



Life Pinna

LIFE20 NAT/IT/001122

LIFE PINNA

*Conservation and re-stocking of the Pinna nobilis
in the western Mediterranean and Adriatic sea*

REPORT ON THE PINNA NOBILIS STATUS EX POST DELIVERABLE D 3.2





Deliverable D 3.2

REPORT ON THE PINNA NOBILIS STATUS EX POST

LIFE20 NAT/IT/001122

LIFE PINNA

Conservation and re-stocking of the *Pinna nobilis* in the western Mediterranean and
Adriatic sea

AC/Task responsible:

ARPAL

Other contributors:

Miramare MPA (Shoreline), Strunjan MPA (NIB), UBICA srl (on behalf
of ARPAL)

Table of Contents

Summary	2
Report on the P. nobilis status ex post	3
Miramare Marine Protected Area (MPA)	3
Monitoring results on juveniles of Pinna nobilis (2022–2025)	8
Strunjan MPA	12
Monitoring results on juvenile Pinna nobilis individuals (2023–2025)	14
Capo Mortola MPA	20
References	33



Summary

Within the framework of Action D3 of the LIFE PINNA project, project partners carried out systematic monitoring activities aimed at assessing the presence, distribution, and conservation status of *Pinna nobilis* populations in both donor and recipient sites. Monitoring was conducted continuously from the beginning to the end of the project, covering Marine Protected Areas (MPAs) and selected coastal sites.

At the end of 2021, only 8 living fan mussels were observed in the Miramare Marine Protected Area (MPA), where high densities were usually measured only a couple of years before. Even more impressive, the results from Strunjan MPA in 2022, where 858 shells of *P. nobilis* were counted and measured in a total surveyed area of 6200 m² (mean density of about 14 ind/100 m²) with only 2 animals alive. Monitoring campaigns realized in 2021-2022 confirmed mass mortality events also along the northern Adriatic coasts.

Data obtained from the Tyrrhenian areas selected for the Life Pinna project (i.e. Capo Mortola MCA and Asinara MPA) confirmed the absence of fan mussels along the western coasts of Italy. In Capo Mortola, only one empty shell was observed during 2022 monitoring campaign; in other areas along the Ligurian coast, where the presence of fan mussel populations was documented in 2018, no living specimen of *P. nobilis* was observed. In the Asinara MPA, the decline of the resident population of *P. nobilis* started in 2018; in 2019, only one living specimen was observed, but its presence was not confirmed during summer 2022 monitoring. Molecular studies by the University of Sassari suggested that a multifactorial disease might be responsible for the mass mortality event (Scarpa et al, 2020; Scarpa et al, 2021).

Comfortable data are arising from monitoring activities in north Adriatic small harbours, also outside MPA boundaries: in 2021/2022, more than one hundred juveniles have been observed during citizen science events. This evidence underlines the importance of promoting citizen science activities to enlarge the knowledge about the presence of *P. nobilis* along the Italian coasts and, in particular, in Life Pinna areas.

However, monitoring activities carried out by partners in the framework of Life Pinna project actions confirmed a drastic decline of *P. nobilis* populations in Adriatic donor/receiving areas. As reported below, project partners expanded the search area for animals as well as the monitoring effort, aiming to identify populations suitable for project actions. However, these efforts did not yield the desired results: data obtained from seabed monitoring and from larval collectors during the project confirmed the absence of populations of *P. nobilis*. Ex post monitoring in the areas where fan mussel specimens were transplanted did not show any evident variations compared to ex ante monitoring. Finally, monitoring data in Bergeggi MPAs and in Giannutri island (Arcipelago Toscano National Park) showed also in these sites a drastic reduction of previously monitored fan mussels populations.



Report on the *P. nobilis* status ex post

Miramare Marine Protected Area (MPA)

Monitoring activities conducted over recent years within the Miramare Marine Protected Area (MPA) and the coastal waters of Friuli Venezia Giulia have provided a comprehensive assessment of the distribution and density of *Pinna nobilis* populations. Up to 2019, the Gulf of Trieste, particularly its coastal zone, was confirmed as a high-abundance area for *P. nobilis*. The population displayed a heterogeneous age structure and played a key ecological role, functioning both as a settlement and recruitment area for post-larvae and as an important reservoir of reproductive specimens. Overall population density was notably high, especially when compared with other Mediterranean regions. In early autumn 2016, a mass mortality event affecting *P. nobilis* populations was first detected in the southwestern Mediterranean. Subsequently, the epidemic progressively spread across the basin, impacting Spanish, French, Tunisian and Turkish waters, and eventually reaching Italian coastal areas. The outbreak expanded from Sardinia to Sicily and from Puglia to Tuscany, finally affecting the Gulf of Trieste by the end of 2019. Disease progression is rapid, typically resulting in mortality within one to three months. Recent scientific evidence indicates a multifactorial aetiology, with rising average sea temperatures acting as a facilitating factor for the proliferation and virulence of the pathogens involved. Between late 2019 and 2021, the Upper Adriatic Sea was severely impacted by the mass mortality event, leading to a drastic reduction of *P. nobilis* populations, which are currently considered critically compromised in this area. In response to this situation, the Miramare MPA, in coordination with the competent authorities, has undertaken targeted actions aimed at identifying and monitoring the few surviving individuals. Beyond its relevance for local conservation, this activity is of broader significance, as surviving specimens may exhibit natural resistance to the pathogens responsible for the outbreak. The identification and characterisation of such individuals represent a potentially critical step towards the development of effective recovery and restoration strategies for *P. nobilis* at the Mediterranean scale. Within the framework of the Miramare MPA monitoring programme, specific survey activities were implemented in 2021 to detect surviving individuals. These actions consisted of underwater reconnaissance surveys carried out through scuba diving, including georeferenced mapping of live specimens and subsequent assessments of their health status. The protocol used is the module 11N developed by the Italian Environmental Protection System and commonly adopted in all MPAs contexts. This type of monitoring has been very useful and is aimed at assessing the early stages of mortality, when collecting data on both dead and living animals allows for broader ecological assessments. As mortality progressed, monitoring efforts necessarily had to focus on living specimens and their health status alone, with the presence of dead animals taking a back seat. Over the years, tens of thousands of dead fins have been measured, making this type of assessment unnecessary. Monitoring activities aimed solely at identifying living individuals for mapping purposes are useful for highlighting "sanctuary" areas but also for collecting specimens for reproduction. These activities were carried out using DPVs (diver propulsion vehicles) and, in this case, transects of 500 m and 1,000 m were adopted in order to cover the largest possible areas. The size of these transects is justified by the small number of living individuals and therefore by the need to cover very large areas in order to find them.

By way of comparison, a transect conducted using the 11N 100m*6m method covers an area of 600 square metres, whereas a 1,000 m*3m transect (for greater accuracy, considering the higher swimming speed, only 1.5m per side of the transect is analysed) covers 3000 square metres.

Sampling was conducted along belt transects measuring 100 m in length and 6 m in width. Two divers systematically surveyed each transect, recording the presence and location of live specimens. Three transects were surveyed per study area. In addition, opportunistic searches were performed during the remaining bottom time of each dive. Overall, more than 30 dives were carried out, resulting in the detection and mapping of 28 live *P. nobilis* specimens (Fig. 1.1 and Table 1).



Figure 1.1. Maps of survivors in Miramare MPA in 2021.

The checks carried out showed that there were only eight live specimens as of 31/12/2021 (Fig. 1.2 and Table 1). It cannot be ruled out that some live specimens escaped the search operations. During summer monitoring activities, the release of one specimen was also filmed, suggesting the possibility of additional new arrivals in future years. This hypothesis is also supported by the monitoring carried out in the areas outside the MPA, especially in the harbours, and by the collaboration with the Port Authority of Trieste, CST (Diving Club of Trieste) and Società Nautica Grignano, which led to the discovery of more *P. nobilis* juveniles.



Figure 1.2. Map of dead and alive specimens in Miramare MPA at the end of 2021.

Table 1. Individuals of *P. nobilis* found in 2021 at Miramare MPA.

MIRAMARE MPA							
Year	Season	Site	Site area (m2)	Method	Transect area (m2)	Living specimens	Death specimens
2021	Summer	Miramare	300.000	11N	54.000	28	2943
2021	Winter	Miramare	300.000	11N	54.000	8	3033

Another census, carried out on 07/11/2021 in the small port of Grignano within zone B of the Miramare MPA, revealed the presence of 18 juvenile *P. nobilis* specimens (max shell length outside the sediment equal to 10 cm) (Table 2). Twelve divers, accompanied by researchers from Miramare MPA. During this activity it was possible to map the individuals present, as shown in Figure 1.3. By the end of 2021, no live specimens had been found inside the Grignano harbour.

Table 2. Juveniles of *P. nobilis* found in 2021 inside the harbour of Grignano, near the MPA of Miramare.

Grignano harbour					
Year	Season	Date	Site	Method	Living specimens
2021	Summer	07/11/2021	Grignano harbour	11N	18
2021	Winter	13/12/2021	Grignano harbour	11N	0



Figure 1.3. Map of alive juveniles in Grignano harbour.

Other areas adjacent to the MPA were also investigated in 2021, such as the marinas and small moorings along the coast of Trieste (Sistiana, Canovella and Santa Croce). The information collected and the indications obtained also with the help of technical divers operating in the Gulf of Trieste area allowed mapping the presence of juveniles in other port areas (Pier F.lli Bandiera -Port of Trieste, Bay of Sistiana and Porto Piccolo) (Fig. 1.4).

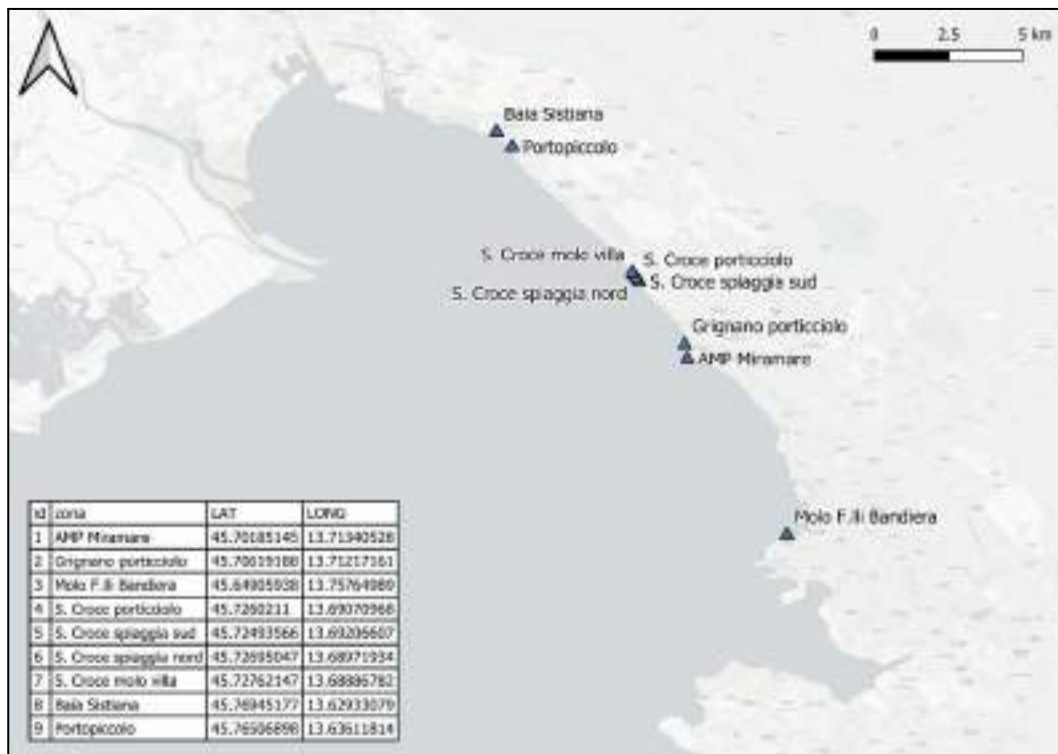


Figure 1.4. Areas in the Gulf of Trieste (blue triangles) where the presence of juvenile individuals has been reported (Bay of Sistiana, Portopiccio, F.lli Bandiera pier) or of which there is certainty thanks to monitoring or surveys carried out (S. Croce, Grignano).

Monitoring activities conducted in the Gulf of Trieste by the Working Group (Shoreline/NIB) in 2021/2022 resulted in the identification and mapping of numerous living individuals of *P. nobilis*. The distribution is broad both spatially and in size, with generally more live individuals in the northernmost areas. Regarding juveniles (max. 15 cm), more than 100 specimens were found in the marine section between Barcola and Valle Cavanata in the summer of 2022.



Monitoring results on juveniles of *Pinna nobilis* (2022–2025)

Table 3. Descriptive summary of *P. nobilis* records in 2022–2023.

Category / Location	No.of Juveniles	Details and Conservation Actions
Direct Monitoring	3	Recorded alongside 30 adults in the Gulf of Trieste.
Citizen Science	20	Confirmed through validated sightings reported by the public network.
Larval Collectors	15	Found on mussel farms (shell height 3.5 – 5 cm); transferred to aquaria.
High-Risk Sites	21	Located in hazardous locations (docks, mooring, and anchorage sites).
Grado Lagoon	7	Detected and monitored in hazardous locations (docks, mooring, and anchorage sites)
TOTAL JUVENILES	66	Overall count of young specimens recorded.

During the 2024–2025 monitoring period, a total of 30 live *P. nobilis* individuals were recorded, including 25 individuals in the Grado/Marano Lagoon (Figure 1.5 and 1.6), three in the Bay of San Bartolomeo (near the Slovenian border), and two within the Miramare MPA. Of the 25 individuals detected in the lagoon, eight were identified and confirmed through the active involvement of divers participating in citizen science initiatives. These specimens were mainly located in high-risk areas, including docks, mooring sites and anchorage zones (Table 4).



Figure 1.5. Areas of the Grado and Marano lagoon have been identified as likely habitats for *P. nobilis*.



Figure 1.6. Blue indicates tagged individuals of *P. nobilis* found in the lagoons of Grado and Marano. Yellow indicates new areas where new individuals may be found.

Table 4. Here is the updated descriptive table reflecting the 2024–2025 monitoring data:

Location / Source	No. of Individuals	Context & Conservation Notes
Grado/Marano Lagoon	17	Found through institutional monitoring activities.
Grado/Marano Lagoon (Citizen Science)	8	Confirmed by divers; located in high-risk areas (docks, moorings).
Bay of San Bartolomeo	3	Located near the Slovenian border.
Miramare MPA	2	Recorded within the Marine Protected Area.
TOTAL RECORDED	30	Total live individuals for the 2024–2025 period.

To date, a very high proportion of juvenile individuals, although not yet quantitatively assessed, have either been found dead or were no longer detectable. In several cases, dead individuals were observed with shells still present in the substrate but completely empty, while in many other cases no shells were recovered at all. This latter observation is particularly relevant, as the absence of shells suggests that mortality was more likely caused by predation rather than by the disease responsible for the mass mortality of *P. nobilis* populations. Many juveniles were also found to have settled in structurally unsafe or unstable conditions (Fig. 1.6). The extremely rapid decomposition of dead individuals and/or their removal by predators makes the collection of samples suitable for pathogen diagnosis particularly challenging. Nevertheless, a limited number of dead specimens—both captive and wild—were examined. In all cases, the presence of known pathogens associated with mass mortality events, particularly the protozoan *H. pinnae*, was not detected. It is also noteworthy that adult *P. nobilis* individuals did not appear to experience significant mortality during the same monitoring period. Overall, these findings highlight the dual role of harbour and coastal infrastructures, which may provide favourable conditions for larval settlement and early growth of *P. nobilis*, while simultaneously representing a major source of risk for juvenile survival.

Mooring lines, overhead cables and other movable structures associated with boating activities can easily cause mechanical damage to juveniles when subjected to regular movement and handling. Similar unsafe settlement conditions were also observed in several natural environments (Fig. 1.6).



Figure 1.6. Juveniles of *Pinna nobilis* on rocks.

Afterwards, new areas were monitored in the Gulf of Trieste 2025, two near the mouth of the Isonzo River, one in Marina Julia. Unfortunately, numerous small and medium-sized individuals were found, but all were dead, with their shells still inside the sediment (Fig. 1.7 and Fig. 1.8).



Figure 1.7. New two areas monitored near the Isonzo mouth.



Figure 1.8. New area monitored in Marina Julia, in the Gulf of Trieste.

There are no longer any individuals of the species *P. nobilis* present in the Miramare MPA. The latest monitoring did not find any surviving individuals, either new or old. The same situation applies along the Trieste coast. The only area of the Gulf of Trieste where young *P. nobilis* are still present is the Grado/Marano lagoon.

Strunjan MPA

The Strunjan Landscape Park was founded on February 2, 1990. The main goal of the institution was the protection of natural values and the preservation of biodiversity and landscape diversity. The park has three close protected areas (Fig. 2.1): Strunjan Nature Reserve (Naravni rezervat Strunjan), Strunjan-Stjuža Nature Reserve (Naravni rezervat Strunjan-Stjuža) and Natural Monument Pine Trees Avenue (Naravni spomenik Pinijev drevored). The park area preserves the landscape with its mosaic distribution of landscape structures, the ecological characteristics of the salt pans, the lagoon and the seashore, as well as the natural processes and connections between the supralittoral, the midlittoral and the infralittoral zones (KPS, 2019).

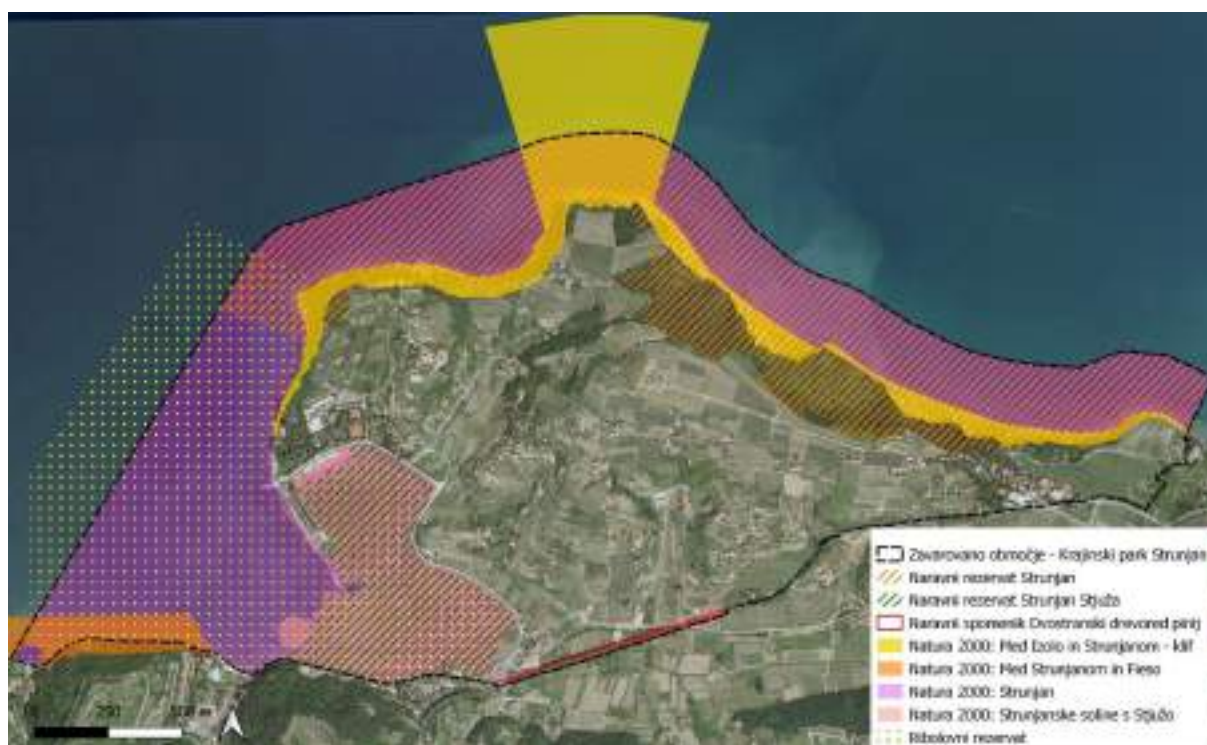


Figure 2.1. Protected areas of the Strunjan Landscape Park.

The selected donor and receiving areas are located in the Strunjan Landscape Park, within the Natura 2000 and fishing reserve area (Fig. 2.2; 45°31'56.22 "N; 13°35'58.42 "E), and include the area of the mussel farm where the collection of *Pinna nobilis* was planned. They were selected and described within the Actions A1.1 (deliverable D_A1.2) and A1.2 (deliverable D_A1.2).



Figure 2.2. Donor and receiving site area in the Landscape Park Strunjan (white polygon, 45°31'41.55" N; 13°35'55.76" E).

Within this zone the monitoring of the status of *P. nobilis* ex-ante was performed during spring and summer 2022 by conducting visual censuses under scuba diving. The monitoring was described within the Actions D3.1 (deliverable D_D3.1). The monitoring protocol module 11N developed by the Italian Environmental Protection System was applied, with some adaptations to make it suitable for the Slovenian coast. In particular, given the reduced extension of habitat suitable for *P. nobilis* in the area (maximum 8 m depth), the width of the transects had to be reduced to 1 m, in order to obtain more detailed results on *P. nobilis* distribution. Altogether 858 shells of *P. nobilis* were counted and measured in a total surveyed area of 6200 m². Only two of them were alive and have been observed within the Strunjan MPA, outside donor and receiving area, during the citizen science activities. To have a clearer view on the status of *P. nobilis* along the Slovenian coast, 10 additional sites were monitored, for a total surveyed area of 2700 m². Altogether 564 dead shells were counted and measured, 14 of them were juvenile (less than 15 cm). Only 2 alive specimens were found and georeferenced at two sites (Debeli rtič and Ankaran), and they were both juvenile, measuring 10 x 4.5 cm and 11 x 4 cm respectively (Table 2.1).

Table 2.1 Results of ex-ante monitoring (period 2021-2022) with transects following the standard protocol.

Date	Site	Coordinates	Transect depths	surveyed area (m ²)	tot. number of individuals	Mortality	total Dead	adult dead	juvenile dead	Alive juveniles	Alive adults
22/05/2022	Strunjan MPA zone A and B	45°32'24.07"N, 13°30'56.07"E 45°32'20.5"N, 13°37'07.2"E	2.5-3.5 m; 4-5 m; 6-7 m	5400	645	100%	644	639	5	0	2
25/05/2022	Strunjan MPA zone C1	45°31'55.38"N, 13°36'18.8"E	2.0-5.1 m; 2.5-3.1 m	300	148	100%	148	148	0	0	0
30/06/2022	Strunjan MPA zone C1	45°31'56.15"N, 13°36'56.95"E	8 m; 11 m	300	64	100%	64	64	0	0	0
14/07/2022	Strunjan mariculture	45°31'58.2"N, 13°35'50.7"E	18 m -18 m	200	0	100%	0	0	0	0	0
16/08/2022	Sečovlje mariculture	45°29'19.61"N, 13°39'55.52"E	9-10 m	500	0		0	0	0	0	0
18/07/2022	MBP	45°31'2.95"N, 13°34'4.18"E	3 m; 5 m	200	130	100%	130	129	1	0	0
19/07/2022	Pinna valobran	45°31'37.88"N, 13°33'59.79"E	11 m, 12.5-13.7 m	200	32	100%	32	32	0	0	0
26/07/2022	Pinna isihars	45°31'45.03"N, 13°32'45.05"E	12 m	100	0	100%	0	0	0	0	0
29/07/2022	Pinnašek	45°31'22.37"N, 13°33'59.2"E	7.5 m; 10 m; 13 m	300	43	100%	43	43	0	0	0
03/08/2022	Izerjevo polje	45°35'00"N, 13°42'05"E	5 m, 8 m, 3.4 m	300	111	99%	110	108	2	1	0
04/08/2022	Ankaran	45°34'50.1"N, 13°43'35.5"E	2 m, 4 m, 6 m	300	125	99%	125	119	6	1	0
10/08/2022	MBP	45°31'2.95"N, 13°34'4.15"E	6.9 m, 9 m	200	34	100%	34	34	0	0	0
16/09/2022	Boja vido	45°32'54.88"N, 13°33'24.5"E	22.3-22.3 m	300	0		0	0	0	0	0
07/11/2022	Sečovlje	45°33'01.9"N, 13°35'13.9"E	2 m, 4 m, 6 m	300	79	100%	79	76	3	0	0

Monitoring ex-post results (2023–2025)

Given the worsening of the status of *Pinna nobilis* monitoring activities have been performed throughout the project, and monitoring have been performed also outside the planned donor and receiving areas. The same method used for the ex ante monitoring campaign, was applied to investigate new areas to obtain information on the status of *Pinna nobilis* along the whole Slovenian coast. The methodology consists in conducting visual censuses under scuba diving. Divers were equipped with a video camera, GPS, and gauge. Each transect was also recorded with a GoPro. Survey areas were selected based on cartographies and expert judgement, as well as information obtained through citizen science. With this method 7 additional sites (one inside the NP Strunjan) have been investigated from spring 2023 and 2024 (Fig. 2.1). At each site transects of 100 m² were performed at three depth, for a total surveyed area of 2100 m² and a total of 535 empty shells of *Pinna nobilis* counted and measured. Most of the shells were lying and were broken, and belonged to adult individuals. Only 2 empty shells measured less than 15 cm. No living specimens were found in those transects (Table 2.2).

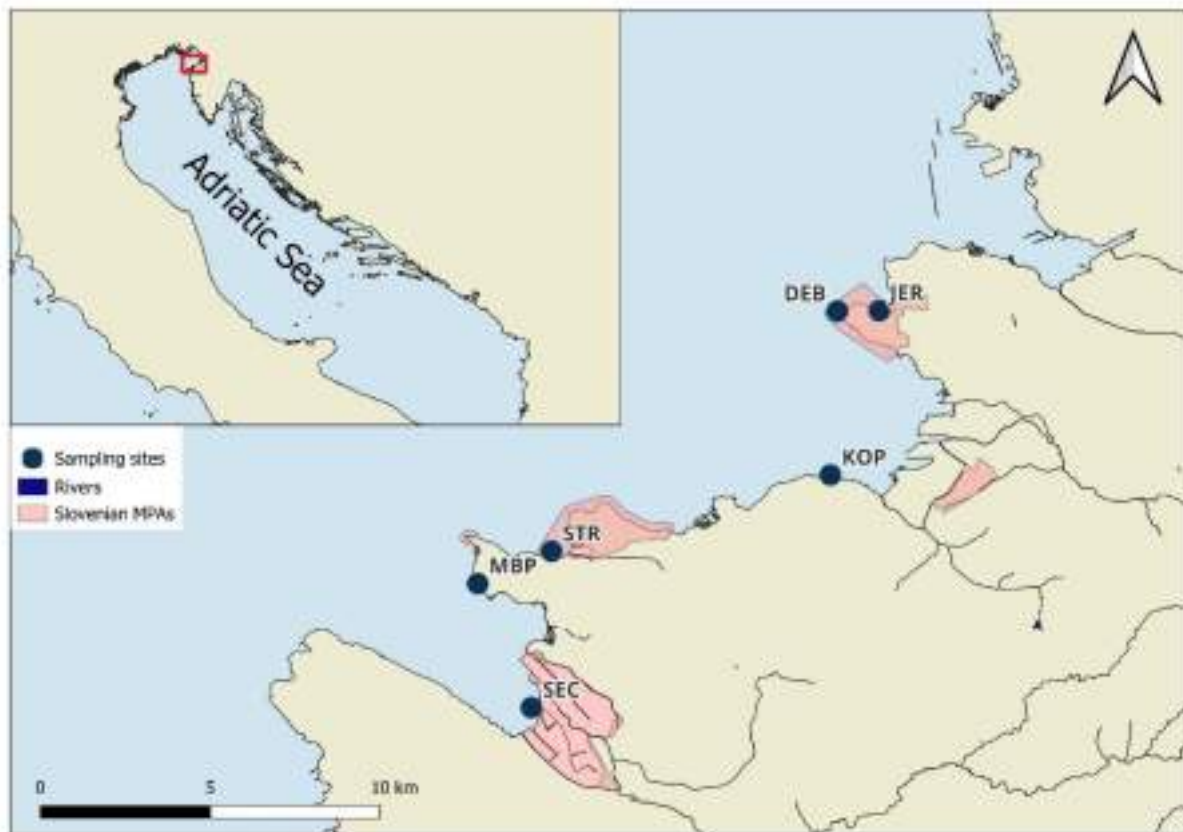


Figure 2.1: The map of the study area with protected areas in pink and the sampling stations surveyed as blue dots.

Table 2.2. Results of ex-post monitoring (period 2023-2025) with transects following the standard protocol.

Date	Site	Coordinates	Transect depths	Surveyed area (m ²)	tot number of individuals	Mortality	Total deads	Dead adults	Dead juveniles	Alive juveniles	Alive adults
19.7.2023	Sabotivje B	47°29'7.50" N, 13°35'20.47" E	3.5 m, 4.7 m, 3 m	300	3	100%	3	3	0	0	0
3.10.2023	Posidonia	45°32'54.00" N 13°42'0.38" E	2 m, 3.5 m, 6 m	300	67	100%	67	66	1	0	0
11.10.2023	Koper-Semadela	45°32'54.00" N, 13°42'0.38" E	2 m, 2.5 m, 3 m	300	172	100%	172	172	0	0	0
23.7.2024	Sr. Jernej (IER)	45°55'31.40" N, 13°43'3.09" E	3 m, 4 m, 5 m	300	107	100%	107	107	0	0	0
6.8.2024	STR salina	45°31'35.81" N, 13°37'43.98" E	4 m, 5 m, 7 m	300	35	100%	35	35	0	0	0
22.8.2024	Jernej zaliv	45°30'35.15" N, 13°40'10.18" E	4 m, 5 m, 6 m	300	35	100%	35	34	1	0	0
28.8.2024	Debeli rtič	45°35'30.33" N, 13°42'8.14" E	5 m, 6 m, 5 m	300	115	100%	115	115	0	0	0



Figure 2.2. Empty shell of *Pinna nobilis* found during monitoring activities at site POS.



Figure 2.3. Empty shells of *Pinna nobilis* at site DEB.



Ten additional fieldworks were performed to find living and endangered specimens, with a simplified protocol, that do not include measuring and counting empty shells. The aim was to increase the surveyed area and so increase the chance to find living specimens. No living *P. nobilis* were found (Table 2.3). Moreover additional opportunistic dives were performed whenever possible with the same aim.

Table 2.3. Results of ex-post monitoring (period 2023-2025) through a simplified protocol

Date	Site	Coordinates	Surveyed area (m2)	Habitat	Living individuals
10.07.2025	Pacug zone A	45°31'608"N 13°35.357"E	400	sediment - rock limit	0
15.07.2025	Flesa zona A	45°31'33.2"N 13°34'49.5"E	400	sediment - rock limit	0
18.07.2025	Flesa zona B	45°31'584"N 13°34'985"E	400	sediment - rock limit	0
23.07.2025	Pacug zone B	45°31'614"N 13°35'562"E	400	sediment - rock limit	0
4.08.2025	Jadranka Izola	45°32'25.5"N 13°40'16.6"E	400	seagrass	0
5.08.2025	Rex	45°32'53.4"N 13°41'25.3"E	400	seagrass	0
12.08.2025	Sečovlje	45°29.227' N, 13°35.338' E	400	mariculture	0
14.08.2025	Izola-Koper Posidonia	45°32.917' N, 13°42.163' E	400	seagrass	0
19.08.2025	Pacug C	45°31'36.1"N 13°35'32.6"E	400	sediment - rock limit	0
25.08.2025	Strunjan	45°31,982' N, 13°35,607'E	400	mariculture	0

Altogether from the beginning of the project, 17 living specimens have been recorded and monitored through opportunistic and dedicated surveys. Nine of them were found during ex-ante monitoring campaigns, 8 of them during the ex-post campaigns (Table 2.4). Unfortunately most of them were found dead or were no longer detectable during the second monitoring. In September 2025 only one of them was confirmed to be still alive (Fig. 2.5). This individual was first recorded in February 2023, it was 15.7 cm high and it was then monitored at least once per year. Material for genetics was collected with a swab and sent to UNISS laboratory. It was confirmed as *Pinna nobilis*, and no pathogens were detected.

Table 2.4. Number of living specimens found with opportunistic and dedicated survey during the two periods (ex-ante 2021-2022 and ex-post 2023-2024)

Ex-ante monitoring					
Date	Site	coordinates	Depth (m)	N. of living <i>P. nobilis</i>	Height
09/06/2022	Piran MBP	45°31'3.35"N 13°34'4.42"E	4.8	1	2 cm
01/06/2022	Koper (port protection)	45°33'31.0"N, 13°43'52.4"E		1	3 cm
11/07/2022	Ankaran beach	45°34'32.29"N 13°43'55.50"E	3	2	15 cm
03/08/2022	Debeli ritič beach	45°35.639' N, 13°42.707'E	3.4	1	5 cm
04/08/2022	Ankaran	45°34.543' N, 13°43.921' E	2	1	10 cm
27/10/2022	Poseidonia	45°32'53.01"N 13°41'49.95"E	2.9	1	15 cm
03/11/2022	Poseidonia	45°32'53.01"N 13°41'49.95"E	3.1	2	10.3 cm, 2.5cm
Ex-post monitoring					
Date	Site	coordinates	Depth (m)	N. of living <i>P. nobilis</i>	Height
31/01/2023	Marina Izola	45.534414 N, 13.650853 E	2.7	1	18 cm
03/08/2023	Valdoltra	45.578948 N, 13.724608 E	3.6	1	15.3 cm
08/09/2023	Svetega Jerneja bay	45.593058 N, 13.721475 E	2.1	1	16.5 cm
17/09/2023	Seča	45.498804 N, 13.583525 E	2.2	2	15.7 cm
07/03/2024	Jernejev zaliv	45.578948 N, 13.724608 E		1	
18/03/2024	Seča	45.498804 N, 13.583525 E	2.2	1	
22/08/2024	Debeli ritič	45°35'36.74"N, 13°43'16.43"E	3.5	1	20 cm
13/09/2024	Lazareti	45°35'41.3"N 13°43'16.9"E		2	
24/02/2025	Seča	45.498804 N, 13.583525 E	2.2	1	>20cm

With the monitoring of larval collectors, a total of 26 alive juveniles, from 0.5 to 8 cm of total height, and 68 empty shells were found in the autumn 2023. Additionally 3 juveniles, of 5 to 5.5 cm, were found in mussel farms in the same year. In autumn 2024, only 18 juveniles, from 0.5 to 2 cm of total height, and no empty shells were found in larval collectors. All these juveniles were transferred and kept in the facilities at the Marine Biology Station in Piran, for monitoring their recovery before transplantation.

With citizen science activities the database of *P. nobilis* sightings has been implemented during the project period. Thanks to the collaboration of colleagues and other divers in the period 2021-2022 (ex-ante) 16 records were collected for a total of 26 living specimens. In the period 2023–2025 (ex-post) 7 additional records were confirmed for a total of 8 living individuals of *P. nobilis*. Altogether, 23 records were collected during the whole project, for a total of 36 living specimens of *P. nobilis*. Most of them were juveniles, but few specimens of 20 cm were also reported. Unfortunately in September 2025 only one of those individuals was confirmed to be still alive.



Figure 2.4. One of the few specimens of *Pinna nobilis* still alive in september 2025, surrounded by empty shells (Photo by Ciril Mlinar).

Table 2.5. Citizen science records of living specimens of *P. nobilis* along the Slovenian coast in the two periods (ex-ante 2021-2022, and ex-post 2023-2025)

Ex-ante						
Date	N. of individuals	location	Species	Height	depth (m)	observer
12/01/2022	1	unknown	<i>P. nobilis</i>	about 10 cm		Ciril Mlinar Cic
29/11/2021	1	Fiesa-Pacug	<i>Pinna</i> sp.		9 m	Tea Knapič
31/07/2021	1	Fiesa	<i>Pinna</i> sp.			Jana Šubic
ND	1	Žusterna	<i>P. nobilis</i>			Oceandiving
22/05/2022	2	pod Belvederjem	<i>P. nobilis</i>			Oceandiving
05/06/2022	2	Izola	<i>P. nobilis</i>	5-10 cm		Peter Valenčič
27/01/2022	1	Mussel farm	<i>P. nobilis</i>	0-5 cm		Prosub
05/01/2022	1	Mussel farm	<i>P. nobilis</i>	0-5 cm		Prosub
11/11/2021	1	Ankaran	<i>P. nobilis</i>	>10 cm	1-2 m	Peter Valenčič
20/12/2021	1	Ankaran	<i>pinna</i> sp.		1.5 m	Peter Valenčič
12/08/2022	2	Piran	<i>P. nobilis</i>	about 10 cm		Manja Rogelja
04/09/2022	3	sl. sv. Jerneja (2), Ankar	<i>Pinna</i> sp.	6.5 and 10.5 cm	3.5, 4.5, 5.8	DRM skupina
13/10/2022	about 4	marina Izola	<i>Pinna</i> sp.	about 20 cm	4 m	Valter Žiža
15/01/2023	about 5	janova barka (shipwre	<i>Pinna nobilis</i>	adult	about 20 m	Manja Rogelja
05/02/2023	1	Sečovlje	<i>Pinna nobilis</i>	juvenile < 15cm	1.9 m	Ciril Mlinar Cic
22/04/2023	1	Fiesa	<i>Pinna nobilis</i>	juvenile	8m	Marko Sajo
Ex-post						
Date	N. of individuals	location	Species	Height	depth (m)	observer
02/09/2023	2	Izola	<i>Pinna nobilis</i>	ND	3m	Dominika Jakopič
13/09/2023	1	Debeli rtič	<i>Pinna nobilis</i>	ND		Robert Bokavšek
19/12/2023	1	Piran	<i>Pinna nobilis/Atrina?</i>	ND		Citizen science
27/07/2024	1	Maona (shipwreck)	<i>Pinna nobilis/Atrina?</i>	ND	about 20m	Gregor Butala (DC Sharky)
24/08/2024	1	Debeli rtič	<i>Pinna nobilis</i>	ND		Vojko Živec
06/08/2025	1	Izola	<i>Pinna nobilis</i>	15-20cm		Nino Orozović
12/09/2025	1	Piran	<i>Pinna nobilis</i>	5-9 cm width	10m	Manja Rogelja

Capo Mortola MPA

Capo Mortola is a rocky promontory located in the westernmost part of the Ligurian coast. Since 2020, Regione Liguria established the Capo Mortola Marine Conservation Area (MCA), as part of the Hanbury Botanical Gardens Regional Protected Area, included in the Nature 2000 site "Fondali Capo Mortola – San Gaetano" (IT 1316175).

The seabed is characterised by the presence of a vast *P. oceanica* meadow that develops to a maximum depth of 30 m, and rocky outcrops and coralligenous formations which provides shelter to a great number of animal and plant species, including vertebrates and invertebrates protected by European regulations. The highly diversified coralligenous population settles within the meadow and beyond its lower limit, at depths greater than 30 m (Fig. 3.1).

The MCA is also a valuable conservation area due to its geological and geomorphological features, including a karstic freshwater spring, known as the "Polla di Rovereto", which gushes out 1 km from the coast at a depth of about 40 m (Calvino and Stefanon, 1963). The presence of *Pinna nobilis* in this area has been documented by several scientific and recreational divers before the mass mortality event.

Monitoring activities were carried out in November 2022 and July 2025 by UBICA srl with Underwater Scientific Divers on behalf of ARPAL, following the national safety standards for environmental monitoring (ISPRA, 2013).

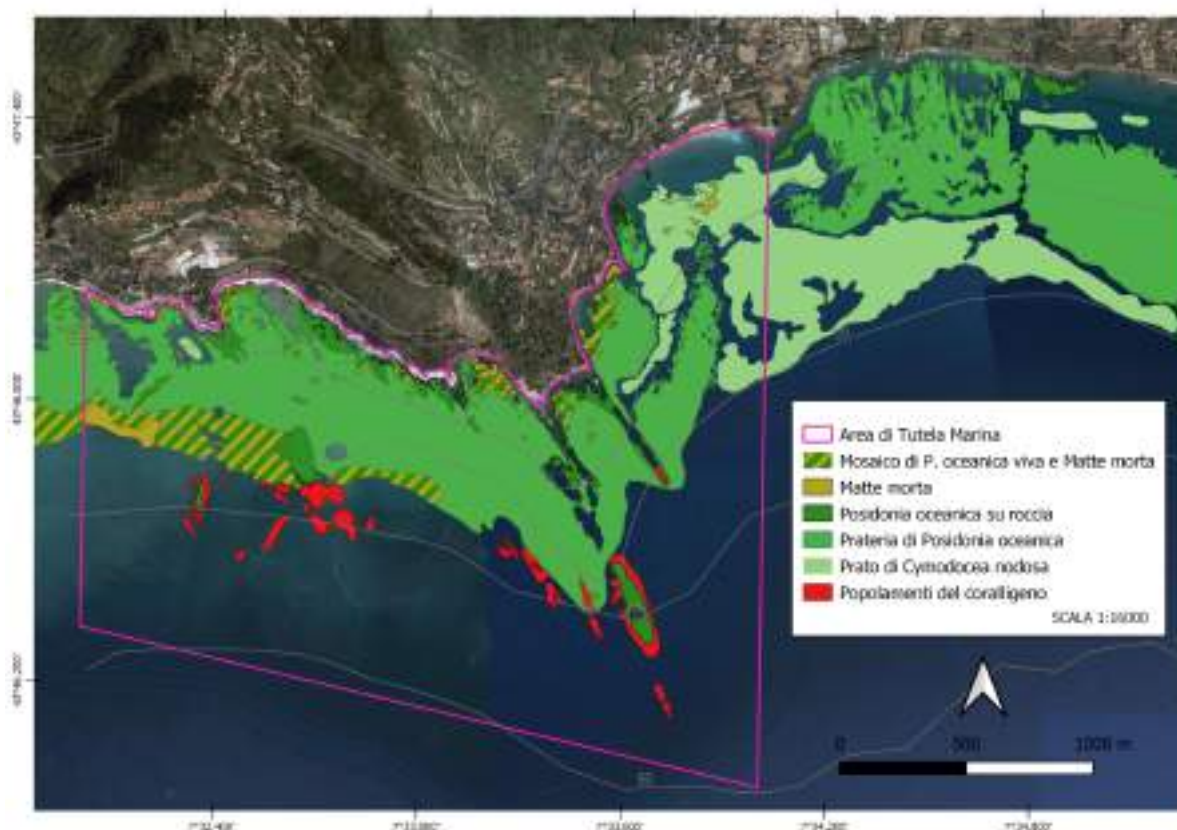


Figure 3.1. Bionomic map of habitats in the Capo Mortola MCA (Coppo et al., 2020).

In order to monitor presence and health status of *P. nobilis* in the Capo Mortola area ex-ante and ex-post transplantation of the organisms for restocking, 3 sites were identified (Tab. 3.1 and Fig. 3.2).

The sites were chosen on the basis of:

- the opportunity to investigate different habitats at different bathymetries;
- the need to focus the survey effort on the Capo Mortola area, considered the most suitable for the possible transplantation of organisms;
- evidence of *P. nobilis* presence in the area before the mass mortality event.

Site	Lat.	Lon.	Depth (m)	Note
MOR-A	43.780600	7.538360	28	Report of <i>Pinna nobilis</i> (2017) by Reef Check (id 59473634)
MOR-B	43.776105	7.558325	15	Shallow point, near coast
MOR-C	43.77252	7.560065	20	Deep Point, far from the coast

Table 3.1. Description of the sites with name, coordinates (latitude and longitude) and depths of the starting point of the first transect and notes on site characteristics.



Figure 3.2. Map of the 3 monitoring sites MOR-A, MOR-B, MOR-C.

At each study site (corresponding to cells of 100 m x 100 m), 3 linear transects of 100 m length have been defined. Data are acquired by visual census considering an area of 600 m² per transect (100 m length and 6 m width) (La Mesa et al, 2019). All specimens of *P. nobilis* are counted and measured for collecting information on:

- health status (alive, dead or injured);
- coordinates (latitude, longitude and depth);
- substrate (e.g. Posidonia meadow, sandy bottom);
- impacts from human activities.

Measured biometric variables are (Fig. 3.3):

- unburied length (h);
- maximum shell width (W);
- shell width at the base (w).

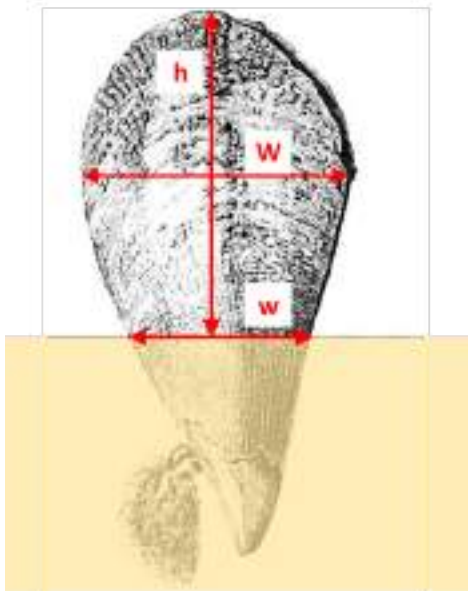


Figure 3.3. Biometry of *P. nobilis*.

Monitoring was carried out at 3 sites at different depths (- 28 m, - 20 m and - 15 m depth, respectively) by surveying, at each site, 3 transects of 100 m each, about 30 m apart (Fig. 3.4).



Figure 3.4. Map of the 3 transects of 100 m length (TA, TB and TC, respectively) at the 3 sites (MOR-A, MOR-B and MOR-C) during the two monitoring campaigns (2022 and 2025).

The following provides a detailed description of the individual transects carried out during the two campaigns and the respective field sheets.

Site MOR_A, the westernmost of the selected sites, is located at a depth of 13 m and is characterized by a dense meadow of *P. oceanica* interrupted by boulders of varying sizes covered by algae and by sandy corridors likely resulting from anchoring.

In 2022, at a depth of approximately 13 m, a fragment of a *P. nobilis* valve was found, measured, and photographed (Figure 3.5, panel B); this fragment was not observed again in 2025.



A



B



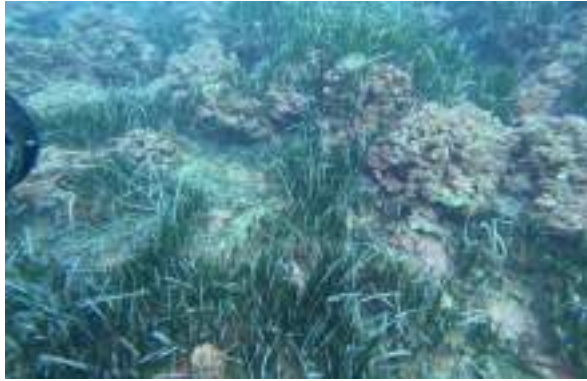
C



D

Figure 3.5. MOR_A – Habitat characterized by a dense *Posidonia oceanica* meadow, interspersed with boulders of varying sizes covered by algae and sandy corridors. (A); Fragment of *P. nobilis* valve found in 2022 (B); Monitoring campaign 2025 (C-D).

Site MOR_B, located at a depth of approximately 16 m, shows features very similar to those of MOR_A (Figure 3.6). No *P. nobilis* specimens were found during either the 2022 or 2025 monitoring campaigns.



A



B



C



D

Figure 3.6. MOR_B - Habitat characterized by a meadow of *Posidonia oceanica* interrupted by rocky outcrops; Monitoring campaign 2022 (A-B); Monitoring campaign 2025 (C-D).

Site MOR_C, the deepest site (-29 m) monitored, is characterized by pre-coralligenous biocoenoses with concretion formations by calcareous algae, and the presence of sponges, yellow gorgonians (*Eunicella cavolinii*), and other bioconstructor organisms (Figure 3.7).

In the middle of the third transect, at a depth of 21 m, a dead *P. nobilis* specimen, still intact and in vertical position, was found. Both valves were photographed and measured. No specimens were observed during the 2025 monitoring campaign.



A



B



C



D

Figure 3.7. MOR_C - Habitat characterized by a pre-coralligenous community with concretion formations by calcareous algae, and the presence of sponges, yellow gorgonians (*Eunicella cavolinii*), and other bioconstructor organisms. Monitoring campaign 2022 (A-B); Monitoring campaign 2025 (C-D).



The following tables report data from ex-ante and ex-post monitoring campaigns carried out in Capo Mortola, as well as beginning and end coordinates of each transect.

SITE	TR	Ex-ante campaign 02/11/2022				
		Entry		Exit		Results
		Latitude	Longitude	Latitude	Longitude	
MOR_A	TA1	43.781296	7.539367	43.780226	7.539094	
	TA2	43.781307	7.538900	43.780260	7.538900	Shell fragment
	TA3	43.781330	7.538456	43.780351	7.538354	
MOR_B	TB1	43.776725	7.558633	43.776954	7.557017	
	TB2	43.777204	7.558633	43.777289	7.557171	
	TB3	43.777625	7.558520	43.777756	7.557245	
MOR_C	TC1	43.772838	7.560159	43.773749	7.559316	
	TC2	43.772599	7.559715	43.773419	7.558804	
	TC3	43.772292	7.559464	43.772975	7.558246	Empty shell

SITE	TR	Ex-post campaign 11/07/2025				
		Entry		Exit		Results
		Latitude	Longitude	Latitude	Longitude	
MOR_A	TA1	43.781302	7.539287	43.780300	7.539133	
	TA2	43.781302	7.538866	43.780266	7.538752	
	TA3	43.781313	7.538479	43.780391	7.538382	
MOR_B	TB1	43.776726	7.558633	43.776953	7.557017	
	TB2	43.777147	7.558571	43.777323	7.557108	
	TB3	43.777659	7.558702	43.778097	7.557011	
MOR_C	TC1	43.772929	7.560489	43.773897	7.559385	
	TC2	43.772690	7.559863	43.773407	7.558736	
	TC3	43.771996	7.559544	43.773009	7.558303	

Additional monitoring activities

Additional efforts to gain information on the presence of *P. nobilis* specimen have been carried out in the area of Capo Mortola in 2022.

In the framework of action A.1 of the Life Pinna project, eight HD video transects (about 500 m of length) have been realized in the Capo Mortola area; other six analogous videos have been recorded in the eastern nearby zone (Fig. 3.8). These fourteen videos have been analysed to find insights on the presence of fan mussels: unfortunately, no evidence has been found.

Furthermore, a rapid monitoring protocol, based on the circle monitoring approach (García-March & Vicente, 2006), has been developed and applied in two sites (Fig. 3.8). For each site, a visual census has been performed in a circle of 10 m radius (surface of about 300 m²): no evidence of fan mussel has been observed.

The drastic reduction of *P. nobilis* population along the Ligurian coast was confirmed during a monitoring campaign realized in 2022 in three areas where the presence of fan mussel was documented in 2018.

Moreover, with the aim of gathering information about the possible presence of *P. nobilis* specimens along the ligurian coast, the circle monitoring approach has been applied by ARPAL during other institutional monitoring activities aimed to assess the health status of posidonia meadows. Unfortunately, no specimen of *P. nobilis* was observed.



Figure 3.8. Lines represent HD video transects. Stars indicate circle monitoring areas.



Monitoring the presence of specimens of *Pinna nobilis* during monitoring activities on *Posidonia oceanica* meadows applying the circle sampling monitoring protocol.

Circle sampling method

The area surveyed is delimited by the radius of the circle, scientific divers do not have to go far from the starting point and to get the coordinates of the sampling station, only one GPS coordinate of the centre of the circle is required. Depending on meadow cover, depth and density of individuals, the surface area explored can be increased or reduced (see table below), maximizing the sampling time. If many divers are available, this proves to be a very quick and efficient method. Circle sampling can be easily adapted to position the individuals for spatial distribution or population dynamics studies. Finally, the sampling units are easily allocable in a chart for posterior location. This method will be usually recommended for the evaluation of populations, especially within *Posidonia oceanica* meadows.

Radius	Advantages	Disadvantages
5.6-8 m	Units easily sampled. Appropriate for deep samples and/or for meadows with high shoot density or populations with a high number of individuals. Surface area between 100-200 m ² .	Small surfaces with low density of individuals. If the number of individuals is high, the 8 m radius could be excessive.
10 m	A large area is surveyed, and individuals may be tagged, in reasonable time for a SCUBA dive.	Area is too large with high shoot density and in deep locations (>15 m), independently of the number of individuals.
15-20 m	Large areas are explored (700-1256 m ²) in a reasonable time. Advisable for 3 -4 divers.	Feasible with low shoot density, low depth (<15 m) and when individuals are neither tagged nor measured. It is difficult to keep the line marking the radius straight. The points of origin and turn of the circles must be signalled at different distances from the centre. Rock outcrops and irregular seabed topography difficult the work.

The starting point of the exploration should be marked with a buoy floating over the meadow canopy. For two divers it is advisable to make concentric rings of increased length. Care should be taken to divide the surface to be explored by each diver proportionally. For a first ring of 5 m of radius, the diver closer to the centre should explore from 0-5 m, and for a second ring comprising the interval between 5 to 8 m. The diver holding the line to mark the radius should be careful to keep it as straight as possible. The line of the tape can be deposited on the seafloor and the area carefully explored in small portions.





Station	LAT	LON	ZSC	depth	date	time	OSS
MONT315	44.222630	9.499590	IT13333690 Fondali Punta Moneglia	15	07/06/2023	13:30:00	Dagnino Parodi
MONT3INF	44.222280	9.498540	IT13333690 Fondali Punta Moneglia	21			
MONT115	44.223930	9.498020	IT13333690 Fondali Punta Moneglia	15	07/06/2023	16:30:00	Parodi Dagnino
MONT1INF	44.223810	9.497570	IT13333690 Fondali Punta Moneglia	20.5			
CAM15R2	44.338510	9.153620	IT1332674 Fondali M. Portofino	15	15/06/2023	12:00:00	Parodi Dagnino
CAM15R1	44.345970	9.153090	IT1332674 Fondali M. Portofino	15	15/06/2023	14:00:00	Dagnino Parodi
MESB15M	44.138330	9.643610	IT1344270 Fondali Punta Mesco-Riomaggiore	15	10/07/2023	13:30:00	Parodi Moretto
LEVB15R2	44.169167	9.595278	IT1344272 Fondali Punta Levanto	15	11/07/2023	12:00:00	Parodi Dagnino
LEVB11INF	44.201650	9.540070	IT1343474 Fondali Punta Apicchi	29	17/07/2023	13:00:00	Dagnino Moretto
LEVB115	44.202880	9.540231	IT1343474 Fondali Punta Apicchi	15	17/07/2023	14:00:00	Moretto Dagnino
LEVB12INF	44.160340	9.602740	IT1344271 Fondali Punta Picetto	22	19/07/2023	13:00:00	Dagnino Parodi
LEVB1215	44.160590	9.603890	IT1344271 Fondali Punta Picetto	15			
LEVB1315	44.159020	9.604940	IT1344271 Fondali Punta Picetto	15	19/07/2023	14:00:00	Dagnino Parodi
LEVB13INF	44.158780	9.604410	IT1344271 Fondali Punta Picetto	26	19/07/2023	14:45:00	Dagnino Parodi
RIV15R2	44.245280	9.436110	IT1333370 Fondali Punta Baffe	15	28/07/2023	11:00:00	Romanelli Parodi
RIV15R1	44.254000	9.411960	IT1333371 Fondali Punta Manara	15	28/07/2023	12:30:00	Romanelli Parodi
LERBT315	44.388330	8.677630	IT1332477 Fondali Arenzano-Punta Ivrea	15	14/08/2023	10:30:00	Parodi Romanelli
LERBT3INF	44.387810	8.677890	IT1332477 Fondali Arenzano-Punta Ivrea	19.5			
LERBT2INF	44.384610	8.650050	IT1332477 Fondali Arenzano-Punta Ivrea	18	24/08/2023	10:15:00	Dagnino Moretto
LERBT215	44.384699	8.648688	IT1332477 Fondali Arenzano-Punta Ivrea	15			
LERBT1INF	44.383010	8.646680	IT1332477 Fondali Arenzano-Punta Ivrea	20.5	30/08/2023	10:45:00	Dagnino Moretto
LERBT115	44.383850	8.646920	IT1332477 Fondali Arenzano-Punta Ivrea	15			
ALBCET1INF	44.326250	8.527810	IT1322470 Fondali Varazze-Albissola	18	04/06/2024	13:10:00	Parodi Dagnino
ALBCET115	44.326350	8.527620	IT1322470 Fondali Varazze-Albissola	15			
ALBCET3INF	44.333520	8.545620	IT1322470 Fondali Varazze-Albissola	17.5	20/06/2024	11:40:00	Dagnino Moretto
ALBCET315	44.333580	8.544970	IT1322470 Fondali Varazze-Albissola	15			
ALBCET215	44.329500	8.538220	IT1322470 Fondali Varazze-Albissola	15	26/06/2024	13:00:00	Dagnino Moretto
ALBCET2INF	44.328890	8.539520	IT1322470 Fondali Varazze-Albissola	21	26/06/2024	14:00:00	Dagnino Moretto
ALAS15R1	44.002142	8.177325	IT 1325675 Fondali Capo Mele-Alasio	15	02/07/2024	16:00:00	Dagnino Parodi
LAIG15R2	43.972336	8.165295	IT1325675 Fondali Capo Mele-Alasio	15	03/07/2024	11:00:00	Dagnino Moretto
ALAS15R2	44.029506	8.222985	IT1324974 Fondali S.Croce-Gallinara-Capo Lena	15	03/07/2024	14:00:00	Dagnino Moretto
CER15R2	44.104548	8.251056	IT1324973 Fondali Loano-Albenga	15	04/07/2024	10:00:00	Moretto Parodi
CER15R1	44.085009	8.239650	IT1324973 Fondali Loano-Albenga	15	04/07/2024	12:00:00	Moretto Parodi



Station	LAT	Lon	ZSC	depth	date	time	OSS
LAIG15R1	43.949255	8.177880	IT1325675 Fondali Capo Mele-Alassio	15	09/07/2024	11:00:00	Dagnino Moretto
NOLBT1NF	44.207140	8.420090	IT1323271 Fondali Noli-Bergeggi	20.4			
NOLBT115	44.205710	8.419480	IT1323271 Fondali Noli-Bergeggi	15	16/07/2024	10:45:00	Parodi Romanelli
NOLBT3NF	44.232840	8.439080	IT1323271 Fondali Noli-Bergeggi	17.5	16/07/2024	12:00:00	Dagnino Moretto
NOLBT315	44.234490	8.438730	IT1323271 Fondali Noli-Bergeggi	15	16/07/2024	13:00:00	Dagnino Moretto
NOLBT215	44.230010	8.430480	IT1323271 Fondali Noli-Bergeggi	15			
NOLBT2NF	44.229290	8.430830	IT1323271 Fondali Noli-Bergeggi	18.5	17/07/2024	11:00:00	Dagnino Moretto
GEBT1NF	44.367180	9.066200	IT1332575 Fondali Nervi-Sori	33	31/07/2024	11:00:00	Dagnino Moretto
GEBT115	44.374000	9.067000	IT1332575 Fondali Nervi-Sori	15	31/07/2024	13:00:00	Parodi Romanelli
GEBT3NF	44.370420	9.031430	IT1332575 Fondali Nervi-Sori	34	31/07/2024	14:00:00	Dagnino Moretto
GEBT315	44.379360	9.033940	IT1332575 Fondali Nervi-Sori	15	01/08/2024	09:30:00	Parodi Romanelli
GEBT2NF	44.377200	8.991280	IT1332576 Fondali Boccadasse-Nervi	30	01/08/2024	11:30:00	Dagnino Moretto
GEBT215	44.383060	8.994720	IT1332576 Fondali Boccadasse-Nervi	15	01/08/2024	13:00:00	Parodi Romanelli
PORT15R2	44.339075	9.227664	IT1332673 Fondali Golfo di Rapallo	15	26/06/2025	12:00:00	Parodi Dagnino
PORT15R1	44.319212	9.215763	IT1332674 Fondali M. Portofino	15	26/06/2025	13:00:00	Parodi Dagnino
ZOAG15R1	44.338056	9.248889	IT1332673 Fondali Golfo di Rapallo	15	27/06/2025	12:00:00	Dagnino Moretto
DIAN15R2	43.916389	8.112778	IT1315670 Fondali C. Berta - Diano Marina - Capo Mimososa	15	15/07/2025	10:30:00	Moretto Parodi
DIAN15R1	43.903667	8.094055	IT1315670 Fondali C. Berta - Diano Marina - Capo Mimososa	15	15/07/2025	12:00:00	Moretto Parodi
SANR15R1	43.801250	7.755417	IT1316274 Fondali S. Remo - Arziglia	15	16/07/2025	10:40:00	Parodi Moretto
SANR15R2	43.815367	7.818450	IT1315973 Fondali Arma di Taggia - Punta San Martino	15	16/07/2025	12:30:00	Moretto Parodi
MORB15R1	43.779167	7.546389	IT1316175 Fondali Capo Mortola - San Gaetano	15	23/07/2025	11:00:00	Dagnino Moretto
MORB15R2	43.784959	7.585090	IT1316175 Fondali Capo Mortola - San Gaetano	15	23/07/2025	13:00:00	Dagnino Moretto
MESB15M	44.138330	9.643610	IT1344270 Fondali Punta Mesco Riomaggiore	15	07/08/2025	13:00:00	Parodi Dagnino



Monitoring activities at Bergeggi MPA and at Giannutri Island (Arcipelago Toscano National Park) and along the Ligurian coast

In the framework of Life Pinna project, investigations utilizing both scientific divers and ROV (remote-operated vehicle) were also carried out at Bergeggi MPA and at Giannutri Island (Arcipelago Toscano National Park). Obtained results are reported in the following annexes:

- 1. Technical Report on the Monitoring of *Pinna nobilis* in the area facing the Island of Bergeggi
- 2. Technical Report on the Monitoring of *Pinna nobilis* at Giannutri Island (Tuscan Archipelago)
- 3. Report on the use of ROV (Remote-Operated Vehicle) in monitoring pinna population in Bergeggi and Arcipelago Toscano

Moreover, the ROV was also utilized in searching pinna specimens in different sites along the ligurian coast. Results are summarized in the following annex:

- 4. Report on the use of ROV (Remote-Operated Vehicle) in monitoring pinna population in other areas in Liguria



References

Calvino F, Stefanon A. 1963. Osservazioni geologiche sulla polla rovereto e le altre sorgenti sottomarine della Mortola (riviera di Ponente). Atti dell'Istituto di Geologia dell'Università di Genova, 1(1):205-239.

Diviacco G, Coppo S. 2020. Atlante degli habitat marini della Liguria. ISBN 88-89104-20-1.

García-March JR, Vicente N. 2006. Protocol to study and monitor *Pinna nobilis* populations within marine protected areas. Malta Environmental and Planning Authority, MedPAN Project. 78 pp.

Istituto Superiore per la Protezione e la Ricerca Ambientale. 2013. Buone prassi per lo svolgimento in sicurezza delle attività subacquee di ISPRA e delle Agenzie Ambientali. ISPRA Manuali e Linee guida 94/2013. ISBN 978-88-448-0625-5.

Ivajnsič D, Orlando-Bonaca M, Donša D, Grujić JV, Trkov D, Mavrič B, Lipej L. 2022. Evaluating seagrass meadow dynamics by integrating field-based and remote sensing techniques. *Plants*, 11(9):1-15.

KPS. 2019. Landscape park Strunjan (Slovenia) marine protected area. Presentation report for inclusion in the spami list. Available on 19.3.2022: <http://spami.medchm.net/storage/239/Presentation-report-Strunjan-Landscape-Park-Slovenia-2019.pdf>.

La Mesa G, Paglialonga A, Tunesi L (ed). 2019. Manuali per il monitoraggio di specie e habitat di interesse comunitario (Direttiva 92/43/CEE e Direttiva 09/147/CE) in Italia: ambiente marino. ISPRA, Serie Manuali e linee guida, 190/2019.

Lipej L, Mavrič B, Orlando-Bonaca M. 2012. Opredelitev stanja populacij leščurja in morskega datlja ter habitatnih tipov morski travniki in podmorski grebeni v Naravnem rezervatu Strunjan in priporočila za usmerjanje obiska morskega dela rezervata: zaključno poročilo o projektu. Piran: Morska biološka postaja, Nacionalni inštitut za biologijo: 49 pp.

Lipej L, Ivajnsič D, Makovec T, Mavrič B, Šiško M, Trkov D, Orlando-Bonaca M. 2018. Raziskava z oceno stanja morskih travnikov v Krajinskem parku Strunjan: zaključno poročilo o izvedenem delu. Piran: Morska biološka postaja, Nacionalni inštitut za biologijo. 37 pp.

Scarpa F, Sanna D, Azzena I, Mugetti D, Cerruti F, Hosseini S, Cossu P, Pinna S, Grech D, Cabana D, Pasquini V, Esposito G, Cadoni N, Atzori F, Antuofermo E, Addis P, Sechi LA, Prearo M, Peletto S, Mossa MA, Saba T, Gazale V, Casu M. 2020. Multiple non-species-specific pathogens possibly triggered the mass mortality in *Pinna nobilis*. *Life*, 10(10):238.

Scarpa F, Sanna D, Azzena I, Cossu P, Casu M. 2021. From dark to light and back again: is *Pinna nobilis*, the largest Mediterranean bivalve, on the brink of extinction? *Veterinaria*, 70(1):1-14.

