REPUBLIC OF CROATIA
MINISTRY OF ENVIRONMENTAL AND NATURE PROTECTION

State Institute for Nature Protection

County of Primorje and Gorski kotar
Priroda
Public Institution
for protected areas management

UNEP

MAP

RAC/SPA

MedMPAnet project

MONITORING PROTOCOL FOR CORALLIGENOUS COMMUNITY

Case study - Croatia

Published by: RAC/SPA

For bibliographic purposes, this volume may be cited as:
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.

Layout: Zine El Abidine MAHJOUB and Asma KHERIJI.

Cover photo credit: Sara KALEB.
Photos credits: Sara KALEB, Petar KRUZIC, Joaquim GARRABOU, State Institute for Nature Protection, Ante ZULJEVIC and Andrej JAKLIN.

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

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

MONITORING PROTOCOL FOR CORALLIGENOUS COMMUNITY

MedMPAnet project

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

Study required and financed by:

MedMPAnet project

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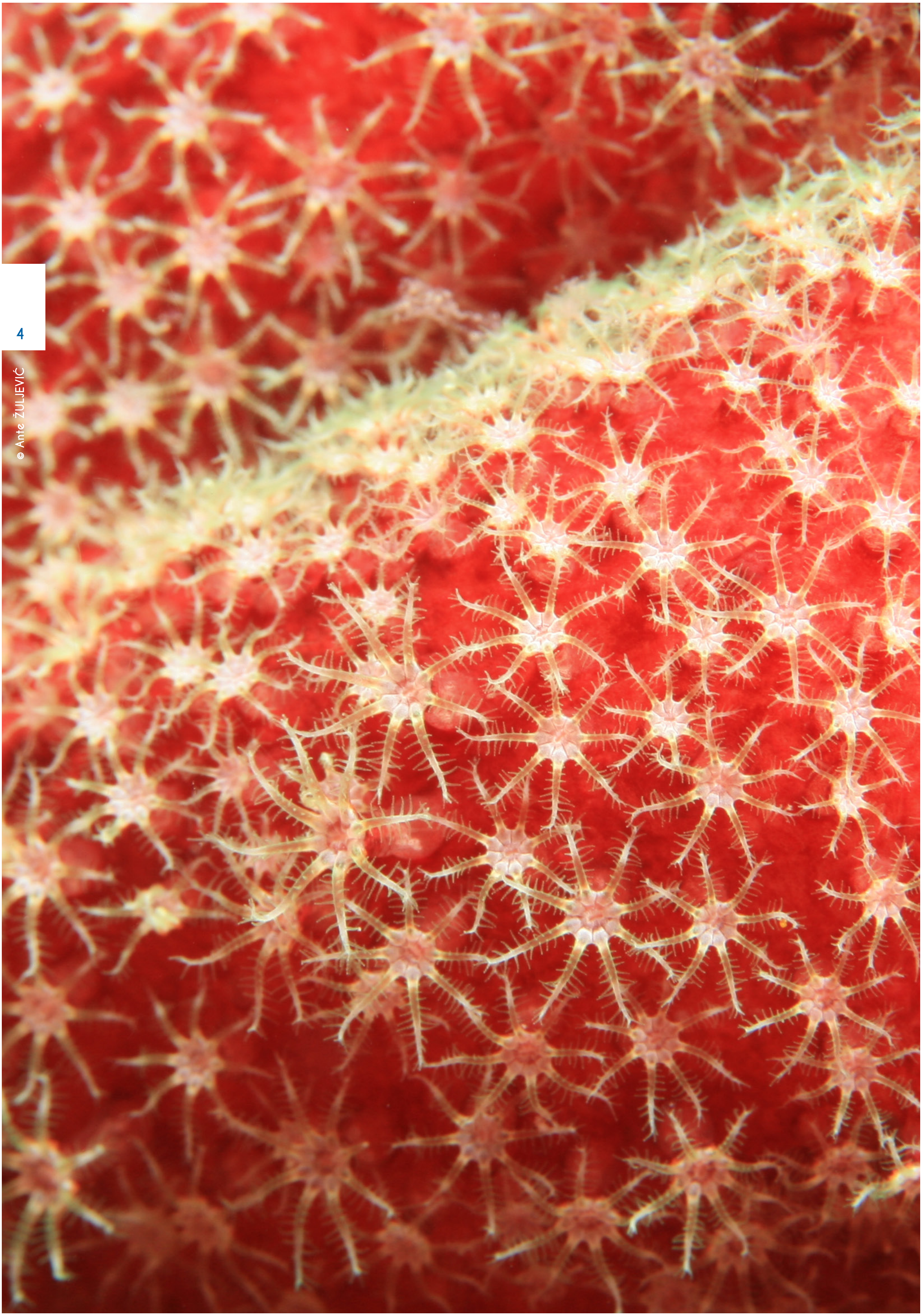
Reference of the study:

MoU Nº 01/MedMPAnet/2013

CONTENT



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1. MONITORING SCHEME FOR CORALLIGENOUS COMMUNITY

English name(s) + code(s)

- Author(s)
  *1170 Reefs Coralligene (Coralligenous community).

Group of habitat types

- List of similar habitat types that can be grouped together taking into account the potentially involved staff and logistics.

Description and ecology

- Very brief description of basic characteristics

  Coralligenous assemblages develop in dim-light conditions below 20 m depth (up to 100-130 m in some areas) were calcareous algal species and different macroinvertebrate species (Bryozoans, scleractinians, serpulids and sponges) develop complex bioconstructions (Ballesteros, 2006). These bioconstructions are found on vertical walls and overhangs as well as on horizontal and sub-horizontal bottoms. The coralligenous communities usually develop at depth below the thermocline (where temperatures rarely exceed 20 ºC).

  Coralligenous habitat support high levels of biodiversity and a complex trophic net (Ballesteros, 2006), several species of calcareous algae and macroinvertebrate species are considered typical species of the habitat type 1170. However, the specific list has to be determined on regional basis since coralligenous show a great spatial heterogeneity.

  Coralligenous assemblages are threatened by specific direct and indirect human activities, which affect the stability of this precious ecosystem and thus strongly compromise their future conservation. These disturbances include direct and indirect impacts of fishing activities (e.g. trawling, exploitation of the red coral), degradation by wastewater, the colonization by invasive species and the effects of global climate change (Hong 1983, Coma et *al*. 2004, Ballesteros, 2006, Garrabou et al. 2009, García-Rubies *et al.* 2013, UNEP/MAP-RAC/SPA, 2008). The main impacts of these stressors on coralligenous habitat are reduction of abundance of target species, habitat destruction and mass mortality events of key species.

Current surveillance

- Description of activities undertaken in Croatia after the year ~ 2000.

  Coralligenous habitat is widespread along the Croatian coast. However, this habitat is insufficiently studied and there are no precise historical as well as recent data on its distribution and status. There is a total lack of cartography of coralligenous bottoms all over the Adriatic Sea. Limited information is available only from protected areas (National and Nature parks) and sporadic studies of benthos.

  Existing information on the distribution of coralligenous habitat in Croatia is mainly based on scattered information from scientific literature, marine protected areas and Natura 2000 documentation and expert personal communication. Besides, partial and patchy information on ecological aspects and conservation status is available from local studies (Kipson, 2013) and monitoring within marine protected areas (Kružić, 2009 a, b; 2010; 2011; 2012 a, b; 2013 a, b, c).

Existing data

- Existing data are more or less in inadequate format and should be transferred into common database. There are few reports that concern strictly marine habitats (map or information about status). No information about survey conditions, habitat quality or pressures is in current databases. Habitat database (CroHabitats), as a part of Nature Protection Information System, will be finished in 2014. Until then SINP is holding several simpler GIS databases on habitats where data from different research and mapping of marine habitats is stored. At present there are only several smaller marine areas mapped in more detail.

  The basic habitat map is Croatian habitat map produced in 2004 (OIKON for MENP, 2004), which is in fact more an indicative map of marine habitats.

  More detailed marine habitat maps are few:

  - marine habitat maps of national park Brijuni, nature parks Lastovo Islands and Telascica (MedPAN South, SUNCE);
  - map of marine coastal habitats of southern and eastern Istria (SHAPE project);
  - marine habitat map of the northern part of Dugi otok Island (SUNCE);
  - marine habitat maps of the part of the islands in Split-Dalmatia County (SUNCE, BIUS, IOR);
  - marine habitat maps of Bisevo Island and southeastern part of Vis Island (COAST project);
  - marine habitat map of the part of sites of Ecological network in Sibenik-Knin County (PMF).

Other databases:

- habitat map of Posidonia meadows in NP Mljet (still only in NP Mljet database).

Detailed mapping of marine habitats is planned through project within Structural funds (starting at earliest end of 2016 – beginning of 2017).

Potential application:

- existing maps could be used for adapting/expanding the list of monitoring sites;
- existing data could be used to assess the temporal evolution of the conservation status of coralligenous assemblages in case a proper design could be applied to each specific site (i.e. if data are collected with the same criteria suggested in the protocol).

Distribution

- Basic information on world and European distribution pattern and natural conditions.

Coralligenous assemblages are exclusive and widespread in the Mediterranean Sea; depth range varies from 20 to 120 m according to light availability and nature of the substratum (Ballesteros, 2006). There are only reliable estimations of total cover of coralligenous habitats at small scale (marine protected areas cartography), but we lack estimations at Mediterranean scale. Coralligenous are considered threaten by human activities and pressures. Available information reported on significant decrease in the abundance (biomass) of target species due to fishing activities (e.g. groupers, spiny lobsters, red coral), decrease in habitat complexity due to the mechanical impacts and colonization by invasive species, and decrease in the abundance of key species due to mass mortalities.

Scheme of surveillance

- Monitoring scheme is framed by the data filled in the table below:

Component of the conservation status	Way of surveillance	Complementary notes
Range	Mapping	Distribution data will be provided as presence on a 10 x 10 km grid; polygons created by adjacent cells will define the outer limits of the overall area in which a habitat type occurs, namely the range (Evans & Arvela, 2011). Major discontinuities due to natural factors should be excluded to the range (Evans & Arvela, 2011). Discontinuity in the range will be calculated considering the recommended gap distance of 40 km between distribution cells or polygons (Evans & Arvela, 2011).
Area	Mapping	Because of the lack of precise maps coming from complete surveys, the surface (in km^2) area covered by the habitat type 1170 could be estimated on the basis of partial data with some extrapolation and/or modelling or on expert opinion with no or minimal sampling (Evans & Arvela, 2011). A real assessment of the area covered by habitat type and its change over time would only be possible after mapping in higher resolution, e.g. with minimum mapped surface area ranging from 1 to 25 m^2 as suggested by UNEP/MAP-RAC/SPA (2011). Detailed marine habitat mapping is planned through the Structural funds end of 2016 – beginning of 2017.

Component of the conservation status	Way of surveillance	Complementary notes
Structure and functions	Monitoring - research on localities - scientific research	Fundamental descriptors of coralligenous in most monitoring programs in the Mediterranean include specific composition, habitat complexity, degree of impact of main disturbances affecting the coralligenous habitat and information on environmental conditions. Descriptors can be monitored with direct Scuba-based methods up to 40 m depth and with the support of ROVs beyond this depth. As there is no baseline for the Mediterranean nor for Croatia, the definition of indices to assess conservation status of coralligenous is still under development. It will be possible to describe changes in coralligenous status by comparing changes in habitat data throughout the time. According to budget availability, baseline data from monitoring should be combined with scientific research in order to clarify if descriptors and classification methods under development are suitable for Croatian assemblages. Additional research to assess the response of typical (engineering) species in coralligenous habitat to different stressors; and research to test the effectiveness of ROVs as additional devices for assessing the conservation status.
Future prospects	Monitoring - research on localities - scientific research	Future prospects should be evaluated by considering the future trends and likely future status of range, area and structure and functions; future trends of habitats are dependent on pressures and threats (negative influence) and conservation policies (positive influence) (Evans & Arvela, 2011). When possible the BACI approach (Before/After-Control/Impact, Underwood, 1992; 1993; Garrabou et *al.*, 1998) is recommended to identify impacts occurring within a defined time period, to evaluate the effects of anthropogenic disturbances and identify prevention and conservation measures. BACI studies are also suggested to assess and maximize the effects of management measures.

Logistics

Future coralligenous/reefs (or Marine habitats) Working Group will be led by State Institute for Nature Protection (SINP).

SINP will coordinate national monitoring activities.

The SINP coordinator has the following tasks:

- nominate monitoring coordinator and members of the Working Group ;
- prepare agreements for all paid contractors ;
- prepare agreements with cooperating institutions ;
- organize all works and meetings ;
- assure input of data into database ;
- survey and coordinate monitoring activities ;
- check the quality of monitoring results ;
- initiate revision of monitoring programme/scheme when necessary ;
- Etc.

- University of Zagreb, Faculty of Science, Department of Biology (PMF), Zagreb: scientific institution - advisor for testing videographic/monitoring methods.
- Institute for Oceanography and Fisheries (IOR), Split: scientific institution responsible of national monitoring activities under WFD and preparation of monitoring under MSFD - advisor of national monitoring activities.
- Rudjer Boskovic Institute, Centre for Marine Research (IRB), Rovinj: scientific institution - advisor of national monitoring activities.
- University of Trieste, Department of Life Science (UT), Trieste: scientific institution - advisor of monitoring activities.
- University of Zagreb, Faculty of Electrical Engineering and Computing, Laboratory for Underwater Systems and Technologies, Zagreb.

Roles of participants

- Current overview of both available and needed capacities is summarized in the table below:

Kind of work	Current specialists & institutions	Specialisation needed
Preparation of methodologies	Members of the MedMPAnet project coralligenous team - from PMF, IOR, IRB, UT, SINP	Marine biologists with good knowledge of calcareous macroalgal and macroinvertebrate species and methodology for assessing the state of health of the rocky benthic communities, and experienced in field data collection
Expert examination	Members of the MedMPAnet project coralligenous team - from PMF, IOR, IRB, UT, SINP	Marine biologists with good knowledge of calcareous macroalgal and macroinvertebrate species and methodology for assessing the state of health of the rocky benthic communities
Expert coordination (membership in WG)	Members of the MedMPAnet project coralligenous team - from PMF, IOR, IRB, UT, SINP	Marine biologist experienced in coordination, with good knowledge of local capacities
Communication with IT experts	SINP	Biologist experienced in GIS, with knowledge of local databases

Kind of work	Current specialists & institutions	Specialisation needed
Regional coordination of the field work	• Possible several regional coordinators • Members of the MedMPAnet project coralligenous team - from PMF, IOR, IRB, UT + SINP + experienced marine field biologists - Latinka Janjanin (Istria County), NGOs (Sunce (Split), 20000 miles (Zadar), MPA staff (Brijuni, Telascica, Kornati, Mljet, Lastovo Islands) & coastal Counties staff (PI Priroda)	Marine biologists with good knowledge of calcareous macroalgal and macroinvertebrate species and methodology for assessing the state of health of the rocky benthic communities, and experienced in field data collection
Field work	Members of the MedMPAnet project coralligenous team - from PMF, IOR, IRB, UT + SINP + experienced marine field biologists - Latinka Janjanin (Istria County), NGOs (Sunce (Split), 20000 miles (Zadar), MPA staff (Brijuni, Telascica, Kornati, Mljet, Lastovo Islands) & coastal Counties staff (PI Priroda) + trained SCUBA divers (for technical support): Petronije Tasić	Marine biologists with good knowledge of calcareous macroalgal and macroinvertebrate species and methodology for assessing the state of health of the rocky benthic communities, and experienced in field data collection; SCUBA divers trained in collection of scientific data (also students and interns); Seaman experienced in operating boats and supporting scientific work at sea.
Data evaluation	On national level: SINP + support from Members of Coralligenous Working Group On regional level – regional coordinators	Marine biologists with good knowledge of calcareous macroalgal and macroinvertebrate species and methodology for assessing the state of health of the rocky benthic communities

Pilot project

- Clarification if a pilot project is needed.

  According to budget availability, pilot projects could be devoted to:

1. To establish baselines on coralligenous habitat thriving in the Croatian waters, we should plan a sampling scheme that will cover areas under different environmental and protection levels along of the Croatian coast. This scheme could be coupled with the mapping efforts. To gather information on species composition and abundance we propose the application of the protocol described in the monitoring program as a starting point. This pilot project should be addressed in priority in geographic areas for which the monitoring sites need to be identified.
2. The use of video transects for data acquisition could be explored. Depending on the way the images are obtained, videography could potentially be applicable for most of the proposed descriptors. This point is also important for the development of monitoring protocols for deep waters, since for these areas the use of ROVs and/or AUVs will be required.
3. Experimental setups to explore the response of typical (engineering) species in coralligenous habitat to different stressors. The expected results will provide key information for the development of the indices to evaluate the conservation status of coralligenous habitat.
4. Exploring the adoption of new methodological approaches based on the combination of new acoustic methods with AUVs would enable development of mapping approaches devoted to specific areas.

Funding

- General estimation of costs for monitoring programmes of the habitat type(s) giving a framework for planning of capacities and preparation of monitoring programmes in the table below:

Activity	Costs per 6 year period	Trend in following periods
Preparation of methodologies & examination	€ 4.500,00	decreasing
Theoretical coordination (Working Group)	€ 3.000,00	stable
Coordination of the field work	€ 16.200,00	stable
Pilot project	€ 147.600,00	decreasing
Collection of existing data	€ 4.260,00	stable
Monitoring on plots (field workers)	€ 215.820,00	increasing
Scientific research	€ 26.400,00	decreasing
Data analysis	€ 76.800,00	stable
TOTAL	**€ 494.580,00**	

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2. MONITORING PROGRAMME FOR CORALLIGENOUS COMMUNITY

COMMON CHAPTERS

English Name (Natura Code)

1170 Reefs
Coralligene (Coralligenous community)

Equivalents in different classifications

- EUNIS, National habitats classification

EUNIS:
A4.26
A4.26D
A4.32

National habitat classification:
G.4.3.1.

Phytocoenological conversion

- Alliances and association

The National Classification of Habitats encompasses 10 associations and facies of coralligenous habitat (Bakran-Petricioli, 2011). However, the most recent scientific knowledge question whether such classification should be retained in the future. Firstly, the presence of many outlined associations and facies is not confirmed to date along the Croatian part of the Adriatic Sea. Secondly, it is questionable whether the nomenclature with associations and facies should be used altogether in the future, since it showcased many inconsistencies and it has been largely abandoned by the international scientific community.

Below, the current Classification is outlined and the notes on their presence along the Croatian part of the Adriatic are provided.

National Classification of Habitats (NCH)
G.4.3.1.1. Association with species *Cystoseira corniculata*

Association with species *Cystoseira corniculata* - Coralligenous community with domination of species *Cystoseira corniculata*.

Note: This is a transitional association between the biocenosis of infralittoral algae and coralligenous habitat and it has not been recorded in the Adriatic to date.

G.4.3.1.2. Association with native species of genus *Sargassum*

Association with native species of the *genus Sargassum* - Coralligenous community with domination of native species of the genus *Sargassum*.

Note: This is a transitional association between the biocenosis of infralittoral algae and coralligenous habitat and it has not been recorded in the Adriatic to date.

G.4.3.1.3. Association with species *Mesophyllum lichenoides*

Association with species *Mesophyllum lichenoides* - Coralligenous community with domination of species *Mesophyllum lichenoides*.

Note: The presence of the red encrusting algae *Mesophyllum lichenoides* has not been confirmed in the Adriatic to date. In the Northern Adriatic, another cogeneric species, *Mesophyllum macroblastum* (Foslie) Adey, represents one of the most important algal bioconstructors within the coralligenous habitat.

G.4.3.1.4. Association with species *Lithophyllum frondosum* and *Halimeda tuna*

Association with species *Lithophyllum frondosum* and *Halimeda tuna* - Coralligenous community with domination of species *Lithophyllum frondosum* and *Halimeda tuna*.

Note: Current accepted name of *L. frondosum* is *Lithophyllum stictaeforme* (Areschoug) Hauck. This species is an important algal bioconstructor in the Adriatic Sea, however its association with the abundant green algae *Halimeda tuna* has not been observed to date.

G.4.3.1.5. Facies with species *Eunicella cavolinii*

Facies with species *Eunicella cavolinii* - Coralligenous community with domination of species *Eunicella cavolinii*.

Note: This is one of the most representative aspects of the coralligenous habitat within the Central and South Adriatic Sea. In the Northern Adriatic, *E. cavolini* is present but in putatively lower densities and to date, it has not been observed to form a facies of coralligenous habitat there.

G.4.3.1.6. Facies with species *Eunicella singularis*

Facies with species *Eunicella singularis* - Coralligenous community with domination of species *Eunicella singularis*.

Note: To date, this facies of the coralligenous habitat has not been recorded along the Croatian part of the Adriatic Sea.

G.4.3.1.7. Facies with species *Leptogorgia sarmentosa*

Facies with species *Leptogorgia sarmentosa* - Coralligenous community with domination of species *Leptogorgia sarmentosa*.

Note: To date, this facies of the coralligenous habitat has not been recorded along the Croatian part of the Adriatic Sea.

G.4.3.1.8. Facies with species *Paramuricea clavata*

Facies with species *Paramuricea clavata* - Coralligenous community with domination of species *Paramuricea clavata*.

Note: This is one of the most representative aspects of the coralligenous habitat along the Croatian part of the Adriatic Sea.

G.4.3.1.9. Facies with species *Parazoanthus axinellae*

Facies with species *Parazoanthus axinellae* - Coralligenous community with domination of species *Parazoanthus axinellae*.

Note: This aspect of the coralligenous habitat is present along the Croatian part of the Adriatic Sea.

G.4.3.1.10. Platform coralligenous

Platform coralligenous – Formed by biogenic build-up of the bottom that was soft at the beginning (mostly by the growth of calcareous encrusting algae).

Note: This aspect of the coralligenous habitat is present along the Croatian part of the Adriatic Sea.

In addition to the outlined associations and facies, a facies with species *Coralium rubrum* could be also included among the aspects of the coralligenous habitat (currently it is only included within biocenosis of semi-dark caves, G.4.3.2).

Range

- Total world and European range of the habitat type with description of its **distribution pattern** (including maps)
- Remarks on phytocenological variability

Coralligenous outcrops, which are hard bottoms of biogenic origin that thrive under dim light conditions, represent an endemic habitat for the Mediterranean Sea (Ballesteros, 2006). They are common all around the Mediterranean coasts (UNEP/MAP-RAC/SPA, 2008). Coralligenous outcrops develop on rocky reefs and biodetritic bottoms from ~20 m down to 120 m depth, in relatively constant conditions of temperature, currents and salinity (Laborel, 1987). The minimal depth for the formation of coralligenous outcrops depends on the amount of irradiance reaching the sea bottom. Therefore, they can develop even in very shallow waters if light conditions are dim enough to allow a significant development of coralline algae (Laborel, 1987; Sartoretto, 1994). According to Ballesteros (1992) these irradiance levels range between 0.05 % and 3 % of the surface irradiance. Two main morphologies of the coralligenous outcrops may be distinguished (Ballesteros, 2006): banks (growing over more or less horizontal substrata) and rims (growing on vertical cliffs and in the outer parts of marine caves).

The most widely studied outcrops are those of the northwestern Mediterranean. There, two main algal communities have been distinguished: an assemblage dominated by *Halimeda tuna* and *Mesophyllum alternans*, thriving in relatively high light levels, and an assemblage dominated by encrusting corallines (*Lithophyllum stictaeforme, L. cabiochae, Neogoniolithon mamillosum*) and *Peyssonnelia rosamarina*, and receiving low light levels (Ballesteros, 2006).

Distribution in Croatia

- Summary of **historical development of distribution**

Coralligenous habitat is widespread along the Croatian coast. However, this habitat is insufficiently studied and there are no precise historical as well as recent data on its distribution and status. There is a total lack of cartography of coralligenous bottoms all over the Adriatic Sea. Limited information is available only from protected areas (National and Nature parks) and sporadic studies of benthos. This lack of information and the high costs of the required field work make regular monitoring programme in the Adriatic Sea difficult to implement.

Complete distribution of coralligenous habitat in Croatia is still unknown. Distribution shown in Figure 1 is based on the available data form SINP databases mainly consisting of presence/absence data gathered from literature and most of the data from SINP databases as well as from research/mapping projects by different experts or institutes, faculties and NGOs in the framework of the national or international projects and SINP coordinated research.

Some information was also drawn from distribution of typical species associated with this habitat and potential SCIs for this habitat type. In order to determine complete range of this habitat type in Croatia, comprehensive and systematic mapping is needed.

Citizen science initiatives based on volunteering divers could be used to acquire data on the distribution of coralligenous habitat in Croatia. Various data are being already collected in the scope of several initiatives across the Mediterranean. Joining one of the current initiatives could be a way to gather precious information on the distribution of the coralligenous habitat, which would be really difficult to obtain otherwise. However, to take advantage of these initiatives dissemination plan should be set up, including the cooperation with the Croatian research institutions and the main diving associations. Some of examples of citizen science initiatives are: http://www.observadoresdelmar.es (Spain, English version available), Comber http://www.comber.hcmr.gr/?q=content/home (Greece).

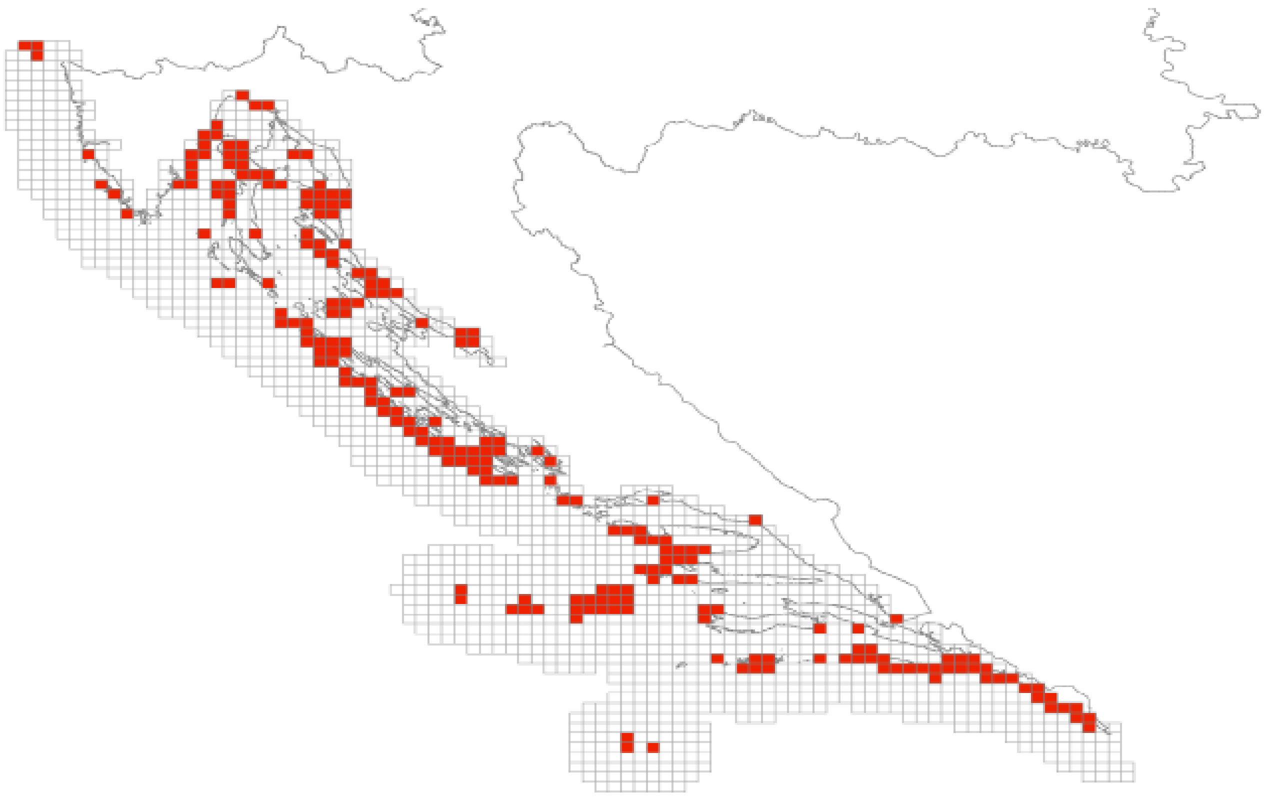

Figure 1. Distribution of coralligenous habitat in Croatia

Typical species

- List of typical species of the habitat type (or subtypes – e.g. associations/subassociations)

A draft list of species to be considered in the inventory and/or monitoring of coralligenous communities was provided by UNEP/MAP-RAC/SPA (2011). The species were arranged in the following categories:

- Algal builders ;
- Animal builders ;
- 'Agglomerative' animals ;
- Bioeroders ;
- Species of particular importance (particularly abundant, sensitive, architecturally important or economically valuable) ;
- Invasive species.

Based on the above-mentioned list and field data, a preliminary selection of typical/indicator species that should be monitored within the national protocol has been proposed (Table 1).

Regarding the species selected, it should be emphasized that the Assessment and Reporting under Article 17 of the Habitats Directive does not require a full assessment of the conservation status of each typical species.

The reporting format only asks for a list of species which have been considered and a brief description of the method used to assess their conservation status as part of the overall assessment of structure and functions. Therefore, it is not expected that typical species will be monitored closely (Evans and Arvela, 2011).

Furthermore, to avoid potential confusion, we emphasize that invasive species (either alien or not normally occurring in the habitat) are included in this list as they are often very good indicators of poor conservation status. They should not be confused with 'typical species' and where appropriate they should be reported under 'threats & pressures' (Evans and Arvela, 2011).

Table 1. Preliminary list of typical/indicator species occurring within the coralligenous habitat along the Croatian part of the Adriatic Sea

Algal builders	
Rhodophyta[1] • Coralline algae • Encrusting *Peyssonnelia* spp.	
Animal builders	
Bryozoans • *Myriapora truncata* Pallas 1766 • *Schizotheca serratimargo* (Hincks, 1886) • *Pentapora fascialis* (Pallas 1766) • *Smittina cervicornis/Adeonella pallasii* • Encrusting bryozoans[2]	**Serpulids** • *Filograna implexa/Salmacina dysteri* • *Serpulidae* • *Protula* sp. **Scleractinians** • *Caryophyllia inornata* (Duncan 1878) • *Caryophyllia smithii* (Stokes and Broderip 1828) • *Hoplangia durotrix* (Gosse 1860) • *Leptopsammia pruvoti* (Lacaze-Duthiers 1897) • *Madracis pharensis*
'Agglomerative' animals	
Sponges • *Faciospongia cavernosa* (Schmidt 1862)	**Bryozoans** • *Beania* spp.
Bioeroders	
Sponges • *Cliona* sp. **Echinoids** • *Echinus* sp. (Lamarck 1816) • *Sphaerechinus granularis* (Lamarck, 1816)	**Molluscs** • *Gastrochaena dubia* (Pennant 1777) • *Lithophaga lithophaga* (Linnaeus 1758)
Species of particular importance (particularly abundant, sensitive, architecturally important or economically valuable)	
Rhodophyta • Uncalcified *Peyssonnelia* spp. **Sponges** • *Crambe crambe/ Spirastrella cunctatrix* • *Petrosia ficiformis* • *Hexadella racovitzai* • *Aplysina cavernicola* • *Axinella cannabina* • *Axinella polypoides*	**Gorgonians** • *Paramuricea clavata* (Risso 1826) • *Eunicella singularis* (Esper 1791) • *Eunicella cavolini* (Koch 1887) • *Corallium rubrum* (Linnaeus 1758) **Alcyonarians** • *Alcyonium acaule* (Marion 1878) **Zoantharians** • *Parazoanthus axinellae* (Schmidt 1862)
Invasive species	
Chlorophyta • *Caulerpa racemosa* var. *cylindracea* (Sonder 1845)	**Rhodophyta** • Red turf algae[3]

[1] This group includes species such as *Lithophyllum stictaeforme* (J.E. Areschoug) Hauck 1878, *Mesophyllum macroblastum* (Foslie) Adey, *Lithothamnion minervae* Basso, *Neogoniolithon mamillosum* (Hauck) Setchell & L. R. Mason, encrusting *Peyssonnelia rubra* (Greville) J. Agardh 1851, *Peyssonnelia squamaria* (S.G. Gmelin) Decaisne 1842, *Peyssonnelia polymorpha* (Zanardini) F. Schmitz 1879, etc. Due to difficulty of their identification by non-experts based on photo sampling, these algae will be treated in the analysis as two categories: Coralline algae and encrusting *Peyssonnelia* sp.

[2] This group includes bryozoans such as *Smittoidea* sp., *Rhynchozoon* sp, *Schizomavella* sp., *Celleporina* sp. Due to inability to identify these species based on photo sampling, they will be treated in the analysis as the category of encrusting bryozoans.

[3] This group includes species such as *Womersleyella setacea* (Hollenberg) R.E.Norris 1992, *Lophocladia lallemandii* (Montagne) F.Schmitz 1893, *Acrothamnion preissii* (Sonder) E.M.Wollaston 1968. For their unequivocal identification a physical sample needs to be examined.

Habitat types generally associated in the field

- Enumeration of habitat types that come in mosaics or are exposed to succession (phytodynamic successions, zonations or mosaics)

In many cases biocoenosis of infralittoral algae (G.3.6.1) included in the habitat type "1170 Reefs" and the habitat type "8330 Marine caves" may be found at the same sites where coralligenous habitat is present. Depending on the irradiance levels, coralligenous assemblages may be found as enclaves within the assemblages of infralittoral algae or follow them in vertical zonation, developing in conditions of reduced irradiance (usually below 30 m depth). Depending on the site's geomorphology, marine caves may be present at the same sites, sometimes even within the same depth range as the coralligenous habitat and the biocenosis of semi-dark caves may develop in conditions of further reduction of the irradiance (e.g. in overhangs, tunnels).

Above the sea level or within the subsurface layer at the same sites where coralligenous habitat develops at depth, several other habitats included in the habitat type "1170 Reefs" could be found, such as:

- F.4.2.1. Biocoenosis of supralittoral rocks ;
- G.2.4.1. Biocoenosis of upper mediolittoral rocks ;
- G.2.4.2. Biocoenosis of lower mediolittoral rocks.

Structures and functions

- Description of physical components of the habitat type
- Description of structural and functional characteristics of the habitat type important for typical/threatened/indicator species
- Description of ecological processes occurring at a number of temporal and spatial scales including notes on fragmentation

In the Croatian waters, coralligenous assemblages develop in dim-light conditions below 20 m depth (up to 100-130 m in some areas) (Bakran-Petricioli, 2011). These bioconstructions are found on vertical walls and overhangs as well as on horizontal and sub-horizontal bottoms. The coralligenous communities usually develop at depth below the thermocline (where temperatures rarely exceed 20 ºC). For the implementation of adequate management plans and conservation measures for coralligenous assemblages, the understanding of the functioning of their key species is essential. These studies may be enhanced by inclusion of species that could be considered as:

(a) indicator species, i.e. their presence and abundance can be related to the differential response to several disturbance pressures;

(b) species that are structurally important. The main species belong to the most conspicuous taxa such as macroalgae, sponges, anthozoans and bryozoans.

The species presence and abundance that characterise the coralligenous habitat in different areas is still poorly known. The available data indicate the high heterogeneity of the assemblages. The current patterns of distribution and abundance respond to multiple interacting ecological and historical factors. Nonetheless, recently the project IndexCor (Sartoretto *pers. comm.*), focused on the coralligenous thriving in the French Mediterranean coast, provided the first indicator species list for the coralligenous, outlining their sensibility to disturbances (mostly based on expert opinion). The main factors causing impacts (change) in the coralligenous communities were identified as: increased concentration of organic matter, elevated sedimentation rate, habitat destruction and seawater warming. However, some of determined indicator species are absent or show low abundance in the Croatian part of the Adriatic Sea (at least according to the available information). Therefore, the application of the same set of indicator species to the Croatian coralligenous communities is not straightforward.

Pressures and threats

- Detailed and precise description of known important influences from the present and past (pressures) and prospective ones (threats)

Coralligenous assemblages are threatened by specific direct and indirect human activities, which affect the stability of this precious ecosystem and thus strongly compromise their future maintain. These disturbances include direct and indirect impacts of fishing activities (e.g. trawling, exploitation of the red coral), degradation by wastewater, the colonization by invasive species and the effects of global climate change (Ballesteros, 2006; UNEP/MAP-RAC/SPA, 2008).

The effects of disturbances on the coralligenous habitat are still poorly known. However, the available data indicate long-lasting effects after impacts of acute events (e.g. mass mortalities linked to anomalous temperatures and severe storms; Linares *et al.* 2009; Teixido *et al.* 2013). After these events, the assemblages showed limited recovery capacity. Moreover, bearing in mind the life-history traits of most species thriving in the coralligenous habitat (long-lived species with slow population dynamics), the assemblages could be already following degradation trajectories under the effects of slow drivers of change (e.g. pollution, sedimentation). Despite of this, some positive effects of recovery have been also documented, such as recovery of fish stocks (e.g. groupers) after fishing prohibition (e.g. Garcia-Rubies *et al.* 2013).

Trawling is probably the most destructive fishing method and is causing degradation of large areas of coralligenous concretions. Trawling does not only cause direct physical damage by breaking down the coralligenous structure and rolling the coralligenous blocks, but also negatively affects photosynthetic production of encrusting and erect algae by increasing turbidity and sedimentation rates when applied to adjacent sedimentary bottoms (UNEP/MAP-RAC/SPA, 2008).

Special type of trawling which uses the "St. Andrew Cross" to collect precious red coral is highly destructive. This kind of gear is currently forbidden in most Mediterranean countries (including Croatia), however some poachers still use it.

Both traditional and recreational fishing also have an effect on coralligenous communities, although they mainly affect the target species. Fishing leads to a significant decrease in mean specific number of fish species, producing changes in the community composition. This effect is due not only to the nearly total absence of some fishes and lobsters (e.g. *Epinephelus marginatus* and *Palinurus elephas*), but also to the notable scarcity of other species. Besides, fishing activities can degrade habitat complexity due the breakage and mortality of fragile macrobenthic species during contact with fishing lines and nets (Bavestrello *et al.* 2000). The consequent erosion of complexity results from the reduction in the abundance and/or size of large gorgonian and bryozoan colonies for instance. The reduction of complexity could infer further biodiversity loss, however the extent of this impact and the associated mechanisms are still poorly understood (Cerrano *et al.,* 2010).

The coralligenous habitats are among the most popular sites for recreational diving in the Mediterranean due to their great variety of life and great visual appeal. Some studies have detected the direct impact of divers on the largest invertebrates developing fragile calcareous skeletons such as the bryozoans (e.g. *Pentapora fascialis*). The impact was greater on boulders covered by coralligenous concretions than on vertical walls, probably as a result of the protection provided by the dense canopy of the gorgonian Paramuricea clavata (Garrabou *et al.,* 1998). Furthermore, gorgonian populations displayed higher mortality rates in areas submitted to high diving activities (Coma *et al.,* 2004) reducing thus the protective canopy for other fragile species.

Dense and thick formations of <u>mucilaginous aggregates</u>, caused by seasonal proliferation of several phytoplankton species, may cause severe damage to the sessile benthos in the coralligenous habitat, especially to the erect suspension feeders. These aggregates may prevent normal food supply and induce partial and total mortality (e.g. Giuliani *et al.,* 2005). In addition, these aggregates may facilitate the spread of microbial pathogens (Danovaro *et al.,* 2009). Mucilage events were sporadically recorded in the Adriatic Sea since the 18th century (Fonda Umani *et al.,* 1989) and this threat is likely to enhance in the future, as the predicted increase in seawater temperature and stability of the water column due to climate change may promote more frequent formation and higher persistence of the aggregates (Danovaro *et al.,* 2009).

<u>Eutrophication</u> (e.g. due to waste water discharges or aquaculture) may inhibit coralline algae growth, increase bioerosion rates, decrease species richness and densities of the largest individuals of the epifauna, eliminate some taxonomic groups and increase the abundance of highly tolerant species. Thus, it can considerably affect the structure of coralligenous assemblages (Hong, 1980, 1983; Ballesteros, 2006).

Some species introduced into the Mediterranean have become <u>invasive</u> and a number of them can thrive in, or are more or less adapted to, the coralligenous habitat. Currently, only introduced algal species are known to be threatening the coralligenous community. Among them, putatively the most dangerous one is the filamentous red alga Womersleyella setacea, which is currently distributed along most of the Mediterranean basin, including the majority of Croatian part of the Adriatic Sea. To date, dense settlements were observed within the coralligenous in the N.P. Kornati and Biševo Island (unpublished data) (Fig. 2).

Another invasive algal species, *Caulerpa racemosa* var. *cylindracea* has been found in Croatia on more then 120 locations, including the upper level of coralligenous assemblages, at least on Biševo Island and Pelješac Penninsula, thriving among gorgonians *Paramuricea clavata* and *Eunicella cavolinii* (Fig. 3). These species can form thick carpets covering all organisms from the encrusting and basal stratum. We already have some evidences showing significant negative impacts on recruits and adult survival rates of different organisms and abnormal reproductive cycles of species recovered (e.g. Cebrian *et al.* 2012; Linares *et al.* 2012). Other invasive algae, recorded in the Adriatic and potentially posing a threat to the coralligenous assemblages are *Acrothamion preissii* and *Lophocladia lallemandii*. They have been also reported to be colonizing coralligenous habitats in the western Mediterranean but to date they were not observed in the Adriatic deeper than 15 m, thus not affecting the coralligenous habitat.

Several episodes of suspension feeder mortality events have been recorded in the Western Mediterranean (e.g. Cerrano *et al.* 2000, Garrabou *et al.* 2009). The characteristic summer conditions of reduced resources, high water column stability and high temperatures (normally during late summer) lasted much longer than usual in the summer. This coincided with a mass mortality of benthic suspension feeders, affecting coralligenous communities situated at a depth of up to 40 m, where the temperature anomaly was also detected. Since mass mortalities have been related to the anomalous positive temperature conditions, and these conditions are expected to be more frequent under the current <u>global warming</u> trend, mass mortality events might increase during next decades (Garrabou *et al.* 2009).

Overall, the impacts of these disturbances are expected to cause profound changes in the specific composition, structure and functioning of coralligenous assemblages.

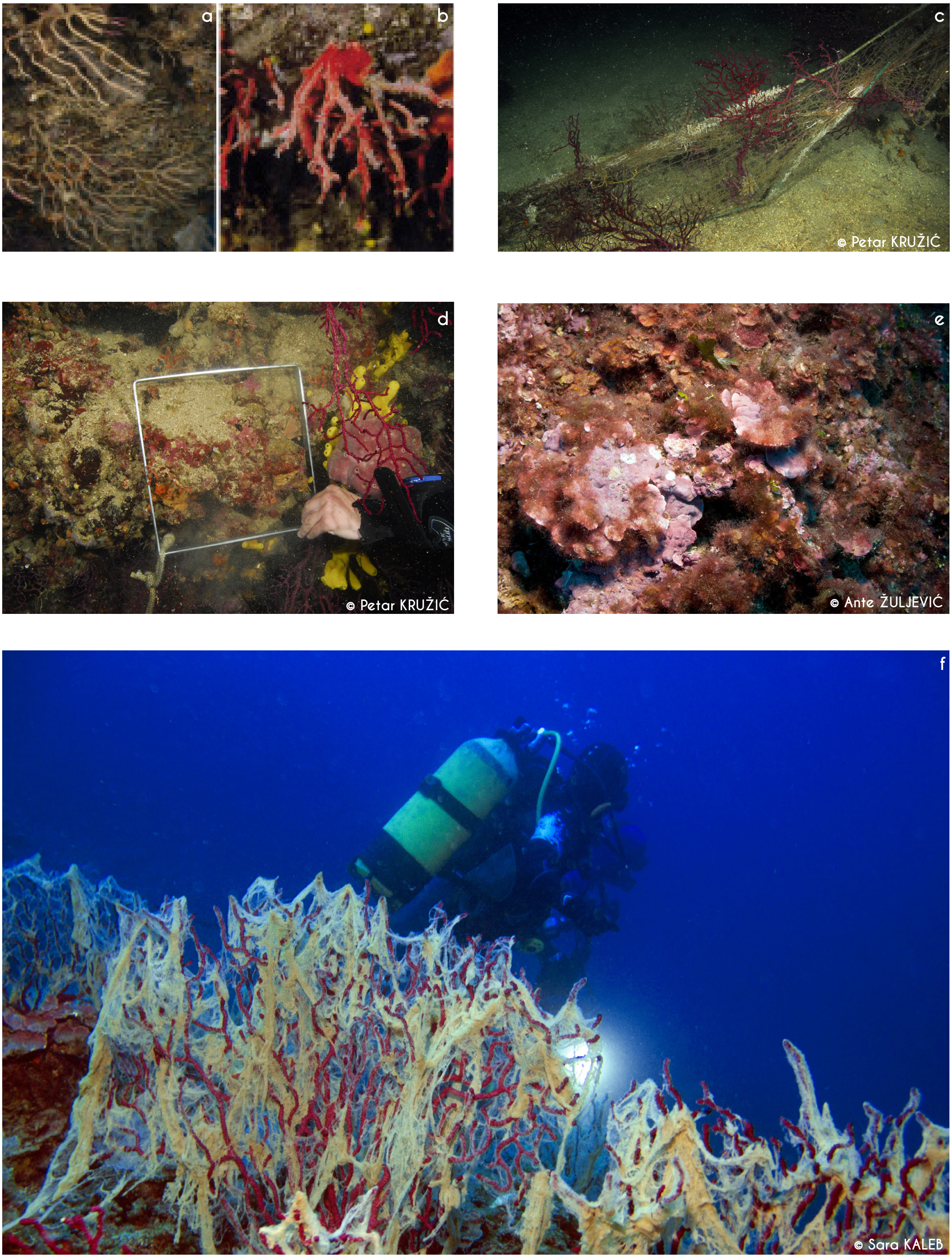

Figure 2. Disturbances affecting coralligenous habitat. Mass mortality outbreaks related to global climate change:
a) naked branches (devoid of tissue) of the red gorgonian *Paramuricea clavata* (adopted from Garrabou *et al.* 2009);
b) necrotic tissue (greyish in color) of the precious red coral *Corallium rubrum* (adopted from Cerrano *et al.* 2000);
c) destructive impact of fishing nets;
d) sedimentation over coralligenous outcrops;
e) invasive red turf algae *Womersleyella setacea* overgrowing coralligenous main builders, calcareous red algae.
f) mucilaginous algal aggregates over gorgonian branches;

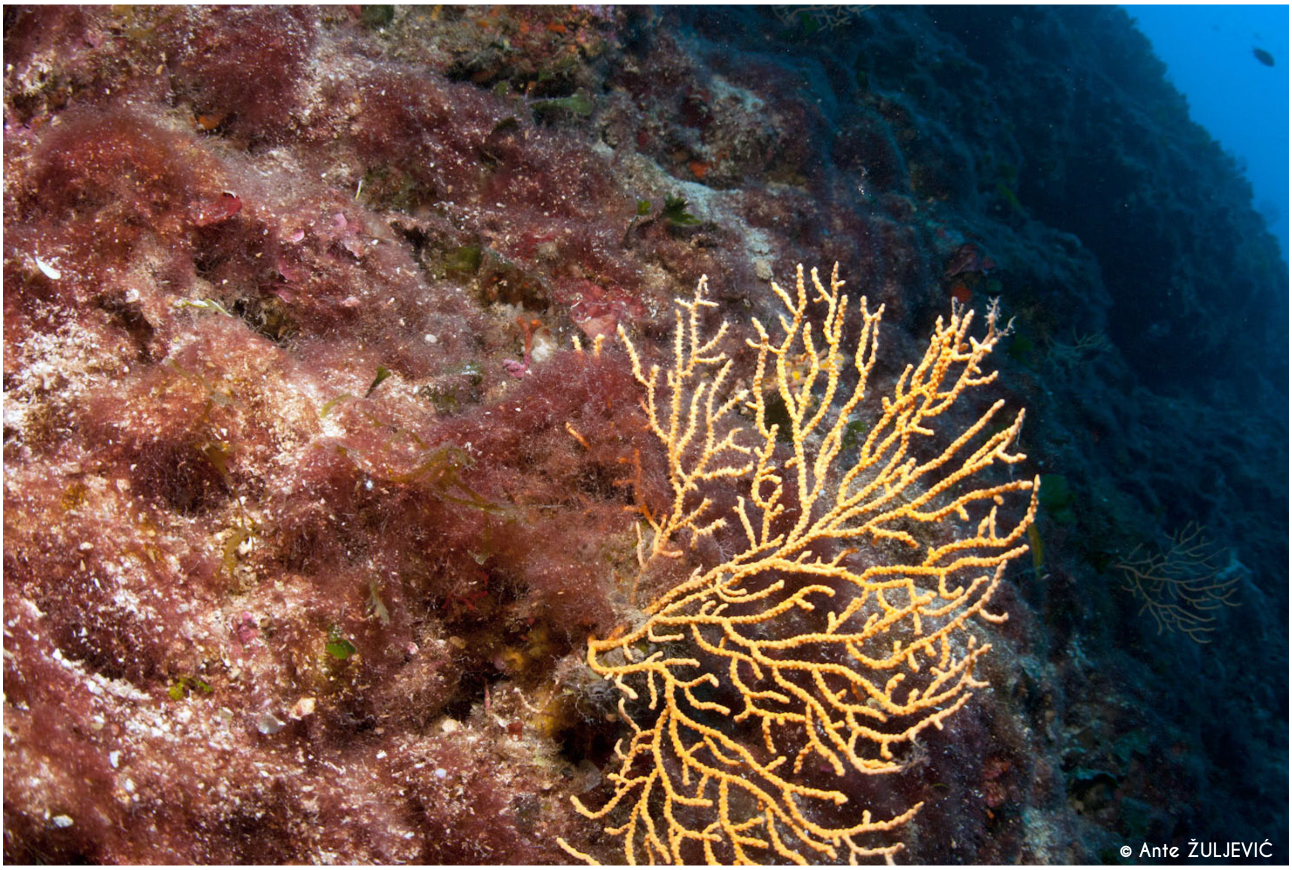

Figure 3. Invasive red turf algae *Womersleyella setacea* found in the upper depth limit of coralligenous assemblages at Mana Island, Kornati National Park

Conservation measures

- Detailed and precise description of measures already **realized as well as needed** to avoid pressures and threats

National legislative protection

Some species of corals associated with coralligenous habitat are strictly protected according to Nature Protection Act (NPA) (Official Gazette 80/2013) and Ordinance on strictly protected species (Official Gazette 144/2013). Those are for example *Corallium rubrum, Paramuricea macrospina, Eunicella verrucosa, Savalia savaglia* etc. Article 228 of Nature Protection Act prescribes a fine of 25.000 to 200.000 Croatian kunas for legal persons and 7.000 to 30.000 kunas for physical and responsible persons for a misdemeanour on strictly protected species.

According to NPA and the Ordinance on habitat types, habitat map, endangered and rare habitats and habitat conservation measures (Official Gazette 119/09), coralligenous biocenosis is an endangered habitat. Ordinance also lists general conservation measures for each main habitat type, both terrestrial and marine. Those measures are then incorporated into other sectoral plans or serve as guidelines for introducing stricter and more specific measures. Some of the general measures that concern also coralligenous habitat are: maintain or improve favourable physical and chemical characteristic of seawater; conserve favourable structure of seafloor and coast; conserve species important for habitat type; do not introduce alien species and GMO; etc.

Marine Fisheries Act (Official Gazette 81/2013, article 76, item 19) prescribes a fine of 40.000 to 75.000 kunas for violation of prohibition of fishing by trawl nets, dredges, shore seines or similar nets over coralligenous habitat and maerl beds, defined by Article 4.2 of the Council Regulation (EC) No 1967/2006.

Annexes of the Habitats Directive

According to National Classification of Habitats of the Republic of Croatia, coralligenous biocenosis, together with 7 other biocenoses is part of Annex I habitat - 1170 (Reefs) - listed on Annex I of the Habitats Directive.

Regulation on Ecological network has been proclaimed in October 2013 (Official Gazette 124/2013). There are 119 sites of Ecological network Natura 2000 in which reefs (including coralligenous outcrops on most of the sites) are the target habitat. A list of these sites is included in Annex III of the Regulation on Ecological network.

Conservation of areas of ecological network is assured by nature impact assessment procedure, by effective management of sites and by conducting basic conservation measures.

Red List

Red Book of Corals of the Republic of Croatia is in preparation and will be finished in 2014. From 116 corals found in the Croatian part of the Adriatic, 84 of them are listed on the Red List. Conservation measures that arise from the Red Book include reduction of anthropogenic pollution, more efficient implementation of legislation, reduction of fishing effort, establishment of monitoring, etc.

A part of coralligenous outcrops is located within Croatian marine protected areas (MPAs) including: Telašćica Nature park, Kornati National park, Mljet National park and Lastovo Islands Nature park. The level of protection and its enforcement within these MPAs can vary significantly.

Bearing in mind recent scientific evidences (Linares and Doak, 2010; Micheli *et al.,* 2012) every effort should be made to regulate more controllable impacts (e.g. fishing) within MPAs in an attempt to increase the resilience of marine organisms and habitats (including the coralligenous) facing less controllable effects of climate change. There is a number of recommendations on what can be made in order to maintain (or restore) coralligenous habitats in favourable conservation status.

As outlined by the Action plan for the conservation of the coralligenous and other calcareous bio-concretions in the Mediterranean Sea (UNEP/MAP-RAC/SPA, 2008), measures aimed at protecting the coralligenous environment (in fact applicable to many other coastal benthic habitats) should include the following:

- Wastewater dumping should be banned over coralligenous bottoms, and in their vicinity.
- Trawling prohibition by Council Regulation (EC) No 1967/2006 (Article 4.2) must be rigorously enforced in areas with coralligenous outcrops and in their vicinity, aiming to avoid not only the physical damage to this habitat but also the indirect effects due to increased turbidity and silting.
- Any other anthropogenic activity involving an increase in water turbidity and/or sediment removal (e.g., coastline modification, beach regeneration) should be avoided in the vicinity of coralligenous outcrops.
- Adequate management of traditional and recreational fisheries must be implemented in order to prevent stock depletion of target fish and crustaceans.
- Diving should be managed in the manner not interfering with the normal functioning and conservation of the coralligenous environment.
- A suitable legislation concerning the introduction of alien species should be urgently enacted.

Figure 4 shows Natura 2000 sites for the habitat type 1170 Reefs.

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Figure 4. Natura 2000 sites for the habitat type 1170 Reefs (from SINP, 2014)

Specific chapters for biogeographical regions where the given habitat type occurs

MONITORING PROGRAMME FOR THE CONTINENTAL / ALPINE / MEDITERRANEAN BIOGEOGRAPHICAL REGION

Each Monotoring Programme includes following common preliminary information

- Short description of **basic scheme of surveillance** (how mapping and monitoring are combined)
- **Sharing the data** or methodologies with other monitoring programmes (for other habitat types or species, other projects or monitoring systems)
- Rules of occupational safety and compliance with all relevant statutory instruments including list of permits needed for research when that is the case (instructions for the field workers).

The basic scheme of surveillance includes periodic monitoring of reference parameters as indicators of conservation for the targeted habitat type. Monitoring is conducted by a combined method that includes gathering of habitat and species data by scuba divers up to 40 m depth and by the Remote Operate Vehicles (ROVs) beyond this depth range.

Monitoring parameters include:

- **Structural and functional parameters**:
  - Species/Categories composition/abundance (semi- or quantitative data) ;
  - Indicators on the degree of complexity of coralligenous habitats ;
  - Indicators on coralligenous functioning: bioeroders and bioconstructors ;
  - Qualitative, semi- and quantitative indicators on the impacts of different disturbances on coralligenous communities (e.g. presence of fishing nets, invasive species, sedimentation, high diving pressure).

These parameters can be determined every three years.

- **Environmental parameters:**

Mainly temperature conditions obtained with temperature data loggers (other parameters could be added in the future depending on the technological developments, e.g. transparency, pH). Temperature records can be obtained on hourly basis and recovered on annual or semi-annual basis. The data loggers can be setup every 5 m from surface down to 40 m in order to acquire information on stratification dynamics along the vertical profile, including depths where the coralligenous habitat develops.

Mapping and monitoring should be combined in a way to increase the knowledge on the distribution of the coralligenous habitat. The monitoring sites could then be chosen with regards to different environmental conditions, providing a broader view on the status of the habitat.

As suggested by the Action plan for the conservation of the coralligenous (UNEP/MAP-RAC/SPA, 2008), when selecting monitoring sites one should keep in mind the existence of previous information on the extension and ecological quality of the coralligenous habitat.

During selection process, it is recommended to consider the following questions:

- Is there previous information available on coralligenous assemblages at the site or, if there is no available information at all, are the sea bottom geomorphological features suitable for the development of coralligenous frameworks ?
- According to the present knowledge, are considered coralligenous assemblages representative for a wider geographical area ?
- Are considered coralligenous assemblages especially healthy to be able to serve as reference points ?
- Are considered coralligenous assemblages under some clearly recognizable direct or indirect anthropogenic disturbance that would allow the assessment of the impact of these disturbances ?

Sharing of data gathering efforts/costs:

Depending on the monitoring protocols adopted for other habitats included in the habitat type “1170 Reefs” and the habitat type “8330 Submerged or partially submerged sea caves” that develop at the same sites as the coralligenous habitat, the monitoring efforts could be combined. For example, in those cases groups in charge of monitoring of these habitats could share the associated costs.

Permissions needed:

Permission to carry out the monitoring activities should be obtained from the Croatian Ministry of Environmental and Nature Protection (MENP). The written request should outline methods to be used during the underwater work i.e. photosampling and visual census performed while Scuba diving, setting up devices to monitor physical and chemical conditions.

Since data on the composition of the coralligenous assemblages in the Adriatic Sea is lacking, scientific research is envisaged to improve the current knowledge. For such purpose, the personnel in charge of the monitoring should have permission to collect voucher specimens of species that cannot be identified from the images. Additional permission should be obtained from the MENP for the collection of these specimens.

When working inside the protected areas, planned field activities should be also communicated to the public authority managing them.

Field mapping

- Detailed description how the habitat type is surveyed during system of mapping for all habitat types prepared directly by SINP (if no mapping is planned the whole chapter "field mapping" has to be deleted)

Comprehensive mapping of this habitat type is needed, since there is no systematic knowledge on its distribution along the Croatian coasts. The requirement for reporting is to provide distribution on a basic scheme of surveillance: 10x10 km. However, bearing in mind the characteristic patchy distribution of coralligeneous habitats the resulting grid would actually show that coralligeneous is present everywhere thus providing a biased image.

Mapping of coralligenous habitat is very complex because of its patchy distribution, sometimes limited extensions and occurrence of some of the assemblages on vertical walls. These features make its mapping expensive and time consuming and will demand the combined use of the most modern technologies and new analytical methods (use of new devices such as side-scan sonar or multibeam echosounder) for field surveys and post-data treatment. Methodological problems associated with mapping of coralligenous habitats, such as the acquisition and interpretation of side-scan sonar images for horizontal substrata, or multibeam echosounder images suitable both for horizontal substrata as well as vertical cliffs (the latter are one of the most characteristic substrata where coralligenous outcrops develop), need to be addressed to provide significant advances in mapping activities. An example of an Integration of different technologies into a Geographic Information System (GIS) to study coralligenous biocenosis is: http://www.rac-spa.org/cor/Session%202/03-%20Canese%20etal.pdf (Italy).

Overall, acquiring detailed information on the current distribution of coralligenous habitat can be envisioned as a long-term goal due to extension of Croatian coasts. In this context, Croatia is planning to apply for EU Structural Funds to undertake mapping of the marine habitats (however the earliest actions are expected to start in 2016). RAC/SPA applied for funding to MAVA for habitat mapping, including Croatia (still pending of resolution).

Monitoring on plots

Objectives

- Clarification why (this type of) monitoring is chosen for habitat type surveillance (if not the whole chapter "monitoring on plots" has to be deleted) and **what outputs are awaited**
- Description of connection with monitoring of other habitat types

Habitat type 1170 and the coralligenous assemblages within it are very sensitive to change in environmental conditions as well as to mechanical impacts. Such changes create high stress that affects habitat structure and function, and may result in habitat degradation and ultimately could cause biodiversity losses, which in extreme cases can drive to local extinction of some populations. Monitoring is chosen in order to:

(i) estimate the conservation status of the habitat

(ii) assess the temporal trend of habitat changes

(iii) plan appropriate measures to minimize impacts

(iv) assess the effect of selected measures

(v) if necessary, re-fix strategies according to the concept of adaptive management based on the immediate integration of the monitoring results.

The ultimate goal is to produce a range of useful information that enable elaboration of efficient management measures to ensure that the habitat and the constituent species remain or are returned to a favourable conservation status in accordance with the HD requirements.

For the coralligenous habitat we lack basic information, which hinders to retain a fix definition of the methods and metrics to be used. In contrast, we propose the basic methodological approach that will enable gathering the information needed and that will serve as basis to reformulate the methods adopted. For instance, we lack information on the abundance of potential key species in the coralligenous, thriving in different areas of the Croatian coast. Therefore, only after determining the list of key / important species for monitoring we could retain the monitoring methods. Besides, bearing in mind the depth range in which coralligenous outcrops develop, and the limited bottom working time, the applicability of protocols has to be tested.

In summary, monitoring scheme proposed here is based on the most recent (although scarce) knowledge on the monitoring approaches for this habitat, the compilation of available information for the coralligenous thriving along the Croatian coast as well as on the results of the fieldwork (July 2013) devoted to test the monitoring protocols in the framework of the MedMPAnet Project. The final goal of the monitoring is the surveillance of the habitat in order to estimate changes in its structure as well as modifications of the community composition and functioning at each monitored site.

Outputs awaited are:

1. Community composition in macrobenthic species/ categories ;
2. Indicator on habitat complexity ;
3. Information on the degree of impact of main disturbances affecting the coralligenous habitat ;
4. Information on environmental conditions (temperature regimes and sedimentation).

The information collected should allow quantifying coralligenous health status indices.

These indices are currently being developed under different national initiatives in other Mediterranean countries (e.g. IndexCor – France). The information from the Croatian coast could be an original data set to validate such indices.

Field work instructions

- Determination of field workers specialization
- **Detailed instructions** for the field work including:
  - period for monitoring (+ other limits like temperature if appropriate);
  - character of plots to be chosen in the field and how to mark it;
  - description of data recording.

Field workers specialization

1. Field sampling (including acquisition of photosamples and gathering information on habitat complexity, presence and absence of disturbances affecting the habitat, and setting up temperature data loggers) requires trained divers: marine biologists, MPA managers and recreational divers not necessarily with a degree in environmental sciences.
2. Data analysis on species composition (identification of main selected species/categories), data treatment on habitat complexity, assessing the degree of disturbance regime and temperature conditions requires marine biologists (ideally with some experience in coralligenous habitats).
3. Regarding the occurrence of major disturbances in the coralligenous habitat (such as mass mortality, presence of invasive species, fishing nets and/or mucilagenous aggregates), an alert mechanism through citizens' science initiatives could be set up. Local people could track the changes on the yearly basis, upon successful completion of a specific training that would build up their capacities. Such an approach would save a lot of resources at mid-term.

Period of monitoring

The ideal period of monitoring is late summer (late August to early October). At that time water transparency and temperature allow better performances on data gathering and photosampling. In addition, if any mass mortality occurred during summer it can be observed in this period. The periodicity of monitoring for each site should be every 3 years as a minimum, since temporal trends are expected to be monitored.

For environmental conditions temperature data loggers should be recovered at least once per year. In this case other periods of the year may be suitable (such as summer months of July or August).

Character of plots to be chosen in the field and how to mark it

Bearing in mind the depth ranges where coralligenous habitats develop (>25 m depth) along the Croatian coasts, the sampling will be carried out using random plots and transects in each selected site for monitoring.

For each monitoring site, a short video could be produced that would display the remarkable landscape marks to identify the diving site, and the diving track till the sampling area. The wide-angle video camera (e.g. GoPro cameras) could be used.

Definition of a monitoring site

A location where coralligenous outcrops are developed.

At each site, determine the depth range were the monitoring will be carried out (e.g. 30-35 m), in order to avoid the potential effect of depth in the outcome of the surveys.

Within the depth range selected, in order to limit the effects of local heterogeneity on the outcome of the surveys, determine when possible, with the help of remarkable seascape marks, the specific monitoring area (e.g. it should be an area of several 100 m^2) of each sampling site. Eventually some marks can be fixed to help the relocalization of the area.

Within the specific monitoring area the data recording (sampling scheme, Fig. 5) will be carried out.

Description of data recording

At each site photosampling will be combined with visual census to gather the information on habitat structure and function as well as on the degree of impact of the main disturbances.

For different parameters we outline the metrics to be collected, the sampling approach to be used and the data acquisition process. Since the same sampling approach is used for different parameters, it is only described once and referred to thereafter.

Habitat structure and function

1. Habitat species/categories composition and abundance

Parameter: Species composition and abundance

Method: Photosampling of minimum of three areas of 2,5 m^2 (comprised of 10 contiguous photos of 50 x 50 cm quadrats to ensure species identification) within the same depth range. The development of new high-resolution video cameras may offer the opportunity to use these devices in the future instead of photo cameras. The use of video could speed up the time of acquisition.

From photographs it will be possible to identify the presence of typical (target) species and estimate their abundance using semi-quantitative (e.g. assessing frequency of occurrence) or quantitative (assessing % cover) method.

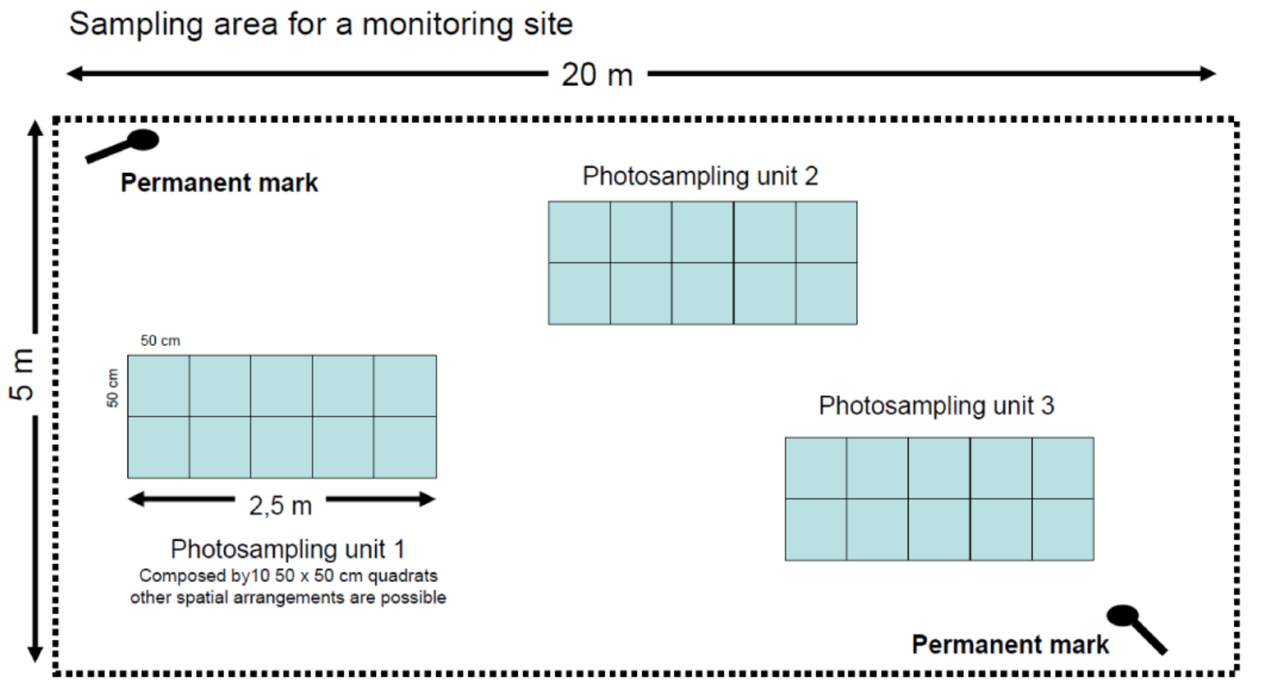

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Figure 5. Sampling scheme

2. The degree of complexity of coralligenous habitat

Parameter: Structural complexity of the habitat focusing on the cover of the three main layers described for the coralligenous: basal (encrusting), intermediate (bushes) and upper (erect) layers. By combining the estimates on the cover data obtained for each layer it will be possible to characterise the complexity of the coralligenous habitat at each sampling site. The method is still to be developed but all available studies are based on the species list and their abundance. For instance, depending on the cover of each layer, the site will obtain a score, which then can be combined (e.g. summed-up) to determine the degree of complexity.

Description of the layers for which the cover will be estimated:

Basal layer: composed mainly of encrusting calcareous algae (e.g., *Mesophyllum macroblastum* and *Lithophyllum stictaeforme*), non-encrusting algae *Peyssonellia* spp., encrusting macroinvertebrates (sponges *Crambe crambe*, *Spirastrella cunctatrix*- and tunicates – *Diplosoma* sp., *Cystodites dellechajei*)), boring sponges, turf (aggregates of small organisms such asseasonal hydrozoans, filamentous algae), bare rock and sediment.

Intermediate layer: composed mainly of massive or bush-like organisms below 15 cm in height such as sponges (*Iricina* spp., *Cacospongia* spp., *Spongia* spp., *Chondrosia reniformis, Axinella damicornis*), anthozoans (*Leptopsammia pruvoti, Caryophillia smithii*), bryozoans (*Myriapora truncata, Smittina cervicornis, Adeonella pallasi*) and tunicates (*Halocynthia papilosa*).

Upper layer (or erect stratum): composed of arborescent and massive species that can reach heights and/or diameters above 15 cm (mainly gorgonians, but also sponges such as *Axinella polypoides, Axinella cannabina*).

In this approach it is important to emphasize that the focus is on the morphology/size of the organism and not on its taxonomic identity, as the same species could be attributed to different layers, depending on the size of the actual specimen. For example, branchy bryozoan *Pentapora fascialis* or sponge *Aplysina cavernicola* could be attributed to intermediate layer if colonies are smaller than 15 cm, whereas larger colonies (>15 cm) would qualify for the upper layer (erect stratum).

Methods: Basal and intermediate layers. Cover for these two layers will be estimated from photographs obtained by photosampling (see description of the method for Habitat species/categories composition and abundance parameter).

Erect layer: Cover of erect layer will be obtained with visual census. Along three 10 x 1 m horizontal transects the cover of erect species present at the monitored site will be estimated. To help with the estimates the divers can use a bar of one meter long and note species present and estimate their density within each 1 m^2. In this manner, the diver will evaluate the density over the surface that extends 50 cm over and below the bar and afterwards he/she will move to the next m^2.

To avoid counting of all colonies, the following categories of density will be assessed for each quadrat:

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: 10-20 colonies per m^2

Category 5: >20 colonies per m^2

For example, in one quadrat the diver will note Category 3 when 4 colonies of Paramuricea clavata and two colonies (specimens) of *Aplyisina cavernicola* higher than 15 cm are present.

The total cover of the erect layer for each transect will be obtained by summing up the values of scores for each category determined for each quadrat:

Category 1: Score = 0

Category 2: Score = 1

Category 3: Score = 2

Category 4: Score = 3

Category 5: Score = 4

Finally, the cover of the erect layer will be obtained from the total score per transect (i.e. the sum of the scores of ten quadrats). The total score can range from 0 to 40. The estimate of erect layer cover in each transect will be determined according to the following categories:

Total score value	Cover
0	Null
1-10	Low
11-20	Medium
>20	High

3. Bioconcretion. Cover of algal and animal builders

Method: Estimate of the cover of encrusting calcareous algae and macroinvertebrates contributing to build-up of the coralligenous outcrops from photoquadrats obtained by photosampling (see description of the method for Habitat species/categories composition and abundance parameter).

4. Bioerosion. Estimate the abundance of bioeroders: *Cliona* spp. cover and enumeration (quantitative or semi-quantitative) of bioeroding molluscs *Gastrochaena dubia* and *Lithophaga lithophaga*

Method: Estimate of the cover of boring sponge *Cliona* spp. and enumeration of bioeroding molluscs from photoquadrats obtained by the photosampling (see description of the method for Habitat species/categories composition and abundance parameter).

5. Bioerosion. Estimate the effects of bioeroders: grazing marks

Method: Evaluation of grazing marks from photoquadrats obtained by photosampling (see description of the method for Habitat species/categories composition and abundance parameter).

6. Abundance of macro-bioeroders (sea urchins *Sphaerechinus granularis, Echinus* sp.)

Method: Visual census of sea urchins along each of the three 10 x 1 m horizontal transects used to estimate the cover of the erect layer. For this parameter the observers will count the total number of individuals of each species in each quadrat along the same transects.

Degree of impact of disturbances

7. Fishing pressure

Method: visual census / direct observation providing an estimate on the presence and type of fishing gear at the study site. If fishing net/long line is observed within the coralligenous habitat, its length should also be estimated.

Category	Total number of fishing gears
Low	0
Medium	1-5
High	>5

8- Sedimentation

Method: Estimate of the presence of sediments from photoquadrats obtained by photosampling. This parameter will be already available from the estimates of cover of basal layer (see description of the method for Habitat species/categories composition and abundance parameter).

9. Conservation status of gorgonian populations (Estimates on the impacts of mass mortality on gorgonian populations)

Method: Visual census that can be performed (or not) along the 10 x 1 m transect used to evaluate the cover of the erect layer and macrobioeroders.

Along transects the percentage of affected colonies will be quantified based on the assessment of a minimum of 100 colonies. Colony is considered to be affected when the necrosis rate accounts for more than 10% of its total surface (Fig. 6). For affected colonies it should also be noted whether the necrosis is recent (presence of denuded axis or axis colonized by pioneering species such as hydrozoan species), old (axis covered by long-lived species such as bryozoans, calcareous algae) or both types of necrosis are present (Fig. 7).

10. Mucilagenous aggregates

Method: Visual census on mucilaginous aggregates coverage along transects. Estimates can be made in each quadrat to cope with the potential heterogeneity, however usually this phenomenon is quite homogenous, at least at the scale of the 10 m^2 transects, and it could be easier to provide a single estimate for the whole transect.

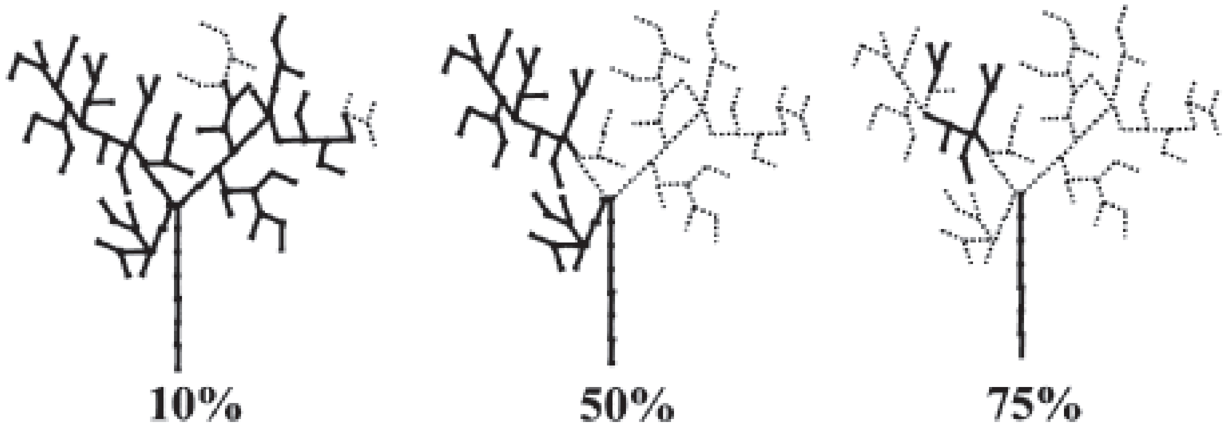

Figure 6. Estimation of the colony›s extent of injury (adopted from Perez *et al.* 2000).
According to the proposed protocol, colonies with > 10 % injured surface are considered as affected

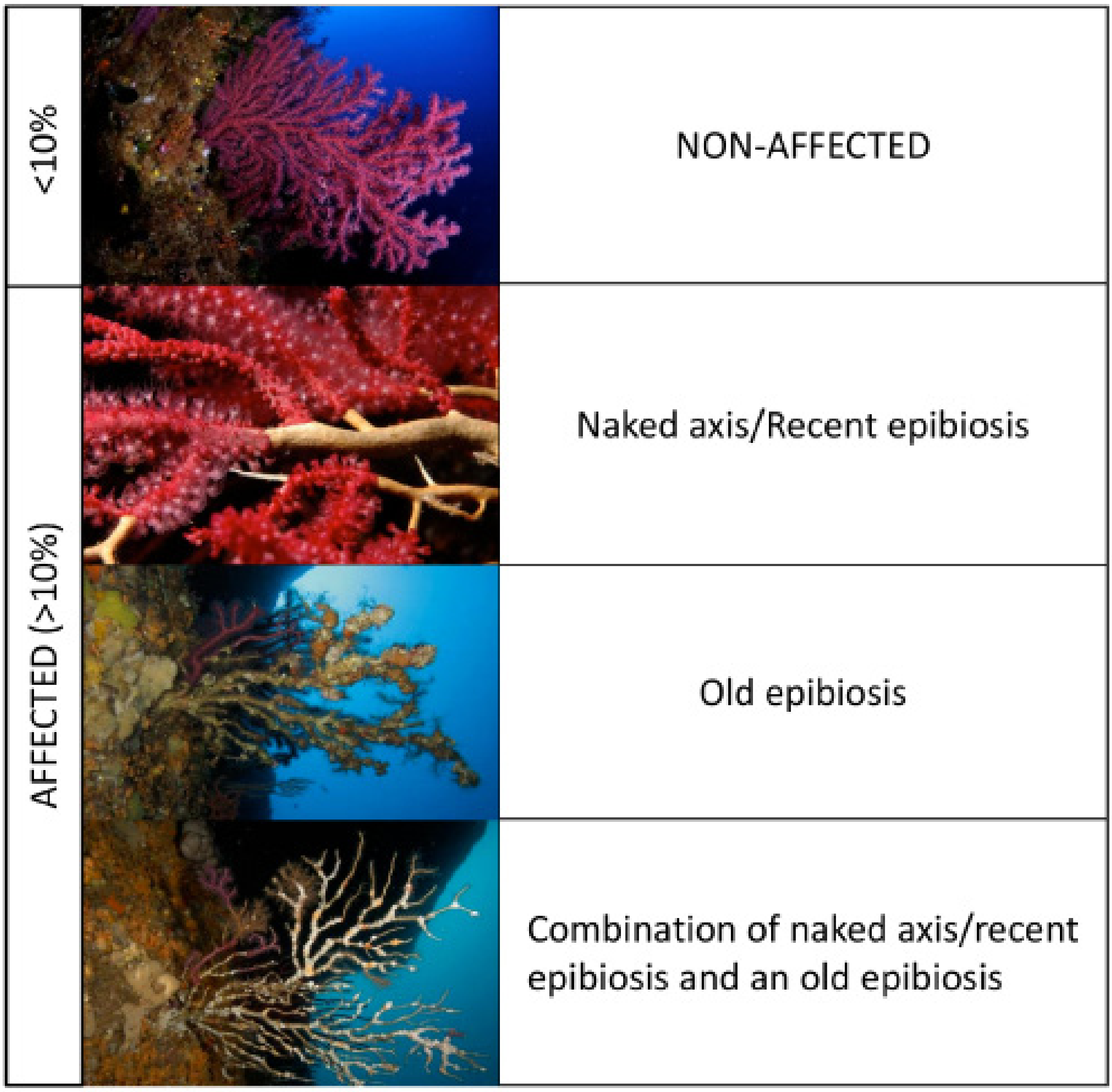

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Figure 7. Illustration of non-affected and differently affected gorgonian colonies
using categories as defined in the data form (see the Annex II)

Category 0 (Null): 0 % cover of the transect

Category 1 (Low): low abundance in the basal-intermediate layers and/or in the erect layer

Category 2 (Medium): High abundance either in the basal-intermediate layers or in the erect layer

Category 3 (High): High abundance both in the basal-intermediate layers and in the erect layer

In the case of high heterogeneity within transects, we could determine the cover of mucilaginous aggregates in each quadrat and determine its total cover following a similar system to the one proposed for the cover of the Erect layer.

11. Invasive species: Abundance of invasive species

Method: Estimates on invasive species abundance from photoquadrats obtained by photosampling (see description of the method for Habitat species/categories composition and abundance parameter).

Environmental parameters

12. Temperature records to detect temperature anomalies

Method: Setup of temperature data loggers along vertical transects (when possible). Data loggers should be set up every 5 m down to 40 m depth. For more information see www.t-mednet.org.

Sampling design

- Detailed description of the **selection of plots** (classification, random choice etc.) for monitoring including distribution in time (respecting the six-year official periods of reporting) and a shape file in GIS (should be added later)
- Specification of the number of field workers (or man days per year) needed
- Particularities of potential pilot project (if relevant)

General approach to set-up the sampling design:

Since the monitoring programme is aimed to asses the conservation status of the coralligenous habitat and its evolution over time in the Croatian coastal waters, the sampling design has to be able to cope with the spatial heterogeneity (including differential environmental conditions and different degree of pressures) and time as a factor. However, because of information scarcity on the distribution of the coralligenous and the kind of assemblages thriving along the Croatian coast as well as their respective surfaces and depth ranges, it is difficult to propose a sampling design scheme. Besides, the sampling design should take into account potential priority areas for the monitoring already known by the authorities in charge of the monitoring.

Instead, here we will describe a generic sampling design that should be adapted according to the personnel and budget available for the monitoring programme. Eventually, it is intended to guide the process of selection of monitoring sites to fulfil, in a reasonable manner, the goals of the monitoring.

1. Define main geographic areas characterised by their environmental conditions (e.g. temperature, currents, freshwater inputs, geomorphology) ;
2. Within each geographic area select zones under different management regimes (i.e. Marine Protected Areas, N2K sites, etc.).

With this basic scheme we will cover the two main axes – Environmental and Anthropogenic pressures. For instance, with three geographic regions and two management schemes (protected vs. non-protected zones), we would have six conditions to monitor. To cope with the spatial variability both to the geographic gradients and management schemes, we should include in the sampling design replicates of each of the 6 conditions to monitor to ensure the significance of the potential changes in conservation status detected. This means, for instance, that we would have a minimum of three (ideally 9 sites per condition) monitoring sites submitted to the selected management scheme within each of the determined geographic areas. Overall, following the example we would have a total of 18 monitoring sites (minimal option with 3 replicates for each condition). In each monitoring site the data for the parameters (see above) would be gathered.

Monitoring of all known aspects of coralligenous habitat would imply an enormous amount of work and associated costs and in addition, it is not required by the reporting format for the Habitats Directive.

Instead we propose to focus on gorgonian dominated assemblages (G.4.3.1.8. Facies with species Paramuricea clavata and G.4.3.1.5. Facies with Eunicella cavolini in sites where P. clavata is not present or thrive too deep i.e. below 40 m depth) which are among the most representative ones due to their structural complexity, easy delineation in the field, and abundance of ecosystem engineers (gorgonians; sensu Jones *et al.,* 1994) that are sensitive to various disturbances and whose loss may imply further decrease in biodiversity or greater vulnerability of other species initially sheltered by their canopies.

However, in order to cover the whole geographic range of the Croatian part of the Adriatic Sea, or to include locations with particular disturbances/environmental conditions, other assemblage could be selected in sites where gorgonians are not present, thrive too deep (below 40 m depth) or are scarce.

Once the selection is made, the monitoring should stick to the same assemblage over time at each site, in order to enable the assessment of trends.

Working with these selected assemblages, the number of monitoring sites would range from a minimum of 18 (one assemblage and 3 sites per condition) to a maximum of 108 (2 assemblages and 9 sites per condition) per each depth range considered.

As mentioned, the sites can be monitored every three-five years and this will reduce the annual monitoring effort, from a minimum of 6 sites to a maximum of 36 sites.

The final goal is to compare temporal trends regardless of the target assemblage chosen in each area. However, in the selection of sites we have to bear in mind to have replicates of the same assemblages within each condition. This would provide the robustness of the potential changes assessed.

In each sampling site selected, the GPS coordinates of each monitoring site should be recorded (for shape files in GIS). At each monitoring site 2 teams of two divers should work. One team will be in charge of the photosampling and the second one will carry out the random horizontal transects (visual census). With this scheme 1 site = 1 dive of 4 divers. The sampling should be carried out at least once every 3 years. This opens the possibility to carry out the sampling of the selected sites along the evaluation period.

Beyond 40 m depth ROVs should be used. The same sampling scheme can be applied but the operational costs will be much higher. On the other hand, at depth where coralligenous develops ROVs can operate for longer periods of time than divers, which may balance the higher operational costs. However, probably the sampling design for the deep range of coralligenous should be modified accordingly, depending on the operational capacity of ROVs.

For the temperature surveys specific dives should be organized: for site selection, setting up the fixation points, setting up the data loggers and for their annual or (preferably) semi-annual recovery. It is not necessary to set up temperature data loggers in each monitoring site for the same geographic area. The temperature survey should be placed in a site representative of each area. The minimum distance between temperature surveys sites should be around 20-40 km depending on the hydrographic conditions.

Figure 8 shows potential sites for monitoring in Croatia.

Figure 8. Potential sites for monitoring (SINP; Google Earth background)

Table 2. Potential monitoring sites for coralligenous habitat

Area	Levels of protection	Potential sites
Sector A	Marine Reserve/Natura 2000 Marine Reserve/Natura 2000 Marine Reserve/Natura 2000	Prvić (Cape Šilo) Prvić (Cape Stražica) Site A-3 (to be determined)
	Natura 2000 Natura 2000 Natura 2000	Ćutin Mali Krk (Tenki) Krk (Cape Sokol)
	Natura 2000 Natura 2000 Unprotected	Brseč (Cape Lonjica) Brestova (Cape Stupova) Cres (Cape Selzine)
Sector B	National Park/Natura 2000 National Park/Natura 2000 National Park/Natura 2000	NP Kornati (Mali Obručan) NP Kornati (Mana) NP Kornati (Samograd)
	Natura 2000 Natura 2000 Natura 2000	Babuljaši Islet Blitvenica Island of Rivanj (Rivanj channel)
	Nature park/Natura 2000 Nature park/Natura 2000 Nature park/Natura 2000	NP Telašćica (V Garmenjak) NP Telašćica (Sestrica) NP Telašćica (Prisika)
	Natura 2000 Natura 2000 Natura 2000	Island of Dugi otok (Cape Lopata) Island of Dugi otok (Mežanj Islet) Island of Dugi otok (Brbinšćica)
	Unprotected Unprotected Unprotected	Rogoznica (Smokvica) Site B14 (to be determined) Site B15 (to be determined)
Sector C	National Park/Natura 2000 National Park/Natura 2000 National Park/Natura 2000	NP Mljet (Lenga) NP Mljet (Štit) NP Mljet (Cape Korizmeni rat)
	Nature park/Natura 2000 Nature park/Natura 2000 Nature park/Natura 2000	Nature Park Lastovo (Struga) Nature Park Lastovo (Kopište, Plič Kaleb) Nature Park Lastovo (Bijelac or Crnac)
	Natura 2000 Natura 2000 Natura 2000	Hvar - Pakleni otoci (Vodnjak) Vis (Komiža) Vis (Biševo)
	Unprotected Unprotected Unprotected	Site C10 (to be determined) Site C11 (to be determined) Site C12 (to be determined)

Particularities of potential pilot project

Pilot project should be envisaged in order to screen additional locations with coralligenous habitat and select the missing ones that satisfy both criteria of geographical area and protection level, as indicated in Table 2. We emphasize that proposed list includes minimum number of sites that should be monitored. Ideally, 6 to 9 sites would be monitored per condition. In such case, additional screening of appropriate sites should be carried out within the pilot project.

Data forms

- Forms as sheet tables, check lists etc.
- Have to be user-friendly and contain **clear data structure** – no latitude making misinterpretation possible and minimum of free text fields
- Communication with SINP needed because of the structure of actual and prepared official databases (CroHabitat etc.) and the forms prescribed

Forms have been developed for visual census and the assessment of gorgonian health status (see Annex I and II).

Scientific research

Objectives

- Clarification why also scientific research is chosen as a part of species surveillance (if not the whole chapter “Scientific research” has to be deleted) and what outputs are awaited

Three main research themes should be developed for the monitoring of coralligenous habitat:

1. Establish baselines on coralligenous species composition and abundance from Croatian coasts. Most of the available information on the characterization of coralligenous assemblages is based on data obtained in the NW Mediterranean (e.g. Kipson *et al.,* 2011). Therefore the information (although it is still incomplete) on species and their abundance, as well as their structural roles, is mostly available from these areas. Bearing in mind high species richness and spatial heterogeneity found in the coralligenous habitat, it is expected that coralligenous thriving in the Adriatic, and more specifically, along Croatian coasts will display specific characteristics that should be properly documented and quantified.

   In particular, there are no historical data on the composition, distribution and status of the coralligenous assemblages in the Adriatic Sea, thus scientific research is needed to obtain these baseline data (to date, baseline data have been acquired in comparable manner only for several sites along Croatian coast, e.g. Kipson 2013).

2. Identify indicators for assessment of the status and functioning of the coralligenous habitat. These indicators have not been defined yet at the Mediterranean level. Such information is necessary to obtain coralligenous ecological status indices (to be developed or adapted from other Mediterranean initiatives). To be useful, these indicators should be applicable to the wide spectrum of coralligenous habitats found, including those thriving along the Croatian coast. The outputs awaited by the research include, for instance, clarification on the efficient use of information on species composition and abundance, as well as information on habitat complexity obtained from field surveys. Likewise research on the response of the coralligenous habitat to different stressors is also needed to evaluate the conservation status and management options.

3. Develop adapted mapping approaches for the coralligenous. The use of modern acoustic methods coupled with the use of ROVs and AUVs should furnish valuable data to fill in the enormous current gap in our knowledge on the extension and distribution of coralligenous habitats in Croatian waters but also at the Mediterranean scale.

Framework assignment

- Basic instructions with a hypothesis to be tested
- Proposal of academic institutions or other subjects able to do the research

Basic information on the role of species, structural complexity, biodiversity patterns.

1. To establish baselines on coralligenous habitat thriving in the Croatian waters, we should plan a sampling scheme that will cover different areas of the Croatian coast. This scheme could be coupled with the mapping efforts. To gather information on species composition and abundance we propose the application of the protocol described in this document as a starting point. However, the use of simplified protocols could be also envisioned. For instance, the use of video transects for data acquisition could be explored. Depending on the way the images are obtained, videography could potentially be applicable for most of the descriptors. This point is important also for the development of monitoring protocols for deep waters, since for these areas the use of ROVs and/or AUVs will be required.

   Furthermore, we should ensure that areas exposed to different pressures are included in the surveys. Information obtained from such sites would be a key to select candidates for indicator species as well as to determine indices for the assessment of the conservation status of coralligenous habitats.

2. The analysis of data obtained within Theme 1 (baseline information) would provide a key information to determine indicator species, especially through the comparative analysis of coralligenous assemblages submitted to different pressures. This analysis would provide the first empirical evaluation of the effects of anthropogenic activities on coralligenous habitat and it should be coupled with experimental setup to explore the response of typical (engineering) species to different stressors. Overall, in this manner the basis could be laid down for determination of the most appropriate indicator species and for development of indices used to assess the conservation status of coralligenous habitat.

3. Mapping of coralligenous habitat along the Croatian coast is only feasible over the long-term. However, the adoption of new methodological approaches based on the combination of new acoustic methods with AUVs would enable development of mapping approaches devoted to specific areas. This is a fertile research topic from which coralligenous habitat could benefit.

Proposal of academic institutions able to do the research include:

- University of Zagreb, Faculty of Science, Zagreb
- Rudjer Boskovic Institute – Centre for Marine Research, Rovinj
- Institute for Oceanography and Fisheries, Split
- University of Zagreb, Faculty of Electrical Engineering and Computing, Laboratory for Underwater Systems and Technologies, Zagreb

THE WAY OF EVALUATION NEEDED FOR ALL FOUR COMPONENTS OF THE CONSERVATION STATUS IS DESCRIBED:

Evaluation of the conservation status components

Range

- Description of the data use and interpretation for preparation of the distribution map (map will be prepared for all biogeographical regions together)
- Description of the data use and interpretation to filling in 10 x 10 km grid cells (map will be prepared for all biogeographical regions together)
- Proposal of rules for gap closure to join grids together where appropriate according to the environmental parameters

The patchy distribution of coralligenous habitat throughout the Mediterranean biogeographic region of Croatia represents a major difficulty to obtain precise information on its distribution map. The position of all sites where occurrence or absence of coralligenous is known, should be projected on the map with superimposed 10 × 10 km grid. A first version of the map will be produced and coordinated by SINP and it will be subsequently updated with the results of different field trips devoted to the monitoring and mapping activities as well as with other potential sources of data. For each sampling site geographical coordinates should be recorded using GPS and than projected on the map with 10 × 10 km grid defined for the monitoring program. The presence/absence of the habitat should be reported in order to estimate changes of the whole range and habitat data should be gathered in order to trace trends.

In a part of occurrence sites (the list should be proposed in coordination with SINP) the whole monitoring procedure on sampling plots as described should be preformed.

Area covered by habitat type

- Description of the data use and interpretation to determination of:
  - the surface area incl. methodology of analysis ;
  - the distribution pattern, if possible.

Mapping of coralligenous habitat is very complex because of its patchy distribution, sometimes limited extensions and occurrence of some of the assemblages on vertical walls. These features make its mapping expensive and time consuming and will demand the use and combination of the most modern technologies and new analytical methods (use of new devices such as side-scan sonar or multibeam echosounder) for field surveys and post-data treatment.

Methodological problems associated with mapping of coralligenous habitats such as the acquisition and interpretation of side-scan sonar images for horizontal substrata, or multibeam echosounder images suitable both for horizontal substrata as well as vertical cliffs (the latter are one of the most characteristic substrata where coralligenous outcrops develop), need to be addressed in order to enable significant advances in mapping activities. An example of an integration of different technologies into a Geographic Information System (GIS) to study coralligenous habitat is: http://www.rac-spa.org/cor/Session%202/03-%20Canese%20etal.pdf (Italy).

Specific structures and functions

- Description of the data use and interpretation to determine the conditions and status of typical species

Data gathered in each monitored site will furnish information on:

1. Community composition of macrobenthic species/categories ;
2. Indicator on habitat complexity ;
3. Information on the degree of impact of main disturbances affecting the coralligenous habitat ;
4. Information on environmental conditions (temperature regimes and sedimentation).

The dataset obtained will furnish the basis for the development of indicators on the conditions and status of typical species. Several initiatives are being developed to establish the most suitable indicators (Gatti *et al.,* 2012, Dether *et al.,* 2011, Project Index-Cor S. Sartoretto *pers. comm.*), but at this moment there is still lack of consensus on the indices to be applied. Nevertheless all initiatives are based on the acquisition of information proposed in the monitoring protocol. Therefore, promotion and/or joining ongoing initiatives in the Mediterranean analysis to be ready to test and eventually to adopt the procedures to determine the conditions and status of typical species should be encouraged.

Although the indices are not yet available, the data collected can already provide sound information on the health condition of the coralligenous communities in the monitored areas. Generally, substantial decreases in the number of recorded macrobenthic species as well as decreases in the abundance of typical species (especially those contributing to the structural integrity) and/or deterioration of their condition may indicate negative trends within the coralligenous habitat. Furthermore, the presence and increasing abundance of alien species, increase of sedimentation cover, bioerosion and fishing gears as the increase of the affected colonies of gorgonian indicate a degradation process within this habitat. Although we still lack of categorization of habitat status, for some indicators there is a basis for their establishment.

For example, spatial comparisons on the conservation status of gorgonian population can inform about differential degree of impacts on the populations of this key organism. Moreover, temporal comparisons of this indicator can inform about the positive, stable or negative trend of populations. In fact, according to the available literature, healthy populations harbour less than 10 % colonies affected by recent necrosis (Garrabou *et al.,* 2009). Beyond this value we could categorize the condition status of gorgonian population, using several classes. For the other proposed indicators similar analysis can be applied once the datasets gathered furnish enough information.

Future prospects

- Description of the information use and interpretation to determination of:
  - main **pressures and threats** and their value
  - **conservation measures** and other positive provisions realized to avoid pressures and threats

As reported in the section "Pressure and threats" coralligenous habitat is being submitted to different sources of strong disturbances which can have profound impacts on its structure and function. The most relevant sources of disturbance (bearing in mind that most of them can act synergically) are:

1. Fishing activities: extraction of resources and mechanical impacts
2. Eutrophication
3. Recreational diving (mechanical impacts)
4. Mucilagenous algal aggregates
5. Invasive species
6. Warming of seawater
7. Acidification

To some extent, coralligenous habitats are currently affected by the listed pressures. The future prospects will depend on the nature of pressures (local versus local and direct and diffuse action mode). For pressures such as fishing, eutrophication and recreational diving, effective management actions may be taken to reduce their impacts because they act at the local level and in a direct manner. In these cases regulation and control of the human activities can be effective in limiting or even reversing the degraded condition of affected areas. However, for other pressures conservation and management options are more challenging because these pressures act at larger scales in a diffuse manner and control of their sources is not possible. Finally, the interactions between pressures are difficult to forecast.

Overall, bearing in mind the slow population dynamics of key species of coralligenous habitats, reversal from bad or poor conditions to the good ones cannot occur immediately, regardless of the management action adopted. Likewise, sites displaying good conditions could be already submitted to degradation that is still not being noticed at the indicator level. For slow dynamic systems such is the coralligenous one, delaying management actions may be compromising the recovery, at least at mid-term.

Monitoring and proposed research actions will furnish dataset that would provide the basis to better explore and forecast the potential trajectories for the coralligenous habitat under different management options. For instance, the information on the geographic and bathymetric distribution of typical species and their thermotolerance, coupled with their climatic models, will allow to detect areas at risk of suffering recurrent mass mortalities.

Joining international initiatives dealing with global change impacts (warming and acidification) would be highly valuable to stimulate elaboration of more meaningful future prospects for coralligenous habitat. Overall, this newly acquired information will assist in shaping expert opinion on future prospects.

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ANNEX I. FORM USED FOR VISUAL CENSUS

Observer: Species:		Date: Depth:						Site:				
		Sectors (1 m)										
Transect	Parameter	1	2	3	4	5	6	7	8	9	10	TOTAL
1	Erect layer											
	Bioeroders											
	Mucilaginous											
2	Erect layer											
	Bioeroders											
	Mucilaginous											
3	Erect layer											
	Bioeroders											
	Mucilaginous											
	Fishing nets:											
	Comments:											

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ANNEX II. FORM USED FOR RAPID ASSESSMENT OF GORGONIAN HEALTH STATUS

Observer: **Species:** **Depthsurvey:**	**Date:** **Kind of bottom:**	**Site:**
NON AFFECTED		
AFFECTED (>10 %)		
a) Naked axis / recent epibiosis		
b) Old epibiosis		
Combination a) and b)		
Comments:		

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