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***Report on the plans for
implementation of pilot actions***

Version: 1.0 (March 2025)

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1 Introduction

Work Package 2 (WP 2) is built around realistic objectives that all BIOPRESSADRIA partners expect to achieve within the established timeline. The primary and main goal of this package is to mitigate the negative impacts caused by beach tourism and leisure boating activities on coastal habitats. BIOPRESSADRIA plan to achieve that by developing and testing pilot actions that will address these issues effectively.

The first step in this process is to identify and causally connect these signs of habitat degradation and damage with such activities. Recognizing these signs is essential, as it forms the basis for proposing and planning the most appropriate pilot actions. In fact, only by understanding the specific nature of the pressures on these coastal areas it will be possible to plan effective interventions that address the root causes of degradation.

This report focuses on **WP 2 Activity 1, which is dedicated to the definition and development of cross-border plans for pilot actions and to the carrying out of preliminary activities** that will lay the groundwork for the **concrete implementation of these actions (part of WP 2 Activity 2 and 3)**. This activity involves planning sessions for two type of pilot actions, as foreseen by the project:

- **Pilot Actions Type 1:** this typology focuses on the development and testing of spatial zoning as a tool to identify, quantify and manage the pressures caused by recreational boating and anchoring. It builds partially on the results of the SASPAS project. The intense use of beaches, nautical traffic, anchorage areas, and port moorings all contribute to significant impacts on valuable coastal habitats, including dune systems, beaches, the first strip of sea, seagrass meadows, and sensitive organisms. To address these issues, an evaluation must be conducted in the pilot areas, to define clear zoning criteria to understand the level of these disturbances, determine appropriate distances for anchoring and mooring in relation to the seagrass meadows, as well as establish limits on the intensity and size of nautical traffic in these areas.
- **Pilot Actions Type 2:** building on the outcomes of the SASPAS project (which concretely introduced eco-buoy solutions to discourage anchoring in seagrass areas), this plan aims to expand the scope by developing a broader protection strategy. This strategy follows a cross-border approach, considering various coastal components. The objective is to suggest and test practical actions to mitigate the pressures on coastal habitats. These actions will involve the application of a wide range of technical solutions that could be standardized and implemented across borders to address the challenges of protecting coastal ecosystems from human activities, including on one side very practical applications of eco-mooring systems, but also governance tests on the other.

To address the challenges posed by habitat degradation, it is important to identify and understand the extent of the issues affecting pilot sites. In this way, it is possible to determine the origin of the



problems, to attempt a quantification and helps in deciding which pilot actions are the most effective. In fact, the identification process is not just about spotting degradation but also about quantifying the problems as accurately as possible to make informed decisions about the actions needed.

All ideas regarding possible pilot actions need to be transformed into well-structured steps that align with the project's logical flow, delving into the details and ensuring their readiness for implementation. A vital aspect of this process consists in sharing these ideas with all relevant stakeholders, ensuring their involvement in the decision-making process. This sharing process, as outlined in WP1, is a fundamental part of the BIOPRESSADRIA project and shown in the following scheme.

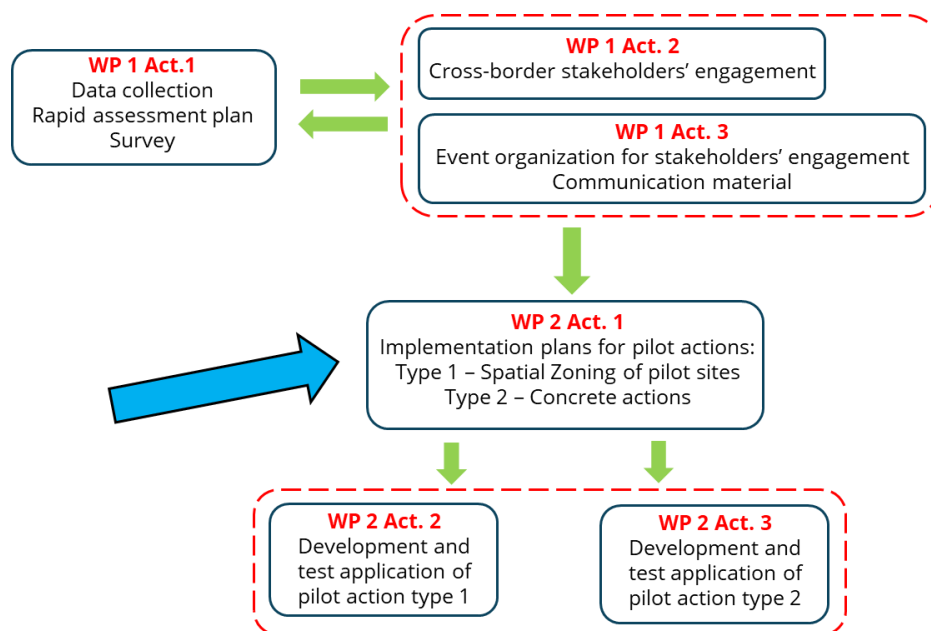


Figure 1 - Workflow diagram illustrating the sequence and connections between activities in work packages WP1 and WP2.

The process begins with data collection and the creation of a rapid assessment plan, followed by a survey to consolidate the gathered information (WP 1 activity 1). Next, the data is used to actively engage stakeholders in a cross-border context, fostering collaboration between regions (WP 1 activity 2). This leads to the organization of events and the development of informational materials to encourage open and transparent dialogue among partners and stakeholders (WP 1 activity 3). After this initial phase, the implementation of pilot actions types 1 and type 2 is planned (WP 2 activity 1). Finally, methods are developed and tested in the selected areas for type 1 actions, and practical solutions are implemented and evaluated for their effectiveness in type 2 actions (WP 2 activity 2).

This document defines the elements and the timeline of the various planned actions, illustrating their qualitative and quantitative characteristics and their inclusion in the geographical context of the five pilot areas.



2 Panzano Bay

2.1 Brief overview of the pilot area

Panzano Bay (Friuli Venezia Giulia) is a shallow and sheltered embayment of the Northern Adriatic Sea, located in the northeastern part of the Gulf of Trieste. Here, *Cymodocea nodosa* and other marine seagrasses species with similar environmental requirements (*Zostera marina*, *Z. noltei* and species of the *Ruppia* genus) take advantage of the conditions of substantial naturalness of the coastal shallows.

In Panzano Bay, two Natura 2000 sites are located (Figure 2):

1. the SAC/SPA (Special Area of Conservation (Special Protection Area) IT3330007 “Cavana di Monfalcone”,
2. 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).

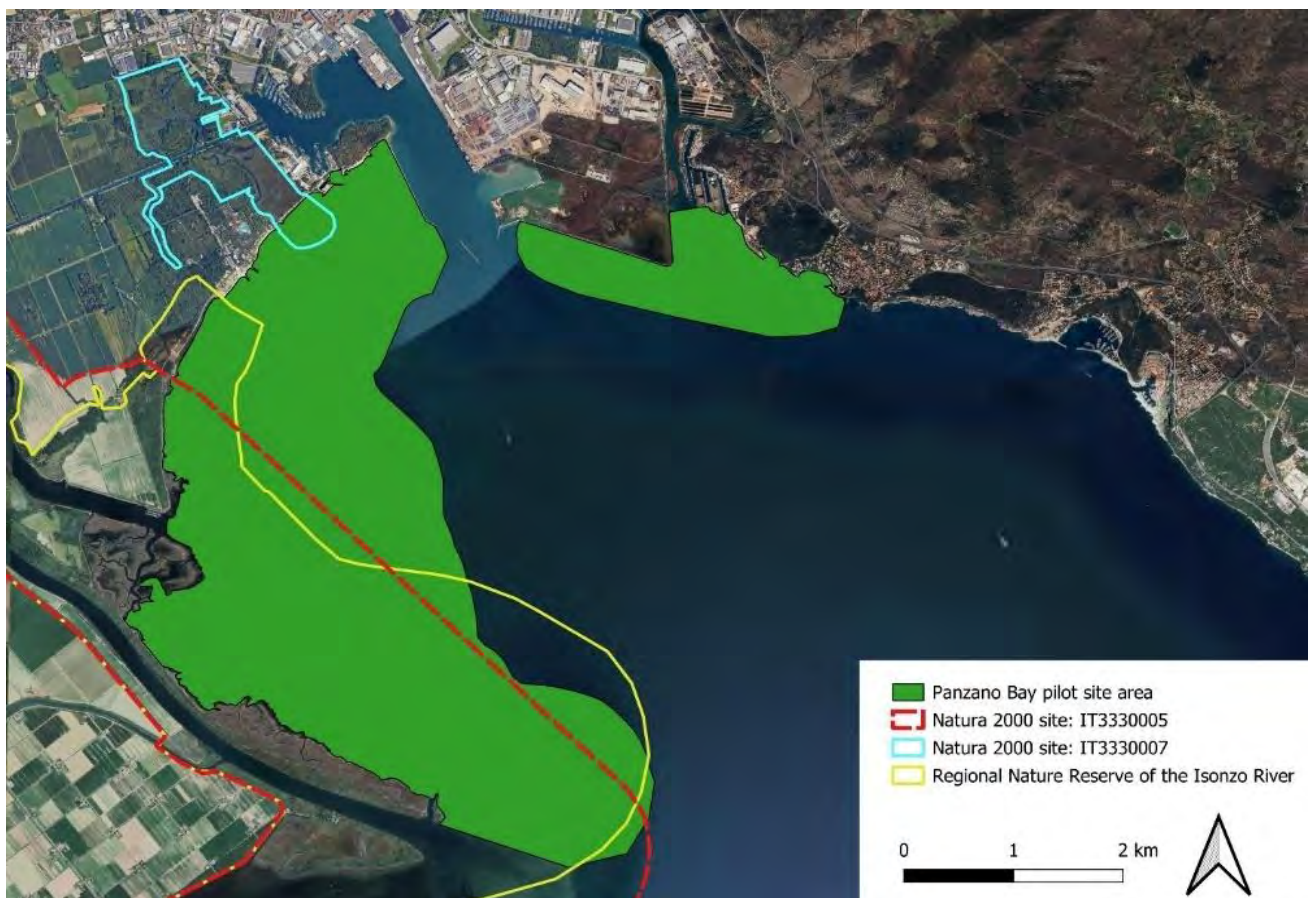


Figure 2 - The “Panzano Bay” pilot site area and the two Natura 2000 sites.



Regarding the site's marine area, the following Natura 2000 habitats are present:

- **1110 Sandbanks which are slightly covered by shallow sea water all the time.** This habitat is permanently submerged and predominantly surrounded by shallow water. Marine seagrass meadows can be present: *Zostera marina* (in brackish-salt waters), *Cymodocea nodosa* (in salt waters) and *Zostera noltei* in shallower salt waters.
- **1140 Mudflats and sandflats not covered by seawater at low tide** which is partially covered by *Zostera noltei* and partly coated by green, blue, brown algae and diatoms.
- *Brief analysis of natural and human-made features*

Although the Municipality of Monfalcone sums up more than 30 thousand inhabitants and the city is characterized by strong industrialization and shipbuilding, the stretch of coast considered nevertheless retains a certain naturalness, especially from a morphological point of view, in relation to the protection that the coastal arc offers the bay and the consequent conservation over time of sandbank structures which favor the sedimentation of sandy material and the development of marine seagrass meadows.

The bay is frequented by recreational boaters during the period from spring to autumn, both by smaller boats that anchor in shallow waters (some hundreds, especially during weekends), and by medium-length boats that moor at depths of some meters.

The beaches are available for sea activities (mainly local or near-local people, due to lack of large tourist infrastructures) and offer the use of kitesurfing and windsurfing rental.

- *Pressures and quali-quantitative evaluation of consequent impacts on valuable habitats*

Beach and leisure boating tourism associated pressures are mainly related to the high concentration of leisure boat traffic, even if considerably more modest in size, on average.

The human activities that cause disturbance in the area have been identified mainly among the sports activities such as recreation or bathing with small boats. The area is famous for its kitesurfing activities, but this has no significant effect on seagrass meadows or habitats. Diving activities are very limited and although there are 3 diving schools in the area none of the three frequent the project area except in an extremely sporadic way.

In the area there are also other pressures that may have an impact on target habitats: mussel and fish farming. There are no fishing activities other than small-scale artisanal fishing conducted with small boats and mainly fishing with gillnets. The shallow-water area with seagrass meadows is a popular destination for free-diving fishermen.



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The causes of possible pollution in Panzano Bay are determined by the Valentinis Canal (derivation of the Isonzo river), Brancolo Canal, Isonzo river, Staranzano purification plant diffuser. The runoff of urban areas and the flooding of the river Isonzo can also cause pollution.

To get to the main possible threat to marine seagrass meadows caused by leisure activities in Panzano Bay, they result to be very scarce. In particular, the effective impacts of recreational boating and frequent anchoring have never been considered and analysed so far. There is no ongoing monitoring aimed at controlling any phenomena of damage and disappearance of the seagrasses.

To connect this data to leisure boat traffic, as the Bay of Panzano is strongly frequented in the summer period, the Municipality of Monfalcone (LP) will contribute to the BIOPRESSADRIA project implementation by focusing on boats pressures on seagrass meadows and its ichthyofauna, primarily due to boats anchoring impacts.

Regarding leisure boats traffic, there is no available information on boats spatial and temporal distribution in the area, related to the recent past. Qualitative observations and data report that the very shallow colonized bottoms can be the main disturbed/impacted target site due to anchoring.

On the one hand, anchoring on surface banks is a very common practice in the summer; on the other hand, the limited size of these vessels does not suggest, at first glance, threats of significant magnitude. This also considers the strong growth capacity of the widespread *C. nodosa*, which can therefore re-colonize spaces lost and eradicated due to anchoring.

To delve deeper into this topic, an analysis is planned soon, through remote satellite images analysis, of the presence of boats of various types and sizes and of the relative anchoring points of these boats.

Concerning the presence of nektonic fish communities, as planned in WP1 Act. 1, the preliminary results from the scrutinization of the echograms and the initial examination of the fish-tracks in the raw files from the pilot site do not appear to indicate a positive effect of the buoy field on the presence of nektonic organisms. These preliminary findings require further investigation, such as a more accurate assessment of organisms near the seabed, which will be conducted during the next analysis phases. As of now, the relatively small number of fish recorded does not allow for definitive conclusions about a potential aggregative effect of the buoys on nektonic organisms.



2.2 Pilot actions description

Pilot action type 1

As for type 1 actions, data relating to seaside pressures, leisure boating and anchoring disturbance will be treated to develop the application of a spatial zoning procedure to search for possible additional or alternative sites for eco-buoy fields. The urban coastline is characterized by several activities (commercial harbor, shipyards, marinas, aquatic sport centers, as well as natural protected areas) so the site is fit for developing a zoning approach. This will be developed with the WP1 and WP2 leaders, in line with the approaches implemented in other pilot sites.

Pilot action type 2 - Protective action on the existing eco-friendly buoy field

The pilot site of Monfalcone - Panzano Bay has some peculiarities compared to other project pilot sites. As an industrial center and a commercial harbor, Monfalcone's coast is rich in economic activities and therefore little space is left for further actions.

A buoy field was installed in July 2021 in Panzano Bay within the SASPAS project, to encourage eco-friendly mooring. Finding a suitable location for the buoy field in the territory of the Municipality of Monfalcone, at that time, was the result of a long procedure and finally an agreement with the Maritime Authority was found (see next section for further details).

Against this background, the Municipality of Monfalcone plans to capitalize the existing buoy field in order to maintain and improve it. With BIOPRESSADRIA, the buoy field will be repositioned in the same position, as authorized. Since the buoy field was maintained and used during the summer seasons even after the end of SASPAS, at the expense of the Municipality, before repositioning the installations will be maintained and reconditioned. Exchange of information is currently taking place internally with the responsible technical department of the Municipality of Monfalcone and more detailed information will follow.

This protective action of the existing eco-friendly buoy field aims to stop/reduce impacts from anchoring and reduce the pressure on marine seagrass meadows.

2.3 Implementation phase of the pilot actions

A roadmap of the actions in the existing buoy field will be established in collaboration with the responsible "technical department", with a description of the planned steps. This implementation phase will involve the positioning, removal and maintenance of the buoy field. Where possible, single elements will be improved.



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The area where eco-friendly buoys are placed was selected with SASPAS project in agreement with the Maritime Authority, taking into account the appropriate safety distances from the coast and the harbor breakwater (Figure 3 and Figure 4).

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 harbour of Monfalcone and as many from the shoreline of Lido di Panzano (“Isola dei Bagni”). These positioning permits safe navigation to/from the commercial harbour and represents a satisfactory temporary mooring point for those numerous pleasure boats that - in the favourable season - drop anchor for a few hours of the day in the bay.

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 seagrasses 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*).

Therefore, the operations planned for the implementation of the activity are the following:

- revision of the mooring equipment (buoys, ropes, hardware),
- check of the anchoring systems to the seabed, consisting of fixed metal poles and equipped with a retention system,
- re-positioning of the anchors on the same site,
- installation and renewal of the signaling systems on the buoys of the four vertices of the buoy field.





Figure 3 - Photo-plan of the project area, in the bay of Panzano. The 30 white circles represent roughly the position of the 30 installed mooring buoys.





Figure 4 – Images of the installed mooring buoys in Panzano Bay.

2.4 Stakeholders' contribution to the definition of the plans for pilot action

Given the peculiarity of Monfalcone pilot site, where an eco-friendly buoy field is already placed, the contribution of stakeholders will mainly evaluate and provide feedback on the existing buoy field. In other words, it will mainly consist of an *ex-post* evaluation, including recommendations for future actions.

Based on the informal feedback received so far, the feedback that the Municipality of Monfalcone gathered from the users of the buoys was very positive. They are highly appreciated by the local communities for their convenience in easily mooring, in addition to being eco-friendly and free of charge. A truly win-win situation, for the local communities and for the environment.

However, stakeholder feedback in relation to the buoy field as well as on pilot actions type 1 will be further examined during the project as part of the stakeholder dialogue. There is indeed the need to continue a stakeholder dialogue that started initially with SASPAS.

The first meeting will take place in spring 2025.



3 MPA Porto Cesareo

3.1 Brief overview of the pilot site

The Porto Cesareo Marine protected Area (PC-MPA) was established by the Environment Ministry in 1997 by a Ministerial Decree dated 12/12/97, in the form of a National Marine Reserve. PC-MPA is entrusted to a Management Public Body, formed by the Porto Cesareo and Nardò Municipalities (in which territory the Reserve lies), and the Province of Lecce.

The PC-MPA covers an area of 16,654 hectares and 32 km of coastline, encompassing the shores of Porto Cesareo and Nardò, and lies in the eastern part of the Gulf of Taranto (Ionian Sea). It is one of the biggest MPAs in Italy, the biggest in the Apulia Region, and the third for its size among those instituted recently in Italy. The purposes of the MPA are the protection of the sea environment, the promotion of social-economic eco-compatible development, the realization of environment educational projects for interested people without age limit as well as promotion and realization of projects of scientific research.

The MPA is structured into 2 A Zones, 2 B Zones, and 1 C Zone (Table 1):

Table 1 – Zones A, B and C of the MPA

CODE	AREA DESIGNATION	MAIN PROVISIONS	
		PROHIBITED	ALLOWED under Regulation and Authorized by Management Body
A	Area Restricted to Use (No Take Zone)	Swimming, underwater activities, navigation, anchoring, fishing	Scientific research and guided tours only if allowed by the Managing Authority
B	Regulated Uses	Recreational fishing	Navigation, Professional artisanal fishing, Swimming, snorkeling, diving, navigation
C	General Uses	Anchoring	Anchoring, mooring, Recreational fishing

The limits of the MPA are to the north Punta Prosciutto and to the south Inserraglio Tower (Figure 5). The southern coast is rocky, partially low and partially with high cliffs, while the northern coast is sandy, with dune systems.



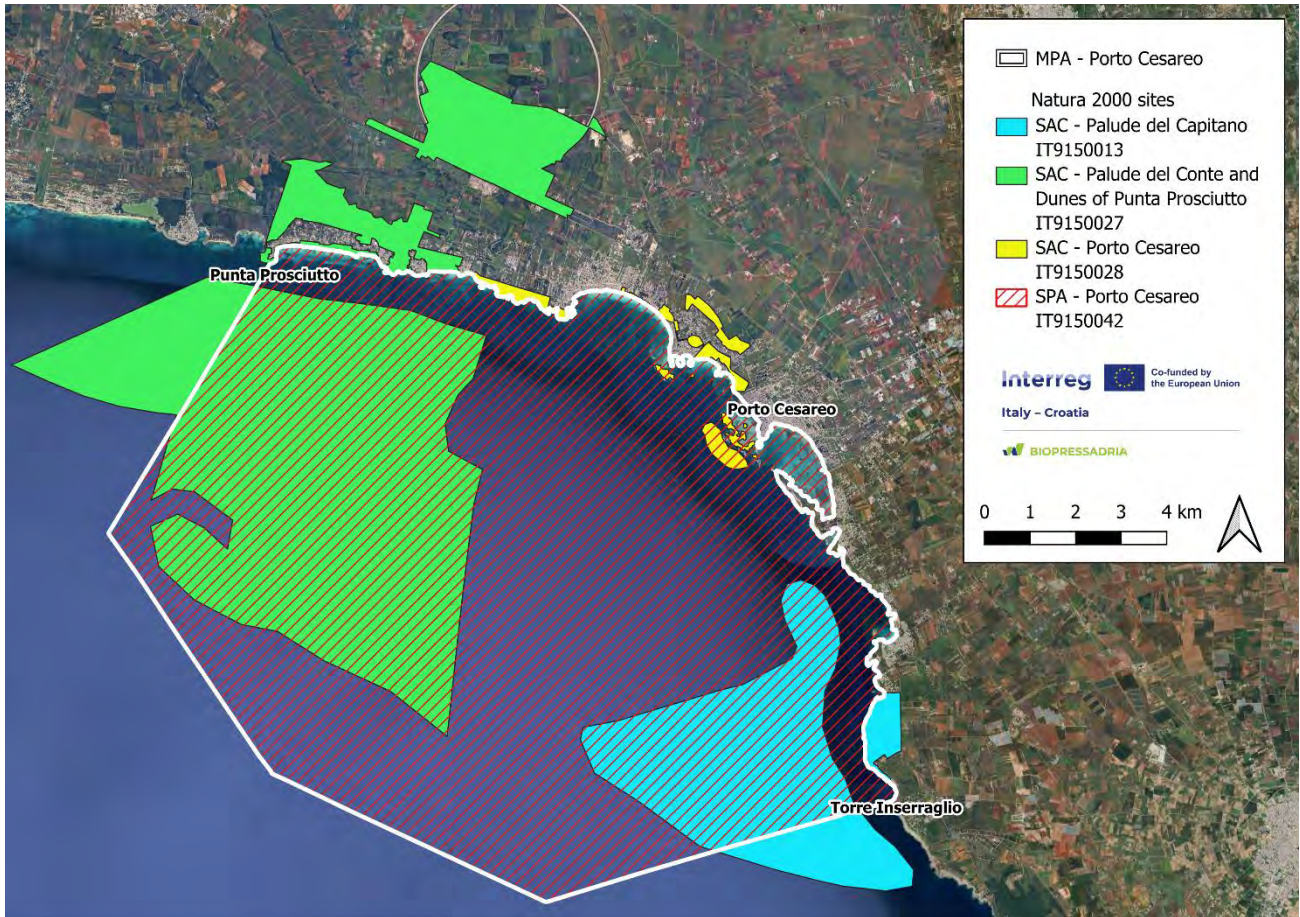


Figure 5: The extent of the MPA and the related coastline, from Punta Prosciutto to the north-west to Torre Inserraglio (Inserraglio Tower).

In the MPA there are three SACs (Special Areas of Conservation), established according to Habitat Directive (92/43/EC), and one SPA (Special Protection Area) established according to Bird Directive (2009/147/EC).

The Natura 2000 Network is, therefore, represented by:

- **"Porto Cesareo"** SAC (IT9150028 Code), falling in the C Zone of the MPA, with a surface of 21,8 ha.
- **"Palude del Capitano"** SAC (IT9150013 Code), falling in the C and B Zones, with a surface of 1.676 ha.
- **"Palude del Conte and Dunes of Punta Prosciutto"** SAC (IT9150027 Code), falling partially in the C Zone, with a surface of 3659,5 ha, and partially in A Zone with a surface of 1047,6 ha.
- **"Porto Cesareo"** SPA (IT9150042 Code), covering completely the MPA, with a total surface of 16780,66 ha.



The coastal landscape is also characterized by the presence of two Regional Protected Areas:

- the Regional Directed Preserve "**Palude del Conte and coastal Dune-Porto Cesareo**", entrusted to the Town of Porto Cesareo,
- the Regional Natural Park "**Portoselvaggio-Palude del Capitano**" entrusted to the Town of Nardò, into the which there are 5 terrestrial SIC, three of them include the already said marine parts.



Figure 6: The Porto Cesareo MPA and the municipalities of Porto Cesareo and Nardò.

- *Valuable habitats*

The **valuable habitats** within the MPA include extensive **Posidonia oceanica meadows**, **Cymodocea nodosa seagrass beds**, and **coralligenous formations** that play an important role in coastal stabilization and biodiversity conservation. These habitats contribute to mitigating coastal erosion and serve as essential spawning and nursery grounds for various marine species. The emerged, submerged and intertidal habitats cover 16.654 ha. For preventing erosion, marine habitats seagrass meadows such as *Posidonia oceanica* and *Cymodocea nodosa*, as well as coralligenous bioconstructions, play a major role. The attenuation effect of *P. oceanica* on hydrodynamics is related to the wave energy and height attenuation and reduction of the sediment resuspension and transport in wave current. Within the MPA, *Posidonia oceanica* meadows mainly colonize the substrates of the 3 SACs and form coastal habitats such as banquettes. In the winter and autumn periods, banquettes are widely distributed along the coast, creating deposits up to several



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meters high, which play a very important ecological role in containing erosive phenomena along the coast.

Table 2: Bentic habitat with SPA-RAC code

SPA-RAC CODE	Habitat	Area (ha)
III. 2. 3. 4.	Association with <i>Cymodocea nodosa</i> on superficial muddy sands in sheltered waters	18,60
IV. 3. 1	Coralligenous biocenosis	389,60
III. 6. 1	Biocenosis of infralittoral algae	423,90
III. 2. 3	Biocenosis of superficial muddy sands in sheltered waters	55,40
III. 2. 3	Biocenosis of coarse sands and fine gravels mixed by the waves	138,10
III. 3. 2	Biocenosis of coarse sands and fine gravels under the influence of bottom currents	7.988,50
III. 5. 1. 3	Facies of dead "mattes" of <i>Posidonia oceanica</i> without much epiflora	132,80
III. 6. 1. 1	Overgrazed facies with encrusting algae and sea urchins	714,10
IV. 3. 2	Semi-dark caves	10,60
IV. 3. 1 III.3. 2.	Mosaic of coralligenous biocoenosis and biocenosis of coarse sands and fine gravels under the influence of bottom currents	1.566,70
IV. 3. 1 III. 5. 1	Mosaic of Coralligenous and <i>Posidonia</i> meadows	1.852,40
III. 5. 1	<i>Posidonia</i> beds (<i>Posidonion oceanicae</i>)	3.363,40
		16.654,10

In detail, the "**Porto Cesareo**" SAC (IT9150028 Code), falls in the C Zone of the MPA, with a surface of 21,8 ha, "**Palude del Capitano**" SAC (IT9150013 Code), falls in the C and B Zones, with a surface of 1.676 ha and "**Palude del Conte and Dunes of Punta Prosciutto**" SAC (IT9150027 Code), falls partially in the C Zone, with a surface of 3659,5 ha, and partially in A Zone with a surface of 1047,6 ha.

The main habitats classified in these SACs are reported in Table 3.



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Table 3 – Main habitat in the “Porto Cesareo” SAC (IT9150028), “Palude del Capitano” SAC (IT9150013) and “Palude del Conte and Dunes of Punta Prosciutto” SAC (IT9150027).

Main habitats	SAC IT9150028	SAC IT9150013	SAC IT9150027
Coastal and halophytic habitats			
Code 1120 - <i>Posidonia</i> beds (<i>Posidonion oceanicae</i>)	x	x	x
Code 1170 - Reefs			x
Code 1210 - Annual vegetation of drift lines	x		x
Code 1240 - Vegetated sea cliffs of the Mediterranean coasts with endemic <i>Limonium</i> spp.	x	x	x
Code 1310 - <i>Salicornia</i> and other annuals colonizing mud and sand		x	
Code 1410 - Mediterranean salt meadows (<i>Juncetalia maritimi</i>)	x		x
Code 1420 - Mediterranean and thermo-Atlantic halophilous scrubs (<i>Sarcocornetea fruticosi</i>)	x	x	x
Coastal sand dunes and inland dunes			
Code 2110 - Embryonic shifting dunes			x
Code 2120 - Shifting dunes along the shoreline with <i>Ammophila arenaria</i> ("white dunes")			x
Code 2230 - <i>Malcolmietalia</i> dune grasslands			x
Code 2240 - <i>Brachypodietalia</i> dune grasslands with annuals	x		x
Code 2250 - Coastal dunes with <i>Juniperus</i> spp.	x		x
Freshwater habitats			
Code 3170 - Mediterranean temporary ponds		x	
Code 3260 - Water courses of plain to montane levels with the <i>Ranunculion fluitantis</i> and <i>Callitriche-Batrachion</i> vegetation			x
Phrygane			
Code 5420 - <i>Sarcopoterium spinosum</i> phryganas Sclerophyllous scrub (matorral)		x	
Natural and semi-natural grassland formations			
Code 6220 - Pseudo-steppe with grasses and annuals of the Thero- <i>Brachypodietea</i>	x	x	x
Rocky habitats and caves			
Code 8330 - Submerged or partially submerged sea caves	x	x	
Forests			
Code 9340 - <i>Quercus ilex</i> and <i>Quercus rotundifolia</i> forests			x



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- *Brief analysis of natural and human-made features*

The Porto Cesareo MPA represents a well-regulated ecological and economic system where different user groups interact with its resources. These groups, which include professional fishermen, recreational users, scientific researchers, and economic operators utilize the area under strict governance to ensure the sustainable use of its ecosystem services.

Porto Cesareo, in particular, is a small town with 6.380 inhabitants in December 2023¹, working both in tourism and fishing. In Nardò, in 2023, there were 30.788 inhabitants².

Below are listed official data about use of the MPA, collected from the MPA in the year 2023:

- 76 vessels licensed for professional fishing,
- 78.262 permits (permit days) for recreational fishing, issued from MPA,
- 3.903 permits (permit days) for underwater activities,
- 660 mooring buoys and 20609 permit days for mooring.

Professional fishing is allowed only in the B and C zones, and only for resident fishermen using selective artisanal gears. Fishing has a long and consolidated tradition in the area. In fact, there is a large small-scale coastal fishing fleet, managed by about 200 fishermen. Commercial fishing plays a fundamental role in the local economy; in addition to being a source of employment and food resource, it is also crucial for the social and cultural role it plays in relation to the many activities that animate the coast. Most small-scale fishers work on their own, outside organised structures.

The MPA imposes stringent regulations to balance resource use with conservation. Only fishers with legal or operational bases in the municipalities of Porto Cesareo or Nardò are permitted to operate, and only within B and C zones, excluding the "La Strea" inlet.

Recreational activities represent a significant component of MPA usage. Bathing, snorkelling, and diving are the most popular activities, with bathing allowed freely in B and C zones and diving regulated through a permitting system. In recent surveys, over 10,000 individuals participated in guided diving activities annually, contributing to local economic dynamics.

The MPA is also a focal point for scientific research and education. Research initiatives have catalogued 103 species of fish, molluscs, crustaceans, and echinoderms through projects like S.A.M.P.E.I.³.

¹ Source: <https://www.comune.portocesareo.le.it/sezione-informazioni/utilita/dati-istat>

² Source: <https://www.tuttitalia.it/puglia/59-nardo/statistiche/popolazione-eta-sesso-stato-civile-2023/>

³ Terlizzi, A.; Tedesco, P.; Mangia, D.; Izzi, C. Progetto S.A.M.P.E.I.—Progetto Pilota per il Miglioramento della Selettività degli Attrezzi da Posta All'interno dell'Area Marina Protetta di Porto Cesareo, per la Riduzione delle Catture Accessorie e dei Rigetti in Mare. Relazione Finale, Febbraio 2015. Available online: <http://www.ampportocesareo.it/attivita/progetti/item/s-a-m-p-e-i>



Visual census studies conducted within the MPA have demonstrated higher biodiversity and abundance compared to non-protected areas. Educational programs regularly engage schools and universities, fostering awareness and promoting the importance of marine conservation among younger generations.

Economic stakeholders such as diving centers, tour operators, and boat rental services are integral to the MPA's operations. These businesses generate employment and revenue while adhering to conservation guidelines. The presence of these stakeholders underscores the economic importance of the MPA, where sustainable tourism is a key component. Surveys indicate that most tourists express a willingness to pay for access to the protected area, demonstrating the perceived value of its ecological services.

- *Pressures and quali-quantitative evaluation of consequent impacts on valuable habitats*

Pressures and impacts on the MPA include tourism-related overuse, anchoring damage to seagrass meadows, coastal erosion, and pollution from urban and agricultural runoff. The main affected habitats include *Posidonia oceanica* banquette and Coastal dunes, which are subject to trampling and unregulated beach access. Climate change effects, such as rising sea levels and increased storm intensity, also pose a long-term threat to the integrity of the MPA.

Management strategies focus on sustainable tourism, habitat restoration, and stricter enforcement of conservation regulations. The MPA is part of the Natura 2000 network, which includes three Special Areas of Conservation (SACs) and one Special Protection Area (SPA). These designations reinforce the legal framework for habitat conservation and biodiversity protection within the area.

3.2 Pilot actions description

The planned pilot actions within the BIOPRESSADRIA project for the Marine Protected Area (MPA) of Porto Cesareo include both previously considered interventions and newly developed in other territory and adapted to the area. These actions are designed to restore coastal biodiversity and enhance the ecological resilience of the shoreline, particularly in response to anthropogenic pressures.

The pilot actions have been carefully designed to address key pressures impacting the **coastal and marine ecosystems** of the **Marine Protected Area (MPA) of Porto Cesareo**. These pressures stem from both **tourism-related activities** and **climate change effects**, requiring a **comprehensive and adaptive approach** to **reduce environmental degradation** while enhancing sustainable beach use.

The pilot actions are designed to mitigate both human-induced pressures and climate change effects on the coastal and marine ecosystems of the Marine Protected Area (MPA) of Porto Cesareo. These



actions integrate scientific methodologies, nature-based solutions, and sustainable management strategies to ensure long-term conservation and resilience of the coastal environment.

Pilot Action 1: Carrying Capacity Assessment of the Beach

This action focuses on determining the **optimal number of visitors** that the MPA can sustainably support, ensuring the conservation of sensitive ecosystems while maintaining a high-quality tourist experience. The study mainly focuses on the sensitive dune and beach environment and includes:

- **Data collection and field surveys** on environmental, tourism, and social factors.
- **Physical, ecological, and social carrying capacity analysis** using internationally recognized methodologies.
- **Development of monitoring indicators** and an **early warning system** for detecting overcapacity situations.
- **Implementation of a sustainable beach management plan**, including regulatory measures, infrastructure adjustments, and awareness campaigns.

This action builds upon previous **tourism management studies** but integrates an updated scientific framework and stakeholder involvement to ensure its effectiveness.

This action focuses on assessing and managing **human-induced pressures**, particularly on ***Posidonia oceanica* banquettes** and other sensitive coastal ecosystems. The key pressures addressed include:

- **Trampling and compaction of *Posidonia* banquettes** caused by beachgoers and unmanaged tourism. These organic accumulations play a crucial role in sediment retention and beach stability, yet they are often misperceived as waste and removed without ecological considerations.
- **High visitor density**, leading to ecosystem degradation and habitat loss, particularly in the **intertidal zones and sandy coastal areas**.
- **Littering and pollution**, which can negatively impact marine biodiversity and water quality.

By determining the **carrying capacity** of the MPA's beaches, this action aims to **regulate visitor numbers**, optimize **tourist flow management**, and **implement conservation measures** to protect the fragile coastal ecosystem.



How Pilot action 1 can reduce Pressures:

- **Carrying capacity assessment:** by determining the optimal number of beachgoers, the action will regulate and distribute visitor flows, reducing excessive trampling and habitat degradation.
- **Preservation of *Posidonia oceanica* banquettes:** this action will highlight the ecological importance of banquettes, preventing their unnecessary removal and mitigating beach erosion caused by sediment loss.
- **Sustainable beach management plan:** through the development of regulatory measures, infrastructure adaptations, and awareness campaigns, tourist activities will be better controlled, reducing pollution, littering, and physical damage to sensitive habitats.
- **Early warning system:** continuous monitoring will help detect overcapacity situations, allowing for adaptive management strategies to be implemented before significant environmental degradation occurs.

This action is expected to improve the ecological balance between tourism and conservation, preventing long-term degradation while ensuring a high-quality visitor experience. By implementing data-driven management strategies, the MPA can anticipate peak pressures, mitigate ecosystem damage, and enhance public awareness of sustainable tourism practices.

To ensure that the carrying capacity assessment (pilot action 1) leads to effective management of visitor pressure, the following controls are foreseen during the implementation phase. First of all, monitoring visitors' flow using drones to assess beach occupancy trends. Based on this, the MPA of Porto Cesareo will carry out an analysis of seasonal peaks to adjust visitor regulations dynamically.

Pilot Action 1 includes the development of **specific key indicators**, which will be shared with the project's scientific partners, for the continuous monitoring of carrying capacity and the proposal of an early warning system to identify potential overload situations.

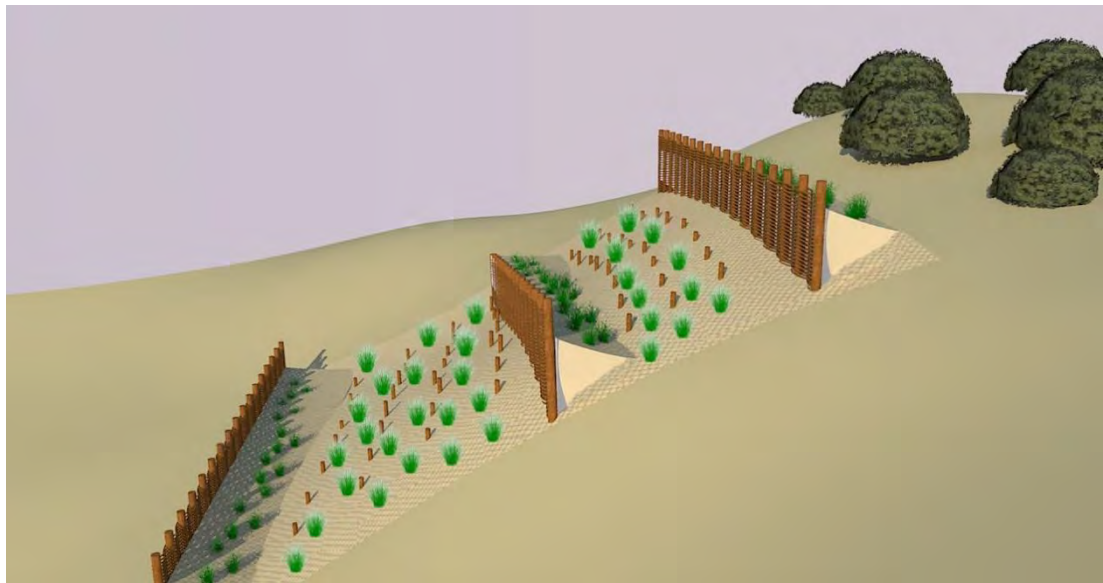
As part of Pilot Action 1, the Marine Protected Area will develop a **strategic plan to optimize the sustainable use of the beach**, including regulatory measures, necessary infrastructure, and awareness activities for residents and tourists, as well as providing practical recommendations for short- and long-term management.



Pilot Action 2: Environmental Restoration and Coastal Valorization

This intervention focuses on **dune habitat restoration** and **biodiversity conservation** along the coastline, using nature-based methodologies. It includes:

- **Dune reconstruction** through the deposition of *Posidonia oceanica* biomass mixed with sand, transported from nearby areas.
- **Stabilization and erosion prevention and control** using natural engineering techniques, such as:
 - Wooden fences to trap sand and promote natural dune formation.
 - Coconut fiber bio-mats and jute netting, to prevent erosion and enhance sediment retention.



- **Revegetation** efforts by planting:
 - Native perennial herbaceous species (from habitat types 2110 and 2120).
 - 150 juniper (*Juniperus* sp.) specimens to reinforce dune stabilization.

- **Installation of educational signage** to raise awareness among beachgoers about the ecological importance of dune habitats and conservation efforts.



This action builds upon previous dune restoration projects conducted in the area (e.g., Torre Lapillo under the POR Puglia 2014/2020 program) while incorporating enhanced conservation techniques and public engagement strategies.

This action targets **pressures linked to coastal erosion and tourism infrastructure** while promoting **nature-based solutions for beach restoration**. The main pressures considered include:

- **Climate change-induced erosion:** Rising sea levels and extreme weather events are accelerating the loss of sandy habitats, which are essential for dune stability and coastal resilience.
- **Trampling on dunes** by tourists, leading to vegetation loss, destabilization of sand structures, and increased vulnerability to erosion.
- **Uncontrolled beach use**, which intensifies habitat degradation and reduces the ecosystem's natural capacity to recover.
- **Alteration of sediment dynamics** due to past interventions or inadequate beach management practices.

To counter these pressures, the action includes **dune restoration, revegetation, and protective structures** (such as **fencing barriers** and **bioengineering techniques**) to **reinforce the resilience of the coastal system**. Additionally, **informational signage and awareness campaigns** will help educate visitors on the importance of responsible beach use.



Italy – Croatia



How Pilot Action 2 can reduce Pressures:

- Dune restoration and stabilization: by using *Posidonia oceanica* biomass, this action rebuilds natural dune barriers, protecting the coastline from wind and wave erosion while reducing the impacts of rising sea levels and storm surges.
- Trampling control through natural engineering: The installation of fencing barriers, bio-mats, and jute netting will foster dune growth and stabilization, preventing further erosion caused by uncontrolled trampling.
- Revegetation with native species: The reintroduction of dune vegetation (including herbaceous perennials and *Juniperus* sp.) will help to reinforce sand retention, increase biodiversity, and enhance the natural resilience of the ecosystem.
- Educational signage and awareness campaigns: Informing beachgoers about the ecological role of dunes and proper beach usage will help reduce harmful behaviors, such as unauthorized access to dunes and the removal of natural materials.

This action is expected to counteract coastal erosion, enhance habitat regeneration, and promote responsible beach use. The combination of bioengineering techniques and public awareness initiatives will help create a self-sustaining system, where both natural and human activities can coexist with minimal negative impact. The effectiveness of this approach has been validated through previous restoration projects, such as those implemented at Torre Lapillo under the POR Puglia 2014/2020 program.

The implementation of Pilot Action 2 within the BIOPRESSADRIA project requires a structured and continuous monitoring approach to ensure the success of coastal restoration efforts and the enhancement of climate resilience in the Marine Protected Area (MPA) of Porto Cesareo. Given that restoration relies on nature-based interventions, systematic field assessments will be essential to track progress, detect challenges, and adapt management strategies accordingly. Vegetation growth will be monitored through frequent surveys assessing the survival rate of transplanted native plants, including *Juniperus* sp., and the overall percentage of vegetative cover. Ensuring successful plant establishment will be crucial for the long-term stability of the dunes and their ability to resist erosion.

To gain a more comprehensive understanding of the intervention's effectiveness, erosion and sediment balance will be analyzed using topographic surveys, aerial drone mapping, and GIS tracking. These tools will help detect variations in the beach profile, identify erosion hotspots, and monitor sediment movement over time. By comparing this data with historical shoreline records, researchers and conservationists will be able to assess how well the restoration measures are mitigating coastal degradation.

Another critical aspect of the monitoring process will involve observing visitors' behavior in and around the restored areas. The effectiveness of educational signage in deterring unauthorized foot



traffic on the dunes will be evaluated, and reports will be compiled to identify any recurring issues related to non-compliance. Ensuring that tourists respect restricted areas will be fundamental in preventing new disturbances to the fragile ecosystem.

Since dune restoration is a slow and gradual process, monitoring will extend beyond the project's duration to ensure the long-term resilience of the coastal environment. Annual geomorphological assessments will track the natural expansion or degradation of dunes.

By combining **sustainable tourism management (Action 1)** with **coastal restoration and resilience-building (Action 2)**, the MPA Porto Cesareo BIOPRESSADRIA pilot actions aim to **reduce pressures from marine traffic, beachgoers, anchoring, and climate-related erosion, ultimately ensuring long-term protection of the MPA's biodiversity and ecosystem functions.**

3.3 Implementation phase of pilot actions

The preliminary activities of the BIOPRESSADRIA pilot actions focus on gathering essential data, engaging stakeholders, and setting the foundation for effective implementation.

For Pilot Action 1, which aims to manage tourist pressure on coastal habitats, initial activities include collecting environmental, tourism, and social data to assess the status of beach usage and its impact on *Posidonia oceanica* banquettes. Field surveys and remote sensing techniques will be used to map sensitive areas and identify key stressors. Additionally, collaboration with scientific partners will ensure the development of specific monitoring indicators and an early warning system to detect potential overcapacity situations.

For Pilot Action 2, which focuses on coastal restoration and climate resilience, the preliminary phase involves assessing dune morphology and erosion rates, through drone surveys and historical data analysis. The selection of appropriate restoration techniques, such as graticciata barriers and native vegetation planting, will be based on past successful projects and consultation with environmental experts. Before implementation, local stakeholders, including conservation authorities and tourism operators, will be engaged to ensure alignment with conservation goals and sustainable tourism practices.

- *Site selection*

The selection of sites for the BIOPRESSADRIA pilot actions follows a structured process based on scientific, environmental, and managerial criteria to ensure the most effective implementation of restoration and conservation efforts.



Italy – Croatia



For Pilot Action 1, which focuses on managing tourist pressure, site selection is based on high visitor density areas within the Marine Protected Area of Porto Cesareo that show significant environmental stress, particularly on *Posidonia oceanica* banquettes, the Coastal dunes and the beach environment. Data from previous environmental assessments, field surveys, and stakeholder consultations help identify critical zones where carrying capacity analysis and management interventions are most needed.

For Pilot Action 2, which aims at coastal restoration and climate resilience on the beach environment, the selection process considers areas experiencing severe erosion, loss of dune habitats, and climate-induced degradation. Priority is given to locations where natural dynamics can be effectively restored through bioengineering techniques, such as the use of fencing barriers, sediment stabilization, and revegetation. Past restoration projects and scientific evaluations guide the choice of optimal intervention sites.

By integrating scientific data, environmental impact assessments, and stakeholder input, the selection process ensures that the pilot actions are implemented in the most vulnerable and ecologically valuable areas, maximizing their long-term effectiveness and sustainability.

- *Operational activities*

The operational activities of the BIOPRESSADRIA pilot actions are structured to ensure a balance between conservation efforts of beach environment and its priority habitats and human activities within the Marine Protected Area of Porto Cesareo. Given the diverse stakeholders involved, potential conflicts or overlaps in land use and zoning have been carefully considered to minimize disruptions and maximize ecological benefits.

For Pilot Action 1, which focuses on managing tourist pressure on coastal habitats, the primary operational activities include data collection, field surveys, and carrying capacity analysis to establish optimal visitor thresholds. This action directly interacts with areas of high tourist influx, particularly beaches with *Posidonia oceanica* banquettes and Coastal dunes, which are often mismanaged or removed due to public perception. A potential challenge is the conflict between tourism operators and conservation priorities, as limiting access or enforcing regulations may face resistance from businesses reliant on beach tourism. To address this, extensive stakeholder consultations and awareness campaigns will be conducted to align conservation goals with local economic interests.

For Pilot Action 2, focused on coastal restoration and climate resilience, operational activities involve dune stabilization, bioengineering interventions, and vegetation restoration to protect the beach environment. These activities are implemented in areas where erosion and dune degradation are critical, requiring careful coordination with existing land-use regulations and zoning laws. A key constraint is the potential restriction on certain recreational beach areas during restoration works,



as temporary closures or controlled access may be necessary. Additionally, the use of biomass from *Posidonia oceanica* for dune restoration must comply with environmental guidelines, ensuring that material collection and relocation do not disrupt other ecological functions.

Both pilot actions require on-site visits and continuous monitoring to assess progress and mitigate any unforeseen conflicts. These efforts are designed to create a harmonized approach where biodiversity protection, climate adaptation, and sustainable tourism management coexist effectively, ensuring the long-term resilience of the Marine Protected Area of Porto Cesareo.

3.4 Stakeholders' contribution to the definition of the plans for pilot action

During the stakeholder meeting held in Otranto on December 19, 2024, various forms of feedback were received regarding the BIOPRESSADRIA pilot actions. The meeting gathered representatives from local authorities, economic operators, environmental associations, and scientific partners, allowing for a comprehensive discussion on the proposed interventions.

The local authorities expressed their full approval of the pilot actions and confirmed their commitment to supporting their implementation. They recognized the importance of managing tourist pressure on coastal habitats and restoring degraded dune systems to enhance the resilience of the Marine Protected Area of Porto Cesareo. Their support will be crucial in ensuring effective governance and the successful integration of these actions into broader territorial planning strategies.

Representatives from economic operators and associations acknowledged the need for conservation efforts but emphasized the importance of maintaining a balanced approach between existing economic activities and environmental protection. They requested an ongoing collaboration to ensure that visitor management strategies, restrictions, or restoration works do not negatively impact local businesses, tourism, and recreational activities. They also highlighted the importance of educational initiatives to raise awareness among tourists and residents about the benefits of conservation.

The meeting resulted in a constructive dialogue, where stakeholders pledged to work together to develop solutions that align both socio-economic interests and ecological sustainability. Economic operators and associations guaranteed their support in facilitating conservation measures, provided that the project team actively engages them in decision-making and ensures that restrictions or changes are well-communicated and effectively managed.

Overall, the feedback received confirmed a strong institutional endorsement of the project while also highlighting the need for a collaborative and adaptive approach to harmonize conservation efforts with local economic interests. The insights gathered during the meeting will guide the refinement of



implementation strategies, ensuring that the BIOPRESSADRIA pilot actions are effectively integrated into the local socio-economic and environmental landscape.

- *Stakeholders' engagement plan*

Stakeholders and decision-makers have been involved since August 2024 through the dissemination of a specific communication outlining the project objectives and the distribution of a questionnaire to be completed. Subsequently, on December 19, 2024, an initial meeting was organized to discuss the pilot actions and the importance of stakeholder involvement throughout the various implementation phases.

Following this meeting, the staff of the Porto Cesareo MPA developed the necessary tender documentation for the implementation of activities and the selection of experts required for their execution.

At the end of March 2025, another stakeholder meeting will be organized to present the intervention plan for the pilot actions and clarify their role in the implementation process. Additionally, another meeting will take place in June to present the initial results of the pilot actions and prepare for the summer season, focusing on how to monitor the implemented actions through a participatory process.

The Marine Protected Area of Porto Cesareo has been engaged for years in an ongoing dialogue with stakeholders, as required by the phases of the “*Europarc Sustainable Tourism*” Certification, which promotes close collaboration between the protected area and stakeholders. This process involves the identification of a common action plan to be implemented, as well as regular meetings and forums.

This continuous engagement has allowed the Marine Protected Area to establish a solid group of stakeholders and decision-makers who actively support and participate in the life of the protected area. For this reason, no issues have been identified regarding stakeholder involvement.



4 Kornati National Park

4.1 Brief overview of the pilot area

Pilot area is located in Kornati National Park in the central Adriatic Sea, within Šibenik-Knin County, Croatia. The Kornati archipelago consists of 89 islands, islets, and reefs, covering an area of approximately 32,000 ha. This unique marine environment features a rugged landscape dominated by limestone formations, cliffs, and karst phenomena. The largest island, Kornat, stands as the focal point of the park and reaches a height of 237 meters. The terrestrial and marine ecosystems of Kornati are home to a wide range of biodiversity, including endemic plant species and diverse marine life. In 1980, the archipelago was declared a national park, providing it with a high level of protection.

Kornati National Park marine area is part of the European ecological network Natura 2000 (site code **HR4000001**). The park features significant habitats, including marine seagrass beds of *Posidonia oceanica* (code: 1120), reefs (code: 1170), and submerged or partially submerged sea caves (code: 8330).

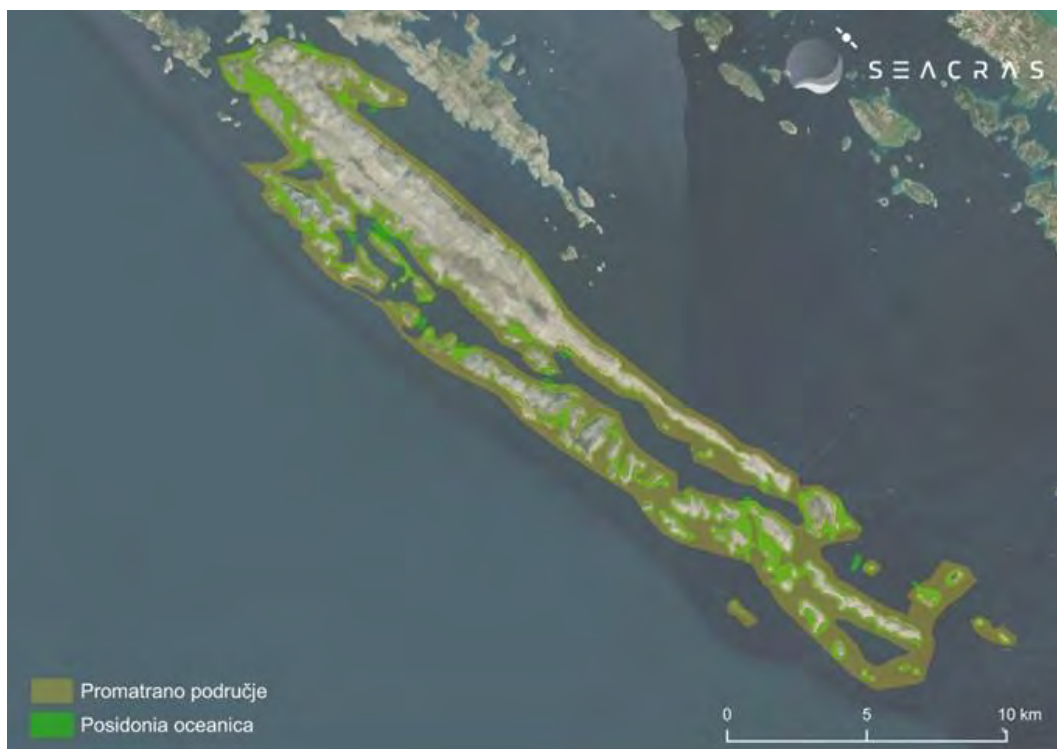


Figure 7 *Posidonia oceanica* habitat map inside the Kornati National Park (promatrano područje = observed area).

The pilot area is located on Levrnaka Island, in particular the bays of Lojena and Anica. The main habitat types are *Posidonia oceanica* (code 1120) and infralittoral sands which are part of habitat type Sandy bottom permanently covered by the sea (code 1110).

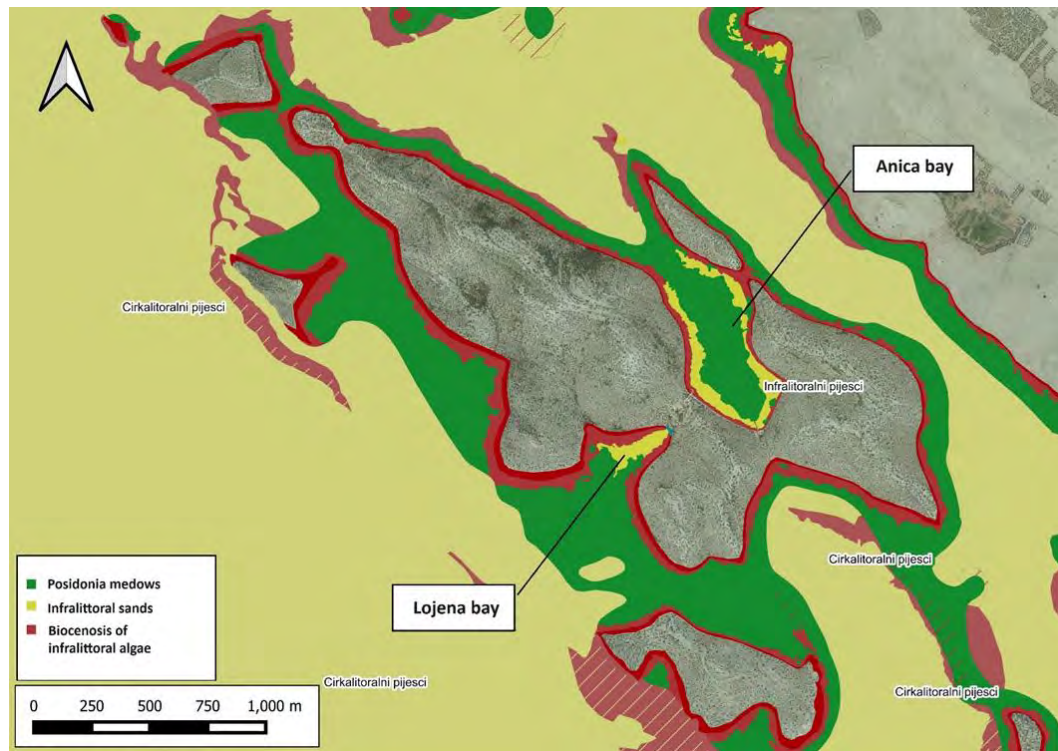


Figure 8 – Habitat map (Pilot area is located on Levrnaka island - in Lojena and Anica bay. Anica bay).

In the pilot area there is a restaurant with its own dock and a souvenir shop in use for promotional purposes for Kornati National Park. In Lojena bay there is also a popular beach for tourists that visit the island of Levrnaka. As planned in the previous SASPAS project, 12 eco-friendly buoys were installed at that time in Anica Bay for nautical tourists.

The pilot area is mostly used for beach and swimming activities by tourists which are brought there by tourist companies as well as with charter sailing boats agencies.

Pressures on *Posidonia* beds present in Kornati National Park are related to wastewater from restaurants and houses, marine litter, invasive species and climate change related pressures (temperature increase, potential sedimentation increase etc.). However, the most significant identified pressure is mechanical damage by anchoring. Annually, the park is visited by around 20,000 individual vessels. On an average day during the peak summer season (July and August), there are around 200 vessels in the park, on some days even 400. Information on the number of boats and



their rough temporal distribution is collected based on the park entrance tickets sale. However, these numbers can only be used as a rough estimate, due to the ticket sale system.

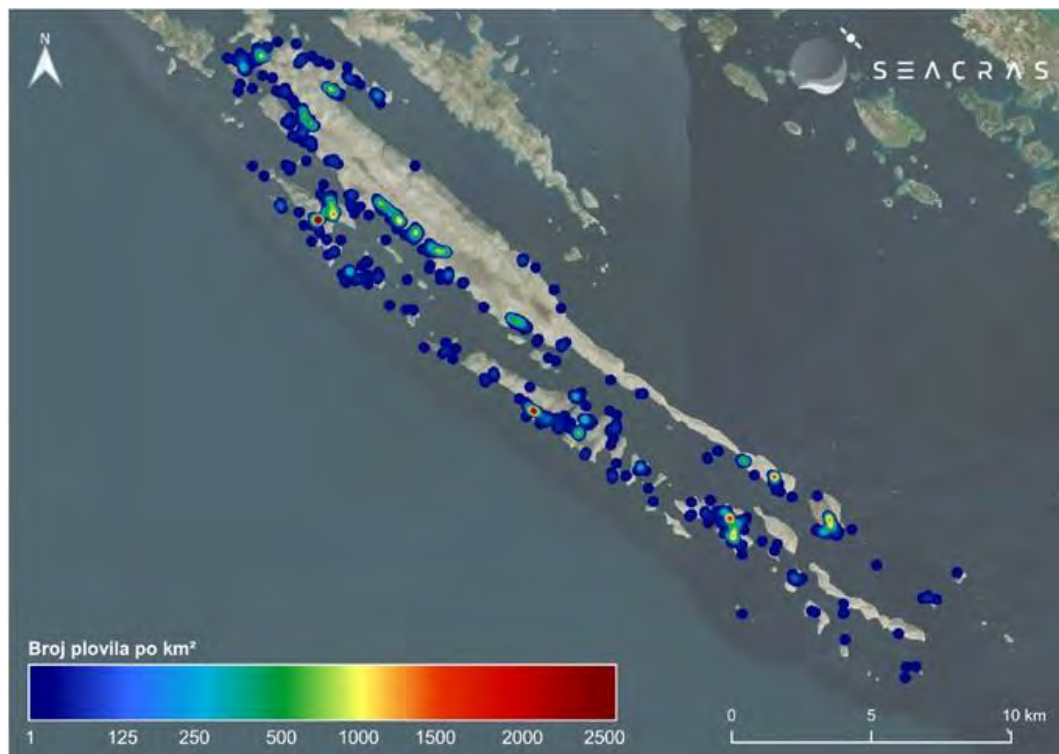


Figure 9 - Boat pressure presented on the whole Kornati National park in period 1.8.-31.8. 2023 (number of vessels/km²).

4.2 Pilot actions description

Pilot action type 2

The Kornati National Park plans to install eco-friendly buoys for leisure boaters in Lojena and Anica bay. In Anica Bay additional buoys will be positioned, as shown in Figure 10, that shows boat pressure in both bays. Note that Lojena bay doesn't presently have an eco-buoy field set up and the pressure in that particular location is by far the greatest.

The installation of eco-friendly buoys for leisure boaters aims to stop/reduce impacts from anchoring. As shown in Figure 11, the pressure is by far greatest in Lojena bay area during summer months, since the pilot area is popular tourist location in the Kornati National Park. In the long run our hypothesis is that by providing boaters with eco-friendly buoy field we can reduce free anchoring significantly, which potentially can reduce *Posidonia oceanica* degradation.



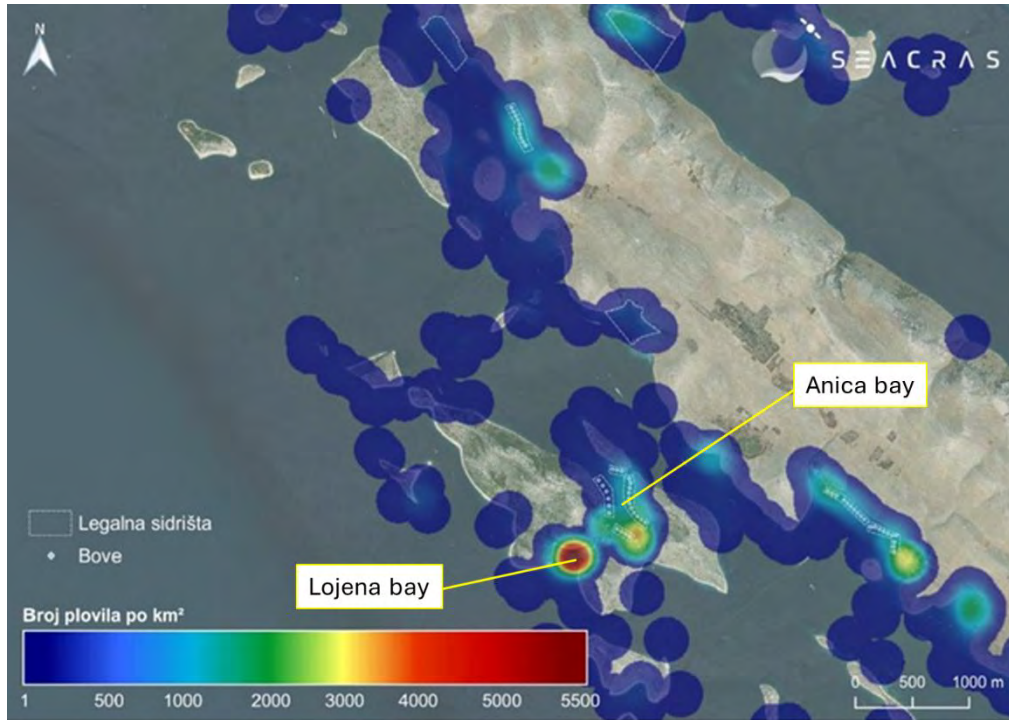


Figure 10 - Number of vessels/km². Dots represent buoys (Legalna sidrišta = legal anchorage areas, bove = buoys).

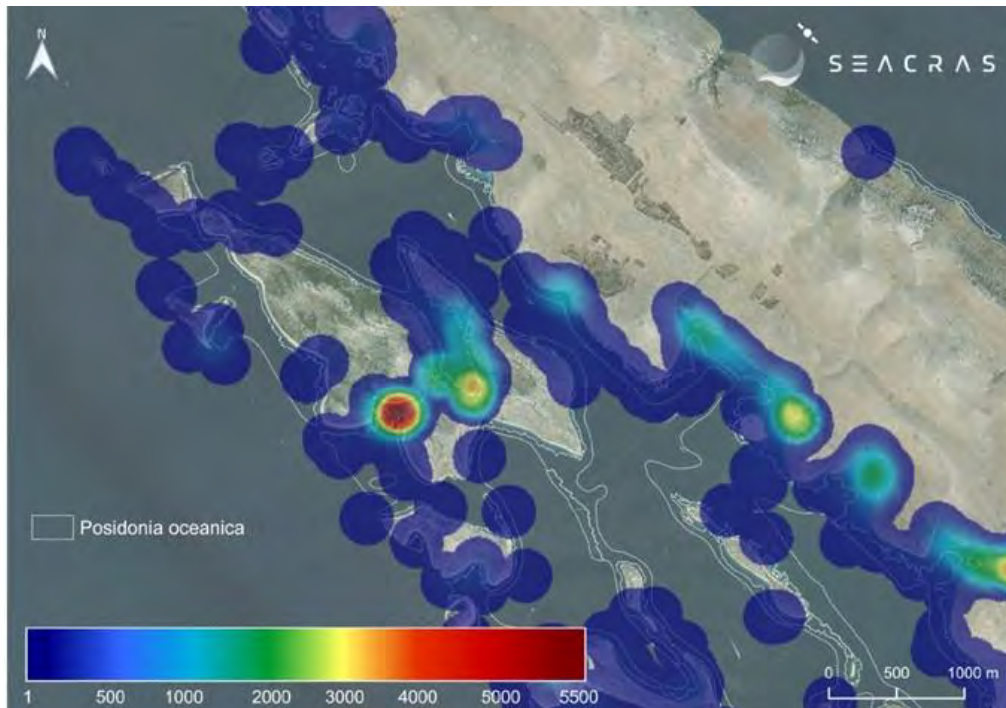


Figure 11 - Boat pressure shown inside the mapped Posidonia oceanica beds (number of vessels per km²).



Controls/monitoring will be carried out during and after the project duration to verify the quality and effectiveness of the pilot actions. Kornati National Park typically removes existing buoys for storage during the winter and redeploys them before the start of the tourist season. Their effectiveness will be monitored as part of the daily operations of park employees.

The Kornati National Park (PP6) will also share their experience on technical verification of eco-buoys functioning and duration in NP Kornati, in order to collaborate with Sea & Karst (PP8) in developing a technical guide, as recommendation for future buoys concession in Split-Dalmatia County (with Natura 2000 site Pakleni islands - HR3000095 Pakleni otoci - as a first pilot area) (see paragraph 6.2 – Pilot Action 2 “Conceptual solution for the Pakleni Islands nautical eco-moorings”).

4.3 Implementation phase of the pilot actions

All permits have been obtained, and the public procurement for purchasing and installing the buoys will take place between March and April 2025, so as to ensure that the buoys installation is completed before the tourist season, providing boaters with a safe eco-friendly anchoring solution.

The pilot action locations primarily include Lojena Bay, with Anica Bay as a secondary site; precise positioning of the buoy fields will be soon available. However, the general location for eco-friendly buoys in Lojena bay is shown in Figure 12.



Figure 12 - Anchoring boats in Lojena bay where the eco-friendly buoys will be installed.

4.4 Stakeholders' contribution to the definition of the plans for pilot action

Our main stakeholders would be tourist agencies that rent boats and sailboats, marinas and charters so we intend to inform them about the impacts of free anchoring and encourage them to promote using eco-friendly buoys with the use of leaflets and

Dialogue will be carried out during stakeholder events (June 2025).



5 Dubrovnik-Neretva County

5.1 Brief overview of the pilot area

The pilot area of this project is situated in Dubrovnik-Neretva County, Croatia, focusing on the marine Natura 2000 sites listed below.

Through preliminary discussions with port authorities and stakeholders, we identified areas where there was no significant pressure, leading to a reduction in the scope of some ecological network areas. Consequently, the selected areas for monitoring and analysis now include:

- **HR4000007** Badija i otoci oko Korčule (Badija and the islands around Korčula),
- **HR3000431** Akvatorij J od uvale Pržina i S od uvale Bilin žal uz poluotok Ražnjić (Aquatorium J from Pržina Bay and S from Bilin žal Bay along the Ražnjić Peninsula),
- **HR3000162** Rt Rukavac – Rt Marčuleti (Cape Rukavac – Cape Marčuleti),
- **HR3000163** Stonski kanal (Ston Channel),
- **HR4000028** Elafiti (Elaphiti Islands),
- **HR3000165** Uvala Slano (Slano Bay),
- **HR3000170** Akvatorij uz Konavoske stijene, where only the northern and southern sections will be monitored, excluding the central Konavoske stijene area (Aquatorium along the Konavle Cliffs, where only the northern and southern sections will be monitored, excluding the central Konavle Cliffs area),
- **HR3000150** Pelješac - from uvala Rasoka to rt Osičac (Pelješac – from Rasoka Bay to Cape Osičac),
- **HR4000015** Malostonski zaljev, focusing on the southern section from Sreser to uvala Brijesta and uvala Kuta in the inner bay,
- **HR3000152** Otok Proizd and Privala on Korčula (Island Proizd and Privala near Korčula),
- **HR3000476** Uvala Divna – Pelješac (Divna Bay – Pelješac),
- **HR3000153** Otok Korčula - from uvala Poplat to Vrhovnjak (Island Korčula – from Poplat Bay to Vrhovnjak).

Key focus of the pilot action will be on the **HR4000007** Badija and the islands around Korčula and **HR3000431** Aquatorium J from the Pržina Bay and S from the Bilin žal Bay along the Ražnjić Peninsula, along with the area between Korčula Island mainland and Ježevica Channel. These sites host ecologically significant habitats such as *Posidonia oceanica* meadows, recognized as a priority habitat



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under the EU Habitats Directive. Additionally, these areas support *Cymodocea nodosa* meadows and sandbanks, both of which are crucial for biodiversity, carbon sequestration, and coastal stability.

The pilot area is characterized by a combination of natural and human-made features. The landscape consists of rocky and sandy coastlines, sheltered bays, and karstic limestone formations, while human intervention includes ports, marinas such as ACI Marina Korčula and Lučica Marina, and coastal infrastructure linked to tourism and maritime transport. The area is extensively used for tourism, particularly boating, snorkelling, and diving, as well as for leisure boating involving yachts, excursion boats, and water taxis. Passenger ferries link the area to the mainland and Italy, and traditional fisheries and aquaculture also contribute to the region's economic activities.

These human activities exert significant pressure on the marine environment, particularly on *Posidonia oceanica* meadows, which suffer from damage due to unregulated anchoring. Coastal development continues to expand, placing additional strain on these habitats, while pollution from wastewater discharge and plastic debris further degrades the ecosystem. Additionally, invasive species, such as the green algae *Caulerpa cylindracea*, are spreading rapidly in disturbed areas, threatening native biodiversity.

Given these pressures, the *Public Institution for the Management of Protected Natural Areas of Dubrovnik-Neretva County* (PP7 - PIDNC) has opted to implement only Pilot Actions of Type 2, focusing on monitoring, evaluation, and policy recommendations rather than physical interventions. The key objective of these actions is to establish a robust and data-driven foundation for future conservation measures. As part of this approach, we will procure services for selected Natura 2000 sites that have *Posidonia oceanica* as a target habitat type. During the drafting of the WP1 Act. 1 Pilot Area Characterization, we assessed the state and pressures affecting these sites, permitting the selection of the most impacted locations, particularly those under significant stress from anchoring, tourism, and leisure boating activities.



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Figure 13 – Pilot Action Area - selected Natura 2000 sites.



Figure 14 – Natura 2000 – HR4000007 Badija i otoci oko Korčule (Badija and the islands around Korčula) and HR3000431 Aquatorium J from the Pržina Bay and S from the Bilin Žal Bay along the Ražnjić Peninsula.



5.2 Pilot actions description

A key aspect of the project includes the procurement of services for comprehensive monitoring and detection of boat activities, anchoring patterns, and environmental conditions in the defined protected areas and ecological network sites. This public procurement will focus on detecting boats, monitoring anchoring sites, assessing mooring infrastructure, and identifying undefined and illegal anchorages. Additionally, an integrated assessment of eutrophication descriptors, sediment composition, and fuel pollution indicators will be conducted across the entire marine area of the designated protected sites.

One of the main activities of this pilot action will be the spatial analysis of boat pressure across the selected sites to better understand the extent of impact and identify critical zones requiring intervention. The total monitoring area will cover at least 120 square kilometers, with boat detection and anchoring data collected through remote sensing methods. The analysis will track the number of anchored and moored vessels over time, categorizing them based on their lengths, and identifying hotspot areas of pressure. The collected data will overlap with the distribution of *Posidonia* meadows, allowing for precise impact assessments.

In addition to this broad spatial analysis, a more focused approach will be taken in a smaller section of the county, specifically the eastern part of Korčula. Here, we will conduct additional monitoring of key environmental parameters, including eutrophication levels, sediment composition, and fuel pollution indicators, to provide a more detailed and localized evaluation of the impacts on *Posidonia* meadows. This targeted approach will provide valuable insights into the relationship between tourism activities and habitat degradation, serving as a model for broader conservation efforts.

To ensure that our findings contribute to long-term planning and conservation, we will actively engage with the county spatial planners and port authorities. Through a series of meetings and workshops, we will present our data and advocate for the inclusion of specific measures in future spatial planning policies. In this process, we will also leverage the experience and work undertaken by our project partner Sea and Karst (PP8). Their successful implementation of a nautical study for their county's spatial plan will serve as a reference and best-practice example for integrating sustainable boating regulations into spatial planning at the county level.

5.3 Implementation phase of the pilot actions

The implementation of the pilot action follows a structured timeline. The process commenced with the procurement of data collection resources throughout 2024, followed by field surveys and mapping by mid-2025. Stakeholder workshops will be conducted in early 2025 to incorporate local insights into the pilot action design. The finalization of the monitoring framework is expected by early 2025, after which monitoring and data collection efforts will be carried out through mid-2025.



Evaluation and policy drafting will take place in late 2025, and the final report summarizing findings and recommendations will be submitted in early 2026.

5.4 Stakeholders' contribution to the definition of the plans for pilot action

Stakeholders are expected to contribute significantly to the pilot action, providing critical insights and support for its execution. Local authorities and port operators are likely to offer regulatory backing for the proposed anchoring guidelines, while the tourism industry may express concerns over potential restrictions on anchoring. Environmental organizations are anticipated to strongly advocate for conservation measures and may provide valuable scientific expertise to enhance the monitoring framework. To facilitate stakeholder engagement, a series of workshops, public consultations, and participatory field surveys will be carried during spring 2025, ensuring that the pilot action is transparent and inclusive.



6 Pakleni Islands

6.1 Brief overview of the pilot area

- *Where is the pilot area*

The Pakleni islands lie along the southern coast of the island of Hvar in the **Middle Adriatic**, in Croatia, administratively they belong to **Split-Dalmatia County**⁴ and local self-government unit - **City of Hvar**⁵.



Figure 15 – Location of Pakleni Islands in relation to the Adriatic Sea (red square) and the mainland (on the left) and the landscape of the archipelago (on the right). Source: Public institution for the management of protected parts of nature in the Split-Dalmatia County SEA AND KARST, author: Branimir Jukić.

- *Valuable habitats*

Pakleni Islands marine area is part of the European ecological network Natura 2000 under the code **HR3000095** to preserve the following habitat types: *Posidonia* beds (*Posidonia oceanica*, code: 1120), sandbanks which are slightly covered by sea water all the time (code: 1110), mudflats and sandflats not covered by seawater at low tide (code: 1140), reefs (code: 1170) and submerged or partially submerged sea caves (code: 8330). The conservation area for Natura 2000 species and habitat types is 1996.60 ha⁶, while the area covered by each habitat type is showcased in Table 4.

⁴ Regional self-government unit, <https://www.dalmacija.hr/>

⁵ <https://www.hvar.hr/portal/>

⁶ <https://interni.bioportal.hr/ekomreza/natura/report/site?site-code=HR3000095>



Table 4 – Habitat types present on the site and assessment for them.

Code	NAME	ANNEX I HABITAT TYPES					SITE ASSESSMENT			
		PF	NP	COVER [ha]	Caves	Data	Representativity A B C D	Relative Surface A B C	Conservation A B C	Global A B C
1110	Sandbanks which are slightly covered by sea water all the time	0	0	1.450		M	B	C	A	B
1120	Posidonia beds (Posidonium oceanicae)	1	0	330		G	A	C	B	A
1140	Mudflats and sandflats not covered by seawater at low tide	0	0	0,05	0	M	B	C	B	B
1170	Reefs	0	0	195		G	B	C	B	B
8330	Submerged or partially submerged sea caves	0	0		2	M	B	C	B	C

PF: Value "1" indicates the priority form for habitat types that can have a non-priority as well as a priority form (6210, 7130, 9430). NP: Value "1" indicates a habitat type that no longer exists in the site; Caves: for habitat types 8310, 8330 (caves) the number of caves is entered if estimated surface is not available. Data quality: G = 'Good' (e.g. based on surveys); M = 'Moderate' (e.g. based on partial data with some extrapolation); P = 'Poor' (e.g. rough estimation). Representativity (Degree of representativity of the habitat type on the site): A= excellent, B=good, C=significant, D=non-significant. 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): A = >15%, B = 2-15%, C = <2%. Conservation (Degree of conservation of the structure and functions of the natural habitat type): A = excellent conservation, B = good conservation, C = average or reduced conservation. Global assessment (Global assessment of the value of the site for conservation of the natural habitat concerned): A = excellent value, B = good value, C = significant value.

Recently, a detailed habitats' distribution map has been produced (Figure 16) so the revision of the above table indicating habitat types, their surface and assessment has been updated by the Ministry of Environmental Protection and Green Transition.

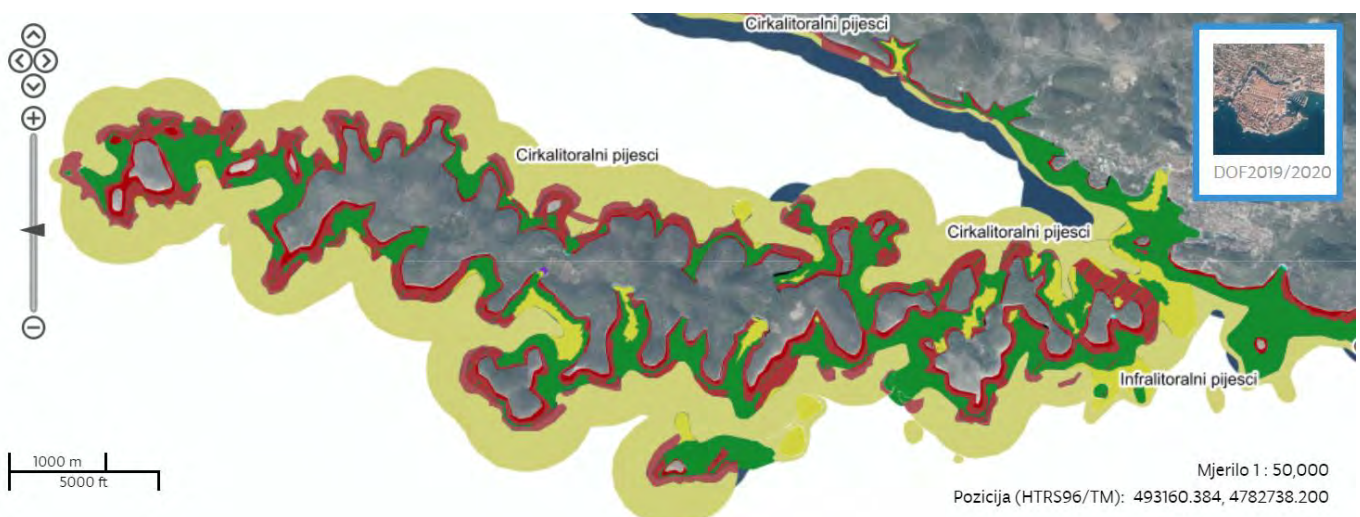


Figure 16 – Marine habitats map (in yellow: 1110 - Sandbanks which are slightly covered by sea water all the time, in red: 1170 - Reefs, in green: 1120 - Posidonia beds, note: 1140 - Mudflats and sandflats not covered by seawater at low tide and 8330 - Submerged or partially submerged sea caves are small surfaces not visible on this map), Source: <https://bioportal.hr/gis/>.



After the sandbanks which are slightly covered by sea water all the time, the most widespread habitat in the sea of Pakleni are **Posidonia beds (1120)**. *Posidonia* beds characterize the infralittoral zone of the sea from a few tens of centimetres in the passages between the Pakleni Islands up to a maximum recorded depth of 35 meters. On hard or soft substrates, these settlements form the main climatogenic community. A related species and the basic constructor of the settlement is the flowering sea plant *Posidonia* (*Posidonia oceanica*). Due to the favourable ecological conditions, the leaves of this flowering plant around the island of Hvar reach their maximum length of over 1 meter, and form extremely dense settlements that in some locations create the so-called *matte*. Particularly important for the preservation are *Posidonia* beds in the passages between Pakleni Islands, whose leaves reach the very surface of the sea and the so-called *matte*, a twisted agglomerate of sediment and dead plant anchored to the substrate, which is in fact an example of carbon storage.

Another less abundant marine seagrass, ***Cymodocea nodosa*, covers shallow parts of Pakleni Islands marine area**. *Cymodocea nodosa* contributes to the diversity of habitats on the sandy substrate, by forming association with the species *Cymodocea nodosa* (NKS⁷ G.3.2.2.1.) present on the southeast side of the Ždrilca passage and in the interior of the Taršće cove in a mosaic with the biocenosis of *Posidonia oceanica* species beds (NKS G.3.5.1.). The association with the species *Cymodocea nodosa* (NKS G.3.2.3.4.) is also widespread on the muddy sands of Luka Solina in the most sheltered part of the bay near Roman Villa⁸.

- *Brief analysis of natural and human-made features*

The Pakleni Islands are a group of 16 smaller islands, islets and rocks: **Vodnjak Mali, Vodnjak Veli, Travnica, Paržanj, Borovac, Sveti Klement, Dobri, Vlaka, Stambedar, Planikovac, Borovac - another island of the same name, Gojica, Marinkovac, Jerolim, Gališnik and Pokonji Dol** (Figure 16). The last two islets are not part of the protected area. The Pakleni Islands contribute significantly to the exceptional diversity of the western part of the island of Hvar. In addition, the Pakleni Islands are one of the main landscape features of both the entire island and the Town of Hvar. They have a characteristically indented coast, which gives the Hvar tourist area a special value and attractiveness. The Pakleni Islands are among the most beautiful and geomorphologically interesting on the Adriatic coast. **They were built from limestone**, which on the largest island, St. Klement, reach a height of 96 meters. There are interesting **areas of diluvial sands** in the bay of Palmižana and Port of Soline. The sandy and pebble beaches of Pakleni Islands represent a rare landscape value for the predominantly rocky coast of the Adriatic islands. Due to the aforementioned characteristics, the Pakleni Islands since 1968 enjoy the status of a significant landscape. Several breccias exist on the

⁷ NKS – national classification system according to Ordinance on habitat types list and habitat map (OJ 27/2021): https://narodne-novine.nn.hr/clanci/sluzbeni/2021_03_27_588.html

⁸ Kurtović Mrčelić, J., 2017., "Studija zaštite podmorja ekološke mreže Natura 2000 na sidrištima Splitsko-dalmatinske županije" Javna ustanova za upravljanje zaštićenim dijelovima prirode na području Splitsko-dalmatinske županije MORE I KRŠ, Split



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island of Borovac. There are caves on Dobro otok, Meštrovićapunta, between Veli and Mali Ždrilac, and pits: on Dobri otok, above Stori Stoni Bay, between Vela Glova and Carnjene bays. Among the underwater geological values, the following should be highlighted: vertical rock Kampanel, Sika od Vodnjaka, vertical rock Zub (about 300 meters south of cape Klobuk Veli Vodnjok), underwater cave next to the islet of Vloka⁹.

The cultural heritage of protected areas is an integral part of the act on the declaration of protection over Pakleni Islands. An overview of individual cultural and ethnographic assets is given below, regardless of whether they are formally protected or not. The Pakleni Islands are characterized by a **rich cultural heritage** dating back to the age of the **Illyrians**.

- *Use*

According to the population census from 2021, the settlement of Hvar, which also includes the Pakleni Islands, has 3,519 inhabitants. Pakleni Islands have **18 inhabitants**. During the season, the number of inhabitants increases. Some caterers accommodate workers on Pakleni Islands, estimable at least in **300**. Most of them still travel back to Hvar. In terms of **tourists**, during the year 2022, **428** arrivals, i.e. a total of **3,423** overnight stays through **31** accommodation units, as part of the households or form of hotel business in Pakleni Islands. The number of overnight stays on the mainland of Pakleni is not a relevant indicator of the number of tourists, as the largest number of visitors are **daily visitors** transported by local boats called *barkarioli*, who mostly spend the night in the town of Hvar, and taxi boats that bring visitors mainly from Central Dalmatia where they spend the night. A total of 3,634 one-day excursionists is estimated per day in the heart of the season (July and August), and **up to 333,569 one-day excursionists annually**. In addition to daily visitors coming by barkarioli and taxi boats, a significant part of tourists is represented by **leisure boats users** being **charter or private** vessels (sailboats and yachts). In 2022, a total of 15,162 vessels stayed per day in ACI marina Palmižana situated on Pakleni Islands. With an average of 5 people per vessel, the total number of visitors was approximately **75,808**.

Additionally, estimates of the annual number of vessels anchoring/mooring outside the ACI marina peak 30,534 and with an average of 5 people stay per vessel, the total number of visitors is **152,671** per year.

Based on the above estimates, we arrive at a figure of **565,471 visitors per year for Pakleni Islands**. In the aquatorium of Pakleni Islands, in the passage between the islets of Marinkovac and Jerolim, **mini cruisers with a length of over 24 m (mainly from the home port Krilo Jesenice, near town**

⁹ Kurtović Mrčelić, J., Taraš, M., Petit, S., Ferretti, M. (2023): Pakleni Islands diagnosis and strategic plan. Split



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of Split), waiting for berthing in the port of Hvar are anchoring. Their guests visit Pakleni Islands via taxi boats. It is estimated that about 15 of them anchor per day in the heart of the season¹⁰.

Thorough **analyses of ecosystem services** showcase that the most important ecosystem service of the marine ecosystem of Pakleni Islands is related to tourism¹¹.

The Pakleni Islands have a rich tourist offer. In terms of **Hospitality services**, there are at least 17 establishments on Pakleni, maybe more because 25 of them pay utility bills. **SCUBA diving** is organized in the marine area of Pakleni Islands by 2 facilities in Hvar: Aqualis and Viking diving centers. **Sea kayaking** is carried out by 2 facilities in Hvar with an offer on Pakleni: AndAdventure Croatia sea kayaking, Devotion jdoe Kayak & SUP Hvar. Many **tourist agencies** (18 facilities in Hvar, some with an offer on Pakleni) organize mainly transfers on Pakleni Islands¹². More than 60 charter agencies have been identified however data on their offer in respect to Pakleni Islands is not available.

In addition to the tourist offer, fishing and agriculture are also present. For **agriculture**, information is available on 7 agriculture farms that deal with agriculture and 4 family farms that deal with animal husbandry. In terms of **fishing**, the stakeholders estimate that there are about 20 active fishermen (commercial fishing) in the area of the town of Hvar who use the Pakleni Islands as a fishing area. There is sport and recreational fishing¹³.

- *Pressures and quali-quantitative evaluation of consequent impacts on valuable habitats*

The Pakleni islands are in the heart of the navigation routes of the central Adriatic, which marked their history and shaped their current development. Exceptional gastronomic offer, the indented coastline with small pebble and sandy beaches, picturesque forests and the vicinity of the historical city of Hvar with important accommodation capacity, made Pakleni Islands a well-known nautical destination. However, because of a lack of proper management measures, the marine ecosystem of Pakleni Islands is under exceptional **pressure from nautical tourism**.

Hvar barcaroli, with their small vessels (ranging from 6 to 12 meters), are of special importance for the city of Hvar due to its coastal location and the appeal of the Pakleni Islands. These boats offer a unique service compared to others, making them key players in Hvar's nautical tourism. There are

¹⁰ Kurtović Mrčelić, J., Taraš, M., Petit, S., Ferretti, M. (2023): Pakleni Islands diagnosis and strategic plan. Split

¹¹ Visintin, F. *et al* (2020): IMPRECO Common strategies and best practices to IMProve the transnational PROtection of ECOsystem integrity and services Deliverable T2.3.1 - Measures for EcoSystem (M4ES), DOI: [10.13140/RG.2.2.26018.20160](https://doi.org/10.13140/RG.2.2.26018.20160)

¹² Kurtović Mrčelić, J., Taraš, M., Petit, S., Ferretti, M. (2023): Pakleni Islands diagnosis and strategic plan. Split

¹³ Jakl Z., Miletić A., Špika M. (2023): A study on determining the type and extent of current fishing activities and proposals for recommendations for the preservation of the marine ecosystem of Pakleni Islands. Association for nature, environment and sustainable development Sun. Client PI SEA AND KARST



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approximately 30 barcarioli owners (35 in 2021), who provide nearly all-day transportation between Hvar town and the Pakleni Islands. They belong to a specific association and guild. Passengers are dropped off at four locations on the Pakleni Islands: Jerolim, Stipanska, Ždrilac, and Palmižana. Of the fleet, 15 boats serve Jerolim and Stipanska, 6 serve Ždrilac, and 9 larger boats (with a capacity of 50 people) go to Palmižana. Most barcarioli dock at piers, which suggests minimal anchoring impact, but this should be verified using remote sensing techniques to fully assess the anchoring effect. The main pressures from this target group relates to **marine litter, bilge water and fuel**.

Another important group creates pressure not only in terms of marine litter and fuel but also **noise generation: taxi boats**. They often operate from the Port of Hvar towards Pakleni Islands, however, they also operate from other parts of Dalmatia, so their number can only be roughly estimated. Most often, they have direct arrangements with hospitality services in Vinogradišće, Ždrilca and Marinkovac. We suppose that they also use docks however this is something that should be checked by remote sensing methods to completely exclude the anchoring impact from taxi boats.

In the aquatorium of Pakleni Islands, in the passage between the islets of Marinkovac and Jerolim, mini cruisers are anchoring, as above specified. Their big anchors and chains represent a huge threat to Posidonia meadows. That is also the case with anchors of **sailboats and yachts** whether they are private or charter boats.

In addition to anchoring, posing a threat to habitats, the main pressures related to leisure boaters are **grey and black tanks, bilge water, as well as marine litter and noise production from yachts**. There is no pump for emptying the vessel's tanks on Pakleni Islands, but also in the wider area, so it is obvious that the tanks are emptied into the sea, more or less close to the shore (we estimate 400 vessels/day of different tank capacities). In the conversation with the stakeholders, it was recorded that the tanks are often emptied at distances smaller than the prescribed 0.5 NM¹⁴, and often inside the bay. **Monitoring of marine litter** has been carried out in the framework of ML-REPAIR project. The Pakleni Islands are mainly polluted by glass items, suggesting a local vessel-based source¹⁵.

Threats, pressures, and activities with impacts on the site¹⁶ have been generally identified as referred in Table 5.

¹⁴Kurtović Mrčelić, J., Taraš, M., Petit, S., Ferretti, M. (2023): Pakleni Islands diagnosis and strategic plan. Split

¹⁵ Stagličić N., Bojanić Varezić D., Kurtović Mrčelić J., Pavičić M., Tutman P. (2021): Marine litter on the shallow seafloor at Natura 2000 sites of the Central Eastern Adriatic Sea, Marine Pollution Bulletin, Volume 168, 2021, 112432, ISSN 0025-326X, Dostupno na: <https://doi.org/10.1016/j.marpolbul.2021.112432> [26. travnja 2024.]

¹⁶ <https://interni.bioportal.hr/ekomreza/natura/report/site?site-code=HR3000095>



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Table 5 – Threats, pressures and activities with Impacts on the site (Type: N = Negative, P = Positive; Rank: H = high, M = medium, L = low).

CODE	DESCRIPTION	TYPE	RANK	POLLUTION	OCCURENCE
D03.01.02	Piers / tourist harbours or recreational piers	N	H		
E03.01	Disposal of household/ recreational facility waste	N	M		
E03.04	Other discharges	N	M		
F02	Fishing and harvesting aquatic resources	N	M		
F05	Illegal taking / removal of marine fauna	N	M		
G01.01	Nautical sports	N	H		
G01.07	Scuba diving, snorkelling	N	H		
H05.01	Garbage and solid waste	N	H		
I01	Invasive non-native species	N	M		

Public Institution Sea and Karst (PP8) activities within the Biopressadria project will focus on Posidonia beds and anchoring, which is currently the main threat to this priority habitat type.

In 2022, a total of 15,162 vessels stayed per day in ACI marina Palmižana situated on Pakleni Islands. Estimating the annual number of vessels anchoring/mooring outside the ACI marina amounts to 30,534 vessels¹⁷. During the monitoring carried out in 2016 it was recorded that in the heart of the season at the beginning of August, during stable weather conditions, the total number of vessels present during the 15-30 minutes monitoring period within 11 bays was 265 respectively¹⁸.

Posidonia beds on Pakleni Islands cover a surface of 330 ha¹⁹. This habitat is present in most of the bays also attractive for nautical tourists and therefore under anchoring pressure. **Monitoring of the state of Posidonia beds** in relation to anchoring is implemented on Pakleni Islands since 2019.

Measurements are being carried out at six locations (Figure 17) on bays on the southern side of the Pakleni Islands. The selected locations cover areas that are or will be under the anchoring concession (four locations). Anchor blocks are currently installed at two of them, while free anchoring is taking place at two locations. Two additional locations were selected to serve as reference locations: the Pakleni Bok Bay and a location is at the bottom of Okorija Bay.

¹⁷ Kurtović Mrčelić, J., Taraš, M., Petit, S., Ferretti, M. (2023): Pakleni Islands diagnosis and strategic plan. Split

¹⁸ Kurtović Mrčelić, J. (2016): Pakleni Islands vessels monitoring report, Public Institution Sea and Karst

¹⁹ www.bioportal.hr





Figure 17 – The starting points of the transects at the monitored locations to establish monitoring of the impact of anchoring on the condition of *Posidonia* beds at Pakleni Islands.

Both reference sites showed high conservation status while locations where free anchoring takes place showed the lowest mean value of the CI. Sites with regulated mooring systems showed intermediate CI values. A regulated mooring system with fixed concrete blocks has been used for more than ten years. Anyhow, it is not expected that the regeneration of *P. oceanica* occurred in such a period but **regulated mooring system protected further devastation** during the last 10 years of intensive nautical tourism compared to free anchoring areas. Our results pointed out the dramatic devastation of the protected species *P. oceanica* and the related priority habitat type within the Natura 2000 site, caused by free anchoring. A positive effect of the installation of mooring systems in the Natura 2000 site was noted however to completely reduce the damage to protected seagrass, a new, environmentally friendly mooring design is required²⁰.

Monitoring will be repeated in 2025 in the framework of BIOPRESSADRIA project activities.

²⁰ Kurtović Mrčelić, J., Žuljević, A., Boban, J., 2021. Preliminarni rezultati praćenja utjecaja sidrenja na naselja posidonije unutar Natura 2000 područja Pakleni otoci, Hrvatska – ECOMAP kongres, URL: https://www.bib.irb.hr/1151179/download/1151179.Book_of_abstract.pdf

6.2 Pilot actions description

Sea and Karst (PP8) is planning to implement two pilot actions that are part of Pakleni Islands strategic documents, namely the Management Plan for protected areas and ecological network sites (6105): Hvar²¹ and Pakleni Islands Diagnosis and Strategic Plan²². Details of two pilots are explained in the next section.

Pilot Action Type 1. Sea and Karst will advocate modification of the Physical Plan of the City of Hvar to include mooring sites. County Physical Plan, which is a plan of higher order to which local plan of the City of Hvar has to comply, is defining nautical mooring sites through the recently adopted *Plan of nautical mooring sites in Split-Dalmatia County*²³ which preparation was coordinated by Sea and Karst. Actual Hvar's Physical Plan prohibits the construction and planning of anchorages in the Pakleni Islands archipelago (Art. 81). City of Hvar is in the process of changing the physical plan so adequate modification of the Physical Plan of the City of Hvar will be advocated by Sea and Karst according to *Plan of nautical mooring sites in Split-Dalmatia County*. Sea and Karst has long experience in advocating physical planning of eco moorings in Natura 2000 sites. We are the first County in the Republic of Croatia to have the obligation of planning moorings and to plan eco-moorings in Natura 2000 sites.

Pilot Action Type 2. We will prepare a *Conceptual solution for the Pakleni Islands nautical eco-moorings* (in Croatian: *Idejno rješenje*) which is the main technical document for the location permit and concession tender before investing in eco-moorings installation. That will include bottom type probing (sand, stone, Posidonia), identification of best technical solutions for each eco mooring according to bottom type and boat size, etc. In HR3000095 Pakleni Islands Natura 2000 marine site, the *Plan of nautical mooring sites in Split-Dalmatia County* defines 15 concession fields inside 8 locations: Luka Soline – west, Luka Soline – bay Prevojice, bay Taršće, bay Vinogradišće, Stipanska bay, passage Jerolim and Marinkovac, Ždrilca, bay Vlaka. The plan obliges the use of technical and technological solutions of ecological moorings that are adapted for various types of sea-bottoms, i.e. for the target habitat types of the area of the ecological network Natura 2000. Our Conceptual solution will be based on WP1 output on anchoring pressure - boats density maps production which will serve as bases for capacitating mooring places according to boats length.

Sea and Karst pilot actions relate to the HR3000095 Pakleni Islands Natura 2000 marine site (Figure 18) and aim to stop/reduce impacts from leisure boating especially anchoring.

²¹ https://moreikrs.hr/pu_6105_hvar_konacni-pdf/

²² Kurtović Mrčelić, J., Taraš, M., Petit, S., Ferretti, M. (2023): Pakleni Islands diagnosis and strategic plan. Split

²³ <https://moreikrs.hr/plan-rasporeda-nautickih-sidrista-splitsko-dalmatinske-zupanije-pdf/>





Figure 18 – Planned concession fields for nautical moorings of Pakleni Islands (from the southwest part of the coastline to the east and back to the northwest part are located following sites: Luka Soline – west, Luka Soline – bay Prevojice, bay Taršće, bay Vinogradišće, Stipanska bay, passage Jerolim and Marinkovac, Ždrilca, bay Vlaka). Source: Plan of nautical mooring sites in Split-Dalmatia County.

- How these pilot actions can reduce the pressure and be effective.

Once the concession for nautical moorings of Pakleni Islands is granted all boats entering bays with planned concession fields will have to moor to the buoy instead of throwing boat anchors to the sea bottom. Free anchoring is forbidden within bays with concessions fields for nautical moorings and 150m from the nautical mooring field in the direction of the open sea because of safety reasons²⁴. However, the concession granting can occur only if both pilot actions are implemented. BIOPRESSADRIA pilot actions are a precondition for the installation of nautical moorings at Pakleni Islands. Once a concessioner is in place, improved management of solid and liquid waste shall occur because the concessioner signs a contract with Split-Dalmatia County obliging him to respect the *Ordinance on economic use, use or construction of buildings, concession on request, and special use of maritime property in the area of Split-Dalmatia County (OJ 163/23)*²⁵.

²⁴ Rules on the safety of maritime navigation in the inland waters and territorial sea of the Republic of Croatia and the manner and conditions of performing supervision and management of maritime traffic (OJ 79/2013, 57/2015)

²⁵ https://www.pomorskodobro.dalmacija.hr/DesktopModules/Bring2mind/DMX/API/Entries/Download?language=hr-HR&Command=Core_Download&EntryId=26388&PortalId=4



- *Controls/monitoring to be carried out during and after the project duration to verify the quality and effectiveness of the pilot actions.*

During the project implementation, Sea and Karst will sign contracts with one service provider for a *Conceptual solution for the Pakleni Islands nautical eco-moorings* preparation and one service provider for bottom-type probing (sand, stone, Posidonia) which will guarantee quality and effectiveness of pilot action realization. Conceptual solution will also be fitted to the results of the *Nautical tourism pressure analysis report for pilot area of the ecological network Natura 2000 HR3000095 Pakleni Islands* prepared by the service provider SeaCras Ltd. Stakeholders' contribution is also an important control mechanism explained in the following paragraph 6.4. Once the project ends all documentation will be transmitted to our Associated Organisation AO1 - Split-Dalmatia County Administrative Department of Tourism, Maritime Affairs and Traffic carrying out the process of awarding a concession on maritime property including nautical moorings at Pakleni Islands.

6.3 Implementation phase of the pilot actions

- *Preliminary activities*

The preliminary activities for Pilot 1 started many years ago. Sea and Karst formalized them in our letter to the City of Hvar addressed on the 9th of August 2023. (Ur.broj. 303-02/23-01/131; Klasa: 2181-179-23-1) asking for modification of the Physical plan of the City of Hvar to include mooring sites.

The preliminary activities for Pilot 2 concern the preparation of calls for tenders, one for the *Conceptual solution for the Pakleni Islands nautical eco-moorings* preparation and one for the service provider for bottom-type probing (sand, stone, Posidonia) at Pakleni Islands nautical eco-moorings locations. Calls will be ready by the first week of March 2025. Contracting is expected by the end of March and then the realisation of Pilot 2 starts in April 2025.

- *Pilot action' site selection.*

Sites for Pilot Action 1 and 2 are the same. They are bays inside of which concession fields for nautical moorings of Pakleni Islands are planned according to the *Plan of nautical mooring sites in Split-Dalmatia County*²⁶ (Figure 18). 15 concession fields are located inside 8 locations: Luka Soline – west, Luka Soline – bay Prevojice, bay Taršće, bay Vinogradišće, Stipanska bay, passage Jerolim and Marinkovac, Ždrilca and bay Vlaka that we can consider as sites for our pilots.

The map of the pilot action locations is shown in Figure 18. Pictures of all locations/sites are indicated in Figure 19 and Figure 20.

²⁶ <https://moreikrs.hr/plan-rasporeda-nautickih-sidrista-splitsko-dalmatinske-zupanije-pdf/>





Luka Soline – west



Luka Soline – bay
Prevojice



bay Taršće



bay Vinogradišće



Stipanska bay

Figure 19 – Locations at the south coastline of Pakleni Islands.



passage Jerolim and
Marinkovac



Ždrilca south



Ždrilca north



bay Vlaka

Figure 20 – Locations at the north coastline of Pakleni Islands.



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- *Spatial analysis*

Spatial analyses were carried out during the preparation of the *Anchoring Study of Split-Dalmatia County*²⁷ and the *Plan of nautical mooring sites in Split-Dalmatia County*²⁸. Analyses were carried out for the Split-Dalmatia County, Island of Hvar, Pakleni Islands and for each location by considering navigational and meteorological characteristics, technical-technological and traffic-navigational characteristics, maritime safety measures, maps of habitats of the Natura 2000 ecological sites, list of recorded strictly protected species, technical-technological methods of anchoring and organization of anchorages. Furthermore, analyses of existing physical plans were done, as well as of previous studies concerning the suitability of moorings for a site. In the *Anchoring Study of Split-Dalmatia County* there is a detailed description for each of the eight sites planned for mooring fields at Pakleni Islands, such as maritime characteristics of the site, state for the observed location, marine conservation, recommendations for the observed location. In the *Plan of nautical mooring sites in Split-Dalmatia County* for each of the eight sites planned for mooring fields at Pakleni Islands, the emplacement of each mooring field (georeferenced coordinates), its size and maximum capacity is defined as well as the obligation to use technical-technological methods of ecological mooring inside Natura 2000 sites.

Table 6 – Number of mooring fields, surface, and maximum capacity for nautical moorings at Pakleni Islands, Hvar.

No.	Location	No. mooring fields	Surface (m ²)	Maximum capacity
1	Luka Soline – west	1	18,806	13
2	Luka Soline – bay Prevojice	2	40,084	21
3	bay Taršće	2	63,471	38
4	bay Vinogradišće	2	53,490	35
5	Stipanska bay	2	43,450	26
6	passage Jerolim and Marinkovac	2	38,800	20
7	Ždrilca	3	64,027	36
8	bay Vlaka	1	14,133	5
		15	336,261	194

²⁷ <https://moreikrs.hr/st6udija-sidrista-splitsko-dalmatinske-zupanije-pdf/>

²⁸ <https://moreikrs.hr/plan-rasporeda-nautickih-sidrista-splitsko-dalmatinske-zupanije-pdf/>



- *Suitability analysis of the pilot actions*

As previously said, both pilot actions are part of Pakleni Islands strategic documents, namely the Management Plan for protected areas and ecological network sites (6105): Hvar²⁹ and Pakleni Islands Diagnosis and Strategic Plan³⁰. Details of two pilots are explained in the next section.

- *Possible overlap or conflict in different uses or activities*

All locations where nautical moorings are planned are used for other purposes as well mainly for beach and recreational tourism. Usage of this area was analysed by the expert team during the preparation of the *Anchoring Study of Split-Dalmatia County*³¹ and is referred to in the section “state for the observed location” for each of the eight locations planned for nautical moorings. All usages were duly considered, and the emplacement of mooring fields is defined in a way not to compromise other usages at the considered location. Further discussions were also carried out with stakeholders which is described in the following section.

6.4 Stakeholders’ contribution to the definition of the plans for pilot action

Stakeholders of Pakleni Islands and the City of Hvar to which Pakleni territorially belong, already support the installation of ecological mooring fields. A wide consultation process was carried out during the preparation of the Management Plan for protected areas and ecological network sites (6105): Hvar³² and Pakleni Islands Diagnosis and Strategic Plan³³. The widest and most comprehensive consultation process with users of the space was carried out in the period from 2020 to 2023 during the development of the Management Plan for protected areas and areas of the ecological network (6105): Hvar. 4 workshops, 1 questionnaire, 1 public presentation, 1 public consultation were held, and 61 stakeholders participated in total. Stakeholders' recommendations are integrated into the adopted Management Plan, which also applies to the area of Pakleni Islands. During the preparation of the Pakleni Islands Diagnosis and Strategic Plan, 10 semi-structured interviews were carried out from 04. to 27.04.2023. with key stakeholders from the water, energy, waste and tourism sectors. Meetings with stakeholders were organised on 20.11.2023., 13.03.2024. and 26.09.2024 during which the Pakleni Island Committee was formed, and the Pakleni Islands Diagnosis and Strategic Plan was adopted. Also, during the finalization of the *Plan of nautical mooring sites in Split-Dalmatia County*, a public hearing procedure was carried out which resulted in the addition of some new sites and modification of mooring fields emplacement for some sites. In

²⁹ https://moreikrs.hr/pu_6105_hvar_konacni-pdf/

³⁰ Kurtović Mrčelić, J., Taraš, M., Petit, S., Ferretti, M. (2023): Pakleni Islands diagnosis and strategic plan. Split

³¹ <https://moreikrs.hr/st6udija-sidrista-splitsko-dalmatinske-zupanije-pdf/>

³² https://moreikrs.hr/pu_6105_hvar_konacni-pdf/

³³ Kurtović Mrčelić, J., Taraš, M., Petit, S., Ferretti, M. (2023): Pakleni Islands diagnosis and strategic plan. Split



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addition, during the Erasmus+ project “Circular Economy on Small EU Islands” Inter-islands visit to Pakleni Islands (12.-14. September 2023.) we held a presentation of nautical moorings to local stakeholders. As usual, we expect to have discussions and opposite opinions.

- *Stakeholders' engagement plan*

We are planning to hold the Pakleni Islands Committee meeting in the spring and fall of 2025 to discuss pressure analyses carried out by contracted service provider SeaCras Ltd. based on which we will discuss the arrangement of vessels within the mooring field of each location. Pakleni Islands Committee is composed of 27 members headed by City of Hvar Mayor. The composition of the island Committee consists of representatives of the water sector, waste management sector, cultural and natural heritage preservation sector, catering, agriculture, fishing, tourism, and nautical, educational, and scientific sectors, as well as representatives of public bodies and institutions that create development policies and strategies. Representatives cover the local and regional levels of activity. There is a balance between public, private, and non-governmental sector representatives. NGO Sunce, BIOPRESSADRIA project partner, is also a member. Public Institution Sea and Karst representative heads natural heritage incl. landscape topic. Decisions are accepted if 80% of the members vote for them by the deadline set by the Representative of the Island Committee. The minimum deadline for making decisions is one week from the notification to board members in writing or orally at the meeting of the Island Committee.

The meeting of the Island Committee should not be organized during the tourism season.

