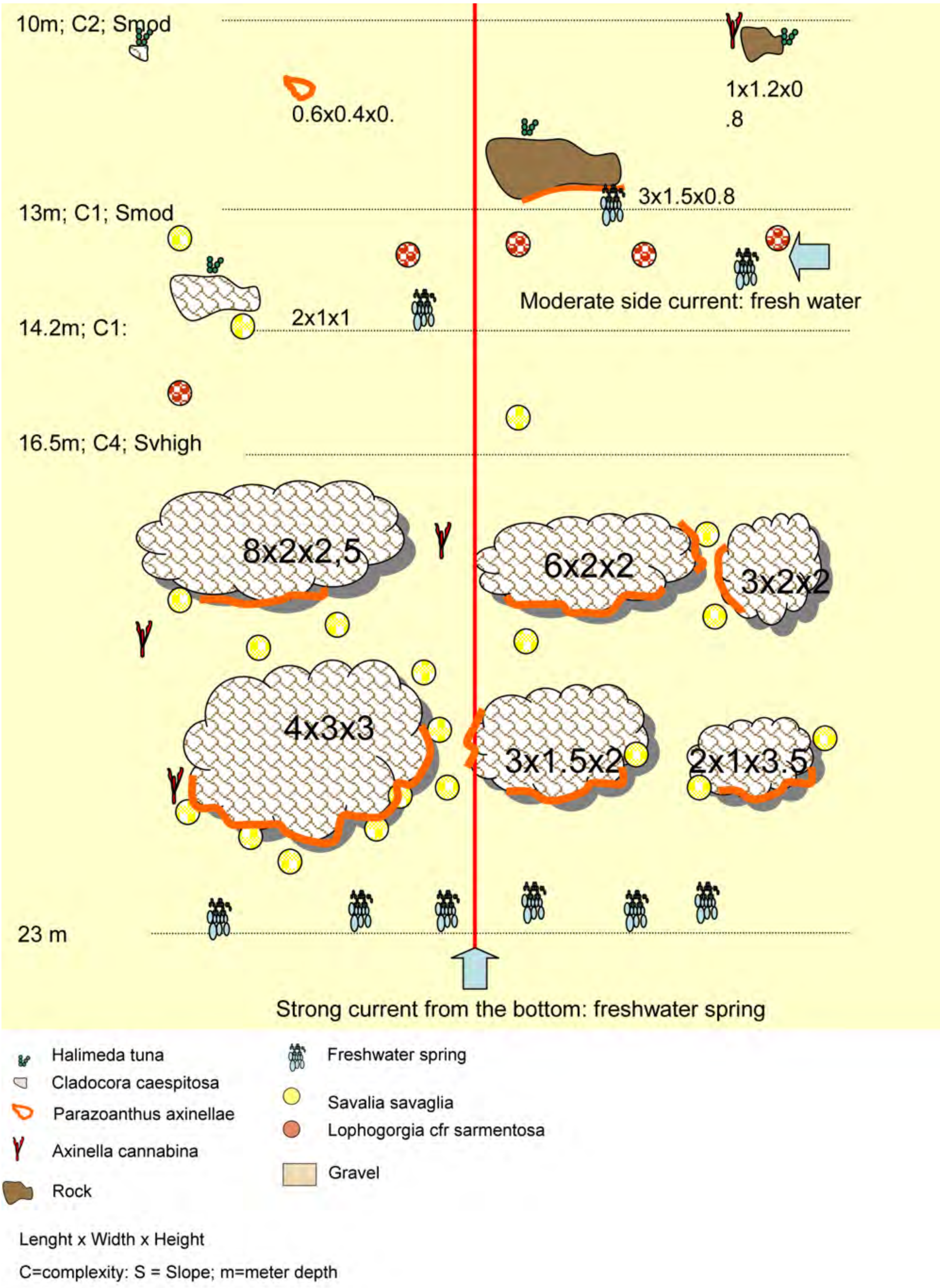


Figure 18: Schematic map of the Dražin Vrt area, illustrating the species contributing to the Coralligenous assemblage. Size of *Cladocora caespitosa*, main currents, depth, freshwater springs, slope steepness (mod = moderate, high= high, vhigh=very high) are reported.

3.2. Assesment of fish assemblages

Habitat data

Despite of we selected 15 meters as work depth, coast characteristics made difficult to complete all transects within this depth, ranging the transect depth from 5,8 to 19,3 meters, being the average depth of all transects 13,88 meters. In the same way habitat heterogeneity made hard to keep a constant depth obtaining values of verticality varying from 2 to 8,7 meters (Table 6).

Habitat complexity values, explained by the number of boulders (mainly medium and large blocks), varied from sites with low complexity like those inside the Kotor bay to high complex sites like Sv. Nikola or Mala Krekavica (Table 6).

Rocky matrix was the predominant habitat in the transects surveyed with the exception of the Katic Islets zone (Katic Is. And Sv. Nedjelja), Dubovac Cliff and the coast near the islands of Mamula (Ploca) and Stari Ulcinj (O. Stari Ulcinj) were Posidonia oceanica was dominant, and the Kotor bay, where sandy and muddy bottoms were the principal habitat (Table 6).

Table 6 Mean depth (m), mean verticality (m), number of small, medium and large boulders and average percentage cover of rocky matrix, Posidonia oceanica, sand and pebbles associated to fish assemblages visual censuses.

Table 6: Mean depth (m), mean verticality (m), number of small, medium and large boulders and average percentage cover of rocky matrix, Posidonia oceanica, sand and pebbles associated to fish assemblages visual censuses

Site	Mean depth	Verticality	Small	Medium	Large	%Rock	%Posid	%Sand	%Pebbles
Rat Platamuni	16,8	4,3	64,0	24,0	13,3	86,7	13,3	0,0	0,0
Sv. Nikola	19,0	8,7	59,3	22,0	20,7	100,0	0,0	0,0	0,0
Seka Albaneze	15,0	6,0	18,3	6,0	6,3	75,0	21,7	3,3	0,0
Rat Kostovica	10,8	4,3	61,0	16,3	10,0	83,3	16,7	0,0	0,0
Velika Krekavica	16,8	7,0	51,7	20,0	9,7	96,7	3,3	0,0	0,0
Mala Krekavica	17,8	4,3	61,3	21,7	16,7	100,0	0,0	0,0	0,0
Katic Is.	16,7	2,7	37,3	16,7	12,7	30,0	70,0	0,0	0,0
Sv. Nedjelja	10,7	8,0	39,3	12,3	15,3	38,3	61,7	0,0	0,0
Dubovac Cliff	15,5	5,0	37,3	12,0	8,0	36,7	63,3	1,7	0,0
Formika Is.	13,3	3,3	50,7	17,7	12,0	60,0	16,7	23,3	0,0
Drazin Vrt	17,7	4,0	28,0	7,7	3,3	29,3	0,0	44,7	26,0
Iza Perasta	10,3	3,3	32,0	1,0	0,0	0,0	0,0	85,3	14,7
Seka Albaneze	19,3	4,7	18,0	6,7	7,0	64,7	33,3	2,0	0,0
Stari Ulcinj Is.	15,7	4,0	46,0	20,7	14,3	76,7	22,0	1,3	0,0
O. Stari Ulcinj	11,0	3,3	27,3	19,3	13,3	45,3	48,0	6,7	0,0
Rt Kruce	14,8	4,2	40,3	19,0	12,3	66,0	25,3	8,7	0,0
Rt Rep	16,7	2,7	48,7	9,7	7,3	48,7	22,7	28,7	0,0
Valdanos	8,1	2,5	64,0	23,0	13,7	85,3	8,7	0,0	6,0
Rt Mendra	9,7	2,7	83,0	18,7	8,0	93,7	0,3	6,0	0,0
Opaljike	5,8	2,0	34,0	20,3	13,0	72,0	0,0	28,0	0,0
Mamula Is.	14,3	4,7	40,0	11,0	9,0	98,0	2,0	0,0	0,0
Ploca	11,0	4,7	24,3	8,0	5,0	46,7	53,3	0,0	0,0
Seka Kociste	15,7	3,3	24,0	16,7	5,7	76,0	19,3	4,7	0,0
Nikola East	7,5	4,3	81,0	12,7	4,3	89,3	10,7	0,0	0,0
Nikola West	14,0	4,7	94,7	22,7	9,3	88,0	12,0	0,0	0,0
Hrid Galiola	16,5	5,7	66,3	9,7	8,3	87,3	3,3	9,3	0,0
Skolj	13,7	4,7	28,7	12,7	10,3	60,7	31,3	8,0	0,0
Mogren	14,3	4,7	25,0	22,0	11,3	71,3	24,0	4,7	0,0

As the Kotor bay was clearly different from the rest of the sites surveyed the two sites placed inside the bay were excluded from data analysis.

PERMANOVA analysis presented differences in the habitat characteristics at Locality level and at Small scale, while there were not significant differences at Zone scale. Pair-wise test showed that these dissimilarities were presents between all localities with the exception of Mamula (Table 7).

PCA plot displayed similar results to those obtained in PERMANOVA analysis (Fig. 19). The first two axes of the ordination explained the 53,2% of the variability obtained, dividing the graph into three parts. Above were the sites with sandy bottoms, mainly represented by the Ulcinj locality. At the right side of the plot were placed the sites of Petrovac locality with high percentages of *P. oceanica.* Finally, at the left bottom were found the deepest transects with high complexity represented by the Platamuni locality.

Table 7: Habitat PERMANOVA analyses results and Pair-wise test between localities. Significant F-values and corresponding P-values are indicated in bold.

Source	df	SS	MS	Pseudo-F	P(perm)
Locality	3	99,225	33,075	2,3893	**0,0117**
Zone(Locality)	7	99,357	14,194	1,0774	0,3783
Site(Zone(Locality))	14	182,73	13,052	3,073	**0,0001**
Res	53	225,11	4,2473		
Total	77	616			

Pair-wise test		t	P(perm)
Platamuni	Petrovac	1,9467	**0,01**
Platamuni	Ulcinj	1,5892	**0,0442**
Platamuni	Mamula	1,063	0,3435
Petrovac	Ulcinj	1,7168	**0,0438**
Petrovac	Mamula	1,2934	0,3313
Ulcinj	Mamula	1,3084	0,205

Fish assemblages

In total, 41 species were detected along the three campaigns in the visual censuses of fish assemblages. Labrids with 12 and sparids with 11 were the families with more number of species followed by serranids with 6 (Table 8). The rest of families were represented by just one species with the exception of centracanthids and scorpaenids with two. *Trigla lucerna* was not localized during the realization of the censuses but detected by other divers in the course of the dives and thus were not taken into account for the analysis.

None of the 41 species were detected at all the transects done. *Coris julis, Chromis chromis* and *Serranus cabrilla* were the species more frequently founded. On the other hand, 25 species did not reach the 30% of presence, being excluded from subsequent analysis. Some of these omitted species were common Mediterranean species that due to its low density in the zone were not present in a high number of transects (Table 8), however they were frequently detected during the dives. This was the case for example of *Diplodus sargus* and *Sarpa salpa*, two frequently sparids found in the Mediterranean, which did not appear in the transects of the 2012 campaign (Table 8).

The three species more abundant were the shoaling species *Chromis chromis, Boops boops* and *Spicara smaris* with 223,8 ind., 135,5 ind. and 56,1 individuals 250 m^{-2} respectively. Excluding these three shoaling species *Coris julis* appeared to be the more abundant species with 28,2 ind/250m^2. Far from this species but also abundant we found *Symphodus ocellatus, Oblada melanura, Serranus cabrilla, Diplodus vulgaris* and *Diplodus annularis* (Annex 5).

Species richness per site ranged from 8 species censused at iza Perasta to 30 in Rat Kostovica with an average value of 18,39 species observed per site. Regarding the total and “reduced” abundance we found medium values of 487,3 and 67,5 individuals 250m^{-2} respectively varying between 2369,6 ind./250m^2 at Seka Albaneze to 84,7 ind./250m^2 at Iza Perasta for total abundance and from 145,3 ind./250m^2 in Opaljike to a minimum of 22,6 ind./250m^2 in Katic Is. for “reduced” abundance (Annex 5).

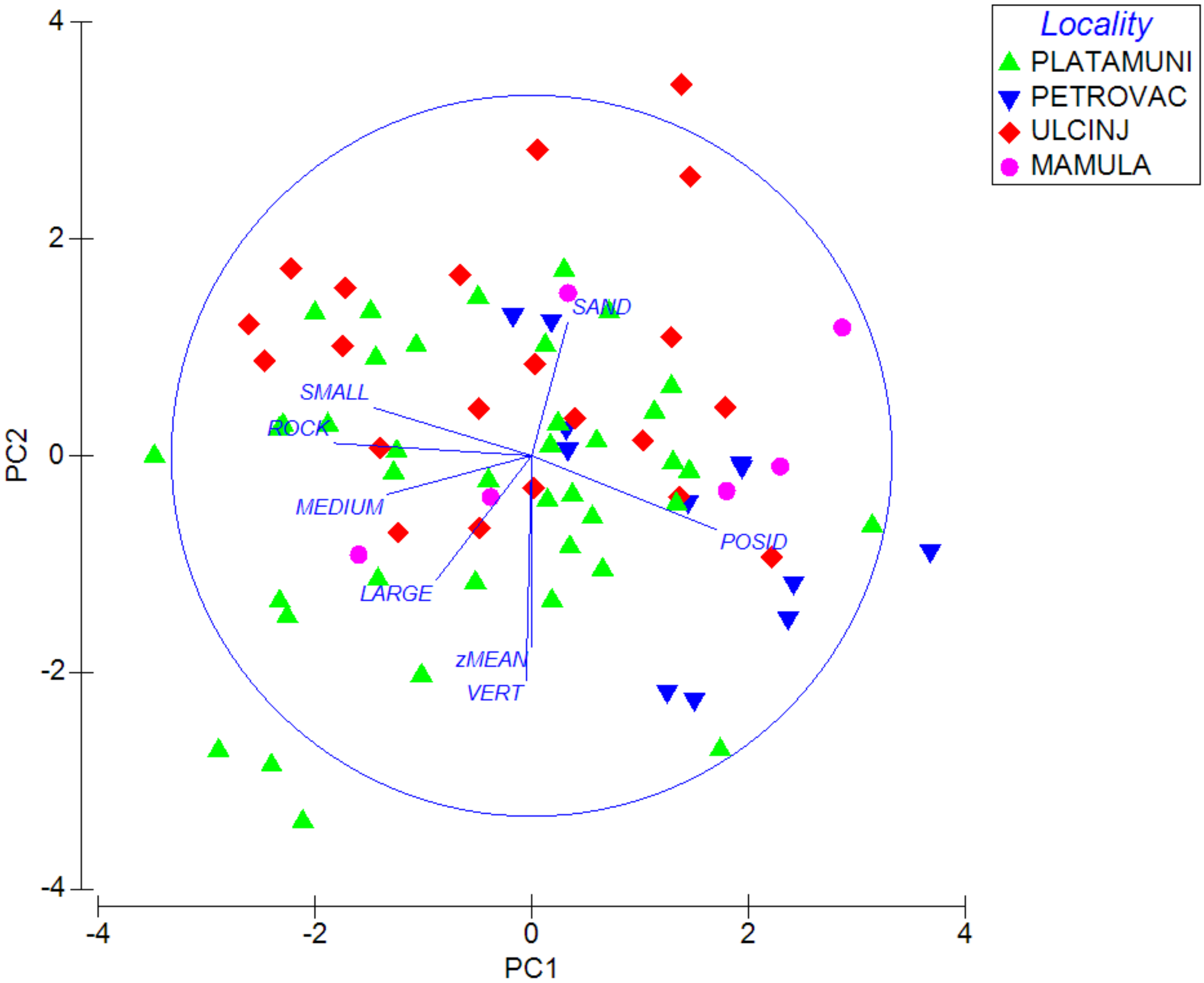


Figure 19: PCA ordination plot of transects within localities. PC1: 32,3% PC2: 20,9%

Table 8: Percentage frequency of occurrence of the fish species observed in the quantitative assessment. Present/absent table of fish species at each campaign and locality.

		Year			Locality				
Species	**Freq%**	**2008**	**2011**	**2012**	**Kotor**	**Mamula**	**Platamuni**	**Petrovac**	**Ulcinj**
A.anthias	2,4	+	+				+		
A.imberbis	44,0	+	+	+		+	+	+	+
B.boops	54,8	+	+	+	+	+	+	+	+
C.chromis	90,5	+	+	+	+	+	+	+	+
C.julis	92,9	+	+	+		+	+	+	+
D.annularis	57,1	+	+	+	+	+	+	+	+
D.dentex	2,4		+						+
D.puntazzo	16,7	+	+	+		+	+	+	+
D.sargus	25,0	+	+				+	+	+
D.vulgaris	63,1	+	+	+	+	+	+	+	+
E.costae	6,0	+	+				+		+
E.marginatus	4,8	+	+				+	+	+
L.bimaculatus	11,9	+		+			+	+	
L.merula	4,8	+	+		+		+	+	
L. viridis	2,4	+						+	
Mugilidae	2,4	+		+			+	+	
M.helena	10,7	+	+	+			+	+	+
M.surmuletus	71,4	+	+	+		+	+	+	+
O.melanura	15,5	+	+	+		+	+	+	+
P.pagrus	6,0	+	+				+	+	+
P.phycis	3,6	+					+	+	
S.aurata	4,8	+	+				+	+	+
S.cabrilla	86,9	+	+	+		+	+	+	+
S.cantharus	59,5	+	+	+		+	+	+	+
S.cinereus	6,0		+		+				+
S.doderleini	54,8	+	+	+	+	+	+	+	+
S.hepatus	7,1		+		+				
S.maderensis	9,5	+		+		+	+	+	
S.maena	16,7	+	+	+			+	+	+
S.mediterraneus	64,3	+	+	+	+	+	+	+	+
S.melanocercus	44,0	+	+	+		+	+	+	+
S.ocellatus	54,8	+	+	+	+	+	+	+	+
S.roissali	6,0	+	+				+	+	+
S.rostratus	39,3	+	+	+		+	+	+	+
S.salpa	11,9	+	+				+	+	+
S.sarda	1,2	+						+	
S.scriba	63,1	+	+	+	+	+	+	+	+
S.scrofa	1,2	+					+		
S.smaris	22,6	+	+	+	+		+	+	+
S.tinca	77,4	+	+	+	+	+	+	+	+
T.pavo	10,7	+	+	+			+	+	+

Table 9: a) b) PERMANOVA analyses results and Pair-wise test between localities for the entire community (a) and for richness, total abundance and "reduced" abundance (b).
Significant F-values and corresponding P-values are indicated in bold.

a)

Source	df	SS	MS	Pseudo-F	P(perm)
Locality	3	12878	4292,8	1,9959	0,026
Zone(Locality)	7	15766	2252,4	1,5541	0,0213
Site(Zone(Locality))	14	20116	1436,9	1,7995	0,0002
Res	53	42318	798,46		
Total	77	91601			

Pair-wise test		t	P(perm)
Platamuni	Petrovac	1,4854	0,0767
Platamuni	Ulcinj	1,2278	0,1785
Platamuni	Mamula	0,88256	0,6126
Petrovac	Ulcinj	2,1157	0,0141
Petrovac	Mamula	2,0606	0,3353
Ulcinj	Mamula	1,38	0,1233

b)

Source

Richness	df	SS	MS	Pseudo-F	P(perm)
Locality	4	257,06	64,266	3,3392	0,0949
Zone(Locality)	7	142,35	20,336	1,8452	0,1498
Site(Zone(Locality))	15	163,89	10,926	1,2845	0,234
Res	57	484,83	8,5058		
Total	83	1017,6			

Total abundance	df	SS	MS	Pseudo-F	P(perm)
Locality	4	3,94E+06	9,84E+05	3,1214	0,1507
Zone(Locality)	7	1,91E+06	2,72E+05	0,34559	0,8908
Site(Zone(Locality))	15	1,18E+07	7,90E+05	2,4759	0,0106
Res	57	1,82E+07	3,19E+05		
Total	83	3,74E+07			

Reduced abundance	df	SS	MS	Pseudo-F	P(perm)
Locality	4	20061	5015,2	2,1867	0,1516
Zone(Locality)	7	16345	2335	1,0492	0,4315
Site(Zone(Locality))	15	33144	2209,6	1,8237	0,0533
Res	57	69063	1211,6		
Total	83	1,38E+05			

PERMANOVA analysis completed with the entire community revealed high variability at site and zone levels while at the locality level we just found differences between the localities of Petrovac and Ulcinj (Table 9a). These results match with the nMDS plot obtained, however this nMDS graph must be read carefully because of its high stress (Fig. 20).

PERMANOVA analysis were performed also on "reduced" fish community, were all pelagic, shoaling and cryptic species were removed. Results of that analysis almost match with previous one, presenting significant differences at locality level just between Petrovac and Ulcinj and high variability at the smaller scales (Table 10).

With respect to the PERMANOVA analysis done to evaluate the differences in abundance, total and "reduce", and those in the species richness, we did not distinguish significant results at locality level. We just found meaning changes at site level in the total abundance (Table 9b). When we checked the PERMANOVA by single species we met significant results at locality level only for *Symphodus mediterraneus* and differences at zone level for *Mullus surmuletus* and *Serranus cabrilla*. Other five species showed differences just at small scale (Table 11).

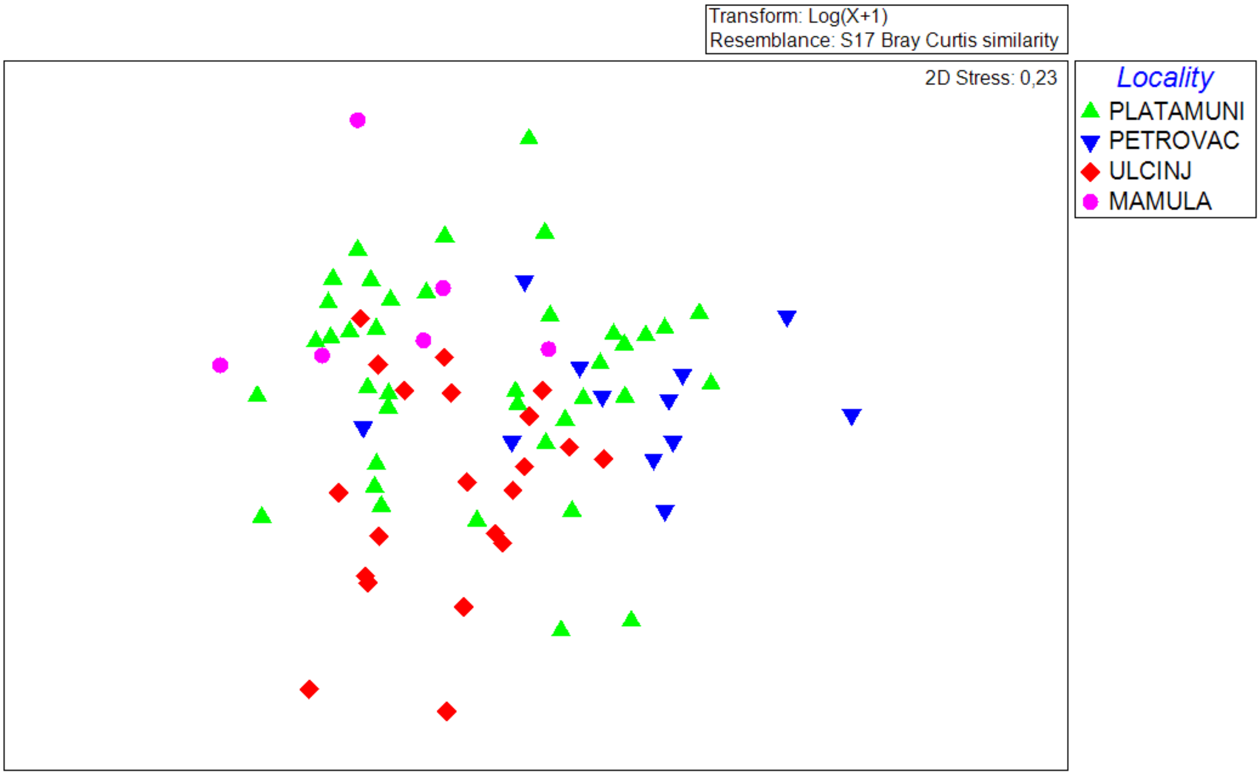


Figure 20: nMDS plot of the entire community

Table 10. PERMANOVA analyses results and Pair-wise test between localities for the "reduced" community. Significant F-values and corresponding P-values are indicated in bold.

Source	df	SS	MS	Pseudo-F	P(perm)
Locality	3	12819	4273,2	1,9959	**0,0245**
Zone(Locality)	7	15685	2240,8	1,5541	**0,0454**
Site(Zone(Locality))	14	21379	1527,1	1,7995	**0,0001**
Res	53	42776	807,09		
Total	77	93017			

Pair-wise test		t	P(perm)
Platamuni	Petrovac	1,4085	0,0849
Platamuni	Ulcinj	1,4447	0,08
Platamuni	Mamula	0,73206	0,7699
Petrovac	Ulcinj	2,1201	**0,013**
Petrovac	Mamula	1,5519	0,3319
Ulcinj	Mamula	1,4994	0,0684

Table 11. PERMANOVA analyses results for the species with significant differences. Significant F-values and corresponding P-values are indicated in bold.

	C. chromis			*D. vulgaris*		
Source	MS	Pseudo-F	P(perm)	MS	Pseudo-F	P(perm)
Locality	3,12E+05	3,8805	0,0963	110	1,9849	0,1744
Zone(Locality)	61377	0,21852	0,9626	54,902	0,75233	0,6206
Site(Zone(Locality))	2,83E+05	2,8392	**0,0057**	72,349	3,1337	**0,0018**
Res	99847			23,088		

	M. surmulletus			*S. cabrilla*		
Source	MS	Pseudo-F	P(perm)	MS	Pseudo-F	P(perm)
Locality	23,243	0,55553	0,7013	109,05	2,2022	P(perm)
Zone(Locality)	46,226	11,334	**0,0007**	54,393	4,9526	0,1594
Site(Zone(Locality))	4,0326	0,36408	0,9826	10,837	1,9016	**0,0172**
Res	11,076			5,6988		**0,042**

	S. cantharus			*S. mediterraneus*		
Source	MS	Pseudo-F	P(perm)	MS	Pseudo-F	P(perm)
Locality	42,665	0,83661	0,5393	52,528	18,921	0,0361
Zone(Locality)	53,782	1,5528	0,1958	1,752	0,13616	0,9647
Site(Zone(Locality))	34,223	3,2155	**0,0016**	13,245	2,5321	**0,0044**
Res	10,643			5,231		

	S. tinca			*C. julis*		
Source	**MS**	**Pseudo-F**	**P(perm)**	**MS**	**Pseudo-F**	**P(perm)**
Locality	2,0208	0,13459	0,9661	4510,1	2,9449	0,1394
Zone(Locality)	15,677	1,3486	0,292	1649,7	2,5565	0,0603
Site(Zone(Locality))	11,496	2,8408	**0,0022**	637,7	1,859	**0,046**
Res	4,0468			343,04		

SIMPER analysis done with the entire community showed an important influence of shoaling and pelagic species on the nMDS ordination due to its high abundance, therefore a "reduced" fish community were used in a second SIMPER analysis in order to avoid the influence of these species.

This second SIMPER analysis determined six species as the responsible of the dissimilarities between sites. *D. vulgaris, D. sargus* and *S. cabrilla* were present mainly in the southern locality (Ulcinj) with shallower depth and rocky bottom. Similarly *C. jullis* and *S. ocellatus* prefer rocky bottoms but were more frequents at Platamuni.

Finally, *D. annularis* prefers habitats with more occurrence of sand and *P. oceanica* (Fig. 21).

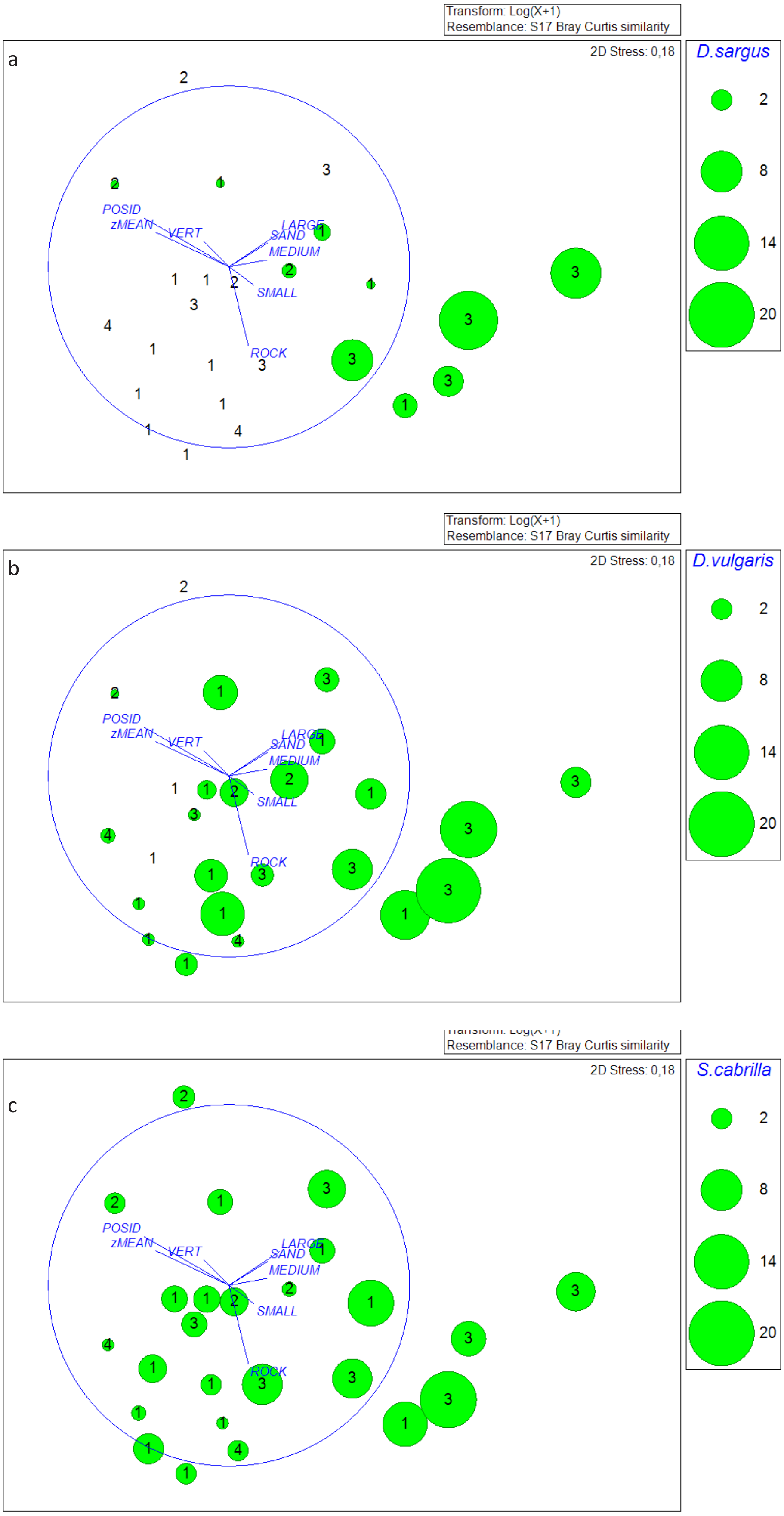


Figure 21: (a-c) nMDS bubble plots constructed on the sites per fish assemblages matrix. Bubble size is proportional to the importance of the species at each site. Numbers in the bubble represents the locality. 1: Platamuni, 2: Petrovac, 3: Ulcinj, 4: Mamula

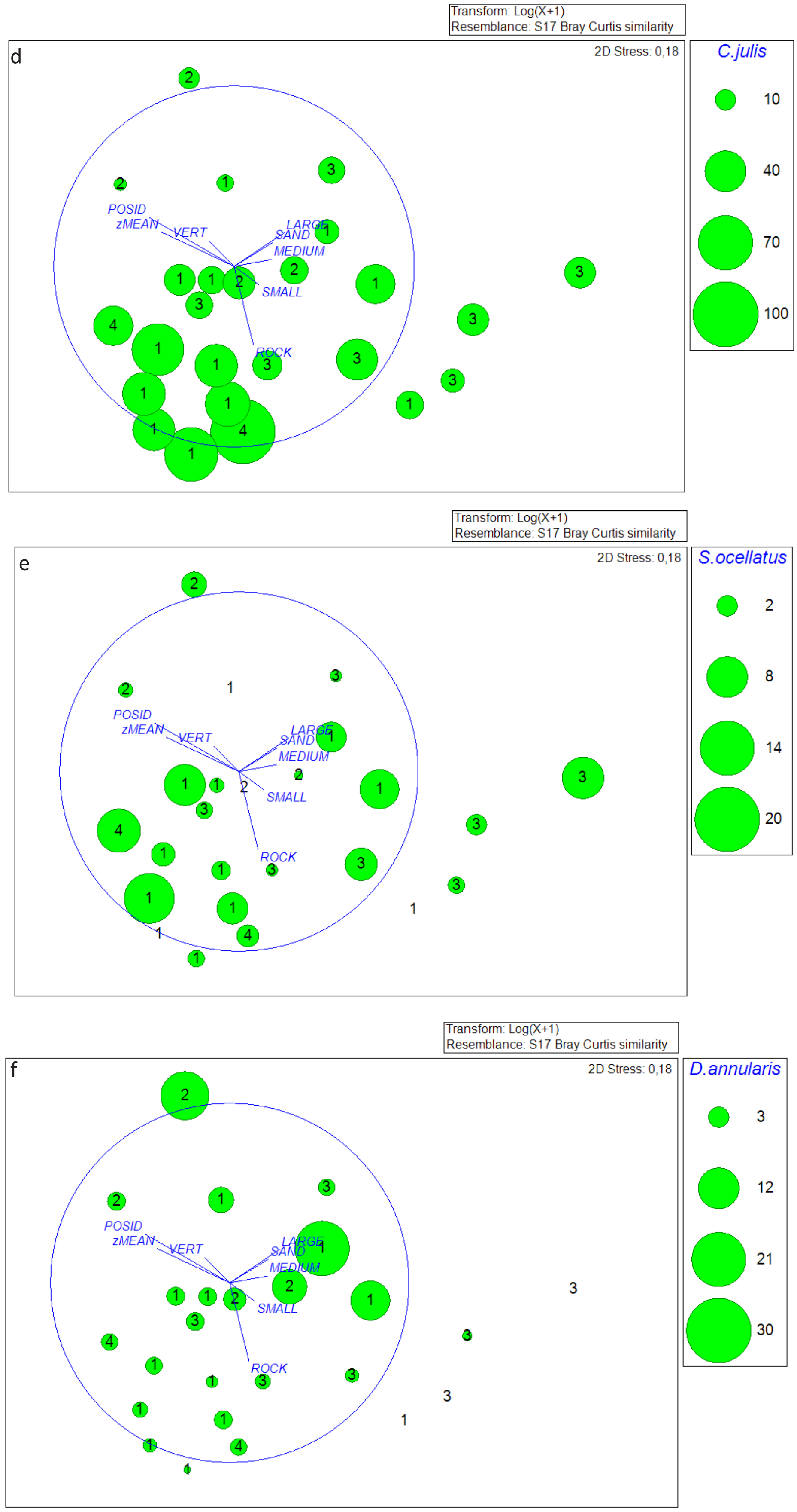


Figure 21: (d-f) nMDS bubble plots constructed on the sites per fish assemblages matrix. Bubble size is proportional to the importance of the species at each site. Numbers in the bubble represents the locality. 1: Platamuni, 2: Petrovac, 3: Ulcinj, 4: Mamula

4. DISCUSSION

4.1. Assessment of the benthic assemblages

The benthic assemblages surveyed along the coast of Montenegro are diverse and typical of the infralittoral of Mediterranean hard and soft substrates, with the notable exception of those in the Bay of Kotor, which represent a *unicum*. All the assemblages seem to be in a good state of health, with the exception of the upper infralittoral in the offshore sites, where the date fishery, when and where practised, has provoked a profound change in both the physical structure of the substrate and the biological composition of the benthic communities.

Dates are collected once the rock has been demolished mechanically. This kind of destructive fishery increases the amount of stone blocks, gravel and sand at the bottom of the cliff and triggers a change in the state of the system from forested to barren. This action, coupled with overfishing, which dramatically reduces the size and number of predatory fish, is at the base of the proliferation of barren habitats dominated by sea urchins in shallow Montenegrin waters. Indeed, fishing with explosives is a plague for Montenegro, and has led to the impoverishment of predator fish assemblages.

The barren stable state characterises the upper rocky infralittoral at all the sites of the open sea visited except Mamula, Seka Albaneze and Seka Kočište. Some of the areas surveyed were the object of study by algologists in past decades (Ŝpan and Antrolić 1983), who reported a luxuriant algal canopy with several species, brown algae in particular. Sea urchin grazing has led to the disappearance of photophilic algal assemblages from a large part of the Montenegrin coast. These have now been substituted by a coralline barren area.

Seka Albaneze showed *Cystoseira* assemblages flourishing, although in the first survey a sea urchin front and a vast barren area were reported. It is beyond the scope of this report to comment on the cause of the expansion of the barren areas. However, it is worth highlighting the complexity of the mechanisms regulating the presence of alternative stable states such as the *Cystoseira* kelp and the barrens. Among the other causes, a trophic cascade could be invoked to explain the phenomenon. The decrease in number, after intensive fishing, of large sea urchin predators, such as a number of sea bream species, may lead to the explosion of grazers and to a consequent reduction in the algal canopy. According to this model, following protection the dominance of sea urchins should come to an end because fish abundance and size increase should lead to algal assemblage recovery. In the case of Seka Albanese, the reduction in barren area between 2008 and 2011 seems to be the result of a storm, rather than of predation, which swept most of the urchins away from the reef.

In the south of the country, the lower infralittoral is dominated by soft bottoms, sand and mud. South of Cape Mendra at Opalijke, fine sand assemblages start at about 5-6 m depth and include some *Cymodocea nodosa* and a few rocky outcrops with *Posidonia oceanica*. Sand is mixed with mud around 20 m depth. Similarly, at Valdanos, north of Cape Mendra, soft bottoms - mainly mud, start at about 12- 14 m depth. In contrast, Cape Mendra is a rocky promontory. The greater frequency of soft bottoms in the south of the country is very likely to correlate to the nearness of the Bojana River delta. At the base of the cliffs at depths of between 16 and 20m colonies of large sized *Axinella* cfr *cannabina* are very common. In this part of the country, at such depths, water transparency is reduced and a cloud of mud is often observed close to the cliff foot. Also in this case there is the possible effect of the Bojana river.

Very well preserved, *Posidonia oceanica* beds dominate the lower infralittoral in most of the other sites, together with pristine sciaphilic assemblages, where the slope or the complexity of the substratum is high.

Algal turf was important in Mendra. This may be the consequence of high slope and runoff from date fishing.

The infralittoral fringe is often characterised by brown alga *Cystoseira amentacea*. However, turf dominates on vertical walls and, in the southernmost site, the fringe is dominated by mussel beds, in some cases down to 2.5 m depth.

Inside Boca Kotorska at Dražin Vrt and Strp a Coralligenous assemblage was found between 12 and 30 m depth. At Dražin Vrt, impressive *Cladocora coespitosa* reefs were present and were associated with a rich assemblage of large-sized sponges and cnidarians, notably massive colonies of the false black coral, *Savalia savaglia,* the gorgonian *Leptogorgia* cfr *sarmentosa* and the yellow cluster anemone *Parazoanthus axinellae*. In the other two sites investigated no such large reefs were found, only small colonies. At Iza Perasta, brown algae characterized the first few metres and large sponges were common at greater depths, notably *Geodia cydonium*.

At Strp, a Coralligenous assemblage was found from 12 to 24 metres. From 12 m depth large blocks were found with large-sized *Axinella* cfr *cannabina* on top and massive colonies of *Parazoanthus axinellae* on the sides of the blocks facing offshore (See Annex I). Intermingled with the *P. axinellae* colonies large ascidians (*Microcosmus* sp.) and other suspension feeders were found (namely small *Cladocora caespitosa, Balanofillia* sp., etc.). Deeper, a gravel assemblage was found, with several small freshwater springs. Close to each spring, as observed at Dražni Vrt, large colonies of *Savalia savaglia* were found, apparently emerging from the soft bottom. However, it is more likely that these were attached to a hard substrate before being covered by sediment (See Annex I). Colonies were as large as 1 m^2, without other important associated megabenthic species, the exception being some areas where very large (12-15 cm) *Mytilus galloprovincialis* were associated. Most of the *S. savaglia* colonies were not fan-shaped but prostrate, forming an irregular, tridimensional, globule-like structure. Where *Savalia* colonies were found, *Leptogorgia* cfr *sarmentosa* was also present, but at a few metres distance. *L. sarmentosa* colonies were large, up to half a square metre. White colonies of *S. savaglia* were also found, with the same ecological features. At the other qualitatively surveyed site of Sveti Djordje, several broken pieces of *C. caespitosa* were found, together with large-sized sponges.

Massive *C. caespitosa* reefs were reported in the bay in the 1970 study. Stjpčević and Parenzan (1980) report a total surface area of 1 985 000 m2 for the Cladocora reef, corresponding to 0.08% of the surface area of the two bays (24.7 km^2). The same study reported a very wide distribution of *Cladocora* in the Kotor and Risan Bays (Table 11).

In our survey inside the Bay we did not find a correspondence with the data shown by Stjpčević and Parenzan. It remains to be established whether this difference is due to a) inaccurate estimations in the 1970 survey, when diving technologies were less sophisticated, b) mechanical damage caused by fishing gears, aquaculture development, anchoring and mooring activities, increased shipping traffic or a combination of all of these factors.

4.2. *Pinna nobilis*

Even though the data gathered are preliminary, the observed mean density of individuals (2,13/100 m^2) shows a density similar to that reported for some Marine Reserves of the western Mediterranean (e.g. 1 Individual /100 m^2 for Port Cross; 1,5 Individual /100 m^2 for Columbretes and the range from 0 to 3.5 individuals/100 m^2 for Scandola). Density is rather lower compared to the Adriatic population of the nearby National Park of Mljet, where densities range between 2 to 20 individuals/100 m^2. Considering that the area investigated is not protected, this result is very encouraging and the Bay of Trašte is a good candidate for the protection of the species.

4.3. Assessment of fish assemblages

Regarding the abundance data we distinguished differences between total and "reduced" abundances. While total abundance, more variable and linked to shoaling species, is similar to those found in other works, the "reduced" abundance is lower than in other studies (Table 13). This "reduced" abundance is formed mostly by sedentary species, which were more affected by harmful practices. It is also remarkable the low abundance and size of species with high commercial value (*Epinephelus* spp., *Diplodus* spp., *Sparus aurata , Dentex dentex)*. However if we pay attention to richness data (12,7 species/250 m^2) we observe that this richness is similar to others reached in comparable studies along the Mediterranean. García-Charton observed 15 species/250 m^2 on average (García-Charton *et al.* 2004) and Treviño-Otón & García-Charton (unpublished data) detected 15,1 species/250 m^2. This shows that species appear but its frequency and abundance is clearly under its charge capacity.

Linked to this approximation it is also remarkable the homogeneity exhibited by fish population in comparison to that presented by habitat characteristics. Habitat complexity is determinant in the definition of fish communities (García-Charton & Pérez-Ruzafa 1998 and 2001), thus it will be expectable that localities with high complexity, like several sites at Platamuni and Petrovac localities, show higher abundances than the ones found. This homogeneity could be explained by the fact that Montenegrin coast is under important impact levels through overfishing and harmful fishing practices (Fig. 22).

Dynamite fishing and date mussel extraction are extended activities all along the coast (Mačić, unpublished data). During our work we were able to record both activities as we felt several underwater dynamite blasts while diving and we found date mussel in the menu of a restaurant in Kotor. Due to these uncontrolled fishing activities fish assemblages are clearly below the carrying capacity of the localities surveyed. The zones proposed as MPA have potential for housing bigger populations because of its high habitat complexity and satisfactory fish species richness but it is necessary to implement protection measures in order to recover fish abundance.

Figure 22: Signs of dynamite fishing were repeatedly observed during our survey. In this picture, a dead fish on the sea bottom, and scavengers.

Table 12: Distribution of Cladocora after Stjpčević and Parenzan 1980

Map ref.	Location	Size m²	Length
a	Perast to church of Banja	120 000	1 km
b	Between the 2 islands & the opening of Verige Strait	1.500 000	-
c	Perast to Orahovac	200 000	5 km
d	From Ljuta southwards, small areas in front of Pjerovici & Tomici	45 000	300 m
e	In front of Glavati	40 000	800 m
f	Between Strp & Zopat	80 000	1 km

Table 13: Summary of values of mean total and 'reduced' abundance per 250 m² reported by other authors and the present study, referring exclusively to rocky photophilous bottoms. The size of the sampling units originally used in the different studies is also indicated.

Reference	Area	Original size of sampling unit (m²)	Total abundance (ind. 250 m^{-2})	Red. Abundance (ind. 250 m^{-2})
Guidetti (2000) Est. Coast. *Shelf Sci.* 50: 515-529	Otranto (Apulian coast, southern Adriatic)	40	1451.3	370.6
Guidetti *et al.* (2002) *Mar. Environ. Res*. 53: 77-94	4 loc. along the Apulian coast	125	818.8	95.9
García-Charton *et al.* (2004) Mar. Biol. 144: 161-182	3 unprotected areas in western Mediterranean (Aguilas, Isla Grosa, Mallorca)	250	618.6	186.6
Bonaca & Lipej (2005) *Mar. Ecol.* 26: 42-53	Southern Gulf of Trieste, northern Adriatic	100	91.2	72.3
Harmelin-Vivien *et al.* (2008) *Biol. Conserv.* 141: 1829-1839	Outer, unprotected part of 6 MPAs in western Mediterranean	125		132.0
Treviño-Otón & García-Charton unpublished data (2009)	Unprotected zone Cabo de Palos – Islas Hormigas MPA (Spain)	250	446.2	110.9
La Mesa *et al.* (2010) *Italian Journal of Zoology,* iFirst, 1–14	Galiinaria island, western Ligurian sea (Italy) (12-16 meters depth)	78,5	427.9	
This study (2008 - 2012)	Montenegro	250	487.3	67.5

4.4. Quality of the environment

Based on observations made during the survey, the quality of the environment along the Montenegrin coast appears very good, the exception being those areas where tourist activities are over-developed (Fig. 23). Rocky areas (in particular vertical cliffs) seem to be in excellent condition and inland the only concern is from Mediterranean maquis fires (Fig. 24). Underwater, the number of fish species recorded is similar to that of other areas of the Mediterranean, but abundance and size resulted very low; this is likely to be a result of intensive fishing with explosives. For example, few, and generally small-sized, groupers were observed during our dives. The shallow and low exposed small pebble/sandy beaches and creeks seem to be an important nursery for fish.

Figure 23: The quality of the environment along the Montenegrin coast appears very good, the exception being those areas where tourist activities are overdeveloped.

Figure 24: Rocky areas (in particular vertical cliffs) seem to be in excellent condition. Inland, the only concern is from Mediterranean maquis fires.

4.5. Main human activities and threats to the coastal and marine environment

Fishing, and to a much greater extent, tourism, are the two main human activities along the coast. No other sizeable industries are present. Pollution from untreated sewage may be a problem in the near future following the development of tourist infrastructure and the general increase in human pressure along the coast. The dumping of solid waste or soil from the road and other constructions will be a serious problem if the negative effects on marine life are underestimated, especially in the Bay of Kotor.

Tourism

Threats are due to the rapid expansion of tourism and the future plans for tourism infrastructure (the sale of land seems to be very active and still in progress). No sewage treatment seems to take place at present but some are planned. New infrastructure (hotels, marinas, roads etc.) are likely to increase dramatically. Beach-based and nautical tourism seem to be the target activities at present and all development appears to be in that direction. The threat from diving is not important at this stage as diver numbers are low. Nearly most, if not all, of the beaches and creeks are occupied by tourist activities, while cliffs and rocky coasts are mostly still intact. As a Management Plan from the Ministry of Tourism and the Environment exist for the Montenegrin coast it would be important for future action in the coast to recall and follow as appropriate this Plan.

Fisheries

Four main fisheries are located along the coast (Bar, Petrovac, Buda and Herceg Novi). About 17 trawlers of small/medium size operate. Small-scale fishing is practised by many individuals all along the coast. The main gears include nets, trammel-nets, pots/traps and long-lines. Official statistics on the structure of fisheries and catches will be available from a report expected by September 2012.

The impact of legal fishing does not appear to be severe (few units were seen fishing during our mission), but the real problem is the practice of fishing with explosives and other illegal typologies of fishing. This seems to be common and frequent all along the coast of Montenegro. In three out of the eight places visited we found proof of this practice (dead fishes - often partially consumed by scavengers, or fishes presenting injuries).

Others sources

Other impacts may be a consequence of untreated solid domestic waste - see, for example, the dumping area close to Opaljike (Fig. 25), quarries - see, for example, the one close to Stari Ulcinj (Fig. 26), and mining activities.

Figure 25: Untreated solid domestic waste near Opaljike

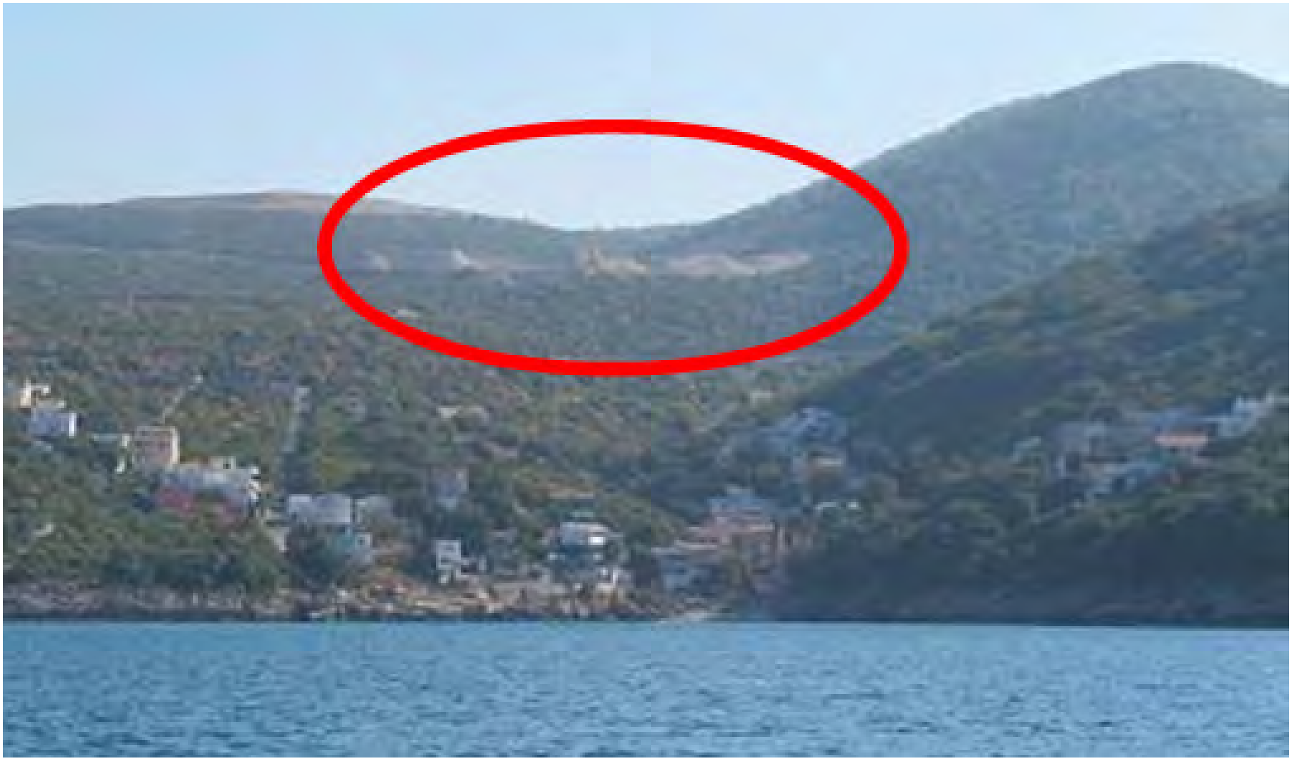


Figure 26: Quarry close to Stari Ulcinj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5. SUGGESTED SITES FOR PROTECTION

During our three missions in Montenegro, we collected quantitative data, consulted the available literature and reports and talked to colleagues and local people. But, more importantly, we spent roughly 30 days along the Montenegrin coasts and underwater, and it is mostly this direct source of information that helped us to reach our conclusions.

Our suggestion is that there are three main areas that deserve prioritary protection, namely Katič, Platamuni and Stari Ulcinj. They have potential for housing bigger fish populations because of their high habitat complexity and satisfactory fish species richness, but it is necessary to implement protection measures involving establishment of no-take areas and buffer zones in order to recover fish abundance at least in these sectors of the Montenegrin coast.

Three further areas deserve protection for more specific reasons, two of them located inside the Bay of Kotor and another one in the bay of Trašte. These areas should be designated as micro reserves, much smaller than the three MPAs previously identified, and aimed at the protection of the coralligenous assemblages of the Bay of Kotor and of *Pinna nobilis* in the Bay of Trašte.

Suitable areas for establishing Marine Protected Areas

Petrovac - Katič

We suggest including the area between Rt Skočidevojka and Dubovica, from the coast to a depth of about 50 m, as the whole area deserves protection. Here, we suggest giving the highest status of protection to the small islets, sv Nedelia and Katič and the surrounding areas - the outcrop of Formica and Dubrovica. It could be reasonable to extend the MPA southward to include Rt Pečin and Rt Crni, highlighted as important areas to be protected in a report of the Italian company SGI.

Platamuni and adjacent reefs

We suggest including the area between the Seka Albaneze and Rt Platamuni, from the coast to a depth of about 50 m, as the whole area deserves protection. Here, we suggest giving the highest level of protection to the outcrop of the Seka Albaneze and the surrounding areas. We suggest extending the MPA to include Rt Kostovica towards the south, and at least one Km of coast to the north of Seka Albaneze. We recommend giving a high protection status also to the Seka Kočište towards the north, in the Gulf of Trašte, and to the offshore part of Sv Nikola southwards, in the Gulf of Budva.

Ulcinj

We suggest including the area between Obala Stari Ulcinj, from the coast to a depth of about 35-40 m, as the whole area deserves protection. Here, we suggest giving the highest status of protection to the area between Kruče and Rep.

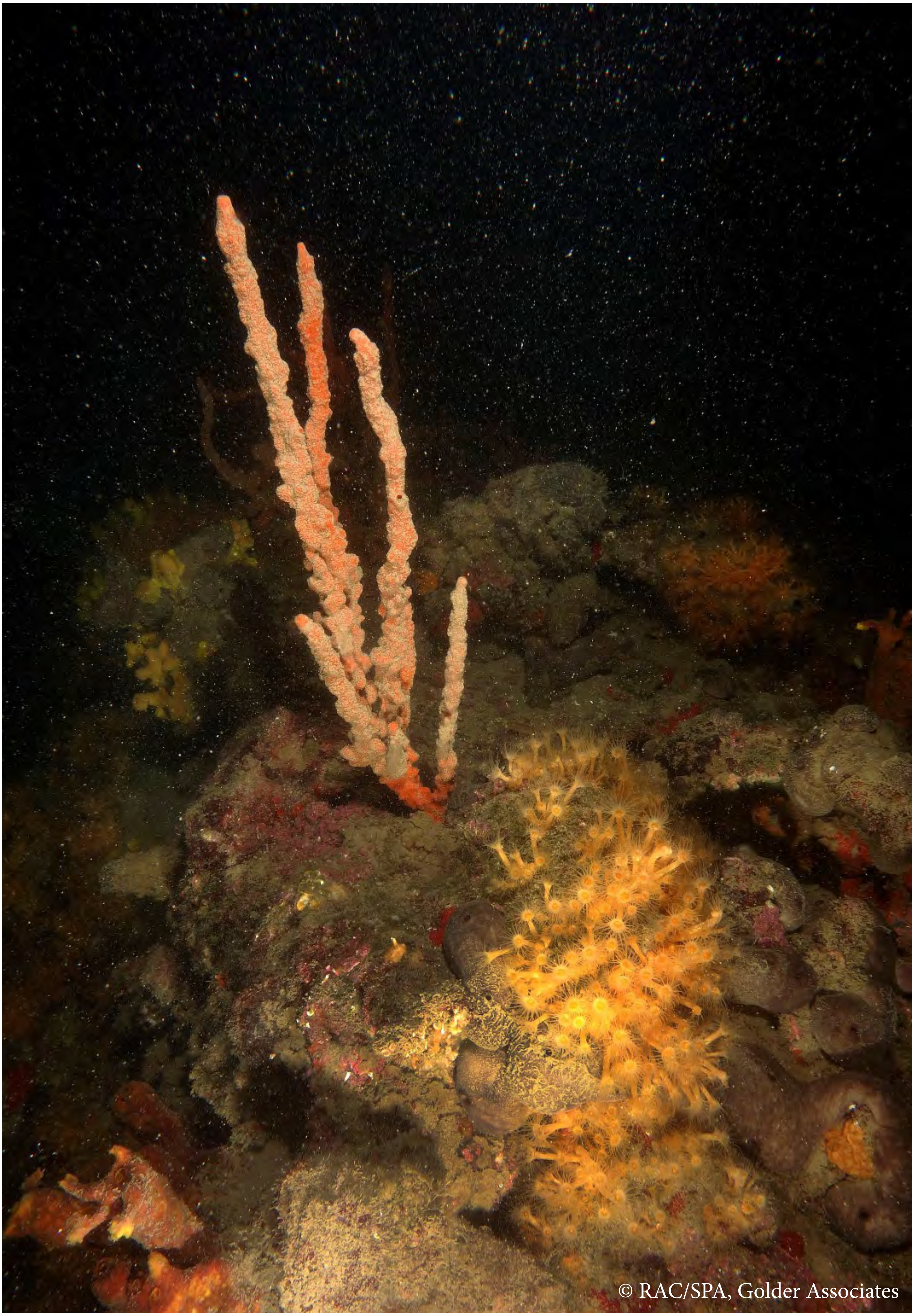
Suitable areas for establishing Micro reserves

Boka Kotorska

We suggest the areas close to Drazni vrt and Strp in the Bay of Kotor and Risan as suitable microreserves to protect the Coralligenous assemblages found and described in these areas. What is important here is to protect a small part of the coast (roughly 600 m for the core area plus a buffer area of 300 m at the two sides) down to 30 m, in particular to prevent mechanical damage to the structure, dumping of waste or construction debris, entanglement of fishing gears and any source of organic pollution. Scuba diving should be regulated and the collection of organisms strictly prohibited.

Trašte Bay

This area is likely to be affected by tourism development, including the construction of marinas and a sewage outfall. However, the Bay hosts an impressive *Pinna nobilis* population. We suggest protecting two sites (Kamenolom Oblatno and Maslinada) in the Bay by establishing two microreserves aimed at safeguarding the *Pinna nobilis* population. The protection of Kamenolom Oblatno could be combined with that of the Seka Kočiste. Major threats to *Pinna nobilis* include mechanical damage to the shell, dumping of waste or construction debris, entanglement of fishing gears and any source of organic pollution. All these activities should be banned. Scuba diving should be regulated and the collection of organisms strictly prohibited. We suggest protecting at least one of the two sites surveyed, in an area no smaller than 100.000 m^2, centred on the site surveyed.



6. EXECUTIVE SUMMARY

The report includes the findings of three different marine biodiversity survey missions to Montenegro carried out in 2008 (20-29 July 2008) principally in the northern and central coast of the country, in 2011 (25 October-03 November 2011) in the southern coast and in the Bay of Kotor, and in 2012 (12 – 20 June) in the Bay of Boka Kotorska, island Sv. Nikola (in front of Budva town) and Trašte Bay.

The report includes two series of data, one on the benthic habitats and other on the fish assemblages. Notes on the human activities and related socio-economic aspects were also included in the report. All available data were merged, analysed and a general discussion about the state of the benthic habitats provided, together with suggestion of sites for protection.

Conclusion of the report is that the benthic assemblages surveyed along the coast of Montenegro are diverse and typical of the infralittoral of Mediterranean hard and soft substrates, with the notable exception of those in the Bay of Kotor, which represent a *unicum*. Most of the assemblages seem to be in a good state of health, with the exception of the upper infralittoral in the offshore sites, where the date fishery has provoked a profound change in both the physical structure of the substrate and the biological composition of the benthic communities. The barren stable state characterises the upper rocky infralittoral at all the sites of the open sea visited except Mamula, Seka Albaneze and Seka Kočište.

Very well preserved *Posidonia oceanica* beds dominate the lower infralittoral in most of the surveyed sites, but also some locations with regresive changes are noted.

Inside Boka Kotorska at Dražin Vrt and Strp, impressive *Cladocora coespitosa* reefs were present and were associated with a rich assemblage of large-sized sponges and cnidarians, notably massive colonies of the false black coral, the gorgonian and the yellow cluster anemone.

It was expectable that localities with high complexity, like several sites at Platamuni and Petrovac localities, show higher fish abundances than the ones found. This homogeneity could be explained by the fact that Montenegrin coast is under important impact of overfishing and harmful fishing practices (dynamite fishing and date mussel extraction). It is also remarkable the low abundance and low size of species with high commercial value (*Epinephelus* spp., *Diplodus* spp., *Sparus aurata, Dentex dentex*). However if we pay attention to richness data (12,7 species/250 m^2) we observe that this richness is similar to others reached in comparable studies along the Mediterranean. This shows that species appear, but its frequency and abundance is clearly under its capacity.

Our suggestion is that there are three main areas that deserve prioritary protection, namely Katič area, Platamuni area and Stari Ulcinj area. They have potential for housing bigger fish populations because of their high habitat complexity and satisfactory fish species richness,, but it is necessary to implement protection measures involving establishment of no-take areas and buffer zones in order to recover fish abundance at least in these sectors of the Montenegrin coast.

Three further areas deserve protection for more specific reasons, two of them located inside the Bay of Kotor and another one in the bay of Trašte. These areas should be designated as micro reserves, much smaller than the three MPAs previously identified, and aimed at the protection of the coralligenous assemblages of the Bay of Kotor (Dražin Vrt and Strp) and of *Pinna nobilis* in the Bay of Trašte.

Annex I: Daily report

July 20-21, 2008

These first two days were spent meeting with representatives of the Ministry of Tourism and the Environment (Ana Pajović) and of the Marine Biology Institute of Kotor (Vesna Mačić and Slavica Kašćelan). The meetings were aimed at gathering information about the status of the Montenegrin marine and coastal environment and of its protection and to discuss possible sources of information/plans about the protection and development of marine and coastal areas and about fishery activities of the country (some documents do exist but were not available at the time of the meetings. They will be provided in the near future).

Finally, a protocol of data collection by SCUBA diving was finalized. It was decided to collect data on fish assemblages (by UVC), on the structure of the benthic habitats and of the most important benthic habitat and species of the infralittoral zone. Data collection was to be carried out on 100 m long transects running parallel to the coast for fish and on transects perpendicular to the coast from 20-25 m depth up to 0-2 m depth for the benthos. It was decided to collect data from three transects for each of the sites inspected (generally two per day).

July 22, 2008

Diving at Mamula Island and at Poseĵdonov Grad (Figs. 1-2), close to the mouth of Kotor Bay.

July 23, 2008

Two diving sites were selected close to Stari Ulcinj, in the south of the country. However, due to bad weather conditions it was not possible to dive. It is important that the mission in September gathers data from the area between Valdanos beach Mendra cape (Fig. 3), and Ulcinj (Fig. 4). The Velika Plaza south of Ulcinj (Fig. 5) is a crowded beach while the inland area (wetland) is already protected (though its exact protection status needs to be checked); no further investigation seems necessary along the beach due to massive tourism in the area.

Figure 1: Mamula Island

Figure 2: Poseĵdonov Grad

Figure 3: Valdanos beach and Rt Mendra

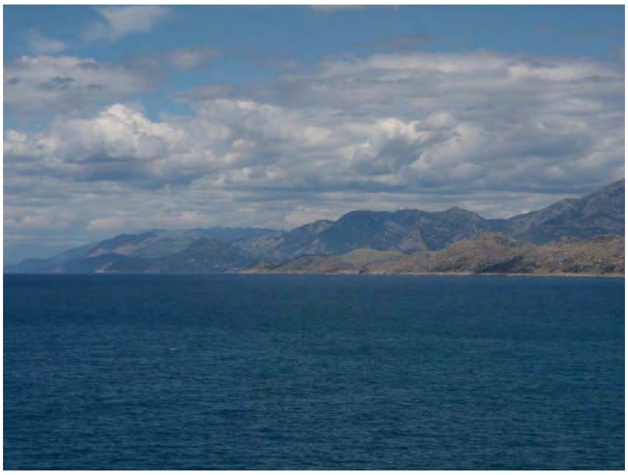


Figure 4: Surroundings of Ulcinj

Figure 5: The crowded beach of Velika Plaza

July 24, 2008

Diving at Rt (Cape) Platamuni and Sveti Nikola islet (Figs. 6-7).

Figure 6: Platamuni Cape

Figure 7: Sveti Nikola islet

July 25, 2008

Diving at Katič islets (off Petrovac): Sveta Nedjelja and Katič (Fig. 8)

Figure 8: Katič islets (off Petrovac): Katič on the left and Sveta Nedjelja on the right

July 26, 2008

Diving at Rt (Cape) Dubovica and Formica islets and Stolac point (Dubovac cliff) (Figs. 9-10)

Figure 9: Formica islets close to Rt (Cape) Dubovica

Figure 10: Stolac Cape (Dubovac cliff)

July 27, 2008

Diving at Seka Albaneze (Figs. 11-12) and Rt (Cape) Kostovica creek (Fig. 13).

Figure 11: Seka Albaneze

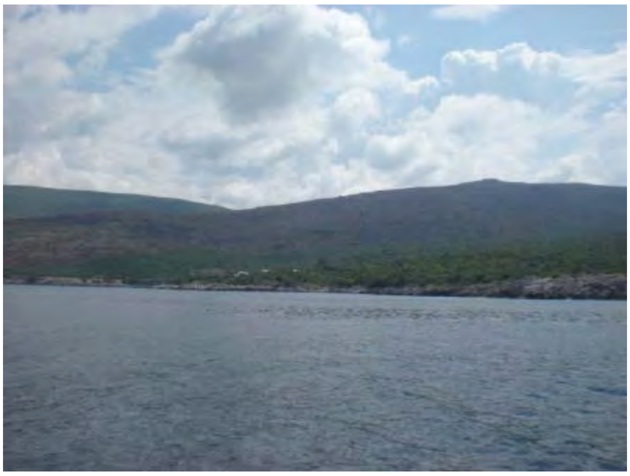


Figure 12: The coast surrounding the Seka Albaneze

Figure 13: Creek and pebble beach close to Rt (Cape) Kostovica

July 28, 2008

Diving at Krekavica (large & small): Rt Velika Krekavica and u. Mala Krekavica (Figs. 14-15).

Figure 14: Krekavica: large Rt V Krekavica

Figure 15: Krekavica: (small) Mala Krekavica

July 29, 2008

Diving at Kotor bay (Drazin Vrt) (Figs. 16-17). In this diving session only qualitative data were collected.

Figure 16: Kotor Bay. Drazin Vrt on the right

Figure 17: Kotor Bay. Drazin Vrt.

Second mission

October 25, 2011

On the day of our arrival, we were welcomed in Bar early in the morning by Dr. Vesna Mačić from the Marine Biology Institute of Kotor. After checking into the hotel we spent the day setting up the work schedule for the next two weeks.

We decided to keep the protocol chosen in the previous campaign, three replicates of 50 x 5 m parallel to the coast for fish assemblage visual censuses, and perpendicular transects to the coast from 0-2 m depth up to 20-25 m depth for the benthos. As in the first campaign we planned two dives each day, corresponding with the two sites, and at each dive we performed three replicates.

October 26, 2011

Diving day at Opaljike and rt Mendra (Figs. 18-19), the southernmost sites of the study, near the small town of Ulcinj and the delta of the Bojana river respectively. The two sites were very shallow (in particular Opaljike) and seemed highly influenced by the Bojana river.

Figure 18: Opaljike

Figure 19: rt Mendra

October 27, 2011

Two more sites, rt Rep and Valdanos, (Figs. 20-21) were investigated under good sea conditions. Again, we detected the influence of the Bojana river, with deposits of mud and low visibility.

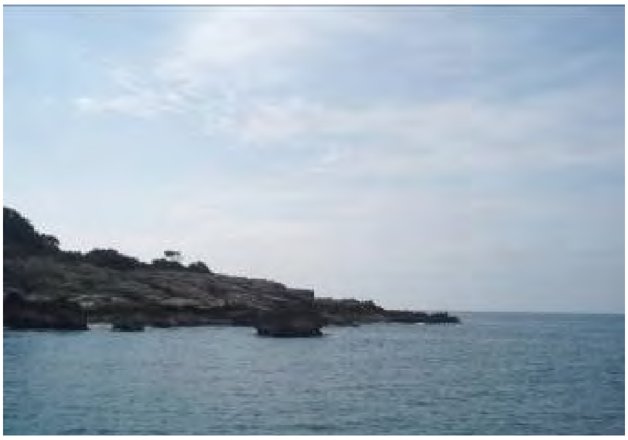


Figure 20: rt Rep

Figure 21: Valdanos

October 28, 2011

This day we surveyed the small island of o. Stari Ulcinj and a small cape near the sites surveyed the previous day, rt Kruče. (Figs. 22-23).

Figure 22: o. Stari Ulcinj

Figure 23: rt Kruče

October 29, 2011

On this day we only performed one census, finishing the survey on south Montenegro. The site selected was a part of the coast in front of the island Stari Ulcinj surveyed the previous day (obala Stari Ulcinj, (Fig. 24)). Here, as on the island Stari Ulcinj, the influence of the Bojana river was not observed. After the census we packed and moved to Kotor.

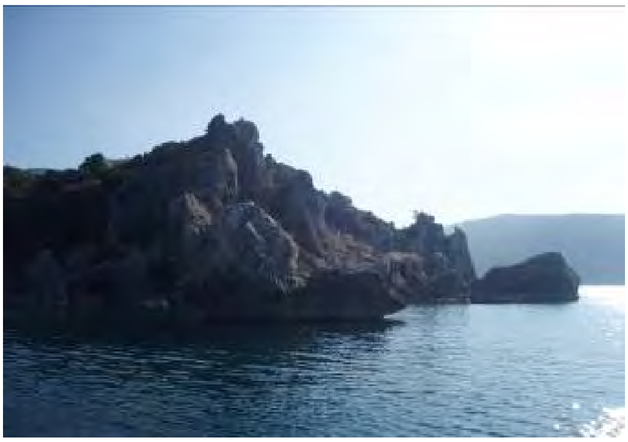


Figure 24: obala Stari Ulcinj

October 30, 2011

On this day we censused the locality Seka Albaneze (Fig. 25). This point was previously censused in the 2008 campaign, but we were interested in repeating the survey to evaluate possible shifts in the community.

Figure 25: Seka Albaneze

October 31, 2011

This was our first day of diving inside the Kotor bay. The location had a particular up-welling of fresh water that conferred special characteristics to the site.

Figure 26: Dražin Vrt

November 1, 2011

On this day we repeated the dive in Dražin Vrt in order to evaluate thorouly the coraligenous assemblage present at this location. After this dive we did a short dive around the islet Ostrvo Sveti Đorđe (Fig. 27) located in the mouth of the bay, searching for other locations with coraligenous.

Figure 27: Ostrvo Sveti Đorđe (island St George)

November 2, 2011

It was our last diving day of the present campaign. We finished the census inside the Kotor bay, diving in Iza Perasta (Fig. 28). Again, our objective was to find new places with the spectacular coraligenous assemblage found at Dražin Vrt.

Figure 28: Iza Perasta

Third mission

June 12, 2012

Arrival from Bar to Kotor and discussion on planed activities. Considering that this was third field survey in Montenegro organized by RAC SPA, it was previously agreed that methodology should have been be the same of the previous two surveys. Because of that, it was confirmed that data for the benthic assemblages would be collected along 10m wide transects perpendicular to the coast, from surface to about 25m depth. Data on fish assemblages would be collected by means of underwater visual census technique along 100m long transects running parallel to the coast. Also photo documentation would be performed during all dives.

June 13, 2012

This first day was spent diving in the bay of Kotor looking for further sites with the coralligenous assemblage found in the October 2011 at Drazni Vrt. Hence, It was chosen to perform random trials at two sites, instead of quantitative transects, in order to explore a larger area at each of the selected sites.

The first dive was at the St George island. The trial started on the eastern side of the islet and proceeded anticlockwise up to the channel between St George and Our Lady of the reef Islet. In one hour of trials no coralligenous was found. The eastern side of St George appeared to be under the influence of a tidal current from the boka. A strong current characterized this part of the islet. The first 6 meters were dominated by brown algae, namely *Cystoseira* spp. and *Sargassum* sp. (Fig. 29). Deeper, a soft bottom, mainly constituted by gravel was found with little blocks intermingled. Megabenthos was rare and mainly represented by sponges and some small colonial organism. No *Cladocora caespitosa* was found in this area. On the southern part of the islet a similar condition was found. Here, the assemblage of large brown algae is absent and it is substituted by a turf and some sciofilous algae. Notably a very large amount of wastes was found down to 10 m (Fig. 30). Deeper gravel dominates. No corallignous was found but numerous small colonies of *Cladocora caespitosa* were present in the entire area explored and the sponge *Axinella* cfr *cannabina* was frequent.

Second dive was at Strp. The random trial started at the eastern end of the village and proceeded eastward. Here, from 12 to 24 meters a Coralligenous assemblage was found. From 12 m, depth large blocks were found with large sized *Axinella* cfr *cannabina* on top and massive colonies of *Parazoanthus axinellae* on the side of the blocks facing offshore (Fig. 31). Intermingled with the *P. axinellae* colonies large ascidians (*Microcosmus* sp.) and other suspension feeders were found (namely small *Cladocora caespitosa, Balanofillia* sp., etc.).

Deeper, a gravel assemblage was found with several small fresh water springs. Close to the each spring , as observed at Dražni Vrt, large colonies of *Savalia savaglia* were found, popping out apparently from the soft bottom, but more likely they were before attached to an hard substrate then covered by the sediment (Fig. 32). Colonies were as large as 1 square m without other relevant megabenthic species associated. The exception being some areas were very large 12-15 cm *Mytilus galloprovincialis* were associated. Most of the *S. savaglia* colonies were not fan-shaped, rather they were prostrated and formed an irregular, tridimensional, globules-like structure. Where *Savalia* colonies were found, *Leptogorgia* cfr *sarentosa was found as well but meters apart. L. sarmentosa* colonies were large, up to half square meter. At the western end of the trial, white colonies of *S. savaglia* were found, under the same ecological features (Fig. 33).

Sponge assemblages was rich. The mixture of large blocks and *Savalia* + *Leptogorgia* colonies was continue for at least 400 m along the coast. The shallower portion of the explored area was similar to Drazn Virt with large blocks brown algae and *Codium* sp.

Figure 29: St George Island The first 6 meters were dominated by brown algae, namely *Cystoseira* spp. and *Sargassum* sp.

Figure 30: St George Island a very large amount of wastes was found down to 10 m

Figure 31: Strp: from 12 m, depth large blocks were found with large sized *Axinella* cfr *cannabina* on top and massive colonies of *Parazoanthus axinellae* on the side of the blocks facing offshore

Figure 32: Strp, large colonies of *Savalia savaglia* were found, popping out apparently from the soft bottom, but more likely they were before attached to an hard substrate then covered by the sediment

Figure 33: Strp, at the eastern end of the trial, white colonies of *S. savaglia* were found

June 14, 2012

Mamula island (Fig. 34) is located in the entrance to the Boka Kotorska Bay and it was also visited in 2008 survey, but at that time it was no better explored. Because of possible importance for the future activities in the creation of MPA in this survey it was explored better. Also, coastal area close to Mamula (Uvalla Ploča, Fig. 35) island was explored during the second dive of the day.

Figure 34: Mamula Island

Figure 35: Uvala Ploča

June 15, 2012

On the third day we started survey in the area of island Sv. Nikola off Budva town (Fig. 36-37). This island was never before included in the rapid assessment activities and as we concluded in previous survey (October 2011) that this area could be of potential importance, it was a part of this field survey. Two dives were performed close to the south part of the island, on the west and other on the eastern part of the island.

Figure 36: Island Sv. Nikola off Budva town, eastern side

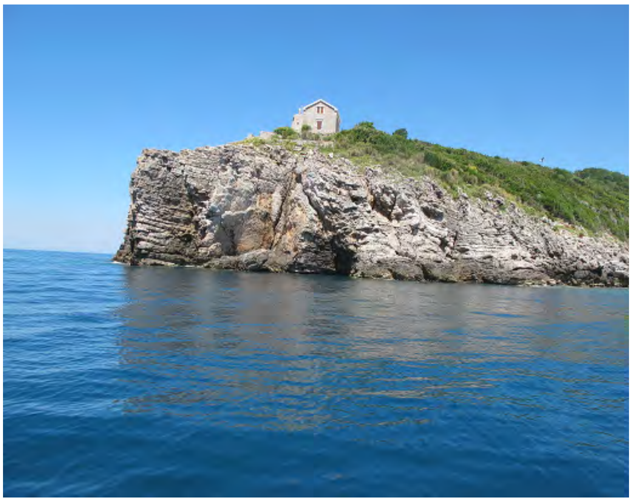


Figure 37: Island Sv. Nikola off Budva town, south tip

June 16, 2012

West side of island Sv. Nikola (Fig. 38) is not suitable for constructions on the coast and regarding that on this side of island there are some interesting sites for divers this area was surveyed better. First dive was on Galiola outcrop and second on školj (Sv. Nikola west). First dive was indicated as very important for the biodiversity and complexity of habitats.

Figure 38: Island Sv. Nikola off Budva town, western side

June 17, 2012

Divers of Institute of marine biology and Italian SGI recorded, in Trašte bay, some locations very important for the protected species *Pinna nobilis,* but no other surveys were performed in this area so fare. Because of that survey activities in this project were performed in this area. During the day three dives, one at the very rich in biodiversity Seka Kočiste (Fig. 39) and the other two in area where high density of *P. nobilis* were reported, were performed and on all locations very high density of this protected species were recorded (Figs. 40-41).

In almost all the dives fruit of *Posidonia oceanica* were found on the plant (Fig. 42), and thousands were floating around. Seeds were commonly found on the sea bottom in almost all the transects.

Figure 39: Seka Kočiste is very rich in biodiversity

Figure 40: High density of this protected species were recorded in Trašte bay

Figure 41: High density of this protected species were recorded in Trašte bay

Figure 42: In almost all the dives fruits of *Posidonia oceanica* were found on the plant

June 18, 2012

Last dive was at Rt Mogren (Figs. 43-44), an interesting spot very close to the harbor of Budva. Here diving was disturbed because we heard by an underwater explosion. This is the result of illegal fishing with explosive, unfortunately still very common along the Montenegrin coasts.

Figure 43: Rt Mogren

Figure 44: Rt Mogren

Annex 2. List of species at the surveyed sites

	Dražin Vrt	Dubovac Cliff	Formica Islets	Hrid Galiola	Iza Perasta	Katić islets	Kruče	Mala Krekavica	Mamula	Mamula II	Mendra	Mogren	Obala Stari Ulcinj	Opaljike	Posejdonov Grad	Rat Kostovica	Rat Platamuni	Rep	Seka Kočište	Seka Albaneze	Seka Albaneze	Stari Ulcinj	Sv Nikola (Budva) inshore	Sv Nikola (Budva) offhore	Sveti Nikola	Uvalla Ploča	Valdanos	Velika Krekavica
ALGAE				X																								
Acetabularia acetabulum						X		X	X	X																X		X
Amphiroa rigida	X			X	X		X			X		X	X	X				X				X						
Codium bursa	X	X	X	X	X	X	X		X	X	X	X	X			X		X	X	X	X	X		X		X	X	
Caulerpa racemosa																			X									
Codium vermilara	X	X			X	X		X																				
Corallina officinalis				X			X			X	X	X	X	X		X		X				X		X			X	
Cladophora spp.	X			X	X					X									X				X	X				
Cystoseira amentacea var. stricta					X				X	X				X	X	X		X	X					X				X
Cystoseira corniculata					X			X	X	X					X	X			X	X	X							
Cystoseira discors var. latiramosa	X				X			X		X	X					X			X	X	X							
Cystoseira spp.	X				X		X		X	X	X			X	X	X		X	X	X	X	X		X			X	
Dasycladus vermicularis			X							X		X			X	X			X	X	X							X
Dictyota sp.	X			X	X		X			X	X	X	X					X	X			X	X	X				
Dilophus spp.	X				X	X		X	X	X	X	X			X			X		X	X		X					
Flabellia petiolata		X	X	X		X	X		X	X	X	X	X			X	X	X	X	X	X	X		X	X	X	X	
Halimeda tuna	X	X	X		X	X	X			X		X	X			X		X	X	X	X	X		X			X	
Halopteris sp.	X		X	X	X	X		X	X	X	X	X	X	X		X		X	X	X	X	X	X	X		X	X	
Jania rubens						X	X	X		X	X	X	X	X		X		X	X	X	X	X	X	X		X	X	
Lophocladia lallemandii		X													X													X
Mesophyllum spp.	X			X	X					X			X						X					X				
Padina pavonica	X	X	X	X	X	X	X			X		X	X		X	X		X	X	X	X	X	X	X		X	X	
Palmophyllum crassum		X	X			X	X	X		X	X		X		X	X	X		X		X			X	X			
Peyssonnelia spp.	X		X	X	X	X	X		X	X	X	X	X			X		X	X	X	X	X	X	X	X		X	X
Pseudolithophyllum expansum	X																		X		X	X		X			X	
Sargassum spp.	X				X				X						X				X	X	X	X						
Sphaerococcus coronopifolius						X		X		X				X					X			X		X				
Ulva rigida	X				X																							
Vidalia volubilis	X				X					X									X									
Algal turf		X		X		X		X				X			X	X	X								X	X		X
PHANEROGAMAE																												
Posidonia oceanica		X	X	X		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X		X	X	X
Cymodocea nodosa														X														
PORIFERA																												
Agelas oroides		X	X			X	X				X	X	X		X	X		X				X		X			X	X
Anchinoe sp.	X	X	X	X		X	X			X		X	X		X	X			X					X				
Axinella sp.							X					X	X						X		X			X				
Axinella cannabina	X						X											X	X					X			X	
Chondrila sp.		X		X		X		X		X		X	X		X		X		X	X	X			X	X			X
Chondrosia sp.		X	X	X		X	X			X		X			X	X			X	X	X			X			X	X
Clatrina sp.						X	X	X				X	X		X			X	X			X		X				
Clionidae	X	X			X	X	X	X		X	X	X	X	X		X		X	X	X	X			X	X		X	
Crambe crambe	X	X	X	X		X	X				X	X	X	X	X	X	X	X	X	X	X	X		X	X			X
Geodia cydonium	X				X																							
Dysidea avara	X				X																							
Ircinia spp.	X	X	X	X		X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	
Petrosia ficiformis	X	X		X	X	X	X			X		X	X	X	X	X		X				X		X	X		X	
Porifera ind. 1	X	X	X		X			X		X		X		X	X			X		X	X		X	X				X
Porifera ind. 2		X					X	X					X		X	X		X		X	X			X				X
Spirastrella cunctatix		X	X	X			X			X	X	X	X	X	X		X		X	X	X	X		X	X	X		X
Verongia aerophoba	X				X																							
CNIDARIA																												
Aglaophenia sp.		X						X		X	X				X				X					X				X
Anemonia sulcata		X								X			X	X	X	X												X
Anemonia viridis	X											X		X					X			X						
Balanophyllia sp.	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X		X	X	X	X	X	
Caryophyllia sp.	X				X														X					X				
Cerianthus sp.		X	X		X																			X				
Cladocora caespitosa	X	X			X	X	X								X			X									X	
Leptosammia pruvoti															X									X				
Lophogorgia cfr sarmentosa	X												X															
Parazoanthus axinellae	X					X		X				X						X	X					X		X		
Phymanthus pulcher							X																					
Polyciathus sp.	X				X																							
Savalia savaglia	X																											
POLYCHAETA																												
Bispira sp.	X									X								X	X				X	X				
Harmodice carunculata										X		X			X	X				X	X				X			X
Filograna implexa																			X					X				
Protula sp.		X	X	X						X		X	X		X	X			X	X	X	X		X				X
Sabella penicillus						X			X								X	X						X				
Sabella spallanzani				X	X	X			X			X					X	X						X			X	
Serpula vermicularis			X					X		X	X	X				X						X		X			X	
Terebellidae			X	X								X			X	X								X				
HECHIUROIDEA																			X					X				
Bonellia viridis	X																											
MOLLUSCA																												
Arca noe		X	X				X				X		X			X		X	X	X	X	X			X		X	X
Bittium latreilli		X						X				X				X							X					X
Cerithium sp.										X			X						X									
Chromodoris krohni			X					X				X							X					X				
Discodoris atromaculata		X						X			X		X			X								X				
Fasciolaria lignaria		X																						X				
Flabellina affinis			X						X						X				X			X		X				X
Flabellina cfr babai	X									X														X				
Gastrochaena dubbia	X	X	X	X		X	X	X		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X		X	
Hexaplex trunculus		X						X			X	X				X		X		X	X						X	X
Hypserodoris picta	X						X																					
Janolus sp.																						X						
Lithophaga lithophaga		X	X	X		X	X				X	X	X	X	X	X	X	X		X	X	X			X		X	X
Luria lurida			X					X																				
Mytilus sp.							X				X		X	X				X				X					X	
Ostrea sp.	X																											
Octopus vulgaris				X																				X				
Patella sp.										X								X					X	X			X	
Phyllidia flava												X												X			X	
Pinna nobilis		X	X			X	X	X	X						X					X	X							
Pteria hirundo	X																											
Vermetus arenarius	X												X					X		X	X	X					X	
Stramonita haemastoma											X							X									X	
CRUSTACEA																												
Balanidae		X	X			X		X				X	X	X		X		X		X	X				X			
Dromia sp.													X															
Pagurus bernhardus											X																	
Palemon serratus											X																	
Palinurus elephas												x																
Scyllarides latus																												X
ECHINODERMATA																												
Arbacia lixula		X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X
Antedon sp.																			X									
Coscinasteria tenuispina			X								X			X	X	X				X	X							X
Echinaster sepositus	X	X	X	X	X	X				X	X	X	X		X	X	X	X	X	X	X		X	X	X	X	X	X
Hacelia attenuata						X				X		X							X	X	X	X				X		X
Holothuria forskali				X					X			X	X						X		X				X			
Holothuria tubulosa	X	X		X	X		X	X		X	X		X			X		X	X		X	X	X	X			X	
Marthasterias glacialis	X	X	X			X	X	X		X		X	X		X	X	X			X	X		X	X	X		X	X
Ophidiaster ophidianus		X	X			X				X		X			X	X	X		X	X	X			X	X	X		X
Ophioderma sp.		X									X	X									X			X				
Ophiotrix sp.		X						X								X			X									X
Paracentrotus lividus		X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sphaerechinus granularis		X			X	X	X			X	X				X	X		X					X	X	X		X	X
BRYOZOA																												
Myriapora truncata						X			X	X		X			X	X			X	X	X		X	X	X			X
Porella cervicornis															X				X		X			X				X
Schizoporellidae		X	X			X		X				X			X	X				X	X			X	X	X		X
ASCIDIACEA																												
Halocynthia papillosa	X		X	X	X	X	X	X		X		X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
Microcosmus sp.	X		X			X																		X				
Sydnium sp.			X													X												
Total number of taxa	48	45	39	32	34	43	39	36	20	51	36	53	44	25	44	50	18	44	57	42	49	36	23	67	26	17	37	37

Annex 3. Form used to collect data from benthos

OBSERVER(s):		**AREA / SECTOR:**		**DATE/TIME:**	
LAND USE:			**TRANSECT #**	**BEG:**	
GEOMORPHOLOGY:				**FIN:**	
Depth (m)	**HABITAT TYPE (dominant)**	**COMPLEX (1-4)**	**HETEROG. (#habitats / cover)**	**SPECIES**	**PHOTO**
OBSERVATIONS:					

Annex 4. Form used to collect data from fish assemblages by UVC

PROJECT:	AREA:	LOC:	SITE:	REPL
	OBSERV:	DATE:	z min z max	

	1	2 5	6 10	11 30	31 50	51 100	101 200	201 500	+ 500

SEGMENT	% Posidonia	% Sand	OBSERVATIONS
1			
2			
3			
4			
5			

Annex 5. Species abundance, mean abundance, total abundance and species richness 250 m-2 (± standard error of the mean, SEM) of the fish assemblage observed in each site in the quantitative assessment of the coast of Montenegro by visual census using SCUBA.

	Year	2008					
	Locality	PLATAMUNI					
	Zone	Eastern Grbalj		Western Grbalj		Krekavica	
Species	Site	Rat Platamuni	Sv. Nikola	Seka Albaneze	Rat Kostovica	Velika Krekavica	Mala Krekavica
A.anthias				6,00 ± 1,13			
A.imberbis		0,33 ± 0,06		0,33 ± 0,06	0,67 ± 0,06	1,67 ± 0,23	1,33 ± 0,25
B.boops		155,67 ± 17,78	131,00 ± 17,94	153,00 ± 17,32	118,67 ± 18,86	47,33 ± 8,95	6,00 ± 1,13
C.chromis		112,67 ± 15,95	19,00 ± 2,13	178,00 ± 26,64	18,00 ± 2,15	177,33 ± 26,71	173,67 ± 8,51
C.julis		18,00 ± 0,66	6,67 ± 0,25	20,00 ± 0,66	13,67 ± 0,54	36,33 ± 2,33	18,33 ± 1,09
D.annularis		2,33 ± 0,44	4,67 ± 0,62	2,00 ± 0,11	21,33 ± 3,47	11,00 ± 2,08	
D.dentex							
D.puntazzo					0,33 ± 0,06	0,33 ± 0,06	2,00 ± 0,19
D.sargus			0,33 ± 0,06		1,33 ± 0,17	0,33 ± 0,06	2,67 ± 0,41
D.vulgaris		1,67 ± 0,23	5,67 ± 0,88		3,00 ± 0,22	4,33 ± 0,73	11,33 ± 1,22
E.costae					0,33 ± 0,06		
E.marginatus				0,33 ± 0,06	0,33 ± 0,06		
L.bimaculatus		0,33 ± 0,06	0,33 ± 0,06				0,33 ± 0,06
L.merula					1,00 ± 0,11		
L. viridis							
Mugilidae							
M.helena		0,33 ± 0,06		3,00 ± 0,57	1,00 ± 0,19	0,33 ± 0,06	
M.surmuletus		2,67 ± 0,06	2,33 ± 0,17	2,67 ± 0,17	2,33 ± 0,23	8,00 ± 0,61	9,00 ± 1,24
O.melanura					1,00 ± 0,19	3,33 ± 0,54	0,33 ± 0,06
P.pagrus					0,33 ± 0,06		
P.phycis						0,33 ± 0,06	
S.aurata					0,33 ± 0,06		0,33 ± 0,06
S.cabrilla		3,33 ± 0,17	3,00 ± 0,11	3,67 ± 0,06	3,00 ± 0,19	10,00 ± 0,82	9,33 ± 0,54

	Year	2008					
	Locality	PLATAMUNI					
	Zone	Eastern Grbalj		Western Grbalj		Krekavica	
Species	Site	Rat Platamuni	Sv. Nikola	Seka Albaneze	Rat Kostovica	Velika Krekavica	Mala Krekavica
S.cantharus		2,33 ± 0,23	1,00 ± 0,11	3,33 ± 0,44	10,00 ± 0,89	12,33 ± 1,17	0,67 ± 0,06
S.cinereus							
S.doderleini		0,67 ± 0,06	0,67 ± 0,06	0,67 ± 0,06	2,33 ± 0,23	1,00 ± 0,11	0,33 ± 0,06
S.hepatus							
S.maderensis					0,33 ± 0,06	1,00 ± 0,11	0,67 ± 0,06
S.maena		1,33 ± 0,25		21,67 ± 2,59		19,00 ± 2,13	1,00 ± 0,19
S.mediterraneus		2,67 ± 0,33	0,67 ± 0,06	0,33 ± 0,06	0,67 ± 0,13	1,33 ± 0,13	1,33 ± 0,06
S.melanocercus		1,33 ± 0,17	1,33 ± 0,13	0,67 ± 0,06	0,33 ± 0,06		1,00 ± 0,19
S.ocellatus		1,00 ± 0,19		16,00 ± 2,83	4,33 ± 0,73	7,33 ± 0,62	
S.roissali					0,33 ± 0,06		
S.rostratus			0,33 ± 0,06	0,33 ± 0,06	1,00 ± 0,11		
S.salpa					1,00 ± 0,19	2,67 ± 0,50	
S.sarda							
S.scriba		0,33 ± 0,06	0,33 ± 0,06	0,33 ± 0,06	2,67 ± 0,06	0,33 ± 0,06	1,00 ± 0,11
S.scrofa					0,33 ± 0,06		
S.smaris		121,33 ± 18,67	2,67 ± 0,50	5,33 ± 1,01			
S.tinca		1,33 ± 0,17	1,33 ± 0,06	0,67 ± 0,06	1,67 ± 0,23	1,00 ± 0,11	1,33 ± 0,17
T.pavo			1,00 ± 0,11		0,33 ± 0,06	0,33 ± 0,06	0,67 ± 0,13
Total abundance		429,67 ± 55,60	182,33 ± 23,39	418,33 ± 54,04	212,00 ± 29,55	347,00 ± 48,24	242,67 ± 15,81
"Reduced" abundance		38,00 ± 2,83	29,67 ± 2,82	57,00 ± 5,85	73,33 ± 8,23	100,33 ± 10,06	60,00 ± 5,66
Richness		19	18	20	30	23	21

Species	Year	2008			
	Locality	PETROVAC			
	Zone	Katic Islets		Dubovica	
	Site	Katic Is.	Sv. Nedjelja	Dubovac Cliff	Formika Is.
A.anthias					
A.imberbis		0,33 ± 0,06	0,67 ± 0,13	0,33 ± 0,06	2,00 ± 0,19
B.boops		297,67 ± 30,93	200,33 ± 11,02	75,00 ± 7,21	153,00 ± 17,32
C.chromis		53,33 ± 5,13	43,67 ± 6,58	21,67 ± 1,73	84,00 ± 5,75
C.julis		3,67 ± 0,25	18,00 ± 1,11	10,33 ± 0,94	24,33 ± 0,71
D.annularis		2,33 ± 0,25	8,67 ± 0,63	16,67 ± 1,41	3,67 ± 0,69
D.dentex					
D.puntazzo		0,33 ± 0,06			
D.sargus		0,33 ± 0,06	1,00 ± 0,11		
D.vulgaris		0,33 ± 0,06	6,67 ± 1,17		3,67 ± 0,52
E.costae					
E.marginatus		0,33 ± 0,06			
L.bimaculatus		0,67 ± 0,06	0,33 ± 0,06	0,33 ± 0,06	0,67 ± 0,06
L.merula		0,33 ± 0,06			
L. viridis				0,33 ± 0,06	0,33 ± 0,06
Mugilidae		0,33 ± 0,06			
M.helena		0,33 ± 0,06	0,33 ± 0,06		
M.surmuletus		2,67 ± 0,23	6,33 ± 0,60	2,00 ± 0,22	2,67 ± 0,17
O.melanura			0,33 ± 0,06		
P.pagrus		0,33 ± 0,06			
P.phycis		0,33 ± 0,06			0,33 ± 0,06
S.aurata			0,33 ± 0,06		
S.cabrilla		2,00 ± 0,11	1,00 ± 0,11	2,33 ± 0,06	3,67 ± 0,23

Species	Year	2008			
	Locality	PETROVAC			
	Zone	Katic Islets		Dubovica	
	Site	Katic Is.	Sv. Nedjelja	Dubovac Cliff	Formika Is.
S.cantharus		1,00 ± 0,11	1,00 ± 0,11		0,33 ± 0,06
S.cinereus					
S.doderleini					0,33 ± 0,06
S.hepatus					
S.maderensis		0,33 ± 0,06			
S.maena			13,00 ± 2,46	2,67 ± 0,50	5,33 ± 0,50
S.mediterraneus		0,67 ± 0,13	1,00 ± 0,11		0,33 ± 0,06
S.melanocercus		0,33 ± 0,06	1,00 ± 0,11	2,33 ± 0,17	2,00 ± 0,29
S.ocellatus		1,00 ± 0,19	0,33 ± 0,06	3,00 ± 0,48	
S.roissali			0,33 ± 0,06		
S.rostratus		2,33 ± 0,44	1,00 ± 0,11	0,67 ± 0,06	0,67 ± 0,06
S.salpa		0,33 ± 0,06		6,00 ± 1,13	
S.sarda					0,67 ± 0,13
S.scriba		1,00 ± 0,11	2,33 ± 0,23	0,67 ± 0,13	1,33 ± 0,06
S.scrofa					
S.smaris		118,33 ± 11,83	29,67 ± 4,03	12,00 ± 1,13	
S.tinca		2,00 ± 0,11	4,00 ± 0,33	0,67 ± 0,06	3,33 ± 0,06
T.pavo					0,33 ± 0,06
Total abundance		493,00 ± 50,70	341,33 ± 29,31	157,00 ± 15,42	293,00 ± 27,13
"Reduced" abundance		22,67 ± 2,62	53,67 ± 5,03	45,33 ± 4,78	48,00 ± 3,23
Richness		27	23	17	21

Species					
Year	2011				
Locality	KOTOR		PLATAMUNI	ULCINJ	
Zone	Perast		Western Grbalj	Stari Ulcinj	
Site	Drazin Vrt	iza Perasta	Seka Albaneze	Stari Ulcinj Is.	o. Stari Ulcinj
A.anthias			7,33 ± 1,39		
A.imberbis			2,67 ± 0,50	1,67 ± 0,31	1,67 ± 0,23
B.boops	924,33 ± 94,23	23,67 ± 4,47	724,33 ± 90,85	124,33 ± 10,77	24,67 ± 4,38
C.chromis	1199,67 ± 101,36		713,33 ± 27,30	385,33 ± 57,11	49,33 ± 4,16
C.julis			25,33 ± 1,36	40,00 ± 2,67	17,00 ± 0,29
D.annularis	2,00 ± 0,22		2,67 ± 0,23	1,33 ± 0,17	2,33 ± 0,35
D.dentex				0,33 ± 0,06	
D.puntazzo				1,33 ± 0,06	
D.sargus				8,00 ± 1,14	
D.vulgaris	0,67 ± 0,06			7,67 ± 0,31	0,67 ± 0,06
E.costae				0,67 ± 0,13	
E.marginatus					
L.bimaculatus					
L.merula	0,33 ± 0,06				
L. viridis					
Mugilidae					
M.helena					
M.surmuletus			4,00 ± 0,66	4,67 ± 0,31	2,00 ± 0,22
O.melanura				2,67 ± 0,50	
P.pagrus				1,33 ± 0,17	
P.phycis					
S.aurata					
S.cabrilla			2,67 ± 0,23	7,33 ± 0,17	3,00 ± 0,22

Species					
Year	2011				
Locality	KOTOR		PLATAMUNI	ULCINJ	
Zone	Perast		Western Grbalj	Stari Ulcinj	
Site	Drazin Vrt	iza Perasta	Seka Albaneze	Stari Ulcinj Is.	o. Stari Ulcinj
S.cantharus			1,33 ± 0,17	12,00 ± 0,65	3,00 ± 0,19
S.cinereus		6,00 ± 0,22			
S.doderleini	1,67 ± 0,17	1,00 ± 0,11	1,00 ± 0,11	2,00 ± 0,22	1,33 ± 0,17
S.hepatus	13,33 ± 0,74	3,00 ± 0,11			
S.maderensis					
S.maena				0,33 ± 0,06	
S.mediterraneus	12,33 ± 1,10	2,00 ± 0,29	0,67 ± 0,06	1,00 ± 0,11	1,00 ±
S.melanocercus			3,67 ± 0,33	1,67 ± 0,06	0,33 ± 0,06
S.ocellatus	2,67 ± 0,41	48,00 ± 9,07	0,33 ± 0,06	5,00 ± 0,94	1,33 ± 0,13
S.roissali					
S.rostratus				2,00 ±	1,33 ± 0,17
S.salpa					
S.sarda					
S.scriba	1,33 ± 0,13	0,67 ± 0,13	1,00 ± 0,19	2,00 ± 0,11	1,67 ± 0,06
S.scrofa					
S.smaris	107,67 ± 16,80		878,00 ± 36,46	13,00 ± 2,46	
S.tinca	6,00 ± 0,22	0,33 ± 0,06	1,33 ± 0,17	3,33 ± 0,35	0,33 ± 0,06
T.pavo					0,33 ± 0,06
Total abundance	2272,00 ± 215,49	84,67 ± 14,46	2369,67 ± 160,06	629,00 ± 78,98	111,33 ± 10,91
"Reduced" abundance	40,33 ± 3,11	61,00 ± 9,99	51,33 ± 4,96	104,33 ± 8,26	35,67 ± 2,15
Richness	12	8	16	24	17

Species	Year Locality Zone Site	2011 ULCINJ Rep rt Kruce		rt Rep		Valdanos		Ulcinj rt Mendra		Opaljike	
A.anthias											
A.imberbis		4,67	± 0,55	0,67	± 0,13	0,33	± 0,06	4,00	± 0,76		
B.boops				109,33	± 9,58	71,00	± 7,75	26,00	± 4,91	2,67	± 0,50
C.chromis		368,00	± 26,04	284,67	± 14,14	129,67	± 9,59	83,67	± 2,05	13,33	± 2,14
C.julis		20,67	± 1,54	16,67	± 1,53	23,67	± 1,18	13,00	± 1,14	22,67	± 0,60
D.annularis		1,67	± 0,23	2,00	± 0,22	0,67	± 0,13				
D.dentex						0,33	± 0,06				
D.puntazzo		0,33	± 0,06			0,67	± 0,06	0,67	± 0,06		
D.sargus						16,00	± 1,14	4,33	± 0,38	12,00	± 0,39
D.vulgaris		2,33	± 0,25	2,67	± 0,17	15,00	± 0,94	19,67	± 0,83	4,33	± 0,27
E.costae						0,33	± 0,06	0,67	± 0,06		
E.marginatus								0,33	± 0,06		
L.bimaculatus											
L.merula											
L. viridis											
Mugilidae											
M.helena				0,67	± 0,06						
M.surmuletus		1,33	± 0,06	4,33	± 0,38	4,00	± 0,11	5,00	± 0,38	6,33	± 0,44
O.melanura						4,67	± 0,45	6,00	± 1,13	64,33	± 9,80
P.pagrus				0,33	± 0,06						
P.phycis											
S.aurata										0,67	± 0,13
S.cabrilla		7,67	± 0,35	6,67	± 0,44	5,67	± 0,33	15,00	± 0,11	7,00	± 0,22

Species	Year Locality Zone Site	2011 ULCINJ Rep rt Kruce		rt Rep		Valdanos		Ulcinj rt Mendra		Opaljike	
S.cantharus		6,33	± 0,35	3,67	± 0,60	0,33	± 0,06	3,00	± 0,22	0,33	± 0,06
S.cinereus										2,00	± 0,22
S.doderleini		3,00	± 0,22	0,33	± 0,06			2,00	± 0,19		
S.hepatus											
S.maderensis											
S.maena											
S.mediterraneus		2,33	± 0,13	0,33	± 0,06	1,00	± 0,11	0,33	± 0,06	1,00	± 0,11
S.melanocercus				0,33	± 0,06						
S.ocellatus		0,67	± 0,13	0,67	± 0,06	2,00	± 0,11	1,33	± 0,17	8,33	± 0,17
S.roissali										4,67	± 0,23
S.rostratus		3,33	± 0,17	0,67	± 0,06	0,33	± 0,06	0,67	± 0,13		
S.salpa				26,00	± 4,91	14,67	± 2,06			9,67	± 0,83
S.sarda											
S.scriba		1,00	± 0,11			4,00	± 0,39	0,67	± 0,13	1,00	±
S.scrofa											
S.smaris											
S.tinca		3,00	±	0,67	± 0,06	6,67	± 0,23	0,67	± 0,06	1,00	± 0,19
T.pavo								0,33	± 0,06		
Total abundance		426,33	± 30,29	460,67	± 32,59	301,00	± 24,89	187,33	± 12,90	161,33	± 16,42
"Reduced" abundance		53,67	± 3,71	65,33	± 8,69	100,00	± 7,50	73,67	± 5,18	145,33	± 13,77
Richness		15		18		20		20		17	

Species					
	Year	2012			
	Locality	PLATAMUNI			
	Zone	Sveti Nikola			
	Site	Nikola West	Hrid Galiola	Skolj	Mogren
A.anthias					
A.imberbis			5,33 ± 0,06	2,67 ± 0,17	2,00 ± 0,11
B.boops		24,00 ± 4,54		94,67 ± 8,95	
C.chromis		87,00 ± 5,79	849,33 ± 106,84	99,00 ± 8,26	36,33 ± 4,63
C.julis		68,33 ± 3,24	41,67 ± 0,91	43,67 ± 2,38	43,33 ± 1,06
D.annularis		0,33 ± 0,06	1,33 ± 0,25	1,67 ± 0,06	1,00 ± 0,19
D.dentex					
D.puntazzo					
D.sargus					
D.vulgaris		2,33 ± 0,23	0,67 ± 0,06	0,67 ± 0,06	5,00 ± 0,94
E.costae					
E.marginatus					
L.bimaculatus			0,33 ± 0,06		
L.merula					
L. viridis					
Mugilidae					
M.helena			0,33 ± 0,06		
M.surmuletus		1,00 ± 0,11		0,67 ± 0,13	0,33 ± 0,06
O.melanura		0,33 ± 0,06			
P.pagrus					
P.phycis					
S.aurata					
S.cabrilla		2,00 ± 0,19	4,33 ± 0,06	1,00 ± 0,19	2,00 ± 0,11
S.cantharus			0,33 ± 0,06	0,33 ± 0,06	1,00 ± 0,11
S.cinereus					
S.doderleini		0,67 ± 0,06	2,00 ± 0,19	1,33 ± 0,13	1,33 ± 0,25
S.hepatus					
S.maderensis					
S.maena			2,67 ± 0,50		
S.mediterraneus		3,67 ± 0,33	2,00 ± 0,19	0,33 ± 0,06	1,67 ± 0,06
S.melanocercus		1,33 ± 0,06	0,67 ± 0,06	0,67 ± 0,13	1,00 ± 0,11
S.ocellatus		1,33 ± 0,06		12,00 ± 1,57	1,67 ± 0,23
S.roissali					
S.rostratus		0,67 ± 0,06	0,33 ± 0,06	0,33 ± 0,06	0,33 ± 0,06
S.salpa					
S.sarda					
S.scriba		4,33 ± 0,13	3,33 ± 0,44	4,33 ± 0,54	1,00 ± 0,19
S.scrofa					
S.smaris				118,67 ± 11,88	
S.tinca		6,33 ± 0,38	3,67 ± 0,35	3,67 ± 0,27	2,33 ± 0,06
T.pavo					
Total abundance		203,67 ± 15,31	918,33 ± 110,18	385,67 ± 34,90	100,33 ± 8,18
"Reduced" abundance		92,67 ± 4,99	60,67 ± 2,71	70,67 ± 5,64	62,00 ± 3,44
Richness		15	16	17	15

Species					
	Year	2012			
	Locality	MAMULA		PLATAMUNI	
	Zone	Mamula		Traste	Sveti Nikola
	Site	Mamula Is.	Ploca	Seka Kociste	Nikola East
A.anthias					
A.imberbis		3,00 ± 0,19	0,33 ± 0,06	0,67 ± 0,13	3,67 ± 0,69
B.boops			47,33 ± 8,95	166,67 ± 31,50	94,67 ± 17,89
C.chromis		112,67 ± 12,61	349,33 ± 40,75	379,33 ± 21,18	245,33 ± 19,26
C.julis		98,00 ± 7,18	36,67 ± 1,59	63,67 ± 3,96	47,33 ± 0,92
D.annularis		2,00 ± 0,38	2,00 ± 0,11	2,00 ± 0,38	2,33 ± 0,17
D.dentex					
D.puntazzo		0,67 ± 0,13			
D.sargus					
D.vulgaris		0,67 ± 0,06	1,00 ± 0,19		9,00 ± 0,68
E.costae					
E.marginatus					
L.bimaculatus					
L.merula					
L. viridis					
Mugilidae					0,33 ± 0,06
M.helena					
M.surmuletus		2,33 ± 0,27	0,67 ± 0,06	0,33 ± 0,06	1,00 ± 0,19
O.melanura		12,00 ± 2,27			
P.pagrus					
P.phycis					
S.aurata					
S.cabrilla		2,00 ± 0,11	0,67 ± 0,06	3,67 ± 0,27	0,67 ± 0,13

Species					
	Year	2012			
	Locality	MAMULA		PLATAMUNI	
	Zone	Mamula		Traste	Sveti Nikola
	Site	Mamula Is.	Ploca	Seka Kociste	Nikola East
S.cantharus		0,67 ± 0,13	1,33 ± 0,17	1,67 ± 0,23	0,67 ± 0,06
S.cinereus					
S.doderleini		1,00 ± 0,11	0,67 ± 0,06	2,00 ± 0,29	2,00 ± 0,11
S.hepatus					
S.maderensis		0,33 ± 0,06			
S.maena				0,67 ± 0,06	
S.mediterraneus		2,33 ± 0,06		2,00 ± 0,19	1,67 ± 0,17
S.melanocercus		1,67 ± 0,23	0,33 ± 0,06	0,67 ± 0,06	
S.ocellatus		2,33 ± 0,27	9,00 ± 1,24	2,67 ± 0,50	4,67 ± 0,49
S.roissali					
S.rostratus		0,33 ± 0,06	2,00 ± 0,29	0,33 ± 0,06	0,33 ± 0,06
S.salpa					
S.sarda					
S.scriba			1,00 ±	0,67 ± 0,13	3,33 ± 0,25
S.scrofa					
S.smaris				166,67 ± 31,50	
S.tinca		3,33 ± 0,17	1,33 ± 0,17	2,00 ± 0,38	5,67 ± 0,52
T.pavo					0,33 ± 0,06
Total abundance		245,33 ± 24,30	453,67 ± 53,87	795,67 ± 90,87	423,00 ± 41,71
"Reduced" abundance		129,33 ± 11,43	56,67 ± 4,11	81,67 ± 6,51	79,33 ± 3,87
Richness		17	15	17	17

Annex 6: Technical expertise transfer

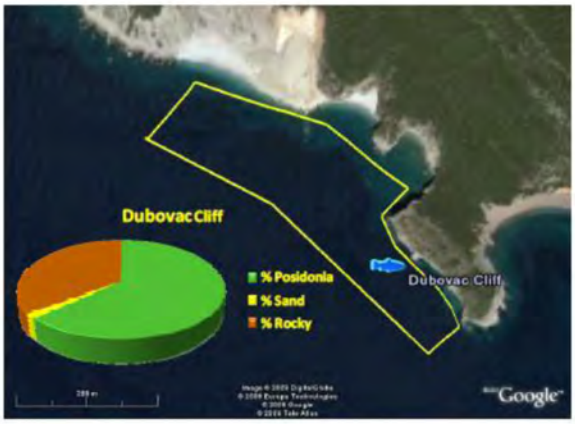
Technical expertise transfer from Dr Badalamenti to the staff of the Marine Biology Laboratory of Kotor was assured by the detailed discussion of all the plans for the survey of the benthic assemblages during the pre-survey. Before dives the protocols for data collection were discussed and the local staff provided with all the relevant information on the methodology involved. All the material used and the techniques involved in data collection were made clear to the Marine Laboratory of Kotor staff. One researcher from the Laboratory dived with Dr Badalamenti and also collected alone data on the benthic assemblages and habitat structure. At the end of each dive the data gathered were discussed and comparisons made between the results obtained by different people.

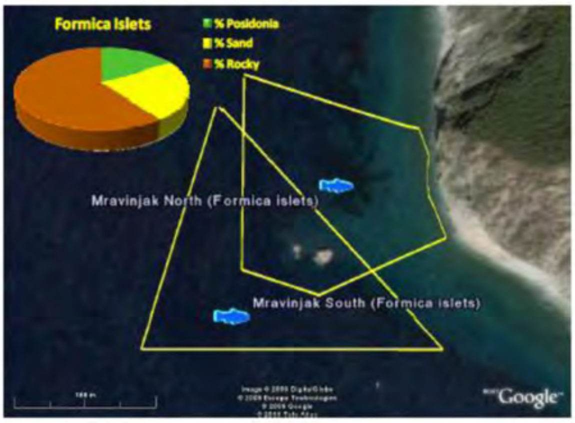
Photographs and films taken were seen on the computer and the main species were identified in a participatory fashion. Relevant references were provided and in some cases pdf files or power point presentations were supplied. References consisted of animal and plant identification, sampling design, habitat structure and aspects of socio-cultural and economic assessment of marine protected areas. Formal presentations on: MPA designation, effect of protection on human activities, effects of human activities on MPAs, specific sampling design and data analysis for dealing with conservation issues and marine protected areas were provided and ppt presentations given to the audience, together with the relevant literature (as pdf file) cited during presentations. Some of the papers provided were also discussed after the end of the mission.

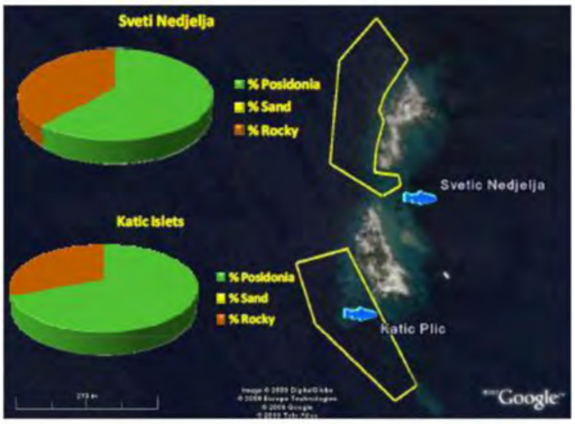
Technical expertise from Dr García-Charton and Mr Treviño-Otón to the Marine Biology of Kotor staff consisted firstly on, based on knowledge of local researchers about the geomorphological conformation of Montenegrin coast and rocky bottoms, discussing and designing a priori a sampling scheme able to capture the spatial variability of fish assemblages with visual censuses using SCUBA. Sampling procedures were clearly described, and rudiments of visual censuses techniques were explained in order to be reproducible in further local investigations. At the end of each dive (assisted by a field technician), the observations of fish species by all divers participating in the field trips were reported to complete the qualitative picture of the studied fish assemblage.

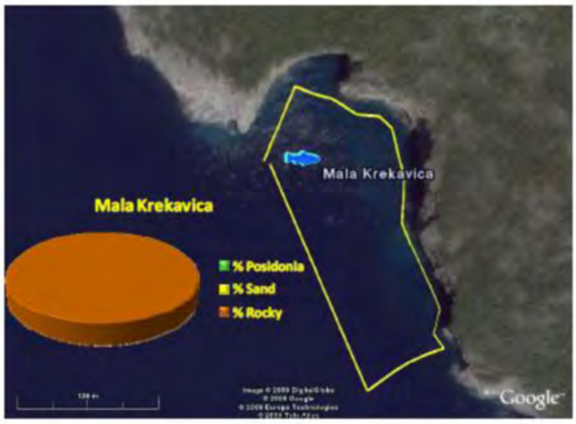
When possible, photographs were taken by the “benthos team” to confirm species identifications. Discussions were continuously opened with local research staff in order to exchange relevant information and opinions regarding the adequacy and feasibility of possible management measures to be proposed, taken the ecological, fisheries, social, and economic situation into account. Relevant references on fish visual census techniques, sampling design, composition and structure of Mediterranean fish assemblages, and ecological effects of marine protected areas, were provided to local research staff.

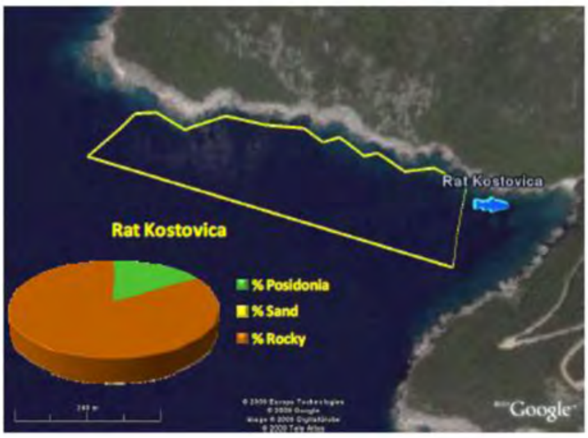
Annex 7: Figures of surveyed site areas in the Montenegro coast and percentage of sea bottom composition

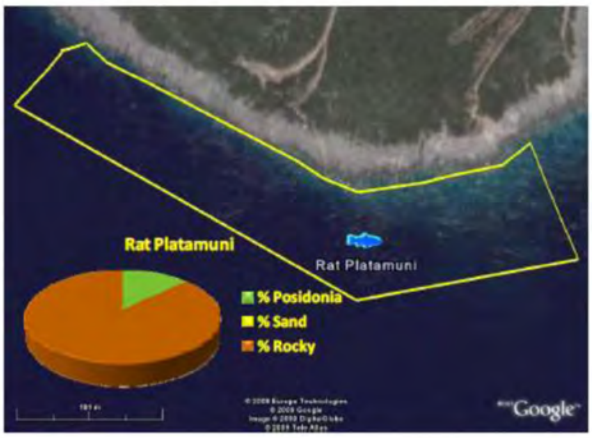


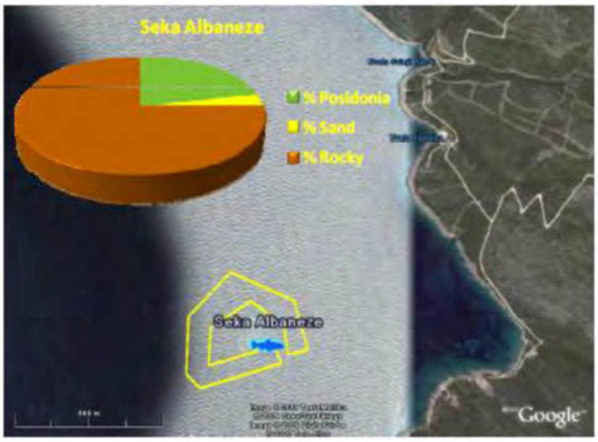




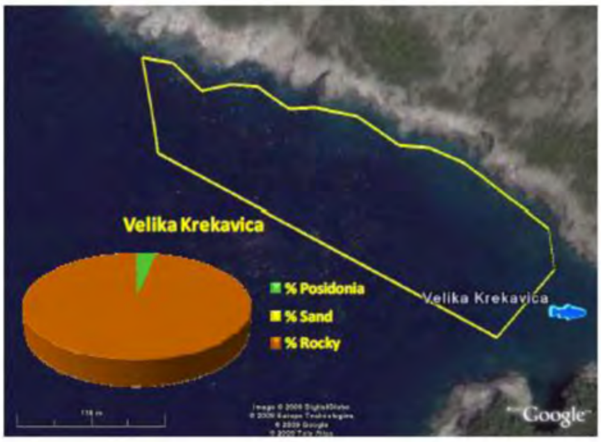


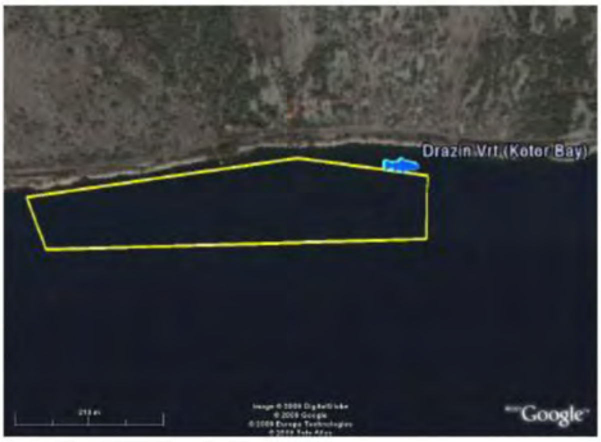




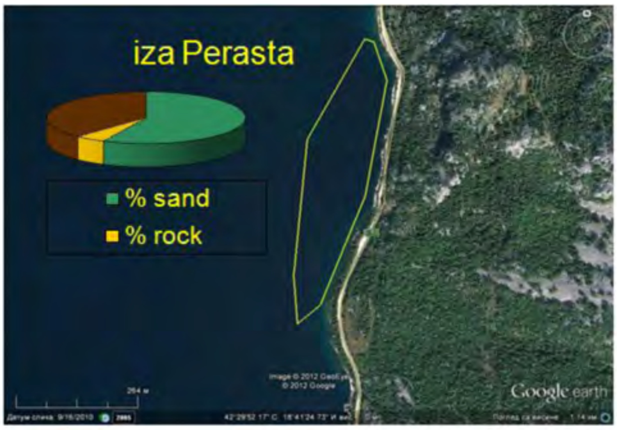

Seka Albaneze
% Posidonia
% Sand
% Rocky
Seka Albaneze
Google

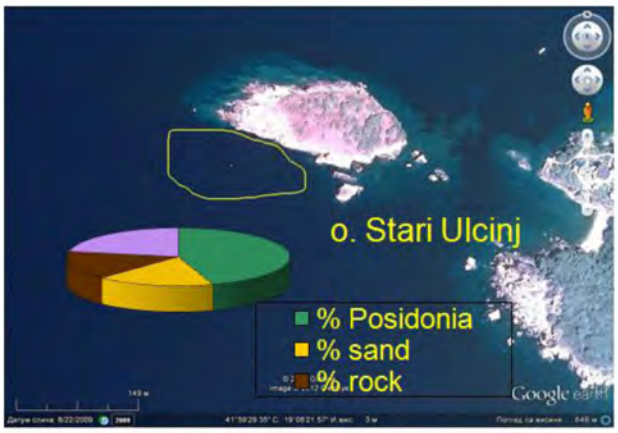

Sveti Nikola
% Posidonia
% Sand
% Rocky
Sveti Nikola
Google

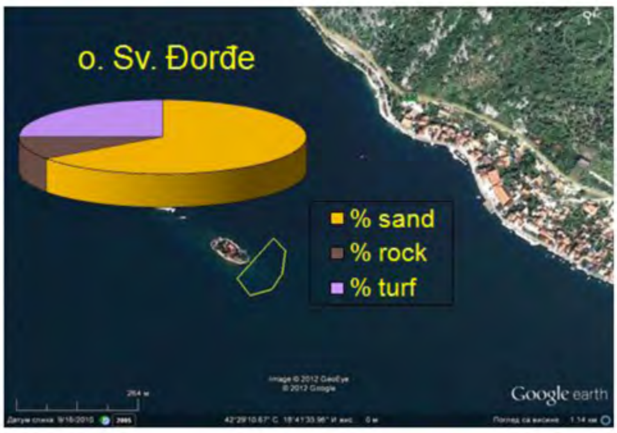

Velika Krekavica
% Posidonia
% Sand
% Rocky
Velika Krekavica
Google

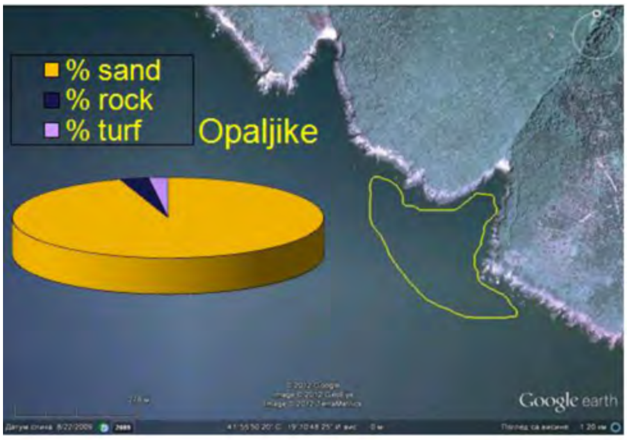

Dražin Vrt (Kotor Bay)
Google

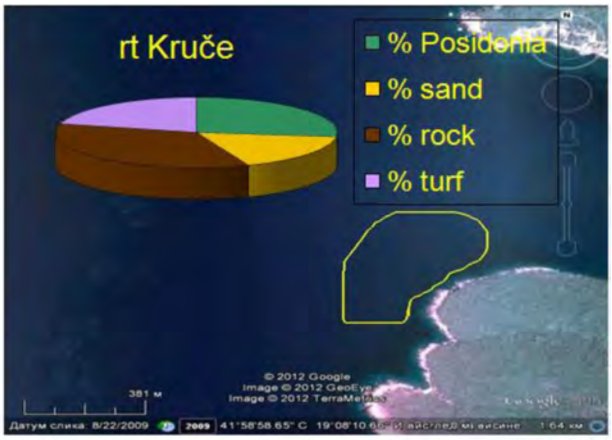

Dražin Vrt
% sand
% rock
% turf
Google earth

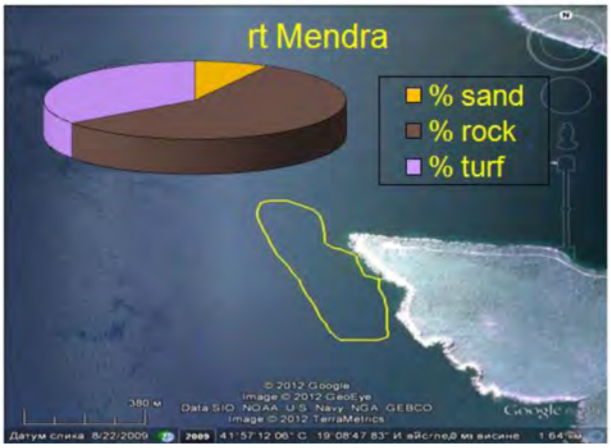

iza Perasta
% sand
% rock
Google earth

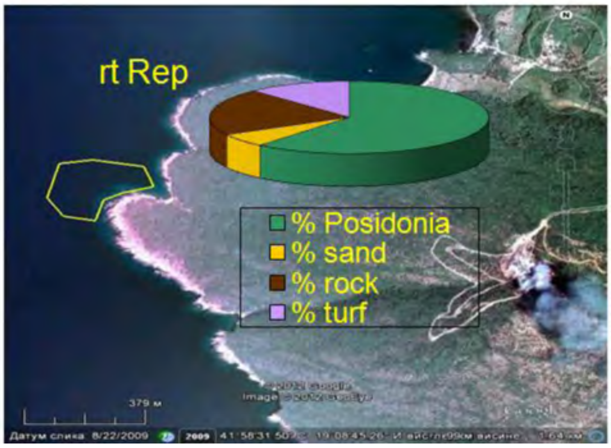

o. Stari Ulcinj
% Posidonia
% sand
% rock
Google earth

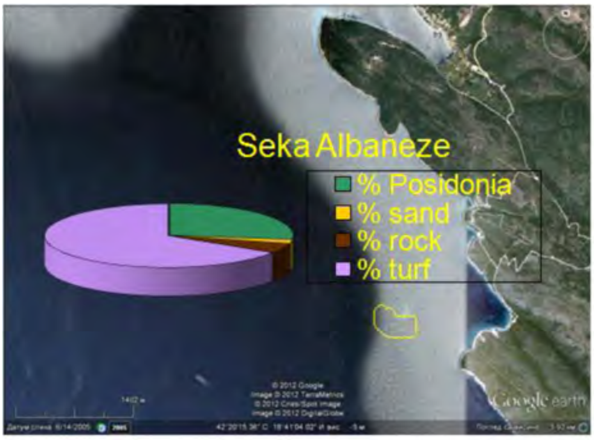

o. Sv. Đorđe
% sand
% rock
% turf
Google earth

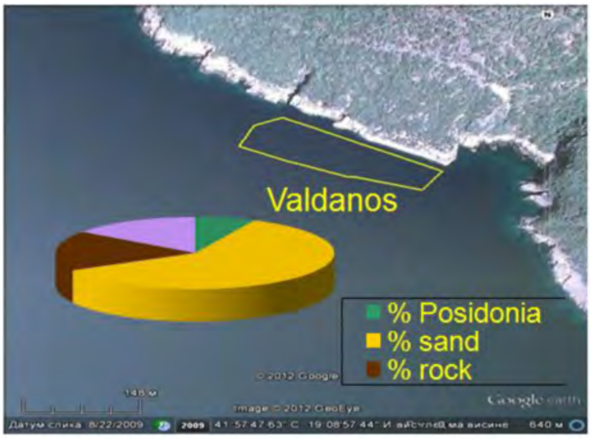

% sand
% rock
% turf
Opaljike
Google earth

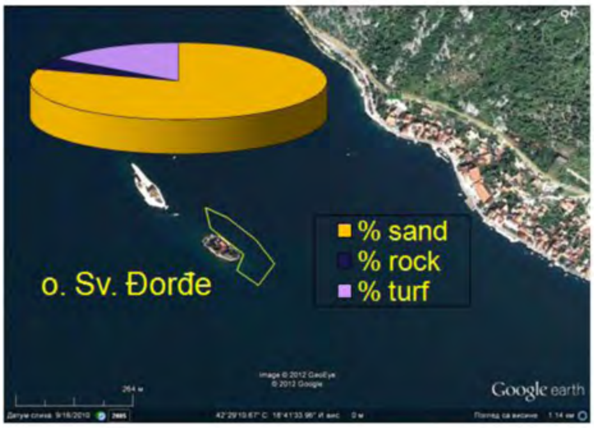

rt Kruče
% Posidonia
% sand
% rock
% turf

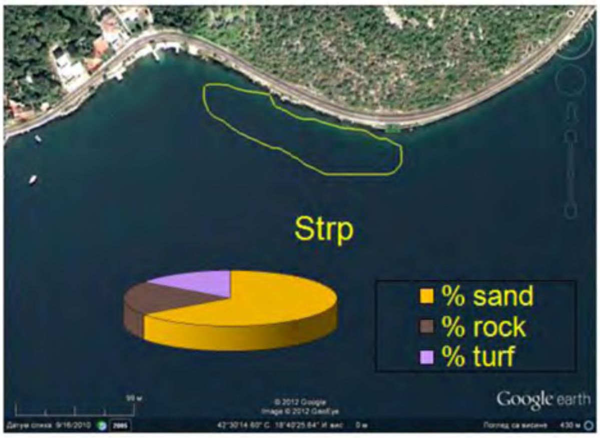

rt Mendra
% sand
% rock
% turf

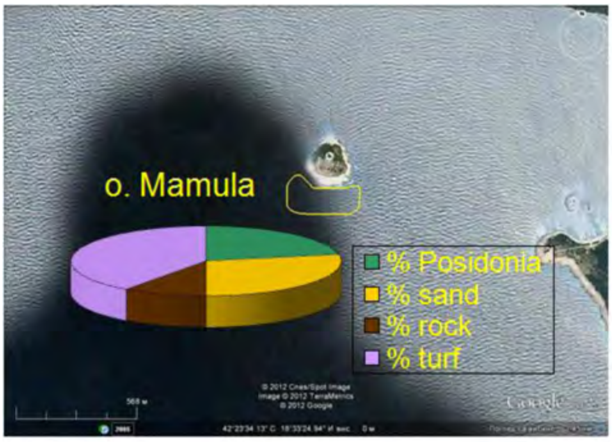

rt Rep
% Posidonia
% sand
% rock
% turf

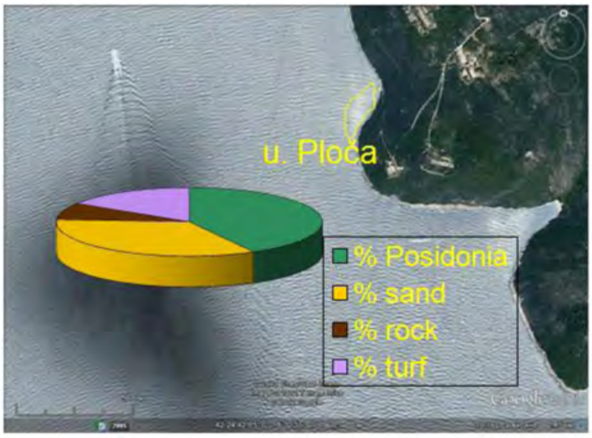

Seka Albaneze
% Posidonia
% sand
% rock
% turf

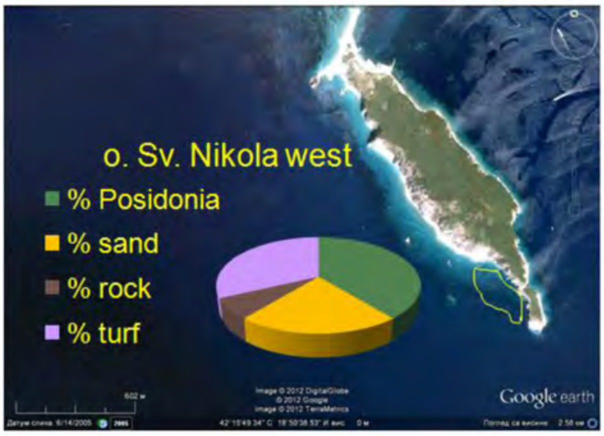

Valdanos
% Posidonia
% sand
% rock

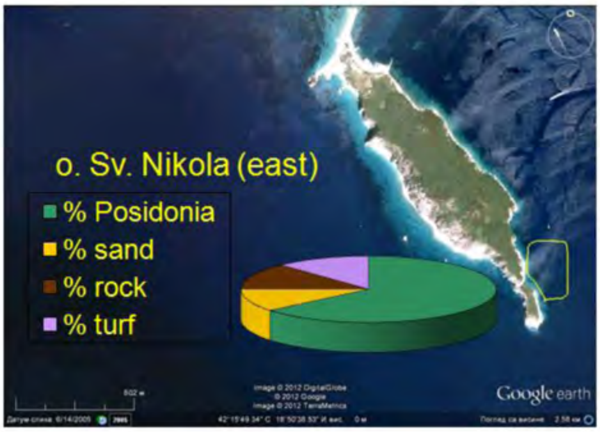

o. Sv. Đorđe
% sand
% rock
% turf
Google earth

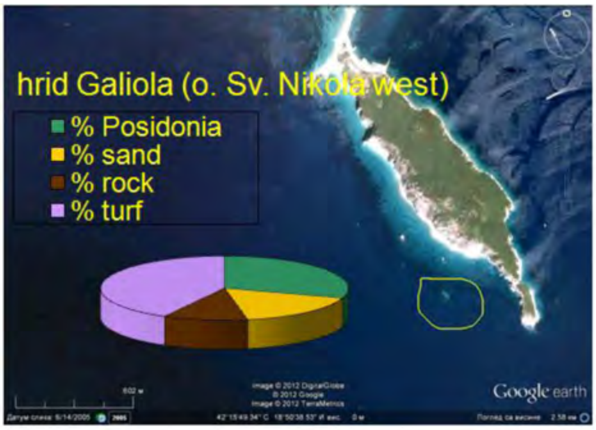

Strp
% sand
% rock
% turf
Google earth

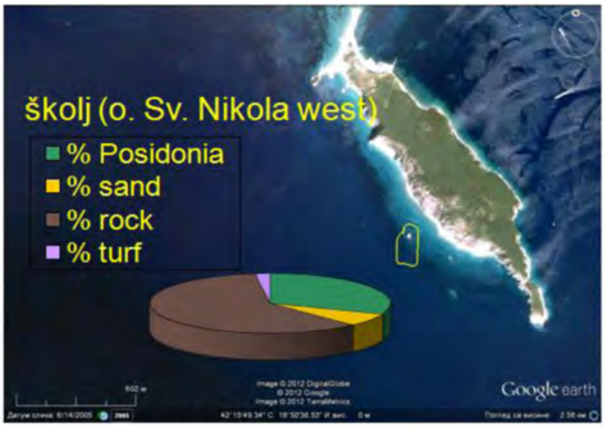

o. Mamula
% Posidonia
% sand
% rock
% turf

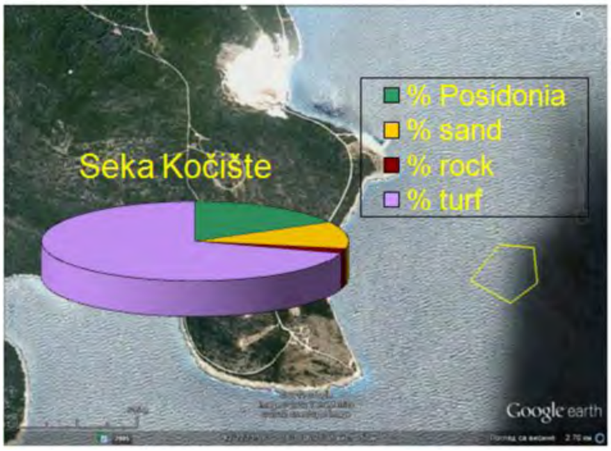

u. Ploča
% Posidonia
% sand
% rock
% turf

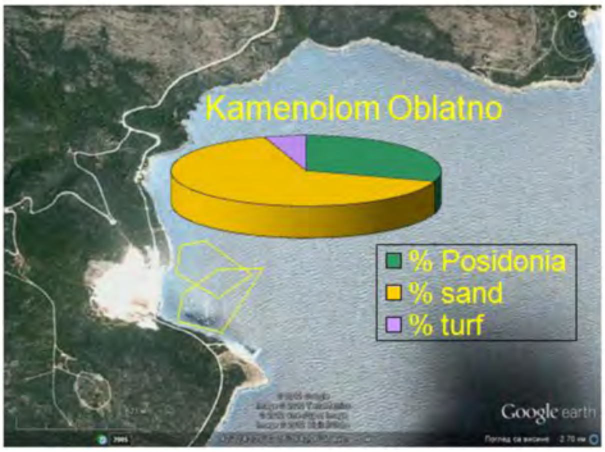

o. Sv. Nikola west
% Posidonia
% sand
% rock
% turf
Google earth

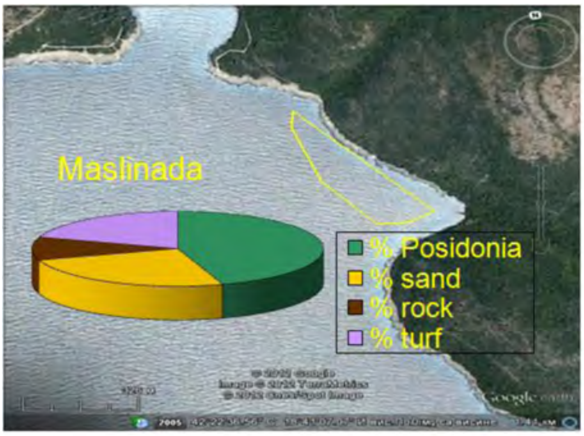

o. Sv. Nikola (east)
% Posidonia
% sand
% rock
% turf
Google earth

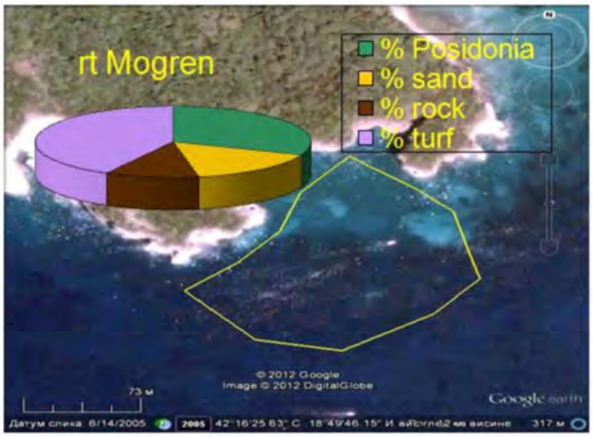

hrid Galiola (o. Sv. Nikola west)
% Posidonia
% sand
% rock
% turf
Google earth


školj (o. Sv. Nikola west)
% Posidonia
% sand
% rock
% turf
Google earth


Seka Kočište
% Posidonia
% sand
% rock
% turf
Google earth


Kamenolom Oblatno
% Posidonia
% sand
% turf
Google earth


Maslinada
% Posidonia
% sand
% rock
% turf


rt Mogren
% Posidonia
% sand
% rock
% turf
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obala Stari Ulcinj
% Posidonia
% sand
% rock
% turf

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