Marine Seagrass Safeguard Integrated Management Program (MSSIMP) including guidelines for the definition of the correct attitude and behavior in protected areas and for the correct management of the involved areas and areas with similar characteristics.

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Contents

1. THE SASPAS PROJECT

1.1. Introduction

SASPAS (Safe Anchoring and Seagrass Protection in the Adriatic Sea) is a project financed by the INTERREG Italy-Croatia Cross Border Cooperation Program. It aims to offer a proposal to develop and share actions and advanced policies for the conservation and sustainable use of the territory.

The common challenge of Project SASPAS is to preserve and obtain a better conservation status of biodiversity of the Adriatic Sea ecosystem in order to decrease its vulnerability through a series of concrete pilot actions, accompanied by data collection and analysis.

The overall goal is to improve marine seagrass habitat conservation and restoration by testing safe, eco-friendly anchoring systems, performing pilot transplantations, carrying out monitoring activities and defining a possible integrated management system for marine seagrasses in the Project areas and – in perspective - in similar Adriatic sites. The project's end result aims to increase the conservation status of habitats and species in the Natura 2000 sites involved in the Project areas.

This document refers to the final task of the Project, which is divided into two Work Packages, 5.1 and 5.2. One consists of the creation of an Integrated Management System for seagrasses in the Adriatic Area by creating a geographic information system (GIS), using new data and others previously collected, the main target of this task being the project areas, but trying to enlarge the view on a large-scale basis. This leads to the other task, in which a set of principles for proper sustainable use of resources is proposed.

In the framework of the latter task, the indications for the setup, the installation, and the operation of the ecological anchorage systems are the most relevant output of the project, as they integrate and potentially disseminate experiences for all valuable coastal areas interested by marine seagrasses, at least in the Adriatic area. These indications are supported by accounts of Mediterranean experiences in transplanting, monitoring and conservating seagrass meadows and the other valuable habitats and species related to them. Regarding marine seagrasses, the conservation effort is concerned with protecting them from leisure boat traffic, mooring/anchoring, and similar disturbances with an integrated and extensive spatial approach.

In essence, the SASPAS project wants to achieve two significant goals: on the one hand, the integration between the local community and environmental standards at a national scale for conservation and, on the other, the proper and better use of natural resources by yachting and boating.

Marine seagrasses (in particular *Posidonia oceanica* meadows, habitat 1120* in the context of the Natura 2000 Network) are widespread along part of the coastal areas of the Countries participating in the Interreg Program, and their conservation status is similar in the two Member States involved in the project. Therefore, significant results can be achieved by establishing good cross-border cooperation between the Italian and Croatian key partners. The cross-border approach ensures coordinated actions in planning and performing the protection and restoration activities, as well as the foreseen Marine Seagrass Safeguard Integrated Management Program (i.e., the principles and experiences derived from the SASPAS Project in terms of concrete management and action in protected areas and their

surroundings) which consists in the collection of existing information on the site to approach and practical steps in order to implement protection actions in agreement with local authorities pragmatically and according to regional and national regulations.

The innovative aspect that goes beyond the existing practices consists of joint cross-border biodiversity protection and restoration through the development of specifically tailored innovative solutions. These are suitable for the typology of the sites studied but harmonized to a reasonable extent for the Adriatic area and then applicable to other similar realities facing the same biodiversity protection and restoration issues.

Figure 1-1. *Environmental monitoring of the three project sites was one of the most important actions of the project. Designed to evaluate the effects on the seagrass meadows of the other two key actions of the project (transplantations and eco-friendly buoy laying), they have made it possible to acquire significant information on the ecological status of the sites, on their impacts and pressures applying internationally defined protocols. Through underwater surveys by expert biologists, data were collected, samples were taken, numerous videos and photographs were shooted.*

1.2 Project context and rationale

The common challenge of the SASPAS project is to preserve and improve the biodiversity conservation status of the Adriatic Sea ecosystem to reduce its vulnerability. The objective is to improve the conservation of the seabed and valuable coastal habitats through marine seagrasses actual and concrete protection, especially towards boat anchoring, pilot transplantation of aquatic rooted macrophytes, monitoring activities, and definition of an integrated system of conservation of habitats and species of Natura 2000 sites of the Programme area.

The project is in line with the EUSAIR strategy, as the planned activities aim to improve the marine and coastal environment, as well as to stop the regression and the consequent loss of marine seagrasses, in particular those of *Posidonia oceanica*, priority species included in the European Habitat Directive 92/43/EEC. EUSAIR encourages joint management in our cross-border area under the SASPAS project.

The managing bodies of Parks and Natura 2000 sites, even outside the current partnership and in the perspective of future every day challenges, will be able to apply the operational and monitoring approach envisaged by the project, to obtain data on the distribution and quality of marine populations and to carry out the same protection and restoration activities, already partially attempted in the Mediterranean.

All environmental agencies and government institutions operating for the implementation of the Natura 2000 network will benefit from the concrete management approach of SASPAS concept. In addition, the bodies responsible for managing the Parks and Marinas will use the results to permanently improve the sustainability of their facilities.

1.3 The history of the SASPAS proposal

Why such a SASPAS proposal? What is the state of experimentation of eco-buoy fields and other concrete actions for the protection of seagrass meadows (*P. oceanica* especially) in the Adriatic Sea?

Different experiences in the Mediterranean Sea and especially in France and Spain were and are performed, but as it will be presented below in a specific review, they are mostly punctual and localized experiences, developed mainly to offer a top-level service to pleasure boating customers, safeguarding local meadows, rather than being part of an integrated plan for the safeguard of the valuable habitats of the coastal zone. In the best of cases, where attention to the endangered seagrass meadows was paid, the experiences did not come to bring together in a single approach the two elements capable, in our opinion, of making the difference for a truly integrated and advanced management of the coastal strip, namely: on the one hand a usable information base on the quality conditions of valuable habitats and on the existing pressures; on the other hand, the ability of the public administrator to use this information to implement concrete protection actions in the light of an integrated management of coastal areas, balancing the need for conservation and recreational tourism enjoyment.

SASPAS, even in a limited context of representative sites, tested some concrete actions to evaluate this possibility.

Below we will see how it was possible, with some difficulties, to reach a shared concept for the realization of eco-friendly buoy fields, starting from solutions that obviously had some differences between the sites. These sites were chosen precisely because they represented different realities in terms of type of coast, underwater landscape, marine seagrass species and distribution, characteristics of tourist and nautical pressure and more.

In this sense, a particularly effective step was to combine the preliminary survey (WP 3.1) with a particularly in-depth and challenging phase aimed at defining the main existing pressures on the coastal habitats of the pilot sites (WP 3.2). It was therefore not so much a question of identifying the quality of existing meadows beyond a quick assessment, but of describing the main existing problems, underlying any phenomena of retreat or in any case of degradation of the quality of the populations, in terms of loss of structure and function of habitat and of species habitat.

The concept for a project strongly and deliberately dedicated to the realization of concrete actions was therefore born from the observation that some significant sites could be identified to underline different characteristics that marine seagrasses populations showed in response to anthropogenic disturbances, especially consequent to recreational anchoring. For this reason, considerable energy has been dedicated to completing the long and sometimes very difficult procedures to obtain permits for the laying of buoy fields. Achieving these results on two sites represents a great satisfaction for the partners. In a third site, the analysis of the existing pressures allowed the definition of a different position for the laying of the buoy field compared to the one previously indicated by the existing management plan of the Natura 2000 site. Also in this case, having shared this result satisfies partners.

1.3. Anticipation of SASPAS's roadmap

The Project workplan developed through different work packages:

- WP 0 – Project preparation, including drafting of proposal.
- WP 1 – Project management and coordination of activities, including start-up activities, day-to-day management, coordination, internal communication, Project steering and financial management.
- WP 2 – Communication, including start-up activities, media-relations, digital management, events.
- WP 3 – The first action, that is the integrate monitoring, including the preliminary survey, the initial phase of drivers and pressures identification and assessment, the monitoring campaigns.
- WP 4 – The concrete main actions, including the laying of eco-friendly buoy fields and the marine seagrasses transplantation tests.
- WP 5 – The proposed management approach, including a digital platform for data presentation and the guidelines SASPAS followed for the marine seagrasses safeguard management program.

The following flow chart summarizes SASPAS concrete tasks and highlights the links and the necessary exchanges of information/data along the different activities of WPs 3-4-5.

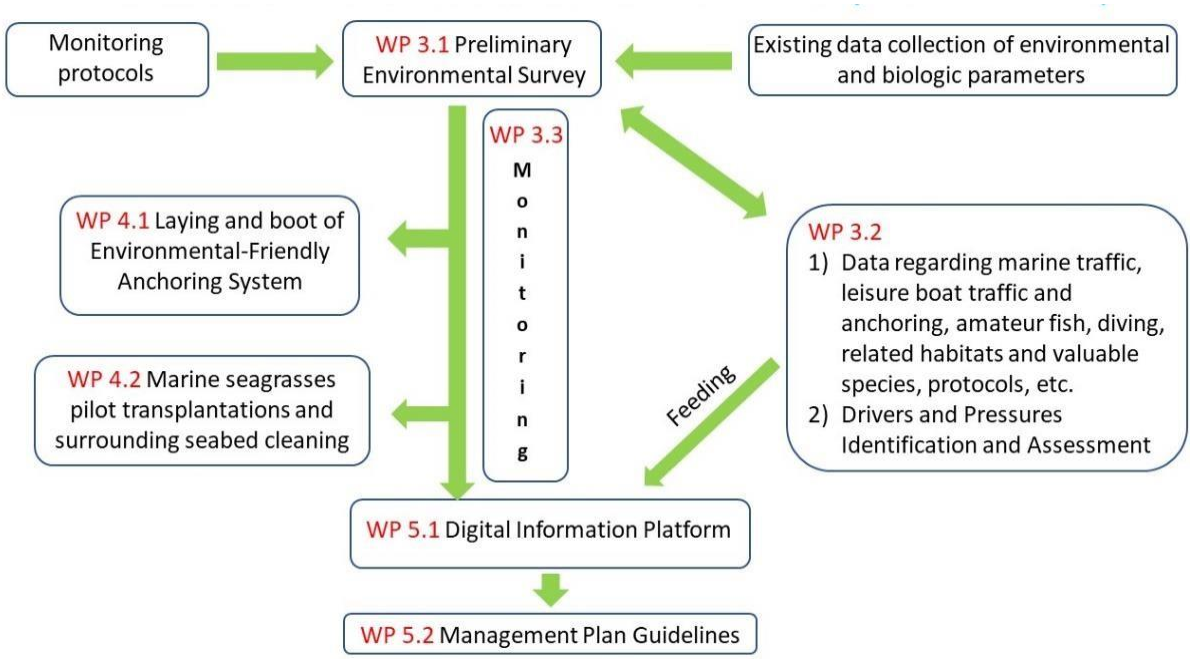


***Figure 1-2**. Flow chart of SASPAS work packages activities*

For a better understanding of the logical relationships and consistency between the different activities, a scheme of the rational development of SASPAS, with specific focuses, can be drawn.

STEP 1

WHAT IS SASPAS? HOW IS IT DEVELOPED? WHAT IS THE AIM?

The purpose of SASPAS is to preserve and get a better status of conservation of biodiversity of the Adriatic Sea ecosystem, with **a specific focus on the marine seagrass meadows** in order to decrease their vulnerability, through a series of concrete pilot actions.

SASPAS significant goals are on the one hand, a better integration between local community needs and environmental standards; on the other, the proper and conscious use of natural resources by leisure boaters.

STEP 2

SITES DESCRIPTION – TARGET SPECIES DESCRIPTION

DEFINITION OF A MONITORING PROTOCOL

The pilot sites were characterized to understand the state of the meadows, without advanced research work, but to highlight starting conditions and any significant current impact.

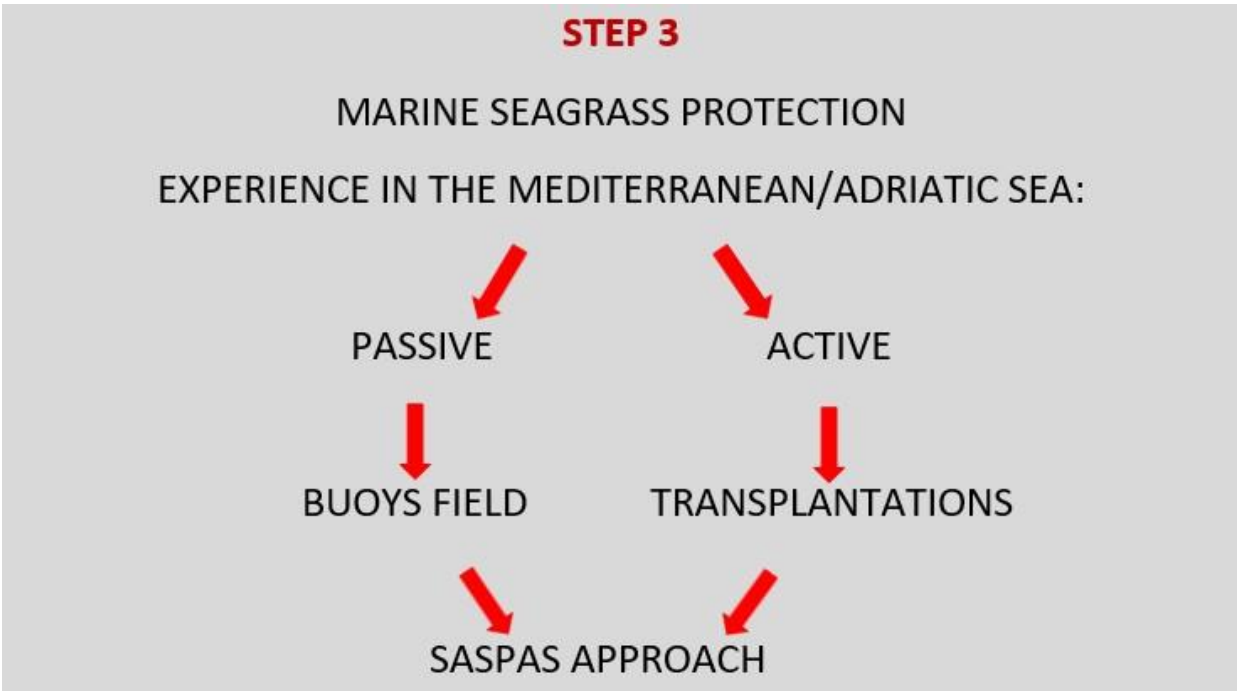
The focus of this activities consisted in a rapid assessment of damage extent, if any, through a general assessment of the meadows (main characteristics, species, etc.) and of their structural and functional role, for the conservation of the sites.

Main existing impacts were described, thanks to an activity of information search and evaluation, based on a DPSR analysis, which took particularly into account the physical impacts resulting from navigation, anchoring and the presence of leisure boats.

STEP 3

MARINE SEAGRASS PROTECTION

EXPERIENCE IN THE MEDITERRANEAN/ADRIATIC SEA:



The implementation of an administrative permitting pathway was an important step of the project, as it took a significant part of the time to share a vision of our concept and to reach a go for our concrete actions. **An important focus to highlight consists in the critical steps of authorizations requests** to Natura

2000 Managing Authorities (at different institutional levels in Italy and Croatia), due to ordinary time delays (heightened by the pandemic) and to the additional fact that previous identified sites for buoy fields did not always match with our proposals, based on practical constraints and on effective use of coast.

As below described, constraints were also due to Local Spatial Planning, to Maritime Authorities and to different stakeholders, as fishing categories, leisure boater associations, non-governmental organizations have different views of actual current use of the coast and of the need of a balance between use of resources and conservation perspectives.

Implementation of concrete actions was achieved through two main activities, in addition to a monitoring control of site and meadow conditions:

1) installation of experimental eco-buoy fields, not to solve the general mooring problem of the coast but to understand the reactions of stakeholders and the sustainability of this solution, aimedto avoid large part of the anchoring impacts acting against marine seagrasses, especially in specific high density touristic areas;
2) various transplantation techniques, not to reforest but to test them in critical conditions, also considering that Adriatic coasts have been a little out of the large Mediterranean transplanting projects until now.

STEP 4

PERFORMED ACTIVITIES IN EACH SITE AND MAIN RESULTS

- CONTROLS/MONITORING
- EFFECTIVENESS OF ACTIONS
- STAKEHOLDERS' RESPONSE

Stakeholder response resulted more difficult to achieve and quantify, given that the reality of leisure boaters is very widespread and distributed throughout the Adriatic, on numerous marinas, with very different types and sizes of boats. In addition, recently the number of larger yachts has increased, and this kind of users is more difficult to proactively control.

A post-check was easier, based on the actual verification of the number of buoys engaged or - on the opposite - of the conventional anchorages on free areas, with or without marine seagrass coverages.

We conducted monitoring on that all, with pragmatic attention to the actions performed, since it was not objective of SASPAS to overlap the scientific research on marine seagrasses; however, we used the current and updated protocols for the basic surveys of marine seagrass populations, thanks to quality indices (after Italian ISPRA and others governmental Agencies protocols).

An important **focus was made on simple effectiveness of actions**, through repeated controls of the use of buoy fields during summer period, highlighting typology of boats, period of buoy engagement, damages, and more.

STEP 5

SASPAS EXPERIENCE

PROS/CONS OF OUR APPROACH

MANAGEMENT GUIDELINES WE FOLLOWED

An information platform, with all project data and other useful info was created, very versatile and suitable for understanding and managing different local realities (first our three sites, other sites in a post-project perspective).

This gathering of data resulted an important measure to define, at the end of the Project, key messages (or programmatic routes) that describe our Adriatic pilot site conditions, our pathways to have eco-buoy fields and transplantation made and our attempt for a final assessment. Below, pros and cons that we recorded while working constitute another important **focus that we wish to open, comparing similar indications and experiences** (international and national), without any desire for criticism, indeed, to increase the significance of the assessments made.

Pros and cons represent, through these key messages, the difficulties that we went through between partners and Administrations, the coordination difficulties between Italian and Croatian partners, how much stakeholders were available to follow this approach, problems in the identification of possible areas to protect or to limit access.

STEP 6

POSSIBILITY OF SASPAS ACTIONS TRANSFERABILITY

Another important **focus is opened to the transferable SASPAS criteria**, to try an estimate of other Adriatic coastal areas in similar conditions, on the basis of available data, of marine seagrass colonization, retreat dynamics problem, strong use of the coastal resources.

SASPAS actions can be replicated in other marine areas of the Adriatic Sea with similar characteristics to the study sites selected in the Project. A selection of different areas in the Northern, Central and Southern

Adriatic Sea are below presented as potential areas in which to transfer SASPAS methodology, through the analysis of specific criteria, such as presence of protected areas and tourism vocation.

Figure 1-3. *An important focus of SASPAS turned to the development of a pattern going, based on the collection of primary data, on the analysis of existing pressures and on the possibility of identifying active and passive solutions for the protection of marine seagrasses meadows.*

1.4. Aims of the project's final document

Concrete actions, activities, and results, together with all gathered data are summarized, analysed, discussed, and presented in this report, having the objective to draft a proposal for a management plan which aims to balance environmental conservation requirements and conscious use of natural resources by the tourism industry and leisure boat users. This balance involves the attempt to integrate the needs of the community with the rules and laws for the protection of coastal natural resources.

This step also considers the way we treated information on our operational sites, trying to geographically extend their significance to a reasonable extent, thanks to a wide data collection on the valuable habitats

of the Adriatic Sea (see WP 5.1). After this, we introduce the rationale at the basis of our concrete actions, which are also described, together with their objectives.

The path we followed was not that of a research project, but a proposal for a practical and pragmatic approach to present simple operational procedures to face problems of impacted valuable coastal habitats – primarily marine seagrass habitats - due to boat anchoring and connected pressures through protecting actions and enhancement of environmental consciousness.

This last objective materialized in the organization of a series of conceptual, informative, and operational steps, to arrive at a sort of application procedure that constituted the guidelines followed by SASPAS. The definition of this procedure encountered various difficulties, partly expected, linked to the lack of useful information or the difficulty in finding it, and also due to authorization problems, at different levels.

This operational procedure is, in the opinion of SASPAS team, a way to logistically and conceptually break down the various steps necessary to address, in a given area, the problem of threats to marine seagrasses and associated valuable habitats. The procedure is particularly suitable when threats are due to direct and indirect disturbances of pleasure boating and anchoring.

A conscious resource management program was therefore drawn up, with a particular focus on coastal and nautical tourism and the impacts resulting from leisure boats navigation and anchoring. Drafting of the guidelines was an attempt, with all the difficulties of the case, to reach an integrated management of valuable coastal sites, with every possible simplification so that the public manager comes to have a toolbox, useful to manage its territory. This management approach must consider current regulations, environmental characteristics of the area of competence, existing tourist pressure, existing program agreements with the other administrative realities above and below ordered, all within the scope of its own discretionary power.

2. THE PROJECT STUDY SITES

2.1. The selected protected areas

All the monitoring activities and concrete actions planned in the SASPAS Project were carried out and implemented out within the three project study areas:

1) Monfalcone (Bay of Panzano-GO), Friuli-Venezia Giulia Region-Italy

2) Kornati National Park (NP) (Nacionalni Park Kornati-ŠI), Šibenik-Knin County-Croatia

3) Regional Natural Park (RNP) of Coastal Dunes from Torre Canne to Torre San Leonardo (BR), Apulia Region-Italy

Two of the project areas, Apulia Region with the RNP Coastal Dunes and Kornati NP, are characterized by a widespread coverage of *P. oceanica* (Linnaeus) Delile 1813. In both areas, in summer, there is a significative presence of pleasure boats. So, the development of the tourism industry has to consider the preservation of the territory in terms of quality and sustainability, intended as a unicum among land, coast and sea.

Regarding of the bay of Panzano, under the Monfalcone Municipality, it presents a relevant coverage of other marine seagrasses, i.e., *Cymodocea nodosa* (Ucria) Ascherson 1870, *Zostera noltei* Hornemann 1832 and *Zostera* subg. *Zostera marina* Linnaeus 1753.

Marine seagrasses play a fundamental role in consolidating coastal sediments and slowing down erosive phenomena, thanks to their root system with which they anchor themselves to the bottom. Moreover, with their leaves they favour the capture of suspended sediments, helping to limit turbidity, not to mention a series of advantages for marine and lagoon organisms that find refuge in this type of habitat.

In particular, in each of the sites of interest, the SASPAS project foresaw:

- the execution of preliminary monitoring (ante operam) to characterize the phanerogam populations and associated benthic communities present in areas subject to anthropogenic impact (especially caused by the anchoring of pleasure boats);
- carrying out interventions to limit and mitigate the damage caused by anthropogenic impacts thanks to:
  - the laying of eco-compatible anchoring systems (buoy fields);
  - the execution of pilot transplants of marine phanerogams (*Posidonia oceanica* at the Dune Costiere regional park - Brindisi - and the Kornati National Park in Croatia and *Cymodocea nodosa* in the Gulf of Panzano - Monfalcone);
  - the execution of annual monitoring (*post operam*) of the phanerogam populations present in the vicinity of these interventions to verify their effectiveness.

Figure 2-1. *Coastal erosion is one of the main problems reported in recent decades along all the coasts of the world. It consists in the loss of territory surface, both emerged and submerged, causing a progressive retreat of the shoreline. As can be seen from the image, even the Coastal Dune Park, in some points of the sandy coast, is affected by this phenomenon which, in addition to reducing the extension of the beaches, seriously endangers the dune systems behind it. This system of dunes, in addition to represent a habitat for numerous species, also plays the fundamental role of protecting the backshore, favoring the accumulation of sand and counteracting the effects of erosion.*

2.1.1. Monfalcone (Bay of Panzano)

The Bay of Panzano is a small bay of the Adriatic Sea (Friuli Venezia Giulia), located in the northern part of the Gulf of Trieste, limited to the south-west by Punta Sdobba, at the mouth of the Isonzo River. In the Bay of Panzano are located two Natura 2000 sites:

- the SAC (Special Area of Conservation) IT3330007 Cavana di Monfalcone
- the SAC/SPA (Special Area of Conservation/Special Protection Area) IT3330005 Foce dell'Isonzo-Isola della Cona (Mouth of the Isonzo River and Cona Island) (Figure 2-2).

Figure 2-2. *Location of the Bay of Panzano, one of the study areas, and its Natura 2000 sites.*

SAC IT3330007 Cavana di Monfalcone

The Natura 2000 site Cavana di Monfalcone extends over a surface of 133 ha, 12% out of which are marine, in the transition area between the flat land and the Adriatic Sea. The area is relevant because of its ecological system characterized by rare habitats in a good state of conservation. In fact, a complex system of spring canals is still present, not modified by the land reclamation, close to the coastline and therefore in direct contact with salty and marine waters. The aquatic surfaces with different state of trophy, water speed, depth and salinity preserve a rich and well-diversified aquatic vegetation and a good overall biodiversity.

Regarding the site's marine area, the Natura 2000 habitat 1110 is present (Sandbanks which are slightly covered by sea water all the time) and it extends for 13 ha ca. It consists primarily of sandy sediments, as well as sediments of larger grain sizes, including boulders and pebbles; smaller grain sizes, including mud, may also be present. This habitat is permanently submerged and predominantly surrounded by shallow

water. Above the sandbanks the water depth is seldom more than a few dozen meters. In these sub-littoral sandbanks, seagrass meadows can be present: *Zostera marina* (in brackish-salt waters), *Cymodocea nodosa* (in salt waters) and *Zostera noltei* in shallower salt waters.

The other Natura 2000 habitat identified in the site that concerns the presence of marine phanerogams, is the 1140 (Mudflats and sandflats not covered by sea water at low tide). It is characterized by sands and mud emerging during the low tides, partially covered by *Zostera noltei* and partly coated by green, blue, brown algae and diatoms. It covers a surface of 3 ha ca.

SAC/SPA IT3330005 Foce dell'Isonzo-Isola della Cona

The SAC/SPA Foce dell'Isonzo–Isola della Cona extends over a surface of 2.668 ha, 40% out of which is marine. It is situated in the eastern side of the region Friuli Venezia Giulia, along the last stretch of the Isonzo River, and it largely coincides with the Foce dell'Isonzo Regional Nature Reserve.

The marine part of the site covers about 1.100 ha of shallow waters with relevant extensions of seagrass meadows; in the marine part of the site the habitat 1110 and the habitat 1140 are present.

Referring to Natura 2000 standard data, habitat 1110 covers an area of more than 1200 ha and habitat 1140 almost 70 ha. For both habitats, the data quality has to be considered *good* (e.g., based on surveys). As regards of the degree of habitat type representativity (a measure of 'how typical' a habitat type is), for 1110 is evaluated as *excellent*, for 1140 is *good*.

In addition, their structure and functions conservation are estimated as *excellent* for habitat 1110 and *good* for 1140, as well as the global assessment. The relative surface (area of the site covered by the natural habitat type in relation to the total area covered by that natural habitat type within the national territory) is reported to be between 100 and 15% for 1110 and less than 2% for 1140.

2.1.2. Regional Natural Park of Coastal Dunes from Torre Canne to Torre San Leonardo

The Regional Natural Park Dune Costiere, from Torre Canne to Torre San Leonardo, covers the territories of Ostuni and Fasano on approximately 1.100 ha along 8 km of coastline and extends until the internal agricultural areas occupied by centuries-old olive groves and ancient farms (*masserie*). The boundary follows the course of the *lame*, small erosive furrows typical of the Apulian countryside, for a total of 55 kilometers.

Figure 2-3. *The mainland territory, used for agricultural purpose, is home to hundreds of thousands of centuries-old olive trees.*

The Park is partially set inside the Natura 2000 SAC IT9140002 Litorale brindisino (Brindisi coastline), whose goal is to preserve natural habitats and species of plants and animals in danger of extinction (Figure 2-4). This SAC is in fact characterized by high value coastal wetlands, inhabited by rare and endangered species of flora and fauna, which reproduce here or during their migrations (Figure 2-5 and Figure 2-6).

In particular, a high-value habitat is present within the protected area, namely Posidonia beds, considered as priority in the context of Natura 2000 network. From the depth of 10 m ca., *Posidonia oceanica* meadows are present on *matte* structure.

In addition, the Natura 2000 site include a narrow coastal strip of land characterized by low cliff areas, as well as several retrodune wetland environments (Fiume Grande, Fiume Piccolo, Fiume Morello) and a long dune belt with both herbaceous vegetation and juniper.

***Figure 2-4**. The RNP Dune Costiere and its habitats.*

SAC IT9140002 Litorale brindisino

The Natura 2000 site Litorale brindisino extends over a surface of 7.256 ha, 95% out of which is marine. The priority habitat 1120* (*Posidonia* beds) affects 50% of its total area. It is also characterized by the presence of inland wetlands, in which rare or endangered migratory bird species stop or reproduce.

In the site's marine area, habitat 1110 is present. It consists mainly of sandy sediments. Other sediment types are medium to coarse grained, including boulders and pebbles, as well as smaller grained sediments, including mud.

***Figure 2-5**. Location of the RNP Dune Costiere study area partially set in the Natura 2000 site.*

In the SAC area, there is a pronounced differentiation between the coastal area and the inland because of the SS 379 road, seen as a break in continuity among the following environments:

1) wetlands behind the coastal dune belt (Large River, Small River, and Morello river);

2) *lame*, linear incisions in the ground perpendicular to the coastline, with a flat bottom and quite sloping sides, which originated from the erosive action of surface waters. They are fossil rivers, as evidenced by the presence of ancient rivers, which formed the riverbed.

Regarding the priority habitat 1120* (Posidonia beds), it covers an area of 3.628 ha. Within the site, the degree of representativity of the habitat type, its structure and function conservation and its overall assessment, are estimated as *excellent*. The relative surface, namely the area of the site covered by the natural habitat type in relation to the total area covered by that natural habitat type within the national territory, is reported to be less than 2%.

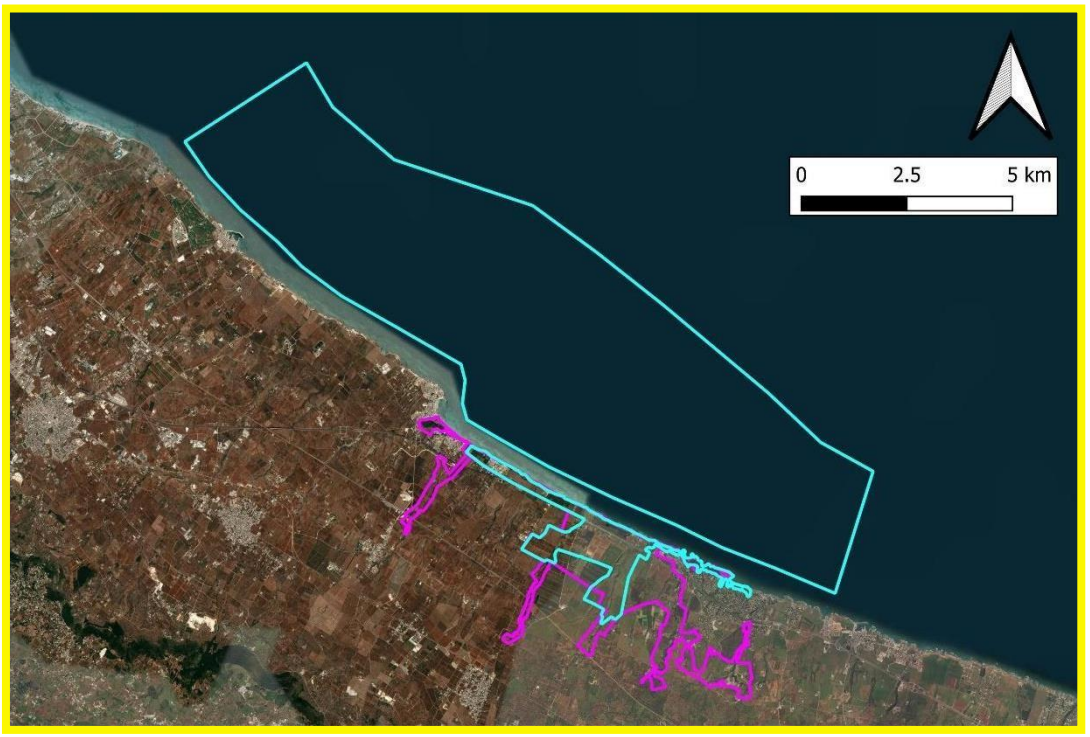


***Figure 2-6**. The RNP Dune Costiere (pink) and the N2K site Litorale brindisino (light blue) partially overlapping.*

***Figure 2-7**. The Project site in the Parco Dune Costiere Brindisine, coast of Ostuni. The* Posidonia oceanica *meadow extend from the upper limit of about 8 m to a lower limit of about 25-30 m. From the coast to the open sea, they do not have a continuous and uniform distribution: the upper limit is represented by fragmented patches of meadows which alternate with sandy lenses and dead matte, home to abundant indigenous alga* Caulerpa prolifera*, In this change of environments, where coherent substrates emerge mixed with the* P. oceanica *meadows, the coralligenous habitat is also found. Some evidence leads to hypothesize the action of erosive underwater phenomena that correspond also to the dynamics of the coastline retreat.*

2.1.3. Kornati National Park

The Kornati Archipelago is over an area of 320 km^2 and includes 149 island, isles, and reefs. Part of the Archipelago was proclaimed National Park in 1980 due to exceptional geomorphological features ("crowns"), anthropogenic terrestrial vegetation ("rocky pastures"), rich marine biodiversity, and oceanographic specificities.

SCI HR4000001 – "Nacionalni Park Kornati"

Kornati National Park is designated as Site of Community Importance SCI HR4000001 – "Nacionalni Park Kornati" (Figure 2-8). The park[1] was established in 1980 and its management began in 1982. It currently

[1] The data cited in the following paragraphs are reported in the articles: Casier (2011); Mihelcic and Ramov (2018); Ivković, (2015).

includes 89 islands and reefs, a total area of 217 km², of which almost 80% is marine territory (land 50 km² / sea 167 km²) and a total coastline of 238 km. Karst features dominate its geomorphology.

The islands were once covered with forests of evergreen oak that human activity has transformed into rocky pastures. Kornati is best known for its steep cliffs ("crowns") that at some places go vertically downhill over 90 meters deep into the sea.

It is estimated that at least 2,500 to 3,000 families of benthic and pelagic fauna live in the Kornati archipelago such as 353 species of macroalgae, 3 species of underwater flower plants as well as about 850 animal species – 61 species of corals, 177 species of mollusks, 127 species of polychaetes, 61 speciesof decapod crabs, 64 species of echinoderms and 185 species of fishes.

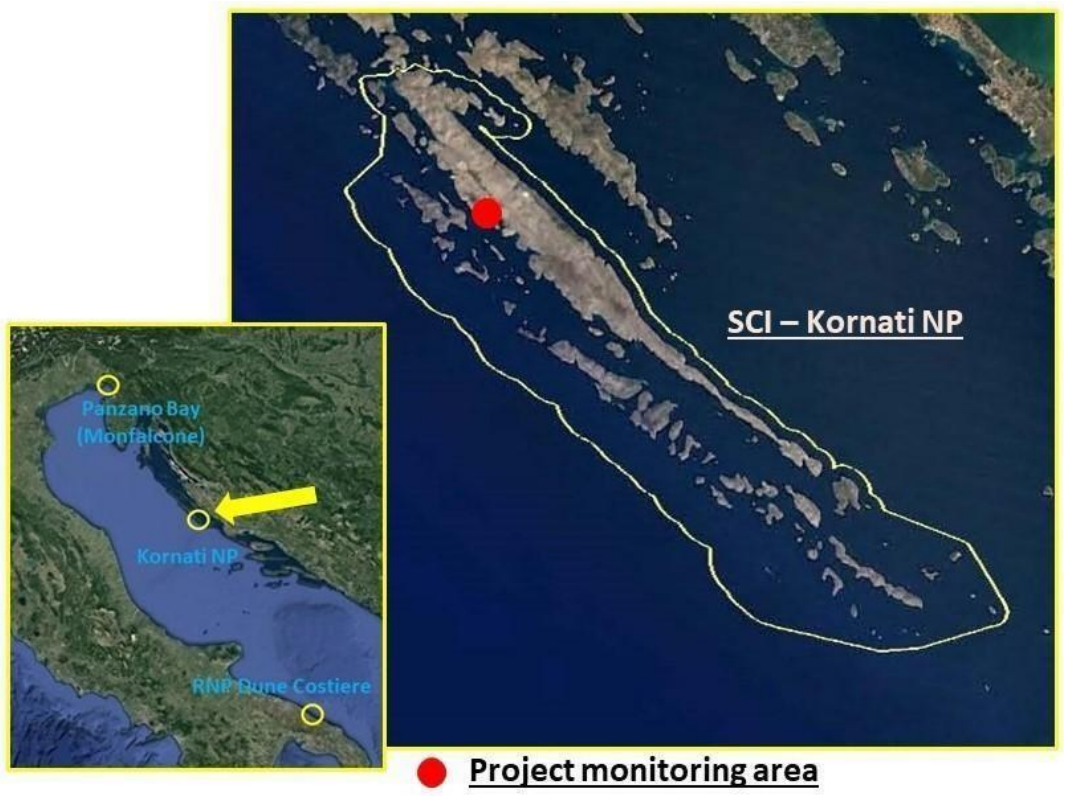


***Figure 2-8**. Location of the study area in the Natura 2000 site Kornati NP.*

In the Natura 2000 site data form *P. oceanica* meadows (habitat 1120*) cover an area of 2100 ha, but the data quality has to be considered *poor* (e.g., rough estimation). The degree of representativity of the habitat type on the site (a measure of 'how typical' a habitat type is), its conservation of the structure and functions and the global assessment of the value of the site for conservation of the natural habitat are considered *good*. The relative surface (area of the site covered by the natural habitat type in relation to the total area covered by that natural habitat type within the national territory) is reported to be less than 2%.

The presence of alien species is included among the anthropogenic threats. *P. oceanica* is particularly threatened by some macroalgal species: *Caulerpa cylindracea*[2] (that has been observed in the last years and is spreading in the entire park) and the turf-forming red algae *Womersleyella setacea* and *Acrothamnion preissii* (two species that grow over *Posidonia* rhizomes).

Public Institution, under the competence of the Ministry of Economy and Sustainable Development, manages the Kornati National Park. The land part of the park is entirely privately owned (around 620 owners).

Figure 2-9. *Among the islands of the Kornati National Park there are numerous small bays sheltered from the prevailing winds that over the centuries have been used by the local inhabitants for their daily practices (fishing, farming or cultivation). Today these bays, still to a limited extent impacted by man, are a reference point for motor or sailing boats to spend the night on board and start sailing again the next day. However, the repeated anchoring of these boats puts* Posidonia oceanica *meadows in serious danger.*

Four no-take zones are present where scientific research is only allowed. Sailing is allowed in the entire Kornati National Park except in the areas of strict protection. Anchoring and overnight stay are allowed only in 19 locations (bays and coves). Autonomous diving is allowed only in organized groups, with a license for autonomous diving in the Kornati NP obtained in advance.

Since 2013, traditional fishing in Kornati National Park is forbidden and only recreational fishing is allowed.

[2] *Caulerpa cylindracea* Sonder [previously known as *Caulerpa racemosa* var. *cylindracea* (Sonder) Verlaque, Huisman *et* Boudouresque]

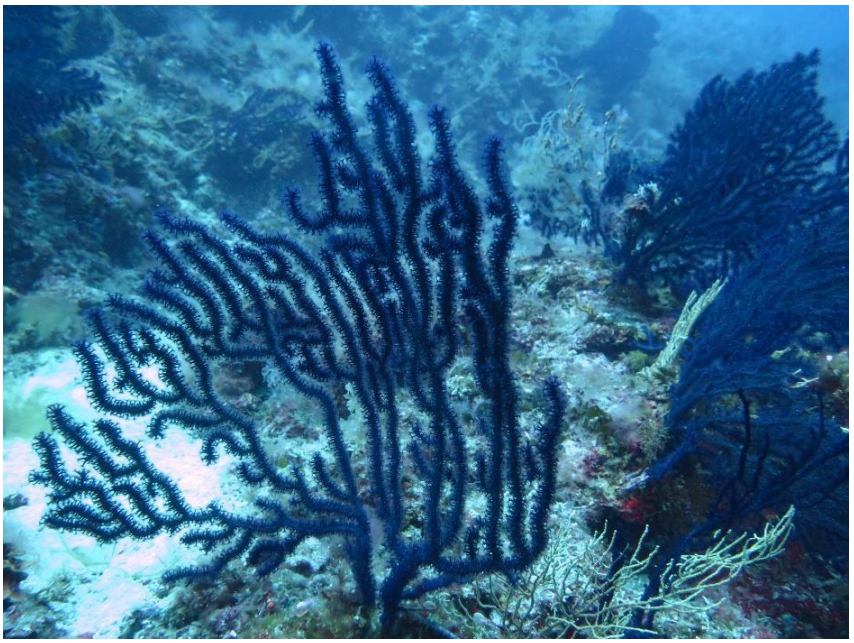


Figure 2-10. *Some open and deeper sites of the Kornati Park are used for diving. Despite the scarce ichthyofaunal component - unfortunately a general element of the Adriatic reality - the seabed of this archipelago has an interesting and compelling benthic component.*

Figure 2-11. *The benthic component of the fauna and vegetation associated with* P. oceanica *represents an essential element of the trophic chain of coastal habitats. Numerous organisms such as Polychaeta, Mollusca, Crustacea, etc. find substratum and refuge in the dense canopy of the meadow.*

2.2. Background information on project study sites monitoring methodologies

The monitoring methodologies adopted in SASPAS refer to national and international protocols developed to evaluate the Ecological Status of seagrass meadows, with specific implementations in relation to taxa (e.g., *Posidonia* and other seagrass species) (OSPAR, 2009; ISPRA, 2012; APAT-SIBM-ICRAM, 2003; Buia *et al*., 2004; Water Framework Directive 2000/60/EC; Marine Strategy Framework Directive 2008/56/EC; RAC/SPA - UNEP/MAP, 2014).

Regarding the Italian guidelines, the considered parameters in this protocol also refer to the institutional methodological sheets of the Ministry of the Environment, drawn up in collaboration with ISPRA (Ministero dell'Ambiente and ISPRA, 2017).

At present, following the Water Framework Directive 2000/60/EC (WFD), *P. oceanica* is to be used as Biological Quality Element and several WFD-compliant biotic indices based on *P. oceanica* have been

developed and applied in the Mediterranean Sea for the definition of the Ecological Status of coastal water bodies (Pergent-Martini *et al*. 2005; Gerakaris *et al*. 2017).

P. oceanica meadows is a good biological indicator because it is a benthic, long-lived species, widely present in the Mediterranean basin, and is susceptible to pollution and environmental disturbance; is also a useful tool for assessing the environmental impact of human activities, thus being adequate for determining the GES (Good Environmental Status) following the Marine Strategy Framework Directive 2008/56/EC (MSFD).

There are four species of seagrasses native of European waters:

- *Posidonia oceanica* (Neptune grass)
- *Zostera marina* (eelgrass)
- *Zostera noltei* (dwarf eelgrass)
- *Cymodocea nodosa* (little Neptune grass or slender seagrass)

These species are present in several classification systems adopted over the years by the European Union:

- Reference List of Marine Habitat Types for the Selection of Sites to be included in the National Inventories of Natural Sites of Conservation Interest (RAC/SPA - UNEP/MAP, 2016);
- Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and wild fauna and flora (Habitat Directive) – Annex I: Animal and plant species of community interest whose conservation requires the designation of special areas of conservation;
- CORINE biotopes;
- European Nature Information System (EUNIS) habitat classification.

They are also listed as threatened species in the Annexes of the following conventions and protocols:

- Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention) - Annex II: List of Endangered or Threatened Species;
- Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean (SPA/BD protocol)- Annex II: List of endangered or threatened species;
- Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) - Appendix I: Strictly protected flora species.

In the Habitat Directive, the only species of seagrass listed is the *P. oceanica*, but only as a habitat in Annex I and not a species in the other annexes.

Zostera marina, *Zostera noltei,* and *Cymodocea nodosa* are not considered as species in the Habitat Directive, but they can be considered as communities associated with Annex I habitats reported in table 1. Codes and Annexes for each species are reported in Table 2-1.

All these species are present in the Adriatic Sea. In particular, the project sites Regional Natural Park of Coastal Dunes from Torre Canne to Torre San Leonardo and the Kornati National Park are characterized by widespread coverage of *P. oceanica*. In Monfalcone (Bay of Panzano), there is an important coverage of marine seagrasses *Cymodocea nodosa* (*Zostera marina* and *Zostera noltei* are also present).

***Table 2-1**. Reference codes for the identification of each species and annexes of threatened species.*

CONVENTIONS & PROTOCOLS	SPECIES		
	Posidonia oceanica	*Zostera marina /Zostera noltei*	*Cymodocea nodosa*
RAC/SPA	III.5.1	III.5.1, III.1.1, III.3.1, I.2.1, III.2.3	III.3.1, III.5.1, III.1.1., III.2.3
EU Habitats Directive	Annex I: 1120*	Annex I :1110, 1120*, 1130, 1140, 1150*	Annex I: 1110, 1120*, 1150*, 1160
CORINE biotopes	11.34	11.34, 11.23, 13.2, 14, 21	11.23, 11.34, 21, 11.22
EUNIS Classification	A5.535	A2.613	A5.531
Barcelona Convention	Annex II	Annex II	
SPA/BD protocol	Annex II	Annex II	
BERN Convention	Appendix I	Appendix I (only *Z.marina*)	Appendix I

A brief description of the seagrass species that can possibly be found in the three project sites are reported the **Annex 1**.

2.2.1. SASPAS sites monitoring

As mentioned before, the monitoring methodologies adopted in SASPAS refer to national and international protocols/guidelines and were applied to field activities planned in the preliminary survey and, more extensively, in the monitoring campaigns.

In the preliminary survey, the protocol was applied to wider areas to refresh the knowledge of the biodiversity status in the project sites (e.g., species, bathymetry, seagrass presence/absence, meadows extension, coverage) and to identify the specific areas where concrete actions were planned, to protect the habitat *P. oceanica* beds and/or other marine seagrasses. Information was also gathered regarding operative limits, general critical issues, and the different anthropogenic impact to which the sites were subjected (administrative limitations, prohibitions, local ordinances, anthropogenic use, fishing, etc.) The location and extent of the study areas, the number of transects, the sampling sites, and the positions for patches contour markers (*balise*) were also identified.

The same methodologies used during the preliminary survey activities, were adopted the monitoring campaigns, to control the efficiency and success of protection measure activities. Phenological (life cycle of the plant) and distributive dynamics of marine seagrasses were considered to identify the potential impact that the project (laying of anchoring system and seagrass transplantations) could have on *P. oceanica* meadows and other seagrass meadows and other valuable habitat and species.

Due to their wide distribution at the national and European levels and similar basic structure (leaves, roots, rhizomes), the monitoring protocols for *Zostera marina*, *Zostera noltei*, and *Cymodocea nodosa* appear relatively similar.

The monitoring activities were carried out on selected stations. In each study site, three zones were selected where three monitoring stations were positioned at different depths, for a total of 9 stations (Figure 2-12).

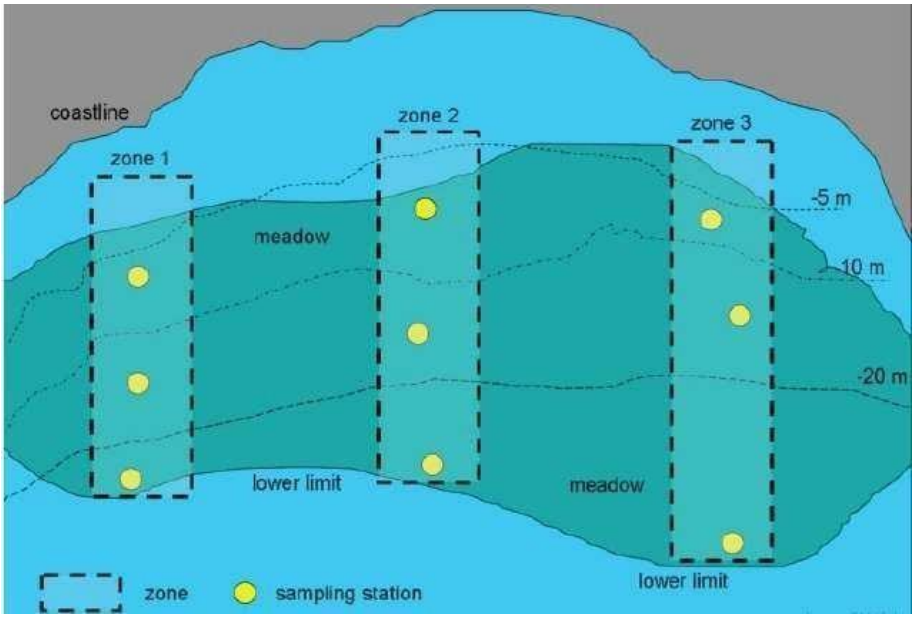


***Figure 2-12**. 3 zones for each study sites and 3 monitoring stations for each zone in the monitoring of marine phanerogams for SASPAS project (RAC/SPA - UNEP/MAP, 2014).*

The status indicators selected for the monitoring protocol are reported in the **Annex 2**.

3. PROTECTION OF MARINE SEAGRASSES AND DAMAGES FROM ANCHORING

Marine seagrasses constitute a valuable habitat and perform several functions along coastal marine environments. Having a solid root anchoring system in the sea floor, they can play an effective role against erosion, compacting sediments. The leaf component, in addition to slowing down the wave motion, promotes the capture of suspended solids, enhancing sedimentation. Seagrass meadows represents a complex ecosystem of high ecological value, where the fish and benthic fauna and the plant community find shelter, food, and reproduction sites. The high oxygen production, thanks to the large leaf system of these macrophytes, the biomass production values and the CO_2 storage capacity, should also not be forgotten.

Various causes are behind the reduction of the seagrass population along the Italian and Mediterranean coasts: artificialization, modification and exploitation of the coastline, pollution, illegal fishing, pleasure boating, to mention the main ones.

Regarding **recreational anchoring**, which is connected to an important economic activity in the Mediterranean Sea, leisure boats usually prefer to anchor on seagrass meadows rather than on other bottoms (i.e., sand, rock) in order to have a secure temporary mooring and because of they are considered a good anchoring ground.

In the areas where pleasure boating traffic is most considerable, the contradiction between tourism development and the need for environmental protection and conservation leads to conflicts that are presently difficult to solve with a balanced sustainable exploitation. Consequences consist in a continuous loss of the ecosystem value of the seagrass populations, expressed in terms of direct and indirect benefits. Therefore, for management bodies is usually problematic to program environmental protection activities or govern, the use of sea especially during the touristic season.

Presently there are still no available guidelines, concerning the Adriatic Sea (Italian. Slovenian and Croatian coastlines) or the Italian seas all together, for the concrete sustainable management of the marine seagrass resource, related to the problem of anchorages. As reported later, the marine protected areas implement an advanced management of the marine seagrass resource according to specific protocols, but very vast extensions of *P. oceanica* and other similar species remain currently excluded from a structured protection management.

Likewise, the government environmental agencies (ISPRA, in Italy; AZO in Croatia, as an example) are engaged in numerous research projects, for methodological and conservation purposes relating to this coastal resource. Over time they have made available an exhaustive information framework and a rich handbook production relating to the management of marine seagrasses (expecially *P. oceanica*) and the importance of their protection. An integrated approach, which brings together multiple institutions and control and management bodies to reach the difficult balance between conservation and use remains more difficult to implement.

However, several local interventions, meant to safeguard marine seagrasses, have been carried out against the wild boat anchorages which causes, directly and indirectly, significant loss of meadows. These actions are released from an integrated action for the coastal zone management.

In particular, the development and installation of environmentally friendly anchoring systems (anchorages and simple signaling buoys) can cancel or significantly reduce impacts on marine seagrass meadows caused by the anchorage, as well as by other minor causes (traffic, swimming and bathing, submersed garbage, diving, etc.). Furthermore, they can preserve seagrass optimal ecological status of key species, the ecological role they play in the habitat and numerous species that make it (Benthic organisms, fish fauna), in addition to the stabilization of the erosion basins. Environmentally friendly anchoring system's main function is to reduce chain abrasion on the seafloor.

The installation of environmental-friendly buoys also appears to be a direct signal of public attention/awareness to all users (sailors, divers, etc.) rising the quality level of the site in terms of environmental and sustainable offer.

The **environmentally friendly anchoring systems** should be placed in areas where the ecological requirements are ensured, but plant are disappearing due to tourism activities. Furthermore, **seagrass transplantations** can help to re-establish seagrass meadows disappeared due to anthropic pressures (see paragraph 3.2). To be successful, the chosen sites should meet two basic requirements: a) historical presence of the meadows; b) termination or absence of impacts preventing their growth and development (assured also by placement of anchoring eco-buoys).

After a general overview of the protection experiences of marine seagrasses in the Mediterranean, particularly from the impacts of pleasure anchoring, the rationale of the SASPAS experience to achieve the laying of eco-friendly buoy fields and the pilot tests of seagrass transplantation is introduced.

3.1. Environmentally eco-friendly anchoring systems

3.1.1 The experiences in the Mediterranean context

The experiences of eco-friendly buoy fields carried out in the Mediterranean are many, even if local actions most of the time, connected to marine protected areas or coastal areas of value which intended to increase the level of protection of their seabed in relation to conditions of strong leisure boat traffic and high anchoring pressures.

The development of the tourism industry, together with the attraction that important parts of the Mediterranean coasts draw due to the high naturalistic and landscape quality, led to the expansion over time of an offer for nautical tourism, declined in different ways and for several interested users. The concentration of these interests has led to conditions of considerable pressure on the environment, especially in cases where more basic favorable characteristics have overlapped, such as:

- landscape-naturalistic attraction of the coast;
- existence of coastal infrastructures suitable for supporting nautical tourism;

• quality of the water and the coast in terms of transparency, cleanliness, lack of marine litter and waste;

• coastal morphology and presence of variously protected areas or archipelagos;

• accessibility of the coast.

Obviously, these characteristics show variability and interdependence which in some cases confer extremely high attractive values, as can be the case of certain examples of the coast and greater Tyrrhenian islands, the Dalmatian coast, the Greek archipelagos, stretches of the Tunisian coast, just to name a few. Some particular examples, with a fortunate mix of these characteristics, have a relatively limited anthropic development together with a strong vocation for nautical tourism which therefore takes advantage of the natural aspects of the coast.

It follows, coming to the last decades of development of nautical tourism, that just the most significant sites from a naturalistic point of view are undergoing strong pressure from boaters, especially when the coast offers suitable conditions for camping and tourist cabotage. This leads to a request for more or less temporary moorings and daily anchorages that affect the closest sites to the shoreline, protected from marine weather events, suitable for land excursions rather than snorkelling or scuba diving, or more.

A short circuit course is created between two boundary conditions: on the one hand, sites and coasts that have an articulated offer for nautical tourism, but which now have a limited offer in terms of landscape, naturalness and scarce anthropization; on the other hand, sites and archipelagos that are relatively underperforming in supporting nautical tourism or at least not yet as efficient, but rich in terms of coastal beauty and naturalness.

As for the subject in question, what is a good, indeed an excellent indicator of ecosystem quality, a basis of a chain of natural values that distinguish the Mediterranean coastal landscape? The answer indicates marine phanerogams and primarily *Posidonia oceanica*. The huge and wide stretches of meadows constitute monumental structures that have developed over the centuries along most of the Mediterranean coasts, which have penetrated the underwater landscape and constitute now a fundamental element of it. But that for a series of reasons, directly or indirectly connected to the anthropic development, these extensions are undergoing a strong retreat, due to erosion, pollution and deterioration of hydrological characteristics, eradication, physical elimination in relation to man interventions and coastal works. We can put this species to another species of our interest, *Cymodocea nodosa* (Neptune grass). Similar species, it is more linked to environments dominated by fine sediments, more characteristic of estuarial and lagoon areas. Large meadows of this species colonize the seabed running along the coast of the Bay of Panzano in Monfalcone, while the other two project sites are characterized by the presence of *P. oceanica*.

It is not necessary here to investigate the well-known role of marine phanerogams, already mentioned above, in the coastal ecosystem and the support they offer in terms of biomass production, oxygen production and CO2 storage, nursery area for fish species and non, erosion protection and more.

In this context, the problems resulting from the anchoring and physical elimination of these marine plants have been the subject of both study and real intervention approaches in various cases, particularly in Spanish and French Mediterranean contexts. As mentioned above, depending on the characteristics and morphology of the coast, the anchorage, whether temporary, overnight, or permanent, constitutes a

pressure which can have an impact on the hold of the seagrass system, i.e., the minimum level of patch continuity and the minimal shoot density that allow survival and possible expansion of meadow.

***Figure 3-1**. The use of anchoring with dead weight on* P. oceanica *meadows is still a very widespread practice in the Mediterranean.*

A quick evaluation of the available information, general and not related to specific local aspects, leads to outline the following brief framework, related to impact of boat anchoring towards marine seagrasses.

Available data on the vulnerability of coastal habitats in relation to pressure from pleasure boat anchoring

Scientific literature is very vast on this issue, considering that especially since the 1970s, studies on the quality of coastal environments have strongly deepened the knowledge on world marine seagrasses and on *P. oceanica* in particular. More recently, sensitized by the growing tourist pressure in the Mediterranean and by the strong attention that has grown on environmental conservation matters, the research institutes have focused on the issue of anchoring and impacts on the meadows, working above all on the methodological updating of marine seagrasses study and on new knowledge of their coastal distribution.

Information framework on the Mediterranean areas with the greatest impact from pleasure anchoring

The Mediterranean areas of SASPAS interest are those in the Adriatic, where Dalmatia has, nowadays, a very strong concentration of recreational tourism, equaled only in some limited Apulian Salento areas. Nonetheless, it should not be forgotten that the Upper Adriatic and especially Veneto and Friuli Venezia Giulia coasts have a very high concentration of leisure boat traffic even if on average considerably more modest in size. This presence is particularly dense in the lagoon or perilagunar areas and along the beaches. In this coastal area, the significant presence of marine seagrasses is limited to the coastline that runs from the Monfalcone coast to the Marano-Grado lagoon. *Cymodocea nodosa* and other species with similar environmental requirements take advantage here of the conditions of substantial naturalness of the coastal shallows, which present considerable bathymetric variability with an alternation of tidal flats and shoals even at a reasonable distance from the shoreline. these habitats are suitable for colonization of *C. nodosa*, together with other similar marine seagrasses: *Zostera marina* (Eelgrass) and *Zostera noltei*, (Dwarf Eelgrass).

Other Mediterranean sites with high nautical tourist pressure, where the problem of impacts on meadows due to anchoring has become an environmental emergency, are those of the Tyrrhenian coasts, Sicily and its archipelagos, Sardinia, Ionian Greek islands. In these contexts, the numerous marine protected areas play an important and indisputable function of conservation and protection against fish fauna and submerged rocky habitats, but less attention is paid to the *P.oceanica* meadows.

UE programmes and other national research initiatives have dealt with these topics in relation to the Italian situation, but mainly deepening the study of the quality of the populations and their state of conservation, with respect to various pressures evaluated and compared. Therefore, the research activities concerned the issue of eco-friendly anchors only to a limited extent and in any case without deepening the management aspects and those related to the permitting process. In Italy the school of Genoa is very advanced on the methodological aspects for the parametric evaluation of the quality and conservation level of marine seagrasses; in addition, several European Projects (LIFE Programme) addressed and are presently addressing these topics and have deepened the aspects relating to the possibility of environmental recovery interventions through different methods of seagrass transplantation.

In Dalmatia and more generally along the whole coast of Croatia, from Kvarner to the Dubrovnik district, the strong development of nautical tourism is a significant threat to the conservation of *P. oceanica* meadows, especially if we consider that the fleets of pleasure boats prefer to anchor precisely in the smallest and most protected bays where the high density of moorings causes physical damage to the plant due to the anchor, to the chains and to continuous mooring and unmooring operations, with the consequence of a huge eradication phenomena. There are currently no attempts to limit these phenomena which are becoming increasingly widespread, except for those protected areas where navigation and mooring are prohibited.

Regulatory interventions for anchoring pleasure boats in sensitive areas

Data on this topic are less available, except for specific areas of particular interest where, in relation to the existence of protected or otherwise valuable areas, much has been concretely done to limit anchoring

impacts on marine seagrasses habitats. Balearic Islands are a good example, due to the size of the area considered, of organized intervention aimed, on the one hand, at limiting the areas where free anchoring is possible, and on the other hand to prevent or at least discourage anchoring on areas that are not regulated. Furthermore, a concrete action plan was put in place, equipped with constantly growing means and personnel, for the proactive control of large yachts to direct them to anchor sites compatible with the existing seagrass meadows.

***Figure 3-2**. The conservation interventions of* P. oceanica *in the Balearic Islands are at a very advanced stage of application and practical implementation.*

A similar approach has guided French authorities in banning and regulating the access to large yachts in some areas closer to the coast on some areas of the Côte d'Azur.

While much has been studied on this part of the Mediterranean, it appears that the issue is less felt in the Adriatic Sea. However, the stakeholders concerned are increasingly aware of the aspects of marine seagrass conservation and in general of the overcrowding of the coasts due to the increasing density of recreational boat traffic. The public managers of some of the most critical and busiest areas, such as the Dubrovnik aquatorium, the Pakleni Islands and other districts are thinking of traffic and anchoring limitation systems, even with a certain willingness and agreement of the stakeholders of the tourism economic chain, increasingly aware of the value of the ecosystem and the importance of valuable coastal habitats conservation.

Examples of different experiences performed in the Mediterranean Sea and especially in Spain, mostly punctual and localized, are reported below:

LIFE POSIDONIA - Protection of Posidonia Fields in SCI Areas, LIFE00 NAT/E/7303 - Direcció General de Biodiversitat, Conselleria de Medi Ambient, Governor of the Illes Balears. ILLES BALEARS (ESPAÑA) (2001-2006)

The project for the protection of *Posidonia* meadows in SCI areas of the Balearics aimed to adopt conservation measures for seagrass meadows. On the basis of the good results obtained thanks to the anchoring regulations at the National Land and Maritime Natural Park of Cabrera, Portocolom and Cala d'Or, this project proposed, among other measures, the installation of anchoring points and the corresponding Management Plan. Another important action of the project was the creation of a detailed map of all the *Posidonia* meadows.

LIFE Posidonia Andalucía - Conservation of *Posidonia oceanica* meadows in the Andalusian Mediterranean Sea. LIFE09 NAT/ES/000534 (2011-2016)

The Life Posidonia Andalucía project's main objective was to improve the conservation status of *Posidonia oceanica* meadows in Andalucía, by undertaking research and then applying appropriate protection measures. The first aim of this project was to identify the state of the *Posidonia* meadows and their temporal evolution and the second one was to reduce the main threats to this habitat type (invasive alien species, trawlers, and free anchoring). Ecological mooring buoys were installed to reduce erosion and the dispersion of IAS (aggravated by free anchoring). An information campaign regarding the location and use of these buoys that was specifically addressed to potential users took place prior to installation and an "Anchoring Code of Conduct" was created.

LIFE SeaForest - LIFE17 CCM/IT/000121 (2018-2023)

The project has, as generic objective, the increase of the capacity of the carbon reservoirs of *Posidonia oceanica* meadows through erosion reduction and subsequent consolidation of the habitat 1120 in the Italian protected areas: National Park of Cilento, Vallo di Diano and Alburni (province of Salerno), National Park of Asinara and National Park of the La Maddalena archipelago (province of Sassari).

Among the expected results of the project, the following ones should be mentioned:

- the definition of an anchor and mooring management plan in critical areas for *Posidonia*, for users interested in mooring in the area included in the plan;

- the removal of mooring facilities no longer working and causing serious damage to the *Posidonia* meadows, the implementation of experimental pilot actions of *Posidonia* re-vegetation in the areas where the old moorings were removed and the installation of sustainable 'Manta Ray' moorings to allow mooring in areas outside the *Posidonia* meadows.

Project SEAPASS - INTERREG IIIA (2000-2006) – Greece-Italy. Sistemi Elettronici Applicati per la Protezione dell'Ambiente e lo Sviluppo Sostenibile (Applied Electronic Systems for Environmental Protection and Sustainable Development).

The main objective of the project was to spread "best practices" for tourism development and environmental protection through the installation of telematic systems and the creation of environmentally friendly mooring fields. The locations of Otranto in Italy and Patras in Greece were chosen to promote the Mediterranean seabed protection system, even outside Italian Marine Protected Areas.

3.1.2 SASPAS eco-friendly anchoring systems

Mooring systems have been proposed to test their implementation in the project sites and to address a new conservation policy in a framework of balancing protection of the ecosystem and use of the natural resources for touristic purposes.

The installation of moorings was preceded by preliminary surveys to gather the general information on seagrass distribution and related problems (fishing, areas of major pressure due to free anchoring or traffic, points of erosion and retreat of the meadows, typology of sediments, etc.) and identified potential sites for the installation of the ecological mooring field.

As regards the type of ecological moorings, reference was made to the most recent scientific publications and European Reports on this topic[3].

However, in each site, the starting criteria for choosing the site locations were:

- identification of a wide area, colonized by marine seagrasses;
- precise identification of punctual sites, without coverage, for mooring posts placement;
- sites had to be mooring areas for pleasure boats or mooring areas for recreational diving boats.

The moorings were preferably installed outside the meadows or within limited decolonized areas, if available. Depending on the type of sites, the sandy areas were preferred rather than the rocky areas, where the collateral damage for the installation could be greater.

All the specification regarding the type of ecological moorings, theirs laying and the areas selected are reported in the sections of the report dedicated to each project case study (see chapters 4, 5 and 6).

[3] such as MEDPAN, European Commission (Management of Marine Protected Areas of the Mediterranean Sea), 2006; Capitalisation sur les Mesures de Gestion au Sein des Aires Marines Protégées de Méditerranée (Ize S., 2017)

Figure 3-3. *Eco-buoy fields are located in the most important protected shelters of the Kornati Archipelago and in the bay of Panzano in Monfalcone. The photo refers to the Kravljacica bay, at Kornati NP.*

An updated picture of the pressure due to anchoring during the summer season was given by the collection of data regarding the following parameters, to control and verify the number, type and size of boats dropping anchor both on the natural meadows and at the eco-friendly buoys:

- number of buoys,
- buoys placement (within or outside meadows),
- boat dimension target,
- estimation of buoys daily used,
- presence of installed warnings or disincentives to anchoring,
- persistence of free anchoring.

The main results of the buoys monitoring are reported in the sections dedicated to each project case study (see chapters 4, 5 and 6).

3.2. Seagrass transplantation

3.2.1 The experiences in the Mediterranean context

Seagrass restoration projects are a relatively young field and, thus, new transplantation approaches are continuously conceived, depending on the species, the environment, and other specific features of the project itself. In the last decades, several transplantation methods have been created and tested and they can be divided firstly into two main groups: mechanical transplanting and manual transplanting.

Both mechanical transplanting and manual transplanting methods require: 1. knowledge of seagrass species growth habits and life histories and 2. available seagrass stocks to be used as donor meadows (either cultivated or wild, with the wild meadows usually the most used). Different parts of the donor meadow can be used for the transplant activity (e.g., entire shoots, just the rhizomes, seeds) and each of these parts can be prepared with different methods to be used as planting units. The planting units in seagrass transplantation projects can be: 1. sediment-free (as anchored or unanchored sprigs, shoots or rhizomes), 2. sediment-intact (as sods, cores or plugs, characterized by sediment plus intact rhizome/root systems) and 3. seeds (Ganassin & Gibbs 2008; Matheson et al., 2017). Generally, sediment-intact transplanting units are preferred since the root and rhizome system is relatively undamaged and they also provide a reservoir of the original rooting medium (Fonseca et al. 1998; Matheson et al. 2017). In environments characterized by high water motion, larger planting units have generally more chances of survival than smaller ones because they offer greater anchorage and less rhizome disturbance (Paling et al., 2001). Sediment-free transplants are more favoured in habitats characterized by fine sands, moderate water movement and good light availability (Orth et al., 1999; Paling et al., 2007). To protect the transplants and favour their establishment and growth, sheltering or sediment stabilising devices (e.g., meshes, fences, screens of wooden fascines, artificial seagrass mats) can also be used (Campbell & Paling 2003; van Keulen et al., 2003; Barausse et al., 2015; Bonometto et al., 2018). In any case, even if without the placement of protective devices, it is generally advisable to mark the transplanted areas with different types of signals (e.g., poles, buoys) so that their boundaries can be clearly visible.

Mechanical transplanting methods have the advantage of being potentially suitable for large-scale applications, but also the disadvantages of requiring high initial investment costs, of being cost and effort demanding to maintain the employed heavy equipment and machineries, and of being not always cost effective (Sfriso et al., 2021). To our knowledge, there are not many examples of mechanical transplanting methods applied in seagrass restoration project in the Mediterranean Sea, since they are usually applied in very large areas (e.g., Nakase & Shimaya 2001; Paling et al., 2001, 2003; Lewis et al., 2006; Marion & Orth 2010; Suykerbuyk et al., 2016; Edward et al., 2019). However, mechanical transplants of big sods (approx. 2 m^2 and 40–60 cm thick) have been successfully carried out in the Venice lagoon in the frame of projects supported by the Water Authority of Venice (MAV, SELC Soc. Coop. 2009; OOPP et al. 2018).

Manual transplanting methods require less effort, are usually less expensive and have a lower environmental impact than mechanical transplanting methods (Curiel et al., 2003, Sfriso et al., 2021); however, trained operators, familiar with seagrass handling and planting methods and generally also able to work in or under water, are required. In fact, if intertidal areas can be accessible on foot during low tide, in shallow waters during high tide the restoration work is carried out by snorkelling; in deeper waters, the restoration work is always carried out only with the help of boat operators and SCUBA divers. Manual

transplanting methods are the ones most used in the Mediterranean Sea (see below for references) and were used also during SASPAS project.

About the seagrass species composing the meadows considered in SASPAS project, i.e., *Cymodocea nodosa* in Panzano Bay - Monfalcone and *Posidonia oceanica* in NP Kornati and RNP Dune Costiere, the literature reports different transplantation methods currently used in the Mediterranean Sea (see **Annex 3** for more details):

Cymodocea nodosa

- sod and rhizome transplantation,
- transplantation of large sods,
- transplantation of seedlings obtained from seeds germinated in laboratory conditions,
- sod transplantation using biodegradable bags.

Posidonia oceanica

- sod transplantation,
- transplantation of seedlings obtained from seeds germinated in laboratory conditions,
- transplantation of cuttings using iron wire meshes and artificial reefs,
- transplantation of cuttings with a patented gabion supporting structure,
- transplantation of cuttings using biodegradable supports and iron wire meshes enclosed in concrete frames,
- transplant of cuttings and seedlings using non-degradable and degradable mats.

Figure 3-4. *Operators with expertise in selecting and handling the plants are required in order to minimize seagrass damage during the transplantation activities. In deep waters, scuba divers are necessary to carry out monitoring and transplantation activities.*

3.2.2 SASPAS transplantation methods

As for the installation of the buoys field, preliminary surveys were carried out before the seagrass transplantations to gather the general information on their distribution and related problems (anchoring pressure, retreat of the meadows, etc.) to identify potential sites for seagrass transplantation and the most suitable techniques.

Posidonia oceanica transplantation

P. oceanica transplants were carried out using two similar manual techniques.

Technique 1

The rhizome transplantation method was carried out using an innovative patented (patents n. 0001400800/2010 and n. 102015000081824/2018) staple made up of a totally biodegradable polymer (Mater-Bi®; Biosurvey S.r.l. and IDEA S.r.l.), with an appearance similar to plastic (Calvo et al., 2014; Scannavino et al., 2014). This biodegradable support consists of a purpose-designed star-shaped anchoring system with 5 arms to which fasten the seagrass rhizomes (Figure 3-5). At the donor site, *P. oceanica* shoots were picked up by hand in submersion and subsequently kept in containers filled with sea water. Once back to the ground, *P. oceanica* rhizomes were fastened to the arms of the biodegradable staples, using tear-off bands. Two leaf bundles were fixed at each arm of each support, for a total of 10 leaf bundles per staple (Figure 3-6). After fixing the cuts to the armrests, the biodegradable supports were assembled at the central node and then anchored to the bottom sediment, by fastening the star staple centers with linchpins inserted in pre-installed biodegradable pickets by SCUBA divers**.**

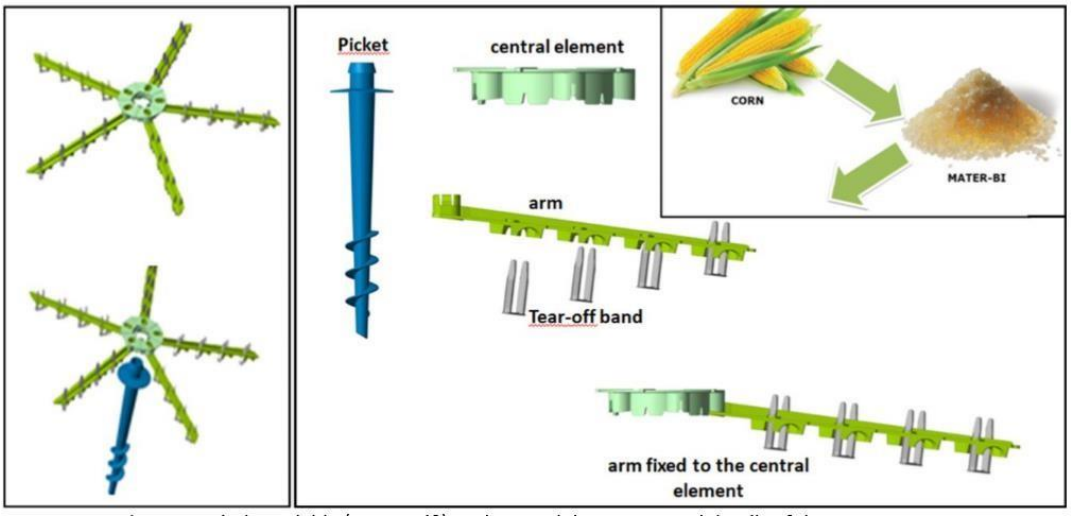


Figure 3-5. *The biodegradable (Mater-Bi®) modular system used to anchor P. oceanica shoots to the substrate in NP Kornati. On the left a general view of the star-shaped anchoring staple; on the right details of its components.*

Figure 3-6. *Detailed view of* P. oceanica *shoots fixed to the star-shaped biodegradable staples.*

Technique 2

The rhizome transplantation method was carried out using an alternative test to the technique 1. Shoots were mounted on exotic wood supports, heavy enough and of low degradability to resist on the sea floor at least for a couple of years. The cuttings, each of which is formed of at least three shoots of leaves, were attached with biodegradable plastic ties to the wooden supports, and the wooden base was fixed on matte with iron pin (Figure 3-7).

Figure 3-7. P. oceanica *attachment scheme and wooden base fixed on matte with iron pin*

Cymodocea nodosa transplantations

C. nodosa transplants were carried out using two different manual techniques. The first technique consisted in the collection and planting of sods (i.e., planting units made up by plants with leaves, roots and rhizomes plus the native sediment that surrounds the rooting apparatus). The second technique consisted in the manual collection of shoots (i.e., planting units made up by bare root cuttings), which were subsequently re-planted thanks to anchoring staples.

The donor site and the recipient site were marked using poles and georeferenced by a GPS. Thetransplants were conducted by operators with wet suites and other personal protective equipment, withthe help of a support boat for the execution of the field operations. Operators worked in a partial immersion mode, considering the depth and the tide.

Technique 1

Transplantation of sods. In agreement with many authors (e.g., Cancemi et al., 2002, Paling et al., 2009, Sfriso et al., 2019), transplanting was carried out when the seagrasses were not in their growing period (since September to April) to minimize plant stress. At the donor site, *C. nodosa* sods were carefully collected from the substrate through a 21 cm diameter steel core drill (Figure 3-8). Each sod was placed in a perforated bucket, covered with hemp fabric, to be transferred to the transplant site. Furthermore, during transport sods were constantly wetted to avoid drying. In the transplant site, holes with the same size of the collected sods (21 cm of diameter) were created in the sediment through the air-lift samplers. Within the same day of collection, sods were positioned in the donor site, where they were suitably oriented in the sediment together with the hemp fabric; all these operations were carried out by SCUBA divers.

Figure 3-8. *A typical steel core drill as the ones used to extract* C. nodosa *sods from the donor site to transplant them in the acceptor sites.*

Technique 2

Transplantation of bare-root transplant cuttings. The plants were collected using air-lift samplers, which allowed to free rhizomes and leaves from the sediment (Figure 3-9). During the removal and cleaning of seagrasses, it was important to ensure the presence of apical meristems of the growing rhizome in the individual planting units, as they provide a source of new shoots and horizontal growth for the colonization of new areas. For vegetative stocks, at least two apical shoot per planting unit were selected. Subsequently, sprigs were placed into tanks with flowing seawater, floating baskets, or similar carriers, to be transported to the planting site (acceptor area/site) within the same day of collection. The seagrasses were planted directly into the seabed, where they were anchored using U-shaped metal staples by SCUBA divers. Sprigs were attached to the staples by manually inserting the rhizome root portion of the plant fragments under the curved part of the staple and fixing the plants to the bottom sediment, to limit the impact of hydrodynamics and waves.

Figure 3-9. *Example of one of the floating baskets used to carry* C. nodosa *shoots collected from the donor meadows to the acceptor area where they were planted in Panzano Bay – Monfalcone.*

3.2.3 SASPAS monitoring activities related to transplantation

After the preliminary survey (activity 3.1), aimed to characterize the biodiversity of the project sites and gathering up-to-date information on the distribution and quality of seagrasses, monitoring campaigns were carried out to control the plant phenological life cycle and the spatial dynamics of marine seagrasses as a response to the concrete actions (activity 3.3). The analyses included all monitoring data, especially those concerning the retreat or surface increase dynamics, in relation to increase or hopefully decrease of free anchoring pressures on or very close to meadows. The goal was to characterize and quantify, in time and space, the measured impacts and assess trends in biodiversity, as far as possible over the Project time frame.

By integrating the literature suggestions (Fonseca et al., 1998; Cunha et al., 2012; Pirrotta et al., 2015; Calvo et al., 2021) with the operational framework of the project, annual campaigns were organized which therefore had the aim of monitoring the conditions of natural control meadow sites, transplantation plots and prairie areas close to eco-buoy fields.

Coming to the specific topic of transplantations, it is appropriate to anticipate that recently Calvo et al., (2020) mentioned that "a good result in the early stages of transplantation does not necessarily correspond to a real success of the transplant, and vice versa a low initial performance does not necessarily compromise its positive outcome in the future" since it is important to follow the transplant plots over time in the middle and long term.

This approach is shared by the partners of the Project operational sites, who intend to continue the periodic controls of the transplant plots.

Posidonia oceanica

A monitoring plan was prepared that provides in each transplanted parcel the selection and labelling of some anchor modules for each of the patches implanted. In each of the five brackets of the selected and labelled anchor module, the following variables were evaluated for each monitoring campaign:

- evidence of eroded leaf apex,
- length of rhizome,
- total number of shoots in the arm,
- number of shoots of the external cutting,
- longest leaf length, in the outer cutting.

Therefore, the following variables were derived for each monitored anchor module:

- total number of cuttings,
- number of beams per cutting,
- number of total bundles,
- number of dead beams.

Cymodocea nodosa

For *C. nodosa* the transplantations state and progress were monitored evaluating the following parameters:

- survival rate of the transplanted sods,
- survival rate of the transplanted shoots (by staples),
- colonization of the seabed,
- leaf/rhizome development.

The main results of all the pilot transplantations are briefly reported in the sections dedicated to each project case study (see chapters 4, 5 and 6).

4. SASPAS CASE STUDY 1: MONFALCONE (PANZANO BAY)

The preparation steps of activities (permit requests, stakeholders' involvement, and choice of sites) and the implementation of the actual activities (seagrass transplantation, monitoring, and buoys laying) are described in the following paragraphs.

4.1. Preparing SASPAS activities in Monfalcone

4.1.1. Choice of sites

The Bay of Panzano (Monfalcone), except from the waterway to the commercial port, is an extremely shallow embayment, strongly frequented in the summer period, even if the number of boats is lower than the average number registered in Kornati NP - one of the other two project sites. The conditions concerning seagrass meadows show that although anchoring boats are numerous in summertime, their impact is scarce. In fact, unlike the slow growth dynamics of *Posidonia oceanica*, present in the other two project areas, *Cymodocea nodosa* here is able to well recover any rarefaction phenomena that occur due to direct physical causes, thanks to its strong branching capacity.

In general, excluded some specific sites, the impacts from yachting traffic on the colonized shallows are in fact modest on low-medium entity, both as direct (physical) and indirect (suspended and embedded sediments) actions.

For these reasons, the monitoring zones (and stations - see Annex 2) were placed in specific sites where anchoring pressures occur:

- in the northern part of the Panzano bay, near the site "SAC - Cavana di Monfalcone", on a *Cymodocea nodosa* meadow [presence of medium-sized boats (sailboats)];
- near the "SAC - Foce dell'Isonzo – Isola della Cona", on *Cymodocea nodosa* meadows mixed with other species, *Zostera noltei* and *Z. marina* (presence of small-size boats).

The host sites for the pilot *C. nodosa* transplantations were located near "SAC - Foce dell'Isonzo – Isola della Cona" and the monitoring zones.

The buoy field (for the anchoring system) was located at a distance of about 450 meters from the dam of the Monfalcone commercial port and as many from the shoreline of Lido di Panzano (Isola dei Bagni), in an area representing a temporary mooring area for a large number of pleasure boats.

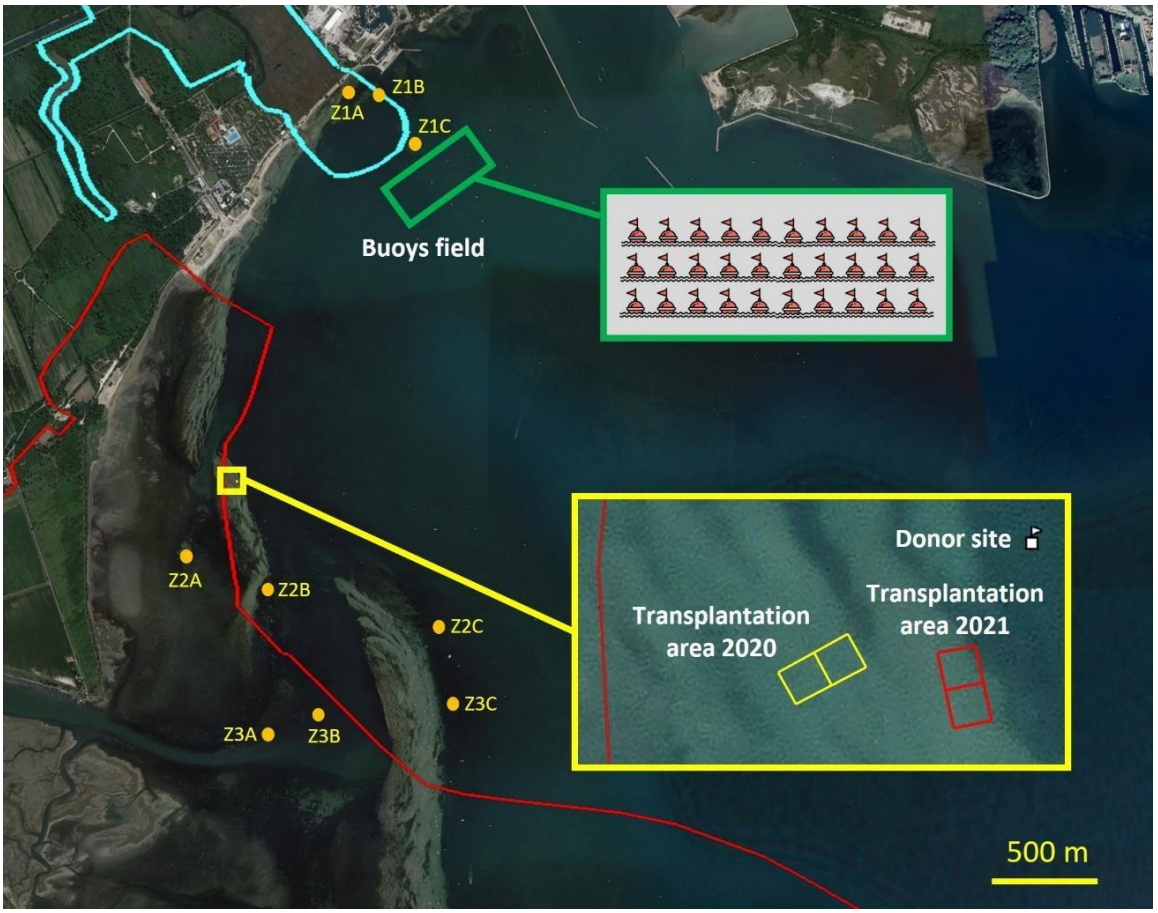


Figure 4-1. *Bay of Panzano: location of the buoys field and of the pilot seagrass transplantation areas.*

Figure 4-2. *Due to the morphological and sedimentological characteristics of the North Adriatic Sea, the bottom level of the bay of Panzano is an example of a coast dominated by fine sediments. The macrophytes that colonize these shallows are therefore adapted both to this type of sea bottom and to the condition of turbidity typical of these waters. Nonetheless, due to the substantial naturalness that these coasts preserve and to the bathymetric heterogeneity, characterized by alternating shallows, tidal flats, shoals, freshwater emissions and more, the meadows cover considerable extensions to the east and especially to the west of Monfalcone, up to Grado and beyond, not to mention the North Adriatic lagoons.*

Figure 4-3. *The bottom of the Bay of Panzano, at the Monfalcone project site, is characterized by the presence of dense seagrass meadows, mainly of the species* Cymodocea nodosa, Zostera marina and Zostera noltei. *They are "close relatives" of the more famous* Posidonia oceanica *and play an important role in containing erosion phenomena, capturing suspended sediments and*

providing shelter and food for the fish and benthic fauna. It is not uncommon to find, in the meadow, specimens of the great mollusk Pinna nobilis, an endemic species of the Mediterranean, subjected to protection, which has recently registered serious phenomena of infection by microorganisms throughout the Mediterranean Sea.

4.1.2. Stakeholder and Decision Makers identification

The contacts with the various stakeholders related to the world of pleasure boating, marinas, professional and amateur fishing and maritime infrastructures showed different results.

The design concept of the buoy field, of the underwater vegetation transplants and the general rationale of the project received good initial feedbacks, on a general overview, despite the problems of the pandemic which slowed down and often stopped the possibility of dialogue and exchange of ideas.

Their involvement brought to attention the real and updated needs for frequentation and use of the buoys by boaters in the area and the need of safe waterways, free of obstacles, for fishing vessels navigation to reach the small harbour of Marina Nova a Panzano, especially in adverse weather conditions.

A fruitful dialogue and collaboration were obtained from the Maritime Authority, that is the Harbour Master's Office (Capitaneria di Porto di Monfalcone, dependent on the Trieste Maritime Directorate and the Ministry of Sustainable Infrastructure and Mobility - MIMS), even if explaining the general rationale of SASPAS and the conceptual framework aimed at the cross-border management of coastal environmental resources resulted difficult, due to the high institutional division and partitioning of competences of the Italian government departments.

In this sense, a similar approach to the management of public interventions, such as the adoption of the institutional instrument that in Italy is called "conference of services" could help and give initial project propulsion thanks to the sharing of ideas and the evaluation of cross-constraints at an early stage of the development of activities.

Less stakeholder involvement was recorded by yachting associations and some marinas, which were less interested in aspects of conservation of valuable habitats and new perspectives of eco-friendly anchorages to protect marine seagrasses. We estimate that the reasons may be related to the following causes:

- lower environmental awareness on a general level;
- less attention to the habitats and the underwater landscape in respect to the familiarity towards the coast and the terrestrial landscape;
- lack of environmental information from the institutions towards pleasure boaters.

4.1.3. Permits and authorizations

With regard to permits and authorizations, before the field phases the procedure for their acquisition was activated through informal contacts with the competent authorities as regards:

a) aspects relating to environmental protection of the sites envisaged by the project;

b) territorial competence for the sites and for the execution of concrete actions;

c) the operational and safety phases at sea and d) the laying of floating structures.

For aspects relating to the environmental protection of plans or projects that operate within or near Natura 2000 sites, the procedures at national level are well codified as they are the responsibility of the regional offices and, specifically, of the Friuli Venezia Giulia Region (*Servizio Biodiversità*-Biodiversity Office). For the aspects relating to territorial competence, where the actions fall geographically, the Municipality of Staranzano (the Municipality adjacent to Monfalcone), where marine seagrass transplantation was carried out, was contacted as the Municipality of Monfalcone is directly involved as a leader partner in the Project.

For activities at sea, for the permits relating to the field activities and for the boats, the responsibilities are well defined at national level and referable to the Maritime Authority of Monfalcone (*Capitaneria di Porto di Monfalcone*) and to the *Comando Zona dei Fari e dei Segnalamenti Marittimi di Venezia(MARIFARI Venezia)*, the Italian Navy competent office for maritime signals.

For the installation of the buoys, the *Servizio pianificazione paesaggistica, territoriale e strategica* of the Friuli Venezia Giulia Region, was also contacted to assess any landscape and constraints and for the occupation, even if temporary, of a marine sector for the laying of the buoys. The *Demanio Marittimo*, the Marine State Property Office, was also contacted to assess the existence of specific constraints or competences in the marine sector involved.

Considering that in interest of the project, in addition to the SACs and SPAs, the Regional Nature Reserve of the Isonzo Mouth is also present; the Municipality of Staranzano, the managing body of the Reserve, was also contacted to verify possible constraints for the marine seagrasses transplantation test to be carried out.

Although not directly part of the permits and authorizations phases, the evaluation of stakeholder's requests made it possible to focus in detail on the location of the sites for the finalization of the concrete action program. This process of acquiring opinions and decisions was necessary to properly initiate and coordinate the project activities and carry out concrete actions.

Environmental permits

As required by European regulations implemented by the Italian state, any project or plan must be examined by the competent Authorities to verify whether these, although having the purpose of restoring or maintaining a high level of environmental quality, can generate negative impacts on the environment.

Specifically, the Habitats Directive provides that projects and plans operating within or near Natura 2000 sites must be screened through a procedure known as Appropriate Assessment, to verify that there are no negative impacts on habitats and species, with respect to the conservation objectives of the Natura 2000 site, both individually but also in combination with other existing plans and projects. The conclusions

of this assessment procedure allow the competent authorities to make sure whether the plan or project is likely to adversely affect the integrity of the site or neighbouring sites.

The Impact Assessment procedure must consider all potential pressures and consequences on the conservation values of the site or sites concerned, focus on the species and habitats for which the area has been designated as a Natura 2000 site (sites designated under the Birds Directive and sites designated under the Habitat Directive) and on all the essential elements for the operation and structure of the site.

For the activities planned at the Monfalcone site, the evaluation phase consisted in a report certifying no need for an Appropriate Assessment. This report concluded that the planned actions not only would not have had significant effects on the adjacent Natura 2000 sites, but they were also included in the management plans of the relative sites and considered appropriate for the conservation of habitats and species. Based on the produced document, the Regional Biodiversity Office assessed that a further Appropriate Assessment was no needed, only asking for sharing the collocation sites of transplantation tests and buoys positioning.

The definitive geographical location of the transplantation sites and buoys was finalized after a process that lasted a few months after hearing the opinion of the Regional Biodiversity Office, the Municipality of Staranzano (as manager of the Isonzo Mouth Nature Reserve), different considered stakeholders and the Maritime Authority. The transplantation and buoy sites were chosen based on environmental and project needs (see relative paragraph) in accordance with the Management Plan of the Natura 2000 SAC/SPA Mouth of the Isonzo - Isola della Cona site and the Conservation and Development Plan of the Isonzo Mouth Nature Reserve.

Specifically, the “Mouth of the Isonzo-Isola della Cona Management Plan” calls for actions that envisage the “improvement of marine seagrass conservation with incentives for the conservation/restoration of seagrass meadows” and the "creation of a buoy field outside the site for leisure activities and to avoid disturbance in the most sensitive areas ".

To obtain the authorizations in time for the realization of the works and evaluating the results, the decision to relocate the transplantation and buoy-field site in the area of competence of the Municipality of Monfalcone (Project LP), was important in the advancement of the project, respect the initially envisaged sitting in the Staranzano Municipality competence area. In general, minimizing the number of entities or administrations to be involved in the authorization process helps to launch concrete actions in the field more quickly, especially to evaluate their effectiveness within the timeframe set by the project, particularly when the interventions involve biological components that respond to seasonal/annual dynamics.

Authorization for activities at sea

As regards field activities to be performed in the Bay of Panzano (Monfalcone study area), several meetings, emails and telephone contacts took place with the Maritime Authority – Harbour Master’s Office (*Capitaneria di Porto di Monfalcone*). In fact, it should be noted that the envisaged actions at sea (transplantations and buoy field) have required specific ordinances in which were reported:

a) the coordinates of the work areas also in order to forbid navigation to third parties;

b) operation specification and methodology (working days, hours, nautical means, personnel, safety, etc.).

The exchanges with the Harbor Master's Office made it possible to focus on the ways in which the actions at sea would take place, for the aspects relating to the location of transplant sites and buoy fields and on safety. As regards the nautical means to be used, the discussion mainly concerned the type of registration of the vessel with the competent bodies.

Regarding the location of the sites proposed for the Project concrete actions, various constraints and indications suggested by the Maritime Authority were considered and discussed:

- distance from the breakwater leading to the commercial harbour (at least 400 m);
- no interference with the port navigation channel;
- respect for the bathing distance from the coastline (200 m) along Panzano beach;
- check on the nautical chart of off-limits areas or submarine cables/pipelines;
- verification of specific uses for bathing or for the summer period (e.g., kitesurf corridor);
- verification of bathymetric levels;
- environmental and territorial authorizations;
- characteristics of the mooring (night/day, free or for a fee, boat size limits, responsible reference figure for the buoy field, etc.);
- presence of buoys with night light signals;
- procedure of authorization with the Navy signal authority.

As regards the aspects relating to the transplantation operations of marine seagrasses, the type of intervention and the operating bathymetric elevation of the order of one meter maximum did not need to employ professional divers, but a technical staff composed of marine biologists was fit for purpose. In addition, it is important to highlight that the use of professional divers, who come from the experience of commercial, oil and metalworking diving, is often not appropriate in the biological context, where the substrate and the underwater landscape are themselves elements of attention and not just boundary conditions.

For this reason, the personnel employed in the field are certified according to the standards of the European Scientific Diving Panel (ESDP[4]) and the Italian Association of Underwater Scientific Operators (AIOSS[5]).

On the other hand, the process for the approval of the boat to support activities at sea was more complex. Based on current regulations, regardless of the distance in which one operates from the coast or the bathymetry of the site, the nautical vehicle must be registered in "use for third parties". Specifically, at the end of an intense exchange of assessments with the Harbor Master's Office, the activities at sea were carried out using a boat registered in "third party use", authorized to transport goods and passengers, in

[4] http://scientific-diving.eu/wiki/index.php?title=Main_Page

[5] http://www.aioss.info/certificazione.asp

addition to the crew. The initial solution, which involved the use of working boats, of Partner's property, was not accepted.

In general, it seems appropriate to point out that the different solutions for registering the boat at the competent offices (Harbor Master's Office or Regional Port Inspectorate) in the last decade have been the subject of numerous complaints and cross-complaints, with court appeals by the interested companies (owners of the boats) at the Regional Administrative Courts (TAR) and through parliamentary instances too, which have recently accepted the requests and brought about some improvements. In summary, the problem arises from a restrictive and subjective interpretation of the articles of law (Article 25 of Law no. 472 of 1999) by the Port Authorities regarding the use of boats registered for "own use". It is therefore suggested to the bodies/administrations involved to pay particular attention to this aspect, starting the dialogue with the Harbor Master's Offices well in advance, taking also into account this issue in the tender phase.

Once the authorization procedures were completed with the Harbor Master's Office, the last administrative act was prepared for MARIFARI, the body of the Italian Navy competent for the surveillance and maintenance of signals for maritime navigation. The seasonal positioning of a buoy field therefore required the sending of proper documentation to this Office in order to verify possible needs and prescriptions for the buoy installation. Considering the proximity to the coast, the temporary seasonal use, and the small size of the buoy field, the Office didn't give further prescriptions in addition to what was already foreseen in the project.

At the end of the above-described procedures, a few days before the execution of the works in the Panzano Bay related to both the transplantations and the buoy laying, the Harbor Master's Office of Monfalcone issued the specific ordinances.

4.2. Implementation of SASPAS activities in Monfalcone: transplanting, buoys positioning and monitoring

4.2.1. Transplantation of C. nodosa

In Panzano Bay-Monfalcone, two pilot transplantation campaigns were carried out: the first in September 2020 and the second in April 2021. *C. nodosa* transplantation were carried out using two different manual techniques (see paragraph 3.2.2).

The host sites for the pilot transplanting were identified in parcels near the SPA, SAC Foce dell'Isonzo - Isola della Cona, in areas characterized by the presence of *C. nodosa* meadows mixed with other species (*Zostera noltei* and *Zostera marina*), shallow depth and the occurrence of anchoring pressures due to small boats. For both transplantations, a healthy continuous meadow was selected nearby as a donor site, where plants were collected with adequate spacing, to avoid stress (Figure 4-4).

For each transplantation, two square transplant areas (10 m x 10 m) were selected: one for the manual transplanting method by collection and planting of vegetated plugs (Figure 4-5) and one for the transplanting by manual collection of shoots - bare root planting cuttings (Figure 4-6).

Altogether, 100 plugs and about 100 sprigs of *C. nodosa* were placed in the transplantation areas during each transplantation campaign.

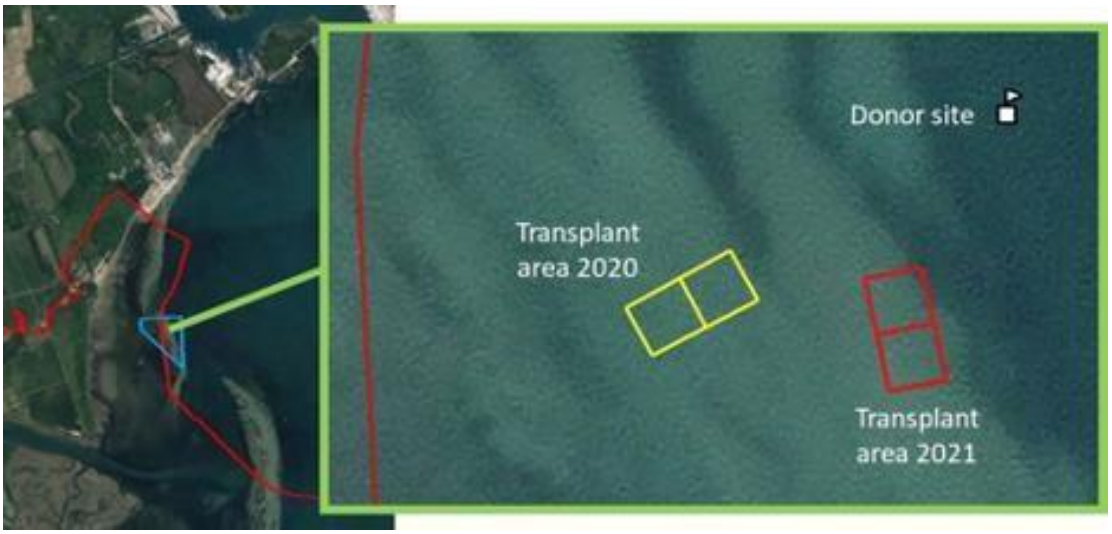


***Figure 4-4**. Host and donor sites in Panzano Bay – Monfalcone.*

***Figure 4-5**. Pilot transplantation of C. nodosa sods in Panzano bay-Monfalcone in September 2021: a) identification of the donor meadow; b) collection of sods; c, d) temporary storage of sods and their transport to the site to be reforested; e, f) manual planting of sods into the substrate by means of jute bags.*

***Figure 4-6**. Pilot transplantation of C. nodosa sprigs in Panzano bay-Monfalcone in April 2021: a) temporary storage of sprigs and their transport to the site to be reforested; b, c) sprig attachment to staples; d) sprig planting into the substrate by means of staples.*

***Figure 4-7**. Numerous small and medium-sized vagile and benthic organisms find their habitat among the leaf canopy and in the sediment of the seagrass meadows of Panzano bay. Among the leaves, small crustaceans, mollusk, juveniles of fish find food or shelter while in the sediment, rich in organic substance, a rich benthic fauna develops, composed of filtering bivalves, Echinoderms and Polychaetas. The same leaves then give hospitality to a variety of algal and animal epiphytes, a source of nourishment for numerous other species.*

4.2.2. Buoy positioning

Presentation and objective of the action

The action provided for the laying of no. 30 ecological buoys, to be positioned at maximum depths of 4 meters, for the temporary daytime mooring of boats of limited size, approximately within 12 meters, during summertime.

The buoy field had two specific objectives:

a) to push the small boat owner to moor at the buoys, outside the seagrass meadows;

b) to moor at the buoys, rather than dropping anchor on the meadows if any.

For these reasons, the intention was to position the buoy field partly inside and outside the meadow, to embrace the dual objective.

As already known, the spirit of the Project was not to solve the problem of moorings in Monfalcone or to limit anchoring on the beach, but to test an integrated approach for the protection of the meadows and compare it with other different Mediterranean and Adriatic experiences, finalizing the activities with the proposal of guidelines to be prepared at the end of the project for the correct and sustainable balancing of the need for conservation and protection of the coastal strip with the use of resources for commercial tourism purposes.

The Municipality of Monfalcone, leader of the Project and partner responsible for the action relating to the Bay of Panzano site, prepared the tender for the identification of the executor, who supplied and installed the buoys, testing an advanced anchoring method. Possible technical solutions consisted of the manta-ray system or the “Harmony” type system. As part of the contract, the subject managed the buoy-field for the summer period, acting as an operational contact for maintenance needs and in terms of safety.

The anchoring systems solution based on pins fixed in the sea bottom made it possible to avoid the laying of concrete blocks (dead weight) which cause considerable disturbance and which - in the case of seagrass meadow - are a disturbing element for the plant. The length and size of the pins was calculated to balance the holding powers of the dead weights, according to estimates by Rigutini (2017).

The areas where buoys were placed are shown in Figure 4-8; they obtained authorization for installation form the Friuli Venezia Giulia Region, both for environmental and landscape aspects.

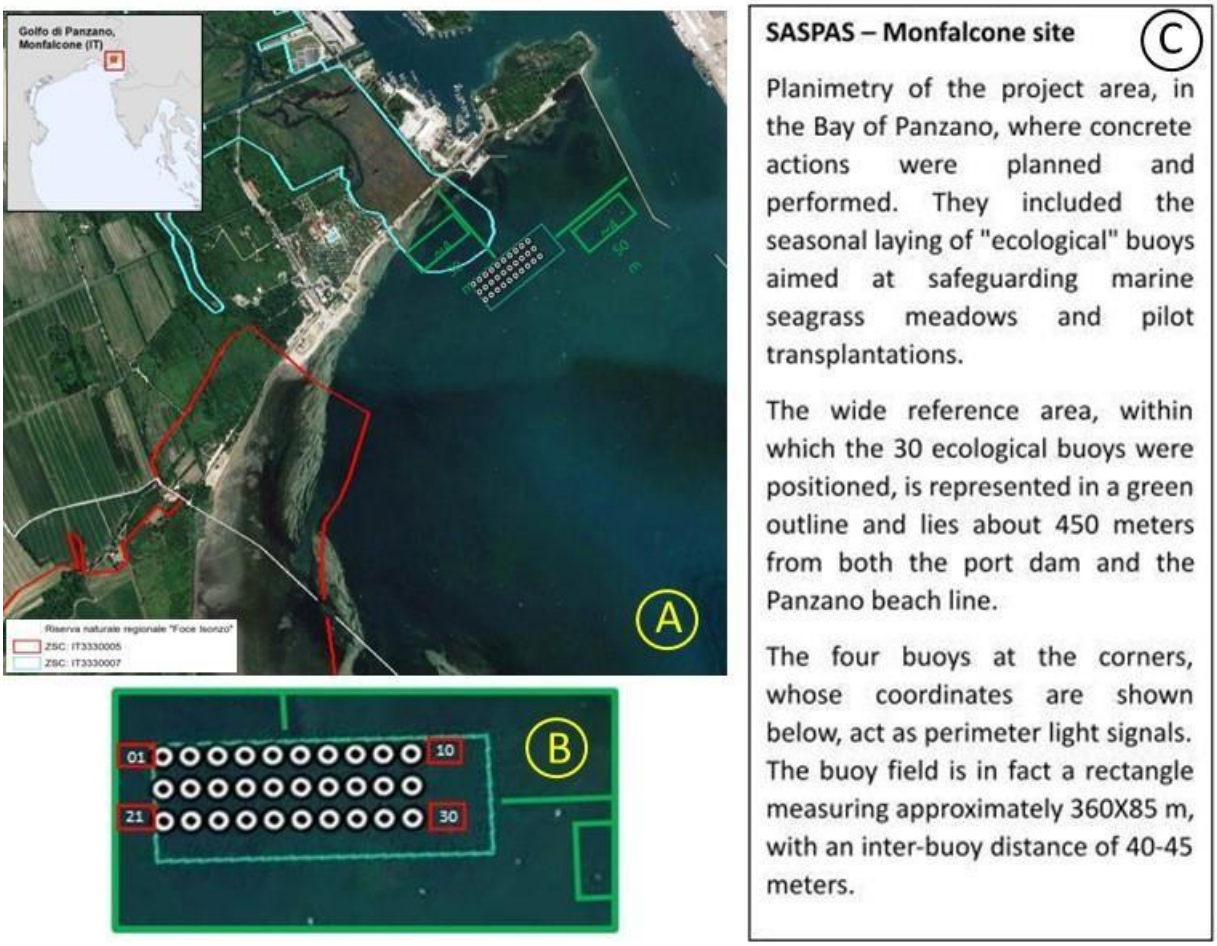


***Figure 4-8**. The buoy field in the Monfalcone study area: a) buoy field and Natura2000 sites; b) detail of the buoy filed; c) information on Monfalcone's buoy field.*

The buoy laying area

Figure 4-9 frames the general area of interest. The photo-plan of Figure 4-10, on the other hand, highlights in particular the coast of the Panzano Bay that runs from the Commercial Harbor of Monfalcone till Punta Sdobba. The various concrete actions of the Project are here envisaged, including the seasonal laying of "ecological" buoys aimed at safeguarding the seagrass meadows. In the plan, the polygon within which the exact laying point of the ecological buoy field will be identified is represented in a green outline. This identifies a large, determined area, selected in agreement with the Maritime Authority taking into account the appropriate safety distances from the coast and the port breakwater.

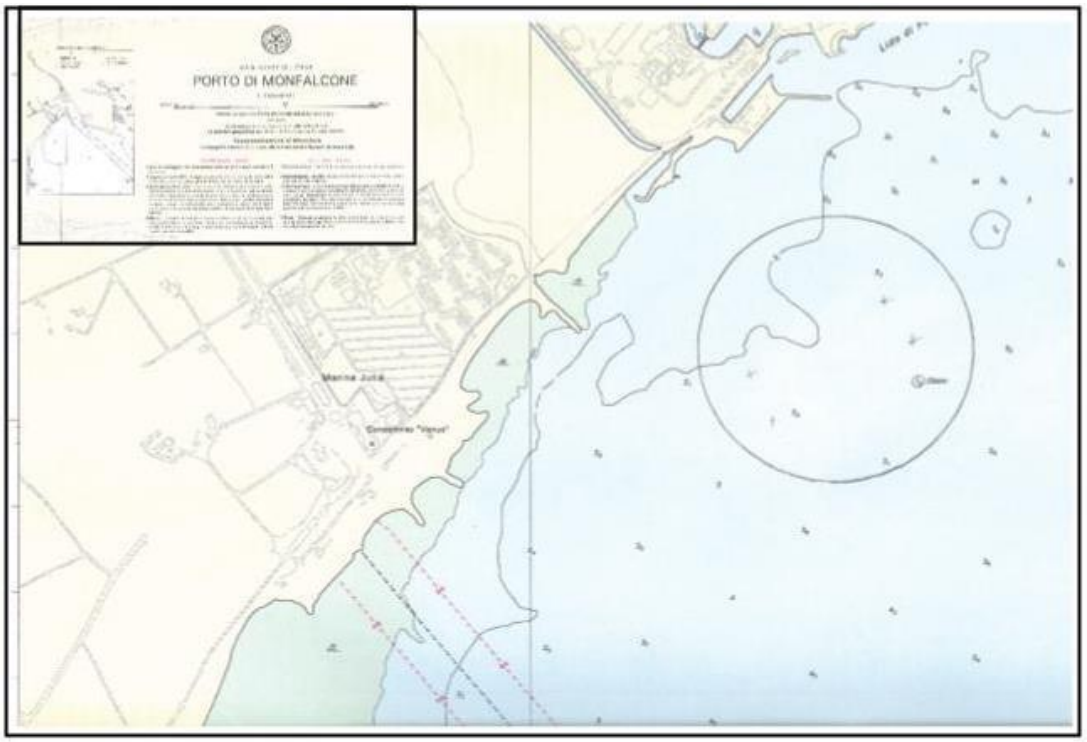


***Figure 4-9**. Extract from the Italian Nautical Chart no. 236 "Port of Monfalcone". The figure has the sole purpose of framing the project area within the port plan and cannot be used for any scale or correspondence operation. The expected buoy field lies within the circle shown in the figure.*

In particular, for the identification of a specific area where to place the buoy field, several criteria were considered:

- proximity to the seaside area of Panzano Bay, of interest for the smaller yachting fleet of the Monfalcone coast area;
- rules related to port regulations and minimum distances from the shoreline and from the commercial port breakwater for the installation of structures;
- scarce presence of marine seagrass meadows;
- minimum depth of 3 meters to permit temporary anchorage of medium size leisure boats.

Taking these criteria into account, the buoy field was designed at about 450 meters from the dam of the merchant canal harbor of Monfalcone and as many from the shoreline of Lido di Panzano (Isola dei Bagni) (Figure 4-10). These positioning permits safe navigation to/from the commercial harbor and represents a satisfactory temporary mooring point for those numerous pleasure boats that - in the favorable season – drop anchor for a few hours of the day in the bay.

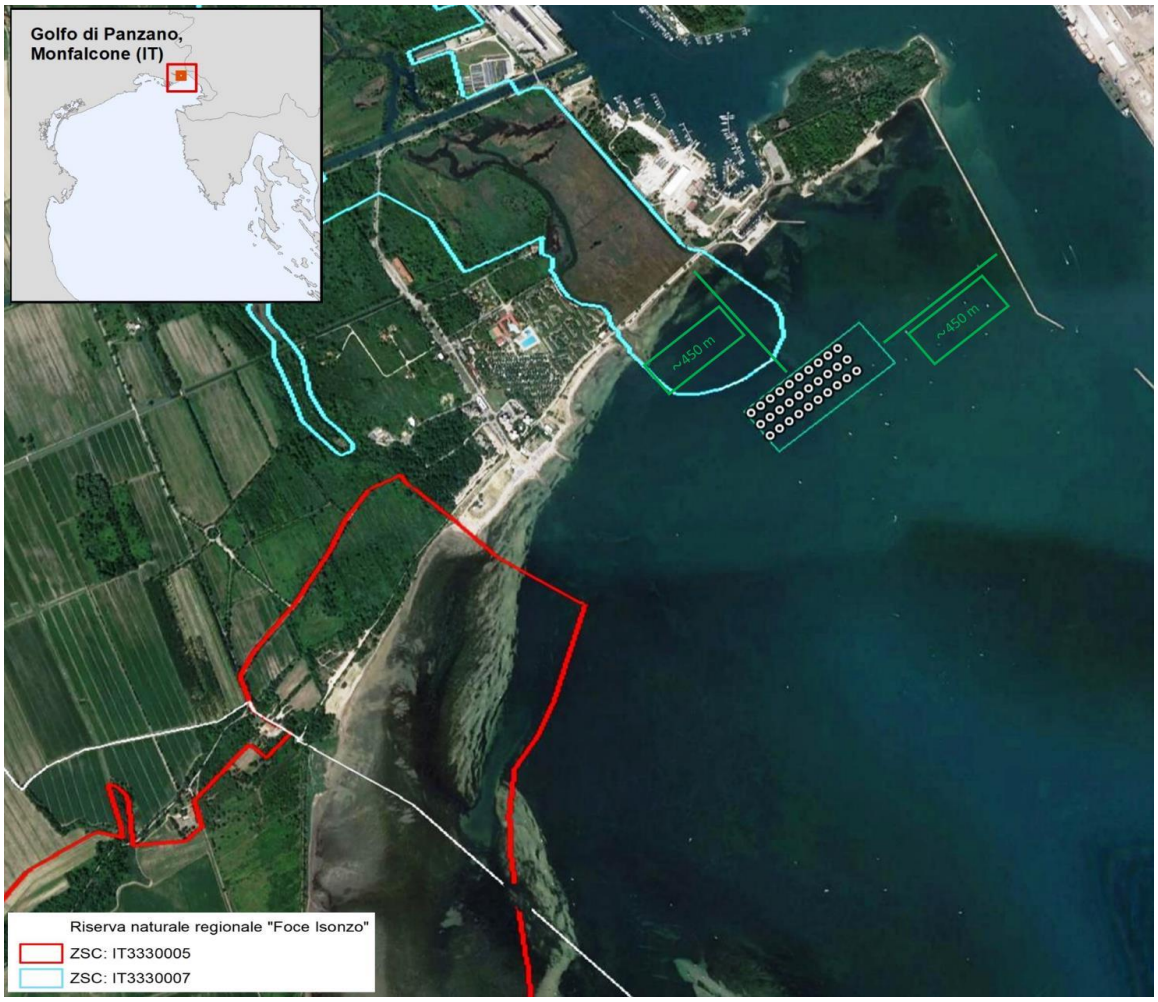


***Figure 4-10**. Photo-plan of the project area, in the Bay of Panzano. The polygon outlined in green represents the laying area of the buoy field that meets the criteria of distance from the coasts and harbour breakwater. The 30 white circles represent roughly the position of the 30 installed mooring buoys.*

Inside the large area initially assumed, the buoy field was slightly moved to the SW, in relation to the request of local fishermen for their preferential landing direction, when headed to the small marina of Panzano.

The chosen area, with a low presence of marine seagrasses, offers the required depths and allows to attract boaters, with the aim of relieving the pressure on the nearby areas where a high density of marine segrasses occurs, as well as - in the spirit of the project - to evaluate the will and the availability of the public to use this type of service to safeguard valuable coastal habitats.

The area where mooring buoys were laid, shown in the plan, lies on bathymetry of the order of 3-4 meters, with a compact sandy bottom with a variable fine component, colonized in a discontinuous and

inhomogeneous manner by submerged aquatic macrophytes (marine seagrasses of the species *Cymodocea nodosa*).

In fact, in the wider area considered in the project, the distribution of marine seagrasses mainly sees the presence of *C. nodosa*, a species of subtropical origin which prefers sandy bottoms with a variable silty component, but which also colonizes substrates with coarser granulometry.

Positioning and functional scheme of buoy field

The laying methods were proposed by the successful operator, obviously following project indications and safety requirements issued by the Maritime Authority in its specific authorization for field operations.

Working methods allowed sufficient precision for anchors positioning according to the laying pattern with maximum error of 3 meters with reference to the vertical of the anchoring point, reachable with normal GPS terminals with "WAAS-EGNOS" functionality.

The Figure 4-11 shows the positioning scheme of the pilot buoy field, with the relative distances between the buoys. In addition, it presents the characteristics of the single mooring points with the water heads, the corresponding approximate lengths of the mooring, and the anchoring method.

The positioning geometry of the buoy field takes into account the expectations for the size of vessels that will likely moor and other safety aspects, as better described later on. According to the indications issued by the Harbor Master's Office of Monfalcone, the distance between the single buoys was decided at 40 meters.

As previously mentioned, this standard scheme represents the final methodological solution, starting from the design prescriptions and with the necessary technical adjustments, on the basis of appropriate inspections of the conditions on site.

***Figure 4-11**. Buoy field and indicative representations for the functional positioning of the single mooring points.*

Necessary materials were supplied and installed according to Project descriptions in the quantities indicated. Solutions proposed by the assignee met the required characteristics and were supported by indications of discrepancies, clarifications or specific improvements.

At the corners of buoy field, four compact LED lights were installed on the buoys. In these buoys a sticker with Project information and mooring indications was attached.

Lines, thimble, shackles and other materials were supplied and dimensioned as appropriate.

Anchoring features

Anchoring system:

- variant 1 (mixed mud-sand-gravel bottom): screw drive system consisting of a 150 cm pole and two 20 cm diameter helical discs; solid round eyebolt 16 mm in diameter;

- variant 2 (predominantly mud bottom): screw driven system consisting of a 200 cm pole and two 30 cm diameter helical discs; solid round eyebolt 16 mm in diameter.

The 30 anchoring points are connected to each other with a special line, in rows of 10, for easier maintenance and recovery in case of loss of the buoy.

Buoys:

- the 4 corner buoys are biconical, orange in color and fitted on the top with a special self-powered yellow night signaling LED lamp;

- the remaining 26 mooring buoys are biconical, orange in color and equipped with a through shaft with two steel rings suitable for mooring boats.

Mooring rig, between buoy and sea-bottom:

The connection system consists of a section of high tenacity 100% polyester rope with a diameter of 24 mm connected to the spliced ends and equipped with a galvanized iron thimble by means of 14 mm diameter shackles.

***Figure 4-12**. Buoys positioned at Monfalcone, in Panzano bay. On the left, an ordinary buoy and, on the right, a corner buoy, with lighting device.*

Installation

The installation of the mooring equipment included the following activities, in logical sequence, to be carried out by the contractor:

- agreements with the Contracting Authority (Monfalcone Municipality, SASPAS LP);
- request to the Maritime Authority to issue authorization for sea operations, from the point of view of navigation safety;
- definitive confirmation by the Contracting Authority of the coordinates of the positions at which to position the buoys;

- carrying out the laying operations, according to the regulations issued by the Maritime Authority, as per point below;
- communication to the Contracting Authority of the completion of the operations and production of an "as-built" documentation with the geographical indications of accuracy of the positioning of the buoys and any other necessary information.

The buoys were made available to users free of charge, without generating any profit. All the material remains the exclusive property of the contracting authority.

Management and controls of the buoy field

The buoys were positioned and therefore usable in the period between June and October 2021. During the period of activity, along the summer bathing season, the executor provided a general surveillance of the buoy field, in coordination with the Contracting Authority, which included:

- general surface check of the tightness of the equipment;
- control of equipment after any significant meteorological event;
- verification of the tightness and possible replacement of the indication stickers affixed to the buoys;
- prompt interventions, when necessary, estimated at a maximum of 3, for operations for maintenance of stranded buoys and their relocation.

For these tasks, the executor indicated a reference figure on site, who could be contacted by the Contracting Authority, the Maritime Authority, and by users in general at any time, in order to provide prompt intervention for every need.

As regards of the buoys hauling at end of season, a date was communicated to the executor, who proceeded to clear the maritime area. The executor carried out a cleaning of the hauled equipment and made it available to the Contracting Authority.

Requirements for the use of buoys and moorings by users

The buoys have on the top a free ring suitable to tie the vessel of users. This ring, in fact, is connected to the mooring line by means of a through steel shaft which absorbs all shocks. To moor the boat, it is advisable to proceed alternatively in two ways:

1) tie or hook a mooring line equipped with a carabiner to the upper ring of the buoy, taking care to leave a few meters of line between the buoy itself and the coupling point on board;

2) use a “double” line by passing one end inside the ring of the buoy and fixing. subsequently both ends on board. In this way it will be easier, at the moment of unmooring, to free your boat from the buoy as

it is sufficient to loosen one of the two fixing points on board and retrieve the line without having to approach the buoy again.

The moorings, in accordance with the prescriptions dictated by the Monfalcone Municipality, are designed and built to accommodate boats and boats under the following conditions:

- boats small or medium-sized (max 12m);
- boats constantly monitored;
- mooring available only during the day and in favorable weather and sea conditions;
- boats to be individually moored on the buoy;
- users must be careful when approaching the vertex light buoys in order to avoid collisions with them that could compromise the operation of the lamp.

4.2.3. Monitoring

The monitoring activities foreseen by the WP 3 program were diverse and all demanding. The preliminary survey carried out at the beginning of the project in the bay of Panzano was dedicated to an initial assessment of the quality of the *Cymodocea nodosa* meadows which colonize the shallow waters, and which have high density and homogeneity of coverage, with the exception of the tidal flats, which emerge in medium low tides and which, for this reason, are not colonizable.

The aim was therefore to characterize this project site in order to attribute a degree of quality to the meadows, together with their related habitats and species, and to contribute the necessary information useful for the correct identification of suitable sites for transplantations and for the laying of the buoy field. This baseline is important because possible future changes could be recognized by assessing the monitored parameters over time (for example, dynamics - progress/regression - of the meadow through balise placement).

The results of this preliminary survey (activity 1 of the WP 3) highlighted that no anomalies were found considering the composition of benthic communities. As concern the marine seagrass meadows, the main disturbances seemed to be related to the presence of anchoring. However, the selection of sites potentially affected by this type of pressure was necessary to test the efficiency of safe anchorage systems and of the marine seagrass pilot transplantations.

The objective of the activity 2 of the WP 3 (DPSIR analysis) was to combine the information collected during the preliminary survey with the available data collected on the environmental quality status of the sites and of the current marine seagrass populations; this resulting mass of information was therefore analyzed in the light of the main existing pressures. The aim was to interpret the consequent most significant impacts affecting these valuable habitats on the various sites to better target their conservation and management.

For the Bay of Panzano (Monfalcone) site, the results of the DPSIR analysis showed how the coastal conformation and the large marine area of tidal flats and shallow waters were characterized by remarkable naturalness and maintained high topo-bathymetric variability. These conditions resulted in

the stability of extensive meadows of *Cymodocea nodosa*, species with a marked seasonality and with a strong underground hypogean component. The Bay offers reason for anchoring and sheltering a fleet of smaller pleasure boats that anchor on 1-3 meters of seabed to spend the day at sea. Despite the numbers, this pressure did not seem to lead to significant impacts on the meadows. We believe this is mainly due a) to the strong branching and recolonization efficiency of the macrophyte after the eradication events and b) to the scarce use of chain catenaries, considering the modest size of the boats.

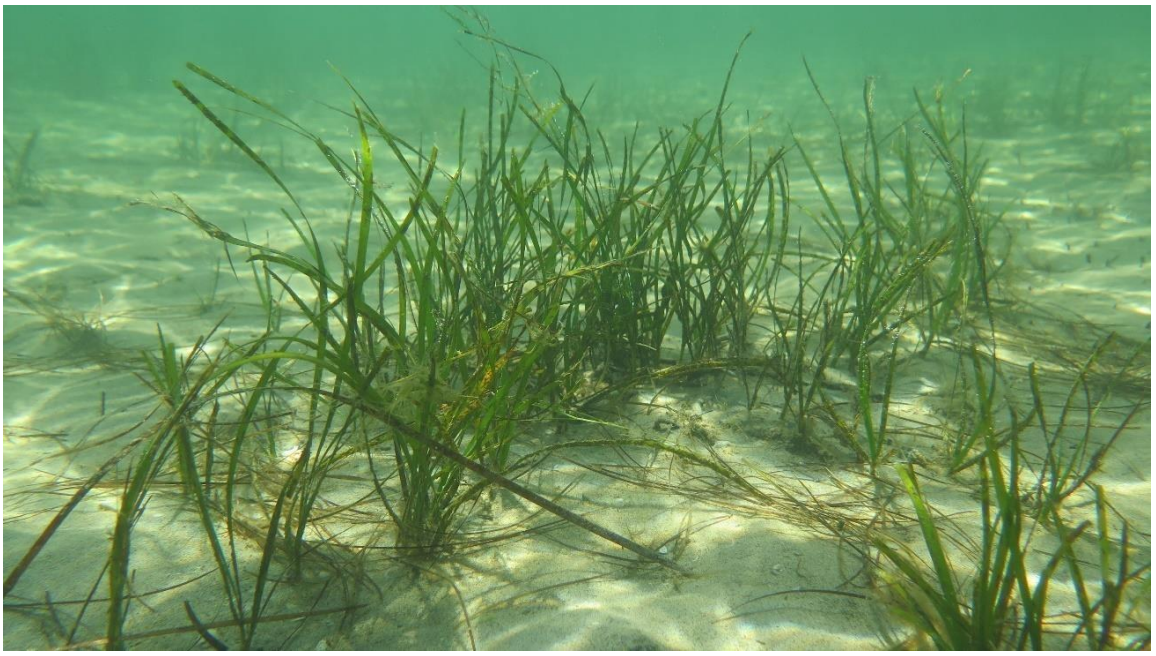


***Figure 4-13**. In the Panzano Bay, the Project involved the execution of two pilot transplantations of* Cymodocea nodosa *of the extension of some 200 sq. meters.*

The monitoring campaigns planned during the project (activity 3 of WP 3) had different purposes.

The first objective envisaged control campaigns, on the same points as the preliminary survey of WP 3.1, to verify the possible existence of significant factors of variability over time in the natural meadows.

It was not, as we have already said, an intensive series of investigations on the phenology, coverage, and biometric parameters of the existing marine seagrasses; some basic parameters have been identified to highlight significant mid-term deviations and to verify the overall stability of the stands.

Results point out that the comparison of the data collected during the monitoring campaigns in 2020, 2021 and 2022 with those collected during the preliminary survey (2019, WP 3 activity 1) showed, at the Panzano Bay, some differences between the parameter values. These differences were probably due to different sampling periods, phenological cycles (growth rate and spread, reproductive season, etc.) of the seagrass species (*Cymodocea nodosa*, *Zostera noltei* and *Z. marina*), and water depths. However, no anomalies were found.

During all monitoring campaigns (and the 2019 preliminary survey), a general visual assessment in the monitoring areas showed the absence of (filamentous) macroalgal blooms and alien species and, considering the abundance of epiphytes, the dominance of the encrusting layer (mainly represented by red calcareous algae) highlighted a positive condition of the quality status of seagrass meadows (as reported in literature).

Concerning human disturbance and the evidence of mechanical pressures, some fishing-nets, fixed to the sea bottom by poles, were observed only during the preliminary survey in 2019 and the 2020 monitoring campaign.

The second objective was to check the progress of marine seagrasses transplantations within the project schedule. It is known that a full evaluation of the results of these environmental restoration actions should take more time (Calvo *et al*., 2020). In this regard, it is important to underline that the partners responsible for the areas that hosted these interventions have declared themselves available to continue the checks of the transplantation plots over time, in the spirit of keeping alive the attention on the importance of the actions tested and pushing their interest in the various stakeholders.

The transplantations of *C. nodosa* carried out at the Monfalcone site showed that a fundamental condition is represented by seasonality. It turned out that spring transplantation, compared to autumn one, allows a rapid and immediate development of the rhizomes and of the root system in a favourable moment for the plant, which is characterized by strong seasonality, being a marine seagrass of sub-tropical origin.

Figure 4-14*. Two different techniques were applied for transplanting: sods and cuttings. In the foreground, the upper part of a sod is still clearly recognizable after about a year from its planting on a bare bottom with numerous recently developed shoots enlarging from the sod. The presence of new shoots outside the sod shows the positive outcome of transplantation due to the rapid growth of the rhizomes*

The control at the end of summer 2021 showed a strong colonization which showed high densities and coverages outside the limits of the transplanted sods. Considering the exposure of the area to the north-east winds, which have a high impact on these shallows, the cuttings method, although already favourably

Table 4-1. *Sods and Staples survival rate (monitoring campaigns of January 2021, September 2021, and May 2022).*

		Monitoring campaigns		
		January 2021	September 2021	May 2022
First pilot transplantation (carried out in **September 2020**)	Sods survival rate (%)	95	50	50
	Staples survival rate (%)	(*)	< 10	0
Second pilot transplantation (carried out in **April 2021**)	Sods survival rate (%)	-	100	90
	Staples survival rate (%)	-	70	50

(*) The small leaf size of *Cymodocea nodosa*, due to the slow growth during the winter months, made it more difficult to identify them, so it was not possible to confirm their presence or absence.

A further objective was to verify the effectiveness of the buoy field installed. This aim was pursued both by verifying the propensity of boaters to anchor on these buoys, and by checking whether the new buoy field resulted in a lower impact from anchoring on the meadows.

Repeated checks were carried out over time, with on-site inspections or checks from shore, to take note of the number and type of boats that moored at the buoys, any damages to installed equipment, and frequency and duration of mooring.

Table 4-2. *Data collected related to the buoys field in the Bay of Panzano (Monfalcone) site.*

	Panzano Bay (Monfalcone)
Species involved	*Cymodocea nodosa*
Meadow in buoy area	At the edge (50 m)
Buoys number	30
Boat dimension target	Up to 12 m
Daily use of buoy (aver. est.)	6 (averaged) / 16 (weekends)
Warnings or disincentives to anchor on meadows	NO
Persistence of free anchoring nearby	YES
Damages occurred to buoys	2 poles driven slightly damaged

Figure 4-15. *In the Bay of Panzano, the monitoring of surveying stations and transplantation plots were carried out by means of a support boat which, in addition to allowing the sites to be reached by means of a GPS navigation system, allowed the transport of operators and equipment, also performing the fundamental function of surveillance and safety in accordance with the procedures developed with the competent marine authorities*

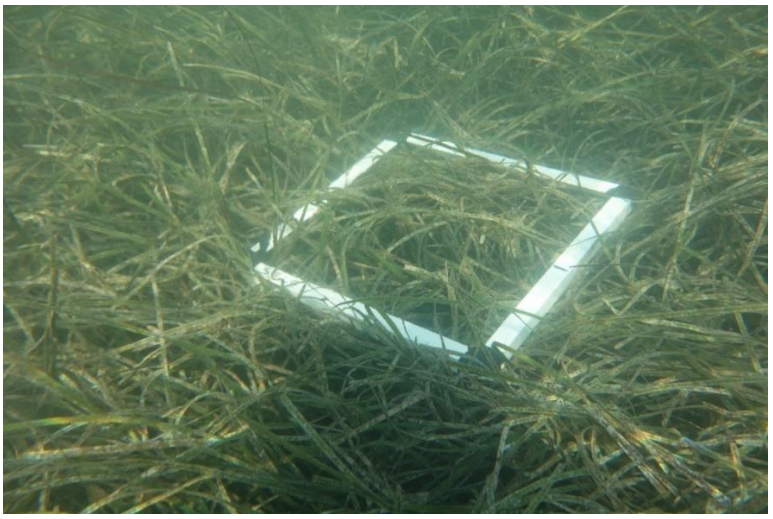


Figure 4-16. *In the monitoring protocols of marine seagrasses, the estimation of shoot density is included among the various biological indicators. In the case of the Panzano Bay, where the species to be monitored is almost exclusively* Cymodocea nodosa*, the method includes, with several replicates, counting the shoots inside a quadrat arranged on the meadow with random mode.*

Figure 4-17. *The monitoring included the verification of marine seagrass coverage to highlight any retreat phenomena.*

5. SASPAS CASE STUDY 2: KORNATI NATIONAL PARK

The different preparation steps of activities (permit requests, stakeholders' involvement, and choice of sites) and the implementation of the concrete activities (seagrass transplantation, monitoring, and buoys laying) are described in the following paragraphs.

5.1. Preparing SASPAS activities in Kornati National Park

5.1.1. Choice of sites

The morphological and landscape context of Park Kornati changes dramatically compared to the site of Monfalcone in the Upper Adriatic Sea. The archipelago of the Kornati Islands is the island district with the largest number of islands in the Mediterranean Sea, composed of 147 islands, islets and large rocks.

Like much of the Dalmatian coast, the archipelago has in common with the Istrian coast a mainly limestone and jagged rock structure, with numerous bays and inlets at times very deep and sheltered.

Kornati NP is characterized by the presence of two easily identifiable coast types:

- a vast area of the park, where the depth of the seabed increases rapidly and the exposure to winds does not allow anchoring; in these areas, the seabed and the seagrass meadows are in excellent natural conditions;
- numerous sheltered and very sheltered sites where anchorage actions cause a significant impact, including the eradication of marine seagrasses and consequent degradation and loss of species and habitats.

For these reasons, two typologies of monitoring areas positioned on *P. oceanica* meadows have been considered: the first one is the "Anchoring site" (in the sheltered Kravljačica Bay), where anchoring pressures occur, and the second one is the "Diving site" (located between Borovnik island and Balun Island, an area quite exposed to the open sea) where diving boats frequently anchor only for authorized diving activities.

For the first transplantation operation, the host site was identified in Kravljačica Bay (in "the Anchoring site), characterized by evidence of a frequent presence of anchored boats. The second transplantation was located at Anica Bay, on the nearby island of Levrnaka, where meadows of *P. oceanica* are partially destroyed due to many years of uncontrolled anchoring.

Figure 5-1. *At Kornati National Park, in Dalmatia, six stations have been chosen within a protected bay, characterized by considerable tourist-nautical pressure; the remaining three stations have been identified in an open position, in a more exposed site, preferred for the mooring of support boats for sport diving.*

The eco-buoy fields (for the anchoring system) were placed in four locations (10 buoys in each area): Kravljačica Bay, Tomasovac Bay, Strižnja Bay and Šipnate Bay.

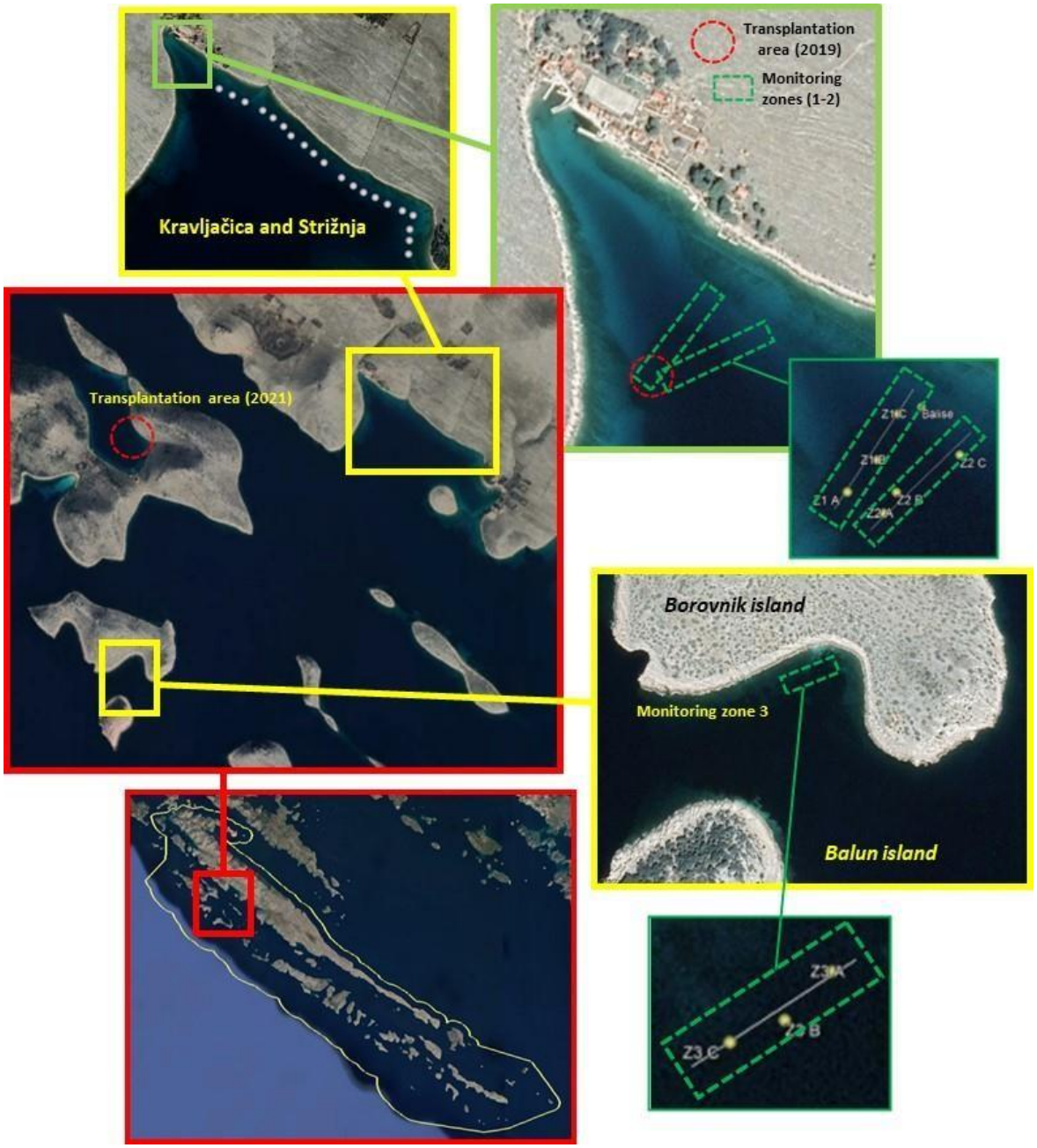


Figure 5-2. *Kornati NP: location of the the pilot seagrass transplantation areas and of the monitoring zones.*

Figure 5-3. *Kornati NP: location of the buoys' fields.*

5.1.2. Stakeholder and Decision Makers identification

The project and specific concrete actions were based on the involvement of local, regional and national public Authorities, protected areas/natural heritage Management Bodies, associations, NGOs, as well as education and training organizations, universities, and research institutes. Managers of protected areas, local, regional and national public bodies, environmental associations, and NGOs, as well as the general public, will mostly benefit from project activities.

Media relations and scientific publications, as well as events, were dedicated primarily to these Target Groups, which were reached by press releases and conferences, articles published in specialized magazines, targeted flyers, brochures, and posters; one event for each location was performed at project conclusion.

A participatory process with the inclusion of stakeholders was foreseen in the spirit of the Project. For this reason, the Park has developed an operation of continuous informal daily contacts with associations, boat brokers, marinas and other interested parties, which has been rewarding for spreading attention to the valuable habitats to be protected. The Park also had a great need to implement eco-buoy fields to receive the numerous visitors in a compatible manner.

Stakeholders were included in all project phases, with particular emphasis on the Digital Information Platform (DIP) and the development of a Marine Seagrass Safeguard Integrated Management Program, which is particularly useful in the prospective of the Park. They will have reserved access to advanced consultation services to the DIP and will be involved in all the phases of the management program development.

5.1.3. Permits and authorizations

In 1996, the Kornati National Park Public Institution first started the process of setting up an anchoring system ("buoy") intended for mooring visitor vessels in the Park area. The basic idea of the Public Institution was to install a suitable number of anchorages in the appropriate bays inside the Park area and subsequently to completely prohibit free anchoring in the Kornati National Park.

The advantages of establishing such an anchor system are:

- preserved biocenosis of the seabed in the bays where visitors enter with their vessels;
- the maximum number of vessels per day in the Park area is determined and regulated;
- designated locations where visitor vessels may be confined;
- improving navigation and mooring safety in the Park area.

Following the decision to install the anchor system, the Kornati National Park Public Institution went through the process of collecting the necessary documentation and permits, which included the following steps:

- preparation of the study of anchorages and moorings to determine the number of anchor systems in the park area and potential locations for their installation;
- harmonization of the Spatial Plan of the Kornati National Park (OG 118/2003) together with the Ordinance on Internal Order in the Kornati National Park (OG 141/2010 and 53/2011) which enable the installation of anchor systems in the Park area;
- preparation of the Preliminary anchor systems design for each bay in the Park in which their installation is planned, made based on the Study of anchorages and moorings;
- obtaining location permits;
- obtaining a concession;
- announcing a tender for the public procurement of anchoring systems.

Anchor location selection

Before starting the process of obtaining the necessary permits to install an anchorage system, it was necessary to prepare a study of anchorages and moorings. This study should be an expert basis that defines the spatial scope based on numerous characteristics such as meteorological, traffic navigation, maritime safety measures, and technical methods of anchoring and proposes the number of anchorages and the locations for their installation at the proposed area.

For this purpose, the Public Institution commissioned the Study of Anchorages and Moorings in the Kornati National Park to "Rijekaprojekt" d.o.o in 2007.

Spatial planning documents

According to the Spatial Planning Act (OG 153/13, 65/17, 114/18, 39/19, 98/19, hereinafter: the Spatial Planning Act), the maritime area is planned:

1) National Spatial Development Plan;
2) Spatial plan of the protected ecological and fishing area (Spatial plan of the ZERP);
3) Spatial plan of the continental shelf of the Republic of Croatia;
4) spatial plans of national parks and nature parks covering the marine area;
5) spatial plans of counties that cover the maritime area and spatial plans of cities, ie municipalities;
6) general urban plans and urban development plans covering the maritime area.

According to the Spatial Planning Act, within the Protected Coastal Area of the Sea Anchorages, nautical touristic ports should not be planned outside the construction area of the restricted areas. Boundaries and restriction areas are plotted on the Croatian Basic Map (HOK), supplemented by orthophoto maps.

The Spatial Plan of the Kornati National Park (OG 118/2003), together with the Ordinance on Internal Order in the Kornati National Park (OG 141/2010 and 53/2011), enables the installation of anchor systems in the Kornati National Park.

The procedures for assessing the potential impacts resulting from the eco-buoy fields, the Natura 2000 network and the permitting process are described in detail in **Annex 4**.

5.2. Implementation of SASPAS activities in Kornati NP: transplanting, monitoring and buoys positioning

5.2.1. Transplantation of *P. oceanica* plants

In NP Kornati, two pilot transplantation campaigns were carried out: the first in October 2019 and the second in October 2021. *P. oceanica* transplantation were carried out using two different manual techniques (see paragraph 3.2.2).

For the first transplantation (using technique n. 1), two plots (10 m x 10 m each) were identified as acceptor areas in Kravljačica Bay (the "the Anchoring site"). These plots were characterized by the absence of seagrasses or very low meadows coverage values and the evidence of the frequent presence of anchored boats. The meadows used as donors were those in an area located between Borovnik Island and Balun Island ("the Diving site") (Figure 5-4).

The transplantation technique that SASPAS has decided to use comes from the Palermo school (Calvo et al., 2014). For this purpose, the *Biosurvey* company was commissioned, which has developed a very interesting method that builds on previous techniques but optimizes the intervention procedures in two main directions:

- on the one hand, it uses biodegradable plastic supports (Mater-b, a biodegradable and compostable bioplastic) with a modular structure;
- on the other hand, it permits simple operations thanks to the lightness of the materials. It provides for a large part of the work on land or on board, limiting underwater activities.

***Figure 5-4**. Host (= Anchoring site) and donor (= Diving site) sites in Kornati National Park.*

Altogether, 12 patches composed each of 6 supports, 720 cuttings and about 2160 shoots were placed, at a depth of -11 m, in the Kravljačica Bay, for a total of about 200 square meters.

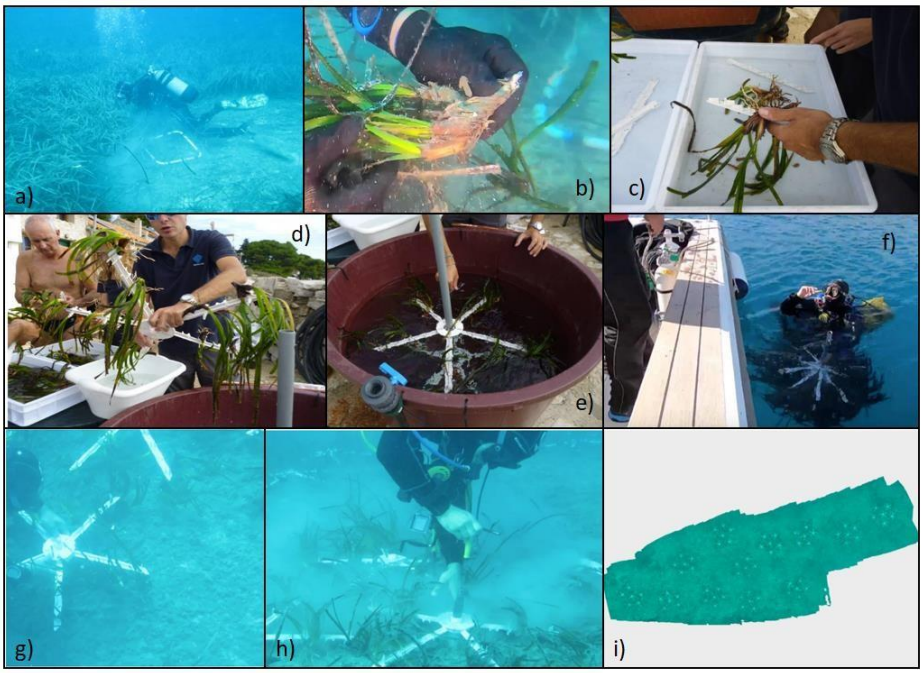


***Figure 5-5**. The pilot transplantation procedure carried out in NP Kornati: a) identification of the donor meadow (- 15 m); b) harvesting of* P. oceanica *cuttings; c) and d) fastening of cuttings to the biodegradable staple arms and assembly of the star-shaped support once back on the ground; e) temporary storage of planting units in plastic containers filled with seawater; f) transport of the planting units to the acceptor site; g) and h) fixing of the planting units to the picket; i) photo-mosaic of the reforestation pilot plant.*

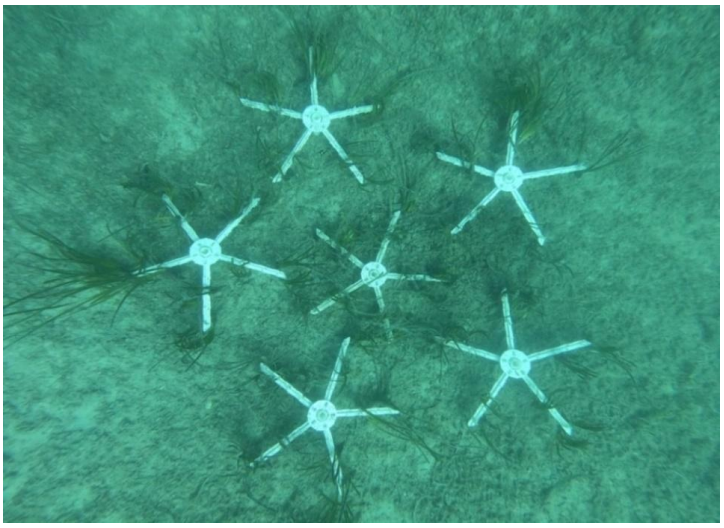


***Figure 5-6**. Surface view of six star-shaped biodegradable supports (= 1 module emulating a meadow patch), with fastened P. oceanica shoots, fixed to the bottom sediment at NP Kornati.*

For the **second transplantation** (using technique n. 2), the two areas chosen for the collection of cuttings of *Posidonia oceanica* and subsequent planting were both located at or nearby Anica Bay, on the island of Levrnaka. Due to many years of uncontrolled anchoring, meadows of *P. oceanica* at Anica Bay are partially destroyed, settled on dead matte with discontinuity and low density (Figure 5-7 and Figure 5-8).

This technique was adopted as it involves the use of degradable materials (wooden supports and biodegradable plastic cable-ties) and, in perspective and with the necessary training, allows the park institution to operate autonomously for similar interventions.

***Figure 5-7**. Transplantation and donor areas on the island of Levrnaka.*

The plant scheme inside the transplant area has positioned 25 nuclei, each formed by 8 wooden bases (Figure 5-11). It gives a nucleus with sufficient density to start a centrifugal colonization thrust and thus to obtain a meadow effect in perspective, which increases as the various nuclei come into contact each other.

A total of 200 wooden basis were placed, on which approximately 800-900 cuttings were mounted. The 25 nuclei were placed to cover a surface of about 200 m².

***Figure 5-8**. Collection of* Posidonia oceanica *cuttings.*

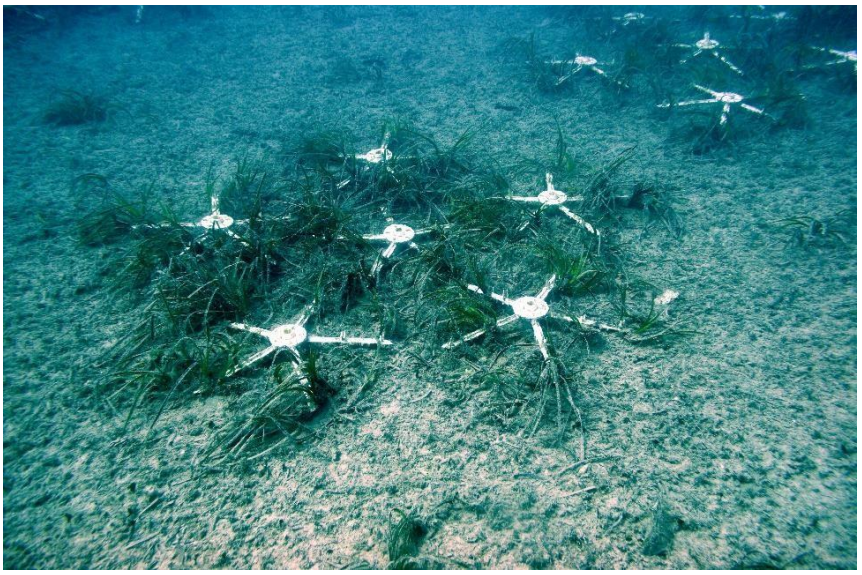


Figure 5-9. *The transplant operation carried out at the Kornati Park was aimed at evaluating the effectiveness of the method in a disturbed context such as the protected bay, where numerous boats moor a few meters from the shore to stay overnight, with the result of a continuous movement of the bottom, uplift of the sediment and physical disturbance by anchors and chains. The transplant plots were protected by appropriate signaling buoys that have blocked boat access, but the conditions of considerable sedimentation are visible and have been used as a pressure element to be taken into account in the controls.*

Figure 5-10. *In addition to the project main actions, the collection of wastes on the sea bottom was also included in the activities at the Kornati Park site, with appropriate frequency.*

Figure 5-11. P. oceanica *cuttings fixed and ready for transport to the host area*

5.2.2. Buoy positioning

The impact of the planned intervention on the existing state of the environment

As part of the implementation of anchoring sites in the aquatorium of the Kornati National Park, it was planned to install a total of 40 anchoring points with buoys for boat mooring. The JLD type (Manta Ray) or equivalent were intended for anchoring. During the installation of anchors, it was certain that a negligible impact on marine sediment was possible during the shooting of materials into the seabed. However, this impact was short-lived and spatially limited, and the marine environment was thought to return to its original state within 24 hours of completion. It is important to emphasize the advantage of anchors over traditionally used concrete blocks for anchoring ships. The impact of such a new system is negligible both on the seabed and seagrass beds of *Posidonia oceanica* and other protected species.

During the installation and later exploitation of the anchorage, there is no contact and thus no damage to the vegetation cover, as is the case with concrete blocks. The elements of the anchor system must also be taken into account, and a solution was chosen that ensured that the anchor chain did not touch the seabed even during the lowest water level.

Furthermore, no structures were envisaged on the coast, nor will any other works be undertaken for anchoring needs. Therefore, no environmental impact was expected on the mainland part of the aquatorium locations in question.

Since the Kornati National Park area is under a strict protection measure, implementing the anchor system in the manner described above is the only environmentally friendly solution. Moreover, installing buoys for mooring prevents anchoring "in the wild", thus endangering the vegetation cover on the seabed.

With this new system, eliminating the turbidity produced by the operations of lowering and hauling the anchors, including dragging the chains on the seabed, must also be considered.

Figure 5-12. *Among the main actions of the Project, the installation of eco-friendly buoys aimed at avoiding the use of their anchors by leisure boats, is the most significant. Specifically, in the Kornati Islands, 40 eco-friendly buoys were installed on four location of the park, 10 each, which allowed mooring in the summer months of boats up to 16 m in length.*

The buoy laying area

The location selected for the installation of the environmental-friendly buoy fields are (Figure 5-13):

Location (according to Kornati NP Spatial Plan)	**Aquatorium area defined by boundary points**	**Anchorage-system design**
Kravljačica Bay	20.278,75 m^2	For boats up to 16 meters (circular anchorage)
Tomasovac Bay	24.375,50 m^2	
Strižnja Bay	19.033,96 m^2	
Šipnate Bay	17.205,26 m^2	

KRAVLJAČICA BAY

According to the Spatial Plan of the National Park "Kornati", anchorages were placed on the Kravljačica bay - anchorage for 10 boats up to 16 meters (circular anchorage). Anchorage is located on the south side of the island of Kornat, where the Kravljačica bay is located.

TOMASOVAC BAY

According to the Spatial Plan of the National Park "Kornati", anchorages were located on the Tomasovac bay- anchorage for 10 boats up to 16 meters (circular anchorage). Anchorage is located on the south side of the island of Kornat, where the Tomasovac bay is located.

STRIŽNJA BAY

According to the Spatial Plan of the National Park "Kornati", Anchorage was located at the Strižnja bay-anchorage for 10 boats up to 16 meters (circular anchorage). Anchorage is located on the south side of the island of Kornat, where the Strižnja bay is located.

ŠIPNATE BAY

According to the Spatial Plan of the National Park "Kornati", Anchorage was located in the Šipnate bay - anchorage for 10 boats up to 16 meters (circular anchorage). Anchorage is located on the south side of the island of Kornat, where the bay of Šipnate is located.

Figure 5-13. *Location of the selected sites in Kornati NP for positioning the environmental-friendly anchoring system. From N to S: Tomasovac Bay, Šipnate Bay, Kravljačica Bay and Strižnja Bay.*

Choice of buoys

It was planned to anchor yachts up to 16 m long at the berths in question. The distance between buoys is at least 30 m. Vessels are anchored with the possibility of sailing around the buoy depending on the wind direction. It is calculated that the wind will act on all ships equally and turn them in the same direction. The anchor system includes sizing all elements of the anchor system according to the categorization of the vessel.

Considering stopping the use of large concrete blocks and anchoring chains that negatively impact the environment, especially the seabed, the Manta Ray underwater system was preferred and specifically modified and adapted as follows (Figure 5-15 and Figure 5-16).

The anchorage consists of the following elements:

1) drilled underwater folding anchor;

2) anchor rope;

3) smaller submerged buoy, as a jumper;

4) anchor chain;

5) anchor rope;

6) anchor buoy.

The Manta Ray system is used for anchoring boats on the seabed (geomechanical anchors). This system can also be applied in anchoring on loose sediment, both on sandy or gravelly bottom, as a replacement for a concrete anchor block.

Anchors are composed of the following elements: anchor foot, coupler, pin and pull bar. The specific type and dimension of pins were chosen according to the type of sediment in which the anchors were placed and considering the traction force given by the mooring yacht.

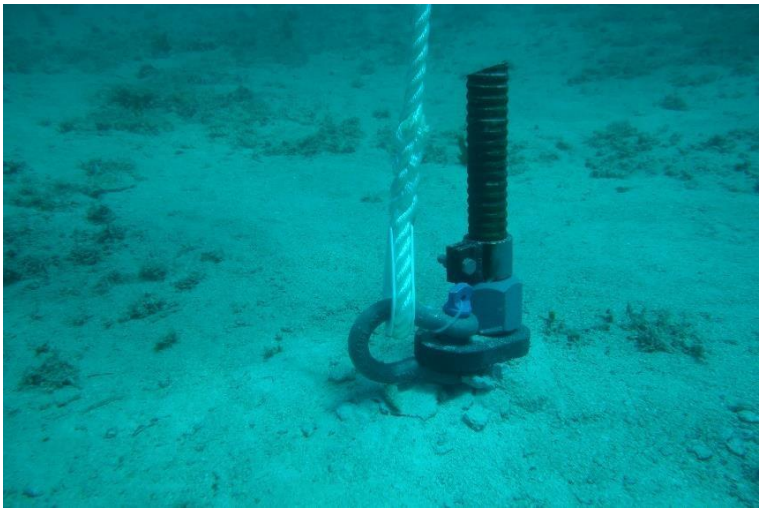


***Figure 5-14**. Anchor pin fixed in the bottom rock.*

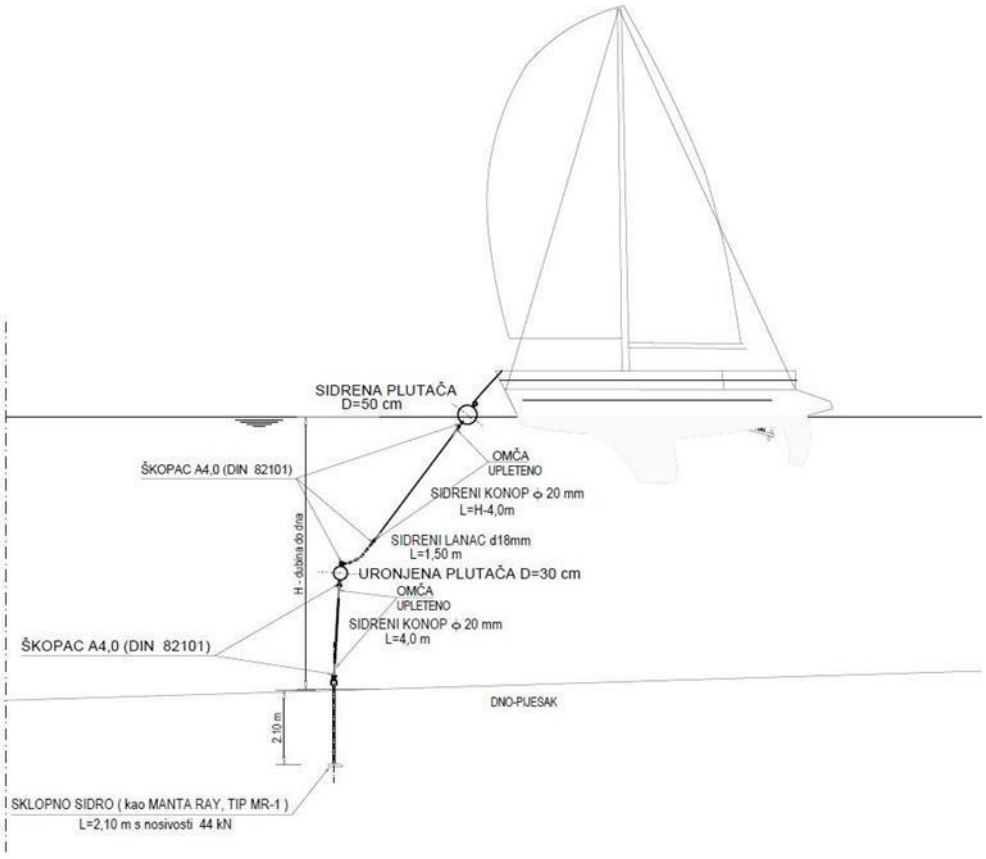


***Figure 5-15**. Anchoring scheme.*

Considering the geological structure of the surrounding area, as well as the slope and depth of the seabed, it is assumed that the bay has a sandy bottom mixed with clay and powder. According to the manufacturer's table of Manta Ray anchors for this type of soil and load, the anchor MR-1, length = 2.10 m with a load capacity of 44 to 66 kN was selected. After simultaneous drilling and installation of the anchor, a control test of the bearing capacity of the anchor was performed using a press with a dynamometer on site. In case the anchor did not show sufficient load capacity, another was placed on the train, or the type of anchor was changed. According to the situation, it was placed exactly in the previously pinned places at the bottom.

To prevent scratching of the chain on the seabed, a submerged floating-buoy (jumper) with a 30 cm diameter was inserted between the seabed and the surface buoy. A 1,50 m long anchor chain was installed above the jumper, connected by a floating clamp on one side and an anchor rope on the other. The role of the anchor chain is to ensure elasticity and thus durability of all movable elements of the anchorage exposed to constant movement due to the influence of wind and waves.

A synthetic rope was used for anchoring which does not float on the sea, causing danger of entanglement in the vessel's propellers. Polyamides (nylon) and polyester (telon, dacron, terylene) rope were most used.

The rope size was determined according to that of the ship and the maximum load with a high safety factor due to the wear of the rope and the knot tied.

The length of the anchor rope above the anchor chain depended on its depth, and a value of 4.00 m less than the depth of the anchor point in question was adopted. Stainless steel rods of appropriate cross-section (depending on the thickness of the rope) were inserted into the ends. The ends of the braids are heat-treated to prevent stratification of the rope. A buoy buckle connected the anchor ropes. The anchor buoy is 50 cm in diameter, ball-shaped, and made of PVC resistant to UV radiation and all-weather conditions. A 16 mm diameter rod with an alcove diameter of approx. 150 mm at the top and a 40 mm diameter alcove at the bottom pass through the buoy along its entire length.

Buoys are marked on three sides in the upper hemisphere with the logo and inscription of the Concessionaire, the maximum size of the ship, and signs that reflect light for easier mooring in the dark. All markings are resistant to wear and UV rays.

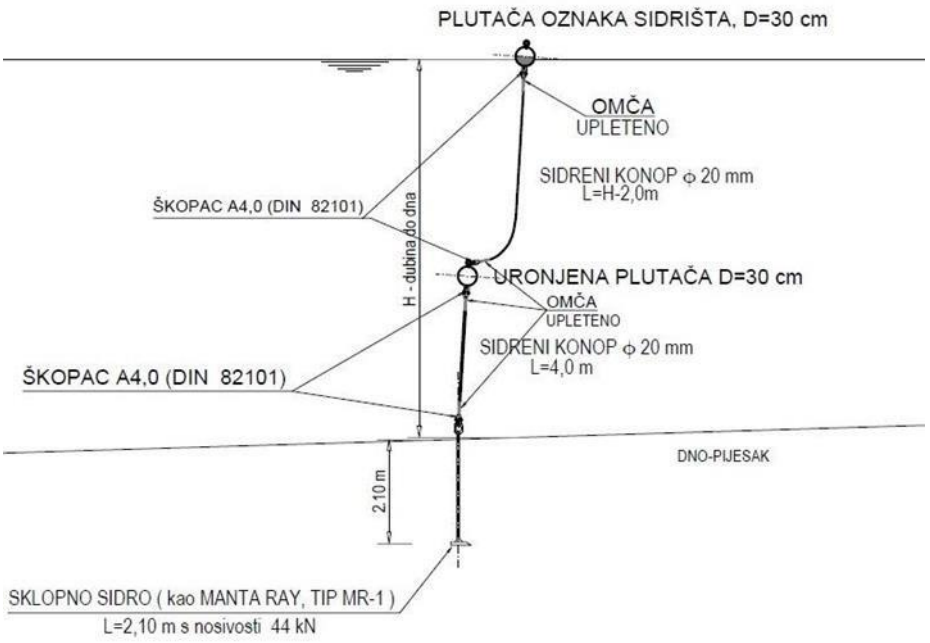


***Figure 5-16**. Scheme of anchoring structure.*

5.2.3. Monitoring campaigns

As for the Bay of Panzano site, the results of the preliminary survey (activity 1 of the WP 3) showed that considering the marine seagrasses meadows, the main specific disturbances in the Kornati Park seemed to be related to the presence of anchoring. In particular, it was possible to identify a site where *P. oceanica*

meadows were more impacted by the anchoring pressures (Anchoring site) and one that was less affected by them (Diving site). No anomalies were found related to the composition of benthic communities.

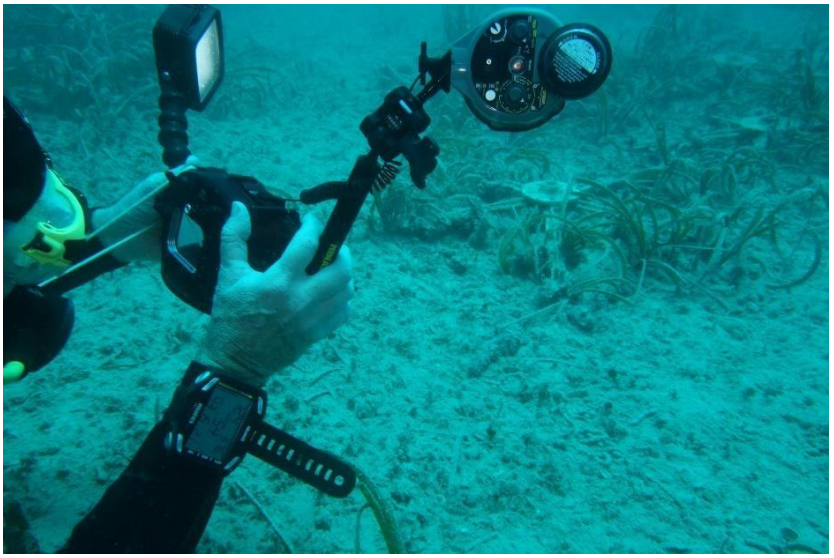


***Figure 5-17**. The Project included numerous moments of verification of the quality status of marine seagrasses through specific SCUBA dive sessions. In these monitoring campaigns, in addition to acquiring general environmental data, ample space was also devoted to photographic documentation and video-recordings which will be used to evaluate the results of transplants, the efficiency of eco-friendly buoy systems and, more generally, to disseminate experiences.*

The results of the DPSIR analysis (WP 3.2) showed how the coast that descends from Istria to Dalmatia well represented by the site of the Park. It consists of a rocky littoral, with rocky or pebble beaches and rocky or coarse sandy bottom, being scarce or absent at all the river inputs and having a quite clear water column. The coast attracts an impressive tourist flow that includes a large fleet of pleasure boats that anchor for the night in the various bays staying for several days. This also occurs especially in the Park, where up to now, the protection policies do not presently include particular attention to the *P. oceanica* habitat.

The conditions of *P. oceanica* populations in the Park are good, except for the numerous bays where the pleasure boats drop anchor. The average size of these boats, the frequent use of chain catenary, the spillages and the sewer result in a strong disturbance against the meadows, which show retreatment estimated over 50% in these minor embayments.

The monitoring campaigns planned during the project (WP 3.3), on the same points as the preliminary survey, highlighted how, at the Kornati NP, the comparison of the data collected during the monitoring campaigns carried out in 2020, 2021 and 2022 with those collected during the preliminary survey (2019) showed some changes in the mediocre values of the main parameters. In particular, the meadow conservation status changed from MODERATE to POOR in the “Anchoring site” and from GOOD to

MODERATE in the “Diving site” due to the decrease recorded (compared to 2019) in the coverage percentage. However, data analysis showed no changes in the ecological conditions of the meadow (BAD in the “Anchoring site” and POOR in the “Diving site”), and the analysis of balises highlighted stable meadow conditions, as signs of retreat were not recorded. Some denser patches of *Posidonia* were observed.

As for the site of Panzano bay, during all monitoring campaigns (and the 2019 preliminary survey), no (filamentous) macroalgal blooms and alien species were found and, considering the abundance of epiphytes, a positive condition of the quality status of seagrass meadows was related to the dominance of the encrusting layer (mainly represented by red calcareous algae).

Concerning human disturbance and the evidence of mechanical pressures, at the “Anchoring site”, signs of disturbance and some litter on the seabed were reported (bottles and cans plastic containers). At the “Diving site” (Zone 3), the meadow was continuous with low sedimentation and no visible signs of disturbance; only a few points were devoid of meadow, possibly due to anchoring (anchors and chains).

Considering the success of marine seagrasses transplantations within the project schedule, for the *P. oceanica* transplantation in Kravljačica Bay, it can be affirmed that, from a technical point of view, the tests carried out showed good results, at least in the project small time scale. The plots realized (the first dates back to 2019) are still in good condition, and about 65% of the installed cuttings are growing, while the remaining 35% showed different degrees of degradation or had completely disappeared. On Kornati Island, the transplantations carried out did not suffer significant physical damage at all. However, they are affected by a condition of strong sedimentation, which harms the canopy of the transplanted cuttings (Figure 5-18) and the natural adjacent patches.

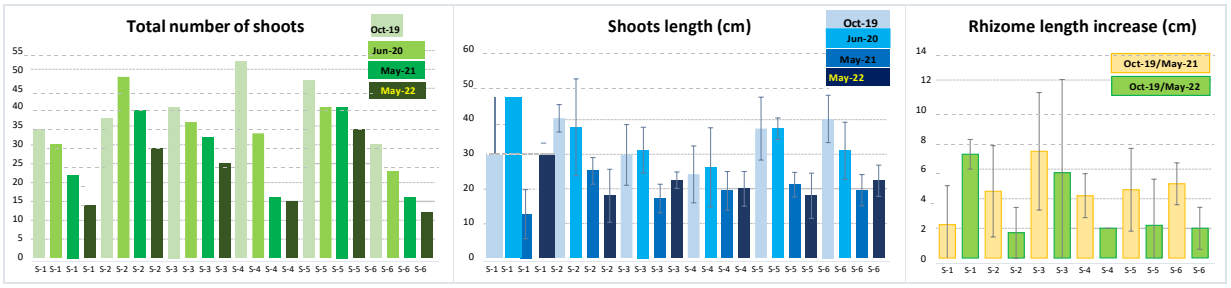


Figure 5-18. *Total number of shoots, average values of shoot length, average values of rhizome length increase of the 6 monitored support (S-1, S-2, S-3, S-4, S-5 and S-6) in October 2019, in June 2020, in May 2021 and in May 2022.*

The characteristic of Park Kornati is that of an archipelago that offers numerous shelters and has small inlets where the anchoring, even overnight, of numerous pleasure boats is an element of strong pressure against the meadows that often reach almost to the surface in the best and healthy cases. These small embayments behave as sedimentation basins, also due to continuous mooring, anchoring, boat movements.

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

As for the Monfalcone –Panzano bay site, a further objective was to verify the effectiveness of the buoy field installed. This aim was pursued by verifying boaters' propensity to anchor on these buoys and checking whether the new buoy field resulted in a lower impact from anchoring on the meadows.

The first activity consisted of repeated checks over time, with on-site inspections or checks from shore, to take note of the number and type of boats that moored at the buoys, any damages to installed equipment, and frequency and duration of mooring.

Table 5-1. *Data collected related to the buoys field in the Kornati NP site.*

	Kornati N.P.
Species involved	P. oceanica
Meadow in buoy area	Outside (100 m)
Buoys number	40
Boat dimension target	Up to 16 m
Daily use of buoy (aver. est.)	18 (averaged) / 32 (weekends)
Warnings or disincentives to anchor on meadows	NO
Persistence of free anchoring nearby	NO (free anchoring is present in nearby bays, but not where buoys are located)
Damages occurred to buoys	5 buoys damaged (buoy hooks broke or buoys sank)

Figure 5-19. *Special markers (balises) were positioned to check any retreat or increase of the meadow patches limits.*

Figure 5-20. *International monitoring protocols of* Posidonia oceanica *include, among other indicators, control of the lower and upper limits of the meadows or of the single patches, in order to verify whether setbacks, conditions of stability or surface increases occur over time. The protocol includes the installation of some markers (balises) along the limit of the meadow which will be inspected in time and photographed with a standardized method.*

Figure 5-21. *A balise is visible after a year of stay at the sea-bottom, partially colonized by fouling. A reasonable stable condition of the lower limit can be inferred. Their disappearance or overturning near the limit may also suggest the presence of trawling pressure or anchoring.*

6. SASPAS CASE STUDY 3: REGIONAL NATURAL PARK OF DUNE COSTIERE FROM TORRE CANNE TO TORRE SAN LEONARDO (OSTUNI-FASANO)

Activities for permit requests, for stakeholders' involvement, and for the choice of the pilot sites are reported in the following paragraphs, together with description of implementation of Project concrete actions.

6.1. Preparing SASPAS activities in RNP Dune Costiere

6.1.1. Choice of sites

As opposed to what was found for the other sites, in the RNP Coastal Dunes, despite the significant number of berths in the marinas, observations carried out and information acquired (DPSIR analysis – WP 3.2) significantly suggest that marine seagrass rarefaction due to summer anchoring boats on the meadows is a minor impact on this area. In fact, marine seagrasses coverages show only limited disturbances attributable to yacht anchoring, which mainly occurs very close to the shore on the unvegetated sea floor.

As an overall view, the site examined along the Brindisi coast of Ostuni represents, therefore, in the context of the Project, an intermediate situation, in terms of anchorage disturbance, between what was detected in Monfalcone and in Kornati Park.

The data collected with the activity of WP 3.2, in fact, show a low propensity for boaters to anchor in the area previously indicated as suitable for eco-buoys as part of the management plan of the Natura 2000 site. The entire coastline included in the RNP Coastal Dunes has small extensions of shoreline, with sandy sediments, in front of dune structures in varying degrees of conservation. In most cases, considering the data collected, these beaches are undergoing a progressive reduction in amplitude due to erosive phenomena. These also seem to have effects on the underwater populations, highlighted by a notable increase in the dead matte surfaces, as found in the examination of the available information (WP 3.2) and directly observed during the preliminary survey and monitoring activities (WPP 3.1 and 3.3).

This series of considerations and the existence of some signs of modest criticality - although in a generally positive context - have guided the identification of the Project area, as reported in the following cartography. In this context, preliminary survey stations were positioned, and places to carry out pilot transplantation were defined. In this regard, it should be made clear that the objective of the intervention is not reforestation or large-scale restoration but rather the assessment of the technical feasibility and effectiveness of the most innovative solutions for planting the macrophyte, thanks to a pilot action of limited proportions where specific damages occurred. The Natura 2000 site management plans provide actions and activities that are recognized as necessary for maintaining the species and habitats in the sites in a satisfactory state of conservation. Such interventions are excluded from the Appropriate Assessment procedure (Art. 6 of Directive 92/43/EEC Habitat).

Figure 6-1. *Sampling scheme applied to the monitoring Zones (1-2-3) in the Regional Natural Park of Coastal Dunes and Posidonia oceanica pilot transplantation area.*

The monitoring zones (and stations) were placed in specific sites near the "SAC - Litorale Brindisino", where limited anchoring pressures occur due to the presence of medium-sized boats in an area located at about 400 meters from the coast and the zones were arranged almost parallel to the coastline.

The transplantation area is located near the monitoring zones, inside a discontinuous meadow that shows the upper limit to a depth of 7 m, characterized by the presence of patches of *Posidonia oceanica*, dead matte and sandy bottom. The dead matte distribution is fragmented and partially localized on sub-superficial rocky states.

In the preliminary phase of the SASPAS project, thanks to a desk GIS activity and a preliminary survey, the general conditions of the coastal area and the seagrass meadows and zoobenthic communities were

examined. In particular, the area's distribution of macrophytes and associated biocenosis was analysed, referring to the documentation available, especially on the Puglia Region[6] website.

Also, information not only specific to *Posidonia oceanica* but also related to the coralligenous biocenosis was acquired, relating to the park's largest area. This basic information has allowed a reasoned and programmed execution of a short initial survey (planned in the Project framework), with the conducting of observations by underwater scientific operators for the choice of monitoring and transplanting sites.

At the beginning of the Project, attention was focused during the preliminary survey (WP 3.1) to:

- identification of appropriate sites for monitoring activities and marine seagrasses transplantation, balancing sufficient depth but not excessive distance from the shore;
- proximity to the upper limit of the meadows, to highlight the survey in the areas generally most threatened by erosion and anthropogenic pressures;

These conditions, considered satisfactory, were observed in the marine sector north of the main logistics base of Villanova, at the beach of the Morelli River, as the seagrass meadows showed sufficient homogeneity for the purposes of the project. In the chosen site's surroundings, it has been verified that there are dead mattes and sandy lenses devoid of vegetation. Some areas show lower density and degree of coverage, together with erosive phenomena, which could be configured as indicators of habitat regression.

The proposed area presents a series of requirements of specific interest for transplantation, which can be summarized as follows:

- availability of adjacent donor meadows in good condition, able to provide sufficient material (about 1000 cuttings) for transplantation with negligible disturbance to the conservation status of the habitat;
- distance from the shoreline is not excessive but, in any case, sufficient to avoid interference with the recreational and bathing use of the beach;
- proximity to the operational base for the planned in-shore phases (selection of plants and equipment for transplantation).

[6] http://www.sit.puglia.it/portale_rete_ecologica/biomap

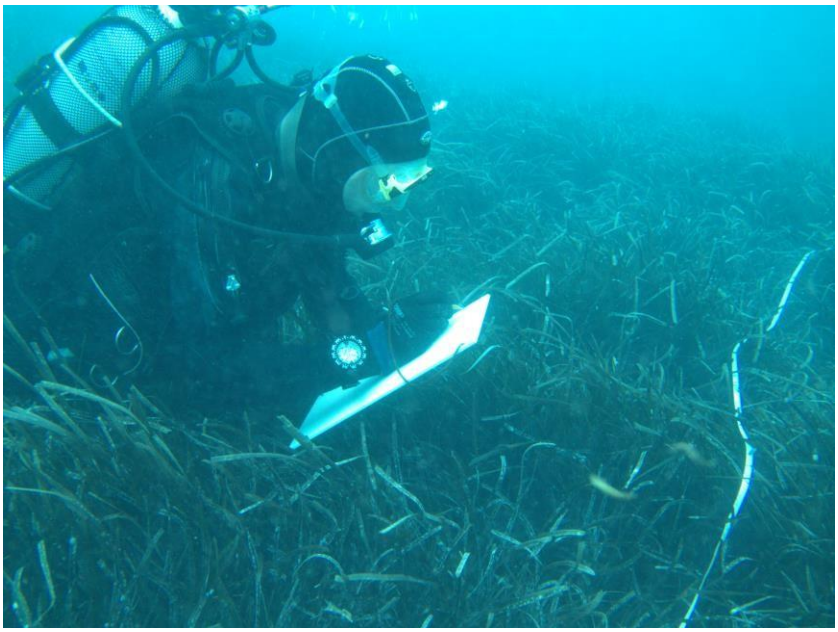


Figure 6-2. *The initial survey, conducted at the site of the Parco Dune Costiere Brindisine on a network of 9 stations, included an evaluation procedure of the P. oceanica coverage that could not be extremely thorough in terms of and long-term dynamics, but which made it possible to characterize the general conditions of the meadows and to identify any phenomena of retreat of the limits of the patches.*

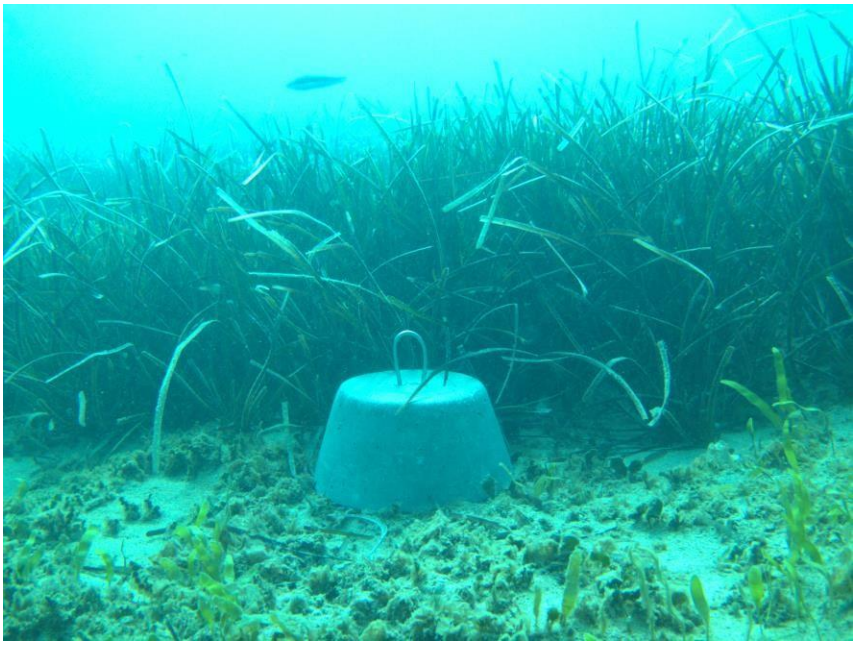


Figure 6-3. *The controls carried out at the site of the Parco Dune Costiere Brindisine by balises showed, in the three years of checks, very scarce limit retreat.*

6.1.2. Stakeholder and Decision Makers identification

Starting from the project's technical activities, the Park identified the Decision Makers and the Stakeholder who can potentially directly or indirectly affect the project and, in general, the management of the *Posidonia oceanica* habitat. Stakeholders were selected during the project implementation through individual meetings in order to understand the needs of the area and the different points of view on the project activities.

In the initial phase, the Park involved the public, local and regional bodies that have direct competence over the area, including the Municipality of Ostuni, the Municipality of Fasano, the Province of Brindisi, the Harbour Office of Brindisi (*Capitaneria di Porto di Brindisi*), the Environment and the State Office of the Apulia Region. These first individual meetings revealed that the impact of recreational craft is relatively low in the pilot area of the RNP Coastal Dunes, as from analyses carried out from the preliminary results of monitoring activities (WP 3.2).

The same bodies were involved and provided support during the implementation phases of the pilot action of transplantation of *Posidonia Oceanica*. Local stakeholders, including local and regional associations and SMEs operating in the area of activities at sea, were involved during the pilot activities and the event with the local and regional authorities. The stakeholders highlighted the need to create more formative events on the balance of the present habitats and, in general, on the marine ecosystem along this littoral.

The Park set up a specific event in the form of a round table between stakeholders and decision-makers in order to assess the implementation and impacts of the SASPAS project and discuss conservation and ecosystem protection actions in the marine area of the Park. For this purpose, the bodies and stakeholders involved have identified the need for increased cooperation at the design stage. At a regional level, this will allow and push the regional technical offices to support activities and coordinate them within the framework of regional technical planning. At the technical level, this will also allow a more streamlined and fast timing during the authorization phase.

6.1.3. Permits and authorization

Regarding the permits and authorizations procedure, the Park contacted all regional and local managers of the maritime domain in order to receive the guidelines for the procedure authorization of the activity. Starting from the consideration that the transplantation activity was in line with the plan of the SAC area, already authorized by the Puglia Region with the Resolution no. 2436 of the Puglia Regional Executive on 15th December 2009, “Final approval of the Management Plan of the Site of Community Importance "Litorale brindisino" (IT9140002)”, the Park did not need any further authorization. Regarding organization and logistics, after a first meeting with the Commander of the Harbour Office of Brindisi, a request to authorize and regulate the implementation of SASPAS practical actions was positively accepted.

The suitable requirements above mentioned (donor meadows, distance from shoreline…), considered satisfactory, were observed in the marine sector north of the main logistics base of Villanova, at the beach

of the Morelli River, where the meadows showed enough homogeneity for the purposes of the project, at least on the bathymetry of interest. In fact, the entire coast of the Park shows substantially homogeneous *Posidonia oceanica* meadows, with an upper limit of approximately 7 meters.

In this regard, the "Consortium for the Management of the Regional Natural Park of the Coastal Dunes from Torre Canne to Torre S. Leonardo" informed the Environmental and Ecology Service of the Province of Brindisi (responsible for the Site of Community Importance "Litorale Brindisino" (IT9140002)), the Ecology Service Office and Planning Office and the Land Planning Service Parks and Biodiversity Protection Office of the Region of Puglia about the more suitable areas identified for the project implementation.

Brief description of the pilot intervention of marine fan transplant in the project site of the Regional Natural Park of the Coastal Dunes from Torre Canne to Torre San Leonardo.

The actions envisaged by the Project included the execution of a marine seagrass pilot transplantation (*Posidonia oceanica*) of limited size, to be conducted a few hundred meters offshore, at about 8 meters of depth. The proposed area presented a series of requirements of specific interest for transplantation, which can be summarized as follows:

- availability of adjacent donor prairie in good condition, able to provide sufficient material (about 1000 cuttings) with negligible disturbance to the conservation status of the posidonietum;
- dead matte bottom, well suitable for optimal rooting of re-implanted cutting;
- not excessive distance from the coast, but in any case, sufficient to avoid interference with the recreational and bathing use of the beach;
- proximity to the operational base for the planned ground phases (selection of plants and equipment for transplantation).

The intervention was carried out by the Spin-off of the University of Palermo Biosurvey S.r.l. through a patented system, based on biodegradable plastic materials described in the ISPRA Manual "Conservation and management of naturalness in marine-coastal ecosystems: the transplantation of the meadows of *Posidonia oceanica*[7]" (ISPRA, 2014).

Activities to be carried out and timing

Two transplantation plots were realized, each of 100 m2. The pilot transplantation activities were carried out, in relation to weather-marine conditions, in the time interval from February 25 to March 2, 2021.

Intervention area

[7] https://www.isprambiente.gov.it/files/pubblicazioni/manuali-lineeguida/MLG_106_2014.pdf (p.47)

The area concerned by the intervention is shown in Figure 6-4. Coordinates represent the two plot sites. Activities at sea were authorised by the Harbour Master of Brindisi (order no. 09/2021).

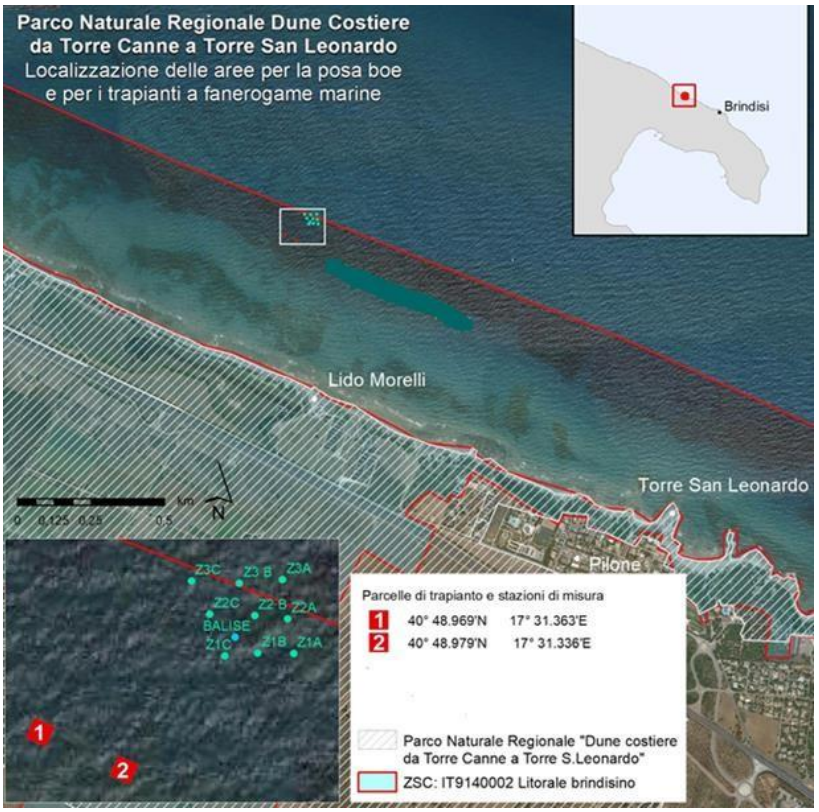


***Figure 6-4**. Selected area for P. oceanica transplanting in RNP Dune Costiere.*

6.2. Implementation of SASPAS activities in RNP Dune Costiere: transplanting, monitoring and biocenotic mapping

6.2.1. Transplantation of P. oceanica

In RNP Coastal Dunes, the pilot transplantation campaign was located on Morelli waterfront (Ostuni), near to the SIC Area "Litorale Brindisino". The transplantation site was located inside a discontinuous meadow that shows the upper limit to a depth of 8 m, characterized by the presence of patches of *Posidonia oceanica*, dead matte and sand devoid of vegetation. The distribution of the dead matte was fragmented and partially localized on sub-superficial rocky states. The donor meadow was located near the receiving site.

The transplantation was carried out in two contiguous parcels (Figure 6-5) in relation to the area's bathymetry, each representing approximately an area of about 100 square meters, for a total of about 200 square meters of transplanted area.

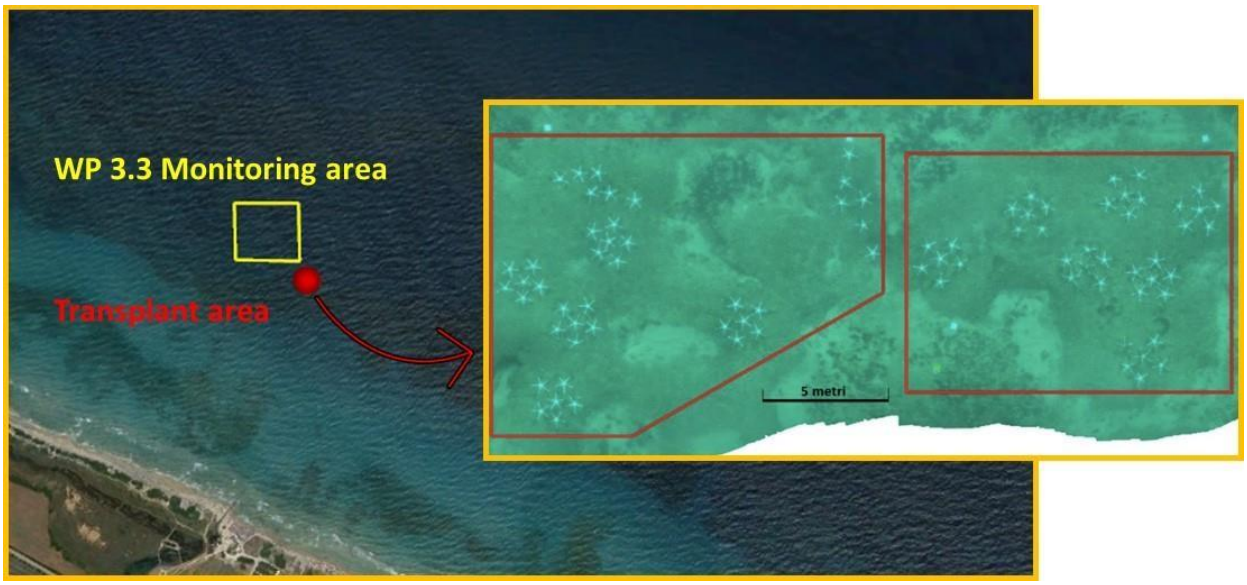


***Figure 6-5**. Transplantation area in RNP of Coastal Dunes and Detailed photomosaic of the pilot reforestation plant.*

Altogether, 14 patches composed each of 6 supports (in each one at least 30 rhizomes fixed) were arranged in the area, for a total of 84 anchoring modules and about 2,500 rhizomes.

***Figure 6-6**. Collection of P. oceanica cuttings by underwater operations.*

Figure 6-7. *The transplantation method of P. oceanica adopted in the case of the Parco delle Dune Brindisine site was developed by Biosurvey, a spin-off of the University of Palermo which collaborated on the Project. The School of Palermo has effectively tested one of the most used methods in the Mediterranean context. Any solution must be adopted with extreme attention and after considering the contour conditions and the pressures that have led or are leading, in the various sites investigated, to the rarefaction or the retreat of the meadows.*

Figure 6-8*. Fixing of cuttings to the arms (a), temporary storage of anchoring modules with cuttings/rhizomes.*

Figure 6-9. *The transplantation of P. oceanica, on the site of the Parco delle Dune Costiere Brindisine, included a phase of preparation of the plant material on the shore, and an underwater phase for the laying of the elements at the sea bottom, at about 400 meters from the coastline.*

Figure 6-10. Posidonia oceanica *transplantations have been carried out in the Kornati Islands Park and in the Coastal Dunes Regional Park. The planting technique to fix the cuttings to the seabed involved the use of specific modules made with a biodegradable material which, in addition to favoring the stabilization of the shoots over time by rooting, degrade naturally over a few years without causing environmental pollution phenomena.*

6.2.2. Monitoring campaigns

As mentioned before, contrary to what was found for the other two project study sites, in the RNP Coastal Dunes, despite the significant number of berths in the marinas, the observations carried out in the field (preliminary survey in 2019) and the information acquired (DPSIR analysis – WP 3.2) highlighted how marine seagrass rarefaction due to summer anchoring boats on the meadows was a negligible impact on this area. In fact, marine seagrasses coverages presented only limited disturbances attributable to yacht anchoring, which mainly occurs closer to the shore, on an unvegetated sea floor. Furthermore, fishing represented a very limited disturbance as well.

The site examined, along the Brindisi coast of Ostuni, therefore represents, in the context of the Project, an intermediate situation, in terms of anchorage disturbance, between what was detected in the Panzano Bay (Monfalcone) and what was detected in the Kornati NP.

At the RNP Coastal Dunes, the comparison of the data collected in 2019 (preliminary survey) and 2020, 2021 and 2022, during the monitoring campaigns (activity 3 of WP 3), found changes in the values of the main parameters. In fact, a decrease of the index value related to the ecological conditions of the meadow in Zone 2 and Zone 3 (from POOR to BAD) (due to the decrease recorded in shoot density) was found (but no changes in the ecological conditions of the meadow in Zone 1, still POOR). Considering the conservation status of the meadow, no change or slight decrease in the index value was recorded in Zone 2 (still GOOD) and Zone 1 (from HIGH to GOOD); whereas the reduction in the average coverage at the Zone 3 stations resulted in a decrease of the index value (from HIGH to POOR). However, as for the Kornati NP site, the analysis of balises showed a stable meadow condition, as there were no signs of retreat.

As for the other sites, during all monitoring campaigns (and the 2019 preliminary survey), no (filamentous) macroalgal blooms and alien species were found and, considering the abundance of epiphytes, the dominance of the encrusting layer (mainly represented by red calcareous algae) was related to a positive condition of the quality status of seagrass meadows.

As for human disturbance and the evidence of mechanical pressures, none were observed in or near the monitoring Zones during all the monitoring campaigns.

Considering the progress of marine seagrasses transplantations within the project schedule, as for the Kornati NP site, from a technical point of view, the tests carried out with *P. oceanica* showed good results. The plots created (back to February 2021) are still in good condition, and about 65% of the installed cuttings are growing, while the remaining 35% have different degrees of degradation or have completely disappeared.

Differently from the Kornati NP, at the Coastal Dune Park, the supports where the cuttings were fixed suffered significant damage due both to the effects of significant storm events, which were able to affect the sea-bottom despite the 8-meter depth and to the impacts related to amateur fishing and anchoring. In particular, in May 2022, only two of the six biodegradable monitored supports were found (support 2 and support 4) (Figure 6-11).

However, during controls, excellent vital conditions of the transplanted cuttings were still found on the Coastal Dunes Park site. As mentioned here, the problem can be traced back to physical impacts of another kind.

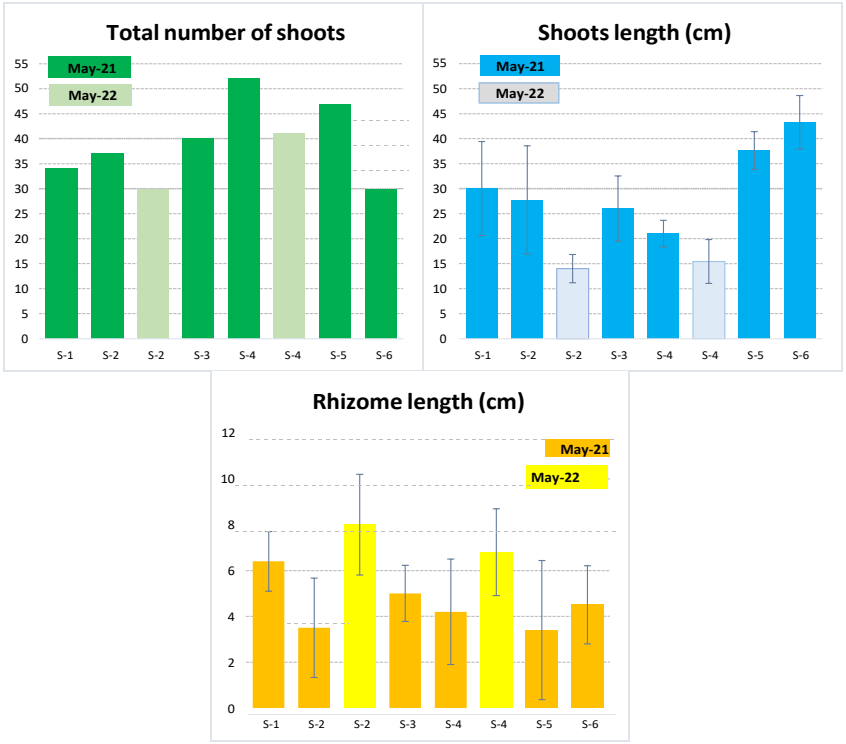


Figure 6-11. *Total number of shoots, average values of shoot length, and average values of rhizome length increase of the 6 monitored support (S-1, S-2, S-3, S-4, S-5 and S-6) in May 2021 and in May 2022 (only for S-2 and S-4).*

Figure 6-12. *During the project,* Posidonia oceanica *transplantations carried out in the Park Kornati and in the Coastal Dune Park were the subject of specific monitoring campaigns. On the basis of an international standard protocol, SCUBA divers acquired a series of indications to assess the course of the transplants and the state of the transferred cuttings.*

6.2.3. Alternative action to buoy positioning: biocenotic mapping

As mentioned before, in the RNP Coastal Dunes, the observations carried out on the field (Preliminary survey – WP 3.1) and the information acquired (DPSIR analysis – WP 3.2) significantly suggest that marine seagrass rarefaction due to summer anchoring boats on the meadows results in a minor impact on this area.

For this reason, after a phase of evaluation of the WP 4.1 action (eco-buoy field laying) in the site, the possible corrective and replacement actions, and the criteria for the identification of the project objectives, it was decided to prepare a modification of the originally planned activities.

It was therefore proposed to conduct a survey of the *Posidonia oceanica* marine seagrass that should include the entire front of the Park, focusing essentially on the upper limit of the meadows, which are more subject to erosion and retreat and including a final evaluation of the areas of major interest for the anchorage and their overlap with the meadows. These areas could be those where - for the future - the laying of buoy fields could be hypothesised instead of the site initially foreseen by the Local Management Plan inside the *P. oceanica* meadows, which does not seem to be favourable at the moment for location, distance from the shore and real needs of use by leisure boats.

In this way, the mapping and subsequent evaluation of the most appropriate sites for the anchorage of leisure boats, even without the simultaneous installation of eco-friendly buoys, are justified because they are conceptually linked to the DPSIR analysis evaluation activity (WP 3.2) and to the analysis aimed at identifying potential buoy fields.

Biocenotic mapping: area and methodology

The biocenotic map effort aimed to investigate the *Posidonia oceanica* meadows (Natura 2000 habitat 1120*-*Posidonia* beds) in the marine area of the SAC Litorale brindisino, in front of the coast of the RNP Dune Costiere, through the use of Side Scan Sonar.

The biocenotic detailed characterization was realized through the following work phases:

1) surveying planning in a GIS environment;
2) data acquisition activities at sea;
3) processing of acquired data;
4) data interpretation activities;
5) validation of the thematic mapping;
6) cartographic restitution.

All the data acquired and processed in this work will be inserted in a geodatabase prepared in the GIS environment. This procedure will allow the elaboration of detailed thematic maps for a spatially explicit visualization of the results obtained in the SASPAS WP 5.1 platform.

Biocenotic mapping: main results

The activities and consequent results were carried out thanks to a Side Scan Sonar and Multibeam survey. The geoacoustic survey made it possible to draw up detailed thematic maps (biocenotic and bathymetric cartography). The investigated area extends parallel to the coast for about 10 km and offshore for about 5 km, from the bathymetric band of 10 meters to that of 50 meters deep, covering a total area of about 4113 hectares. The study area is characterized by an environmental context of high naturalistic value since it represents part of the "Litorale Brindisino" SAC CODE - IT9140002.

The surveys carried out through multibeam allowed us to elaborate, in a GIS environment, the map of the bathymetry of the study area. The spatial elaboration of this theme has given the production of isobaths every meter of depth (Figure 6-13). The Side Scan Sonar survey allowed us to develop, in a GIS environment, the map of the biocenoses of the study area (Figure 6-14).

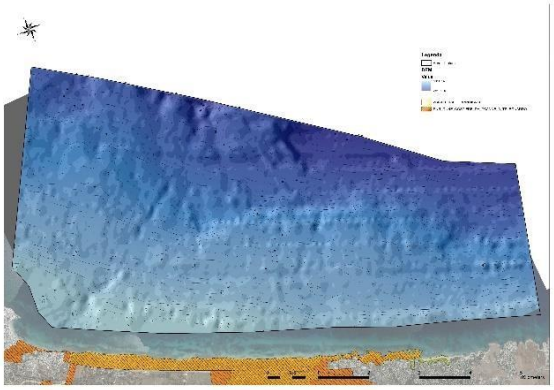


Figure 6-13. *Map of the bathymetry of the study area.*

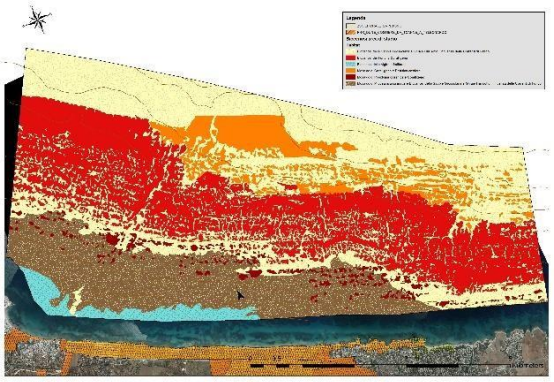


Figure 6.14. *Map of the biocenoses of the study area.*

The types of habitats identified are listed below:

Habitat	Area_ha	Percentuale
Biocenosis of coarse sands and line gravels under the influence of bottom currents	1529,62	37,19%
Coralligenous biocenosis	1253,90	30,48%
Biocenosis of infralittoral algae	117,40	2,85%
Mosaic of coralligenous and biocenosis of the coastal detritic bottom	351,73	8,55%
Mosaic of *Posidonia oceanica* meadows and coralligenous biocenosis	90,78	2,21%
Mosaic of *Posidonia oceanica* meadows and biocenosis of coarse sands and fine gravels under the influence of bottom currents	769,99	18,72%
TOTAL	4113,42	100,0 %

A more detailed description of the survey conducted for the biocenotic mapping is given in the **Annex 5**. The entire work performed has already been reported as a specific deliverable.

7. KEY MESSAGES ON SEAGRASS TRANSPLANTING AND SAFE ANCHORING

7.1 SASPAS stepway to protect marine seagrass meadows

Concrete pilot actions were the focus on which SASPAS project was implemented. These actions regarded the improvement of the marine seagrasses habitat conservation and restoration by (*i*) testing safe eco-friendly anchoring systems, (*ii*) performing pilot transplantations, (*iii*) carrying out monitoring activities and defining a practical integrated management system for marine seagrasses in the Project areas and – in prospective - in similar Adriatic areas.

Setting up ecological safe anchoring systems was the most relevant project's output, as it integrates and potentially disseminates experiences for all valuable coastal areas interested by marine seagrasses.

What were the concrete steps with which we implemented SASPAS actions? Let's see how we moved from the design rationale to the definition of a road map that constitutes the guidelines we believe opportune and suitable for effectively safeguarding marine seagrass meadows in areas with strong anchoring pressure of pleasure boats:

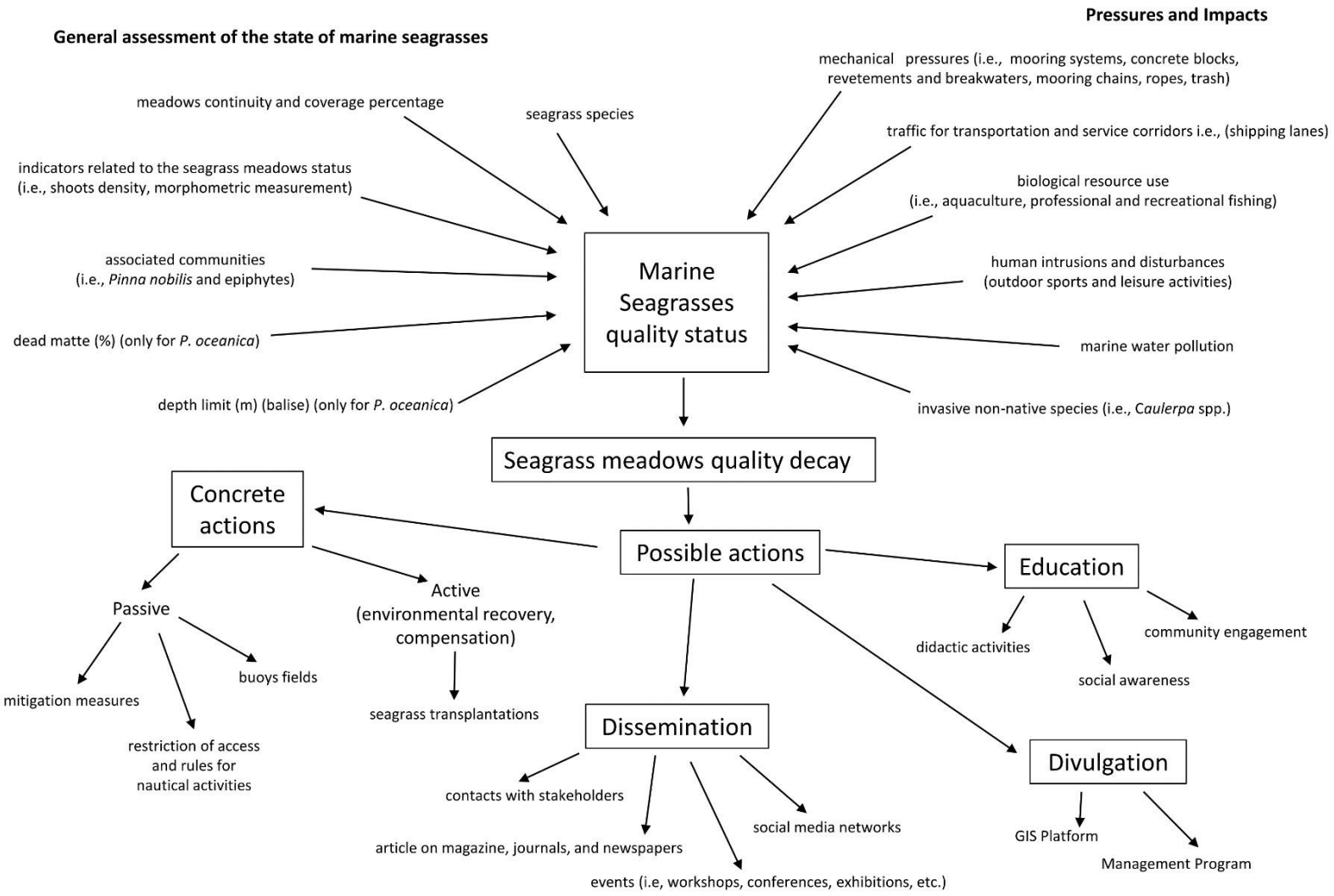
- **we identified and chose representative areas of Italian-Croatian Adriatic realities with seagrasses meadows, with different touristic characteristics and different leisure boat traffic pressure;**
- **we have characterized these areas to assess the health status of the meadows, without an advanced research work, but just to understand if there are significant impacts, especially due to boat anchorages;**
- **we have tried and adapted various transplantation techniques, not with a large "reforestation" purpose, but to test them in critical conditions and in the Adriatic areas, which have remained somewhat off the center of interest of the large Mediterranean transplantation projects;**
- **we have laid experimental eco-buoy fields, not to solve the mooring problem of pleasure boating, but to understand the reactions of yachters and the sustainability of this solution, to avoid most of the impacts on marine seagrasses;**
- **we carried out controls on everything, in the times and possibilities of the Project, with attention to the application purposes, since the objective of SASPAS is not to take over the scientific research on marine seagrasses; however, we have used the updated official protocols.**

The assessment phase, at the conclusion of SASPAS, was a process of reviewing the data collected to measure the performance of our actions, the possibility of applying them pragmatically and with procedural steps, the response of stakeholders to the actions. This phase was process oriented given that the characteristics of the different operational sites of SASPAS were extremely variable and did not allow the use of common evaluation metrics.

Here are summarized our steps to finalize the work, as reported above so far:

- **to create a platform with project data and other useful info, very versatile and suitable for understanding and managing different local realities (*in primis* the three sites, in post-project perspective other Adriatic sites with more or less similar features);**
- **to define our guidelines, describing our Adriatic realities and the steps we followed, using, if possible and when available, national handbooks and guidelines (scientific and grey literature, environmental agencies products and similar materials);**
- **the story of SASPAS concrete actions represent our guidelines and the difficulties that we have encountered between partners, with the administrations, the difficulties to coordinate Italian and Croatian approaches, procedures and rules;**
- **different sites and different users corresponded to different stakeholder responses to our actions and for this reason we learned a variety of approaches of leisure boaters to the need of marine seagrasses protection, even if this behavior resulted difficult to measure.**

The conceptual scheme of the following figure shows the guidelines that accompanied our work in SASPAS with an approach oriented to the different processes of analysis of the site conditions, of the existing pressures and of the possible protective actions to be implemented in favor of marine seagrasses.


General assessment of the state of marine seagrasses
Pressures and Impacts
meadows continuity and coverage percentage
seagrass species
mechanical pressures (i.e., mooring systems, concrete blocks, revetements and breakwaters, mooring chains, ropes, trash)
traffic for transportation and service corridors i.e., (shipping lanes)
indicators related to the seagrass meadows status (i.e., shoots density, morphometric measurement)
biological resource use (i.e., aquaculture, professional and recreational fishing)
associated communities (i.e., Pinna nobilis and epiphytes)
Marine Seagrasses quality status
human intrusions and disturbances (outdoor sports and leisure activities)
dead matte (%) (only for P. oceanica)
marine water pollution
depth limit (m) (balise) (only for P. oceanica)
invasive non-native species (i.e., Caulerpa spp.)
Seagrass meadows quality decay
Concrete actions
Possible actions
Education
Passive
Active (environmental recovery, compensation)
didactic activities
community engagement
social awareness
buoys fields
mitigation measures
seagrass transplantations
Dissemination
Divulgation
restriction of access and rules for nautical activities
contacts with stakeholders
social media networks
article on magazine, journals, and newspapers
GIS Platform
Management Program
events (i.e, workshops, conferences, exhibitions, etc.)

7.2 Recommandations from SASPAS experience

The analysis of the conceptual scheme and of the different components that we have decided to include in the pathway of SASPAS concrete actions leads to some simple recommendations for the effective protection of marine segrasses from anchorings;

- a maximum number of boats should be permitted to access the specific protected site, established on the base of the number of mooring buoys available and the capacity of designated anchorage areas on sandy bottoms; in the same actions, sand bottom site should be proposed than seagrass covered ones;
- traditional mooring systems inside seagrass meadows should be replaced by seagrass/eco-friendly systems in order to make plant recovery possible in the areas damaged by anchoring and mooring; the number, concentrations and localization of buoys should be carefully determined;
- considering the general inobservance of restrictions on anchoring, local surveillance should be implemented, also employing video technologies and closer co-operation with law enforcement;
- one of the main conservation goals should be the implementation of a proper and periodical educational program, containing awareness actions about the importance of marine habitats and campaigns in order to change boaters' attitudes and behaviours regarding anchoring in coastal areas;
- design and implement a long-term monitoring plan to measure the effects of any new management strategy.

We may define some major issues which came to attention and deserve an in-depth analysis as a result of our «guidelines»

- in perspection, how much is it possible to carry out a zoning process for the sustainable use of the coast to balance use and conservation?
- how much is it possible/complicated to activate conservation areas in the marine seagrass habitat, based on the use of eco-buoy fields?
- what are, one after the other, the difficulties encountered for authorizations, for dialogue with the maritime authority, for operations along the coast?
- what has been the response of recreational boaters to an offer of ecological anchoring buoys and to the first light indications for a more sustainable behavior in the use of valuable coastal habitats?

To give answers, based on the experience of SASPAS, below is a list of points which focus on issues, recommendations, and facts in order to consolidate the results of our Project and to replicate similar actions in other marine Adriatic areas.

- Significant results can be achieved by establishing good cross-border cooperation among partners, in planning, coordinating, and performing actions. Protection and restoration solutions should be

developed and specifically tailored for each study sites but harmonized as much as possible for the Adriatic area facing the same biodiversity protection and restoration issues.

- In order to conduct a preliminary environmental survey, it's important to examine existing data collections on environmental and biological parameters, as well as information on use, pressures and impacts of the areas under investigation. In addition, the sharing of monitoring protocols between partners prior to the start of survey activities is relevant to the planning and conduct of fieldwork at the project study sites.

- An appropriate balance is essential between the need for a scientific assessment and a pragmatic approach, in order to have a prompt activation plan, ready for the specific sites to intervene on.

- The importance of these preliminary data assessment moments does not mean that lengthy site-specific activities must be activated separately before effective cross-border cooperation and the exchange of experiences. In fact, it is only after the beginning of shared experiences that the project performances gain strength and that the exchange of points of view and procedures becomes a rewarding challenge for all partners.

- The installation of environmental-friendly buoys could represent a direct signal of public attention/awareness to all users (sailors, divers, boaters etc.), rising the quality level of the site in terms of environmental and sustainable offer.

- The safe-anchoring systems should be placed in areas with specific ecological requirements and where human activities were responsible for the disappearing of seagrasses. To be successful, the selected sites should meet at least 2 criteria: (*i*) the historical presence of seagrass beds, (*ii*) the cessation/absence of impacts that prevent seagrasses growth and development (also ensured by the placement of anchoring buoys itself).

- Eco-friendly buoy fields should be preferably installed outside the meadows or within limited decolonized areas, if available. Depending on the type of sites, the sandy areas should be preferred rather than the rocky areas, where the collateral damage for the installation could be greater.

- At each site, it should be decided in advance whether to perform mechanical or manual seagrasses transplantation in relation to site location, budget availability, size of project area and whether operators are trained or untrained. Both methods require: (*i*) knowledge of seagrass species growth habits and life histories, (*ii*) available seagrass stocks to be used as donor meadows.

- Authorization procedures of the Maritime Authority are complex. Strong difficulties were experienced in reaching the approval of ecological anchoring systems. As far as permits and authorisations are concerned, knowing the site's governance structure in terms of administrative bodies and maritime authority helps to speed up communication with the competent authorities to organize procedures, obtain permits prior to the field phases. The regulations for the use of nautical means for scientific operations can constitute an element of difficulty, taking into account the very restrictive and still obsolete regulations, often subject to variable interpretation.

- When conducting operations in a protected area (Natura 2000 site or a Park/Reserve), bear in mind that a formal assessment of field activities is necessary to check possible impacts on habitats and species. This has its own timeframe and regulation, also considering that the implementation of the anchorage sites is often already included in the management plans of the Natura 2000 sites, but frequently positioned in an approximate if not erroneous way. Further and particular difficulties are expectable in the case of MPA and parks;

- There is a need for consultations with public institutions and authorities to coordinate actions, which are difficult to implement if not already foreseen at the regulatory level. Minimizing the number of entities or administrations to be involved in the authorization process or managing their requests and constraints with appropriate anticipation helps to launch concrete actions in the field more quickly, especially to evaluate their effectiveness within the timeframe set by the project. This is particularly important when the interventions involve biological components that respond to seasonal/annual dynamics. A so called “conference of services”, organized beforehand between competent bodies can be a winning choice.

- The choice of buoy laying area should take into account the constraints and indications of the Maritime Authority, in order to respect the rules of marine spatial planning (distance from breakwater, harbours, navigation channel, bathing area; presence of submarine cables, off-limits area, kitesurf corridor, other buoys; verification of bathymetric levels etc.).

- On the use of buoys, recommendations and information should be provided to users to avoid accidents or misuse (maximum boat size, boat monitoring, when to moor and in what weather conditions, general care when approaching the buoy)

- A preparatory study on anchorages and moorings is recommended in order to define the area where ecological buoys are to be placed, taking into account the different characteristics of the site (weather conditions, maritime traffic and navigation, maritime safety measures, choice and number of buoys).

Finally, creating a system of ecological buoys for the safe anchoring of boats is not easy and involves a long list of aspects to be taken into account. In particular, when conservations actions are proposed in or near protected areas, the request for permits could also be very long. Moreover, in practical terms, the choice of where to place the buoy field has to consider geomorphological and meteorological area's characteristics, as well as the needs of the users.

It must also be said that passive conservation actions are gaining more and more ground as they do not involve a series of elements that could be unsuccessful (active transplantation does not always give the expected results in the long run). Thus, the present work acquires even more value in this perspective and constitutes a knowledge base for future replications.

Figure 7-1. *The eco-anchoring buoys represent a good balance between the need to support the leisure boaters vocation and the environmental sustainability, especially in areas where anchoring overlap the meadows.*

8. IDENTIFICATION OF POSSIBLE ADRIATIC SITES FOR REPLICATION

SASPAS project has placed a series of active and passive actions in the field of marine phanerogams conservation. As well explained in the present document, active actions concern the monitoring and the transplanting of marine seagrasses, being the target both *Posidonia oceanica* and *Cymodocea nodosa*. Passive actions, on the other hand, involve the positioning of ecological buoy systems to prevent impacts from anchoring and boating, especially during the summer touristic season.

The SASPAS team believes that these actions can be replicated in other marine areas of the Adriatic Sea with similar characteristics to the study sites selected in the project. In the following paragraphs a selection of different areas in the Northern, Central and Southern Adriatic Sea is presented as potential areas in which to transfer SASPAS methodology. These areas are chosen on the basis of specific criteria:

- the presence of a protected area (MPA, National or Regional Park) or a Natura 2000 site;
- the area's tourist vocation, especially in terms of boating and anchoring;
- the presence of marine phanerogams based on different sources of information, specified on a case-by-case basis for each potential area.

1) Area near Gabicce Mare (Marche, Italy)

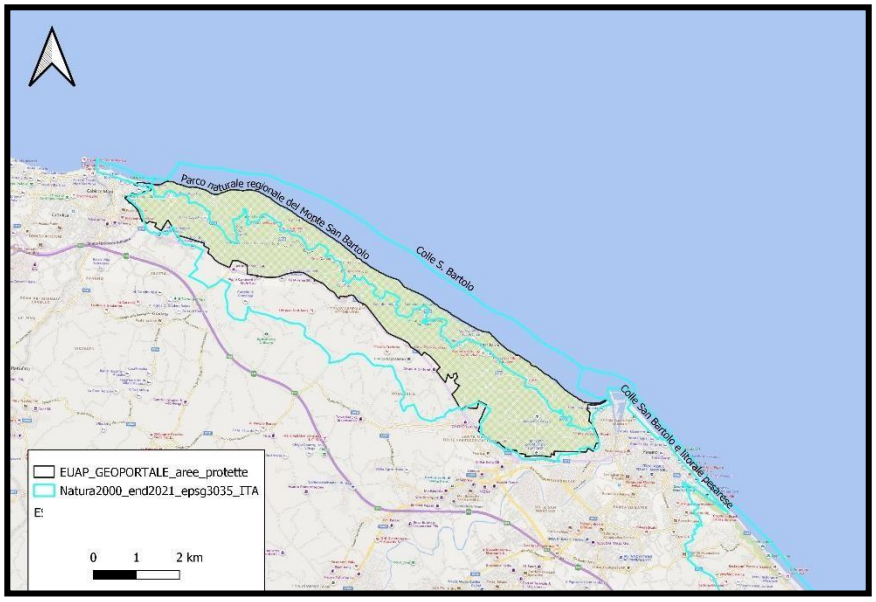


***Figure 8-1**. Area near Gabicce Mare (green area = RNP Monte S. Bartolo; light blue line = Natura 2000 sites).*

The area is in front of the Regional Natural Park Monte San Bartolo, which also partially corresponds to the SAC IT5310006 Colle S. Bartolo and to the SPA IT5310024 Colle San Bartolo e litorale pesarese (Figure 8-1). During the summer season, this area is subjected to mass tourism, also for its proximity to Monte

Conero, a traditional destination for nautical tourism (Figure 8-2). In general, the whole area of the Marche region, where Gabicce Mare is located, experiences a significant presence of tourists who visit the hinterland but especially the coast, thanks to the presence of large sandy beaches and shallow waters.

***Figure 8-2**. Area north of Monte Conero where boating is clearly visible (from UNIVP 2014).*

Regarding of the presence of seagrasses, in the standard data form of the SAC IT5310006 Colle S. Bartolo the habitats 1170-*Reefs* and 1210- *Annual vegetation of drift lines* are present (https://natura2000.eea.europa.eu/Natura2000/SDF.aspx?site=IT5310006). Thus, it seems that the site does not host marine phanerogams. In contrast, a study by the Department of Life and Environmental Sciences at the Polytechnic University of Marche shows the presence of two mixed meadows of *Cymodocea nodosa*, *Nanozostera noltii* and *Zostera marina* (Figure 8-3). The meadows are located at both ends of the SAC near the coastline and sheltered by a system of breakwater barriers.

Figure 8-3. Distribution of habitats and seagrasses in the Regional Natural Park Monte S. Bartolo and in the SAC IT5310006 Colle S. Bartolo (from UNIVP 2014).

The following table shows the information related to the selected site 'Area near Gabicce Mare' (Table 8-1), highlighting the characteristics of the site that fit a possible SASPAS site.

Table 8-1. Similar aspects between Gabicce Mare area and SASPAS study sites

Area near Gabicce Mare (Marche, Italy)	
Presence of regional/national protected areas	✓ (Regional Natural Park Monte San Bartolo)
Presence of Natura 2000 sites	✓ (SAC IT5310006 Colle S. Bartolo; SPA IT5310024 Colle San Bartolo e litorale pesarese)
Type of seabed	✓ (Mostly sandy)
Coastal-marine Natura 2000 habitats	✓ (1170, 1210)

Marine phanerogams[8]	✓ (*C. nodosa, N. noltii, Z. marina*)
Area's Body of Management	✓ (For the territory of the SAC-SPA included in the Regional Natural Park of Monte San Bartolo: Ente Parco Naturale Regionale del Monte S. Bartolo; for the territory not included in the Park: Province of Pesaro and Urbino)
Summer tourism	✓ (Intense: the area is a traditional destination for holidays, boating and sailing)

2) Pakleni islands (Hvar, Croatia)

Pakleni islands are a small archipelago under the Hvar Municipality, interested by the presence of the SCI HR3000095 Pakleni otoci (Figure 8-4). The SCI is a marine site, and it covers a marine surface of almost 20 km^2.The area suffers of a very intense mass tourism during the summer period, where the presence of sailboats and motorboats is strong (Figure 8-5*Figure*). In addition, the island of Hvar is one of the most visited islands in the Dalmatian region and the entire area, in front of the city of Split, is strongly impacted by tourism.

As concern the Natura 2000 habitats, according to standard data form, in SCI are present habitat 1110-*Sandbanks which are slightly covered by sea water all the time*, 1120-*Posidonia beds* (*Posidonion oceanicae*), 1140-*Mudflats and sandflats not covered by seawater at low tide*; 1170-*Reefs*, 8330-*Submerged or partially submerged sea caves* (https://natura2000.eea.europa.eu/Natura2000/SDF.aspx?site=HR3000095).

Regarding of the presence of marine phanerogams, in addition to the standard data form, the meadows are also reported in the project Interreg Mediterranean POSBEDMED2. In fact, the project's web viewer shows that the presence of Posidonia beds involves much of the coastal areas of the mainland and islands of Split-Dalmatian County. The layer on Posidonia bed relates to the distribution of meadows represented by the 1k grid of the European Environmental Agency, as shown in the screenshot below (Figure 8-6).

[8] UNIVP-Polytechnic University of Marche. *Caratterizzazione biocenotica e restituzione cartografica per l'individuazione di eventuali habitat e specie di interesse comunitario nelle aree prospicienti le aree protette della Marche. Relazione tecnica*. Report and field work were coordinated by Prof. C. Cerrano, DiSVA-Department of Life and Environmental Sciences. The surveys activities were conducted in June-November 2014. http://www.ambiente.marche.it/Portals/0/Ambiente/Natura/Comunicazione/Biblioteca/Relazione_tecnica_2.pdf

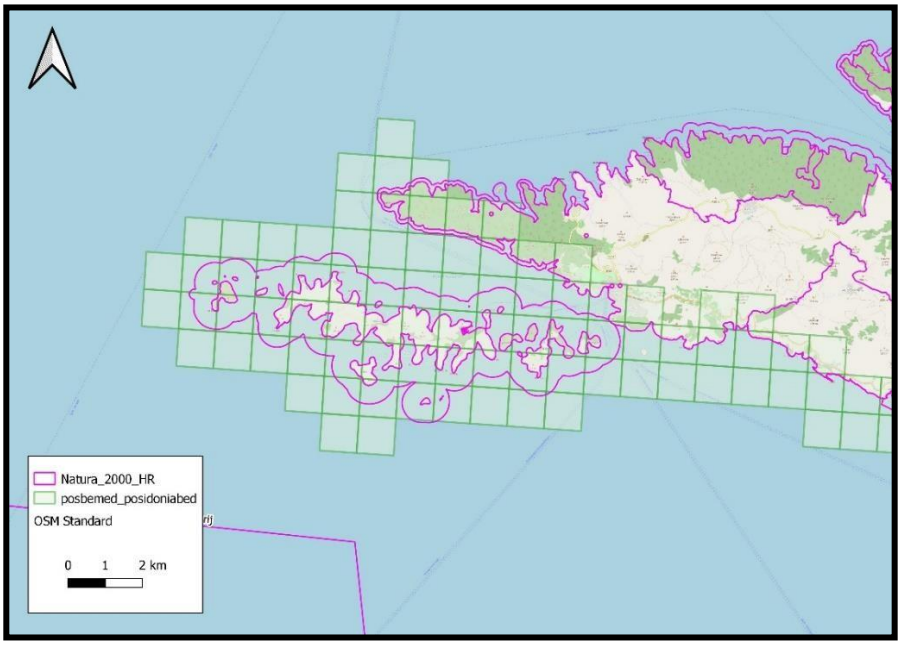


***Figure 8-4**. Pakleni islands and its SCI (pink line). The 1k EEA grid (green squares) represents the Posidonia Beds distribution according to the project POSBEDMED2.*

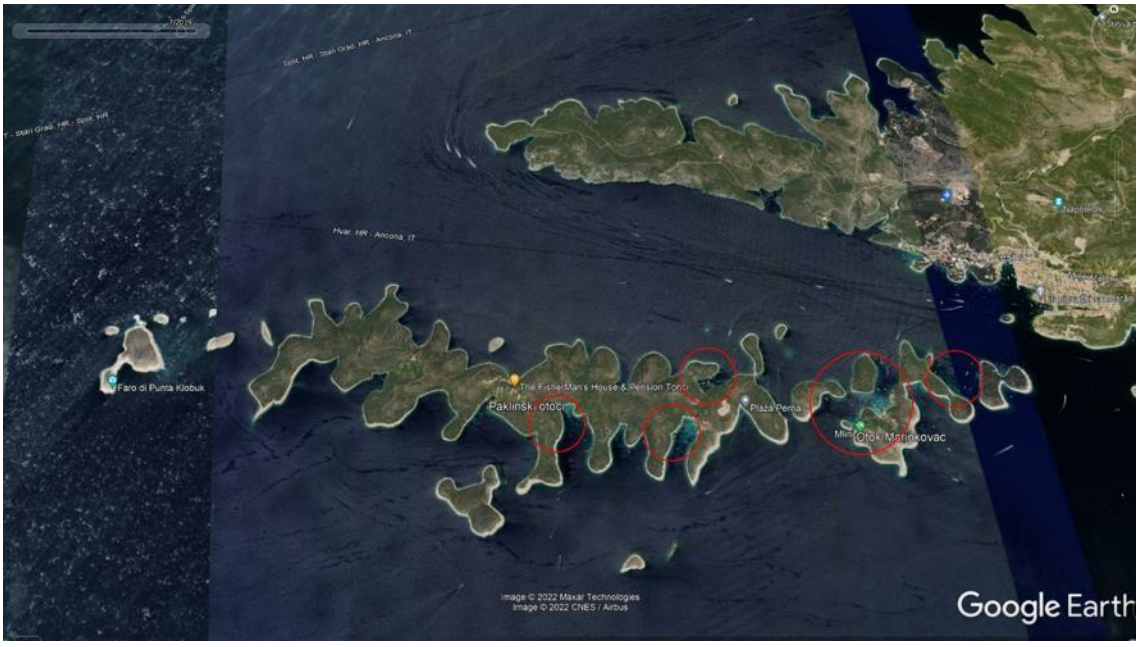


***Figure 8-5**. The intense marine traffic and boating in the Pakleni channel and Pakleni islands (screenshot from Google Earth). To note also the anchored boats in the red circles.*

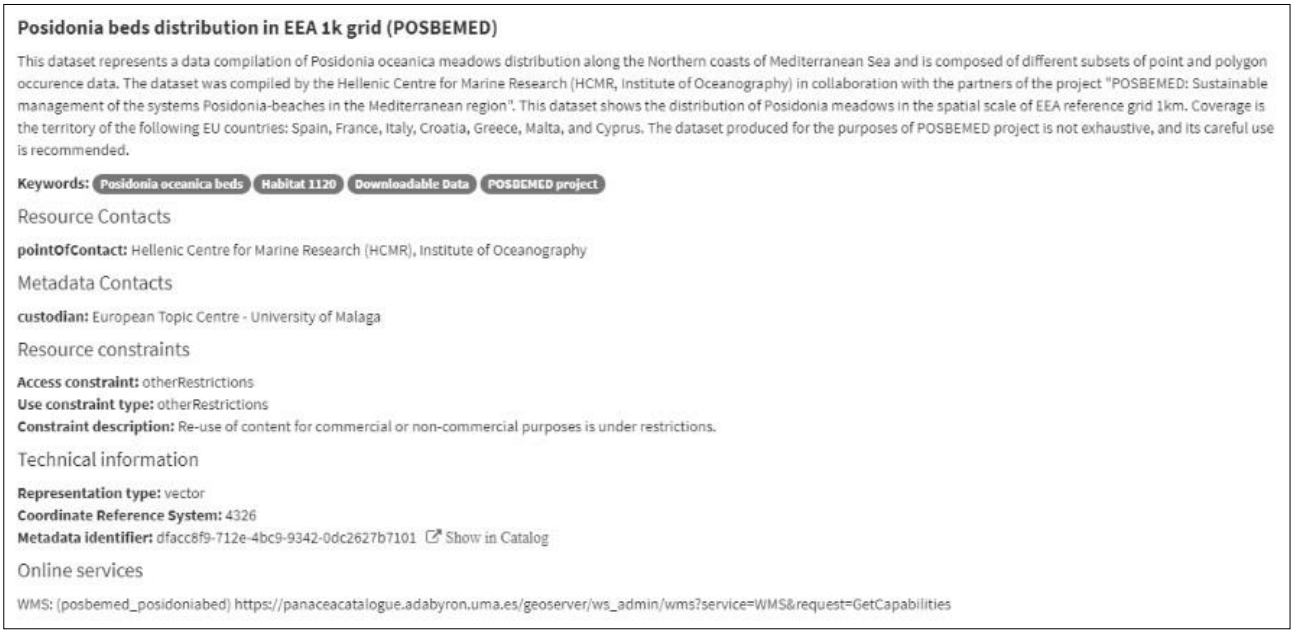


***Figure 8-6**. The layer on Posidonia beds distribution (screenshot from POSBEDMED web viewer).*

Table 8-2 shows the characteristics that the 'Pakleni Islands' site possesses, with a view to replicating SASPAS methodology.

***Table 8-2**. Similar aspects between Pakleni islands and the SASPAS study sites*

Pakleni islands (Split-Dalmatian County, Croatia)	
Presence of regional/national protected areas	×
Presence of Natura 2000 sites	✓ (SCI HR3000095 Pakleni otoci)
Type of seabed	✓ (Both hard rocky bottom and soft sandy bottom)
Coastal-marine Natura 2000 habitats	✓ (1110, 1120, 1140, 1170, 8330)
Marine phanerogams[9]	✓ (*P. oceanica*)

[9] POSBEDMED2 web viewer https://panaceacatalogue.adabyron.uma.es/gvsigonline/core/public_project_load/posbemed2/)

Area's Body of Management	N.A. (In the SCI standard data form, information about the Body(ies) responsible for the site management is not provided. So, in terms of territorial administration the area falls under the municipal administration of Hvar)
Summer tourism	✓ (Very intense: not only regarding of Pakleni islands but the whole Split-Dalmatian County)

3) Nature Park Strunjan (Coastal-Karst Region, Slovenia)

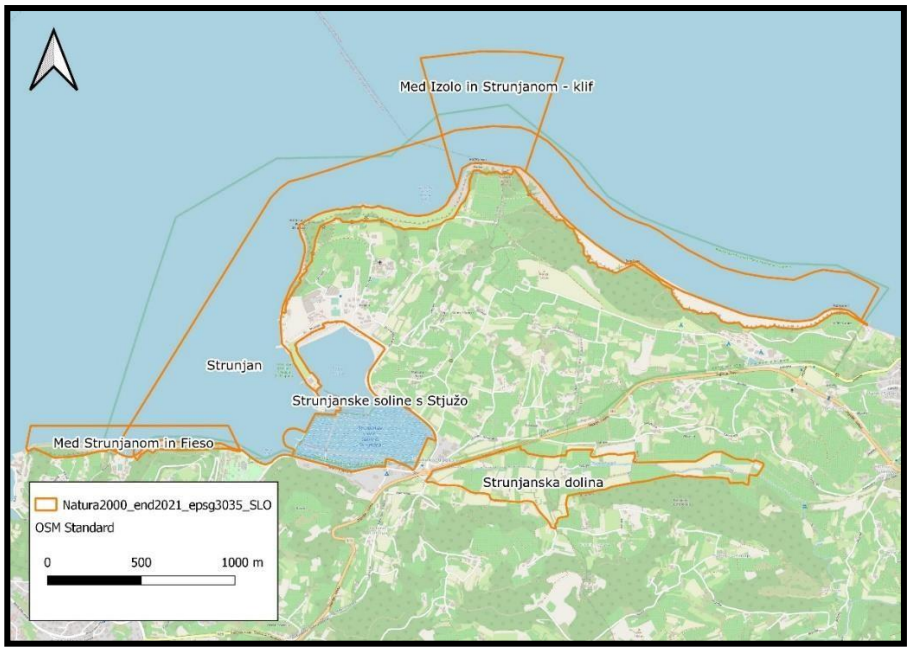


***Figure 8-7**. The Nature Park Strunjan (green line) and the Natura 2000 sites partially or totally included in the Park (orange line).*

The Nature Park is located between the territory of Piran and Izola Municipalities. Both cities are tourist destinations during the summer period, but the tourism flow is moderate compared to the other two proposed sites seen above. From West to East, the Nature Park Strunjan partially or totally includes different Natura 2000 sites (Figure 8-7): SAC SI3000307 Med Strunjanom in Fieso (https://natura2000.eea.europa.eu/Natura2000/SDF.aspx?site=SI3000307), SPA SI5000031 Strunjan (https://natura2000.eea.europa.eu/Natura2000/SDF.aspx?site=SI5000031), SAC SI3000238 Strunjanske soline s Stjužo (https://natura2000.eea.europa.eu/Natura2000/SDF.aspx?site=SI3000238) and SAC SI3000249 Med Izolo in Strunjanom – klif (https://natura2000.eea.europa.eu/Natura2000/SDF.aspx?site=SI3000249). The SAC SI3000386 Strunjanska dolina is outside the park boundaries.

As concerns Natura 2000 coastal and marine habitats, according to sites' standard data forms, in the Park are reported: 1130-*Estuaries*, 1140-*Mudflats and sandflats not covered by seawater at low tide*, 1150-*Coastal lagoons*, 1170-*Reefs*, 1210-*Annual vegetation of drift lines*, 1240-*Vegetated sea cliffs of the Mediterranean coasts with endemic Limonium spp.*, 1310-*Salicornia and other annuals colonizing mud and sand*, 1420-*Mediterranean and thermo-Atlantic halophilous scrubs (Sarcocornetea fruticosi)*.

Regarding of seagrasses, based on the *Italian Interpretation Manual of the 92/43/EEC Directive habitats*[10], 1140 can be associated with the presence of marine phanerogams populations. As just seen in the proposed site above, the presence of meadows is confirmed by the POSBEDMED2 project (Figure 8-8).

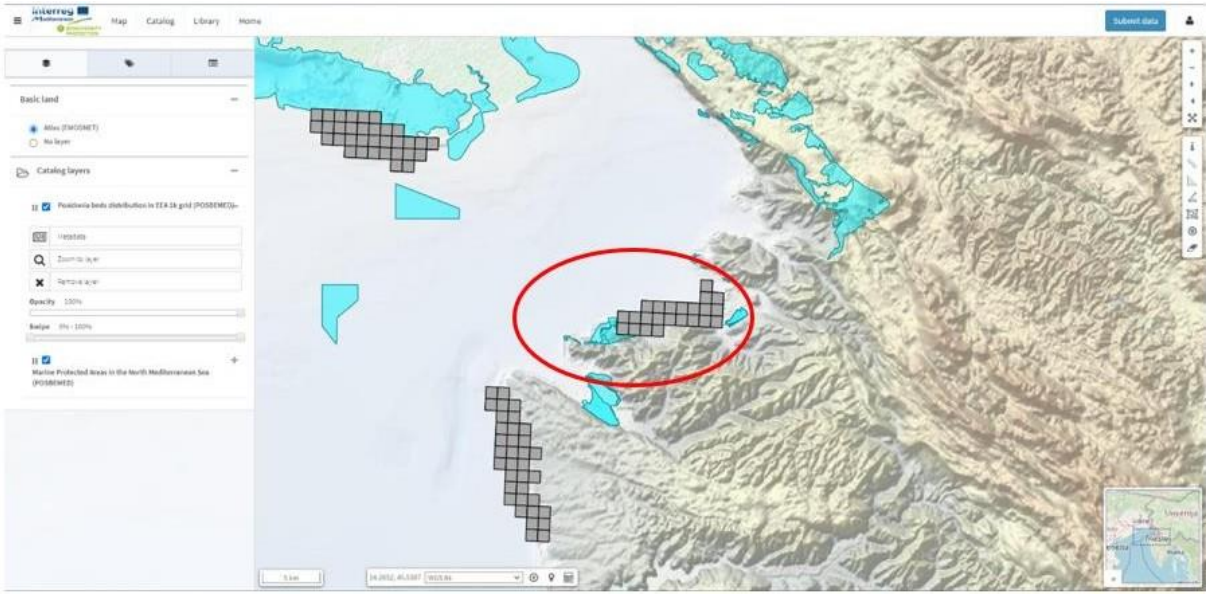


***Figure 8-8**. In the red circle the distribution of marine phanerogams in Nature Park Strunjan and its surroundings (screenshot from POBEDMED2 web viewer).*

In the table 8-3 are reported the aspects in common between the Nature Park Strunjan and the SASPAS project sites.

[10] Biondi, E., Blasi, C., Burrascano, S., Casavecchia, S., Copiz, R., Del Vico, E., ... & Zivkovic, L. (2009*). Manuale Italiano di Interpretazione degli habitat della Direttiva 92/43/CEE*. SBI, MATTM, DPN. http://vnr.unipg.it/habitat/index.jsp

Table 8-3. Similar aspects between Nature Park Strunjan and the SASPAS study area

Nature Park Strunjan (Coastal-Karst Region, Slovenia)	
Presence of regional/national protected areas	✓ (Nature Park Strunjan)
Presence of Natura 2000 sites	✓ (SAC SI3000307 Med Strunjanom in Fieso, SPA SI5000031 Strunjan, SAC SI3000238 Strunjanske soline s Stjužo, SAC SI3000249 Med Izolo in Strunjanom – klif)
Type of seabed	✓ (Hard rocky bottom and soft bottom both sandy and muddy)
Coastal-marine Natura 2000 habitats	✓ (1130, 1140, 1150, 1170, 1210, 1240, 1310, 1420)
Marine phanerogams	✓
Area's Body of Management	✓ (Javni zavod Krajinski park Strunjan)
Summer tourism	✓ (Moderate)

EXTRA AREA: Bay of Kotor (Region of Kotor, Montenegro)

The Bay of Kotor is a winding bay in the southwestern Montenegro, facing the Southern Adriatic Sea (Figure 8-9). At the moment, in the bay there aren't protected areas such as regional or national park, as well as Natura 2000 sites. Nevertheless, according to experts in the field of marine conservation, the establishment of a protected area has been talked about for many years. In fact, the bay of Kotor is particularly exposed to mass tourism and it represents a typical destination for boating, sailing and even cruise ships due to its special shape and geomorphological characteristics. The bay is the southernmost fjord in the Adriatic Sea and is an exceptional natural harbour (Figure 8-11).

***Figure 8-9**. The Bay of Kotor, Montenegro.*

As for the presence of marine phanerogams, the web viewer of the POSBEDMED2 project shows Posidonia beds in almost the whole bay (Figure 8-10***Figure***).

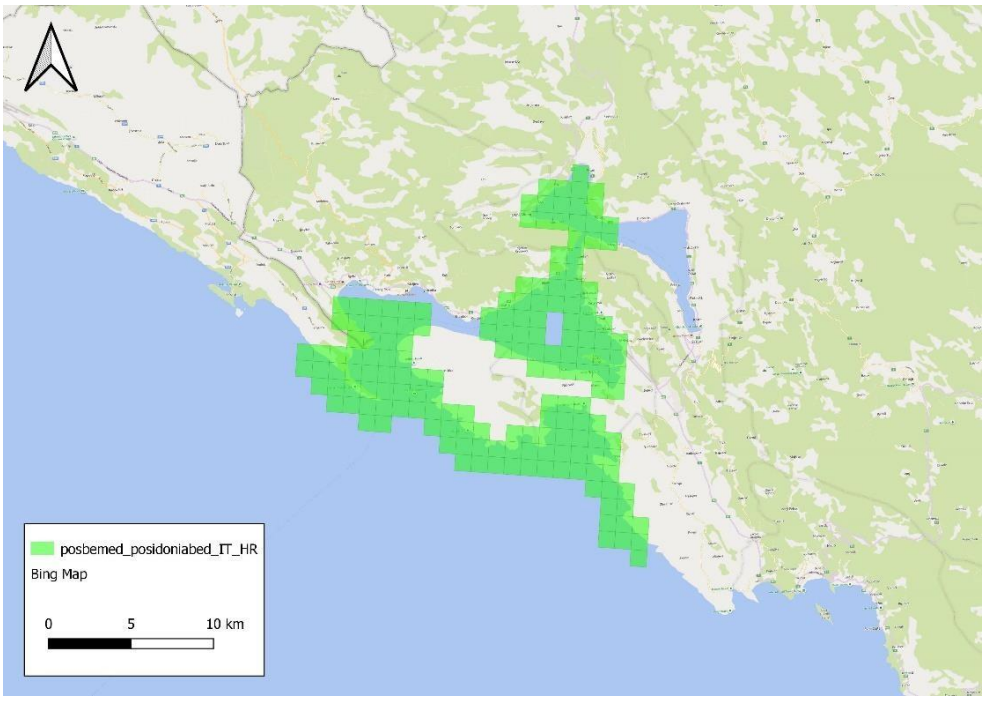


***Figure 8-10**. Distribution of Posidonia beds (green squares) according to POSBEDMED2 project.*

Table 8-4 shows the common characteristics between the SASPAS project study sites and the Bay of Kotor.

***Table 8-4**. Similar aspects between the Bay of Kotor and the SASPAS study sites.*

Bay of Kotor (Kotor region, Montenegro)	
Presence of regional/national protected areas	×
Presence of Natura 2000 sites	×
Type of seabed	✓ (Hard rocky bottom and soft sandy bottom)
Coastal-marine Natura 2000 habitats	×
Marine phanerogams	✓

Area's Body of Management	✓ (In terms of territorial administration, Municipalities that form the Bay of Kotor region are Kotor, Herceg Novi and Tivat)
Summer tourism	✓ (Very intense: as well as being a traditional destination for boating and sailing, the bay is also a destination for cruises (***Figure* - C**))

In conclusion, there are several areas that could be possible sites for replication of the SASPAS methodology. From north to south, the Adriatic Sea offers many opportunities in which to exercise conservation efforts, both on the eastern and western sides of the sea. The locations proposed above as possible replication sites have three characteristics in common, i.e. the presence of an area with a level of protection, marine phanerogams and significant summer tourist flows. The Bay of Kotor has a few exceptions, such as the absence of a protected area. However, it was considered appropriate to include it in the list of possible replication sites because of the need to protect the area with appropriate regulations, especially with regard to the regulation of recreational boating and sailing. Setting up a system of ecological buoy fields is the best way to lighten the impact of anchoring, and nautical tourism in general, on surrounding seagrass meadows.


A
Plicina Tuđja
Uvala Polje
Gospa od milosrđa
Sveti Marko
Ostrvo Cvijeća
Google Earth


NEMILA
МАНАСТИР САВИНА
B
Google Earth

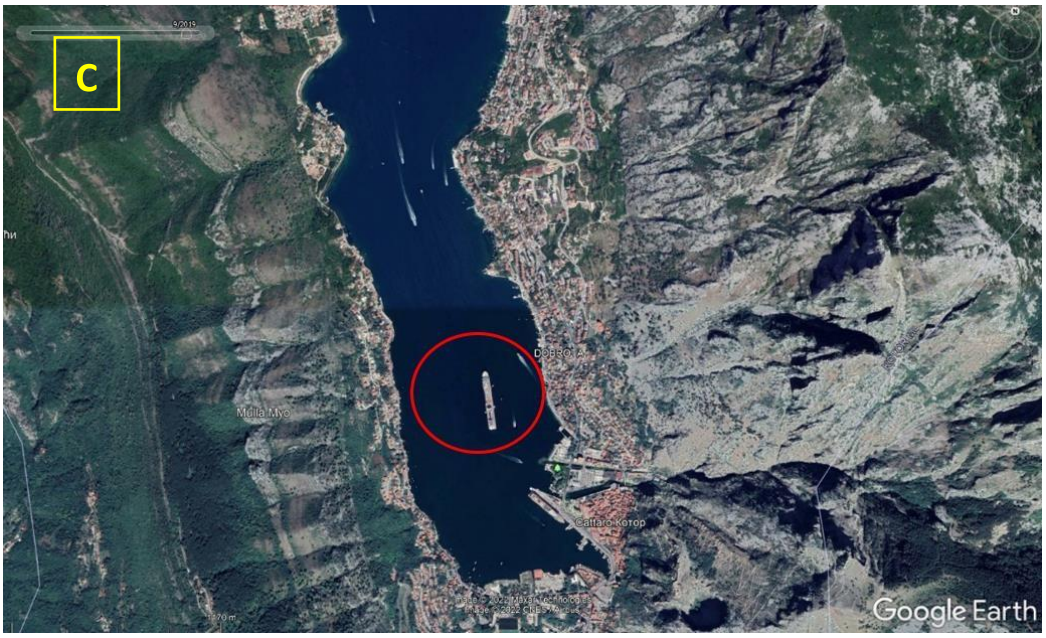


***Figure 8-11**. The Bay of Kotor: (A) Sveti Marko island (B) Herceg Novi (C) Kotor. To note the intense marine traffic and anchoring (screenshots from Google Earth).*

In order to show the potential of SASPAS methodology and implications, another set of three areas was selected. These areas fulfill to 2 of the 3 criteria seen above, that is (*i*) the area's tourist vocation, especially in terms of boating and anchoring; (*ii*) the presence of marine phanerogams based on different sources of information, specified on a case-by-case basis for each potential area.

Also, regarding the implications, this means that there are several opportunities for local administrators and decision makers in approving transplanting and monitoring actions in their management area, as well as providing for the installation of ecological buoys. Several topics are involved in this argument, such as active and passive actions to address climate change in coastal areas, protecting natural systems from the degradation and implementing the functionality of a natural area in relation to ecosystem services.

The selected three areas are illustrated in the following paragraphs.

1) Banco Anfora (Friuli Venezia Giulia Region, Italy)

Figure 8-12. *Banco Anfora in the Marano-Grado lagoon and the intense boating and anchoring in its area (screenshot from Google Earth)*

The so-called Banco Anfora is part of the long sandbar that separate the Marano and Grado lagoon from the Northern Adriatic Sea. Here, during the summer season, boaters and tourists attend the area (Lignano Sabbiadoro and Grado, famous tourist destinatios, are very close), as well as local citizens (Figure 8-12). At the back of the *banco*, there is also two popular restaurants, only accessible by boat. The presence of marine seagrasses is not currently surveyed in any European database (as seen above for the POSBEDMED2 project), but according to local experts it is well known.

2) Area near Gallipoli (Puglia Region, Italy)

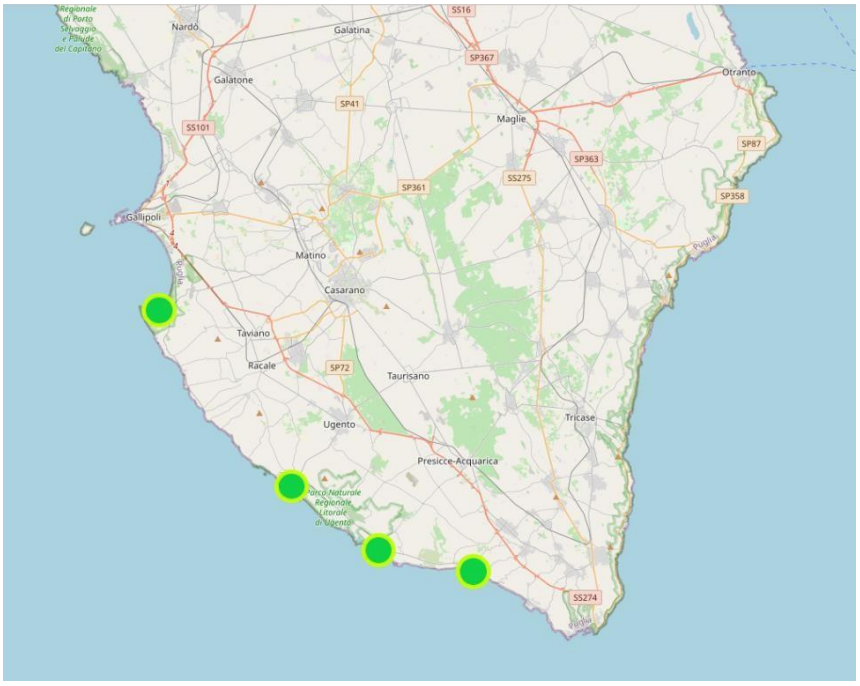


***Figure 8-13**. Gallipoli's Posidonia banquettes surveyed by POSBEDMED2 project (screenshot POBEDMED2 web viewer).*

Gallipoli is located along the western coast of Salento in the Lecce district, overlooking the Ionian Sea. This area regards the more-wide area of the Adriatic-Ionian Sea. The town of Gallipoli bases part of its economy on tourism, so its coast and sea are frequented by a large number of people during the summerseason. According to the POSBEDMED2 project web viewer, Figure 8-13 shows the Posidonia banquettesposition along the coast. Figure 8-14 shows a detail of the coastline, highlighting the large number of boatsand tourists that frequent the Torre San Leonardo area south of Gallipoli.

***Figure 8-14**. Boats and tourists (red circles) attending the coast and sea of the Gallipoli area (screenshot from Google Earth).*

3) Lopud island (Dubrovnik-Neretva County, Croatia)

***Figure 8-15.** Lopud island and the intense marine traffic along its coast and in its bays (screenshot from Google Earth).*

Lopud Island is part of the Elaphiti archipelago off the dalmatian coast, north to Dubrovnik. The island is famous for its sandy beaches and it's very popular among tourists and boaters, as shown in Figure 8-15. Marine phanerogams are present in the area, as surveyed by the POSBEDMED2 project (Figure 8-16) which places the Posidonia banquettes in the Šunj Beach, the most visited beach of the island, due to its fine sand and clear water.

***Figure 8-16**. Posidonia banquette in Lopud island surveyed by POSBEDMED2 project (screenshot POBEDMED2 web viewer).*

In conclusion, the SASPAS methodology could not only be transferred to protected areas but could be a forward-looking choice for local governments to protect marine seagrasses. In fact, areas where coastal tourism is well developed may experience degradation of natural marine systems, such as Posidonia beds due to massive anchoring. Coastal tourism is the largest source of income in many areas, but it remains important to combine the preservation of the local economy with that of the natural systems on which that economy indirectly depends and, not least, which also play an important role in resilience with respect to climate change.

GLOSSARY

blue carbon: carbon captured by the world's oceans and coastal ecosystems, which store it as biomasses and in the sediment

cutting: planting unit taken from a donor meadows site and usually made up of rhizomes and shoots

endemic species: a species that is found only in a given geographic region

matte: biogenic structure typical of *Posidonia oceanica*, which is made up by dead rhizomes intertwined with dead roots and trapped sediment

meristem: portion of a plant that contains tissue which divides and gives rise to similar cells or plant structures (e.g., tissues, organs, rhizome, roots, leaves)

pioneer species: a species with a growth strategy that enables it to rapidly colonise a new environment

planting unit: each single unit used in transplanting activities that is obtained by a donor meadow; it can be prepared with different methods and can be represented by different parts of a plant, such as the entire shoot, just the rhizomes, a seed

restoration: a series of actions aiming at returning an ecosystem to its previous healthy condition; a synonym is rehabilitation

rhizome: underground stem, which can grow horizontally (plagiotropic) or vertically (orthotrophic)

seedling: young plant obtained from the germination of a seed

shoot: a single plant that arises from a rhizome

sod: section of sediment with a seagrass, held together by the plant's roots and rhizomes and excavated to be transplanted; a synonym is plug

sprig: a seagrass fragment (or stem) bearing leaves, rhizomes and roots, taken from a seagrass meadow with the purpose of restoration

transplantation: planting of seagrass shoots or sods derived from another seagrass area into a new site to be restored

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The monitoring campaign were partly carried out in the Regional Natural Park of Coastal Dunes with the collaboration of the Ostuni delegation of "Lega Italiana Navale". Help and cooperation were received from the Brindisi Harbour Master Office (Capitaneria di Porto) and the branch office of Ostuni (Delegazione di Spiaggia). Underwater controls and a professional photo session were also provided by marine biologists Luciana Muscogiuri and Cataldo Licchelli.

Surveys in the Kornati National Park were carried out with the operational support of Najada Diving of Murter and the Kornati N.P. marine spread.

Coordination of activities, at all operational sites (Monfalcone, Kornati N.P., Coastal Dunes R.N.P.) was provided by local project partners with support of all partners in time for the relevant activities.

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P. oceanica transplantations were partly performed by Biosurvey, a spin-off company of Palermo University (Italy), using biodegradable patented underwater supports *C. nodosa* transplantations were carried out by Project Partners (SELC and CORILA/UNIVE).

Last but most important, a special tribute should be paid to the memory of Vladislav Mihelčić, who started with strong belief this project together with his colleagues from Park Kornati and who passed too early away in July 2022.

All partners gave their contribution to this final document.

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ANNEXES

Annex 1

Posidonia oceanica

Posidonia oceanica (Linnaeus) Delile is a seagrass endemic to the Mediterranean Sea (Figure 1). This plant grows from shallow subtidal waters to 50-60 m depth in areas with very clear waters (Borum & Greve, 2004); indeed, the presence of this species is considered an indicator of good water quality (Pergent-Martini et al., 2005). It is one of the most important climax communities located on the hard and soft bottom. *P. oceanica* is generally found in well-oxygenated waters, tolerates relatively large variations in temperature and hydrodynamics, and is sensitive to desalination, normally requiring a salinity of between 36 and 39 psu (it is not present in the areas in front of the river mouths). *P. oceanica* meadows are one of the most important Mediterranean habitats, and they play a key role in the marine ecosystem regarding primary production, biodiversity, nursery function, and the balance of sedimentation dynamics. They are an excellent indicator of the quality of the marine environment.

P. oceanica is catalogued as a "priority habitat" in Annex I of EU Habitat Directive 92/43/EEC and listed, as a protected species, at the Mediterranean level, in the Barcelona Convention Annex II (list of endangered or threatened species), in the SPA/BD - Protocol Annex II (List of endangered or threatened species) and Appendix I (Strictly Protected Flora Species) of the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention).

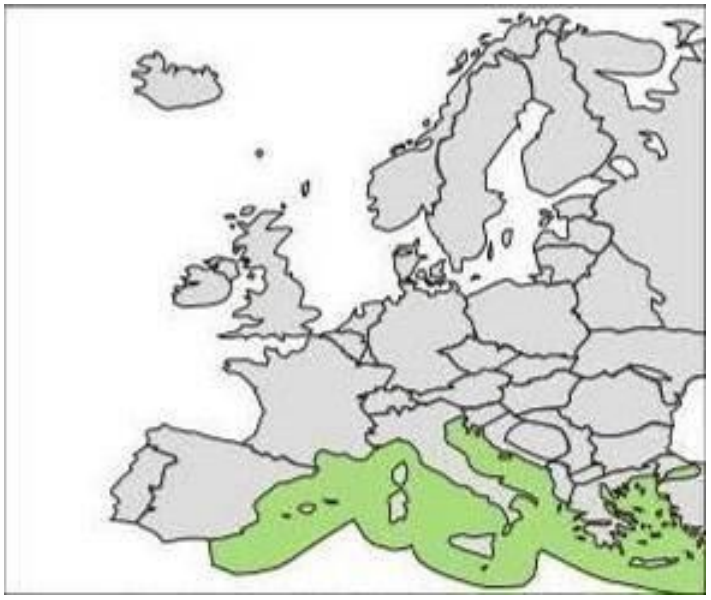

***Figure 1**. Geographical distribution of P. oceanica (green area) in the European Community (Borum et al., 2004).*

***Figure 2**. A meadow of* Posidonia oceanica*, where fishes and other animal species can find shelter and food.*

P. oceanica is characterized by leaf bundles consisting of 5 to 10 leaves attached to vertical rhizomes; the leaves have a width of 5-12 mm and a length usually variable between 20 and 40 cm, but some leaves can reach lengths of up to 1 m (Borum & Greve, 2004) (Figure 3); for this reason, it is considered one of the largest seagrass species in the world (Duarte, 1991b). As for *C. nodosa*, the vertical rhizomes are attached to horizontal rhizomes, which branch and grow through terminal apices. Rhizome internodes are short (0.5-2 mm), reflecting the slow horizontal growth of the plant, and rhizome thickness varies between 5 and 10 mm. Roots are 3-4 mm thick, up to 40 cm long and richly branched (Borum & Greve, 2004). *P. oceanica* rhizomes can be easily distinguished from those of other Mediterranean seagrass species mainly for the presence of dense and hairy vestiges of the old degrading leaf sheaths around the rhizomes (Borum & Greve, 2004). Flowering is usually rare, with less than 1 flower produced per 10 square meters per year, but it may be more frequent during warm years. Flowers are large and produce a fruit of about 10 mm in diameter. *P. oceanica* reproduces primarily vegetatively through the branching of rhizomes (Borum & Greve, 2004). A feature unique to *P. oceanica* is the production of matte, a biogenic structure made up by dead plagiotropic and orthotropic rhizomes intertwined with dead roots and trapped sediment (Boudouresque & Meinesz, 1982). *P. oceanica* is also one of the few seagrasses that can colonize both hard and soft bottoms, showing high morphological and physiological plasticity thanks to its root growth pattern and architecture (Hemminga and Duarte, 2000; Balestri et al., 2015).

***Figure 3**. Cutting of* Posidonia oceanica. *A) general overview of the rhizome cutting, bearing 2 shoots; B) magnification of the rhizome portion, where the leaf remains typical of this species are highlighted by red arrows; C) magnification of a leaf portion covered by a dense community of epiphytic algae (green arrows); D) magnification of a leaf portion, where grazing signs are visible (blue arrows).*

Since the 1960s, it is estimated that 13 to 50% of Mediterranean *P. oceanica* meadows have undergone a considerable regression or were even lost (Marbá et al., 2014; Telesca et al., 2015); according to a recent study (Chefaui et al., 2018), in the worst case scenario, they could reach 70-75% of regression within 2050 and the possible complete disappearance within 2100, if concrete and effective actions are not applied. Besides various national legislations, *P. oceanica* is protected by the Marine Strategy Framework Directive (MSFD) (2008/56/EC), the European Union's Habitats Directive (92/43/CEE) and the Barcelona and Bern conventions.

As just hinted, *P. oceanica* is a slow-growing species; therefore, its recovery from damage is slow, and the recovered areas remain vulnerable (Duarte 1991b; Marbá et al. 1996; Gonzalez-Correa et al. 2005; Gobert et al., 2006). Moreover, for the structural complexity of *P. oceanica* meadows, the full recovery of impacted beds is considered impossible within a human timescale (Boudouresque et al., 2012).

Cymodocea nodosa

Cymodocea nodosa (Ucria) Ascherson is a warm water species widely distributed throughout the Mediterranean Sea, the Canary Islands, and the North African coast (Figure 4). The species does not extend further north than the southern coasts of Portugal. *C. nodosa* can be found in shallow subtidal areas and deep waters (50-60 m).

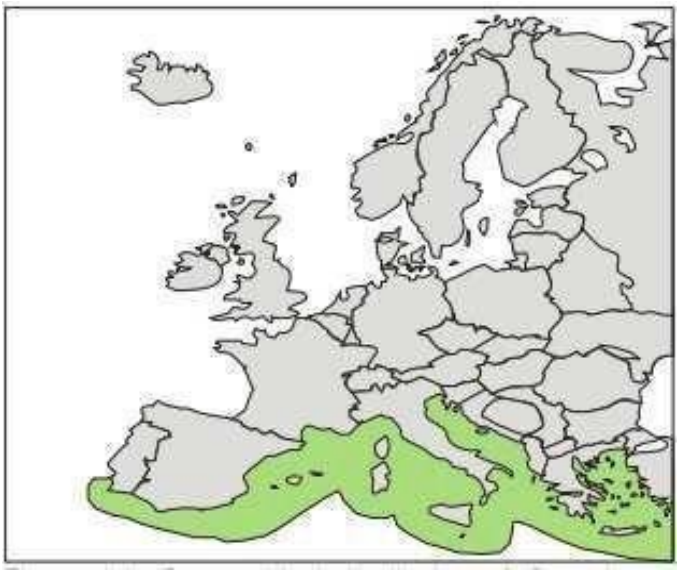

Figure 4. *Geographical distribution (green area) of* Cymodocea nodosa *in the European Community (Borum et al., 2004).*

Besides being present in the eastern Atlantic Ocean, from the coast of Senegal to the south of Portugal, *Cymodocea nodosa* is a marine dioicous seagrass, common and abundant along all the clear and warm waters of Mediterranean coasts, where it colonizes sandy and muddy bottoms, and it is found in the shallow intertidal and subtidal zones, up to depths of 40-60 m (e.g., Duarte 1991a; Buia et al., 2003; Borum & Greve, 2004; Mascaró et al., 2009; Máñez-Crespo et al., 2020) (Figure 5).

Figure 5*. A meadow of* Cymodocea nodosa *growing on a silty-sandy bottom.*

C. nodosa has leaf bundles consisting of 2 to 5 leaves, each 3 to 5 mm wide, with 7 visible veins; the shoots are attached to vertical rhizomes (orthotropic) with short rhizome segments, which in turn are attached to a horizontal rhizome with white to pink horizontal segments (plagiotropic), 1-6 cm long (Borum & Greve, 2004) (Figure 6). It is a fast-growing species (up to 70 mm/day), with the rhizome that may grow several meters per year and leaves that can usually reach a maximum length of up to 40-45 cm during summer (Cancemi et al., 2002; Borum & Greve, 2004). Greater lengths can be achieved in transitional environments such as the Venice lagoon, where the mean shoot length ranges between 60 and 90 cm, with single shoots up to 1.5 meters long (Sfriso & Ghetti 1998; Sfriso 2020). Therefore *C. nodosa* is considered a pioneer species, able to colonize bare areas (Borum & Greve, 2004) quickly. It reproduces mainly vegetatively, with the generation of new shoots from the horizontal rhizome, but also sexually, with the production of seeds during spring (Cancemi et al., 2002; Máñez-Crespo et al. 2020). However, in nature, this species' germination and seedling survival rates are variable and generally low (Buia & Mazzella, 1991; Zarranz et al., 2010).

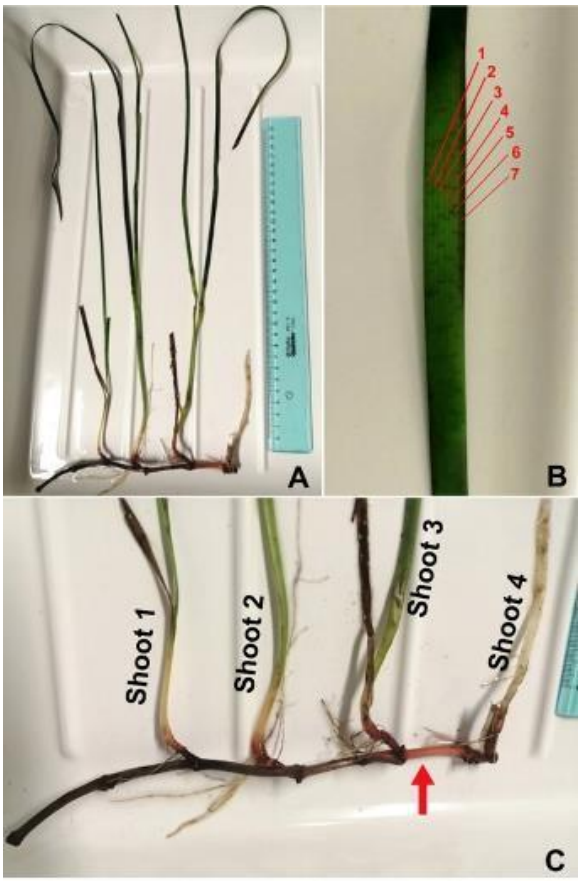

***Figure 6**. Cutting of* Cymodocea nodosa. *A) general overview of the rhizome cutting, bearing 4 shoots; B) magnification of a leaf portion, where the 7 main veins typical of this species are highlighted; C) magnification of the rhizome portion, with the four shoots tagged and the typical pink color of the rhizome evidenced by a red arrow.*

Based on the present trends, a recent study (Chefaui et al., 2018) estimates that *C. nodosa* meadows can reach a regression of about 20.8% within 2050 and, in the worst scenario, of about 46.5% within 2100; this species is currently reported under the *OSPAR List of Threatened and/or Declining Species and Habitats*.

Zostera marina* and *Zostera noltei

Zostera marina Linnaeus is found from arctic waters along the northern Norwegian coast, where it can survive several months of ice cover, to the Mediterranean Sea (Figure 7). The species is very abundant in the Baltic Sea, the North Sea and along the Atlantic coasts down to northern Spain. Further south, *Z. marina* becomes rarer in the Mediterranean Sea; the species is mostly found as small, isolated stands, but dense eelgrass beds do occur, especially in transitional water systems (lagoons and ponds). In the Adriatic Sea, *Z. marina* forms dense beds, with trailing leaves up to 120-130 cm long in sheltered bays and lagoons from the lower shore to about 4-5 m depth. It is widespread in the northern Adriatic lagoons, where there are extensive meadows with 100% cover. *Z. marina* prefers muddy-sandy substrates, and in intertidal environments tending towards emergence, it shows a range overlap with *Z. noltei*.

Z. marina is catalogued as a threatened species, at the Mediterranean level, in the Barcelona Convention Annex II (list of endangered or threatened species), in the SPA/BD Protocol Annex II (List of endangered or threatened species), and in Appendix I (Strictly Protected Flora Species) of the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention).

Zostera noltei Hornemann is distributed from the southern coasts of Norway to the Mediterranean Sea, the Black Sea, and the Canary Islands and has been recorded as far south as on the Mauritanian coast (Figure 7). In the Adriatic Sea, *Z. noltei* forms dense beds, typically in the intertidal region (although it can occur in the very shallow subtidal), on mud/sand mixtures of varying consistency. *Z. noltei* forms dense beds in the muddy sand of intertidal areas, where *Z. marina* is sparse due to its lower tolerance to desiccation.

Z. noltei is catalogued as a threatened species, at the Mediterranean level, in the Barcelona Convention Annex II (list of endangered or threatened species) and the SPA/BD Protocol Annex II (List of endangered or threatened species).

Sensitivity: nutrient concentrations and light attenuation in the water column are the most important water quality parameters affecting seagrass growth. Another habitat characteristic, salinity, may also play a role in the transitional waters. Deeper populations of seagrasses are characterized by high sensitivity to turbidity, as prolonged increases in this parameter can reduce light penetration and prevent adequate photosynthesis. Some species (especially *P. oceanica*) are indicators of the overall quality of coastal waters since they are very sensitive to pollution and can only grow in clean unpolluted waters.

Other species (such as *Zostera* spp.) are considered to have an “intermediate” sensitivity to other factors such as water temperature, contamination by synthetic compounds and hydrocarbons, increases in nutrient levels, and abrasion. Terrestrial herbicides can inhibit growth and cause a decline in seagrass meadows. Eutrophication (high phosphorus and nitrate concentrations) may increase the cover of

epiphytic algae and prevent photosynthesis of seagrass or the abundance of the slime mould *Labrynthula macrocystis* (pathogenic agent of wasting disease) (OSPAR, 2009).

Threats: physical disturbance, nutrient enrichment, marine pollution, disease, increased turbidity, aquaculture, introduction, and competition from alien species are all factors that affect seagrass beds and can threaten the extent and quality of these habitats.

Physical disturbance occurs on both intertidal and subtidal beds. It may be caused by trampling, dredging, use of mobile fishing gears, anchoring of boats, the laying of submarine cables, as well as land claim and adjacent coastal development.

Massive contributions or substantial sediment depletion and prolonged low light regimes (caused above all by anthropogenic factors – such as incorrect beach nourishment practices) can trigger a meadow regression. This is compounded considering the biological characteristics of the plant (slow growth rates) and the dynamics of the meadow (low resilience, i.e., very slow recovery after external disturbances).

Discharges of liquid effluents modify the chemical characteristics of the water column because they increase the contribution of pollutants and nutrients.

The invasion of alien rhizophytic species may enhance meadow decline since they compete for space and light and increase the contents of labile organic matter in the sediment.

Another threat is the increased turbidity caused by eutrophication, sand extraction, and dredging activities, which are major factors in the decline of seagrasses (OSPAR, 2009).

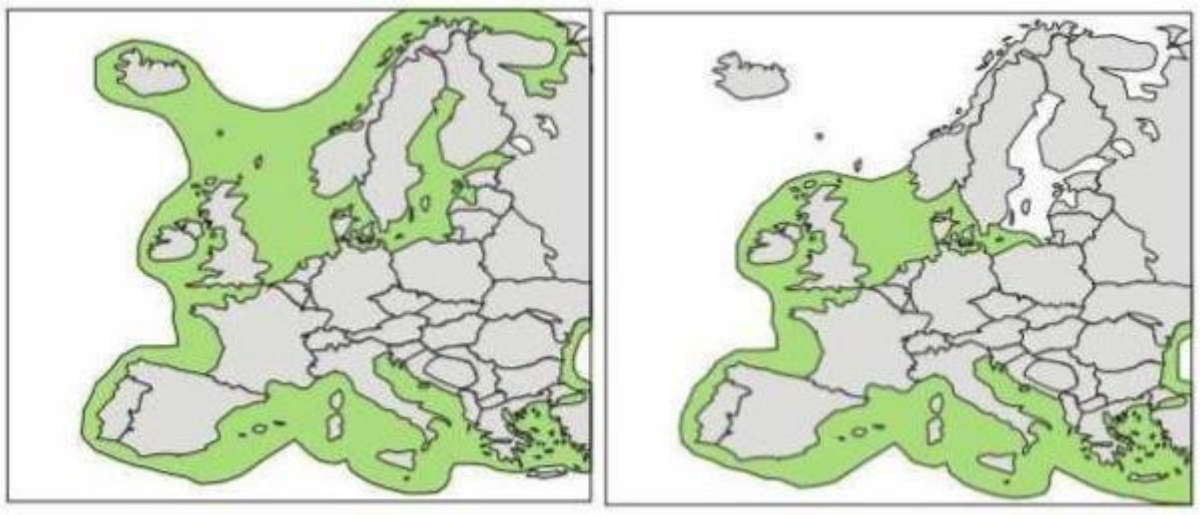

***Figure 7**. Geographical distribution (green area) of Zostera marina (left) and Zostera noltei (right) in the European Community (Borum et al., 2004).*

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Annex 2

Indicators

For *P. oceanica*, a strictly marine and typically Mediterranean species that can reach depths of up to 30-40 m, and with some structural peculiarities (matte, leaf organization, etc.), the protocols developed at the national and international levels have added other specific indicators (balise, lower and upper limits, lepidochronology, etc.) to define the Ecological Quality Status according to the WFD.

Considering that:

- the activities scheduled by the SASPAS project (42 months) allow us to carry out only two vegetative monitoring seasons,

- some status indicators have ecological significance only if collected for several years,

- the structure and phenology of P. oceanica, partially differ from the other seagrasses ones;

- the species require different transplant and monitoring periods,

- seagrass meadows are characterized by large variation between years,

only status indicators able to provide meaningful and useful answers within the timeframe of the project have been selected for the monitoring protocol.

The sampling methodology scheme and the indicators proposed are reported in Figure 1. The scheme, taken from the ISPRA *P. oceanica* monitoring protocol (ISPRA, 2012) for WFD monitoring, has been simplified to be adapted to the objectives and timing of the SASPAS project; the indications reported in the RAC/SPA - UNEP/MAP (2014) monitoring protocol for *P. oceanica* have also been considered to achieve the integration of the two protocols.

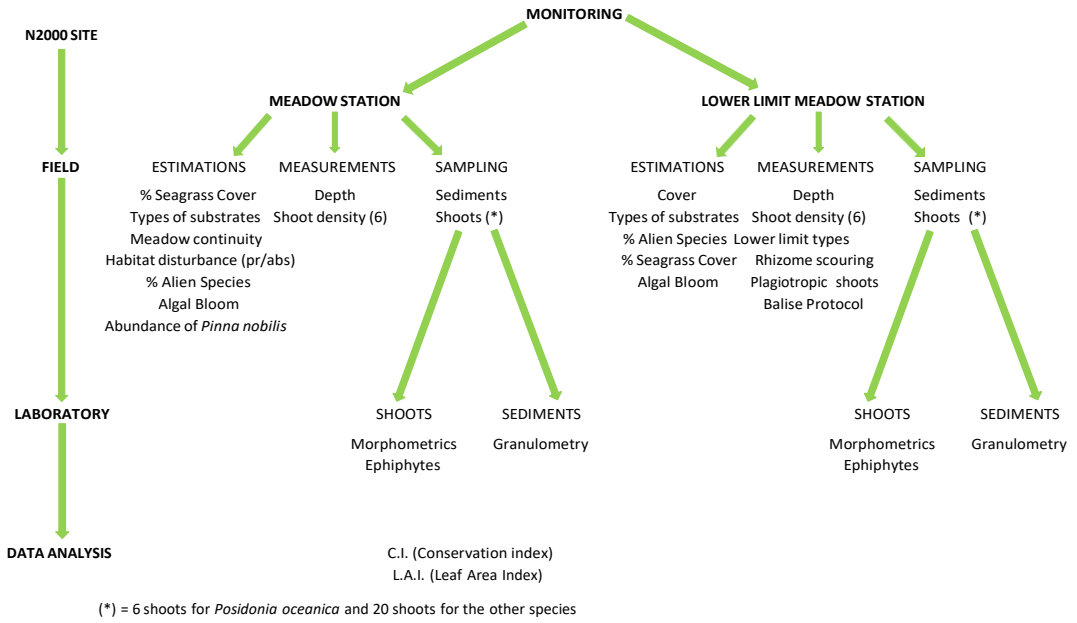

***Figure 1**. Sampling methodology scheme (ISPRA 2012, modified)*

The following table shows the indicators selected for the protocol (Table 1).

***Table 1**. SASPAS project's selected indicators.*

	SEAGRASS MEADOWS		
INDICATORS	*Posidonia oceanica*	*Zostera* spp.	*Cymodocea nodosa*
Meadow Cover (%)	x	x	x
Continuous/discontinuous meadow	x	x	x
Dead matte (%)	x		
Depth limit (m)	x		
Substrate type	x	x	x
Shoot density (shoots/m^2)	x	x	x
Shoot morphometric measurement	x	x	x
Balisage protocol	x		
Blooms and filamentous algae	x	x	x
Epiphytes (phyto-zoobenthos)	x	x	x
Pinna nobilis Abundance	x	x	x
Alien species (e.g., *Caulerpa* spp.)	x	x	x
Presence/absence of habitat disturbance	x	x	x

The figure is an example of a possible sampling design to test the spatial variability within each sampling site in different circular zones (Gerakaris et al., 2017, modified) (Figure 2). In each station, shoot density is measured in random quadrats and meadow cover is estimated along linear 10 m transects (T1, T2, T3). The green polygon is a part of a hypothetical meadow.

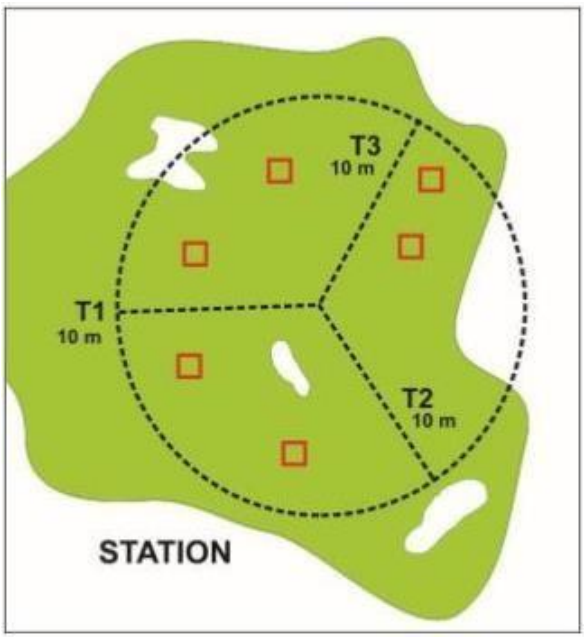

***Figure 2**. A possible sampling design to test the spatial variability within each sampling site in different circular zones (Gerakaris et al. 2017, modified)*

Percentage Cover and meadow continuity

Seagrass cover and its continuity/discontinuity describe the seafloor fraction covered by seagrasses on a 0-100% scale and provide a measure of seagrass abundance. As cover is depth-dependent, any measure of cover was related to water depth. Both density and length of shoot affect the estimation of the seagrass cover (e.g., short shoots may have the same cover as meadows of sparser but longer shoots). Seagrass cover may reflect the patchiness of seagrass stands, seagrass cover within patches, or both aspects.

Percent seagrass cover is usually visually estimated by a diver as the fraction of the bottom covered by seagrasses. Cover can be estimated directly as percentage or according to a cover scale. For P. oceanica the cover of the dead matte was also evaluated.

SASPAS protocol: all percent cover values were assessed using the Line Intercept Transect (LIT) technique (Bianchi et al., 2004) (Figure 3 and Figure 4). Each 10 m in length, three transects were monitored at each station (transects extend radially from a fixed central point). Key elements (Lx) cover measurements along

the transects (live seagrass; unvegetated muddy/sandy patches; unvegetated rocky patches; dead matte) were considered for each transect at the nine stations.

Along the transects, all the key element changes were noted and recorded. Thus, the seagrass presence was referred to as a percentage of transect length. This linear pattern was also reported to m2 and averaged as an approximation.

The per cent cover (R%) along a 10 m transect was calculated from the following formula:

$R\% = \sum(Lx/10*100)$

where Lx is the length of the cover, 10 is the length of the transect.

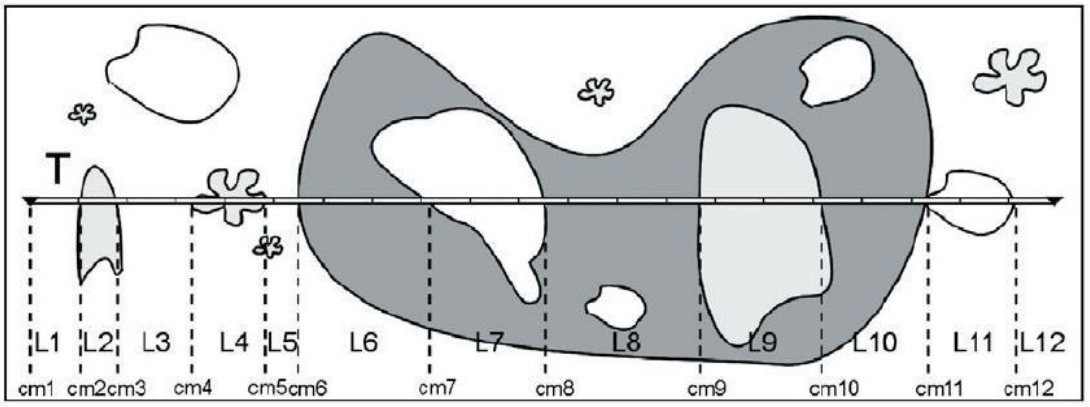

***Figure 3**. Line Intercept Transect (LIT) technique (Bianchi et al., 2004).*

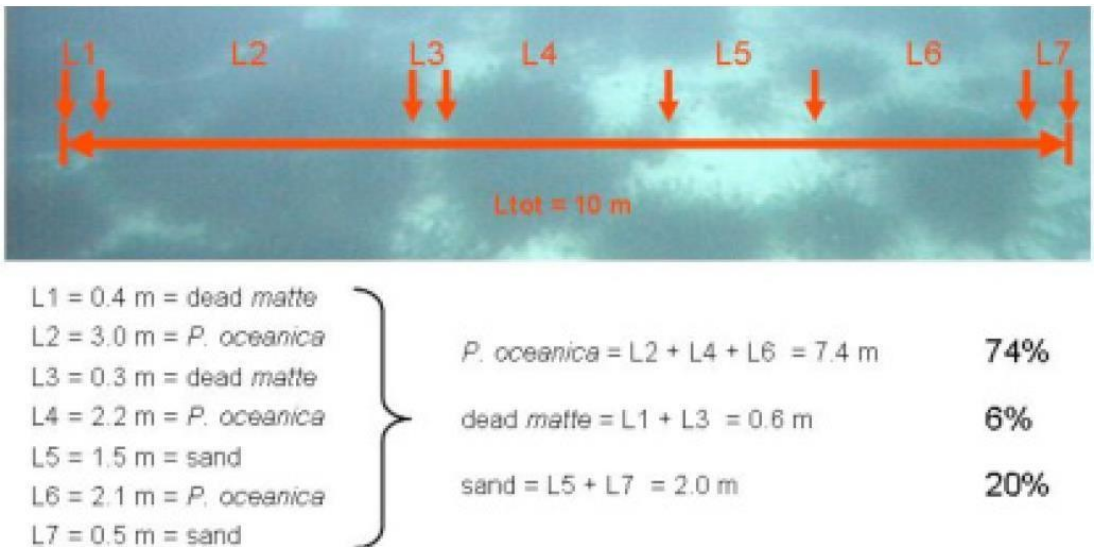

***Figure 4**. Example of LIT technique for the assessment of percentage cover (RAC/SPA - UNEP/MAP, 2014).*

Shoot density

Shoot density is the number of seagrass shoots/m2, thus providing a measure of seagrass abundance along depth gradients. The decline in density with depth suggests that shoot density responds faster than other indicators (e.g., biomass and cover) to environmental changes and may be an early indicator of change or negative trends that are occurring in the habitat type (Borum et al., 2004).

SASPAS protocol: shoot density was measured non-destructively by counting the number of shoots within the sampling unit (six replicated quadrats) launched randomly at least one meter apart at each sampling station. As shoot density is depth-dependent, any measure of shoot density was related to water depth.

When shoot density is high (i.e., ≥ 2500 shoots/m^2), counting dense stands is only feasible using small sub-areas. Duarte and Kirkman (2001) suggested different frames size depending on the expected shoot density: 0.5 m x 0.5 m for less than 300 shoots/m2, 0.25 m x 0.25 m for 300-3000 shoots/m^2 and 0.1 m x 0.1 m for more than 3000 shoots/m2.

For *P. oceanica*, the number of shoots per m^2 is one of the most widely used descriptors to assess ecosystem health (Pergent-Martini et al., 2005; UNEP/MAP-RAC/SPA, 2011) because it provides information on the viability and dynamic of meadows (Table 2). This indicator also reveals changes due to human influence when measured on a multi-year time scale. Since the meadow density is strongly affected by the depth, Pergent et al. (1995) identified four classes, which are a function of the theoretical mean densities for each depth. They reflect the ecological conditions of the meadow (Buia et al., 2004). Recently this classification was updated for the interpretation of monitoring data (UNEP/MAP-RAC/SPA, 2011).

Along the lower limit of *P. oceanica* meadows, rhizome scouring (laying bare of the rhizomes) and plagiotropic shoots (plagiotropic to orthotropic rhizome ratio) were also considered.

Table 2. Meaning of meadow cover at the lower limit (UNEP/MAP-RAC/SPA, 2011 modified).

Depth (m)	High	Good			Moderate			Poor			Bad
1	> 1133	1133	to	930	930	to	727	727	to	524	< 524
2	> 1067	1067	to	863	863	to	659	659	to	456	< 456
3	> 1005	1005	to	808	808	to	612	612	to	415	< 415
4	> 947	947	to	757	757	to	567	567	to	377	< 377
5	> 892	892	to	709	709	to	526	526	to	343	< 343
6	> 841	841	to	665	665	to	489	489	to	312	< 312
7	> 792	792	to	623	623	to	454	454	to	284	< 284
8	> 746	746	to	584	584	to	421	421	to	259	< 259
9	> 703	703	to	547	547	to	391	391	to	235	< 235
10	> 662	662	to	513	513	to	364	364	to	214	< 214
11	> 624	624	to	481	481	to	338	338	to	195	< 195
12	> 588	588	to	451	451	to	314	314	to	177	< 177
13	> 554	554	to	423	423	to	292	292	to	161	< 161
14	> 522	522	to	397	397	to	272	272	to	147	< 147
15	> 492	492	to	372	372	to	253	253	to	134	< 134
16	> 463	463	to	349	349	to	236	236	to	122	< 122
17	> 436	436	to	328	328	to	219	219	to	111	< 111
18	> 411	411	to	308	308	to	204	204	to	101	< 101
19	> 387	387	to	289	289	to	190	190	to	92	< 92
20	> 365	365	to	271	271	to	177	177	to	83	< 83
21	> 344	344	to	255	255	to	165	165	to	76	< 76
22	> 324	324	to	239	239	to	154	154	to	69	< 69
23	> 305	305	to	224	224	to	144	144	to	63	< 63
24	> 288	288	to	211	211	to	134	134	to	57	< 57
25	> 271	271	to	198	198	to	125	125	to	52	< 52
26	> 255	255	to	186	186	to	117	117	to	47	< 47
27	> 240	240	to	175	175	to	109	109	to	43	< 43
28	> 227	227	to	164	164	to	102	102	to	39	< 39
29	> 213	213	to	154	154	to	95	95	to	36	< 36
30	> 201	201	to	145	145	to	89	89	to	32	< 32
31	> 189	189	to	136	136	to	83	83	to	30	< 30
32	> 179	179	to	128	128	to	77	77	to	27	< 27
33	> 168	168	to	120	120	to	72	72	to	24	< 24
34	> 158	158	to	113	113	to	68	68	to	22	< 22
35	> 149	149	to	106	106	to	63	< 63			
36	> 141	141	to	100	100	to	59	< 59			
37	> 133	133	to	94	94	to	55	< 55			
38	> 125	125	to	88	88	to	52	< 52			
39	> 118	118	to	83	83	to	48	< 48			
40	> 111	111	to	78	78	to	45	< 45			

Shoot morphometric measurement

The study of the phenological characteristics of marine seagrasses describes the state of the vitality of plants through the analysis of vegetation turnover and cyclic phases that characterize the species and the meadow.

SASPAS protocol - The following parameters will be measured in a laboratory: shoot length (mm/shoot), shoot width (mm/shoot), the average number of leaves (leaves/shoot), leaf necrosis (% leaves/shoot) of the shoots collected randomly in each station (for *P. oceanica* only orthotropic shoots will be sampled). For each station, we propose the collection of 6 shoots for *P. oceanica* and 6 shoots for the other species (that will also be used for epiphyte measurements).

The limited number of shoots (6) collected compared to those planned by other monitoring protocols (6-18) (ISPRA, 2012) is justified by the fact that the monitoring operations aim to preserve the meadows as much as possible, considering how they are already damaged by trawling or anchoring.

To assess the conservation status of the P. oceanica meadows, the monitoring protocol foresees the application of two indices, the Leaf Area Index (LAI) and the Conservation Index (CI).

Leaf Area Index (LAI): The photosynthetically active surface (m^2/m^2) was determined by multiplying the mean surface of one-shoot leaves (only one face) by meadow shoot density.

Conservation Index (CI): (only applicable to P. oceanica): CI = P/(P+D), where: P= % of alive P. oceanica; D= % of dead matte.

Based on the values of CI, meadows were classified according to the criterion proposed by Montefalcone (2009) following the WFD requirements:

Bad	Poor	Moderate	Good	High
CI<0.3	0.3≤CI<0.5	0.5≤CI<0.7	0.7≤CI<0.9	CI≥0.9

Algal blooms and filamentous algae

Macroalgal blooms can vary significantly over time because they grow fast and are regulated by wind exposure and can be decimated after a storm. The presence and quantity of filamentous algae (especially the genera Ulva and Cladophora) were used as an indicator of nutrient richness in coastal waters.

SASPAS protocol: the presence/absence of macroalgal blooms was measured by the aqua scope's visual estimations from boats.

Abundance of epiphytes

Epiphytes (phyto- and zoo-) can be a prominent component of seagrass ecosystems when nutrient concentrations are high. Both composition and abundance are important. Samples with associated epiphytic assemblages were collected in immersion and stored frozen or in a preservation liquid until laboratory analysis.

SASPAS protocol: 6 shoots of *P. oceanica* and 20 shoots of the other species (that were also used for morphometric measurements) were collected for each station.

Each shoot collected was carefully examined under a stereomicroscope to determine the organisms present. They were classified into three morpho-functional categories: encrusting (encrusting or prostrate algae), turf (algae less than 10 mm long) and erect (algae greater than 10 mm) (Airoldi & Cinelli, 1997; Irving and Connell, 2002a, 2002b). Zoobenthos organisms were only reported when their presence was

significant. Then, cover, i.e., the percentage of area occupied by organisms on the leaf surface, was calculated and divided among the three morpho-functional categories.

Associated communities

The abundance of bivalve *Pinna nobilis* (listed in the Annex IV of HD) is considered an indicator of meadow health (Borum et al., 2004; Díaz-Almela e Duarte, 2008). The presence of P. nobilis can be affected by physical impacts on the meadows (e.g., boat anchoring).

SASPAS protocol: Pinna nobilis density was measured by counting all individuals encountered within a 1 m corridor for both sides of each of three transects 10 m long (see "Belt Transect" technique in Bianchi et al., 2004) and evaluating their status (dead or alive).

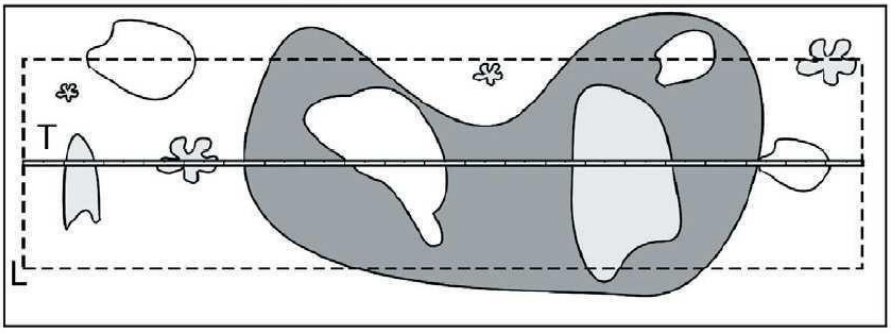

***Figure 5**. "Belt transect" technique for the evaluation of Pinna nobilis associated to seagrass meadows (Bianchi et al., 2004).*

The lower limit of meadows and balise placement (only for* Posidonia oceanica*)

The lower depth of the meadow extension is more fragile than the upper one and can be considered as an indicator of the dynamics of the entire meadows. In addition, its bathymetric identification was performed by the " balisage " technique, which allows us to verify its evolution in the temporal scales envisaged by the project. It consists of the installation of marking points (balises), dead bodies were placed on the bottom at the edge of the meadow, and the possible retreat or increase of the contour was monitored.

SASPAS protocol: Considering the project's schedule, the protocol adopted by the Reseau de Surveillance Posidonies (Charbonnel et al., 2000) was applied in a simplified form with the laying of three balises and a photographic survey.

During the Preliminary Survey (WP 3.1), divers tried to find three sections of the lower limit (characterized by degraded/risk of meadows conditions), placing three balises (1 balise at each section). Only one section was identified, and all three balises were placed along it. Divers took photos: no. 3 frontal pictures

(central, lateral right side and left lateral side) from 0.5 m off the seafloor, using a picket installed 1.5 m from the balise, downward to the P. oceanica meadow.

Because of the characteristics of the two study areas (NP Kornati and Litorale Brindisino), the balises were placed on the bottom of the stations in an area characterised by discontinuous meadows by the edge of patches of Posidonia characterized by degraded/risk conditions. The selected limit did not correspond to the actual lower limit of the meadow (as represented in the example in the following figures), as only possible anchor-risk contours were considered to monitor their retreat dynamics.

Continuous meadow: if the stations are placed in an area characterized by the presence of a continuous meadow (see figure below), the balise technique will not be applied because in the areas potentially subject to anthropogenic impact (where boats are anchored at a depth of probably 4-8 meters) a lower limit will not be "physically" present.

Discontinuous meadow: if the stations are placed in an area characterized by the presence of discontinuous meadows (patches of seagrasses), the balise technique will be applied. Three sections of the limit of patches (characterized by degraded/risk conditions of the meadows) will be selected to place one balise per section. The limit selected will not correspond to the proper lower limit of the meadow (as represented in the example in Figure 6), as we only consider possible endangered contours by anchoring.

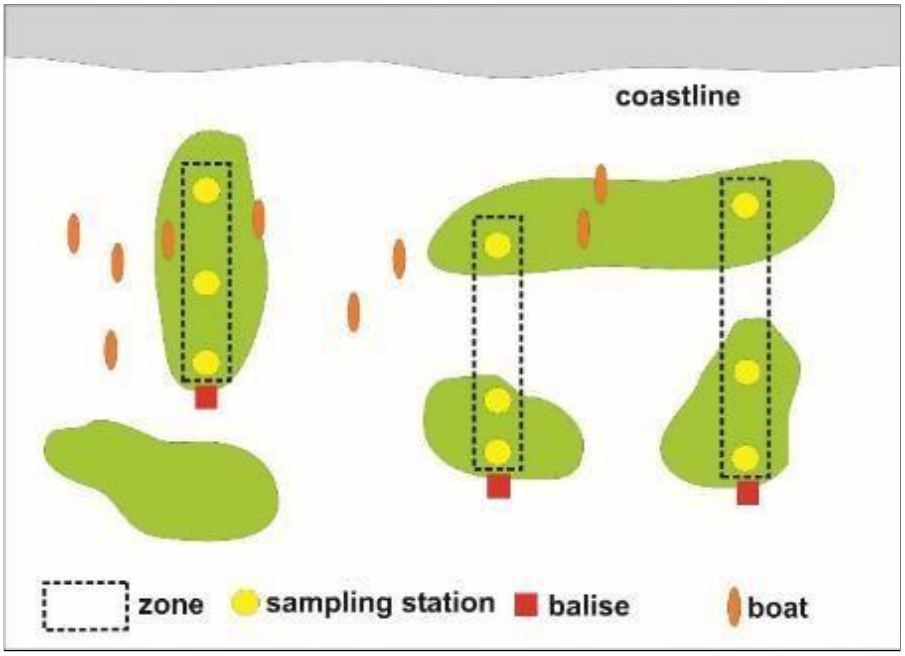

***Figure 6**. Example of balise placement in a discontinuous meadow.*

The typology of lower limits is based on the description of Pergent et al. (1995) integrated by Montefalcone (2009) and UNEP/MAP-RAC/SPA (2009):

- progressive limit: with plagiotropic (horizontal) rhizomes beyond the limit oriented toward the bottom, the absence of matte, regularly decreasing cover (indicates colonization of the meadow in depth);

- sharp limit: the meadow stops abruptly with the presence of vertical rhizomes but in the absence of matte; it is characterized by high (>25 %) or low (<25 %) cover (these limits usually indicate a state of equilibrium, but low percent cover may indicate environmental deterioration and an early imbalance);

- erosive limit: the meadow stops abruptly with the presence of a pronounced step of matte and cover > 50%;

- sparse limit: density is less than 100 shoots per m^2 and covers less than 15 % (in general, it reflects degraded conditions);

- regressive limit: the presence of dead matte beyond the limit, within the dead matte, a few isolated shoots or residual patches of alive *P. oceanica* may persist, with or without a step of matte, isolated or connected to the meadow (it testifies a decline of the meadow).

Recent classifications of the status of the meadow in function of lower limit depth, typology and % cover are reported in the following tables (UNEP/MAP-RAC/SPA, 2009, 2011).

***Table 3**. Status of the meadow in function of the lower limit depth (UNEP/MAP-RAC/SPA 2011, modified).*

	High	Good	Moderate	Poor	Bad
Depth (m)	> 34.2	34.2 to 30.4	30.4 to 26.6	26.6 to 22.8	< 22.8

***Table 4**. Status of the meadow in function of the lower limit typology (UNEP/MAP-RAC/SPA 2011, modified).*

	High	Good	Moderate	Poor	Bad
Lower limit	progressive	sharp (cover > 25 %)	sharp (cover < 25 %)	sparse	regressive

***Table 5**. Status of the meadow in function of the lower limit cover (UNEP/MAP-RAC/SPA 2011, modified).*

	High	Good	Moderate	Poor	Bad
% cover at lower limit	> 35 %	35 % to 25 %	25 % to 15 %	15 % to 5 %	< 5 %

Type of substrate

The substrate type, through visual observation, was also evaluated. Sediment samples were collected for laboratory grain-size analyses.

Alien species

The presence of alien species is included among anthropogenic threats. *P. oceanica* is particularly threatened by some algal species: three species of the genus *Caulerpa* (*C. taxifolia*, *C. prolifera* and *C. cylindracea*) and the turf-forming red alga *Womersleyella setacea*. For this reason, the WFD protocols applied in the Mediterranean Sea require their reporting and coverage estimation.

SASPAS protocol: the abundance of alien species was evaluated as cover using the same methods described for seagrass cover (along three transects at each station).

Presence/absence of habitat disturbance

Evidence of mechanical pressures (e.g., mooring systems, concrete blocks, piers, chains, ropes, and trash) and signs of impacts (e.g., detached shoots, detached plates of matte, damages due to trawling or anchoring) was identified through visual observation.

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Annex 3

SEAGRASS TRANSPLANTATION METHODS

Transplantation methods used up to now for the species *Cymodocea nodosa* (Ucria) Ascherson in the Mediterranean Sea

In the Mediterranean Sea, currently the most used transplanting methods for this species include transplantation of seedlings obtained from seeds germinated in laboratory conditions (e.g., Zarranz et al. 2010; Balestri & Lardicci 2012), transplantation of rhizome cuttings (e.g., Curiel et al 2003; Sfriso et al. 2019, 2021) and transplantation of sods (e.g., Curiel et al. 2003; Sfriso et al. 2019, 2021; Da Ros et al. 2020). Some examples of *C. nodosa* transplants in the Mediterranean Sea are listed below.

Here are chronologically ordered examples of transplantation activities carried out in the Mediterranean Sea for *C. nodosa*. For each example, the method of transplantation, the involved area, a brief description of the activity (extracted, almost as it was, from the related publication), and the publication reference are listed.

EXAMPLE 1

Methods of transplantation: Sod and rhizome transplantation

Involved areas: Lagoon of Venice

References: Curiel et al., 2003.

Brief description of the method: "At each station two 5 m x 5 m cells (A and B) were established. At cell A, […] a non-anchoring method (sods, i.e., plants with substrate intact)" was used, "whereas at cell B […] a rhizome method (bundles of rhizomes with shoots held in the superficial sediments with plastic clips)" was used. "At each station, […] 25 Planting Units (PU) sods" were transplanted "in cell A and bundles of 7-9 rhizomes each in cell B. Sods were harvested using a 30 cm high by 23 cm diameter metallic corer. Rhizomes with an average length of 30-50 cm were collected using a water jet to minimize damage to the plants. Between harvesting and transplanting (about three hours), the PUs were carried by boat and sods stored in PVC buckets, covered with a wet cloth, whereas rhizomes were stored in containers filled with seawater. In the A cells, holes were dug using the corer and sods were placed in the holes. In the B cells, PUs were buried in the bottom with plastic clips. PUs were installed at a regular distance of 1 m by using 5 m x 5 m aluminium frame with a uniform grid of PVC piping. The planting frame was removed after each grid was transplanted. Transplanting was done by SCUBA or SNORKEL divers."

EXAMPLE 2

Methods of transplantation: Transplantation of large sods

Involved areas: Lagoon of Venice

References: MAV - SELC Soc. Coop., 2009; OOPP et al., 2018; Curiel et al., 2021.

Brief description of the method: "The technique of collecting and repositioning large sods with a mechanized methodology was developed after a series of pilot experiments carried out on" *Cymodocea nodosa* meadows "on sandy or silty-sandy sediments, on average bathymetry of about 2-3 m. […] For the execution of these interventions, a specific hydraulic bucket has been designed, mounted on a servo-assisted arm capable of picking up sods of about 2 m^2 and 40-60 cm thick. […] The activity allowed us to obtain 2250 m^2 of *Cymodocea nodosa* sods, from donor sites with high seagrass coverage. The seagrasses have been re-implanted in the Southern lagoon basin in plots of approximately 350 m^2 each; sods were deployed at about 1.30 m from each other. Site monitoring at the end of the third vegetative season showed coverage of 80-100%, and an increase in the vegetated area of 3.2-3.8 times besides low mortality rates of transplanted sods (6% to 13%). […] A second intervention with the mechanized methodology was carried out in May 2016 in the central basin of the lagoon in order to restore an area of about 0.6 ha with *Cymodocea nodosa*. The intervention involved the removal of a total of 450 sods of about 2 m^2 each from two donor sites and the subsequent replanting on a sandy-muddy bottom on a 1.5-3.0 m head. […] After the end of the third growing season, sods gave rise to an almost continuous meadow with a coverage of 75-100% that did not allow the single sods to be recognized each other anymore."

EXAMPLE 3

Methods of transplantation: Transplantation of seedlings obtained from seeds germinated in laboratory conditions

Involved areas: Along the coasts of Gran Canaria, Spain

References: Zarranz et al., 2010.

Brief description of the method: "Wild-collected seeds" were induced to germinate "under hyposaline conditions" and germinated seedlings were acclimated "in tanks (1.6 m3)" until they "developed sufficient roots and shoots for transplantation (30-45 days)". Successively the "transplantation of acclimated seedlings to the field in dense groups" was carried out. Two transplant treatments were used: "i) seedlings scattered on nylon nets tied with thread (20x20 cm nets with 20 sown seedlings in each, n=60, density=500 seedlings m-2) and ii) seedlings clustered in biodegradable trays made of compressed coconut fibre dust (= trays), which allowed a healthy root growth in 12compartments of 3x3x5 cm, with three seedlings per compartment and up to 36 seedlings per tray, n=108, density=3333 seedlings m-2. The nylon nets and trays were anchored using metal staples. […] A sheltered location was selected as acceptor area to improve chances of establishment."

EXAMPLE 4

Methods of transplantation: Transplantation of seedlings obtained from seeds germinated in laboratory conditions

Involved areas: Along the coast of Livorno (Italy)

References: Balestri & Lardicci, 2012.

Brief description of the method: “Seeds of *C. nodosa* were collected from 16 randomly chosen areas (six seeds per area) spaced at least 30 m apart within” the selected “meadow […] at a depth of ca. 1 m […]. Seeds were transported to an aquaculture facility […]. The cultivation system consisted of four outdoor fibreglass tanks (5000 L) connected to a system that pumped naturally filtered seawater, equipped following a protocol under the Italy patent application (PI/2005/A/000092). Seawater temperature in tanks ranged from 11 °C (winter) to 30 °C (summer) during the study period. Soon after collection, seeds were sown 2-3 cm deep in sand collected from the donor meadow in five rectangular plastic containers (45 x 15 x 16 cm). There were 15 seeds per container.” Nine to ten months later, “the number of germinated seeds was counted. Emerged seedlings were removed from the substrates […], selected for uniformity of size (1 leaf, ca. 2 cm leaf length) and transplanted individually in containers filled with a mixture (80% v/v) of beach sand (washed with seawater) and volcanic stone […]. Two container types, rectangular (45 x 15 x 14 cm) and round pots (30 cm diameter, 14 cm height), were tested. There were six rectangular and six round containers, 10 cm apart, in each tank, providing 24 seedlings in total. They were placed at a depth of ca. 1 m and rotated within each tank over the study period. […]” The seedlings were left to grow and became 4-year-old plants that were used as mother plants for the subsequent propagation experiments. From a “ subset of randomly selected mother plants” […] cuttings were excised at the start of the growing season […] and at the end of the growing season […]; two plants grown in round containers and two plants grown in rectangular containers were used in each experiment.” For each growing season “four horizontal rhizomes were randomly selected from each plant. Rhizomes were cut into unbranched fragments […] and planted in round containers (54 cm diameter, 12 cm height) filled with a mixture of beach sand and volcanic stone (80% v/v)” to obtain stock plants. […] Stock plants regenerated from mother plants in the propagation experiment were cut into fragments […]. Fragments of uniform size […] were excised from the lateral branches […] and immediately transplanted at two replicate sites […] close to a *C. nodosa* meadow. Transplants were anchored to the substrate using metal pins (4 cm in length) that were removed soon after rooting.”

EXAMPLE 5

Methods of transplantation: Sod and rhizome transplantation

Involved areas: Venice Lagoon, Po Delta Lagoon, Comacchio Valleys

References: Progetto LIFE SeResto LIFE 12 NAT/IT/000331; Sfriso et al., 2019, 2021.

Brief description of the method: “The transplants of aquatic angiosperms took place in an area measuring approximately 36.6 km^2 […]. Thirty-five stations characterized by shallow waters were identified in the study area, along the edges of the salt marshes and lagoon canals. […] Sods […] approximately 30 cm in diameter […] were collected with a manual corer and arranged in groups of three for a total of nine sods per station […]. In order to avoid damaging the bottom, all operations were carried out by remaining on board of flat local boats or by divers. The depth of the intervention area was generally less than one meter on the average tide level, and the boats were used during high tide to reach even the shallowest areas that emerge at low tide. Angiosperm sods and rhizomes were supplied by managers of closed fishing ponds […], where ecological conditions are high and aquatic angiosperms are abundant. Hundreds of full-

grown rhizomes were transplanted individually at each station using pliers with a handle of approximately 1 m lengths."

Besides *C. nodosa*, other transplanted species were *Z. marina, Z. noltei* and *R. cirrhosa*. The transplants were successful in 32 out of the 35 stations, and after 4 years ca. 10 km^2 of lagoon bottoms were colonized with an average coverage of 40%. In the fifth year, coverage increased to approx. 15 km^2 and is still increasing. Transplants of the same species were also carried out in the northernmost part of the lagoon of Venice, in the lagoon and ponds of the Po Delta and at Fattibello in the Comacchio valleys in the framework of the Life projects: Lagoon Refresh (LIFE 16 NAT/IT/000663) and Transfer (LIFE19 NAT/IT/000264).

EXAMPLE 6

Methods of transplantation: Sod transplantation using biodegradable bags

Involved areas: Gabicce Mare, western coastline of the Adriatic Sea

References: Da Ros et al., 2020.

Brief description of the method: "The seagrass transplanting was carried out […] using biodegradable bags made of corn starch inserted in biodegradable containers (made with rice husks), which were anchored with U-shaped stainless-steel rods. A manual stainless-steel corer was used to dig a clod" (= sod) "from the donor seagrass meadow, avoiding any damage to the roots and leaves. This clod was immediately inserted into a biodegradable bag, and in turn, the bag was inserted into the biodegradable container to maintain the consistency of the clod. The container was then inserted in the receiving sediments and anchored with a U-shaped stainless-steel rod. To limit the potential impact of shoots removal from the donor meadow," a "final shoot density for the transplanted plots of the 10% of the density assessed in the donor meadow" was chosen. "Thus, 13 containers, each containing 11-13 shoots of seagrass, were planted in each of the" selected acceptor sites.

Transplantation methods used up to now for the species Posidonia oceanica (L.) Delile in the Mediterranean Sea

For almost complete Italian guidelines about *P. oceanica* transplants, see the ones published by ISPRA (Manuali e Linee Guida n. 106/2014), Calvo et al. 2014, Cinelli et al. 2014. In the Mediterranean Sea, currently the most used transplanting methods for this species use seedling, rhizome cuttings, and adult plant shoots as planting units and different anchoring methods (e.g., Molenaar & Meinesz 1995; Balestri et al. 1998; Cinelli et al. 2014; Pirrotta et al. 2015; Alagna et al. 2019; Bacci et al. 2019; Tomasello et al. 2019; Ward et al. 2020; Curiel et al. 2021; Piazzi et al. 2021); the transplant of sods is instead less applied (e.g., Sanchez-Lizaso et al. 2009; Bacci et al. 2019; Curiel et al. 2021). Some examples of *P. oceanica* transplants in the Mediterranean Sea are listed below.

Here are chronologically ordered examples of transplantation activities carried out in the Mediterranean Sea for *P. oceanica*. For each example, the method of transplantation, the involved area, a brief description of the activity (in most of the cases extracted, almost as it was, from the related publication), and the publication reference are listed.

EXAMPLE 1

Methods of transplantation: Transplantation of seedlings obtained from seeds germinated in laboratory conditions

Involved areas: coastal area off Rosignano Solvay, Liguria (Italy)

References: Balestri et al., 1998.

Brief description of the method: "Mature fruits of *P. oceanica* were collected at Livorno from shoreline drift material […] and transported to the laboratory. Fruits were cut in half, and the seeds extracted. Seeds were placed on plastic filters (0.5-cm mesh) maintained at a distance of 10 cm from the bottom in four 20-l tanks containing natural aerated seawater (38‰ salinity). Two hundred seeds were used per tank. Tanks were placed in a growth chamber at a temperature of 16 °C with a 16-h photoperiod provided by cool white fluorescent lights with 30 µmol m-2s-1 irradiance. Seawater was renewed completely every week. Germination of seeds was achieved within two weeks. Two months after germination, homogeneously sized seedlings were selected. To minimize damage, seedlings were individually inserted into 3x3-cm cheesecloths, which were then fixed to plastic grids (25x25 cm, 1-cm mesh) using a nylon thread. […] Experiments were carried out […] at […] two sites." The first experiment was planned "to study the effects of the substratum and site on survival and development of transplanted seedlings. […] Experimental units were represented by grids with five equally spaced seedlings. Six experimental units were placed at each site and fixed at the corners with 20-cm long steel bars. Treatment variables […] were […] substratum and […] site. […] The second experiment was […] designed to assess the potential impact of herbivores on transplant success. […] The two main herbivores […] *Sarpa salpa* and […] *Paracentrotus lividus* […] were excluded by enclosing the experimental units within cages and nets. Cages (30 x 30 x 25 cm) were made of 10-mm mesh (green wire) without the basal side. They were anchored at each corner with 20-cm long stainless-steel bars. Nets (50 x 50 cm, 1-cm mesh) were supported by 40-cm long steel wire bars and buried to a depth of 10 cm, while the top was tied to prevent herbivores from entering. […] This experiment was conducted only on 'matte'. Treatments […] were: (1) herbivore exclosure (caging vs. fencing vs. unmanipulated control) and (2) site […]. Nine experimental units were placed at each site."

EXAMPLE 2

Methods of transplantation: Sod transplantation

Involved areas: coastal area off Alicante (Spain)

References: Sanchez-Lizaso et al., 2009.

Brief description of the method: "Sods of approximately 1 m^2 surface area and 40 cm depth were extracted from the area expected to suffer for a harbor expansion. These sods were transferred to bare areas surrounded by seagrass meadows at the same depth of the donor site (about 10 m) […]. Over 200 sods were cut, lifted with air balloons and transported underwater to the transplanted site, where they were fixed to the seabed."

EXAMPLE 3

Methods of transplantation: Transplantation of cuttings using iron wire meshes

Involved areas: Gulf of Palermo (Italy)

References: Pirrotta et al., 2015.

Brief description of the method: "About 700 shoot cuttings growing on sand, at a depth of 16 m, were collected according to harvesting guidelines […] in order to minimize damage to the donor bed. In particular, material suitable for transplanting, consisting of terminal plagiotropic cuttings with three leaf bundles […], was selected. Cuttings were then stored in large coolers with small amounts of seawater to prevent desiccation during transport to the planting sites. Subsequently, cuttings were fixed on galvanized electro welded iron wire mesh […]. Grids were 1x1 m with a mesh of 5 cm, and 39 cuttings (≈117 shoots) were positioned per grid. Within 12 h from sampling, a test transplant, consisting of 3 grids, was performed at each of the five selected sites. In addition, three grids were transplanted at one control site (procedural control) close to the donor bed, in order to evaluate the effect induced by cutting transplantation itself. The grids were anchored on sand, the same substratum as the donor bed, using 70 cm long iron spikes and at a lower depth (14 m) than the donor bed."

EXAMPLE 4

Methods of transplantation: Transplantation of cuttings with a patented gabion supporting structure

Involved areas: Capo Feto, South-West coast of Sicily (Italy)

References: Alagna et al., 2019.

Brief description of the method: "*P. oceanica* orthotropic rhizomes, about 10-15 cm long, were collected from […] two sites" of the donor meadow. "Only orthotropic rhizomes were collected […]. Rhizomes were trimmed at 10 cm (length measured from the rhizome trimming point to the leaf meristem) by cutting the base to ensure comparable biometry and biomass among individuals. Cuttings were stored underwater in nets placed on the sea bottom to minimize disturbance and transplanted within 2 days. […] Transplantation occurred on ad-hoc constructed gabions made of metallic grids […] of 100x50x50 cm, filled with limestone rocks of two selected size ranges […]. The gabion mattresses constituted the supporting structure […] on which cuttings were secured according to five different anchoring techniques" (free inserted beneath rocks or fastened with devices of different materials). "Based on previous experiences, transplantation density was kept at 36 rhizomes m^{-2} […]. Moreover, 4 batches of 18 cuttings

were placed at each of the two sites close to the gabion mattresses on coarse sandy patches to compare *P. oceanica* rooting ability on sand to that on rocky substrate […]. Each cutting was tied to a metal stake with a small rope and inserted beneath the substrate."

EXAMPLE 5

Methods of transplantation: Transplantation of cuttings using biodegradable supports and iron wire meshes enclosed in concrete frames; sod transplantation

Involved areas: Priolo Gargallo - Sicily, S. Marinella - Lazio, Ischia - Campania and Piombino - Tuscany, (Italy)

References: Bacci et al., 2019 - LIFE S.E.POS.S.O. Project.

Brief description of the method: Two different supports and methods were employed for the transplantation of cuttings. At Priolo Gargallo, plastic-like modules made up of a totally biodegradable polymer (Mater-Bi®; Biosurvey S.r.l. and IDEA S.r.l.) were used; the biodegradable modules had a star shape with 5 arms. 10 plagiotropic rhizome cuttings were fastened to each biodegradable support, 2 cuttings per arm, and only cuttings with an average of three shoots were selected. The planting units were fixed on dead matte with linchpins inserted in pre-installed biodegradable pickets; 72 of the planted modules could be monitored on a total area of 2500 m^2. At S. Marinella and Ischia, the employed modules consisted in 50x50 cm square concrete frames enclosing iron wire meshes, to which 8 cuttings, each bearing a single orthotropic shoot, were fastened. The planting units were fixed to sand bottoms with different methods (e.g., just positioned and pressed on the bottom, through the use of pickets). At S. Marinella, 260 of the planted modules could be monitored on a total area of 10000 m^2; at Ischia, 100 of the planted modules could be monitored in a total area of 1600 m^2. SCUBA divers carried out the planting activities. At Piombino, sods with a surface area of 4 m^2 were excavated from the substrate with a hydraulic bivalve bucket that allowed the collection of intact sods including also the associated fauna. The sods were temporary stored and transported to the acceptor site with a split-barge motor vessel, which allowed the water inflow and thus kept the plants and the associated fauna alive until their positioning. Of the 340 transplanted sods, 314 could be monitored in a total area of 1362 m^2.

EXAMPLE 6

Methods of transplantation: Transplantation of cuttings using Artificial Reefs

Involved areas: Gulf of Augusta, Syracuse (Italy)

References: Tomasello et al., 2019 – PON TETIDE Project.

Brief description of the method: "Several ARs (Artificial Reefs) hosting *P. oceanica* transplants were positioned at about 13 m depth […]. The AR design was chosen according to the characteristics of the study area and considering several aspects (i.e., hollow, size, material, shape). In particular, four ARs, each one consisting of three modules of 10 tons, were located. These modules are made of reinforced concrete and composed by a common base of 2x3 m with multiple communicating shelters, and an upper form

with three different heights (varying between 100 and 180 cm), to result shelters with different volumes, light and water movement […]. Over each AR module, 10 *P. oceanica* cuttings, each one bearing at least three shoots, were fixed by an innovative system, opportunely adapted for hard substrate."

EXAMPLE 7

Methods of transplantation: Transplant of cuttings and seedlings using non-degradable and degradable mats

Involved areas: Capo Carbonara, Sardinia; Elba Island, Tuscany (Italy)

References: Piazzi et al., 2021.

Brief description of the method: "Drifting *P. oceanica* cuttings, naturally uprooted, were collected" from the "bottoms by SCUBA scientific divers. At Capo Carbonara, the cuttings were harvested in natural storage sites characterized by sand bottom clearing areas within the extensive meadow where the restoration was set up […]. At Elba Island, natural storage sites occurred in small bays adjacent to the transplanting site […]. The cuttings to be used as transplanting material were selected on the basis of their size, number of shoots, and health conditions visually estimated. Where necessary, cuttings were split to obtain the required size." In both the sites "one cutting consisted of a fragment of the rhizome of about 20 cm bearing 1-3 shoots. […] At Elba Island, 300 *P. oceanica* seedlings collected in accumulation areas along the coast or found on the surrounding bottoms by SCUBA scientific divers, were also used. Both shoots and seedlings were anchored to the substrate through manual inclusion in the mats previously fixed to the bottom." At Capo Carbonara non-degradable mats were used, while at Elba Island degradable mats. Non-degradable mats were "Macmat® R (Maccaferri, Bologna, Italy)," reinforced geomats "obtained by a three-dimensional polymer matrix extruded onto a double twisted steel woven mesh […]. Degradable mats" were "made of natural coconut meshes coupled with a double twisted steel woven mesh R.E.C.S.® […]. Both mats had a mesh size of 8 × 10 cm and a thickness of about 5 cm. The mats were anchored by metal pickets 120 cm long to the dead matte" (the structure made of *P. oceanica* rhizomes and the trapped sediments) "at a depth of 15-20 m (with a mean of 1 picket per m^2)."

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Annex 4

Park Kornati: specific procedures for assessing the impact on the environment and assessing the acceptability of the project on the ecological network Natura 2000

Environmental impact assessment is an assessment of possible significant environmental impacts of the project determined by the Environmental Protection Act (OG 80/13, 153/13, 78/15, 12/18, 118/18) and the Decree on Environmental Impact Assessment 61/14, 3/17, hereinafter: Decree on Environmental Impact Assessment). It is carried out within the preparation of the intended intervention, before the issuance of a location permit for the implementation of the intervention or other approval for the intervention for which the issuance of a location permit is not mandatory. Measures and/or a program for monitoring the state of the environment determined by the decision on the acceptability of the projectfor the environment are mandatory in the content of permits for the implementation of the project issued under a special law.

The Decree on Environmental Impact Assessment for the instalment of anchorages does not foresee the implementation of the environmental impact assessment procedure, i.e., the assessment of the need for impact assessment of the project on the environment.

However, as prescribed by the Regulation on Environmental Impact Assessment, for seaports with more than 100 berths, it is necessary to carry out an assessment procedure on the need for environmental impact assessment carried out by the ministry responsible for environmental protection and nature (now: Ministry of Economy and Sustainable Development, hereinafter: the Ministry).

For seaports open for the public transport of special (international) economic interest for the Republic of Croatia and special purpose seaports of importance to the Republic of Croatia, it is necessary to carry out the environmental impact assessment procedure following the Regulation on Environmental Impact Assessment.

If the planned anchorage is located in the area of the ecological network Natura 2000, before issuing the location permit, it is necessary to carry out the procedure of assessing the acceptability of the intervention on the ecological network following the Nature Protection Act (OG 80/13, 15/18, 14/19, 127/19). The assessment of the project's acceptability consists of the preliminary and the main assessment of the acceptability and the determination of the prevailing public interest and the project's approval under compensatory conditions.

Under the Nature Protection Act, for interventions for which a special regulation governing environmental protection stipulates the obligation to assess the impact on the environment, the preliminary assessment is performed before initiating the procedure for assessing the project's impact on the environment. For an intervention for which a special regulation governing environmental protection imposes an obligation to assess the environmental impact, or it is determined in the assessment procedure on the need for assessment, the main assessment is performed within the environmental impact assessment procedure.

The Ministry conducts the Preliminary Assessment and the Main Assessment of Eligibility for Interventions:

- for which the state administration body responsible for environmental protection conducts the environmental impact assessment procedure or the assessment procedure on the need for environmental impact assessment according to a special regulation in the field of environmental protection;

- whose scope is located in the area of two or more units of regional self-government and/or the City of Zagreb.

The Managing Authority conducts the Preliminary Assessment and the Main Assessment for the interventions:

- for which the body of regional self-government responsible for environmental protection carries out the environmental impact assessment procedure or the assessment procedure on the need for environmental impact assessment according to a special regulation in the field of environmental protection;

- which may significantly impact the conservation objectives and integrity of the ecological network area, except for those for which the Ministry is responsible.

Decisions from the above procedures are attached to the application for the issuance of a location permit as prescribed by the Law on Physical Planning.

Location permit

By the Ordinance on interventions in space that are not considered construction and for which a location permit is issued (OG 105/17, 108/17), it is necessary to obtain a location permit for anchorages. In the process of issuing a location permit, the competent authorities issue special conditions and determine compliance with spatial planning documentation and maritime publications. The Law regulates the procedure for issuing a location permit on Physical Planning.

The procedure is initiated at the request of the interested party, and the competent administrative body makes the decision of the county, respectively, the ministry responsible for the construction and physical planning (current: Ministry of Physical Planning, Construction and State Property).

The location permit ceases to be valid if no application for a concession is submitted within two years from the day the location permit becomes final.

After the Study of anchorages and moorings to set up an anchor system in the Kornati National Park, preliminary designs of anchor systems were prepared for each bay in the Park where their installation was planned. Based on these conceptual projects, a location permit was requested from the Administrative Department for Physical Planning and Construction of Šibenik-Knin County.

After obtaining location permits, the Ministry of the Sea Transport and Infrastructure was asked for a concession for the special use of the maritime property.

Concession

It is necessary to obtain a concession to install anchor systems in the appropriate areas of the maritime domain in the Kornati National Park. According to the Maritime Property and Seaports Act (OG 158/2003, 100/2004, 141/2006, 38/2009, 123/2011, 56/2016, and 98/2019), a concession is a right by which a part of a maritime property is partially or fully excludes from general use and gives for special use or economic use to natural and legal persons, following spatial plans.

According to their purpose, the Law on Maritime Property and Seaports distinguishes between ports open to public traffic and ports for special purposes. Also, ports can be open for international traffic or domestic traffic. By the Law on Maritime Property and Seaports, according to the size and importance for the Republic of Croatia, ports open to public traffic are divided into:

1) ports of special (international) economic interest for the Republic of Croatia;

2) ports of county importance;

3) ports of local importance.

According to the activities performed in special-purpose ports, these ports can be:

1) military ports;

2) nautical tourism ports;

3) industrial ports;

4) shipyard ports;

5) sports, fishing, and other ports of similar purpose.

According to the importance of the Republic of Croatia, special purpose ports referred to in his Article are divided into:

1) ports of importance for the Republic of Croatia;

2) ports of county importance.

The Ordinance prescribes categorization and conditions that must be met by nautical anchorages on the categorization of nautical tourism ports and the classification of other facilities for the provision of mooring and accommodation services for vessels (OG 120/19).

The Decree prescribes the procedure for obtaining a concession on a maritime domain on the procedure for granting a concession on a maritime domain (OG 23/2004, 101/2004, 39/2006, 63/2008, 102/2011, 125/2010, 83/2012 and 10/2017) (hereinafter: the Regulation).

According to the Regulation, concessions on the maritime domain are granted following:

- Law on Maritime Property and Seaports;
- location permit;
- spatial planning documents;
- Regulations.

The concession for the special use of the maritime property is granted upon request, and the grantor of the concession for the special use of the maritime property for facilities of national importance is the Government of the Republic of Croatia. It issues a concession for up to 99 years. The preliminary procedure is carried out by the Ministry of the Sea, Transport and Infrastructure.

Anchorages under concession are managed by economic entities that have been granted a concession by the competent authorities (state administration and regional self-government) following the Maritime Property and Seaports Act or are part of a port open to public traffic (port areas), in which case the competent port authority manages them. The Decree on the Establishment of the Port Authority determines the port area to which the competence of the Port Authority extends.

The concession is issued for special use or economic use of a part of the maritime domain based on a public tender following the Maritime Property and Seaports Act, the Concession Act (OG 69/17, 107/20), location permit, spatial planning documents, and the Decree on Procedure granting a concession on a maritime domain (OG 23/04).

The letter of the initiative is submitted to the competent administrative department of the county, respectively the ministry responsible for maritime affairs (current: Ministry of the Sea, Transport and Infrastructure), and the competent authority responds within a certain period and, if necessary, requires additional documentation.

According to the Maritime Property and Seaports Act, a concession may be granted to a legal or natural person who meets the following conditions:

1) that it is registered to perform the economic activity for which it is requesting a concession;
2) to have appropriate technical, professional, and organizational capabilities for the realization of the concession;
3) to have a guarantee for the realization of the plan and program for the realization of the concession;
4) that all obligations from previous concessions have been settled so far;
5) that her concession has not been revoked so far.

Fulfilment of the conditions from the above points 2 and 3 is proven by a feasibility study containing the amount of investment and depreciation method, and it is desirable to have a conceptual design and feasibility study at the beginning of the procedure, which documentation is required in the further procedure.

For seaports, it is necessary to determine the border of the port area in advance (by the boundaries determined by the spatial planning documents of the local self-government unit) and implement it in the land register. The border of the port area is not determined for anchorages, but it is necessary to obtain a location permit.

A concession for an out-of-port area may be granted after the maritime domain boundary has been determined and implemented in the land register (Decree on the procedure for determining the maritime domain boundary).

Furthermore, following the Law on Maritime Property and Seaports, the concession is granted for a period of 5 to 99 years, respectively:

1) The concession for the economic use of the maritime property and the use or construction of buildings of importance to the county is granted by the County Assembly for up to 20 years, and the competent administrative body carries out the preliminary procedure in the county.

2) The concession for the economic use of maritime property, which includes the use or construction of buildings of importance to the Republic of Croatia, is granted by the Government of the Republic of Croatia for up to 50 years, and the Ministry carries out the preliminary procedure.

3) A concession covering the construction of new buildings of importance to the Republic of Croatia, which requires large investments and whose overall economic effects cannot be achieved within 50 years, is granted by the Government of the Republic of Croatia for over 50 years with the consent of the Croatian Parliament.

When determining the deadline for the concession, the purpose, scope, and number of required investments, as well as the overall economic effects achieved by the concession, are taken into account. Exceptionally, if a certain project is in the interest of the Republic of Croatia or if it deems it justified, the Government of the Republic of Croatia may always decide on announcing a public collection of bids and granting a concession on a maritime domain.

Buildings of importance for the Republic of Croatia are determined by regulations in the field of physical planning, and buildings of importance for the county are considered to be all other buildings.

Based on the decision on the concession, the grantor of the concession and authorized person enter into a concession agreement.

From the very beginning, the Public Institution has decided not to charge for berths on planned anchor systems, so it will not use the maritime asset economically. Thus, the Public Institution decided to seek a concession for the special use of the maritime property.

Concession in protected areas

Maritime property may be given for special use or economic use following environmental and nature protection regulations.

In doing so, the Nature Protection Act prescribes the following:

- Concession cannot be granted in a strict reserve.
- In a national park, special reserve, and speleological facility, a concession may be granted in the manner prescribed by the Nature Protection Act.
- Concessions on the maritime domain in a national park and special reserve may be granted following a special regulation governing the granting of concessions on the maritime domain.
- In the nature park, regional park, forest park, significant landscape, and monument of park architecture, concessions may be granted according to a special regulation with the opinion of the Ministry. An opinion is not required when the decision on the concession is made by the Government or the Croatian Parliament.
- The competent public institution does not have to have a concession for the use of natural resources in the protected area it manages.
- The Government may, by a special decision, determine certain protected areas, ie other parts of nature owned by the Republic of Croatia or maritime property on which protected parts of nature are located, on which no concession can be granted.

The concession is awarded based on a public tender following the Concessions Act and the Maritime Property and Seaports Act. Notice of the intention to grant a concession, in addition to the data prescribed by the Concessions Act, must also contain the conditions for nature protection determined by the Ministry, which are an integral part of the decision on granting a concession and the concession contract.

According to Article 19, paragraph 3 of the Maritime Property and Seaports Act, in a national park, a concession for the economic use of a maritime property may be granted only by the Government of the Republic of Croatia and in other protected parts maritime domain and seaports, but with the prior consent of the Ministry.

Concession in a protected area or speleological facility is granted following the Nature Protection Act for a period of six to 55 years.

After collecting the necessary documentation, the Public Institution Kornati National Park requested from the Ministry of the Sea, Transport, and Infrastructure and then received a concession for the special use of the maritime property. This opened the way for the Public Institution to announce a tender for the public procurement of anchor systems.

In the meantime, the Public Institution of Kornati National Park has also made implementation projects of anchor systems at all planned locations to facilitate (more precisely determine) the procedure of conducting public procurement for the installation of anchor systems.

Annex 5

In the frame of the Deliverable 4.1, the Regional Natural Park of "Coastal Dunes from Torre Canne to Torre San Leonardo" carried out the Biocenotic Map of the area ZSC "Litorale brindisino". The activities and results have been obtained used the Side Scan Sonar and Multibeam surveys. The geoacoustic survey made it possible to draw up detailed thematic maps (biocenotic and bathymetric cartography). The area extends parallel to the coast for about 10 km and offshore for about 5 km, from the bathymetric band of 10 meters to that of 50 meters deep, covering a total area of about 4113 hectares. The study area is characterized by an environmental context of high naturalistic value since it represents part of the "Litorale Brindisino" SAC CODE - IT9140002 (Figure 1).

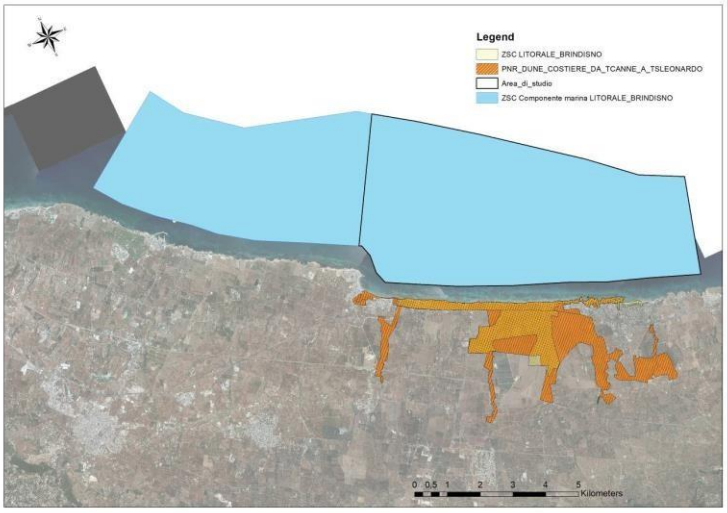

Figure 1. *Study area represents part of the "Litorale Brindisino" SAC CODE - IT9140002.*

A Klein 3900 Side Scan Sonar and an R2 Sonic 2024 multi-beam echo sounder were used for the geomorphological and bathymetric study carried out in this work. The Side Scan Sonar survey produces photogrammetry that allows us to identify the different lithologies and biocoenoses that characterize the seabed investigated. The investigation with the Multibeam allows you to obtain a detailed surface area of the seabed. It is important to underline that these survey methodologies have been standardized within the Marine Strategy Framework Directive (MSFD), which entered into force in July 2008.

The detailed biocenotic and morpho-bathymetric characterization involved the realization of the following working phases:

1. Survey planning in a GIS environment;
2. Data acquisition activities at sea;
3. Processing and processing of the acquired data;
4. Data interpretation and validation activities;5. Cartographic restitution.

In order to validate the spatially explicit data obtained from the interpretation of the mosaic of the SIDE SCAN SONAR sonograms, n. 28 prospecting points (truth at sea) along 7 transepts. The validation points were located between 10 and 20 meters deep to characterize and define, more precisely, the *Posidonia oceanica* habitats (Figure 2).

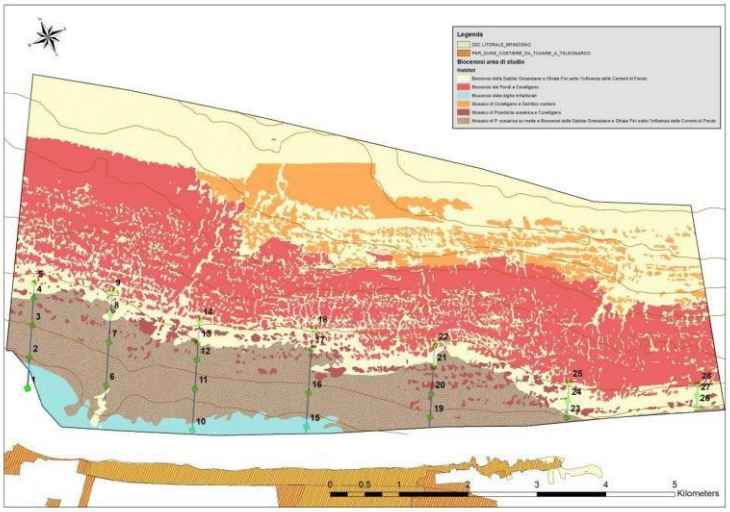

Figure 2. *Location of the no.7 transepts.*

The surveys carried out through multibeam allowed to elaborate, in a GIS environment, the map of the bathymetry of the study area. The spatial elaboration of this theme has allowed the production of isobaths every meter of depth (Figure 3). While the investigations carried out through the use of the Side Scan Sonar validated in the phase "truth at sea" have allowed us to develop, in the GIS environment, the map of the biocenoses of the study area (Figure 4).

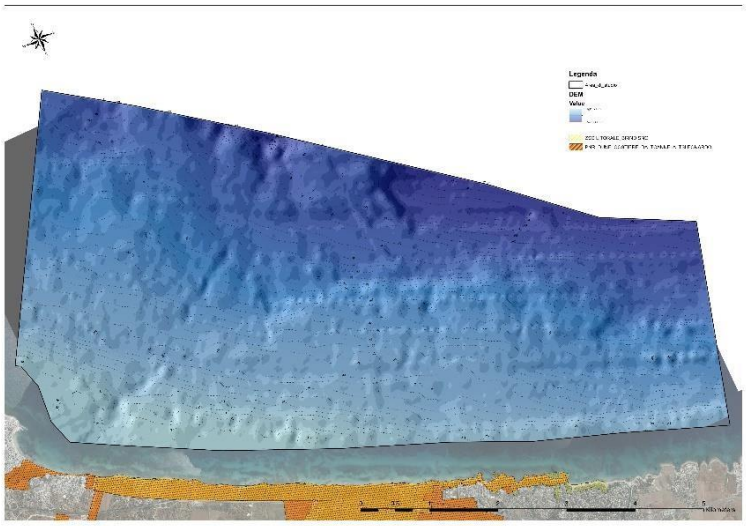

Figure 3. *Map of the bathymetry of the study area.*

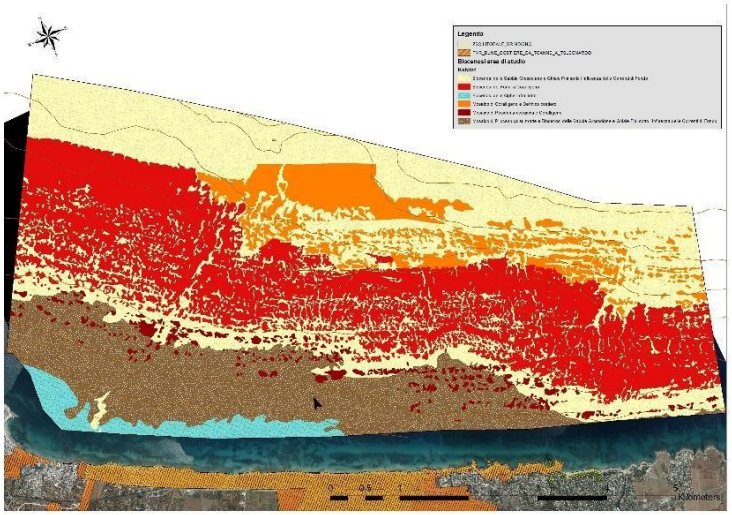

Figure 4. *Map of the biocenoses of the study area.*

The types of habitats identified are listed below in the following Table:

Habitat	Area_ha	Percentuale
Biocenosis of coarse sands and line gravels under the influence of bottom currents	1529,62	37,19%
Coralligenous biocenosis	1253,90	30,48%
Biocenosis of infralittoral algae	117,40	2,85%
Mosaic of coralligenous and Biocenosis of the coastal detritic bottom	351,73	8,55%
Mosaic of Posidonia oceanica meadows and coralligenous biocenosis	90,78	2,21%
Mosaic of Posidonia oceanica meadows and Biocenosis of coarse sands and line gravels under the influence of bottom currents	769,99	18,72%
TOTAL	**4113,42**	**100,0 %**

The biocenosis of infralittoral algae (Figure 5) is a typical population that colonizes the well-lit rocky infralittoral. In the survey area, the biocoenosis of infralittoral algae colonizes the rocky substrate identified in the bathymetric belt between 0 and -10 meters deep and is mainly located in the northernmost stretch of sea.

Figure 5. *Biocenosis of infralittoral algae.*

In the range between -10 and -20 meters deep, the prevailing biocenoses show a mosaic of *P. oceanica* on matte and Biocenosis of the Coarse Sands and Fine Gravels under the influence of the background currents (Figure 6).

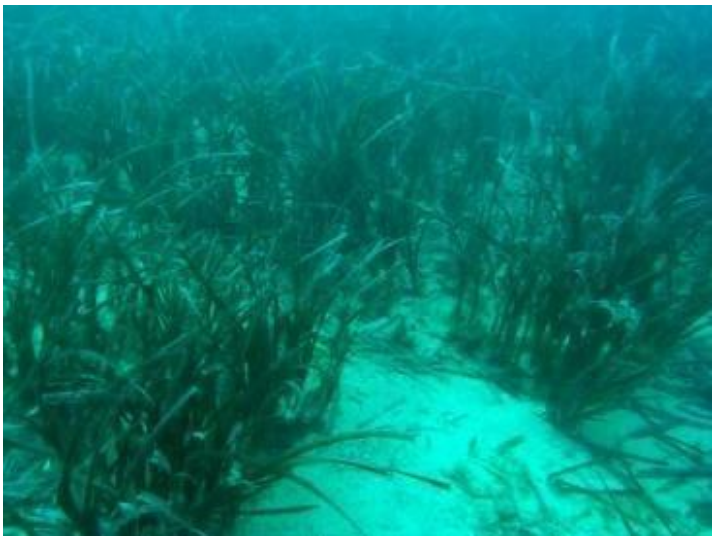

Figure 6. *Mosaic of* Posidonia oceanica *meadows and Biocenosis of coarse sands.*

The depth of the study area, with a depth of -20 m, is characterized by the constant presence of Coralligenous Biocoenosis. The term coralligenous indicates a biogenic substrate, that is, "built" by living organisms, particularly by the set of calcareous concretions mainly formed by red algae with calcareous thallus, serpulids and bryozoans (Figure 7).

The habitat called "Biocenosis of the Coarse Sands and Fine Gravels under the Influence of the Bottom Currents", which colonizes most of the investigated area, is characterized by typical soft bottom species, mainly molluscs and polychaetes.

Figure 7. *Coralligenous biocenosis.*