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

D3.5.1 Long-term strategy and roadmap of the Ecological Observing System in the Adriatic Sea

WP3 – Design of the Ecological Observing System in the Adriatic Sea (ECOAdS)
Act. 3.5 – Defining the strategy and the roadmap of the ECOAdS

PP3 IZOR / Ivica Vilibić
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ECOlogical observing System in the Adriatic Sea: oceanographic observations for biodiversity (ECOSS)

Work Package:	WP3 - Design of the Ecological Observing System in the Adriatic Sea (ECOAdS)
Activity:	3.5 Defining the strategy and the roadmap of the ECOAdS
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CONTENTS

1. INTRODUCTION

Within the activities defined by the work plan of the Interreg Italy-Croatia project "ECOlogical observing System in the Adriatic Sea: oceanographic observations for biodiversity" (ECOSS), in particular for the design of the Ecological Observing System in the Adriatic Sea (ECOAdS) carried out through the Work Package 3, this deliverable aims to define a roadmap of activities for the next 10 years, its full implementation and maintenance, defining key activities, milestones and players.

In its introductory part, the deliverable aims to frame the clarification of questions like: (i) what are marine observatories and why are marine ecological observatories (MEOs) needed, (ii) what could be the main requirements for ecological observatories for contributing also to conservation issues, and (iii) why is the Adriatic a significant area for the establishment of a MEO.

Then, we will report on the main activities performed on the project, based on reviews of (i) existing ecological monitoring programmes and ecological observing systems in the Adriatic and at Natura 2000 sites, (ii) key oceanographic processes and performance indicators in the Adriatic and at Natura 2000 sites, and (iii) relationships between ecological status and Ecosystem Services, also including participatory approach with stakeholders carried out through three project stakeholder workshops in September and December 2020 and June 2021. The strategy and the roadmap will continue with the SWOT (Strengths-Weaknesses-Opportunities-Threats) analysis, which will critically provide the input for defining vision and key challenges of the ECOAdS. To materialize the vision and accomplish goals and key challenges, the measures will be defined, each of them containing instruments, key players and users of interest. The final words in this long-term strategy and the roadmap will serve as a motivation for the Adriatic ecological community to go in the proposed direction, which will hopefully lead to higher capacities in monitoring, governance and conservation of the Adriatic Sea and of the ecological resources it provides.

2. THE ECOAdS CONTEXT

The Natura 2000 (N2K) network of protected areas, both at land and at sea, is the main biodiversity conservation instrument in Europe, following the EU commitment to the international Convention on Biological Diversity (CBD) and of the EU Biodiversity Strategy. The basis are the Habitats and Birds directives (EEC 1992 and EC 2009), which set the same rules and obligations for all EU, still, the application of the legislation varies by countries, which are left with a considerable degree of freedom to set up their own conservation strategy. Further, for marine N2K sites, other EU directives must be legally followed, like Marine Strategy Framework Directive – MSFD (EC 2008), Water Framework Directive – WFD (EC 2000), and Maritime Spatial Planning – MSP (EC, 2014).

The successful implementation of the N2K network as well as their governance and management systems require being adaptive and founded on well-designed and dynamic research and monitoring strategies. This implies that agencies and managers should have the institutional capability and tools to carry out suitable monitoring, evaluate and report the derived results, and adapt properly their conservation strategy. Marine Ecological Observatories (MEOs), by promoting harmonization mechanisms, transnational information flow, and knowledge co-production at regional level to inform the N2K governance and management systems (GMS), can support N2K network implementation and the application of an ecosystem-based approach to its management.

The design of MEOs should be able to generate new knowledge on the dynamics between the human dimension and the natural systems, by involving researchers, policy makers and members of the civil society. Further, they should be able to collect a variety of knowledge and viewpoints to favour innovation and development in information planning and management at a proper spatial scale. Only in this way, MEOs can offer real support for conservation strategy planning, setting goals, harmonizing standards and protocols, and monitoring.

Essential attributes that MEOs should incorporate in their own governance systems and observation framework has been proposed (Manea et al., 2020):

(i) An agreed conceptual framework for the harmonization of monitoring schemes, data acquisition and analysis at trans-regional and national levels,
(ii) Data platforms to deliver oceanographic and ecological information and knowledge, fully adopting the open science approach,
(iii) Tight cooperation among the fragmented multi-level governance systems and responsible managing authorities of N2K sites, and

(iv) Local ecological knowledge and priorities for the effective involvement of stakeholders and the civil society within the mechanism of knowledge co-production.

The Adriatic Sea region, as defined by the MSFD, comprises 368 marine N2K sites mainly covering the nearshore zone (0-1 Nautical Miles) and without offshore sites beyond the 12 NM EEA, 2019). On the base of the spatial measurement assessed through the use of data from November 2017 of MAPAMED dataset, the Adriatic counts 44 Italian and 245 Croatian sites wholly or partially marine, which cover respectively ca. 1694 km^2 (ca. 1.2%) and 5998 km^2 (ca. 4%) of the basin.

The Adriatic Sea hosts a number of well-established monitoring programs, acting at different spatial scales, from national to county/region level, and fixed-point observing systems (i.e. pylons, buoys, tide gauges, oceanographic platforms). These latter provide multidisciplinary and automated monitoring of coastal and offshore marine environments, with high temporal resolution, for a series of marine and atmospheric variables. In general, ongoing monitoring observations are mainly linked to the fulfilment of the obligations established by various EU Directives (mainly WFD and MSFD) or to specific programs and initiatives, such as the Italian Long-Term Ecological Research network, LTER-Italy. They address a wide variety of environmental issues, spanning from the assessment of the quality of transitional, coastal and marine waters to the monitoring of target species (e.g. dolphins and sea turtles) and other biotic components (e.g. plankton, macroalgae, coralligenous assemblages). It must be mentioned that neither of these initiatives are shared between the two countries, nor their focus is on N2K sites. In the case of ECOAdS, we considered the fixed-point observing systems, located in the pilot study area and of which ECOSS partners are managers and/or direct scientific advisors (Fig. 1).

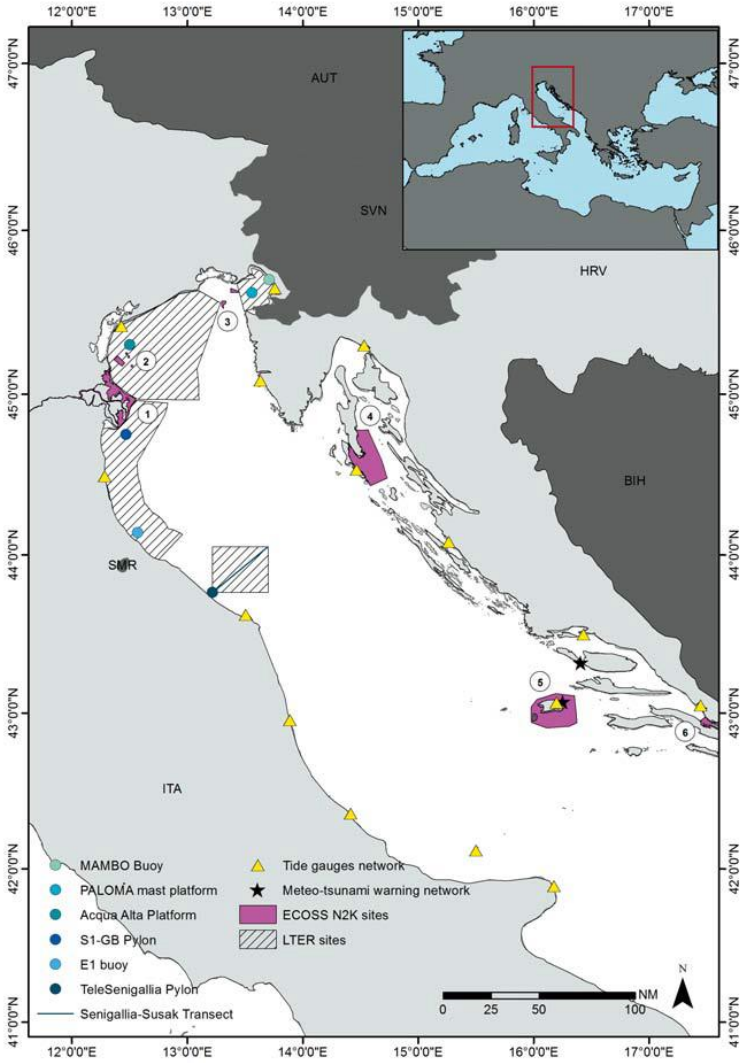

Figure 1. ECOSS N2K sites and fixed point observing systems managed by ECOSS project partners (after Manea et al., 2020).

3. STATE-OF-THE-ART

3.1. Existing ecological monitoring programmes and observing systems in the Adriatic Sea

This chapter is reviewing information on existing ecological monitoring programmes and observing systems in the Adriatic Sea, acquired within the frame of the Activity 3.1 “Assessment of existing ecological monitoring programs and observing systems of the ECOSS project”. The full report (D3.1.1) may be found at the project web pages (https://www.italy-croatia.eu/web/ecoss).

In the above-mentioned report, information about 30 existing ecological monitoring programmes and observing systems in the Adriatic Sea are provided. The information contains (1) the name and duration of the existing ecological monitoring programme, (2) its sub-region and geographical coverage, (3) engaged institutions, (4) programme web page, (5) data accessibility, availability and policy, (6) relevance in relation to EU directives and EUSAIR pillars, and (7) short description of the ecological monitoring programmes and observing systems. A great number of the listed projects is connected either to (1) monitoring for EU Directives (MSFD, WFD, MSP, H&BD), or (2) Long Term Ecological Research - LTER networks, (3) water quality monitoring, (4) seabed habitats monitoring, (5) offshore observational towers, pylons and buoy, or (8) specific observational networks (parameter-oriented or process-oriented).

The survey points out different strengths of the programmes and the systems, which are (1) a variety of monitoring programs with observing systems, (2) monitoring for EU Directives result in a great collection of data, (3) all relevant players (from research-performing organisation to regional agencies) are engaged in development of the ECOAdS, while the weaknesses encompass (1) a lack of collaboration vs. competition due to sometimes limited financial resources, (2) relatively low open availability of data for both research and governance, and (3) absence of long-term investment in maintenance of the programmes and the systems. There might be opportunities for the future of the programmes and the systems through merging and rationalising of efforts with transfer of knowledge, including clear data policies based on open-science principles, with financing optimized to avoid duplication of activities. However, threats remain mostly on the high governance level, like underfinancing of long-term activities and monitoring programmes, and showing not a good will in sharing the knowledge and the data, in particular between competing organisations and the two countries in general.

Table 1. The statistics of all presented monitoring programs and observing systems as completed through the ECOSS deliverable D3.1.1 Report on the assessment of existing ecological 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 indicates an involvement of majority of ECOSS partners in the fulfilment of obligations according to WFD, MSFD, H&BD and MSP. As the directives require a wide approach in monitoring, there is a lack of observation and data for some group of parameters demanded by certain directives. It is also evidenced a lack of coordination among the directives in the Adriatic, in particular reflecting the differences in their implementations between Croatia and Italy. To this respect, synergies and discrepancies among these legal instruments have been analysed in Activity 3.3 (within D3.3.1) and 4.4.1 (D4.4.1), in order to suggest how ECOAdS, as a monitoring platform, may respond and contribute to their requirements, boosting the synergies and overcoming the weaknesses.

It should be added that there might be some monitoring activities not reported in the analyses, yet such activities are of local coverage, while all reporting has been done for the significant programmes and activities. Also, there are additional products available to adjoin in situ monitoring programmes and observing systems that are based on remote sensing measurements, like satellites, which might be useful for governance of the Adriatic Sea and of the N2K sites.

3.2. Ecological monitoring, conservation strategies and management questions of Natura 2000 marine sites

This chapter is reviewing the information about the environmental status of the six N2K marine sites in the Adriatic Sea selected as case studied in ECOSS, the monitoring activities and the main management questions, acquired within the frame of the Activity 3.2 "Ecological monitoring, conservation strategies and management questions of Natura 2000 marine sites". The full reports delivered within this activity may be found at the project web pages (https://www.italy-croatia.eu/web/ecoss).

The management objectives for each N2K site (Table 2) are either specifically focused on a single species, when pressures in N2K sites are expected to affect only a target species, or they are more general, embracing habitats and communities:

Table 2: Management goals and objectives for each N2K site

NATURA 2000 SITE(s)	GOAL	MANAGEMENT OBJECTIVES
Cres-Lošinj (HR 3000161) and Viški akvatorij (HR3000469)	Preservation of the common bottlenose dolphin (*Tursiops truncatus*) population at a favourable status	• Protect and increase the population of *T. truncatus* • Prevent over-exploitation of prey of *T. truncatus* • Preserve incoming/outgoing genetic flow for *T. truncatus* • Maintain a good seawater quality • Decrease/regulate interactions between human activities and *T. truncatus* individuals
Malostonski zaljev (HR4000015)	Preservation of target habitats ('Shallow inlets and bays' and 'Reefs') at a favourable status	• Prevent high eutrophication and pollution levels in the bay • Assess distribution and conservation status of the identified target benthic species • Maintain/restore the current status of target species populations
Tegnùe di Chioggia	Conservation of	• Maintain/restore the current status of

(IT3250047) and Trezze San Pietro e Bardelli (IT3330009)	mesophotic biogenic reef communities at a favourable status	target species populations • Preserve coralligenous community diversity and gene pool • Preserve bioconstruction process • Minimize nutrient load and pollution from coast • Reduce human activities inside and next to the N2K sites • Assess the presence and impact of invasive species • Reduce impact of marine debris on benthic species
Delta del Po: tratto terminale e delta Veneto (IT3270017) and Delta del Po (IT3270023)	Conservation of target habitats and species at a favourable status in the Po Delta	• Improve water circulation and quality • Reduce impact of invasive species • Monitor and limit fishing • Create/restore optimal habitats for target species (nesting/resting/feeding sites) • Maintain/restore the current status of target species populations • Increase genetic diversity of the Adriatic sturgeon • Decrease tourism-induced disturbance at nesting bird sites • Control of the yellow-legged gull population and terrestrial predators of target birds' eggs

Indeed, the design and implementation of a proper management plan including the enforcement of the management strategies is the foreseen future for the N2K sites. Such plans are lacking in Croatia, as it can be seen in Fig. 2, and are prerequisite for a proper management and protection of the N2K sites.

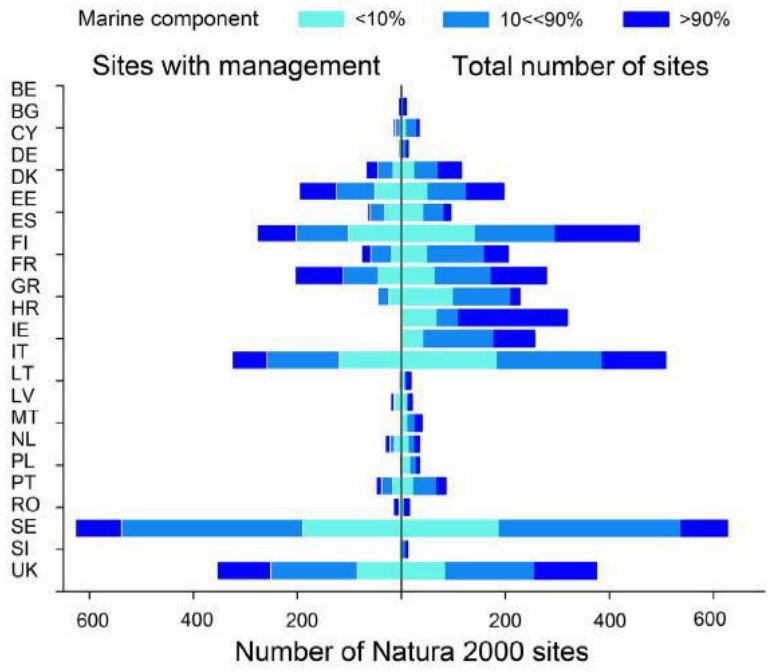

Figure 2. Number of sites of the N2K network with a marine component in each country (after Fraschetti et al., 2018). The number of sites for which a management plan exists and/or official management and conservation measures are applied is also showed.

Regarding management strategies for the selected six N2K Adriatic sites, they are summarized as the following:

Viški akvatorij (HR3000161):

- Improving human capacities (rangers and experts for marine mammals) and improving equipment capacities (lack of speed boats).
- By forthcoming regulations on N2K habitats and species conservation, PI Sea and Karst should have bigger legislative power for N2K area.
- Greater cooperation with BWI.
- Adoption of the management plan with clearly defined management objectives.
- Better promotion and presence of Public institution Sea and Karst in the community (soon PI will dispose a Visitor center Blue cave- Biševo).

- Improve involvement of local community in management and increase education activities for local community.

Cres-Lošinj (HR 3000161):

- Adoption of the management plan with clearly defined management objectives.
- Recommended additional monitoring programme – addition of biopsy sampling to the existing monitoring program to obtain samples for genetic analyses, in order to better understand processes affecting the well-being of the local, resident bottlenose dolphin community inhabiting in this N2K site.

Malostonski zaljev (HR4000015):

- Careful communication and education of the local population is needed to ensure the long-term preservation of the value of the Mali Ston Bay.
- In addition to the adoption of the regulations and management plan relating to the area of the ecological network, since the area is under national protection, according to the Nature Protection Act (OG 80/13, 15/18, 14/19, 127/19) it is necessary to adopt an ordinance on protection and preservation for protected areas of national importance.
- Given that the nature in the marine part of Mali Ston Bay benefits changed by the millennial use of this area, evaluation of the situation, redefinition of objectives and planning are the most important management activities in Mali Ston Bay.
- Adoption of the management plan with clearly defined management objectives.

Trezze San Pietro e Bardelli (IT3330009):

- Improvement of frequency of existing monitoring programmes and recommended additional monitoring programme – monitoring of cetaceans and pelagic fauna.
- Increasing effectiveness of managing authority (improve financial resources, data baselines patrolling and purchase buoys).
- For ecological data (community structure and composition) a continuous/recurring monitoring should be implemented.
- As marine litter can impact communities and habitats, thus a recurrent and at least visual observation of the accumulation of marine litter should be carried out.
- The effect of human activities (i.e. poaching, scuba diving, commercial fishing) on target species should be assessed.

Tegnùe di Chioggia (IT3250047):

- Arising the effectiveness of a managing authority (improve financial resources, data baselines patrolling and purchase buoys).
- For ecological data (community structure and composition) a continuous/recurring monitoring should be implemented.
- The effect of human activities (i.e. poaching, scuba diving, commercial fishing) on target species should be assessed.
- As marine litter can impact communities and habitats, thus a recurrent and at least visual observation of the accumulation of marine litter should be carried out.

Delta del Po: tratto terminale e delta Veneto (IT3270017) and Delta del Po (IT3270023):

- Making a data baseline where data will be collected in continuous. Also, some lagoons need more monitoring stations.
- Implementation and revision of the management plan.

3.3. Key oceanographic processes and performance indicators for NATURA 2000 marine sites

The purpose of this chapter is to summarize the main elements, structure and aims of the conceptual model, developed within Activity 3.3 "Identification of key oceanographic processes and performance indicators for NATURA 2000 marine sites", which aims to connect ecological and oceanographic observations with performance indicators, proper for answering specific management questions on environmental quality, conservation and biodiversity of N2K sites. The full report (D.3.3.1) may be found at the project web pages (https://www.italy-croatia.eu/web/ecoss).

The generic conceptual model consists of a schematic box-arrow conceptual model that displays and simplifies the most important socio-ecological elements related to the management of N2K sites and their connections. The model splits the different elements in social, ecological and oceanographic (Fig. 3). The social elements (yellow boxes) are characterized by all those elements concerning the governance domain of N2K management: EU Directives targeted by ECOSS (i.e. H&BD, WFD, MSFD), the public/management authority of the N2K sites, the management goals, objectives, conservation strategies, the stakeholders involved in the N2K sites and human activities. The ecological elements (green boxes) identified are: target species and ecological processes for which N2K sites were designated, the

ecosystem services, the ecological monitoring programmes and the ecological variables measured. The oceanographic elements (blue boxes) include: global changes, ocean processes, oceanographic observing system and the monitored oceanographic variables. Performance indicators constitute a cross-cutting element (orange box), since they can be obtained from single ecological or single oceanographic variables, combinations of multiple ecological or multiple oceanographic variables, or even combinations of one or several ecological variables with one or several oceanographic variables. The monitoring programmes, the variables and the performance indicators are then all included in the ECOAdS box (red box).

Few information on the ecological processes and the conservation status of target species in the considered N2K sites is documented, mainly due to the lack of management plans and monitoring activities. In addition, ecological data are often not available or have been collected only occasionally in the past, fact that prevents a proper assessment of the key oceanographic processes driving the ecosystem at the selected sites.

Based on the descriptive indicators identified for each target species and ecological process in the N2K sites, a coherent ecosystem-based indicator system for threatened species and habitats has been developed in the project (Deliverable 4.4.1).

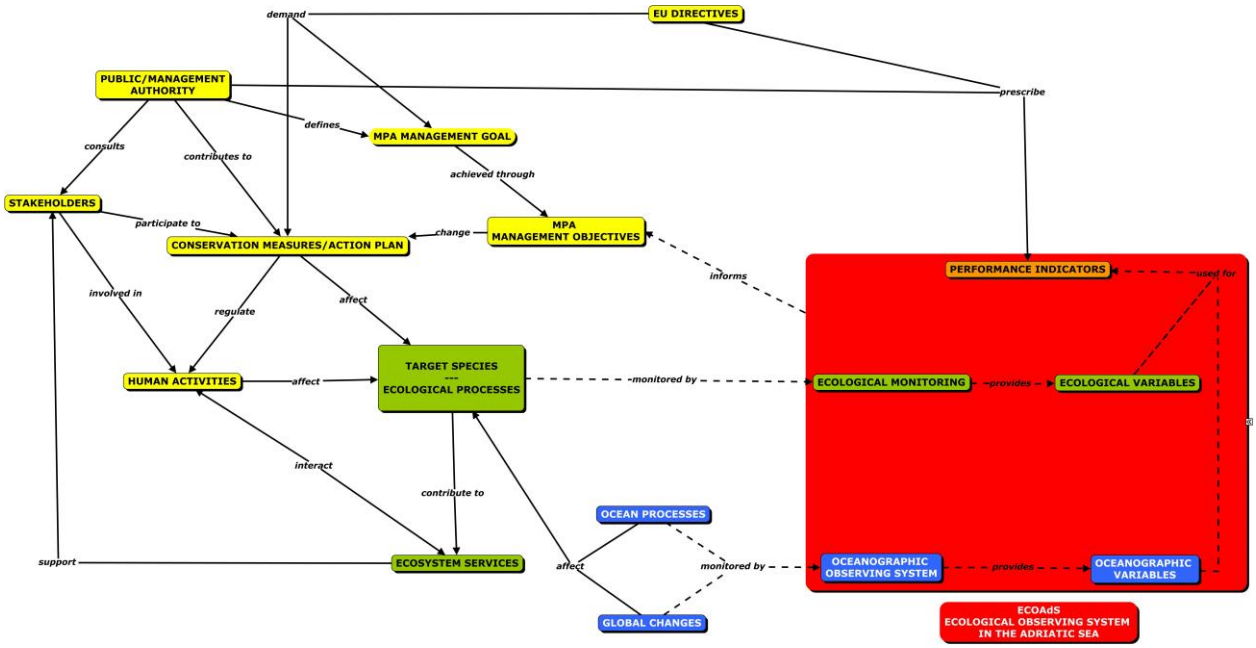

Figure 3. Generic conceptual model linking ECOAdS with MPA management and EU Directives.

The comparative analysis among the environmental directives (H&BD, WFD and MSFD), carried out within Activity 4.4.1 (D4.4.1, in all their relevant aspects shows some inconsistencies and weaknesses. In fact, though the goal of the directives is the protection of the aquatic environment and the preservation and sustainable management of the resources, they lack in harmonized monitoring frameworks and in homogeneity in the adoption of terminology related to the monitoring parameters and variables. Some gaps also exist since the level of implementation of the H&BD is left to each Member State, the management plans are not mandatory, and how to concretely apply an ecosystem-based management approach is not properly addressed. Nevertheless, the directives are complementary to each other on multiple aspects: the conservation priority objectives extend across different spatial and ecological levels, they are applied within different jurisdictional boundaries, and the different parameters can be jointly monitored to have a more complete picture of the environmental status.

3.4. Relationships between ecological status and Ecosystem Services

This chapter aims to advance the knowledge on the multiple Ecosystem Services (ES) provided by the marine and coastal ecosystems of northern-central Adriatic Sea, and to analyse their links with underling ecological structures and processes: this information is acquired within the frame of the Activity 3.4 “Relationships between ecological status and Ecosystem Services”. The full report (D3.4.1) may be found at the project web pages (https://www.italy-croatia.eu/web/ecoss).

A conceptual model to represent how ES are generated within social-ecological systems is presented, arising from the interactions and feedbacks occurring among ecosystem, society and governance system (Fig. 4).

Based on the conceptual model and from an ES perspective, the general goal is a healthy ecosystem that provides multiple ES both now and in the future. To achieve this goal, management should target the ES capacity rather than their flow and should do so with temporal perspective, to prevent that the capacity declines over time. Preserving ES capacity can be assimilated to the build-up of insurance for our future, as it would increase the resilience of the ecosystem and of the ES flow with respect to perturbations. Given a global context in which these perturbations are expected to increase dramatically (e.g. increasing frequency and intensity of extreme events due to climate change, but also the outbreaks of

new diseases, as in the case of COVID-19), the investment in ecological resilience could be the only way to adapt to an ever-changing situation.

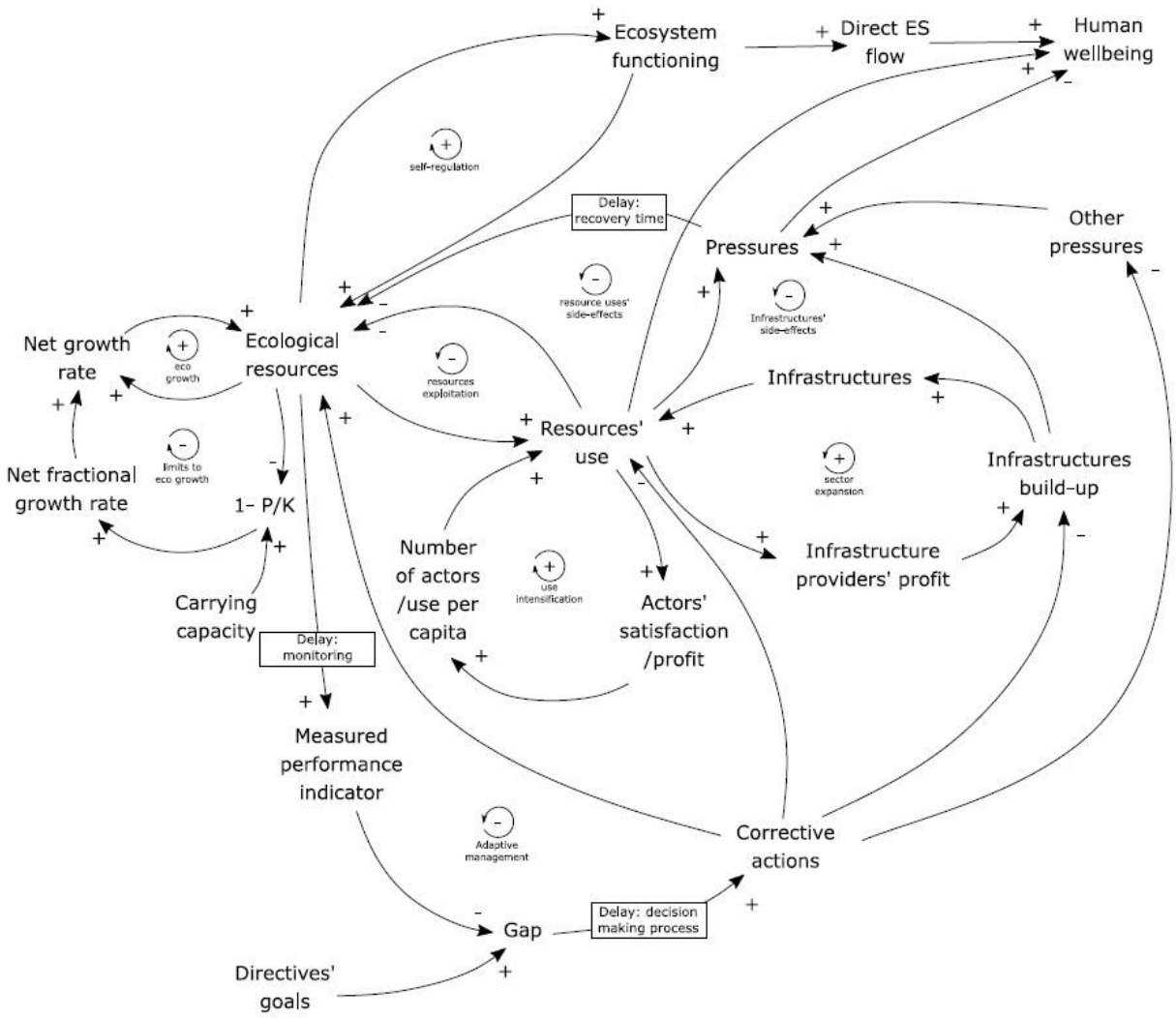

Figure 4. Conceptual model representing the generation of ecosystem services in socio-ecological systems. The model is developed as a Causal Loop Diagram, in which arrows denote causal links between variables (from project D3.4.1).

The ES assessment at the northern-central Adriatic scale, structured as a quantification of their capacity and flow, provides a relevant amount of data and information on three key cultural services, namely tourism, recreational navigation (Fig. 5) and recreational fishery. This broad scale assessment is needed to characterize the context in which the six selected N2K sites are located. Given a situation in which the available knowledge on the ES capacity and flow in marine and coastal systems is very limited, this assessment represents a step forward towards the implementation of integrated management approaches such as that outlined above.

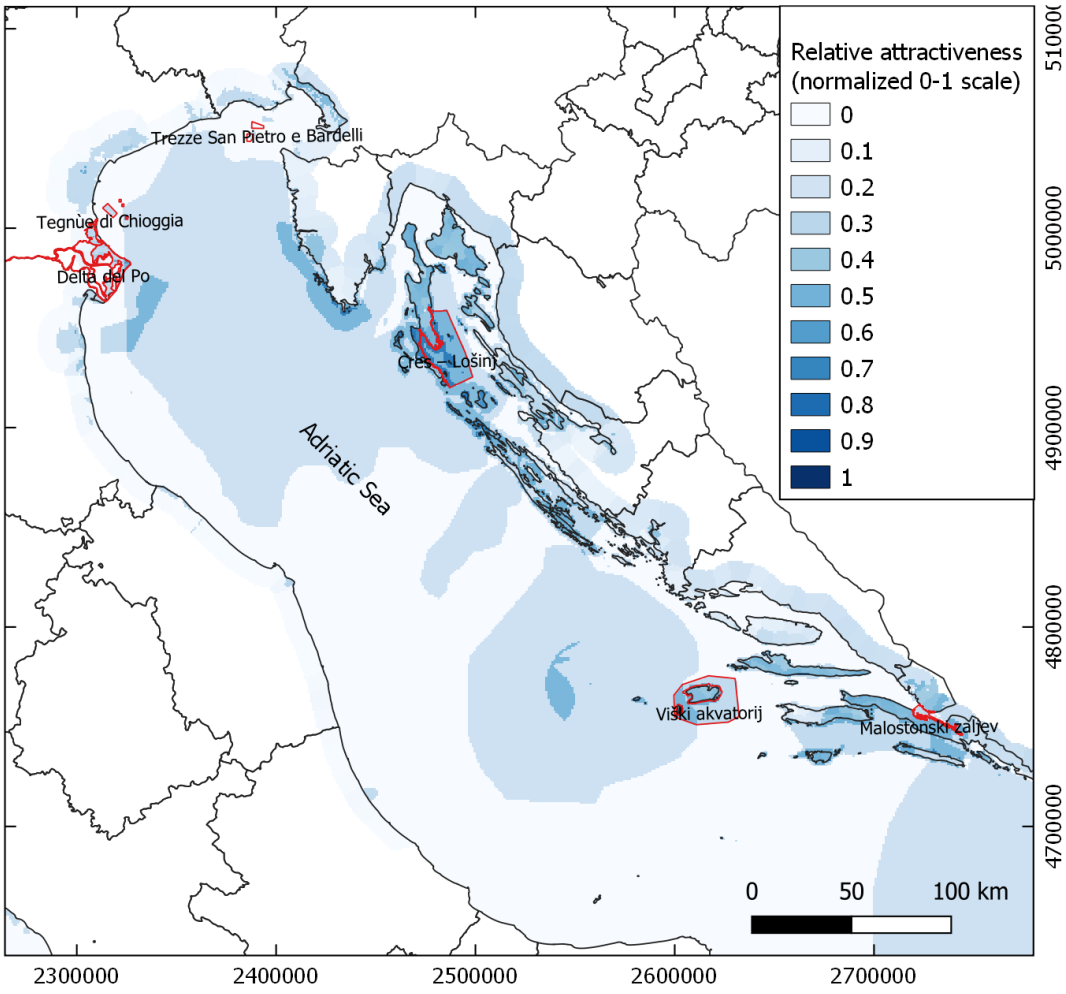

Figure 5. Capacity of the recreational navigation ecosystem service, corresponding to the relative attractiveness of marine and coastal ecosystems of northern-central Adriatic Sea, as perceived by the owners of leisure boats, expressed on a normalized 0-1 scale (from project deliverable D3.4.1).

3.5. Stakeholder engagement and participatory approach

Three workshops were organized within the ECOSS project, in which the stakeholders' comments, suggestions, rating of different ideas and other items relevant for the project were collected and then discussed.

On the 25th of September 2020 Blue World Institute, in collaboration with the Lead Partner and WP3, WP4 and WP5 leaders, has hosted an online workshop entitled "Needs and challenges to build the Adriatic ecological observing system ECOAdS". The 34 participants represented various project target groups: 6 governance bodies, 7 protected area management bodies, 4 universities and institutes, and 6 NGOs. The workshop was held separately for Italian and Croatian participants in order to facilitate the discussion in the native languages.

During the discussions, it was mainly evidenced:

- A lack of communication between decision-makers and stakeholders, including the most effective involvement of the stakeholders;
- The lack of proper understanding of how the management process and implementation works, followed by the enforcement of the management and protection measures, and the monitoring of their effectiveness;
- Species and habitats are not well represented in the N2K currently, and protected areas are isolated and mainly established on economic interests rather than on ecological and conservation reasons;
- Need of a large-scale monitoring and to harmonize and standardize monitoring activities, where the observatories should become a planning support tool, not just a library or repository of environmental data;
- The local and indigenous knowledge should be operationally included in practical management activities;
- The sharing, the transparent analysis and the integration of the collected data at the regional scale should be enhanced, in particular of the data obtained through programs funded with public money;

- The coordination between and within different EU programs should be improved, in particular between these tackling many similar problems;
- Best practices should be transmitted also through educational activities.

Other details on the discussion are available in the ECOSS deliverable D2.4.2.

The second ECOSS stakeholder workshop (ECOSS deliverable D2.4.3) was held on the 3rd of December 2020 and it was targeted only to PhD students. It was organized by Blue World Institute, in collaboration with the Lead Partner and WP3, WP4 and WP5 leaders, and entitled "Needs and challenges to build the Adriatic ecological observing system ECOAdS".

The students were asked to comment a number of issues related to N2K sites and to their management. The answers are shown in Figures 6-9.

The comments and the ratings which emerged in the workshops regarding the different issues to the relevant management of N2K sites might be included to improve the management and the governance of the N2K sites, as well as when doing revisions of the national legislations regarding environmental issues of the Adriatic Sea.

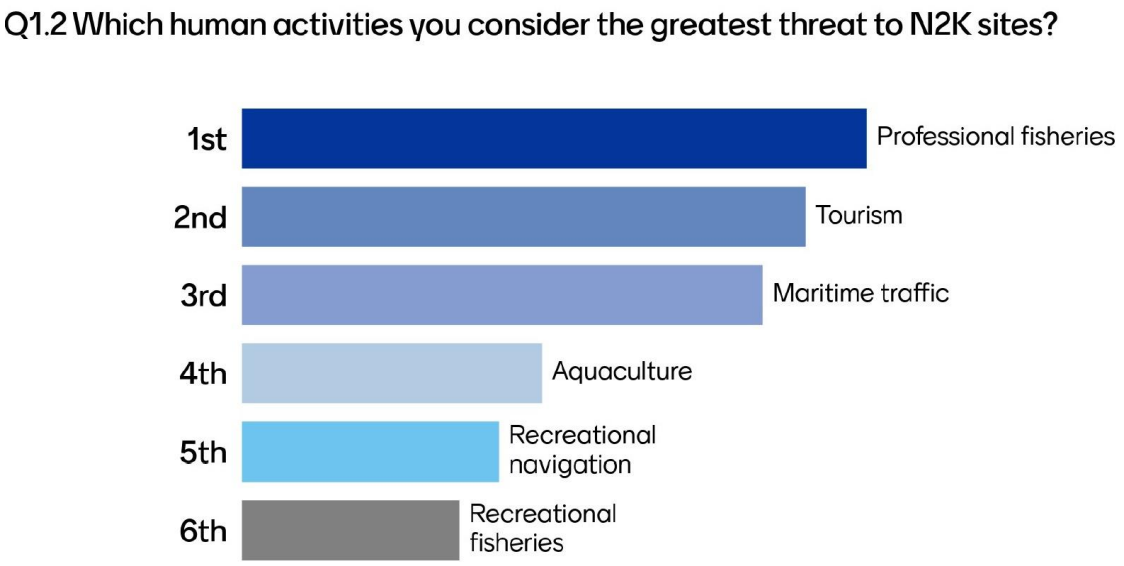

Figure 6. Mentimeter responses by stakeholders to question Q1.2.

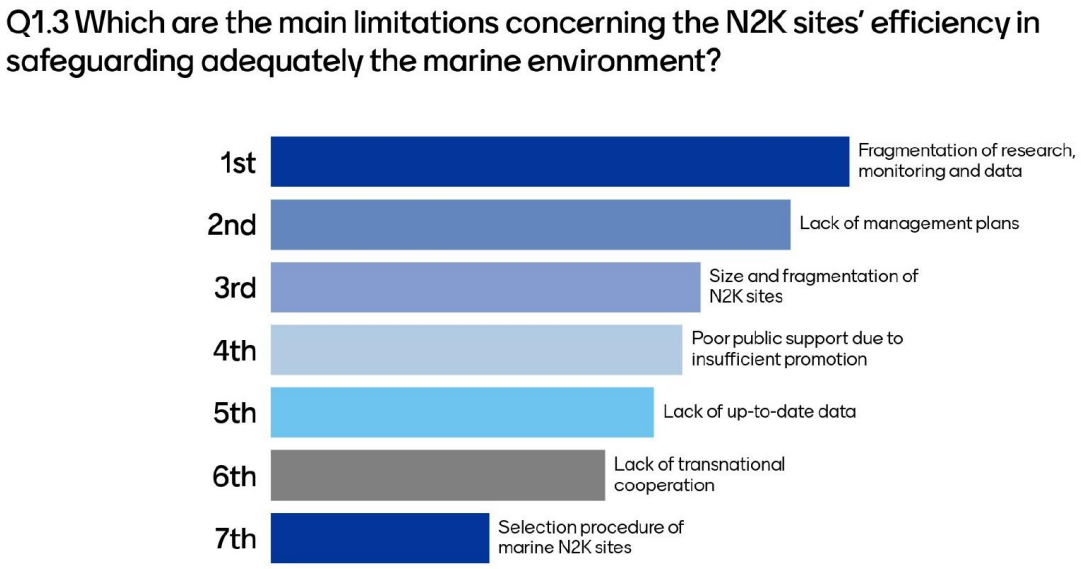

Figure 7. Mentimeter responses by stakeholders to question Q1.3.

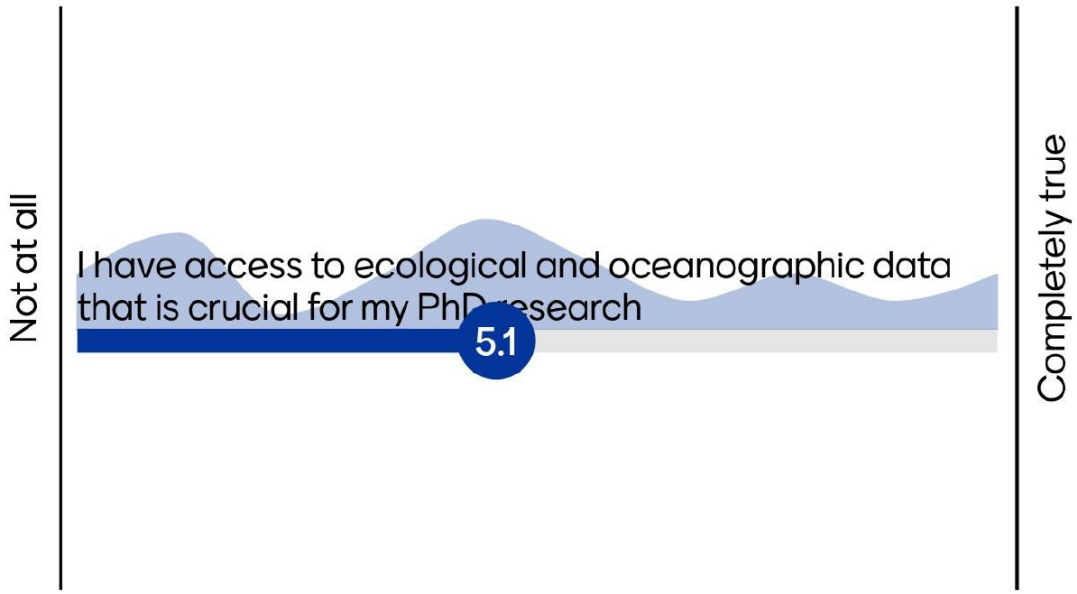

Figure 8. Distribution of mentimeter responses by stakeholders to question about the usage of the data in a PhD research.

Figure 9. Distribution of mentimeter responses by stakeholders to question about the usage modelling tools in the Natura 2000 monitoring activities.

The third stakeholder workshop was held online on 8 June 2021 and was mainly focused on dissemination of the ECOSS results, including establishment of the Adriatic Ecological Observing System (ECOAdS), the corresponding ECOAdS Strategic Plan and Roadmap and the corresponding web portal www.ecoads.eu.

4. SWOT ANALYSIS

SWOT (Strengths-Weaknesses-Opportunities-Threats) analysis will assess all information relevant for ECOAdS, in this document and from other sources, to craft a strategy for sustainability and longevity of the ECOAdS.

Strengths

- There is a variety of monitoring programs and observing systems that cover the Adriatic Sea region;
- The majority of organizations engaged in monitoring programs are involved in the fulfilment of obligations according to WFD, MSFD, H&BD and MSP;
- The composition of the ECOSS partnership, from scientific research-performing organizations through regional agencies, is enabling for exchange of information and data;
- The conceptual model for the management of the N2K sites, threats, pressures and activities with impacts on site and main management questions is clearly defined;
- Different monitoring systems are already established and there is a good knowledge on target species populations and trends at the N2K sites;
- For most of the target species peer-reviewed literature is available, providing important knowledge about the species biology and ecology;
- There is a great number of enthusiastic researchers, in particular at the PhD level, willing to conduct relevant research for the management of N2K sites.

Weaknesses

- There is lack of information and data for certain parameters required by the directives due to a lack of harmonization in their implementation;
- The long-term investment in maintenance of long-term ecological research and monitoring, beside the directives, mostly depend on short-term resources and projects;

- The collaboration between some research groups and research institutes is not at the satisfactorily level;
- The collaboration between research-performing organizations, agencies and regional/local authorities is not well established;
- There is a scarce availability of ecological data and they are not well disseminated towards potential users and public;
- There is little information on the ecological processes, as 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 (most institutions that conduce monitoring programs do not open their data to the public);
- The most of selected N2K sites has not approved management plan nor clearly defined conservation goals/issues/strategies;
- Due to their regular activities, the majority of the managing authorities has no resources to maintain monitoring and adequate surveillance of the area;
- Performance indicators are not defined in all selected N2K sites.

Opportunities

- Cooperation between managing authorities and research institutions/organization as established within the ECOSS project 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 infrastructures 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 knowledge-based governance of N2K sites;
- An integrated platforms and programmes of observing networks may allow for boosting the importance of monitoring of the marine environment, which can result in better operational and forecasting systems;

- ECOAdS contributes to the harmonization of monitoring schemes, data acquisition and analysis at national and trans-regional levels, providing suggestions for a most effective and coordinated application of the EU directives
- Societal needs for blue and green economies and preservation of biodiversity may push N2K governance to use sustainable and knowledge-based management procedures;
- Transfer of knowledge and information between partners from Croatia and Italy may allow the definition and creation of better environmental protection policies and strategies;
- Building the ECOAdS web portal and providing direct access to the data may boost a comprehensive research, relevant for the management of the Adriatic N2K sites and the marine environment.
- ECOAdS may function as a cooperation bridge between Italy and Croatia, building a cross-boundary ecosystem-based marine knowledge framework, which could be expanded to the whole Adriatic region, using the policy and financing tools available in the area.
- ECOAdS could serve as a coordinated and co-located platform serving different European Environmental Research Infrastructures, sustaining the components that are under development in the Adriatic area.
- ECOAdS is in line with plans and strategies for the next decade, at the national, macro-regional (e.g. EUSAIR) European (e.g. EU Biodiversity Strategy for 2030, the European Green Deal) and global levels (e.g. the Global and European Ocean Observing Systems, the Ocean Decade) and might therefore contribute to their fulfilment.

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, ending with failing in conserving the marine ecosystems and the benefits they provide;
- Political situation at higher level might have a repercussion on the collaboration and maintenance of the research and other connections established for protection of the Adriatic Sea, and therefore impact a great number of activities related to the common sea;

- A lack of management plans in a due time may results in a lack of proper governance of N2K sites;
- Avoiding applying the open science principles, including open data policies and data sharing, may prevent the research, acquisition of knowledge and proper management of the N2K sites in the Adriatic.
- A scarce level of commitment of the ECOSS partnership could hamper the possibility to maintain the observatory with the appropriate actions at the local and national levels.

5. VISION AND KEY CHALLENGES OF THE ECOAdS

ECOAdS is conceived as a shared platform between Italy and Croatia able to support coordinated efforts of oceanographic and ecological monitoring and research at the basin scale, and the definition of common management and conservation practices to favour a better governance of the N2K sites in the Adriatic Sea.

The ECOAdS vision will be fulfilled through following specific goals and key challenges:

- Strengthening of the observational capacities, including human resources, necessary to carry out the ecological research and monitoring following the main European Directives, and to support the conservation strategies at N2K sites;
- Adoption of agreed conceptual frameworks for the harmonization and integration of monitoring schemes;
- Boosting the cooperation between research-performing organisations and bodies in charge of governance of N2K sites and favouring a multi-governance system;
- Sharing the data coming from observations acknowledging the open-data and open-science principles through the ECOAdS web portal;
- Inclusion of local and indigenous knowledge and civil society voice within the management and governance of N2K sites.

6. KEY PLAYERS, USERS AND INSTRUMENTS

6.1. ECOAdS key players

ECOAdS key players are enrolled in the provisions and executions of ecological monitoring programmes or ecological observing system, policy-making and decision-making of environmental issues at national and N2K levels, and management and governance of N2K sites in the Adriatic Sea.

- Marine research institutes and universities

Institute of Marine Sciences of the National Research Council (CNR-ISMAR), Italy, http://www.ricercamarina.cnr.it/en/ismar.php: CNR-ISMAR integrates multidisciplinary research skills in marine and transitional environments with a holistic approach. Cutting-edge research is carried out by combining long and short-term observational approaches, on physical, chemical and biological oceanographic and ecological studies. CNR-ISMAR has a long tradition in the management of fixed-point observatories, long term series of plankton and bio-geochemical processes both in the water column and the seabed. It integrates competences in marine spatial planning, developing tools for the analysis of cumulative impact and coexistence of maritime uses, effective management of human activities in the sea and preservation of marine resources. CNR ISMAR is also involved in the implementation of the main EU marine policy and Directives (MSFD, WFD, H&BD), linking research and institutional needs, promoting science-to-policy initiatives at national and EU level.

Institute for Marine Biological Resources and Biotechnology (CNR-IRBIM), Italy, http://www.ricercamarina.cnr.it/en/irbim.php: CNR-IRBIM conducts scientific research to study life and biodiversity in seas and oceans. The institute promotes and carries out fundamental and applied research activities to expand knowledge on marine organisms and ecosystems and their evolution, also in relation to global change and the human impact.

The **National Interuniversity Consortium For Marine Sciences (CoNISMa), Italy,** http://www.conisma.it/en/: CoNISMa promotes and coordinates research and scientific activities and their applications in the field of Marine Sciences among the 35 associated Universities. It has legal personality (MIUR DM 15.03.1996 and 05.16.1996), it is placed under

the supervision of the Ministry of University and Scientific and Technological Research and it is registered in the National Research Registry (No 515810DU). Conisma joins the Marine Board of the European Science Foundation. CoNISMa has the purpose to promote and coordinate research and other scientific and applicable activities in the field of Marine Sciences among the associated Universities not only favouring the cooperation between Universities, other public and private research Bodies, local and territorial Authorities, Industries, but also their access and their possible participation in the creation and management of foreign or international laboratories that work in the field of Marine Sciences, according to the norms of the present Statute.

Stazione Zoologica Anton Dohrn (SZN), Italy, http://www.szn.it/index.php/en: The mission of the Stazione Zoologica is the research of the fundamental processes of biology, which include marine organisms and their biodiversity, in close link with the study of their evolution and the dynamics of marine ecosystems, using an integrated and interdisciplinary approach. The study of the resulting biotechnological applications is part of the mission of SZN. Apart from this specific research activities, the mission of the Stazione Zoologica – in accordance to its tradition – is nowadays to: (i) provide access to marine organisms for the international scientific community; (ii) provide qualified consultancy to public Institutions; and (iii) provide advanced training. In particular, the ability to develop research activity and at the same time to provide specialized scientific services with a high technological impact and with a multidisciplinary approach, represent the strength of the Stazione Zoologica Anton Dohrn; this characteristic makes the SZN unique among the national research institutes.

Institute of Oceanography and Fisheries (IOF), Croatia, http://www.izor.hr: The Institute of Oceanography and Fisheries was founded in 1930 as the first national scientific institution dedicated to marine research. The scientific activity of the Institute has been multidisciplinary from the beginning, encompassing biological, chemical and physical oceanography as well as sedimentology, fishery and mariculture. A significant part of this research aims at detecting complex interactions that shape the Adriatic marine environment, since understanding the ecosystem's functioning represents a necessary prerequisite to creating measures for the protection of ecosystem and its biological resources, with a view to sustainable exploitation. In addition, numerous projects funded by the European Commission or different commercial entities, enable us to carry out monitoring of populations and stocks of marine organisms, biotope mapping, initial assessments of the marine environment and various studies on environmental state and impacts. The physical, chemical and biological long-term data series

collected by the Institute represent a valuable basis for the implementation of European directives, aiming at aquatic environment management and protection (MSFD, WFD).

Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGS), Italy, http://www.inogs.it: OGS, Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (National Institute of Oceanography and Applied Geophysics) is an internationally oriented public research institution. This institution operates and develops its own mission in the European Research Area (ERA) and internationally, prioritizing the basic and applied research fields of: (i) Oceanography (under the Physical, Chemical and Biological aspects); (ii) Geophysics and Marine Geology; and (iii) Experimental and Explorative Geophysics. OGS applies its own expertise in Earth Sciences, and in Marine and Polar regions to contribute not only to the spreading and widening of the knowledge, but also to the practical solution of environmental, economical and social issues in line with the National Program of Research (PNR) and strategic objectives set by the EU, with particular referral to Horizon 2020. Counting on its own vessel, the OGS Explora—an oceanographic research ship—and other strategic infrastructures of excellence, OGS works for the safeguarding and enhancement of the environmental and natural resources in order to evaluate and prevent geological, environmental and climatic risks, with the aim of spreading scientific culture and knowledge. All these efforts are also made in collaboration with analogous European and international institutions, with private high-tech industries and qualified enterprises. The aim is to ease the transfer of the results of the research from the scientific world to that of production and thus contribute to the technological and socio-economic development of the Country.

Ruđer Bošković Institute, Croatia, https://www.irb.hr: The Institute is the largest Croatian scientific research center of a multidisciplinary character. The Mission of the Institute is excellent scientific research in the natural, biomedical and engineering sciences, with contributions to higher education and cooperation with the business sector based on outstanding scientific research. The vision of the Institute is to be a recognized top European centre of scientific excellence. In marine sciences, the most of the research is conducted through two departments: Centre for Marine Research (CIM) and Division for Marine and Environmental Research (ZIMO). The Center for Marine Research (CMR) Rovinj is an interdisciplinary center, whose activities are focused upon basic and applied oceanographic research, including the following areas: (i) processes and dynamics within and between trophic levels (primary and secondary production, cycle of basic and biogenic elements); (ii) investigation of water mass dynamics; (iii) flora, fauna and animal communities (taxonomy, ecology and organism communities in natural and polluted areas); and (iv) ecological, physiological and genetic research on marine organisms and the impacts of pollution; monitoring of pollution and marine water quality; investigation of eutrophication. The Division

of Marine and Environmental Research, with 104 scientists and technicians organized in 12 laboratories and one marine station (Martinska, near the city of Šibenik), is the largest interdisciplinary RBI division. The laboratories carry out research in oceanography, aquatic chemistry, radioecology, geochemistry, biogeochemistry, bioelectrochemistry, environmental electrochemistry, ecotoxicology, aquaculture and fish pathology, ecological modeling and environmental informatics. The scale of research problems spans from nanoscience to satellite oceanography.

University of Dubrovnik, Institute for Marine and Coastal Research, Croatia, https://www.imp-du.com/en: The activities of the Institute are basic and concern the research of natural features in the Adriatic Sea and its coastline, particularly research into the structure and processes of ecosystems, use and interpretation of scientific information for the benefit of developing and furthering the cooperation of research scientists with similar institutes and scientific groups both nationally and abroad, education and cultural activity, as well as the provision of professional services to interested users. The Institute, in accordance with scientific progress and economic opportunities, also develops other activities, such as: monitoring living marine and land resources, monitoring sea quality, experimental rearing of plant and animal species with the aim of acquiring fundamental knowledge and studying the various stages of natural processes, maintenance and popularization of aquariums, maintenance and popularization of the Botanical Garden on Lokrum, formation of scientific and expert collections, as well as the organization of courses and lectures that reflect on the Institute's fundamental activities.

- Regional and national environmental agencies and policy-makers

Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA), Italy, https://www.isprambiente.gov.it/en: The Italian National Institute for Environmental Protection and Research (ISPRA – Istituto Superiore per la Protezione e la Ricerca Ambientale) is a public legal entity subject to the vigilance of the Italian Ministry for the Environment, Territory and Sea, and provided with technical, scientific, organizational, managerial, administrative and financial autonomy. The Institute performs scientific, technical and research functions as well as assessment, monitoring, control, communication, training and education activities. Supports the Ministry in several environmental sectors i.e. marine and water environments, soil, air, habitats, ecosystems and biodiversity. Furthermore, facilitates the coherent implementation of national environmental policies through the scientific and technical co-ordination with the 21 environmental agencies of the Italian regions and

autonomous provinces. ISPRA is responsible for the technical aspects of the EU Marine Strategy Framework Directive implementation and reporting; performs the role of National Reference Center for all EIONET components and is member of two EEA European Thematic Centers (Biodiversity and Inland, coastal and marine waters). In case of maritime accidents or of other marine pollution emergencies, ISPRA provides national authorities with scientific and technical advice. At regional level, ISPRA experts are formally involved in implementation of the Barcelona Convention for the protection of the environment of the Mediterranean region and related Protocols. ISPRA is the national data provider on sea level and waves. Data gathered are used for analysis and re-analysis and they are the core of Mediterranean, national and local forecasting. ISPRA provides, comprehensively and systematically, the high-resolution estimation of the physical state of Italian seas as well as real time monitoring.

Agenzia regionale per la prevenzione, l'ambiente e l'energia (ARPA), Italy: The regional agencies for prevention, environment and energy (Agenzia regionale per la prevenzione, l'ambiente e l'energia) are agencies established in 21 Italian regions (e.g. ARPAE, ARPAV, ARPA FVG, etc.), with the aim to ensure the authorizations and concessions, environmental monitoring, control and prevention to favour sustainability, health protection, safety of the territory and the enhancement of resources and environmental knowledge in a region. Their commitment is also in the development of forecasting systems and models to improve the monitoring and knowledge of environmental systems and of the anthropogenic and natural factors that affect them, monitoring new forms of pollution and degradation of ecosystems. The agencies promote the sustainability of human activities that affect the environment, health and safety of the territory, both through the controls provided for by the regulations, and through prevention activities in the issuance of environmental permits and concessions, studies, projects, environmental communication. Finally, ARPA agencies also play a key role in observation, forecasting, research and development in the meteorological and climatological field, addressing the cognitive issues underlying the policies of adaptation and mitigation of climate change, as well as carrying out important research studies in the field of epidemiological and toxicological issues connected to the complex environment-health combination.

Ministry of Economy and Sustainable Development, Croatia, https://mingor.gov.hr: *Directorate for Nature Protection*: Nature and parts of nature are of interest to the Republic of Croatia and enjoy its special protection. The Directorate for Nature Protection performs administrative and professional tasks related to the conservation of biodiversity and geodiversity, assessment of acceptability for the ecological network, conservation and protection of parts of nature including protected areas and ecological network areas. *Directorate for Environmental Impact Assessment and Sustainable Waste Management*: The

Directorate for Environmental Impact Assessment and Sustainable Waste Management performs administrative and other tasks related to environmental impact assessment, strategic environmental impact assessment of strategies, plans and programs, determination of environmental protection measures for interventions for which the obligation to assess the impact of the project is not prescribed. on the environment, liability for environmental damage, prevention of major accidents involving hazardous substances, issuance of environmental permits and other permits, approvals and keeping various registers in accordance with the scope of work. *Directorate of Water Management and Marine Protection*: The Directorate of Water Management and Marine Protection performs administrative and professional tasks related to the direct application of laws, other regulations and planning documents in the field of water, sea and coastal management and drafting of draft laws and other regulations. In the field of marine and coastal protection, the Administration performs professional tasks related to the preservation and recovery of marine and coastal ecosystems, monitoring and observation of the Adriatic Sea at the national level, subregion (Adriatic Sea) and region (Mediterranean Sea), implementation of protection measures and managing the marine environment and coastal area and conducting oversight of the Marine Referral Centre.

- Non-governmental organisations (NGOs)

Blue World Institute (BWI), Croatia, https://www.blue-world.org: The Blue World Institute of Marine Research and Conservation was founded in 1999. The Blue World Institute is an independent non-profit organisation set up with the intention to carry out scientific research and conservation of the marine environment as well as educational activities, with an emphasis on the Adriatic Sea and the wider Mediterranean basin. Our three main programmes – research, education and conservation – provide a framework for executing multiple projects aimed at furthering the understanding of the marine environment, its flagships species, and public participation in their protection. Recognising their invaluable role in the ecosystem, our research focuses on large marine vertebrates with an aim to contribute to the protection and conservation of the whole marine environment. This is achieved through cooperation with competent authorities, development of innovative management measures, creation of partnerships with relevant stakeholders and involvement of the public through awareness-raising and education. Research on protected species is conducted under permits issued by relevant authorities following national legislation of the countries where we operate and is carried out following a set of voluntary adopted set of standards and norms ensuring animal welfare.

Sunce, Croatia, https://sunce-st.org/en: Association Sunce was founded in 1998 by the group of Split intellectuals as a response to the growing need for an independent and expert body that will offer solutions to environmental issues and nature protection. Today Sunce is known, at the national and international level, as one of the leading organizations for the protection of nature and environment in Croatia. We are committed to increasing the standards and improvement of environment and nature protection, we encourage the involvement and participation of the public and advocate for the creation of a responsible society conscious connection between people and nature. We are here to protect the interests and the public's right to a healthy environment and create solutions to conservation and rational use of natural resources for the benefit of all citizens.

Društvo za oblikovanje održivog razvoja (DOOR), Croatia, https://door.hr/english: DOOR is a civil society organization of experts devoted to the promotion of sustainable energy development, founded in 2003. Today DOOR has more than 60 members, five members Steering Committee and eleven employees. We have successfully implemented more than 100 projects with goals ranging from climate change mitigation, encouraging citizens' participation in sustainable energy policy-making, improving education about renewable energy sources and alleviating energy poverty. Within our projects we organized more than hundred workshops, round tables, trainings, conferences and other public events attended by several thousand participants, we published a dozen manuals, organized a number of study trips and established continuous cooperation with numerous organizations from Croatia and abroad.

Dolphin Biology and Conservation (DBC), Italy, http://www.dolphinbiology.org/**:** DBC is a not-for-profit organization registered as an Association of Social Promotion in the Region Friuli Venezia Giulia. DBC has a legal base in Cordenons (Pordenone, Italy) and a field station in Loreo (Rovigo, Italy). It aims to contribute to the conservation of nature and of the marine environment, particularly the wild fauna, through activities that increase understanding, appreciation and protection of biodiversity and our natural heritage**.**

Legambiente, Italy, https://www.legambiente.it/: it is a not-for-profit association, made by citizens caring for environmental conservation, for the quality of life and for a fair and just society for solidarity. Based on active volunteer participation from citizens, Legambiente mission embraces the scientific environmentalism, gathering and delivering data on ecosystems, for sustaining projects and environmental campaigns which address the main environmental issues of the Country.

Lega Italiana Protezione Uccelli (LIPU), Italy, http://www.lipu.it/: the Italian Association for Bird Protection addresses Nature conservation, biodiversity protection and the promotion of

the cultural ecology in Italy. It is a large community made by members, volunteers, field operators taking care of wildlife, through more than 100 local sections, for recovery and first aid. It manages more than 30 natural reserves, open to the public.

Sea Sheperd Italia onlus, Italy, https://www.seashepherd.it/: Sea Shepherd is an international, non-profit marine conservation organization that engages in direct action campaigns to defend wildlife and conserve and protect the world's oceans from illegal exploitation and environmental destruction. The Italian branch acts at the national level to document and fight illegal activities at sea.

World Wildlife Fund-Italia (WWF-Italia), Italy, https://www.wwf.it/: in accordance with the WWF international mission, WWF Italia is an organization that, with the help of the citizens, contributes effectively to the conservation of natural systems in Italy and in the world.

- NATURA 2000 governance bodies

Public institution for the management of protected parts of nature of the Dubrovnik-Neretva County, Croatia, https://www.zastita-prirode-dnz.hr: The activity of the Public Institution is the protection, maintenance and promotion of protected parts of nature in order to protect and preserve the originality of nature, ensure the smooth running of natural processes and sustainable use of natural resources, and oversee the implementation of nature protection conditions and measures for the area. Pursuant to the Decree on the ecological network and the competencies of public institutions for the management of ecological network areas, in the area of Dubrovnik-Neretva County, 2 areas important for the conservation and favourable status of wild bird species of interest to the European Union and their habitats, areas important for the conservation of migratory bird species, and especially wetlands of international importance (Areas of Conservation Important for Birds), and 69 areas important for the conservation and achievement of favourable status of other wild species and their habitats, as well as natural habitat types of interest to the European Union (Conservation areas important for species and habitat types). Areas located within the boundaries of the national parks are managed by the Public Institution National Park Mljet and the Public Institution Nature Park Lastovo Islands, and the Public Institution manages all other areas.

Public Institution "Sea and Karst" of the Split-Dalmatia County, Croatia, http://moreikrs.hr: The public institution MORE I KRŠ performs the activity of protection, maintenance and promotion of protected areas of Split-Dalmatia County in order to protect and preserve the originality of nature, ensure the smooth flow of natural processes and sustainable use of

natural resources, and oversee the implementation of nature protection conditions and measures. The institution also manages the area of the ecological network in accordance with the Nature Protection Act and bylaws. In accordance with the Nature Protection Act, the institution performs direct supervision in protected areas, as follows: (i) over certain plant and animal species, and supervises protected natural values through the chief supervisor, supervisor and nature conservationist; and (ii) supervision over the implementation of conditions and protection measures in the area it manages.

Public institution Nature of Šibenik-Knin County, Croatia, https://priroda-skz.com: The primary objective of the institution is to protect, maintain and preserve the authenticity of the natural environment and the sustainable use of natural and cultural goods at the sites it manages, thereby benefiting local residents, visitors and future generations. The great natural wealth and cultural heritage of the Šibenik-Knin County require particular protection and conservation measures. Apart from the Krka and Kornati National Parks and Vrana Lake Nature Park, all other areas of great natural importance are also protected by national legislation. In the category of significant landscape in the Šibenik-Knin County as many as seven sites, there are two nature monuments and nearly sixty sites of the ecological network Natura 2000 are protected. There is also St Nicholas' Fortress, a cultural and historical monument under the UNESCO protection, which is located within the significant landscape Channel – Port in Šibenik, along with its buffer zone. These areas boasting diversified and unique flora and fauna as well as exceptional geomorphological heritage are managed by the Public Institution Nature of the Šibenik-Knin County, which was established in 2007.

Natura Jadera, Public institution for the management of protected parts of nature in the Zadar County, Croatia, https://natura-jadera.com: Since April 2003, Natura Jadera has been managing 13 protected parts of nature in Zadar County and areas of the European ecological network Natura 2000 (except for the areas within the borders of NP Paklenica and PP Telašćica, Vrana Lake and Velebit). The basic activities can be briefly grouped as follows: (i) protection of natural values; (ii) ensuring sustainable use of natural resources (concession approvals); (iii) determining and monitoring the state of nature (research and monitoring); (iv) prevention of harmful human interventions and disturbances in nature (supervision); (v) promotion and education; and (vi) creating conditions for rest and leisure.

Public Institution "Priroda" of the Primorje-Gorski Kotar County, Croatia, https://ju-priroda.hr: The special goals of the institution are aimed at the preservation of biological, geological and landscape diversity, ie the protection of valuable parts of nature and the sustainable use and valorization of natural heritage in the Primorje-Gorski Kotar County. The specific goals of the work of the Public Institution "Priroda" arising from the program activities

are the following: (i) to determine and monitor the state of nature; (ii) preparation of documents for natural values management; (iii) encouraging the sustainable use of natural resources; (iv) creation of preconditions for sustainable tourist valorization of valuable natural heritage; (v) raising the level of knowledge, understanding and public support for nature protection; (vi) strengthening the capacity of nature protection by involvement in national and international projects; and (vii) reduction of direct pressures on natural values.

Public Institution Natura Histrica of the Istria County, Croatia, http://www.natura-histrica.hr/en: Natura Histrica is a public institution for the management of protected areas and other protected natural values in the Istria County. The main activity of the institution is the protection, maintenance and promotion of protected areas and other protected natural resources in the Istria county in order to protect and preserve the authenticity of nature, ensuring a smooth ongoing of natural processes and a sustainable use of natural resources and the monitoring of nature protection conditions and measures implementation in the managed areas. In order to ensure a rational and sustainable use of natural resources Natura Histrica monitors the performing manner of allowed economic activities in protected areas. As a distinct legal entity, Natura Histrica performs its activities since July 4th 1996 and it's the first such institution established in Croatia. The institution is financed from the county budget provided for this purpose, from the budget of some cities and municipalities, from funds that the institution acquires with performing its own activities and from other sources provided by law.

- Key active projects relevant to ECOAdS

ADRIA-CLIM, https://www.italy-croatia.eu/web/adriaclim: AdriaClim is the acronym of the new research project funded by the Italy-Croatia Interreg Cooperation Programme that is dedicated to supporting the development of science-based regional and local climate change adaptation plans. AdriaClim will address climate change threats by developing regional and local adaptation plans based on up-to-date meteorological and oceanographical information acquired through newly implemented observing and modelling systems for the Adriatic Sea.

ADRIREEF, https://www.italy-croatia.eu/web/adrireef: ADRIREEF has the ambition to combine innovative actions related to natural and artificial Adriatic reefs with possible socio- economic impacts originated from activities such as aquaculture and tourism, two sectors of Blue Economy. As the success of activities strongly depends on the structural and ecological performance of the reefs (both natural and artificial), the project will also include setting up and testing of suitable technologies with low impact for underwater monitoring. A White paper

on the exploitation of Adriatic reefs will also include a specific plan for future funding projects in the forthcoming programming period 2021-2028.

CASCADE, https://www.italy-croatia.eu/web/cascade: CASCADE will develop a set of concerted and coordinated actions including monitoring (observing and modelling) and management (Maritime Spatial Planning - MSP, Integrated Coastal Zone Management - ICZM, Land-Sea Interaction - LSI) to enhance the knowledge and to evaluate the quality and assess the vulnerability of inland, coastal and marine ecosystems in Italy and Croatia with the final objective to restore endangered species and to support integrated management. The integrated modelling and observing systems will be developed to design and implement MSP/LSI/ICZM, management and restoration actions in 11 pilot areas. Pilot actions will assess and protect coastal and marine biodiversity in degraded areas, set up restoration actions, assess the impacts of extreme events on ecosystems and understand how to avoid conflicts and boost synergies in the areas. The project will consolidate long-lasting research capabilities in the field through a concrete dialogue with stakeholders and the participation of Agencies, research centres and universities in order to enhance inland, coastal and marine knowledge. Such shared information and monitoring protocols are essential for supporting concrete actions dealing with environmental vulnerability, fragmentation and safeguarding of ecosystem services at cross-border level.

CHANGE WE CARE, https://www.italy-croatia.eu/web/changewecare: CHANGE WE CARE fosters concerted and coordinated climate adaptation actions at transboundary level. The project explores climate risks faced by coastal and transition areas contributing to a better understanding of the impact of climate variability and change on water regimes, salt intrusion, tourism, biodiversity and agro-ecosystems affecting the cooperation area. The main goal is to deliver integrated, ecosystem-based and shared planning options for different problems related to climate change (CC), together with adaptation measures for vulnerable areas to decision makers and coastal communities who may best benefit from it.

CREW, https://www.italy-croatia.eu/web/crew: CREW aims at achieving the following objectives: set up a cross border Observatory to monitor best practices and data on Italian and Croatian coastal wetlands; protect the biodiversity in Italian and Croatian coastal wetlands by the implementation of a coordinated methodology for wetlands management (Wetland Contract); share a cross border strategy and strengthen synergies among Italian and Croatian coastal wetlands; improve the public awareness about the value of the wetlands ecosystems among policy makers, managers, professionals, and general public and strengthen their active engagement in territorial governance.

INNOVAMARE, https://www.italy-croatia.eu/web/innovamare: InnovaMare strategic project will jointly develop and establish an innovation ecosystem model in the area of underwater robotics and sensors for purposes of monitoring and surveillance sector with a mission-oriented on the sustainability of the Adriatic Sea. IT will tackle one of the main current challenges: increasing the effectiveness of the innovation activities in the relevant fields of the blue economy, by enhancing the transfer of knowledge within the cooperation area between the enterprises, R&D centers, higher education and the public sector through education and capacity building actions for different stakeholders.

NET4MPlastic, https://www.italy-croatia.eu/web/netformplastic: the project aims to collect data on the distribution and composition of the Microplastic along the Croatian and Italian coastal and marine areas. A numerical model will simulate the marine transport processes of the Microplastic in the Adriatic Sea to identify possible Microplastic concentration zones in the pilot areas according to fluvial discharge and marine conditions. The drone images will be used to identify the presence of plastic, while some other parameters will be measured in real time by installing a specific platform on boats or on marine drones. Sampling will be done at the river mouth, in marine environment, on the beach and collecting biota samples. Chemical and biological analysis will identify the Microplastic, possible origin of the Microplastic and possible health impacts.

RESPONSe, https://www.italy-croatia.eu/web/response: The project aims at empowering local policy-makers to enable climate-smart governance approaches and promote sustainable living in Adriatic marine and coastal areas. RESPONSe will provide the tools to foster effective policy-making on climate adaptation at local level and support strategic decision-making on how best to address the effects of climate change on the coastal areas of the Adriatic basin. Building on the development of tailored climate services tackling vulnerabilities of the Adriatic region, RESPONSe will promote the engagement of local policy-makers and help mainstreaming adaptation planning into policy frameworks.

SASPAS, https://www.italy-croatia.eu/web/saspas: The challenge of SASPAS is to preserve and get a better status of conservation of biodiversity of the Adriatic Sea ecosystem in order to decrease its vulnerability. The overall objective is to improve seagrass preservation and restoration through: laying safe anchorage innovative systems, performing pilot transplantations, carrying out monitoring activities and by defining an integrated management system for seagrasses in Adriatic area. The main outputs referred to the activities are: a Monitoring system with 2 data collections/monitoring campaigns, the placement of environmentally friendly anchoring systems, pilot transplantations of seagrasses and an

Integrated Management System for seagrasses in the Adriatic area, made by a GIS Digital Information Platform and a Marine Seagrass Safeguard Integrated Management Program.

SOUNDSCAPE, https://www.italy-croatia.eu/web/soundscape: The Northern Adriatic Sea (NAS) is an area highly impacted by increasing maritime traffic, tourism and resource exploitation, whilst having a very vulnerable biodiversity. The main objective of the project is to create a cross-border technical, scientific and institutional cooperation to face together the challenge of assessing the impact of underwater environmental noise on the marine fauna and in general on the NAS ecosystem. This cooperation aims to ensure an efficient protection of marine biodiversity and to develop a sustainable use of marine and coastal ecosystems and resources. The objectives of the project are to be pursued in three ways: Implementing a shared monitoring network for a coordinated regional and transnational assessment of the underwater noise, evaluating the noise impact on marine biological resources, developing and implementing a planning tool for straightforward management.

SUSHI DROP, https://www.italy-croatia.eu/web/sushidrop: Within SUSHI-DROP, a customized unmanned underwater vehicles will be developed and equipped with acoustical and optical technologies in order to implement a non-invasive mean to assess environmental status of habitats, fish stocks population and, in general, to monitor the biodiversity of marine ecosystems. We are planning to assess the accuracy of the opto-acoustic surveys in deriving single-species abundance indices (in numbers or weight) for direct input into stock assessments, and to evaluate the benefits brought by these new technologies with respect to the classical procedures based on fish sampling. Moreover, a dedicated open-access database system will be created to collect, maintain and share the scientific data acquired by the UUVs.

WATERCARE, https://www.italy-croatia.eu/web/watercare: WATERCARE aims to improve the quality of the microbial and environment and resource efficiency in bathing and coastal waters reducing the microbial contamination by using innovative tools in waste management and treatment WATERCARE will: develop an innovative Water Quality Integrated System (WQIs) composed by a realtime hydro-meteorological monitoring network; realize an ad-hoc infrastructure for bathing waters management in a pilot site through a forecast operational model; realize feasibility studies in other 4 target sites to improve planning and management of environmental problems of the marine system; develop a real-time alert system able to preventively identify the potential ecological risk from focal contamination of bathing waters and to support governance decision and processes in bathing water management.

6.2. ECOAdS users

ECOAdS users are national and international beneficiaries, institutions, programmes and platforms that are using provisions of the ECOAdS for their activities, spanning from the basic and applied research and education, through strategic programming, policy-making and governance, towards local populations and the public.

- Research-performing and research-funding organisations and programmes

Being the operators of the ecological monitoring programmes and observing systems, research-performing organisations (public and private research institutes, universities, NGOs) are also users of the ECOAdS products, including ECOAdS web portal. Indeed, the systematization of the observational ecological networks and the access to the data through one-stop-shop portal is of highest relevance for performing high-quality research activities and obtaining state-of-the-art knowledge on various issues related to marine sciences and geosciences.

These organisations may be found on the above list, which is not exhaustive.

Regarding research-funding organisations, they might use this roadmap to direct their calls for projects towards a sustainable and long-term observation activities and research, which is based on ecological data availability. For the Adriatic Sea, these might be:

Croatian Science Foundation, http://www.hrzz.hr: Croatian Science Foundation provides support to scientific, higher education and technological programmes and projects in the Republic of Croatia, fosters international cooperation, and helps the realization of scientific programmes of special interest in the field of fundamental, applied and developmental research. By joining the European Charter for Researchers and Code of Conduct for the Recruitment of Researchers in 2011, the Foundation accepted the alignment of its rules with those of other European countries.

Environmental Protection and Energy Efficiency Fund (EPEEF), https://www.fzoeu.hr: The Environmental Protection and Energy Efficiency Fund (EPEEF) is the central point for collecting and investing extra budgetary resources in the programmes and projects of environmental and nature protection, energy efficiency and use of renewable energy sources. In the system of management and control of utilisation of EU structural instruments in Croatia, the Fund performs the function of Intermediate Body level 2, for the specific objectives in the field of

environmental protection and sustainability of resources, climate change, energy efficiency and renewable energy sources. The activities of the Fund comprise the tasks related to financing of the preparation, implementation and development of programmes and projects and similar tasks in the field of conservation, sustainable use, protection and improvement of the environment, and in the field of energy efficiency and use of renewable energy sources.

- Researchers, in particular PhD students and postdocs

Aside from research-performing organisations, marine researchers are a primarily user of ecological monitoring programme ecological observational data. Normally the researchers are affiliated with the research-performing institutions, however they might work independently, or even part of other institutions, yet being interested to increase their knowledge and the research skills. This particularly applies to young researchers, PhD students and postdoctoral researchers, which are at the beginning of their careers and need for proper entrance to the science, for which the ECOAdS portal, products and roadmap might be of a great help.

- International programmes

As the research is not a local but global issue, including standards of data collection, acquisition and interpretation, there are a great number of international programmes that are covering these topics and therefore might be beneficial of the ECOAdS data portal and products. These are:

EuroGOOS, https://eurogoos.eu: EuroGOOS identifies priorities, enhances cooperation and promotes the benefits of operational oceanography to ensure sustained observations are made in Europe's seas underpinning a suite of fit-for-purpose products and services for marine and maritime end-users. EuroGOOS is the European component of the Global Ocean Observing System of the Intergovernmental Oceanographic Commission of UNESCO (IOC GOOS). EuroGOOS Secretariat is located in Brussels, serving 44 members and supporting five regional systems in Europe. EuroGOOS working groups, networks of observing platforms (task teams), and regional systems (ROOS), provide fora for cooperation, unlock quality marine data and deliver common strategies, priorities and standards. These many EuroGOOS networks work towards integrated, sustained and fit-for-purpose European ocean observing, underpinning the EOOS framework.

MonGOOS, http://www.mongoos.eu: MonGOOS shall engage in activities related to the production and use of operational oceanography services in furtherance of four principal objectives: (i) Improved Fitness for Purpose. Continuously advance the scientific understanding and technological development upon which the Services are based; (ii) Greater Awareness. Promote the visibility and recognition of the Services with governmental agencies and private companies, encourage their integration at national, regional, European and global levels; (iii) Increased Downstreaming. Enhance the usability of the Services and their usefulness for policy implementation, societal needs and science; (iv) Improved Capacity. Support the planning and implementation of international initiatives involving operational oceanography and promote the participation of non-EU Mediterranean countries in producing the Services.

MonGOOS will elaborate a continuous working framework with EuroGOOS and GOOS Africa in order to define common roles and activities in the Mediterranean Sea, and foster collaboration with Black Sea GOOS and global ocean GOOS initiatives.

SEADATANET, https://www.seadatanet.org: SeaDataNet is a distributed Marine Data Infrastructure for the management of large and diverse sets of data deriving from in situ of the seas and oceans. Professional data centres, active in data collection, constitute a Pan-European network providing on-line integrated databases of standardized quality. The on-line access to in-situ data, meta-data and products is provided through a unique portal interconnecting the interoperable node platforms constituted by the SeaDataNet data centres. The development and adoption of common communication standards and adapted technology ensure the platforms interoperability. The quality, compatibility and coherence of the data issuing from so many sources, is assured by the adoption of standardized methodologies for data checking, by dedicating part of the activities to training and preparation of synthesized regional and global statistical products from the most comprehensive in-situ data sets made available by the SeaDataNet partners. Data, value added products and dictionaries serve wide uses: e.g. research, model initialisation, industrial projects, teaching, marine environmental assessment.

Copernicus Marine Service, https://marine.copernicus.eu: The Copernicus Marine Service (or Copernicus Marine Environment Monitoring Service) is the marine component of the Copernicus Programme of the European Union. It provides free, regular and systematic authoritative information on the state of the Blue (physical), White (sea ice) and Green (biogeochemical) ocean, on a global and regional scale. It is funded by the European Commission (EC) and implemented by Mercator Ocean International. It is designed to serve EU policies and International legal Commitments related to Ocean Governance, to cater for the needs of society at large for global ocean knowledge and to boost the Blue Economy across all maritime sectors by providing free-of-charge state-of-the-art ocean data and information.

It provides key inputs that support major EU and international policies and initiatives and can contribute to: combating pollution, marine protection, maritime safety and routing, sustainable use of ocean resources, developing marine energy resources, blue growth, climate monitoring, weather forecasting, and more. It also aims to increase awareness amongst the general public by providing European and global citizens with information about ocean-related issues.

European Marine Board (EMB), https://www.marineboard.eu: The European Marine Board is a unique strategic pan-European Forum for seas and ocean research and technology. We provide a strategic forum to develop marine research foresight, initiate state-of-the-art analyses and translate these into clear policy recommendations to European institutions as well as national governments. As an independent, self-sustaining, non-governmental advisory body, the European Marine Board transfers knowledge between the scientific community and decision makers, promoting Europe's leadership in marine research and technology.

The European Marine Board bridges the gap between science and policy using different approaches, such as: (i) Strategy – identifying scientific challenges and opportunities through foresight activities, analysis and studies, and providing high-level recommendations; (ii) Forum – bringing together European marine research stakeholders to share knowledge, identify common priorities, develop common positions and collaborate; (iii) Voice – expressing a collective vision of European marine research priorities to meet future science and societal challenges and opportunities.

EMB has an outstanding reputation as a provider of high-quality science-policy advice. Our publications are designed for a non-technical audience, providing recommendations for future research and capacity building which can be addressed by European and national funding mechanisms. It facilitates the transfer of the best scientific knowledge available to the core of marine research policy. This is done by interacting directly with decision makers, and steering discussions between scientists and policy makers on a certain topic. We represent the European marine scientific community in different events and our network is our primary pool of experts.

JPI-Oceans, https://www.jpi-oceans.eu: By joining forces, JPI Oceans focuses on long-term collaboration between EU Member States, Associated Countries and international partners. The platform provides its member countries with a shared voice, strategic agenda and action plan to address complex ocean-related societal challenges that cannot be solved at national level.

JPI Oceans adds to the value of national research and innovation investments by aligning national priorities and implementing joint actions. This is achieved by: (i) planning and launching joint calls for transnational research and innovation projects; (ii) sharing research

infrastructures and resources; (iii) enhancing science-policy cooperation with stakeholder involvement to translate science into policy; (iv) initiating new forms of collaboration between projects and scientists; (v) strategic community building, disseminating and communicating research results to support their exploitation and facilitating mutual learning. In supporting research and innovation JPI Oceans is helping to ensure society has better knowledge of the seas and oceans, and the potential for sustainable blue growth and jobs whilst also addressing the challenges of climate change and human impact on the ocean.

EFARO, https://efaro.eu: EFARO's mission is to enable its vision through the provision of: (i) sound science and scientific advice for the people of Europe; (ii) evidence-based advice on the sustainable management of aquatic living resources; (iii) coordination of a trusted and influential community of aquatic research institutes, be it marine or fresh water; (iv) knowledge on fisheries, aquaculture and innovations in sustainable harvesting or production in the aquatic environment.

To achieve its mission EFARO will maintain an active, efficient and effective platform for: (i) coordinating and communicating between the community of aquatic research institutes at the European and the Regional level acknowledging regional specifics and activities and stimulating (regional) cooperation; (ii) maintaining influential dialogues with policy makers, industry and societies; (iii) contributing to the development and implementation of the European research agenda for the sustainable use and management of aquatic living resources; (iv) supporting sound science and providing scientific advice to governments; (v) sustaining a scientific network through traditional and new business opportunities.

- Policy-makers and decision-makers

As the Adriatic Sea marine resources are among the most important resources in almost all Adriatic countries, in particular in Croatia and Italy, and ECOAdS with its holistic framework could be beneficial for policy-makers and decision makers who deal with these resources management. These includes national and regional ministries and agencies which are governing the ecological resources and networks along the Adriatic coasts and the Adriatic itself, like:

Directorate for Nature Protection, Ministry of Economy and Sustainable Development, Croatia, http://www.haop.hr: The Croatian Environment and Nature Agency (HAOP) is an independent public institution established by a decree of the Government of the Republic of Croatia in June 2015, and started operating on 17 September 2015. HAOP was created by merging the Environmental Protection Agency (CEA) and the State Institute for Nature

Protection (SINP) and took over their tasks of collecting and compiling data and information on the environment and nature in order to ensure and monitor the implementation of environmental and nature protection policy, sustainable development and other professional activities related to environmental and nature protection.

Ministry of the Sea, Traffic and Infrastructure of the Republic of Croatia, https://mmpi.gov.hr: The Among other, Ministry of the Sea, Transport and Infrastructure performs administrative and other tasks which is related to the ECOAdS issues: (i) protection of the sea from pollution from ships; seaports, maritime domain and delimitation of maritime domain, maritime insurance and maritime agencies; ports on inland waterways; land freight transport centers; airports; (ii) organizing the development of strategic infrastructure projects and investment programs for all modes of transport, of special importance to the Republic of Croatia and preparing proposals to the Government of the Republic of Croatia for their approval and implementation; (iii) organization of appropriate large infrastructure investment works in the construction of transport infrastructure facilities and devices, except for their reconstruction and maintenance, and other appropriate major infrastructure works of importance for sustainable development of the Republic of Croatia which are fully or largely financed from the state budget entities in the construction of such facilities and monitors and controls these investments.

Ministry of Science and Education of the Republic of Croatia, https://mzo.gov.hr: The Ministry of Science and Education supports the overall development of the Republic of Croatia by ensuring the conditions for: (i) upbringing and education and the formation of competent, enterprising and responsible persons with an accessible, inclusive, quality and accessible system of lifelong learning; (ii) quality vocational education that responds to current and future labor market needs, and (iii) for the development of science based on excellence and international competitiveness.

Directorate for Fisheries, Ministry of Agriculture of the Republic of Croatia, https://ribarstvo.mps.hr: Directorate for Fisheries is a central policy-making body in the fields of fisheries and aquaculture in the Republic of Croatia, preparing and implementing the legislative related to these two activities.

Public Institution RERA S.D. for coordination and development, http://www.rera.hr: Public Institution RERA S.D. for Coordination and Development of the Split-Dalmatia County was established by the Decision on Establishment by the County Assembly in June 2011. Pursuant to the Regional Development Act (OG 147/14, 123/17 and 118/18), JU RERA S.D. is established as a public institution for the purpose of performing activities of public interest with the aim of

effective coordination and encouragement of regional development for the area of the Split-Dalmatia County, and performs the following tasks of public authority: (i) prepares the county development strategy and other strategic and development documents for the area of the county and their implementation documents for which they are authorized by the founder; (ii) checks the compliance of the strategic development planning documents of the county with hierarchically higher strategic planning documents and makes decisions confirming the compliance; (iii) provides professional assistance in the preparation and implementation of support programs to public bodies and public institutions from the Split-Dalmatia County founded by the Republic of Croatia or counties, in the preparation and implementation of development projects of interest for county development, especially projects co-financed by structural and investment funds European Union funds; (iv) provides professional assistance in the preparation and implementation of development projects of public bodies and public institutions from the area of the county, which are the founders of local and regional self-government units, and which are of interest for the development of the county; (v) implements county development programs authorized by the founder; (vi) implements programs of the Ministry and other central state administration bodies related to more balanced regional development.

Ministry of Ecological Transition of Italy (MITE), https://www.minambiente.it/**:** MITE is responsible for preparing and implementing the government's policy in the fields of sustainable development, climate, energy transition and biodiversity. It has functions relating to: protection of biodiversity, ecosystems and the marine-coastal heritage, safeguarding of the territory and waters, policies to combat climate change and global warming, sustainable development, energy efficiency and circular economy, integrated management of the waste cycle, remediation of Sites of National Interest (SINs), environmental assessment of strategic projects, combating atmospheric-acoustic-electromagnetic pollution and risks arising from chemical products and genetically modified organisms. The Ministry also guides and supervises the activities of the Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA) and of national parks and marine protected areas. It promotes good environmental practices, sustainable mobility and urban regeneration according to sustainability criteria. It promotes environmental education in schools.

Ministry of University and Research of Italy (MUR), https://www.mur.gov.it/it**:** MUR has the main functions of guiding, programming and coordination of the national scientific and technological research.

- Research infrastructures

eLTER RI, https://www.lter-europe.net/elter-esfri: the integrated European Long-Term Ecosystem, critical zone and socio-ecological Research Infrastructure (eLTER RI) RI adopts a fundamentally systemic approach to observe and analyse the environmental system, encompassing biological, geological, hydrological and socioecological perspectives. While several existing thematic environmental RIs focus on impacts of climate change and/or other elements of environmental change, eLTER RI is only research infrastructure embracing holistically the integrated impacts of such stressors on a wide variety of European benchmark ecosystems (major geo-eco-sociological systems across the continent's eco-climatological zones and Earth's critical zone). eLTER RI comprises terrestrial, freshwater and transitional water sites. It allows in-situ, co-located acquisition and gathering of Essential Variables ranging from bio-physicochemical to biodiversity and socio-ecological data. Ecosystem change caused by long-term pressures and short-term pulses is investigated in a nested design across the scales covered by the eLTER RI site network.

LifeWatch ERIC, https://www.lifewatch.eu: In setting up LifeWatch ERIC, the EC is seeking to address, by means of long term investment, the global factors (climate, demographic pressure, pollution, soil consumption, etc.) responsible for ongoing loss of biological diversity and ecosystem functioning, with direct impacts on the well-being and development of today's society. Understanding the evolution and functions of biodiversity and ecosystem services is now of crucial importance, not only for scientific reasons, but also to meet the demand from policy makers, managers and stakeholders for scientific-based tools. This requires analysis of both impacts and managerial decisions on a range of spatial and temporal scales; observation (and monitoring) of data from both ecosystems and laboratory experiments; and appropriate storage and management of relevant data. It also implies the setting of standards to ensure interoperability and accurate models of ecosystem dynamics. LifeWatch ERIC seeks to understand the complex interactions between species and the environment, taking advantage of High-Performance, Grid and Big Data computing systems, and the development of advanced modelling tools to implement management measures aimed at preserving life on Earth. Combining a wide range of ICT tools and resources with deep knowledge of the domain, LifeWatch ERIC's mission is to be a "first class" worldwide provider of content and services for the Biodiversity research community by: (1) offering new opportunities for large-scale scientific development; (2) enabling accelerated data capture with innovative new technologies; (3) supporting knowledge-based decision-making for biodiversity and ecosystem management; and (4) providing training, dissemination and awareness programmes.

EMBRC RI, https://www.embrc.eu: The European Marine Biological Resource Centre (EMBRC) The European Marine Biological Resource Centre (EMBRC) is a European 'research infrastructure' that provides researchers and companies with access to marine organisms and the facilities to study them, including experimental facilities and technological platforms. It works across a wide range of marine biology areas and with diverse stakeholders including users from academia, industry, technology and education. Its mission is to: (1) provide access to marine biological organisms and their habitats for experimental purposes and applied research; (2) promote the sustainable use of marine resources; (3) deepen fundamental knowledge on marine organisms and their role in the environment, pushing the frontiers of science; (4) explore marine biodiversity for new products, inspiration, and innovation; and (5) promote the use of marine experimental models in mainstream science.

ICOS ERIC, https://www.icos-cp.eu: The Integrated Carbon Observation System, ICOS provides standardised and open data from more than 140 measurement stations across 13 European countries. The stations observe greenhouse gas concentrations in the atmosphere as well as carbon fluxes between the atmosphere, the land surface and the oceans. The mission of ICOS is to produce standardised, high-precision and long-term observations and facilitate research to understand the carbon cycle and to provide necessary information on greenhouse gases. The ICOS data generate scientific knowledge, which advances the fulfilment of the United Nations' Sustainable Development Goals and the European Union's Societal Challenges, especially those concerning climate change. It actively communicates to society the science-based knowledge that is relevant to climate action and decision-making. ICOS has been an Observer to the United Nations Framework Convention on Climate Change (UNFCCC) since December 2019. As an Observer, it helps the UNFCCC to reach its goal for global consensus on actions to mitigate and to adapt to climate change as outlined in the Paris Agreement.

EMSO ERIC, http://emso.eu: The European Multidisciplinary Seafloor and water column Observatory (EMSO) aims to explore the oceans, to gain a better understanding of phenomena happening within and below them, and to explain the critical role that these phenomena play in the broader Earth systems. EMSO consists in a system of regional facilities placed at key sites around Europe, from North East to the Atlantic, through the Mediterranean, to the Black Sea. Observatories are platforms equipped with multiple sensors, placed along the the water column and on the seafloor. They constantly measure different biogeochemical and physical parameters that address natural hazards, climate change and marine ecosystems. EMSO offers data and services to a large and diverse group of users, from scientists and industries to institutions and policy makers. It is an extraordinary infrastructure to provide relevant information for defining environmental policies based on scientific data. EMSO is a consortium

of partners sharing in a common strategic framework scientific facilitity (data, instruments, computing and storage capacity).

JERICO RI, https://www.jerico-ri.eu: JERICO-RI is an integrated pan-European multidisciplinary and multi-platform research infrastructure dedicated to a holistic appraisal of coastal marine system changes. It is seamlessly bridging existing continental, atmospheric and open ocean RIs, thus filling a key gap in the ESFRI landscape. JERICO-RI establishes the framework upon which coastal marine systems are observed, analysed, understood and forecasted. JERICO-RI enables open-access to state-of-the-art and innovative facilities, resources, FAIR data and fit-for-purpose services, fostering international science collaboration.

DANUBIUS RI, https://www.danubius-ri.eu: The International Center for Advanced Studies on River –Delta – Sea Systems DANUBIUS-RI is a pan-European distributed research infrastructure supporting interdisciplinary research on large river-sea systems. DANUBIUS-RI wants to fill the gap of fragmented research on European research on river-sea systems, drawing on existing research excellence across Europe, enhancing the impact of European research while maximizing the return on investment. It provides access to a range of European river-sea systems, facilities and expertise; a 'one-stop shop' for knowledge exchange in managing river-sea systems; access to harmonized data; and a platform for interdisciplinary research, inspiration, education and training. DANUBIUS-RI offers a source-to-sea perspective to resolve problems arising from human impacts on River-Sea-Systems.

- NATURA 2000 and national parks' managers

All N2K governance bodies, established at county or region levels, are described in the ECOAdS key players section, yet they are also among the main users of the ECOAdS. Aside them, authorities of National Parks are also possible users, in particular:

Public Institution National Park Mljet, https://np-mljet.hr: The Mljet National Park is the oldest marine protected area in the Mediterranean and it has delighted its numerous visitors for 60 years with the colours and the scent of untouched nature. The Park was founded on 11 November 1960, and the renowned researcher and academician Branimir Gušić was a great contributor to its protection status. The Mljet National Park stretches over almost 5300 hectares, including a marine area of 500 meters from the coast, islands and cliffs, and therefore spans over almost a third of the island. Two deep bays filled with seawater, known as Malo Jezero and Veliko Jezero (Small Lake and Great Lake) are the most famous locations of this area and an important geological and oceanographical phenomenon. The entire surface area of the

park is extremely rich with life, and numerous endemic and endangered species are a testament of the importance of protecting it. The Mljet NP will not disappoint the fans of cultural heritage either, thanks to its numerous archaeological finds and the heritage of our ancestors present in the old island settlements. The Benedictine monastery located at one of the most beautiful locations in these areas, on the island of St. Mary on Veliko jezero is also the most visited location of the National Park.

Public Institution National Park Kornati, https://np-kornati.hr: The task of the Institution is protection, maintenance and promotion of the National Park in order to protect and conserve the authenticity of the natural environment; to ensure an undisturbed progress of natural processes and sustainable use of natural resources as well as monitoring the implementation of requirements and measures of nature conservation in the area they manage, in accordance with law. The Institution is established as a legal entity. Internal organizational units are established within the Institution in order to deal with certain interconnected tasks as well as with general, technical and auxiliary tasks of larger extent, whose performance requires both a certain degree of independence and a mutual relationship.

Public Institution National Park Krka, http://np-krka.hr: Krka National Park lies within Šibenik-Knin County, and covers a total area of 109 km² of the loveliest sections of the Krka River, and the lower course of the Čikola River. The national park is a vast and primarily unaltered area of exceptional natural value, including one or more preserved or insignificantly altered ecosystems. The purpose of the park is primarily to serve science, culture, education and recreation, while tourism activities have also been introduced for its visitors. Including the submerged part of the river at the mouth, the Krka River is 72.5 km long, making it the 22nd longest river in Croatia. It springs in the foothills of the Dinara mountain range, 2.5 km northeast of Knin. With its seven waterfalls and a total drop in altitude of 242 m, the Krka is a natural and karst phenomenon. The travertine waterfalls of the Krka River are the fundamental phenomenon of this river.

Krka National Park is managed by the Public Institute, under the jurisdiction of the Ministry of Environmental and Nature Protection of the Republic of Croatia. The activities of the Institute include protection, preservation and promotion of the national park, for the purpose of protecting and conserving the natural resources, and supervising the implementation of environmental protection measures within the protected area.

Public Institution National Park Brijuni, https://www.np-brijuni.hr: Along the coast of western Istria, there are several groups of islands among which the most interesting, the largest and the most indented is the Brijuni group of 14 islands and islets. The total surface area of the Brijuni

National Park is 3,395.00 ha, of which there is 2,651.70 ha of sea, while the surface of the islands is 743.30 ha. The length of all island coastlines amounts to 46.82 km, while the length of the sea border amounts to 22.93 km.

- Local populations and public

As ECOAdS portal will provide the information about available ecological monitoring programmes and observing systems, local population might use the information there to get answers to their questions, through the data itself, derived products or through communication with the scientists. That also applies to the general public, which might get more coherent and quality-checked information than coming from other sources that might be not reliable.

6.3. ECOAdS sustainability instruments

Here, we list the sustainability instruments that might be the basis for the longevity of the ecological monitoring and observing systems in the Adriatic Sea:

- European framework programmes for RTD

Horizon 2020 is the financial instrument implementing the Innovation Union, a Europe 2020 flagship initiative aimed at securing Europe's global competitiveness. Seen as a means to drive economic growth and create jobs, Horizon 2020 has the political backing of Europe's leaders and the Members of the European Parliament. They agreed that research is an investment in our future and so put it at the heart of the EU's blueprint for smart, sustainable and inclusive growth and jobs. By coupling research and innovation, Horizon 2020 is helping to achieve this with its emphasis on excellent science, industrial leadership and tackling societal challenges. The goal is to ensure Europe produces world-class science, removes barriers to innovation and makes it easier for the public and private sectors to work together in delivering innovation. Horizon 2020 is open to everyone, with a simple structure that reduces red tape and time so participants can focus on what is really important. This approach makes sure new projects get off the ground quickly – and achieve results faster. The EU Framework Programme for Research and Innovation will be complemented by further measures to complete and further develop the

European Research Area. These measures will aim at breaking down barriers to create a genuine single market for knowledge, research and innovation.

Horizon Europe. Research and innovation provide new knowledge and innovative solutions to overcome our societal, ecological and economic challenges. Horizon Europe helps researchers and top class innovators to develop and deploy their ideas. It teams up the best talent and equips them with world-class research infrastructures. Moreover, it supports breakthrough innovations and helps to create new services and markets.

Horizon Europe will: (i) Maximise its impact and deliver on the EU's strategic priorities, such as the recovery, green and digital transitions, and tackles global challenges to improve the quality of our daily lives; (ii) Strengthen EU science and technology by increasing investment in highly skilled people and cutting-edge research; (iii) Foster the EU's industrial competiveness and its innovation performance, notably supporting market-creating innovation via the European Innovation Council and the European Institute of Innovation and Technology; (iv) Enhance access to excellence for researchers across Europe to foster participation and collaboration.

Article 185 initiatives. Article 185 of the Treaty on the Functioning of the European Union (TFEU) allows the EU to participate in research programmes jointly undertaken by several EU countries with the possibility to associate non-European countries. The criteria to identify potential article 185 initiatives are set out in the Horizon 2020 programme: (i) a clear definition of the objective to be pursued; (ii) a clear and firm commitment from the participating Member States; (iii) indicative financial commitments of the participating countries, including prior commitments to align national and/or regional investments for transnational research and innovation and, where appropriate, to pool resources; (iv) its relevance to the EU policy objectives and the added value of the action at EU level; (v) the critical mass, with regard to the size and the number of programmes involved, the similarity or complementarity of activities and the share of relevant research they cover; (vi) a well-prepared joint programme and priorities; (vii) a well-organised implementation structure.

JPI – Oceans, https://www.jpi-oceans.eu. JPI Oceans is an intergovernmental platform that strives to increase the impact of national investments in marine and maritime research and innovation. It contributes to aligning national priorities and implement joint actions including the launch of joint calls for transnational research and innovation projects and sharing of research infrastructures. JPI Oceans has 20 member countries including two non-Member States of the EU (Norway and Turkey).

BLUEMED Initiative, http://www.bluemed-initiative.eu. The BLUEMED Initiative aims to advance a shared vision for a more healthy, productive, resilient, better known and valued

Mediterranean Sea, promoting the citizens' social well-being and prosperity, now and for future generations, and boosting economic growth and jobs. The BlueMed Research and Innovation Initiative is an intergovernmental regional-scale initiative launched in 2014 during the Italian Presidency of the European Union, aiming to advance a shared vision for a healthier, productive, resilient, better-known and valued Mediterranean Sea. It addresses research and innovation through a multi-disciplinary approach, linking economy, environment and humans, to build sustainable Blue Growth by means of networks of actors and international science diplomacy efforts. Since 2017, with the signature of the Valletta Declaration, the Initiative is formally joined by 16 EU and non-EU Mediterranean countries and steered by the EuroMediterranean Group of Senior Officials BlueMed Working Group (GSO BlueMed WG), co-chaired by the European Commission and the co-chair of the Union of the Mediterranean (currently Jordan) and supported by the Secretariat of the Union of the Mediterranean.

- Regional cooperation programmes

Interreg Italy-Croatia Programme, https://www.italy-croatia.eu**.** The Italy-Croatia CBC Programme is the financial instrument supporting the cooperation among the two European Members States territories overlooking the Adriatic sea. With 236.8 M € of total budget, the Programme enables regional and local stakeholders to exchange knowledge and experiences, to develop and implement pilot action products and services, to support investments by creation of new business models, to test the feasibility of new policies, having as the final aim the improvement of the life quality and conditions of more than 12.4 M citizens living in the Area.

The Italy-Croatia cooperation area shows a distinct blue and green pattern, featuring the sea basin, coastal landscapes, green but also urban areas. The location of the Adriatic Sea in the very centre of the territory – although shared with other Countries – on one hand, requires more efforts to accomplish collaboration aims related with the cross-border integration of economic, educational and labour markets. On the other, it is a joint economic and environmental asset, and a natural platform for cooperation building on long-dating trade exchange contacts reflected in some common traits of cultural heritage. The whole Programme area, which comprises parts of the territory of Italy and Croatia, spreads over 85.562 km2 and, according to the last census (2011), its population is 12.465.861 inhabitants. In total, the cross-border cooperation area is made up of 33 statistical NUTS III territories (25 provinces in Italy and 8 counties in Croatia).

Interreg Italy-Slovenia Programme, https://www.ita-slo.eu: With a financial allocation of more than € 90 million, Interreg V-A Italy –Slovenia Programme will support a smart, sustainable and inclusive growth as planned by the Europe 2020 Strategy, spending significant resources on growth, innovation, quality of life and environmental sustainability, also through the improvement of the efficiency of public administration. The Programme will cover the seven-year period of the European Programme 2014-2020, which will be developed to provide continuity with the previous 2007-2013 Programme, which has funded 87 projects aimed at enhancing competitiveness, research and innovation, protection and promotion of cultural and natural resources, and cross-border activities.

EUSAIR, https://www.adriatic-ionian.eu: The EU Strategy for the Adriatic and Ionian Region (EUSAIR) is a macro-regional strategy adopted by the European Commission and endorsed by the European Council in 2014. The Strategy was jointly developed by the Commission and the Adriatic-Ionian Region countries and stakeholders, which agreed to work together on the areas of common interest for the benefit of each country and the whole region. The general objective of the EUSAIR is to promote economic and social prosperity and growth in the region by improving its attractiveness, competitiveness and connectivity. With four EU members and four non EU countries the strategy will contribute to the further integration of the Western Balkans. The participating countries of the EUSAIR agreed on areas of mutual interest with high relevance for the Adriatic-Ionian countries, being it common challenges or opportunities. The countries are aiming to create synergies and foster coordination among all territories in the Adriatic-Ionian Region in the four thematic areas/pillars: (1) Sustainable tourism; (2) Environmental quality; (3) Connecting the region; and (4) Blue growth.

Interreg ADRION Programme, https://www.adrioninterreg.eu. The ADRION programme is a European transnational programme that invests in regional innovation systems, cultural and natural heritage, environmental resilience, sustainable transport and mobility as well as capacity building. By bringing together eight Partner States, ADRION aims to act as a policy driver and governance innovator for the benefit of more than 70 million people in the Adriatic and Ionian region.

As a transnational cooperation programme, ADRION main contribution will be to exchange and transfer experiences between regions, support transnational interventions and capacity building, as well as to answer to current needs and challenges within the region. To this end, the Programme focuses its investments in four Priority Axes, namely:

1. *Innovative and smart region:* Promoting business investment in R&I, developing links and synergies between enterprises, research and development centres and the higher

education sector, in particular promoting investment in product and service development, technology transfer, social innovation, ecoinnovation, public service applications, demand stimulation, networking, clusters and open innovation through smart specialisation.

2. *Sustainable region:* Conserving, protecting, promoting and developing natural and cultural heritage; Protecting and restoring biodiversity and soil and promoting ecosystem services, including through Natura 2000, and green infrastructure.

3. *Connected Region:* Developing and improving environment-friendly (including low-noise) and low-carbon transport systems including inland waterways and maritime transport, ports, multimodal links and airport infrastructure, in order to promote sustainable regional and local mobility.

4. *Supporting the governance of the EUSAIR:* Enhancing institutional capacity of public authorities and stakeholders and efficient public administration by developing and coordinating macro-regional and sea-basin strategies.

Interreg MED Programme, https://interreg-med.eu**.** The main objective of the Interreg MED Programme is to promote sustainable growth in the Mediterranean area by fostering innovative concepts and practices and a reasonable use of resources and by supporting social integration through an integrated and territorially based cooperation approach. Interreg MED Programme will promote cooperation between a varied typology of actors of these thirteen Mediterranean countries. Our aim lies in optimizing existing results achieved in the previous period as well as facilitating new cooperation frameworks for all partners situated in the Programme cooperation area. Accordingly, Interreg MED Programme establishes the following key cooperation principles aiming at consolidating the character of future projects and their related activities. These fundamental principles represent the DNA of the Interreg MED Programme and are coherent with the promotion of development, of good governance and supported by the European Union Cohesion Policy: (i) Thematic concentration, (ii) Result-orientation, (iii) Transnationality, (iv) Territorial relevance, (v) Sustainability, (vi) Transferability, (vii) Capitalisation.

Interreg Central Europe Programme, https://www.interreg-central.eu. Interreg CENTRAL EUROPE improves capacities for regional development in innovation, carbon dioxide reduction, the protection of natural and cultural resources as well as transport and mobility. With our funding, we support transnational cooperation like yeast supports baking. We are the small but important ingredient that helps innovative yet isolated ideas grow: into jointly developed, tested and accepted solutions for a better central Europe. We are currently funding 138 cooperation projects across central Europe. In total, around 246 million Euro from the

European Regional Development Fund (ERDF) will be transferred to transnational partnerships in the coming years. The projects address shared regional challenges in the fields of innovation, low-carbon economy, environment, culture and transport.

Interreg Europe Programme, https://www.interregeurope.eu. Interreg Europe helps regional and local governments across Europe to develop and deliver better policy. We create an environment and opportunities for sharing solutions and policy learning. We aim to make sure that government investment, innovation and implementation efforts all lead to integrated and sustainable impact for people and place. We know that better performance leads to better results. By building on its forerunner, INTERREG IVC (2007-2013), Interreg Europe aims to get maximum return from the EUR 359 million financed by the European Regional Development Fund (ERDF) for 2014-2020. This time round, it's still about doing good, but doing it better! Solutions exist that can help our regions become the best that they can be. Today, the EU's emphasis is very much on paving the way for regions to realise their full potential – by helping them to capitalise on their innate strengths while tapping into opportunities that offer possibilities for economic, social and environmental progress. To achieve this goal, Interreg Europe offers opportunities for regional and local public authorities across Europe to share ideas and experience on public policy in practice, therefore improving strategies for their citizens and communities.

Interreg Croatia – Bosnia and Herzegovina – Montenegro Programme, https://www.interreg-hr-ba-me2014-2020.eu. The Interreg IPA Cross-border Cooperation Programme Croatia – Bosnia and Herzegovina – Montenegro 2014-2020 is a trilateral programme dedicated to achieve harmonious development of the cross-border area and the European Union as a whole. A lengthy title indeed, but every term in it carries great importance for Croatia's, Bosnia and Herzegovina's and Montenegro's cooperation: (i) Interreg stands for territorial cooperation among countries of Europe. It is a framework developed by the EU that allows joint actions and policy exchanges between different states; (ii) IPA is an abbreviation for Instrument for Pre-Accession Assistance, meaning the EU framework that allows cooperation among EU Member States and candidate and/or potential candidate countries; (iii) Cross-border Cooperation (Programme), oftentimes shortened to CBC, refers to one of Interreg's three strands of cooperation: cross-border, transnational and interregional; (iv) Croatia, Bosnia and Herzegovina and Montenegro refers to countries participating in the Programme which have agreed to jointly overcome challenges crossing national borders and mutually use untapped growth potential in the cross-border area; (v) 2014 – 2020 stands for the current multiannual financial framework, i.e. the seven-year timeframe and planning horizon of using EU resources.

- National research and environmental agencies

Croatian Science Foundation, https://hrzz.hr**.** Croatian Science Foundation was established by the Croatian Parliament in December 2001 under the name The National Foundation for Science, Higher Education and Technological Development of the Republic of Croatia. Its mission is to promote science, higher education and technological development in Croatia in order to ensure the development of economy and to support employment. The Foundation provides support to scientific, higher education and technological programmes and projects, fosters international cooperation, and helps the realization of scientific programmes of special interest in the field of fundamental, applied and developmental research. The Foundation operates from two offices - Zagreb and Opatija. The Executive Director and the Department for Legal Affairs and Contracting are situated in Zagreb, while the departments for Project Evaluation, Finance and International Relations, and Assistant to the President of the Board are located in Opatija. Several external associates also contribute to the Foundation's work on a daily basis, such as the bookkeeping and accounting services and IT support. By joining the European Charter for Researchers and Code of Conduct for the Recruitment of Researchers in 2011, the Foundation accepted the alignment of its rules with those of other European countries.

Unity Through Knowledge Fund, http://www.ukf.hr. The mission of the Unity through Knowledge Fund is to unite scientific and professional potential in Croatia and Diaspora in development of the knowledge based society. Unity through Knowledge Fund accomplishes its mission through following goals: (i) *Supporting research that is competitive on international level*. The Fund encourages basic and applied scientific research that creates new knowledge and exhibits potential to compete on an international level. Two project types will be financed: those that attract experts and investments into Croatia and those that enable the cooperation/leading of European and other international projects. In particular, support will be given to collaborative projects with Diaspora that enable transfer of knowledge and technology from leading international research and scientific institutions to Croatian private and public sector; (ii) *Fostering research that creates new values in Croatian economy*. The Fund supports projects that directly and indirectly strengthen the Croatian economy. The development of innovations, commercial and other application of scientific results will be financed. In particular, support will be given to the investments made by the business sector into scientific projects. In particular, support will be given to the investments made by the business sector into scientific projects. With the use of the resources of scientific and professional Diaspora, companies that apply new knowledge will be supported; (iii) *Supporting projects that help the development of research infrastructure in Croatia*. The Fund supports all initiatives that contribute to the development of scientific system in Croatia. UKF supports and encourages the

development that results in competitiveness on international level, supports education and scientific excellence in order to make Croatia a desirable place for top scientists from abroad (including those from Diaspora). Projects that are in accordance to the mission of UKF through the work in administrative, infrastructural and managing segment of science and technology will be financed.

The Environmental Protection and Energy Efficiency Fund (EPEEF), https://www.fzoeu.hr. The Environmental Protection and Energy Efficiency Fund (EPEEF) is the central point for collecting and investing extra budgetary resources in the programmes and projects of environmental and nature protection, energy efficiency and use of renewable energy sources. In the system of management and control of utilisation of EU structural instruments in Croatia, the Fund performs the function of Intermediate Body level 2, for the specific objectives in the field of environmental protection and sustainability of resources, climate change, energy efficiency and renewable energy sources. The activities of the Fund comprise the tasks related to financing of the preparation, implementation and development of programmes and projects and similar tasks in the field of conservation, sustainable use, protection and improvement of the environment, and in the field of energy efficiency and use of renewable energy sources, and in particular: (i) Expert and other tasks in relation to the collection, management and utilisation of the Fund's resources; (ii) Acts as an intermediary in the matters related to the financing of environmental protection and energy efficiency from foreign funds, international organisations, financial institutions and bodies, as well as national and foreign legal and natural persons; (iii) Maintaining the database of programmes, projects and similar activities in the field of environmental protection and energy efficiency, and of the required and available financial resources for their implementation; (iv) Promoting, establishing and carrying out cooperation with international and national financial institutions and other legal and natural persons, for the financing of environmental protection and energy efficiency in accordance with the National Environmental Strategy and the National Environmental Action Plan, the Energy Development Strategy and the Implementation Programme for the Energy Development Strategy, national energy programmes, other programmes and acts in the field of environmental protection and energy efficiency, and international treaties to which the Republic of Croatia is party, for the purposes specified in the provisions of the Act on the Environmental Protection and Energy Efficiency Fund; and (v) Other tasks related to promoting and financing environmental protection and energy efficiency that are set out in the Statute of the Fund.

- Private foundations and NGOs

Created within large private companies or as NGOs, foundations are committed - sometimes with very significant resources - to supporting well-defined actions in line with their missions and which may involve public or private actors. Many foundations have stated objectives of supporting research and innovation, environmental preservation, sustainable development, capacity building and education.

One Ocean Foundation, https://www.1ocean.org, develops specific projects that help safeguard marine life. Recently it has launched a "Business for Ocean Sustainability" research project. Produced with the support of SDA Bocconi, McKinsey & Company and CSIC, the project – focusing for this first edition on the Mediterranean Sea, but with cross-border potential – examines the current relationship between ocean sustainability and the economy from a new perspective. More than 220 international companies, start-ups, associations and NGOs are involved, spanning 13 industry sectors.

Prince Albert II of Monaco Foundation, https://www.fpa2.org/home.html: The Prince Albert II of Monaco Foundation (PA2F) is dedicated to the protection of the environment and the promotion of sustainable development on a global scale. The Foundation supports initiatives of public and private organizations, in the fields of research and studies, technological innovation and socially-aware practices. The Foundation supports projects in three main geographical zones and focuses its efforts focus on three main areas.

- Bilateral cooperation and in kind contributions

Aside all above instruments, the cooperation between all the quoted institutions through bilateral cooperation agreements may help in achieving some of the proposed measures and activities. This also include the work of staff engaged for some other activities, the use of equipment and other items that might help to fulfil the ECOAdS goals. In addition, philanthropy might help for fundraising of some proposed activities, in particular related to purchase of equipment necessary for carrying out the necessary ecological measurements.

7. THE ROADMAP AND THE MEASURES

In this section, the measures that are part of the ECOAdS roadmap are listed, specifically targeting the key activities that would assure the sustainability of the ECOAdS on the long term. Each measure contains: the aim of the measure, the description, the timeframe of the measure (short-term, 1-2 years, middle-term, 3-5 years, long-term, 6-10 years), and funding programmes and instruments that may be consumed to get a financial framework for the activity.

7.1. Integrating and standardising the ecological monitoring programmes and observational networks

Aim: To integrate and standardize sampling strategies and procedures within the ecological monitoring programmes and observational systems, harmonizing the implementation of the EU directives.

Description: Ecological monitoring programmes and observational networks are exhibiting an obvious diversity in the Adriatic Sea, in its spatial and temporal coverage, choice of parameters to be sampled, data acquisition procedures, duration of observations, etc. This largely comes for different implementation in Italy and Croatia of the EU Directives relevant for marine ecological monitoring, like MFSD, WFD, MSPD, HB and BD. With such a diverse approach, it is quite hard to properly assess environmental changes on the long term. Therefore, these programmes and systems should be integrated and harmonised on the basin-level, in order to properly assess the level of the environmental status and its changes in time.

Timeframe and milestones: 3-5 years (2024-2026).

Funding programmes and instruments: National funding, Horizon Europe, Interreg programmes, Research Infrastructures

Key players involved: research performing institutions, environmental agencies, policy-making institutions

7.2. Preparing ECOAdS to climate change monitoring and assessment

Aim: To set up a climate component of the ECOAdS.

Description: Climate changes represent an inevitable part of our lives, reflecting to the long-changes in the Adriatic and the Mediterranean ecosystems. To quantify climate changes on the long-term, it is necessary to establish monitoring of key climate parameters at the appropriate temporal scales, allowing for assessment of long-term changes in the Adriatic ecosystem. These activities should cover the key areas, including those most vulnerable to climate changes, and should be secured on the long-term (decades or more).

Timeframe and milestones: 6-10 years (2027-2031).

Funding programmes and instruments: National funding

Key players involved: research performing institutions, environmental agencies

7.3. Modelling and predicting ecosystem conditions and processes

Aim: To develop and implement new IT solutions for proper management of environmental data.

Description: The quality, compatibility and coherence of the data issuing from so many sources requires the adoption of standardized methodologies for data quality control and data management. This is a challenge for a diversity of marine environmental data and therefore the development of IT tools and procedures that would help data management is of utmost importance, in particular to be oriented towards users. Tools should also be structured in a multi-level approach, as different users have different requirements on data and data products.

Timeframe and milestones: 1-2 years (2022-2023).

Funding programmes and instruments: National funding, Horizon Europe, Interreg programmes, Research Infrastructures

Key players involved: research performing institutions, environmental agencies, local and national policy-makers

7.4. Creating tools for easy management with data and products

Aim: To develop state-of-the-art modelling tools for assessing and forecasting ecosystem changes and processes.

Description: Projections of ecosystem conditions in the near future (e.g. a few days) and on climate scales is an important tool for proper management of eventual hazards and eventual deterioration of the system and biodiversity relations. For that reason, ecological models should be developed at high resolutions, to have capacities for reproduction of ecological processes in such a dynamic basin like the Adriatic Sea. Once being verified, these models should be turn into operational mode and forecast environmental condition at time scales over a few days. At key areas, such as N2K sites, these forecast might serve as a tool for proper planning and activation of proper measures that may mitigate the forecasted environmental hazards. Further, these models might be adapted to climate scales and be used for projections of environmental condition in the next decades.

Timeframe and milestones: 3-5 years (2024-2026).

Funding programmes and instruments: National funding, Horizon Europe, Interreg programmes, private fondations

Key players involved: research performing institutions

7.5. Including local knowledge and citizen science into ecosystem-based management

Aim: To develop procedures, including participatory approaches, that would allow for proper inclusion of local and indigenous knowledge into practices and decisions of research performing institutions, environmental agencies and policy-makers.

Description: Local and indigenous knowledge refers to the understandings, skills and philosophies developed by societies with long histories of interaction with their natural surroundings. For rural and indigenous peoples, local knowledge informs decision-making about fundamental aspects of day-to-day life. Citizen science refers to the scientific research conducted, in whole or in part, by amateur (or nonprofessional) scientists. Both approaches have not been used widely in the environmental research in the Adriatic Sea, still having a large potential to document some processes and relations in the ecosystem still unknown and therefore to help research to better quantify the environmental changes, primarily on the local level.

Timeframe and milestones: 3-5 years (2024-2026).

Funding programmes and instruments: National funding, Interreg programmes, in kind contributions

Key players involved: N2K managers, environmental agencies, local populations, research performing institutions

7.6. Open data and open science

Aim: To develop data policies based on open data, open science and FAIR principles.

Description: Open science aims to make scientific research (including publications, data, physical samples, and software) and its dissemination accessible to all levels of an inquiring society, amateur or professional. This also holds true to the data attained through the ECOAdS, which should be accessible to all users, following the FAIR principles (Findability, Accessibility, Interoperability, and Reuse) of digital assets. To achieve that level, all key players should develop the rules for exchange of the ecological data through ECOAdS and agree on the common data policy at the Adriatic level.

Timeframe and milestones: 1-3 years (2022-2024).

Funding programmes and instruments: National funding, Horizon Europe, Interreg programmes, Research Infrastructures

Key players involved: national policy-makers, research performing institutions, environmental agencies

7.7. Securing long-term financing of the ECOAdS

Aim: To secure financial sustainability of ecological observations on the long term.

Description: The cost of sampling at the sea and obtaining the ecological marine data is quite high, in particular compared to similar activities at land. For this reason, a long-term basin-wide monitoring programme should be agreed between Croatia and Italy (also through Measures 6.1 and 6.2) and set up on the long term, including its financial framework. All the quoted measures will easily fall down if an appropriate level of financial support is not secured at national and basin level.

Timeframe and milestones: 3-5 years (2024-2026).

Funding programmes and instruments: National funding, EU funding, Research Infrastructures

Key players involved: national policy-makers, research performing institutions, environmental agencies

7.8. Fostering collaborations between scientists, managers and policy-makers

Aim: To establish a permanent platform for exchanging ideas about ecological monitoring in the Adriatic Sea.

Description: Collaborations and exchange of ideas between key players are a key to a success of any long-term action related to proper functioning of the Adriatic observing systems. For this reason, a permanent platform will be established as a body that will direct and maintain the functioning of the ECOAdS after the end of the ECOSS project. This platform will be composed of ECOAdS key users, in particular of research performing institutions, environmental agencies and policy-making organisations. The platform will meet once or twice a year and monitor the

performance and sustainability of ECOAdS, including the creation of specific documents that will push the ECOAdS activities in the right direction.

Timeframe and milestones: 1-2 years (2021-2022).

Funding programmes and instruments: National funding, in kind contributions

Key players involved: national policy-makers, research performing institutions, environmental agencies

7.9. Educating professionals and managers of Natura 2000 sites

Aim: To increase the education of researchers, engineers and technicians who will be engaged in ECOAdS.

Description: Considering a multi-level organisation of ECOAdS for the proper functioning of which different experts should be engaged (marine researchers, policy-makers, decision-makers, local and national managers, IT experts), education in all of these aspects and gaining the competences and skills necessary for proper enrolment in ECOAdS activities should be carried out. For that, the communication with universities that have marine and blue components in their university will be established, upgrading already existing courses and creating new ones relevant to ECOAdS.

Timeframe and milestones: 3-5 years (2024-2026).

Funding programmes and instruments: National funding, Interreg programmes

Key players involved: universities, research performing institutions, environmental agencies

8. CONCLUSIONS AND PERSPECTIVES

As part of the design of ECOAdS, which is entailing the existing ecological monitoring programmes and observing systems, ECOSS recognizes that these existing observing platforms and monitoring schemes operate at various scales, with different aims and maturity levels. An adequate coordination among all ECOAdS components, which should connect the local, the regional, up to the whole Adriatic basin scale, is a must for proper management and governance of environmental status in the Adriatic Sea and at N2K sites. In the design of a long-term sustainable and successful observatory, ECOAdS needs to be harmonized and incorporated into a suitable and clear governance structure, which could effectively support a shared understanding of the state of the marine environment and the connections among oceanographic and ecological observations with conservation issues.

Overall, ECOAdS can represent an opportunity to build a common knowledge and monitoring framework at a transnational level to overcome the N2K sites fragmentation, incorporating marine connectivity aspects and supporting transnational cooperation for planning and managing the Adriatic Sea conservation and the sustainable use of its resources. In the hope that the role of ECOAdS in supporting the transnational sharing of knowledge and in informing N2K Adriatic network and conservation strategies will be recognized, we suggest that a regional collaboration scheme at the Adriatic level, such as EUSAIR, becomes an initial platforms to support ECOAdS long-lasting activities.

This document presents the state-of-the-art of all information relevant to future sustainability and management of ECOAdS, including its vision, strengths, weaknesses, opportunities and threats for it and measures that may help to reach this goal. In relation to that, all key players that may act towards that goal are referenced and all users who may have benefits from ECOAdS and available instruments (including financial) to be used for achieving the ECOAdS longevity are listed in this strategy and roadmap document. We believe and hope that this effort might be of help in directing the future activities and to achieve the full operability of ECOAdS on the long term.