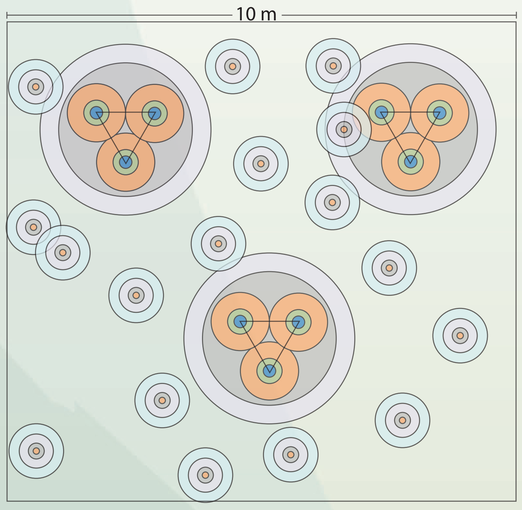
Two years of seagrass restoration in the northern Venice lagoon: detecting changes in macrophytes, macrozoobenthos and fish of recreated habitats under the LIFE SeResto project

Scapin L.[1], Facca C.[1], Zucchetta M.[1], Oselladore F.[2], Rampazzo F.[2], Berto D.[2], Franzoi P.[1] and Sfriso A.[1]

1 - Centre for Estuarine, coastal and MArine Sciences (CEMAS), Department of Environmental Sciences, Informatics and Statistics – Ca' Foscari University Venice
Via Torino 155, 30170 Venezia Mestre, Italy
2 - Istituto Superiore per la Protezione e la Ricerca Ambientale (ISPRA), Dipartimento Mitigazione e Prevenzione degli Impatti
Loc. Brondolo 30015 Chioggia, Italy
pfranzoi@unive.it

The project LIFE12 NAT/IT/000331 – SEagrass RESTOration (SeResto) started in 2014 aiming at recreating seagrass meadows in the northern basin of the Venice lagoon (Northern Adriatic Sea, Italy), where most of them have been lost due to human-induced eutrophication and sediment resuspension. *Cymodocea nodosa*, *Zostera marina*, *Zostera noltei* and *Ruppia cirrhosa* sods and rhyzomes were transplanted during spring 2014 in locations with suitable environmental conditions for plants to engraft and spread.

By the end of the project (2018), this is expected to trigger the re-colonisation of shallow-waters on large scale, and to enhance the overall ecological status (sensu Water Framework Directive: WFD 2000/60/EC) of the area by restoring seagrass habitat for both flora and fauna.



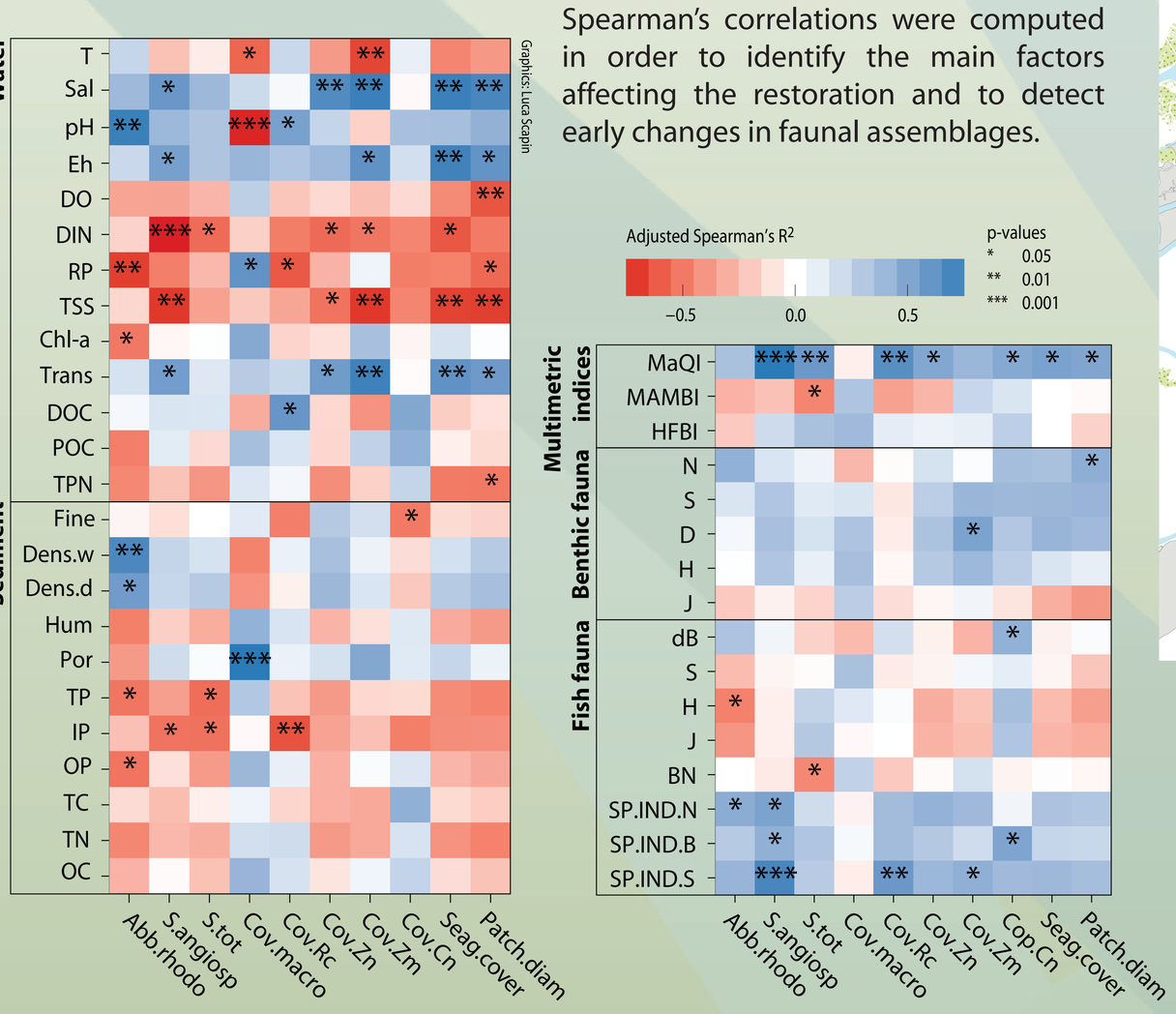
Expected seagrass development in a transplantation site

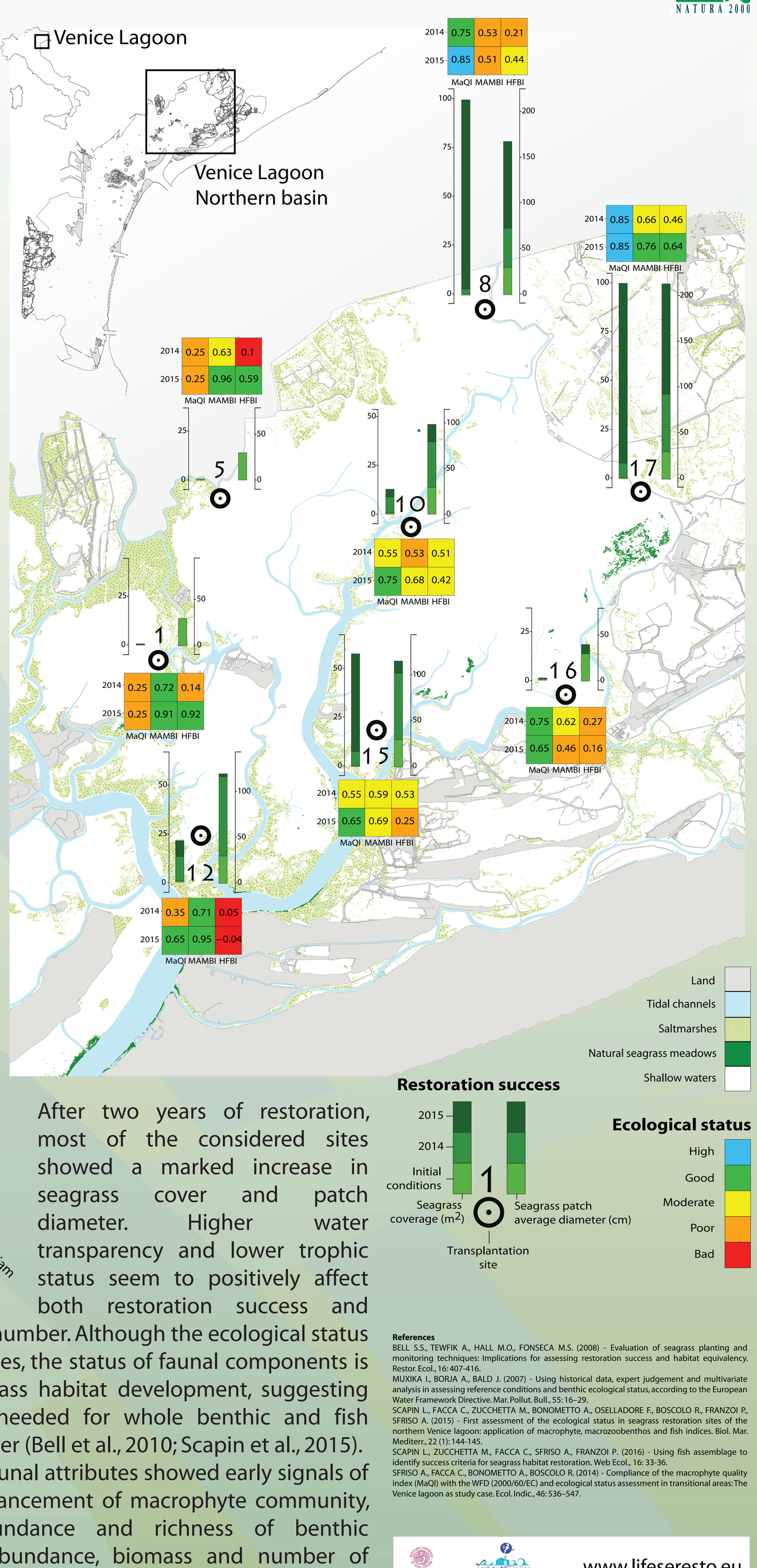
- Transplanted sods
- Seagrass coverage - 1st year
- Seagrass coverage - 2nd year and new growing points
- Seagrass coverage - 3rd year and new growing points
- Seagrass coverage - 4th year and new growing points
- Seagrass coverage - 5th year and new growing points

Transplantations were followed by the monitoring of water and sediment parameters, as well as of macrophyte, macrozoobenthos and fish assemblages during 2014 and 2015. The ecological status of biological elements was assessed by applying three WFD-compliant multimetric indices: the Macrophyte Quality Index (MaQI; Sfriso et al., 2014), the Multivariate-Azti Marine Biotic Index (MAMBI; Muxika et al., 2007) and the Habitat Fish Bioindicator Index (HFBI; Zucchetta et al., in prep.).

The success of restoration at the end of the first year (2014) and second year (2015) was evaluated by calculating variations in seagrass coverage and seagrass patch diameter within each 100 m^2-transplantation site.

Spearman's correlations were computed in order to identify the main factors affecting the restoration and to detect early changes in faunal assemblages.





Restoration success

Ecological status

- High
- Good
- Moderate
- Poor
- Bad

After two years of restoration, most of the considered sites showed a marked increase in seagrass cover and patch diameter. Higher water transparency and lower trophic status seem to positively affect both restoration success and angiosperm species number. Although the ecological status increased at many sites, the status of faunal components is not related to seagrass habitat development, suggesting that more time is needed for whole benthic and fish assemblages to recover (Bell et al., 2010; Scapin et al., 2015). Despite that, some faunal attributes showed early signals of response to the enhancement of macrophyte community, such as total abundance and richness of benthic invertebrates and abundance, biomass and number of seagrass-indicator fish species (sensu Scapin et al., 2016).

Key to variables

Water	Sediment
T: temperature	Fine: percent fine sediments (<63µm)
Sal: salinity	Dens.w: wet bulk density
DO: dissolved oxygen	Dens.d: dry bulk density
DIN: dissolved inorganic nitrogen	Hum: humidity
RP: reactive phosphorus	Por: porosity
TSS: total suspended solids	TP: total phosphorus
Chl-a: chlorophyll-a	IP: inorganic phosphorus
Trans: light transmission at the bottom	OP: organic phosphorus
DOC: dissolved organic carbon	TC: total carbon
POC: particulate organic carbon	TN: total nitrogen
TPN: total particulate nitrogen	OC: organic carbon

Macrophyte community and restoration success	Benthic and fish fauna
Abb.rhodo: abundance of rhodophytes	N: total abundance
S.angiosp: number of angiosperm species	S: total number of species
S.tot: total number of species	D: Margalef's species richness
Cov.macro: macroalgal coverage (without *Vaucheria*)	H: Shannon's species diversity
Cov.Rc: *Ruppia cirrhosa* coverage	J: Pielou's species evenness
Cov.Zn: *Zostera noltei* coverage	dB: total density of biomass of fish fauna
Cov.Zm: *Zostera marina* coverage	BN: average individual weight of fish fauna
Cov.Cn: *Cymodocea nodosa* coverage	SP.IND.N: density of abundance of seagrass-indicator fish species
Seag.cover: total seagrass coverage (m2)	SP.IND.B: density of biomass of seagrass-indicator fish species
Patch.diam: average diameter of seagrass patches (cm)	SP.IND.S: number of seagrass-indicator fish species

The project is funded by European Union's LIFE+ financial instrument and contributes to the environmental recovery of a Natura 2000 site (SIC IT3250031 - Northern Venice Lagoon).

References

BELL S.S., TEWFIK A., HALL M.O., FONSECA M.S. (2008) - Evaluation of seagrass planting and monitoring techniques: Implications for assessing restoration success and habitat equivalency. Restor. Ecol., 16: 407-416.

MUXIKA I., BORJA A., BALD J. (2007) - Using historical data, expert judgement and multivariate analysis in assessing reference conditions and benthic ecological status, according to the European Water Framework Directive. Mar. Pollut. Bull., 55: 16–29.

SCAPIN L., FACCA C., ZUCCHETTA M., BONOMETTO A., OSELLADORE F., BOSCOLO R., FRANZOI P., SFRISO A. (2015) - First assessment of the ecological status in seagrass restoration sites of the northern Venice lagoon: application of macrophyte, macrozoobenthos and fish indices. Biol. Mar. Mediterr., 22 (1): 144-145.

SCAPIN L., ZUCCHETTA M., FACCA C., SFRISO A., FRANZOI P. (2016) - Using fish assemblage to identify success criteria for seagrass habitat restoration. Web Ecol., 16: 33-36.

SFRISO A., FACCA C., BONOMETTO A., BOSCOLO R. (2014) - Compliance of the macrophyte quality index (MaQI) with the WFD (2000/60/EC) and ecological status assessment in transitional areas: The Venice lagoon as study case. Ecol. Indic., 46: 536–547.

www.lifeseresto.eu

Life SeResto