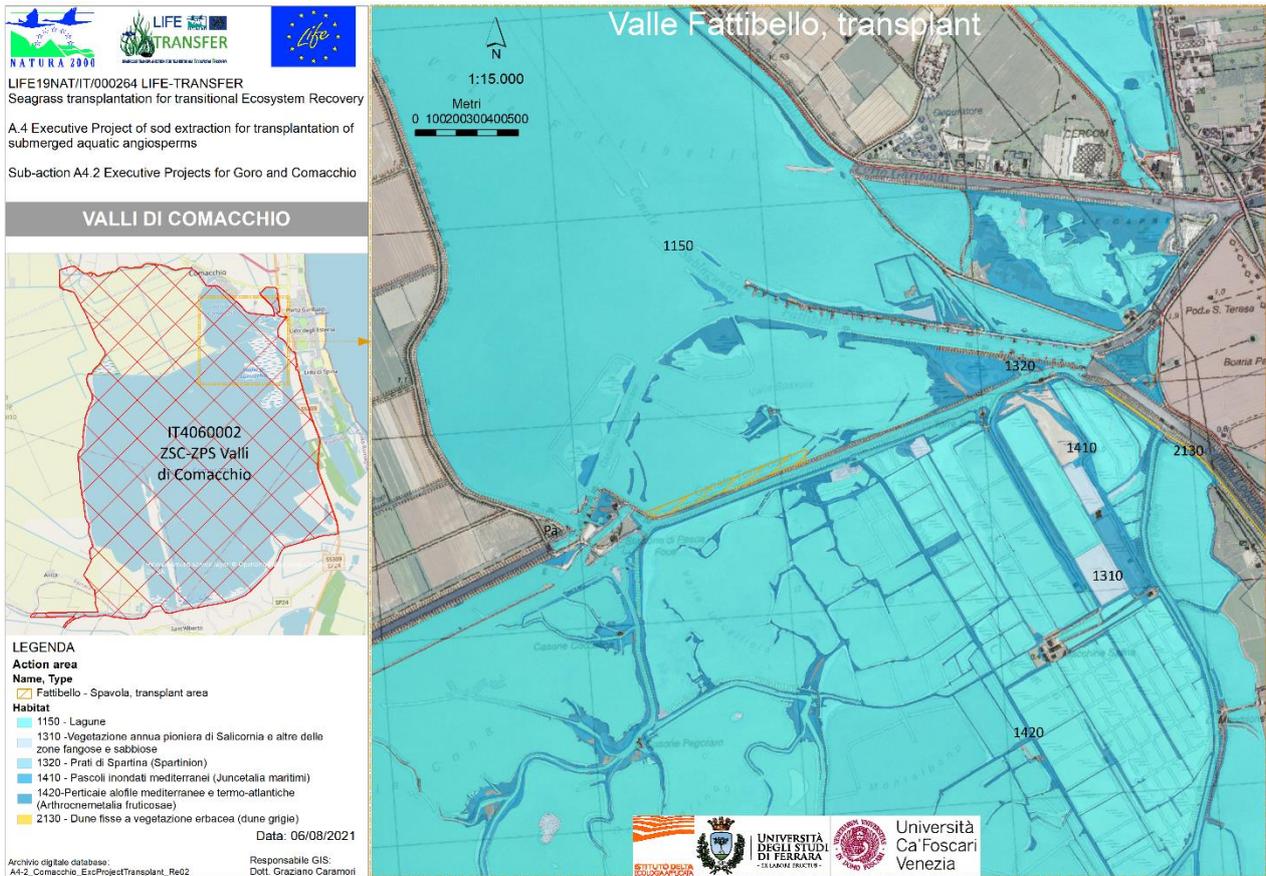


Seagrass transplantation for transitional Ecosystem Recovery

# A.4 Executive Project of sod extraction for transplantation of submerged aquatic angiosperms

Sub-action A4.2 Executive Project for Goro and Comacchio

## VALLI DI COMACCHIO - VALLE FATTIBELLO -



Beneficiary responsible for implementation: UNIFE

Responsibilities in case several beneficiaries are implicated: UNIFE; IDECO; DAIS-UNIVE

Working group: Michele Mistri, Graziano Caramori, Adriano Sfriso

Ferrara, 20/09/2021

Status: final



SEAGRASS TRANSPLANTATION FOR TRANSITIONAL ECOSYSTEM RECOVERY

**LIFE19NAT/IT/000264 LIFE-TRANSFER**

## **Seagrass transplantation for transitional Ecosystem Recovery**



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**Seagrass transplantation for transitional Ecosystem Recovery**

## Summary

**EXECUTIVE SUMMARY (ENGLISH)..... 4**

NATURA 2000 SITE OF INTERVENTION ..... 6

    Donor site ..... 8

    Transplant area ..... 10

SPECIES TRANSPLANTED ..... 13

TECHNIQUE OF TRANSPLANT ..... 16

TRANSPLANT PROGRAMME ..... 17

    Period..... 17

    Quantity ..... 18

PERMITS..... 22

**LIFE19NAT/IT/000264 LIFE-TRANSFER**  
**Seagrass transplantation for transitional Ecosystem Recovery**

## **EXECUTIVE SUMMARY (ENGLISH)**

The operations of explantation from the donor site, and transplantation at the recipient site, will be carried out by at least 2 specially trained fishermen at a time. Two campaigns will be carried out each year. The first campaign will be in Autumn, and operations will start in September and last till the end of October. The second campaign will be in Spring, and operations will start in May and last till the end of June.

The seagrass that will be used is *Ruppia cirrhosa*, a typical species of these lagoons.

The recipient site is Valle Fattibello (Fig. 1), where a total area of 1000 m<sup>2</sup> will be transplanted during the course of the whole project. The donor site will be Valle Campo (Fig. 2), where *Ruppia cirrhosa* is very abundant. Because 30 cm- diameter cores will be used, and the harvesting of the sods is carried out on a large area, the impact on the donor site will be negligible. Due to the short distance from donor to transplant site, both operations will be made in the same day.

*Ruppia cirrhosa* will be transplanted by means of 15 cm-diameter sods. At each campaign, a total of 72 (9 sods x 8 stations) sods will be removed from the donor site, through with a 15 cm diameter corer or spade.

Removed sods will be maintained covered by water in buckets or bags until transplantation. In the transplant site, with the same corer or spade used for removal, sods will be placed into sediments. Transplant operations will be carried out from a boat in order to minimize sediment disturbance in the operating areas.

Transplants will be carried out in eight stations of 10mx10m areas, signaled with appropriate poles. At each station, 9 sods will be transplanted into clusters of 3, spaced 1m from each other. The distance from three groups of sods will be approx 5m.

The sods removal/transplant operations will be implemented by local operators (fishermen) trained in

subaction Action A5.2 and supervised by the technical staff of UniFe.

The optimal season for transplants is autumn. In fact, during this period there is no interference with the growth of opportunistic macroalgae (mainly Ulvaceae, Cladophoraceae, Gracilariaceae, Solieriaceae) due to the progressive decrease in temperature. However, in areas where macroalgae



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are absent or have a negligible biomass, as in the Valli di Comacchio, the transplant activities can be carried out also in spring.

The action will start in autumn 2021; sod removal/transplant operations will continue until the end of the project (2025) in order to have the greatest chance of success.



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## NATURA 2000 SITE OF INTERVENTION

The project will be implemented into the Natura 2000 site IT4060002 Valli di Comacchio, with complete overlapping of SIC and SPA. Valle di Comacchio is a large a complex of different lagoons, Figure 1, with a total surface of 16,781 ha. The northern part of the site is reclaimed land, the other parts of the site are a complex of brackish coastal lagoons, the main lagoons locally known as “Grandi Valli” are connected through the sea via a set of channels and regulated sluices. Valle Fattibello is an open brackish lagoon, receiving freshwater from the North and sea water directly from the sea. A set of small lagoons with regulated water movement compose the reaming part of the site. The action will be implemented in the site in order to trigger the seagrass meadows in Valle Fattibello.





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## Donor site

The donor area is the same Natura 2000 site but into a different closed lagoon named Valle Campo, in some isolated ponds in which after a survey the *Ruppia cirrhosa* was found in abundance, therefore the local population will not be damaged by the harvesting. Because 30 cm- diameter cores will be used, and the harvesting of the sods is carried out on a large area, the impact on the donor site will be negligible. Due to the short distance from donor to transplant site, both operations will be made in the same day.

Valle Campo, due to its endowment of structures and infrastructures, and the fact that it is separated from the larger valleys, is a productive valley where the traditional activity of valley farming is practiced. It is owned by the Municipality of Comacchio. Valle Campo, as well as the internal part of the large Valli, fall into the Pre-Park area where interventions that allow extensive productive activities to take place are permitted in such a way as to ensure compatibility with the landscape and environmental values of the places.

The total harvesting during 5 years of the action C2 is calculated in 170 m, which in respect at the donor area represent the 0,31% of the area occupied during a period of 5 years. Considering the capacity to renew of *R. cirrhosa* the donor area population will not be damaged.

In



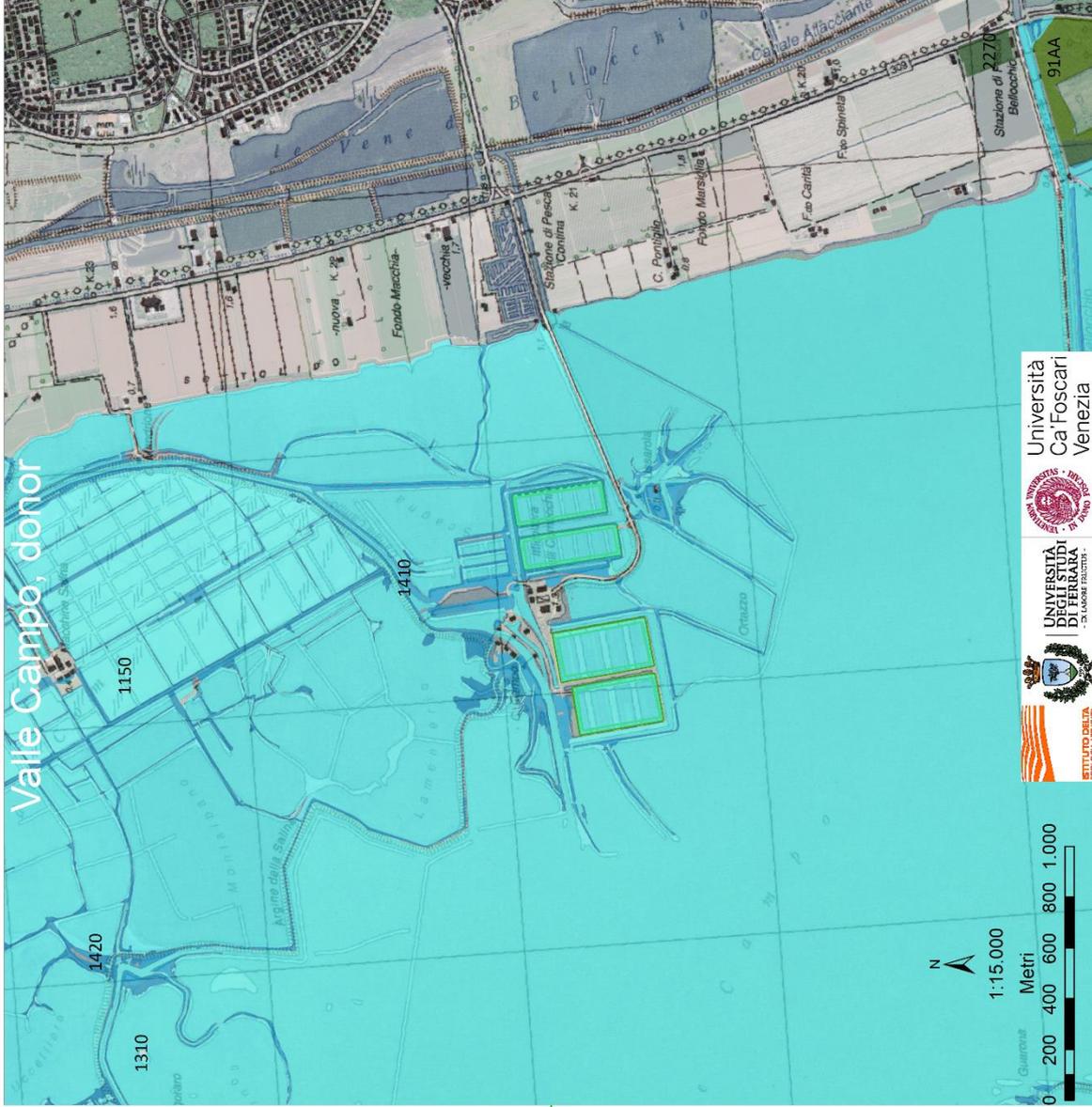
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 Seagrass transplantation for transitional Ecosystem Recovery  
 A.4 Executive Project of sod extraction for transplantation of submerged aquatic angiosperms  
 Sub-action A4.2 Executive Projects for Goro and Comacchio

VALLI DI COMACCHIO



Legenda

- Habitat
  - 1150 - Lagune
  - 1310 - Vegetazione annua pioniera di Salicornia e altre delle zone fangose e sabbiose
  - 1410 - Pascoli mondiali mediterranei (Juncetalia maritimi)
  - 1420 - Perticarie alofile mediterranee e termo-atlantiche (Arthrocnemum fruticosae)
  - 2270 - Foreste dunari di Pinus pinaster e/o Pinus pinaster
  - 91AA - Boschi orientali di quercia bianca
  - Action area
  - Valle Campo, Donor area
- Data: 06/08/2021  
 Responsabile GIS:  
 Archivio digitale database:  
 A4-2\_Comacchio\_ExecProj\_Donor\_Rev03  
 Dott. Graziano Caramori



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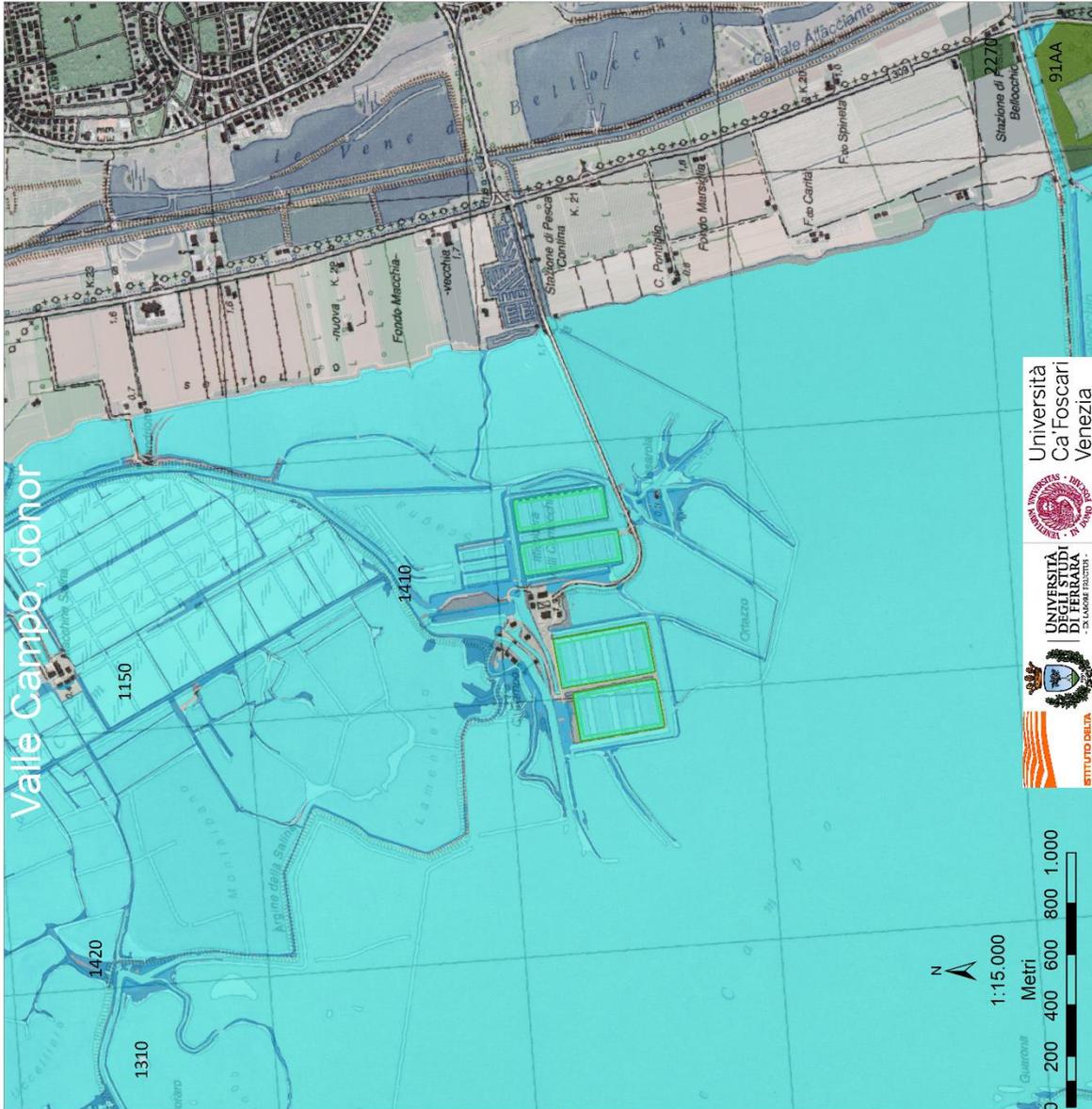
Seagrass transplantation for transitional Ecosystem Recovery





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Figure 2 is represented the donor area, the distribution of *R. cirrhosa* is along the borders of the isolated ponds therefore the map is the best representation at the scale 1:5.000 but it cannot be a mirror representation of the actual distribution.



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UNIVERSITÀ DEGLI STUDI DI FERRARA  
UNIVERSITÀ DEL SALENTO  
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Seagrass transplantation for transitional Ecosystem Recovery  
A.4 Executive Project of sod extraction for transplantation of submerged aquatic angiosperms  
Sub-action A4.2 Executive Projects for Goro and Comacchio



**Legenda**  
Habitat  
1150 - Lagune  
1310 - Vegetazione annua pioniera di Salicornia e altre delle zone fangose e sabbiose  
1410 - Pascoli mondiali mediterranei (Juncetalia maritimi)  
1420 - Pteridacee alofile mediterranee e termo-atlantiche (Arthrocnemum fruticosae)  
2270 - Foreste dunari di Pinus pinaster e/o Pinus pinaster  
91AA - Boschi orientali di quercia bianca  
Action area  
Valle Campo, Donor area  
Archivio digitale database:  
A4-2\_Comacchio\_ExcProj\_Donor\_Rev03  
Data: 06/08/2021  
Responsabile GIS:  
Dott. Graziano Caramori

Figure 2: donor area, Valle Campo,



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## Transplant area

The recipient site is Valle Fattibello, where a total area of 1000 m<sup>2</sup> will be transplanted during the course of the whole project. Fattibello is the largest of Comacchio's minor valleys. The surface, including Valle Spavola is approximately 500 ha. Its boundary is partly delimited to the north and east by the embankment of the Ostellato Navigabile canal -Portogaribaldi and the Pallotta canal; to the south from the embankment of the Foce canal and to the west from the embankment that separates the Valle Pega from the reclamation. In the southern part Fattibello is separated from the Valle Spavola by means of a discontinuous embankment. Valle Fattibello thus represents the drainage basin of the Logonovo canal and the Porto Canale through the Vallette and Pallotta canal system. The circulation of water is linked to the flow of tide, taking into account the delays associated with the longitudinal development of the canals. The tidal excursions in the valley are between +20 and -20 above sea level, while the bathymetry of the valley is about 40-60 cm. In this sub-basin, with the LIFE09NATIT000110 project, the terminal section of the Fattibello canal was re-excavated to improve the hydraulic efficiency in front of the new 4-light artifact that puts in communication between the valleys and the sea, it is a stretch of about 400 m. The excavated soil was deposited within already existing delimited areas, forming new bumps to favor the nesting of the avifauna. The Valle Fattibello-Valle Spavola complex is very important from a hydrodynamic and environmental point of view, given that the water exchange of part of the Valli di Comacchio system is articulated here, where most of the discharge manifolds of the Polesine di S.Giorgio drainage systems converge. Here freshwater mix with the salty ones coming from the only mouths towards the sea (the Porto Canale and the Logonovo canal) and, in conditions of constant occlusion of the Bellocchio-Gobbino, Valle Fattibello and its internal channels, are the only area from which it is possible the natural recovery of juvenile fish in the Valli di Comacchio.

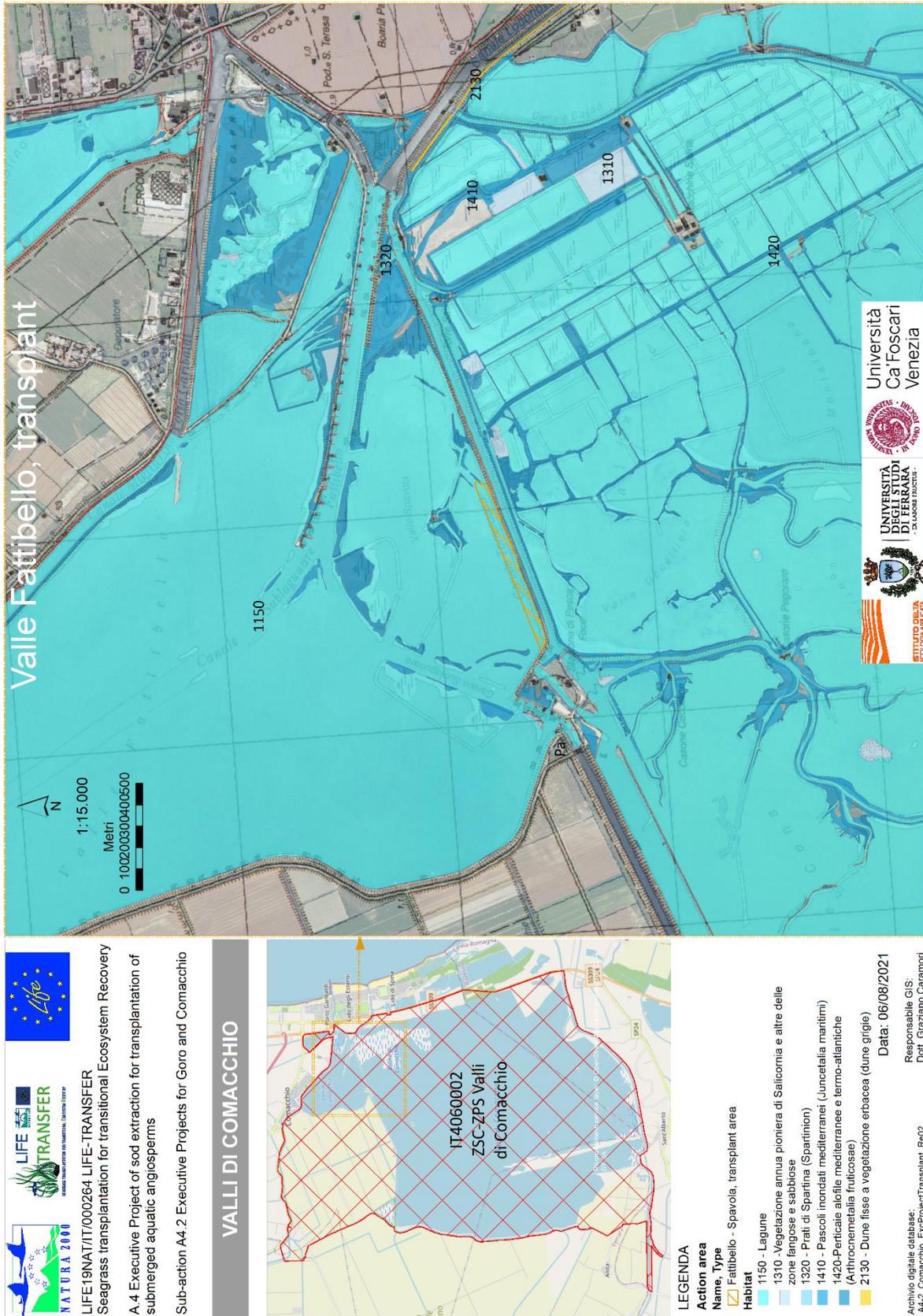


Figure 3: transplant area, Valle Fattibello.

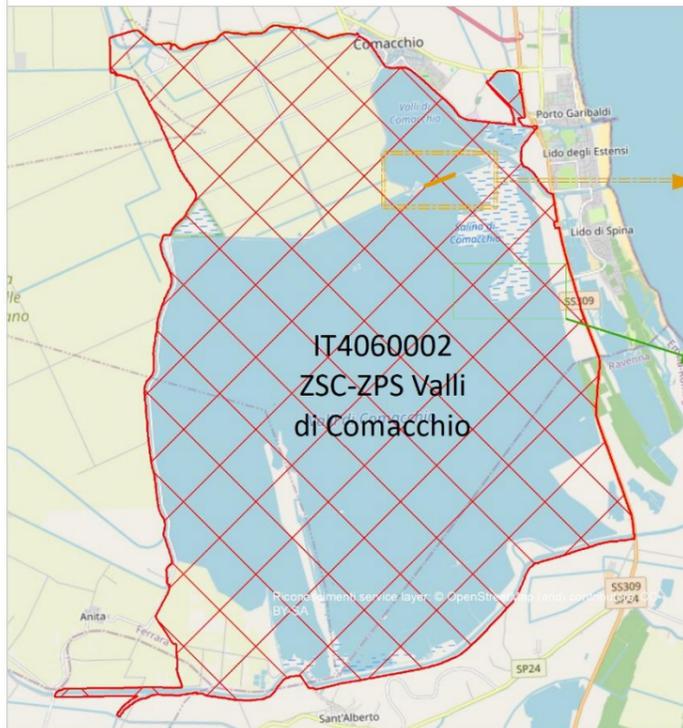


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 Seagrass transplantation for transitional Ecosystem Recovery

A.4 Executive Project of sod extraction for transplantation of submerged aquatic angiosperms

Sub-action A4.2 Executive Projects for Goro and Comacchio

VALLI DI COMACCHIO



LEGENDA

Action area

- Fattibello - Spavola, transplant area
- Valle Campo, Donor area

Habitat

- 1150 - Lagune
- 1310 -Vegetazione annua pioniera di Salicornia e altre delle zone fangose e sabbiose
- 1320 - Prati di Spartina (Spartinion)
- 1410 - Pascoli inondati mediterranei (Juncetalia maritimi)
- 1420-Perticaie alofile mediterranee e termo-atlantiche (Arthrocnemetalia fruticosae)

Data: 06/08/2021

Archivio digitale database:  
 A4-2\_Comacchio\_ExcProjectDonor-Transplant\_Re02

Responsabile GIS:  
 Dott. Graziano Caramori

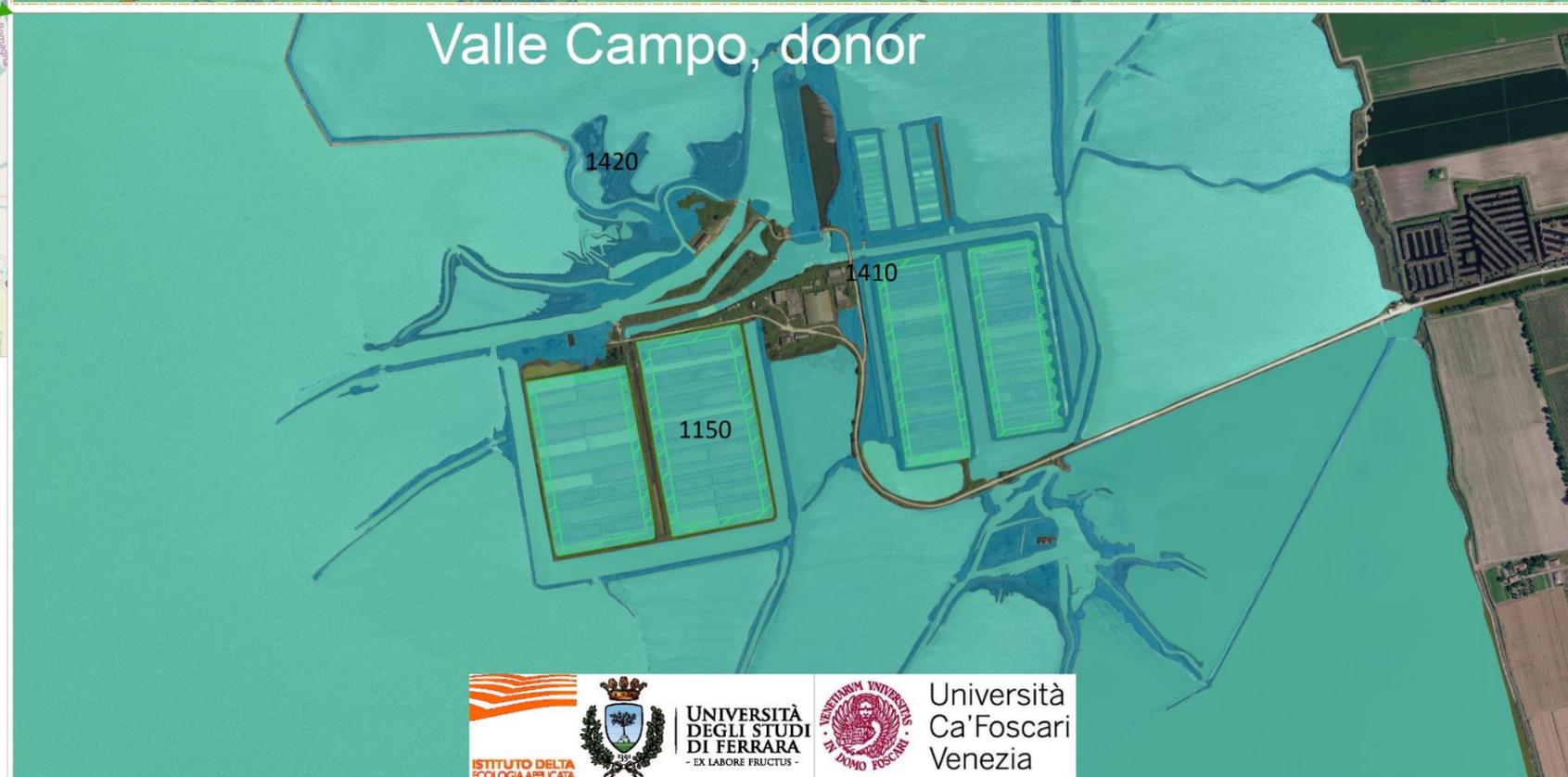
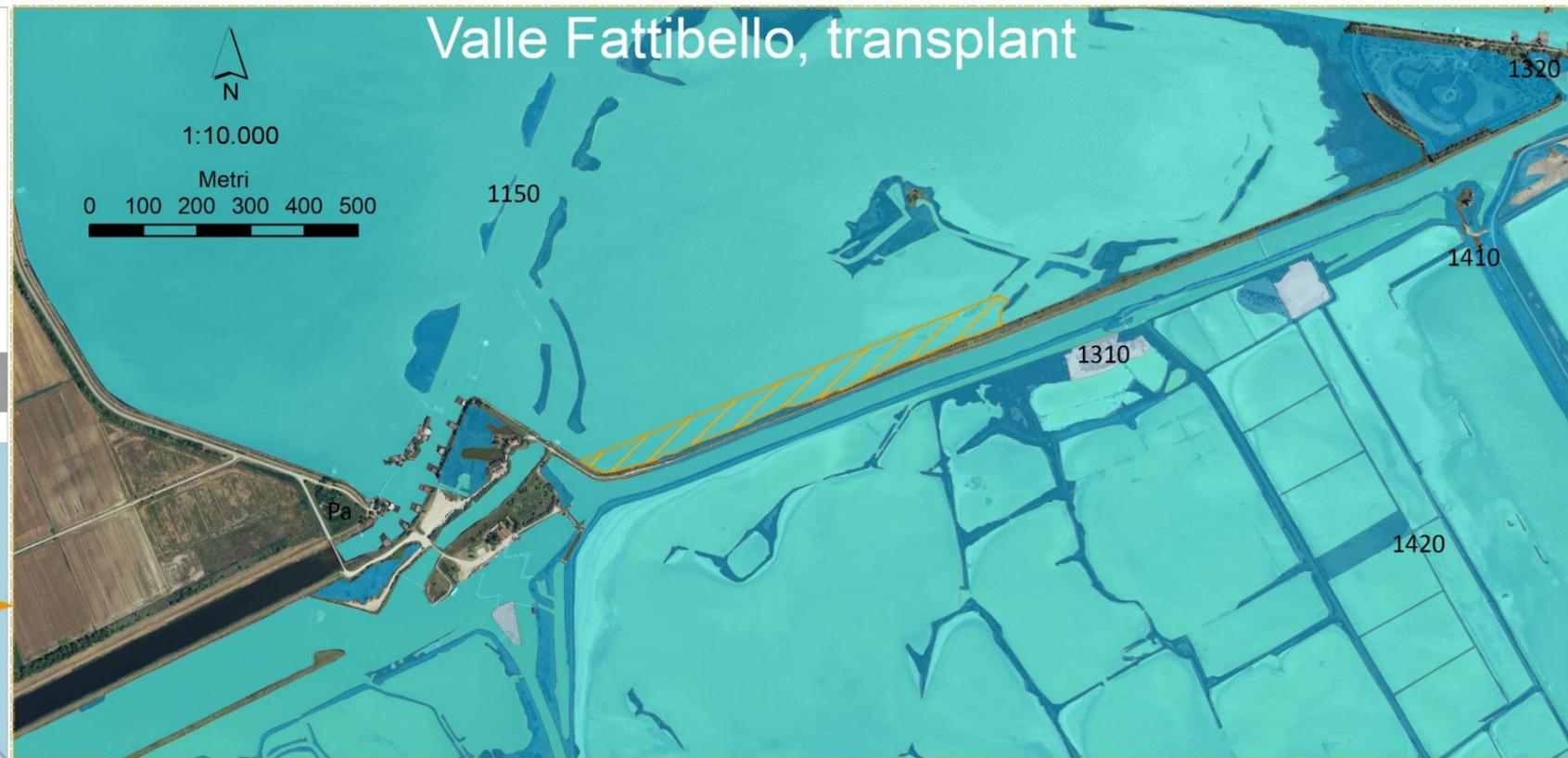


Figure 4: overview of donor and transplant areas.

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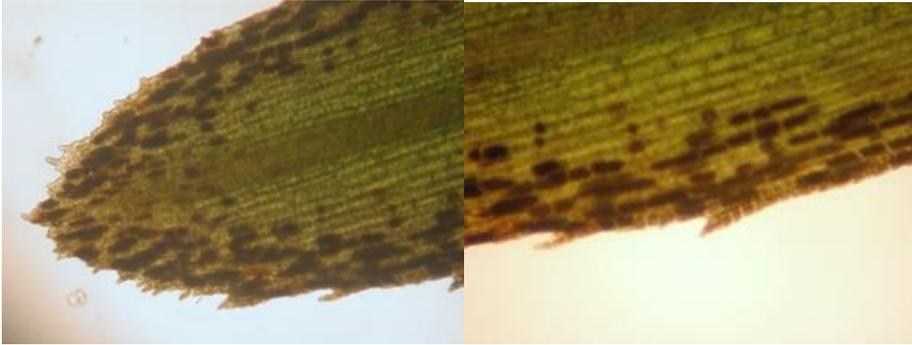
## SPECIES TRANSPLANTED

The seagrass that will be used is *Ruppia cirrhosa*, a typical species of these lagoons.

Lagoon	Foreseen by Application form	Species	Best time for transplant (season)	Best time for transplant range (°C)	Salinity range (‰)	Sediments texture	Level of confinement	Water transparency
Fattibello	<i>Ruppia cirrhosa</i>	<i>Ruppia cirrhosa</i>	Summer /Autumn	20-30	15-30	clay	very low water renewal	Medium

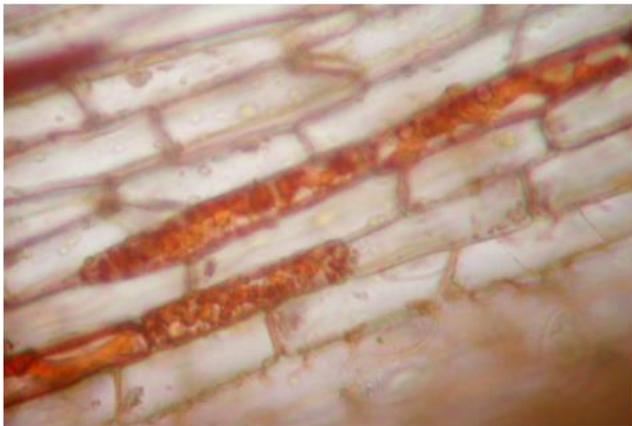
*Ruppia cirrhosa* prefers partially desalted environments or environments subjected to high salinity fluctuations and very fine and anoxic sediments. It is present all year round, including the winter months, although at low temperatures the growth effort barely compensates for the losses due to breathing. It produces flowers, seeds and fruits between July and August. In this period it also reaches its maximum development. The leaf bundles are emitted directly from the rhizomes or from long herbaceous stems. These carry packages of 3-5 leaflets of 15-17 cm in length by 0.8-1.0 mm in width which taper to 0.5-0.6 mm at the apex. In well-developed meadows, the leaf bundles can exceed one meter in height. The density of the leaf bundles is very high and varies from 5000 to 33000 units per m<sup>2</sup>. The leaves have only one central rib. The terminal parts are regularly serrated with numerous apical denticles presenting 2-3 prominent cells. Single spiny teeth facing upwards are issued at regular intervals along the edges of the entire apical part of the leaflets. The teeth are simple, measure 30-50 µm in length and consist of 3-6- (12) stacked cells of 10-12 µm in diameter.

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*Teethed apex of a leaf (left) and detail of the marginal teeth and tannic cells (right) of *R. cirrhosa**

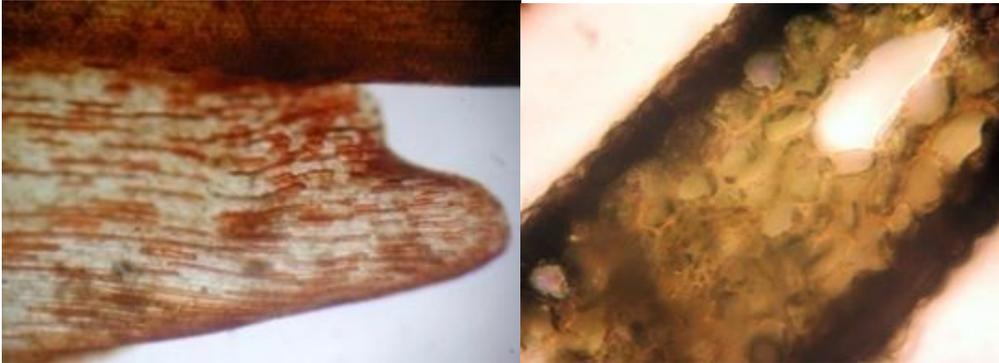
In the apical part, but generally on the whole leaf plate, there are numerous reddish-brown tannic cells which are generally more swollen than the epidermal ones and measure: 15-20 x 25-50- (75)  $\mu\text{m}$ . These are also present in the stems and basal sheaths. In this case they are slender, very elongated and measure: 8-12- (14) x 300-400- (500)  $\mu\text{m}$ .



*Elongated tannic cells of a stem*

The basal part, attached to the rhizomes, is wrapped in a swollen leaf sheath 2.0-2.5 mm wide by 12-15 mm long. The apical part of the sheath has 2 obtuse ears, 700-800  $\mu\text{m}$  wide. The cross section of the leaves is flattened and elliptical, much more elongated than that of *Ruppia maritima* and has a central vascular bundle and two small, strongly flattened lateral lacunae with a diameter greater than 70-80- (100)  $\mu\text{m}$ . Externally the epidermal layer is composed by rounded-quadrangular cells of 15-20  $\mu\text{m}$  in diameter. Then there are 1-3 layers of medullary cells that laterally line the gas-filled lacunae. At the center of the leaflet there are instead the vascular bundles. The thickness of the cross section is 170-200  $\mu\text{m}$ .

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*Obtuse ear of the leaf sheat (left) and detail of the gap and the central vascular bundle (right)*

Reproduction occurs vegetatively through the growth and diffusion of the rhizomes or, sexually, with the production of flowers, fruits and seeds. The inflorescences are carried by very long flower peduncles: 10-15- (20) cm long by 0.7-1.0 mm of diameter. These are wound in a spiral and give rise to (3)-5-10 female pedunculated flowers (carpels) which then produce as many fruits. Often the fruits are aborted and in this case they are not pedunculated. Ripe fruits are symmetrical and have an ellipsoidal shape. On average they measure approx. 2 mm long by 1.0-1.2 mm wide and have a rostrate apex. The male flowers are short and carry numerous globose pollen sacs (anthers) of 0.8-1.1 x 1.3-1.6 mm, shaped like a coffee bean, also rich in tannic cells. The anthers have a very short peduncle and remain enveloped by the leaf sheaths.

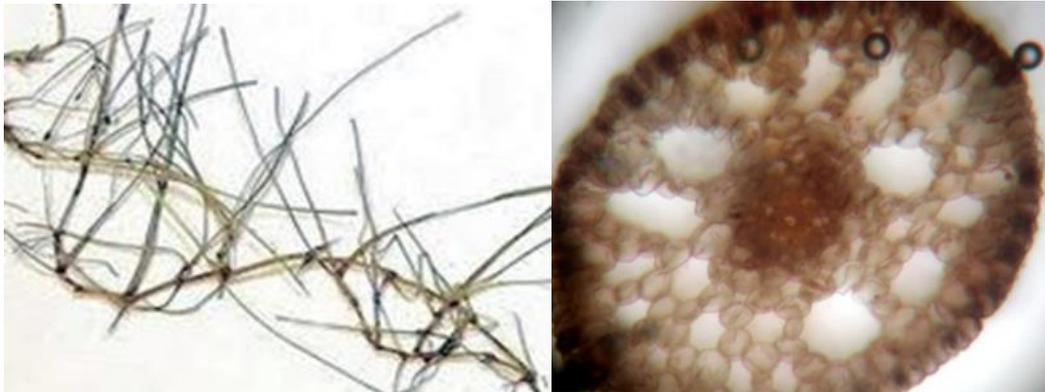


*Male flowers with globose pollen sacs*

The rhizomes are very slender, on average they have a diameter of 0.8-1.2 mm and have numerous nodes and internodes. The internodes are rather short, on average measuring 0.7-1.0 cm, and have a yellowish color. From the nodes are emitted both herbaceous stems and leaf bundles and numerous rootlets some cm long and having a diameter of 300-330  $\mu\text{m}$ . In cross section, the rhizomes have a typical central vascular structure with some partially lignified reddish-brown colored vessels. There are also numerous large gaps which give the section a trabecular appearance.

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**Seagrass transplantation for transitional Ecosystem Recovery**

The rhizomes of *Ruppia* penetrate the sediments up to 5-7 cm and are easily eradicable. Similarly to *Zostera, noltei* also in this case the rhizomes grow for short distances and then become blackish and tend to rot. The rootlets are thin and slender.



*Rhizome with numerous nodes and internodes (left) and cross section of a rhizome (right)*

#### TECHNIQUE OF TRANSPLANT

In each intervention site 9 small sods of 15 cm in diameter will be transplanted. This surface guarantees a certain extension of the rhizomes so that the sods have greater rooting capacity. This operation requires the use of a corer and considerable operational efforts, especially if the operations are carried out from the boat. The collection of the angiosperm sods and/or rhizomes to be transplanted will be carried out in Valle Campo. Transplants in the selected sites will continue every year for all the project duration. Removed sods will be maintained covered by water in buckets or bags until transplantation. In the transplant site, with the same corer or spade used for removal, sods will be placed into sediments. Transplant operations will be carried out from a boat in order to minimize sediment disturbance in the operating areas.

The sods removal/transplant operations will be implemented by local operators (fishermen) trained in subaction Action A5.2 and supervised by the technical staff of UniFe.

#### SOD EXPLANT

Considering that the bottoms of the donor sites are mostly composed of fine sediments, the removal operations must be carried out, as far as possible, from the boat, in order not to disturb the bottoms. For the operation of sod removal a 15 cm diameter corer will be used, taking the first 15-20 cm of sediment with the rhizomes of the selected species. Care must be taken that all the angiosperm

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Seagrass transplantation for transitional Ecosystem Recovery

leaves of the sods are inserted vertically inside the corer so that they are not cut and thus the vitality of the sod is not reduced

*SOD TRANSPLANT*

Transplants will be carried out in eight stations of 10mx10m areas, signaled with appropriate poles. At each station, 9 sods will be transplanted into clusters of 3, spaced 1m from each other. The distance from three groups of sods will be approx 5m. The angiosperm sods after collection must be placed in perforated buckets, in turn immersed in larger baskets in order to remain moist until the moment of transplant



*Sod corer (left) and buckets to keep explanted sods wet (right)*

It would be advisable to carry out the explants from Valle Campo on the same day or the day before the transplants, in order to be completely viable. For the transplant of each sod it will be necessary to prepare a hole in the bottom of a size equal to the size of the clod itself (diameter of about 15 cm). To facilitate the transplant operations, we suggest the use of the same corer employed for the sod explant.

## TRANSPLANT PROGRAMME

### Period

The optimal season for transplants is autumn. In fact, during this period there is no interference with the growth of opportunistic macroalgae (mainly Ulvaceae, Cladophoraceae, Gracilariaceae, Solieriaceae) due to the progressive decrease in temperature. However, in areas where macroalgae

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are absent or have a negligible biomass, as in the Valli di Comacchio, the transplant activities can be carried out also in spring.

Two campaigns will be carried out each year. The first campaign will be in Autumn, and operations will start in September and last till the end of October. The second campaign will be in Spring, and operations will start in May and last till the end of June.

The action will start in autumn 2021; sod removal/transplant operations will continue until the end of the project (2025) in order to have the greatest chance of success.

Year	2021		2022		2023		2024		2025	
Season	----	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn

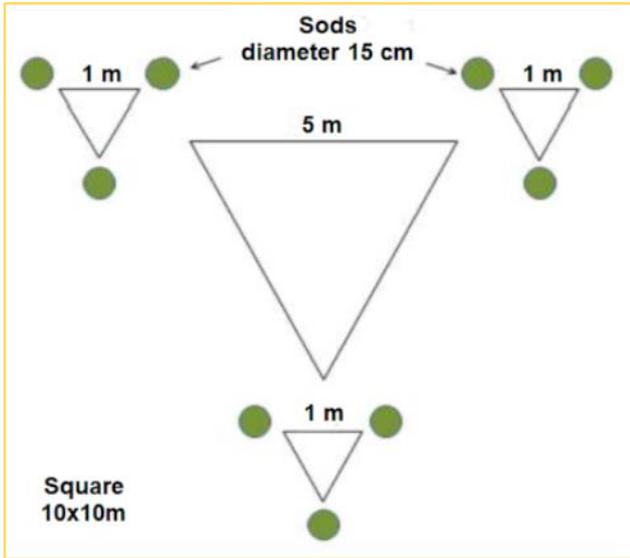
## Quantity

*Ruppia cirrhosa* will be transplanted by means of 15 cm-diameter sods. At each campaign, a total of 72 (9 sods x 8 stations) sods will be removed from the donor site, through with a 15 cm diameter corer. In each site 9 clods of approx. 15 cm in diameter will be transplanted, arranged within an area of 10x10 m (approx. 100 m<sup>2</sup>). The sods will be transplanted in 3 groups of 3 sods, each approx. 1 m from each other and the 3 groups of sods in turn will be spaced approx. 5 m. The arrangement of the transplants will be in a triangle.

Considering two transplant campaign each year, a part 2021 with one campaign, 9x8= 56 stations will be transplanted for a total transplant surface of approximately 5,600 square meters.

Year	2021		2022		2023		2024		2025		
Season	----	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	<b>Tot</b>
Stations	----	8	8	8	8	8	8	8	8	8	<b>56</b>
N° of sods	----	72	72	72	72	72	72	72	72	72	<b>648</b>

Seagrass transplantation for transitional Ecosystem Recovery



*Transplant scheme of the sods at each site*



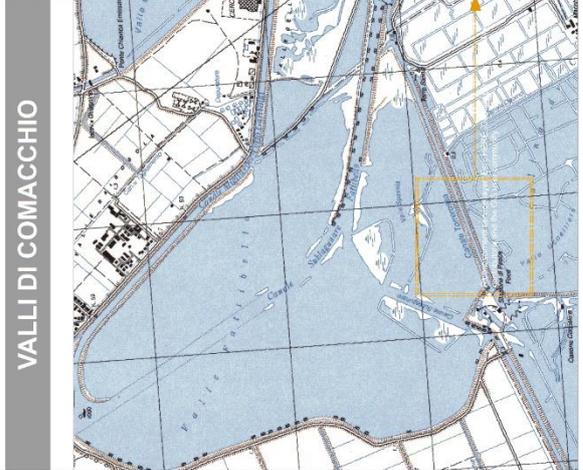
**Valle Fattibello, transplant**

LIFE TRANSFER  
NATURA 2000

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Seagrass transplantation for transitional Ecosystem Recovery

A.4 Executive Project of sod extraction for transplantation of submerged aquatic angiosperms

Sub-action A4.2 Executive Projects for Goro and Comacchio



**LEGENDA**

- Station 10 x 10 m
- Action area
- Name, type
- Fattibello - Spavola, transplant area

Data: 06/08/2021  
Responsabile GIS: Dott. Graziano Cairamori  
Archivio digitale database: A4-2\_Comacchio\_ExecProjectTransplant\_StationsRc00

Figure 5: Stations scheme in transplant area, Valle Fattibello – Spavola.



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**Seagrass transplantation for transitional Ecosystem Recovery**

It is expected that, in the years following the transplant in the sites where the rooting will be successful, a natural dispersion of the seeds produced by the transplanted sods will begin. The seeds that will take root will grow and in turn will be new triggers for the natural dispersion of angiosperms, which over time are expected to gradually flow into small widespread patches and then into a single compact meadow



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**Seagrass transplantation for transitional Ecosystem Recovery**

## PERMITS

The operations are subjected to the authorization and impact assessment "nulla osta and valutazione di incidenza" from the Parco del Delta del Po dell'Emilia-Romagna, which released the positive authorization document N° "ISTANZA: 2021/00093/NO\_ORD\_INC" attached.