13th International MEDCOAST Congress on Coastal and Marine Sciences, Engineering, Management and Conservation, MEDCOAST 2017

EXPERIMENTAL TRANSPLANTATION OF POSIDONIA OCEANICA

Pierre Descamp[1], Thomas Cornu[2], Maud Bougerol[3], Pierre Boissery[4], Celine Ferlat[1], Gwenaelle Delaruelle[1], Julie Deter[5], Sylvie Gobert[6],

[1] Andromede Oceanologie, 7, place Cassan, 34280 Carnon, France.
Tel. + 33 4 67 66 32 48.
E-mail: contact@andromede-ocean.com
[2] Bouygues TP Monaco, 3 rue du Gabian, 98000 Monaco.
Tel. + 33 4 13 64 61 09.
E-mail: t.cornu@bouygues-construction.com
[3] Bouygues TP, Pôle d'expertise environnementale, Direction Technique, 1 avenue Eugène Freyssinet, 78280 Guyancourt, France.
Tel. + 33 1 30 60 45 81.
E-mail: M.BOUGEROL@bouygues-construction.com
[4] Agence de l'Eau Rhône Méditerranée Corse, F-13001 Marseille, France.
Tel. + 33 4 26 22 30 00.
E-mail: Pierre.BOISSERY@eaurmc.fr
[5] UMR ISEM, University of Montpellier 2, Place E. Bataillon, 34095 Montpellier, France.
Tel. + 33 4 67 14 34 80.
E-mail: julie.deter@umontpellier.fr
[6] Laboratory of Oceanology, B6c Bat Chimie, University of Liege, Sart Tilman, MARE and AFFish Centres, B4000 Liege, Belgium.
Tel. +32 43 66 33 29.
E-mail: sylvie.gobert@ulg.ac.be

Abstract

The project of extension at sea of Monaco required the realization of important environmental measures to protect the marine environment. Among differents actions was included a significant experimental measure of transplantation of nearly 500m^2 of *Posidonia oceanica* located in the project area.

To reach this objective we have developed and implemented the SafeBent protocol. The SafeBent protocol allows to sample clods of seagrasses (0.8m^2 / 60cm thick) with a marinized transplanter (Model Optimal 880) operated with a very long arm shovel (27m) from a jackup. The main advantages of this method are:

- high transplantation rate (up to 32m^2/jour);
- conservation of the structure of the seagrasses in meadows;
- conservation of the sediment;
- easy transport of clods in specially manufactured metal baskets

The transplantation was carried out between 20 March and 15May 2017. Seagrasses were reimplanted in the ground of the AMP of Larvotto (384m^2) and on the berm of the dam along the port of Fontvieille in specially constructed concrete planters (116m^2).

The present communication aims to present the Safebent method and the results obtained to date.

Introduction

Located on the Mediterranean coast and independent since 1297, the Principality of Monaco covers a surface area of 2km^2 (second smallest independent state in the world after the Vatican), and has a population of 38,499 (2016 census). This is the highest population density on the planet and it is pursuing its growth, generating essential needs in terms of housing and infrastructure in the Principality.

As Monaco can only grow by expanding into its territorial waters, several offshore building operations have been conducted (Larvotto district then Fontvieille in the 60s-70s). In 2014, the principality's government initiated a new offshore urbanisation project. The project is located in the Anse du Portier, to the East of Port Hercule. Its boundaries are the Larvotto Nature Reserve to the East, and the Spélugues Nature Reserve to the West.

The objective of the Anse du Portier project is to create an offshore extension of about 6 hectares allowing the development of a new luxury eco-district. Construction will consist in two main phases: (i) construction of the maritime infrastructure planned for 2020; (ii) construction of the developments and superstructures planned for 2025.

The creation of the Anse du Portier maritime infrastructure in Monaco has strong environmental ambitions and applies the ARC sequence. "Avoid, Reduce, Compensate" in French and European law (10th July 1976 Act, directive n° 2014/52/EU, 3rd August 2009 Act, 10th July 2010 Act, environmental assessment reform on 3rd August 2016, 8th August 2016 Act to reclaim biodiversity, nature and landscapes).

The Environmental Impact assessment made it possible to draw up the site's initial condition, to prioritise environmental stakes and anticipate impacts in order to propose coherent measures to avoid and reduce them and to compensate residual impacts.

upport measures have further been added to the ARC measures. Amongst these, an experiment to save Posidonia oceanica by transplanting was decided as part of scientific research.

This operation is a first due to the large surface area involved (about 500 m^2), and due to the removal technique in "clods" used.

The equipment and method used have been grouped together here under the "SafeBent" protocol name.

Current state of knowledge of Posidonia transplantation

Posidonia oceanica seagrasses play a central part in the functioning of Mediterranean coastal environments. They have significant primary production and export part of this production to many coastal, and even abyssal, ecosystems. They control sedimentary flows, have a role in reducing hydrodynamism and in protecting beaches from erosion, in recruiting commercially interesting fish and prawn species and in protecting endangered species such as the *Pinna nobilis* (*in* Ramoge, 2006). The economic value of the ecosystemic services provided by *P. Oceanica* not including tourism is assessed to be at least between 25.3 and 45.9 million € / year, or < 283-513 € / ha /year (Campagne et al. 2015).

Furthermore, the seagrasses provide a habitat with exceptionally high specific diversity (biodiversity). Their protection therefore became obvious, not only for reasons related to ecological balance and the protection of heritage, but also for economic reasons (Gobert et al. 2006)

Reasonably well-known to the public, Posidonia has suffered major regression during the XXth century with the loss of about 200 m² of seagrasses per day (Holon, 2015). Very often "publicised" and at the centre of all the public awareness-raising campaigns to preserve the Mediterranean, the Posidonia has a strong symbolic value as a "victim" of pollution and coastal development.

Various *P. oceanica* transplantation techniques have been tried and tested in the past such as the installation of drilled concrete frames in which cuttings are planted, plastic or metal mesh, hooks, posts (Cooper, 1976, 1979, 1982; Cinelli 1980; Giaccone and Calvo, 1980 Meinesz et al., 1990, 1992; Molenaar, 1992; Molenaar and Meinesz, 1992; Molenaar et al., 1993; Genot et al., 1994, Vangeluwe et al., 2004). Clod transplantation techniques (Chessa and Fresi, 1994; Rismondo et al., 1995), and techniques involving laboratory grown plantlets (Piazzi et al., 2000) have also been experimented. Campbell (2000) considers that a reintroduction operation is a success if the implant survival rate is at least 50% and if the rhizome progression rate is at least 50%.

The results of these experiments show that the *P. oceanica* cutting survival rate is variable and sometimes difficult to assess with any degree of accuracy. Indeed, most operations mentioned in the literature cover experimental tests, carried out on small surface areas, and most transplantation operations have not been the subject of assessments more than 2 years after they were carried out. Boudouresque *et al.,* (2006) empirically assess survival rates for rhizomes transplanted in the Mediterranean at about 30 to 40 %.

Outside the Mediterranean, and therefore for other species, there have been transplantations of large surface areas of Magnoliophyta by moving clods using sub-marine robots or machines. Between 1996 and 1999 the Australian ECOSUB I project transplanted 510 m² of Posidonia seagrasses. The survival rate two years after the transplantation was 76.8 % for *Posidonia sinuosa* and 75.8 % for *Posidonia coriacea*. At the start of the 2000s, the development of ECOSUB II made it possible to transplant a surface area of 154 m². These transplantations had a survival rate equivalent to the experiments carried out with ECOSUB I (Paling *et al*., 2001a, 2001b). The American GUTS system

(Giga Unit Transplant System) was used to transplant 43 m² of *Halodule wrightii* and *Thalassia testudinum* (Uhrin *et al*., 2009). After three years of monitoring, 74.1% of transplanted units had survived (66.7 % for *H. wrightii* and 88.9 % for *T. testudinum*).

Material and methods

Choice of source zones

7 source zones have been selected in the Anse du Portier, at depths of between 11 and 18m using seagrass quality criteria (assessed using the EBQUI, BiPo and PREI indexes) and technical accessibility criteria (depth, absence of obstacles). A very accurate map of seagrass performed by photogrammetry showed that the coverage was below 100% (fig. 1). The source seagrass was of a mediocre to average quality with a subnormal density. This seagrass was probably a "young" seagrass which was regrowing as it did not have a matted base: the root system which penetrated the sediment to a depth of about twenty centimetres was borne directly by the rhizomes.

Over 650 numbered targets fixed to metal rods were planted in the seagrass before transplantation in order to identify each source and guide the digger operator's work.

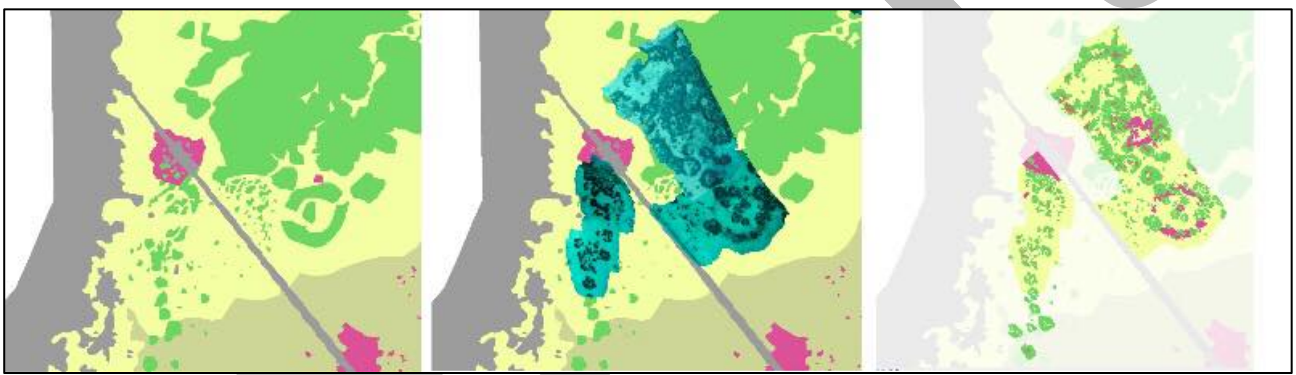

Fig 2: Advantage of photogrammetry (2, 3) on side scan sonar (1) to precisely map seagrass meadows (scale : 1cm = 20m)

Choice of replanting zones

The host sites were defined on the basis of an analysis of: (i) general knowledge from studies of *P. oceanic*a biology and ecology; (ii) feedback from existing Mediterranean and worldwide transplantation experiments; (iii) the characteristics of the source and receiving sites (substrate type, depth, proximity, etc.).

Due to the limited size of Monaco's territory, the choice was very limited, and 2 very different sites were selected:

In the Larvotto Reserve, at 300 m from the source zones, at a depth of between 17 and 19.8 metres. On this site, the baskets were buried in the sand-mud substrate at the lower boundary of an advancing seagrass.

At the foot of the Fontvieille breakwater at 2 km from Anse du Portier, on the berm (flat slab located at the foot of the dam) at a depth of 14 m. The Fontvieille replanting required 2 planters, 1.7 m wide and 60 m long, to be built on the berm.

Test phases

2 preliminary tests were conducted before the project began. A first test (on *Juncus effusus*) was carried out on land to validate the effectiveness of the removal tool and its ease of use. This test was used to check that the cuts were neat at the edges of the clods and that the tool operator was able to aim at and remove a target using only video assistance.

The second test was carried out on *Posidonia oceanica* in Monaco. The purpose of this test was to validate the feasibility of the entire removal/transport/replanting cycle, to check that the clods were not damaged and to anticipate possible technical problems.

As these tests validated all previously defined key quality points, the Monegasque authorities authorised the transplantation operation following the qualified opinion of an independent scientific expert (Pr. Sylvie Gobert).

Works organisation

General organisation

The work was organised into 2 workshops, managed by 2 different teams. The first workshop was the removal workshop (fig. 2). It was run from a Jackup (31*12m) and was located over the natural seagrass zones. The second workshop covered replanting. It was run from the pontoon (36*16m) floating over the replanting zone in the Larvotto Reserve.

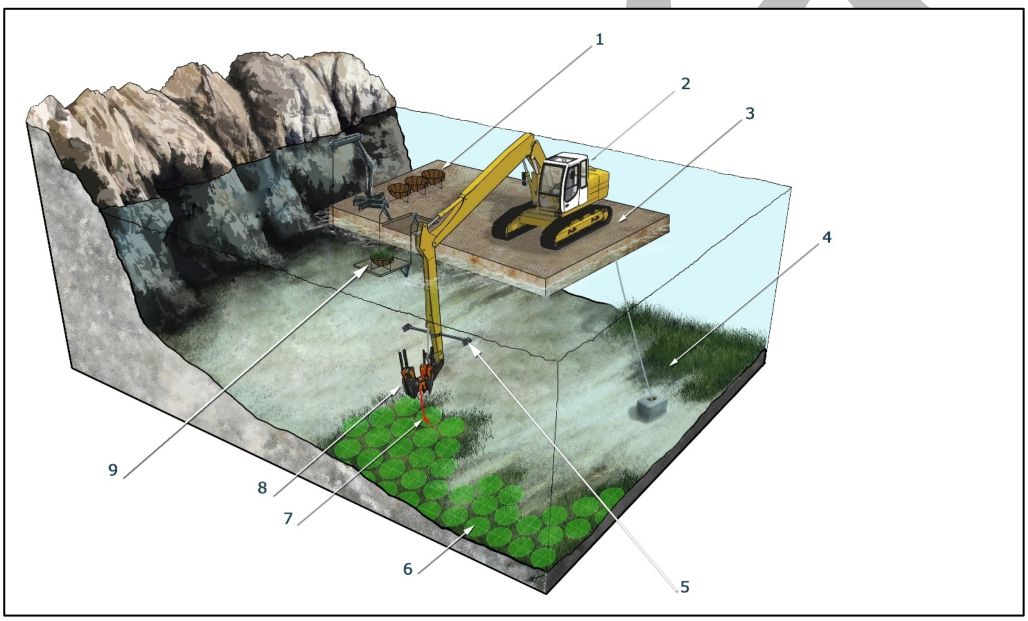

Fig. 2: The plant removal workshop: 1. Transport baskets, 2. Long arm digger, 3. Jackup, 4. Seagrass to be transplanted, 5. Video control, 6. Cartography using photogrammetry and installation of targets in the seagrass before plant removal, 7. laser sights, 8. Transplanter, 9. Mobile platform

Removal

The plants were removed using an Optimal 880 tree spade specially modified for this project and for use in the sea (fig. 3). The Optimal 880 was composed of a chassis bearing four spades mounted on hydraulic jacks that dig into the sediment. When they close, the spades cut the roots and the rhizomes and form a compact elongated half-sphere-shaped clod.

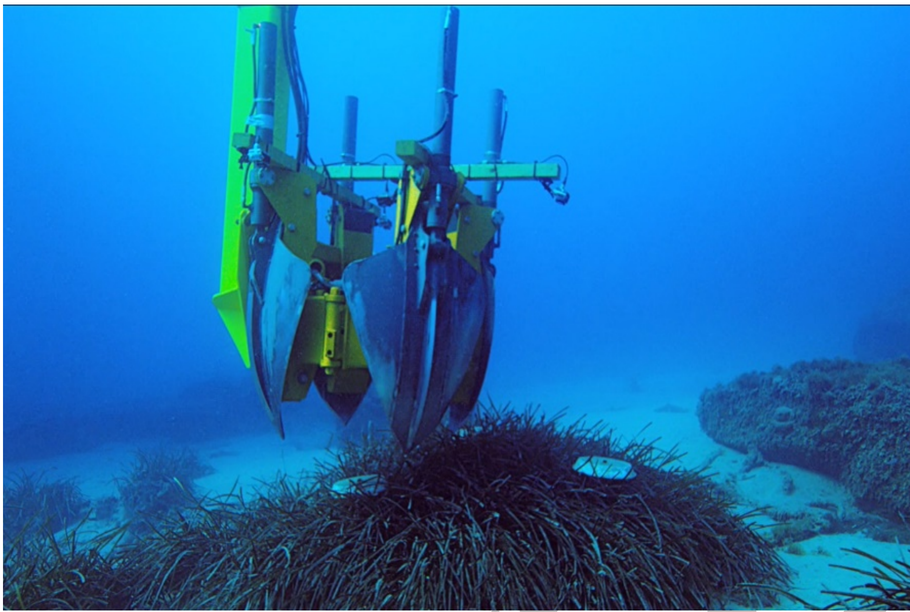

Fig. 3: The translanter in operation

A video assistance system using four Gopro cameras, a laser pointer to aim at the targets and a spirit level to check the flatness of the removed clods was installed on the transplanter. This system has returns to the digger's cabin, allowing the operator to remove plants from the seagrass accurately. The transplanter was mounted on a long-arm digger fitted with two extra extensions. The digger arm length was therefore extended to the exceptional length of 27 metres in order to be able to remove material at depths of up to 20 metres.

The digger was loaded onto the Mose Jackup making it possible to work in stable conditions in swells of up to one metre. Once the Posidonia clod had been removed, it was placed in a 50 cm high "basket" of a diameter of 100 cm (0.8 m^2 approx.) used to transport it to the replanting site.

The transport baskets were made from a 10mm round metal bar frame covered in coconut coir fabric and a maize geotextile film which kept the clod together while being porous and quickly biodegradable. A moving platform that could be immersed to -1.5 metres on the side of the Jackup made it possible to handle the baskets out of the water (platform raised) and the placement of the removed plants in the transport baskets without leaving the water (platform lowered).

5% of the clods were taken from a depth of between 15 and 16.9 metres. The distribution of baskets per depth range was the following: 2.2% between 13 and 13.9 m; 10.6% between 14 and 14.9 m; 48.6% between 15 and 15.9 m; 36.1% between 16 and 16.9 m; 2.6 % between 17 and 18 m.

Transport of the removed plants

Once the removed plants had been placed in the transport baskets, the baskets were suspended at a depth of -10m below 400L buoys, before being towed to their replanting area at a maximum speed of 1.5 knots. For transplants for the Fontvieille site 2 km away, a protective lid was added over the baskets to prevent the sediment from leaching during transport which lasted in excess of one to one and a quarter hour.

Replanting

Larvotto site

Basket sized beds were created using a Toyo pump by divers from the Monégasque company Trasomar. The baskets containing the Posidonia were then placed in these holes. The baskets were replanted at depths of between 17 and 19.8 m.

Fontvieille site

On the Fontvieille site, the Trasomar divers placed the baskets in concrete planters at a depth of -14m. The empty spaces between the baskets were filled with 6.3/16mm washed gravel to maintain the sediment in place.

Results

Replanting on the Larvotto site

480 baskets were transplanted on the Larvotto Reserve, i.e. 384 m^2 of Posidonia. The transplants were installed along the south-west edge of the seagrass, at a depth of between 17 and 19.8 metres (fig 4).

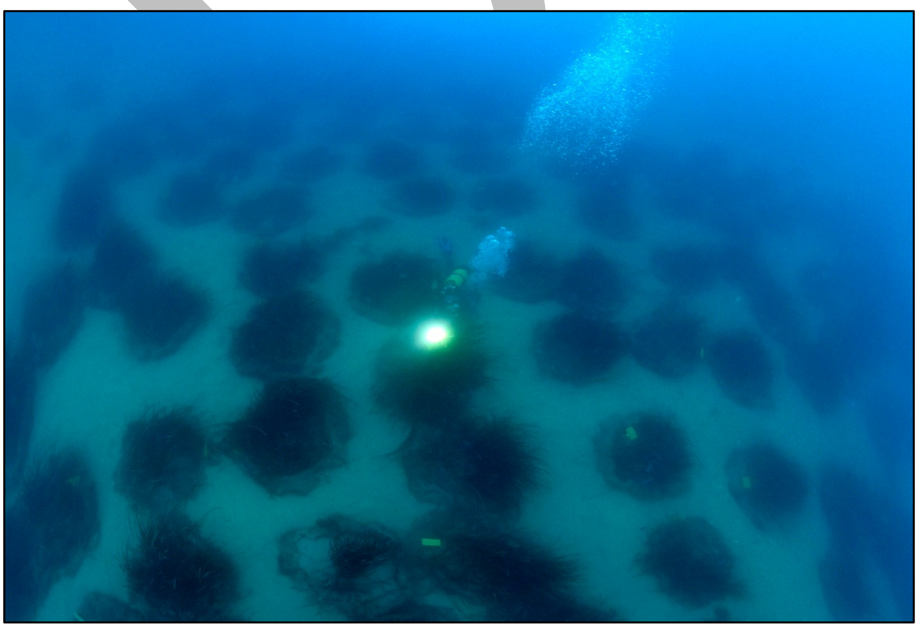

Fig. 3: Transplants on the Larvotto replanting site

Initially it was planned to regularly align and space the baskets. If this objective was partially achieved when sea conditions were ideal, most often the swell prevented accurate use of the Toyo pump. The strategy used by the replanting team was therefore to create holes farther apart and to return to fill the gaps in calmer conditions.

The alignment and regularity of the replanting was deteriorated by this without it having any negative functional impact on the main replanting objective. On the other hand, the increased space between each basket led to replanting over a bigger surface area than initially planned. As extensions to the West and East were not possible, the transplants had to be replanted up to a depth of 19.5 metres, a bathymetric difference sometimes in excess of the -3m target compared to the source zone, which it was initially intended to avoid. Thus, the average seagrass depth from which the transplants replanted in the Larvotto Reserve were taken was -15.4m whereas their average replanting depth was 17.5 metres.

Replanting on the Fontvieille site

In the Fontvieille zone, the 140 baskets (or 112 m² of seagrass) were directly placed between the concrete ballast forming the planters (fig 5). Thus, on an initially sparse berm, a unique and green submarine garden was created which was immediately inhabited by fish fauna. Indeed, from the moment the work was completed, many Labridae species nests were observed in the coir fabric that was apparent on the basket edges.

Several shoals of dream fish settled on the site as soon as the work was completed. In a few months, average leaf length was divided by two dues to this nevertheless natural grazing. On the Fontvieille site, two fan mussels were involuntarily transplanted with the Posidonia without any apparent damage.

Fig. 4: Transplants in the planters at the foot of the Fontvieille breakwater

Transplanted surface area per day

On average, weather conditions permitting, 24 removals were planned per day. In reality it was possible to carry out up to 41 removals per day. However, many uncertainties (swell, visibility, Jackup movements) slowed down these speeds.

Over the entire period, the average speed was 18.4 transplanted baskets per day (*14.7* m^2*/day*) +/- 10 with a maximum of 41 baskets/day (or *32.8* $m^{2/}$*/day*).

Increased speeds were noted as the work progressed, particularly due to a better control of the operations, but also due to improved weather conditions. The final third of the work was more efficient, with speeds often higher than the initial objectives.

Removed plant quality

Each plant removal was the subject of a quality control at the time of removal, and then when it was replanted. The removed specimen must have coverage in excess of 50%, be sufficiently horizontal, and the basket must be filled with sediment. If one of the criteria was not met, the specimen was destroyed (which was a rare occurrence). 640 specimens were considered compliant at workshop 1. Amongst those, 20 were cancelled by workshop 2 or lost during transport.

In the Eastern part of the site, the very fine and muddy sediment tended to flow away when the transplanter opened while the Posidonia was still held by the spades. This caused many specimens to be bared over heights of about 5 to 10cm. To correct this quality defect, 20 cm metal staples were placed by divers to make sure the rhizomes stayed on the seabed. This operation was carried out during the weeks following replanting.

The Larvotto replanting area was deep (17 to 19.5m) and the spaces left between the baskets in the Larvotto zone compared to what was planned made it difficult to respect a bathymetric difference of less than 3m between the removal and replanting zones. Thus, 24.8% of the removed specimens were “lowered” by more than 4m from their initial depth.

60% of the baskets had an estimated coverage of over 70% and 23% a coverage rate of over 50%. 4.4% of the specimens had 100% coverage. In this respect, the quality objective was exceeded.

Discussion

Technical analysis of the SafeBent® method

The SafeBent® method made it possible to transplant an average of 14.4 m^2 per day, with a maximum of 32.2 m^2, in other words, more than the Australian, American and Spanish methods which were on average less than 10 m² per day.

The daily basket transplantation rate was, however 5.5 baskets/day lower than what was initially planned, and eight extra transplantation days were required to reach the target. The transplant transport to the Fontvieille site, the farthest replanting site, also penalised the work’s progress. In fact, only 8 baskets could be transported at a time. For the Australian and American operations (Paling et al., 2001a, 2001b and 2002 ; Uhrin et al.2009), the critical point in the reduction of speed noted by the authors was also the transport time between the source and replanting sites.

Items for improvement were identified during the removal operation (alterations to the transplanting machine and the sinkable platform) in order to increase the speed and reduce the damage to the removed seagrasses. For the replanting phase, a pontoon installed on piles instead of a floating pontoon would have allowed the Toyo pumps to be used more accurately, and therefore a higher density and better alignment could have been achieved when replanting.

Ecological analysis of the SafeBent® method

It is premature to come to any conclusions or to analyse the success of the operation from an ecological point of view. The assessment of the operation's success rate will require several years.

Nevertheless, on the Fontvieille site, it has been observed that the replanting of the seagrass in the concrete planters has created a living environment. Indeed, beyond the aesthetic appearance of this underground garden, the area was colonised by rich fish fauna from the moment the work was completed. On the Larvotto site, the replanting of the seagrass at three meters from the Larvotto Reserve seagrass made it possible to increase the latter's size. The existing "young" seagrass which was progressing in size is a good potential for the transplanted seagrass, even if the depth is relatively deep (between 17 and 19.8 metres).

In the 3 months following the operations, no specific necrosis or mortality was discovered on the replanting sites. Similarly, it seems that the moderate summer winds did not pull out the rhizomes. The use of staples in the seagrass after transplanting most certainly contributed to this result.

In July 2017, there were young Posidonia leaves present on many of the transplanted specimens, which is proof that the plants' living cycle was not interrupted by the transplantation.

<u>Conclusion</u>

The Posidonia transplantation operation in the Anse du Portier was carried out in compliance with the Safebent protocol in 48 days thanks to the mobilisation of significant human and equipment resources. The final result is $496m^2$ of transplanted seagrass, or 37% of the initially existing seagrass. This operation is symbolic of the inclusion of the marine environment in the project to extend Monaco into the sea as it concerns the architect species considered to be the keystone to the balance of Mediterranean coastal ecosystems.

This operation also made it possible to increase the surface area of the Larvotto reserve seagrass in an area that was currently increasing in size, presenting good growth potential for the transplanted seagrass, even if the depth is relatively deep (between 17 and 19.8 metres).

Finally, the transplantation operation made it possible to create a submarine garden and the vegetalisation of a marine structure (Fontvieille berm) which was initially of limited ecological interest. This unique development seems to have started off well despite overgrazing of the zone by dream fish (*Salpa sarpa*) and many marine species settled in the zone immediately to create a new rich and diverse ecosystem.

In the absence of time-related data and in the face of the many natural or man-made uncertainties that may disrupt the regrowth of the transplanted seagrass, it is impossible to assess the success of the operation at this time. The monitoring of the seagrass's survival on the two very different replanting sites will have major scientific significance and the operation will be a reference for future Mediterranean coastal developments. The post-transplantation scientific monitoring, which began in May 2017, will continue for 5 years between 2017 and 2021.

References

Campagne, C.S., Salles, J.-M., Boissery, P., and Deter, J. (2015). *Posidonia oceanica*: ecosystem services identification and economic evaluation of goods and benefits. Marine Pollution Bulletin *97*.

Chessa L.A., Fresi E. (1994). Conservazione e gestione delle praterie di Posidonia. In: Monbailliu X., Torre A. edits. La gestione degliambienti costieri e insulari del Mediterraneo. Edizione del Sole publ., Ital.: 103-127.

Cinelli F. (1980). Le fanero game marine : problemi di trapianto e di riforestazione. *Mem. Biol. mar. Oceanogr., N.S.,* Ital., suppl. 10 : 17-27.

Cooper G. (1976). La Posidonie, plante étonnante. La pêche ou la mariculture ? *Cah. Jardinier de la Mer,* Fr., 1 : 1-57.

Cooper G. (1979). *Posidonia oceanica* = un arbre. *Cah. Jardiniers de la Mer,* Fr., 3 : i-vi + 1-66.

Cooper G. (1982). Réimplantation de *Posidonia oceanica.* Protection des implants. {Bull. Ecol., }Fr., 13 (1) : 65-73.

Genot I., Caye G., Meinesz A., Orlandini M. (1994). Role of chlorophyll and carbohydrate contents in survival of *Posidonia oceanica* cuttings transplanted to different depths. *Marine Biology*, Allem., 119: 23-29.

Giaccone G., Calvo S. (1980). Restaurazione del manto vegetale mediante trapianto di Posidonia oceanica (Linneo) Delile. Risultati preliminari. Mem. Biol. Mar. Oceanogr., Ital., suppl. 10: 207-211.

Gobert S, Cambridge ML, Velimirov B, Pergent G, Lepoint G, Bouquegneau JM, Dauby P, Pergent-Martini C, Walker D.I. (2006). Biology of Posidonia. Seagrasses: Biology, Ecology, and Conservation. Springer, Dordrecht, The Netherlands.

Holon F. (2015). Interactions entre écosystèmes marins et pressions anthropiques : Applications au suivi et à la gestion des eaux côtières de la mer Méditerranée

Meinesz A., Caye G., Loques F., Macaux S. (1990). Analyse bibliographique sur la culture des phanérogames marines. *Posidonia Newsletter*, Fr., 3 (1): 1-67.

Meinesz A., Molenaar H., Bellone E., Loques F. (1992). Vegetative reproduction in *Posidonia oceanica.* I. Effects of rhizome length and transplantation season in orthotropic shoots. *Marine Ecology,* Allem., 13 (2) : 163-174.

Molenaar H. (1992). Etude de la transplantation de boutures de la phanérogame marine *Posidonia oceanica* (L.) Delile. Modélisation de l'architecture et du mode de croissance. Thèse Doct. Sci. Vie, Biol. mar., Univ. Nice-Sophia Antipolis, Fr.: 1-221.

Molenaar H., Meinesz A. (1992). Vegetative reproduction in *Posidonia oceanica.* II. Effects of depth changes on transplanted orthotropic shoots. *Marine Ecology*, Allem., 13 (2): 175-185.

Molenaar H., Meinesz A., Caye G. (1993). Vegetative reproduction in *Posidonia oceanica.* Survival and developent in diferent morphological types of transplanted cuttings. *Botanica marina*, Allem., 36 (6) : 481-488.

Paling E.I., van Keulen M., Wheeler K.D., Phillips J., Dyhrberg R. (2001a). Mechanical seagrass transplantation in Western Australia, Ecological Engineering, 16(3): 331-339.

Paling E.I., van Keulen M., Wheeler K.D., Phillips J., Dyhrberg R., Lord E.A. (2001b). Improving mechanical seagrass transplantation, Ecological Engineering, 18(1): 107-113.

Piazzi L., Balestri E., Balata D., Cinelli F. (2000). Pilot transplanting experiment of Posidonia oceanica (L.) Delile to restore a damagedcoastal area in the Mediterranean Sea. Biol. mar. Medit. 7(2): 409-411.

RAMOGE (2012). Protection and conservation of *Posidonia oceanica* seagrasses. Ramoge Publ., Monaco:1-202.

Rismondo A., Curiel D., Solazzi A., Marzocchi M., Chiozzotto E., Scattolin M. (1995). Sperimentazione di trapianto di Fanerogame marine in Laguna di Venezia: 1992-1994. In: SITE Atti, Ital., 16: 699-701.

Uhrin, A. V., Hall, M. O., Merello, M. F. and Fonseca, M. S. (2009). Survival and Expansion of Mechanically Transplanted Seagrass Sods. Restoration Ecology, 17: 359–368.

Vangeluwe D., Lepoint G., Bouquegneau J.M., Gobert S. (2004). Effet de la transplantation sur les pousses de Posidonia oceanica. Vie et milieu, 2004 54 (4) : 223-230.

Key words

Transplantation, Posidonia oceanica, Ecological engineering, Safebent.