TECHNICAL REPORT ON TRANSPLANTATION STATE AND PROGRESS (Kornati National Park)

Final Version of 31/May/2022

Deliverable Number D.4.2.3.

Project Acronym	SASPAS
Project ID Number	10048261
Project Title	SAFE ANCHORING AND SEAGRASS PROTECTION IN THE ADRIATIC AREA
Priority Axis	3 - Major change Environment and cultural heritage
Specific objective	3.2 - Contribute to protect and restore biodiversity
Work Package Number	4
Work Package Title	Protecting and restoring marine seagrasses
Activity Number	4.2
Activity Title	Marine seagrasses pilot transplantations and surrounding seal
Partner in Charge	PP5 – Kornati Na
Partners involved	PP5 – Kornati National Park Public Institution PP1 - SELC Soc. Coop. PP3 - Regional Natural Park “Coastal Dunes from Torre Canne to Torre San Leonardo” PP4 – SUNCE
Status	Final
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Summary

Abstract

This document (deliverable D.4.2.3) describes the results of the activities planned in WP 4.2 (Marine seagrasses pilot transplantations and surrounding seabed cleaning) to update the status and progress of the seagrass pilot transplantations in the Kornati NP site.

From a technical point of view, the tests carried out with *P. oceanica* showed good results. The *P. oceanica* transplantations did not suffer significant physical damage; however, they are affected by a condition of strong sedimentation which harms both the canopy of the transplanted cuttings and that of the natural adjacent patches.

1. Introduction

1.1. Aim and objectives

SASPAS (Safe Anchoring and Seagrass Protection in the Adriatic Sea) is an INTERREG project that aims to provide a proposal to develop and share actions and advanced policies for the conservation and sustainable use of the territory.

The common challenge of Project SASPAS is to preserve and get a better status of conservation of biodiversity of the Adriatic Sea ecosystem in order to decrease its vulnerability.

The overall objective is to improve the conservation and restoration of seagrasses by installing safe anchoring systems, performing pilot transplantations, carrying out monitoring activities and establishing an integrated management system for seagrasses in the Adriatic area. The change will result in an increase in the level of conservation of habitat types and species in the Natura 2000 sites involved in the Project areas. To achieve the envisaged change the project will adopt a scientific-applicative approach, following the DPSIR (Driving force – Pressure – State – Impact - Response) causal framework, analyzing the interactions between society and the environment - the cause-effect relationships between interacting components of complex social, economic, and environmental systems. By doing so, it is possible to measure the effectiveness of responses put in place.

Since marine seagrasses and especially *Posidonia oceanica* beds (1120*) are widespread along the coastal areas of Interreg Programme and their conservation status is similar in the two Member States, significant results can only be achieved by establishing a good cross-border cooperation between the Italian and Croatian key partners. The cross-border approach ensures coordinated and cooperative actions in planning and performing the protection and restoration activities, as well as in the development of the envisaged Marine Seagrass Safeguard Integrated Management Program (i.e., the proposed guidelines for the management and proper behavior in protected areas). The innovative aspect, which goes beyond the existing common practices, consists in the joint protection and restoration of biodiversity at transboundary level through the development of specifically- tailored innovative solutions, harmonized for the Adriatic area and applicable to other similar realities facing with the same biodiversity protection and restoration issues.

The project activities have been carried out within the three project study sites (Figure 1):

- Monfalcone (Bay of Panzano),
- Kornati National Park – (Nacionalni Park Kornati),
- Regional Natural Park of Coastal Dunes from Torre Canne to Torre San Leonardo.

This proposal is well suited to the Adriatic, in particular to the Apulia (Regional Natural Park of Costal Dunes from Torre Canne to Torre San Leonardo) and Kornati National Park, characterized by widespread coverage of *P. oceanica*. In both sites, in the summer, there is a significant flow of pleasure boats, and the development of the industry tourism cannot fail to reckon with the need to preserve the quality of the

territory, understood as a whole between land, coast and sea. In Monfalcone (Bay of Panzano), there is an important coverage of marine seagrasses (i.e., *Cymodocea nodosa*) too.

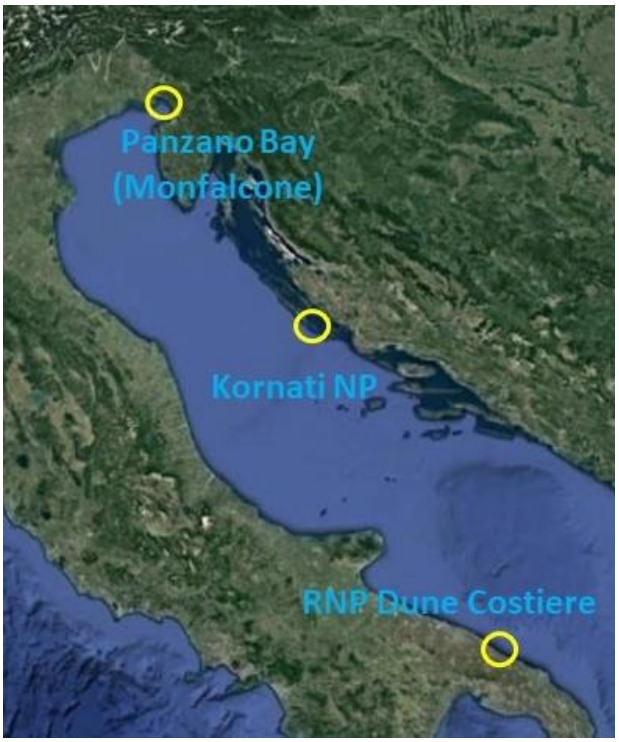

Figure 1. Location of the three project sites.

Both *P. oceanica* and *C. nodosa* play a crucial role in the consolidation of coastal sediments, slowing erosive phenomena, thanks to their rhizomial apparatus with which they anchor to the bottom; with the leaf they promote the capture of suspended sediments, helping to limit turbidity, not to mention a number of benefits for marine and lagoon organisms.

The main project outputs related to the planned activities are:

- monitoring system with data collections/monitoring campaigns,
- placement of environmentally friendly anchoring systems (anchorages and simple signaling buoys) and pilot seagrass transplantations,
- Integrated Management System for seagrasses in the Adriatic area, made by a GIS Digital Information Platform (DIP) and a Marine Seagrass Safeguard Integrated Management Program (MSSIMP).

Protected areas managers, local, regional, and national public bodies, environmental associations, and NGOs, as well as the public will mainly benefit from the project activities.

1.2. Structure of Work Package 3

The objective of the Work Package 3 - *Integrate real-time monitoring system of marine seagrasses (phanerogamae) - in the involved Natura 2000 sites* – is to monitor and gather data on marine seagrasses in the three project sites, to improve the protection and to restore the biodiversity in the cross-border area.

The WP3 package consists of three activities:

- activity 3.1 - Preliminary Environmental Survey,
- activity 3.2 - Driver and Pressure Identification and Assessment,
- activity 3.3 - Monitoring campaigns.

Monitoring campaigns were carried out to control the plants phenological life cycle and the spatial dynamics of marine seagrasses as a response to the concrete actions (activity 3.3). Moreover, they helped to identify the potential impacts that the project could have on seagrass meadows and other valuable habitats and species. They were also monitored the status and progress of the seagrass pilot transplantations planned in WP 4 Activity 2 (Marine seagrasses pilot transplantations and surrounding seabed clearing).

All the activities were conducted adopting up-to-date safety protocols, to reduce risks during underwater operations. Expert marine and transitional water biologists, according to standard operating procedures for the macrophytobenthos, performed laboratory analyses of collected samples.

Pilot transplantation tests of *Posidonia oceanica* and *Cymodocea nodosa* were conducted with the aim of evaluating the effectiveness of some methods in difficult environmental contexts, in relation to the existence of various pressures, such as mainly the anchoring of pleasure boats.

The controls carried out on the transplantation plots were aimed at quantifying, among other parameters, the percentage of development of the shoots of the relocated plants.

This document (deliverable D.4.2.3) describes the results of the activities planned in WP 4.2 (Marine seagrasses pilot transplantations and surrounding seabed cleaning) to update the status and progress of the *Posidonia oceanica* pilot transplantations in the Kornati NP site.

2. The Kornati NP project area.

Kornati National Park is designated as Site of Community Importance SCI HR4000001 - Nacionalni park Kornati (Figure 2). The park[1] was established in 1980 and its management began in 1982. It currently includes 89 islands and reefs, a total area of 217 km², of which almost 80% is marine territory (land 50 km² / sea 167 km²) and a total coastline of 238 km. Karst features dominate its geomorphology.

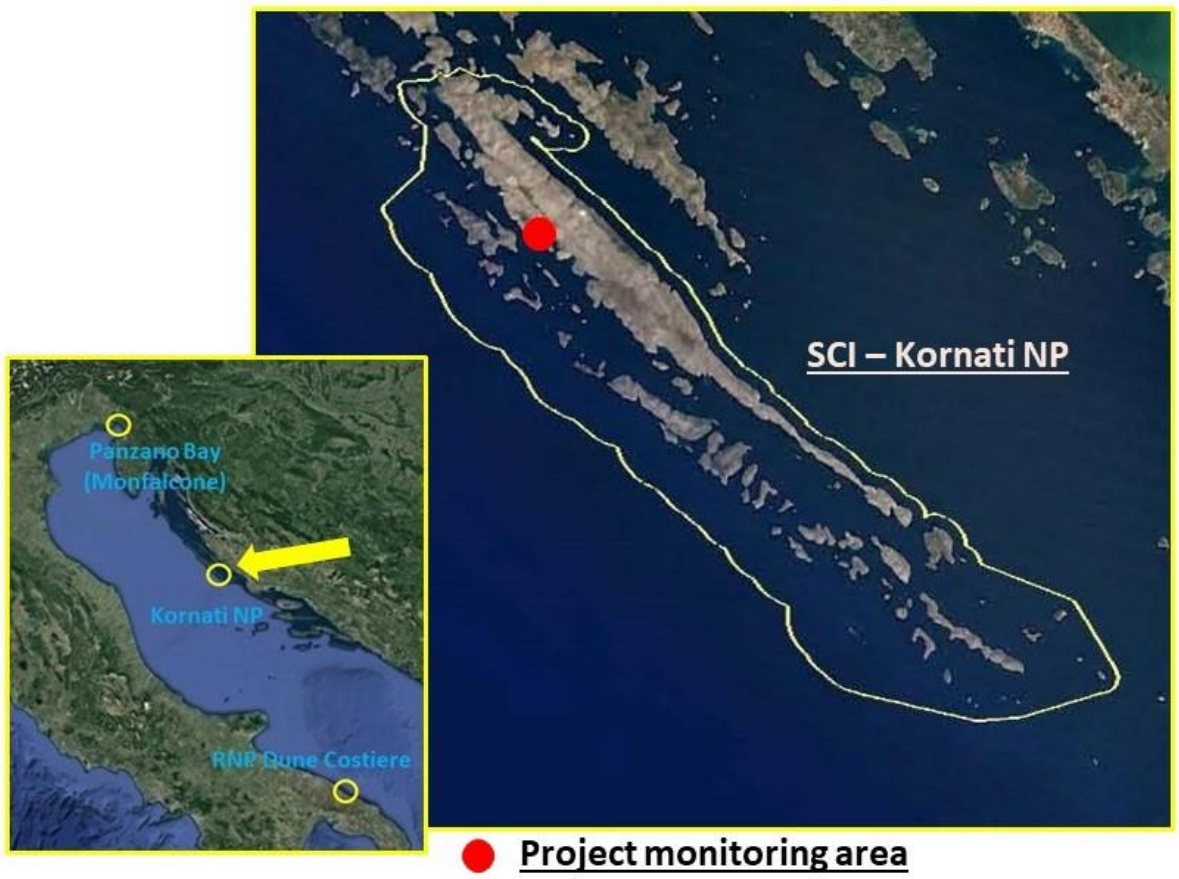

Figure 2. Location of the study area in the Natura 2000 site Kornati NP.

It is estimated that at least 2,500 to 3,000 families of benthic and pelagic fauna live in the Kornati archipelago such as 353 species of macroalgae, 3 species of underwater flower plants as well as about 850 animal species – 61 species of corals, 177 species of mollusks, 127 species of polychaetes, 61 species of decapod crabs, 64 species of echinoderms and 185 species of fishes. Meadows of *P. oceanica* are also present in the park, up to a depth of 25-30 meters. The presence of alien species is included among the

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

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

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

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

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

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

3. The marine seagrass transplantations

In NP Kornati, two pilot transplantation campaigns were carried out: the first in October 2019 and the second in October 2021 (Figure 3). *P. oceanica* transplantation were carried out using two different manual techniques: 1) biodegradable supports consisting of a patented[3] star-shaped anchoring system with 5 arms to which fasten the seagrass rhizomes (Scannavino *et al*., 2014) and 2) wooden supports (to which fasten the seagrass rhizomes) heavy enough and of low degradability in order to resist on the sea floor at least for a couple of years.

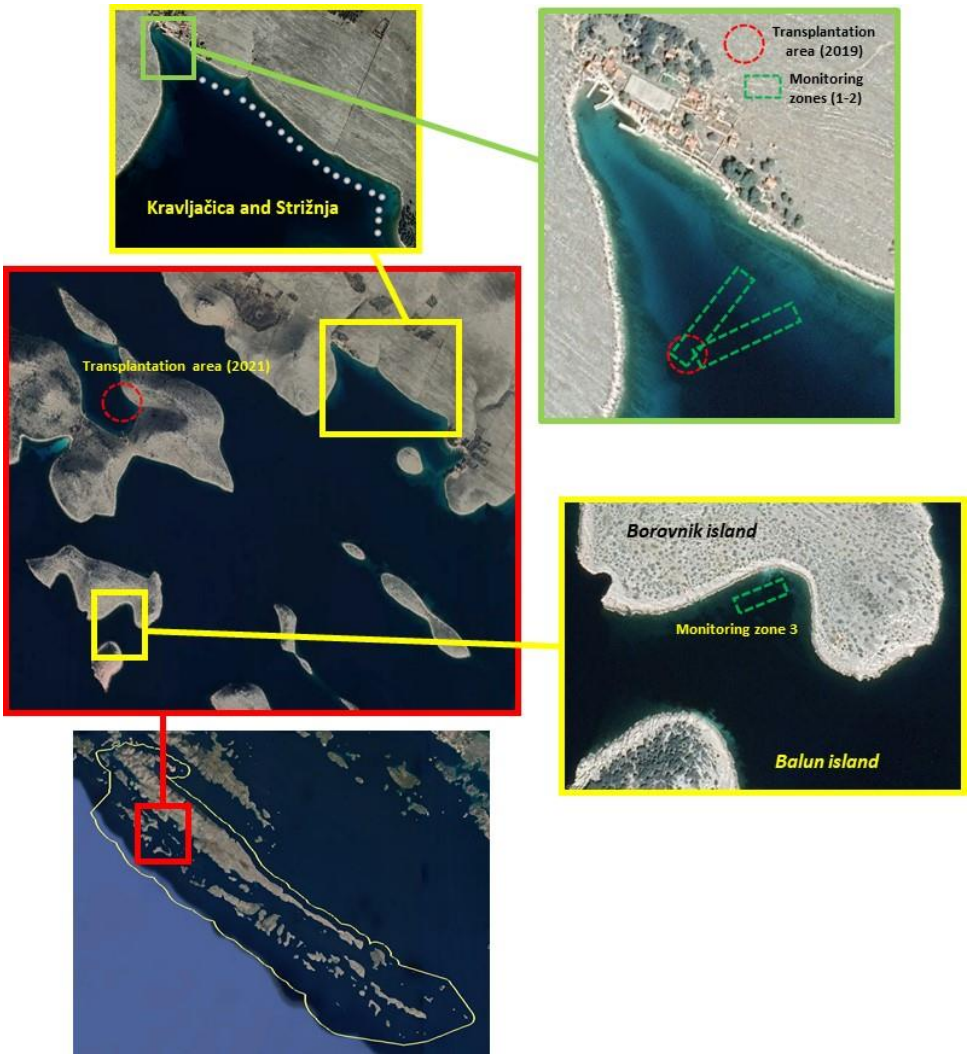

Figure 3. Kornati NP: location of the pilot seagrass transplantation areas and of the monitoring zones.

3 (Patents n. 0001400800/2010 and n. 102015000081824/2018 - Mater-Bi®; Biosurvey S.r.l. and IDEA S.r.l.)

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

Altogether - using technique No 1 - 12 patches composed each of 6 supports, 720 cuttings and about 2160 shoots were placed, at a depth of -11 m, in the Kravljačica Bay, for a total of about 200 square meters.

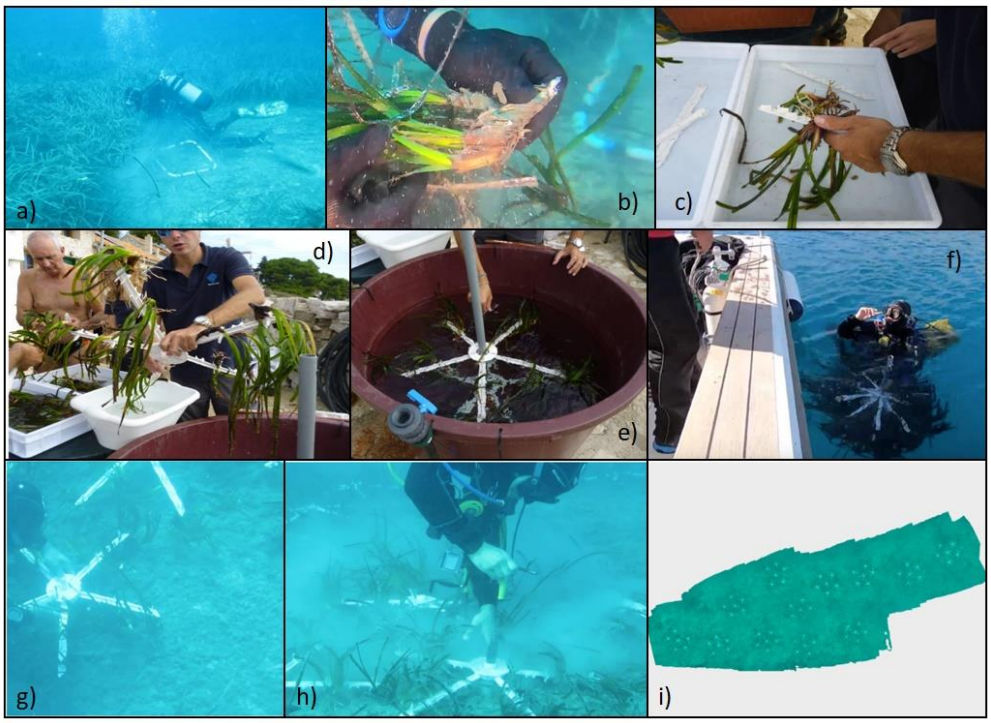

Figure 4. The pilot transplantation phases: a) identification of the donor meadow (- 15 m); b) harvesting of P. oceanica *cuttings; c) and d) fastening of cuttings to the biodegradable staple arms and assembly of the star-shaped support once back on the ground; e) temporary storage of planting units in plastic containers filled with seawater; f) transport of the planting units to the acceptor site; g) and h) fixing of the planting units to the picket; i) photo-mosaic of the reforestation pilot plant.*

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

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

Figure 5. Posidonia oceanica *attachment scheme and cuttings fixed and ready for transport to the host area.*

3.1.1. Monitoring of seagrass transplantation

***P. oceanica* transplantation in Kravljačica Bay**

Monitoring campaigns were carried out since October 2019, identifying, and labelling a total of 6 supports randomly distributed along the transplant patches. Shoot density, height of the longest leaf and increase length of the rhizome were regularly measured.

The results of the monitoring campaigns are reported in Figure 6 and Figure 7; it is important to underline that, since October 2019, the transplanted area in Kravljačica Bay has been frequently monitored and all transplantations were always in good conditions. In May 2021, *Caulerpa cylindracea* was observed in the transplant area.

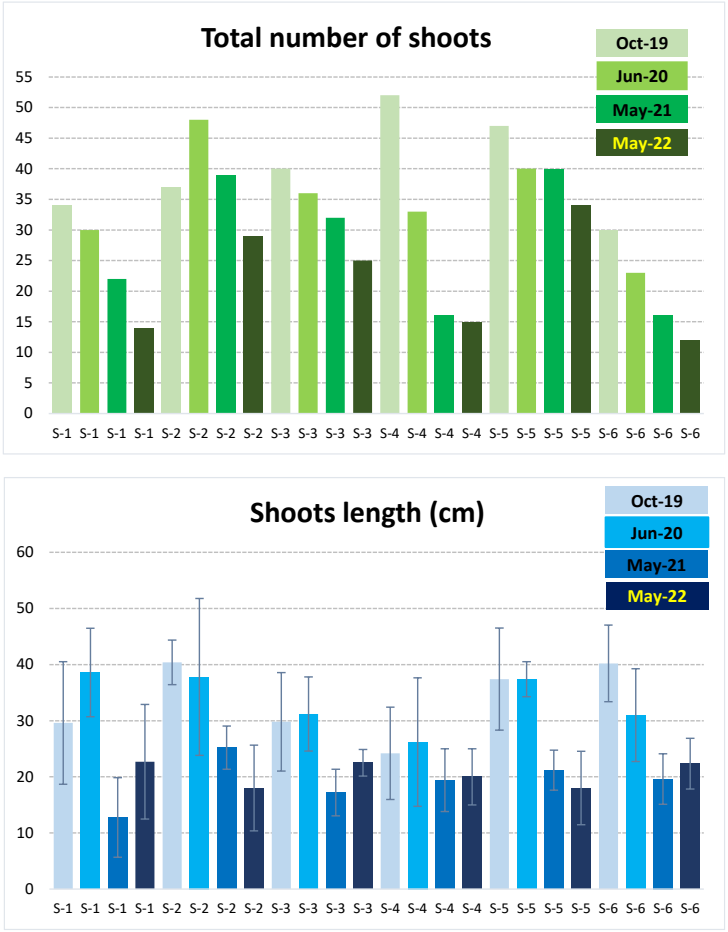

Figure 6. Total number of shoots and average values of shoot length of the 6 monitored support (S-1, S-2, S-3, S-4, S-5 and S-6) in October 2019, in June 2020, in May 2021 and in May 2022.

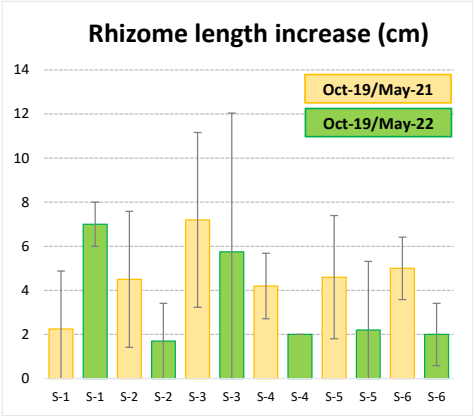

Figure 7. Average values of rhizome length increase of the 6 monitored support (S-1, S-2, S-3, S-4, S-5 and S-6) from October 2019 to May 2021 and from October 2019 to May 2022.

The total number of shoots and the leaf length showed a general slow decrease in all the six measured supports. The decrease was partly due to the high sedimentation trend still going. The rhizomes length showed an increase in all the supports from October 2019 to May 2021. Considering the average values of the parameter for the period October 2019 - May 2022, they are lower and this is because, between 2021 and 2022, some cuttings were lost or damaged.

***P. oceanica* transplantation in Arnica Bay**

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

Figure 8. June 2020: seagrass transplantation in the Kravljačica Bay (in the Anchoring site).

Figure 9. May 2021: seagrass transplantation in the Kravljačica Bay (in the Anchoring site).

Figure 10. October 2021: seagrass transplantation in the Kravljačica Bay (in the Anchoring site).

Figure 11. May 2022: seagrass transplantation in the Kravljačica Bay (in the Anchoring site).

Figure 12. October 2021: seagrass transplantation in the Anica Bay.

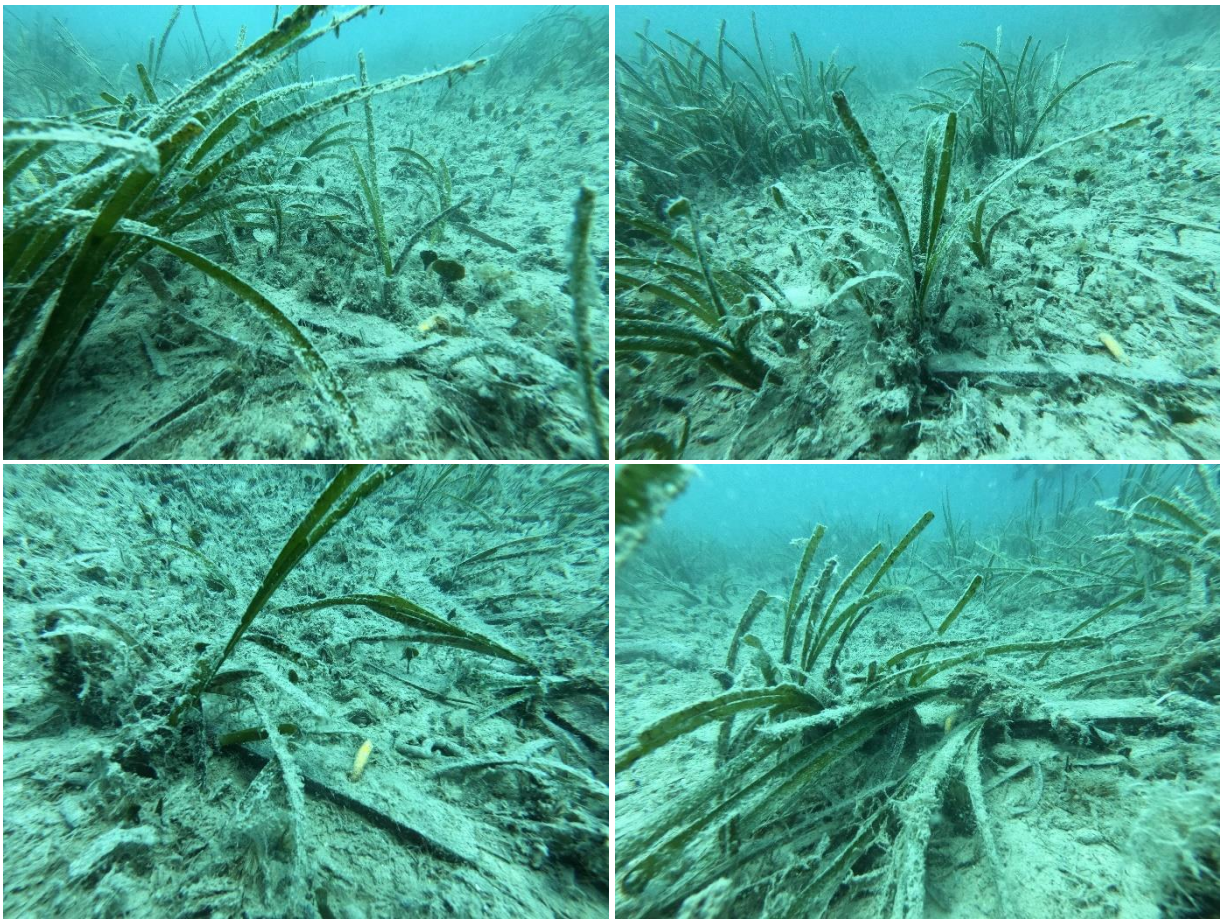

Figure 13. May 2022: seagrass transplantation in the Anica Bay.

3.1.2. Sediment traps

Seagrass meadows can decrease the amount of suspended sediment by trapping particles on the leaves and by enhancing particle sedimentation on the seabed (reducing flow velocity).

In May 2021, some "sediment traps" were placed on the seabed to collect the deposited material in the area in Kravljačica Bay where the seagrass transplantations were carried out and in nearby areas. They were truncated conical artifacts, with a square base, in plastic material for use as a "square sediment trap", with inox or plastic net, to cover the opening of the traps (Figure 14).

In October 2021, the sediment inside the traps was collected, placed in an oven, and the dry weight was calculated. The average value of the sediment inside the traps was twice the one of the areas outside the transplantations, proving the important role of the seagrass in decreasing the amount of suspended sediment.

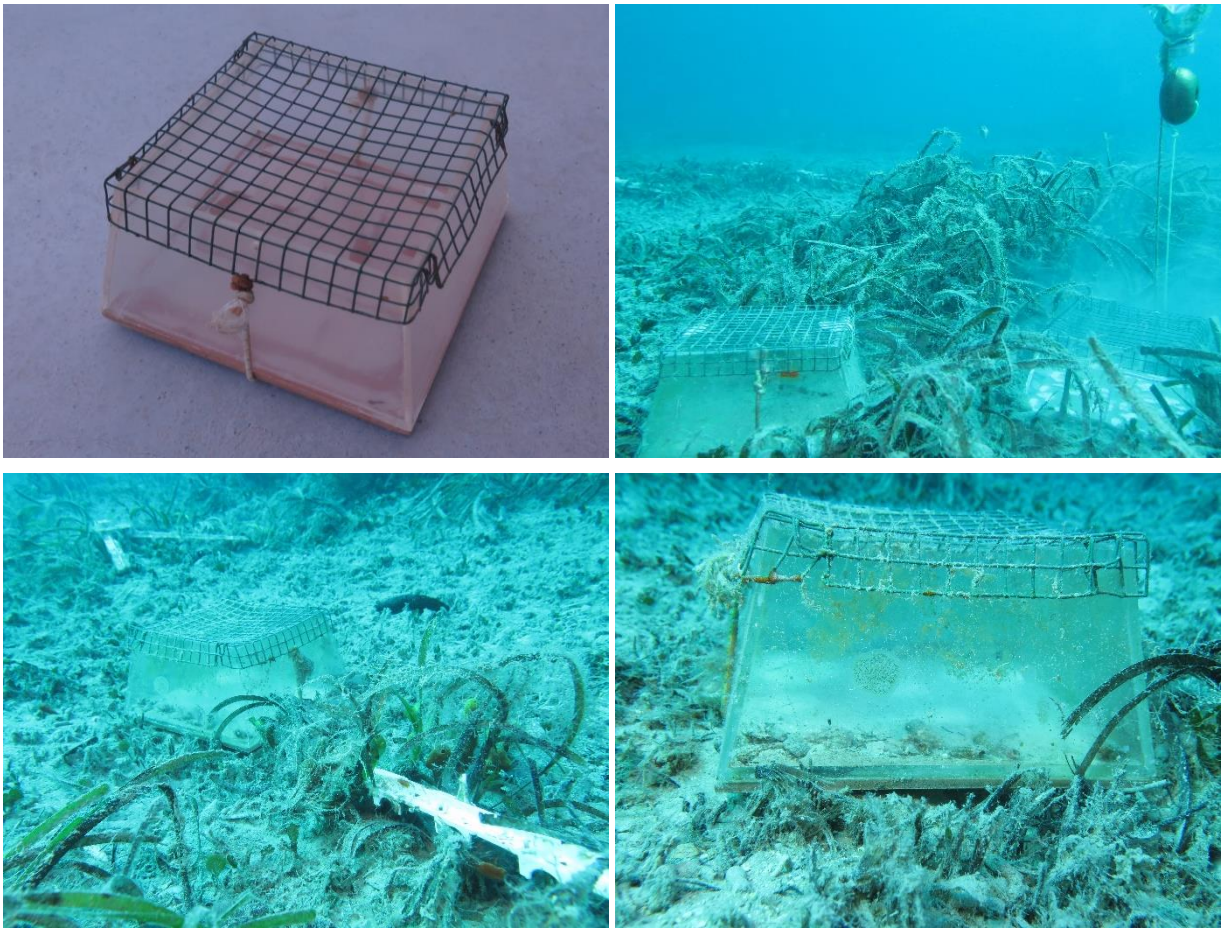

Figure 14. May 2021: Example of sediment trap, with inox or plastic net, to cover the opening. The traps were placed on the on the seabed to collect the deposited material in Kravljačica Bay.

4. CONCLUSIONS

From a technical point of view, the tests carried out with *P. oceanica* showed good results. The plots created (the first dates back to 2019) are still in good condition and about 65% of the installed cuttings are growing, while the remaining 35% has different degrees of degradation or completely disappeared.

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

The transplantation carried out is then affected by a condition of strong sedimentation that harms both the canopy of the transplanted cuttings and that of the natural adjacent patches. However, the transplantations carried out did not suffer significant physical damage at all.

5. REFERENCES

Casier R., 2011. Marine Protected Areas in the Mediterranean Sea. Alfred Toepfer Natural Heritage Scholarschip 2011. Awarded on the EUROPARC Conference 2011 in Bad Urach, made possible by the Alfred Toepfer Stiftung F.V.S.

Ivković N., 2015. Invasive tropical algae of genus Caulerpa in the Adriatic Sea. Thesis performed at Subdepartment of Water Ecology. Pp. 22.

Mihelcic V., Ramov M., 2018. Specific fishing regulations in Croatia: the case of Kornati National Park and Telašćica Nature Park. Presentation (MedPAN Workshop 2018).

Scannavino A., Pirrotta M., Tomasello A., Di Maida G., Luzzu F., Bellavia C., Bellissimo G., Costantini C., Orestano C., Sclafani G., Calvo S., 2014. Biodegradable anchor modular system for transplanting Posidonia oceanica cuttings. Conference Paper. 5th Mediterranean Symposium on Marine Vegetation (Portorož, Slovenia).