

ECOLOGICAL observing System in the Adriatic Sea: oceanographic observations for biodiversity

Priority Axis 3: Environment and cultural heritage

Specific Objective 3.2: Contribute to protect and restore biodiversity

D3.1.1 Report on the assessment of existing ecological monitoring programs and observing systems

WP3 – Design of the Ecological Observing System in the Adriatic Sea (ECOAdS)
A3.1 – Assessment of existing ecological monitoring programmes and observing
systems

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1. INTRODUCTION

Within the frame of the Activity 3.1 “Assessment of existing ecological monitoring programs and observing systems”, this report aims to analyze the current activities, the relevant observing programmes carried out in the area and the available level of knowledge with emphasis on the connections with the main Directives, the EUSAIR pillar and topics and the Maritime Spatial Planning (MSP) principles. Obtained analysis will represent one of the main foundation of the deliverable D3.5.1 and a reference milestone for further activities in the area.

A questionnaire has been designed with the aim of collecting as much as possible information about existing ecological monitoring programs and observing systems, necessary to build up the deliverable. The questionnaire has been distributed to the project partners only, as the partnership represents a large proportion of the institutions engaged in monitoring programs in the study area.

For this deliverable, the Questionnaire included the following information:

- name of the existing ecological monitoring programme/programmes and observing systems;
- duration;
- Adriatic sub-region and geographical coverage of the existing ecological monitoring programme;
- institutions engaged in the existing ecological monitoring programme;
- ecological parameters monitored by the ecological monitoring programme/listed in Tables as Annexes;
- web page of the existing ecological monitoring programme;
- availability of data / data sharing policy;
- web service or portal for data sharing;
- connection of monitoring programmes with EUSAIR pillars and EU Directives;
- short description of the monitoring programme;
- Annexes containing list of parameters of the Marine Strategy Framework Directive (MSFD); Water Framework Directive (WFD), Habitats Directive (HB), Marine Spatial Planning MSP.

After presenting obtained information about existing ecological monitoring programs and observing systems, all information has been assessed and a SWOT (strengths-weaknesses-opportunities-threats) matrix has been created. Finally, a few conclusions were drawn from the documents and analysis.

The monitoring programmes and observing systems included in the deliverable might not cover the whole set of monitoring programs active in the study area. Nevertheless, being those in which the project partners are involved, it is more likely that data can be made available for the scopes of the ECOS project and the creation of the ECOAdS.

2. EXISTING ECOLOGICAL MONITORING PROGRAMS

2.1. Monitoring of parameters needed for evaluation of the state of descriptors according to Adriatic Monitoring Plan enabling fulfilment of obligations of the Republic of Croatia according to MSFD

1. The name of the existing ecological monitoring programme /programmes:

Monitoring of parameters needed for evaluation of the state of descriptors according to Adriatic Monitoring Plan enabling fulfillment of obligations of the Republic of Croatia according to MSFD (2008/56/EU)

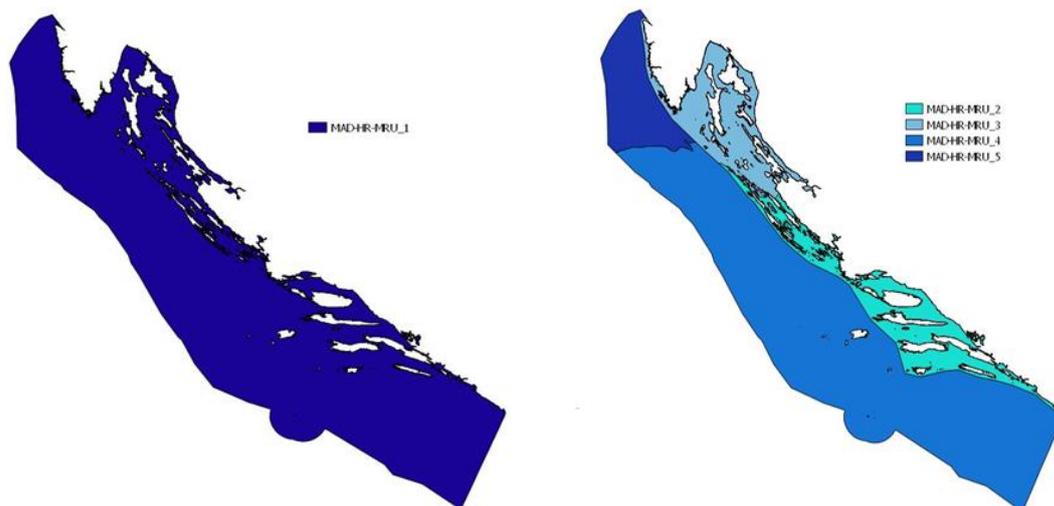
Financed by: Ministry of Environment and Energy, Republic of Croatia

2. The duration of the existing ecological monitoring programme/programmes:

6 years cycles

3. The Adriatic sub-region and geographical coverage of the existing ecological monitoring programme (for example: water bodies, Marine Reporting Units):

5 marine reporting units (MAD-HR-MRU1; MAD-HR-MRU2; MAD-HR-MRU3; MAD-HR-MRU4; MAD-HR-MRU5) (see figure below)



Croatian marine reporting units used as scales of assessment for MSFD reporting

4. Institutions engaged in the existing ecological monitoring programme:

- Institute of Oceanography and Fisheries, Split
- Institute Ruđer Bošković, Zagreb

5. Ecological parameters monitored by the ecological monitoring programme (sorted as physical, chemical and biological parameters):

Parameters from the MSFD directive demands, in line with national financial resources (see Table 1)

6. Web page of the existing ecological monitoring programme (if applicable)

Izveštajni sustav monitoringa Jadrana (Reporting system of the Adriatic Sea monitoring) database under development) <http://faust.izor.hr/nmon/pocetna>

7. Are the monitored data available and under which conditions (data sharing policy?):

Restricted, for now.

8. Are monitoring programmes connected with EUSAIR pillars or EU Directives?

Yes, with MSFD http://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/marine-strategy-framework-directive/index_en.htm

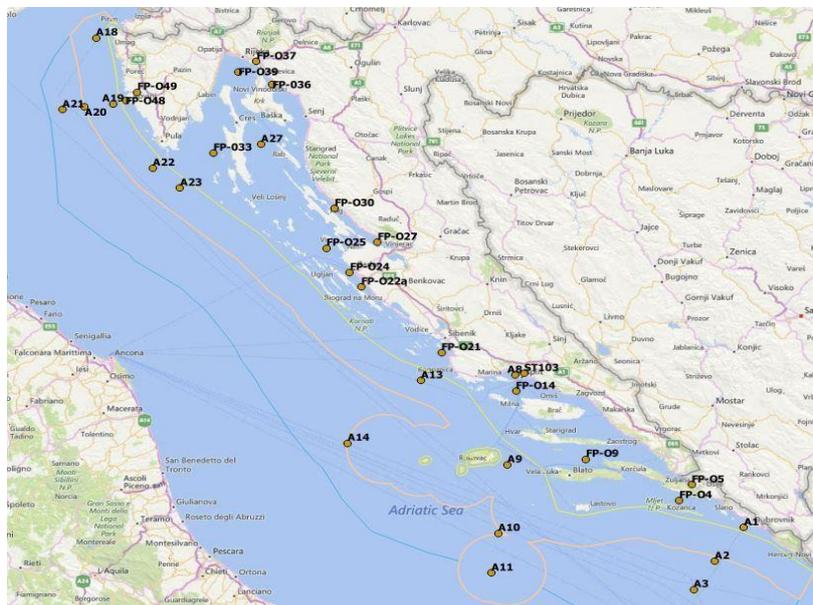
9. Short description of the monitoring programme (max. 2 pages, figures included) (for example: kind of short Technical Report with listed parameters for certain MSFD Descriptor, sampling locations, sampling frequency, link of metadata availability)

To fulfill the commitments according to MSFD 2008/56/EU, Republic of Croatia is obliged to conduct Monitoring program for assessment of the environmental state of marine waters under the sovereignty of RH based on initial assessment of the state of marine environment of Croatian part of the Adriatic. Project task is Implementation of the "Monitoring and observation system for assessment of the Adriatic Sea state" in accordance with Monitoring Plan for Croatia (OG 153/2014). This project covers monitoring of physical, chemical and biological parameters in coastal and marine waters at sites predicted with Monitoring plan as well as monitoring of invasive species at selected sites. Project task is, beside monitoring and data collecting, data processing, data validation and input in *Reporting system of the Adriatic Sea monitoring*. Input of data from other projects performed by other authority institutions dealing with marine environment is also project task.

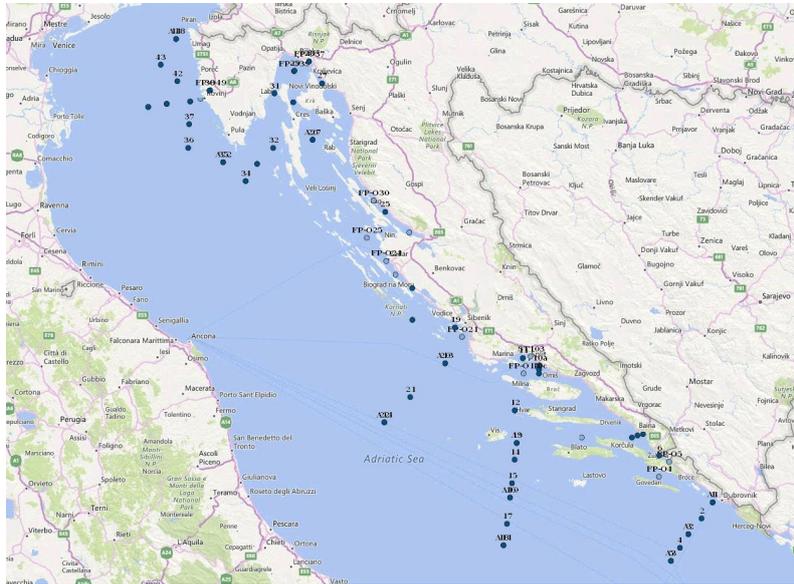
To improve data comparability and data quality, project task is also to use methods of validation in accordance with EEA and other demands with the aim to achieve certainty and data reliability (QA/QC).

Project activities are: monitoring and observing of parameters for evaluation of the state of descriptors D5 and partly D1, D2, D4, D7, D10 and D11 from MSFD and data collecting to implement Monitoring plan for the Adriatic (i); data quality assurance and quality control of data Activity of interpretation, validation and data input into *Izveštajni sustav monitoringa Jadrana (Reporting system of the Adriatic Sea monitoring)* (ii).

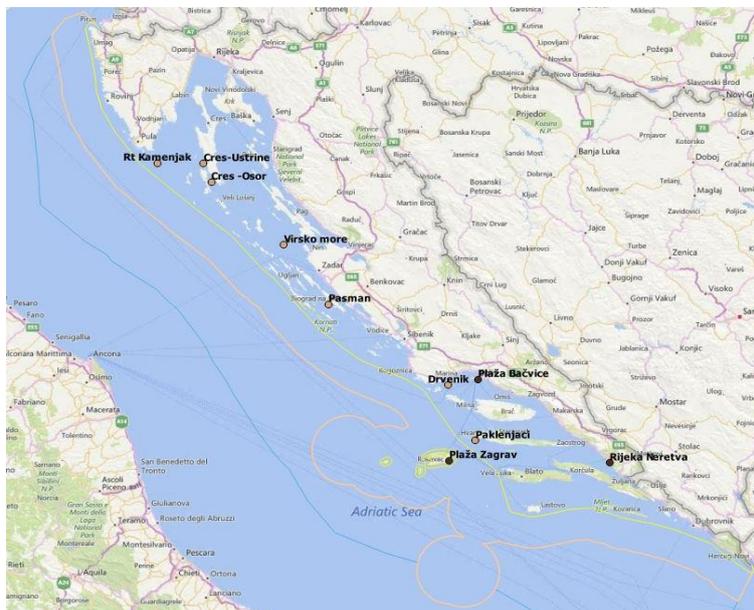
Sampling sites for monitoring of descriptors covered with this project are shown in figures below.



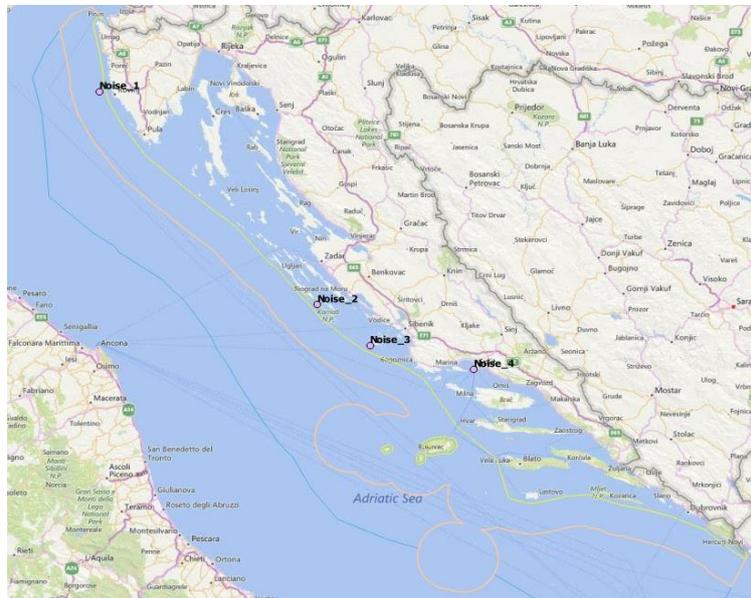
Sampling sites for monitoring of D5 and partial monitoring of D1, D2 and D4 descriptors.



Sampling sites for partial monitoring of descriptor D7.



Sampling sites for monitoring of marine litter swallowed by organisms or found on beaches (descriptor D10)



Sampling sites for monitoring of underwater noise (descriptor D11)

Parameters of the Marine Strategy Framework Directive (MSFD) (for monitoring programme described in 2.1)

Parameter	Yes/No
Angiosperms biomass and its annual/seasonal variability	
Angiosperms species composition and its annual/seasonal variability	
Fish abundance	
Fish age / size structure	
Fish distribution	
Genetically distinct forms of native species abundance	
Genetically distinct forms of native species occurrence	
Genetically distinct forms of native species spatial distribution	
Habitats' (predominant, special, protected and endangered) characteristics	
Introduction of microbial pathogens	
Introduction of non-indigenous species	X

Invertebrate bottom fauna biomass and its annual/seasonal variability	
Invertebrate bottom fauna species composition and its annual/seasonal variability	
Macro-algae biomass	
Macro-algae species composition	
Marine mammals actual range	
Marine mammals natural range	
Marine mammals population dynamics	
Marine mammals status	
Non-indigenous or exotic species abundance	
Non-indigenous or exotic species occurrence	
Non-indigenous or exotic species spatial distribution	
Other protected species actual range	
Other protected species natural range	
Other protected species population dynamics	
Other protected species status	
Phytoplankton species compositions and its geographical and seasonal variability	X
Reptiles actual range	
Reptiles natural range	
Reptiles population dynamics	
Reptiles status	
Seabirds actual range	
Seabirds natural range	
Seabirds population dynamics	
Seabirds species' status	
Selective extraction of species	
Translocations of non-indigenous species	
Zooplankton species compositions and its geographical and seasonal variability	X
Acidification	
Abrasion	
Biological effects of contaminants	X
Concentration of contaminants	X
Currents	

Depth	
Extraction	
Ice cover	
Marine litter	X
Mixing characteristics	
Nutrient concentrations	X
Oxygen	X
Residence time	
Salinity	X
Seabed Bathymetry	
Seabed Structure	
Seabed Substrata Composition	
Seabed Topography	
Sealing	
Siltation (changes in)	
Smothering	
Temperature	X
Turbidity	
Underwater noise	X
Upwelling	
Wave exposure	

Parameters of the Water Framework Directive (WFD) (for monitoring programme described in 2.1)

Parameters	Yes/No
Angiosperms Abundance	X
Angiosperms Cover	X
Angiosperms Depth Distribution	
Angiosperms Presence of Sensitive Taxa	
Benthic Invertebrate Fauna - Presence of Sensitive Taxa	X
Benthic Invertebrate Fauna Abundance	X
Benthic Invertebrate Fauna Composition	X

Benthic Invertebrate Fauna Diversity	X
Macro-algae - Presence of Sensitive Taxa	X
Macro-algae Abundance	X
Macro-algae Cover	X
Macro-algae Depth Distribution	X
Macro-algae Species Composition	X
Phytoplankton Abundance	X
Phytoplankton Bloom Frequency / Intensity	
Phytoplankton Composition	X
Phytoplankton Diversity	X
Specific synthetic pollutants	X
Specific non-synthetic pollutants	X
Acidification	
Ammonium	X
Nitrates	X
Nutrient Conditions	X
Oxygenation	X
Bed Quantity	
Bed Structure	X
Bed Substrate	X
Conductivity	X
Depth Variation	
Direction of Dominant Currents	
Intertidal Zone Structure	
pH	X
Salinity	X
Temperature	X
Transparency	X
Residence Time	

2.2. Systematic research of water quality in transitional and coastal waters of the Republic of Croatia

1. The name of the existing ecological monitoring programme /programmes:

Systematic research of water quality in transitional and coastal waters (Sustavno istraživanje kakvoće prijelaznih i priobalnih voda (since 2012)

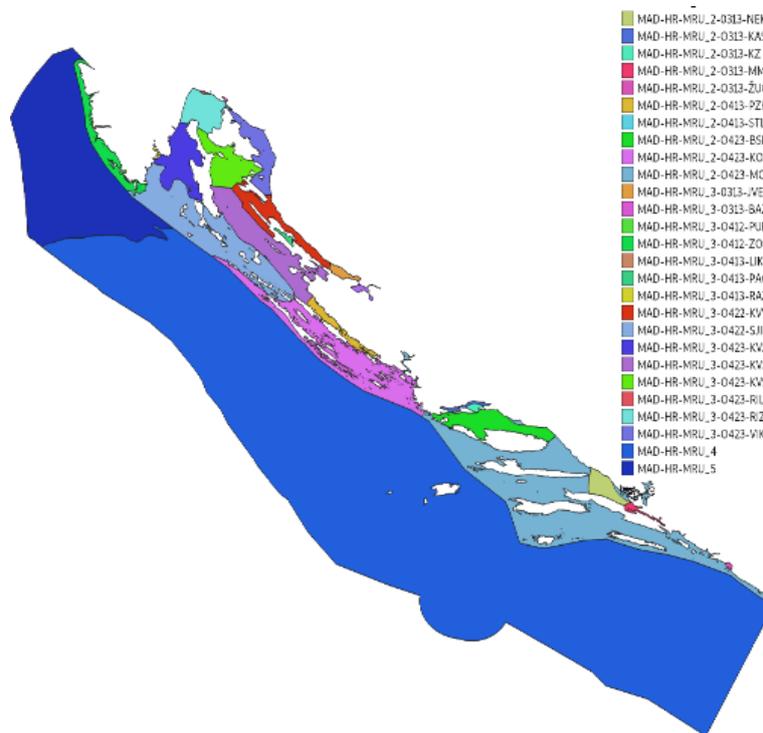
Financed by: Croatian Waters, Republic of Croatia

2. The duration of the existing ecological monitoring programme/programmes:

Monitoring programme started in 2009. Since 2012 it is performed in 2-year cycles

3. The Adriatic sub-region and geographical coverage of the existing ecological monitoring programme (for example: water bodies, Marine Reporting Units):

25 transitional water bodies; 26 coastal water bodies (see figure below)



Croatian coastal water bodies used as scales of assessment for WFD reporting

4. Institutions engaged in the existing ecological monitoring programme:

- Institute of Oceanography and Fisheries, Split; Croatia
- Institute Ruđer Bošković, Zagreb, Croatia
- National Laboratory of Health, Environment and Food, Maribor, Slovenia

5. Ecological parameters monitored by the ecological monitoring programme (sorted as physical, chemical and biological parameters):

Parameters from the WFD Directive demands, in line with national financial resources (table below)

6. Web page of the existing ecological monitoring programme (if applicable)

- Reporting system of the Adriatic Sea monitoring (database under development)
<http://faust.izor.hr/nmon/pocetna>;
- Database and indicators of the state of the marine environment, mariculture and fisheries
<http://baltazar.izor.hr/azo>

7. Are the monitored data available and under which conditions (data sharing policy?):

Restricted, for now.

8. Are these data shared by web service or through other web systems (if yes please indicate the web address):

Partially to the EEA and EMODNET Chemistry portal.

9. Are monitoring programmes connected with EUSAIR pillars or EU Directives?

Yes, with WFD http://ec.europa.eu/environment/water/water-framework/index_en.html

10. Short description of the monitoring programme (max. 2 pages, figures included) (for example: kind of short Technical Report with listed parameters for certain MSFD Descriptor, sampling locations, sampling frequency, link of metadata availability)

The monitoring program "SYSTEMATIC RESEARCH OF WATER QUALITY IN TRANSITIONAL AND COASTAL WATERS" is a WFD based program, performed in transitional and coastal water bodies in Croatia. The

main purpose of this program is to establish the ecological status of water bodies /taking into account the status of:

- supportive physico-chemical parameters and chlorophyll a,
- biological quality elements (required by the WFD),
- specific RB pollutants (Zn and Cu)
- hydromorphological alterations and
- chemical status (priority substances in water, sediment and biota).

In heavily modified water bodies the ecological potential is assessed. Obtained results are used as a basis for the River Basin Management Plans (including the Programme of measures).

Parameters of the Water Framework Directive (WFD) (for monitoring programme described in 2.2)

Parameters	Yes/No
Angiosperms Abundance	
Angiosperms Cover	
Angiosperms Depth Distribution	
Angiosperms Presence of Sensitive Taxa	
Benthic Invertebrate Fauna - Presence of Sensitive Taxa	X
Benthic Invertebrate Fauna Abundance	X
Benthic Invertebrate Fauna Composition	X
Benthic Invertebrate Fauna Diversity	X
Macro-algae - Presence of Sensitive Taxa	X
Macro-algae Abundance	X
Macro-algae Cover	X
Macro-algae Depth Distribution	X
Macro-algae Species Composition	X
Phytoplankton Abundance	X
Phytoplankton Bloom Frequency / Intensity	X
Phytoplankton Composition	X
Phytoplankton Diversity	X

Specific synthetic pollutants	X
Specific non-synthetic pollutants	
Acidification	X
Ammonium	X
Nitrates	X
Nutrient Conditions	X
Oxygenation	X
Bed Quantity	
Bed Structure	
Bed Substrate	
Conductivity	X
Depth Variation	
Direction of Dominant Currents	X
Intertidal Zone Structure	
pH	X
Salinity	X
Temperature	X
Transparency	X
Residence Time	

2.3. Adriatic Dolphin Project

1. *The name of the existing ecological monitoring programme /programmes:*

Adriatic Dolphin Project

2. *The duration of the existing ecological monitoring programme/programmes:*

Since 1987. Since 1999 conducted by the Blue World Institute

3. *The Adriatic sub-region and geographical coverage of the existing ecological monitoring programme (for example: water bodies, Marine Reporting Units):*

Alongshore from Istra to Lastovo, extending to a few miles SW of the outer stretch of islands

4. Institutions engaged in the existing ecological monitoring programme:

Blue World Institute

5. Ecological parameters monitored by the ecological monitoring programme (sorted as physical, chemical and biological parameters):

Biological: Population dynamics, population structure, habitat use, spatial distribution, Foraging

Physical (Cres-Lošinj archipelago only): underwater noise

6. Web page of the existing ecological monitoring programme (if applicable)

www.blue-world.org

7. Are the monitored data available and under which conditions (data sharing policy?):

Data is not publicly shared, but available for cooperative research projects.

8. Are these data shared by web service or through other web systems (if yes please indicate the web address):

No

9. Are monitoring programmes connected with EUSAIR pillars or EU Directives?

Primary species of interest of this monitoring program (bottlenose dolphin) is listed in Annex II of The Habitats Directive http://ec.europa.eu/environment/nature/legislation/habitatsdirective/index_en.htm

10. Short description of the monitoring programme (max. 2 pages, figures included) (for example: kind of short Technical Report with listed parameters for certain MSFD Descriptor, sampling locations, sampling frequency, link of metadata availability)

Research on bottlenose dolphins started in Cres-Lošinj archipelago in 1987 and has been ongoing since. Until 2004 field work was conducted in summer seasons only, since 2005 it is done year-round. Since 2007 field work is conducted in summer months in waters around Vis and Lastovo islands. In 2013 field work was expanded to include the waters of northern Dalmatia. With this last expansion of field work,

the cumulative study area stretches from Istrian peninsula in the north to the island of Lastovo in the south.

Primary method in all study areas is collection of photo-identification data from small research vessels. The database contains reference dorsal fin catalogue, information on capture histories of identified individuals and data on spatial and temporal distribution of research effort. From these, spatio-temporal distribution maps are created, demographic parameters and social structure of the population are estimated, as basic information on the status of the bottlenose dolphin communities along the eastern Adriatic coast.

Besides this, other data were collected with various durations: data on behaviour of dolphin groups, underwater acoustics, tissue and stomach content samples from stranded carcasses, UAV based data on dolphins' morphometry, and marine traffic and fisheries intensity.

2.4. Monitoring of sea turtles in the Adriatic

1. The name of the existing ecological monitoring programme /programmes:

Monitoring of sea turtles in the Adriatic (unofficial name)

2. The duration of the existing ecological monitoring programme/programmes:

Since 2010 (irregular)

3. The Adriatic sub-region and geographical coverage of the existing ecological monitoring programme (for example: water bodies, Marine Reporting Units):

Whole Adriatic Sea

4. Institutions engaged in the existing ecological monitoring programme:

Blue World Institute, Croatian Natural History Museum

5. Ecological parameters monitored by the ecological monitoring programme (sorted as physical, chemical and biological parameters):

Biological: spatio-temporal distribution, migrations, abundance, survival rates

6. Web page of the existing ecological monitoring programme (if applicable)

www.euroturtles.eu

7. Are the monitored data available and under which conditions (data sharing policy?):

Data is not publicly shared, but available for cooperative research projects.

8. Are these data shared by web service or through other web systems (if yes please indicate the web address):

Yes – only data collected through a citizen science app is publicly available (<https://www.euroturtles.eu/web-app/#/explore>)

9. Short description of the monitoring programme (max. 2 pages, figures included) (for example: kind of short Technical Report with listed parameters for certain MSFD Descriptor, sampling locations, sampling frequency, link of metadata availability)

The monitoring of sea turtles in the Adriatic Sea started in 2010 and is since conducted through various projects and cooperations (projects NETCET (<http://www.netcet.eu/>) and EUROTURTLES (<https://www.euroturtles.eu/#/>)). The data on sea turtles' occurrence, distribution and abundance are collected through aerial surveys (so far conducted in 2010, 2013, 2016 and planned for 2019). Satellite tagging campaign was used to examine migrations and survival rates of the sea turtles released back to sea after incidental by-catch. Additionally, a citizen science app is available for reporting sightings by general public.

Parameters of the Marine Strategy Framework Directive (MSFD) Annex III (for monitoring programmes described in 2.3 and 2.4)

Parameter	Yes/No
Angiosperms biomass and its annual/seasonal variability	
Angiosperms species composition and its annual/seasonal variability	
Fish abundance	
Fish age / size structure	
Fish distribution	
Genetically distinct forms of native species abundance	
Genetically distinct forms of native species occurrence	

Genetically distinct forms of native species spatial distribution	
Habitats' (predominant, special, protected and endangered) characteristics	
Introduction of microbial pathogens	
Introduction of non-indigenous species	
Invertebrate bottom fauna biomass and its annual/seasonal variability	
Invertebrate bottom fauna species composition and its annual/seasonal variability	
Macro-algae biomass	
Macro-algae species composition	
Marine mammals actual range	Yes
Marine mammals natural range	Yes
Marine mammals population dynamics	Yes
Marine mammals status	Yes
Non-indigenous or exotic species abundance	
Non-indigenous or exotic species occurrence	Yes
Non-indigenous or exotic species spatial distribution	
Other protected species actual range	Yes
Other protected species natural range	Yes
Other protected species population dynamics	Yes
Other protected species status	Yes
Phytoplankton species compositions and its geographical and seasonal variability	
Reptiles actual range	
Reptiles natural range	
Reptiles population dynamics	
Reptiles status	
Seabirds actual range	
Seabirds natural range	
Seabirds population dynamics	
Seabirds species' status	
Selective extraction of species	
Translocations of non-indigenous species	
Zooplankton species compositions and its geographical and seasonal variability	
Acidification	

Abrasion	
Biological effects of contaminants	
Concentration of contaminants	
Currents	
Depth	
Extraction	
Ice cover	
Marine litter	
Mixing characteristics	
Nutrient concentrations	
Oxygen	
Residence time	
Salinity	
Seabed Bathymetry	
Seabed Structure	
Seabed Substrata Composition	
Seabed Topography	
Sealing	
Siltation (changes in)	
Smothering	
Temperature	
Turbidity	
Underwater noise	Yes
Upwelling	
Wave exposure	

Annex 3 – Parameters of the The Habitats Directive (HD) (for monitoring programme described in 2.3 and 2.4)

Parameter	Yes/No
Natural range of natural habitat types of community interest	Yes
Area covered by natural habitat types of community interest	Yes
Specific structure of natural habitat types of community interest	
Necessary functions of natural habitat types of community interest	

Status of conservation of species in natural habitat types of community interest	Yes
Population dynamics of animal and plant species of community interest	Yes
Natural range of animal and plant species of community interest	Yes
Presence of habitat for animal and plant species of community interest	Yes
Population dynamics of animal and plant species of community interest in need of strict protection	
Natural range of animal and plant species of community interest in need of strict protection	
Presence of (sufficiently large) habitat of animal and plant species of community interest in need of strict protection	
Incidental capture and killing of animals of community interest in need of strict protection	
Population dynamics of animal and plant species of community interest in need of strict protection	
Natural range of animal and plant species of community interest in need of strict protection	
Presence of (sufficiently large) habitat of animal and plant species of community interest whose taking in the wild and exploitation may be subject to management measures	

Parameters of the Marine Spatial Planning (MSP) (for monitoring programme described in 2.3 and 2.4)

Parameter	Yes/No
Aquaculture areas	
Fishing areas	
Installations and infrastructures for the exploration, exploitation and extraction of oil, of gas and other energy	
Resources, of minerals and aggregates, and for the production of energy from renewable sources	
Maritime transport routes and traffic flows	
Military training areas	
Nature and species conservation sites and protected areas	Yes
Raw material extraction areas	
Scientific research	Yes
Submarine cable and pipeline routes	
Tourism	
Underwater cultural heritage	

2.5. Long-Term Ecological Research network (LTER-Italy); site “Northern Adriatic Sea”

1. *The name of the existing ecological monitoring programme /programmes:*

Long-Term Ecological Research network (LTER-Italy); parent site “Northern Adriatic Sea”

2. *The duration of the existing ecological monitoring programme/programmes:*

Within the LTER-Italy network: 2006 – on-going.

Data available since the 60s.

3. *The Adriatic sub-region and geographical coverage of the existing ecological monitoring programme (for example: water bodies, Marine Reporting Units):*

Northern Adriatic Sea, from the Gulfs of Trieste and Venice to the Delta del Po and Romagna Coast and to the area off-shore Senigallia.

4. *Institutions engaged in the existing ecological monitoring programme:*

CNR-ISMAR, CNR-IRBIM, OGS and UNIVPM

5. *Ecological parameters monitored by the ecological monitoring programme (sorted as physical, chemical and biological parameters):*

The following list includes all the parameters that are measured, although not all with the same frequency and not all in the whole area.

Physical parameters (atmosphere and sea): air humidity, air temperature, air pressure, wind direction, wind speed, wind gust, precipitation rate; pressure, current speed, current direction, wave height, wave period, wave direction, water temperature, water salinity, water transparency, conductivity, fluorescence, turbidity, CDOM

Chemical parameters: dissolved oxygen, pH, dissolved organic carbon, coloured dissolved organic carbon, inorganic carbon, dissolved macronutrient concentration (N-NH₄, N-NO₃, N-NO₂, P-PO₄, Si-SiO₄)

Biological parameters: chlorophyll a, phyto- and zooplankton abundance, and biomass, biodiversity, change in population size over time, community pattern, community structure, underwater video-monitoring of pelagic communities (e.g. fish, megazooplankton), benthic foraminifera abundance

6. Web page of the existing ecological monitoring programme (if applicable)

Web page on the LTER Dynamic Ecological Information Management System Site and Dataset Registry (DEIMS-SDR): <https://deims.org/92fd6fad-99cd-4972-93bd-c491f0be1301>

Web page on the web site of the Italian Long-Term Ecological Research Network (LTER-Italy): <http://www.lteritalia.it/?q=macrositi/it12-alto-adriatico>

7. Are the monitored data available and under which conditions (data sharing policy?):

14 datasets produced by the parent site Northern Adriatic Sea are available via the Dynamic Ecological Information Management System Site and Dataset Registry (DEIMS-SDR) under a Creative Commons (CC-BY) license.

8. Are these data shared by web service or through other web systems (if yes please indicate the web address):

The list of the shared datasets is available here (via DEIMS-SDR): <https://deims.org/92fd6fad-99cd-4972-93bd-c491f0be1301> (associated data section)

Data from OGS-NODC are available here: <http://nodc.ogs.trieste.it/nodc/>

Data from the fixed observatories can be visualized at the following web pages and their use is permitted upon request by citing the source:

Mambo buoy: <http://nettuno.ogs.trieste.it/ilter/GoTTs/mambo.html>

Acqua Alta Tower: <http://www.ismar.cnr.it/infrastrutture/piattaforma-acqua-alta>

S1-GB dynamic pylon: http://s1.bo.ismar.cnr.it/perl/s1_home.pl

E1 buoy: http://e1.bo.ismar.cnr.it/perl/e1_home.pl

TeleSenigallia dynamic pylon: <http://rmm.an.ismar.cnr.it/index.php/meda-senigallia>

9. Are monitoring programmes connected with EUSAIR pillars EU Directives?

The research and monitoring activities of the LTER parent site “Northern Adriatic Sea” are relevant to the EUSAIR Pillar 3 (Topic 1) by increasing marine knowledge through integrated oceanographic and ecological monitoring. Moreover, while its monitoring activities are not specifically coordinated for the implementation of EU Environmental Directives, LTER-Italy has the potential to contribute in understanding the state of the environment to define GES under the MSFD.

10. Short description of the monitoring programme (max. 2 pages, figures included) (for example: kind of short Technical Report with listed parameters for certain MSFD Descriptor, sampling locations, sampling frequency, link of metadata availability).

The Long-Term Ecological Research (LTER) aims at better understanding, analysing, and monitoring changes in ecosystem patterns and processes over extended time periods, typically decades. Since the 80s LTER started to be organized in network of sites (LTER networks), across the globe. The Italian LTER Network (LTER-Italy; www.lteritalia.it) is a formal component of LTER-International and LTER-Europe since 2006 and it consists of 79 research sites, organized in 25 parent sites, which include terrestrial, freshwater, transitional and marine ecosystems, managed and coordinated by public research, monitoring Institutions and Universities.

The marine component of LTER-Italy is made up of 25 research sites, organized in eight parent sites, mainly representing transitional and coastal ecosystems. Among them, the LTER parent site Northern Adriatic Sea (NAS) includes four research sites (Gulf of Trieste, Gulf of Venice, Po Delta and Romagna Coast, Senigallia-Susak Transect), where meteo-oceanographic and biological data, mainly on plankton, are gathered through both oceanographic cruises and fixed point observatories. Detailed information can be found in the ILTER Dynamic Ecological Information Management System Site and Dataset Registry, DEIMS-SDR (<https://deims.org/92fd6fad-99cd-4972-93bd-c491f0be1301>).

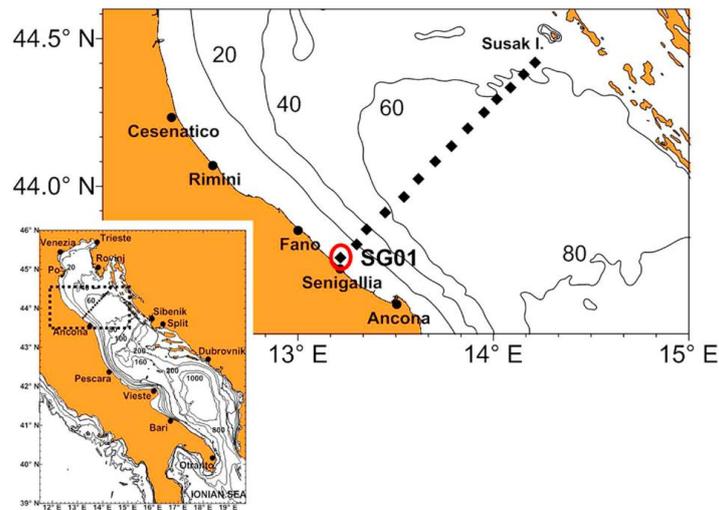
In the figure the LTER-Italy parent site NAS, with its four research sites is shown. 1: Gulf of Trieste; 2: Gulf of Venice; 3: Po Delta and Romagna Coast; 4: Senigallia-Susak Transect. The fixed point observatories at each research sites are evidenced.



The Senigallia-Susak (SS) transect is located in the lower part of the northern Adriatic sub-basin, where the Western Adriatic Current (WAC) become sharper, clearly separating nutrient rich coastal waters from oligotrophic offshore waters and affecting the horizontal spatial variability of phytoplankton communities. The SS transect represents a LTER (Long-Term Ecosystem Research) site, where physical parameters (temperature, salinity, density, turbidity, fluorescence, dissolved oxygen), nutrient concentration (nitrate, nitrite, ammonia, orthophosphate, silicate) and phytoplankton abundance and biomass (total phytoplankton, diatoms, dinoflagellates, coccolithophyceans, phytoflagellates) along a trophic gradient have been recorded since 1988.

The transect includes 14 stations from Italian to Croatian coast: 7 stations located from the Italian coast to the midline (30 nM) were sampled since 1988 to today, with monthly to bimonthly frequency, while the whole transect from 1999 to 2002.

The western coastal station (SG01, 1,2 nM, bottom depth 12 m) is samples more frequently with a monthly frequency. In that station a meteomarine pylon (TeleSenigallia) is equipped with a meteorological station and several oceanographic sensors at water depths of 2 m, 10 m and 16 m. The joint system is in a key area to observe near-coastal processes (upwelling, stratifications, biological productivity) and the water masses transiting to or from the northern Adriatic.



The Senigallia-Susak sampling stations

Parameters of the Marine Strategy Framework Directive (MSFD) Annex III (for monitoring programmes described in 2.5)

Parameter	Yes/No
Angiosperms biomass and its annual/seasonal variability	
Angiosperms species composition and its annual/seasonal variability	
Fish abundance	
Fish age / size structure	
Fish distribution	
Genetically distinct forms of native species abundance	
Genetically distinct forms of native species occurrence	
Genetically distinct forms of native species spatial distribution	
Habitats' (predominant, special, protected and endangered) characteristics	

Introduction of microbial pathogens	
Introduction of non-indigenous species	Yes
Invertebrate bottom fauna biomass and its annual/seasonal variability	
Invertebrate bottom fauna species composition and its annual/seasonal variability	
Macro-algae biomass	
Macro-algae species composition	
Marine mammals actual range	
Marine mammals natural range	
Marine mammals population dynamics	
Marine mammals status	
Non-indigenous or exotic species abundance	
Non-indigenous or exotic species occurrence	
Non-indigenous or exotic species spatial distribution	
Other protected species actual range	
Other protected species natural range	
Other protected species population dynamics	
Other protected species status	
Phytoplankton species compositions and its geographical and seasonal variability	Yes
Reptiles actual range	
Reptiles natural range	
Reptiles population dynamics	
Reptiles status	
Seabirds actual range	
Seabirds natural range	
Seabirds population dynamics	
Seabirds species' status	
Selective extraction of species	
Translocations of non-indigenous species	
Zooplankton species compositions and its geographical and seasonal variability	Yes
Acidification	
Abrasion	
Biological effects of contaminants	

Concentration of contaminants	
Currents	
Depth	
Extraction	
Ice cover	
Marine litter	
Mixing characteristics	
Nutrient concentrations	Yes
Oxygen	Yes
Residence time	
Salinity	Yes
Seabed Bathymetry	
Seabed Structure	
Seabed Substrata Composition	
Seabed Topography	
Sealing	
Siltation (changes in)	
Smothering	
Temperature	Yes
Turbidity	Yes
Underwater noise	
Upwelling	
Wave exposure	

Parameters of the Water Framework Directive WFD (for monitoring programmes described in 2.5

Parameters	Yes/No
Angiosperms Abundance	
Angiosperms Cover	
Angiosperms Depth Distribution	
Angiosperms Presence of Sensitive Taxa	
Benthic Invertebrate Fauna - Presence of Sensitive Taxa	
Benthic Invertebrate Fauna Abundance	

Benthic Invertebrate Fauna Composition	
Benthic Invertebrate Fauna Diversity	
Macro-algae - Presence of Sensitive Taxa	
Macro-algae Abundance	
Macro-algae Cover	
Macro-algae Depth Distribution	
Macro-algae Species Composition	
Phytoplankton Abundance	Yes
Phytoplankton Bloom Frequency / Intensity	Yes
Phytoplankton Composition	Yes
Phytoplankton Diversity	Yes
Specific synthetic pollutants	
Specific non-synthetic pollutants	
Acidification	
Ammonium	Yes
Nitrates	Yes
Nutrient Conditions	
Oxygenation	Yes
Bed Quantity	
Bed Structure	
Bed Substrate	
Conductivity	Yes
Depth Variation	
Direction of Dominant Currents	
Intertidal Zone Structure	
pH	Yes
Salinity	Yes
Temperature	Yes
Transparency	Yes
Residence Time	

2.6. Regional Water Protection Plan - Monitoring of marine waters

1. The name of the existing ecological monitoring programme /programmes:

Regional Water Protection Plan - Monitoring of marine waters

2. The duration of the existing ecological monitoring programme/programmes:

Depending on stations, from 2006 to 2018 (today); monthly for physical parameters, nutrients, and contaminants in water; yearly for contaminants in sediment; every two months for biological parameters.

3. The Adriatic sub-region and geographical coverage of the existing ecological monitoring programme (for example: water bodies, Marine Reporting Units):

Gulf of Trieste (from Muggia to the mouth of Tagliamento river) - physical parameters: in 53 sampling stations (only 39 active stations at present); nutrients: in 21 sampling stations; contaminants in water: in 22 sampling stations; contaminants in sediment: in 19 sampling stations. All stations are included in 19 marine water bodies.

4. Institutions engaged in the existing ecological monitoring programme:

ARPA FVG

5. Ecological parameters monitored by the ecological monitoring programme (sorted as physical, chemical and biological parameters):

Physical (air and water temperature, Salinity, Density, pH, dissolved oxygen, DO%, PAR, KPAR, REPAR, %PAR, Turbidity, Conductivity, speed of sound in water), chemical (nitrate, nitrite, ammonia, silicate, orthophosphate, TP, TN, contaminants in water and sediments (heavy metals, Organochlorines, trace metals)), biological (biodiversity and density of phytoplankton, including toxic and alien species, jellyfish aggregations). Trophic index (TRIX), assessment of the ecological status of surface waters.

6. Web page of the existing ecological monitoring programme (if applicable)

<http://www.arpa.fvg.it/cms/tema/acqua/acque-marino-costiere-e-lagunari/index.html>

7. Are the monitored data available and under which conditions (data sharing policy?):

Public data, partially available on the web page, most part of data are available after formal request to ARPA-FVG

8. Are these data shared by web service or through other web systems (if yes please indicate the web address):

No, to our knowledge

9. Are monitoring programmes connected with EUSAIR pillars or EU Directives?

Yes, with MSFD http://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/marine-strategy-framework-directive/index_en.htm

10. Short description of the monitoring programme (max. 2 pages, figures included) (for example: kind of short Technical Report with listed parameters for certain MSFD Descriptor, sampling locations, sampling frequency, link of metadata availability)

Regional coastal waters of FVG belong to the northernmost part of the Upper Adriatic basin, characterized by shallow waters and a circulation of water masses strongly influenced by meteorological factors. The Northern Adriatic has recently been designated as a "sensitive area" by Legislative Decree 152/2006. For this reason, the ARPA FVG monitors the quality of marine and coastal waters which is carried out, on a monthly basis, in 39 sampling stations distributed along the coast from Muggia to the mouth of the Tagliamento river, the stations are representative of 19 water bodies. The main parameters measured at sea are: temperature, salinity, density, pH, dissolved oxygen and chlorophyll, nutrients (nutrient salts, total nitrogen and phosphorus), the analyses on the phytoplankton community, and numerous chemical compounds (from hydrocarbons, metals, fertilizing substances, herbicides and pesticides, etc.) required by law. Furthermore, ARPA FVG observes the presence of gelatinous aggregates in the water column, and estimates their size and density, using an underwater camera.

2.7. Monitoring of water and shellfish quality in shellfish farming areas

1. The name of the existing ecological monitoring programme /programmes:

Monitoring of water and shellfish quality in shellfish farming areas

2. The duration of the existing ecological monitoring programme/programmes:

Depending on stations: microbiological analyses every two or three months; toxicological analyses every 15 days, two, three or six months; chemical analyses every three or six months.

3. The Adriatic sub-region and geographical coverage of the existing ecological monitoring programme (for example: water bodies, Marine Reporting Units):

Gulf of Trieste, 52 sampling stations (see the map of the farming areas on the web page)

4. Institutions engaged in the existing ecological monitoring programme:

ARPA FVG, laboratories of the Experimental Zooprophyllactic Institute of Venetia in Pordenone and Padua (microbiological, chemical and biotoxicological analyses of the shellfish), Integrated University Health Agency of Trieste (ASUITs) for the sampling activities.

5. Ecological parameters monitored by the ecological monitoring programme (sorted as physical, chemical and biological parameters):

Microbiological and chemical analyses of water and shellfish and shellfish toxicology analyses to investigate the presence of toxic phytoplankton.

6. Web page of the existing ecological monitoring programme (if applicable)

<http://www.arpa.fvg.it/cms/tema/acqua/acque-marino-costiere-e-lagunari/approfondimenti/schede/Molluschicoltura-l-ambiente-per-la-tutela-della-salute.html>

7. Are the monitored data available and under which conditions (data sharing policy?):

Public data: a report with the activities and results of 2016 is available on the web page, more data are probably available after formal request to ARPA FVG.

8. Are these data shared by web service or through other web systems (if yes please indicate the web address):

No, to our knowledge

9. Are monitoring programmes connected with EUSAIR pillars or EU Directives?

Yes, with MSFD http://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/marine-strategy-framework-directive/index_en.htm

10. Short description of the monitoring programme (max. 2 pages, figures included) (for example: kind of short Technical Report with listed parameters for certain MSFD Descriptor, sampling locations, sampling frequency, link of metadata availability)

ARPA FVG carries out samplings of waters and molluscs in the areas designated and classified by the Region for seafood farming. In particular, it assesses microbiological, biotoxicological and chemical contaminants.

The analysis of the microbiological quality of molluscs relative to the areas where they were collected or bred has as purpose the classification of the same areas. In fact, based on the quality levels detected from the microbiological monitoring carried out for a period of at least six months, in the newly classified areas, or three-year areas, in the areas already classified, the areas are identified and classified into three levels of possible microbiological contamination:

zone A: low level of contamination;

zone B: presence of the contaminant;

zone C: high level of contamination.

In addition to the microbiological contamination there is a possible natural contamination, which makes the edible mollusc toxic. This contamination is due to toxic algae that molluscs eat, accumulating algal toxins inside the body. The biological monitoring of the phytoplankton in the waters where the molluscs grow and the chemical analysis of the toxins contained in the molluscs allow to prevent possible intoxication phenomena.

2.8. Bathing water quality monitoring

1. The name of the existing ecological monitoring programme /programmes:

Bathing water quality monitoring

2. The duration of the existing ecological monitoring programme/programmes:

Monthly from 1st May to 30th September every year

3. The Adriatic sub-region and geographical coverage of the existing ecological monitoring programme (for example: water bodies, Marine Reporting Units):

Gulf of Trieste, 55 sampling stations along the coast

4. Institutions engaged in the existing ecological monitoring programme:

ARPA FVG

5. Ecological parameters monitored by the ecological monitoring programme (sorted as physical, chemical and biological parameters):

Density of *Escherichia coli* and *Enterococcus* spp., diversity and density of phytoplankton, including toxic microalgae, air and water temperature, currents, waves, wind

6. Web page of the existing ecological monitoring programme (if applicable)

<http://www.arpa.fvg.it/cms/tema/acqua/balneazione/index.html>

7. Are the monitored data available and under which conditions (data sharing policy?):

Public data, available on the webpage.

8. Are these data shared by web service or through other web systems (if yes please indicate the web address):

No, to our knowledge

9. Are monitoring programmes connected with EUSAIR pillars or EU Directives?

Yes, with MSFD http://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/marine-strategy-framework-directive/index_en.htm and with WFD http://ec.europa.eu/environment/water/water-framework/index_en.html

10. Short description of the monitoring programme (max. 2 pages, figures included) (for example: kind of short Technical Report with listed parameters for certain MSFD Descriptor, sampling locations, sampling frequency, link of metadata availability).

In all water bodies where bathing is allowed, ARPA FVG carries out monthly checks, according to national and European legislation, starting from the month preceding the opening of the bathing season. Sampling and analysis are carried out according to a predetermined program.

At the end of each bathing season, on the basis of the data series relating to the last four previous seasons and the analytical results of the microbiological parameters (*Escherichia coli* and *Enterococcus* spp.) a water quality assessment is performed.

Subsequently the Region classifies these waters as waters of "poor", "sufficient", "good" or "excellent" quality.

In 1999, the ecological research site has been equipped with a meteo oceanographic buoy (MAMBO) in order to acquire continuous data on meteorological conditions at sea and on seawater physical and biogeochemical properties. Due to the high temporal dynamics of ecological processes in coastal ecosystems, continuous and real-time data of the main meteorological, physical and biogeochemical properties are fundamental for a better understanding of marine ecosystem functioning.

2.9. Visual census of the seafloor by ROV

1. The name of the existing ecological monitoring programme /programmes:

Visual census of the seafloor by ROV

2. The duration of the existing ecological monitoring programme/programmes:

Yearly

3. The Adriatic sub-region and geographical coverage of the existing ecological monitoring programme (for example: water bodies, Marine Reporting Units):

Gulf of Trieste, in three areas (one area designed to study Maerl habitat and two areas to study human impacts on the seafloor). Every area has three sampling stations.

4. Institutions engaged in the existing ecological monitoring programme:

ARPA FVG, ARPA Veneto

5. *Ecological parameters monitored by the ecological monitoring programme (sorted as physical, chemical and biological parameters):*

Calcareous red-algae (Maerl/Rodoliths) distribution and human impacts on the seafloor (e.g. trawling)

6. *Web page of the existing ecological monitoring programme (if applicable)*

<http://www.arpa.fvg.it/cms/tema/acqua/acque-marino-costiere-e-lagunari/approfondimenti/ROV-veicolo-subacqueo.html>

7. *Are the monitored data available and under which conditions (data sharing policy?):*

Public data, probably available after formal request to ARPA FVG.

8. *Are these data shared by web service or through other web systems (if yes please indicate the web address):*

No, to our knowledge

9. *Are monitoring programmes connected with EUSAIR pillars or EU Directives?*

Yes, with MSFD http://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/marine-strategy-framework-directive/index_en.htm

10. *Short description of the monitoring programme (max. 2 pages, figures included) (for example: kind of short Technical Report with listed parameters for certain MSFD Descriptor, sampling locations, sampling frequency, link of metadata availability)*

ARPA FVG has recently bought a ROV, fundamental for the visual census of the seabed envisaged by the Marine Strategy. Specifically, module 8 and 9 of the marine strategy require respectively to detect the presence on the bottom of beds of red calcareous algae (Maerl / Rodoliths) and of areas subjected to physical damage due to the anthropic works or fishing activities with invasive means.

ARPA FVG makes observations of the seabed once a year. The surveys are carried out in three areas off the Gulf of Trieste, of which one area is identified for the study of Maerl and two for the study of physical damage. On each area three stations are identified and on each station three transects (of a

length of about 100m) are performed with ROV, for a total of 27 surveys. The activities take place over a couple of weeks. ROV is shared with ARPA Veneto for monitoring the damage on the relative seabed.

2.10. Seagrasses and macroalgae monitoring UNITS and FVG Region

1. *The name of the existing ecological monitoring programme /programmes:*

Seagrasses and macroalgae monitoring UNITS and FVG Region

2. *The duration of the existing ecological monitoring programme/programmes:*

From 2000

3. *The Adriatic sub-region and geographical coverage of the existing ecological monitoring programme (for example: water bodies, Marine Reporting Units):*

Gulf of Trieste

4. *Institutions engaged in the existing ecological monitoring programme:*

University of Trieste - Department of Life Sciences, University of Bologna - Department of Biological, Geological, and Environmental Sciences, OGS

5. *Ecological parameters monitored by the ecological monitoring programme (sorted as physical, chemical and biological parameters):*

Biological parameters: spatial distribution, species richness, density, coverage, community structure and dynamic.

Physical parameters (atmosphere): air humidity, air temperature, air pressure, wind direction, wind speed, wind gust

Physical parameters (sea): pressure, water temperature, water salinity, water transparency, conductivity, fluorescence, turbidity

Chemical parameters: dissolved oxygen, pH, alkalinity, dissolved organic carbon, dissolved organic nitrogen, dissolved organic phosphorus, inorganic carbon, particulate organic carbon, particulate

nitrogen, particulate phosphorus, dissolved macronutrient concentration (N-NH₄, N-NO₃, N-NO₂, P-PO₄, Si-SiO₄)

Biological parameter: chlorophyll *a*, zooplankton abundance, microphytoplankton abundance, microzooplankton abundance, picoplankton abundance, nanoplankton abundance, biomass, microphytobenthos abundance, macrozoobenthos abundance, meiobenthos abundance

Biological processes: primary production, secondary production, exoenzymatic activities in water and sediment

6. Are the monitored data available and under which conditions (data sharing policy?):

Data is not publicly shared, but available for cooperative research projects. The Seagrasses distributional maps are available at the FVG Region.

7. Are these data shared by web service or through other web systems (if yes please indicate the web address):

No, to our knowledge

8. Are monitoring programmes connected with EUSAIR pillars or EU Directives?

Yes, with Habitat Directive:- *Posidonia oceanica* as Habitat 1120 (SIC Posidonia Grado; with MSFD: - Coralligenous (Trezza and Tegnue) monitored by ARPA-FVG; and with Habitat Directive: - Coralligenous as Habitat 1170 (SIC Trezze-Tegnue)
http://ec.europa.eu/environment/nature/legislation/habitatsdirective/index_en.htm;
http://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/marine-strategy-framework-directive/index_en.htm

9. Short description of the monitoring programme (max. 2 pages, figures included) (for example: kind of short Technical Report with listed parameters for certain MSFD Descriptor, sampling locations, sampling frequency, link of metadata availability)

The monitoring of seagrasses (*Posidonia oceanica*, *Cymodocea nodosa*) is carried out in the whole Gulf of Trieste. Monitoring is carried out by SCUBA divers along transects parallel and perpendicular to the coastline. Data of density and coverage are taken together with samples phenological measures in the laboratory.

The macroalgae are sampled by SCUBA diving, on rocky (natural and/or artificial) substrata, from midlittoral zone through to the maximum depth where the seaweeds were present. The collected

material are fixed in a 4% formaldehydes-seawater solution and a humid herbarium has been set up and kept in a dark cool chamber at the Department of Life Sciences of the University of Trieste.

2.11. Coralligenous monitoring UNITS; TRECORALA; PRIN ReefReseArch Resistance and resilience of Adriatic mesophotic biogenic habitats to human and climate change threats Research project of national interest

1. The name of the existing ecological monitoring programme /programmes:

Coralligenous monitoring UNITS; TRECORALA; PRIN ReefReseArch Resistance and resilience of Adriatic mesophotic biogenic habitats to human and climate change threats Research project of national interest, funded by the Italian Ministry of University and Research - Call 2015, Prot. 2015J922E4

2. The duration of the existing ecological monitoring programme/programmes:

from 2006

3. The Adriatic sub-region and geographical coverage of the existing ecological monitoring programme (for example: water bodies, Marine Reporting Units):

Gulf of Trieste

4. Institutions engaged in the existing ecological monitoring programme:

University of Trieste - Department of Life Sciences, University of Bologna - Department of Biological, Geological, and Environmental Sciences, OGS

5. Ecological parameters monitored by the ecological monitoring programme (sorted as physical, chemical and biological parameters):

Biological parameters: spatial distribution, species richness, density, coverage, community structure and dynamic.

6. Web page of the existing ecological monitoring programme (if applicable)

TRECORALA: <http://www.gradoambiente.it/trecorala>; ReefReseArch: <https://reefresearch.jimdo.com/>

7. Are the monitored data available and under which conditions (data sharing policy?):

Data is not publicly shared, but available for cooperative research projects. Data from the TRECORALA projects are available at the FVG Region. Some data have been published (check-list of macroalgae and macrozoobenthos of the Trezze) in Falace et al., 2015

8. Are these data shared by web service or through other web systems (if yes please indicate the web address):

No, to our knowledge

9. Are monitoring programmes connected with EUSAIR pillars or EU Directives?

Marine Strategy: Coralligenous (Trezza and Tegnue) monitored by ARPA-FVG

Habitat Directive: - Coralligenous as Habitat 1170 (SIC Trezze-Tegnue) (http://ec.europa.eu/environment/nature/legislation/habitatsdirective/index_en.htm; http://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/marine-strategy-framework-directive/index_en.htm)

10. Short description of the monitoring programme (max. 2 pages, figures included) (for example: kind of short Technical Report with listed parameters for certain MSFD Descriptor, sampling locations, sampling frequency, link of metadata availability)

Coralligenous samples are collected on the upper horizontal surfaces of the outcrops by scraping and collecting the benthos with a vacuum lift on randomly selected quadrats of 2500 cm². Species compositions and coverage are determined in the laboratory. Others samples are collected through photographic samples, analyzed in the lab by dedicated software.

Parameters of the Marine Strategy Framework Directive (MSFD) Annex III (for monitoring programme described in 2.5 to 2.12)

Parameter	Yes/No
Angiosperms biomass and its annual/seasonal variability	
Angiosperms species composition and its annual/seasonal variability	Yes
Fish abundance	

Fish age / size structure	
Fish distribution	
Genetically distinct forms of native species abundance	
Genetically distinct forms of native species occurrence	
Genetically distinct forms of native species spatial distribution	
Habitats' (predominant, special, protected and endangered) characteristics	Yes
Introduction of microbial pathogens	
Introduction of non-indigenous species	
Invertebrate bottom fauna biomass and its annual/seasonal variability	
Invertebrate bottom fauna species composition and its annual/seasonal variability	Yes
Macro-algae biomass	
Macro-algae species composition	Yes
Marine mammals actual range	
Marine mammals natural range	
Marine mammals population dynamics	
Marine mammals status	
Non-indigenous or exotic species abundance	Yes
Non-indigenous or exotic species occurrence	Yes
Non-indigenous or exotic species spatial distribution	
Other protected species actual range	
Other protected species natural range	
Other protected species population dynamics	
Other protected species status	
Phytoplankton species compositions and its geographical and seasonal variability	
Reptiles actual range	
Reptiles natural range	
Reptiles population dynamics	
Reptiles status	
Seabirds actual range	
Seabirds natural range	
Seabirds population dynamics	
Seabirds species' status	
Selective extraction of species	

Translocations of non-indigenous species	
Zooplankton species compositions and its geographical and seasonal variability	
Acidification	
Abrasion	
Biological effects of contaminants	Yes
Concentration of contaminants	
Currents	
Depth	
Extraction	
Ice cover	
Marine litter	
Mixing characteristics	
Nutrient concentrations	
Oxygen	
Residence time	
Salinity	
Seabed Bathymetry	
Seabed Structure	
Seabed Substrata Composition	
Seabed Topography	
Sealing	
Siltation (changes in)	
Smothering	
Temperature	
Turbidity	
Underwater noise	
Upwelling	
Wave exposure	

Parameters of the Water Framework Directive (WFD) (for monitoring programme described in 2.5 to 2.12)

Parameters	Yes/No
Angiosperms Abundance	
Angiosperms Cover	Yes
Angiosperms Depth Distribution	Yes
Angiosperms Presence of Sensitive Taxa	
Benthic Invertebrate Fauna - Presence of Sensitive Taxa	
Benthic Invertebrate Fauna Abundance	Yes
Benthic Invertebrate Fauna Composition	Yes
Benthic Invertebrate Fauna Diversity	Yes
Macro-algae - Presence of Sensitive Taxa	Yes
Macro-algae Abundance	Yes
Macro-algae Cover	Yes
Macro-algae Depth Distribution	Yes
Macro-algae Species Composition	Yes
Phytoplankton Abundance	
Phytoplankton Bloom Frequency / Intensity	
Phytoplankton Composition	
Phytoplankton Diversity	
Specific synthetic pollutants	
Specific non-synthetic pollutants	
Acidification	
Ammonium	
Nitrates	
Nutrient Conditions	
Oxygenation	
Bed Quantity	
Bed Structure	
Bed Substrate	
Conductivity	
Depth Variation	
Direction of Dominant Currents	

Intertidal Zone Structure	
pH	
Salinity	
Temperature	
Transparency	
Residence Time	

Parameters of the Habitats Directive (HD) (for monitoring programme described in 2.5 to 2.12)

Parameter	Yes/No
Natural range of natural habitat types of community interest	Yes
Area covered by natural habitat types of community interest	Yes
Specific structure of natural habitat types of community interest	
Necessary functions of natural habitat types of community interest	
Status of conservation of species in natural habitat types of community interest	Yes
Population dynamics of animal and plant species of community interest	
Natural range of animal and plant species of community interest	
Presence of habitat for animal and plant species of community interest	Yes
Population dynamics of animal and plant species of community interest in need of strict protection	
Natural range of animal and plant species of community interest in need of strict protection	
Presence of (sufficiently large) habitat of animal and plant species of community interest in need of strict protection	
Incidental capture and killing of animals of community interest in need of strict protection	
Population dynamics of animal and plant species of community interest in need of strict protection	
Natural range of animal and plant species of community interest in need of strict protection	
Presence of (sufficiently large) habitat of animal and plant species of community interest whose taking in the wild and exploitation may be subject to management measures	

Parameters of the Marine Spatial Planning (MSP) (for monitoring programme described in 2.5 to 2.12)

Parameter	Yes/No
Aquaculture areas	
Fishing areas	
Installations and infrastructures for the exploration, exploitation and extraction of oil, of gas and other energy	
Resources, of minerals and aggregates, and for the production of energy from renewable sources	
Maritime transport routes and traffic flows	
Military training areas	
Nature and species conservation sites and protected areas	Yes
Raw material extraction areas	
Scientific research	Yes
Submarine cable and pipeline routes	
Tourism	Yes
Underwater cultural heritage	

2.12. Integrated monitoring programme of transitional water bodies in according to legislative decree n. 152/2006 (aimed to chemical and ecological status classification and to assessment of the quality of shellfish waters - specific destination waters).

1. The name of the existing ecological monitoring programme /programmes:

Integrated monitoring programme of transitional water bodies in according to legislative decree n. 152/2006 (aimed to chemical and ecological status classification and to assessment of the quality of shellfish waters - specific destination waters).

2. The duration of the existing ecological monitoring programme/programmes:

Since 2010 (monitoring programme of transitional water bodies for chemical and ecological status classification);

Since 2004 (monitoring programme of transitional water for quality of shellfish waters).

3. The Adriatic sub-region and geographical coverage of the existing ecological monitoring programme (for example: water bodies, Marine Reporting Units):

Coastal lagoons of Caleri, Marinetta, Vallona, Barbamarco, Canarin, Scardovari;
 Mouths of Po river (Po di Maistra, Po di Pila, Po di Tolle, Po di Gnocca, Po di Goro).

4. Institutions engaged in the existing ecological monitoring programme:

ARPAV, SISTEMI TERRITORIALI SPA

5. Ecological parameters monitored by the ecological monitoring programme (sorted as physical, chemical and biological parameters):

- Physical parameters

Current direction
Current speed
Air temperature
Wind direction
Wind speed
Air pressure
Air humidity
Sky coverage
Solar radiation
Tide conditions
Water colouration (visual analysis)
Transparence
Depth
Water temperature
pH
Salinity
Dissolved oxygen (%)
Dissolved oxygen (ppm)
Conductivity

Chlorophyll "a" CTD
Sediment density
Sediment porosity

- Biological, microbiological and chemical parameters

Water nutrients (nitrate, nitrite, ammonia, orthophosphate)
Phytoplankton
Potentially toxic Phytoplankton
Macrophytes
Benthic macroinvertebrates
Chlorophyll "a"
Contaminants in water, sediments and biota (fish and molluscs) - D.Lgs. 172/2015
Color Pt/Co
Suspended solid
AVS/Lfe in sediment
Granulometry and organic matter in sediment
Ecotoxicological tests in sediment
Microbiological analyses of shellfish
Shellfish toxicology analyses (PSP)

6. *Web page of the existing ecological monitoring programme (if applicable)*

Not available

7. *Are the monitored data available and under which conditions (data sharing policy?):*

Public data, available on the ARPAV webpage

8. *Are these data shared by web service or through other web systems (if yes please indicate the web address):*

<http://www.arpa.veneto.it/dati-ambientali/open-data/idrosfera/acque-marino-costiere-e-acque-di-transizione>

9. Are monitoring programmes connected with EUSAIR pillars EU Directives (for EUSAIR Pillars please consult <https://www.adriatic-ionian.eu/about-eusair/pillars/>, for EU Directives see http://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/marine-strategy-framework-directive/index_en.htm - Marine Strategy Framework Directive, http://ec.europa.eu/environment/water/water-framework/index_en.html - Water Framework Directive, https://ec.europa.eu/maritimeaffairs/policy/maritime_spatial_planning_en - Maritime Spatial Planning Directive, http://ec.europa.eu/environment/nature/legislation/habitatsdirective/index_en.htm - The Habitats Directive):

Yes (WFD)

10. Short description of the monitoring programme (max. 2 pages, figures included) (for example: kind of short Technical Report with listed parameters for certain MSFD Descriptor, sampling locations, sampling frequency, link of metadata availability)

ARPAV makes periodical controls on about 100 stations located in the coastal lagoons of Caleri, Marinetta, Vallona, Barbamarco, Canarin, Scardovari and in the 5 mouths of Po River (Fig.1)

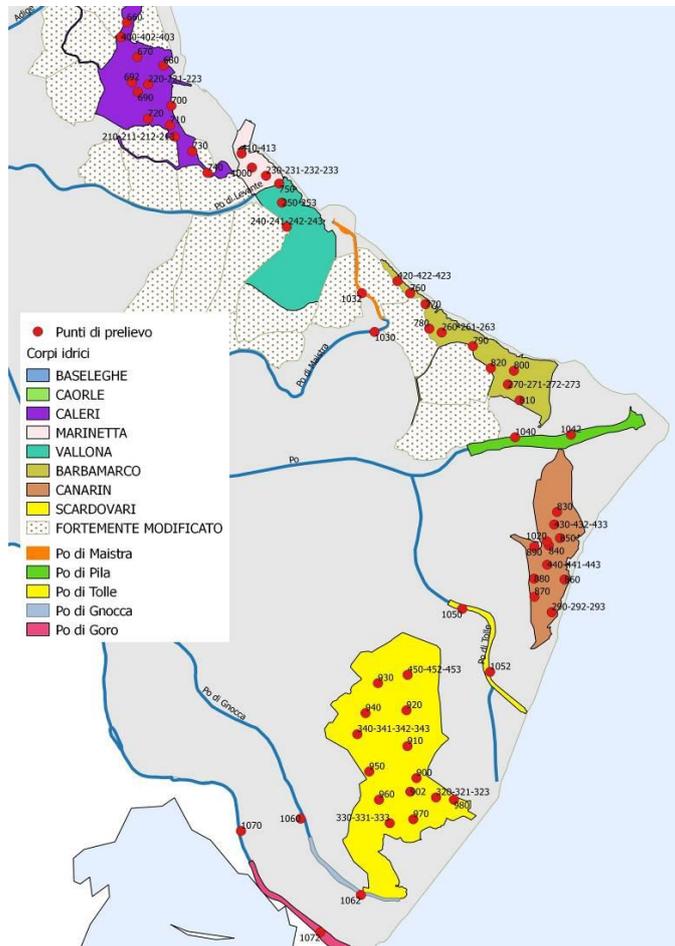


Fig. 1. Monitored sites in transitional water bodies of Delta Po area.

In Tab. 1 it is reported an example of monitored parameters and their frequency in 2017-2019 period.

Tab. 1. Parameters and frequencies of operating monitoring programme.

		2017	2018	2019
Biological Quality Element	Macrophytes		2 times	
	Phytoplankton	4 times	4 times	4 times
	Benthic macroinvertebrates		1 time	

Physical-Chemical Quality Elements	Nutrients	4 times	4 times	4 times
	Oxygen (AVS/LFe in sediment)	3 times	3 times	3 times
	(granulometry and organic matter in sediment)	1 time	1 time	
	Other contaminants in water	4 times	4 times	4 times
	Other contaminants in sediment	1 time	1 time	
	Priority substances in water	4 times	4 times	4 times
	Priority substances in sediment	1 time	1 time	
	Priority substances in molluscs	2 times	2 times	2 times
	Priority substances in fishes		1 time	1 time

ARPAV carries out samplings of water and mollusc in the areas designated by the Veneto Region for molluscs protection. In particular, it assesses microbiological, biotoxicological and chemical contaminants. Annually ARPAV assesses the compliance of these waters based on the standard limits indicated in the reference legislation.

After every monitoring cruise it is published a short technical report about observed CTD-data and about any anomalous conditions. Every year it is also produced an annual report about all the data collected.

This documents are available on <http://www.arpa.veneto.it/temi-ambientali/acqua/file-e-allegati/documenti/acque-di-transizione> .

2.13. Arpae Emilia-Romagna

1. *The name of the existing ecological monitoring programme /programmes:*

Arpae Emilia-Romagna, monitoring program

2. *The duration of the existing ecological monitoring programme/programmes:*

Since 1981 (37 years)

3. *The Adriatic sub-region and geographical coverage of the existing ecological monitoring programme (for example: water bodies, Marine Reporting Units):*

Emilia Romagna coast, Sacca di Goro (MRU: no)

4. Institutions engaged in the existing ecological monitoring programme:

Daphne, Arpae Emilia-Romagna

5. Ecological parameters monitored by the ecological monitoring programme (sorted as physical, chemical and biological parameters):

Physical (temperature, Salinity, Density, pH, dissolved oxygen), chemical (nitrate, nitrite, ammonia, silicate, orthophosphate, chlorophyll), biological (abundance of total phytoplankton and of phytoplankton main groups). Harmful algal blooms, eutrophication related phenomena, mucilage occurrence, macroalgal blooms, jellyfish.

6. Web page of the existing ecological monitoring programme (if applicable)

<https://www.arpae.it/index.asp?idlivello=130> (only in Italian)

7. Are the monitored data available and under which conditions (data sharing policy?):

No.

8. Are these data shared by web service or through other web systems (if yes please indicate the web address):

https://www.arpae.it/elenchi_dinamici.asp?tipo=tec_mare&idlivello=1451

9. Are monitoring programmes connected with EUSAIR pillars or EU Directives? Directive,

Yes

10. Short description of the monitoring programme (max. 2 pages, figures included) (for example: kind of short Technical Report with listed parameters for certain MSFD Descriptor, sampling locations, sampling frequency, link of metadata availability)

Arpae Daphne makes periodical controls on 41 stations along the Emilia Romagna coastline between Lido di Volano and Cattolica, from about 500 m to about 10 km offshore.

It monitors physical (temperature, Salinity, Density, pH, dissolved oxygen), chemical (nitrate, nitrite, ammonia, silicate, orthophosphate, chlorophyll), biological (abundance of total phytoplankton and of phytoplankton main groups) quantities, together with harmful algal blooms, eutrophication related phenomena, mucilage occurrence, macroalgal blooms, jellyfish.

Physical and chemical parameters measured on 14 stations at about 500 m offshore (salinity, temperature, surface and bottom dissolved oxygen, transparency and chlorophyll a) are used for the periodic ecological bulletin. Data are averaged on 3 sub-areas called A, B and C, three homogeneous zones for physical and chemical characteristics.

Parameters of the Marine Strategy Framework Directive (MSFD) (for monitoring programme described in 2.13)

Parameter	Yes/No
Angiosperms biomass and its annual/seasonal variability	
Angiosperms species composition and its annual/seasonal variability	
Fish abundance	
Fish age / size structure	
Fish distribution	
Genetically distinct forms of native species abundance	
Genetically distinct forms of native species occurrence	
Genetically distinct forms of native species spatial distribution	
Habitats' (predominant, special, protected and endangered) characteristics	
Introduction of microbial pathogens	
Introduction of non-indigenous species	
Invertebrate bottom fauna biomass and its annual/seasonal variability	
Invertebrate bottom fauna species composition and its annual/seasonal variability	
Macro-algae biomass	
Macro-algae species composition	
Marine mammals actual range	
Marine mammals natural range	
Marine mammals population dynamics	
Marine mammals status	
Non-indigenous or exotic species abundance	
Non-indigenous or exotic species occurrence	
Non-indigenous or exotic species spatial distribution	
Other protected species actual range	
Other protected species natural range	
Other protected species population dynamics	
Other protected species status	
Phytoplankton species compositions and its geographical and seasonal variability	
Reptiles actual range	
Reptiles natural range	

Reptiles population dynamics	
Reptiles status	
Seabirds actual range	
Seabirds natural range	
Seabirds population dynamics	
Seabirds species' status	
Selective extraction of species	
Translocations of non-indigenous species	
Zooplankton species compositions and its geographical and seasonal variability	
Acidification	
Abrasion	
Biological effects of contaminants	
Concentration of contaminants	
Currents	
Depth	
Extraction	
Ice cover	
Marine litter	
Mixing characteristics	
Nutrient concentrations	
Oxygen	yes
Residence time	
Salinity	yes
Seabed Bathymetry	
Seabed Structure	
Seabed Substrata Composition	
Seabed Topography	
Sealing	
Siltation (changes in)	
Smothering	
Temperature	yes
Turbidity	

Underwater noise	
Upwelling	
Wave exposure	

Parameters of the Water Framework Directive (WFD) (for monitoring programme described in 2.13)

Parameters	Yes/No
Angiosperms Abundance	
Angiosperms Cover	
Angiosperms Depth Distribution	
Angiosperms Presence of Sensitive Taxa	
Benthic Invertebrate Fauna - Presence of Sensitive Taxa	
Benthic Invertebrate Fauna Abundance	
Benthic Invertebrate Fauna Composition	
Benthic Invertebrate Fauna Diversity	
Macro-algae - Presence of Sensitive Taxa	
Macro-algae Abundance	
Macro-algae Cover	
Macro-algae Depth Distribution	
Macro-algae Species Composition	
Phytoplankton Abundance	Yes
Phytoplankton Bloom Frequency / Intensity	Yes
Phytoplankton Composition	Yes
Phytoplankton Diversity	Yes
Specific synthetic pollutants	
Specific non-synthetic pollutants	
Acidification	Yes
Ammonium	Yes
Nitrates	Yes
Nutrient Conditions	Yes
Oxygenation	Yes
Bed Quantity	
Bed Structure	

Bed Substrate	
Conductivity	Yes
Depth Variation	Yes
Direction of Dominant Currents	Yes
Intertidal Zone Structure	
pH	Yes
Salinity	Yes
Temperature	Yes
Transparency	Yes
Residence Time	

2.14. Other reported projects

1. The name of the existing ecological monitoring programme /programmes:

We include here projects, in which our working group is directly involved, which are not monitoring programmes, but include, among other activities, the assessment of ecological variables. These activities will be the object of our answers to this questionnaire. The projects are:

- a) project Ritmare-SOLVE, Sistema Osservativo della Laguna di Venezia (Venice lagoon observing system)
- b) project Venezia 2021, Research Program for a "regulated" lagoon
- c) project Life REDUNE, Restoration of dune habitats in Natura 2000 sites of the Veneto coast
- d) Interreg project AdriSmartFish, Valorisation of SMall-scale ARTisanal FISHerY of the Adriatic coasts, in a context of sustainability

2. The duration of the existing ecological monitoring programme/programmes:

- a) project Ritmare-SOLVE: 2016
- b) project Venezia 2021: 11/2018-12/2021
- c) project Life REDUNE: 10/2017 – 03/2022
- d) Interreg project AdriSmartFish: 01/2019-6/2021

3. The Adriatic sub-region and geographical coverage of the existing ecological monitoring programme (for example: water bodies, Marine Reporting Units):

- a) project Ritmare-SOLVE: Venice lagoon
- b) project Venezia 2021: Venice lagoon
- c) project Life REDUNE: Penisola del Cavallino (IT3250003); Laguna del Mort e Pinete di Eraclea (IT3250013); and Laguna di Caorle - Foce del Tagliamento (IT3250033).
- d) Interreg project AdriSmartFish: Northern Adriatic (GSA 17)

4. Institutions engaged in the existing ecological monitoring programme:

- a) project Ritmare-SOLVE: CORILA, Ca Foscari University, University of Padua, CNR, OGS
- b) project Venezia 2021: CORILA, Ca Foscari University, University of Padua, CNR, OGS
- c) project Life REDUNE: Ca Foscari University, Veneto Region, SELC soc. coop., Veneto Agricoltura, EPC s.r.l.
- d) Interreg project AdriSmartFish: Veneto Region, Ca' Foscari University, Autonomous Region Of Friuli Venezia Giulia, Emilia Romagna Region, Marche Region, Region of Istria, Primorje-Gorski Kotar County, Zadar County, Institute Of Oceanography And Fisheries, Ministry Of Agriculture (Croatia).

5. Ecological parameters monitored by the ecological monitoring programme (sorted as physical, chemical and biological parameters):

- a) project Ritmare-SOLVE: within the project, our working group has been in charge of the assessment of ecosystem services
- b) project Venezia 2021: within the project, our working group is in charge of the assessment of ecosystem services
- c) project Life REDUNE: extent and species composition of dune habitats; ecosystem services assessment before and after the project's restoration actions
- d) Interreg project AdriSmartFish: monitoring of small-scale artisanal fishery

6. Web page of the existing ecological monitoring programme (if applicable)

- a) project Ritmare-SOLVE: not available
- b) project Venezia 2021: not available yet
- c) project Life REDUNE: <http://www.liferedune.it/>

d) Interreg project AdriSmartFish: not available yet (information sheet: https://www.unive.it/pag/fileadmin/user_upload/ateneo/ricerca/documenti/progetti_internazionali/intereg_2014_2020/SMARTFISH_infosheet.pdf)

7. Are the monitored data available and under which conditions (data sharing policy?):

- a) project Ritmare-SOLVE: reports possibly available upon request to CORILA
- b) project Venezia 2021: data not yet available. Reports will possibly be available upon request to CORILA
- c) project Life REDUNE: results will become available in the form of project reports
- d) Interreg project AdriSmartFish: results will become available in the form of project reports

8. Are these data shared by web service or through other web systems (if yes please indicate the web address):

- a) project Ritmare-SOLVE: no
- b) project Venezia 2021: no
- c) project Life REDUNE: reports will be available on project website (see above, question 6)
- d) Interreg project AdriSmartFish: reports will be available on project website (see above, question 6)

9. Are monitoring programmes connected with EUSAIR pillars or EU Directives?

- a) project Ritmare-SOLVE: HD, MSPD (the project is connected with these directives as it quantifies some of their relevant parameters, in particular, it maps the area covered by natural habitat types of community interest (HD) and it maps fishing areas (MSPD))
- b) project Venezia 2021: HD, MSPD (as in the previous case, the project is connected with these directives as it quantifies some of their relevant parameters, in particular, it maps the area covered by natural habitat types of community interest (HD) and it maps fishing areas (MSPD))
- c) project Life REDUNE: HD (the project is connected with the HD as it maps the area covered by habitat types of community interests and it implements activities aimed at the restoration of these habitats)
- d) Interreg project AdriSmartFish: EUSAIR, MSPD (the project is directly relevant to pillar 1 of EUSAIR (Blue growth) and is connected to the MSP as it maps fishing areas)

10. Short description of the monitoring programme (max. 2 pages, figures included) (for example: kind of short Technical Report with listed parameters for certain MSFD Descriptor, sampling locations, sampling frequency, link of metadata availability)

a) project Ritmare-SOLVE: within the project, the work carried out by our research groups consists in the mapping of a set of regulating, provisioning and cultural ecosystem services in the Venice lagoon. The mapping makes use of a variety of ecological, morphological, hydrological and socio-economic data, referred to the year 2015, or to a period as close as possible, depending on availability. This resulted in the first assessment of ecosystem services in the study area, producing maps of 12 ecosystem services, namely climate regulation, water purification, erosion prevention, lifecycle maintenance, artisanal fishing, recreational fishing, clam harvesting, hunting, tourism, recreational navigation, information for cognitive development and traditions.

b) project Venezia 2021: the ecosystem services assessment carried out within this project will build upon the ecosystem services maps produced within the project Ritmare-SOLVE. New data about the supply and actual use of ecosystem services will be collected, which will allow to update, both temporally and spatially, the previously available maps.

c) project Life REDUNE: the project includes the monitoring of dune habitats (mobile dunes and fixed dunes) in the project sites, and the assessment of the ecosystem services provided by these habitats. The habitat mapping is done by using a combination of drone images and plot-based vegetation sampling. The monitoring of ecosystem services includes four services, namely materials, coastal protection, climate regulation, and recreation and leisure, which are assessed by collecting ecological data (e.g. biomass, presence of organic materials on the beach) and socio-economic data (e.g. supply of environmental education activities). The monitoring of habitat and ecosystem services takes place during the first and last project years, before and after the implementation of the restoration actions foreseen by the project.

d) Interreg project AdriSmartFish: the project includes the monitoring of small-scale artisanal fishery (SSF) in the northern Adriatic Sea (GSA 17), which includes in particular: characterization of the SSFs in the area, in terms of ports, number and characteristics of vessels; social characterization of the SSFs, in terms of people employed, demographics, generated income, time trends; identification of fishing strategies, as seasonality, gear employed, local specificity, selectivity, discard, environmental impact; qualitative and quantitative description of landings, time trends, local variations, market value for each Italian Region/Croatian County and GSA17, as a whole; assessment of potential vulnerability of SSF to climate change effects, in terms of species composition, but also fleet structure and fishing strategies; identification of main fishing grounds, and conflicts with other uses of the marine space (e.g. recreational fishing, aquaculture, clam dredging and industrial fishing, marine transportation).

3. EXISTING ECOLOGICAL MONITORING OBSERVING SYSTEMS

3.1. Acqua Alta Tower

1. *The name of the observing system/network:*

Acqua Alta Tower

2. *The time span in which the observing system/network has been operational:*

Acqua Alta Tower: 1992 – on-going

3. *The Adriatic sub-region and geographical coverage by the observing system/network:*

Northern Adriatic Sea, Gulfs of Venice

4. *Institutions engaged in management of the observing system/network:*

CNR-ISMAR

5. *Ecological parameters monitored by the observing system/network (sorted as physical, chemical and biological parameters):*

Acqua Alta Tower:

Physical parameters (atmosphere and sea): air humidity, air temperature, air pressure, wind direction, wind speed, wind gust, precipitation rate; pressure, current speed, current direction, wave height, wave period, wave direction, water temperature, water salinity, water transparency, conductivity, fluorescence, turbidity;

Chemical parameters: dissolved oxygen, pH, dissolved macronutrient concentration (N-NH₄, N-NO₃, N-NO₂, P-PO₄, Si-SiO₄),

Biological parameter: chlorophyll a, phyto- and zooplankton abundance, and biomass, biodiversity, change in population size over time, community pattern, community structure, underwater video-monitoring of pelagic communities (e.g. fish, megazooplankton)

6. *Web page with data products of the observing system/network:*

Data from the fixed observatories can be visualized at the following web pages:

Acqua Alta Platform: <http://www.ismar.cnr.it/infrastrutture/piattaforma-acqua-alta>

7. Are the monitored data available and under which conditions:

Data use is permitted upon request by citing the source.

8. Are observing systems and data products connected with EUSAIR pillars EU Directives

The research and monitoring activities of the above-mentioned fixed-point observatory are relevant to the EUSAIR Pillar 3 (Topic 1) by increasing marine knowledge through integrated oceanographic and ecological monitoring. Moreover, while their monitoring activities are not specifically coordinated for the implementation of EU Environmental Directives, they have the potential to contribute in understanding the state of the environment to define GES under the MSFD.

9. Short description of the observing system (max. 2 pages, figures included):

The Acqua Alta oceanographic tower is located 15 km offshore of Venice in the northern Adriatic Sea, at a bottom depth of 16 m. The platform is fully equipped with a large set of autonomous instrumentations that acquire atmospheric, hydrological and oceanographic data with several meteorological stations and sensors (including different measurement systems of waves and currents). At the site, biological and chemical measurements are routinely acquired, with periodic sampling of the water column.



Photo of the Aqua Alta Tower

3.2. E1 Meteo-oceanographic buoy

1. The name of the observing system/network:

E1 meteo-oceanographic buoy

2. The time span in which the observing system/network has been operational:

2006 – on-going

3. The Adriatic sub-region and geographical coverage by the observing system/network:

Northern Adriatic Sea, Po River Delta and Romagna coast

4. Institutions engaged in management of the observing system/network:

CNR-ISMAR

5. Ecological parameters monitored by the observing system/network (sorted as physical, chemical and biological parameters):

Physical parameters (atmosphere and sea): air humidity, air temperature, air pressure, wind direction, wind speed, wind gust; pressure, current speed, current direction, water temperature, water salinity, water transparency, conductivity, fluorescence, turbidity, CDOM

Chemical parameters: dissolved oxygen, nitrate, dissolved organic carbon, inorganic carbon

Biological parameters: chlorophyll a, benthic foraminifera abundance

6. Web page with data products of the observing system/network:

Data from the fixed observatories can be visualized at the following web pages:

E1 buoy: http://e1.bo.ismar.cnr.it/perl/e1_home.pl

7. Are the monitored data available and under which conditions:

Data use is permitted upon request by citing the source.

8. Are observing systems and data products connected with EUSAIR pillars EU Directives?

The research and monitoring activities of the above-mentioned fixed-point observatories are relevant to the EUSAIR Pillar 3 (Topic 1) by increasing marine knowledge through integrated oceanographic and ecological monitoring. Moreover, while their monitoring activities are not specifically coordinated for the implementation of EU Environmental Directives, they have the potential to contribute in understanding the state of the environment to define GES under the MSFD.

9. Short description of the observing system (max. 2 pages, figures included):

The E1 buoy is located 4 km offshore Rimini, over a bottom depth of 10.5 m. E1 buoy accommodates meteorological instrumentation at 2.5 m above the mean sea level and physical and biochemical sensors (CTD, dissolved oxygen, Doppler Current Profiler, two fluorometers and scattering) at two water depths:

1.5 m and 8 m. The site is a key monitoring point for studying hypoxic and anoxic events in the north Adriatic Basin and for validating "ocean colour" satellite observation with in situ data. The station is autonomous and equipped with data-logger, NRT transmission devices and a power system.



Photo of E1 meteo-oceanographic buoy

3.3. S1-GB dynamic pylon

1. The name of the observing system/network:

S1-GB dynamic pylon

2. The time span in which the observing system/network has been operational:

2004 – on-going

3. The Adriatic sub-region and geographical coverage by the observing system/network:

Northern Adriatic Sea, Po River Delta and Romagna coast

4. *Institutions engaged in management of the observing system/network:*

CNR-ISMAR

5. *Ecological parameters monitored by the observing system/network (sorted as physical, chemical and biological parameters):*

Physical parameters (atmosphere and sea): air humidity, air temperature, air pressure, wind direction, wind speed, wind gust, precipitation rate; pressure, current speed, current direction, water temperature, water salinity, water transparency, conductivity, fluorescence

Chemical parameters: dissolved oxygen, dissolved organic carbon, inorganic carbon

Biological parameter: chlorophyll a, benthic foraminifera abundance

6. *Web page with data products of the observing system/network:*

Data from the fixed observatories can be visualized at the following web pages:

S1-GB dynamic pylon: http://s1.bo.ismar.cnr.it/perl/s1_home.pl

7. *Are the monitored data available and under which conditions:*

Data use is permitted upon request by citing the source.

8. *Are observing systems and data products connected with EUSAIR pillars EU Directives?*

The research and monitoring activities of the above-mentioned fixed-point observatories are relevant to the EUSAIR Pillar 3 (Topic 1) by increasing marine knowledge through integrated oceanographic and ecological monitoring. Moreover, while their monitoring activities are not specifically coordinated for the implementation of EU Environmental Directives, they have the potential to contribute in understanding the state of the environment to define GES under the MSFD.

9. *Short description of the observing system (max. 2 pages, figures included):*

The S1-GB dynamic pylon (Ex S1 buoy) is located 5 km offshore of the Po River delta, over a bottom depth of 21.3 m. The station acquired meteorological data at 8.5 m above the mean sea level and physical and biochemical data (temperature, salinity, dissolved oxygen, superficial current, fluorescence, CDOM and turbidity) at 1.6 m (superficial level) and 18 m (deep level) depths. The S1-GB pylon is located in a key monitoring area for studying the interaction between the northern Adriatic Sea and the Po

River. The station is autonomous and equipped with data-logger, NRT transmission devices and a power system.



Photo of S1-GB meteo-dynamic pylon

3.4. TeleSenigallia dynamic pylon

1. The name of the observing system/network:

TeleSenigallia dynamic pylon

2. The time span in which the observing system/network has been operational:

2006 – on-going

3. The Adriatic sub-region and geographical coverage by the observing system/network:

Northern Adriatic Sea, area off-shore Senigallia.

4. Institutions engaged in management of the observing system/network:

CNR-IRBIM, UNIVPM

5. Ecological parameters monitored by the observing system/network (sorted as physical, chemical and biological parameters):

Physical parameters (atmosphere and sea): air humidity, air temperature, air pressure, wind direction, wind speed, wind gust; pressure, current speed, current direction, wave height, wave period, wave direction, water temperature, conductivity, water salinity, turbidity, fluorescence.

Chemical parameters: dissolved oxygen, coloured dissolved organic carbon

6. Web page with data products of the observing system/network:

Data from the fixed observatories can be visualized at the following web pages:

TeleSenigallia dynamic pylon: <http://rmm.an.ismar.cnr.it/index.php/meda-senigallia>

7. Are the monitored data available and under which conditions:

Data use is permitted upon request by citing the source.

8. Are observing systems and data products connected with EUSAIR pillars EU Directives?

The research and monitoring activities of the above-mentioned fixed-point observatories are relevant to the EUSAIR Pillar 3 (Topic 1) by increasing marine knowledge through integrated oceanographic and ecological monitoring. Moreover, while their monitoring activities are not specifically coordinated for the implementation of EU Environmental Directives, they have the potential to contribute in understanding the state of the environment to define GES under the MSFD.

9. Short description of the observing system (max. 2 pages, figures included):

The Tele–Senigallia pylon is located at the western edge of the Senigallia–Susak transect. It is equipped with a meteorological station, a CTD probe and oxygen-turbidity-fluorescence, CDOM sensors at 5 m depth and a current meter at 12.5m depth and it acquires data in near real time. The joint system is in a key area to observe near-coastal processes (upwelling, stratifications, biological productivity) and the water masses transiting to or from the northern Adriatic.



Photo of TeleSenigallia-dynamic pylon

3.5. Mambo meteoceanographic buoy

1. The name of the observing system/network:

Mambo meteoceanographic buoy

2. The time span in which the observing system/network has been operational:

1999 – on-going

3. The Adriatic sub-region and geographical coverage by the observing system/network:

Northern Adriatic Sea, Gulf of Trieste

4. Institutions engaged in management of the observing system/network:

OGS

5. Ecological parameters monitored by the observing system/network (sorted as physical, chemical and biological parameters):

Physical parameters (atmosphere): air humidity, air temperature, air pressure, wind direction, wind speed, wind gust

Physical parameters (sea): pressure, water temperature, water salinity, water transparency, conductivity, fluorescence, turbidity

Chemical parameters: dissolved oxygen, pH, alkalinity, dissolved organic carbon, dissolved organic nitrogen, dissolved organic phosphorus, inorganic carbon, particulate organic carbon, particulate nitrogen, particulate phosphorus, dissolved macronutrient concentration (N-NH₄, N-NO₃, N-NO₂, P-PO₄, Si-SiO₄)

6. Web page with data products of the observing system/network:

Data from the fixed observatories can be visualized at the following web pages:

<http://nettuno.ogs.trieste.it/ilter/GoTTs/mambo.html>

7. Are the monitored data available and under which conditions:

All information, data present in OGS-NODC (National Oceanographic Data Center) are freely available and free of charge under the owner (producer) policy conditions and their wide use for no profit science and education is encouraged.

8. Are observing systems and data products connected with EUSAIR pillars EU Directives?

The research and monitoring activities of the above-mentioned fixed-point observatory are relevant to the EUSAIR Pillar 3 (Topic 1) by increasing marine knowledge through integrated oceanographic and ecological monitoring. Moreover, while their monitoring activities are not specifically coordinated for the implementation of EU Environmental Directives, they have the potential to contribute in understanding the state of the environment to define GES under the MSFD.

9. Short description of the observing system (max. 2 pages, figures included):

The Oceanography Section of the National Institute of Oceanography and Applied Geophysics) is responsible for the site Gulf of Trieste, part of the LTER macrosite North Adriatic. Since 1986, the time-series station “C1” in the Gulf of Trieste (GoTTs, Gulf of Trieste Time series) represents a crucial site for marine ecological research, as it is subject to the interaction among several natural forcing.

In 1999, the ecological research site has been equipped with a meteo oceanographic buoy (MAMBO) in order to acquire continuous data on meteorological conditions at sea and on seawater physical and biogeochemical properties. Due to the high temporal dynamics of ecological processes in coastal ecosystems, continuous and real-time data of the main meteorological, physical and biogeochemical properties are fundamental for a better understanding of marine ecosystem functioning.



Photo of Mambo meteoceanographic buoy

Parameters of the Marine Strategy Framework Directive (MSFD) (for monitoring programme described in 3.1 to 3.4)

Parameter	Yes/No
Angiosperms biomass and its annual/seasonal variability	
Angiosperms species composition and its annual/seasonal variability	
Fish abundance	

Fish age / size structure	
Fish distribution	
Genetically distinct forms of native species abundance	
Genetically distinct forms of native species occurrence	
Genetically distinct forms of native species spatial distribution	
Habitats' (predominant, special, protected and endangered) characteristics	
Introduction of microbial pathogens	
Introduction of non-indigenous species	Yes
Invertebrate bottom fauna biomass and its annual/seasonal variability	
Invertebrate bottom fauna species composition and its annual/seasonal variability	
Macro-algae biomass	
Macro-algae species composition	
Marine mammals actual range	
Marine mammals natural range	
Marine mammals population dynamics	
Marine mammals status	
Non-indigenous or exotic species abundance	
Non-indigenous or exotic species occurrence	
Non-indigenous or exotic species spatial distribution	
Other protected species actual range	
Other protected species natural range	
Other protected species population dynamics	
Other protected species status	
Phytoplankton species compositions and its geographical and seasonal variability	Yes
Reptiles actual range	
Reptiles natural range	
Reptiles population dynamics	
Reptiles status	
Seabirds actual range	
Seabirds natural range	
Seabirds population dynamics	
Seabirds species' status	
Selective extraction of species	

Translocations of non-indigenous species	
Zooplankton species compositions and its geographical and seasonal variability	Yes
Acidification	
Abrasion	
Biological effects of contaminants	
Concentration of contaminants	
Currents	
Depth	
Extraction	
Ice cover	
Marine litter	
Mixing characteristics	
Nutrient concentrations	Yes
Oxygen	Yes
Residence time	
Salinity	Yes
Seabed Bathymetry	
Seabed Structure	
Seabed Substrata Composition	
Seabed Topography	
Sealing	
Siltation (changes in)	
Smothering	
Temperature	Yes
Turbidity	Yes
Underwater noise	
Upwelling	
Wave exposure	

Parameters of the Water Framework Directive (WFD) (for monitoring programme described in 3.1 to 3.4)

Parameters	Yes/No
Angiosperms Abundance	
Angiosperms Cover	
Angiosperms Depth Distribution	
Angiosperms Presence of Sensitive Taxa	
Benthic Invertebrate Fauna - Presence of Sensitive Taxa	
Benthic Invertebrate Fauna Abundance	
Benthic Invertebrate Fauna Composition	
Benthic Invertebrate Fauna Diversity	
Macro-algae - Presence of Sensitive Taxa	
Macro-algae Abundance	
Macro-algae Cover	
Macro-algae Depth Distribution	
Macro-algae Species Composition	
Phytoplankton Abundance	Yes
Phytoplankton Bloom Frequency / Intensity	Yes
Phytoplankton Composition	Yes
Phytoplankton Diversity	Yes
Specific synthetic pollutants	
Specific non-synthetic pollutants	
Acidification	
Ammonium	Yes
Nitrates	Yes
Nutrient Conditions	
Oxygenation	Yes
Bed Quantity	
Bed Structure	
Bed Substrate	
Conductivity	Yes
Depth Variation	
Direction of Dominant Currents	
Intertidal Zone Structure	

pH	Yes
Salinity	Yes
Temperature	Yes
Transparency	Yes
Residence Time	

3.6. Tide gauge network

1. *The name of the observing system/network:*

Tide gauge network

2. *The time span in which the observing system/network has been operational:*

from early 20th century till now

3. *The Adriatic sub-region and geographical coverage by the observing system/network:*

Adriatic

4. *Institutions engaged in management of the observing system/network:*

Croatian Hydrographic Institute, Institute of Oceanography and Fisheries, ISPRA, Slovenian Environmental Agency

5. *Ecological parameters monitored by the observing system/network (sorted as physical, chemical and biological parameters):*

sea level, meteorological parameters, temperature and salinity

6. *Web page with data products of the observing system/network:*

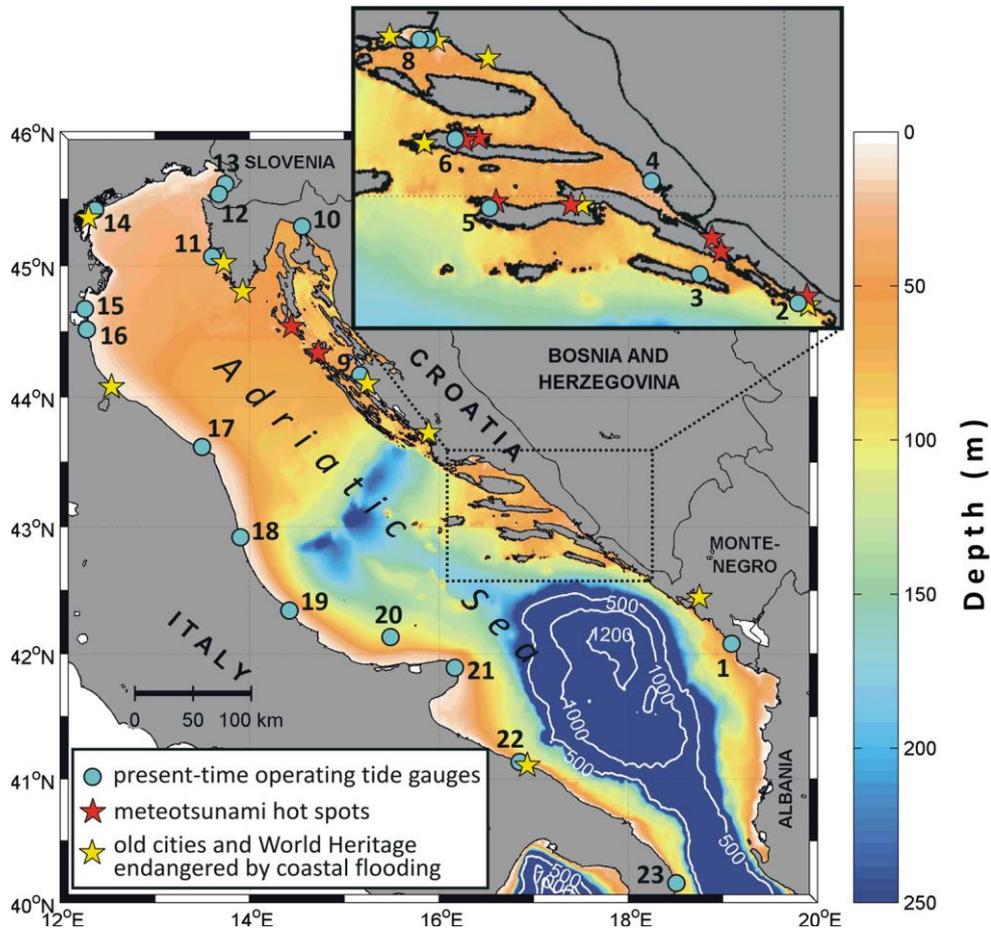
www.hhi.hr, www.mareografico.it, www.izor.hr

7. Are the monitored data available and under which conditions:

some data available for research, some not

8. Short description of the observing system (max. 2 pages, figures included):

The Adriatic tide gauge network consists of more than 20 tide gauges operated by different agencies and research institutes. Some stations are operational since the beginning of the 20th century, while some of them are active in the last 20 years. Different instruments are installed, from float-type tide gauges, through radar tide gauges, till tide gauges of pressure type. Some stations are conjoined with ocean measurements (temperature, salinity, ecological parameters), meteorological measurements and measurements of vertical land movements.



Geographical location of present-day operating tide gauges

Parameters of the Marine Spatial Planning (MSP) (for monitoring programme described in 3.1 to 3.5)

Parameter	Yes/No
Aquaculture areas	
Fishing areas	
Installations and infrastructures for the exploration, exploitation and extraction of oil, of gas and other energy	
Resources, of minerals and aggregates, and for the production of energy from renewable sources	
Maritime transport routes and traffic flows	X
Military training areas	
Nature and species conservation sites and protected areas	
Raw material extraction areas	
Scientific research	X
Submarine cable and pipeline routes	X
Tourism	X
Underwater cultural heritage	X

3.7. High-frequency oceanographic radars

1. *The name of the observing system/network:*

High-frequency oceanographic radars

2. *The time span in which the observing system/network has been operational:*

2014 till present

3. *The Adriatic sub-region and geographical coverage by the observing system/network:*

eastern middle Adriatic

4. *Institutions engaged in management of the observing system/network:*

Institute of Oceanography and Fisheries

5. *Ecological parameters monitored by the observing system/network (sorted as physical, chemical and biological parameters):*

surface currents

6. *Web page with data products of the observing system/network:*

http://jadran.izor.hr/hazadr/index_eng.htm

7. *Are the monitored data available and under which conditions:*

data available for research

8. *Short description of the observing system (max. 2 pages, figures included):*

High-frequency (HF) oceanographic radars are remote sensing instruments that measure surface currents in an area. The radars can measure currents over a large region of the coastal ocean, from a few kilometres offshore up to 200 km, and are the only sensors that can measure currents over a large area of the ocean. The scattered radar electromagnetic waves emitted to all directions over the sea coherently return, resulting in a strong peak of energy at a very precise wavelength, known as Bragg scattering frequency.

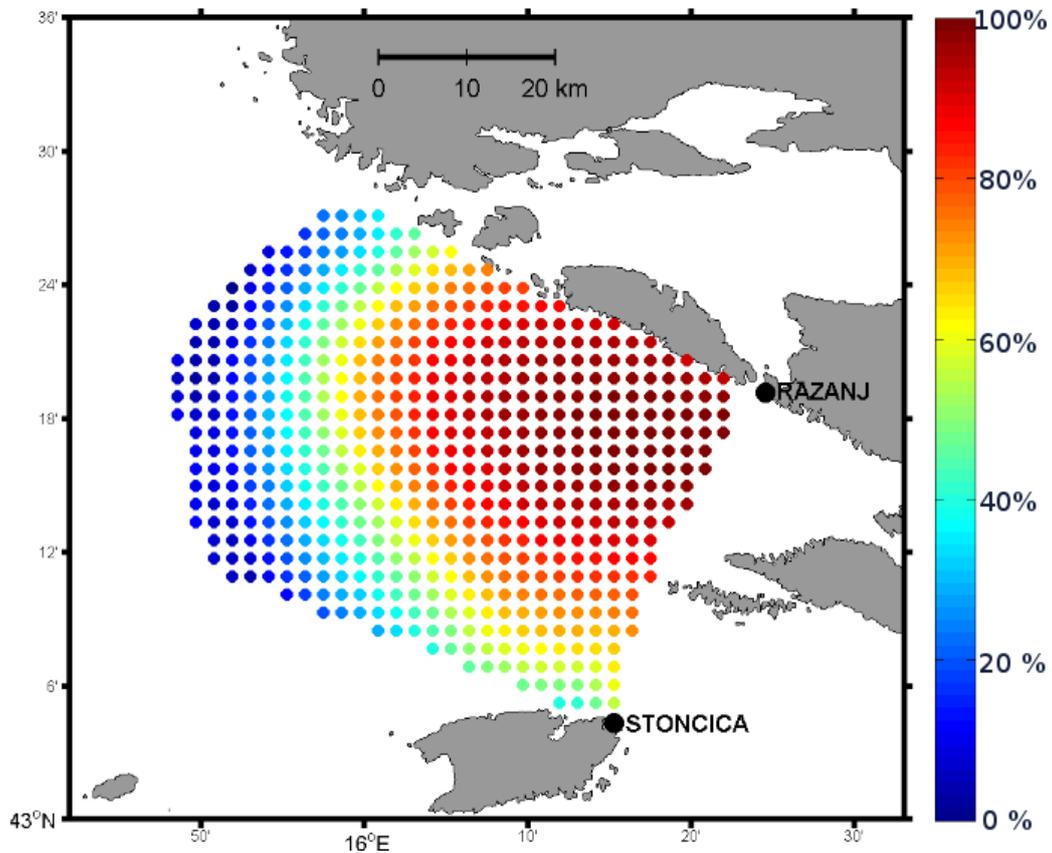
A pair of HF radars have been installed in the middle Adriatic within the frame of the HAZADR project, at Cape Ražanj, island of Brač (43.319688° N; 16.408743° E), and Cape Stončica, island of Vis (43.072141° N; 16.254157° E). The HF radars were of WERA type, manufactured by Helzel GmbH (<http://www.helzel.com>), operating on 26.200-26.350 MHz frequency and covering the area of about 50x50 km with spatial resolution set to 1.5 km (Fig. 1). The installation was carried out during early months of 2014, when the Institute of Oceanography and Fisheries (IOF) team did the installation of the equipment at both sites (Fig. 2), with the help of research vessel Bios Dva.

The HF radars have been working almost continuously till today, except for a few months in early 2015, when the storm of the decade broke the installation at the coast, pulling multi-tonnes boulders along the beach and HF radar installations. However, the repair of the equipment was done quickly as the IOF team was quite skilled and trained for such kind of

hazards. The spatial coverage of the data availability for the first year of measurements is displayed in Fig. 3, while Fig. 4 presents a snapshot to the measurements in the area. The WERA HF radars are also measuring ocean surface waves and direction of the wind, all of them available for the area of Vis Channel, middle Croatian Adriatic.

The acquired data is a necessary compound of the NEURAL project (www.izor.hr/neural), which has an aim of creating operational forecasting surface current forecast based on measurements of HF radar data, forecasts of surface winds by the operational weather prediction mesoscale model, altogether processed by a kind of neural networks, Self-Organizing Maps. The NEURAL project, executed in parallel with HAZADR project, provides an innovative use of HF radar data and ends with an operative product which may be of help for decision makers and hazard mitigation agencies for a number of applications, like safety of navigation, rescue missions at sea, oil spill tracking and modelling, verification of ocean numerical models, etc.

In particular, HF radar data have been found useful for tuning numerical ocean models to obtain better performance and reliability. Ocean numerical models are essential in assessment of any dynamical phenomena in the ocean, therefore serving as a crucial ingredient to the operational oceanography services. Moreover, the dynamics is an essential component for investigations of biogeochemical properties and processes in the ocean and for that reason, the importance of HF radar measurements are being raised in a number of applications and investigations relevant to the ocean and ocean issues.



The percentage of measurements of surface currents by HF radars in the middle Adriatic.
http://jadran.izor.hr/hazadr/geoserver_en2.html.

3.8. Meteotsunami research and warning network

1. *The name of the observing system/network:*

Meteotsunami research and warning network

2. *The time span in which the observing system/network has been operational:*

2017-2019

3. *The Adriatic sub-region and geographical coverage by the observing system/network:*

middle Adriatic

4. *Institutions engaged in management of the observing system/network:*

Institute of Oceanography and Fisheries

5. *Ecological parameters monitored by the observing system/network (sorted as physical, chemical and biological parameters):*

sea level, meteorological parameters

6. *Web page with data products of the observing system/network:* www.izor.hr/messi

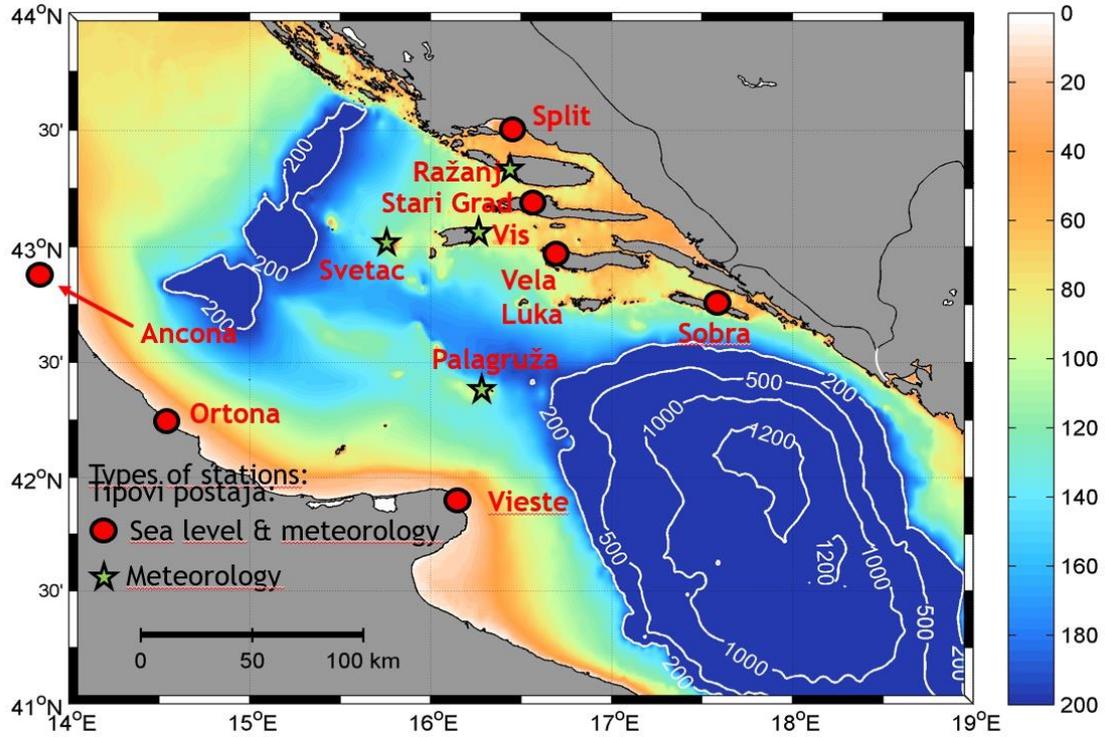
7. *Are the monitored data available and under which conditions:*

freely available for research

8. *Short description of the observing system (max. 2 pages, figures included):*

Four tide gauge stations (Vela Luka, Stari Grad, Sobra and Split) and nine air pressure stations are part of the observing network for meteotsunamis.

All tide gauges are of radar type, equipped also with meteorological sensors, with autonomous power supply. The data has been measure with 1-minute resolution.



Meteotsunami research and warning network in the middle Adriatic.

4. SWOT ANALYSIS

Strengths

- There is a variety of monitoring programs with observing systems that cover Adriatic Sea region
- Majority of organizations engaged in monitoring programs are involved in the fulfillment of obligations according to Water Framework Directive, Marine Strategy Framework Directive, Habitat directive and Marine Spatial Planning directive
- The composition of the ECOS partnership, from scientific research-performing organizations through regional agencies, is enabling for exchange of information and data

Weaknesses

- There is lack of information and data for certain parameters required for the directives demands, partly due to underfinancing of the obligatory monitoring activities
- Long-term investment in maintenance of long-term monitoring ecological series, beside the directives, mostly depend on short-term resources and projects
- The collaboration between some research groups and research institutes is not at the satisfactory level
- The collaboration between research-performing organizations, agencies and regional/local authorities is not well established at some parts of the Interreg Italy-Croatia programme area
- The products derived from monitoring programs mostly depend on relatively weak availability of data and they are not well disseminated towards potential users and public

Opportunities

- Composition of the partnership might be used for building an added value in design and implementation of future monitoring programs beside obligatory directives
- Merging the efforts might enable for development of better observational infrastructure and products to the potential users and products
- Collaboration between researchers and staff coming from different research and management organizations may allow for new ideas and better performance of both Croatian and Italian systems and allow for their competitiveness on the European level
- An integrated platforms and programmes of observing networks may allow for boosting the importance of necessity of monitoring of the marine environment, which can result in better operational and forecasting systems following demands of the society

- Transfer of knowledge and information between partners from Croatia and Italy will allow for definition and creation of better environmental protection policies and strategies

Threats

- Underfinancing of long-term activities necessary for proper monitoring and observation systems of the Adriatic Sea might lead to a deterioration of the level of protection of marine environment and habitats in the Adriatic Sea, ending with failing in preserving Good Environmental Status
- Political situation at higher level might have a repercussion to the collaboration and maintenance of the research and other connection established for protection of the Adriatic Sea, and therefore impact a great number of activities related to the common sea

5. SUMMARY AND CONCLUSIONS

The presented review of existing observing monitoring programs and observing systems in the Adriatic Sea, enlightens their variability originated from different background and involvement of ECOSSE partner organizations. Here we provide the statistics of all presented monitoring programs and observing systems:

Geographical coverage	Local or regional (80%), whole or most of the Adriatic (20%)
Monitoring MFSD parameters	Yes (68%), No (32%)
Monitoring WFD parameters	Yes (72%), No (28%)
Monitoring HD parameters	Yes (40%), No (60%)
Monitoring MSP parameters	Yes (60%), No (40%)
Types of monitored parameters	Physical parameters (64%), Chemical parameters (56%), Biological parameters (88%)
Data accessibility	Fully available (34%), Partially (with a condition) available (26%), Not available (40%)

Reported information indicated to involvement of majority of ECOSSE partners in the fulfillment of obligations according to WFD, MSFD, Habitat and Marine Spatial Planning directives. There is obvious lack of observation and data for some group of parameters demanded by certain directives probably as consequence of underfinancing of monitoring activities.

Yet, the obvious diversity between existing monitoring programs, number of observing systems, duration of observations, lack of data for certain parameters, might be used for providing added value to the management and maintenance of the Adriatic networks and marine-related infrastructure, potentially ending with the increased level of managements of the Adriatic living resources and biodiversity.

Hopefully, this deliverable and the ECOSSE project will result in of such an improvement, and finally in healthy and more productive Adriatic Sea.