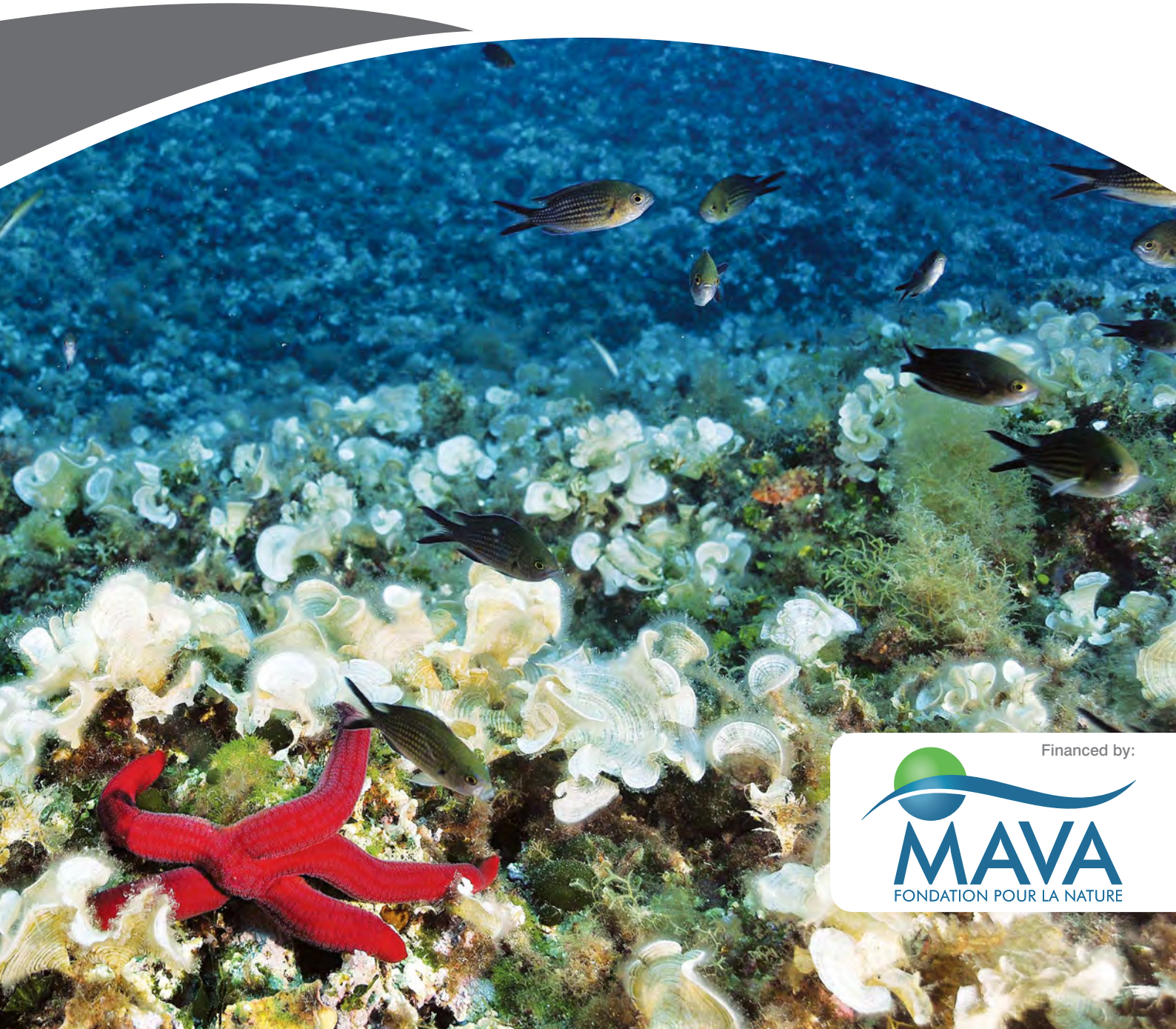
MONTENEGRO
MINISTRY OF SUSTAINABLE DEVELOPMENT AND TOURISM

UNEP MAP RAC/SPA

MEDKEYHABITATS PROJECT

Montenegro: Platamuni and Ratac areas

Mapping of marine key habitats and initiation of monitoring network



Financed by:
MAVA FONDATION POUR LA NATURE

NOTE : The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of UNEP/MAP-RAC/SPA concerning the legal status of any State, Territory, city or area, or of its authorities, or concerning the delimitation of their frontiers or boundaries. The views expressed in this publication do not necessarily reflect those of UNEP/MAP-RAC/SPA.

Mediterranean Action Plan
Regional Activity Centre for Specially Protected Areas (RAC/SPA)
Boulevard du leader Yasser Arafat
B.P. 337 - 1080 Tunis Cedex - TUNISIA
E-mail: car-asp@rac-spa.org

For bibliographic purposes, this volume may be cited as:

UNEP/MAP-RAC/SPA, 2016. Montenegro: Platamuni and Ratac areas. Mapping of marine key habitats and initiation of monitoring network. By Torchia G., Pititto F., Rais C., Trainito E., Badalamenti F., Romano C., Amosso C., Bouafif C., Dragan M., Camisassi S., Tronconi D., Mačić V., Sghaier Y.R. & Ouerghi A. Ed. RAC/SPA - MedKeyHabitats Project, Tunis: 77 pp + Annexes.

Graphic design: Zine el Abidine MAHJOUB - www.zinetoon.com and Yassine Ramzi SGHAIER.

Cover photos credit: © CAR/ASP, Egidio Trainito

This document has been edited within the framework of the MedKeyHabitats Project " Mapping of key marine habitats in the Mediterranean and promoting their conservation through the establishment of Specially Protected Areas of Mediterranean Importance (SPAMI) "

In partnership with : Golder Associates IBM

The MedKeyHabitats Project is implemented with the financial support of MAVA Foundation.

MAVA FONDATION POUR LA NATURE

Available from:
www.rac-spa.org

Montenegro: Platamuni and Ratac areas
Mapping of marine key habitats and initiation of monitoring network

MKH

MEDKEYHABITATS

Study required and financed by:

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

In charge of the study:

Atef OUARGHI, MedKeyHabitats Project, RAC/SPA

Yassine Ramzi SGHAIER, MedKeyHabitats Project, RAC/SPA

Milena BATAKOVIĆ, Environmental Protection Agency of Montenegro

Scientific responsible of the study:

Giovanni Torchia (Golder) - Senior Project Manager and Project Director
Francesco Pititto (Golder) - Project Manager
Chedly Rais (Okianos) - Senior technical review of the work and preparation of the assessment report for SPAMI list
Egidio Trainito (Golder consultant) - Marine photographer and expert in marine biology and taxonomy
Fabio Badalamenti (IAMC) - Senior consultant
Chiara Romano (Scripps Institution of Oceanography) - Senior consultant
Cecilia Amosso (Golder) - Bibliographic research and review
Cyrine Bouafif (Faculty of Science - University of Tunis) - Preparation of the SDF for the two study areas
Massimo Dragan (Golder) - Senior Expert in GIS and cartographic data management
Stefano Camisassi (Golder) - Database and WebGIS expert
Davide Tronconi (Golder) - GIS Expert
Vesna Mačić (Institute of marine biology General biology) - Marine Biology Expert

Reference of the study:

MedKeyHabitats n° 9/2015

TABLE OF CONTENTS

TABLES

FIGURES

ACRONYM AND ABBREVIATIONS

°C	Celsius degrees
‰	One thousand percent
AD	Anno Domini
ASFA	Aquatic Sciences and Fisheries Abstracts
ASTM	American Society for Testing and Materials
cm	Centimeters
cm/s	Centimeters per second
DD	Data deficit (sensus IUCN)
DGPS	Differential Global Positioning System
DTM	Digital Terrain Model
EEC	European Economic Community
EGNOS	European Geostationary Navigation Overlay System
EN	Endangered (sensus IUCN)
EPA	Environmental Protection Agency
ESRI	Environmental System Research Institute
EU	European Union
FAO	Food and Agriculture Organization
GDP	Gross domestic product
GPS	Global Positioning System
HMZS	Institute for Hydro-Meteorology and Seismology
HP	Horse Power
IBM	Institute of Marine Biology of Kotor
IHO	Internationa Hydrographic Organization
IMAP	Integrated Monitoring and Assessment Programme
IMO	International Maritime Organization
IUCN	International Union for the conservation of Nature
kHz	kiloHertz
km	kilometer
km^2	Square kilometers

LC	Least Concern (sensus IUCN)
LOA	Length Over All
m	Meter
MAVA	MAVA Foundation: Foundation aiming at promoting the protection of nature by conserving biodiversity and ecosystem functions
MPA	Marine Protected Area
NE	Not Evaluated (sensus IUCN)
PD	Project Director
PM	Project Manager
psu	Practical salinity unit
QA/QC	Quality Assurance / Quality Control
RAC/SPA	Regional Activity Centre for Specially Protected Areas
s	second
SBAS	Satellite based Augmentation System
SBES	Single Beam Echo Sounder
SPA/BD Protocol	Protocol Concerning Specially Protected Areas and Biodiversity in the Mediterranean
SPAMI	Specially Protected Areas of Mediterranean Importance
SSS	Side Scan Sonar
UNEP	United Nation Environmental program
USGS	United States Geological Survey
UTC	Coordinate Universal Time
UTM	Universal Transverse Mercator
VU	Vulnerable (sensus IUCN)
WGS84	World Geodetic System 1984

1.0 FOREWORD

The MedKeyHabitats Project, financed by the MAVA Foundation, is coordinated RAC/SPA and implemented with the full involvement of the relevant national partners in the Mediterranean countries participating in the Project (Albania, Algeria, Croatia, Egypt, Libya, Morocco, Montenegro and Tunisia). The Project aims at assisting the countries to compile cartographic inventories of marine habitats of conservation interest with the view of extending the network of Specially Protected Areas of Mediterranean Importance network (SPAMI), as required by the Barcelona Convention's Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean (SPA/BD Protocol).

The Project is a contribution to the implementation of the following Action Plans for the conservation of habitats, within the framework of the Mediterranean Action Plan (MAP):

- The Action Plan for the conservation of marine vegetation, adopted by the Contracting Parties to the Barcelona Convention in 1999;
- The Action Plan for the conservation of the coralligenous and other calcareous bio-concretions in the Mediterranean Sea, adopted by the Contracting Parties to the Barcelona Convention in 2008;
- The Action Plan for the conservation of habitats and species associated with seamounts, underwater caves and canyons, aphotic hard beds and chemo-synthetic phenomena in the Mediterranean Sea, adopted by the Contracting Parties to the Barcelona Convention in 2013.

Golder Associates S.r.l. (referred to as "Golder") has been appointed by the Regional Activity Centre for Specially Protected Areas (RAC/SPA) to carry out the surveying and mapping activities of the MedKeyHabitat Project in Montenegro.

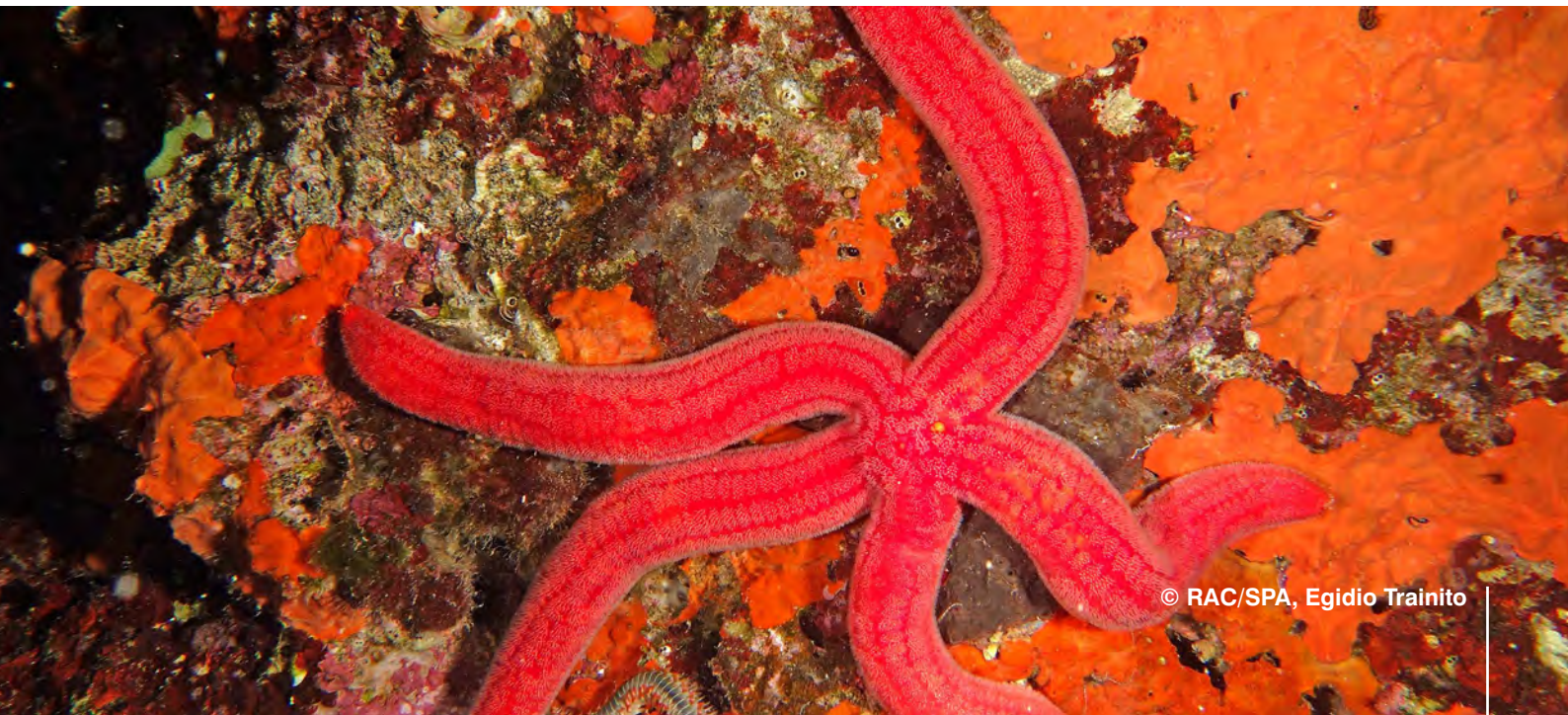
In agreement with the Ministry for Sustainable Development and Tourism of Montenegro the implementation of the MedKeyHabitats Project in Montenegro focused on two selected pilot sites: Platamuni and Ratac.

A preliminary report (Phase I report)[1] was delivered in the final version in August 2015. This Phase I report consisted in collecting the available data in order to perform a summary review and a gap analysis highlighting the most relevant gaps in knowledge for the two study areas. The Phase I report is a baseline of the current knowledge of the two study areas. The results of the preliminary Phase I report are shortly summarized in the present document in Section 4.1.

The results of the Phase I were then used to align and optimize the actions implemented during the geophysical survey and the biological campaign. These field activities were carried out in close collaboration with the team of the Marine Biology Institute of Kotor that actively participated to both missions.

The results and outcomes of the geophysical survey and the biological campaign are presented in this report. The report provides also an assessment of the two sites in view of proposing them to be on the SPAMI List, as well as general orientations for the conservation/management measures for both sites.

[1] UNEP/MAP-RAC/SPA, 2016. Montenegro: Platamuni and Ratac areas. Summary report of the available knowledge and gap analysis. By Torchia G., Pititto F., Rais C., Trainito E., Badalamenti F., Romano C., Amosso C., Bouafif C., Dragan M., Camisassi S., Tronconi D., Mačić V., Sghaier Y.R. & Ouerghi A. Ed. RAC/SPA - MedKeyHabitats Project, Tunis: 32 pp.



© RAC/SPA, Egidio Trainito

2.0 INTRODUCTION

Montenegro has a coastline of 293 Km located in Eastern coast of the Adriatic Sea. The coast of Montenegro is made of a wide variety of rocks, including carbonates, flisch and volcaniclastites. It is however characterized by calcareous rocky shores with sub-vertical and vertical cliffs sloping abruptly down to 20-30 m depth on a mosaic of gravel, sand and mud, intermingled with small pebble/gravel beaches or creeks with gentler slopes (RAC/SPA-UNEP/MAP, 2011).

As reported by several scientific survey papers, the benthic assemblages along the coast of Montenegro are typical of the infralittoral of Mediterranean hard and soft substrate (RAC/SPA-UNEP/MAP, 2011); Kruzic and Benkovic, 2008; Despalatović *et al.*, 2010; Nikolić *et al.*, 2010, Legac and Brenko 1999; Falace *et al.* 2010). Many sites of this coast were assessed as of special interest for conservation, in particular because of their species and habitat diversity and their biological and ecological uniqueness.

The main threats to the marine environment are linked to human activities along the coast, mainly fishing and tourism. As for the other coasts of the Adriatic Sea, the Montenegrin coast could be seriously impacted by the rapid expansion of tourism activities and the future plans for tourism infrastructures (RAC/SPA-UNEP/MAP, 2011). The pollution from untreated sewage may be also a problem in the near future following the development of tourist infrastructures and the general increase in human pressures along the coast. The dumping of soil from road construction or improvement is also becoming a serious problem and the negative effects on marine life need to be considered.

However, in general, the marine environment along the coast of Montenegro is in good conservation status, especially on rocky areas, although barren formations were observed in some location. The possible causes are the overfishing, including the use of explosives and the date harvesting, and sea urchin overgrazing due to decrease in number of large sea urchin predators such as the sea bream species (RAC/SPA-UNEP/MAP, 2011).

To ensure the conservation of sites of interest through appropriate measures, a better knowledge of the distribution of habitats and assemblages is needed to provide a scientific evidence to be used as rationale for conservation measures and to raise the awareness of the public opinion and of decision-makers. It is in this context that this study was planned and carried out.

The present report illustrates the methodology applied during the field work and data elaboration as well as the results of two field surveys, the initial geophysical investigation and the biological campaign. An assessment of the two sites in view of proposing them to be on the SPAMI List and a final section of conclusion and consideration are also provided. Six Appendices - including an atlas of maps, an atlas of photos, raw data and notes collected during the campaign, the filled in Standard Data Forms and a GIS - completed the report. The GIS contains all the geographic data and information and it is available also as WebGIS.

2.1 Scope of work

The scope of work is synthetized in the items listed below:

- Carry out a bibliographic review of the available information on the two study areas: Platamuni and Ratac.
- Carry out the mapping of marine habitats in the two areas. A geophysical survey (side scan sonar and single beam echo sounder) and a biological campaign were conducted.
- Initiate a monitoring network of the marine key habitats and in particular of the Posidonia meadows and coralligenous biocenosis.
- Prepare a final report, a GIS project and a WebGIS including the results of the study.
- Assess the potential of the two sites as candidate for inclusion in the SPAMI list, and propose general orientations for conservation/management measures.
- Provide on-the-job training to the local experts.

3.0 METHODS

The following methodologies were applied during the realization of the project:

- an initial desktop study;
- a geophysical survey and a preliminary data analysis;
- a biological survey (including the setting up of the monitoring network for relevant habitats);
- the preparation of the GIS and WebGIS projects to manage all the available geographic data;
- the data analysis and the elaboration of all available information;
- the preparation of a final report compiling all the collected data.

The MedKeyHabitats Project was implemented in Montenegro having in mind the SPA Protocol, the relevant MAP action plans and the IMAP principles and common indicators. Analysing the lists of species and habitat collected or observed during the survey, the EU Directives habitats and species lists, the CAMP Programme, the EMERALD habitats and species lists and the ones included in the Bern Convention, the CITES were also considered. Moreover it was reported the status assigned to the species by the IUCN.

3.1 Study areas

The study focused on two sites (Figure 1 and Figure 2):

- Platamuni: the study area, located in the Kotor municipality, extends from Žukovac Bay and Greben Kalafat in the north to Cape Platamuni in the south. Approximately 10 km straight coast length, from the coast to a maximum depth of 50 m (total area of about 8,4 km^2) are included in the study area;
- Ratac: the study area, located in the Bar municipality, consists of approximately 1,4 km of coast, from the coastline to a maximum depth of 25-30 m (total area of about 0.94 km^2).

Figure 1: The Platamuni study area

Figure 2: The Ratac study area

3.2 Adopted methodology

3.2.1 Desktop study

In order to establish a preliminary description of the physical and biological features of the study areas, as well as the potential human impacts and threats, a literature research was performed. The research was carried out with the support of databases of peer and non peer-reviewed literature (e.g. Scopus, ASFA, Google Scholar). The following main data sources were considered:

- scientific and "grey" literature;
- previous ecological investigations conducted in the study areas;
- national and international environmental databases (including data from FAO international projects);
- other relevant data and information already available to National experts (Marine Biology Institute of Kotor).

All the available information was then compiled in the bibliographic report delivered in the final version in August 2015. This document, shortly summarized in the present report (section 4.1), included in particular the analysis of the available data at two levels: for the south Adriatic Sea and Montenegrin level, and for the two study areas. The plan for the two surveys (geophysical and biological) was then improved on the basis of the obtained bibliographic outcomes and gap analysis.

3.2.2 Qualitative analysis of fishery activities

The fishery in the study area was described using both bibliographic reference, especially RAC/SPA-UNEP/MAP (2013) and interviews with fishermen and data from some logbooks. The interviews with fishermen were carried out with the support of the local expert Dr. Olivera Markovic.

3.2.3 Main adopted parameters

The positioning of the vessel during the surveys was provided by the Differential Global Positioning System (DGPS). The Hemisphere A31 (antenna) and R330 (receiver) systems were used to receive the differential correction based on the EGNOS[2] satellite based augmentation system (SBAS). The set up system is capable of metric accuracy.

For each survey, the DGPS Antenna was installed on an open space on the vessel and the position of all the equipment was reported as relative location (offset), in comparison with the DGPS, within the QINSy navigation software.

All the geographic data recorded on the field during the two surveys were georeferenced in the WGS84 worldwide coordinate system with system projection UTM (*Universal Transverse Mercator*), Zone 34 North. The geodetic and cartographic parameters for the data acquisition are reported in Table 1.

The vertical adjustment of the recorded data was carried out by integrating the acquired information with the tide-gauge data kindly provided by the HMSZ.

For calibration purposes, a daily DGPS horizontal control was executed by checking the position of the survey vessel moored alongside the quay.

[2] The EGNOS is a system developed by the European Space Agency to improve the reliability and the accuracy of the positioning data.

Table 1: Geodetic and cartographic parameters used during the survey in the two areas

Geodetic Parameters (WGS84)	
Datum	WGS84 – ITRF2008
Ellipsoid:	GRS80 (WGS84) Major semiaxix: a = 6 378 137 m Minor semiaxis: c = 6 356 752,3142 m Pressing: f = 1/298,257223563
Projection:	UTM 34 (Universal Transverse of Mercator)
Central meridian:	21°00'00"
False East:	500 000
False North:	0
Scale factor	0.9996

3.2.4 Geophysical survey

Date: 23th - 28th July 2015.

Golder Team:

- Mission organization and data management – Giovanni Torchia and Mimmo Pazzanese.
- Field work Golder's operators - Francesco Pititto and Salvatore Drago.

The survey was carried out in collaboration with the local expert, Dr. Vesna Mačić of the Institute of Marine Biology (IBM) of Kotor.

Vessel: "Nemirna II" owned by IBM.

Main instruments: C-MAX CM2 side scan sonar; Odom Echotrac single-beam echo sounder; QINSy navigation software; Hemisphere DGPS (A31 Antenna and R330 receiver); electronic pulley to calculate the layback in real-time.

3.2.4.1 Field work method

The **mobilization phase** was conducted in Kotor, in the IBM facilities, and then the vessel moved to Bigova, the base port for all the activities in both the Platamuni and the Ratac areas.

The **positioning** of the vessel and all involved equipment was assured by a Hemisphere DGPS (A31 antenna and R330 receiver). All the positioning data were acquired by the QINSy navigation software, which also recorded the relative position of the vessel and all the involved equipment (offset). In addition QINSY instantaneously received the data about the cable length (provided by the pulley) and calculated the position of the side scan sonar tow fish through the layback algorithm. The calculated position was then exported to the SSS surface unit to georeference the collected information.

The **side scan sonar** survey was conducted using a lateral range of 100 m for a full coverage. This configuration allowed to detect the main seabed features to mid-scale: seabed forms, textures, specific habitats (e.g. seagrass meadows) and the eventual presence of natural morphologies and non-natural objects (e.g. wrecks and small hard substrata on the seafloor).

An in depth analysis was carried out in some small areas by adopting a lateral range of 37,5 m. In the Ratac area two sites were investigated in order to identify the most suitable area to set up the monitoring network for the Posidonia oceanica meadows. In the Platamuni area the in-depth investigations were carried out in a rocky bottom site, close to Sveti Nikolau, based on the indications provided by the local experts.

In both study areas and for both the range selections, the adjacent routes were planned to assure a full coverage with an overlap of more than 40 % among contiguous lines.

The **bathymetric survey** was carried out using the Odom Echotrac single-beam echo sounder and collecting the data in correspondence of the routes coursed for the side scan sonar acquisition. The depth data were recorded using the QINSy navigation software.

For both activities, at the end of each day of survey, a QA/QC activity was performed to verify the data quality and in particular the real coverage of the SSS data.

A total amount of 37 navigation lines were travelled in the Platamuni area and 19 navigation lines in the Ratac area, for a total amount of about 115 km. The total area covered by the survey was 8,4 km^2 for the Platamuni area and 0,94 km^2 for the Ratac area.

A short summary of the daily reports is available in APPENDIX F to this report.

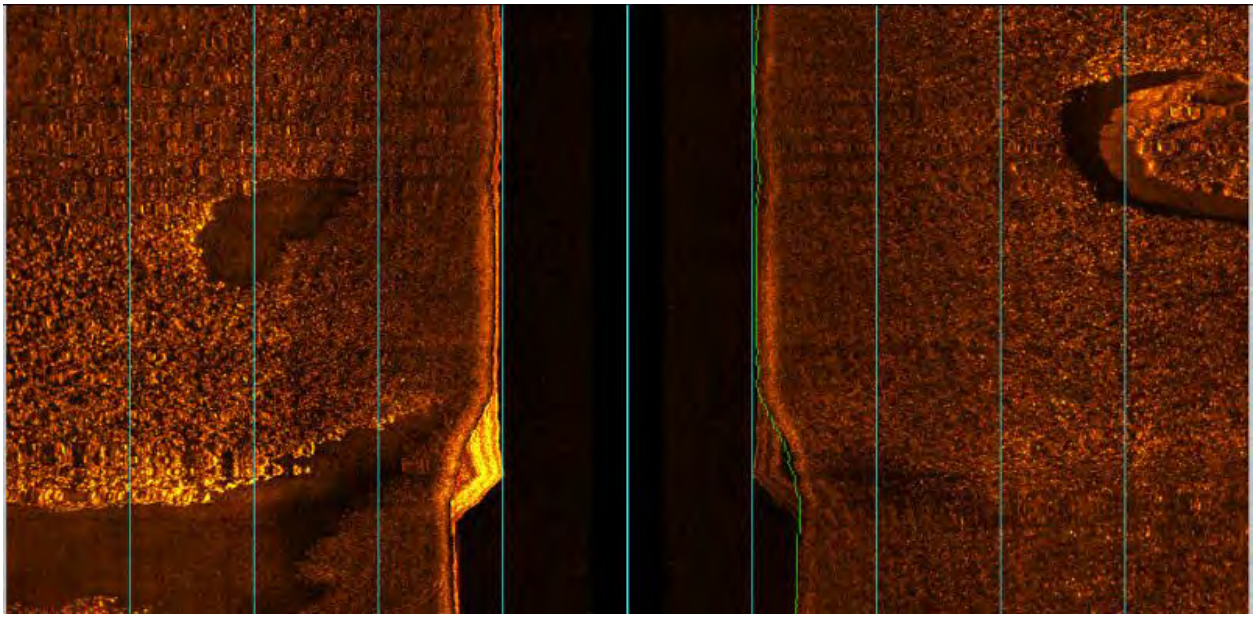


Figure 3: A particular of the survey on the *Posidonia oceanica* meadows

3.2.4.2 Data elaboration method

The collected data were preliminarily elaborated in order to plan the following biological survey. The final data processing was then carried out according to the standard methods and workflows reported in the bibliography for each technique and adopted software.

The **SSS data elaboration** was carried out by firstly converting the SSS data from the original format (.cm2) to geotiff that have been processed by using the SonarWiz5 software.

In practice the acquired sonar data were elaborated to obtain some acoustic images of the sea bottom, according to their effective geometry. The main phases of the elaboration procedure were the following:

- validate and smooth the navigation of all survey lines;
- check the bottom track;
- set the adequate gain (e.g. the Time Varing Gain, TVG), equalization and image enhancement;
- generate the georeferenced images;
- mosaic the adjacent images in few rasters.

At the end of the process, a complete georeferenced mosaic (geotiff file) has been produced, with a pixel resolution of 10 cm.

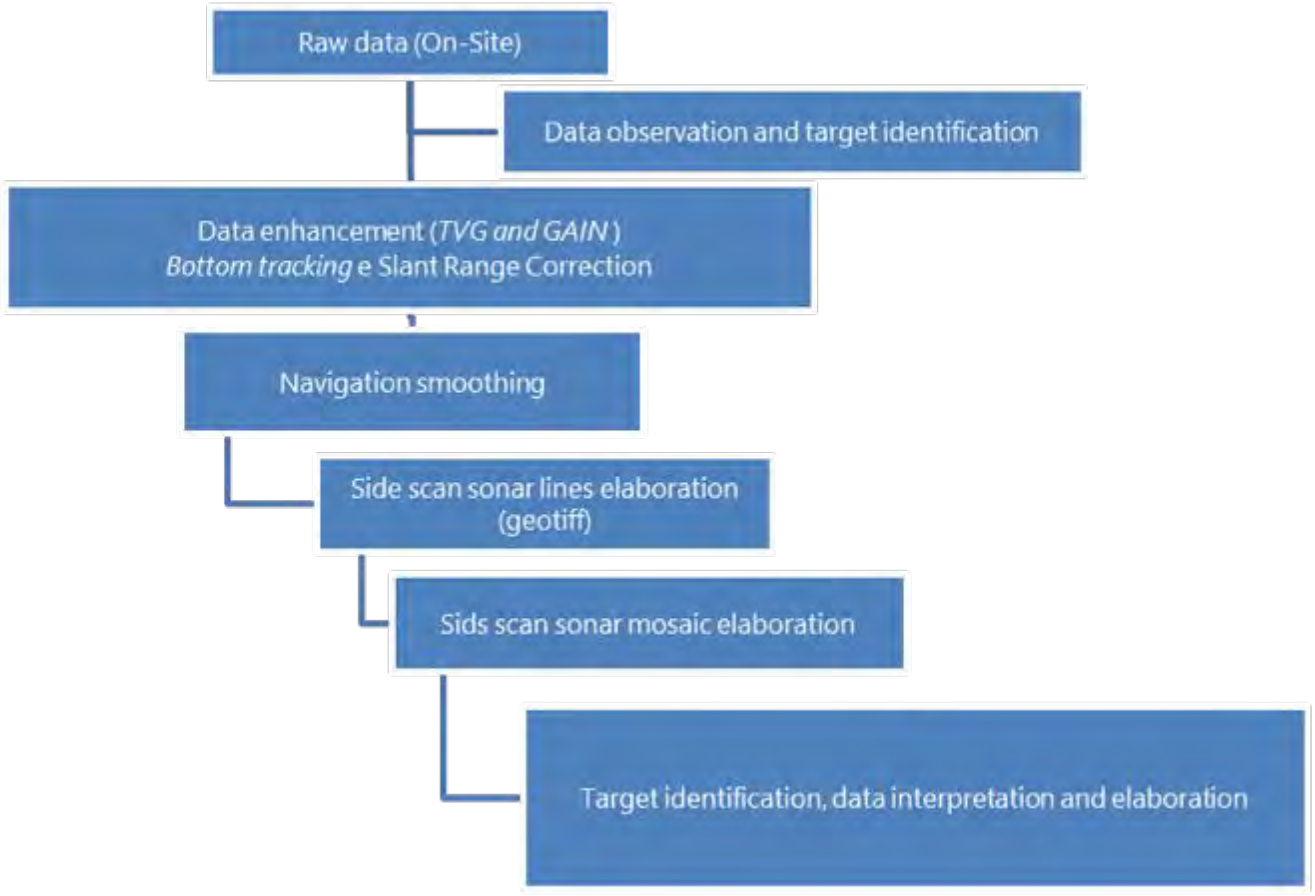


Figure 4: The general workflow for SSS data elaboration

The SSS photomosaic was uploaded in the GIS project to support the cartographic interpretation of the main geomorphological and biological features of the seabottom in the two study areas.

The procedures for the **bathymetric data elaboration** are schematized in the workflow of Figure 5.

Starting from the raw data collected on-site, the navigation was validated and the depth data were graphically processed to control and manually eliminate the eventual presence of erroneous measures (e.g. spikes or multiple echoes). Then the collected data were corrected by applying the tide-gauge data kindly provided by the HMSZ.

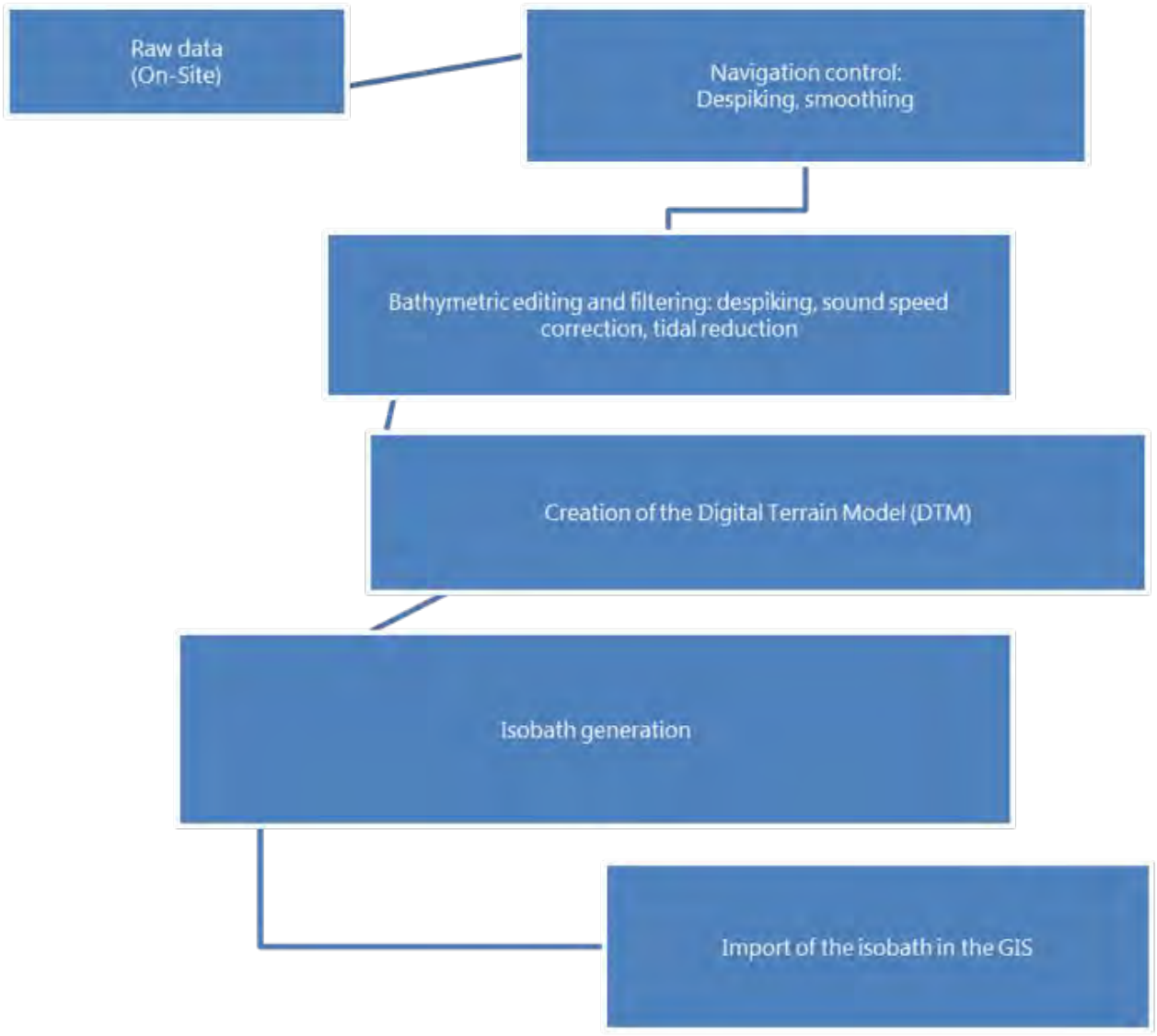


Figure 5: The general workflow for bathymetric data elaboration

The processed data were then exported as x,y,z files and gridded in the Surfer 10 software to calculate a Digital Terrain Model (DTM). Once the DTM generated, the contouring (isobaths) were extrapolated and exported in the GIS software to support all the remaining analysis and derived considerations, as well as fundamental layers in all the produced maps.

3.2.5 Biological survey

Date: 30th September - 9th October 2015.

Golder Team:

- Field work organization and data management – Giovanni Torchia, Chiara Romano and Fabio Badalamenti.
- Field work Golder's operators – Giovanni Torchia, Francesco Pititto, Egidio Trainito.

The survey was carried out in collaboration with the local expert, Dr. Vesna Mačić of the Institute of Marine Biology (IBM) of Kotor and one expert from the RAC/SPA, Dr. Yassine Ramzi Sghaier.

Vessel: "Nemirna II" (owned by IBM) and, during two days in the Platamuni area, a small supporting boat rented in situ from local people in order to carry out some activities with two teams in parallel.

Main instruments: Hemisphere DGPS (A31 antenna and R330 receiver); Van Veen Grab 17 l; Underwater Towed Camera - Mangrove Panoracam; Underwater GoPro Camera 4; Professional digital camera Nikon D3X (24.4 megapixels) and underwater box Sea & Sea MDX D3 Pro; 2 digital cameras Sony RX100 with 2 Inon S2000 Flash and illuminator Light & Motion Sola 600; OpenROV 2.8 Mini Observation Class.

3.2.5.1 Field work methods

The base ports for the biological survey were Bar for the Ratac study area and Bigova for the activities in the Platamuni area.

The **positioning** during the survey was managed by the QINSy navigation software, directly connected to the computer onboard. As per the geophysical survey, the relative position of each object involved in the survey was recorded. The positioning of the underwater towed camera was assessed in real-time during the by updating in the navigation system the cable length and the angle.

Underwater video survey (Mini ROV, towed camera and GoPro). In order to both identify the biocenoses colonizing the rocky zones and correctly interpret the side scan sonar images, video transects were conducted on hard bottoms, through the use of towed camera (PANORACAM VVL-KS-B with a 360 degree rotary underwater camera) and/or mini OpenROV (Mini Observation Class) and/or GoPro managed directly by scuba divers. In total 7 video transects were carried out in the Ratac area and 9 transects in the Platamuni area. The position of the submersed camera was recorded as a *.shp* file by a GPS receiver and layback corrections. All videos were recorded and associated to the investigated transects.

Figure 6: The Nemirna II (main vessel) and the supporting vessel used for the biological survey

Figure 7: The video of the towed camera observed by biologists on board of the Nerimna II, in the Platamuni study area

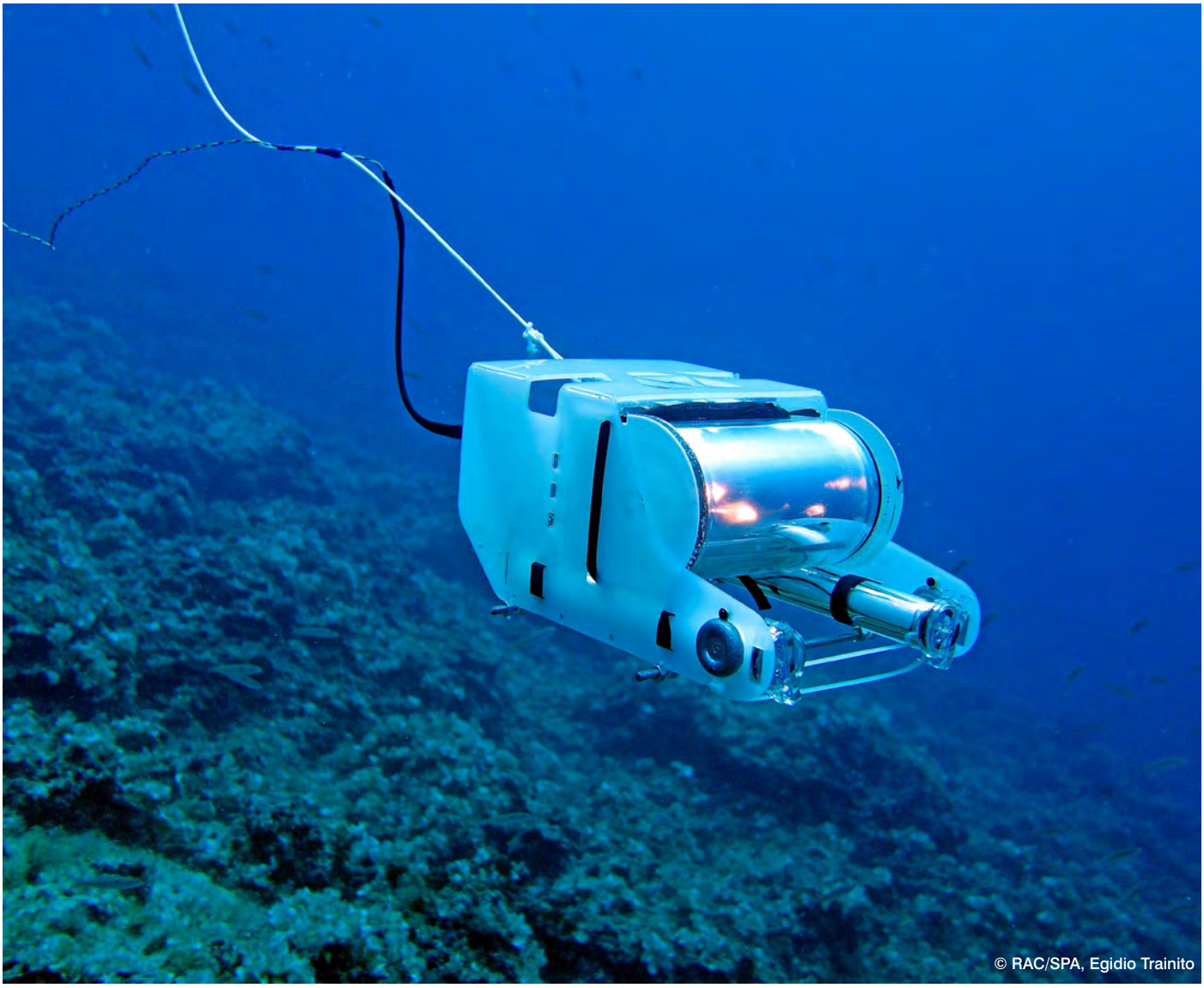


Figure 8: Underwater video survey – the Mini ROV in action in the Platamuni area

Sampling with grab. To classify the habitats of the soft bottoms two samples of sediment with Van Veen grab of 17 l were collected in the Ratac area and five samples were collected in the Platamuni area. The positioning stations were selected per depth and seabed typologies according to the side scan sonar photomosaic (e.g. detritic, sandy, muddy). Samples were rinsed and sieved with a 1 mm mesh. The remaining material was fixed in a 70 % alcohol solution.

Scuba diving surveys. Two scuba diving surveys were conducted in Ratac and seven in Platamuni, in order to complete the inventory of species. The scuba divers collected the data about species distribution and the bathymetry in correspondence of the observations. Videos and professional photographic materials were produced for each site. High-resolution photo analyses were carried out to complete a qualitative list of species for each surveyed site.

Fish visual census. Fish censuses were conducted in three sites. At least three random transects of 25 m each (three replica) were carried out in each site. A PVC table was used to record all present species, their number and the size-class they belong to; three size-classes were used Harmelin-Vivien *et al.*, 1985). The following abundance classes were adopted: 1, 2, 3-5, 6-10, 11-30, 31-50, 51-100, > 100). One site (FVC1) is located in Ratac area between 15 m and 12 m depth. This site is colonized by *Posidonia oceanica* on a hard organogenous bottom. The site is characterized by high rugosity and includes enclaves of coralligenous and sciaphylus biocenoses. The other two sites are located in the Platamuni area: one site (FVC2) is situated between 21 m and 18 m depth in correspondence of the lower limit of the *Posidonia* meadow on rocky bottom; the other site (FVC3) is located between 25 m and 13 m depth on hard bottom with algae partially covered by mucilaginous aggregates

Figure 9: FVC1 in Ratac, the visual census study area is characterized by a diversified and structurally complex organogenous hard bottoms partially covered by *Posidonia oceanica*

Figure 10: FVC2 in Platamuni, the fish visual census study area, in correspondence of the lower limit of the *Posidonia* meadow on the western side of Greben Kalafat

Figure 11: FVC3 in Platamuni, the fish visual census study area is a hard bottom colonized by algae partially covered by mucilaginous aggregates

Setting of the Monitoring networks for key habitats: *Posidonia oceanica meadows*. Two monitoring networks of the Posidonia oceanica meadows, in correspondence of the lower limits, were set-up in two sites: one in Ratac at the depth of 21,4 m and the other in Platamuni at the depth of 30,8 m. The methodology reported in Pergent (2007) was applied (Figure 12 and Figure 13).

A first identification of the limit was carried out using the SSS data. Once on the field, the finer positioning of the area was selected using an underwater towed camera. In each site 11 markers (balises) and 11 stakes were installed close to the limits to be marked, and then finely positioned and fixed by the divers. Two different teams (2 divers each) recorded the following information: the depth of the marker, the marker-to-marker and the photo-stake-to-marker directions, the meadow coverage and density, the percentage of plagiotropic rhizomes, the exposure or burial of the rhizomes, the nature of the substratum and the type of the limit. Two orthotropic rhizomes were collected about 2 meters behind each markers and a sample of sediment was collected in front of the marker 6. The biological samples were stored in alcohol and transferred to the lab for the subsequent analyses. The limit was photographed by taking photos from the stakes and about 2 m above the meadows.

Figure 12: The monitoring network set-up in the Ratac Posidonia meadow (balisage)

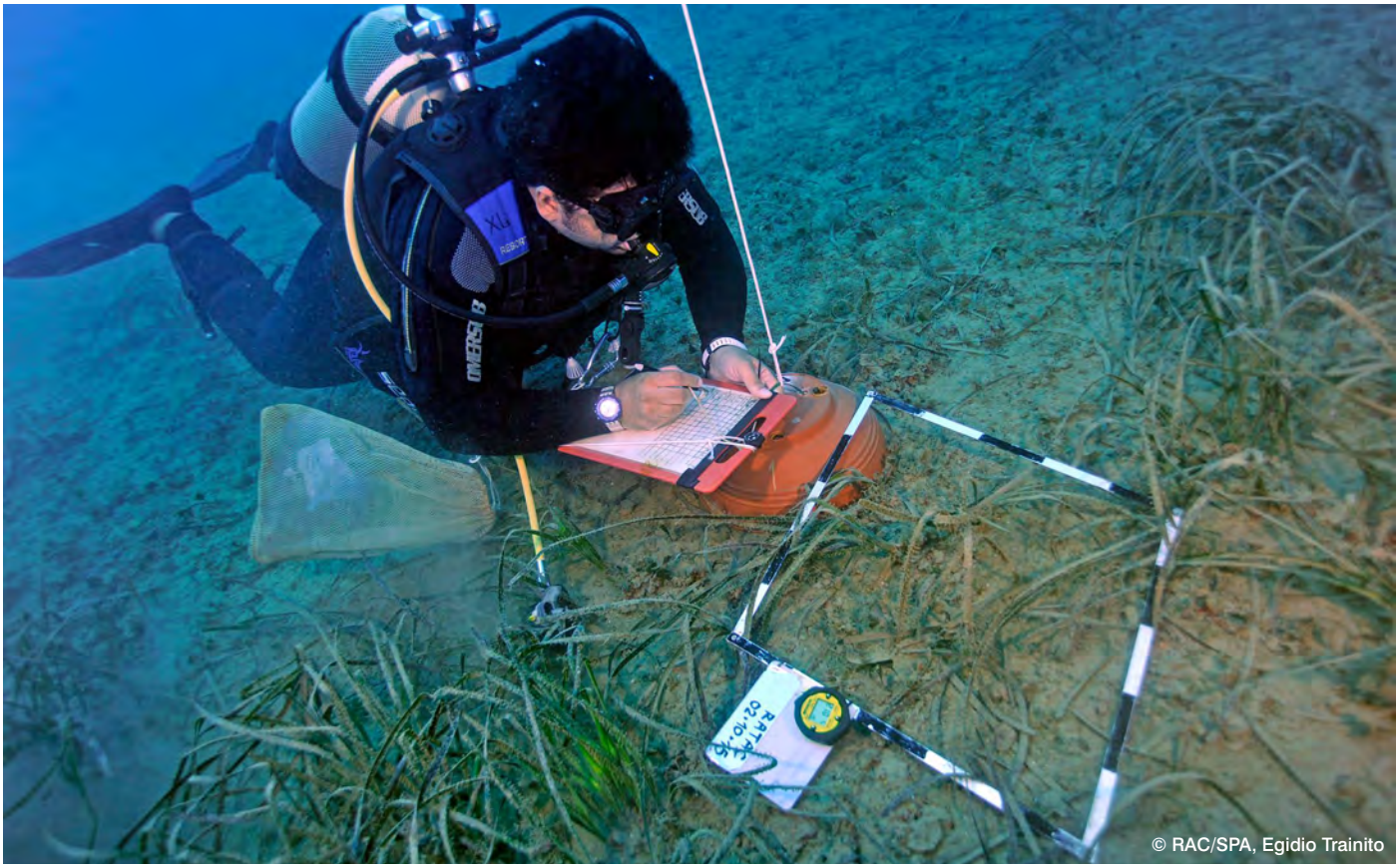


Figure 13: In situ measurements counts in the Ratac *Posidonia* meadow within the setting-up of the monitoring network

Setting of the Monitoring networks for key habitats: coralligenous biocenoses. The monitoring network of the coralligenous was set-up in the Platamuni area in a semi-obscure marine cave colonized by a rich bioconstruction assemblage dominated by madrepores, sponges and erect bryozoans. The methodology indicated in RAC/SPA-UNEP/MAP (2014) was applied: two permanent marks were positioned in the area measuring 20 m x 5 m, both the mechanical penetration inside the bioconstruction and a two elements underwater mastic were used to fix the mark on the substrate; a photosampling of three series of 10 contiguous photos of 50 cm x 50 cm (totally three areas of 2,5 m^2) was carried out; three visual census along 10 m x 1 m transects were conducted; during the visual census all the environmental and biological parameters defined by the methodology (erect layers estimation, macro-bioeroders abundance, fishing pressure, mucilaginous aggregates) were recorded.

Figure 14: One of the two marks fixed in the semi-obscure cave in Platamuni. The tape measure was fixed to the mark to be used for the 10 m visual census transect

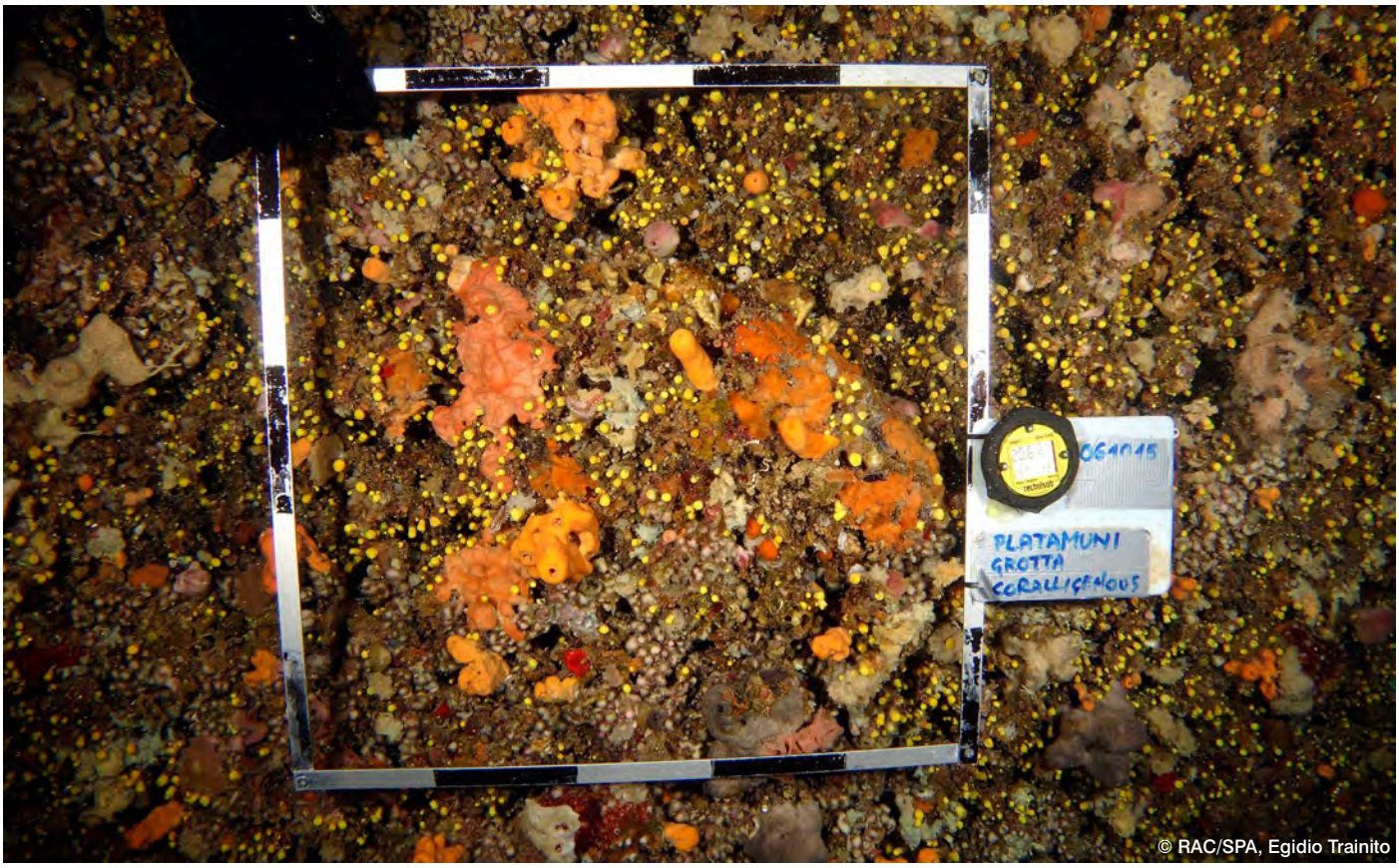


Figure 15: Photosampling in the semi-obscure cave in Platamuni - one of the 50 cm x 50 cm contiguous photos

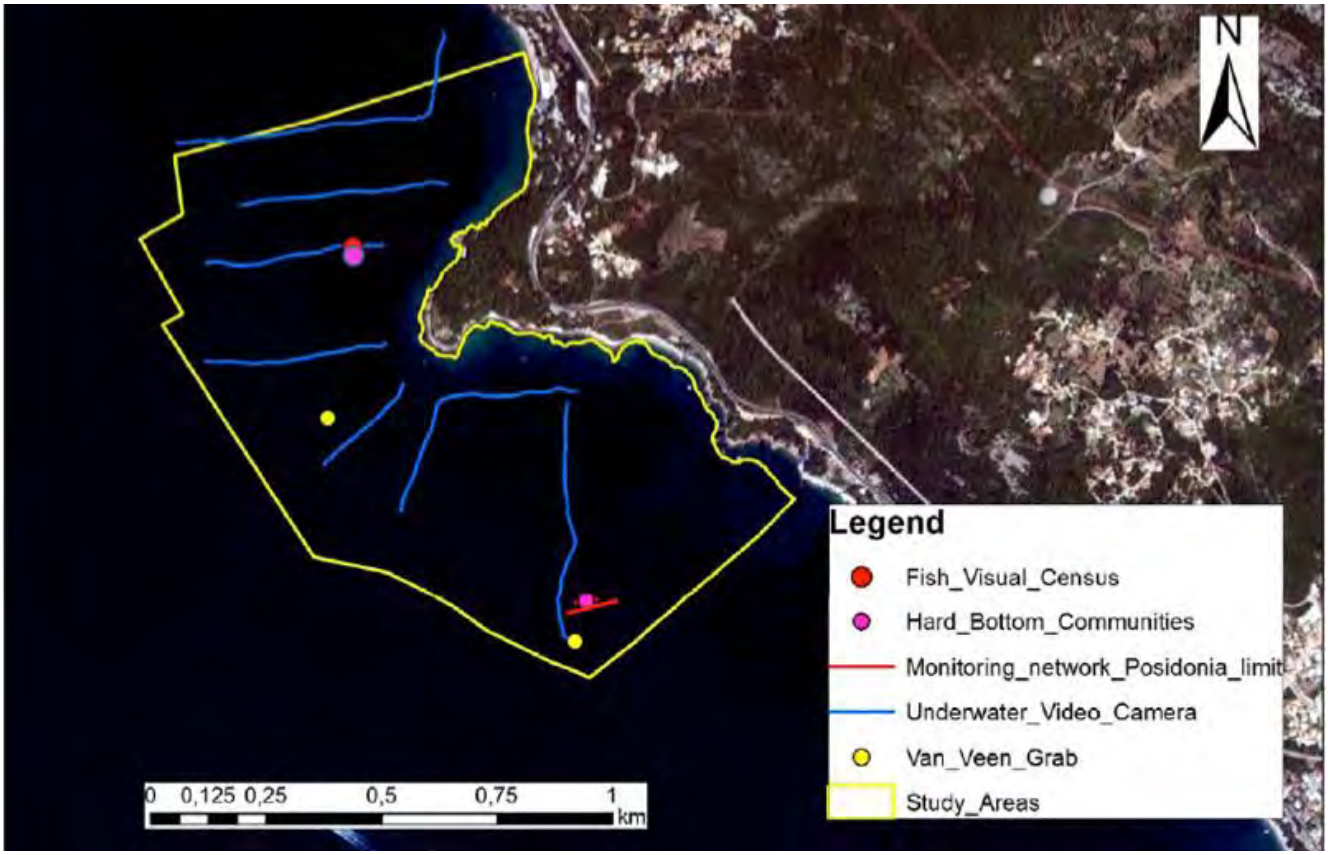


Figure 16: Ratac study area and investigated stations

Figure 17: Platamuni study area and investigated stations

3.2.5.2 Data elaboration methods

The present section describes the main methodologies applied during the phase of elaboration of the information collected during the biological survey, as well as the integration (for biological purposes) of the already collected geophysical data.

The **Golder Team** in charge of the data elaboration was composed by the following experts: Giovanni Torchia, Chedly Rais, Chiara Romano, Fabio Badalamenti, Mimmo Pazzanese, Francesco Pititto, Massimo Dragan.

The **biocenotic maps** were drawn up integrating in ArcGIS all the available geographical data (i.e. SSS data, bathymetry, video and photo information) and the georeferenced notes taken during the field missions.

For the Ratac zone, given the small surface area of the study zone, the map was directly prepared in scale 1:2000. For the Platamuni area, the map was prepared in scale 1:5.000.

Once the scale of restitution fixed and all the information loaded in the GIS project, the different biological features were manually highlighted and contoured as polygons (Figure 18).

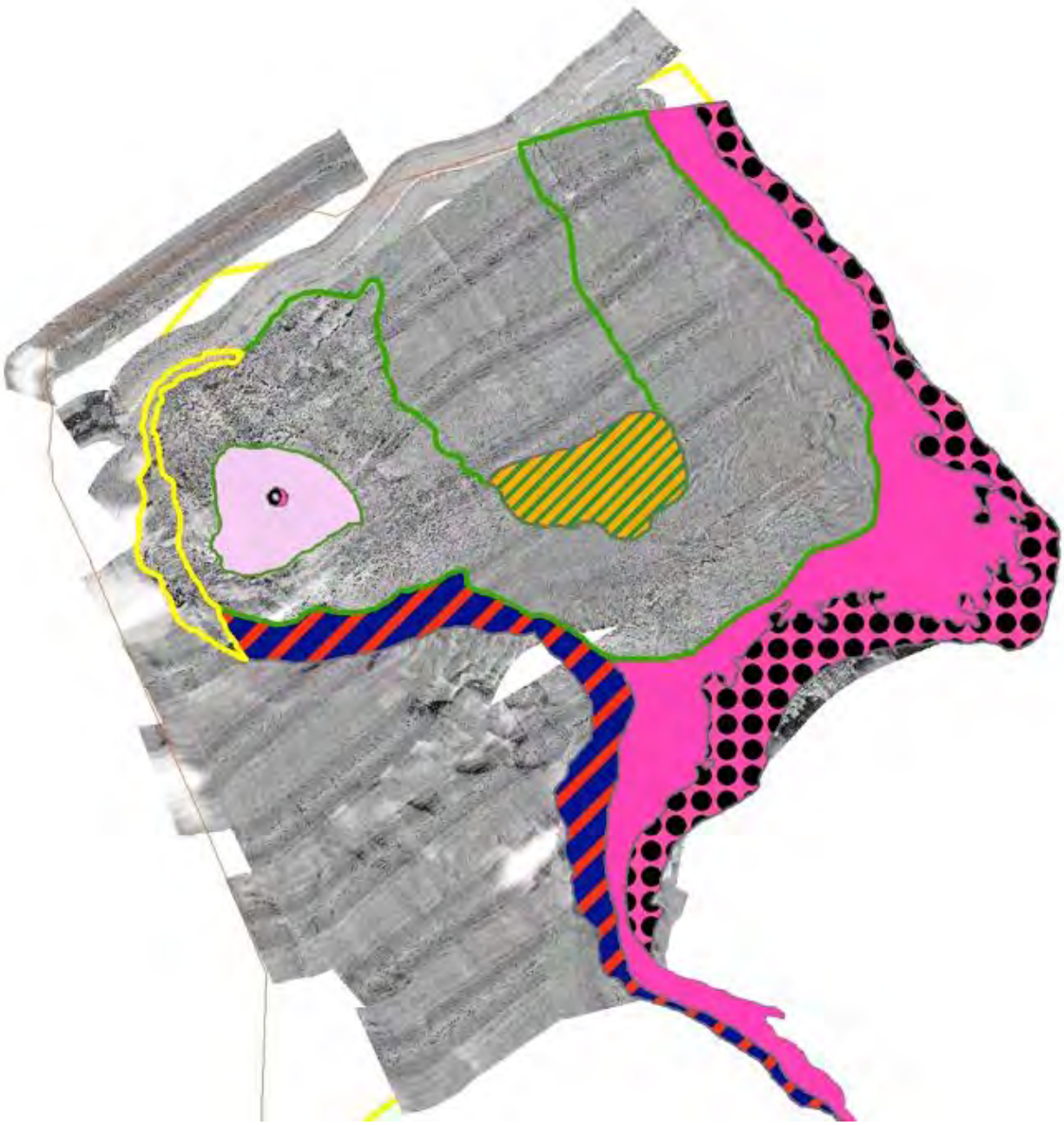


Figure 18: A phase of preparation of the biocenotic map in the Platamuni area

The biocenotic maps were prepared according to the most relevant scientific literature (Pérès and Picard, 1964; Augier, 1982; Meinesz et al., 1983; Bellan-Santini et al., 2002, Bianchi et al., 2003). The symbols and conventions adopted comply with the accepted standard reported in Meinesz et al. (1983) and with the colour standard proposed by Tunesi et al. (2002).

The data collected on the hard bottom communities (mainly photographs and diving notes) were carefully analysed and specific species lists were prepared for each sampling site and specific considerations were provided, with particular emphasis to the species protected by national and international laws and conventions.

The samples collected in the soft bottoms of both areas (7 in total) were transferred to the Golder laboratories for the taxonomic identifications. The sorting phase allowed to separate the macrobenthic species present in the sediments. Their classification was then carried out using the most important taxonomic guides available in the scientific literature. Special care was taken for those species characteristic of the benthic biocenoses (Pérès and Picard, 1964; Bellan et al., 2007). For each sampling point a list of the identified species was prepared but the biodiversity indexes were not calculated given the low number of living species found in the samples.

The fish assemblages data were transferred into Microsoft Excel tables and elaborated. The average values for each station were calculated.

Concerning the initiation of the monitoring network of the seagrass meadows, the phenological and lepidochronological analyses on the shoots of Posidonia oceanica collected in the two sites were carried out in the Golder laboratories. The leaves were carefully separated per classes, numbered per type and the total length, the width and the length of the petiole (only for the adult leaves) were measured. Moreover the type of the apex (broken or not) was recorded. The following indexes were then calculated:

- Weighting A: the percentage of leaves that have lost their apex;
- Foliar surface per shoot;
- Leaf Area Index (LAI): the surface area of the leaves per square meter;

The annual cycles derived from the thickness of the scales of the collected shoots were used to rank the scales (starting from the scale closest to the first living leaf). The rhizomes have been cut in correspondence of the minimum scale thickness, thus obtaining a series of sections enclosed between the two consecutive scales having minimum thickness (lepidochronological year). These segments were put in a dry off oven at about 70°C until a constant weight was obtained. The eventual presence of floral stalk was also noted.

The granulometric analyses of the sediment collected in front of the marker was elaborated in terms of table of composition of the different grain size of the sediments.

Concerning the characterization of the lower limit, the directions "marker-to-marker" and "photo-stake-to-marker" were reported in the GIS software to reconstruct the map of the marking. The horizontal shots have been assembled together to reconstitute the limits, and the cartographic information were integrated in the GIS.

By compiling and interpreting all the collected data, the area around the lower limit was also interpreted in terms of type of the limit, vitality and status of the meadows. The results were reported as comments, tables and charts summarising all the outcomes.

Concerning the initiation of the monitoring network of the coralligenous biocenoses, the high quality photographic data were analysed. All the parameters recorded were reported in Microsoft Excel tables.

In addition to the methodology reported in RAC/SPA-UNEP/MAP (2014), as further technological improvement, we applied a technique that allows to quantify in the photos more precisely the coverage of the found taxonomical units. We report here a detailed sequence of this analysis tool, to allow the local experts to apply it (if useful) also during the future monitoring. The analysis was carried out using Adobe Photoshop commercialized by Adobe, but there is a wide range of commercial packages to perform the same functions.

Starting from the raw data files of the square photos, the detail of the procedure is the following:

- Adjust the contrast, brightness and shadows of the images;
- Apply the perspective correction;
- Rename the original file according to the frame number and the shoot section and save it (to maintain the original file without changes);
- Select only the part of the image inside the frame and resize the image;
- Choose the Brush tool hard round (in Photoshop), apply the white colour (R=255, G=255, B=255), adjust the size of the Brush tool depending on the areas covered by the taxonomical units (e.g. in the case of Figure 21 the size must cover the average area of a single madreporaria) and cover the areas occupied by the chosen taxonomical unit (Figure 19);

- Select all the white areas (i.e. areas covered by the examined taxonomical unit). In Photoshop this action is done choosing the Magic Wand tool, selecting "Zero tolerance", deselecting "Contiguous" and selecting one white area. All the white areas will then be selected;
- Invert selection (keyboard shortcut: MAC: Cmd+Shift+I; WINDOWS: Ctrl+Shift+I);

Figure 19: An example of the quantification procedure using Photoshop

- Make black (R=0, G=0, B=0) with the Brush tool hard round all the non-white areas (the new selection) in order to obtain a result as in Figure 20;
- Deselect the black area;
- Apply to the whole area the Blur filter at Average so that the whole area becomes more or less grey, depending on the percentage of white present in the image of Figure 20.

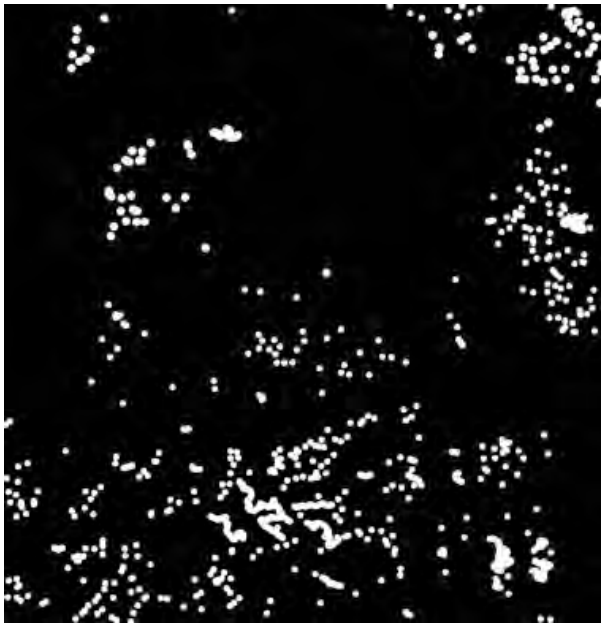


Figure 20: An intermediate step of the quantification procedure

- From the palette colour is then possible to measure the obtained grey. In Photoshop with the shortcut F6 choose the Palette Colour and the tool Eyedropper; with the Eyedropper collect the obtained grey: the read measure of the colour (Figure 22) represents the amount of white (in the scale 0-255).
- The number obtained is equal for the three primary colours and represents the amount of white present in the frame that, in other words, is the percentage of space occupied by the selected taxonomical unit.
- A simple proportion provides this percentage. In the case of the example the result will be provided by the formula "16:255 = x : 100". x = 6,27 means that the selected white area covers the 6,27 % of the frame.
- To report the area in 1 m^2, it is sufficient to rescale the result (obtained on a frame occupying 0,25 m^2). In the example the formula will be: 0,0627 * 0,25 m^2 = 0, 016 m^2.
- Close the file without saving to proceed with further counts (if necessary) or to keep it ready for future counts or controls.

The process may be iterated to calculate the areas covered by all the taxonomic units existing in the frame.

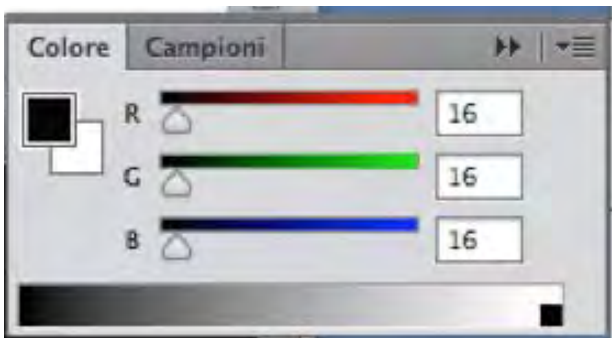


Figure 21: The colour palette indicating the white value after applying the filter

3.2.6 GIS and WebGIS

The overall GIS Project, including all geographical information collected, was developed with the software ESRI ArcGIS 10.3.1 integrated by ArcGIS server. The project was designed to capture, store, manipulate and analyse all type of available geographic data.
The process carried out to develop the GIS can be summarized in the following main steps:

- georeferentiation of the bibliographic data;
- organisation of the geodatabase;
- import of tabular data, images and videos from the field work activities;
- QA/QC

Photos, videos and report tables were stored as hyperlink within the geodatabase.

The geodatabase was organized according to the following structure:

- Basic geographic data;
- Bibliographic data
- 2015 Surveys and other collected information
  - Platamuni
  - Ratac
- Proposed management.

To facilitate the research, data analysis and selection, fish and benthonic species were organized within a specific geodatabase and dynamic tables.

The complete list of the available data (Data Catalogue) and their hierarchical organization is reported in APPENDIX G.

3.2.7 Assessment of the conservation interest of the two sites

The assessment of the conservation interest of the two studied areas was conducted first by filling the Standard Data-entry Form (SDF) adopted by the Contracting Parties to the Barcelona Convention for National Inventories of Natural Sites of Conservation Interest.

In a second step, the conservation interest of the two sites was assessed according to the objectives of the Specially Protected Areas as set by the SPA Protocol (1995) in its Article 4 stipulating that Specially Protected Areas should be established to safeguard:

- representative types of coastal and marine ecosystems of adequate size to ensure their long-term viability and to maintain their biological diversity;
- habitats which are in danger of disappearing in their natural area of distribution in the Mediterranean or which have a reduced natural area of distribution as a consequence of their regression or on account of their intrinsically restricted area;
- habitats critical to the survival, reproduction and recovery of endangered, threatened or endemic species of flora or fauna;
- sites of particular importance because of their scientific, aesthetic, cultural or educational interest.

Furthermore, considering that one of the objectives of the MedKeyHabitats Project is to extend the SPAMI network, an evaluation of the conservation interest of the two sites against the Common criteria for the choice of Protected Marine and Coastal Areas that could be included in SPAMI list was conducted.

The assessment was mainly based on the criteria reported in the Annex I of the Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean. The annex reports in particular the "Common criteria for the choice of Protected Marine and Coastal Areas that could be included in the SPAMI list. The main requisites are the followings:

- Fulfil at least one of the general criteria:
  - Areas of importance for conserving the components of biological diversity in the Mediterranean;
  - Contain ecosystems specific to the Mediterranean area or the habitats of endangered species
  - Areas of special interest at the scientific, aesthetic, cultural or educational levels
- Be evaluated area of Mediterranean interest according to the following criteria:
  - Uniqueness;
  - Natural representativeness;
  - Diversity;
  - Naturalness
  - Presence of habitat that are critical to endangered, threatened or endemic species.
  - Cultural representativeness;

The Annex to the protocol also reports a series of factors and characteristics that should be considered as favourable for the inclusion of a site in the list.

All the made assessments were mainly based on the results of the surveys undertaken as part of this study, using the data concerning the presence and distribution of the key species and habitats and taking advantage of the GIS outputs.

4.0 RESULTS

4.1 Baseline - desktop study

The desktop study report was presented in a separate document titled "Montenegro: Platamuni and Ratac areas - Summary report of the available knowledge, Gap Analysis and detailed execution plan - Phase I final Report – Report N° 1450840457/10413 – August 2015".

The present section briefly describes the main outcomes of the report. The results are divided – as in the original document - in three main sections:

- the southern Adriatic sea and the Montenegrin coasts;
- the Platamuni area;
- the Ratac area.

4.1.1 The southern Adriatic Sea and the Montenegrin coasts

The 293 km of coastline of Montenegro belong to the south-eastern Adriatic Sea and are mostly composed by a wide variety of rocks with a vertical or high slope. The currents dynamics are dominated by the presence of a quasi-permanent cyclonic gyre (Ovchinnikov *et al.*, 1985; Bignami *et al.*, 1990; Malanotte-Rizzoli, 1991). The tide average amplitude in the southern Adriatic is about 25 cm. The water temperature has an average range between 12 and 27 °C and a salinity range (on average) between 38.4 and 38.9 psu. The usual water transparency is about 17.6 m in winter and 20.8 m in summer (Agencija za zaštitu životne sredine, Crna Gora, 2014).

The Adriatic Sea hosts the richest planktonic communities in the Mediterranean (Vukanic and Vukanic, 2003). The **plankton** composition and dynamics, along Montenegrin coast, is influenced by the extensive use of the littoral zone and the increasing development of tourism (Drakulovic and Vuksanovic, 2010), the effects of climatic change (Lucic *et al.*, 2009; Pestorić *et al.*, 2010) and the freshwater inputs (Marini et al., 2010).

The **benthic assemblages** have a zonation typical of the Mediterranean hard and soft substrata (RAC/SPA-UNEP/MAP, 2011); Kruzic and Benkovic, 2008; Despalatović *et al.*, 2010; Nikolić *et al.*, 2010, Legac and Brenko 1999; Falace *et al.* 2010).

The upper infralittoral zone is often characterized by the presence of *Mytilus* spp., with a rich assemblage of predators, including the starfish Coscinasterias tenuispina and the mollusc Stramonita emastoma. The upper part of the infralittoral is mainly characterized by coralline barrens dominated by sea urchins and encrusting algae (RAC/SPA-UNEP/MAP, 2011). Sea urchin grazing has led to the disappearance of photophilic algal assemblages from a large part of the Montenegrin coast. Close to the surface, clear signs of date-fishing (*Lithophaga lithophaga*) are present in many areas. Where the slope or the complexity of the substratum is high, *Posidonia oceanica* meadows and pristine sciaphilous assemblages usually cover the lower part of the infralittoral (RAC/SPA-UNEP/MAP, 2011). In some places, in rocky bottoms between 16 m and 20 m, the colonies of large sized *Axinella cannabina* are present. In the southern part of the country, at such depths, the water transparency is reduced and a cloud of mud is often observed close to the cliff foot, a possible effect of the Bojana River. In general, according to Falace *et al.* (2010), in recent years in the Adriatic Sea there has been a change in macroalgal assemblages (i.e. the migration of sciaphilous macroalgae in shallower waters, a reduction in habitat-forming species - mainly *Cystoseira* spp. and *Sargassum* spp. – together with an increase in Rhodophyta and opportunistic species). The current species composition might be related to both a reduction in light penetration and an increase in the sedimentation rates.

In the Adriatic Sea, 418 **fish species** (about the 72 % of the Mediterranean), belonging to 120 families, are reported. In recent decades, the ichthyofauna composition has changed probably due to the oceanographic changes, the biological invasions and the overfishing by humans (Dulčić 2003). RAC/SPA-UNEP/MAP, (2011) detected 38 fish species along the Montenegrin coast, with overall low fish abundance, highlighted in particular for sedentary species (probably more affected by harmful fishing practices) and for species with high commercial values (e.g. *Epinephelus* spp., *Diplodus* spp. and *Dentex dentex*). Four main fishery ports are present in Montenegro: Bar, Budva, Herceg Novi and Kotor (inside the Boka Kotorska Bay). The fish is sold usually in the market stalls and in the restaurants and these ports are not characterized by organized landing sites or fish auction markets (RAC/SPA-UNEP/MAP, 2013).

According to RAC/SPA-UNEP/MAP, (2012), 20 different **marine habitats** or biocenosis are present along the Montenegrin coast. Moreover, recent studies performed in Boka Kotorska Bay (RAC/SPA-UNEP/MAP, 2013) highlighted the importance of this Montenegrin bay for the biological and ecological uniqueness of this area. The inventory of benthic assemblages counted 77 soft bottom taxa and 150 hard bottom taxa. A total of 23 fish species belonging to 7 families were observed. In addition, 21 different benthic habitats were identified in the Bay, including *Savalia savaglia* facies, coralligenous assemblages *Cladocora caespitosa* and large-sized sponges (*Axinella* spp.) (Annex II of the SPA Protocol).

Fishing and tourism are the two main human activities along the coast. In general the coast seems to be in good conservation status, especially on rocky areas, however in many locations the barren formations were observed. The possible causes are the overfishing, including the use of explosives and the date harvesting, and sea urchin overgrazing due to decrease in number of large sea urchin predators such as the sea bream species (RAC/SPA-UNEP/MAP, 2011).

The Adriatic Sea and the Montenegrin coast could also be seriously impacted by the rapid expansion of tourism activities

and the future plans for tourism infrastructures (RAC/SPA-UNEP/MAP, 2011). The pollution from untreated sewage may be a problem in the near future following the development of tourist infrastructures and the general increase in human pressures along the coast. The dumping of soil from road construction or improvement is also becoming a serious problem and the negative effects on marine life should be considered.

4.1.2 The Platamuni area

The area of Platamuni belongs to the Kotor municipality and is characterized by vertical and steep sedimentary rocks, carbonates limestone cliffs, dolomitic limestone and dolomites (Radović 1964; RAC/SPA-UNEP/MAP, 2011) that descend suddenly down to 20-40 m depth in the sea, where the seabottom is much more flat. The presence of 5 marine caves, as well as holes, fissures, boulders, small coves or bays has been recorded (Agencija za zaštitu životne sredine, Crna Gora, 2014; Mačić, 2014).

No specific data on plankton communities are available from the literature.

Concerning the **benthic communities**, the supralittoral zone is only a few meters wide and it is mostly constituted by the continuation of well-developed maquis. The zone of the study area is mainly characterized by rocky surfaces, with only three small pebble beaches. It the southern portion of the area the cliffs are tens of meters high above the sea level and continue underwater down to 20-30 m depth. Two algae belonging to the genus *Cystoseira, Cystoseira amentacea* and *Cystoseira compressa*, were found in the area and demonstrate the good quality of seawaters (Agencija za zaštitu životne sredine, Crna Gora, 2014). A large number of young *Mytilus galloprovincialis* was observed in the *Cystoseira* formations. The latter could indicate a worsening in the condition of the biocenosis (Mačić *et al.*, 2010). In the infralittoral zone, the rocky surface largely continues in barrens with calcified algae. The presence of erected algae is very rare and the dominant benthonic species are the sea urchins *Paracentrotus lividus* and *Arbacia lixula*, and in some places the sponge *Chondrilla nucula* (Agencija za zaštitu životne sredine, Crna Gora, 2014). These large barren areas are probably the result of the destructive and illegal collection of date mussels and overfishing performed also with explosive devices (Agencija za zaštitu životne sredine, Crna Gora, 2014; RAC/SPA-UNEP/MAP, 2011). The lower infralittoral zones, colonized by the seagrass *Posidonia oceanica* and photophilic algae, are considerably stretched in the area of Greben Kalafat and Cape Kostovica, while the community of small shrubs algae is dominant in the area of the Cape Platamuni, Sv. Nicolau and Krekavice. The seagrass upper limit is at about 11 m, while according to the bibliography the lower limit is at about 24 m (Agencija za zaštitu životne sredine, Crna Gora, 2014).

The marine caves are usually considered important and endangered habitat and, among others, the following species were found (Bussotti *et al.*, 2006):

- the yellow cup (*Leptopsammia pruvoti*);
- a number of multi-colored sponges that lives in completely dark caves (e.g. *Chondrosia reniformis*);
- the cave shrimp (*Stenopus spinosus*);
- the Neptune's lace (*Reteporella grimaldii*);
- the leopard goby (*Thorogobius ephippiatus*);
- Tunicates and many others organisms.

The **fish species** observed within the study area are in general characteristic of the Mediterranean. Few species of commercial value - or important for diving or tourism - (e.g. *Epinephelus* sp., *Diplodus* sp., *Sparus aurata*) were observed, and only in low numbers and small sizes. This situation may be the result of overfishing and in particular of illegal fishing activities that have been documented in the area. The carbonates coastline from Cape Platamuni to Cape Žukovac is considered an important nursery area for fish, especially the groupers, due to the abundance of caves and holes (Mačić, 2014).

More than 14 **biocenoses and associations** (according to UNEP/MAP-RAC/SPA, 2015) were documented in the Platamuni area. These data demonstrate a large diversity and complexity of the study area. An in depth investigation would certainly result in a more extensive list of habitats presence (Agencija za zaštitu životne sredine, Crna Gora, 2014). Among others, the presence in the area of *P. oceanica* meadows and sea caves has to be highlighted, because some of them (e.g. the *P. oceanica* meadows and the Associations with *Cystoseira*) are priority habitats under the EU Habitats Directive (92/43/EEC).

A total of 21 species, protected at national or international level (e.g. species included in the Annexes of the Barcelona Convention or the Bern Convention), were found in the Platamuni area (Agencija za zaštitu životne sredine, Crna Gora, 2014). Some dolphins species and sea turtles were also observed several times in the study area (*personal comm.* from locals), but these incidental observations were never formally reported. The complete list of the species is provided in the bibliographic report. Moreover the presence of the exotic algae species *Womersleyella setacea* and *Caulerpa racemosa*,

[3] The Emerald network is a network of nature protection areas set up to conserve wild flora and fauna and their natural habitats in Europe and de-facto represents the extension of the Natura 2000 principles to non-EU Countries.

and the alien blue crab (*Callinectes sapidus*) were described in the area of Platamuni (Fant *et al.*, 2013; Mačić, 2008; Mačić & Kljajic, 2012). On the basis of data on natural, landscape and cultural values, the area from the Cape Platamuni was identified as EMERALD[3] site in Montenegro.

Concerning **land and sea uses, human impacts and potential threats**, the human population in the area has declined since the WWII and is almost stable since the last two decades. Due to the inaccessibility of most of the area, on land the terrain is mostly preserved from anthropogenic influences and no main infrastructure is present. Just a quarry, organized beaches (Trsteno and Ploce), and few illegal tourist facilities (Žukovac bay, inland bays Nerin, Marovic pile) are present in the vicinity. Concerning the cultural heritage, underwater the remains of a shipwreck from the Hellenistic period and some other petrified remains of amphorae (I century AD) were also reported. In addition, near Cape Platamuni at depth of 71 m there are the remains of the steamer Carlotta, made by George Brown & Company in 1914 in Scotland. On land there are numerous archaeological sites (burial mounds - tumuli), sacral buildings (fourteen churches and a monastery) and cultural landscape constituted by the agglomeration of traditional houses in small rural settlements.

Legal fishing and illegal fishing activities (i.e. fishing with explosives, collecting date mussels and other marine organisms, unauthorized fishing with underwater gun, use of various illicit means for fishing) are also reported in the area (Agencija za zaštitu životne sredine, Crna Gora, 2014; RAC/SPA-UNEP/MAP, 2011). The effects of overfishing are visible on fish and benthic communities. Detailed information on fished quantities and fishing gear used in the area are not available.

Last but not least, according to Pavasovic *et al.* 2009, the Platamuni area is one of the areas vulnerable to impacts of climate change on marine and coastal biological diversity in the Adriatic.

4.1.3 The Ratac area

No specific data on geophysical, geomorphological and oceanographic features are available from literature for the Ratac area. Based on the available bathymetric information (http://www.emodnet.eu/bathymetry) and satellite imagery, the Ratac peninsula seems to be characterized by a few meters high calcareous rocky coastline with many pebble beaches distributed mainly on the east side. The sea bottom seems to be by slowly lowering, passing from a rocky bottom to a quite flat soft bottom.

No specific data on **plankton communities** were available from literature.

Concerning **benthic communities**, only data on phytobentonic species were available (Kljajic *et al.* 2012). In summer the species with the highest coverage are Digenea simplex, followed by *Padina pavonica, Dyctiota dichotoma* and *Peyssonelia squamaria*. In autumn the species with the highest coverage are *Flabellia petiolata* and *Digenea simplex*. The vertical walls of large rock are completely covered by *Flabellia petiolata*, with many epiphyte species. The highest number of macroalgae was observed in the summer of 2011 (23 species) and the lowest in the winter (14 species). A study performed along transects, starting from the beach, highlighted the presence of a supralittoral zone characterized by the remains of organic matter, mainly the seagrass *Posidonia oceanica* (Kljajic *et al.* 2012). The seabed map released by Planetek Italia s.r.l., drawn up from satellite imagery acquired in the late spring of 2012 (and a small portion in spring 2010), reports in the area a narrow strip of rocky bottom along the coastline followed by alternate patches of densely vegetated bottom and sand/soft bottoms.

No specific data on **fish assemblages** were available from literature for the area. The general data on commercial fish species and fishing equipment used in Montenegro are probably applying also for this part of the coast. The main potential threats in the area are related to overfishing, also because of the illegal fishing and the vicinity of the Bar port area, which is the biggest port in the Montenegro (Mačić, 2015, *pers. comm.*).

Concerning **land and sea uses, human impacts and potential threats**, this area is located in the Bar municipality, that has a high summer touristic vocation. Onshore, the ruins of an old monastery represent an important cultural heritage site.

4.1.4 Gap Analysis

As a first result of the outcomes of the bibliographic review, we reported a gap analysis between the available information and the data needed for the identification of marine key habitats and their management within the two study areas.

The gaps were classified – with reference to the aims of the project – as:

- high: very significant – priority to be filled with specific survey/data collection;
- moderately significant – recommended to be filled with specific survey/data collection;
- low significant – a gap that may not be important in this context, and likely is not critical or doesn't require specific survey/data collection.

Where possible the actions of the present project have been aligned in order to fill in (almost in part) the gaps during the project's implementation.

Concerning **the geophysical, geomorphological, and oceanographic features**, different scientific papers are available for the Platamuni area (medium gap) while no specific data were found for Ratac (high gap). The present

project contributes to fill in the gaps by realizing a side scan sonar total coverage and the bathymetric maps of the two areas.

Regarding the **planktonic communities**, no specific data are available for both areas. Some scientific papers report information concerning these communities along the Montenegrin coastline (Lucic *et al.*, 2009; Drakulovic *et al.*, 2010; Marini *et al.*, 2010; Pestorić *et al.*, 2010; Vilicic *et al.*, 2002 ; Vukanic & Vukanic, 2003). The gap is however considered low as this is not fundamental for the definition of the key habitats).

Some data on the **benthonic species** are reported for the supralittoral, mediolittoral and infralittoral zones in the Platamuni area, while only data on some phytobenthic species are available for Ratac. The gap is considered medium for the first area and high for the latter. The present project has contributed to fill in these gaps by studying the benthic species and communities of both sites. The achieved outcomes are fundamental for the planning and the management of the areas, in particular concerning the marine caves in Platamuni.

Specific information is available for the **fish assemblages** in the Platamuni area (no gap) while no specific information were found for Ratac (high gap). The present study started to contribute to the knowledge on the fish assemblages, which is relevant for every management actions to be undertaken.

Concerning habitat and biodiversity, several studies are available for the Platamuni area (Agencija za zaštitu životne sredine Crna Gora, 2014; Fant et al., 2012; Mačić 2008; Mačić, 2014; Mačić and Kljajić 2012; Mačić et al., 2010; Mačić et al., 2013) and the gap is considered medium. Limited data are available for the Ratac area (high gap) and they are limited on the distribution of the seagrass *P. oceanica*. The present project contributed to fill in the remaining gaps by providing: information concerning the species and habitat present in both areas and the detailed maps (full coverage) of the two pilot sites.

Some general information are also available on **land and sea use, human impacts and potential threats**, for the two areas. The gap is considered low for Platamuni and medium for Ratac. The present study contributed to fill in part of the gap by providing some information about the possible human activities on the marine areas (e.g. the fishing) and to assess some of the anthropic pressures on the marine resources.

4.2 Qualitative analysis of the fishery activities

The present section reports the main outcomes derived from the bibliographic information and ad-hoc interview to fishermen carried out – as improvement of the initial SoW – to provide an assessment of the fish species. As per the bibliographic report, the study was reported at two levels: the whole Montenegrin area and the two study zones.

4.2.1 The Montenegrin Area

The Montenegrin fisheries activities can be classified into three main categories: trawling, seining and small-scale fisheries, which operated on demersal and small pelagic resources.

According to RAC/SPA-UNEP/MAP (2013), until early 2011, the Montenegrin fishing fleet included about 170 vessels, mostly for small-scale fisheries; 22 bottom trawlers, only two of which exceed 24 m in length overall (LOA); 8 purse-seiners; 3 multipurpose vessels (bottom trawling and purse seining), two of which were over 24 m LOA. In 2011 new fishing licences were issued for: 3 bottom trawlers longer than 24 m LOA, 16 bottom trawlers, 12 purse seiners, 58 vessels for small-scale fisheries and 10 vessels in subsistence fisheries (these last 10 licences were valid until 22nd August 2012, and were not renewable afterwards).

The most significant fishing activities are restricted to inshore waters. Operating expenses are high and potential days-at-sea are reduced due to the recurrent need to repair old vessels, engines and gears. Most of the trawling activity takes place in the area from Budva to Bar, on muddy and sandy seabed, at depths ranging between 40 and 200 m. There is no fishing activity outside the 12 NM limit. The trawling within the three nautical miles or at depth less than 50 m is prohibited.

There are no organized landing sites of fish auctions markets and fish is sold usually to market stalls and restaurants.

The main trawl catches consist of a wide diversity of species, but only some of them are considered target, either due to the volume of their landings or to their high economic value. The main target species are: the European hake (*Merluccius merluccius*), the red mullet (*Mullus barbatus*) and the deep-water pink shrimp (*Parapenaeus longirostris*). Also important, even if less abundant, are the European squid (*Loligo vulgaris*), the shortfin squid (*Illex coindetii*), the octopuses (*Octopus vulgaris* and *Eledone* spp.) and the Norway lobster (*Nephrops norvegicus*).

The small-scale coastal fishing is carried out by boats and different gears are used (e.g. gillnets, trammel nets, traps for fish and crustaceans, floating and bottom long-lines, harpoons, angles for squids). The one layer gillnets and the three layers trammel nets are probably the most commonly used fishing gear along the coastal area in the whole eastern Adriatic.

The European pilchard (*Sardina pilchardus*) and the European anchovy (*Engraulis encrasicolus*) are the most important commercial species in beach-seine fisheries (hauling by fishermen via manpower to the coast) in the Boka Kotorska Bay, and are caught in small quantities by the purse seiners in the open sea. The Bogue (*Boops boops*) is not an economically important species, but is frequently represented in small-scale fisheries (trammel nets).

The overall level of exploitation of the marine resources, in Montenegro, is unknown because the catches of the coastal fishing gears are not always recorded. A study carried out by RAC/SPA-UNEP/MAP (2013), interviewing the fishermen in different harbours, stated that is not possible to get accurate data on the catches. However the collected information allowed to determine the seasonal dynamics of the most relevant fish species, the types of gears used by season and, among other important information, allowed to assess the vision of the problems related to fishery (e.g. illegal fishing and use of explosive) from the point of view of the fishermen.

4.2.2 The Platamuni Area

The area of Platamuni is mainly exploited by fishermen coming from Budva and the small village of Bigova. It seems that there are no divisions of the territory between fishermen because the area is large enough and the operators are very experienced.

The available knowledge revealed that the length of the licensed boats is usually between 6,5 and 11 m LOA. The propulsion is provided by Diesel engines, which power ranges between 22 and 192 HP and most of the boats have on-board at least the GPS and the sonar.

The most productive seasons for fishing in this area are fall and spring. The average number of suitable fishing days/year ranges between 150-220.

The major problem indicated by the fishermen in the area is the illegal use of explosives (dynamite) for fishing, both from the coast and the boats. They reported that two periods (May-June and October-November) are the most frequent for fishing with dynamite and they believe that the prolonged use of explosives in the area has caused the reduced number of both species variety and of the number of the catches. A second problem they reported is the intense presence of illegal SCUBA divers with underwater lamps, whose activity is relevant during the night, during the summer. They also reported as problematic the illegal entries of trawlers at depths lower than 50 meters.

On average, the gill nets used in the Platamuni area have a length between 400 and 500 m and a height between 3 and 8 m. The mesh size is between 70 and 110 mm. The trammel nets are usually between 400 and 500 m, have a height between 3 and 5 m and a mesh size between 45 and 60 mm.

The longlines used in the Platamuni area have generally hooks Mustad 7-10, a length of about 600-1500 m, and branch line length of about 1-2,5 m and diameter of 0,3-4 mm.

Most of the fishermen use special fishing gears seasonally. During the **spring** the one layer gill net and the three layers trammel are the most used equipment. These nets are usually set in place at dawn and/or at dusk at a depth between 30 and 60 m. The most important species caught by the gill nets are: *Trachinotus ovatus, Zeus faber, Psetta maxima, Lophius budegassa, Dentex dentex, Seriola dumerilii* and *Pagrus pagrus*. The most important target species caught by the trammel nets in spring are: *Palinurus elephas, Mullus barbatus, L. budegassa, Scorpaena scrofa, Labrus merula, Diplodus sargus, Sparus aurata* and *Homarus gammarus*. According to the fishermen indications, this period is very favourable to catch big specimen and most of the catches are directly sold in the local restaurants. This period is also the best for catching the Spiny lobster (*P. elephas*) and the European lobster (*H. gammarus*).

During the *summer*, and in particular in July and August, according to the fishermen, the fishing activities are limited. A large number of recreational vessels passing in the area, in particular large yachts, generate a lot of noise and disturb the fishing. The most used gears in this period are the gill nets, the trammel nets and the longlines. The number of caught species is lower than in spring and usually the target fishing area is on seabottom at depths between 70 and 120 m. The most important species caught by gill nets, in summer, are: *Dentex gibbosus, Z. faber, L. budegassa, Merluccius merluccius* and *P. maxima*. The most important species caught by trammels in the same period are: *P. elephas, L. budegassa, S. scrofa* and *Trigla lucerna*. The most important caught by longlines are: *L. budegassa, M. merluccius, Raja miraletus, Mustelus mustelus, Squalus acanthias, Conger conger, T. lucerna* and *D. dentex*.

During the **fall** almost all fishermen use the higher gill nets (from 4,5 to 8 m). Fishing activities are mainly carried out at depths between 15 and 60 m and the main catches are pelagic species, among them in particular *Seriola dumerili, Scomber japonicus, Auxis rochei* and *Sarda sarda*. All of these species usually live in schools, and catches can be quite large. Fall, together with spring, is one of the most productive periods, in terms of yield (both quantity and number of fishes per day). The most important species caught by gill nets in the fall are: *S. dumerili, S. sarda, S. japonicus, Spondylosoma cantharus, Pagellus erythrinus, Diplodus sargus, S. aurata, P. pagrus* and *Sphyraena sphyraena*.

During the **winter** the number of suitable fishing days is usually reduced because of the weather conditions. The experience of the fishermen is translated in the fact that they are able to distinguish and use all the "good" days. In this period two types of trammel nets are almost exclusively used:

- the first type has a height of 1,5-1,8 m and a mesh of 28-32 mm. This gear is particularly designed for catching octopuses and cuttlefish (*Sepia officinalis*);
- the second type has a height of 1,5-3 m and a mesh size of 50-60 mm. This equipment is designed for catching species belonging to the families Soleidae and Pleuronectidae.

Depending on the target species, fishing activities are carried out between 30 and 80 m depth.

The most relevant species caught in this period are: *S. officinalis, Octopus vulgaris, Solea impar, P. maxima, T. lucerna, L. piscatorius, S. scrofa, S. aurata, S. cantharus* and *Diplodus vulgaris*.

4.2.3 The Ratac Area

The area of Ratac is mainly exploited by fishermen coming from the fishing port of Bar and the nearby small settlement of Sutomore. Most of the boats engaged in the fishery around Ratac area belong to small–scale fishing fleet and most of them are equipped with more than one fishing gear. No trawling activities are reported in the area.

The length of the licensed boats is between 5.9 and 10.40 m LOA. The propulsion is provided by Diesel engines with power ranging between 13.3 and 149 kW. Most of the boats have on-board GPS and sonar.

The most significant problem indicated by some fishermen for this area is the sporadic illegal use of explosives (dynamite) for fishing, both from the coastline and boats. It seems that the magnitude of the phenomenon is lower than in the Platamuni area. A second problem they reported is the presence of the illegal SCUBA divers with underwater lamps and spear guns, even though this activity is strictly forbidden according to the national Law on Marine Fishery and Aquaculture. Most of the illegal diving activities occur during the night. Some fishermen reported the passage of many boats, as well as the fishing or touristic activities, as a problem, because they increase the risk to damage some parts of the fishing gears, especially during the summer period.

Trammel nets, as well as gillnets, bottom long lines and traps are the most common type of fishing gears used in this area although some fishermen reported that small purse seiners carry out fishing activity close to the coast. The most productive seasons for fishing are spring and fall. The average number of suitable fishing days/year ranges between 100 and 180.

The single-layer gillnets used in the Ratac area are called "bukvara", "prostica" and "polandara". The first two types of nets can have a maximum height of 4 m, maximum length of 500 m and mesh size of 20-26 mm and no less than 28 mm, respectively. The height of "polandara" gillnet cannot exceed 22 m, length of 400 m and the mesh size cannot be smaller than 40 mm. The only three-layer trammel net used in the Ratac area is called "popunica", has usually a height between 3 and 4 m, its length between 100 and 200 m, and the mesh size cannot be smaller than 28 mm. This net is used throughout all the year, even though the law permits its use only from 15 August to 30 April. The bottom long lines used in the Ratac area have lengths of about 600 to maximum 1500 m. The traps used in this area are usually set up for catching various species of fish and large crustaceans, such as the Spiny lobster, the European lobster and the Slipper lobsters.

The mentioned fishing gears are used throughout the year depending on the weather conditions. During the **spring** the gillnets and trammel nets are the most used fishing gears. These nets are usually set before sunset and collected early in the morning, at depths between 15 and 30 m. According to interviews with fishermen and data from some logbooks, the most important species caught by gillnets are: *Sarda sarda, Trachinotus ovatus, Scomber scombrus, Seriola dumerilii, Merluccius merluccius, Pagrus pagrus, Pagellus erythrinus, Sparus aurata, Boops boops*. The most important target species caught by trammel nets in spring are: *Mullus barbatus, Lophius budegassa, Scorpaena scrofa, Sepia officinalis, Diplodus sargus, Sparus aurata*.

During the **summer**, according to the fishermen, the fishing activities are restricted due to the large number of recreational vessels passing in the area which generate a lot of noise and disturb the fishing. The most used gears in this period are gillnets, trammel nets and bottom long lines. The most important species caught by gill nets in summer are: *Sarda sarda, Scomber scombrus, Scomber japonicus, Merluccius merluccius, Mullus barbatus, Dicentrarchus labrax, Diplodus sargus, Scorpaena scrofa, Sarpa salpa, Solea impar, Lophius budegassa, Pagellus erythrinus, Scyliorhinus canicula, Octopus vulgaris, Palinurus elephas*. The most important catch by trammel nets is composed of *Mullus barbatus, Scorpaena scrofa, S. porcus, Sepia officinalis, Diplodus vulgaris, Lophius budegassa, Seriola dumerili* and *Raja miraletus*.

During the **fall** the fishing activities are mainly carried out at depths between 10 and 30 m and the main catches are composed by *Mullus barbatus, Merluccius merluccius, Mugil cephalus, Chelon labrosus, Dicentrarchus labrax, Eutrigla gurnardus, Raja asterias, Solea impar, Scomber scombrus, Sarpa salpa, Pagellus erythrinus, Sphyraena sphyraena, Seriola dumerili, Conger conger, Trachinus draco, Oblada melanura*.

During the **winter** the number of suitable fishing days is usually reduced due to bad weather conditions. The most relevant species caught by bottom long lines, in this period, are: *Sepia officinalis, Octopus vulgaris, Merluccius merluccius, Scomber scombrus, Sarda sarda, Auxis rochei, Solea impar, Sparus aurata, Mugil cephalus, Chelon labrosus, Lophius budegassa, Mullus barbatus, Boops boops* and *Diplodus vulgaris. Trigla lyra, Raja miraletus, R. asterias, Lophius budegassa, Dentex dentex, Scyliorhinus canicula*. The main catches collected by traps, in all season are *Homarus gammarus, Palinurus elephas, Scyllarus arctus, Scyllarides latus, Octopus vulgaris* and *Mugil cephalus*.

4.3 Bathymetric and geomorphological maps

The following sections summarise the main outcomes derived from the bathymetric information and the geomorphological data. The bathymetric maps derived from the single beam survey and the side scan sonar data are available for the two study areas in APPENDIX A, are loaded as layers in the GIS and are available as digital PDF in APPENDIX G. Bathymetric maps are available with two different line-spacing: 0,5 m and 2 m for Ratac and 1 m and 2 m for Platamuni.

4.3.1 Ratac

The Ratac study area is mainly covered by hard bottoms. From the surface to about 10 m depth, the slope of the seafloor is limited in almost all the area. The depth strip between about 10 m and 20-25 m depth has a steeper slope and is mainly characterized by the presence of discontinuous hard substrata and biological formations (i.e. seagrass meadows) that provide the seabottom with a high degree of rugosity. In particular there are some channels, fissures and between rock formations that make the seafloor very articulated and complex.

Below the 25 m depth, the rocky bottoms are mainly substituted by sandy bottoms, with a limited mud component. In these soft bottom areas there is anyway the presence of small and isolated rocky substrata.

The geomorphological map of the Ratac area is reported as image in Figure 22, as map in A3 format in APPENDIX A, as pdf map (scale 1: 2.000) in APPENDIX G and as GIS (and WebGIS) layer (scale 1:2.000).

The main geomorphological features found in the Ratac area are the following:

- Superficial pebbles;
- *Posidonia oceanica* meadow;
- Hard bottoms;
- Hard bottoms with *Posidonia* meadow;
- Sandy detritic bottoms;
- Isolated rocks.

Moreover, the presence of dead matte area was highlighted below the lower limit of the *Posidonia* meadow.

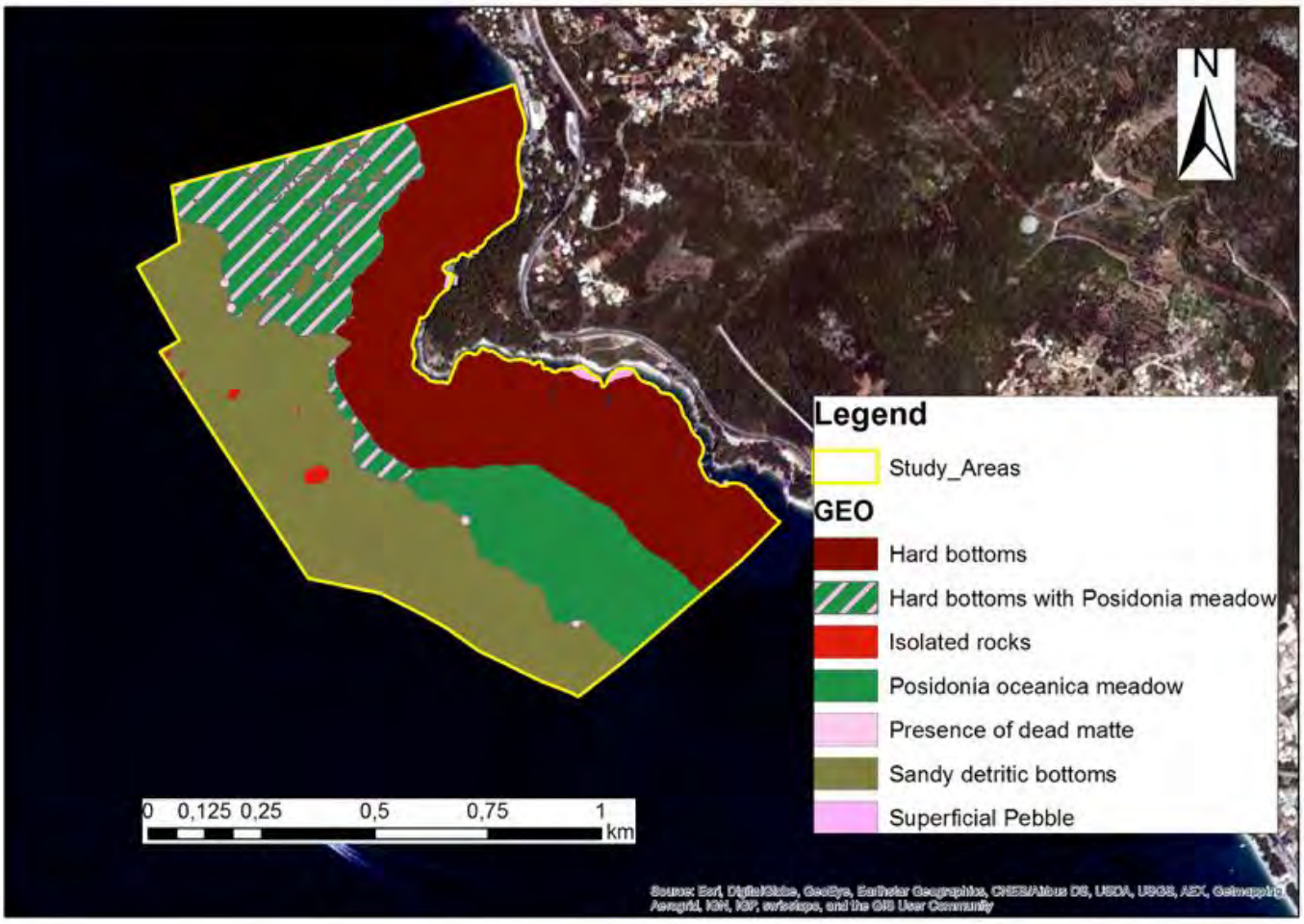


Figure 22: Image of the geomorphological map of the Ratac area

4.3.2 Platamuni

The Platamuni area can be subdivided in two main zones: Greben Kalafat and the rest of the area.

The Greben Kalafat area has a different conformation in comparison with the remaining part of the coast. It is located in the northern part of the study area. The sea bottom is less steep (in comparison with the remaining Platamuni area) and moving from the coast to the open sea it is characterized by shallow rocky bottoms that evolve firstly in a small depression (down to 20 m depth) colonized by soft bottoms and seagrass meadows and then the depth rises again, at a distance of about 800 m from the coastline, in a rocky area that has a limited steep on the north (coastal) side while it goes down to -40 m depth, rapidly, on the western side.

During the field activities the sign of structures that may be linked to a beach rock were recorded on the northern side at a depth of about 29 m.

The remaining Platamuni area is a strip of the coastline characterized by a vertical cliff that reaches quickly about 30-40 m depth. This formation is just interrupted by two small pebble beaches. There is the presence of several underwater caves mainly due to karst phenomena.

The majority of the area, from about 30-40 m depth till the bathymetry of 45 m, is covered by soft detritic bottoms that are pretty flat. No big rocky formations have been recorded in this detritic flat bottom.

In the southern part of the Cape Platamuni, a more flat rocky area has been recorded. In this area the rocky bottoms have a less evident slope and allow the colonization of algae and seagrasses.

The geomorphological map of the Platamuni area is reported as image in Figure 23, in a map in A3 format in APPENDIX A, in the GIS (and WebGIS) as layer (scale 1:5.000) and in digital PDF format in scale 1:5.000 in APPENDIX G.

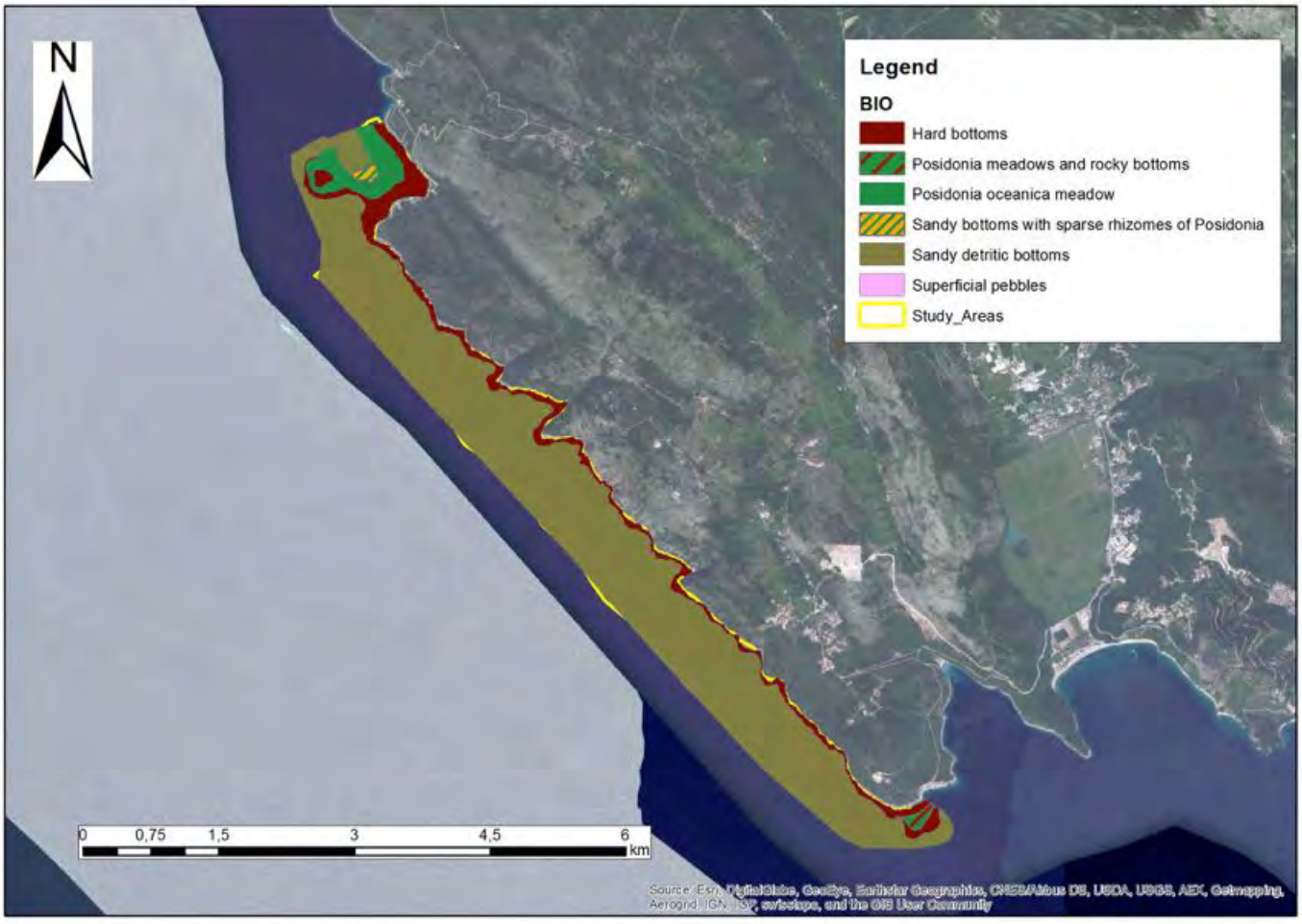


Figure 23: Image of the geomorphological map of the Platamuni area

The main geomorphological features found in the Platamuni area are the following:

- Superficial pebbles;
- *Posidonia oceanica* meadow;
- hard bottoms;
- Soft bottoms sparsely colonized by the seagrass *P. oceanica*;
- Sandy detritic bottoms;
- Objects (e.g. wrecks) and small isolated hard substrata on the bottom.

During the diving in the Greben Kalafat area the wrecks of two vessels have been found (the streamer Srebreno and the destroyer Husar), while in the soft bottoms two small shipwrecks were recorded by SSS survey, they are probably recent wrecks. According to the available SSS image one of them may be a sailboat.

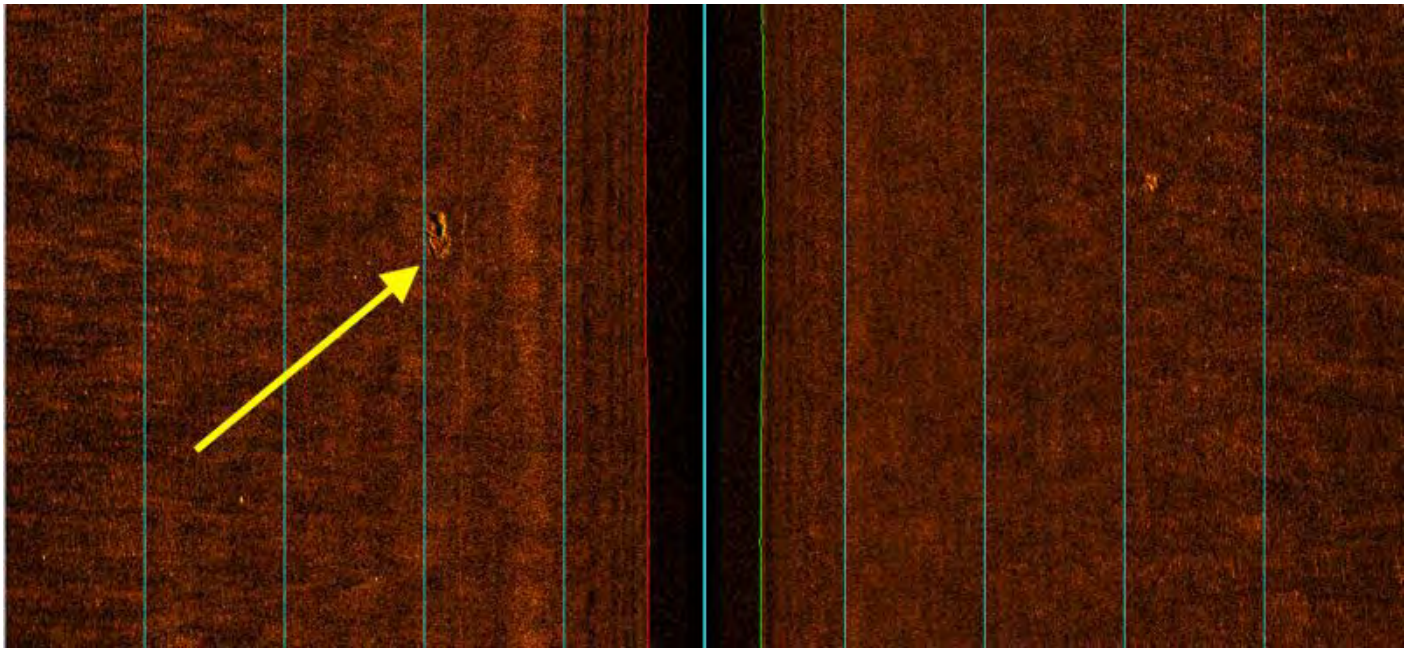


Figure 24: The presence of a shipwreck in the Platamuni area as highlighted during the side scan sonar survey

4.4 Biocenotic maps and benthic assemblages

This section summarizes the main outcomes derived from the biological interpretation of the geophysical data and from the collection of information conducted during the second field survey. The derived biocenotic maps - as well as the punctual information about benthic assemblages – are loaded as layers in the GIS and are also available in A3 format in the APPENDIX A, finally the maps in scale 1: 5.000 for Platamuni and 1:2.000 for Ratac are supplied in digital version in the APPENDIX G.

4.4.1 Ratac

4.4.1.1 Distribution of the benthic biocenoses

The Ratac study area is mainly made of hard bottoms. The most relevant biological communities in the shallow area (0-10 m depth) are the barrens, due to the overgrazing by the sea urchins (*Paracentrotus lividus* and *Arbacia lixula*) that allow only limited colonization of erected vegetal species while the red encrusting algae are very favoured.

In this superficial strip the photophilous biocenoses are very limited in extension and in coverage.

In the portion between 10 and 15 m depth, in almost all the area, the rocky bottoms are colonized by both the photophilous algae and the first patches of the *Posidonia oceanica* meadows. The *Posidonia* goes down to the lower limit of about 22 m (see section 4.6.1). The *Posidonia* meadow covers about 13 % of the study area.

The high rugosity of the rocky bottoms allows the colonization of the upper part of the seafloor by the rhizomes of the *Posidonia* while in the vertical part, also in the superficial zone, it is possible to find aggregations of organisms characteristic of the *Sciaphilous biocenoses* as well as organisms of the Coralligenous (as enclave). Most sciaphilous species (in particular the red algae belonging to the genus *Peyssonnelia*

and some Bryozoans are also colonizing the living shoots of *P. oceanica*. The hard substrata observed are of organogenic origin.

Apart from an area in which the *P. oceanica* meadow is easy distinguishable from the side scan sonar images, it is not possible to map the aggregation of the three biocenoses as separated, at the scale 1:2000. Then in most of the cases the benthic assemblage has to be considered as a mosaic of the three biocenoses. On the other side, most of the depressions and the channels between the rocks, covered by detritic sands, are easy to be separated and have been reported as detritic bottoms in the map. The *P. oceanica* meadow represents about 13 % of the area while the mosaic of the meadow with sciaphilous biocenoses and coralligenous covers about 37 % of the whole Ratac area.

Below the lower limit of the *P. oceanica* meadow, almost in some zones, there is an evident area with presence of dead matte, highlighting that the meadow is in regression. Below the matte the soft detritic bottoms are the dominant in terms of area occupied, and they represent about 33 % of the total study area.

In the detritic flat bottom below the dead mattes are present limited and isolated rocks colonized by organisms belonging to the sciaphilous and the coralligenous biocenoses. The latter represents less than 1 % of the mapped area.

The high rugosity of the rocky area is the most relevant factor influencing the benthic biocenoses and the ecology of all the living organisms in the study area.

The map of the benthic biocenoses for the area of Ratac is supplied in scale 1:2000 in the GIS project (and WebGIS) and in digital PDF in APPENDIX G. In addition it is available in APPENDIX A in A3 format. Finally an image of the map is reported in Figure 25.

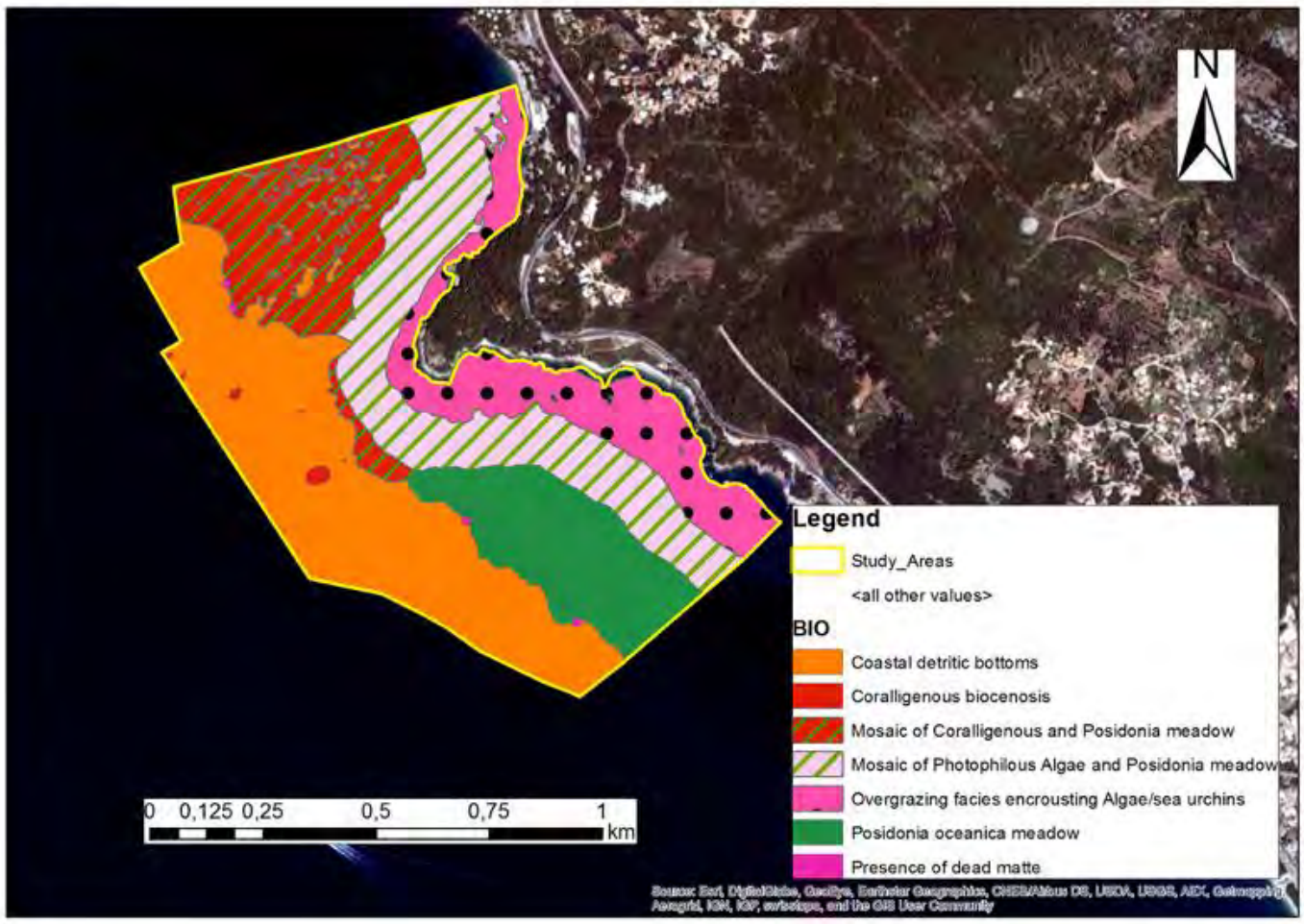


Figure 25: Image of the biocenotic map of the Ratac area, drawn up in scale 1:2.000 and available in the GIS

The complete list of the benthic biocenoses found in the Ratac area is reported in Table 8, along with the relevant estimates of coverage in terms of both surface area and percentage of the 2 dimension surface. It has to be noted that considering that the rugosity characterizes most of the rocky area, it is likely that the real extension of the sciaphilous biocenoses and the coralligenous in the area is underestimated due to the projection from 3D to 2D. It is then likely that they actually cover a greater 3 dimension surface area.

Two priority habitats under the Barcelona Convention are present in the area:

- the *Posidonia oceanica* meadow;
- the Coralligenous biocenosis.

Table 2: Biocenosis present in the Ratac area

Class	Habitats Description	Surface Area (m^2)	%
C	Coralligenous biocenosis	2838	0,30
DC	Biocenosis of coastal detritic bottoms	312636	33,16
HP	*Posidonia oceanica* meadow	126561	13,42
RCEO	Biocenosis of Encrusting Calcareous red algae and sea urchins	142817	15,14
AP_HP	Mosaic of photophilous algae and *Posidonia* meadow	209290	22,20
C_HP	Mosaic of Coralligenous and *Posidonia* meadow	147342	15,63

4.4.1.2 Hard bottom communities

The superficial hard bottoms in the Ratac area are mainly colonized by the sea urchin Arbacia lixula and red encrusting algae.

The rocky bottoms below the 10 m depth are colonized by a more complex association of organisms. In particular 26 algal species were found in the area. The majority of them are semisciaphilous or sciaphilous. Two vegetal species appearing in the Annex II of the SPA Protocol and Annex I of the Bern Convention were found: *Cystoseira corniculata* and the seagrass *P. oceanica*. Moreover the following species have to be mentioned: the algae belonging to the genus *Sargassum* (Listed in Annex II to the SPA Protocol) and the *Lithothamnion corallioides* (List under the EU Habitat Directive).

The presence of a total of 42 different species of benthic invertebrates was recorded in the Ratac area:

- 13 Porifera;
- 5 Cnidaria;
- 6 Polychaeta;
- 3 Bryozoa;
- 10 Mollusca;
- 1 Crustacea;
- 3 Echinodermata;
- 1 Tunicata.

Among them, the Porifera *Sarcotragus foetidus* and the mollusc *Tonna galea* are listed in the Annex II to the SPA Protocol: List of Endangered or Threatened Species and the sponge *Spongia officinalis* is listed as species whose exploitation should be regulated (Annex III to the SPA Protocol and the Bern Convention).

No alien species were found in the Ratac area during the field survey.

Table 3: Benthic species found in the two study areas Ratac and Platamuni

Date	01 10 2015	02 10 2015	03 10 2015	03 10 2015	04 10 2015	05 10 2015	05 10 2015
Dive site	RATAC Posidonia/ Organogenic substrata	RATAC Balisage	GREBEN KALAFAT West	GREBEN KALAFAT North	GREBEN KALAFAT Balisage	PLATAMUNI Sveti Nikolau	PLATAMUNI Cave
Depth (m)	**22**	**23**	**39,6**	**28,8**	**30,6**	**32,8**	**26,5**
Bacteria							
Rivularia sp.							X
Foraminifera							
Miniacina miniacea	X		X				X
Algae							
Acetabularia acetabulum			X			X	
Acrodiscus vidovichii			X				
Amphiroa sp.	X		X			X	
Anadyomene stellata			X	X			X
Cladophora sp.	X	X	X			X	
Callithamnion granulatum							X
Caulerpa cylindracea					X	X	
Codium bursa	X	X	X	X	X		
Codium coralloides				X			
Corallina elongata							X
Cystoseira sp. [1,2]	X		X	X			
Cystoseira corniculata [1,2]	X			X			
Cystoseira foeniculacea f. latiramosa [1,2]			X				
Cystoseira foeniculacea f. tenuiramosa [1,2]				X			
Dyctiota dichotoma	X		X	X		X	X
Dyctiota dichotoma var. intricata			X	X			
Dyctiotales	X		X			X	
Flabellia petiolata	X	X	X	X	X	X	
Gelidium cf. spinosum	X						
Gelidium bipectinatum			X				
Gloiocladia repens			X				
Halimeda tuna	X		X	X		X	X
Halopithys incurva				X			
Hydrolithon farinosum	X		X	X			

Date	01 10 2015	02 10 2015	03 10 2015	03 10 2015	04 10 2015	05 10 2015	05 10 2015
Dive site	RATAC Posidonia/ Organogenic substrata	RATAC Balisage	GREBEN KALAFAT West	GREBEN KALAFAT North	GREBEN KALAFAT Balisage	PLATAMUNI Sveti Nikolau	PLATAMUNI Cave
Depth (m)	**22**	**23**	**39,6**	**28,8**	**30,6**	**32,8**	**26,5**
Lithophyllum byssoides							X
Lithophyllum stictaeforme	X		X				X
Lithothamnion corallioides[4]		X					
Lobophora variegata							X
Meredithia microphylla			X				
Mesophyllum alternans	X		X				X
Mesophyllum expansum							X
Neogoniolithon mamillosum	X						
Osmundaria volubilis			X				X
Padina pavonica	X		X	X		X	X
Palmophyllum crassum			X			X	X
Peyssonnelia bornetii							X
Peyssonnelia rosamarina	X		X			X	X
Peyssonnelia rubra	X		X	X		X	X
Peyssonnnelia squamaria	X	X	X	X		X	X
Peyssonneliaceae n.i.	X		X	X		X	X
Pseudochlorodesmis furcellata			X			X	
Sargassum sp. [2]	X		X				
Sphaerococcus coronopifolius	X			X			
Triclocarpa fragilis	X						
Valonia macrophysa	X		X	X		X	
Wrangelia penicillata	X			X			
Zanardinia typus			X				
Corallinales n.i.	X	X	X	X		X	X
Fanerogamae							
Posidonia oceanica [1,2,4]	X	X	X	X	X		
Porifera							
Acanthella acuta							X
Acanthella cannabina	X						X
Agelas oroides	X		X	X		X	X
Antho inconstans			X				X
Axinella damicornis							X
Axinella vaceleti							X
Axinella verrucosa							X
Cacospongia mollior							X

Date	01 10 2015	02 10 2015	03 10 2015	03 10 2015	04 10 2015	05 10 2015	05 10 2015
Dive site	RATAC Posidonia/ Organogenic substrata	RATAC Balisage	GREBEN KALAFAT West	GREBEN KALAFAT North	GREBEN KALAFAT Balisage	PLATAMUNI Sveti Nikolau	PLATAMUNI Cave
Depth (m)	**22**	**23**	**39,6**	**28,8**	**30,6**	**32,8**	**26,5**
Caulerpa cylindracea							
Chondrosia reniformis							X
Clathrina clathrus							X
Cliona celata			X				
Cliona rhodensis			X			X	X
Cliona sp.	X		X			X	
Cliona schmdti			X				X
Cliona viridis			X			X	X
Crambe crambe			X				
Crella elegans							X
Crella (Grayella) pulvinar			X				X
Cymbaxinella damicornis	X		X			X	X
Cymbaxinella verrucosa	X		X			X	X
Dendroxea sp.							X
Dysidea avara							X
Dysidea fragilis							X
Dysidea sp.							X
Fasciospongia cavernosa							X
Haliclona fulva			X				X
Haliclona mucosa			X				X
Ircinia oros							X
Ircinia variabilis	X						X
Penares helleri							X
Petrosia ficiformis	X						X
Phorbas tenacior	X		X	X		X	X
Pleraplysilla spinifera							X
Poecilosclerida n.i.							X
Sarcotragus foetidus [2]	X	X	X				X
Sarcotragus spinosulus				X			X
Scalarispongia scalaris	X						X
Spirastrella cunctarix	X		X				X
Spongia officinalis [3,5]	X						X
Terpios fugax							X
Terpios gelatinosa							X
Porifera n.i.	X	X	X	X	X	X	X

Date	01 10 2015	02 10 2015	03 10 2015	03 10 2015	04 10 2015	05 10 2015	05 10 2015
Dive site	RATAC Posidonia/ Organogenic substrata	RATAC Balisage	GREBEN KALAFAT West	GREBEN KALAFAT North	GREBEN KALAFAT Balisage	PLATAMUNI Sveti Nikolau	PLATAMUNI Cave
Depth (m)	**22**	**23**	**39,6**	**28,8**	**30,6**	**32,8**	**26,5**
Poecilosclerida							X
Cnidaria							
Aiptasia mutabilis	X						
Balanophyllia europaea [6]			X			X	
Caryophyllia (Caryophyllia) inornata [6]			X			X	X
Caryophyllia (Caryophyllia) smithii [6]							X
Cerianthus membranaceus		X	X				
Cladocora caespitosa [6]							X
Clavularia sp.			X				X
Eudendrium sp.			X				X
Hoplangia durotrix [6]			X				X
Hydrozoa n.i.		X	X			X	X
Madracis pharensis [6]			X				X
Leptogorgia sarmentosa		X					
Leptopsammia pruvoti [6]			X				X
Nausithoe punctata							X
Paracyathus pulchellus [6]							X
Parazoanthus axinellae	X		X				X
Phyllangia americana mouchezii [6]							X
Polycyathus muellerae [6]							X
Sarcodyction catenatum							X
Scleractinia n.i.							X
Polychaeta							
Bispira mariae		X					
Bonellia viridis	X					X	
Filograna/Salmacina							X
Hermodice carunculata			X	X		X	X
Myxicola infundibulum		X					
Protula sp.	X		X	X		X	X
Serpula vermicularis	X		X				X
Serpulorbis arenarius							X
Terebellidae	X		X			X	X
Polychaeta n.i.							X

Date	01 10 2015	02 10 2015	03 10 2015	03 10 2015	04 10 2015	05 10 2015	05 10 2015
Dive site	RATAC Posidonia/ Organogenic substrata	RATAC Balisage	GREBEN KALAFAT West	GREBEN KALAFAT North	GREBEN KALAFAT Balisage	PLATAMUNI Sveti Nikolau	PLATAMUNI Cave
Depth (m)	**22**	**23**	**39,6**	**28,8**	**30,6**	**32,8**	**26,5**
Bryozoa							
Adeonella calveri							X
Beania magellanica			X				X
Bryozoa n.i.	X		X	X		X	X
Caberea borii						X	X
Disporella hispida							X
Felimare orsinii							X
Felimare picta							X
Frondipora verrucosa							X
Myriapora truncata	X		X				X
Patinella radiata						X	X
Porella cervicornis	X		X			X	
Reteporella sp.			X				X
Schizobrachiella sanguinea				X		X	X
Schizomavella mamillata			X			X	X
Smitthina cervicornis							X
Mollusca							
Bittium sp.	X	X	X	X			
Bolma rugosa				X			
Bosellia mimetica			X				
Calliostoma conulus							X
Calmella cavolinii							X
Cerithium sp.						X	
Cratena peregrina	X		X				
Diaphorodoris papillata							X
Facelinidae	X						
Felimare sp.	X			X			
Felimare orsinii							X
Felimare picta							X
Flabellina affinis			X				
Gastrochaena dubia	X		X	X		X	X
Lithophaga lithophaga [2,4,5]			X	X		X	X
Mytilus galloprovincialis							X
Neopycnodonte cochlear							X
Patellidae							X

Date	01 10 2015	02 10 2015	03 10 2015	03 10 2015	04 10 2015	05 10 2015	05 10 2015
Dive site	RATAC Posidonia/ Organogenic substrata	RATAC Balisage	GREBEN KALAFAT West	GREBEN KALAFAT North	GREBEN KALAFAT Balisage	PLATAMUNI Sveti Nikolau	PLATAMUNI Cave
Depth (m)	**22**	**23**	**39,6**	**28,8**	**30,6**	**32,8**	**26,5**
Patella caerulea							X
Patella rustica							X
Peltodoris atromaculata	X						X
Phyllidia flava	X						X
Pinna nobilis [2,4]				X			
Platydoris argo (eggs)	X						
Raphitoma sp.	X						
Serpulorbis arenarius			X			X	X
Tonna galea[2,5]		X	X		X		
Vermetus granulatus							X
Pycnogonida							
Pycnogonida n.i.							X
Crustacea							
Calcinus tubularis						X	
Dardanus calidus			X				X
Eriphia spinifrons							X
Pagurus anachoretus	X					X	X
Cirripedia						X	X
Echinodermata							
Hacelia attenuata						X	
Antedon mediterranea						X	X
Arbacia lixula	X		X	X		X	X
Centrostephanus longispinus [2,4,5]						X	
Echinaster sepositus	X		X			X	X
Hacelia attenuata			X				X
Holothuria (Panningothuria) forskali							X
Ophidiiaster ophidianus [2,5]			X	X		X	X
Ophitotrix fragilis							X
Marthasterias glacialis							X
Paracentrotus lividus [3]			X	X		X	
Spatangus purpureus						X	
Sphaerechinus granularis	X		X			X	

Date	01 10 2015	02 10 2015	03 10 2015	03 10 2015	04 10 2015	05 10 2015	05 10 2015
Dive site	RATAC Posidonia/ Organogenic substrata	RATAC Balisage	GREBEN KALAFAT West	GREBEN KALAFAT North	GREBEN KALAFAT Balisage	PLATAMUNI Sveti Nikolau	PLATAMUNI Cave
Depth (m)	**22**	**23**	**39,6**	**28,8**	**30,6**	**32,8**	**26,5**
Tunicata							
Clavelina dellavallei							X
Diplosoma spongiforme						X	X
Diplosoma sp.							X
Halocynthia papillosa	X		X			X	X
Microcosmus sp.						X	X
Pycnoclavella communis							X
Didemnidae						X	X
1 = Annex I Bern Convention; 2 = SPA Protocol Annex II; 3 = SPA Protocol Annex III; 4 = Habitat Directive; 5 = Bern Convention Annex II-III; 6 = CITES Annex II							

Table 4 - Benthic species protected - according to the different Conventions and Protocols – found in the two study areas

Date	01 10 2015	02 10 2015	03 10 2015	03 10 2015	04 10 2015	05 10 2015	05 10 2015
Dive site	RATAC Posidonia/ Organogenic substrata	RATAC Balisage	GREBEN KALAFAT West	GREBEN KALAFAT North	GREBEN KALAFAT Balisage	PLATAMUNI Sveti Nikolau	PLATAMUNI Cave
Depth (m)	**22**	**23**	**39,6**	**28,8**	**30,6**	**32,8**	**26,5**
Algae							
Cystoseira sp. [1,2]	X		X	X			
Cystoseira corniculata [1,2]	X			X			
Cystoseira foeniculacea f. latiramosa [1,2]			X				
Cystoseira foeniculacea f. tenuiramosa [1,2]				X			
Lithothamnion corallioides [4]		X					
Sargassum sp. [2]	X		X				
Fanerogamae							
Posidonia oceanica [1,2,4]	X	X	X	X	X		
Porifera							
Sarcotragus foetidus [2]	X	X	X				X
Spongia officinalis [3,5]	X						X
Cnidaria							
Balanophyllia europaea [6]			X			X	
Caryophyllia (Caryophyllia) inornata [6]			X			X	X
Caryophyllia (Caryophyllia) smithii [6]							X
Cladocora caespitosa [6]							X
Hoplangia durotrix [6]			X				X
Madracis pharensis [6]			X				X
Leptopsammia pruvoti [6]			X				X
Paracyathus pulchellus [6]							X
Phyllangia americana mouchezii [6]							X
Polycyathus muellerae [6]							X
Mollusca							
Lithophaga lithophaga [2,4,5]			X	X		X	X
Pinna nobilis [2,4]				X			
Tonna galea [2,5]		X	X		X		

Date	01 10 2015	02 10 2015	03 10 2015	03 10 2015	04 10 2015	05 10 2015	05 10 2015
Dive site	RATAC Posidonia/ Organogenic substrata	RATAC Balisage	GREBEN KALAFAT West	GREBEN KALAFAT North	GREBEN KALAFAT Balisage	PLATAMUNI Sveti Nikolau	PLATAMUNI Cave
Depth (m)	**22**	**23**	**39,6**	**28,8**	**30,6**	**32,8**	**26,5**
Echinodermata							
Centrostephanus longispinus [2,4,5]						X	
Ophidiiaster ophidianus [2,5]			X	X		X	X
Paracentrotus lividus [3]			X	X		X	
1 = Annex I Bern Convention; 2 = SPA Protocol Annex II; 3 = SPA Protocol Annex III; 4 = Habitat Directive; 5 = Bern Convention Annex II-III; 6 = CITES Annex II							

4.4.1.3 Soft bottoms communities

The soft seafloor in the Ratac area, at depth between 20 m and 30 m, is mainly composed by detritic sediments that refer to the biocenosis of the sandy detritic bottoms.

The soft sediment is mainly composed by shells of dead molluscs (in particular Bivalves, Gastropods and Scaphopods) and the presence of mud is very limited.

Several encrusting red Algae encounter a suitable substratum on the molluscs' tanatocenosis. In particular, among them, the algae *Lithothamnion corallioides* and *Phymatolithon calcareum*. The red algae *Peyssonnelia squamaria* and the green algae *Flabellia petiolata* have also been found in the soft bottoms of the area. The list of species found in the Ratac area are reported in the Table 5.

Table 5: Benthic species found in the Ratac area

Sampling site	VVG1	VVG2
Depth (m)	**22**	**23**
Algae		
Amphiroa sp.		
Lithothamnion cf. corallioides	X	X
Neogoniolithon sp.		X
cf. Phymatholithon calcareum	X	
Encrousting red algae (unid.)	X	X
Flabellia petiolata		X
Peyssonnelia cf. squamaria	X	X
Polychaeta		
Polychaeta unid.	X	
Mollusca		
Antalis cf. vulgaris	X	X
Nucula nucleus	X	X
Turritella sp. (damag.)		X

In general the found organisms are characteristics of the biocenosis of the coastal detritic bottoms. In Mediterranean this biocenosis is found between 25 and 65 m depth when the waters are clear (UNEP/MAP-RAC/SPA, 2015). This biocenosis is usually reported to host a rich and varied fauna. In the specific case of the Ratac area, the number and quantity of found species is very limited, thus possibly identifying a poor facies of this biocenosis. Concerning the tatantocenosis of the area, in both sampling sites the main organogenic species found in the sediments are the shells of the molluscs belonging to Bivalves (in particular *Nucula nucleus*) Gastropoda and Scaphopoda.

Neither species protected at national and international level nor invasive species were found in the soft bottoms of the Ratac area.

4.4.2 Platamuni

4.4.2.1 Distribution of the benthic biocenoses

The Platamuni area may be subdivided in two main zones, according to their characteristics.

The **Greben Kalafat** area, as already described for the geomorphological features, is characterized by a very complex environment. Along the shoreline the biocenosis with encrusting calcareous algae and sea urchins are dominant and then evolve gradually in an ecotone with photophilous algae (till about 10-15 m depth). Then the seagrass *Posidonia oceanica* colonizes the rocky and soft bottom in the area. The portion around the outer shallow waters (formerly called "Seka Albaneza") is colonized by *Posidonia oceanica*. Between the two meadows, probably due to the increase of the depth in a depression, the *Posidonia* colonize only few zones and just with sparse rhizomes.

The western part of the outer shallow water zone is characterized by the presence of barrens and the *P. oceanica* meadow in the flat bottoms while, when the slope increases, the sciaphilous biocenosis and then the Biocenosis of the Coralligenous colonize the rocks.

From the south of Greben Kalafat to the Cape Platamuni, the shoreline is mainly rocky and characterized by vertical cliffs that continue underwater till 25-35 m depth, on average, where the soft coastal detritic bottoms start.

Along the Platamuni area almost all the superficial rocky bottoms are colonized by the sea urchins, whose grazing activities don't allow the growth of the erected seaweeds. The barrens usually reach 10-15 m depth, depending on the slope of the sea bottoms and gradually evolve in an ecotone formed by a narrow strip of photophilous algae (not always present) and then in a more consistent dominance of sciaphilous algae that, below the 20-25 m evolve in a coralligenous biocenosis. Isolated patches of *P. oceanica* rhizomes are present along the shoreline. However, these formations have very limited extensions that are below the minimum dimension reproducible in a map at the scale 1:5.000.

Moreover, the biocenosis of semi-dark caves is present in some rocky bottoms of the Platamuni area.

Around the Cape Platamuni, on the rocky bottom with reduced slope the *Posidonia* meadow colonizes the bottoms, in a mosaic with organisms characteristic of both the Photophilous and the Sciaphilous biocenoses, at depth respectively between 10-15 and 20-25 m. The deepest rocky bottoms are colonized by organisms characteristic of the coralligenous.

The Table 6 summarises the biocenoses found in the area and their relative coverage both in terms of surface area (m^2) and percentage of the study area.

The majority of the area is covered by coastal detritic bottoms (about 83 %), while the hard bottoms colonized by encrusting red calcareous algae and sea urchins and photophilous biocenoses interest about the 6 % of the study area and those colonized by the Mosaic of sciaphilous biocenoses and coralligenous cover about the 3,28 % of the study area. The *Posidonia* meadows represent about 5 % of the area and are also in mosaics respectively with coastal detritic bottoms (0,41 % of the study area) and with Photophilous and Sciaphilous biocenoses (0,52 % of the study area).

It has to be highlighted that for the rocky bottom biocenoses the values are underestimated due to the projection of a complex 3D environment in the 2D of the map. In particular this projection tends to reduce the real extension of the substrata with high slope limiting them to a very narrow strip close to the shoreline.

The map of the benthic biocenoses for the area of Platamuni is supplied in scale 1:5.000 in the GIS project (and WebGIS) and in digital PDF in APPENDIX G. In addition it is available in APPENDIX A in A3 format. Finally an image of the map is reported in Figure 26.

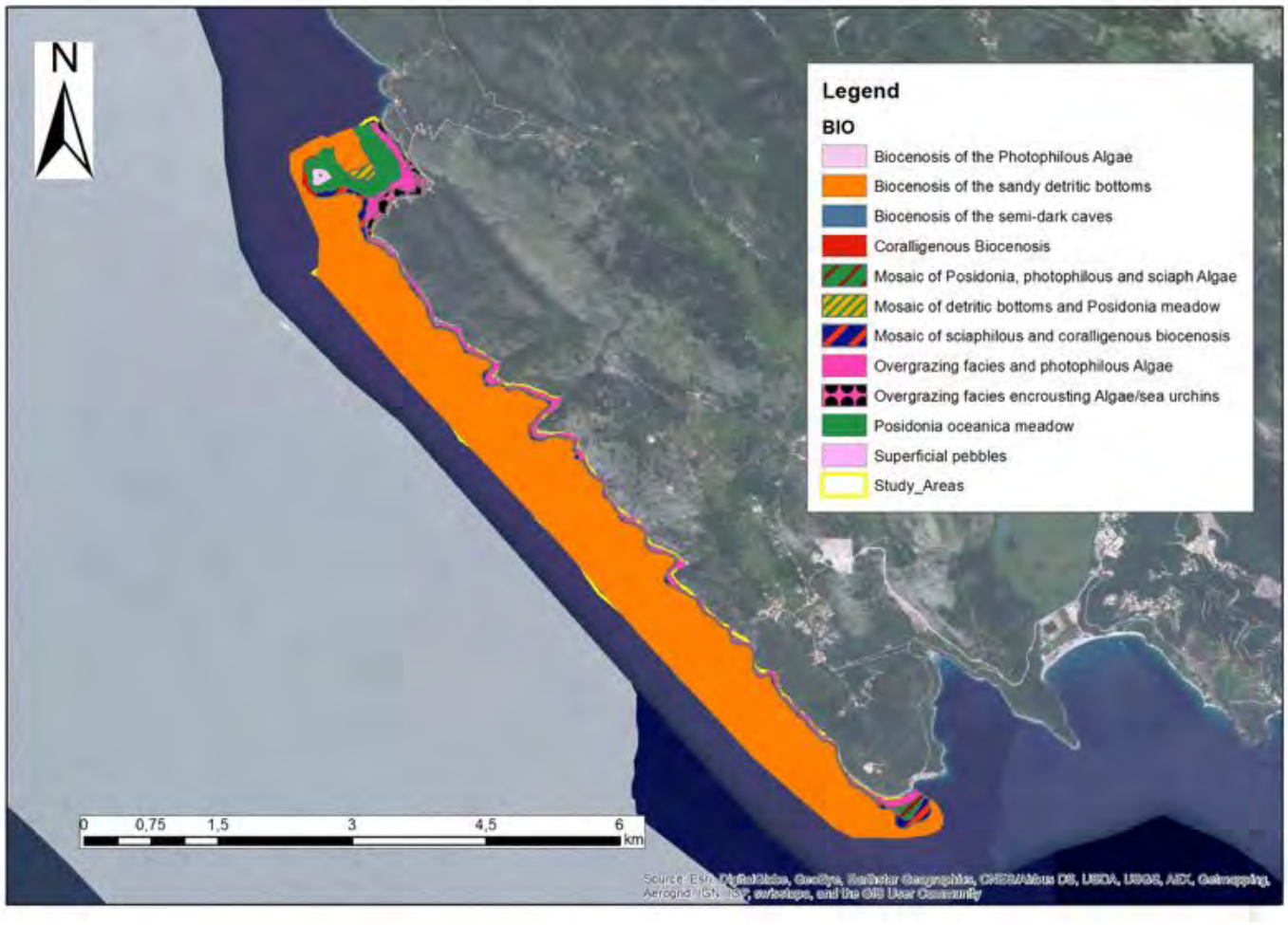


Figure 26: Image of the biocenotic map of the Platamuni area

Table 6: Biocenosis present in the area of Platamuni

Class	Habitats Description	Area m²	Area %
AP	Biocenosis of the photophilous Algae	29905	0,35
C	Coralligenous biocenosis	19326	0,23
DC	Biocenosis of coastal detritic bottoms	7006525	83,09
HP	*Posidonia oceanica* meadow	386260	4,58
RCEO	Biocenosis of Encrusting Calcareous red algae and sea urchins	102611	1,22
SDC	Biocenosis of the semi-dark caves	1906	0,02%
Peb	Pebble area	2314	0,03
BS_C	Mosaic of Sciaphilous biocenoses and coralligenous	276367	3,28
DC_HP	Mosaic of Coastal detritic bottoms and *Posidonia oceanica* meadows	34997	0,42
HP_AP_BS	Mosaic of *P. oceanica* meadow, Photophilous and Sciaphilous biocenoses	43904	0,52
RCEO_AP	Mosaic of RCEO and Photophilous biocenoses	528194	6,26

Three of the priority habitats under the Barcelona Convention have been found in the area:

- the Posidonia oceanica meadow;
- the Coralligenous biocenosis;
- the Biocenosis of the semi-dark caves.

4.4.2.2 Hard bottom communities

The present section reports a brief description of the main benthic species found in the area of Platamuni. For an in-depth description of the species found within the framework of the setting up of the network for the coralligenous monitoring, refer to section 4.6.3.

In total, 44 vegetal and 135 animal species were found in the Platamuni area:

- 43 Algae;
- 1 Seagrass;
- 43 Porifera;
- 18 Cnidaria;
- 8 Polychaeta;
- 15 Bryozoa;
- 25 Mollusca;
- 1 Pycnogonida;
- 5 Crustacea;
- 13 Echinodermata;
- 7 Tunicata.

Among them 12 species are protected according to the SPA Protocol (Annex II), 10 species are listd in the Annx II of the CITES and 2 are listed as species whose exploitation should be regulated (SPA Protocol Annex III):

- Seeweeds:
  - 4 *Cystoseira* according to Annex I of the Bern Convention and Annex II of the SPA Protocol;
  - the genus *Sargassum*, reported in Annex II of the SPA Protocol.
- Seagrasses:
  - The *Posidonia oceanica*, reported in Annex I of the Bern Convention and Annex II of the SPA Protocol;
- Porifera:
  - *Sarcotragus foetidus* (Annex II of the SPA);
  - *Spongia officinalis* (Annex III of the SPA and Bern Convention).
- Cnidaria:
  - 10 species are reported in *Annex II of the CITES convention: Balanophylla europaea, Caryophyllia (Caryophyllia) inornata, Caryophyllia (Caryophyllia) smithii, Cladocora caespitosa, Hoplangia durotrix, Madracis pharensis, Leptopsammia pruvoti, Paracyanthus pulchellus, Phyllangia americana mouchezii, Polycyathus muellerae*
- Mollusca:
  - the *Lithophaga lithophaga, Tonna galea and Pinna nobilis*, included in Annex II of the SPA Protocol and in the Habitat Directive. *L. lithophaga* is also covered by the Bern Convention.
- Echinodermata:
  - *Centrostephanus longispinus* (Annex II SPA Protocol, Habitat Directive and Bern Convention);
  - *Ophidiaster ophidianus* (Annex II SPA Protocol and Bern Convention)
  - *Paracentrotus lividus* (Annex III SPA Protocol).

The complete list of species is reported in Table 3.

The only alien species found in the area during the field survey was *Caulerpa cylindracea*, in correspondence to both the lower limit of the *Posidonia* meadow in the Greben Kalafat zone and the hard bottoms close to Sv. Nikolau.

4.4.2.3 Soft bottoms communities

The superficial soft bottoms of the Platamuni area are prevalently composed by detritic sediments that, as per the Ratac area, refer to the biocenosis of the sandy detritic bottoms.

The sediment is mainly composed by the shells of dead molluscs (in particular Bivalves and Scaphopods) with a very limited percentage of muds.

The detritic shells are a suitable substratum for the colonization of calcareous red algae, in particular belonging to the genera *Lithothamnion, Neogoniolithon* and *Phymatolithon*.

The tanantocenosis of the area is mainly determined by dead Bivalves (e.g. *Tellina pulchella* and *Nucula nucleus*) and Gastropoda (e.g. *Bittium* sp. and *Nassarius* sp.).

Neither species protected at national and international level nor invasive species were found in the soft bottoms of the Platamuni area.

As in the case of the Ratac sea bottoms, the qualitative species richness appears to be quite poor.

Table 7: Benthic species found in the Platamuni area

Sampling site	VVG3	VVG4	VVG5	VVG6	VVG7
Depth (m)	**34**	**26**	**25**	**22**	**35**
Algae					
Amphiroa sp.		X			
Lithothamnion cf. corallioides		X	X	X	
Neogoniolithon sp.		X	X	X	
cf. Phymatholithon calcareum		X			
Encrousting red algae (unid.)	X	X	X	X	X
Flabellia petiolata					X
Peyssonnelia cf. squamaria					X
Polychaeta					
Polychaeta unid.	X	X			X
Mollusca					
Antalis cf. vulgaris	X				
Nucula nucleus		X		X	

4.5 Fish assemblages

4.5.1 Ratac

In the Ratac area the fish census was performed in the station FVC1. The station is located between 12 m and 15 m depth and it is colonized by *Posidonia oceanica* on hard organogenous bottom with enclaves of coralligenous and sciaphylus biocenoses. The hard organogenous substrata are spaced-out by small sandy zones. The rugosity of the site is high.

4.5.1.1 Qualitative analysis

During the diving (for fish visual census in the FVC1 and other diving surveys in the same station and in other Ratac areas) conducted in the site of Ratac a total of 21 species belonging to 11 families were identified. The Sparidae is the most represented family with 5 species. None of the observed species is included in Annex II or III of the SPA Protocol or is considered rare or sensitive according to other international Protocols and Conventions. Four species (3 Sparidae and the red mullet *M. surmuletus*) can be considered of commercial value.

The list below provides a general qualitative overview of the fish population of the Ratac site in the fall season.

Figure 27: The FVC1 station in Ratac, characterized by a diversified and structurally complex organogenous hard bottom, with high rugosity and partially colonised by *Posidonia oceanica*

Table 8: General list of fish observed in the Ratac site

Species (scientific name)	Species (common name)	Family	Station FVC1- Fish Visual Census*	Station FVC1 - out of the visual census activity**	Other stations in the Ratac area***
Apogon imberbis	Cardinalfish	Apogonidae	X		
Boops boops	Bogue	Sparidae			X
Diplodus annularis	Annular seabream	Sparidae	X		
Diplodus vulgaris	Common Two-banded Seabream	Sparidae	X		
Coris julis	Mediterranean rainbow wrasse	Labridae	X		
Chromis chromis	Damsel fish	Pomacentridae	X		
Gobius cf. couchii	-	Gobidae			X
Mullus surmuletus	Red mullet	Mullidae	X		
Muraena helena	Mediterranean moray	Muraenidae			X
Pagrus pagrus	Common sea bream	Sparidae		X	
Parablennius rouxi	Longstriped blenny	Blennidae	X		
Scorpaena maderensis	Madeira rockfish	Scorpaenidae		X	
Scorpaena porcus	Black scorpionfish	Scorpaenidae		X	
Serranus cabrilla	Comber	Serranidae			X
Serranus scriba	Brown comber	Serranidae	X		
Spondyliosoma cantharus	Black seabream	Sparidae		X	
Symphodis mediterraneus	Axillary wrasse	Labridae	X		
Symphodus tinca	Peacock wrasse	Labridae	X		
Spicara maena	Blotched picarel	Centracanthidae	X		
Spicara smaris	Picarel	Centracanthidae		X	
Thalassoma pavo	Ornate wrasse	Labridae	X		

*Species recorded during the fish Visual Census in the station FVC1
**Additional species recorded by scuba divers out of the visual census activity in the same "visual census" station FVC1
***Additional species recorded by scuba divers in other stations in the Ratac area

The following sections analyse the data from the quantitative point of view, considering only the data obtained during the fish visual census in the station FVC1.

4.5.1.2 Quantitative analysis: fish visual census data

The most abundant fish species inhabiting the station FVC1 in the fall is the Pomacentridae *C. chromis* (average of 49 ind/125m^2), followed by *C. julis* (average of 15 ind/125m^2) and *S. maena* (average of 13 ind/125m^2).

The only observed species with juvenile specimens is the *C. chromis*. Other species are represented mainly by sub-adults and adults. As a whole, the 10 % of the counted specimens are juveniles, the 43 % are sub-adults and the 47 % are adults. Neither exceptionally large specimens nor adult of species of commercial interest were observed.

Table 9: Abundance by species observed in the Ratac site (FVC1 station) during the fish visual census

Family	Species	Abundance (%)	Juveniles/125 m²	Sub-adult /125 m²	Adult /125 m²
Apogonidae	*Apogon imberbis*	1,4	0,0	0,0	100,0
Sparidae	*Diplodus annularis*	1,8	0,0	80,0	20,0
Sparidae	*Diplodus vulgaris*	1,4	0,0	100,0	0,0
Labridae	*Coris julis*	16,3	0,0	37,8	62,2
Pomacentridae	*Chromis chromis*	53,6	18,9	35,1	45,9
Mullidae	*Mullus surmuletus*	0,4	0,0	100,0	0,0
Blennidae	*Parablennius rouxi*	0,4	0,0	0,0	100,0
Serranidae	*Serranus scriba*	4,7	0,0	38,5	61,5
Labridae	*Symphodis mediterraneus*	0,7	0,0	100,0	0,0
Labridae	*Symphodus tinca*	1,4	0,0	25,0	75,0
Centracanthidae	*Spicara maena*	14,5	0,0	70,0	30,0
Labridae	*Thalassoma pavo*	2,9	0,0	50,0	50,0
	Subtotal referred to 125 m²		**9**	**39**	**43**

The observed average diversity is 8,7 species/125 m².

Considering the number of individuals, on average 92 ind./125m² were found in the FVC1 of Ratac.

In order to obtain comparable data with other fish abundance values observed in the Mediterranean, the density can be related to 250 m2; the average value observed in the site is 184 ind./250 m2 (total abundance, including all species), and 58 ind/250 m² (reduced abundances, excluding the shoaling species (e.g. *C. chromis* and *S. maena*).

The Tables with the fish visual census raw data are available in APPENDIX F.

4.5.2 Platamuni

Two sites were selected in the Platamuni area for the fish visual census.

FVC2 is situated on the western side of Greben Kalafat, between 21 m and 18 m depth, in correspondence with the lower limit of the *Posidonia* meadow. The rugosity of the site is high and the hard bottoms rapidly decrease till the base of the Greben Kalafat area, at about 35 m depth.

FVC3 is located on hard bottoms in front of the cliff with the Sveti Nikolau church. The censuses were carried out between 25 m and 13 m depth. The hard bottoms are colonized by algae partially covered by mucilaginous aggregates. The rugosity of the site is medium.

Figure 28: The visual census station FVC2 in Platamuni, close to the lower *Posidonia* meadow limit, characterized by high rugosity

Figure 29: the visual census station FVC3 in Platamuni colonized by algae assemblages partially covered by mucilaginous aggregates

4.5.2.1 Qualitative analysis

Totally, in the **Platamuni area**, 34 fish species were identified during the biological survey including the 2 visual census survey stations and observations carried out in the other stations investigated by divers. Eight species belong to the Sparidae family, 7 to Labridae family and 4 to Serranidae family (Table 10).

In the **FVC2 (Greben Kalafat western side)**, considering both fish visual census transects and other diving surveys carried out in the same site, a total of 23 species belonging to 12 families were identified. Sparidae (6 species), followed by Labridae (5 species) and Serranidae (3 species) are the most represented families. No species included in Annex II or III of the SPA Protocol or considered rare were observed in the site. However, the presence of the golden grouper (Epinephelus costae) must be underlined. Six species (3 Sparidae, the grouper, the red mullet and the Atlantic bonito) can be considered of relevant commercial value; 5 species of the list are considered of medium commercial value (2 Sparidae, the peacock wrasse, the black scorpion fish and the moray).

In the **FVC3 site (Sveti Nikolau cliff)**, 16 species belonging to 8 families were observed. Labridae and Sparidae are the dominant families with 5 species each. No species included in Annex II or III of the SPA Protocol were observed. Therefore it must be underlined the presence of the species *Labrus mixtus*, which is generally rarely observed during diving, probably not because it is a rare species, but because adults live below 50 m depth, only juveniles being sporadically found in shallower waters. This species is mainly associated with coralligenous habitats.

Among the 16 observed species, 4 Sparidae (*D. vulgaris, D. sargus; O. melanura; S. cantharus*) can be considered of relevant commercial value; 2 species (*M. helena and S. sarpa*) are generally considered of medium commercial value.

Table 10: General list of fish observed in the Platamuni area

Species (scientific name)	Species (common name)	Family	FV2 Fish visual census	FV2 Out of the fish visual census activity	FV3 Fish visual census	FV3 Out of the visual census activity	Other stations in the Platamuni area
Anthias anthias	Swallowtail seaperch	Serranidae		x			
Apogon imberbis	Cardinalfish	Apogonidae	x		X		
Boops boops	Bogue	Sparidae	x				
Coris julis	Mediterranean rainbow wrasse	Labridae	x		x		
Chromis chromis	Damsel fish	Pomacentridae	x		x		
Diplodus annularis	Annular seabream	Sparidae	x				
Diplodus sargus	White seabream	Sparidae			x		
Diplodus vulgaris	Comm. Two-banded Seabream	Sparidae		x	x		
Epinephelus costae	Golden grouper	Serranidae	x				
Gobius auratus	Golden goby	Gobidae		x			
Labrus mixtus	Cuckoo Wrasse	Labridae				x	
Microlipophrys nigriceps	Black-headed Blenny	Blenniidae					x
Mullus surmuletus	Red mullet	Mullidae	x	x			
Muraena helena	Mediterranean moray	Muraenidae		x		x	
Oblada melanura	Saddled Seabream	Sparidae		x	x		
Pagrus pagrus	Common sea bream	Sparidae		x			

Species (scientific name)	Species (common name)	Family	FV2 Fish visual census	FV2 Out of the fish visual census activity	FV3 Fish visual census	FV3 Out of the visual census activity	Other stations in the Platamuni area
Parablennius rouxi	Longstriped blenny	Blennidae				x	
Parablennius zvonimiri	Zvonimir's Blenny	Blennidae		x			
Sarda sarda	Atlantic bonito	Scombridae		x			
Sarpa sarpa	Salema	Sparidae			x		
Scorpaena maderensis	Madeira Rockfish	Scorpaenidae		x			
Scorpaena notata	Red Scorpionfish	Scorpaenidae			x		
Scorpaena porcus	Black scorpionfish	Scorpaenidae		x			
Serranus cabrilla	Comber	Serranidae	x		x		
Serranus scriba	Brown comber	Serranidae	x				
Spicara smaris	Picarel	Centracanthidaee	x				
Spondyliosoma canthrus	Black seabream	Sparidae	x	x	x		
Symphodus mediterraneus	Axillary wrasse	Labridae			x		
Symphodus melanocercus	Black tailed Wrasse	Labridae	x		x		
Symphodus rostratus	Pointed-snout wrasse	Labridae		x	x		
Symphodus tinca	Peacock wrasse	Labridae		x			
Thalassoma pavo	Ornate wrasse	Labridae	x				
Tripterygion delaisi	Black-faced Blenny	Black-faced Blenny		x			
Tripterygion minor	Pigmy black faced blenny	Pigmy black faced blenny					x

*FV2 – Greben Kalafat western side - Recorded during the fish visual census
**FV2 – Greben Kalafat western side - Additional species recorded by scuba divers out of the visual census activity in the same "visual census" station
***FV3 - Sveti Nikolau - Recorded during the fish visual census
****FV3 - Sveti Nikolau - Additional species recorded by scuba divers out of the visual census activity in the same "visual census" station
*****Additional species recorded by scuba divers in other stations in the Platamuni area

4.5.2.2 Quantitative analysis: fish visual census data

The C. chromis (55 ind/125m^2), followed by *S. smaris, C. julis* and *B. boops* are the most abundant species observed in the fall in the **FVC2 (Greben Kalafat)** site.

Juveniles, belonging to 6 species, are a limited portion of the population (less than the 9 %). Sub-adults represent the 43 % of the population and adults the 48 %. Some observed species of commercial interest were adult.

The observed average species diversity is 9,6 species/125 m^2. The value is similar to the one observed in the Ratac area and available in the literature for the coastal area in Montenegro.

Considering the number of individuals, on average 125 ind./125m^2 were found. The densities referred to 250 m^2 are the following: 250 ind./250 m^2 (total abundance, including all species), and 58 ind/250 m^2 (reduced abundances, excluding the shoaling species e.g. *C. chromis, B. boops* and *S. smaris*).

Table 11: Abundance by species observed in the FVC2 site (Greben Kalafat) Platamuni

Family	Species	Abundance (%)	Juveniles/125 m²	Sub-adult /125 m²	Adult /125 m²
Apogonidae	*Apogon imberbis*	2	0,0	0,8	1,8
Sparidae	*Boops boops*	9,6	0,0	12,0	0,0
Sparidae	*Diplodus annularis*	1,8	0,5	0,0	1,8
Labridae	*Coris julis*	10,4	4,5	4,8	3,8
Pomacentridae	*Chromis chromis*	44	5,0	10,0	40,0
Serranidae	*Epinephelus costae*	1,2	0,0	1,5	0,0
Mullidae	*Mullus surmuletus*	0,4	0,0	0,0	0,5
Serranidae	*Serranus cabrilla*	0,8	0,3	0,0	0,8
Serranidae	*Serranus scriba*	1,6	0,0	0,0	2,0
Centracanthidae	*Spicara smaris*	23,2	0,0	29,0	0,0
Sparidae	*Spondyliosoma canthrus*	1,4	0,3	1,3	0,3
Labridae	*Symphodis melanocercus*	2,4	0,3	1,5	1,3
Labridae	*Thalassoma pavo*	1,2	0,0	0,0	1,5
	Subtotal referred to 125 m2		**11**	**61**	**54**

In the **FVC3 (Sveti Nikolau cliff)** *C. chromis* followed by C. julis and *O. melanura* are the dominant species in terms of number of individuals. Juveniles are very limited, and represent only 5 % of the total population. The 73 % of counted specimens are represented by adults and the 23 % by subadults. The only juveniles observed belong to the species *C. julis*.

The average species diversity is 8 species/125 m².

The density in terms of number of individuals corresponds to on average 56 ind./125m². The densities referred to 250 m² are the following: 112 ind./250 m² (total abundance, including all species), and 58 ind./250 m² (reduced abundances, excluding the shoaling species: *C. chromis*).

Table 12: Abundance by species observed in the Platamuni FVC3 site

Family	Species	Abundance (%)	Juveniles/125 m²	Sub-adult /125 m²	Adult /125 m²
Apogonidae	*Apogon imberbis*	6,1	0,0	0,0	3,7
Sparidae	*Diplodus vulgaris*	8,9	0,0	3,7	1,7
Sparidae	*Diplodus sargus*	2,8	0,0	1,3	0,3
Labridae	*Coris julis*	12,8	2,7	1,3	3,7
Pomacentridae	*Chromis chromis*	44,4	0,0	0,0	26,7
Sparidae	*Oblada melanura*	11,1	0,0	6,7	0,0
Sparidae	*Sarpa salpa*	4,4	0,0	0,0	2,7
Scorpaenidae	*Scorphaena notata*	0,6	0,0	0,0	0,3
Serranidae	*Serranus cabrilla*	2,8	0,0	0,0	1,7
Sparidae	*Spondyliosoma canthrus*	4,4	0,0	2,7	0,0
Labridae	*Symphodis mediterraneus*	0,6	0,0	0,0	0,3
Labridae	*Symphodus melanocercus*	0,6	0,0	0,0	0,3
Labridae	*Symphodus rostratus*	0,6	0,0	0,0	0,3
	Subtotal referred to 125 m²		**3**	**13**	**41**

4.5.3 General comments about the fish assemblages

The fish assemblages of the Ratac area were not described in the literature. The data collected within this project constitute a first reference (qualitative and quantitative) and provide some indirect indication on the fishing pressure in the Ratac coastal zone.

The fish population of the Platamuni area was described (qualitative level) by the Agencija za zaštitu životne sredine, Crna Gora (2014) and Mačić (2014). The list included 49 species[4]. The visual census carried out within the present project reports 3 new species (*Tripterygion minor, Parablennius rouxi* and *Microlipophrys nigriceps*) the previous qualitative list and provides site-specific quantitative data.

Totally, including all the scuba diving observations, 21 species were observed in the Ratac area and 34 in the Platamuni area. The main key data on fish assemblages in the 3 analysed sites (one in Ratac and 2 in Platamuni) are summarized in the table below.

[4] The complete list based on bibliographic data is available in the Phase I final report document No 1450840457/10413

Table 13: Fish assemblages, key data

Parameter	FVC1 - Ratac	FVC2 – Platamuni	Area %
Rugosity of the site	Hight	Hight	Medium
Bathymetry (m)	12-15	18-21	13-25
Total number of species	16	23	16
Average species diversity/125 m^2	8,7	9,6	8
Total number of families	9	12	8
Total number of species listed in the annexes II and III of the SPA Protocol	0	0	0
Total number of species of relevant commercial value	4	6	4
Dominant species	*C. chromis, C. julis, S. maena*	*C. chromis, S. smaris, C. julis*	*C. chromis, C. julis, O. melanura*
Percentage of juveniles %	10	9	5
Total abundance - density (ind./250m^2)	184	250	112
Reduced abundance - density (ind./250m^2)	58	58	58

Greben Kalafat (Platamuni) is the more interesting site in terms of fish assemblages. Probably thanks to the high rugosity of the station and the limited accessibility compared to other stations, it presents the highest species diversity and density.

In general, the average species diversity/125 m^2 observed in Ratac and Platamuni is coherent with the value observed in other sites in Montenegro (e.g. RAC/SPA-UNEP/MAP, 2012 reported inside the Kotorska Bay 4,7 species/250 m^2 at Iza Perasta and 9.3 species/250m^2 at Dražin Vrt) and slightly lower than species richness recorded in other coastal sites in the Mediterranean sea (e.g. García-Charton *et al.*, 2004 observed 15 species/250 m^2 on average and Treviño-Otón & García-Charton - unpublished data 2009 - detected 15.1 species/250 m^2. In Cap Negro (Tunisia), within the MedKeyHabitat Project, 9 species/125 m^2 and 13 species/125 m^2 respectively on a *Posidonia* meadow on rocks and an Infralittoral rocky area were observed.

In Ratac, the fish density and diversity seems low if compared with the high rugosity and structural complexity of the site. Only a limited number of commercial species was observed. The few commercial species counted belong mainly to the category of sub-adult. None specimen exceptionally large was observed. Local experts and literature confirmed that the site is impacted by relevant fishing pressure, including professional fishery and sport fishing (e.g. spear fishing, including illegal spear fishing carried out by night).

Excluding for the shoaling species, the three sites present similar data in terms of fish density. These quantitative data compared to the data of other sites described in the scientific literature seem slightly lower and confirm a reduced coastal fish abundance along the Montenegro coast. Guidetti (2010) along the Apulian coast observed a total abundance of 818 ind./250 m^2 and reduced abundance of 95 ind./250 m^2.

4.6 Setting of the monitoring networks of key habitats

4.6.1 *Posidonia oceanica* meadow: Ratac

In the Ratac area, the average density of the *Posidonia oceanica* meadow, close to the marked lower limit is 33,1 ± 10.8 shoots/m^2. The density of the meadow corresponds to sparse rhizomes.

The limit is regressive, with the presence of dead matte at greater depth.

The photographic reconstruction of the limit and the horizontal shoots taken from the photo-stakes and the markers and the photo-stakes are reported in the GIS (and WebGIS).

The parameters of the meadows measured onsite and the directions of the marker-to-marker segments as well as the segments connecting the photo-stakes and the markers are reported in Table 14.

Figure 30: The lower limit of the meadow in Ratac

Table 14: The main parameters of the meadow collected underwater

Locality: Ratac											
Date: 02 October 2015											
Balise	1	2	3	4	5	6	7	8	9	10	11
Depth (m)	21,1	21,3	21,2	21,1	21,4	21,3	21,4	21,3	21,1	21,3	21,4
Peg	180	185	175	175	185	140	190	185	200	150	170
B-B °	260	270	280	280	230	240	260	280	260	240	
Coverage %	40	40	30	25	40	30	40	30	30	30	20
Density (No/50x50)	10	13	11	8	9	8	9	6	5	10	4
Plagiotr. rhiz. % (No)	4	3	nd	nd	3	nd	4	1	1	4	4
Substrate	SV	SV	SV	SV	SV	SV	SV	SV	SV	SV	SV
Limit typology	R	R	R	R	R	R	R	R	R	R	R

Considering the typology of the limit behind each marker, and according to Pergent (2007), the status of the meadow can be considered between normal and mediocre, as the coverage ranges from poor (S-) to sparse (Sp). Taking into account the density of the rhizomes - normalized with the depth of the limit according to Pergent *et al.* (2005) - the index of the meadows lowers to poor.

The phenological study of the shoots collected in the Ratac meadow (Raw data are available in APPENDIX F) highlights that the average number of leaves (adult and intermediary) per fascicle is 4,4. This measure is relatively low in comparison with other areas of the Mediterranean.

On average there are 2,8 adult leaves per shoot while the average number of intermediate leaves is 1,6. This situation is compatible with the autumn season. Usually the intermediate leaves are the majority in winter and spring, the period of renewed foliar growth. The condition is also confirmed by the finding of 9 juvenile leaves in the 10 examined shoots (average of 0,9 leaves/shoot).

The longest adult leave collected measures 85,5 cm and has a width of about 0,85 cm. The foliar index (calculated on the adult and intermediate leaves) ranges between 123 and 241 cm^2/shoot, with an average value of 176,9 cm^2/shoot. The Leaf Area Index (LAI) is 0,57 m^2/m^2: It is very low due to the very low density of the rhizomes in correspondence of the lower limit.

The Weighting A (29,5 %) is on the average range of the Mediterranean values. The majority of the broken leaves have

the apex damaged by mechanical forces. The result indicates a relatively low hydrodynamic activity and the limited action of the herbivores in correspondence of the lower limit.

The rate of epiphytism is very limited, probably due to the depth and the low water transparency.

Table 15: Main phonological parameters measured in the *Posidonia oceanica* meadows in Ratac

Parameter	Adult	Intermediate
Average N leaves/fascicle	2,8 ± 0,8	1,6 ± 0,5
Average length (cm)	52,7 ± 17,35	37,5 ± 24,58
Average width (cm)	0,87 ± 0,07	0,9 ± 0,07
Weighting A (%)	35,7 ± 28,54	18,8 ± 24,15
Foliar Index (cm^2/cm^2)	118,3 ± 44,89	54,1 ± 27,84

In general, compared with the values recorded in other areas of the Mediterranean, the phenological values are relatively low and seem to indicate a certain degree of sufferance of the meadow in correspondence of the lower limit (Pergent and Pergent-Martini, 1988; Lopez y Royo *et al.*, 2009: Pergent-Martini and Pergent, 2010).

The lepidochronological analysis confirmed a limited vertical growth of the rhizomes (medium rate of 0,3 ± 0,1 mm/year). Compared with other areas of the Mediterranean, these values are on the average for zones characterized by a limited sedimentation rate and with no competition for the light (low density and coverage). The average annual foliar production is 6,30 ± 0,79.

The main lepidochronological parameters for the examined years are reported in Table 16.

The granulometric analyses (reported in APPENDIX F) highlighted that around the limit, the sands are the dominant sediment component. The coarser sandy fraction 2-0,2 mm accounts for 49,5 % of the superficial sediment and the fine sand (0,2-0,05 mm) accounts for 44,2 %. The remaining fractions (the finest: clay and silt) account in total for less than 6 % of the sediments.

According to the indexes suggested by Pergent (2007) and the considerations reported in the bibliography, the status of the meadow is ranging between poor and moderate. The low density of the rhizome indicates that probably this state is related to the reduced transparency of the water, as no mechanical damages were recorded.

Table 16: The main lepidochronological parameters of the meadows in Ratac

	N	N scale	Rhizome Growth
2015	10	6,2 ± 0,42	0,32 ± 0,08
2014	10	5,9 ± 0,99	0,33 ± 0,08
2013	10	6,3 ± 0,48	0,29 ± 0,09
2012	10	6,1 ± 0,88	0,32 ± 0,11
2011	8	6,375 ± 0,52	0,31 ± 0,11
2010	4	6,75 ± 1,5	0,35 ± 0,06

4.6.2 *Posidonia oceanica* meadows: Platamuni

In the Platamuni area, the average density of the *Posidonia oceanica* meadow, in proximity of the lower limit, is 18,2 ± 6,6 shoots/m^2. According to the density, the meadow has to be considered as sparse rhizomes. The limit is regressive, on soft bottoms.

Figure 31: A particular of the lower limit of the meadow in Platamuni

The photographic reconstruction of the limit and the horizontal shoots taken from the photo-stakes and the markers and the photo-stakes are reported in the GIS (and WebGIS).

The parameters of the meadows measured onsite and the directions of the marker-to-marker segments as well as the segments connecting the photo-stakes and the markers are reported in Table 17.

Table 17: The main parameters of the meadow collected underwater

Locality: Platamuni											
Date: 04 October 2015											
Balise	1	2 (5)	3 (4)	4 (2)	5 (7)	6	7 (3)	8	9	10	11
Depth (m)	30,4	30,9	30,8	30,9	30,8	30,5	30,5	30,8	30,8	30,8	30,8
Peg	210	225	225	235	245	245	270	245	250	255	235
B-B °	45	50	65	45	50	60	45	45	50	60	
Coverage %	5	6	2	5	3	6	6	6	3	4	4
Density (No/50x50)	3	7	2	3	2	6	6	7	2	2	2
Plagiotr. rhiz. % (No)	0	1	0	0	0	1	1	0	0	0	0
Scalea	0	0	0	0	0	1	1	0	0	0	0
Substrate	m	m	m	m	m	m	m	m	m	m	m
Limit typology	R	R	R	R	R	R	R	R	R	R	R

Considering the typology of the limit behind each marker and according to Pergent (2007), the status of the meadow can be considered bad. Taking into account the density of the rhizomes - normalized with the depth of the limit according to Pergent et al. (1995) - the meadow is disturbed.

The phenological study of the shoots collected in the Platamuni meadow (Raw data are available in APPENDIX F) highlights that the average number of leaves (adult and intermediary) per fascicle is 4,5. This measure is relatively low in comparison with other areas of the Mediterranean.

On average, there are 2,7 adult leaves per shoot while the average number of intermediate leaves is 1,8. This situation is compatible with the autumn season. Usually the intermediate leaves are the majority in winter and spring when the foliar leaves are in a renewal phase. The renewal condition is also confirmed by the finding of 7 juvenile leaves in the 10 examined shoots (average of 0,7 leaves/shoot).

The longest adult leave collected measures 39,7 cm and has a width of about 0,85 cm. The foliar index (calculated on the adult and intermediate leaves) ranges between 75,9 and 143,5 cm^2/shoot, with an average value of 115,1 cm^2/shoot. The Leaf Area Index (LAI) is 0,21 m^2/m^2: it is very low due probably to the very low density of the rhizomes in correspondence of the lower limit.

The Weighting A (15,6 %) is on the average range of the Mediterranean values. The majority of the broken leaves have the apex damaged by mechanical forces. The result indicates a relatively low hydrodynamic activity and the limited action of the herbivores in correspondence of the lower limit.

The rate of epiphytism is very limited, probably due to the depth and the limited average water transparency.

Table 18: Main phenological parameters measured in the *Posidonia oceanica* meadows in Platamuni

Parameter	Adult	Intermediate
Average N leaves/fascicle	5,2 ± 0,63	1,64 ± 0,67
Average length (cm)	39,26 ± 6,28	20,46 ± 9,96
Average width(cm)	0,86 ± 0,06	0,84 ± 0,05
Weighting A (%)	19,7 ± 19,46	5 ± 15,81
Foliar index (cm^2/cm^2)	84,9 ± 25,09	30,97 ± 9,52

In general, compared with the values recorded in other areas of the Mediterranean the phenological values are relatively low and seem to indicate a certain degree of sufferance of the meadow in correspondence of the lower limit (Pergent and Pergent-Martini, 1988; Lopez y Royo *et al.*, 2009: Pergent-Martini and Pergent, 2010).

The lepidochronological analysis confirmed a limited vertical growth of the rhizomes (medium rate of 0,4 ± 0,1 mm/year).

Compared with other areas of the Mediterranean, these values are on the average for areas characterized by a limited sedimentation rate and with no competition for the light (low density and coverage). The average annual foliar production is 6,50 ± 0,77.

The main lepidochronological parameters per examined year are reported in Table 19.

Table 19: The main lepidochronological parameters of the meadows in Platamuni

	N	N scale	Rhizome Growth
2015	10	6,44 ± 0,73	0,34 ± 0,15
2014	10	6,4 ± 1,07	0,45 ± 0,17
2013	10	6,7 ± 0,67	0,37 ± 0,15
2012	10	6,67 ± 0,71	0,42 ± 0,19
2011	8	7 ± 0,63	0,28 ± 0,08

The granulometric analyses (reported in APPENDIX F) highlighted that around the limit, the sands are the dominant sediment component. The coarser sandy fraction 2-0,2 mm accounts for the 65,5 % of the superficial sediment and the fine sand (0,2-0,05 mm) accounts for the 29,3 %. The clay (fraction < 0,002 mm) accounts for 5,45 % of the sediments and the silts (fraction between 0,02 and 0,002 mm) only for 2,08 %.

According to the indexes suggested by Pergent (2007) and the considerations reported in the bibliography, the status of the meadow is moderate to poor. The low density of the rhizome indicates that probably this state is related to the reduced transparency of the water, as no mechanical damages were observed in the area.

4.6.3 Coralligenous

According to the document RAC/SPA-UNEP/MAP (2014) elaborated within the MedMAP Project by Garrabou *et al.*, the monitoring network aims to produce a series of useful information to elaborate and implement efficient measures for the habitat conservation, in particular:

(i) estimate the conservation status of the habitat;

(ii) assess the temporal trend of habitat changes;

(iii) plan appropriate measures to minimize the impacts;

(iv) assess the effect of selected measures and, if necessary,

(v) re-fix strategy according to the monitoring results.

The periodicity of monitoring should be every 3 years as a minimum. The environmental conditions (namely the temperature) should be recovered at least once per year.

The layout and subtitles of the following sections was organized according to the methodology proposed in RAC/SPA-UNEP/MAP (2014).

4.6.3.1 Site features and area delimitation

Based on the preliminary results of the biological survey and the geophysical data and in agreement with the local expert (Dr. Vesna Mačić), the coralligenous monitoring station was set-up in the Platamuni area, in a semi-obscure marine cave colonized by a rich bioconstruction assemblage dominated by madrepores, sponges and erect bryozoans.

The cave is a cavern of marine abrasion with karst structures in its entrance. Large boulder falls are present on the bottom of the cave; the cavity advances in an area with almost total darkness. A succession of populations is present from the outdoor, with the presence of semi-sciaphilous algae to the innermost with the development of typical populations of semi-obscure caves.

The temperature recorded in the site from the surface to 25 m depth was 24°C along all the profile.

The coordinates, the position in a map and some images of the caves are shown in the figure below.

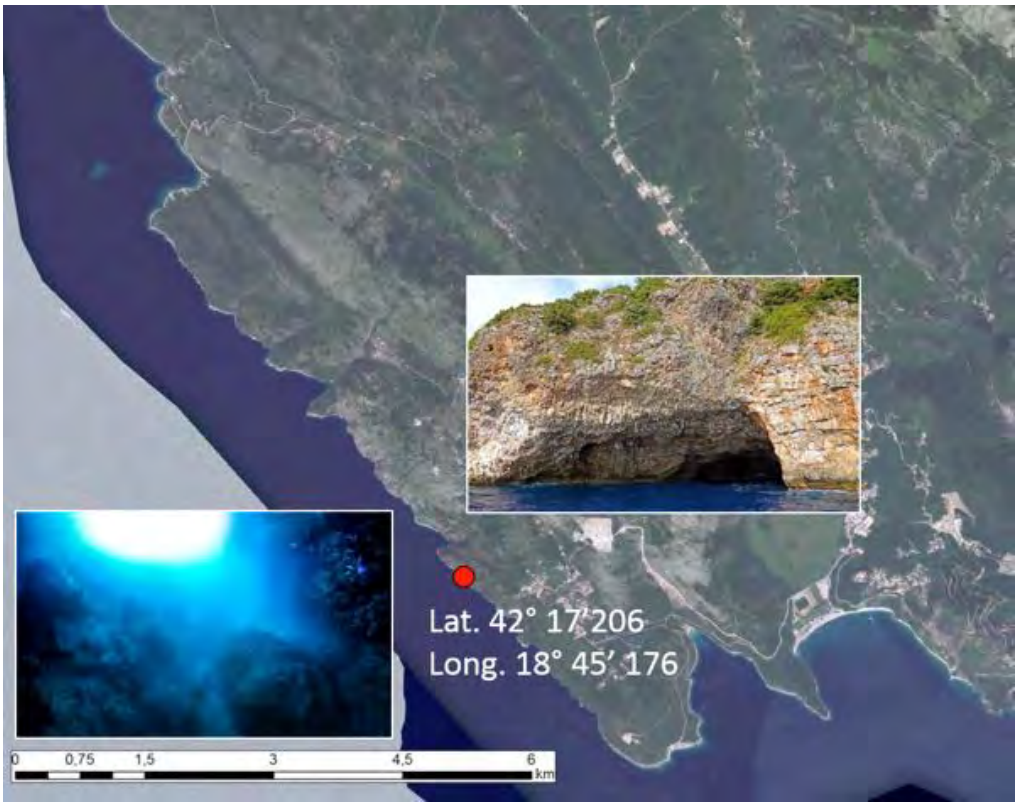


Figure 32: Position of the coralligenous monitoring network set up in Platamuni and panoramic images of the area

Photosampling was combined with visual census. The methodology applied is described in section 3.2.5.1 and is coherent with the approach proposed by Garrabou et al. (RAC/SPA-UNEP/MAP, 2014). The monitoring area was placed on the northern face of the semi-obscure cave. The depth of the monitoring area ranges between 18 m and 22 m. Two permanent marks were positioned in correspondence with the two apexes of the monitoring area measuring 20 m x 5 m. The slope of the monitoring area is about 90°-110°.

4.6.3.2 Habitat species/categories composition and abundance

The total list of species observed by analysing the photoquadrats is reported below. The target species include both the species listed in Annex II and III of the SPA Protocol and those indicated in other international Conventions including the CITES. The target species in the site belong to Porifera and Cnidaria and are indicated with asterisks in the list below. The percentage of covering of target group of species and its frequency of occurrence are also reported. An accurately covering calculation of the species for each photoquadrat was calculated applying the methods described in the section 3.2.5.2.

In APPENDIX C are reported the image of each quadrat and the list of observed species in each photoquadrat; the digital version is included in the DVD provided in APPENDIX G. All the species identified by the analysis of the 30 photoquadrats are listed in the table below with the frequency of occurrence for each species. The target species include both the species listed in the Annex II and III of the SPA Protocol and those indicated in other international Conventions including the CITES.

The percentage of covering of target groups of species is reported in Table 20.

Table 20: Frequency of occurrence of each species classified on the photoquadrats. The value for each unit is reported

Taxa /Species	Frequency		
	Unit 1 (%)	Unit 2 (%)	Unit 3 (%)
Foraminifera			
Miniacina miniacea	0	20	0
Algae			
Palmophyllum crassum	70	20	0
Peyssonneliaceae n.i.	70	20	10
Corallinales n.i.	70	20	20
Porifera			
Acanthella acuta	0	50	0
Agelas oroides	100	100	100
Axinella damicornis	90	40	70
Axinella verrucosa	0	0	10
Chondrosia reniformis	0	0	20
Cliona schmdti	50	10	0
Cliona viridis	10	0	30
Crella elegans	0	20	0
Crella (Grayella) pulvinar	10	30	0
Dendroxea sp.	0	0	30
Dysidea sp.	10	10	10
Fasciospongia cavernosa	30	10	0
Haliclona fulva	30	70	20
Haliclona mucosa	100	90	70
Ircinia oros	30	20	30
Ircinia variabilis	50	40	50
Penares helleri	30	30	0

Taxa /Species	Frequency		
	Unit 1 (%)	Unit 2 (%)	Unit 3 (%)
Petrosia ficiformis	90	100	60
Phorbas fictitius	30	10	0
Phorbas tenacior	10	30	0
Pleraplysilla spinifera	60	100	10
*Sarcotragus foetidus**	50	50	30
Scalarispongia scalaris	50	50	20
Spirastrella cunctarix	80	90	0
*Spongia officinalis***	30	30	20
Terpios fugax	20	0	10
Terpios gelatinosa	0	0	40
Cnidaria			
Caryophyllia (Caryophyllia) inornata +	50	80	0
Hoplangia durotrix +	20	70	0
Madracis pharensis +	90	100	70
Leptopsammia pruvoti +	100	100	90
Polycyathus muellerae +	20	20	0
Poliychaeta			
Hermodice carunculata	10	70	20
Serpula vermicularis	0	10	0
Serpulorbis arenarius	20	30	0
Serpulidae n.i.	60	100	40
Protula sp.	0	0	10
Bryozoa			
Adeonella calveri	100	100	100
Briozoi n.i.	0	0	0
Frondipora verrucosa	0	0	60
Myriapora truncata	90	30	100
Reteporella sp.	100	100	100
Smitthina cervicornis	10	0	0
Mollusca			
Gastrochaena dubia	30	20	20
Peltodoris atromaculata	20	10	0
Felimare orsinii	0	0	10
Felimare picta	0	0	10
Echinodermata			
Hacelia attenuata	0	0	10
Tunicata			
Halocynthia papillosa	10	10	20
*Annex II SPA Protocol; ** Annex III SPA Protocol; + Appendix II CITES			

Table 21: Photosampling - Quantitative cover data (calculated %) for target species (protected sponges and protected corals)

Unit 1	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	1.10	Average
Porifera %	11	0	0	0	0	1,57	0	0,5	0,5	0	1,36
Cnidaria %	6,27	4,7	0,5	0,5	0,5	3,14	3,14	3,92	1,57	1,18	2,54
Unit 2	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.10	Average
Porifera %	0	3,92	0,5	0,5	0	0,5	0	0,5	0	0,5	0,64
Cnidaria %	4,7	6,27	9,8	14,51	10,59	9,41	16,08	14,51	8,23	11,76	10,59
Unit 3	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	3.10	Average
Porifera %	1,18	0	0	0	0	3,14	0	0	0	0,5	0,48
Cnidaria %	1,57	1,18	6,27	0,5	0,5	2,74	1,57	1,17	2,74	1,17	1,94

4.6.3.3 Degree of complexity of the coralligenous habitat

Basal layer and intermediate layers

The cover of the basal and intermediate layers was assessed by analysing each photoquadrat and assigning a value of cover to it. Not always, the sum of the covers amounts to 100, in few cases it is a little lower, because in some photoquadrats a portion of the area was covered by large sponges belonging to the erect layer.

According to the estimation, the **basal layer** covers 52 %, 16 % and the 54 % of the analysed surface areas (Units 1, 2 and 3) corresponding to an average value of **41 % of the surface area**.

The **intermediate layer** occupies 48 %, 83 % and 46 % of the surface corresponding to an average value (medium value between the three units) of the **59 % of the surface area**.

Table 22: Photosampling – Basal layer and intermediate layers estimation of the cover percentage

Unit 1	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	1.10	Average
Basal Layer %	20	25	70	80	80	60	50	30	50	50	52 %
Interm. Layer %	80	75	30	20	18	38	50	70	50	45	48 %
Unit 2	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.10	Average
Basal Layer %	30	30	10	15	15	15	15	15	3	10	16 %
Interm. Layer %	70	70	90	85	85	85	85	83	85	90	83 %
Unit 3	3.1	3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	3.10	Average
Basal Layer %	20	60	65	65	50	50	50	50	70	60	54 %
Interm. Layer %	80	40	35	35	50	50	50	50	30	40	46 %

Erect layers

The estimation of the erect layer recorded during the 3 visual transects are reported in the table below.

Table 22: Photosampling – Basal layer and intermediate layers estimation of the cover percentage

Transect	Depth	Category									
		M1	M2	M3	M4	M5	M6	M7	M8	M9	M10
TR1	18 m	1	1	1	1	1	1	2	2	2	2
TR2	21 m	**3**	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**1**	1
TR3	22 m	1	1	2	1	1	1	1	2	1	1

Category 1 = No colonies per m^2; Category 2 = 1-2 colonies per m^2; Category 3: > 2 < 10 colonies per m^2; Category 4 = 11-20 colonies per m^2; Category 5 = >20 colonies per m^2

According to the methodology (RAC/SPA-UNEP/MAP, 2014) the following score are assigned for each category: Category 1 = 0; Category 2 = 1; Category 3 = 2; Category 4 = 3; Category =4.

The total scores per transect are the sum of the 10 scores defined for each square meter. According to the following scale the cover was defined for each transect: Total score value 0 – Cover = Null; total score value 1-10 – Cover = Low; Total score value 11-20 – Cover = Medium; Total score value >20 – Cover = High.

The result is that in the Platamuni semi-dark cave the erect layers obtained the following total scores: TR1 = 4, TR2 = 4; TR3 = 2.

All the obtained total scores correspond to "**Low cover of erect layers**".

4.6.3.4 Bioconcretion – Cover of algal and animal builders

According to the photoquadrat analysis the cover of bioconcretion (encrusting calcareous algae and macroinvertebrates contributing to the build-up of coralligenous outcrops) is about 100 % in each photoquadrat.

4.6.3.5 Bioerosion – Abundance of bioeroders

The bioeroders **can't be quantified on the base of the photoquardats** considering the features of the site.

4.6.3.6 Bioerosion – Effect of bioeroders

The effects of bioeroders **can't be quantified on the base of the photoquardats** considering the features of the site. The only evident effects of bioeroders were observed in 2 photoquadrats of the Unit 3 (2.3 and 4.3). The effect of bioeroders interests respectively 3,5 % and less than 1 % of the photoquadrats surface

4.6.3.7 Bioerosion – Abundance of macro-bioeroders

No macrobioeroders (e.g. sea urchins) was counted during the visual census along the three transects.

4.6.3.8 Fishing pressure

No fishing gears were observed in the site.

4.6.3.9 Sedimentation

The sampling area identified in the semi-obscure cave is an almost vertical cliff. Sedimentation was **absent** in the photosampling unit 1 and unit 2. Little sediment is observable in the photoquadrats of unit 3 (Figure 33). The sedimentation is **very limited**; it seems to be related to the normal activity of suspensivorous organisms and doesn't seem to constitute a threat for the coralligenous community.

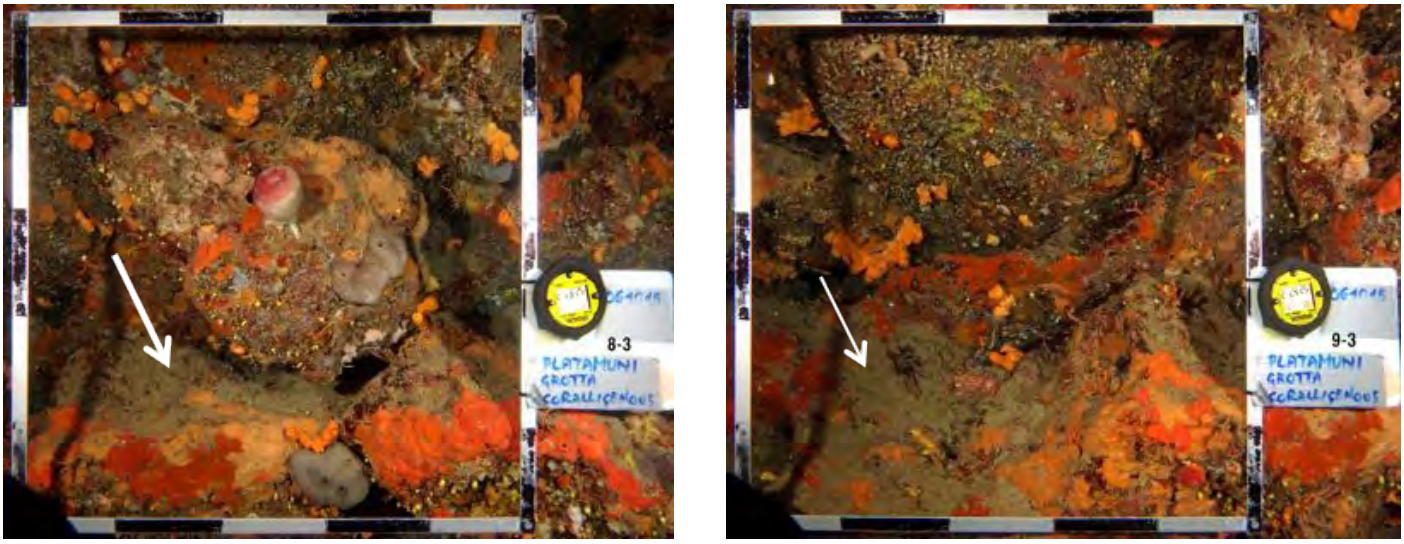


Figure 33: Sedimentation on the photoquadrats of the unit 3 indicated by the white arrow

4.6.3.10 Conservation status of gorgonian population

Gorgonian colonies were **not present** in the area, therefore the status of the gorgonian population was not assessed.

4.6.3.11 Mucilagenous aggregates

No mucilaginous aggregates were observed in the identified Coralligenous monitoring network site. Mucilaginous aggregates were present in the Platamuni area in other investigated stations (e.g. in the rocky areas below Sveti Nikolau cliff).

4.6.3.12 Invasive species

No invasive species was observed during the analysis of the photoquadrats.

4.7 GIS and WebGIS presentation

The GIS and WebGIS projects were developed within the framework of the present action, to facilitate the exploration, the manipulation and analyses, and the management of all available geographic data.

The advantages and functions of a GIS as a management and supporting tool are multiple. Often considered as a simple drawing system, a GIS offers a way to easily view, query, analyse, interpret, and represent spatial data based on their attributes, location and topological relations. Maps, charts, tables and analytical reports can be derived from the data stored in a GIS as a mean of documenting and explaining spatial patterns and relationships to assist in planning and decision-making processes.

The data derived from both the bibliography and the fieldworks were georeferenced and exported as GIS features, then organized into thematic geodatabases.

The GIS is available as DVD, provided in APPENDIX G and was also published as WebGIS, which access is provided by username and password.

The main GIS project (.mxd file) contains the links to all the GIS data, organized per themes in order to reflect the geodatabases' structure. Photos and videos were stored in separate folders and linked to the correspondent features in the GIS project. The data catalogue of the available information is reported in APPENDIX G.

The GIS project offers a series of analysis and elaboration possibilities that could be easily run using the ArcGIS instruments and tools. Here are some examples of the available analysis tools:

- Through the "Join and Relates" tool it is possible to assign to a certain feature the attributes coming from a separate table or feature based on a common field or the spatial location.
- Geoprocessing tools such as "Buffer" is used to generate a buffer area at a determined distance from the selected feature,
- "Clip" is used to cut a feature based on the shape of another feature,
- "Merge" to put together in a single feature data coming from different features of the same geometry type.
- Spatial analysis tools, such as "Tabulate Area", are used to calculate cross-tabulated areas between two datasets and generate a table.

- Selection tools and so "Select by attributes" and "Select by location" are used, respectively, to select features by their attribute values and select features using the location of features in another layer.
- "Measure" tool is very useful to measure distances of features directly on the map,
- "Identify" tool to visualize the attribute table of a certain features by clicking on them,
- "Zoom" and "Pan" tools to explore the data, according to their extent and resolution.

Moreover, the produced GIS project could also integrate data and information from future studies. It could therefore facilitate the management of the two areas and provide a powerful decision making aid for their conservation.

4.8 Assessment of the two sites in view of proposing them to be on the SPAMI list with outline of conservation/management measures for both sites

Using the results of the sections 3.1 to 3.7 of this report, a SDF was completed for each of the two sites. The filled-in Forms are available in the APPENDIX D.

The following Table provides an evaluation of the conservation interest of the two sites with the view of assessing their respective potential as candidate area for the establishment of Marine Protected Area considering the objectives of Specially Protected Areas set in Article 4 of the SPA Protocol.

Table 24: Schematic evaluation of the conservation interest of Platamuni and Ratac

Key questions	Platamuni	Ratac
Does the area include representative types of coastal and marine ecosystems of adequate size to ensure their long-term viability and to maintain their biological diversity ?	Three priority habitats under the Barcelona Convention are recorded in the area. The *Posidonia* meadow, although restricted to Greben Kalafat and Cape Platamuni, constitutes one of the main representative habitats in the area, along with coralligenous formations and semi-obscure and dark assemblages.	The *Posidonia* settled on organogenic substratum, rich of microhabitats and with enclaves of coralligenous and sciaphylus biocenoses offers a set of marine habitats that are representative of the biodiversity of the Mediterranean benthic environment.
Does the area include habitats which are in danger of disappearing in their natural area of distribution in the Mediterranean or which have a reduced natural area of distribution as a consequence of their regression or on account of their intrinsically restricted area ?	The *Posidonia* meadow settled on rocks is present in the area of Greben Kalafat.	The mosaic of coralligenous and *Posidonia* meadow, present in depths between 10 and 22 meters in the northern part of Cape Ratac, are among the rare habitats in the marine zones located near the coast in the Mediterranean.
Does the area include critical habitats to the survival, reproduction and recovery of endangered, threatened or endemic species of flora or fauna ?	Among the 44 vegetal and 135 animal species recorded in the area, 22 species are listed as endangered or threatened species by international and regional agreements (SPA Protocol Annex II, Bern, Convention, CITES and the EU Habitat Directive). Two species are listed in Annex III of the SPA Protocol (species whose exploitation should be regulated)	The endangered or threatened species observed in the Ratac area are the seagrass *Posidonia oceanica*, three algae species (*Cystoseira corniculata, Lithothamnion corallioides, Sargassum* sp.), one sponge (*Sarcotragus foetidus*) and one mollusc (*Tonna galea*). The commercial sponge species Spongia officinalis, listed in the Annex III of the SPA Protocol is also present in the area.
Particular importance of the area because of its scientific, aesthetic, cultural or educational interest.	The cliff extending south of Bigova and the main marine cave constitute aesthetic elements of particular interest. Furthermore, Greben Kalafat with its special geomorphological features, including important extensions of hard substrata with significant species richness and fish density, beside its ecological and aesthetic value, may be of special scientific and educational interest.	The rocky coastline and bottom, as well as the pebble, sand and silt beaches offer a diverse landscape and seascape for the area. Furthermore the Ratac Cape has a cultural value mainly because of the Benedictine monastery.

Considering that the regional value is a basic requirement of an area for being included in the SPAMI List, only the Platamuni area has the potential to be a good candidate for inscription on the SPAMI List. The Ratac area, beside its ecological value, has no special features that make it of particular regional (Mediterranean) importance. Based on these considerations, the following conservation measures are proposed:

- Establish a marine protected areas covering the Ratac area with two levels of protection:

  Protection level 1: Applied to:

  Zone A: includes the area with the main concentration of bioconstruction with at the top *P. ocenica*. This is an area with very high rugosity. The zone should be fully protected against anchoring and fishing activities in order to promote an increasing of fish population. This zone covers 309.578 m^2.

  Zone B: includes all the rest of the Ratac area, which is mainly covered by *P. oceanica* and algae. Strict control of anchoring is recommended. This zone covers 870.529 m^2.

- Establish a marine protected areas covering the Platamuni area with three levels of protection and propose it for inclusion in the SPAMI List:

  Protection level 1: Applied to:

  Zone A: the cave and a surrounding zone of 150 m on the left and 150 m on the right of the cave entrance. This is the most sensitive area and, according to the knowledge of the local expert, is the wider and most unique site - in terms of structure of the benthic community – in the area. The main risk is uncontrolled scuba diving activities. The zone should be fully protected against all fishing activities. Diving and anchoring should be regulated. This zone covers 157.202 m^2.

  Zone B: includes two zones with *Posidonia* meadows. The main recommended management measures here are the prohibition of anchoring and the strict control of fishing gears. These two zones measure 434.502 m^2 and 157.202 m^2

  Protection level 2: Applied to:

  Zone C: covering the Greben Kalafat area till the limit of the detritic bottom. This is the area with highest fish richness, relevant habitat diversity and presence of sensitive species. An intermediate level of protection is recommended, mainly through the control of fishing activity. This zone covers 324.261m^2.

The following figures show in the maps the suggested zonation in Ratac and Platamuni.

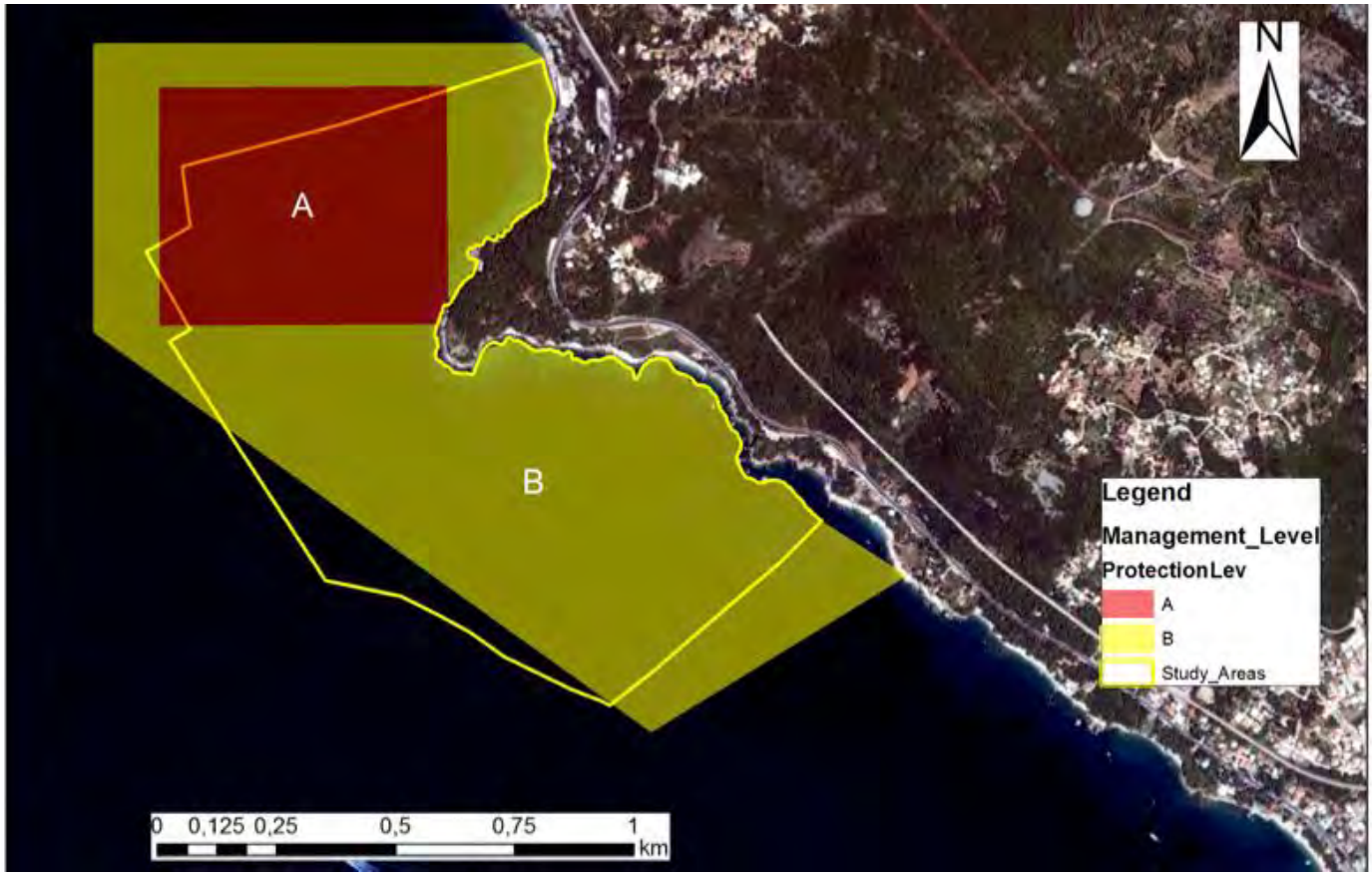


Figure 34: Suggested zonation in the Ratac study area

Figure 35: Suggested zonation in the Platamuni study area

5.0 CONSIDERATIONS AND CONCLUSIONS

The availability of the total coverage Side Scan Sonar mosaic and mapping of marine habitats (available also as WebGIS layers), together with the bathymetric information, constitutes for both areas an important **management tool**, in view of planning the protection measures, or to support any management (e.g. the measures to be set up within the framework of the CAMP Program and the implementation of the strategy for the Integrated Coastal Zone Management in Montenegro), and any monitoring and scientific activities in the areas.

Moreover, concerning the lacks of data identified by the gap analysis (Phase I report), this study provided a significant contribution in improving the knowledge of the distribution of the most important benthic biocenoses in the area.

Several important biocenoses were recorded, some of them are also considered as **Priority Habitats** according to the SPA/BIO Protocol:

- the *P. oceanica* meadow;
- the Coralligenous biocenosis;
- the biocenosis of the semi-dark caves.

According to the assessment of the two areas in the view of proposing them to be on the SPAMI list, it resulted that only the Platamuni area fulfil all the necessary requirements. The assessment has been carried out according to the criteria reported in the Annex I of the Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean.

The main requisites are also reported below:

- Fulfil at least one of the general criteria:
  - Areas of importance for conserving the components of biological diversity in the Mediterranean;
  - Contain ecosystems specific to the Mediterranean area or the habitats of endangered species
  - Areas of special interest at the scientific, aesthetic, cultural or educational levels

- Be evaluated area of Mediterranean interest according to the criteria of Uniqueness, Natural Representativeness, Diversity, Naturalness, Presence of habitats that are critical to endangered, threatened or endemic species, cultural representativeness.

In both the study areas, few habitats deserving specific attention due to their vulnerability as well as for other criteria (e.g. the presence of species either protected or considering having a high heritage value; the presence of a habitat having an intrinsic value from the aesthetic, economic, heritage point of view, or due to its rarity) have been identified. Bardat *et al.* (1997) established a natural space evaluation method. On the basis of these criteria, the habitats can be classified into three main categories:

- **Priority Habitat (P):** habitats the conservation of which is mandatory;
- **Remarkable habitat (R):** habitats that deserve specific attention or management;
- **Other habitats (OH):** habitats that have no rarity or vulnerability character and the heritage, aesthetic and economic importance of which is limited. Usually these habitats do not require special conservation or management measures.

According to the assessment carried out at Mediterranean level, in the two study areas, the identified habitats may be characterized as follow:

- **Ratac:**
  - **Priority habitats:**
    - Coralligenous biocenosis;
    - *Posidonia oceanica* meadows;
  - **Other habitats:**
    - Biocenosis of the coastal detritic bottoms;
    - Biocenosis of Encrusting Calcareous Red Algae and Sea Urchin;
- **Platamuni:** habitats the conservation of which is mandatory;
  - **Priority habitats:**
    - Coralligenous biocenosis;
    - *Posidonia oceanica* meadows;
    - Biocenosis of the semi-dark caves;
  - **Remarkable habitats:**
    - Biocenosis of the Photophilous Algae;
  - **Other habitats:**
    - Biocenosis of the coastal detritic bottoms;
    - Biocenosis of Encrusting Calcareous Red Algae and Sea Urchin;
    - Pebble areas.

The first need for habitats' conservation is the knowledge of their distribution and status. The present study thus provides a powerful inside fulfilling the needs for both biocenotic maps and the first baseline of the most important habitats (e.g. Coralligenous and *Posidonia oceanica* meadows). Moreover the collected data may allow to establish a zero point for the future monitoring of the areas and provide the basic information to plan eventual targeted conservation actions (e.g. physical protection and monitoring study). Few suggested protection measures, specific for both the Ratac and Platamuni area, have already been reported in the Section 4.8.

The present study also contributed to fill the gap in the knowledge of the benthic species (fauna and flora) in the two study areas.

The absence of gorgonians is common to both areas. While it was expected in the Ratac area, where the extension of the hard substrata is limited till the depths of 25-30 m, this absence was a surprise in the Platamuni area, where hard substrata are extended till about 40 m. Gorgonians are accidentally collected by fishermen of Bigova (few km far from Platamuni), but probably the distribution of these species is restricted to deeper areas (below the 50 m depth which correspond to the maximum investigated bathymetry in Platamuni).

The fish diversity and fish abundance observed during the survey in both areas were not particularly high if compared to other Mediterranean coastal sites and especially considering the relevant habitat complexity (rugosity) of some of the sites investigated in Montenegro. These partially limited fish assemblages are probably a consequence of a quite relevant fishing pressure that is, in some cases and according to the available information, exerted also with illegal fishing systems. This fishing pressure is evident in both study areas but is particularly evident in Ratac.

The dominant biocenosis in the soft bottom in both the study areas is the sandy coastal detritic bottom, which is normally found in the Mediterranean Sea between 25 m and 65 m depth.

The **key features** of the **Ratac** marine area can be summarized as follows:

- Hard substrata extended till the depth of 22 m (coverage of about the 55 % of the study area); dominance of the mosaic of the *P. oceanica* meadows with photophilous and sciaphilous biocenoses (coverage of about the 36 % of the area); soft bottom dominated by the coastal detritic bottoms (coverage of the 33 % of the study area).

- 5 protected species and 2 priority habitats (according to SPA Protocol, Habitat Directive, Bern Convention) observed and documented in the area.
- *Posidonia* meadow, whose lower limit is at about 21-25 m. The meadow seems in regression (at least in some areas) probably due to the low transparency of the water (no mechanical damages were observed).
- Presence of a habitat of special interest constituted by *Posidonia* settled on an organogenic substratum, rich of microhabitats and with enclaves of coralligenous and sciaphylus biocenoses.
- Particularly reduced fish assemblages especially if compared to the high habitat rugosity, that may favours the fish biodiversity and abundance;
- Apparent important human pressure, especially due to touristic activities and fishery.

For the **Platamuni** study **area** the key features can be summarized as follows:

- Limited extension of the hard substrata, with the exception of the Greben Kalafat zone. Total coverage of hard substrata about 12 % of the study area; dominance of the Coastal detritic bottoms biocenosis (coverage of 83 % of the area); hard bottom dominated by the mosaic of the overgrazed facies of encrusting algae and sea urchin and photophilous algae (coverage of 7 % of the study area).
- 12 species protected according to the SPA Protocol (Annex II), three of them listed also in the Annex IV of the Habitat Directive, 10 species listed in the Annex II of the CITES, 2 species whose exploitation should be regulated (SPA Protocol Annex III) and 3 priority habitats (according to the SPA Protocol) observed and documented in the area;
- *Posidonia* meadows restricted to few sectors, Greben Kalafat and corresponding coast and Cape Platamuni. Spare patches of *Posidonia* are also present along the shoreline but they are not mappable at the scale of the present study. Concerning the lower limit examined, the quality of the meadow is moderate to poor. The density is very limited and this may be related to the low transparency of the waters (no mechanical damages were observed in the area).
- The soft bottoms in the whole study area are mostly detritic sands, as confirmed by the analysis of the sediment samples collected using the Van Veen grab. No muddy bottoms were found during the present study.
- Presence of two interesting zones:
  (i) the main cave of the cliff settled by key benthic assemblages dominated by madreporaria, sponges and erect bryozoans;
  (ii) the Greben Kalafat area close to the northern limit of the study area.
- Evidence of impact due to date-mussel collection and fish assemblages not particularly rich in terms of abundance. The impact of illegal fishing (and in particular with explosives) can be among the possible causes.

In the **Ratac** study area the habitat located between 10-15 m and 20-25 m depth colonized by *Posidonia oceanica* settled on hard organogenous bottom (bioconstruction) with enclaves of coralligenous and sciaphylus biocenoses constitutes the main key habitat of the area. It covers a surface of 0,27 km^2. Although the habitat is characterized by a particularly high rugosity and offers a huge number of microhabitats, refuges and lairs for fish and macro-invertebrates, the fish population observed during the survey was very limited. According to the available data on fishery, the area is subject to a strong fishing pressure mainly from vessels based in the ports of Bar and Sutomore. In addition, according to information provided by local experts, the sport and the illegal fishing (carried out also by scuba divers) is particularly important in the site.

The fishing pressure is probably facilitated by the easy site accessibility and the proximity of touristic localities like Bar.

In the bioconstruction/*Posidonia* site of Ratac, the presence of protected species is limited to three algae (*Cystoseira corniculata, Lithothamnion corallioides, Sargassum* sp.), the seagrass *Posidonia oceanica*, one sponge (*Sarcotragus foetidus*) and the mollusc *Tonna galea*. *Spongia officinalis*, a sponge species listed in the Annex III of the SPA Protocol was also observed in the area. Considering only the ecological aspects, no uniqueness for the Adriatic Sea or key habitats of exceptional value was discovered in Ratac during the surveys. Considering these abovementioned features, the site doesn't seem to present the characteristics to be selected or the insertion in the SPAMI list. However, considering the extraordinary high rugosity, the limited bathymetry, the easy access and the submarine landscape relevant value of this bioconstruction/Posidonia habitat, it is likely that a protection status could promote an important increasing of emblematic (and protected) fishes (e.g. groupers, brown meagre) and macro-invertebrates in the area.

Considering the small extension of this habitat (and of the entire Ratac area) the effect of the protection suggested in previous section 4.8 for the Zone A, could have only a limited positive impact on the population of endangered species and on priority habitat. However what is particularly important in the case of Ratac is the educational role that this area if appropriately protected could play. After few years of protection the site could become a relevant reference site for snorkelers and scuba divers and play a role of model. According to the results obtained in other Marine Protected Areas in the Mediterranean, a site like Ratac, if protected, can in a few years develop an extraordinary fish population, including several flag species.

This site, if protected, thanks to the extraordinary rugosity and the easy access, could foster the development and

increasing of sustainable tourism, play the promoter role and represent an example of the positive tangible effect of the marine environmental protection. The follow-up is important in terms of promoting education and awareness and the development of MPAs in Montenegro, in the Mediterranean and in the public opinion.

According to the outcomes of the CAMP programme and the Montenegrin strategy for the Integrated Coastal Zone Management, the Ratac area should maintain the status of "protected natural resource" that will allow to preserve some key habitats as the *Posidonia oceanica* meadows on the sea and the communities characterized by *Chritmum maritimum* and *Statice cosyrensis* in the coastal area.

The proposed protection level encompassing the sustainable use of the area is perfectly in line with the measures of protection reported in the Section 4.8 for the marine habitats in the Ratac area.

In the **Platamuni** study area, according to the collected data, two zones, emerging for their peculiarity and richness, seem worthy of protection measures. These zones are the main marine caves located along the cliff and the Greben Kalafat area.

The main marine cave located on the cliff at about 8,6 km south from Bigova (Latitude 42° 17' 206, Longitude 018° 45' 176) presents at the entrance an extraordinary development of bioconstruction, mainly constituted by sponges, madreporaria and bryozoan. This assemblage can be contextualized as a population of semi-obscure cave; moving towards the innermost, the cave is composed by an internal zone of almost total darkness. The benthic assemblage observed in correspondence with the entrance, includes 5 madreporares listed in the Appendix II of the CITES, the protected sponge *Sarcotragus foetidus*, the star fish *Ophidiaster ophidianus* and colonies of extraordinary extension of the madreporaria *Polycyathus muellerae*.

Considering the fragility of the majority of the bioconstructions and species inhabiting the entrance of the cave, the main threat for this habitat is the mechanical impact by divers or fishing gears. The monitoring network was set up in this site in order to assure the monitoring of this semi-obscure cave habitat. Further investigations should be carried out, in particular focused on the madreporaria colonies, like *Phyllangia americana mouchezii* and *Polycyathus muellerae*, which are present in the cliff of the cave with colonies of particular large extension. Even if no ghost fishing gears and no evidence of damage made by scuba divers were observed in the site during the survey, as precautionary measures this caves and a small buffer zone of the cliff around the cave, should benefit of some protection measures (e.g. control of touristic diving activities and forbidden of fishing activities).

The Greben Kalafat site presents in the western side a rich *Posidonia* meadow settled on rocks. The rock is characterized by a steep slope and abundance of cleft and splits (high rugosity). Below the *Posidonia* lower limit the rocks continue till 40 m depth. Benthic assemblages ascribing to coralligenous inhabit this deeper rocky area. The northern side of the Greben Kalafat area presents a probable beach rock in the basal portion at about 29-30 m depth. In correspondence of Greben Kalafat area the highest species richness and fish density highest for the Platamuni area were observed. Totally 11 protected species (Annex II of the SPA Protocol), Paracentrotus lividus (Annex III of the SPA Protocol) and 5 cnidarian listed in the Appendix II of the CITES were recorded in the site. Considering the geomorphological features of the zone, the Greben Kalafat site constitutes one of the few sectors of coast with an important extension of hard substrata far from the coastline. Excluding this area, the submarine extension of the main part of the cliff characterizing the Platamuni area is limited to a few dozens of meters from the coast.

Considering the abovementioned features of Greben Kalafat and the fact that in this site the Posidonia meadows presents the highest extension observed in the Platamuni study area, this zone can be indicated as a key zone (hot spot) for biodiversity, where the implementation of some management and/or protection measures are suggested (e.g. control of fishing activities).

As follow-up, the actions and investigations listed below are suggested:

- Implementation of protection and management measures in both the areas according to the abovementioned rationale and the approach proposed in the section 4.8 "Assessment of the two sites in view of proposing them to be on the SPAMI list with outline of conservation/ management measures for both sites"
- Using the monitoring networks set up, continuation of the monitoring activities carried out in the lower limit of the Posidonia meadows of Ratac and Platamuni (each year) and in the semi-obscure cave benthic assemblage in the cave of Platamuni (every 2-3 years).
- Data capture on the distribution and extension of the colonies of the coral *Phyllangia americana mouchezii* and *Polycyathus muellerae* in Platamuni.

According to the outcomes of the CAMP programme and the Montenegrin strategy for the Integrated Coastal Zone Management, the Platamuni area is characterized on land by high cliffs and low anthropic impacts, host a structured flora and fauna, and has a high vulnerability. The area is included within the EMERALD sites and there is a high need for protection and conservation of the found habitats both on land and in the marine coastal area.

The measures for protection suggested in the Section 4.8 are qualitatively in line with the strategy reported in the CAMP outcomes. According to the present study results,

we suggest some modifications in the zonation of the marine environment compared to that proposed in the CAMP. In the available CAMP documents it seems that the priority for conservation was focused on the southern part of the Platamuni area, including the area around Sv. Nikolau. The outcomes of the present study suggest that the primary attention for conservation – for marine environment - should be the protection of the priority habitats found in the area (the main semi-dark cave located along the Platamuni cliff and the *Posidonia oceanica* meadows, the coralligenous formations and semi-obscure and dark assemblages of the Greben Kalafat zone). Different levels of protection could be applied to these zones as suggested in Section 4.8. In particular the studied cave, according to the knowledge of the local experts, represents the wider and most unique site - in terms of structured community – in the area.

The suggestion reported in the present study may be integrated in a wider conservation strategy, encompassing the zonation of a bigger area, also including the terrestrial habitats.

© RAC/SPA, Egidio Trainito

6.0 REFERENCES

Agencija za zaštitu životne sredine (Crna Gora)., 2014. Studija izvodljivosti i dogovoreni plan za uspostavljanje marinskog zaštićenog područja Platamuni. Podgorica, godine.

Augier A., 1982. Inventaire et classification des biocenoses marines benthiques de la Méditerranée. *Conseil de l'Europe, Collection sauvegarde de la nature*, 29: 59 pp.

Ballesteros E., 2006. Mediterranean coralligenous assemblages: a synthesis of the present knowledge. *Oceanography and Marine Biology*. 44: 123-195.

Ballesteros E., Garrabou J., Hereu B., Zabala M., Cebrian E., Sala E., 2009. Deepwater stands of Cystoseira zosteroides (Fucales, Phaeophyta) in the Northwestern Mediterranean: insights into assemblage structure and population dynamics. Estuarine, *Coastal and Shelf Science*. 82: 477-484.

Ballesteros E., Sala E., Garrabou J., Zabala M., 1998. Community structure and frond size distribution of a deep water stand of *Cystoseira spinosa* Sauvageau in the Northwestern Mediterranean. *European Journal of Phycology*. 33: 121-128.

Bellan-Santini D., Bellan G., Bitar G., Harmelin J.G., Pergent G., 2002. Handbook for interpreting types of marine habitat for the selection of sites to be included in the national inventories of natural sites of conservation interest. UNEP/MAP-RAC/SPA: 217 pp.

Bignami F., Salusti E., Schiarini S., 1990. Observations on a bottom wein of dense water in the southern Adriatic and Ionian Seas. *Journal of Geophysical Research*., 95 : 7249-7259.

Bardat J., Bensettiti F., Hindermeyer X., (1997). Approche méthodologique de l'évaluation d'espaces naturels: exemple de l'application de la directive habitats en France, *Ecologie*. 28(1) : 45-59.

Bianchi C.N., Ardizzone G.D., Belluscio A., Colantoni P., Diviacco G., Morri C., Tunesi L., 2003. La cartografia del benthos. In: Gambi M.C., Dappiano M. (*eds.*): Manuale di metodologie di campionamento e studio del benthos marino mediterraneo. *Biologia Marina Mediterranea*. 10 (Suppl.): 367-394.

Bussotti S., Terlizzi A., Fraschetti S., Belmonte G., Boero F., 2006. Spatial and temporal variability of sessile benthos in shallow Mediterranean marine caves. *Marine Ecology Progress Series*. 325: 109-119.

Caković D., Milošević D., 2013. Program integralnog upravljanja obalnog područja crne gore (camp cg). Studija biodiverziteta i zaštite prirode obalnog područja Crne Gore: 348 pp.

Despalatović M., Grubelić I., Piccinetti C., Cvitković I., Antolić B., Nikolić V., Žuljević A., 2010. Distribution and abundance of the sand star Astropecten irregularis (Pennant, 1777) (Echinodermata, Asteroidea) on the continental shelf in the northern and middle Adriatic Sea. *Acta Adriatica*. 51(1): 35 – 44.

Drakulovic D., Vuksanovic N., 2010. Phytoplankton assemblages and density in the montenegrin coastal sea. Rapp. Comm. Int. Mer Médit., 39: 351.

Drakulović D., Vuksanović N., Joksimović D., 2010. Dynamics of phytoplankton in Boka Kotorska Bay. Studia Marina. 25(1): 1-20.

Dulčić J., Soldo A., Jardas I., 2003. Adriatic fish biodiversity and review of bibliography related to Croatian small-scale coastal fisheries. Split, Croatia, 14th-15th October 2003.

European Commission., 2013. Screening report Montenegro, Chapter 13 – Fisheries. 21 November 2013.

Eusebio A., Bordin R., Jarre R., G Minciotti., 2005. CRNA GORA, speleosub in Montenegro. Speleologia. Riv. Soc. Spel. It. Anno XXVI- Giugno 2005.

Falace A., Alongi G., Cormaci M., Furnari G., Curiel D., Cecere E., Petrocelli A., 2010. Changes in the benthic algae along the Adriatic Sea in the last three decades. *Chemistry and Ecology*, 26: 77–90.

Fant M., Polato F., Rzaničanin A., Molinari A., Bernat P., Mačić V., 2012. Start up of «Katič» MPA in Montenegro and assessment of marine and coastal ecosystems along the coast. DFS, Technical report, Jun-July 2012.

Garcia-Charton J.A., Perez-Ruzafa A., Sanchez-Jerez P., BayleSempere J.T., Renones O., Moreno D., 2004. Multi-scale spatial heterogeneity, habitat structure, and the effect of marine reserves on Western Mediterranean rocky reef fish assemblages. *Marine Biology*. 144: 161–182

Giraud G., 1977. Contribution à la description et à la phénologie quantitative des herbiers à *Posidonia oceanica* (L.) Delile. Thèse Doctorat 3ème cycle, Université Aix-Marseille II : 1-150.

Guidetti P., Bussotti S., Pizzolante F., Ciccolella A., 2010. Assessing the potential of an artisanal fishing co-management in the Marine Protected Area of Torre Guaceto (southern Adriatic Sea, SE Italy). Fisheries Research 101: 180-187.

Harmelin-Vivien, M., Harmelin, J. G., Chauvet, C., Duval, C , Galzin, R., Leleune, P., Barnabe, G., Blanc, F., Chevalier, R., Duclerc, J., Lasserre, G., 1985. Evaluation visuelle des peuplements et populations de poisons, methodes et problemes. *Rev. Ecol.* (Terre Vie) 40: 467-539.

Igić L., 2011. Some species of Bryozoa from the Adriatic Sea and from freshwaters, which are of special importance for fouling complex.

Igić Lj., 2007. Cirripedia of Adriatic. Studia Marina, 24 (2): 1–168.

Kljajic, Z., Drakulović D., maklrović S., Mačić V. (2012): Praćenje biodiverziteta po transketima. Morsko dobro, Tehnički izvještaj, 45 p.

Knezevic J., Mlakar A., Berlengi G., Markovic M., Misurovic A., Markovic M., Buskovic V., Batakovic M., Trumbic I., 2015. National strategy for integrated coastal zone management. CAMP Montenegro: 133 pp.

Krivokapi S., Stankovic Z., Vuksanovic N., 2009. Seasonal variations of phytoplankton biomass and environmental conditions in the inner Boka Kotorska Bay (eastern Adriatic Sea). *Acta Botanica Croatica*. 68 (1): 45–55.

Kruzic P., Benkovic L., 2008. Bioconstructional features of the coral *Cladocora caespitosa* (Anthozoa, Scleractinia) in the Adriatic Sea (Croatia). *Marine Ecology*, 29: 125–139.

Legac M., Brenko M., 1999. A review of bivalve species in the eastern Adriatic Sea. III. Pteriomorpha (Glycymerididae). *Natura Croatica*. 8(1): 9-25.

Lopez y Royo C, Pergent G, Pergent-Martini C, Casazza G., 2010. Seagrass (*Posidonia oceanica*) monitoring in western Mediterranean: implications for management and conservation. *Environmental Monitoring and Assessment* 171: 365-380.

Lucic D., Benovic A., Onofri I., Batistic M., Gangai B., Miloslavic M., Onofri V., Njire J., Brautovic I., Bojanic Varezic D., 2009. Planktonic cnidarian in the open Southern Adriatic Sea: a comparison of historical and recent data. *Annales, Series Historia Naturalis*. 19.

Macic V., 2006. Distribution of seaweed Fucus virsoides J. Agardh in Boka Kotorska Bay (South Adriatic Sea). *Annales, Series Historia Naturalis*. 16.

Mačić V., 2008. Novo nalazište invazivne alge Womersleyella setacea (Hollenberg) R. E. Norris u crnogorskom podmorju. Voda 2008, 37. konferencija o aktuelnim problemima korišćenja i zaštite voda. Mataruška Banja, 3-6. Jun: 293-296 pp.

Mačić V., 2014. Marine caves in the area of future MPA PLATAMUNI (Montenegrin coast). *Studia Marina*. 27(1): 19–30.

Mačić V., Kljajić Z., 2012. Pregled unešeneih vrsta u crnogorskom podmorju. Vode 2012: 255-260 pp.

Mačić V., Panou A., Bundone L., Varda D., 2013. Survey of the future Marine Protected Area of Platamuni and the adjacent peninsula of Lustica with emphasis on marine caves as potential habitats of the endangered Mediterranean monk seal. Istitute of Marine Biology Kotor.

Mačić V., Thibaut T., Antolić B., Sviržev Z., 2010. Distribution of the most common *Cystoseira* species on the coast of Montenegro (South-East Adriatic Sea). *Fresenius Environmental Bulletin*, 19(6): 1191-1198.

Malanotte-Rizzoli P.,1991. The Northern Adriatic Sea as a prototype of convection and water mass formation on the continental shelf, 1991, Deep Convections and DeepWater Formation in the Oceans, P.C. Chu and J.C. Gascard, eds., Elsevier Oceanography.Series, 57, 229-239

Marini M., Grilli F., Guarnieri A., Jones B., Klajic Z., Pinardi N., Sanxhaku M., 2010. Is the southeastern Adriatic Sea coastal strip an eutrophic area? Estuarine, *Coastal and Shelf Science*, 88: 395-406.

Matic-Skoko S., Staglicic N., Pallaoro A., Kraljevic M., Dulcic J., Tutman P., Dragicevic B., (2011). Effectiveness of conventional management in Mediterranean type artisanal fisheries. *Estuarine, Coastal and Shelf Science*. 91 (2011): 314-324.

Meinesz A., Boudouresque C.F., Falconetti C., Astier J.M., Bay D., Blanc J.J., Bourcier M., Cinelli F., Cirik S., Cristiani G., Di Geronimo I., Giaccone G., Harmeline J.G., Laubier L., Lovric A.Z., Molinier R., Soyer J., Vamvakas C., 1983. Normalisation des symbols pour la representation et la cartographie des biocenoses benthiques littorals de Méditerranée. *Annales de l'Institut océanographique*. 59(2): 155-172.

Milanovich S., 2007. Hydrogeological Characteristics of some deep siphonal springs in Serbia and Montenegro karst. *Environmental Geology*. 51: 755-759.

Nikolić V., Žuljević A., Antolić B., Despalatović M., Cvitković I., 2010. Distribution of invasive red alga *Womersleyella setacea* (Hollenberg) R.E. Norris (Rhodophyta, Ceramiales) in the Adriatic Sea. *Acta Adriatica.* 51(2): 195 – 202.

Ovchinnikov I. M., Zats V. I., Krivosheya V. G. Idodov A. I., 1985. The formation of deep Eastern Mediterranean Waters in the Adriatic Sea, 1985, Okeanologija, 25, 911-917. English translation: Oceanology, 25: 704-707.

Parenzan P., Stiepcevic J., 1980. Golfo delle bocche di Cattaro; Condizioni generali e biocenosi bentoniche con carta ecologica delle sue due baie interne: di Kotor (Cattaro) e di Risan (Risano). Estr. da Studia Marina; Vol. 9, 10 - p. 3-153 (76, 79).

Pavasovic A., Cebrian D., Limam A., Dedej Z., Vucijak B., Radovic J., Guidetti P., Buskovic V., Dobrajc Z., 2009. Sub-regional report on vulnerability and impacts of climate change on marine and coastal biological diversity in the Mediterranean Adriatic countries. UNEP-MAP RAC/SPA, Tunis: 52 pp.

Pérès J.M., Picard J., 1964. Nouveau Manuel de Bionomie Benthique de la Mer Méditerranée. *Recueil des Travaux de la Station Marine d'Endoume*. 31(47): 5-137.

Pergent G., 2007. Protocol for the setting up of *Posidonia* meadow monitoring systems. « Med*Posidonia* » Programme / RAC/SPA – Total Corporate Foundation for Biodiversity and the Sea; Mémorandum of understanding N° 21/2007/RAC/SPA_MedPosidonia Nautilus-Okianos: 24 pp + Annexes.

Pergent G., Pergent-Martini C., Boudouresque C.F., 1995. Utilisation de l'herbier à *Posidonia oceanica* comme indicateur biologique de la qualité du milieu littoral en Méditerranée: état des connaissances. *Mesogée*. 54: 3-27.

Pergent G., Pergent-Martini C., 1988. Phénologie de *Posidonia oceanica* (Linneaus) Delile dans le bassin méditerranéen. Annls. Ins. Océanog., Paris, 64(2): 79-100.

Pestorić B., Lučić D., Joksimović D., 2010. Cladocerans spatial and temporal distribution in the coastal south adriatic waters (Montenegro). *Studia Marina*, 25(1): 101-120.

Piazzi L., Balata D., Cinelli F., 2007. Invasions of alien macroalgae in Mediterranean coralligenous assemblages. *Cryptogamie algologie*. 28(3): 289-301.

RAC/SPA-UNEP/MAP, 2011. 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. By Badalamenti F., Garcia Charton J.A., Trevino-Oton J., Mačić V., and Cebrian D. Ed. RAC/SPA - MedMPAnet Project, Tunis: 52 p + Annexes.

RAC/SPA-UNEP/MAP, 2013. Ecological quantitative description of Boka Kotorska Bay marine area (Montenegro). By Golder Associates. Ed. RAC/SPA - MedMPAnet Project, Tunis: 82 pp + Appendices.

RAC/SPA-UNEP/MAP, 2013. Fishery activities assessment in Montenegro : case study of five selected parts of Montenegrin coast. By Mirko Djurović and Olivera Marković. Ed. RAC/SPA - MedMPAnet Project, Tunis: 39p.

RAC/SPA-UNEP/MAP, 2014. Monitoring Protocol for Reefs - Coralligenous Community. By Garrabou J, Kipson S, Kaleb S, Kruzic P, Jaklin A, Zuljevic A, Rajkovic Z, Rodic P, Jelic K, and Zupan D. Ed. RAC/SPA - MedMPAnet Project, Tunis. 35 pages + annexes.

Radović M., 1964. Geografske karakteristike crnogorskog primorja. Godišnjak geografskog Društva SR Crne Gore, Cetinje: 57-73.

Svensen C., Vilicic D., Wassman P., Arashkevich E, Ratkova T., 2007. Plankton distribution and vertical flux of biogenic matter during high summer stratification in the Krka Estuary (eastern Adriatic). *Estuarine, Coastal and Shelf Science.* 71, 381–390.

Trainito E., 2010. Guida all'identificazione dei Pesci Marini d'Europa e del Mediterraneo - P.Louisy - Edizioni Il Castello, 2010.

Trainito E., 2011. Atlante di Flora e fauna del Mediterraneo - Edizioni il Castello, 2011.

Tunesi L., Piccione M.E., Agnesi S., 2002. Progetto pilota di cartografia bionomica dell'ambiente marino costiero della Liguria. Proposta di un Sistema Informativo Geografico per la gestione di cartografie bionomiche e sedimentologiche. *Quaderno* ICRAM, 2: 112 pp.

UNEP., 2014. Status and conservation of fisheries in the Adriatic. Draft internal report. Malaga, Spain, 7-11 April 2014.

UNEP/MAP-RAC/SPA, 2015. Handbook for interpreting types of marine habitat for the selection of sites to be included in the national inventories of natural sites of conservation interest. Denise BELLAN-SANTINI, Gérard BELLAN, Ghazi BITAR, Jean-Georges HARMELIN, Gérard PERGENT. Ed. RAC/SPA, Tunis. 168 p. + Annex (Orig. pub. 2002).

Vilicic D., Marasovic I., Miokivic D., 2002. Checklist of phytoplankton in the eastern Adriatic Sea. *Acta Botanica Croatica*, 61 (1): 57–91.

Vrgoc N., Arneri E., Jukic-Peladic S., Krstulovic Šifner S., Mannini P., Marceta B., Osmani K., Piccinetti C., Ungaro N., 2004. Review of current knowledge on shared demersal stocks of the Adriatic Sea. AdriaMed Technical Documents No.12.

Vukanic D., Vukanic V., 2003. Review of characteristics of zooplankton community in southeastern part of Southern Adriatic. (Available at: http://agris.fao.org/agris-search/search.do?recordID=CS2004000105).

Williams P., 2008. World heritage caves and karst. Gland, Switzerland: IUCN. 57pp. Službeni list Republike Crne Gore (2008): Zakon o zaštiti prirode br 51/08.

United Nations Environment Programme
Mediterranean Action Plan
Regional Activity Centre for Specially Protected Areas (RAC/SPA)
Boulevard du leader Yasser Arafat - B.P. 337 - 1080 Tunis Cedex - TUNISIA
Tel.: (+216) 71 206 649 / 71 206 485 / 71 206 851 • Fax: (+216) 71 206 490
E-mail: car-asp@rac-spa.org • www.rac-spa.org