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SUMMARY

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1 INTRODUCTION

1.1 Resistance presentation

The Interreg project RESISTANCE involved various entities, organizations and institutions from previous selected, specific clusters activities, aimed at safeguarding biodiversity, studying, knowing and reducing marine pollution and managing small ports in the Adriatic Sea. All these realities collaborated together for environmental sustainability and marine resources needs, as well as dealing with the improvements made to the management of small ports, in order to assist and refine the Marine Spatial Planning (MSP) in the area.

The guiding idea of this project was that any joint solution developed in these years and in the future could be effectively developed only if the international cooperation between different corporations is encouraged. This project is an example of cooperation of various experts, members of representatives of local, regional authorities, educational institutions, international environmental organizations, who jointly evaluated their already developed good practices for a sustainable use of marine and coastal resources.

In accordance with the EUSAIR Pillar 3 and the relevant Flagship, the so far achieved knowledge by the seven selected ("*cluster*") projects SOUNDSCAPE, ECOSS, ECOMAP, NET4MPLASTIC, DORY, ML-REPAIR, and SASPAS have been synergically combined to develop sustainable growth, decrease pollution and contamination and protect the unique biodiversity of the Adriatic Sea.

1.2 Aim of this document

The purpose main aim of the RESISTANCE project was to share acquired knowledge and experiences about the sea, as well as about coastal and river environments, by capitalizing the results of selected Interreg projects abovementioned: ECOMAP, ECOSS, NET4MPLASTIC, SOUNDSCAPE, DORY, SASPAS and ML-REPAIR. Some of the objective's set were: Integrated methodologies and tools for marine monitoring relevant for Maritime Spatial Planning, in

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accordance with the Programme specific objective 3.3, and contribution to the Programme result indicator - Quality level of coastal bathing waters (dir.2006/7/CE) and EUSAIR Pillar 3 - Environmental quality; Synergies between the involved projects and related stakeholders to support decisions within Maritime Spatial Planning; Increased environmental awareness among policy makers, local and regional communities, NGOs, general public, by promoting and implementing activities that can lead to a sustainable coastal development (contribution to the Cluster objective) and to the development of integrated methodologies and tools for marine monitoring.

The project aimed to support the improvement of Guidelines and methodologies of Maritime Spatial Planning (MSP) at local and regional levels, develop sustainable growth, decrease pollution and contamination, and protect the biodiversity.

2 INTERNATIONAL AND EUROPEAN MSP LEGISLATIVE FRAMEWORK WITH A FOCUS ON BIODIVERSITY, POLLUTION AND SMALL PORTS MANAGEMENT SIDE LAWS

The Marine Spatial Planning (MSP) was described by various definitions. The most commonly used and exhaustive were developed by the Intergovernmental Oceanographic Commission (IOC) of UNESCO and by the European Union Directive 2014/89/EU:

The Intergovernmental Oceanographic Commission (IOC) of UNESCO (2009) defines MSP “as a public process of analysing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic and social objectives that were specified through a political process”.

The European Union (EU) Directive 2014/89/EU establishing a framework for MSP (EULEX, 2014) defines MSP “as a process by which the relevant Member State’s authorities analyse and organise human activities in marine areas to achieve ecological, economic and social objectives.

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Through their maritime spatial plans, Member States shall aim to contribute to the sustainable development of energy sectors at sea, of maritime transport, and of the fisheries and aquaculture sectors, and to the preservation, protection and improvement of the environment, including resilience to climate change impacts. In addition, Member States may pursue other objectives such as the promotion of sustainable tourism and the sustainable extraction of raw materials".

The pillar that contributed to the birth and the development of MSP legislation was The United Nations Convention on the Law of the Sea (UNCLOS). UNCLOS, entered into force on 10 December 1982, is a worldwide perceived legal arrangement. It can be considered as a "constitution for the oceans" that exalts the concept that "the issues of ocean space are closely interconnected and require to be contemplated as a whole". This treaty defines the importance of international rules, models and strategies efficacious implementation. State Parties that adhere to UNCLOS have rights and duties in the use of sea and ocean space. One of the main obligations is to preserve the marine environment.

In 2021 the Intergovernmental Oceanographic commission of UNESCO and the European Commission's Directorate-General for Maritime Affairs published the document "MSP global International guide on Marine/Maritime Spatial Planning". This guide has collected experiences and information provided by the MSPglobal community in order to accelerate marine/maritime spatial planning processes worldwide.

Some nations with an already developed MSP legislation contributed to support the development of the Joint Roadmap, a framework adopted in March 2017 by IOC-UNESCO and the European Commission. The Government of Sweden, between 2018 and 2020, provided training courses, institutional and technical workshops on marine spatial planning, sustainable blue economy, coastal risk management and ocean literacy to national authorities, officials and experts from more than 50 countries in the world. During the training activities participants

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could test themselves with the board game “MSP challenge” kindly donated by the Government of the Netherlands.

The aim of the Joint Roadmap in this new decade is to triple marine area profiting from MSP, endorsed and guided by governments and their citizens and effectively implemented in more than 30% of marine areas under national jurisdiction by 2030. It is important to underline that this activity follow the UN 2030 Agenda for Sustainable Development. MSP need to comprise all sustainable development goals (SDGs) of UN 2030 and be a vehicle for local realities in reaching them. Furthermore, all the assets involved are favoured by national and regional initiatives in the framework of the United Nations Decades of Ocean Science for Sustainable Development and on Ecosystem Restoration.

Numerous countries around the world already worked and are working on their MSP processes. The goal is to model them to new goals and objectives, such as renewable energy, the achievement of 10% of marine protected areas (MPAs) following the Aichi biodiversity target of the Convention of Biological Diversity (CBD strategic plan 2011-2020), as well as disseminating the urgency to consider also supplementary themes like climate change, transboundary MSP and the blue economy.

The blue economy postulation is a tool by which to view and expand policy agendas that concurrently upgrade ocean health and economic growth. This concept was explained by the World Bank in 2016: “a sustainable ocean economy emerges when economic activity is in balance with the long-term capacity of ocean ecosystems to support this activity and remain resilient and healthy”. The FAO in 2018 started a Blue Growth Initiative (BGI) for the fishing and aquaculture sector that trained at encouraging more productive, accountable and sustainable fisheries and aquaculture sectors by building on the governance and management of aquatic ecosystems, preserving biodiversity and habitat and enhancing communities’ potential. The FAO’s BGI attempts to enforce ecosystem-based approaches to responsible fisheries and aquaculture management, sustain the economic development of countries (with an emphasis

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on developing countries) and empower communities to take full advantage of fisheries and aquaculture in order to improve food security and nutrition, decent work and resilience to shocks. Following the European Green Deal and recovery strategy, the European commission embraced a new concept for a sustainable blue economy that emphasises "businesses that adopt or generate renewable resources, conserve marine ecosystems, diminish pollution and boost resilience to climate change will be incentivised, while others will need to cut down their environmental footprint". The MSP provides help as a decision-making process and leads to sustainable pathways in conjunction with the economic, environmental and social needs of societies. Essentially, the MSP can be considered a promoter of the blue economy.

Some concepts about collaboration between the states and sustainability can be found in previous international deals like:

-The *United Nation fish stock agreement* (a multinational treaty conceived to increase the joint management of migratory fisheries stocks) and *The International plan of action to prevent deter and eliminate Illegal, Unreported and Unregulated (IUU) fishing*, both effective since 2001 thanks to FAO. In 2009, with Port state measure agreements, FAO reinforced measures against IUU fishing further. The treaty affirms that fishing vessels ask for docking at a port and notify the port about details of its fishing activities. Authorization to dock can be rejecting in case of verified unregulated fishing.

-The International convention for the prevention of pollution for ships (MARPOL) adopted on 2 November 1973 at the International Maritime Organisation (IMO), but its annexes were updated until 2005. It concerns regulations and prevention of pollution by oil (Annex I), pollution by noxious liquid substances in bulk (Annex II), pollution by harmful substances carried by sea in packaged form (Annex III), pollution by sewage from ships (Annex IV), pollution by garbage from ships (Annex V) and air pollution from ships (Annex VI).

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In 2008 the European Union adopted the Marine Strategy Framework Directive (MSFD, directive 2008/56/EC), which aimed to establish an integrated approach designed to prevent, protect and safeguard the marine environment from harmful human activities. The directive constitutes the environmental pillar of the EU integrated maritime policy, which identifies the MSP as an intersectoral policy tool that allows public authorities and stakeholders to apply an integrated and coordinated cross-border approach. This framework requires EU countries to develop plans in favour of the Good Environmental Status (GES) evolution. These marine plans are divided into six years cycles and should include preservative measures proposals in order to defend marine ecosystem and ensure the sustainability of related economic activities. States members are called to cooperate with neighbouring countries in a coordinated way for each marine region (the Baltic Sea, the North-east Atlantic Ocean, the Mediterranean Sea and the Black Sea) including an initial state assessment of the marine environment and the human activity impact. Furthermore, each involved state must define what GES consists for its marine waters, identify environmental targets and set up adequate monitoring program. The directive, moreover, contains a series of qualitative descriptors that must be considered by EU countries for their own strategies definition and their good environmental status achievement.

With The Directive 2014/89/EU each state member is obliged to develop and implement their Maritime Spatial Planning through the drafting of specific marine space management plans. All EU countries have to map human activities in their marine waters and identify their most effective future territorial development in time and space. These maps must take into account land-sea interactions, as well as environmental, economic, social and safety aspects. In this regard, all countries should guarantee the best economic, social and environmental data. As The Maritime Spatial Planning Framework Directive states, the MSP is presumed to enforce an ecosystem-based approach (EBA) by guaranteeing that spatial distribution and linked decision-making reflects the principles and elements of EBA. The CBD (2000) describes the ecosystem approach as a procedure for the combined superintendence of land, water and living resources

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that encourages conservation and sustainable use in a balance way. Another focal point of the EU MSP Directive is the trans-boundary cooperation. The Art.11 sets out that all Member States should guarantee trans-boundary cooperation between Member States, while Art.12 encourages the collaboration with third countries.

A good example of transboundary cooperation is defined by The EU Strategy for the Adriatic and Ionian Region (EUSAIR), a macro-regional strategy embraced by the European Commission and approved by the European Council in 2014. This strategy was mutually created by the EU Commission with the Adriatic-Ionian Region countries and stakeholders in an effort to face up together common issues. This strategy aims to constitute synergies and encourage coordination between all territories in the Adriatic-Ionian Region. The MSP supports and is supported by pillars of the EUSAIR flagships 2021-2027, in particular Pillar 1, inherent to the Blue Growth, and Pillar 3, inherent to the Environmental Quality. The Flagship 3 of pillar 3 enhances the promotion of a sustainable growth of the Adriatic region by enriching ICZM and suppling the CRF (Common Regional Framework for integrated coastal zone management, 2019).

The integrated coastal zone management (ICZM), a legally binding protocol of the Barcelona Convention (entered into force in 1978), is a decision-making process for the management of the coast. It uses an integrated approach, taking into account geographical, political, environmental, cultural, historical, and economic aspects of the coastline in attempt to reach of sustainable development goals linked to territorial and urban planning. Both ICMZ and MSP share common principles, but they are different procedures, which must be interrelated and logically implemented. The MSP can be considered as one of the main instrument for enforcing ICZM in the marine part of the coastal zone.

The generation of a correct synergy between ICZM and MSP can also lead to a direct promotion of marine and coastal biodiversity growth. Consequently, this is a reinforcement of all the legislations related to Marine Protected Areas (MPAs). The denomination of MPAs is a key spatial measure for the protection of marine ecosystems and their fundamental biodiversity

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elements. It is the only specific measure detailed within the MSFD and is a key part of the EU Habitats Directive and Birds Directive, as well as of the *Natura 2000* network. The relation between MPAs and MSP is mutual: MPAs are elements of marine space allocation and management MSP-procedure concordant with a future oriented plan, while MSP is a capable tool in the identification of new MPAs. The MSP European policy is also in line with the Life program 2021-2027, in particular sub-programme Nature and Biodiversity which is composed by three main actions: develop and demonstrate eco-innovative techniques and approaches, help to implement and enforce plans and strategies, in compliance with EU legislation, promote best practices and behavioural changes.

The aforementioned MSFD fill up, even if in its minimal parts, the current legal gap regarding under water noise, which becomes a quality parameter of the marine environment in the framework. The EU Commission defines underwater noise pollution as “the intentional or accidental introduction of acoustic energy into the water column, from punctual or diffuse sources” and applies the fundamental principle under which the absence of scientific certainty does not exempt States from the duty to arrange environmental degradation protective measures (15th Principle of Rio Declaration). Second, all countries must ensure that “activities conducted under their own jurisdiction must not cause pollution damage to other states and their environment”.

Regarding other types of marine pollution, the MSFD is also the first EU legal tool that deals with marine litter directly. The evaluation of the status, detection, surveillance, communication and implementation of marine litter and microlitter measures are accomplished in compliance with the pertinent arrangements of the MSFD and have been further detailed in a Commission decision (2017/848/EU). One of the flagship actions against plastic pollution of the oceans, resulting from this strategy, is the directive on Single Use Plastics and fishing gear (Directive 2019/904). This framework submits a series of operations “to prevent and reduce the impact of certain plastic products on the environment, in particular the aquatic environment, and on

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human health, as well as to promote the transition to a circular economy with innovative and sustainable business models, products and materials, thus also contributing to the efficient functioning of internal market"(Art.1). As regards the microplastic issue, ECHA, the EU Chemicals' Agency, introduced a wide-ranging restriction (2019) on microplastics in products on the EU/EEA market to avert or reduce their release to the environment. Furthermore, in the new Circular Economy Action Plan (2020) the Commission made a commitment to direct also unintentional release of microplastics by implementing labelling, standardisation, certification and governing actions. A further contribution in the fight against marine litter was gave by the EU Waste Framework Directive (2008/98/EC), amended in 2018. This amended legislation recognizes that marine litter, especially plastics, derives for the most part from land-based activities, therefore waste avoidance programmes and waste management plans have to be expanded with specific measures. In addition, these measures should be linked and harmonized within the MSFD and the EU Water Framework Directive (Directive 2000/60/EC).

The WFD introduced a new legislative perspective to controlling and safeguarding water, formed not on national or political boundaries but on geographical and hydrological formations defined by the nature of the river basin. It also demands arrangements between different EU policies and set off a detailed timetable for action. This EU framework embraces other legislations regulating specific aspects of water use. An example of these is the Directive 2006/7/EC, concerning the management of bathing water quality. These water regulations are directly linked to MSP studies, which can provide integrated methodologies and tools for marine water monitoring.

Another important regulatory reference is represented by the Regional Plan on Marine Litter Management in the Mediterranean, adopted after the *18th Conference of the Convention for the Protection of the Mediterranean Sea Against Pollution* (Barcelona Convention, 2013), which entered into force on July 8th, 2014. The contracting parties (21 Mediterranean countries and the EU) agreed to adopt the necessary financial, legal and administrative measures to ensure

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the implementation of the Regional Plan. As far as preserving the marine environment from ships waste negative effects in EU ports and improving the reception of port facilities for ship waste the European parliament and council enacted the Directive (EU) 2019/883.

Port exercises give rise to serious strikes in the matter of emissions, noise, water and soil pollution and damaging of habitats. Ports placed near to densely populated urban areas could often have to balance the management of port actions with the protection of natural environment and urban life condition. The EU Commission disclosed guidelines in 2011 on enhancing the Habitats and Birds Directives in estuaries and coastal zone, with a precise focus on finding the appropriate balance between environmental preservation and port evolution. The Commission encourages and supports the initiatives developed by the port sector to improve excellence in environmental management and enforcement by printing guides to good practices. It should be emphasized that most EU ports are small, local ports. These structures combine shipping, fishing and recreation activities. Despite their small extension, they have relevant economic, social and environmental connections with their neighbouring lands.

In addition to the Commission, the Parliament and the Member States, another important body in the management and development of European ports (including small ones) is The European Sea Ports Organisation (ESPO, founded in 1993). This institution is the principal interface between the European ports and the European authorities. In 2019 the ESPO released a Memorandum called “Priorities of European ports for 2019-2024” where it addressed environmental and climate change issues related to European ports. In 1997 the main environmental initiative on the European Port Sector, EcoPorts, was initiated by a number of proactive ports. Subsequently, EcoPorts was fully integrated with ESPO. The principal scope of EcoPorts is to create fair conditions on environment through collaboration and knowledge sharing between ports. It already provides environmental tools to its member. These instruments and strategies are adaptable to ports of different sizes and at different stages. The

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MSP strategy can reinforce and magnify this process involving stakeholders and other interested subjects, also adding innovative and support tools.

3 MSP LEGISLATIVE FRAMEWORK OF ITALY AND ITS ADRIATIC REGIONS, RISKS AND OPPORTUNITIES

The EU MSP Directive was implemented into the Italian legislation with the Legislative Decree 17 October 2016, n.201. The activities of MSP Competent Authority are the responsibility of the Ministry of Sustainable Infrastructures and Mobility (Art.8). The decree establishes an Inter–Ministerial Coordination Table, supervised by a representative of the Presidency of the Council of Ministries (Department for European Policies), with the participation of various Ministries (Art.6). The main tasks for the Inter–Ministerial coordination table to implement are: -1) defining marine areas for the advancement of maritime plans and coastal areas for evaluating sea–land interaction analysis, 2) delineating guidelines for the fulfilment of MSP and improvement of related plans, 3) validating that the Maritime Spatial management Plans coincide with the planning process defined by guidelines. A Technical Committee, supervised by the Ministry of Sustainable Infrastructures and Mobility, is established by Art. 7. It involves representatives of the Ministry of Sustainable Infrastructures and Mobility, the Ministry of Ecological Transition, the Ministry of Agricultural Policies, Food and Forestry, the Ministry of Economic Development and the Ministry of Culture and Ministry of Tourism. Furthermore, one representative of the Regions for each marine Region participating in the Technical Committee. For the marine areas these are delineated by the Inter-Ministerial Coordination Table, the Technical Committee develops MSP plans, according to the guidelines defined by the Inter-Ministerial Coordination Table, including the Strategic Environmental Assessments (SEA) and evaluation procedures related to *Natura 2000* legislation.

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Some national plans, specific for selected sectors, are already available in Italy, and are strategic for the development of the MSP, hence they still need to be contemplated in the advancement of identified regional Maritime Spatial Plans, such as: the *National strategic plan of the ports and logistics*, the *Strategic plan for aquaculture in Italy 2014-2020*, the *National strategic plan on the use of Liquid Natural Gas (LNG) in Italy* (in preparation), the programme of Measures required to obtain a Good Environmental Status (GES) of marine waters as based on the Marine Strategy Framework Directive application. Concerning coastal competence and ICZM, the Ministry of Ecological Transition is liable at national level and actuated the Italian–CAMP project (involving 5 Italian areas: one in Emilia Romagna, two in Tuscany and two in Sardinia). Within this process, the MSP is recognized as a significant issue. Furthermore, the Ministry of Ecological Transition is responsible for the marine biodiversity as well.
Regarding the coastal management, regions also have responsibilities. Ordinary regions (such as Emilia Romagna and Veneto) are responsible for maritime networks and small ports, the administration of maritime properties for touristic purposes, the protection of the environment and the prevention of pollution in inland waters. Special status regions (e.g. Friuli Venezia Giulia) have instead jurisdiction also over fisheries, aquaculture and maritime transport.

The Inter-Ministerial Coordination Table for Maritime Spatial Planning drafted guidelines with indications and criteria for the arrangement of MSP management plans (Decree of the presidency of Council of Ministries, 1 December 2017, published in the Gazzetta Ufficiale on 24 January 2018, n.19). The Decree includes the identification of three marine areas, following the definition of marine sub-regions as reported in the MSFD (2008/56/EU): 1) the Maritime Area “Adriatic”; 2) the Maritime Area “Ionian and Central Mediterranean”, 3) the Maritime Area “Tyrrhenian and Western Mediterranean”. These guidelines include the marine areas up to the limit of the national jurisdiction as well as the coastal and transitional waters, if not already considered under urban or rural plans. In these three proposed plans, each marine area is divided into sub-areas. These sub-areas are defined by peculiar characteristics that allow their

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recognisability, in terms of morphology, ecosystems, landscapes and historical, economic, and productive socio – cultural elements. These guidelines include different other topics, such as strategic goals, multi-level governance, cooperation and consultation with other countries, stakeholders' participation and public communication of the MSP process. Furthermore, these guidelines emphasize the commitment to assure consistency between the maritime plans and objectives of the MSFD include a matrix of interactions between the aims and objectives of the maritime spatial plans and the descriptors of the Marine Strategy, ensuring the achievement and preservation of a Good Environmental Status.

Until now, Italy has not officially completed or adopted a binding maritime spatial plan yet, but organizations and authorities developed dedicated plans and some pilot projects on the progress of the Italian MSP, especially in the Adriatic area, such as:

- the SHAPE project (2011-2014),focused on the development of a multilevel and cross-sector governance system, related to combined management of natural resources, risk avoidance and conflicts solution betwixt usages of the Adriatic coast and sea. It encouraged the reinforcement of the institutional capability required to face these challenges in a cross-border viewpoint. The project focal point was on ICZM and MSP, addressing to promote the ICZM protocol and framework for MSP and ICZM improvement in the Adriatic Region. The MSP activities were mainly concentrated on issues such as:1) an analysis of the MSP legal and policy framework, 2)an ecosystem assessment based on MSFD requirements;3) an examination of problems and opportunities related to MSP in the Adriatic Sea;4) a mapping of main maritime uses (i.e., pilot projects on MSP and its integration with ICZM). Moreover, the project led to the creation of the Adriatic Atlas to Support both ICZM and MSP.

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- The RITMARE project (2012-2017), with investigations and suggestions for MSP in the Emilia – Romagna region. The project was addressed on marine and maritime research topics according to the EUSAIR Action Plan, and in line with the strengthening of the MSP directive. The general purpose was to carry out analyses, interpretations and proposals for MSP and ICZM focused on the coastal and marine area of the Emilia Romagna Region, through a detailed activity of MSP on the area of interest. A portfolio of spatial planning measures was recognized relying to 6 major uses: 1) coastal defence, 2) decommissioning of oil and gas offshore platforms, 3) development of offshore wind farms, 4) fishery and aquaculture, 5) environmental protection and 6) management of areas used for military purposes. The trends of all such uses were analysed to define a "hypothetical proposal" for the study area. The project was mainly focused on coastal and maritime tourism as the fundamental use of the maritime economy of Emilia – Romagna coastal system.

- The ADRIPLAN project (2013-2015): funded by EC DG MARE, which proposed instructions and arranged MSP exercises for transboundary MSP in the Adriatic and Ionian seas. Specifically, the project identified two Focus Areas for which MSP exercises could be designed: the Northern Adriatic area (Focus area 1) and the Southern Adriatic and Northern Ionian area (Focus area 2). In both focus areas various maritime activities were considered, such as: shipping, ports, oil and gas exploitation, fishing, aquaculture, offshore renewable energy production, tourism including recreation and sports, underwater cultural heritage, nature protection, and submarine cables and pipelines. The ADRIPLAN Focus area 1 was defined by new anthropogenic utilizations that would be promoted in the next ten years. For the project aims, three significant planning topics were selected: 1) the need to spatially define the electricity interconnection location between Italy and Slovenia through a submarine cable, 2) the need to find offsetting operations for the fishing sector to be applied following the construction of the Venice Offshore Terminal, and 3) the need to encourage the infrastructural improvement of the Port of Trieste. For the Focus area 2

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three important planning issues were instead selected: 1) encourage and spatially determine environmental protection measures along the Apulian Coast, 2) harmonise current and future antagonistic exercises in Apulian offshore waters, and 3) define cross-border cooperation between Greece, Albania and Italy for fishery and aquaculture.

- The SUPREME project (2017-2018), promoting MSP in the Eastern Mediterranean. Italian partners involved CORILA – Consortium for coordination of research activities concerning the Venice lagoon system, CNR-ISMAR National – Research Council, Institute of Marine Science, University IUAV of Venice, Ministry of sustainable Infrastructures and Mobility, and the Ministry of Ecological Transition.

- the PORTODIMARE project (2018-2021), which involved 11 project partners and 2 associated partners from 6 countries of the Adriatic and Ionian Region (Bosnia and Herzegovina, Croatia, Greece, Italy, Montenegro, Slovenia). The lead partner was the General Directorate for Territorial and Environmental Care of the Emilia-Romagna Region. The project made available tools, working methods and results that were developed and tested in a context of transnational cooperation in the Adriatic and Ionian Region. The fundamental result of its activities is the Geoportal of the Adriatic and Ionian Region (GAIR), an open-source code interoperable platform that allows access to a multiplicity of information layers, functions for data and cartography processing and use of analysis tools dedicated to MSP.

Activities connected to Italian maritime spatial planning could create socio-economic opportunities for the country's growth. Their monitoring and organization are essential to avoid risks linked to environmental alteration and space competition. As concerning the EU sea basins plus Arctic and Black Sea maritime policy issues, the EU Commission is supported in its socio-economic analyses by the EUNETMAR (European Networking Group for Integrated Maritime Policy), an international Consortium set up in 2012 involving selected

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leading European companies and over 350 senior experts on maritime themes. EUNETMAR, in the 2014 blue growth needs analysis and potential for countries paper indicated the six most promising marine Italian exercises for the next years:

1. *Short sea shipping* - within the EU, Italy is the country with the largest quantity of transported goods by this category of shipping, and has a fundamental role within the network "Motorways of the Sea". In total, 446 weekly departures are assured on the Motorway of the Sea, connecting the Italian peninsula with countries (e.g. Albania, Greece, and Montenegro) and Mediterranean islands. The investments in new ships specifically designed for Motorways of the Sea Services have been huge in recent years (ca. €1.8 billion estimated over the last five years). Following the growth of this activity within the MSP tool will be necessary, in order to verify its impact.

2. *Passenger ferry services* - a sector which has a considerable improvement potential, primarily because of its proximate link with other maritime exercises, including shipbuilding, construction of water projects, and coastal tourism; all these activities are strictly connected each other and can take advantage from the improvement and the reinforcement of the others.

3. *Marine aquaculture* - an industry currently managed by small size companies, directed by family-run business and cooperative organisation in the shellfish field. This type of aquaculture farming is particularly developed in the Italian North-Eastern Adriatic area; the potential for shellfish mariculture is almost limitless and product diversification should be advantaged, but polluting repercussion must be attentively studied; extensive aquaculture in brackish lagoons earned rising attention for its traditional aspects and for the preservation of both the habitats and the ecosystem services.

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4. *Protection of habitats* - a fundamental part in the Italian Blue economy, with direct and indirect influence on other exercises, passenger ferry services and cargo transport. Currently there are 363 *Natura2000* marine sites in Italy, covering a total of 6.604 km^2.

5. *Coastal tourism*- the most significant maritime activity in Italy, which attracts both domestic and foreign tourists in large numbers; this activity is considered to be one of the most encouraging in Italy because it has a high potential, not only in socio – economic field but also in terms of environmental sustainability; it is necessary that coastal areas overcrowding, and potential risks are constantly evaluated and monitored; the people can be stimulated with environmental education programs and a sustainable tourism.

6. *Cruise tourism* - Italy is the first travel destination in the world, and it is a "departure hub" of main importance. Venice, Genoa, Naples and Civitavecchia are the four principal home ports: Civitavecchia managed 2.339.676 passengers in 2016, followed by Venice (1.605.660), Naples (1.306.151) and Genoa (1.017.368). A constant control of the cruise ships routes and their effects is required. The air pollution caused by cruise tourism concentrates most of the emissions in ports, close to large population centres, where ships remain anchored for days with their engines running; in addition, other types of pollution caused by this activity, such as marine noise pollution, must be considered.

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4 MSP LEGISLATIVE FRAMEWORK OF CROATIA AND ITS ADRIATIC COUNTIES, RISKS AND OPPORTUNITIES

International and EU strategic background

As a key background element to the Maritime Spatial Planning (MSP), the Mediterranean Action Plan (MAP)was established in 1975 as a multilateral environmental agreement in the context of the Regional Seas Programme of the United Nations Environment Programme (UNEP). The Mediterranean countries and the European Community approved MAP as the institutional framework for cooperation in addressing common challenges of marine environmental degradation. Under the auspices of UNEP/MAP, a framework convention dedicated to the Protection of the Mediterranean Sea against Pollution - The Convention for the Protection of the Mediterranean Sea Against Pollution (Barcelona Convention) - was adopted in 1976 in Barcelona, entered into force in 1978, and amended two decades later to encompass the key concepts adopted at the landmark 1992 Rio Conference and to include coasts in its goals.

The United Nations Environment Programme / Mediterranean Action Plan (UNEP/MAP) is a regional cooperative effort involving 21 countries bordering the Mediterranean Sea, as well as the European Union. Through the UNEP/MAP, these Contracting Parties to the Barcelona Convention and its Protocols are determined to meet the challenges of protecting the marine and coastal environment while boosting regional and national plans to achieve sustainable development. The 22 Contracting Parties to the Barcelona Convention are: Albania, Algeria, Bosnia and Herzegovina, Croatia, Cyprus, Egypt, the European Community, France, Greece, Israel, Italy, Lebanon, Libya, Malta, Monaco, Montenegro, Morocco, Slovenia, Spain, Syria, Tunisia, and Turkey.

The Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention) was adopted in 1995.

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Within this, the Protocol on Integrated Coastal Zone Management in the Mediterranean (ICZM Protocol) is the first international legal document that inserts the obligation of integrated coastal zones management It was adopted in 2008 and entered into force in 2011. It provides the legal framework for an integrated management of the Mediterranean coastal zone. The ICZM Protocol is a unique legal instrument in the entire international community, and MSP became increasingly recognized as the best tool to implement the ICZM Protocol in the marine part of the coastal zone (PAP/RAC, 2023). Croatia became one of the Contracting Parties of the 2008 Integrated Coastal Zone Management (ICZM) Protocol, by signing the document in 2008 and entering it into force in 2013.

In 2008 the EU adopted the Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of the marine environmental policy (Marine Strategy Framework Directive). Following this, in July 2014, the European Parliament and the Council adopted the Directive 2014/89/EU for establishing a framework for Maritime Spatial Planning (MSP), which represents a common framework for the maritime spatial planning in the European Union. In broad terms, the Directive places a legal requirement on Member States to develop and implement Maritime Spatial Plans (MSPs) by 2021 at the latest.

The European Maritime Spatial Planning Platform with was developed this purpose, as a service for Member States to share relevant knowledge and experiences on Maritime Spatial Planning (European MSP Platform, 2023). The platform is funded by the EU Directorate General for Maritime Affairs and Fisheries (DG MARE), and acts as the central exchange forum for the rich knowledge generated in past, current and upcoming MSP processes and projects. This will allow officials; planners and other stakeholders interested in MSP to build on what is already available, avoid duplication of efforts, assist in capacity building and foster development of new practices.

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Moreover, the Decision IG.24/5 of the 21st Meeting of the Contracting Parties to the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean and its Protocols (COP21), held in Naples on the December 5th, 2019, adopted the document entitled "Common Regional Framework for Integrated Coastal Zone Management" which is to be considered as the strategic instrument meant to facilitate the implementation of the ICZM Protocol from 2020 up to 2027.

Regulatory framework in Croatia

Internal waters of the Republic of Croatia include ports and bays along the coast and on islands, and also parts of sea between low waterline at the coast and the straight baseline for measuring width of the territorial waters (European Commission, 2022). The territorial sea is determined in the width of 12 miles from a straight baseline, and agreed boundaries at sea with Italy and Montenegro, while boundaries at sea with Bosnia and Herzegovina are in provisional application. The border with the Republic of Slovenia is not awarded and remains unchanged as of 1991 until Croatia and Slovenia will reach the final delimitation. The graphic depiction and description of the border are exclusively for the purpose of this document. In February 2021, the Croatian Parliament declared the Exclusive Economic Zone of the Republic of Croatia in the Adriatic Sea (EEZ) (Official Gazette 10/21).

In Croatia, the ministry in charge of physical planning is the Ministry of Physical Planning, Construction and State Assets (MPPCSA), which is the competent state body for spatial and physical planning. When it comes to regional maritime spatial planning (MSP) authority, coastal counties' spatial planning institutes are competent for MSP, within the powers defined by the Physical Planning Act (Official Gazette 153/13, 65/17, 114/18, 39/19, 98/19) (PPA).

Since the current Croatian Physical Planning System (PPS) covers both terrestrial and marine areas, maritime spatial planning is traditionally an integrated part of spatial planning. Today's

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maritime spatial planning in Croatia incorporates most of the themes and requirements of MSP included in previous EU and international regulations, primarily the Directive 2014/89/EU – MSP Directive, Directive 2008/56/EC - MSFD and the Protocol to the Barcelona Convention on Integrated Coastal Zone Management in the Mediterranean (ICZM Protocol). The regulations relating to the spatial planning of marine and coastal areas, in particular - the ICZM Protocol, which has been gradually incorporated over the years into the physical planning system, starting with the declaration on protected coastal and marine zones in 2004.

In maritime spatial planning, the Integral management of the coastal area (IUOP) is an extremely important dynamic process of a sustainable management and use of coastal areas, which simultaneously takes into account the fragility of coastal ecosystems and landscapes, the diversity of activities and uses, their interaction, the maritime orientation of certain activities, and uses and their impact on sea and land areas (Ministry of Economy and Sustainable Development, 2023).

As part of the Mediterranean Action Plan of the United Nations Environment Program (UNEP/MAP), the Contracting Parties to the Barcelona Convention signed the Protocol on Integral Management of the Mediterranean Coastal Area in Madrid in 2008, which entered into force in March 2011. This protocol aims to establish a common framework for an integral management of the Mediterranean coastal area and to take the necessary measures to strengthen regional cooperation. The protocol represents an important step in the history of the MAP, and its implementation is expected to enable a sustainable management of coastal areas and strengthen the ability of involved countries to deal with environmental challenges such as climate change. The Republic of Croatia ratified the Protocol in 2012 by passing the Law on Ratification of the Protocol on Integral Management of the Mediterranean Coastal Area (Official Gazette 8/12). One of the obligations of the countries is the development of national strategies for IUOP. In this sense, Croatia already started the preparation of the aforementioned strategy for integral management of the coastal area.

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Currently, there is no single MSP plan at national level for the entire Croatian marine area, while the entire territory of the Republic of Croatia is covered by various spatial plans, which comprise both terrestrial and marine areas (European Commission, 2022).

Following the requirements of the Physical Planning Act (Official Gazette 153/13, 65/17, 114/18, 39/19, 98/19) (PPA), which is the backbone of the legislation on physical planning in Croatia, the preparation of the State Plan for Spatial Development for the entire terrestrial and marine area (up to the external limit of territorial waters) of Republic of Croatia (national level) was initiated in 2018. Spatial plans in Croatia are binding with the status of the subordinate regulations. By adopting the amendment to the PPA (Official Gazette, 65/2017), the MSP Directive was fully transposed into national legislation.

Spatial plans for protected areas managed by national authorities, encompassing both terrestrial and marine areas, were also developed. Moreover, at the sub-national level, all coastal county plans include provisions for their marine areas (up to the external limit of the territorial sea) referring to different sea uses.

For example, Spatial Plans for the regional level were developed at county level. They include provisions for the use of marine areas (up to the external limit of the territorial sea). According to PPA and the regulations enacted under it, these plans include locations for different categories of use, such as ports and marinas, waterways, underwater cables and pipelines, protected areas, underwater archaeological sites and aquaculture areas, etc. Some topics were elaborated in more detail.

For example, the Coastal Plan for Šibenik-Knin County was the first Spatial Plan developed (pilot plan) in Croatia. This Coastal Plan was developed by PAP/RAC and Plan Bleu as part of the UNEP/MAP project "*Integration of Climatic Variability and Change into National Strategies to Implement the Protocol on ICZM in the Mediterranean*" (ClimVar & ICZM), within the framework of the MedPartnership initiative. Being a pilot plan, it is not legally binding. It proposes a vision for the desirable future of the Šibenik-Knin County coastal zone as well as key management

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policies and measures. In this perspective, the plan does not design/regulate land or sea uses and is not a substitute for official spatial planning. Its main focus is on resilience and adaptation to climate change, coastal water management and sustainable spatial development. The plan also addresses a number of issues which are relevant for MSP, in particular: coastal and maritime tourism, aquaculture, biodiversity preservation and measures for coastal protection. Some measures to improve adaptation to climate change of these sectors (and a number of coastal issues) are identified by the plan. Moreover, the coastal plan recommends the elaboration of a marine spatial plan for the Šibenik-Knin County. The preparation of this coastal plan started in January 2013. It was finalised in December 2015 and adopted by the County Assembly in April 2016.

As another good example, the Zadar County includes a detailed zonation of the marine space for different types of aquacultures uses in its spatial plan, owing to the importance of aquaculture among the development priorities in the county.

Furthermore, at the local level, each coastal city and municipality developed its own spatial plan, including elaboration of general urban plans or urban development plans, where it is appropriate or prescribed by regulations. All plans contain provisions for the use of marine area if within their scope. Physical planning activities in counties and cities/municipalities are under the responsibility of special administrative departments.

The complete regulatory framework of maritime spatial planning in Croatia is listed below (MPPCSA, 2023):

- **Acts:**
    - Physical Planning Act (Official Gazette 153/13, 65/17, 114/18, 39/19, 98/19)

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- Act on Physical Planning and Building Tasks and Activities (Official Gazette 78/15, 118/18, 110/19)
- Act on the Chamber of Architects and Chambers of Engineers in Construction and Physical Planning (Official Gazette 78/15, 114/18, 110/19)
- Act on the National Spatial Data Infrastructure Act (Official Gazette 56/13, 52/18, 50/20)
- Act on the Performance of Geodetic Activity (Official Gazette 25/18)

- **Regulations:**
  - Regulation on the physical planning information system (Official Gazette 115/15)
  - Regulation on the definition of construction works, other projects and surfaces of state and regional significance (Official Gazette 37/14, 154/14, 30/21, 75/22)

- **Decisions:**
  - Decision on the Development of the State Spatial Development Plan (Official Gazette 39/18)
  - Decision on the definition of relative weights for architectural and engineering and related advisory services in construction and physical planning (Official Gazette 119/18, 5/19)

- **Ordinances:**
  - Ordinance on the mandatory contents of conceptual designs (Official Gazette 118/19, 65/20)
  - Ordinance on measures for protection against natural disasters and war threats in spatial planning and development – consolidated text (Official Gazette 29/83, 36/85, 42/86)

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- Ordinance on municipalities allowed to adopt spatial development plans with abbreviated contents for the development of the municipality and on the contents, scale of cartographic presentations, and mandatory attachments of such plan (Official Gazette 135/10)
- Ordinance on surveying designs (Official Gazette 12/14, 56/14)
- Ordinance on the contents and required spatial indicators in reports on the spatial status (Official Gazette 48/14, 19/15)
- Ordinance on the State plan for spatial development (Official Gazette 122/15)
- Ordinance on professional examination of persons performing construction and physical planning tasks (Official Gazette 129/15)
- Ordinance on granting approval for the performance of professional physical planning tasks (Official Gazette 136/15)
- Ordinance on the method of calculating the (gross) construction area of a building (Official Gazette 93/17)
- Ordinance on spatial projects that are not considered to be construction works and for which location permits are issued (Official Gazette 105/17, 108/17)
- Ordinance on professional training of persons performing physical planning and construction activities (Official Gazette 55/20)

- **Instructions:**
  - Instruction on the development of draft acts in the procedure of issuing acts pursuant to the Physical Planning Act and Building Act (Official Gazette 56/14)

- **Strategic documents:**
  - Spatial Development Strategy of the Republic of Croatia
  - Physical Planning Programme of the Republic of Croatia

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- The Report on the Spatial Situation in the Republic of Croatia for the Period 2013 – 2019

- **Spatial Plans:**
  - State-level spatial plans
    - Spatial plan of national park Brijuni
    - Spatial plan of national park Kornati
    - Spatial plan of national park Mljet
    - Spatial Plan of Nature Park Telašćica
  - Regional and local spatial plans
    - Dubrovnik-Neretva County
    - Split-Dalmatia County
      - County plan
      - City/municipality plans
      - General urban plans
    - Šibenik-Knin County
      - County plan
      - City/municipality plans: available on local websites
      - General urban plans
      - Spatial plan of the area of special features (PPPPO) Žut-Sit Isles
    - Zadar County:
      - County Plan
      - City/municipality plans
    - Lika-Senj County:
      - County Plan
      - City/municipality plans: available on local websites

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- Primorsko-Goranska County:
  - County Plan
  - City/municipality plans, general urban plans
- Istria County:
  - County Plan
  - City/municipality plans, general urban plan
  - Spatial plan of the area of special features (PPPPO) DonjiKamenjak and the Medulin archipelago

- **Other relevant legislative and strategic acts:**
  - Act on Maritime Property and Seaports (Official Gazette 158/2003, 100/2004, 141/2006, 38/2009, 123/2011, 56/2016, 98/2019)
  - Environmental Protection Act (Official Gazette 80/13, 153/13, 78/15, 12/18, 118/18)
  - Nature protection act (Official Gazette 80/13, 15/18, 14/19, 127/19)
  - Marine Environment and Coastal Area Management Strategy of the Republic of Croatia (in development)
  - Decision on Declaration of the Exclusive Economic Zone of the Republic of Croatia in the Adriatic Sea (Official Gazette 10/2021)
  - Maritime Code of the Republic of Croatia (Official Gazette 181/2004, 76/2007, 146/2008, 61/2011, 56/2013, 26/2015, 17/2019)
  - National strategic plan for the development of fisheries in the Republic of Croatia (Official Gazette 123/2013)

Strategy of marine development and integral marine policy of the Republic of Croatia for the period from 2014 to 2020.

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5 GAPS AND RELATIVE NEEDED UPGRADES IN MSP LEGISLATION AND PROJECTS

The legislation and projects linked to the development of MSP have to constantly evolve to keep pace with new challenges. There are some shortcomings and gaps that will need to be taken into account to address spatial, social and environmental needs. The marine spatial plans, particularly along the Mediterranean marine regions, must be coordinated and interconnected. The exchange of spatial information and amplification of the mapping must be ensured by the cross-border collaboration of the member states. The MSP-MED project (2020-2022) founded by EC DG MARE, for instance, is a good example of sharing the most important MSP information and knowledge between Mediterranean member states and, in addition, non-EU countries. The MSP policy and spatial mapping in the Mediterranean regions will have to be advanced as much as the models proposed by northern European countries, such as Sweden and Netherlands. Countries like Italy and Croatia are currently still setting up their maritime spatial plans. Other necessary actions for the growth of MSP, which are currently lacking, are the involvement of citizens and listening to local stakeholders requests (Zuercher *et al.* 2022). The inhabitants of the Mediterranean coasts must be involved and educated in projects and legislation related to MSP. Furthermore, the new plans and related legislative documentation must take into account the social and economic needs at local level. Considering this aspect would lead to a more efficient translation of the theoretical strategies, applying them to a local reality. In the near future the MSP will need to deal with a changing climate. The current European MSP legislation does not take into account the issue of climate change (Zuercher *et al.* 2022). Properly embedding climate change into the MSP framework will allow for better readiness, upgraded response efficiency and, finally, a reduced susceptibility of marine socio-ecological systems. Between 2018 and 2021 the OCEANPLAN project was developed in order to investigate how ocean MSP can be affected by and adapt to global climate change. Similar

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projects are being developed in more confined areas, such as the Mediterranean Sea and the Adriatic Sea.

European Regional Development Fund

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6 THE INTERREG ITALY-CROATIA RESISTANCE CLUSTER PROJECTS AND THEIR CONTRIBUTION TO THE IMPROVEMENT OF BIODIVERSITY CONSERVATION, SMALL PORTS MANAGEMENT AND MARINE POLLUTION

Here a detailed description of each cluster project within the RESISTANCE project, in terms of both aims and results, is presented.

6.1 *The DORY project*

The DORY project aimed to implement management measures for sustainable fisheries in the Adriatic Sea and provide recommendations. Based on scientific evidence useful to policy makers and players in the fishing sector and maritime spatial planning (MSP), to make European, national, and regional policies on the subject more effective and integrated.

The results illustrated below are also particularly relevant for operators in the fishing sector who, together with political decision-makers and institutions, are called to encourage and support change to achieve greater social, economic, and environmental sustainability.

These recommendations were elaborated based on reported results, concerning the scenarios of possible transboundary spatial management measures for fisheries and the feasibility study related to the establishment of a transboundary marine protected area. The biological, social, and economic effects of these alternative management measures have been elaborated by applying the DISPLACE bio-economic model together with the comparison with the management measures currently in force for fisheries.

The use of this model has in fact allowed to simulate the effects on fish stocks of the ban on fishing in small and large areas, including economic assessments of spatial restrictions and the bio-economic consequences of the redistribution of fishing effort.

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Description of the Maritime Spatial Planning tool: DISPLACE.

- *Model approach*

The DISPLACE bio-economic model is an application that allows you to simulate the behaviour of fishermen (e.g., choice of fishing areas, capture of the various target species, management costs and earnings, etc.) and the effects of fishing on fish stocks.

DISPLACE is a simulation model based on agents, which in this context are individual fishing boats, and therefore manages to calculate the socio-economic and ecological effects on an individual scale.

The individual effects are then aggregated in order to highlight the global effects (e.g. the fishing fleet as a whole or other components of the marine ecosystem). The most important component of this model is the spatial one; in fact all the economic and biological information comes georeferenced via GIS.

The spatial component makes it possible to accurately test all possible management measures through simulation scenarios (e.g., closure of certain marine areas to fishing, technical measures in specific areas, etc.).

This model was created for the management of fisheries resources in the North and Baltic Seas, but thanks to collaboration with its developer (Francois Bastardie, DTU Aqua, Copenhagen) it was possible to implement the application for the Adriatic.

DISPLACE has already been applied in the central and northern Adriatic (GSA 17) to the Italian demersal fishery and the results have been published (Bastardie *et al.* - 2017). The input data for DISPLACE has been recently updated for the DORY project by inserting new target species, new stock assessment data and data of the Croatian fleet active in the GSA17 (e.g., catches, technical data, spatial distribution of fishing effort, etc.).

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-Management Scenarios

In this context, the consequences of five hypothetical spatial fisheries management scenarios and their potential medium-term effects on six fish stocks (hake, sole, red mullet, Norway lobster, mantis shrimp and cuttlefish) were simulated.

As already mentioned in the previous paragraph, the model has been updated using the latest scientific data from each of the six target species.

However, within DORY a special focus was reserved for the stock of sole (*Solea solea*) and cuttlefish (*Sepia officinalis*), as both species play an important economic role for fisheries both in Italy and in Croatia, with the consequent need to implement efficient management measures aimed at preserving shared resources and guaranteeing their sustainable exploitation.

Furthermore, all the management measures simulated with DISPLACE had previously been proposed and discussed with the operators of the sector through a process of involving the stakeholders, which consisted of multiple meetings with the fishermen and with the representatives of the cooperatives, both Italian and Croatian.

The tested scenarios were:

1. The status quo, which includes all restrictions on fishing activities currently in force in Italy, Croatia, and Slovenia.

2. the prohibition of trawling up to 4 nautical miles from the coast on the Italian side (GSA17), which is supposed to reduce the fishing pressure in the first growth areas of many species exploited by fishing, in particular sole and cuttlefish (Figure 6.1.1).

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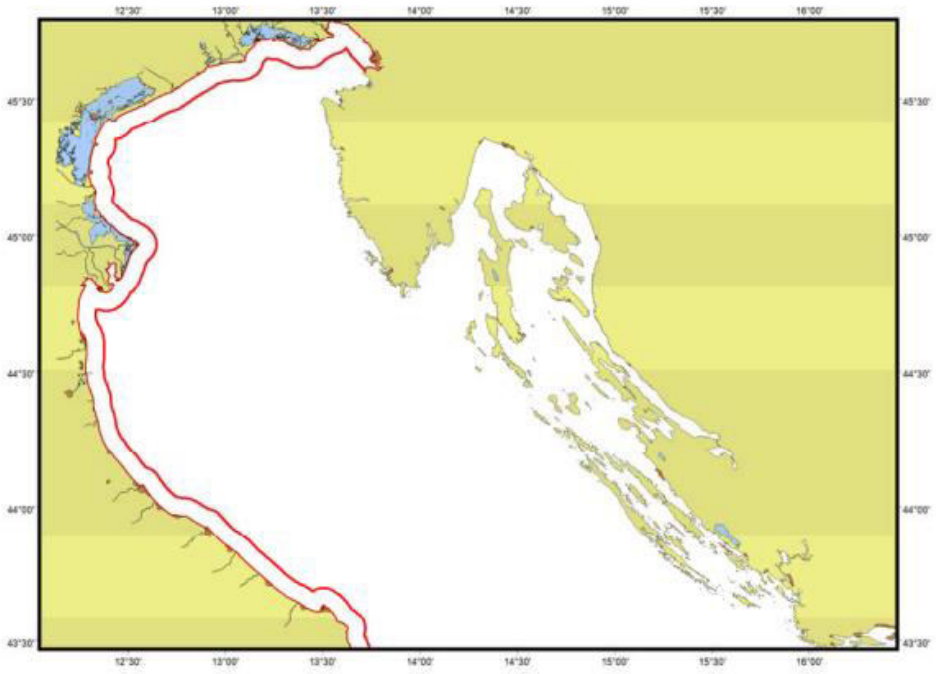

Figure 6.1.1. Map identifying the 4-nautical-mile buffer along the Italian coastline.

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3 The prohibition of trawling up to 6 nautical miles from the coast, on the Italian side (GSA17)

Both this scenario and the previous one exclude Croatian and Slovenian waters due to the complex geomorphologic characteristics of the eastern Adriatic coast, as well as those of the seaport of Monfalcone and Trieste (Figure 6.1.2).

The work shows that the only first growth areas of fished species effectively protected in European Mediterranean waters are those of coastal species, such as red mullet, bream and sole, with 66.8%, 54.1% and 46.1% respectively. This is mainly due to the prohibition of trawling within 3 nautical miles from the coast or at depths of less than 50 meters, currently in force (Article 13 of the European Regulation 1967/2006).

Based on this, it follows that the implementation of the measure of spatial management currently in force (3 nm) with an extension to 6 nm could ensure a more sustainable exploitation of some coastal resources.

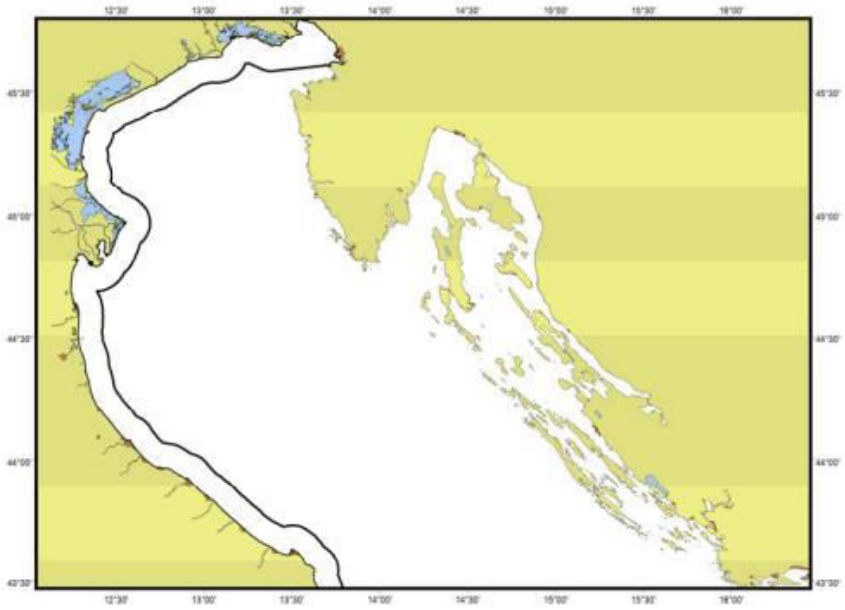

Figure 6.1.2.Map identifying the 6-nautical-mile buffer along the Italian coastline.

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4. The closure of an area known as the "sole sanctuary" (Fig. 6.1.3) for all the towed gear of the Italian and Croatian fleets engaged in demersal fishing.

It has been shown that this area includes a large part of the sole spawning area and therefore its closure should lower the fishing pressure on the spawning stock biomass of this species.

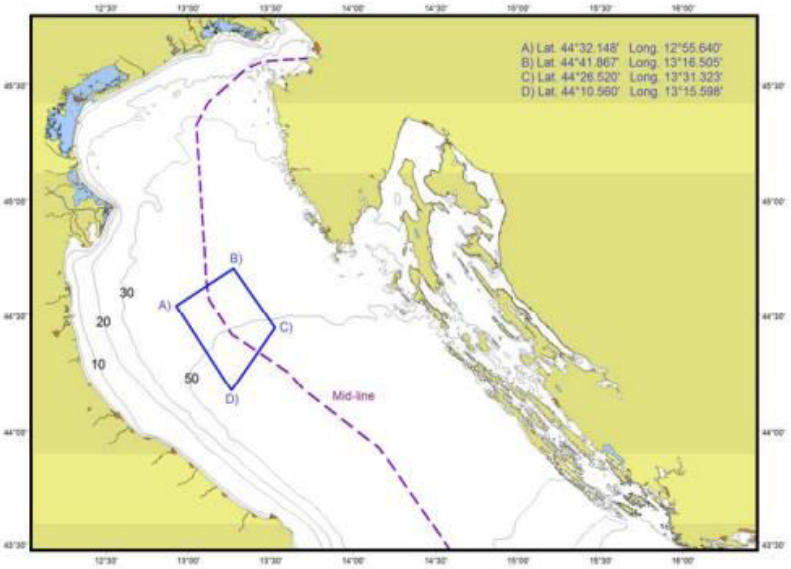

Figure 6.1.3.The 'sole sanctuary' map

5. increase in the selectivity of gillnets by adopting a minimum mesh size (72mm stretched) and increase the minimum landing size of sole to 25 cm (currently 20 cm).

The estimated effects of these scenarios were obtained by carrying out 20 simulations for each scenario, using the Monte Carlo routine, which made it possible to project the scenarios with different fishing patterns, comparing them with the current situation (status quo). So, the results obtained, led to elaboration of the following recommendations.

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Recommendations

The "Sole sanctuary"

The spatial management measure "sole sanctuary" is strongly recommended.

The results and recommendations formulated through the DORY project have already been presented to policy makers and validated during the meeting of the Scientific, Technical, Economic Committee for Fisheries "STECF EWG 19 - 02: Multi - Annual Plans for the fisheries exploiting demersal stocks in the Adriatic Sea" and published in the associated report (STECF, 2019).

The closure of the area would further reduce the small fishing effort currently exerted by trawling and dredging on sole reproducers, in fact the current fishing effort is very low when compared with the rest of the GSA17 due to the concurrence of some factors.

For example, the distance of this area from the main ports and the benthic organisms that populate the substrate, such as for example the bryozoan (*Amathia semiconvoluta*) which blocks the meshes of the nets making fishing very difficult and some species of sea cucumbers which can turn the catch yellow, reducing its commercial value. Furthermore, the ban on fishing in the "sole sanctuary" could be seen as a precautionary measure. In fact, some technological expedients on the networks could allow their exploitation in the future, compromising the stock of reproducers, which is currently exploited in a tolerable way.

In relation to the results obtained with DISPLACE, the exclusion of fast fish from the "sole sanctuary" would lead to a decrease in total fishing effort and landed fish, but also in the discard rate for this species. It is useful to remember that sole is the main target species for this gear. This scenario would lead to an increase in catches per unit of effort in the medium term thanks to the increase in the reproductive potential of the species.

Excluding trawling from the "sole sanctuary" would lead to a decrease in total fishing effort, number of trips per boat, catches per unit of effort and total landed. On the other hand, the duration of outings and sole discards would increase. However, it should be remembered that

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sole is not target species for this gear, constituting only a small fraction of the landed of this segment.

Excluding gillnets from the "sole sanctuary" would lead to an increase in catches per unit of effort and sole landings in the medium term. Also, there would be a reduction in the discarding of this species. Based on the results obtained with DISPLACE and current scientific knowledge, the exclusion of gillnets from the submitted area is strongly recommended, at least from December to February, during the peak of the sole spawning season. This would allow adults breeders to increase the reproductive potential of the stock and thus help regenerate the stock with new recruits. Currently, the catch composition in GSA17 is dominated by small individuals (ages 0+ and 1+), with a low percentage of large individuals. The minimum legal size is equal to 20 cm, while it has been estimated that the length at which 50% of sole individuals has reached sexual maturity is 25 cm.

Minimum landing size and selectivity for sole

According to the data collected during the “SoleMon, scientific fishing survey” (Scarcella *et al.*, 2014), individuals of sole aged 0+ tend to aggregate along the Italian coast, mainly in the area near the mouth of the Po. Growing, at an age 1+ they gradually migrate offshore until the

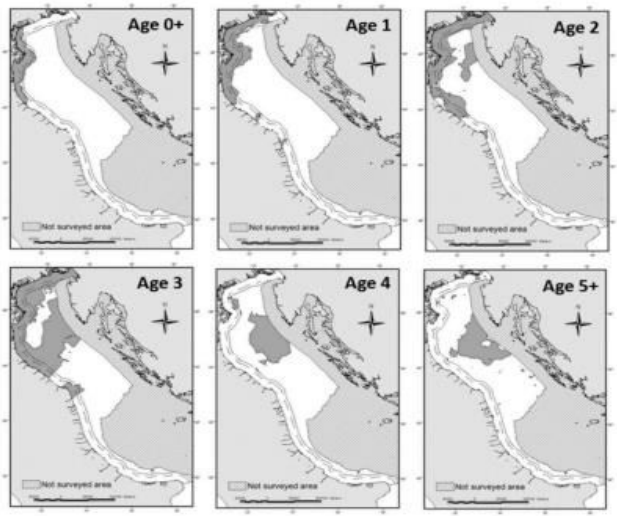

Figure 6.1.4. Maps of the spatial distribution of sole by age class.

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adults (age >3) concentrate in the deeper waters at the centre of the GSA17, between the Italian coasts and southern Istria (Fig. 6.1.4).

The entire life cycle of the sole would seem to follow the Adriatic circulation and the displacement of the water masses that form in the autumn in the northern and central Adriatic, in correspondence with the reproductive season of this species. As a result of these periodic changes in resource availability, local fish markets are supplied with large quantities of some species for relatively short periods, and prices can plummet if supply exceeds demand. As a result of the different spatial distributions, the juveniles are exploited almost exclusively by the Italian fishing fleet, by the swifts and gillnets, while the adults are mainly caught by the Croatian and Slovenian fishing fleets in their respective national waters and by the Italian fleet operating in the international waters. However, since Italian catches are decidedly higher than Croatian and Slovenian ones, global catches are dominated by sole aged 0+ and 1+ (STECF, 2017).
As already mentioned, the minimum landing size for this species is 20 cm, a measure unquestionably far from that of first sexual maturity, estimated at 25 cm and 25.8 cm.
Demographic erosion affects not only the stock's reproductive capacity, but also the average market price and consequently the revenues from fishing activities. The increase of the minimum landing size to 25 cm would shift the fishing target towards the adult portion of the population, guaranteeing young to complete the migration, reach the spawning stock and reproduce at least once before being captured. Furthermore, a complementary measure could be to protect young people even when they are stationed near the coast along the Italian coast. The use of a gillnet with a mesh size of 72 mm (stretched) would help reduce the capture of juvenile specimens. Give results of the DISPLACE model, the estimated medium-term income, thanks to the application of this management measure, should grow, thanks to the increase in the size of sole caught by all fleet segments.

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Protection of 6 nautical miles from the coast

As already mentioned above, it has been demonstrated that the only permanently protected first growth areas in Mediterranean waters are those of coastal species.

This is mainly due to the prohibition of trawling within 3 nautical miles of the coast or 50m depth. Based on the simulations carried out, the implementation of the spatial management measure currently in force (3 nautical miles) with an extension to 6 nautical miles would have the potential to substantially improve the current dynamics of exploitation of fisheries resources (Figure 6.1.5).

The Italian Ministry of Agricultural, Food, Forestry and Tourism Policies (MIPAAFT) regulates the temporary closure of trawl fishing activities for demersal species and pelagic trawlers in the Adriatic Sea.

Since 2012, this regulation also provides for temporary spatial restrictions:

1) Vessels authorized for inshore fishing (<6 nm from the coast) or with an overall length below 15 metres cannot operate within 4 nautical miles from the start of the temporary closure until 31 October.

2) Vessels with an overall length over 15 metres cannot operate within 6 nautical miles from the start of the temporary closure until 31 October.

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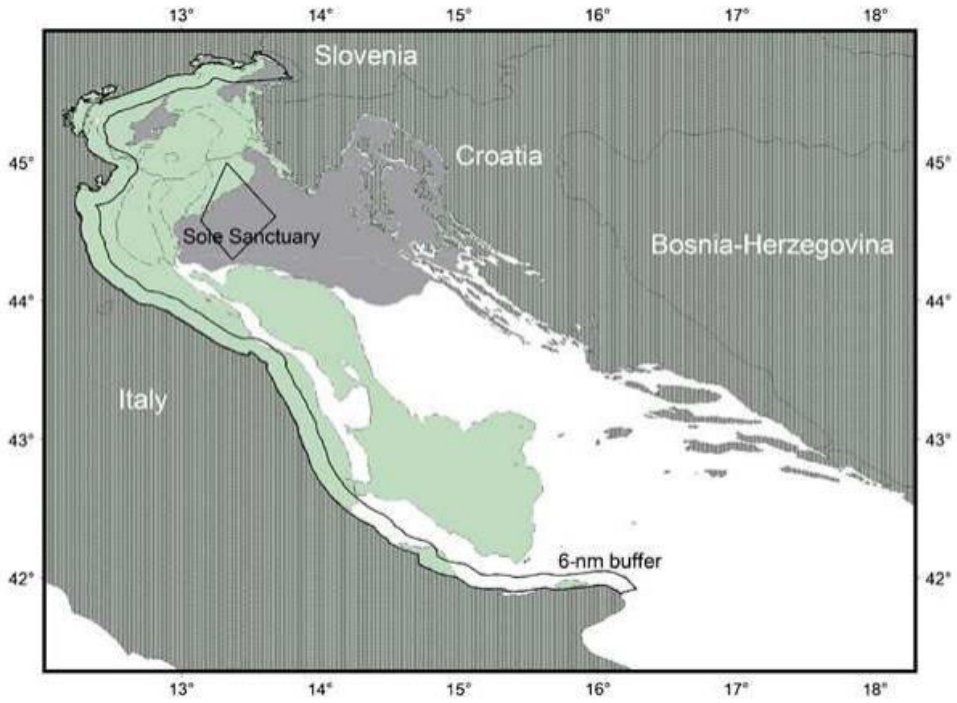

Figure 6.1.5. The "Sole sanctuary" modified from Bastardie *et al.*, 2017

These regulations exclude the maritime compartments of Monfalcone and Trieste because, due to the peculiar geomorphology of the northern Adriatic, the fishing areas of these compartments have a limited spatial extension.

Currently, small Italian trawlers classified as "coastal fishing" operate between 3 and 6 nautical miles from the coast. The trawl fleet with vessels above 15 metres of length and with a higher fishing license generally exploits the offshore fishing areas, except for vessels using the "fast" trawler, which usually operate in shallow waters deep (depth up to 50 metres). The exclusion of small trawlers and fast trawlers from the 6 nautical miles could generate spatial conflicts in the sea area on the outer 6 nm limit along with potential socio-economic problems for these fleet segments. From the DISPLACE results it can be seen that gillnet fishing will benefit from the

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prohibition of 6 nautical miles trawling and fast trawling in terms of catches per unit effort of sole.

The dredges will experience a reduction in fishing effort, as well as in sole and total landed. The discard rates for sole will decrease and there will be an overall increase in catches per unit of total effort.

For trawling this scenario would produce an overall increase in catches per unit of effort, total and sole catches, total and sole landings.

Based on the results of the DISPLACE model and scientific knowledge, the application of this measure would protect not only sole, but also all those species for which the coastal strip represents a first growth area, in particular cuttlefish. In fact, in spring the cuttlefish adults migrate from offshore to coastal waters to reproduce. The juveniles stay near the coast until the end of the summer and then make a migration in autumn towards the deeper waters, where they will remain until the spring of the following year. With this managerial measure part of the cycle could be preserved while ensuring better recruitment. There is currently no minimum landing size for this species.

Furthermore, to increase the reproductive success of the cuttlefish, a good practice could be to let the eggs hatch attached to fixed mail tools (e.g., traps, creels, etc.) avoiding cleaning them with a pressure washer, a practice currently in use in many Adriatic navies. For this purpose, special artificial structures have been tested for the deposition of cuttlefish eggs (Figure 6.1.6).

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Figure 6.1.6 Traps with cuttlefish and eggs

6.2 The ECOSS project

The ECOSS overall objective was the establishment of the ECOlogical observing system in the Adriatic Sea (ECOAdS). ECOAdS aimed at integrating the ecological and oceanographic dimensions within the conservation strategy of the *Natura2000* network, and at proposing a way to go for its future development and maintenance. ECOAdS is an on-line open science platform available through the following link: https://ecoads.eu/ which design was led by National Research Council – CNR from Italy.

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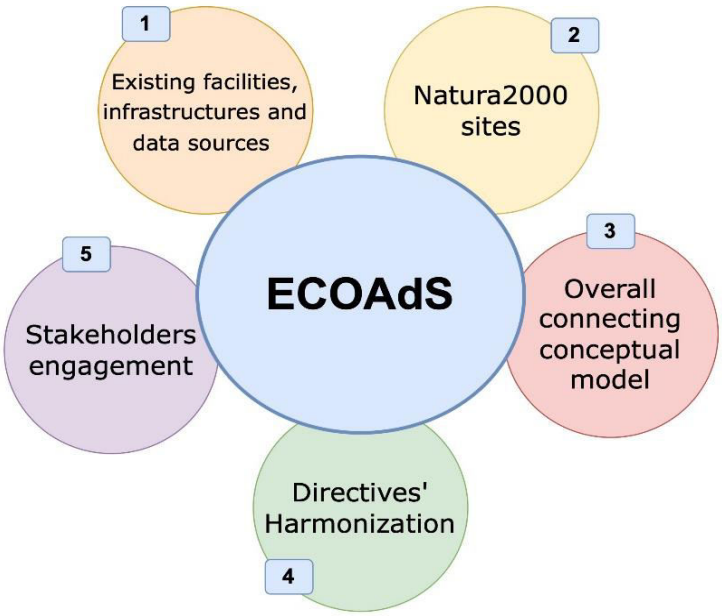
The ECOSS project contributed to the improvement of biodiversity conservation. Its results can be eventually exploited for the marine pollution and small ports management, but this is subject to further investigations that shall be discussed with CNR. In terms of biodiversity conservation, ECOSS addressed the issue of an ineffective monitoring of *Natura2000* habitats and species at Adriatic basin scale. It contributed to the protection of *Natura2000* habitats and species, especially for those sites without management and monitoring plans, which are the majority in the focus area. ECOAdS lays its foundation on the incorporation of ecological connectivity, and it supports the adoption of an ecosystem-based approach to management as well.

Figure 6.2.1 Schematic representation of the key integrating elements of ECOAdS



The key integrating elements of ECOAdS (Fig. 6.2.1) are accessible through the ECOAdS web portal. They addressed the issue of an ineffective monitoring of *Natura2000* habitats and species at Adriatic basin scale through an integrated approach.

The existing facilities, infrastructures and data resources in the area were investigated evidencing through a SWOT analysis their major strengths, weaknesses and gaps. Observing

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and monitoring systems hold different aims and maturity levels. In particular they lack a coherent and harmonized coordination, from the local to the whole Adriatic basin scale. It should be highlighted that none of them has a transnational nature. They should be harmonized at the Adriatic basin scale.

Six *Natura2000* sites have been considered as case studies within the ECOSS project. This analysis evidenced overall a lack of management plans and coordinated and systematic monitoring both in Italy and in Croatia.

An overall connecting model was developed, linking the social, ecological and oceanographic dimensions with the conservation of the coastal and marine environment and its management. Examples of the application of the models are available on the ECOAdS web portal (Fig. 6.2.2).

The ECOAdS has been tested as a monitoring platform that may respond and contribute to the requirements of the main EU directives, in particular the Habitats and Birds, the Water Framework, the Marine Strategy Framework and the Maritime Spatial Planning directives. The harmonization and optimization of the existing monitoring and management frameworks, at national and trans-regional levels, are actually a crucial issue for the most effective and coordinated application of directives. ECOSS proposed the harmonization and prioritization of monitored variables, necessary for the setting up of a coherent ecosystem-based monitoring system, rooted in the ecosystem-based management (EBM) core elements.

An open science approach for local stakeholders' involvement was tested. In three dedicated workshops, we involved MPA managers, NGOs, and PhD students, with the aim of starting to share visions about what the main needs, expectations and challenges in the design and development of ECOAdS could be. Convincingly, the structure of the ECOAdS portal has been improved addressing the main needs, requirements and gaps that emerged during this participatory process.

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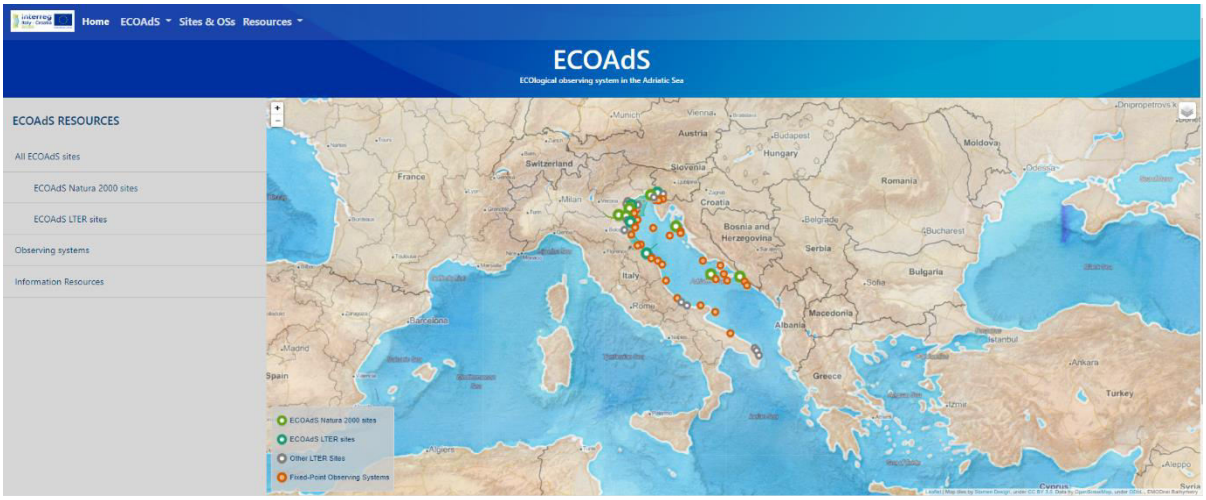

Figure 6.2.2 The outline of the ECOAdS web portal

6.3 The ECOMAP project

The ECOMAP project aimed to support small local ports, local authorities and organisations managing ports, to design and apply better environmental strategies aimed at sustainable management of their maritime space. Human overexploitation constitutes the greatest threat to the coasts today: coastal sites attract increasingly high-density building development; coastal waters are being contaminated by pollutants or excessive nutrient run-off and because population growth and migration continue unabated, pressure on the coasts is unlikely to diminish in the future (World Ocean Review, 2017). ECOMAP aimed to define strategy for implementing eco-sustainable management of marine and tourist ports by promoting a coordinated development and implementation of environmentally friendly solutions and the exchange of knowledge and good practices. The studies during the project helped for the identification of environmental pressure sources to manage and for the development of Integrated-Coastal Zone Management tools to respond dynamically to ongoing changes. In

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order to improve the environmental quality conditions of small marinas and touristic ports, different activities were undertaken implementation of innovative methodologies, investments in tools and small infrastructures and raising awareness. One of good indicators of the level of ports' pollution, but also of how responsibly ports activities are managed, is the microbiological quality of seawater and sediments (Jozić *et al.*, 2022). Two beaches (Prvavoda and Strožanac) and two marinas (Špinut and Strožanac) were monitored for water and sediment quality. Over 300 chemical analyses were performed. Collection of data and information during the project were used for integrated methodologies protocols such as geophysics, geochemistry, geomorphology, biology, ecology, etc., for the geomorphologic and hydrodynamic characterization of sea areas, coastal marine areas and tourist harbours. One of the goals of the ECOMAP project was also to determine microbiological quality of water in four marinas (two in Croatia and two in Italy) and two beaches in Croatia, and to assess whether the study areas are microbiologically loaded. For this purpose, new indicators were introduced to assess anthropogenic pressure (CHL and HB) (Jozić *et al.*, 2022). Thus, ECOMAP added a new analysis to the project by applying a novel methodology for microbial-source tracking. Based on the data collected in the ECOMAP project, it can be concluded that the microbiological quality of the water in all marinas meets the requirements of the project that is it is at least good, except for two sites in the marina Strožanac. The results show that activities in marinas do not have a negative impact on water quality both in the marinas themselves and in the adjacent areas.

The analyses of Faecal indicator bacteria (FIB) levels in sediment were performed in marinas Špinut and Strožanac. Sediments in the marina Strožanac and the adjacent beach next to the mouth of the river Žrnovnica have a great potential to contaminate seawater, as relatively high FIB levels were found in sediment samples. The microbiological quality of bathing waters on the beach of Podstrana was excellent in all sites during the bathing season, thus meeting the Blue Flag criteria for bathing waters. Since the aforementioned results of faecal indicator bacteria in the Žrnovnica River estuarine area showed the potential risk to human health for bathers due

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to their high concentrations, the sanitary survey was conducted to determine the sources of microbial contamination in the wider area of the estuary. Human and Lee Seagull markers were detected, implying two different sources of contamination in the investigated area, human and gull. According to the concentrations of chlorophyll and heterotrophic bacteria, the investigated ports are oligotrophic environments. Therefore, these ports do not contribute to anthropogenic pressure on the adjacent coastal environment (Jozić*et al.*, 2022).

The geophysical, geochemical and biological surveys within the ECOMAP project contributed to improving the knowledge, the dynamic processes and possible presence of pollutants of the test sites (Jozić*et al.*, 2022). Results of scientific research activities and the places where the studies were performed (sampling activities, geophysical surveys) are available online on the interactive map, free of charge to all marina users (Figure 6.3.1). ECOMAP platform will lead to further experiences' exchange to new adherents and new methodologies, given the fact that it is user-friendly.

Figure 6.3.1 Visualisations of the ECOMAP web platform

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In order to mitigate this environmental issue, the marina Podstrana is equipped with the dredging machine (Figure 6.3.2). Also, according to highest ecological standards, two mobile recycling yards were installed in the coastal area with the aim of reducing unsorted waste on beaches.

Four ports (Strožanac, Špinut, Marina Dorica and Porto Baseleghe) improved their ecological status by acquiring the necessary equipment and small-scale infrastructure. In marinas Špinut and Strožanac, equipment and small infrastructure for collection and treatment of wastewater from moles, as well as the system for collection and management of polluted rain waters from repair and maintenance area were installed (Figures 6.3.3 and 6.3.4)

Figure 6.3.2 Dredging machine in the Municipality of Podstrana

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Figure 6.3.3 Physical-chemical purifier of wastewater installed in marina Špinut

Figure 6.3.4 Mobile device for receiving and pumping fecal water from ships in marina Strožanac

In marina of Bibione, through the ECOMAP project, showers with recovery water systems were installed, which permits reuse and saves thousands water litres (Figure 6.3.5).

Figure 6.3.5 Showers installed in marina Bibione

To improve the performances of the de-oiling system in the Marina of Porto Baseleghe, a system of oil-absorbing re-usable filters were installed in the collection manholes to block the

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polluted dust, grit, and oily waters before their arrival to the main filtration system (Figure 6.3.6).

Figure 6.3.6 Mechanical oil separator in marina Porto Baseleghe

In marina Dorica, wastewater management trolley was installed, which uses an innovative oil absorbent technology for hydrocarbons and their derivatives, to reduce pollution caused by boats in the open sea (Figure 6.3.7).

Figure 6.3.7 Mobile pump for boat black waters in marina Dorica

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These processes and equipment were not available in the ports before the ECOMAP. With the successful installation of such equipment, this project's goal to improve the environmental quality conditions of small marinas and touristic ports influenced by anthropogenic activities was successfully accomplished.

Finally, the ECOMAP project efficiently resolved all issues arisen from the project: public lack of knowledge on conservation of biodiversity, lack of capacity for marina environmental management and not monitoring the water and sediment quality. In order to achieve environmental goals set by ECOMAP, raising awareness of the importance of regular monitoring of water quality in the area, due to detecting and reducing sources of pollution and consequently protection of the environment and human health, had a central role. A strong campaign and communication activities, which included even a congress with over 130 participants from 7 EU countries and almost 400 participants in different educations conducted, resulted in the reach of more than 6 million people in Italy and Croatia. New types of planning for the sustainability of ports and marinas were developed through innovative methodologies, investments on tools and small infrastructures and development of common strategies as well as two different kinds of monitoring networks, definition of indicators/pollutants and the establishment of the ECOMAP web map.

6.4 The SASPAS project

The common challenge of the SASPAS project was to preserve and get better status of conservation of biodiversity of the Adriatic Sea ecosystem in order to decrease its vulnerability. The overall objective was 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 seagrass in Adriatic area. In

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Kornati National Park two main activities were carried out for protection and preservation of marine seagrass *Posidonia oceanica*:

- Pilot transplantation of marine seagrass
- Establishment of an environmentally friendly system for anchoring

A pilot transplantation of *Posidonia oceanica* was carried in two locations in Kornati National Park in bays Kravljačica and Anica, selected locations were bays where free anchoring has been present for many years and where Posidonia meadows have been degraded.

In NP Kornati, two pilot transplantation campaigns were carried out using two different manual techniques:

1. Biodegradable supports consisting of a patented star-shaped anchoring system with 5 arms to which fasten the seagrass rhizomes (Scannavino *et. al.*, 2014)
2. Wooden supports (to which fasten the seagrass rhizomes) heavy enough and of low degradability in order to resist on the sea floor at least for a couple of years

In October 2019. Year in bay Kravljačica 720 *Posidonia* cuttings were taken from a healthy meadow in bay Borovnik and attached to supports made of corn starch. These supports have the role of adhering to the rhizomes, while the plant takes root and accepted itself in the seabed. With time, they will completely decompose.

The transplantation process was repeated in October 2021. Year in Anica Bay. 600*Posidonia* cuttings were taken from healthy donor meadows in bay Prisliga. During this transplantation methodology was different and this time supports were made from wooden skirting, and *Posidonia* rhizomes were attached with biodegradable ties.

In order to monitor the progress and success of the transplant procedure in Kravljačica Bay, the condition of the meadow was continuously monitored, which showed that the transplant was successful. There was no visible physical damage on biodegradable carriers, while the success rate was estimated at 65%.

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The results of the monitoring campaign carried out in May 2022 in Anica Bay showed a good survival and status of the transplanted shoots. However, as for the Kravljačica Bay, the high sedimentation of fine sediment particles into seagrass leaves is a major stressor for *Posidonia*.

To reduce the negative impact of anchoring on the habitats of seagrass *Posidonia oceanica*, during July/June 2021 and June 2022 a total of 52 environmentally friendly anchoring buoys, for ships up to 16 meters in length, were set up in the Kornati National Park in following bays:

Figure 6.4.1. Eco friendly buoys in Kravljačica Bay – 10 bouys

Figure 6.4.2. Eco friendly buoys in Strižnja Bay – 10 bouys

Figure 6.4.3. Eco friendly buoys in Šipnate Bay – 10 bouys.

Figure 6.4.4. Eco friendly buoys in TomasovacSuha Punta Bay – 10 bouys.

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Figure 6.4.5. Eco friendly buoys in Anica Bay - 12 bouys.

The installation of the buoys in Kornati National Park was performed by a Croatian company – Murgons d.o.o. All buoys were set up using the "Earth Anchor" system of drilling through sand and sea sediment into the rock surface where the anchors were shot directly into the seabed. Given the nature of the setup, the impact on marine sediment is short-lived and negligible. During the installation, and later the exploitation of the anchorage, there is no contact with the vegetation cover, which is extremely important for the preservation of seagrasses and why this anchor system is more environmentally friendly compared to the installation of concrete blocks.

Each anchorage consists of a circular sea area with an anchor bolt in the centre, as well as an anchor buoy with a final mooring loop of anchor next to it (Figure 6.4.6). It is important to emphasize that this solution was chosen to ensure that the anchor chain does not touch the seabed during the lowest water level.

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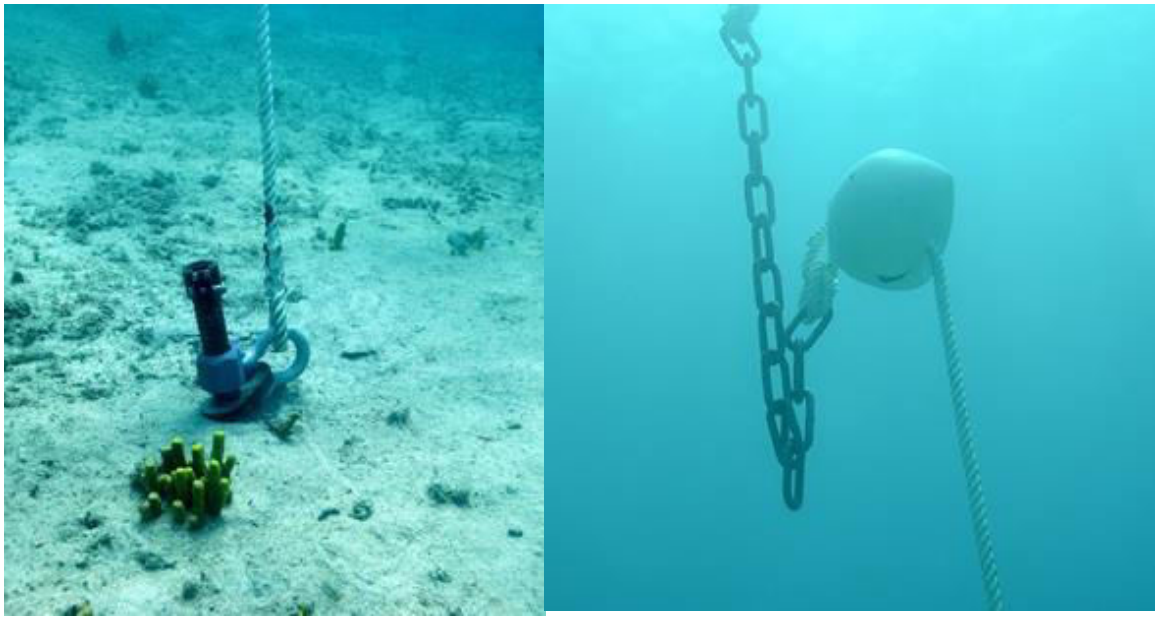

Figure 6.4.6 Installation of the eco – friendly buoys using the “Earth Anchor”system.

Figure 6.4.7 Buoy to which the vessel is moored with a bow.

European Regional Development Fund

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The anchor mooring works in such way that the vessel is moored to the anchor rope and depending on the influence on the wind on the vessel, it rotates around the anchor buoy (Figure 6.4.7).

With the successful installation of such an anchoring system, the realization of the long – term goal of the Kornati National Park has begun, to establish anchorages in all 19 bays and to completely ban free anchoring in the Kornati National Park.

6.5 The SOUNSCAPE project

For the first time, the Italy-Croatia project SOUNDSCAPE: Soundscapes in the North Adriatic Sea and their impact on marine biological resources", measured underwater noise pollution in the northern Adriatic. The North Adriatic Sea (NAS) is an area strongly affected by the increase in maritime traffic, tourism and resource exploitation, despite having a very vulnerable biodiversity.

The SOUNDSCAPE project was able to deliver a first monthly atlas mapped to underwater noise in the North Adriatic Sea. The first recording period started at the end of February 2020: so the project had the unique opportunity to record and map underwater noise during a period of "low human impact" due to the pandemic. The main objective of the Soundscape project is to create cross-border technical, scientific and institutional cooperation between Italy and Croatia to jointly face the challenge of assessing the impact of underwater environmental noise on marine fauna and in general on the NAS ecosystem. This cooperation aims to ensure effective protection of the most sensitive marine species and to develop sustainable use of marine and coastal ecosystems and resources.

Noise pollution produced by human activities disturbs life in the marine environment. In the Adriatic Sea, where the traffic of goods is increasingly intense, the noise of the ships interrupts the communication of dolphins, tunas, turtles and many other animals, as well as interfering

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with their ability to search for food and to orient themselves. The Soundscape project has created a map of underwater noise in the Adriatic, with the aim of monitoring the situation and identifying the most affected areas to protect. To achieve good environmental status (GES) of EU marine waters by 2020, Marine Strategy Framework Directive (MSFD), the descriptor 11 (D11) emphasizes the need to monitor and manage underwater noise. The Soundscape project will contribute to filling the knowledge gap on underwater noise by collecting continuous measurements of noise, assessing its impact on biodiversity and performing advanced sound propagation modelling in the North Adriatic Sea.

The main actions carried out in the project included: implementation of a shared monitoring network for a coordinated regional and transnational assessment of submarine noise by placing nine hydrophones in the North Adriatic Sea; evaluation of the impact of noise on marine biological resources. This includes the study of the effects of underwater noise on two target species: the bottlenose dolphin (*Tursiops truncatus*) and the sea turtle, especially the common one (*Caretta caretta*). Finally, the development and implementation of a planning tool for easy management.

The idea that anthropogenic noise can have harmful effects on marine life dates back to the 1970s, but only since 2000s have studies on this pollutant become conspicuous. Today, international research confirmed the harmful effects of underwater noise on mammals, invertebrates and fish (Duarte *et al.* 2021). Directive 2008/56/EC (Marine Strategy Framework Directive, MSFD; EU), which was revised in Commission Directive 2017/845/EU, 2017, requires the achievement of good environmental status (GES) in European seas, by 2020. Regarding underwater noise, MSFD Descriptor 11 states that GES is obtained when the introduction of energy, including sound, is at levels that do not harm the marine environment. To implement this, there needs to be an established monitoring programme, looking at the current level and possible trends of environmental noise in European seas. Underwater modelling has a long scientific tradition and has been in operation for over 50 years, with its development for

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military purposes. There are essentially five types of models (computer solutions of the wave equation) to describe the propagation of sound in the sea: spectral equation models, normal, beam and parabolic modes and direct finite differences or finite elements, solutions of the full wave equation. All these models take into account the variation of characteristics of the oceanic environment with depth. The most sophisticated and integrated modelling systems allow the numerical reconstruction of the sound field in a given realistic environmental context; with the SOUNSCAPE project three-dimensional noise has been mapped as a function of time, according to flows of environmental data and information on human activity and identification flows. To optimize the value of the data collected during the SOUNDSCAPE project and to better estimate mitigation actions, state-of-the-art modelling was applied to estimate marine noise as a whole by numerical simulation. For this purpose, the Quonops system, by Quiet-Oceans, a company that collaborated on the project, was selected to produce a spatio-temporal estimate of the distribution of noise levels generated by human activities at sea, aggregating multiple sources, and evaluate, thus, the contributions of the sources in the short, medium and long term with the global noise field.

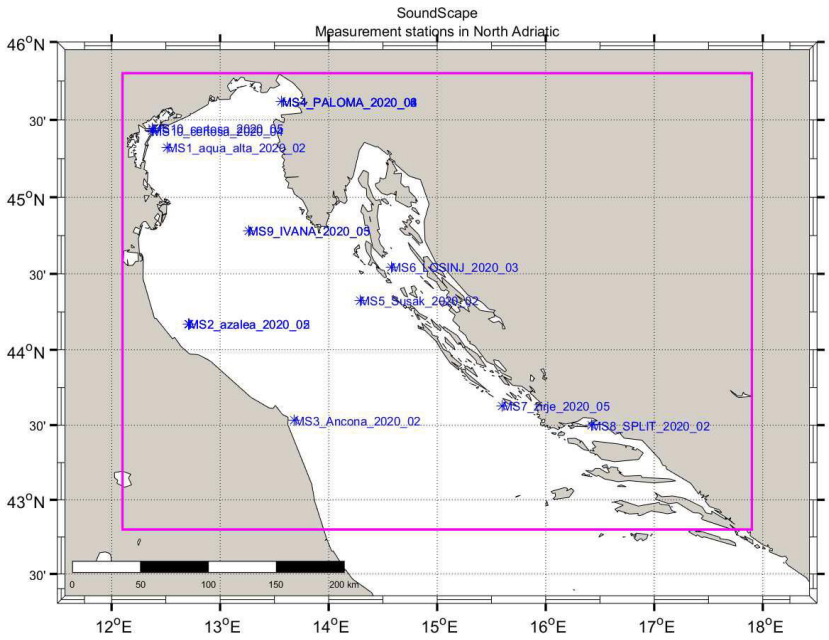

Figure 6.5.1. Location of measurement stations.

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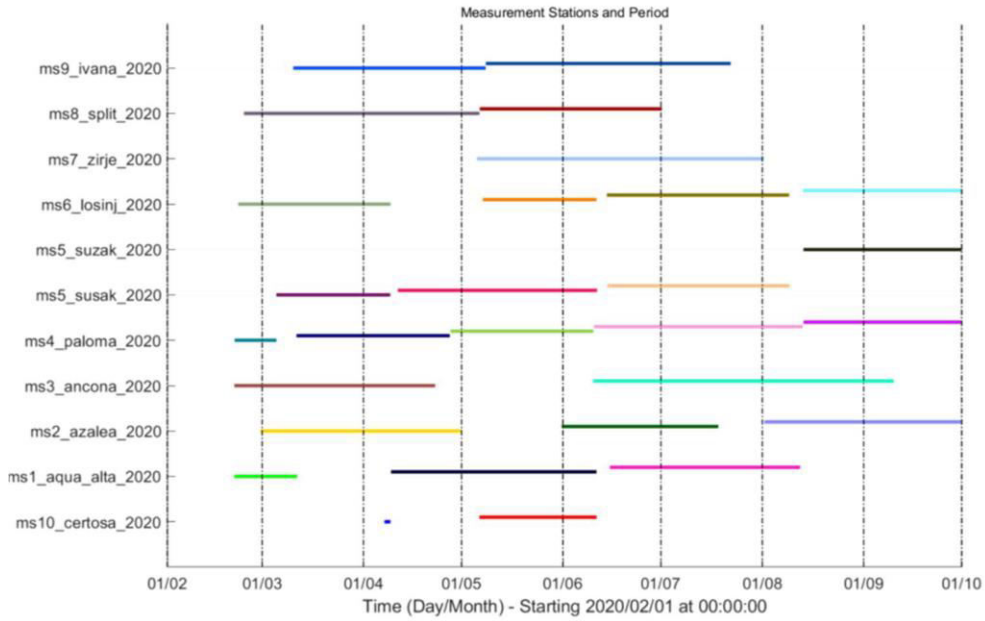

Figure 6.5.2 Periods of Measurement data/station

The results of the QUONOPS model for the Adriatic domain and Lošinj are available on the online platform: *https://qos.quiet-oceans.com/* which can be used in the context of the SOUNDSCAPE project for the next 4 years. On the Quonops Online Service platform, you can find a total of 2016 maps available to the Soundscape project and find the following information:

- 12 months of statistical sound maps from January to December 2020,
- 4 frequencies: 63, 125, 250 and 4000,
- 7 percentiles: 5, 10, 25, 50, 75, 90 and 95%
- 3 depth levels (0-15, 15-30, 30-bottom).
- 2 types of maps: baseline and natural noise level.

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These are maps of basic traffic noise and natural noise contributions and maps of natural environmental noise in the absence of any man-made contributions.

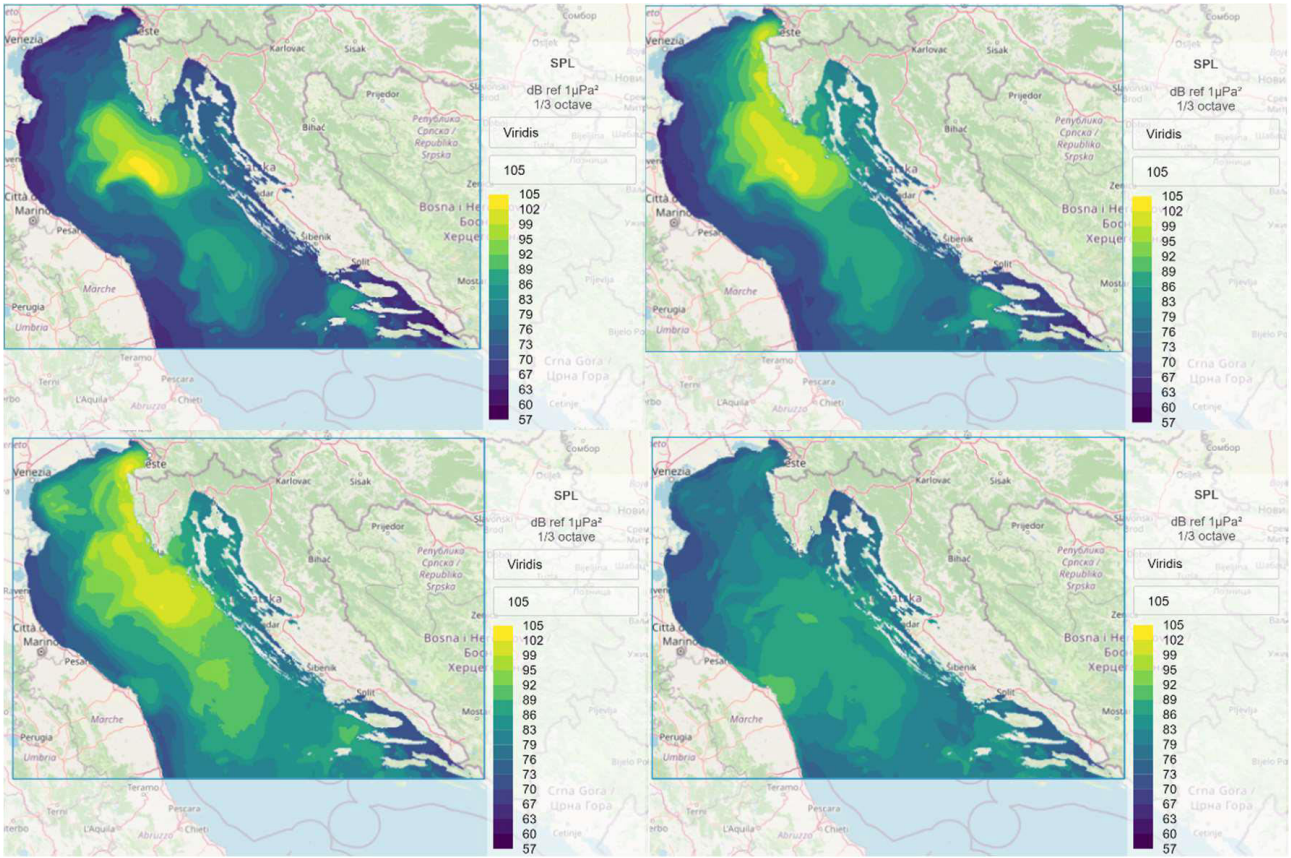

Figure 6.5.3. Adriatic baseline noise-level map, generated for February 2020 and calculated on the whole.

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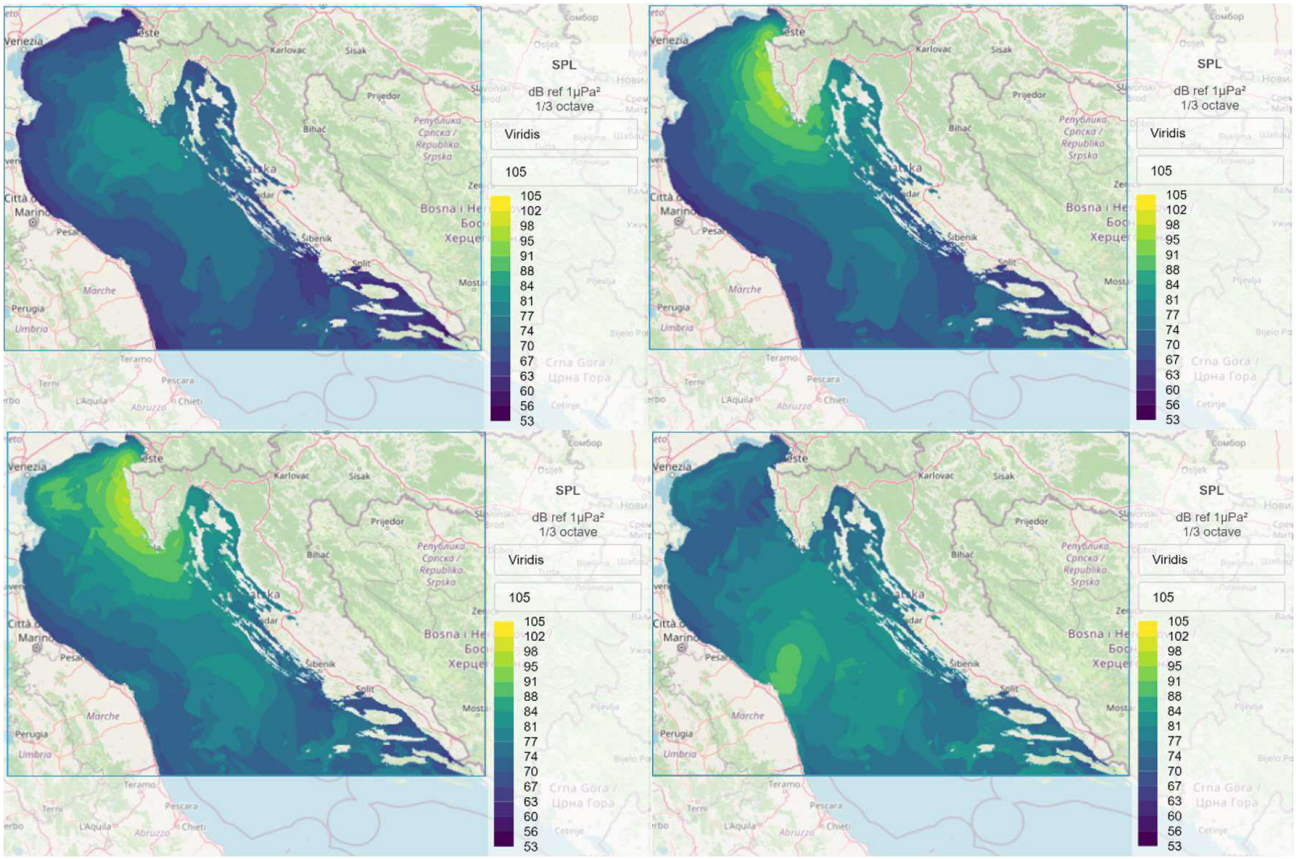

Figure 6.5.4. Adriatic baseline noise-level map, generated for August 2020 and calculated on the whole.

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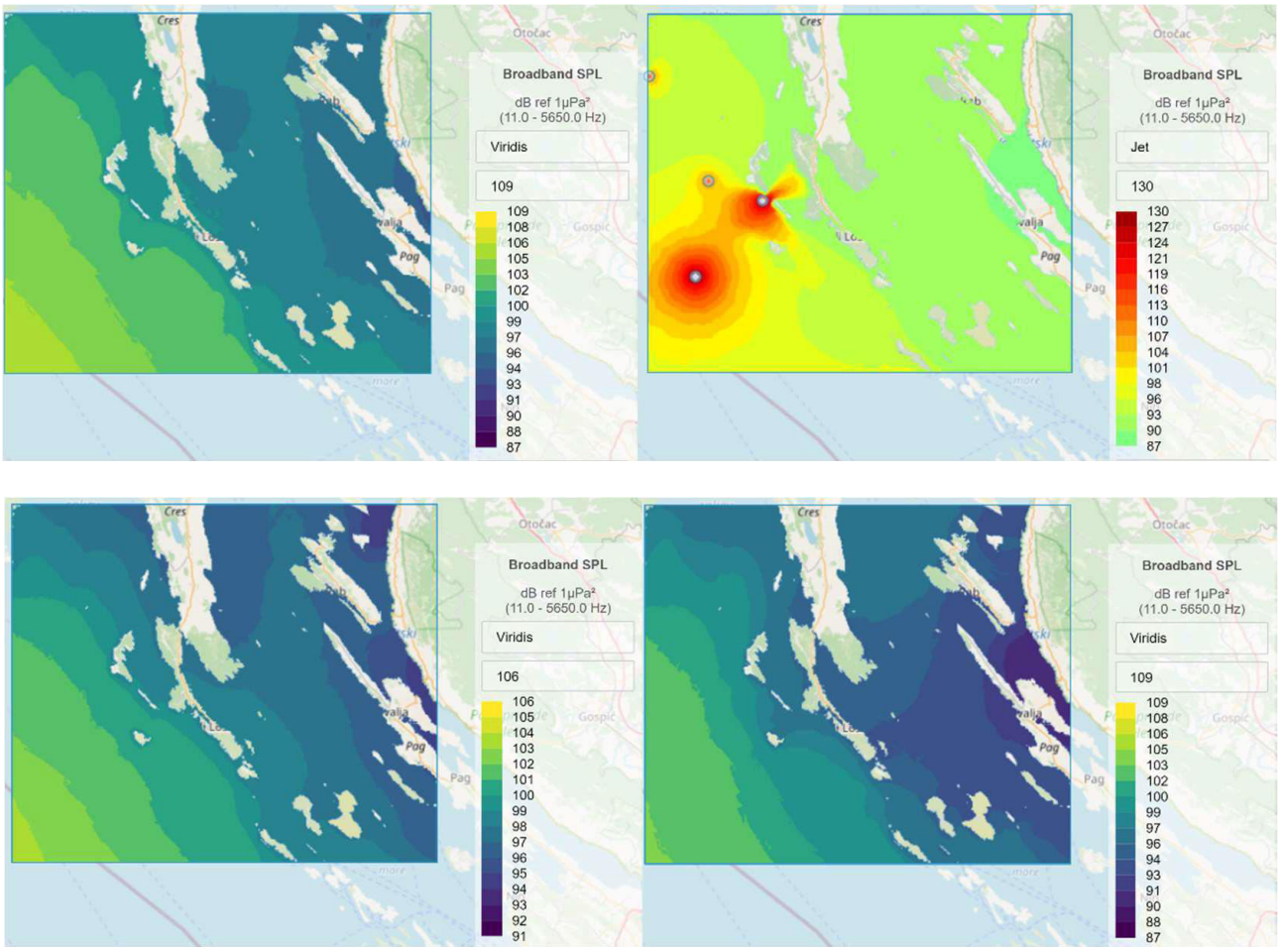

Figure 6.5.5 Losinj model, monthly maps for October and November (top panels from left to right), and December plus instantaneous value (bottom panels from left to right).

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The noise maps (Figures 6.5.3; 6.5.4; 6.5.5) provide an estimate of the spatio-temporal distribution of noise levels in the Northern Adriatic over a year, with particular regard to the inputs generated by human activities at sea. It can be highlighted that naval traffic is concentrated along two main routes which longitudinally cross the Adriatic Sea and branch off towards the main ports (Venice, Trieste, Capo d'Istria) in the northern part of the basin. The distribution of noise levels highlighted by the modelling for the study area seems to be clearly influenced by locally correlated variables such as the depth of the water, which is greater in the central part of the basin, the composition of the sediment, mainly sandy along the Italian coasts and rocky along the Croatian coasts, as well as related temporal variables such as the stratification of the water column during the summer period. In particular, the vertical stratification of the density of the water guides the sound towards lower scales, while the sandy-muddy bottom absorbs the noise more than the rocky bottom, which rather acts as a reflector of the acoustic waves. The composition of the bottom sediment is another limit; in fact this data is unified in the EMODNET and NAVO providers and the spatial resolution may sometimes not be very accurate with respect to the real composition variability of the bottom sediment. The coverage of the AIS data is not sufficient; in fact the number of ships surveyed appears scarce in the southern area of the domain. Another problem is the fact that anthropogenic noise sources such as pleasure boats, drilling or other industrial activities are not included in the model but can locally have an important effect; this is particularly true for the presence of pleasure boats in tourist places during the summer months.

The lockdown in 2020 and the slow reopening during the summer may underestimate the noise data in fact due to the lockdown; the noise values modelled in some periods could be lower than expected in "normal" periods. Finally, also the calibration process can affect the limits of the model: since the data of some stations suffered from an instrumental bias, the model calibration was performed on a limited number of stations mainly distributed along the Italian

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sandy coasts. This means that the values referring to the Croatian coasts, with particular regard to the southern part, could be affected by a higher level of uncertainty.

However, a first atlas of underwater noise maps in the North Adriatic has been created. This fills a relevant gap in the knowledge of noise distribution in the Mediterranean. The maps refer to an exceptional period: the year 2020 represents the lockdown period of the pandemic (from January 2020 to May 2020) with limited naval traffic and no other human activity was allowed. This is a unique opportunity to model a low human impact time. The model suffers from some input limitations and gaps in the calibration data but comparisons with measured data show that it is reliable as an average representation of submarine noise levels in the North Adriatic Sea.

6.6 The ML-REPAIR project

The Marine Litter (ML) is a huge problem also for all countries facing on the semi-enclosed Adriatic basin, due to geographical aspects and anthropic pressures. A strong concern over the presence and distribution of ML in the Adriatic Sea clearly emerged during the previous DEFISHGEAR (DFG) project, which demonstrated also that the local communities, the coastal tourism and the fishing sector contribute to such issue but can also be part of the solution. The fishing sector has a double potential in dealing with the ML issue, for both preventions, by increasing awareness in the correct obsolete fishing gears disposal, and reduction, by acting in *Fishing for Litter (FfL)* initiatives.

In this contest, the ML-REPAIR project was a capitalization project of the previous DFG project, focused toward an environmentally sustainable growth of the touristic and fishery activities in the Adriatic Sea. The project conceived to provide efficient approaches, tools and actions, in order to reduce anthropic debris generation and ML in the Adriatic Sea and consequentially improve the overall environmental quality of its waters in the mid-long term. All actions,

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objectives and planning of the entire project were carried out in such a way as to facilitate the management and the implementation of the project itself, by comparing available strategies and activities proposed by both Italy and Croatia, where social, legislative and economic differences exist. The other main focus of the project was to involve various target groups (fishermen and fishing associations/cooperatives, local communities and the younger population, the tourism sector, public administration bodies and the FLAGS, etc.) of such actions and convince them to actively participate in proposed activities and initiatives.

In the ML-REPAIR project, these goals focused on strategic topics dealing mainly with an enhancement of environmental education of coastal population and tourists, with attention to new generations and fishery communities, and with an optimization of strategies for ML monitoring, management and scientific investigation that foresee an active and aware involvement of fishermen in activities such as *Fishing for Litter* (FfL).

6.6.1 The *Fishing for Litter* (FfL)

The waste that lies on the seafloor or floats in the water column is commonly captured by fishing nets, especially by bottom trawl nets, and constitutes a variable part of the daily catch of fishermen.

The *Fishing for litter* (FfL), i.e., fishing for marine litter by the fishermen and other stakeholders involved, is therefore aimed at solving the problem of Marine Litter, or at least facilitating progress toward a more sustainable future.

Within the ML-REPAIR project, such activities were carried out both in Italy and Croatia, involving various target groups, such as fishermen and fishing associations/cooperatives, local communities and the younger population, the tourism sector, public administration bodies and FLAG (Fisheries Local Action Groups) and LAGs (Local Action Groups).

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This project dealt with the problem of plastics and other discharged waste in the sea. As previous participative projects (DEFISHGEAR, GAP1 and GAP2) clearly demonstrated, the interaction between scientists and fisheries stakeholders is a key tool for the success of every initiative concerning the marine environment. The FfL activities engaged fishermen in monitoring and collecting ML, also experimenting innovative and "smart" tools, such as a free app for Android tablet/smartphone. Three main activities were selected: the generation of Fishing for Litter Implementation Status Map (FFISM), fishing for Litter catches (composition and quantities) and a monitoring of ALDFG and ML affecting *Natura2000* sites.

The Fishing for Litter Implementation Status Map (FFISM)

The ML-REPAIR project aimed to generate a first and comprehensive "map" of the actual state of the FfL activities implementation in the main fishing ports of the Adriatic Sea in the two countries. This map was conceived to provide to policymakers a useful tool to implement FfL plans; the map was filled with relevant information from project partners from both Italy and Croatia, which verified the implementation and feasibility of FfL initiatives. Relevant legislation, administrative or legislative concerns, logistic barriers and collected adopted solutions that could be used as inspiration by ports wishing to start the FfL scheme were also taken in account. The FFISM was composed by an Excel database (Table 6.6.1), and a WEB-GIS map specifically generated for the project, to ensure future public access to collected data.

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N.	Name of the Port	Administrative Region
1	Pescara	Abruzzo
2	Ortona	Abruzzo
3	Cesenatico	Emilia Romagna
4	Bellaria	Emilia Romagna
5	Rimini	Emilia Romagna
6	Riccione	Emilia Romagna
7	Cattolica	Emilia Romagna
8	Goro	Emilia Romagna
9	Porto Garibaldi	Emilia Romagna
10	Ravenna	Emilia Romagna
11	Cervia	Emilia Romagna
12	Trieste	Friuli Venezia Giulia
13	Monfalcone	Friuli Venezia Giulia
14	Grado	Friuli Venezia Giulia
15	Portonogaro	Friuli Venezia Giulia
16	Marano Lagunare	Friuli Venezia Giulia
17	Lignano Sabbiadoro	Friuli Venezia Giulia
18	San Benedetto del Tronto	Marche
19	Fano	Marche
20	Pesaro	Marche
21	Ancona	Marche
22	Civitanova Marche	Marche
23	Bari	Puglia
24	Trani	Puglia
25	Bisceglie	Puglia
26	Molfetta	Puglia
27	Santa Margherita di Savoia	Puglia
28	Barletta	Puglia
29	Manfredonia	Puglia
30	Monopoli	Puglia

N.	Name of the Port	Administrative Region
31	Mola di Bari	Puglia
32	Bibione	Veneto
33	Caorle	Veneto
34	Jesolo	Veneto
35	Venezia	Veneto
36	Giulianova	Abruzzo
37	Termoli	Molise
38	San Cataldo	Puglia
39	Otranto	Puglia
40	Castro	Puglia
41	Brindisi	Puglia
42	Chioggia	Veneto
43	Porto Levante	Veneto
44	Pila di porto Tolle	Veneto
45	Scardovari	Veneto

Table 6.6.1. Fishing ports included in the FFL Implementation Status Map in Italy.

In Italy, the main difficulties encountered in involved ports where FfL was put in place (27) were mainly related to the organization of the scheme itself and the logistics. These are two factors strictly connected to the lack of specific competencies for the different processes to follow and to unclear sources of financial support for the disposal of collected ML. Lastly, the survey investigated also the feasibility of the FFL scheme in ports where it was never implemented before. For the majority, FfL seemed to be a viable option, and also the collaboration of the fishermen was judged very positively. When asked about which incentive or motivation could foster the participation of the fishermen, the interviewees reported mainly economic incentives (also indirect, through discharges in due taxes), but also more information about the initiative and the presence of disposal facilities. The inclusion in the decision-making process was also reported as an important step to gain the fishermen trust and thus their active collaboration. In Croatia, FfL activities were implemented in seven ports. In all these sites, municipal containers

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for ML disposal were placed near the mooring area, which were managed by local public administrations. Since operating in absence of appropriate national legislation, the ML was provisionally classified as mixed municipal waste.

Fishing for litter catches: composition and quantities definition

The aim of this activity was to foster the collaboration with the fishery sector (as started in the previous DFG project), by involving a greater number of ports and vessels in the implementation of the FfL scheme in both Italy and Croatia and define composition and quantities of marine litter.

The ports involved in FfL activities in Italy were Chioggia (VE), Cesenatico (FC), Cattolica (RI) and Molfetta (BA), with a total of 23 fishing vessels actively participating. In Croatia, 9 fishermen ports with a total of 37 boats were instead involved. In order to collect FfL data, three data collection methods were proposed and generated: (1) a datasheet filled by fishermen on board, (2) Sampling on the quayside (3) the ML-REPAIR APP, a free app for Android specifically conceived and generated by the project.

For the method (1), a specific datasheet was conceived and provided to all involved fishermen, where they could take note of the types and quantities (as weight) of ML collected during their normal fishing activities. The datasheet was meant to be filled onboard during the working activities, so only a small set of information was required.

In method (2), in order to collect accurate data on ML, the scientific personnel carried out a characterization of a sub-sample of all waste landed by the fishing vessels randomly selected, was carried out on the port quayside. The waste was sorted, classified according to specific categories generated during the DFG project and updated, weighed and recorded in the data collection form. When possible, the number of items for each category was additionally counted and recorded. The data were then inserted into a specific database.

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Finally, in method (3), fishing vessels equipped with tablets provided by the project had the opportunity to test and apply the ML-REPAIR APP specifically developed by the project to record the main categories of ML caught in the nets. The use of the APP permitted to record ML data in a shorten time as well as to generate, an instant usage of the data from catches and visual proofs (pictures) of the catches (Figure 6.6.2)

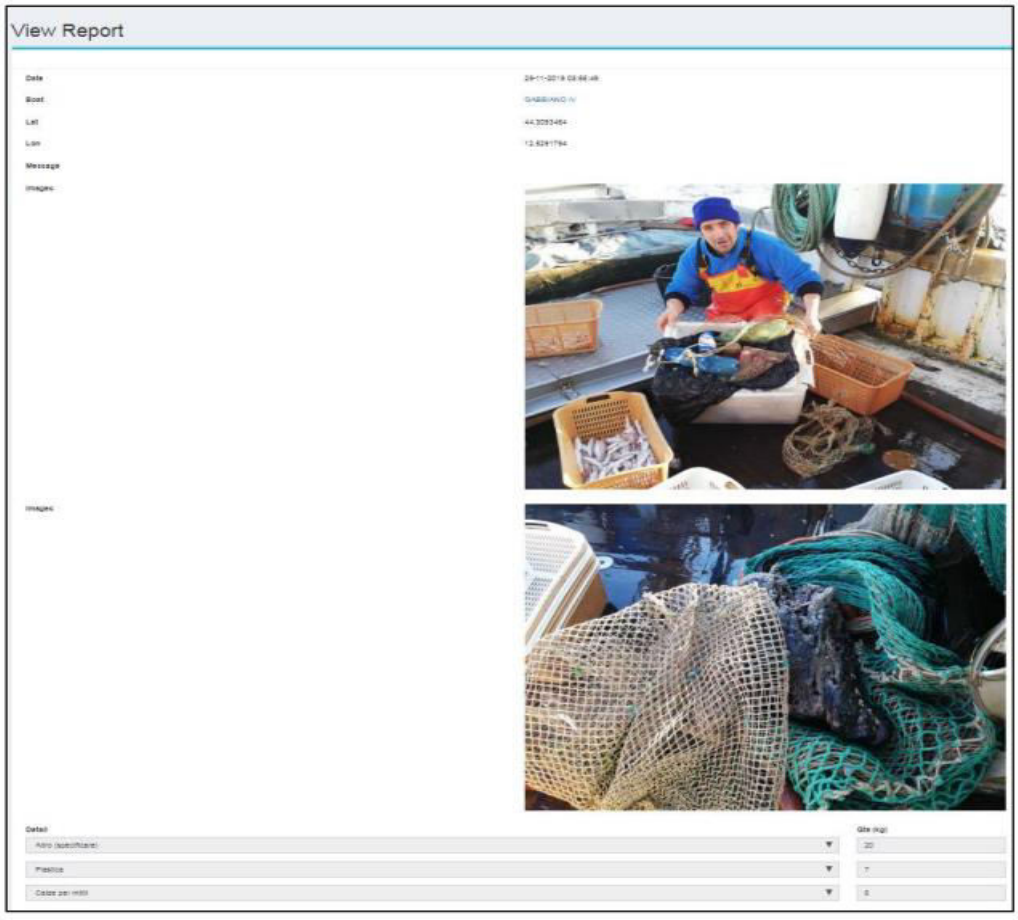

Figure 6.6.2. Screenshot of a typical report from the ML-REPAIR APP.

All data collected by involved fishermen were entered in a specific database different from the one used for the sampling on the quayside (Figure 6.6.3).

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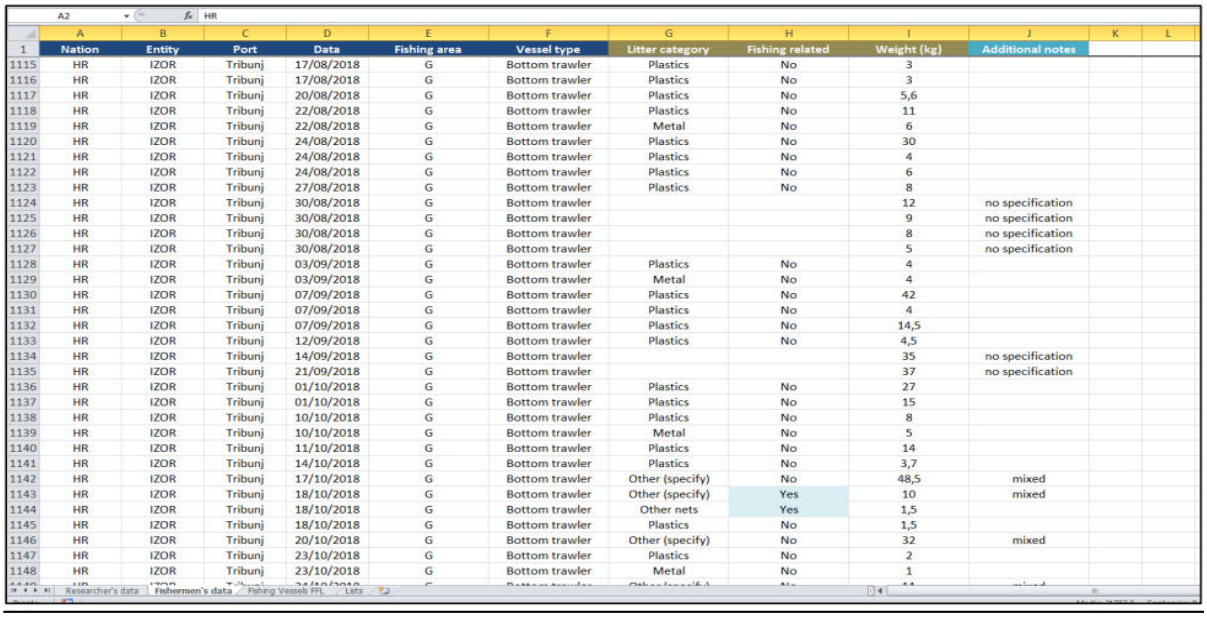

	A	B	C	D	E	F	G	H	I	J
1	Nation	Entity	Port	Data	Fishing area	Vessel type	Litter category	Fishing related	Weight (kg)	Additional notes
1115	HR	IZOR	Tribunj	17/08/2018	G	Bottom trawler	Plastics	No	3	
1116	HR	IZOR	Tribunj	17/08/2018	G	Bottom trawler	Plastics	No	3	
1117	HR	IZOR	Tribunj	20/08/2018	G	Bottom trawler	Plastics	No	5,6	
1118	HR	IZOR	Tribunj	22/08/2018	G	Bottom trawler	Plastics	No	11	
1119	HR	IZOR	Tribunj	22/08/2018	G	Bottom trawler	Metal	No	6	
1120	HR	IZOR	Tribunj	24/08/2018	G	Bottom trawler	Plastics	No	30	
1121	HR	IZOR	Tribunj	24/08/2018	G	Bottom trawler	Plastics	No	4	
1122	HR	IZOR	Tribunj	24/08/2018	G	Bottom trawler	Plastics	No	6	
1123	HR	IZOR	Tribunj	27/08/2018	G	Bottom trawler	Plastics	No	8	
1124	HR	IZOR	Tribunj	30/08/2018	G	Bottom trawler			12	no specification
1125	HR	IZOR	Tribunj	30/08/2018	G	Bottom trawler			9	no specification
1126	HR	IZOR	Tribunj	30/08/2018	G	Bottom trawler			8	no specification
1127	HR	IZOR	Tribunj	30/08/2018	G	Bottom trawler			5	no specification
1128	HR	IZOR	Tribunj	03/09/2018	G	Bottom trawler	Plastics	No	4	
1129	HR	IZOR	Tribunj	03/09/2018	G	Bottom trawler	Metal	No	4	
1130	HR	IZOR	Tribunj	07/09/2018	G	Bottom trawler	Plastics	No	42	
1131	HR	IZOR	Tribunj	07/09/2018	G	Bottom trawler	Plastics	No	4	
1132	HR	IZOR	Tribunj	07/09/2018	G	Bottom trawler	Plastics	No	14,5	
1133	HR	IZOR	Tribunj	12/09/2018	G	Bottom trawler	Plastics	No	4,5	
1134	HR	IZOR	Tribunj	14/09/2018	G	Bottom trawler			35	no specification
1135	HR	IZOR	Tribunj	21/09/2018	G	Bottom trawler			37	no specification
1136	HR	IZOR	Tribunj	01/10/2018	G	Bottom trawler	Plastics	No	27	
1137	HR	IZOR	Tribunj	01/10/2018	G	Bottom trawler	Plastics	No	15	
1138	HR	IZOR	Tribunj	10/10/2018	G	Bottom trawler	Plastics	No	8	
1139	HR	IZOR	Tribunj	10/10/2018	G	Bottom trawler	Metal	No	5	
1140	HR	IZOR	Tribunj	11/10/2018	G	Bottom trawler	Plastics	No	14	
1141	HR	IZOR	Tribunj	14/10/2018	G	Bottom trawler	Plastics	No	3,7	
1142	HR	IZOR	Tribunj	17/10/2018	G	Bottom trawler	Other (specify)	No	48,5	mixed
1143	HR	IZOR	Tribunj	18/10/2018	G	Bottom trawler	Other (specify)	Yes	10	mixed
1144	HR	IZOR	Tribunj	18/10/2018	G	Bottom trawler	Other nets	Yes	1,5	
1145	HR	IZOR	Tribunj	18/10/2018	G	Bottom trawler	Plastics	No	1,5	
1146	HR	IZOR	Tribunj	20/10/2018	G	Bottom trawler	Other (specify)	No	32	mixed
1147	HR	IZOR	Tribunj	23/10/2018	G	Bottom trawler	Plastics	No	2	
1148	HR	IZOR	Tribunj	23/10/2018	G	Bottom trawler	Metal	No	1	

Table 6.6.3. Database where was insert Data sheet: fishing area, vessel type, litter category etc.

As results of overall data collection, in Italy 22 tons of ML were collected in approx. 10 months, while in Croatia around 37 tons of litter could be collected. Approx. 60% of collected ML was composed by plastics, both in Italy and Croatia. In Italy (Figure 6.6.4) a large part of collected plastics was related to mussel nets (26%) or other fishing nets (14%). In Croatia (Figure 6.6.5) this percentage was quite small (5%), while the dominant fraction was composed by generic plastics (bottles, bags, etc). The other categories of found ML were Metal (7-11%), Glass (2-5%), Rubber (3-10%), Wood (4-7%) and Other (7-8%).

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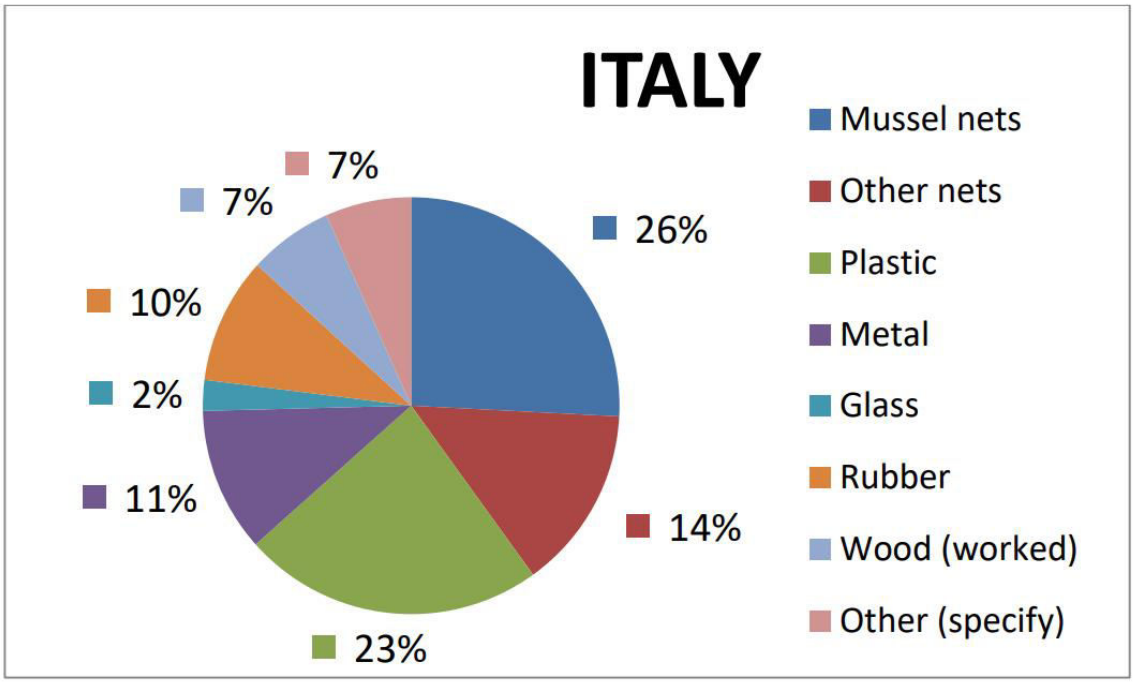

Figure 6.6.4. Composition (%) of marine litter collected by fishermen in Italy.

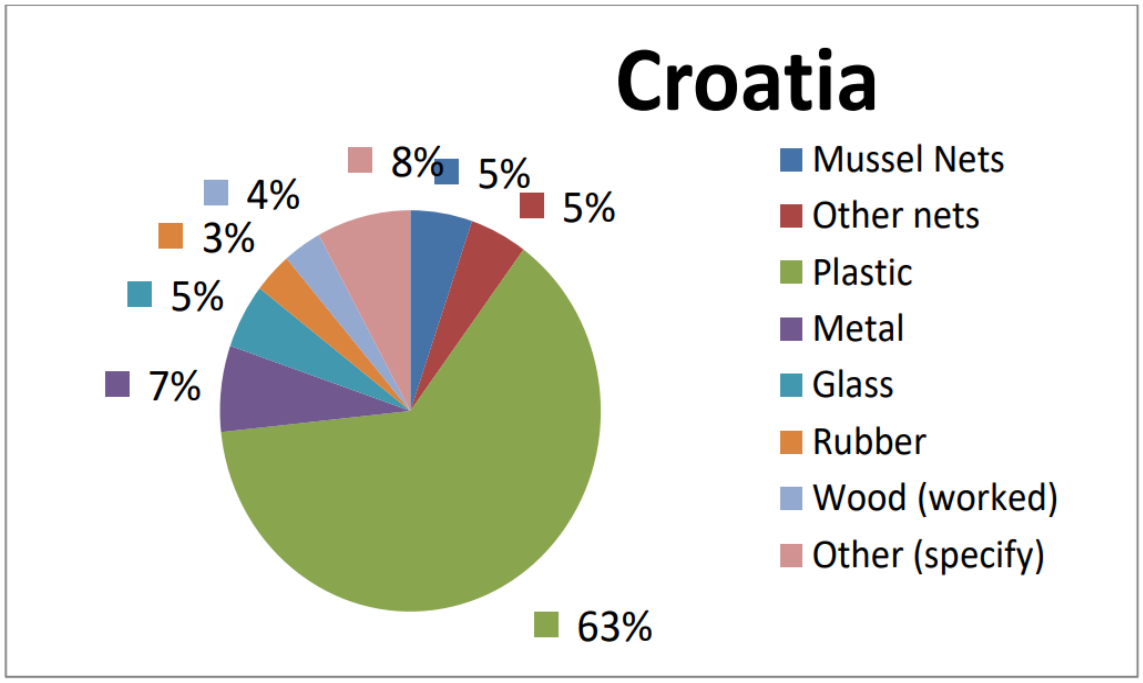

Figure 6.6.5. Composition (%) of marine litter collected by fishermen in Croatia.

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Monitoring of ALDFG and ML affecting Natura 2000 sites

As a final step, also marine litter and pollution in general of the *Natura2000* sites was monitored. The assessment of the ML presence and its active removal encompassed five *Natura2000* sites: *Pakleni islands* (HR3000095), Island of Vis – marine area (HR3000097), *Lokrum Island* (HR4000017) in Croatia, and the two SIC areas *"Tegnùe di Chioggia"* (IT3250047) and *Colle S. Bartolo* (IT5310006) in Italy.The purpose of seafloor monitoring activities in these sites was to improve the available data on quantities, composition, distribution, and possible sources of ML, as well as of abandoned, lost or discarded fishing gears (ALDFG).Depending on the preferences and equipment of the involved project partners, various non-invasive sampling methods were used in different areas, like linear transects performed by SCUBA divers and ROVs (Remotely Operating Vehicles). All collected ML items were analysed onboard, divided into 7 categories (artificial polymer materials, cloth/textile, glass/ceramics, metal, paper/cardboard, processed/worked wood, and rubber), and then classified into 53 subcategories according to the EU MSFD TG10 "*Guidance on Monitoring of Marine Litter in European Seas*" (Galgani*et al.*, 2013; Vlachogianni*et al.*, 2017) Master List. In Croatia, an apparent difference in ML composition, as well as quantities, between the selected locations with regard to the pressure of nautical tourism and exposure to dominant currents and winds, was identified. Glass and ceramic items were the most abundant (63%), followed by plastics (24%) and metals (6%) (Fig. 6.A). The dominance of glass/ceramic items was especially pronounced in locations with high pressure from nautical tourism, with the highest amounts recorded in Palmižana (46 items/100 m^2) where they represented approx 90% of the total number. In Italy, the dominant category was composed by artificial polymer materials (plastics) (>90%) in all monitored locations, followed by metal, ranging between 3-5%. In particular, the contribution of mussel nets can be higher due to the vicinity to mussel farms and the hydrological conditions. Indeed, Melli*et al.* (2017) hypothesized that mussel nets are transported by the main currents (northern branch of the WAC) that flows southward along the

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Italian coast, accumulating on the closest outcrop. During the monitoring, 474 specimens of the sea-sponge *G.cydonium* were identified. Among these sea-sponges, 40 were clearly impacted by ML (entanglement, contact, colonization). Monitoring activities conducted in five selected *Natura2000* sites in Italy and Croatia confirmed that ML pose a significant threat, not only to the marine habitat and species preservation although crucial, but also causes visual landscape contamination. Such activities provided first but fit-for-purpose data and baseline information on the amounts, composition and sources of ML in selected *Natura 2000* sites of Italy and Croatia, being a useful tool for appropriate authorities' managers to gear up their efforts in the ML threat management identify targeted measures to tackle this issue.

The ML-Repair project focused also on the polymeric characterisation of the recovered ML during the monitoring described above. This characterisation, carried out through Vibrational Spectroscopy techniques, constituted an advanced investigation of plastics waste within ML, especially in the aim of suggesting a possible "sustainable fate" for the recoverable plastic fraction, different from landfill disposal. Vibrational spectroscopy included well established techniques applied also in the study of plastic polymers, offering a wide range of sub-techniques, such as non-destructive ones, which could be applied directly to collected sample even on-site and can immediately identify the examined material. Within the ML-REPAIR, it was decided to apply the following three techniques: Fourier Transform Infrared Spectroscopy-Attenuated Total Reflectance (FTIR-ATR), Raman spectroscopy coupled to optical microscopy (μ-Raman), and Near InfraRed Spectroscopy (NIR).

In Table 6.6.2 explanations for acronyms relative to polymeric materials are reported.

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Acronym	*Name*	*Notes*
PE	Polyethylene	
PP	Polypropylene	
coPE-PP	(Polyethylene Polypropylene)	Copolymer or mixture (not discriminable)
PET	Polyethylene terephthalate	Polyesters
PS	Polystyrene	
PVC	Polyvinylchloride	
PA	Polyamides	Nylons
SAN	Styrene-acrylonitrile	
PC	Polycarbonates	
PMMA	Poly (methyl methacrylate)	Plexiglass®
Polyimide	-	techno polymer class
PDMSO	Polydimethylsiloxane	"silicone" elastomer
Cellulose	-	
Methylcell.	Methylcellulose	
N.I.	Not Identified	

Table 6.6.2. Official acronyms relative to polymeric materials.

6.6.2 Environmental education of coastal population and tourists

One project goal was to capitalize the DEFISHGEAR (DFG) project results by educating and raising awareness on ML problems and solutions main target groups that are both sources of the problem and affected by the problem: local communities, tourists, fishermen. A comprehensive cross border campaign was developed and implemented by a series of tools and activities such as exhibitions, workshops, video, posters, leaflets, and work with the media. The campaign was built over a comprehensive communication strategy, while other activities

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have been coordinated and implemented in both Croatia and Italy. Here there are some examples of the activities carried out to raise awareness.

Exhibitions about Marine Litter

Two pilot marine litter exhibitions, "*Plastica(mente)*" (IT) (Figure 6.6.6) and "*Fish market litter exhibition*" (HR) (6.6.7) were successfully developed and installed along the entire cross-border area. The "Plastica(mente)" exhibition consisted of panels and interactive games conceived for children. The "Fish market litter exhibition" concept was instead an open area exhibition formed of litter collected on the beach, with information on Marine Litter statistics.. Such exhibitions travelled from one city to another in both countries, and were installed in or nearby various fish markets. Below some representative images of the exhibitions are reported in Fig. 6.6.6-7.

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Figure 6.6.6.Representative images of the“Plastica(mente)” Exhibition.

Figure 6.6.7. Representative images of the “fish market litter exhibition".

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The Italian version of the exhibition "Plastica(mente)" was installed in Cavallino-Treporti (VE) from June 30thto July 12th,2018) as well as in Chioggia (VE) onJuly17th – 29th2018). The exhibition was installed also on the beach of Sottomarina (VE) during an animation event aimed to raise awareness about marine litter on 31stJuly the and in the beach of Cavallino-Treporti on August1st,2018. The "*Fish market litter exhibition*" was prepared in Marghera (VE) during a school exhibition on 4th June 2019. The "Fish market litter exhibition" was also shown during Plastica(mente) exhibitions in Cavallino and Chiogga. Other exhibitions were showed in various locations in Italy and Croatia, including Cattolica (RN) and Molfetta (BA). A"*Fish market litter exhibition*" was installed also in the Rimini Fish Market (May 18th,2019), made of beach litter items collected during the beach cleaning of the Monte San Bartolo Park.

Educational programme about Marine Litter

A comprehensive educational programme for local communities' children was developed and implemented in order to raise their awareness and understanding of the ML issue. By engaging children, they directly influenced their parents as well. In Italy, this program was composed of 4h laboratories, educating about the ML issue and stimulating the autonomous work of involved students. In total 3785 children and 199 schoolteachers were involved through developed educational programs during period of project implementation.

In Croatia, this program was composed of half-day workshops about the ML topic aside the exhibition *Plastica(mente)* exhibition, as well as three-day workshops including theory, fieldwork and the development of a small project, a competition on the best marine litter project with a field trip as a reward, and a one-day workshop with 15 kindergarten teachers (trained on how to implement workshops about ML for their kindergarten children). In total, 812 children and 26 kindergarten teachers were educated through educational programs developed during the period of project implementation.

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Marine Litter awareness campaign for tourists

This dedicated campaign was focused on raising awareness of tourists visiting the cross-border area on their contribution to the marine litter issue and how they can help to solve it. Specific communication material was produced with short and smart messages, which were distributed on points most frequently visited by tourists, such as beaches, ports, ferries, marinas, tourism agencies, bus/train stops. One unique cross-border campaign was designed taking into account the specificities of each country, primarily in terms of identifying the most appropriate communication channels and tools to be used. This campaign for raising tourists' awareness on ML problem was composed of the following communication materials - video, poster, ashtray, stickers, radio jingles.

The project included also an action concerning the training of beach animators, so that they could in turn provide correct information to tourists. Many actors were involved in this activity, such as:-receptions and front offices of campsites, - hotels and bathing establishments, - Tourist Information Offices, - other facilities for tourists like bike and boat rentals, - farm holidays, - guides, and other stakeholders. The animation on the beach followed a particular methodology and additional values such as creating excellent relationship between the time spent in the activity and number of people involved which leads to one-to-one people involvement, making tourists and local people closer to the aims and goals of the project (such as leaving the beach clean). People involved by all these activities, directly and indirectly, were approx. 3.500.

6.6.3 Biodiversity, Small ports management and Marine pollution in the ML-Repair project

The ML-REPAIR project, dealing mainly on ML, exhibited strong correlations not only with ML pollution, but also with biodiversity and small port management issue.

As was clear from the project description, many Italian and Croatian ports lack dedicated waste containers and provisions regarding marine waste brought ashore.

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Most fishermen, both those involved in the project and those who did not take part in it, still bring back to shore the waste caught during their trips out to sea. The problem, however, is the disposal of this waste. Many small ports lack dumpsters and facilities for their disposal, which discourages fishermen from continuing their spontaneous work of cleaning up the sea. Thanks to the recent *Salvamare law* that recently (July 2022) came into effect in Italy, there is a little extra incentive, a better organization in small and large ports regarding ML and a small economic incentive towards those categories who work also to clean up the sea (e.g., monetary compensation and tax relief) is moreover required. Through the FfL actions and an improved management of small ports, the ideas and actions behind the ML-REPAIR project can also positively affect the biodiversity of the Adriatic Sea. In fact, with less waste in the sea (thanks to cooperation with fishermen in small and large marinas, and public awareness increase) the various fish species, both commercial and non-commercial, and marine biodiversity in general greatly benefit due to a decrease of ML.

6.7 The Net4mPlastic project

6.7.1 Introduction: description of the project

NET4mPlastic project focuses on marine litter (ML) identified in all marine environments that pose serious threats to marine life, human health, and coastal economies. Indeed, large quantities of debris can now be found in the most remote places of the ocean and persist almost indefinitely in the environment. This represents a significant cause for concern, although much of this growing threat to biodiversity and human health is easily preventable with solutions readily available. Some solutions have been tested during Net4mPlastic. Therefore, the project also focuses on some biodiversity aspects even its main objective was not related to biodiversity.

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Persistent plastics have an estimated lifetime for degradation of hundreds of years in marine conditions, and can break up into micro- and nano plastics, allowing their uptake by marine biota throughout the food chain. Microplastic (MP) has been recognised as a global concern, and the knowledge of the occurrence, composition, size and distribution of MP is paramount to understanding their risk. There is still a lack of standard operation protocols for MP detection and quantification and reliable data on concentrations and composition within the marine environment. NET4mPlastic aimed to develop new solutions using numerical simulations for identifying ML accumulation to highlight environment and human health impacts (that could be useful for marine pollution and port management).

During the project we achieved the following points:

1. Revision of sampling methodology
2. Test the possibility of using innovative solutions to monitor the presence of marine litter (aerial and marine drone, holo-sensor, …)
3. Platform and Early Warning System (forecasting MP accumulation)
4. Analysis of MP present in mussels / observation of the assimilation in mussels under controlled conditions
5. Observation of the alterations of human cells grown in vitro
6. Test a new patent to recycle microplastics*
7. Involvement of the population and stakeholder through public engagement events

The dissemination of results may encourage a people better awareness regarding the linkages between all elements of daily activities concerning waste generation and their management.

**Results demonstrate the possibility to use microplastics as filler in this foamy material; there are evidence of good acoustic and thermal insulation properties. Microplastic content and type*

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can be varied to customize final foam properties. Some sample foams obtained with this method are shown below.

As already mentioned, NET4mPLASTIC aims to define origin, abundance, distribution and potential accumulation areas of microplastics (MP) and co-pollutants in marine systems and especially in 4 pilot sites.

The activities of the project were regrouped in three work packages, which are:

- Preliminary activities and project implementation: to i) improve the knowledge on macro and microplastic (MP) and related pollutants in the Adriatic Basin and ii) obtain preliminary results on possible coastal zones of MP accumulation using a transport model. It includes 4 main activities:

- State of art of legal aspects, methodologies, technologies, MP and related pollutants occurrence
- Data collection for selected Macro-Areas in Italy and Croatia and model implementation
- Study and Design of the Integrated Platform's structure associated with early warning system
- Microplastic and health

- Demonstration activities: testing and improvement of developed methodologies to assess potential distribution of plastics and MP. Field surveys and laboratory analysis will allow the quantification and identification of typology of the MP items. Four activities will be performed that are:

- Monitoring plastic and microplastic wastes on coastal and marine environments
- Laboratory analysis on plastic and microplastic wastes on coastal and marine environments
- Numerical simulations
- Microplastic and risks for Human Health

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- Development of Information and Communication Technology (integrated platform), which includes 4 main activities:

- Implementation of the platform (HW, SW) with field and laboratory data
- Development of the UAV/marine drone for data acquisition
- EWS setting and calibration
- Pilot implementation, business simulation and assessment

6.7.2 Description of the pilot sites

Po Delta to assess the influence of riverine input:

The river Po is the largest river in Italy. Its drainage area (74 000 km2) encompasses much of the northern region of the country, with more than 20 million inhabitants, and includes many large cities as well as areas of intensive industrial and agricultural activities. The River Po also provides the largest riverine influx to the Adriatic Sea, with an average daily input of freshwater amounts 1500m^3/s with streamflow ranging between 100 m^3/s and 11500 m^3/s. The river splits into different branches before flowing into the Adriatic Sea. Indeed, the actual water and sediment discharges of the Po have been estimated as follows: Goro (8% water, 8% sediment discharge), Gnocca (16%, 11%), Tolle (12%, 7%), Pila (61%, 74%), Maestra (3%, 1%). Previous studies revealed that both Po River and Adriatic Sea, microplastic concentration up to 84 particles/m3 and in beach sediment concentrations up to 78 particles/m3. Large microplastic abundance (particles 1-5mm) ranged from 2.92 to 23.30 particles per kilogram dry weight.

The second Pilot Site is located along the coast surrounding Pescara, in the south-western part of the Adriatic Sea. It is a site characterized by low sandy coasts with high human impacts due to big cities located along the coast and popular touristic locations.

For the Croatian Pilot sites two locations were chosen: Rijeka area and Split area.

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Rijeka. The peculiarity of the coastal area lies in the contact of sea and land, the diversity of natural resources and economic activities. Numerous human activities in these areas and their intensity can lead to increased pollution of the sea water, overuse of resources, negative environmental impacts and, as a consequence, this can lead to reduced quality of life in this area. In Rijeka area, in Kvarner catchment area, numerous human activities that take place that are permanent or sudden sources of pollution in north part of Croatian side of Adriatic, especially in highly urbanized or industrial zones. The main sources of pollution are the city of Rijeka with its municipal wastewater, followed by maritime-oriented economic activities (ports, shipyards, passenger and cargo terminals), oil industry (refinery, terminal, petrochemistry), thermal power plants and tourism as the most important economic branch in the coastal area. Significant sources of pollution on the islands are numerous hotels, tourist resorts, camps and nautical facilities (sports ports and marinas).

In the **Split** area, 4 rivers are present in the grid domain of PS4, the major of which is the Neretva, located in the southernmost part of the domain, the other rivers are the Jadro, the Cetina and the Zrnovnica all located in the northern coast, toward the city of Split. These rivers could be important sources of MPs for the Adriatic Sea, but further research is needed. In this area the main sources of pollution are municipal wastewaters, maritime-oriented economic activities (ports, shipyard, passenger and cargo terminals), industry and tourism which include hotels, tourist resorts, camps and nautical facilities (sports ports and marinas). Possible source of MP could be sea currents, especially on the islands that are farthest from land as in the Rijeka area.

6.7.3 Methods

Field surveys

Different field surveys were performed using different methodologies. Indeed, during the project, common methods were used to collect marine litter present on the beach (sampling

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collection on 100 m beach stretch, while manta trawl has been used for surface water sampling. In addition, marine sediments have been sampled using a Van Veen grab sampler. Specific methods have been developed for the monitoring of the marine litter and microplastic (MP in biota for instance), and aerial and marine drones have also been used to develop innovative solution for marine litter monitoring.

Laboratory analysis

- Marine litter > 2.5 cm: Visual observation. Marine litter was examined following the protocols established by Galgani *et al.* (2013) and the UNEP (2009). Any items bigger than 2.5 cm were then classified per type of material (plastic, paper, cigarette butts, glass, metal, non-anthropogenic organic matter (O.M.), rubber, ceramic, and other, i.e., materials that did not fit into any of these categories) and/or source (e.g., fishing-related activities)
- Items 1 – 25 mm: visual observation.
- Items > 1mm microscopic analysis to classify the items according to tables 1 and 2.

In addition, some samples have been analysed to chemically categorize the MP-items to better identify their source/origin (Table 6.7.2-6.7.3). The methods used to identify and classify the MP-items are Image analysis, Fourier-Transform Infrared Spectroscopy and Raman Spectroscopy.

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Micro·litter·categories¤
Pellets·(G107,·G108,·G109,·G110,·G111)·¤
Granules·(G116)·¤
Filaments·(G113)·¤
Films·(G114)·¤
Foam·(G115,·G117)¤
Uncategorized·plastic·pieces*¤

Table 6.7.2. Micro-waste categories (from EU TG ML Master List).

Colour·of·plastic·items·¤	Transparency·of·plastic·items¤
White·¤	Transparent¤
Clear-white-cream·¤	Opaque¤
Red·¤	¤
Orange·¤	
Blue·¤	
Black·¤	
Grey·¤	
Brown·¤	
Green·¤	
Pink·¤	
Tan·¤	
Yellow·¤	

Table 6.7.3. Master List of Colours and Transparency of Micro Litter Item.

Numerical simulations

Numerical simulations for microplastic dispersion pathways and potential accumulation areas implemented have been performed. The modelling set up is composed of two models run in sequence: the Regional Ocean Modelling System (ROMS) and the Lagrangian model ICHTHYOP. ROMS has been implemented for each pilot site (figure below) starting from the implementation of the Regione Marche Oil Spill model that provides the initial and boundary conditions. ROMS outputs (currents, temperature and salinity fields) are used to force ICHTHYOP to simulate dispersion pathways and accumulation sites of microplastics of riverine origin.

Webplatform development and EWS

A EWS was also designed and realized within the project. Basically, the system to be designed and erected is depicted in Figure 6.7.1 where the following elements can be identified:

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- A Data Centre with all required hardware and software facilities to collect, process, store in organized way and show to the users all collected data.
- A network composed of communication segments relied on internet technology that allow the collection of data and related information from the different sources: monitoring campaigns data carried out with drones or onboard units, meteo-marine data, bathymetric and river flows data. Also, the storical data of the microplastic concentrations in the Adriatic region shall be stored in the data centre in order to have enough information for the forecasting model to be developed within the project scope.
- The Prediction Model developed by Marche Region composed by own hardware and software facilities able to run custom processing modules producing the microplatics concentration forecast. The data interface between the Prediction Model and the Data Centre is mainly for the collection of new collected data and to transfer to the Data Centre of the forecast reports containing information related to the expected microplastics concentration in a specific area and time range.
- Other data sources or users to collect additional information (e.g. macroplastic information) or to get access to the data platform to find specific data.

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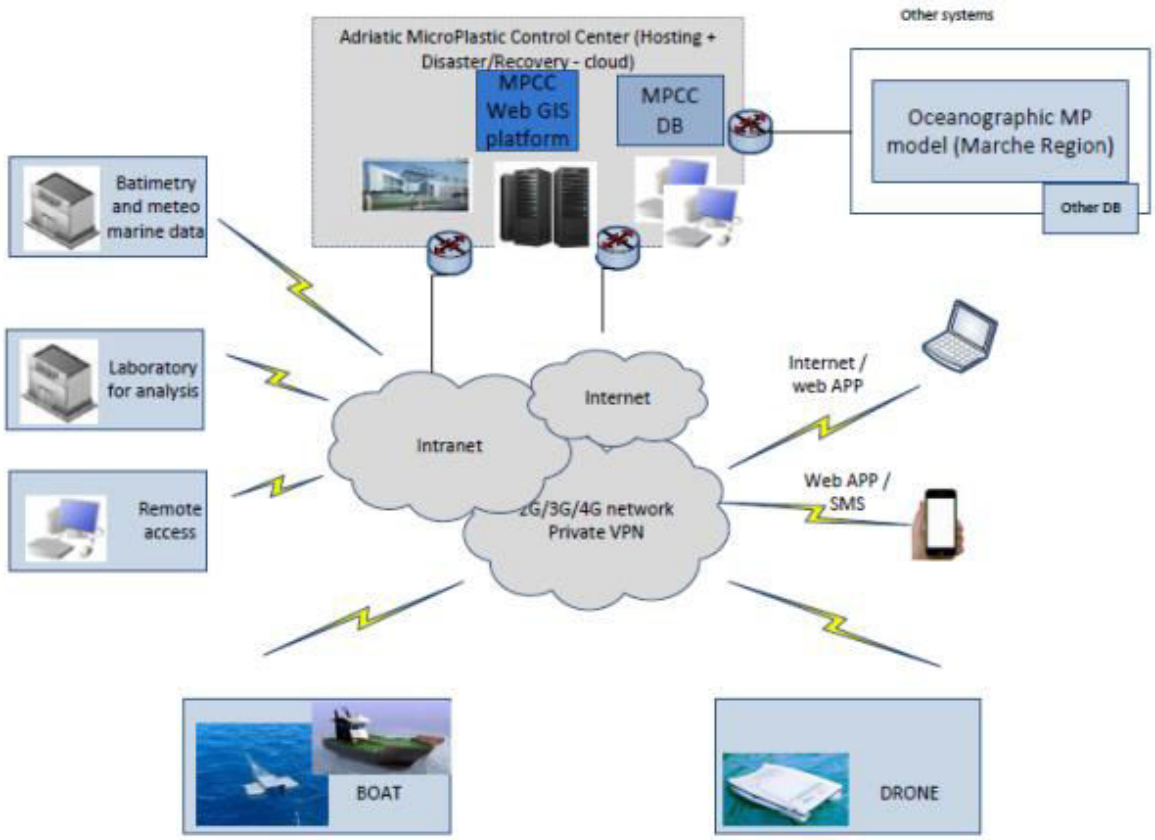

Figure 6.7.1.The EWS Conceptual Design.

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All the data have been integrated in a web platform allowing the dissemination of all the results.

6.7.4 Results

Marine pollution and biodiversity

Marine litter: University of Ferrara has performed 13 field surveys: 11 in the Po Delta area, and 2 surveys at Pescara. In total 10.436 marine litter (ML) items (2.5-50 cm) were collected and sorted. About, 9704 items (93%) were classified as plastic materials (artificial polymer), while 732 items (7%) were assigned to the other macro-categories.

More specifically, along the coasts of Po Delta area, 9617 items were collected.

The plastic material recovered in the marine litter has been categorized in two subsets in relation to the main sources of release:

- Improper waste disposal (IWD): referring to improper waste disposal and urban wastewater, whose release and transport into the marine environment is mainly driven by rivers (68%), and.
- Marine Waste by fishing and aquaculture activities: referring to maritime activities as fishing and aquaculture, whose release may be more or less accidental (25%).

In addition, at Boccasette beach, five marine litter monitoring campaigns were carried out between November 2019 and October 2020, to better understand the impacts of some specific meteorological events on the distribution of the marine litter. A total of 5578 debris items were collected and the average marine litter density was0.35 items/m^2. Moreover, the results indicated that the density of ML during the autumn/winter period was higher than the late-winter/early-summer period. The calculation of the Clean Coast Index (CCI) indicates that

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Boccasette beach was moderately clean during the autumn and winter season, and clean from February to June 2020.

Our results indicate that ML are mainly related to improper waste disposal and fishing/aquaculture activities, therefore giving useful information for future strategies to reduce the presence of ML in coastal environment and impacts on the biodiversity.

Moreover the results also suggest that marine litter accumulation mainly occurred in the upper sector of the beach, where the presence of vegetation or beach wrack may trap the items. Furthermore, the observations of the UAV images confirmed the accumulation of the marine litter in coastal vegetated areas.

Regarding marine pollution and biodiversity aspects, the results of the different field surveys data reveal that:

- ML distribution suggests that the coastal system should be considered in its integrity considering the entire coastal process.
- Vegetation is an important factor in trapping ML
- In addition to the negative impacts related to the presence of macro-litter, our results highlight another potential issue related to the fragmentation of the macroplastics in microplastics, especially in the saltmarsh.
- Monitoring program should also be modified in order to further assess the role of the vegetation and morphology in trapping and accumulating ML,
- UAV monitoring system can help to faster the monitoring operations (also wider and less accessible area) providing useful information to assess the efficiency of mitigation measures
- New cleaning activities should be developed considering all the system including beach wrack and saltmarsh, which are considered as important ecosystems.

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Marine pollution, biota

Regarding the biota, some tests have been performed in order to evaluate the clearance gut rate in bivalves for risk assessment associated with their consumption. Two different purification times were applied:

1. "microbiological" purification lasting 2 days, corresponding to the maximum purification time applied for microbiological contaminants foreseen in shellfish purification plants;
2. "experimental" purification lasting 7 days, assuming to increase the dwell time in the shellfish purification plants up to 7 days if this time allows a better purification from these contaminants.

After 7 days of purification (experimental purification) it was possible to highlight a statistically significant decrease in the presence of the number of microplastic particles found per gram of soft tissue of the analyzed mussels.

Instead, no statistically significant differences emerged between the T0 and T2 groups, indicating that the two-day depuration time may not have been long enough to completely eliminate the microplastic particles or that MP could have been translocated to other tissues, or even to the circulatory system.

Statistically significant differences were found as regards the size class of microplastics found within the analysed mussels, and could explain the ability of bivalve molluscs to eliminate larger microplastic particles more easily and in a shorter time.

Furthermore, smaller sizes of microplastics also show greater toxicity to organisms like Copepoda adults and offspring. Therefore, great attention should be paid to the size effects of microplastics ingested by mussels, especially for those microplastics in smaller size classes.

Microplastics that seem to be eliminated more effectively by mussels, both after 2 and 7 days of purification, are granules, followed by filaments and fragments. Probably the spherical size of the granules allows them not to be strongly retained within the gills of the hepatopancreas of the mussels, which therefore are able to get rid of them more easily; in fact, we observe an

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almost total absence of this type of microplastics in the analysed organisms in all three experimental replicas after 7 days of purification.

Finally, regarding the results obtained from the biological and chemical analysis related to mussel have allowed developing Guidelines and indicators for proper consumption of mussel and shellfish to prevent toxicity and human health risks.

Our results indicate that it's necessary to continuously monitor the presence of microplastic in the environment as well as the presence of MPs in human food, especially the one that comes from the sea, like mussels. Results of this Project show that microplastic is present in the Adriatic Sea in all the pilot sites investigated in this research: in both Italian and Croatian sites, in surface sea water, on the beach sediment and in the mussels. As a consequence, in relation to marine pollution, it is absolutely necessary to determine the maximum acceptable concentration for all the chemicals described as well as the maximum acceptable number of MPs in food, especially mussels and other shellfish. It is important to create food standards that will take into consideration new scientific information about toxicity and the impact of MPs on human health.

Marine pollution and port management

The results obtained during the project have allowed to better understand the distribution of microplastics in the Adriatic Sea through the realization of numerical simulations that were used to develop the EWS, which can be used by local authorities. Understanding where microplastics may accumulate according to the climate conditions could provide used information to fishermen.

Specifically, for each pilot site simulations were initialized on September 1st 2014 for a 4 month start up. Then, starting from January 1st 2015, a 4 year-experimental run was done. The modelling results have been analysed for each pilot site with the scope of identifying the potential coastal accumulation sites for microplastics of riverine origin on a daily and then

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climatological base. When looking at those results it is important to keep in mind that those are not forecasts of microplastic concentrations but an evaluation of the potential beaching.

Starting from the Lagrangian simulations for each pilot site a series of accumulation maps have been computed. This analysis has been performed based on yearly, seasonal, monthly and daily climatological intervals.

For instance, the yearly (Figure 6.7.2) potential accumulation of microplastic (expressed as the percentage of microplastics released from rivers that potentially beach) in the Po delta closely follows the average circulation (characterized by the presence of the Western Adriatic Current - WAC) of the area that flows along the coast of the Delta. Three main areas of potential accumulation can be found:

- The coast just south of the Adige River which is impacted only by microplastic coming from the Adige itself and the Brenta.
- The southern inlet of the Scardovari lagoon: this accumulation site is mostly connected to the presence of the lagoon inlet and the conformation of the reference grid in the area
- the coast between Lido di Volano and Porto Garibaldi: this area results to be the one at risk of the higher impacts and receives microplastics coming mostly from the Po di Goro mouth but also from all the southern delta branches of the Po River.

A secondary accumulation site can be identified between the three mouths of the Po di Tolle due to the local circulation that traps part of the released microplastics between the mouths.

It is of interest to note how each river mouth is clearly visible in the distribution of potential beaching with values of 0. This is due to the fact that in the modelling chain implementation it is not possible for particles to beach.

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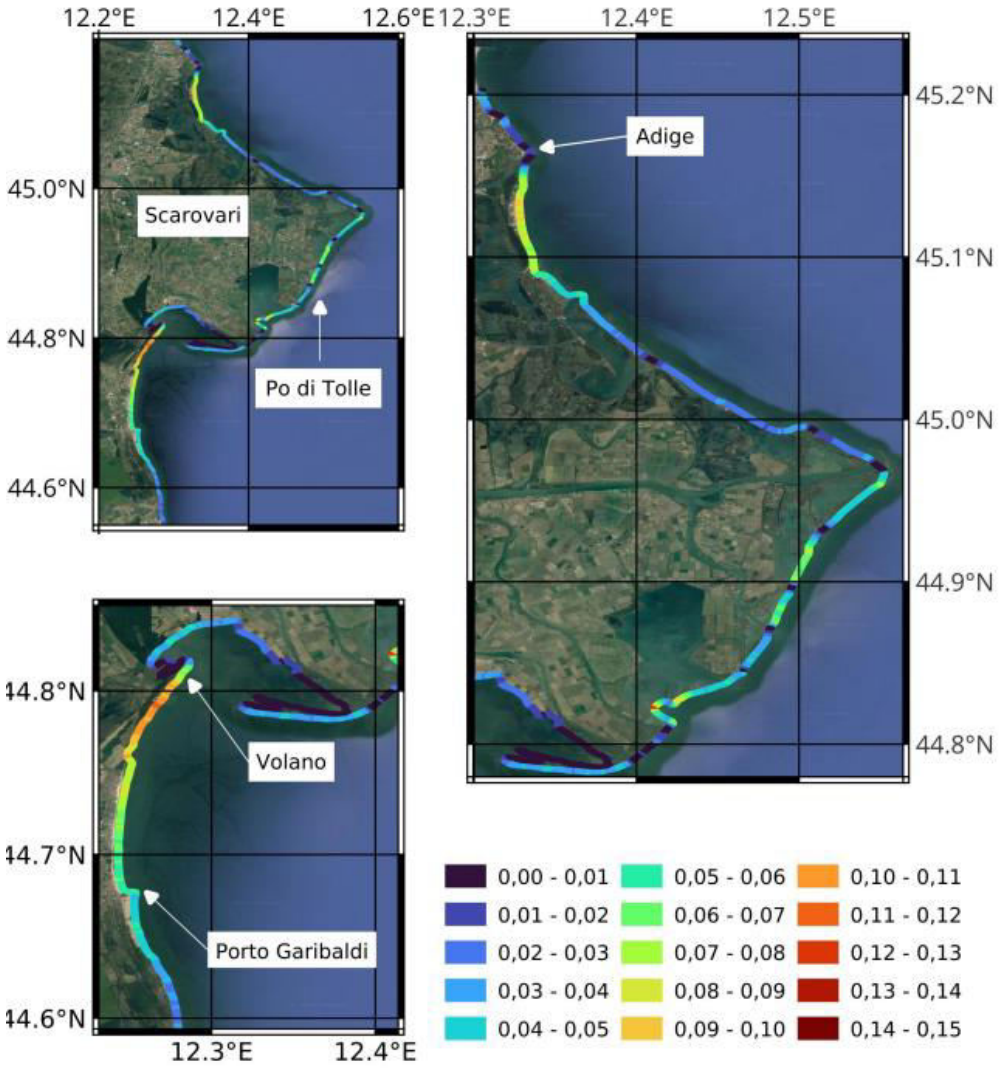

Figure 6.7.2. Yearly potential accumulation of microplastics.

In addition, two protocols for the acquisition of georeferenced photos from the network of "Sea sentinels" (network of voluntary fishermen) have been developed and tested to report the presence of plastic waste scattered on sea waters.

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The first method consists in using mobile devices (Smartphones and/or tablets) they already own in which apps that can be freely downloaded from Google Play will be installed, which are:

• the first app: GPS Map Camera implements the functions of a digital camera capable of taking georeferenced photos (LAT-LON coordinates, date and time) and storing them in a specific folder in the internal memory of the device.

• The second app: FolderSync or OneSync, runs automatically when the device is turned on and, when connected to the Internet. The app uploads the geo-referenced photos taken through GPS Map Camera in a Microsoft OneDrive folder connected to personal accounts of the "Sea sentinels" and accessible to the project team. Once stored in this folder, the project team examine the photos and store them in a further folder whose access is open to the project partners.

The second method consists in using a GPS Map camera software to capture photos and, successively share them by sending the picture(s) via the usual email client.

Sea Sentinels network represents a good opportunity for providing information on sea marine pollution (could be extended to other pollution events like spill oil for instance) to local authorities, scientists, and other stakeholders.

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7 Chapter 7: Conclusions

On the basis of results achieved by above described projects, some final considerations can be made.

Firstly, as suggested clearly by the Ecoss and Ecomap projects, up-to-date monitoring plans need to be put in place in both small and large ports in the Adriatic Sea in order to have a detailed view of the situation. The benthic macrofauna is a very good indicator of pollution (as underlined by the ECOMAP project), so it can be useful in the development of dedicated recommendation and obligations to better manage marine pollution in port areas. Through the EcoAds system, an even faster exchange of knowledge and/or laws and regulations could be foreseen in other areas and regions of the Adriatic, thanks to the opinions and data of all involved experts. A better management of port pollution would also reduce the need for solutions such as Fishing for Litter or sediment drainage. Although Marine Litter is only one aspect of overall marine pollution, even if it is one of the most visible and it's caused in a very direct way by human activities. The simple provision of some rewards and/or financial support to fishermen to motivate and assist them in FfL activities would bring great benefits to the entire community, the environment and the fishermen themselves. In addition, FfL is a very cheap and ecological solution, in comparison to dedicated cruises for removing marine debris from the sea due to the high costs of boat hire, crew, fuel, experts and technicians paid specifically for this task, etc.

In addition to FfL fishing, the analysis and characterisation of fished ML is also important, as carried out by the NET4MPLASTIC project and by the ML-REPAIR project. A better characterisation is necessary for the development of new degradable materials and technologies to reduce marine pollution.

Clearly, the biodiversity of the Adriatic Sea would benefit from good, new port management and a reduction in ML. The SASPAS project demonstrated the need to develop new

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technological tools to face overtourism of protected areas. Such tools were also quite simple to be conceived and applied, indicating that a good project path can even foresee potential effects of human activities in the marine environment. New *Posidonia* grass, partially destroyed by the wild moorings of marine tourism in the Kornati National Park, are expected to recover the previous habitat in a few years. By also providing safe moorings in these places, the effect of tourism on the grass will be greatly reduced helping also micro- and macrofauna to recover and re-colonise these areas.

The protection of biodiversity in the Adriatic also arises from finding the right answer to specific stressors, as proposed by the DORY project. Establishing a sole sanctuary and increasing the minimum catch size to 25 cm so that sole, a highly commercial and prized species in the Adriatic Sea, can reproduce, increase its currently limited numbers; this is an excellent way to protect the biodiversity of our sea and at the same time safeguard the sea economy.

The SOUNDSCAPE project provided an equally useful contribution to the protection of biodiversity in an innovative way. The noise pollution in the sea is rarely considered as a stressor, especially underwater, although many researchers consider it a danger for many sea species. The project, characterising noise pollution distribution in the Adriatic Sea for the first time, allowed evaluating its effects. A better management of human activities generating underwater noise and a better knowledge of its consequences will certainly lead to a greater eco-sustainability of the Adriatic Sea.

Each cluster project included within the Interreg RESISTANCE project tried to conceive and successfully apply solutions and/or actions that could be effectively implemented to improve small ports management, marine pollution reduction and biodiversity defence thematics in the whole Adriatic region. The strengths and the weaknesses of these 7 cluster projects have been evaluated in detail, and results are reported in the Summary matrix (Figure 7.2).The following graphic illustrates how the matrix has to be read (Figure 7.1).

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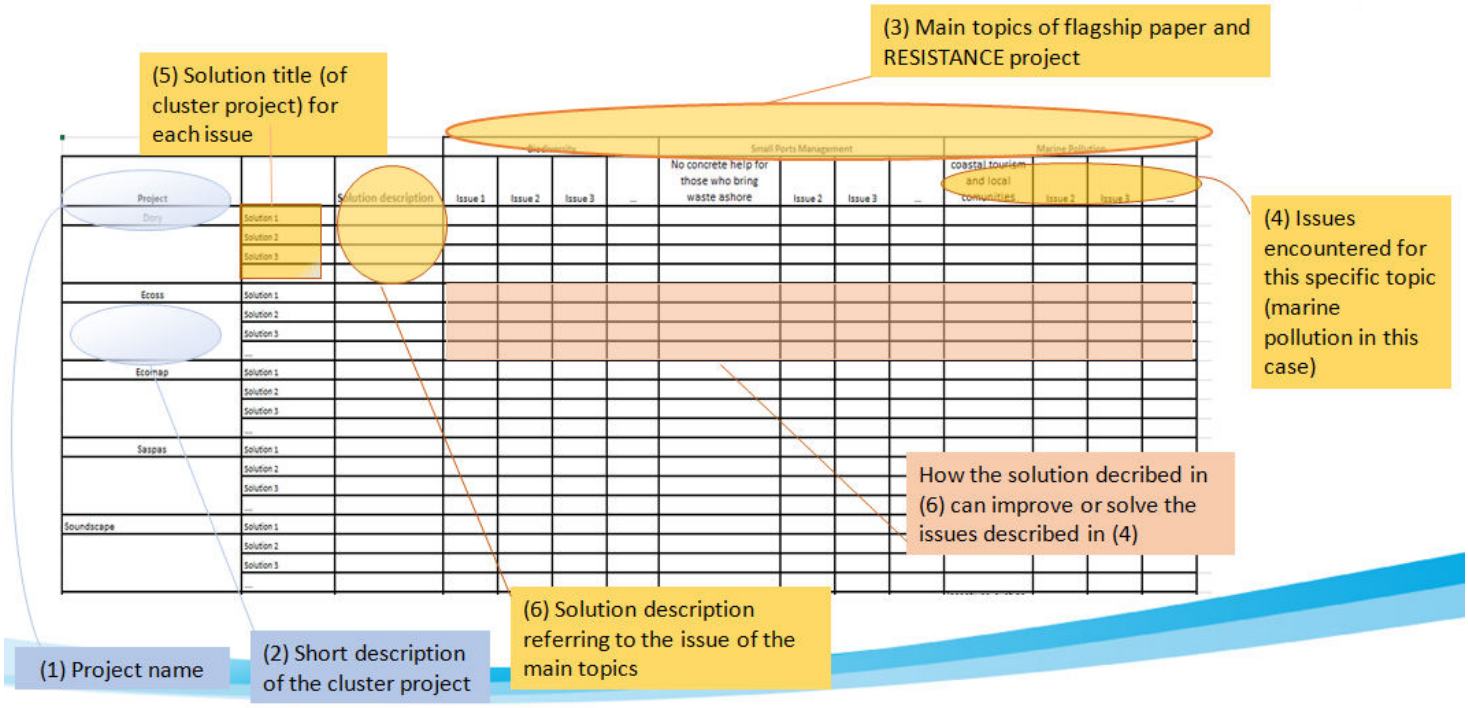

Figure 7.1 Matrix explanation

Each project worked on one of the three major thematic highlighted within this document, but indirectly had a positive influence on the other two as well. This shows how every action taken for improvement and safeguarding always had a positive reaction. This matrix can be easily extended also to other projects aimed to improve the quality of the Adriatic Sea.

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Figure 7.2 Matrix

Dory	Project	
Cross-borderagreements		
Reduction of fishing effort and reduction of fishing days through cross-border agreements	**Solution description**	
Environmental protection also passes through cross-border agreements to reduce fishing effort, fishing days and preserve fish stocks	Biodiversity and fish stocks protection (Dory)	**Biodiversity**
	Ineffective monitoring of Natura 2000 habitats (Ecoss)	
	Public lack of knowledge on conservation of biodiversity (Saspas)	
	Impacts on habitat (Net4mPlastic)	
	Lack of data (Soundscape)	
	Lack of uniformprotocols (Soundscape)	
	Underwater noise pollution impact on animalsbehaviour (Soundscape)	
	Plastics and marine litter impact on marine life	
	Public lack of knowledge on biodiversity conservation (Ecomap)	
	No concrete help for those who bring waste ashore (ML-Repair)	**Small Ports Management**
	Marinas environmental management lack of capacity (Ecomap)	
	Wild anchoring damage the Posidonia meadows (Saspas)	
	Negative visual impact in small marinas	
	Marine litter not only floating, but also on the seabed and in non-visible areas	
Cross-border agreements are needed to preserve more and more areas from human activities pollution	Miseducation of coastal tourism and local comunities (ML-Repair)	**Marine Pollution**
	No data about annual and seasonal level and distribution of underwater noise (Soundscape)	
	No monitoring of water and sediment quality (Ecomap)	
	Human impacts (Net4mPlastic)	
	Authorities and stakeholders management (Net4mPlastic)	

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The project intended to promote the adoption of common management models for supporting sustainable fisheries and development of alternative spatial management measures. The pilot activities tested the innovative solutions for reducing the negative aquaculture ecological impact of the economic activities and enhancing the fish habitats biodiversity.		**Project**	
Economicincentives and training	Maritime Spatial Planning		
Direct and Indirect economic incentives and more information about benefits generated by fishing area s restriction	A good management of the maritime space generate a better allocation of environmental and socio-economic resources	**Solution description**	
A fair gain and income for fishermen can reduce fishing effort and improve marine environment	Excluding fishing activities and certain fishing gears uses can provide benefits to competing human activities	Biodiversity and fish stocks protection (Dory)	**Biodiversity**
		Ineffective monitoring of Natura 2000 habitats (Ecoss)	
		Public lack of knowledge on conservation of biodiversity (Saspas)	
		Impacts on habitat (Net4mPlastic)	
		Lack of data (Soundscape)	
		Lack of uniformprotocols (Soundscape)	
		Underwater noise pollution impact on animalsbehaviour (Soundscape)	
		Plastics and marine litter impact on marine life	
		Public lack of knowledge on biodiversity conservation (Ecomap)	
		No concrete help for those who bring waste ashore (ML-Repair)	**Small Ports Management**
		Marinas environmental management lack of capacity (Ecomap)	
		Wild anchoring damage the Posidonia meadows (Saspas)	
		Negative visual impact in small marinas	
		Marine litter not only floating, but also on the seabed and in non-visible areas	
	MSP can protect, preserve areas and regulate certain activities	Miseducation of coastal tourism and local comunities (ML-Repair)	**Marine Pollution**
		No data about annual and seasonal level and distribution of underwater noise (Soundscape)	
		No monitoring of water and sediment quality (Ecomap)	
		Human impacts (Net4mPlastic)	
		Authorities and stakeholders management (Net4mPlastic)	

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	Project	
Restrictedprotectedfishingareas		
Creation of a restricted protected Area called "Sole Sanctuary"	**Solution description**	
Preserve the biodiversity and hence the reproduction of some species and their juveniles drives fishing activities to a more successful catches (bigger size and healthier fish, so better food on our table)	Biodiversity and fish stocks protection (Dory)	**Biodiversity**
	Ineffective monitoring of Natura 2000 habitats (Ecoss)	
	Public lack of knowledge on conservation of biodiversity (Saspas)	
	Impacts on habitat (Net4mPlastic)	
	Lack of data (Soundscape)	
	Lack of uniformprotocols (Soundscape)	
	Underwater noise pollution impact on animalsbehaviour (Soundscape)	
	Plastics and marine litter impact on marine life	
	Public lack of knowledge on biodiversity conservation (Ecomap)	
	No concrete help for those who bring waste ashore (ML-Repair)	**Small Ports Management**
	Marinas environmental management lack of capacity (Ecomap)	
	Wild anchoring damage the Posidonia meadows (Saspas)	
	Negative visual impact in small marinas	
	Marine litter not only floating, but also on the seabed and in non-visible areas	
The creation of a restricted protected area generates a clear benefit for the marine environment and less polluted sea	Miseducation of coastal tourism and local comunities (ML-Repair)	**Marine Pollution**
	No data about annual and seasonal level and distribution of underwater noise (Soundscape)	
	No monitoring of water and sediment quality (Ecomap)	
	Human impacts (Net4mPlastic)	
	Authorities and stakeholders management (Net4mPlastic)	

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Ecoss	Project	
Adriatic Ecological Observing System (ECOAdS)		
Integrate the existing ecological and oceanographic research and monitoring in the Adriatic Sea within the N 2000 conservation strategies	**Solution description**	
	Biodiversity and fish stocks protection (Dory)	**Biodiversity**
An overall connecting model linking the social, Ecological and oceanographic dimensions with the conservation of the coastal and marine environment and its management.	Ineffective monitoring of Natura 2000 habitats (Ecoss)	
	Public lack of knowledge on conservation of biodiversity (Saspas)	
	Impacts on habitat (Net4mPlastic)	
	Lack of data (Soundscape)	
	Lack of uniformprotocols (Soundscape)	
	Underwater noise pollution impact on animalsbehaviour (Soundscape)	
	Plastics and marine litter impact on marine life	
	Public lack of knowledge on biodiversity conservation (Ecomap)	
	No concrete help for those who bring waste ashore (ML-Repair)	**Small Ports Management**
	Marinas environmental management lack of capacity (Ecomap)	
	Wild anchoring damage the Posidonia meadows (Saspas)	
	Negative visual impact in small marinas	
	Marine litter not only floating, but also on the seabed and in non-visible areas	
	Miseducation of coastal tourism and local comunities (ML-Repair)	**Marine Pollution**
	No data about annual and seasonal level and distribution of underwater noise (Soundscape)	
	No monitoring of water and sediment quality (Ecomap)	
	Human impacts (Net4mPlastic)	
	Authorities and stakeholders management (Net4mPlastic)	

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ECOSS overall objective is the establishment of the ECOlogical observing system in the Adriatic Sea (ECOAdS), shared between Italy and Croatia, able to integrate ecological and oceanographic research and monitoring with Natura 2000 conservation strategies. The project is Build on the facilities, infrastructures andexixtinglong term ecological data in the program area. ECOSS will enhance the marine observational capacities for improving the conservation status and the expansion of the marine component of Natura 2000 network. The synergies and feedbacks among the main conservation management questions, ecological variables and key oceanographic processes will be assessed, basing on the connectivity among habitats and species in coastal and offshore waters.	**Project**	
	Solution description	
	Biodiversity and fish stocks protection (Dory)	**Biodiversity**
	Ineffective monitoring of Natura 2000 habitats (Ecoss)	
	Public lack of knowledge on conservation of biodiversity (Saspas)	
	Impacts on habitat (Net4mPlastic)	
	Lack of data (Soundscape)	
	Lack of uniformprotocols (Soundscape)	
	Underwater noise pollution impact on animalsbehaviour (Soundscape)	
	Plastics and marine litter impact on marine life	
	Public lack of knowledge on biodiversity conservation (Ecomap)	
	No concrete help for those who bring waste ashore (ML-Repair)	**Small Ports Management**
	Marinas environmental management lack of capacity (Ecomap)	
	Wild anchoring damage the Posidonia meadows (Saspas)	
	Negative visual impact in small marinas	
	Marine litter not only floating, but also on the seabed and in non-visible areas	
	Miseducation of coastal tourism and local comunities (ML-Repair)	**Marine Pollution**
	No data about annual and seasonal level and distribution of underwater noise (Soundscape)	
	No monitoring of water and sediment quality (Ecomap)	
	Human impacts (Net4mPlastic)	
	Authorities and stakeholders management (Net4mPlastic)	

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Project		Solution description	Biodiversity								Small Ports Management					Marine Pollution				
			Biodiversity and fish stocks protection (Dory)	Ineffective monitoring of Natura 2000 habitats (Ecoss)	Public lack of knowledge on conservation of biodiversity (Saspas)	Impacts on habitat (Net4mPlastic)	Lack of data (Soundscape)	Lack of uniformprotocols (Soundscape)	Underwater noise pollution impact on animalsbehaviour (Soundscape)	Plastics and marine litter impact on marine life	Public lack of knowledge on biodiversity conservation (Ecomap)	No concrete help for those who bring waste ashore (ML-Repair)	Marinas environmental management lack of capacity (Ecomap)	Wild anchoring damage the Posidonia meadows (Saspas)	Negative visual impact in small marinas	Marine litter not only floating, but also on the seabed and in non-visible areas	Miseducation of coastal tourism and local comunities (ML-Repair)	No data about annual and seasonal level and distribution of underwater noise (Soundscape)	No monitoring of water and sediment quality (Ecomap)	Human impacts (Net4mPlastic)	Authorities and stakeholders management (Net4mPlastic)
Ecomap	Raisepublicawareness	Raise awareness regardingthe regular monitoring importance of water quality in the area								Raise public awareness through a strong campaign, communication activities and dissemination of information (congress, educations, etc.)										

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Contribute to eco-equilibrium and eco-efficiency by sharing new types of planning for the sustainability of ports and marinas in the Italian and Croatian Adriatic sea	**Project**	
Development of the strategy and building capacity		
New types of planning for the sustainability of ports and marinas: innovative methodologies, investments on tools and small infrastructures and development of common strategies	**Solution description**	
	Biodiversity and fish stocks protection (Dory)	**Biodiversity**
	Ineffective monitoring of Natura 2000 habitats (Ecoss)	
	Public lack of knowledge on conservation of biodiversity (Saspas)	
	Impacts on habitat (Net4mPlastic)	
	Lack of data (Soundscape)	
	Lack of uniformprotocols (Soundscape)	
	Underwater noise pollution impact on animalsbehaviour (Soundscape)	
	Plastics and marine litter impact on marine life	
	Public lack of knowledge on biodiversity conservation (Ecomap)	
	No concrete help for those who bring waste ashore (ML-Repair)	**Small Ports Management**
Enhanced capacity of local community and marinas for environmental management	Marinas environmental management lack of capacity (Ecomap)	
	Wild anchoring damage the Posidonia meadows (Saspas)	
	Negative visual impact in small marinas	
	Marine litter not only floating, but also on the seabed and in non-visible areas	
	Miseducation of coastal tourism and local comunities (ML-Repair)	**Marine Pollution**
	No data about annual and seasonal level and distribution of underwater noise (Soundscape)	
	No monitoring of water and sediment quality (Ecomap)	
	Human impacts (Net4mPlastic)	
	Authorities and stakeholders management (Net4mPlastic)	

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Find the right solution for the protection, conservation and restoration of marine seagrass through pilot transplantation of *Posidoniaoceanica* and the establishment of an environmentally friendly anchoring system to prevent further damage to Posidonia meadows.	**Saspas**		**Project**	
Raisepublicawareness	bouysnstallation	Implementation of monitoringsystems		
Raise public awareness about preservation of *Posidoniaoceanica*and encourage sailors to anchor in the area where they will not damage Posidonia meadows	Installation of the bouys in Kornati National Park in all 19 bays where anchoring is allowed and in that way completely ban free anchoring	Development of two different kinds of monitoring networks, definition of indicators/pollutants and the establishment of the ECOMAP web map	**Solution description**	
			Biodiversity and fish stocks protection (Dory)	**Biodiversity**
			Ineffective monitoring of Natura 2000 habitats (Ecoss)	
Raise public awareness through promotion campaigns, media relations and by active involving the local population			Public lack of knowledge on conservation of biodiversity (Saspas)	
			Impacts on habitat (Net4mPlastic)	
		Data collection for biodiversity protection	Lack of data (Soundscape)	
			Lack of uniformprotocols (Soundscape)	
			Underwater noise pollution impact on animalsbehaviour (Soundscape)	
			Plastics and marine litter impact on marine life	
			Public lack of knowledge on biodiversity conservation (Ecomap)	
			No concrete help for those who bring waste ashore (ML-Repair)	**Small Ports Management**
			Marinas environmental management lack of capacity (Ecomap)	
	Continue the Installation of the bouys in Kornati National Park, in bays where eco friendly buoys are not present		Wild anchoring damage the Posidonia meadows (Saspas)	
			Negative visual impact in small marinas	
			Marine litter not only floating, but also on the seabed and in non-visible areas	
			Miseducation of coastal tourism and local comunities (ML-Repair)	**Marine Pollution**
			No data about annual and seasonal level and distribution of underwater noise (Soundscape)	
		Data collection and monitoring lead to a healthier community and tourism	No monitoring of water and sediment quality (Ecomap)	
			Human impacts (Net4mPlastic)	
			Authorities and stakeholders management (Net4mPlastic)	

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This project is the first extensive study on underwater noise in the Mediterranean sea		**Soundscape**	**Project**	
Monitoringunderwater noise	Uniformmodels	Boat surveys		
Biophony was recognized and analyzed in the acustic recordings	New habitat suitability models integrating all available data on target species distribution have beeen created	Change to review the existing knowledge on two target species: *Tursiopstruncatus*and *Carettacaretta*	**Solution description**	
			Biodiversity and fish stocks protection (Dory)	**Biodiversity**
			Ineffective monitoring of Natura 2000 habitats (Ecoss)	
			Public lack of knowledge on conservation of biodiversity (Saspas)	
			Impacts on habitat (Net4mPlastic)	
New data recorded	New factors to consider regarding marine noise pollution	Update of number and distribution of target species on project area	Lack of data (Soundscape)	
			Lack of uniformprotocols (Soundscape)	
			Underwater noise pollution impact on animalsbehaviour (Soundscape)	
			Plastics and marine litter impact on marine life	
			Public lack of knowledge on biodiversity conservation (Ecomap)	
			No concrete help for those who bring waste ashore (ML-Repair)	**Small Ports Management**
			Marinas environmental management lack of capacity (Ecomap)	
			Wild anchoring damage the Posidonia meadows (Saspas)	
			Negative visual impact in small marinas	
			Marine litter not only floating, but also on the seabed and in non-visible areas	
			Miseducation of coastal tourism and local comunities (ML-Repair)	**Marine Pollution**
More data recorded			No data about annual and seasonal level and distribution of underwater noise (Soundscape)	
			No monitoring of water and sediment quality (Ecomap)	
			Human impacts (Net4mPlastic)	
			Authorities and stakeholders management (Net4mPlastic)	

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Contribute to an environmentally sustainable growth of the touristic and fishery activities,providing efficient approaches and actions able to reduce anthropic debris and marine litter in the Adriatic Sea. Consequentially improve environmental quality of Adriatic waters	**ML-Repair**	**Project**	
Education on the importance of recycling and raising tourist awareness	Economic incentives and reception facilities		
Dissemination and information for tourists and workers	Direct and indirect economic incentives and more information from reception facilities	**Solution description**	
		Biodiversity and fish stocks protection (Dory)	**Biodiversity**
		Ineffective monitoring of Natura 2000 habitats (Ecoss)	
		Public lack of knowledge on conservation of biodiversity (Saspas)	
		Impacts on habitat (Net4mPlastic)	
		Lack of data (Soundscape)	
		Lack of uniformprotocols (Soundscape)	
		Underwater noise pollution impact on animalsbehaviour (Soundscape)	
The more people are educated and aware of the consequences of this impact on both marine life and themselves, the more they will contribute to a sustainable future	The more fishermen are facilitated in the FfL, the more effective it will be and improve biodiversity protection	Plastics and marine litter impact on marine life	
		Public lack of knowledge on biodiversity conservation (Ecomap)	
The more people are educated about a sustainable lifestyle, the more litter in the sea will decrease(ideally)	Direct payment and/or tax discharges to provide an economic incentive for cleaning the sea. Accommodation facilities would help in understanding the initiatives, conceptually and economically.	No concrete help for those who bring waste ashore (ML-Repair)	**Small Ports Management**
		Marinas environmental management lack of capacity (Ecomap)	
		Wild anchoring damage the Posidonia meadows (Saspas)	
		Negative visual impact in small marinas	
		Marine litter not only floating, but also on the seabed and in non-visible areas	
Communities and tourists living a more sustainable life prevents dumping and abandonment of waste	Incentives, such as tax deductions or some kind of remuneration could incentivise local coastal communities and tourists to collect waste	Miseducation of coastal tourism and local comunities (ML-Repair)	**Marine Pollution**
		No data about annual and seasonal level and distribution of underwater noise (Soundscape)	
		No monitoring of water and sediment quality (Ecomap)	
		Human impacts (Net4mPlastic)	
		Authorities and stakeholders management (Net4mPlastic)	

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Net4mPlastic			Project	
New monitoringsolutions	ML-Repair APP	Fishing for litteractivities		
Marine drone with holosensor + aerial drone to map the presence of ML on the entire coastal system	Application aimed at recording data of marine litter caught by fishermen in a database	Marine litter collection activities, through cooperation with fishermen and other maritime operators, using nets and other tools.	**Solution description**	
			Biodiversity and fish stocks protection (Dory)	**Biodiversity**
			Ineffective monitoring of Natura 2000 habitats (Ecoss)	
			Public lack of knowledge on conservation of biodiversity (Saspas)	
Identifying "polluted" ecosystems, like saltmarsh			Impacts on habitat (Net4mPlastic)	
			Lack of data (Soundscape)	
			Lack of uniformprotocols (Soundscape)	
			Underwater noise pollution impact on animalsbehaviour (Soundscape)	
		Systematic removal of one of the major problems for the entire marine biodiversity	Plastics and marine litter impact on marine life	
			Public lack of knowledge on biodiversity conservation (Ecomap)	
	The app encourages the collaboration between fishermen and research institutions		No concrete help for those who bring waste ashore (ML-Repair)	**Small Ports Management**
			Marinas environmental management lack of capacity (Ecomap)	
			Wild anchoring damage the Posidonia meadows (Saspas)	
		Removal of negative visual impact in small marinas	Negative visual impact in small marinas	
	It helps in the first classification of marine litter and its organization	marine litter removal consents to study marine waste composition	Marine litter not only floating, but also on the seabed and in non-visible areas	
			Miseducation of coastal tourism and local comunities (ML-Repair)	**Marine Pollution**
			No data about annual and seasonal level and distribution of underwater noise (Soundscape)	
			No monitoring of water and sediment quality (Ecomap)	
			Human impacts (Net4mPlastic)	
Provide information (ML hotspots or ML typologies for instance) to local authorities			Authorities and stakeholders management (Net4mPlastic)	

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Aims to collect data on the distribution and composition of the Microplastic along the Croatian and Italian coastal and marine areas. Numerical simulations of the marine transport processes of the Microplastic in the Adriatic Sea to identify possible concentration zones in the pilot areas. Innovative monitoring solutions were tested to identify the presence of marine litter, while chemical and biological analysis on mP were performed to identify possible origin of the Microplastic and possible health impacts.			**Project**	
Mussels and microplastic	GIS platform including numerical simulations and educational material	Development of an Early Warning System		
Experimentation on the clearance mussel capacity	Web and GIS platform: storage of all information developed/acquired during the project	Development of an EWS based on numerical simulations coupled with physical data .The system provides information on ML concentration according to meteorological conditions	**Solution description**	
			Biodiversity and fish stocks protection (Dory)	**Biodiversity**
			Ineffective monitoring of Natura 2000 habitats (Ecoss)	
			Public lack of knowledge on conservation of biodiversity (Saspas)	
Knowledge on the filtering capacities of mussels		microplastic accumulation zones that could impact	Impacts on habitat (Net4mPlastic)	
			Lack of data (Soundscape)	
			Lack of uniformprotocols (Soundscape)	
			Underwater noise pollution impact on animalsbehaviour (Soundscape)	
			Plastics and marine litter impact on marine life	
			Public lack of knowledge on biodiversity conservation (Ecomap)	
			No concrete help for those who bring waste ashore (ML-Repair)	**Small Ports Management**
			Marinas environmental management lack of capacity (Ecomap)	
			Wild anchoring damage the Posidonia meadows (Saspas)	
			Negative visual impact in small marinas	
			Marine litter not only floating, but also on the seabed and in non-visible areas	
	Provide information to citizen on ML issues		Miseducation of coastal tourism and local comunities (ML-Repair)	**Marine Pollution**
			No data about annual and seasonal level and distribution of underwater noise (Soundscape)	
			No monitoring of water and sediment quality (Ecomap)	
Provide information to fishermen			Human impacts (Net4mPlastic)	
		Provide information on microplastics accumulations that could be used by fishermen (including acquaculture)	Authorities and stakeholders management (Net4mPlastic)	

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The SOUNDSCAPE, ECOSS and SASPAS projects focused on diverse biodiversity issues.

As can be deduced from the SOUNDSCAPE project results, there is still a shortage of data that can significantly help the protection and preservation of marine species such as the *Caretta caretta*turtle. Therefore, it is necessary to implement and improve data collection models for species at risk in order to provide an improvement in the preservation of the Adriatic Sea biodiversity. It is also indispensable to map and characterise the consequences that a new types of pollution, such as noise pollution, overtourism, new pollutants, etc. can have on Adriatic species, both commercial and non-commercial. It is also suggested that both Italian and Croatian coast populations should be educated in order to prevent the problem from reoccurring.

Through the EcoAds, the ECOlogical observing system in the Adriatic Sea developed by the ECOSS project, it is possible to collect data, links and information about ecological and oceanographic research linked to *Natura 2000* conservation strategies. The use of this preferential channel for monitoring and exchanging information can help not only to improve the biodiversity protection, but also to support new solutions to face marine pollution and management of Adriatic small ports.

The ECOMAP and DORY projects focused mostly on the management and improvement of small ports. Regarding the DORY project, the most discussed topic was Marine Spatial Planning (MSP). By using the DISPLACE application possible fishing and socio-economic scenarios in the Adriatic Sea could be simulated. These scenarios were conceived with the aim of demonstrating how a change in MSP recommendations could bring benefits to the area in the short and medium term. A reduction in fishing days and better management of port space were proposed, so that the socio-economic resources of small ports could be better managed and preserved. Another suggested action was to establish a nursery area for *Solea solea vulgaris* in the Adriatic region, where they are known to reproduce, and to increase their minimum fishing size to 25 cm. All such suggestions would certainly help both the economy and port

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management, as well as safeguard the Adriatic commercial species. The Ecomap project aimed instead attention at expanding and improving monitoring systems in ports. This entails investments in small infrastructures in order to clean the heavily polluted waters of touristic ports and develop new methods to define their pollution levels. Concerning public awareness, recycling bins for litter generated at ports were installed and promoted with the purpose of encouraging cleanliness in harbours and waterfront. Both of these projects have the more or less direct consequence of reducing maritime pollution and protecting the Adriatic biodiversity.

Lastly, both ML-REPAIR and Net4mPlastic projects concentrated their actions on marine pollution issue. The first focused on Fishing for Litter (FfL) and collaboration with fishermen and port operators. The FfL initiatives are strongly recommended by international organizations such as UE, UNEP MAP (*Decision IG.22/10 Implementing the Marine Litter Regional Plan in the Mediterranean*). Thanks also to the development and use of the ML-REPAIR App, 22 and 37 tonnes of ML were collected and disposed of in Italy in Croatia, respectively. In addition, the general public was educated and learned thanks to the great dissemination and information promulgated during the project. On the other hand, the NET4MPLASTIC project worked on the filtering capabilities of mussels as a possible application to cleaning of the sea from microplastics. The development of a GIS platform, where the information gathered and developed could be incorporated, was also a useful tool for the future development of more environmentally friendly materials, and it could be used also for educational purposes. All these proposals and actions can help the protection of the Adriatic biodiversity,

The RESISTANCE cluster projects ideas and actions can stimulate updates to the current MSP legislation (Directive 2014/89/EU) and related laws. The protocols and tools developed during these projects can be further capitalized in other Adriatic areas and may support the achievement of the Good Environmental Status (Directive 2008/56/EC) in both Italian and Croatian marine areas. For this to happen, a stricter communication and collaboration between Adriatic institutions, stakeholders and citizens are anyway still necessary.

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8.2 Chapter 3

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8.5 Chapter 6

Fishing for litter catches: composition and quantities definition

More information about the ML-REPAIR APP can be found in the Deliverable 4.2.2.

The App can be downloaded from this link: https://www.italy-croatia.eu/web/ml-repair/docs-and-tools)

Monitoring of ALDFG and ML affecting Natura 2000 sites

For further details, please refer to WP4 – Activity 4.2 Marine plastic characterization protocol and WP4 – Activity 4.2 Scientific report which can be found on the ML-REPAIR site: https://www.italy-croatia.eu/web/ml-repair

Marine Litter awareness campaign for tourist

All videos, posts, images, etc. can be found on the ML-REPAIR site: https://www.italy-croatia.eu/web/ml-repair

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