First attempt of transplanting the key-species *Cystoseira barbata* and *Zostera noltei* at the Romanian coast *(Victor Nita, Dragos Micu, Magda Nenciu)*	"Cercetari Marine" Issue no. 44 Pages 147-163	2014

FIRST ATTEMPT OF TRANSPLANTING THE KEY-SPECIES *Cystoseira barbata* AND *Zostera noltei* AT THE ROMANIAN BLACK SEA COAST

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ABSTRACT

The brown alga *Cystoseira barbata* and the dwarf eelgrass *Zostera noltei* have an outstanding ecological value for the shallow marine ecosystem and are currently undergoing a regeneration trend along the Romanian coast. Nevertheless, this recovery is a slow and sensitive process, strongly influenced by the increasing anthropogenic activities. Under these circumstances, this research was the first attempt of transplanting these valuable species into new locations, less subjected to pollution, urban sprawl or tourism, yet similar from the habitat point of view. The aim of this endeavor was to prove that both species are suitable for transplantation, with the view to regenerating the underwater vegetation covering the Romanian nearshore.

KEY WORDS: in-situ transplanting, key-species, *Cystoseira barbata*, *Zostera noltei*

AIMS AND BACKGROUND

The underwater vegetation of the Romanian coast is a crucial ecosystem component, acting as substrate for epiphyte algal species, foraging and breeding area for invertebrates and fish which carry-out their vital processes within the thickets formed by macrophytes. Macroalgae have a role in protecting the fauna against the disturbing water action, due to their flexible structure; they also offer a shelter against predators and excessive light, but they are also food source and substrate for phytophagous animals (Marin et al., 2013) (Fig. 1). Marine macrophytes respond to environmental factors variations, the substrate quality and quantity of light radiation penetrating into the water column representing the primary factors necessary for their occurrence. The physical structure, hardness, size and cohesion of the substrate are significant in this respect, whereas a substrate which disintegrates under the action of water causes turbidity and reduces transparency, being unfavorable for phytobenthos development (Sava, 2006).

The two species covered by this research, namely the brown alga *Cystoseira barbata* and the marine phanerogam *Zostera noltei*, are classified as key-species for the shallow marine ecosystem, according to the Black Sea Commission definition, being species that influence the structure and functioning of benthic communities, serving as substrate for other plants, as well as shelter, foraging and breeding areas for animals (Zaitsev and Mamaev, 1997). Both species have an outstanding ecological value for the shallow marine ecosystem and are currently undergoing a regeneration process along the Romanian coast. Nevertheless, they are highly sensitive to adverse anthropogenic factors, consequently these species are listed on the Red List (EN = endangered species), pursuant to IUCN criteria.

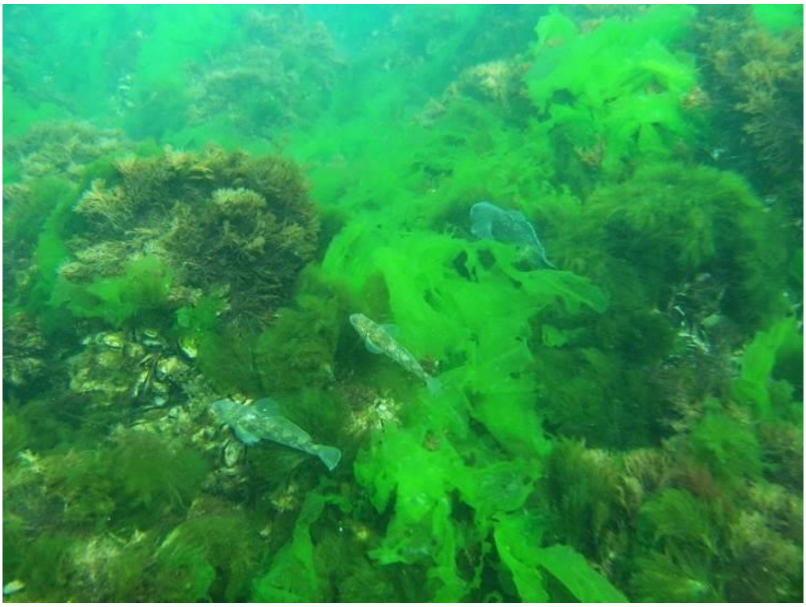

Fig. 1. *Cystoseira barbata - Ulva rigida* asssociation, typical for the southern Romanian coast (original photo NIMRD)

Cystoseira barbata

Cystoseira barbata is a brown alga, with brownish-olive thallus in winter and lighter shaded during the other biological seasons, with sizes reaching up to 2 m, strongly branched. It attaches itself to the substrate by a strong basal disc, from where multiple cylindrical branches stem, on which various round or oval-shaped lined-up or isolated aerocysts are located, acting as floating devices to ease maintaining the vertical position of the species in the water. The receptacles are long, smooth and with few tubercles. It is a perennial species which reaches its development peak in April-May, yet sometimes this process may be delayed by unfavorable conditions, E.g. low water temperature (Marin and Timofte, 2011).

These brown algae act as defence, foraging and spawning grounds for fish juveniles and various marine invertebrates. The elastic and yet firm substrate of the *Cystoseira* thalli and the intricate structure of the branches are ideal locations for the fixation of various macrophytes, both photophilic - bringing them closer to the water surface - and sciaphile - developing in the shadows of the *Cystoseira* thickets (Müller et al., 1969; Bacescu et al., 1971).

All these features make *Cystoseira barbata* an ecological niche very significant for life in the marine ecosystem. In the past, this species was found in association with *Cystoseira crinita* f. *bosphorica*, but the sea ice of 1972, as well as very low temperatures affected the photosynthesis and breeding process of these species (Bavaru, 1972). As a matter of fact, the decline of populations was caused by the aggregated action of two factors, namely the occurrence of ice blocks and very low water temperature, which disturbed photosynthetic activity. As a follow-up of these extreme phenomena, the *Cystoseira* stocks dropped by 80% (Vasiliu and Muller, 1973). Despite the fact that sea ice phenomena had also been reported in previous years, *Cystoseira* fields used to recover, but after this extreme sea ice episode of 1972, this perennial species was unable to regenerate, due to emerging anthropogenic activities. The germs and young plants were unable to develop and restore vegetation in high turbidity coastal waters, caused by discharging in the sea the ground excavated from various constructions or by unsecured high cleves affected by erosion (Bavaru, 1981). This suggests a very important aspect for the subsequent development of *Cystoseira* populations, namely that water transparency must by high to allow the best development of physiological processes (germination, photosynthesis).

However, in recent years a recovery of this perennial species was reported. *Cystoseira barbata* is now present in large compact fields in the southern part of the Romanian coast, in Mangalia, 2 Mai and Vama Veche, where considerable biomasses develop (Fig. 2).

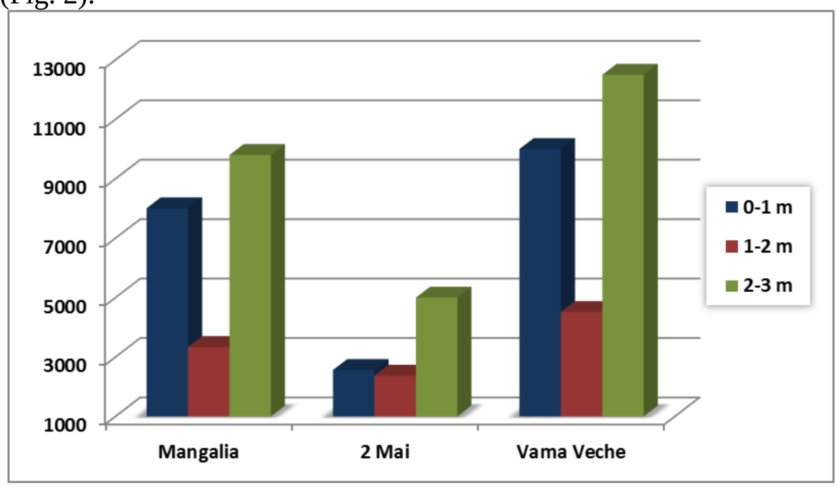

Fig. 2 - *Cystoseira barbata* - mean fresh biomasses on the southern Romanian coast, summer 2013

From the past study years (2009-2011), it can be concluded that this species is currently in a stable state on the analyzed profile, although the biomasses developed are incomparable with those prior to 1970s (*Cystoseira barbata* and *Cystoseira crinita* stock assessments of 1970-1971 indicated 4,900-5,500 tons fresh biomass - Vasiliu, 1984). Under current environmental conditions, both natural and anthropogenic, *Cystoseira barbata* is recovering, yet it is still sensitive to anthropogenic activities (E.g. arranging seafront cleves, building breakwaters, performing excavations in ports etc.).

It must be mentioned that, during the reference period, the *Cystoseira barbata* populations along the Romanian coast were found between 0.5-6.5 m depth. These water depths are the absolute boundaries, but the maximum density of specimens is recorded between 1 m and 4 m depths. During the current study period, the maximum density of specimens was found at 1-3 m depth.

Zostera noltei

Another key species for the shallow marine ecosystem is considered to be the dwarf eelgrass *Zostera noltei*. It attaches itself to the substrate by rhizomes growing in paraller with the seabed. Long, linear, dark green leaves, shaped as a 3 mm wide ribbon grow from the rhizomes. Each leaf has 3 veins (one in the middle and two lateral) and a mucronated tip. 2-3 white rhizoids are located on the knots, aimed at anchoring the species on the substrate (Marin and Timofte, 2011).

In the past, *Zostera noltei* used to be found in association with *Zostera marina* and formed wide underwater meadows in Agigea (covering an area of 30 m^2), Eforie South and Mangalia) (Vasiliu, 1984).

This species has undergone a drastic decline as a follow-up of uncontrolled dredging and water transparency reduction, caused by large amounts of suspensions resulting from various anthropogenic activities. Lingering in the upper horizons (1-3 m), suspensions strongly affect these perennial higher plants, whereas they prevent them from performing photosynthesis. Suspensions (from ports or cleves) triggered hypoxia and even anoxia processes, with lethal effects on populations. Suspensions act directly on seagrass communities by:

- Light penetration limitation into the water layers and selective retention, depending on the size and chemical structure of the particles;
- Siltation processes, deposition of suspensions on the benthic substrate.

The large amount of suspensions shall entail a transparency reduction thus preventing spore attachment, germination and development of species. The morphology of the species varies depending on the amount of available light, the leaves having much larger dimensions where the water transparency is higher. Thus, a sheltered area with high water transparency, not being under the direct influence of waves and currents, favors the development of this marine phanerogam.

Zostera noltei also serves as habitat for many invertebrates and fishes, who find here foraging, breeding and safety areas, also fixing the substrate and improving water quality, which renders this species very important for the marine ecosystem. It is a photophilic species and at its base a series of organisms not requiring much light develop: briozoans, ascidians, various types of mollusks, nematodes, copepods that can also develop well among the epiphytes and, along the surface of the rhizomes, many polichaetes are present, too. The rhizomes and rhizoid system form a real underwater network, which is living environment for various organisms.

The fresh biomass values for the marine higher plant *Zostera noltei* were high in the past years, indicating that this species is currently recovering along our coast (Fig. 3). It was noted that at deeper horizons the biomass of the species *Zostera noltei* grows, whereas the instabilities of environmental factors in shallow waters are no longer present and the development of this key-species is possible. In summer, *Zostera noltei* was epiphyted mostly by *Colaconema thuretii*, a small red alga belonging to phyto-epiphytes.

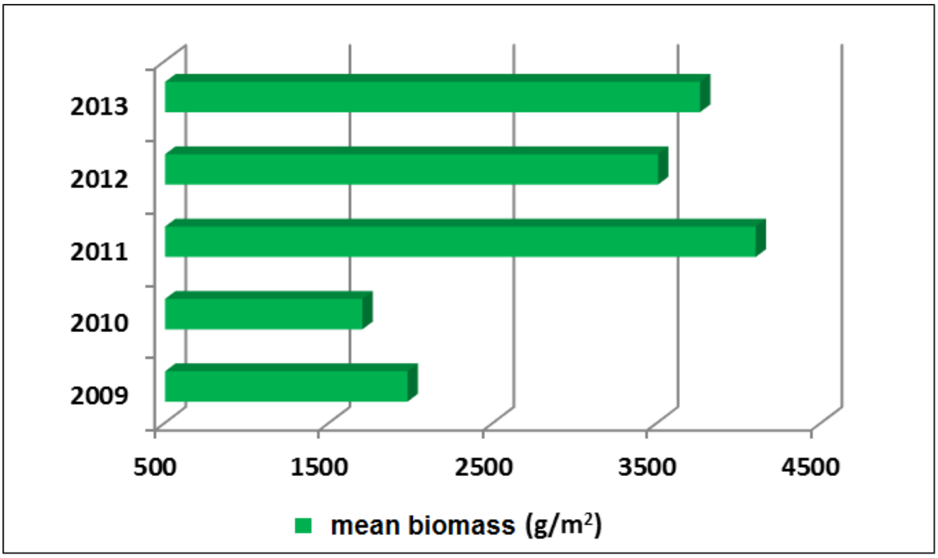

Fig. 3. *Zostera noltei* mean fresh biomass (2009 - 2013) - Mangalia

Currently, *Zostera noltei* forms meadows in the southern part of the Romanian coast, in Mangalia (Fig. 4), covering sandy-muddy substrates on which they settle using a repent rhizome and the rhizoids.

Fig. 4. *Zostera noltei* meadow in Mangalia (NIMRD original photo)

However, not only biomass value is a criterion for a good environmental status. A qualitative analysis of specimens is required, aimed at identifying certain features. From this perspective, the specimens collected in the summer of 2013 from the Mangalia meadow showed some indicative features in this respect:

- Long, fresh, deep green leaves,
- Few epiphytes (*Colaconema thuretii* - main typical epiphyte),
- Long rhizomes and rhizoid system (providing good anchoring on the substrate).

Excessive nutrient enrichment (discharged from waste water treatment plants, agriculture or aquaculture) can have several harmful consequences on the area covered by *Zostera*. Nutrient enrichment can cause eutrophication, resulting in the abundant proliferation of benthic (*Cladophora* sp.) and planktonic epiphyte algae, all potentially harmful to the development and coverage of *Zostera* meadows (they reduce their biomass and the growth depth). Stress caused by excessive nutrients may render *Zostera* specimens vulnerable to infestation by various parasites (Davison and Hughes, 1998).

The occurrence of phanerogams where the substrate allows it (sandy-muddy substrate) is highly important and has a major beneficial impact on the marine ecosystem. Phanerogams are primary producers and provide habitat for several organisms, shaping the light level and also preventing erosion. In areas where the meadows are wide, they shelter a rich fauna, including commercial fish and crustacean juveniles. However, the key-role of phanerogams in the marine ecosystem depends on the structure and quality of phanerogams, thus a wide area, with specimens lacking epiphytes, shelters a rich and diverse fauna and is a zone with a higher ecological quality.

Mussel populations inhabiting the *Zostera* meadows create a connection with this phanerogam by eliminating part of the epiphytic flora forming on leaves (especially in summer). The removal of epiphytes reduces competition for light in favor of phanerogams, for a proper photosynthesis process.

Anchoring activities, collecting edible mollusks, washing various engine crafts are among human activities with an unfavorable impact on phanerogams, which may cause physical disturbances to the sediments.

Depending on the circumstances, the sedimentation or erosion degree may increase, with negative consequences on the viability of *Zostera* meadows. Many coastal activities cause an increase of water turbidity, which tampers with the breeding and photosynthesis process of phanerogams, while reducing their distribution boundaries. Waves and currents, especially during storms, can cause the removal of sediments, uptearing the specimens. Dredging can sometimes cause the tearing of rhizomes and rhizoids (preventing vegetative breeding) and seeds can be buried in sediments too deep to produce germination - sexed breeding (Davison and Hughes, 1998).

MATERIAL AND METHOD

For the development of the translocation process, it was required firstly to identify an area for harvesting the *Cystoseira barbata* and *Zostera noltei* specimens, followed by identifying an area of translocation. With this aim, several surveys were made in the field, during which all potential harvesting and translocation areas of the two species were viewed and analyzed.

Identifying harvesting and translocation areas for Cystoseira barbata

The substrate is an essential factor for the development of *Cystoseira barbata*. It must have certain fundamental physical features, namely it must be hard and coarse to allow the fixation of the young plant. Substrate coarseness, lack of epibiosis and sediments are decisive for the settlement and subsequent existence of *Cystoseira barbata* populations (Marin and Timofte, 2011).

The harvesting site of the sample to be translocated was selected in the nearhsore area of the Venus resort, in a bay with rocky substrate (Fig. 5), where the species is very abundant, being encountered close to the shoreline.

Fig. 5. Sampling location for harvesting *Cystoseira barbata* (original photo V. Nita)

The transplanting method proper consisted in collecting (harvesting) by *snorkeling* rocks with reasonable sizes, with *Cystoseira barbata* fixed on them, from the bay in Venus, where the occurrence of such rocks was confirmed during previous surveys.

When selecting the translocation site, the folowing aspects were considered: easy access, to allow the subsequent monitoring of the transplanted population; spatial characteristics providing the best weatherproof protection of the new population; location away from pollution sources; it is not part of any protected biological association, which, by the disturbance caused by translocation, could endanger the whole ecological balance of the area.

As such, the translocation site was selected in Agigea, sheltered by the protection breakwaters off S.C. MARICULTURA S.R.L. (Fig. 6). Here, the shelter provided by the breakwaters, both to the north and to the south, is sufficient, the opening of the bay allowing the optimal exchange of seawater in the area. The observations made during previous surveys have shown that here the seabed is rocky, with small crevasses, where the translocated rocks with *Cystoseira barbata* can be placed. This way, the resistance of these rocks against potential rollings and topplings caused by hydrodynamism was secured.

The area is somewhat sheltered from tourist impact. Despite the presence of a beach-bar, tourists use for bathing only the northern half of the bay, with a sandy bottom (biogenic sand, with large grains, not causing high and long-term turbidity), the southern half of the bay, selected for transplantation, being unattractive for tourists mainly due to the many unevenesses of the substrate. Water depth in the best positioned zone, where the alga was transplanted, is 1-2 m, similar to the depth in the harvesting zone, another reason for selecting this location. Water transparency is excellent, given the small depth and the nature of the substrate.

Fig. 6. Transplantation location for *Cystoseira barbata* (GoogleEarth printscreen)

Identifying harvesting and translocation areas for Zostera noltei

In order to transplant the dwarf eelgrass, the sampling location was identified first. Subsequently, a translocation area was also selected. These two areas were selected as a follow-up of several surveys in the field, after having studied and analyzed several potential harvesting and translocation sites.

Zostera meadows are extremely vulnerable to human activities in the coastal zone which sometimes result in pollution and disturbing the habitat of this key-species. Coastal development works (breakwater construction, pipelines, dredging) can negatively affect these marine higher plants, by modifying the local hydrography and disrupting sediment balance.

The area selected for harvesting the dwarf eelgrass is located in the exterior zone of the northern breakwater of the Mangalia Shipyard (Fig. 7), known to locals under the name of "*Broken Dike"*.

Fig. 7. Sampling location for harvesting *Zostera noltei* (original photo V. Nita)

Similarly to *Cystoseira barbata*, the following features were crucial when selecting the translocation site of the dwarf eelgrass: easy access, to allow the subsequent monitoring of the transplanted population; spatial characteristics providing the best weatherproof protection of the new population; location away from pollution sources; it is not part of any protected biological association, which, by the disturbance caused by translocation, could endanger the whole ecological balance of the area.

Consequently, the translocation site was selected in the northern part of the Olimp resort. Here, three new breakwater structures were built during 2011-2013. The offshore breakwaters are not north-south parallel and by the angle they form with the foot of the structure they provide excellent shelter against storms (Fig. 8). The substrate here is sandy-muddy, perfect for *Zostera noltei*. Another reason for selecting this location was water depth in the most sheltered area of the breakwater, of approximately 3 m, identical with the depth in the harvesting zone of Mangalia.

Tourism is practically absent in the area, except for the fishery restaurant known as ”*La Briceag*”. Thus, we estimate that the anthropogenic impact on the transplanted plants will be minimum.

Fig. 8. Transplantation location for *Zostera noltei* (GoogleEarth printscreen)

RESULTS AND DISCUSSION

Transplanting Cystoseira barbata

As mentioned above, the *Cystoseira barbata* specimens were harvested from the nearshore area of the Venus resort, in a rocky substrate bay (Fig. 9), where the species is very abundant, being encountered close to the shoreline.

Fig. 9. Harvesting *Cystoseira barbata* specimens (original photo V. Nita)

The transplantation method proper consisted in collecting by *snorkeling* reasonable sized rocks (weighing approximately 4-5 kg each) with *Cystoseira barbata* fixed on them from the bay in Venus (Fig. 10).

Fig. 10. Tagging *Cystoseira barbata* samples before translocation (original photo V. Nita)

The harvesting operations, as well as transportation to the transplantation site and placing in the new location were made using an engine pneumatic boat. The samples were kept in permanently aerated tanks filled with seawater.

Before transplanting in the new location (Agigea area, sheltered by the breakwaters off S.C. MARICULTURA S.R.L.), the *Cystoseira barbata* specimens were tagged with information on the species, date and the institution performing the transplantation (Fig. 10 and Fig. 11).

Fig. 11. Tagged *Cystoseira barbata* specimen - detail - before transplantation in the new location (original photo V. Nita)

Water depth in the best positioned site where the brown alga was translocated is 1-2 m, being similar to the harvesting area. Water transparency is good, given the small depth and the substrate type.

Subsequently, each *Cystoseira barbata* sample was carefully placed between other rocks on the substrate (Fig. 12), to provide the best fixation and resistance to the high hydrodynamism typical for the cold season. This operation was performed by *snorkeling*.

Fig. 12. Placing each *Cystoseira barbata* specimen in the transplantation area (original photo V. Nita)

Transplanting *Zostera noltei*

The transplantation method of the dwarf eelgrass involved using an autonomous diver (Fig. 13). Seagrass samples were collected and moved to the selected area (exterior of the Mangalia Shipyard Northern Breakwater, known to locals as the ”*Broken Dike”*). *Zostera noltei* rhizomes were cut using a spatula-like tool, practically cutting around each sample and then extracting it from the sediment.

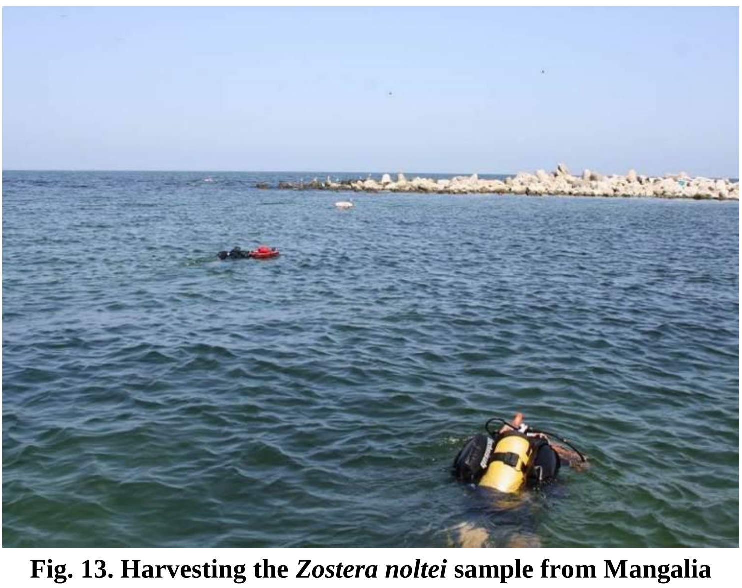

Fig. 13. Harvesting the *Zostera noltei* sample from Mangalia

Before transplanting in the new location (northern area of the Olimp resort), the dwarf eelgrass specimens were tagged with information on the species, date and the institution performing the transplantation (Fig. 14 and Fig. 15).

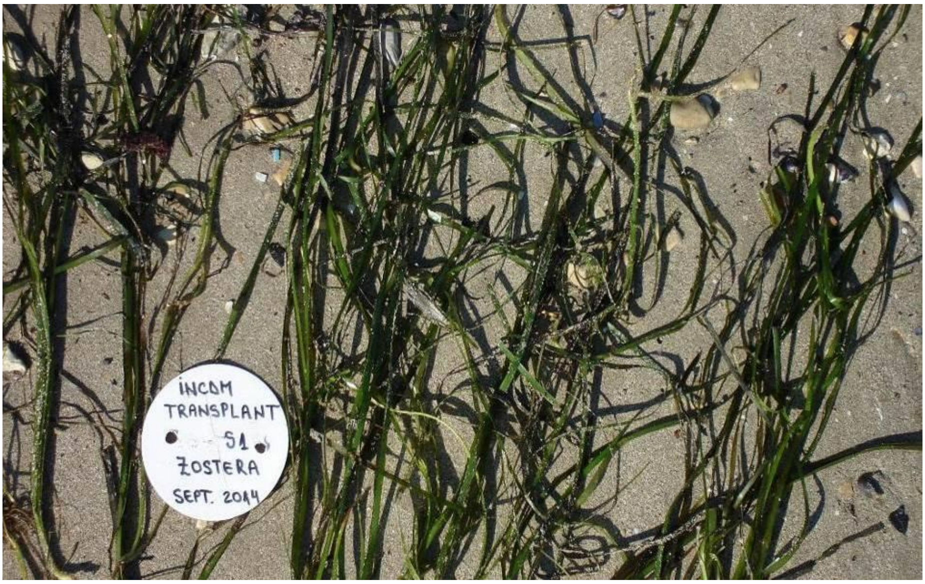

Fig. 14. *Zostera noltei* sample and its tag before transplanting
(original photo V. Nita)

Whereas the fixation of rhizomes on the sedimentary substrate is a lengthly process, the transplanted samples were set in the new locations by covering with a rope net (Fig. 15) with a mesh size of approximately 5 cm (fishing net), which was anchored at corners using appropriate size sinkers (10-15 kg rocks).

Given the easy acces by car, the dwarf eelgrass samples were transported by automobile, for time and cost reasons, yet keeping the sample in permanently aerated seawater tanks at all times.

Fig. 15. Tagged *Zostera noltei* specimen and anchorage net before transplanting (original photo V. Nita)

CONCLUSIONS

This paper is a synthetic outline of the first attempt of transplanting *Cystoseira barbata* and *Zostera noltei* - key-species for the shallow area - at the Romanian coast.

Following a sharp decline caused by the synergic action of several natural and anthropogenic factors, the populations of these two species have recorded slight recovery trends in recent years. The natural rehabilitation process of the marine ecosystem after the convalescence period it recently started to overcome must definitely be supported by ecological reconstruction activities.

One direction in this respect is the creation of ”nurseries” for key-species, allowing them to recover faster at ecosystem level. Our experiences are the first attempts of this type performed at the Romanian coast.

The *Cystoseira barbata* and *Zostera noltei* samples were transplanted successfully from the harvesting locations to the new selected sites. The monitoring performed to date has revealed the stability of the relocated samples. Provided postive results are obtained on the medium and long term, our experiences can be the turning point in starting a wider repopulation program, with the aim of improving marine environment quality and life, in general.

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