

# WHITE PAPER OF INNOVATIVE EXPLOITATION

Work package 5 – Innovative exploitation of Adriatic  
reef for Blue Economy

Activity 5.3 – Definition of recommendations for  
policy makers and funding agencies

Deliverable 5.3.2

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## ABBREVIATIONS

EU	European Union
ROC	Republic of Croatia
NN	Narodne novine (The Official Gazette)
GFCM	General Fisheries Commission for the Mediterranean
HIRC	Hydrographic Institute of the Republic of Croatia
WP	Work package
SMEs	Small and medium-sized enterprises
CS	Communication strategy
MBES	Multi beam echo sounder
ROV	Remotely operated vehicle
MAES	Mapping and assessment ecosystem services
ADCP	Acoustic doppler current profiler
HD	High definition
DPS	Differential Positioning System
PAF	Prioritised Action Framework
EAFRD	European agricultural fund for rural development
ERDF	European Regional Development Fund
CF	Cohesion Fund
EMFF	European Maritime and Fisheries Fund

## 1. ABSTRACT

The ADRIREEF project “Innovative exploitation of Adriatic Reefs in order to strengthen blue economy” funded by the EU through the Interreg Italy-Croatia CBC programme aimed to activate a transborder investigation to highlight the unexploited potential of different reef typologies based on eight selected reefs, natural and artificial, located offshore the Italian and Croatian coasts of the Adriatic Sea. Conclusions of the project, drafted after a scientific monitoring campaign on the status of eight selected case studies and an empowering campaign addressed to train SMEs and local communities on blue business opportunities and the value of reefs (cfr. the assessment of reefs’ Ecosystem Services, deliverable A 5.1), supported that natural and artificial reefs are proven to foster sustainable economic development by promoting research, employing the local population in innovative activities and offering visitors the opportunity to have a direct experience with nature, also from an educational point of view.

This paper is aimed to support policy-makers to emphasise the challenges and opportunities for the sustainable development of Adriatic reefs, and consequently supporting the blue growth.

The project results show that reefs, both natural and artificial, as well as wrecks, are habitats of high natural value and have a high potential for socio-economic valorisation. However, they require a legislative framework covering both nature conservation and socio-economic issues to be shared with neighbouring countries. In addition, as explained in the methodology section of the ecosystem services valuation, both demand and supply indicators should be estimated. In the framework of the ADRIREEF project, only supply-side indicators were calculated. In order to build a more complete representation, it is thus suggested to complete the analysis by reaching the user categories.

In addition to the prescriptions provided and the evaluation of the Ecosystem services provided on reefs, the policy makers will find useful the precise evaluation of reef vocations of the selected case studies within the project.

Other than White paper, the results of the performed activities were used to draft the Guidelines to ease the management and the use of the reefs by existing and potential stakeholders (see. D. 5.2).

## 2. RECOMMENDATIONS FOR DRAFTING REGULATIONS RELATED TO THE SUSTAINABLE USE OF THE UNDERWATER REEFS

### 2.1 REEFS DEFINITION

Within the ADRIREEF project 176 reefs and 109 wrecks were identified in the Adriatic. Forty-seven are artificial reefs (ARs), and they can be found only in the Italian waters. All the other reefs are natural (NRs) and most of them are located in the Croatian side of the Adriatic Sea. There are a total of 109 wrecks, 87 in the Italian territorial waters, 9 in the Croatian territorial waters, and the rest in the international waters. For the project purposes, the definitions of natural and artificial reefs reported in the following paragraphs have been adopted.

#### 2.1.1 NATURAL REEFS

“Natural reefs are either biogenic or geogenic formations protruding from the solid or soft seabed with distinctive living marine resources” (Zec et al., 2019).

Considering natural reefs within the ecological network Natura 2000, it is necessary to emphasise that reefs can be extremely varied: submarine elevations, vertical and overhanging rocks, horizontal solid “shelves” on the seabed, massive boulders, or rocky bottom with a mild slope. The reefs located in the coastal area, where there is a significant pressure of human activities, are endangered due to increased eutrophication, underwater discharge of wastewater, coastal construction and embankment, fish and shellfish farming, marinas and harbours. Permanent damage is caused by concreting and levelling an uneven rocky shore to get areas suitable for bathers (Bakran-Petricioli, 2011).

#### 2.1.2 ARTIFICIAL REEFS

An artificial reef is a submerged natural or manmade structure deliberately constructed or placed on the seabed to emulate some functions of a natural reef such as protecting, regenerating, concentrating, and/or enhancing populations of living marine resources, while doing “no harm”. Objectives of an artificial reef may also include the protection, restoration and regeneration of aquatic habitats, and the promotion of research, recreational opportunities, educational use, sustainable fisheries and aquaculture.

This definition also includes decommissioned structures, or parts of them, intentionally topped down to act as an artificial reef (e.g., rig-to-reefs, sunken ships). The term excludes operational artificial islands, cables, pipelines, extraction platforms, mooring, structures for coastal defence (e.g. breakwaters, dikes, etc.), wind farms, etc. primarily constructed for other purposes. The term also excludes the Fish Aggregation Devices (FADs), employed to attract fish in certain fishing areas, and unless the submerged parts of such structures are not purposely planned and built to mimic some characteristics of the natural

reefs, as a result of multi-actor joint eco-engineering aimed to optimize benefits from marine infrastructures and space according to the Blue Economy (Zec et al., 2019).

Objectives of an artificial reef may also include the protection, restoration and regeneration of aquatic habitats, and the promotion of research, recreational opportunities, educational use, sustainable fisheries and aquaculture.

Improving fishing, especially small-scale fisheries, and protecting coastal sensitive habitats from illegal trawling are traditionally the main purposes of artificial reef installation however, in the last few decades, their implementation has been expanded, to aquaculture, reduction of damage and habitat loss, creation of suitable sites for diving, and research. In Europe, the modern concept of artificial reef was adopted in the second half of the 1900s and several ARs have been developed and placed across Europe, most of them in the Mediterranean (Fabi et al., 2011).

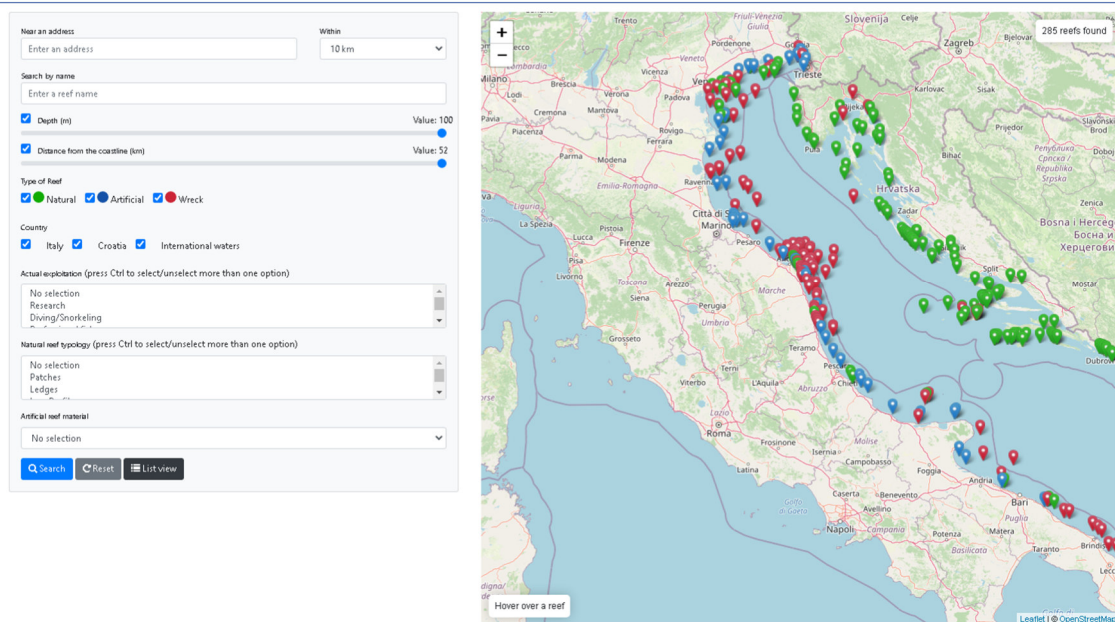
### 2.1.3 NATURAL AND ARTIFICIAL REEFS IN THE ADRIATIC SEA

One of the main outputs of the ADRIREEF Project is the Map of Adriatic reefs (WP3.1 - Reefs Classification - Deliverable D3.1.4) webGis. The map is built with the purpose of geographically representing data regarding the Adriatic natural reefs, artificial reefs and wrecks and filtering them based on some peculiar aspects. The input of the database upon which the webGis is built is composed of data coming from a wide survey conducted within Activity 3.1. Collected information is classifiable in four main groups: reef identification properties, area hosting the reef properties, reef properties and reef eventual exploitation. With the aim to augment the readability of data and basing on this subdivision, in the webGis it was decided to filter data by type, country, usage, natural reef typology and artificial reef material. Moreover, data were filtered by name, distance from the coastline (or from a specific address) and by depth. The technical solution adopted takes advantage of Google Maps APIs, JSON objects, Javascript and GitHub pages and it represents a rapid and easy-to-use option for our purposes.

The webGis main page is reachable at the address: <https://adrireef.github.io/sandbox3/> and is composed by two windows: the one on the left reports all available filters for data, the one on the right reports the map where points, identifying elements, are divided by colour in Natural reefs (green), Artificial reefs (blue) and wrecks (red). Hovering on a reef with the mouse, Name and Location of the element appear in the left bottom corner of the map (Fig. 1).

## Map of Adriatic reefs

WP3.1 - Reefs Classification - Deliverable D3.1.4



**Figure 1. The interface of webGis. On the left side: the filters window. On the right side: the map window with hover function (bottom left) and total number of identified elements (top right) (from Minelli et al., 2019)**

The total number of currently visualised elements is reported at the top right of the map. Moreover, when an element is clicked, a pop up appears reporting the associated relevant information (Fig. 2).

The Adriereef database has been also published on SEANOE in order to make it publicly available (Ferrà et al., 2020; Minelli et al., 2021).





## Paguro wreck

**Type :** Artificial reef  
**Country :** Italy  
**Region :** Emilia Romagna  
**Location :** Ravenna  
**Year of Deployment :** 1965  
**Year of modification :** 1990-1991 and 1999-2000  
**Depth [m] :** 10 - 34  
**Min. Dist. From Coastline [km] :** 20  
**Surrounding Seabed :** Mud  
**Meadows :** No  
**Reef Typology :** Decommissioned structures  
**Material :** Steel/Iron  
**Arrangement of Modules :** No data  
**Total Area [sqm] :** 31400  
**Total Volume [cum] :** No data  
**Number of Oases :** No data  
**Distance between Oases :** No data  
**Oases Dimensions [sqm] :** No data  
**Type of Structures :** jackup drilling rig, iron structures deriving from off-shore activities  
**Number of Structures :** No data  
**Structures Dimension [m] :** No data  
**Distance Between Structures [m] :** No data  
**Modules Shape :** No data  
**Number of Modules :** No data  
**Distance between Modules :** No data  
**Dimension LWH [m] :** No data  
**Experimental/Professional :** Experimental, Professional  
**Scope :** Diving/Snorkelling, Habitat protection, Research  
**Exploitation :** Diving/Snorkelling  
**Possible Exploitation :** Diving/Snorkelling, Research  
**Management :** The managing body is the Emilia-Romagna region, together with the association "Paguro", the Coast Guard of Ravenna, the Marine Research Centre in Cesenatico and ARPAE Emilia-Romagna. Foreseen management measures include: regulation and promotion of human activities, monitoring of physicochemical and biological parameters, training and dissemination activities, removal of derelict fishing gear.  
**Surveillance Service :** no  
**Monitoring Program :** Within the MSFD activities, an annual sampling for contaminants in sediments and biota plus granulometric analysis (period 2018-2020) is carried out by ARPAE Emilia-Romagna.  
**Concession Area :** yes  
**Available Data :** Benthic community, Fish community, Planktonic communities, Sediments, Water column  
**Available literature (Scientific or Grey) :** Bisca A., Ricci V.G., Pepoli R., Rambelli F., Vistoli G.P. 1994. Paguro. Immagini da un relitto. Edizioni Calderini, Bologna. 152 pp.  
 Ponti M., Capra A., Gabbianelli G., Ceccherelli V.U. 1998. Environmental characterization and macrobenthic communities on the Northern Adriatic "Paguro" wreck. Rapp. Comm. int. Mer Médit., 35, 1998, 478.  
 Abstract: The "Paguro" drilling platform wreck has today come to constitute an artificial reef of particular interest. The aim of this study has been to characterise this habitat and to investigate the distribution of macrobenthic communities in relation to the main chemical and physical parameters of the water. For this purpose, a graphic three-dimensional reconstruction of the wreck has been made, direct samples of macrobenthos have been taken, and, finally, photographic transects have been performed. The data thus obtained have been subjected to statistical analysis.  
**Key words :** Artificial Reefs, Zoobenthos, Biodiversity, GIS, Adriatic Sea  
 Pacchioli D., Ponti M. 2002. Censimenti subacquei. I progetti in Adriatico settentrionale. Deep, Anno V, maggio-giugno 2002, n.21, 5-7

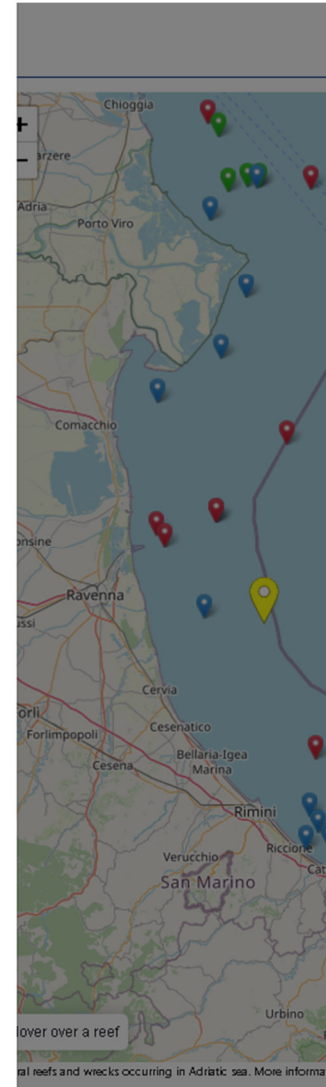


Figure 2: Example of a pop up that appears once an artificial reef is clicked (from Minelli et al., 2019) .



## 2.2 STATUS OF THE REEFS CONSERVATION

Reef protection depends on the legal framework governing the conduct of reef activities. The legal framework sets out the purpose of protection and the objectives for individual reefs or in general. An integral part of this are the regulations and specifically determine the rights and opportunities for the user, and thus become the basis for the protection of the reef.

There are two basic ways to use the reef:

- General use of the maritime domain – Public use

General use implies equal right of access to the reefs of all users. But access to the reefs and the implementation of activities on these reefs can be done only in accordance with the regulations of each domain (culture, nature and environment protection, tourism, transport). Every user must know the regulations relating to the use of reefs. There are two possibilities; to inform itself or to organize an information system to inform users at the local level.

- Specific use of the maritime domain (concessions)

For the time being, there are no concessions for performing activities that specifically cover individual reefs, but this is cannot an obstacle in future for concessions holders who can organize visits to reefs not to get acquainted with the fundamental values and protection measures.

When granting a concession within the concession contract, the rights and restrictions and obligations of the concession holder may be determined, which also can include the protection of the fundamental values of the reef can be included.

## 2.3 THE LEGAL FRAMEWORK FOR CONDUCTING ACTIVITIES ON REEFS

The difficulty of having an universal approach for creating a legal framework for conducting reef activities is suggested by the own definition of the reef. In this case, it is easier to identify underwater reefs which are the object of establishing the framework and focus on the selected reefs. That approach was also applied in this project, in which the selected locations within the project were the focus point.

The prevailing weakness which significantly determines the use of reefs is the overlapping of competences. Therefore,, there is a lack of holistic approach to the reef and its conceptual and functional integrity.

The bigger and more diverse the reef is, potentially higher is the attractiveness for different types of use. Therefore,, there is an overlap of authorities, as well as many interested stakeholders. The great attractiveness of the reef can affect the maritime domain around it. Users attracted by the reef increase

the areas necessary for anchoring or mooring, which usually take place in close proximity, in the shallow parts of the area, and as a consequence have an impact on protected habitats (e.g. Posidonia meadows).

### 2.3.1 REEFS IN PUBLIC USE

Natural reefs, artificial reefs and wrecks can be found in the parts of the maritime domain that are in public use. In that case, regulations related to the rights and obligations of the natural and legal persons operating in that area are applied.

### 2.3.2 SPECIFIC USE OF REEFS

The specific use of reefs are regulated by means of:

- concession for a specific area or for conducting activities;
- obligations for use arising from it (for the manner of use the responsible one is usually the authorised person/(concessionaire)

Parts of the maritime domain can be excluded from public use and given for use to legal and natural persons. Parts of the maritime domain in specific use or excluded from the public use for the purposes of economic use receive a concession. The concession shall comply with the regulations on environment and nature protection.

Legal and natural persons receive a concession approval to conduct activity in the maritime domain that neither excludes nor limits public use of the maritime domain.

Among regulations governing concession granting or concession approval, marine reefs are nowhere explicitly mentioned. It is hypothetically possible to release a concession for economic activity in the category of "Other economic activities". Therefore, it is important to bear in mind that fishing and diving are already regulated by specific regulations. Privileges and concessions are issued for fishing, in accordance with the specific regulations governing fishing, and permits for diving centres are issued for the activity and not for the area. Concessions for aquaculture are granted for the activity of farming that, at least until now, has never included natural reefs

#### **CROATIA**

In the territory of the Republic of Croatia, the most important rights and obligations that public maritime domain users can come across are part of the legal framework of the regulations reported in Table 1.

Table 1 Regulations for the use of the public maritime domain and activities it comprises in the territory of the Republic of Croatia

Regulation	Covered activities	Regulated activities
<b>Regulations in the field of the maritime domain use</b>	Maritime transport	<ul style="list-style-type: none"> <li>- Accidents related to diving (speed boat riding...)</li> <li>- Anchoring in the reef area or the larger area around the reef</li> <li>- Setting up signalling (buoy) facilitates arrival to the reef</li> </ul>
	Concessions for activities in the maritime domain	- Higher number of stakeholders on the reef at the same time makes it difficult to control the activities of individuals
	Port areas  Port area can cover areas comprising reefs. Special types of reefs are embankments on the breakwaters.	<ul style="list-style-type: none"> <li>- In the port area there are activities related to the use of reefs</li> <li>- Embankments on the breakwaters are the surfaces for the hard substrate communities that attract divers and fishermen</li> </ul>
	Diving and snorkelling  Diving can be extended in underwater fishing or collecting organisms (corals, sponges, molluscs...)	Individual diving on the reefs cannot be controlled. Control comes down to documents inspection and finding organisms or archeological artefacts in the vessel.
<b>Regulations in the field of spatial planning and construction</b>	Spatial plans in the maritime domain	Reefs can be more or less visible. The reefs “hidden” in the spatial planning process can cause the use of areas harmful to the reef.
	Planning permit	During the planning permit issuance process, reefs are protected only by interventions that require environmental impact assessment

Regulation	Covered activities	Regulated activities
		and areas within the ecological network Natura 2000
<b>Regulations in the field of environment and nature protection</b>	Restrictions imposed by different categories of the maritime domain protection (Reserves, National parks, Nature parks, Natura 2000). Interventions assessment on nature and environment.	National parks and nature parks are managed by specific institutions. They don't have jurisdiction over maritime transport and fishing. They can identify reefs and establish protection measures with the management plans.
		Other forms of protection are implemented through regional institutions for protected parts of nature management. Implemented management plans can comprise reefs. Management plans do not have legal power over users. They have no jurisdiction over maritime transport, aquaculture, fishing, and diving.
<b>Regulations in the field of cultural heritage preservation</b>	Diving in the areas of protected cultural goods	The reefs on which there are underwater archeological sites and zones with the characteristic of immovable cultural good are in a regime of restricted access to divers.
<b>Regulations governing the exploitation of natural renewable resources</b>	Fishing	Fishing in the National Parks and Nature parks is regulated among the competent institutions for fishing and nature protection.  In other fishing areas, in accordance with the EU acquis which can indirectly limit fishing on the reefs.

Regulation	Covered activities	Regulated activities
		Fishing on the reefs that are not in the protection regime is entirely independent of the reef.
	Aquaculture	<p>Installation of fishing farms in the sea, depending on the size of the fishing farm, is subject to environmental impact assessment, which can also take into account the presence of the reef.</p> <p>Fishing farms that, due to their size, are not subject to environmental impact assessment can be installed above the reef.</p>
<b>Regulations in the field of the tourism activity</b>	Tourist destination marketing and presentation of the values of the cultural heritage, providing services in tourism	The attractiveness of the reef can be the key to opening a new tourist destination. The reef, as a marketing product of the tourist activity which is not in the protection regime, can be destroyed by a great number of visitors.

## ITALY

Industrial activities on the reefs are regulated by two different ITERs, depending on whether it is a place where a reef already exists (artificial or natural) or where an artificial reef has to be installed on the seabed. In the former case, the ITER is defined by the construction site management plan:

- if it is a protected area there is a specific management plan that regulates allowed activities, access, or zoning;
- if it is not a protected area, the fundamental regulation is the Regulation on Navigation Safety, which is issued by the local port authority. In that case, it is possible to develop some industrial activities before obtaining a concession for state property use for the exclusive use of the area.

Professional fishing activity does not fall under this ITER of the concession and is subjected to the national and local fishing regulations.

Critical issues to be taken into considerations are:

- due to the geophysical morphology of the Italian Adriatic coasts, natural reefs are rare, and in several cases are managed through restrictive management plans;
- a significant improvement for the development /implementation of low impacting activities according to the Blue Growth would be the deployment of purposely planned artificial reefs, but the overlapping of competences and issuing bodies that have to express on the request of the concession, makes the process very challenging especially for private legal entities. Rejection of the concession is often issued without any suggestion for alternative areas where to locate the proposed activity consequently, after its reception, the applicant shall identify independently another area and reinitiate the procedure;
- it is worthy to note that the development of new activities at sea, including mining concessions, protected areas, extraction sites, military zones, and others, reduces the number of areas available for new concessions. Moreover, the issued concessions reduce available areas for professional fishing and the areas that fishers can use are becoming smaller and smaller;
- reutilization of dismiss offshore extraction platforms and installation of windmills could represent an excellent opportunity for the development of productive activities in the underwater parts of those structures in the context of an integrated management of maritime spaces.

Table 2. Regulations for the use of the public maritime domain and activities it comprises in the territory of the Republic of Italy

Legal framework	Activities	Regulated activities
<b>Regulations in the field of maritime property</b>	Maritime transport	Safety of navigation authority (local port authority) issues the rules on sailing schedule.
	National plan for identifying suitable and unsuitable areas for exploring and extracting hydrocarbons.	A few areas, currently under the concession for hydrocarbon extraction, could become available (considering the increase in concession fees by 25 times) and suitable for artificial reefs by the implementation of this plan.

	Industrial activity permit	Regional institutions convene a “meeting for services” with all the authorised institutions and organisations to inspect all the concession applications that can be either accepted or rejected.
	Port areas	<p>Port areas and their related infrastructure (including reefs) are under the jurisdiction of the competent port authority. Basins are hard substrates for the colonisation of benthic communities that attract divers and fishermen.</p> <p>In the port area, there are economic activities related to reef use (tourism purposes, diving, and fishing). In order to support benthic communities’ formation, it would be suitable to stipulate the use of biomimetic structures during the construction of the port infrastructure.</p> <p>The use of materials and structures that imitate natural coastal substrates enables sessile organisms to adhere and grow, besides, species like bivalves and corals cover structures creating a protective layer that additionally mitigates hydrodynamic and chemical forces, and increases the community and basin longevity.</p>
	Snorkelling and scuba diving	<p>Individual dives are not regulated by any legal framework.</p> <p>Performed check on diving activities is related to document and patent revision.</p> <p>The use of some areas can be prohibited by the Management plan.</p>



<p><b>Regulations in the field of spatial planning</b></p>	<p>Maritime spatial planning is carried out through management plans drafting that identify the spatial and temporal distribution of important activities and use of the sea, present and future ones, which can comprise: (a) aquaculture; (b) fishing; (c) facilities and infrastructure for research, exploitation, and extraction of gas, oil and other energy sources, minerals and aggregates, and production of energy from renewable sources; (d) sailing routes and traffic flow; (e) military training areas; (f) areas for nature and species conservation and protected areas; (g) exploitation of raw materials; (h) scientific research; (i) routes of underwater cables and pipelines (l) tourism (m) underwater cultural heritage</p>	<p>Maritime spatial planning promotes sustainable growth of the maritime economy, sustainable development of maritime areas, and sustainable use of maritime resources to protect the biological diversity of the reef area.</p> <p>In order to do that it is important to identify reefs through mapping of these sites to avoid loss of biodiversity.</p> <p>In Italy, some activities such as fishing, aquaculture, and tourism are regulated at the regional and others at the national level.</p>
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	Coastal management plan	<p>Coastal protection structures (such as embankments, breakwaters, seawalls...) can be built to meet engineering requirements, providing at the same time important ecosystem services – so-called ecological engineering.</p> <p>Ecosystems can contribute more to coastal protection by wave attenuation in the areas with relatively low tide amplitudes and/or the large intertidal zones.</p> <p>The lack of knowledge that prevents the implementation of intertidal ecosystems for coastal protection is the lack of qualitative presentation of the long-term ecosystem dynamics.</p> <p>Solutions that integrate intertidal ecosystems with coastal protection draft provide promising opportunities in some situations but require a better mechanical understanding of ecosystems dynamics through time and space to allow application on a larger scale. Therefore, funding within the climate change adaptation plans should be promoted to explore these methodologies.</p>
	Concession for the use of the maritime domain.	<p>During the concession for the use of the maritime domain, the reef areas are only protected if the use of the area is subject to the environmental impact assessment, or the site is a protected area (e.g. for Natura 2000 area, the impact assessment is anticipated for the projects within or near the ecological network).</p>

<p><b>Regulations in the field of environment and nature protection</b></p>	<p>Restrictions imposed by conservation state system (nature parks, nature reserves, Natura 2000 ecological network areas).</p>	<p>Marine protected areas are defined by the decision of the Ministry that regulates zoning, allowed activities, and implements European regulation related to habitat and species conservation.</p> <p>Park manages areas with the help of the Coast guard that implements sanctions and control.</p> <p>Other systems for protection can be established through marine protected areas in which European regulation on habitat and species conservation, such as special protection areas, restocking areas, areas of community interest etc.</p> <p>Management plan defines allowed activities.</p>
<p><b>Regulations in the field of environment and nature protection</b></p>	<p>In Italy, laws on environmental impact assessment procedures are issued at the national and regional level depending on the project.</p> <p>If the project is related to fishing, aquaculture, or coastal protection, authority is at the regional level and if it is related to port infrastructure, mining, or energy and carbon storage, authority is at the national level.</p>	<p>This regulation only affects aquaculture.</p> <p>If an artificial reef is to be installed in the sea, the project is not subject to the environmental impact assessment procedure if the end use is intended to be in the form of diving, fishing, research and increase in biodiversity.</p>
<p><b>Regulations in the field of the preservation and conservation of cultural and historical heritage</b></p>	<p>Diving in the area of archeological sites</p>	<p>Reefs located within archeological sites are in the regime of restricted access to divers.</p>

<b>Regulations governing exploitation of renewable energy sources</b>	<b>Fishing</b>	<p>Fishing in nature parks and national parks is regulated by competent institutions, managing authorities, or current management plans.</p> <p>Maritime police is responsible for the enforcement of appropriate regulations and sanctions.</p> <p>Fishing in the areas that are not within protected areas is regulated by the Regulation on Navigation Safety which determines access to the area.</p>
	<b>Aquaculture</b>	<p>Installation of aquaculture and bivalve farms is done with a concession for state property use.</p> <p>Regional institution coordinates conference on service that has to integrate statements of all the other responsible institutions before approving or rejecting any project or concession application.</p>
<b>Regulations governing tourism industry at regional level</b>	<p>Promoting tourist destinations and the natural values of the area.</p> <p>Regulation of the tourist offer that defines minimum requests for different accommodation categories (camps, tourist resorts, boarding houses, hotels...)</p>	<p>Reef attractiveness can be an encouragement for opening new tourist destinations.</p> <p>The biodiversity of the reef, as a tourist destination in a protected area, can be harmed by a great number of visitors.</p>

### 2.3.3 LEGAL FRAMEWORK GOVERNING ARTIFICIAL REEFS INSTALLATIONS IN CROATIA

Artificial reefs installation comprises action, procedure, expenses, function, and interest which can be public or private.

The first step in artificial reef installation is identifying the location for its legal and legitimate installation:

It is necessary to choose the place for the installation of the artificial reef according to the purpose and goal of its installation. The installation of the reef is a spatial intervention that changes the allocation of the space. It is necessary to issue a location permit for interventions within the maritime domain that change the purpose of space. According to the Croatian provisions, reefs' installation is not considered construction, but a part of the installation procedure of the offshore stationary facility for which the location permit is issued.

The main requirement for issuing the planning permit is the coordination of the intervention with the spatial plan, namely with the provisions of the spatial plan (counties) that determine the space allocation in the maritime domain. If the location of the reef installation does not overlap with the space allocation in the competent spatial plans, and is in accordance with the aims of plan management, the permit for installation can be issued.

The next step in artificial reef installation is to determine the legal interest:

When artificial reef installation has a character of restoration intervention, which is in line with the definition according to the GFCM, the intervention has characteristics of extraordinary management of maritime domain implemented by counties in accordance with the law of the Republic of Croatia.

The intervention holder for artificial reef installation, which has the function of protecting, restoring, or conserving organisms to support fisheries, can be a regional self-government unit. An unequivocal legal basis has not been determined for other forms of legal interest in artificial reef installation. In particular, there is no clear basis for entrepreneurial intervention of artificial reef installation, for which a logical entrepreneurial interest would be to exclude that part of the maritime domain from the public use and obtain a concession for the use of the reef.

The procedure of the artificial reef installation, whose holder is the county, starts with drafting the conceptual design. According to the regulations governing environment and nature protection, artificial reef installation belongs to projects that neither require conducting environmental impact assessment, nor evaluation procedure on the need for environmental impact assessment. In the case in which the location for reef installation is included within the area of the ecological network, it is necessary to conduct a preliminary assessment of the acceptability of the project for the ecological network.

Once the conditions from the authority of environment and nature protection are met, in the process of issuing a location permit, the rest of the required consents from competent bodies governed by public law shall be obtained. The fundamental document for artificial reef installation in the maritime domain is

the design of the Maritime study. The Maritime study is created according to the regulation governing legal relations in the sea and submarine area and the safety of navigation in the territorial sea and internal waters.

In accordance with the experience of conducted procedure of the artificial reef installation, the content of the Maritime study comprises navigational, meteorological, oceanographic, and hydrographic characteristics of the area, namely interventions in the area, technical, technological, and traffic navigation characteristics of the interventions in the sea area, maritime safety measures in terms of the maritime safety of navigation and stay of the maritime installations, and protection of the sea from pollution, coming from the maritime installations in the access area and within the intervention sea area, and procedures in the extraordinary circumstances for the safety of navigation and protection of the sea from pollution.

Conditions for artificial reef installation also contain activities that shall be conducted after the physical implementation of the intervention itself. Those are a hydrographic survey of the area and report making of the artificial reef situation. The survey is necessary to record the reef in the official reports of HIRC and signal it on the official nautical charts.

Currently, there is no legal basis in Croatia for issuing a concession or a concession permit for artificial reef management.

#### 2.3.4 LEGAL FRAMEWORK GOVERNING ARTIFICIAL REEFS INSTALLATIONS IN ITALY

In Italy the installation of an artificial reef must be authorised by the relevant bodies that have to issue a concession on the area. This activity usually is also subjected to an Environmental Impact Assessment (EIA) procedure.

The concession is necessary for private companies/associations which want to deploy an artificial reef, while it is not required in the case of artificial reefs constructed by public bodies (e.g., municipalities, regional authorities).

The competent authority to issue this type of concession is usually the Region governing the area where the reef should be installed. The regional offices responsible for the procedures provide the necessary documentation, which can be generally downloaded online. After having received the request for installation, the Region summons all the entities that must express their authorization or opinion in a services conference.

Usually, the application for the concession on the area should require the drafting of specific documentation which includes: chorography and planimetry of the area at the time of the request, project plan and detailed technical report of the proposed project containing: the description of the employed materials, details on the typology (movable or immovable) and technical features of the structures as well

as of their spatial arrangement, and the description of all phases of construction. Documents proving the transparency of the entity and its conformity to IT laws (e.g. no mafia activities) are required.

The Environmental Impact Assessment (EIA) is not mandatory, but it can be requested by the regional body depending on the type and size of the project. If the project falls within a protected area (e.g. Natura 2000 site) or in its vicinity, the application must be integrated with the documentation necessary for the issuance of the authorization by the protection body that must be involved in the evaluation of the project.

Current legislation regulates aquaculture, research and restocking activities through concessions for state-owned maritime areas, normally issued for an initial period of no less than the one planned for the amortisation plan of the initiative to which the concession belongs.

The Italian regulation does not make differences among artificial reefs for recreational fishing, professional fishing, diving or aquaculture whose establishment follows the same administrative procedure.

### 2.3.5 AN OVERVIEW OF THE IMPACT OF INDIVIDUAL ACTIVITIES ON THE REEF

The project analyses the following activities: recreational fishing, nautical tourism (anchoring), diving and aquaculture. An overview of the possible impacts of the activities on reefs is displayed in the following table (Table 3) with a review and assessment of the impact of particular activities on reefs.

Table 3 Overview of the possible impacts of the activities on reefs

Activities	Way of impact	Possible influence	Hazard estimation
Diving	Collecting organisms	Removal of organisms – biodiversity impoverishment	Medium
	Recording and taking photos	Use of flashlight	Low
	Physical disturbance	Habitat damage	From Low to High depending on the amount of divers visiting the reef
	Vessel anchoring	Habitat damage	Medium/High
Nautical tourism	Vessel anchoring	Habitat damage	Medium/High
	Littering	Engulfing reefs with waste	Medium



Activities	Way of impact	Possible influence	Hazard estimation
Aquaculture	Installations anchoring	Habitat damage	Medium
	Nutrient, and organic matter emission	Reef eutrophication	High
	Drug emission (fish culture)	Change in the structure of biological community	Medium/high depending on the densities of fish in the cages and in the national regulations on the use of drugs in aquaculture
	Collecting ichthyofauna-predation on reef	Change in the structure of biological community	High
	Biological and other waste from farms	Engulfing reef with waste, eutrophication	High
Recreational fishing	Catching species important for reef biodiversity	Change in the structure of biological community	From Low to High depending on the effort
	Leaving fishing gears on the reef	Engulfing reef with waste Change in the structure of biological community	Low/Medium
	Anchoring in the reef area or in close proximity	Habitat damage	Medium/High
Commercial fishing	Catching species important for reef biodiversity	Change in the structure of biological community	From Low to High depending on the effort
	Leaving fishing gear on the reef	Engulfing reef with waste Change in the structure of biological community	Medium/High

Activities	Way of impact	Possible influence	Hazard estimation
	Anchoring in the reef area	Habitat damage	Medium/High
	Set-net fishing	Habitat damage when pulling out gear	Medium
Maritime Traffic	Speed boat riding	Sea accidents	Low
	Littering	Engulfing reef with waste	Low
	Ballast water	Invasive species	Medium
	Noise	Disturbance	Medium
Scientific research	Invasive methods research	Habitat damage Change in the structure of biological community	Low

### 2.3.6 RECOMMENDATIONS RELATED TO THE SUSTAINABLE USE OF THE UNDERWATER REEFS

In order to foster a lasting and harmonious Blue growth, the marine spatial planning of the Adriatic area should include actions able to ensure the sustainable development of economic activities while ensuring the integrity of the landscape, functioning of ecosystems and their ability to provide ecosystem services.

For sustainable development, it is essential to solve conflicts for space and resources between different uses and to seize the opportunities for coexistence and synergy of different activities, e.g. small scale fishing and tourism.

Sustainability must be a principle and a transversal approach to all objectives defined for the Adriatic maritime area, emphasizing how the health of the sea and the protection of marine resources are essential factors for long-term economic development and the well-being of local communities.

Considering that the Adriatic reefs constitute very important hot spots for maintaining and increasing fish stocks and providing many other ecosystem services, to ensure development of sustainable activities at the Adriatic reefs should constitute a transversal principle to all the blue economy policies.

These policy should be pursued through several actions such as:

- protection/management of the existing natural and artificial reefs;
- promote the installation of new artificial reefs;
- orient the European funding programmes and the national ones, on Ecosystem Services analysis offered by the reef habitats and protection policies.

### *Protection / management of the existing natural and artificial reefs*

An important objective for the Adriatic area should be the enhancement and implementation of the system of protected areas, taking into account the interactions with the local socio-economic conditions and in synergy with the other uses present in the area.

Particular attention must be paid to the spatial management of the protection of species and habitats and ecosystems protected under the "Habitat" and "Birds" Directives (Natura 2000 Network), highlighting the areas and marine habitats of significant environmental value in order to implement related conservation strategies and monitor conservation in the long term, and to consolidate the existing conservation measures in a regulatory framework that leads to a coherent and effective extension of the protection of seas to 30% by 2030.

It is therefore appropriate to promote research activities in order to monitor over time the habitats of the Adriatic reefs and to well orient the planning activities of the MSP.

As for the artificial reefs already deployed in the Adriatic sea and a part of the natural reefs, adequate site-specific management plans should be implemented in order to allow harmonious development of sustainable activities, guarantee coexistence and synergy among them, regulate exploitation, and maintain or increase the ecosystem services the reefs can provide.

Effective management of reefs can help reduce potential risks such as damage to fishing gears, injuries to recreational divers visiting the reef, decomposed materials or movement of the reef units off-site in the case of artificial reefs (FAO, 2015).

Physical, biological and socio-economic monitoring is a key element of the management plan as it allows to assess the structural performance of the reef on time, to assess whether the reef provides the expected benefits from the ecological and environmental point of view and to evaluate the efficiency of the applied control measures.

The involvement of stakeholders in the reef management is crucial. Professional and recreational fishers and divers can provide support in reef monitoring and evaluation. Applied research is another key element providing assistance in monitoring the activities carried out at the reef, evaluating the efficacy of the adopted management measures and, where necessary, identifying actions to be undertaken and alternative management options.

The open-access may lead to overexploitation and rapid depletion of the reef resources and conflicts within and between user groups. This usually happens where there is a lack of effective restrictions on access by the different user groups (Milon, 1991) or where there is a lack of control to assure that the restrictions are respected.

User conflicts can be generated by stock effects and congestion effects. The former may occur from overexploitation of all species or particular species at the reef site. The latter occurs when the different activities interfere with each other and may result from either incompatible uses (e.g., recreational and commercial fishing), incompatible fishing gears or too many users in a limited site. Stock and congestion effects are not mutually exclusive (FAO, 2015).

Several basic management options for artificial reefs, which can also be applied to natural reefs, are proposed by FAO (2015):

- 1) Selective access control: it may consist in the establishment of property or user rights whereby local fishing communities or recreational associations would be co-responsible with government agencies for regulating access and monitoring both the activities which are carried out at the artificial reef and the physical performance of the reef structures. It is often not feasible due to political and institutional constraints which explicitly forbid discrimination between different groups of users.
- 2) Gear and catch restrictions: this measure is aimed to orient harvesting strategies at the reef through the use of selective fishing gears so to allow optimal fishing yields and avoid disruption of the natural succession of the reefs and associated assemblages. Exploitation strategies should include different types of fishing gear to diversify the catches and exploit all the reef resources to avoid alterations in the equilibrium among the functional groups of fish and macroinvertebrates inhabiting the reef.
- 3) Temporal closure: it can be adopted to avoid the exploitation of the reef resources in particular seasons of the year, for example to favour the reproduction and/or the early growth of juveniles at the reef, but this measure may increase congestion and overexploitation in the remaining periods.
- 4) Temporal segregation of users: it is aimed at separating user groups, allocating specific periods of time when each group is permitted access. Times may be chosen on the basis of various factors such as stock availability, weather conditions, market prices, etc. In this way, the different user groups can continue to use the reef without interacting between them. However, this management measure is easily enforceable only when the different user groups (e.g. recreational and professional fishers) are easily distinguishable and compliance resources permit. In addition, similar to closed seasons, the reef may increase congestion within user groups because access opportunities for each of them are compressed into shorter time periods.
- 5) Spatial segregation of users: it consists in creating separate reef sites or sectors of the same reef for each user group. Nevertheless, this solution can actually increase the likelihood of conflict if perception of better catch rates on or greater attractiveness of one reef (or sector of a reef) over another is reported, with fishers or divers moving without consent onto another reef sector.

However, no single management system can be optimal for all situations and the choice of one or more options must be based on the nature of the reef, the ecosystem services it can offer, the categories of potential users and conflicts, as well as the effectiveness of the management measures adopted.

### *Promote the installation of new artificial reefs*

The report edited by the International Resource Panel (IRP, 2019) for the United Nations Environment Programme stated that during the last 50 years, the rate of natural resource exploitation was higher than the rate of regeneration. At the same time, the demand of ecosystem services is not satisfied by the amount of services effectively delivered by ecosystems (Winkler et al., 2021). The gap between the demand and supply of ecosystem services could be narrowed by restoration actions using Nature-based Solutions (NbS) especially in the proximity of areas where the demand is not fully satisfied by ecosystems (Almenar et al., 2021). Following the IUCN (2016) definition, Nature-based Solutions are “*Actions to protect, sustainably manage and restore natural or modified ecosystems, which address societal challenges effectively and adaptively, while providing human well-being and benefits for biodiversity*”. On this base, NbS enhance ecosystem services provision and address major societal challenges: Climate change mitigation and adaptation, Disaster risk reduction, Economic and social development, Human health, Food security, Water security, Environmental degradation and biodiversity loss (IUCN, 2020). On the other hand, the EC (2021a) defines the NbS as “*solutions that are inspired by and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits, and help build resilience*”. Moreover, NbS must “*benefit biodiversity and support the delivery of a range of ecosystem services*”.

The topic of natural capital, human-made capital and related ecosystem services was approached by ADRIREEF project with the identification of eight natural and artificial reefs and their monitoring in order to evaluate their structural and ecological status and arrive, based on their ecological qualities, to the estimation of their capacity to support different economic activities, in line with the principles of the Blue Economy. Specifically, with regard to artificial reefs and wrecks, the project approached the role of these structures as NbS related to the main societal challenges “3) Social and economic development” and “7) Environmental degradation and biodiversity loss”. It should be underlined that, beyond the project purposes, artificial reefs and wrecks play an important role also in relation to the societal challenge “1) Climate change mitigation and daptation” and “5) Food security” and in some cases also to “2) Disaster risk reduction” where artificial reefs are built to restore destroyed natural reefs which, in turn, reduce coastal erosion.

A reef environment is constituted from either inorganic (rocks) or organic substrate (corals, algae, rocks) and artificial structures (concrete, steel, plastic, tires and carcasses of ships) or associations of these compounds. Once implanted, it joins natural living communities and consolidates itself in that environment. As for the artificial reef, this becomes a dynamic environment, adding changes that converge in processes resulting in benefits of environmental, social and economic scope. In this sense, the artificial reef configures a model of NbS (De Oliveira and Pereira, 2021). According to the analysis carried out by ADRIREEF, although the use of artificial reefs as NbS for fish restocking remains the main purpose, other important results can be achieved, such as the fight against illegal trawling, the creation

of environments where research activities can be carried out, enhancement in educational terms and enjoyment in its various forms (diving, sport and recreational fishing).

In order to support the implementation of NbS, the European Commission put them at the core of EU policy priorities, in particular the European Green Deal, biodiversity strategy and climate adaptation strategy, as a way to foster biodiversity and make Europe more climate-resilient. Current policy goals are:

- provide the evidence for nature-based solutions;
- improve framework conditions for nature-based solutions at EU policy level;
- develop a European research and innovation community;
- advance the development, uptake and upscale of innovative nature-based solutions;
- mainstream nature-based solutions in international research and innovation;

EU research and innovation for nature-based solutions is currently implemented through

- the EU's funding programme Horizon Europe - nature-based solutions will be further tested, deployed, promoted and their benefits and impacts assessed, notably via EU missions
- BiodivERSA ERA-Net is a network of national research programmes on biodiversity across Europe that organises international research funding on a competitive basis. Work will be continued in the upcoming Biodiversity Partnership under Horizon Europe, the EU's next framework programme (2021-2027).<sup>1</sup>

Moreover, according to the EEA Report No 01/2021<sup>2</sup>, many economic and financial instruments that have been developed to stimulate environmental conservation and restoration can be applied to foster the adoption of NbS (Lago et al., 2015). These instruments are commonly embedded across EU environmental law in the form of incentives (e.g. subsidies and payments) or disincentives (e.g. taxes or charges). Other instruments include tradable environmental schemes and risk-financing schemes (e.g. insurance and deposit guarantee schemes). Some incentives may also assume some form of ecosystem service payments.

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<sup>1</sup> [https://ec.europa.eu/info/research-and-innovation/research-area/environment/nature-based-solutions/research-policy\\_en](https://ec.europa.eu/info/research-and-innovation/research-area/environment/nature-based-solutions/research-policy_en)

<sup>2</sup> <file:///C:/Users/m.pinat/Downloads/THAL21001ENN.en.pdf>

As for the insurance-related instruments, the European Commission's research and innovation policy agenda on NbS (EC, 2015) defines the 'insurance value of ecosystems' as the 'sustained capacity of ecosystems to maintain their functioning and production of benefits despite any disturbance' or, elsewhere in the same report, as the 'sustained capacity of ecosystems to reduce risks to human society' caused by natural hazards, climate variability and climate change. The NAIAD project (NAIAD, 2020) has coined the term 'natural assurance schemes' to denote strategies employing NbS that internalise the insurance capacity of ecosystems (Denjean et al., 2017). Consistently, the insurance value would reflect an ecosystem's capacity to 'remain in a given regime and retain its capacity to deliver vital ecosystem services in the face of disturbance and change'. In this sense, there are several best practices of insurance-related instruments which recognized NbS' values into risk-based pricing or risk transfer schemes which provide incentives for investments in loss reduction (Surminski, 2009; Warner et al., 2009). The InsuResilience Initiative<sup>3</sup> developed a catalogue of ecosystem-based adaptation measures based on insurance or similar instruments (Beck et al., 2019).

From an investment perspective, the instruments for financing NbS can be based on debt, equity or a combination thereof (EIB, 2019). They could take the form of:

- Green loans made available to finance eligible green projects. The green loan principles of the Loan Market Association specify under which conditions a project may access green loans (Loan Market Association, 2018);
- Bonds as green bonds that have positive environmental and/or climate benefits. First introduced by the European Investment Bank in 2007, green bonds are expected to play an important role in financing the transition to a carbon-neutral and resilient Europe and the EU's next generation recovery plan. The EU Green Bond Standard, recommended by the High-Level Expert Group on Sustainable Finance, will provide transparency and certainty over the green credentials of investments;

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<sup>3</sup> The InsuResilience Global Partnership for Climate and Disaster Risk Finance and Insurance Solutions was launched at the 2017 United Nations Climate Conference in Bonn (<https://www.insuresilience.org>). The Global Innovation Lab for Climate Finance is another example of a public-private initiative ([www.climatefinancelab.org](http://www.climatefinancelab.org)) addressing innovative financial solutions for climate change and sustainable development



- Catastrophe or CAT bonds as instruments used to obtain financial coverage for climate-related events. They are defined as fully collateralised instruments that pay off on the occurrence of a defined catastrophic event (Cummins, 2008);
- A resilient impact bond as a bond through which an investor is remunerated based on how well resilience measures are implemented, according to pre-defined performance indices (Vaijhal and Rhodes, 2018). It aims to promote resilience and interventions to reinforce the financial infrastructure by turning an index that measures the resilience of an infrastructure into a financial tool;
- The Natural Capital Financing Facility (NCF) that was established by the European Investment Bank and the European Commission as a dedicated programme to support pioneering conservation and NbS projects (EIB, 2019). The NCF includes (1) a finance facility offering direct or intermediated debt or investing in equity instruments/funds and (2) a technical assistance support facility providing grants for project preparation, implementation, monitoring and evaluation. Among others, a project implemented by the Croatian Bank for Reconstruction and Development offers small loans to projects investing in NbS such as eco-tourism (EIB, 2017)

Finally, the implementation of NbS is supported by European funds. Substantial funding for such solutions stems from cohesion policy funds (EC, 2020c). A 2016 study estimated that over the period 2007-2013, around EUR 6.6 billion were invested in green infrastructure, with the highest contribution from the European Agricultural Fund for Rural Development (Trinomics, 2016). Over the period 2014-2020, Member States allocated over EUR 3.7 billion to protection and enhancement of biodiversity, nature protection and green infrastructure and to the protection, restoration and sustainable use of Natura 2000 sites. These investments exceed EUR 10 billion if interventions that indirectly favoured biodiversity protection are included (EC, 2020b). NbS and green infrastructure can also be funded through the European Fund for Strategic Investments (EFSI).

The LIFE programme will contribute to funding NbS via the Natural Capital Finance Facility (NCF), financing projects that generate a revenue stream from natural capital. The LIFE programme will also support the Urban Greening Plans (UGP) introduced by the EU Biodiversity Strategy to 2030 to bring nature back to cities. These plans are expected to mobilise the necessary policy and regulatory reform and leverage financial tools (EC, 2020e).

The new Horizon Europe programme will continue putting emphasis on NbS, including through the new instruments dedicated to mission-oriented research and innovation. Inspired by a seminal report on problem-solving approaches to fuel innovation-led growth (Mazzucato, 2018), the European Commission appointed expert groups to develop recommendations for five thematic areas, among which was adaptation and societal transformation (Hedegaard et al., 2020). The recommendation for this mission area includes boosting nature-based solutions and green-blue multi-purpose infrastructure investments in ecosystems. Research and innovation will address the following: incentives and financial schemes encouraging cooperation among landowners and a high degree of ecological connectivity; transferability

of knowledge and evidence within and across context-specific domains; demonstrated performance and efficiency of nature-based solutions at large scales; and connections between ecosystem quality and human health (Hedegaard et al., 2020).

***Orient the European funding programmes, and national ones, on Ecosystem Services analysis offered by these habitats and protection policies.***

The fourth edition of the EU Blue Economy Report (EC, 2021) dedicated a special focus to quantifying costs and impacts of depletion of blue natural capital and ecosystem services, as well as benefits of their preservation, restoration and adaptation. Preserving and increasing natural capital is key to ensuring the provision of valuable ecosystem services, and for the EU to achieve the Sustainable Development Goals (SDGs) of the United Nations 2030 Agenda (UN, 2015), as called for in the European Green Deal (EC, 2019) and in the EU Biodiversity Strategy for 2030 (EC, 2020). As emphasized by the EU Blue Economy Report's authors (EC, 2021), "The environment is the service provider that enables human society and the economy to exist and develop (p. 118)". This concept entirely reflects the ethos of the ecosystem service approach that aims to support ecosystem and biodiversity conservation policies and to recognize that there are unbreakable limits on using natural capital in order to avoid irreversible losses. Moreover, the EU Biodiversity Strategy to 2020, recognizing the dependence of the human species on nature for the supply of food, energy, raw materials, air, and water (EC, 2011), set its Action 5 to map and assess the status and economic value of ecosystems and their services across the EU and to promote recognition of their economic value in accounting and reporting systems across Europe.

As previously introduced, the topic of natural capital, human-made capital and related ecosystem services was approached by ADRIREEF project adopting the Ecosystem Services Approach (ESA), for estimating the capacity of project case studies to support relevant economic activities (professional fishing, aquaculture, diving and boat excursion). In addition to the above funding programmes and opportunities, some specific actions for biophysical quantifications and monetary estimation to measure on the one hand the environmental costs associated with the exploitation of biodiversity, on the other hand the benefits obtained for human well-being has been recognized, have been undertaken by the Italian Ministry of Ecological Transition. The Ministry promotes and implements tools and initiatives both for the enhancement of Natural Capital, as a basis for promoting the development of a green economy, and for setting up environmental accounting, favouring the integration of biodiversity in programming tools and in territorial planning. In particular, the Ministry is committed to promoting, within the reference framework of the National Strategy for Biodiversity, the integration of biodiversity conservation and ecosystem services into economic and sector policies, starting from the opportunities defined by Law 221/2015 "Environmental provisions to promote green economy measures and to limit the excessive use of natural resources". The economic evaluation of ecosystem services is set, in particular, by art. 67 of Law 221/2015.

The Mapping and Assessment of Ecosystem Services (MAES) process in Italy consists of the three phases proposed in Europe, namely: i. mapping of ecosystems; ii. assessment of the state of conservation; iii. the evaluation of ecosystem services, plus three further phases that make the MAES a tool for planning and sustainable management of the territory, more immersed in the regional realities. The mapping of ecosystems and their state of conservation is a useful tool for identifying the territorial areas on which to envisage projects for the restoration / recovery of ecosystems, implement sustainable territorial planning, also through the creation of green infrastructures and direct interventions, taking advantage of especially the opportunities provided by EU Programmes.

Within the programming period 2014-2020, biodiversity and ecosystem services were taken into due consideration in the programming and implementation tools of the Cohesion Policy, in order to achieve the objectives set out in the National Biodiversity Strategy . Environmental intervention were broken down into thematic objectives (TO) 5 and 6, to which was added the component of efficiency and energy saving declined in TO 4. In particular, within the scope of thematic objective 6 (TO6) "Preserving and protecting the environment and promoting the efficient use of resources", actions were defined and expected results identified regarding both environmental services for citizens, and the protection and enhancement of natural and cultural assets, as well as the competitive repositioning of tourist destinations, considered strategic for the growth and sustainable development of the country. Overall, the ERDF and ESF resources available to the Regions and Autonomous Provinces for the achievement of this specific objective amounted to 2.3 billion euros, of which approximately 4% aimed specifically at halting the loss of biodiversity and a further 6 % to improve the conditions of use of heritage in areas of natural attraction. Added to this were the resources available through the the EMFF, equal to € 215.5 million. The contribution of the four funds (ERDF, ESF, EAFRD and EMFF) for the whole thematic objective 6 (TO6) "preserving and protecting the environment and promoting the efficient use of resources" reached € 4.4 billion for the seven years 2014-2020<sup>4</sup>.

Moreover, the assessment of ecosystems and their services is an added value of LIFE projects. Not only one of the policy objectives to be achieved by the LIFE projects is to improve the condition of ecosystems that are relevant to their area of intervention so as to increase their capacity to deliver ecosystem services but all LIFE Nature and Biodiversity projects financed since 2011 are requested to include an action aimed at assessing the project's impact on ecosystems and their services.

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<sup>4</sup> <https://www.mite.gov.it/pagina/biodiversita>

Finally, Horizon Europe for 2021-2024 in its first key strategic orientation ‘Protecting and restoring ecosystems and biodiversity and managing sustainably natural resources on land and at sea, and achieving climate neutrality and adaptation’ adopted Green Deal’s ‘do no significant harm’ vision focusing on the sustainable use of ecosystems. To this end, Horizon Europe set the Destination ‘Biodiversity and ecosystem services’ which intends to achieve the following expected impact from Cluster 6: *Biodiversity is back on a path to recovery, and ecosystems and their services are preserved and sustainably restored on land, inland water and at sea through improved knowledge and innovation*. Proposals for topics under this destination should set out a credible pathway contributing to Biodiversity and Ecosystem Services, included the specific impact *“Biodiversity and natural capital are integrated into public and business decision-making at all levels for the protection and restoration of ecosystems and their services; science base is provided for planning and expanding protected areas, and sustainably managing ecosystems”*.

### 3. SUMMARY OF PROJECT RESULTS – PROJECT PHASES AND MONITORING RESULTS

The Adriereef project was structured in several Work packages, the main technical ones are listed below in order to report to policy makers the outputs and deliverables of the project which can be consulted.

#### **Work package: 2 (WP2) – Communication activities**

A communication plan was established to develop a communication strategy. This communication plan established communication objectives and target groups used during the project, as well as the level of interaction. The project website was set up and regularly updated with relevant information on the project results to make them available to all interested parties.

In addition, dedicated social media profiles were created and managed to establish a closer and quicker relationship with the project stakeholders and supporters (i.e. blue economy businesses and workers, divers, tourists, etc.). The communication strategy defined quantitative results, level of satisfaction with the conducted activities, web statistics, and overview of the number of downloaded open access publications and files. Videos and printed promotional materials were created (i.e. promotional videos for the two Adriereef festivals, official case studies promotional videos, official flyer/booklet, portrait of the project, posters, roll-ups). The project is focused on the economic activities in the Blue Economy field. Main target groups are business sectors of diving, aquaculture, and fishing (recreational and professional). To share information and results on the project and to reach a bigger general audience, two international festivals were organized, one in Ravenna (Italy) in September 2019, and another one in Vis (Croatia) in July 2021. The aim of each festival was to share knowledge and experience to small and medium-sized enterprises (SMEs), associations and NGOs (e.g. diving), about the potential of the reefs for the Blue Economy. Diving, aquaculture, and fishing were the main festival topics. Festival activities included

lectures, meeting workshops, site visits, exhibition, themed contests, performances, training sessions, sports events, etc.

Also, two scientific workshops (Zadar, Ancona) were organised to collect and share relevant information from the scientific references related to the reefs, analysis of the artificial reefs, and their relationship with the Blue Economy (special activities in the work package 3). Special attention was paid to the cooperation with stakeholders to collect relevant information on the business aspects (on-line survey).

The project provided several key materials and publications concerning the use of natural and artificial reefs in the Blue Economy (see list of activities below).

Finally, during the meetings with the stakeholders, a special initiative for the protection of the Cape Stupisce area (Croatia) was planned: the creation of a protected area (“no take zone”), where any fishing activities are prohibited.

Main output of the WP:

- Developed and implemented communication strategy (CS)
- Created and developed digital tools – website ADRIREEF, Facebook and LinkedIn profiles; online newsletter
- Communication material created (posters, leaflets, visual identity of the project)
- Two festivals held
- Two scientific workshops held
- Stakeholder survey
- Creating materials and publications related to the project and their promotion
- Creating manual for monitoring the condition of sea flowers

### **Work package: 3 (WP3) - Mapping of Adriatic reefs from different perspectives**

This WP was aimed to clarify the current situation of natural and artificial reefs in the Adriatic sea. First of all the definitions and classifications of the reefs, based on the critical methodology and accessible guidelines with the aim of potential commercial exploitation, have been established. Information on the location of reefs (natural and artificial) have been incorporated into a digital reef map, accessible and available on the web. The partnership, after having mapped the Adriatic existing reefs, selected eight case studies and analysed the existing legal framework managing the Italian and Croatian laws. Based on many years of experience of the project partners in artificial and natural reefs monitoring, the most appropriate monitoring methodologies of abiotic and biotic parameters according to different case studies in Activity 3.3 were analysed, as well as whether there were required conditions for the development of economic activities according to the principles of the Blue Economy. To be specific, available technologies with low environmental impact were identified and selected for the field activities implemented in the fourth Work package (WP4).

Also, considering the selected case studies, analysis or mapping of the stakeholders (fishing, aquaculture, diving), and their potential impact on the use of reefs were made and meetings with them were held to determine their interest.

Main output of the WP:

- Determined definition and classification of the reefs (natural and artificial), map of Adriatic reefs designed
- Analysis of legal frameworks in Croatia and Italy (fisheries, aquaculture, blue economy)
- Identification of case studies
- Analysis and selection of appropriate reef monitoring methodologies to be applied to the case studies
- Analysis of stakeholders from the sectors of fishing, aquaculture, and diving.

#### **Work package: 4 (WP4) - Monitoring phase of Adriatic reefs**

To evaluate the structural and ecological evolution of the reef, and its capacity of sustaining different economic activities, a monitoring campaign on the 8 selected Case Studies was conducted, using innovative integrated monitoring of abiotic and biotic descriptors and f technologies with low environmental impact. Definition of the most appropriate monitoring methodology of the sea habitats provides updated knowledge, useful both for the local management plans and for the implementation of European directives for the protection of the marine environment.

Detailed geomorphological mapping of the reef pilot areas was implemented performing multibeam echosounder and/or side-scan sonar surveys, coupled to other investigation methodologies such as the use of ROVs, underwater drones, underwater Structure from Motion photogrammetry, scuba diving. High-tech photo/video 3D recording, including stereo and 360 degrees cameras, was used both for monitoring and communication purposes.

Other monitoring activities included:

- the measurement of physico-chemical parameters at different temporal and spatial scales by (i) fixed near-real time oceanographic observing systems and (ii) by using CTD multiprobes during oceanographic campaigns;
- collection of water samples for additional analysis of nutrients, chemical contaminants and microbiological parameters used to describe the general environmental features of the study sites, as well as to evaluate their trophic status in relation to anthropogenic pressures;
- currents speed and direction were recorded at three case studies using Acoustic Doppler Current Profilers (ADCP) in order to describe relevant weather and marine conditions events which could hinder the regular development of the economic activities foreseen for the CSs; the detailed knowledge of these parameters is useful not only to provide information to reef end-users, but



also to analyse phenomena that may have repercussions on the integrity of submerged artificial structures;

- investigations on the benthic and fish communities were carried out using different survey methodologies with the aim of increasing the knowledge on the biodiversity of the case study sites and, consequently, on the potential ecosystem functions provided by the habitat they represent;
- a series of additional investigations have been carried out by project partners, such as the analysis of contaminants in various environmental matrices (seawater, sediment and biota), the volume occupied by the fouling community or the mussel population structure through photogrammetry, the environmental load including the impact of lost fishing gear;
- all performed investigations were directed at a more comprehensive definition of reef vocations, which included an indication of human activities that should be promoted at site because they follow the principles of the Blue Economy, and those that are not sustainable and therefore need to be banned or carefully managed.

Activity 4.1 was conducted on the Italian coast and activity 4.2 along the Croatian coast.

Identifying the reef's adequacy according to a particular use, among those expected by the Blue economy sectors, was the main focus of this task in order to compare the results obtained from the implementation of activities 4.1 and 4.2. Involved scientists defined the criteria according to which the reef can potentially be dedicated.

Main output of the WP:

- Research with MBES and/or ROV and/or scuba diving allowed the identification of the most adequate reef based on the structural integrity and biological colonisation of the substrate. Integrated monitoring system adaptable to the selected reef to meet the needs of potential stakeholders;
- Installation of integrated monitoring system in situ: it included ADCP (acoustic doppler current profiler), turbidity sensors, temperature sensors, oxygen sensors, video cameras, and it will be powered using renewable energy;
- Photos and data transmitted to the land and visualised through various media (e.g. Totem) to be available to the general public;
- MBES survey conducted to assess any changes in the terrain around the artificial structures and the stability of their structural characteristics;
- Extension of monitoring implementation to other parameters (i.e. biological components);
- Collection and reporting of obtained data.
- Report on monitoring phase from both countries;
- Analysis of the comparison of obtained results;
- Identification of the reef use (tourism, aquaculture, fishing, environment protection, etc.);
- Joint scientific publication.



### **Work package: 5 (WP5) Innovative exploitation of Adriatic reef for blue economy**

The last WP was dedicated to the main outputs, taking into account analysis of the results conducted during the previous work packages (WPs), with the aim of drafting “Guidelines” for the stakeholders of the Blue economy sector and “Code of Conduct” which are the result of the activity 2, and “White Paper” developed at the end of the activity 3. The importance of these results is related to the knowledge transfer, produced during the project implementation, on different target groups, as defined in the project.

The project aims to support the Blue economy and its stakeholders. Upon completion of the project, the acquired knowledge is transformed into simple guidelines for users.

The White paper deals with the challenges of the “innovative exploitation of the Adriatic Reefs to strengthen Blue economy” and recommendations for better use of the reefs.

Main output of the WP:

- Final report on analysis results which defined the socio-economic value of ecosystem service enhancement activities envisaged by the project case studies with respect to four representative economic activities (professional fishing, aquaculture, diving and boat excursion)
- Guidelines available for the business sector included in the blue economy;
- Code of conduct for stakeholders;
- White paper developed.

## 4. IDENTIFIED OPPORTUNITIES FOR THE PERIOD 2021-2028

Based on observed results of all the ADRIREEF project components, a SWOT analysis for the use of underwater reefs was produced (Table 4).

*Table 4 Adriatic reefs ecosystem services SWOT analysis*

<u>Strengths</u>	<u>Weaknesses</u>
<ul style="list-style-type: none"> <li>● A significant number of reefs in the Adriatic sea;</li> <li>● The attractiveness of the reef for users;</li> <li>● Biodiversity of reefs;</li> <li>● Congregating of organisms attractive for fishing;</li> <li>● Some reefs are in the nature protection areas;</li> <li>● Data collection system in fishing and aquaculture;</li> <li>● Significant interventions in aquaculture are subject to prior assessment of the intervention on the environment, nature, ecological network, and subsequently to monitoring.</li> </ul>	<ul style="list-style-type: none"> <li>● Scattered over the large area;</li> <li>● The legal authority for activities is fragmented in many competent authorities, which requires horizontal cooperation in management;</li> <li>● Regional Public institutions for protected areas management have weak mechanisms for effective management in the areas of their competence (e.g. Natura 2000);</li> <li>● The lack of a clear legal basis for the installation of artificial reefs for specific/economic use (diving, fishing...).</li> </ul>

<u>Threats</u>	<u>Opportunities</u>
<ul style="list-style-type: none"> <li>● Growth in the number of users/visitors of the reefs (small intervention of an individual, when aggregated, represents a big intervention of the group);</li> <li>● Destruction of reefs with fishing gears, anchors, collecting organisms (diving);</li> <li>● Invasive species;</li> <li>● Climate change;</li> <li>● Unregulated anchoring;</li> <li>● Nutrients import from the land;</li> <li>● Sea accidents;</li> <li>● Maritime transport.</li> </ul>	<ul style="list-style-type: none"> <li>● Selection of the reef that will be included in the specific category of the maritime domain, which creates basis ecosystemic management of the reef activities;</li> <li>● Project cooperation of competent authorities in the management of the reefs activities;</li> <li>● Drafting management plans for selected reefs that define activities of all the competent authorities;</li> <li>● Interventions in regulations of different authorities which legitimise implementation of management plans on reefs;</li> <li>● Establishing monitoring on reefs using new non-invasive and online technology;</li> </ul> <p>Drafting ecological network management plans, part of reefs that are the target species in Natura 2000 sea areas will be included in the management (Croatia).</p>

## 4.1 FUNDING POSSIBILITIES IN THE NEXT PLANNING PERIOD

Having stated how natural and artificial reefs can support the good environmental status, economic development and sustainable blue growth, here a list of possible EU funded programmes that can support public institutions or private investors in developing artificial reefs, or help in protecting and restoring the natural ones.

It has to be taken into account that according to the Funding programme of the Natura 2000 ecological network and Prioritised Action Framework (PAF) for the Natura 2000 network in the Republic of Croatia (currently in public consultation), an overview of activities related to the green infrastructures and biodiversity has been considered. Considering the wide scope of the green infrastructure definition and keeping in mind the recommendation that “the green infrastructure should be included in PAF where it contributes to the ecological coherence of the Natura 2000 network, including in a cross-border context,

and to the objective of maintaining or restoring favourable conservation status of the targeted species and habitats”, it has been agreed that for the PAF purposes the term “green infrastructure” comprises the areas which are outside the Natura 2000 network and includes sea areas (blue infrastructure).

Possible funding sources are shown in the following table 5:

Table 5 2021/2027 funding programmes

Country	Programme	Missions/Strategic Priorities	Objectives
IT/HR	Interreg IT/HR	PO2 A greener EU	1) Promoting the transition to a circular and resource efficient economy  2) Enhancing protection and preservation of nature, biodiversity and green infrastructure, including in urban areas, and reducing all forms of pollution
		PO4 A more social and inclusive Europe	Enhancing the role of culture and sustainable tourism in economic development, social inclusion and social innovation
IT/HR	Interreg Adrion	PO2 greener EU	1) enhancing protection and preservation of nature, biodiversity and green infrastructure, including in urban areas, and reducing all forms of pollution;  2) promoting the transition to a circular and resource efficient economy

Country	Programme	Missions/Strategic Priorities	Objectives
		Trans/Better cooperation governance	enhancing institutional capacity of public authorities and stakeholders and efficient public administration by developing and coordinating macro-regional and sea-basin strategies.
IT/HR	LIFE programme	Nature and Biodiversity	environmental restoration activities
IT/HR	HORIZON Europe	Pillar 1 – excellent science (improve & enable scientific research)	Excellent Science, Global Challenges and European Industrial Competitiveness, and Innovative Europe.
		Pillar 2 – global challenges and European industrial competitiveness	Industry and stakeholders funded to perform joint R&D activities (cluster 5)
		Pillar 3 – Improve SME growth & the EU innovation landscape	Development on market innovation and technology
IT	PNRR - National plan of recovery and resilience	M2- C4 Safeguarding the quality of air and biodiversity through the safeguard of green areas, soil and marine areas	Investment 3.5 - Restoration and safeguard of marine habitat

Country	Programme	Missions/Strategic Priorities	Objectives
		M4-C2 from research to enterprises	
IT	EFSR-ROP	OP2 – greener Europe	Activities and objectives managed by regional authorities
		OP5 – closer EU	Activities and objectives managed by regional authorities
IT/HR	EAFRD - European agricultural fund for rural development	encouraging sustainable management of natural resources and climate action	realised through national and regional rural development programmes
IT	European Maritime, Fisheries and Aquaculture Fund (EMFAF) 2021-2027	<p>P1 - promote sustainable fishing, restoration and conservation of biological sea resources</p> <p>P2 – promote sustainable aquaculture and production of fish and aquaculture products, contributing to EU food security</p>	*IT: funds managed by regional FLAG - Fisheries Local Action Groups. Promoting calls for public entities and SMEs that are associated.

## 5. GUIDELINES FOR FUTURE

Besides their geomorphological features, marine reefs are significantly characterised by the living communities that inhabit them. Ecologically functional communities relies on adequate biodiversity richness and levels of specific abundance. It means that, to assure the ecosystem services of reefs over time, the biodiversity and the appropriate abundance of species which characterise the reef communities have to be protected, the human activities on the reefs adequately managed and the effectiveness of the management measures assessed by implementing long-term monitoring programmes of abiotic and biotic features of reefs and the definition of appropriate indicators. Monitoring the presence of migratory species can be challenging due to their temporary permanence on the reef, while monitoring the organisms that permanently inhabit the reef (rooted forms, borers, fossorial animals, sedentary organisms, poorly motile organisms, or organisms that have permanent shelter in reefs) could be a good indicator for the state of conservation. Monitoring should be also performed outside the reef in order to evaluate whether eventual changes are caused by the degradation of the reef or are due to overarching environmental factors which affect the wider area where the reef is located.

In Croatia, Reef fishery management can be achieved by Regulation on fishing in protected areas, special habitats and areas with special fishing regulations (The Official Gazette, NN 125/20). When reefs are in the protected areas of nature, the management is conducted with the approval of the Ministry responsible for nature protection and can be specifically regulated for the area of the reef itself. Special fishery management on reefs in the fishing areas which are not included in the nature protection regime can be implemented by including individual reefs in “Areas of the fishing sea with special fishing regulation” which allows to set up specific management measures for the reef area.

In Italy, the activities to be carried out at the reefs included within protected areas are regulated by the management plans of the areas themselves. As a rule, fishing (both professional and recreational) is forbidden in the whole area or, if the area is subdivided into zones with different level of protection, it is forbidden in the portions of greatest environmental value, while it can be permitted through specific regulations that define the gears and timing in the outermost portions. Fishing campaigns for scientific/research purposes, on the other hand, can only be accepted through projects duly authorized by the competent ministry, and by the managing bodies of the area.

As for the reefs (natural and artificial) located outside MPAs, appropriate site-specific fishing management measures have to be set up together as well as adequate control activities aimed to ensure compliance with the applied measures have to be implemented, possibly with the direct involvement of the same users who exploit the reef.

The conclusions of the analysis which has been carried out at the 8 Adriatic reefs chosen as case studies within the Adriareef project, taking into account their specific conditions and their potential for the implementation of Blue economy (Stenek, 2019) are reported below:

- Determine the qualitative and quantitative composition of the reef community in order to identify its level of stability with the aim of implementing the reef's ecosystem services according to the Blue economy;
- Identify indicators and methods for monitoring the stability of the reef to verify the sustainability of blue economy activities;
- Identify existing and future users of the reef, the relationships among them and between them and other stakeholders;
- Define the maximum carrying capacity of the reef;
- Identify the indicators of the Blue economy performance and their corresponding monitoring methods for each reef site;
- Establish management plans and adequate control systems to regulate the use of the reefs from different users taking into consideration either the complex relationships among stakeholders and the competence of the involved institutions;
- In the planning process of the Blue economy development, it is necessary to consider the impact of climate change, whose effects have been recorded on reefs and as such can have inestimable consequences on the implementation of the Blue economy on the reefs.

Following the recommendations related to the use of the reefs for the Blue economy development, it is necessary to develop a legal framework that would be congruent at the Adriatic level.

The main conclusions of the legal framework analyses performed within the Adriareef project (Work package 3), the existing legal documents and guidelines that require greater involvement of the scientific and legislative community at the international level, are as follows:

- The existing legal framework, whether international, European or national, neither includes artificial reefs nor acknowledges the importance that natural reefs deserve as natural habitats;
- The existing legal framework, whether international, European or national, does not include artificial reefs in a way it covers the whole range of possible uses and purposes for which they can be envisioned;
- It may be convenient to estimate the objectives that artificial reefs can meet and consider additional protection measures that natural reefs may need if there are significant commercial activities or other activities that may affect the environment taking place nearby;
- Interactions between natural and artificial reefs, although recognised among scientists and practitioners, are neither considered, regulated nor implemented at the legislative level;
- Even though the use of artificial reefs for increasing fishery resources will remain their main purpose, it is necessary to promote and regulate other purposes (e.g., recreational fishing, diving). In that sense the regulatory framework should include administrative procedures for reefs,



serving these other purposes and measures for promoting activities with low or no environmental impact;

- The regulatory development should comprise both artificial and natural reefs since their main ecological and economic functions are similar. The legal framework should also link artificial and natural reefs with other measures for environment protection and conservation or regeneration of living marine resources (such as marine protected areas etc.);
- Regulatory framework of neighbouring countries sharing the same marine areas should be compatible and appropriate;
- Regardless of their purpose, artificial reefs are objects that permanently occupy public marine areas, and therefore it is necessary to have an appropriate legal procedure (concession or similar) in order to regulate legitimate use of the area and ensure the necessary environmental protection. The same procedure should be implemented on the reefs in which recognisable exploitation or other specific economic activities are conducted;
- An additional national regulatory framework shall be developed as a coordinated action implemented by neighbouring countries to prevent regulatory imbalance at the regional level.
- in order to preserve the reef habitats and their living resources, the obligation of continuous training (with periodic updates) of fishers (both professional and recreational) and their controllers should be introduced. This would contribute to raising awareness of the impacts of fishing and to a more careful and economically sustainable management of fish stocks.

The analysis of ecosystem services highlighted that the submerged reefs, both natural and artificial, as well as wrecks, are habitats of high natural value and have a high potential for socio-economic valorization as also confirmed by the value attributed to NAR/wrecks by economic operators engaged in the Blue economy sectors. Particular interest in economic exploitation was declared by diving centers for both recreational and educational diving, and by professional fishers. Very low interest was shown by capture farmers, while Croatian economic operators organizing boat trips stated some interest in promoting activities at reefs and wrecks as well. In terms of scientific value, NARs and wrecks provide researchers and academics with open-air laboratories where they can carry out research and monitoring activities and in which they can include citizens through citizen science pathways. From the analysis of the data, this ecosystem service as well as food production and fruition still seem to have wide margins of valorisation.

Moreover, the database of the Adriatic reefs represents an unprecedented and comprehensive collection providing a well-detailed state of the art and information that can be useful for different purposes, from spatial management to the strengthening of some economic activities and/or development of new ones taking into account the local environmental features.

The project has also highlighted the potentiality and feasibility of innovative, low-impacting and low-cost monitoring techniques that make it easier to assess on time the ecological status of valuable habitats and evaluate the effectiveness of eventual management measures.

## 6. REFERENCES

1. Bakran-Petricioli, T. (2011): Priručnik za određivanje morskih staništa u Hrvatskoj prema Direktivi o staništima EU, Državni zavod za zaštitu prirode, Zagreb, 2011
2. Fabi, G., Spagnolo, A., Bellan-Santini, D., Charbonnel E., Ali Çiçek, B., Goutayer García, J.J., Jensen, A.C., Kallianiotis, A., Neves Dos Santos, M. (2011): Overview on artificial reefs in Europe. *Braz. J. Oceanogr.*, 59: 155-166
3. FAO. 2015. Practical guidelines for the use of artificial reefs in the Mediterranean and the Black Sea, by Gianna Fabi, Giuseppe Scarcella, Alessandra Spagnolo, Stephen A. Bortone, Eric Charbonnel, Juan J. Goutayer, Naoufel Haddad, Altan Lök, and Michel Trommelen. Studies and Reviews. General Fisheries Commission for the Mediterranean. No. 96. Rome, Italy. <http://www.fao.org/3/a-ax815e.pdf>
4. Ferrà C., Minelli A., Spagnolo A., Scanu M., Tassetti A.N., Ferrari C.R., Mazziotti C., Pigozzi S., Jakl Z., Šarčević T., Šimac M., Kruschel C., Pejdo D., Barbone E., de Gioia M., Borme D., Gordini E., Auriemma R., Benzon I., Vuković-Stanišić Đ., Orlić S., Frančić V., Zec D., Orlić K.Ivana, Soldati M., Uliazzi S., Fabi G. (2020): The ADRIREEF database: natural/artificial reefs and wrecks in the Adriatic Sea. *SEANOE*. <https://doi.org/10.17882/74880>
5. Minelli, A., Ferrà, C., Spagnolo, A., Scanu, M., Tassetti, A. N., Ferrari, C. R., Mazziotti, C., Pigozzi, S., Jakl, Z., Šarčević, T., Šimac, M., Kruschel, C., Pejdo, D., Barbone, E., De Gioia, M., Borme, D., Gordini, E., Auriemma, R., Benzon, I., Vuković-Stanišić, Đ., Orlić, S., Frančić, V., Zec, D., Orlić Kapović, I., Soldati, M., Uliazzi, S., and Fabi, G (2021): The ADRIREEF database: a comprehensive collection of natural/artificial reefs and wrecks in the Adriatic Sea. *Earth Syst. Sci. Data Discuss.* <https://doi.org/10.5194/essd-2020-384> (<https://doi.org/10.5194/essd-2020-384>)
6. Minelli, A., Tassetti A.N., Fabi, G. (2019): Deliverable 3.1.4 Map of Adriatic reefs, Work Package 3 - Mapping of Adriatic Reefs from different perspectives, Activity 1 - Reefs' classification in the cooperation area, Adrireef project.
7. Ministry of Environmental Protection and Energy (MINGOR): Prioritised Action Framework (PAF) for the ecological network Natura 2000 in the Republic of Croatia (draft, 14<sup>th</sup> January 2020)

8. Regulation on the safety of maritime navigation in the internal waters and territorial sea of the Republic of Croatia and the manner and conditions of performing the vessel traffic supervision and management (NN 79/13, 140/14, 57/15)
9. Regulation on fishing in protected areas, special habitats and areas with special fishing regulations (The Official Gazette, NN 125/20)
10. Maritime Domain and Seaports Act (NN 158/03, 100/04, 141/06, 38/09, 123/11, 56/16, 98/19)
11. Stenek, M., (2019): CASE STUDY - eight selected reefs - Blue Economy
12. Zec, D., Fabi, G., Soldati, M.i sur.,(2019): Deliverable 3.1.1. Definition of reefs' category, WorkPackage 3 – Mapping of Adriatic Reefs from different perspectives, Activity 1 – Reefs' classification in the cooperation area, ADRIREEF project.