LIFE12 NAT/IT/000331

The LIFE SeResto project

"Habitat 1150* (Coastal lagoon) recovery by SEagrass RESTOration. A new strategic approach to meet HD & WFD objectives" (Habitat Directive & Water Framework Directive)

The recovery of the northern Venice Lagoon by the repopulation with aquatic phanerogams. Results after 4-year of transplanting activity.

Università Ca'Foscari Venezia

ISPRA Istituto Superiore per la Protezione e la Ricerca Ambientale

Ministero Infrastrutture e Trasporti
Provveditorato Interregionale OO.PP.
Veneto - Trentino Alto-Adige
Friuli Venezia-Giulia
Venezia

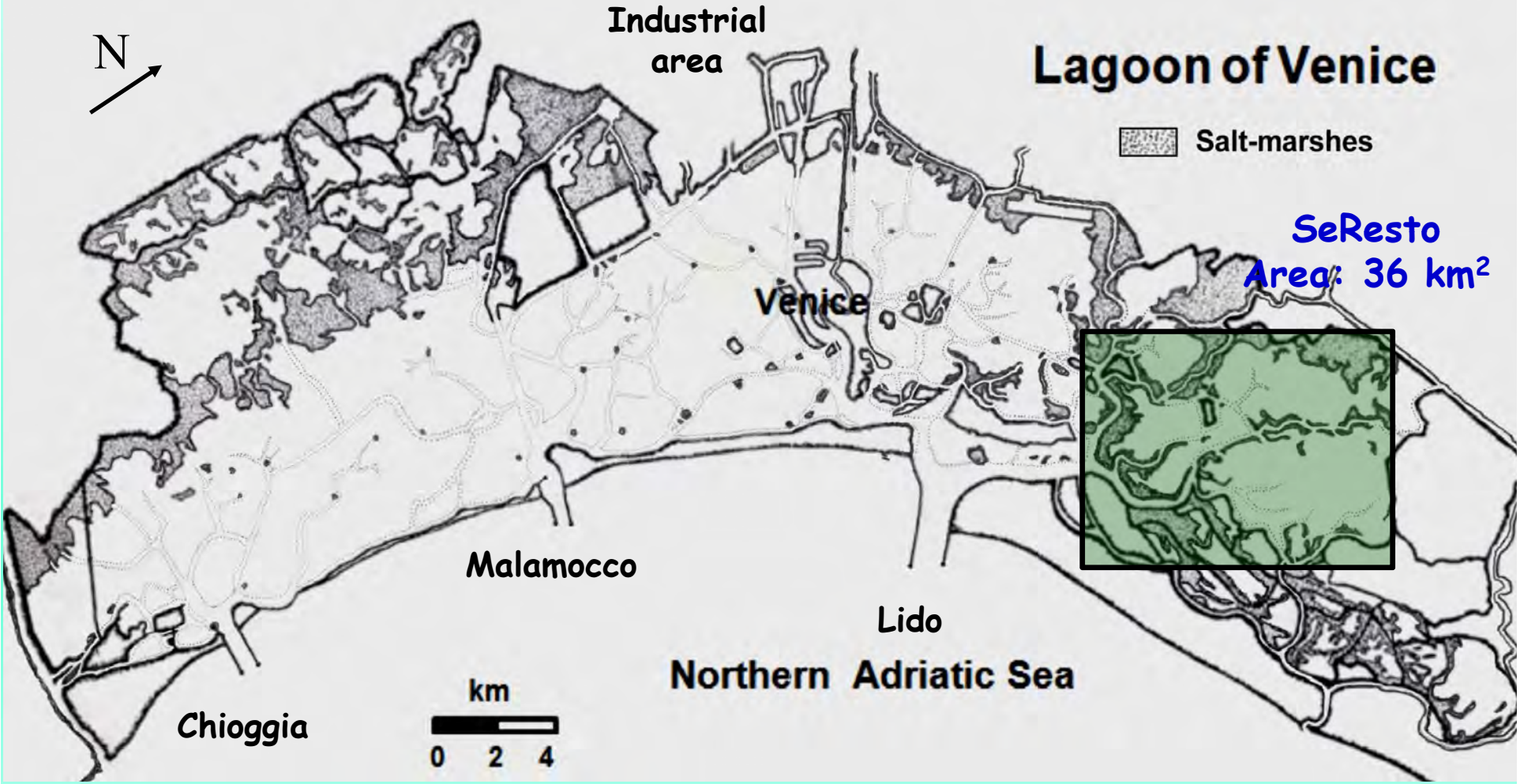
Laguna Veneziana ONLUS
Associazione Ambientalista
per la salvaguardia, la tutela e la valorizzazione
della Laguna veneziana, del bacino scolante e delle zone umide

Lagoon of Venice: total surface: ca. 549 km²

water surface: ca. 432 km²

mean water depth: ca. 1m

Water exchange with the sea ±31 cm every 12 hrs



Partners

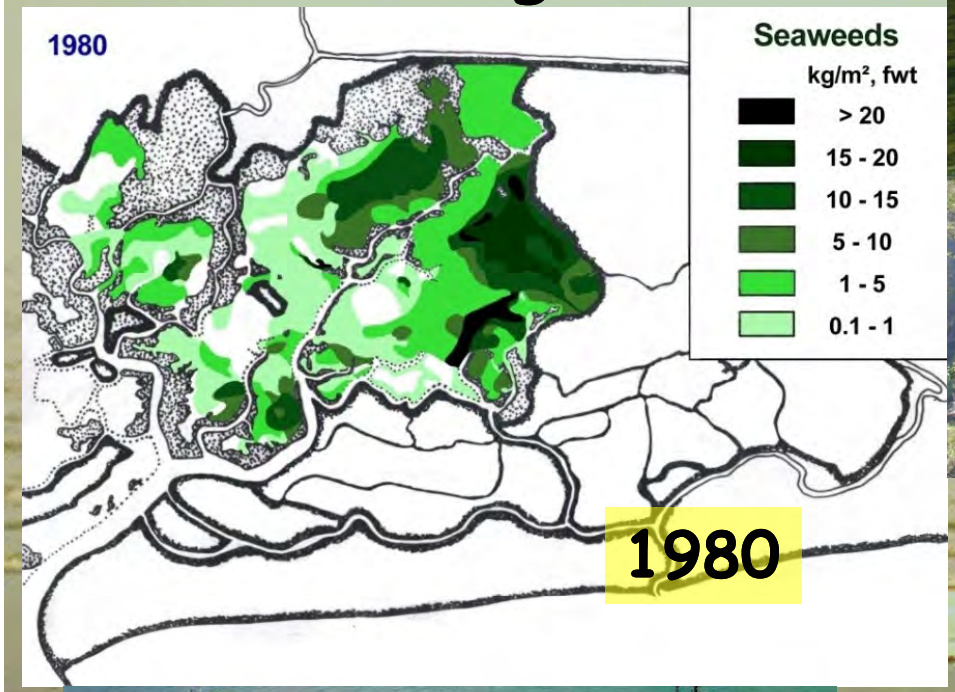
Università Ca' Foscari di Venezia. Dipartimento di Scienze Ambientali, Informatica e Statistica (DAIS-UNIVE);

Instituto Superiore per la Protezione e Ricerca Ambientale (ISPRA);

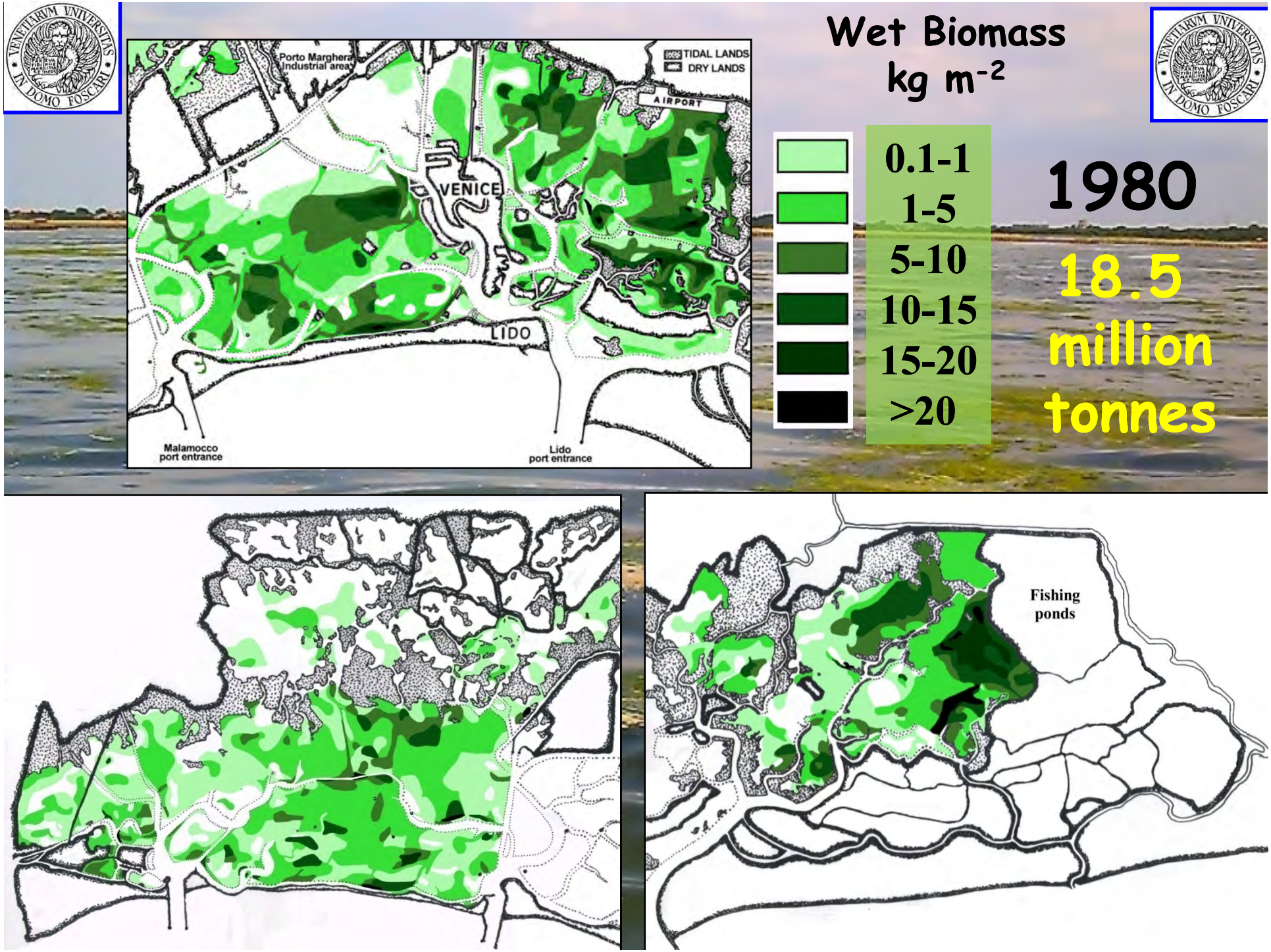
Provveditorato Interregionale per le Opere Pubbliche (OOPP), ex MAV;

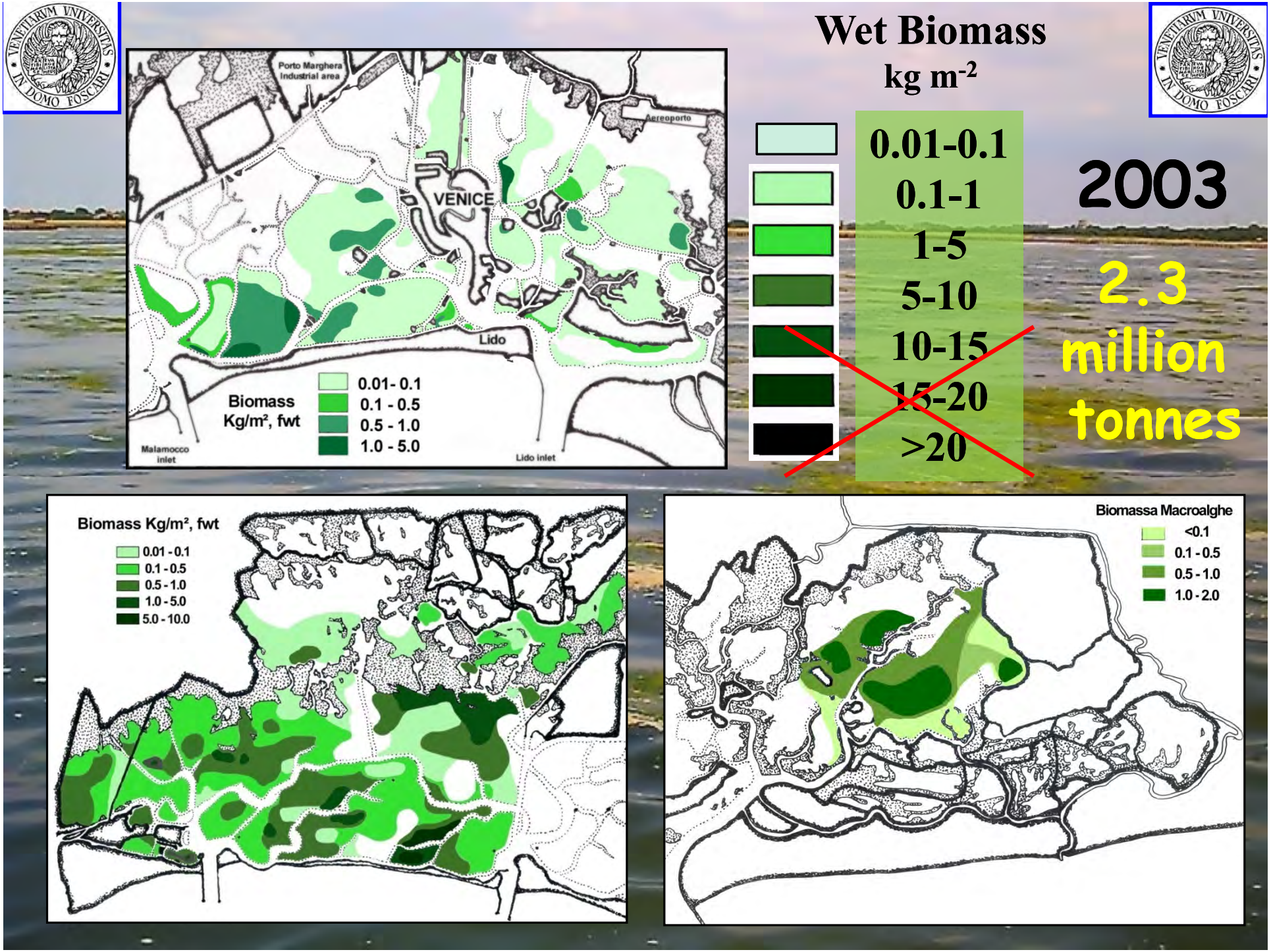
Associazione Laguna Venexiana Onlus

Causes of degradation



SERESTO - Habitat 1150 (coastal lagoon) recovery by SEagrass RESTOration.
A new strategic approach to meet HD&WFD objectives
(accordo n. LIFE12 NAT/IT/000331)


Wet Biomass
kg m-2
0.1-1
1-5
5-10
10-15
15-20
>20
1980
18.5
million
tonnes
Porto Marghera
Industrial area
TIDAL LANDS
DRY LANDS
AIRPORT
VENICE
LIDO
Malamocco
port entrance
Lido
port entrance
Fishing
ponds


Wet Biomass
kg m-2
0.01-0.1
0.1-1
1-5
5-10
10-15
15-20
>20
2003
2.3 million tonnes
Porto Marghera Industrial area
Aereoporto
VENICE
Lido
Biomass Kg/m², fwt
0.01- 0.1
0.1 - 0.5
0.5 - 1.0
1.0 - 5.0
Malamocco inlet
Lido inlet
Biomass Kg/m², fwt
0.01 - 0.1
0.1 - 0.5
0.5 - 1.0
1.0 - 5.0
5.0 - 10.0
Biomassa Macroalghe
<0.1
0.1 - 0.5
0.5 - 1.0
1.0 - 2.0

In the first years after 2010 the situation started to improve:

- ✓ Lower inputs of nutrients, especially phosphorus;
- ✓ Significant reduction of clam fishing.

This is why the SeResto project was designed

SERESTO - Habitat 1150 (coastal lagoon) recovery by SEagrass RESTOration.
A new strategic approach to meet HD&WFD objectives
(accordo n. LIFE12 NAT/IT/000331)

SeResto

is a project based on two strengths:

- ✓ Participation of the Venice population and stakeholders
  (above all: fishermen, hunters, sports clubs)
- ✓ Recolonization with transplants of small sods and individual rhizomes

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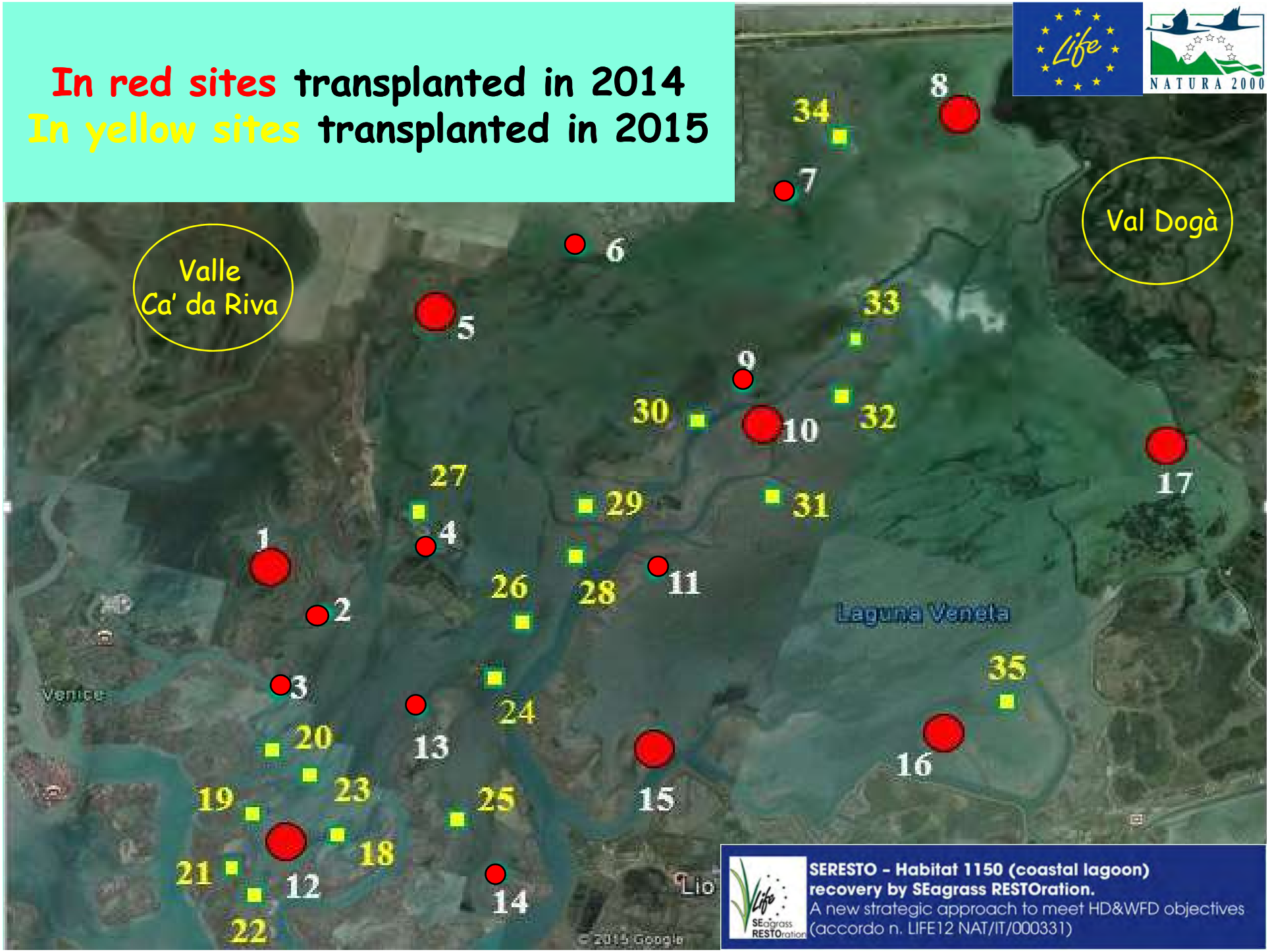
In red sites transplanted in 2014
In yellow sites transplanted in 2015



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Training of operators

40 operators were selected and prepared with a course whose topics were presented in an operative manual.

Operative Manual

77 laminated pages

Topics covered

- ✓Description of the typical aquatic vegetation of the habitat 1150 * (Coastal lagoons);
- ✓Morphology and ecology of aquatic phanerogams of the lagoon;
- ✓Distribution, biomass and growth of the different species;
- ✓Operational procedures for transplantation and dispersal of rhizomes and seeds

C – Concrete Actions

The concrete actions (> 25% of the funding) are the heart of the project and include::

C1 – Transplantation of small sods and their protection with bundles of local shrubs such as *Tamarix*;

C2 – Transplantation of single rhizomes.

Zostera marina

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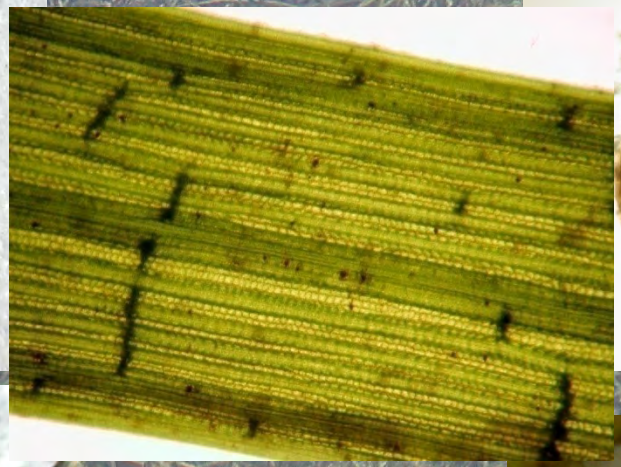
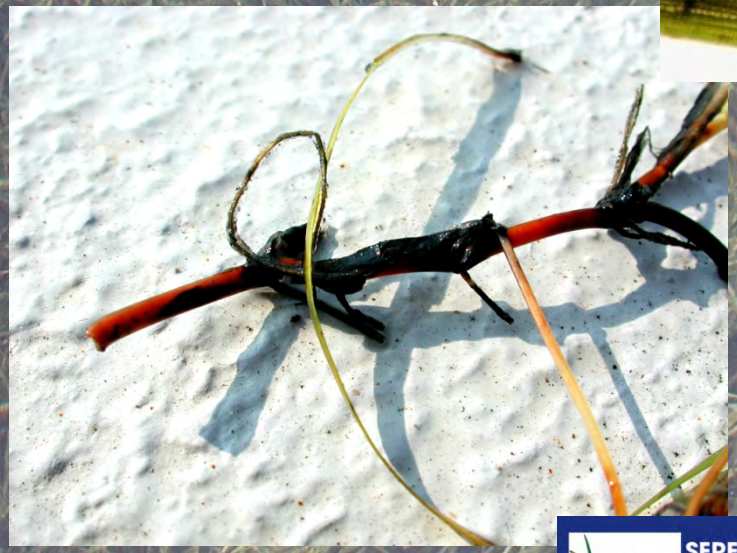
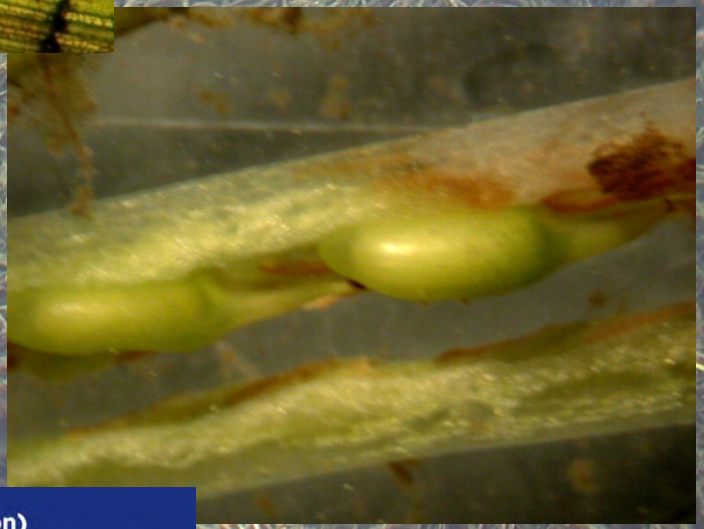
Zostera noltei







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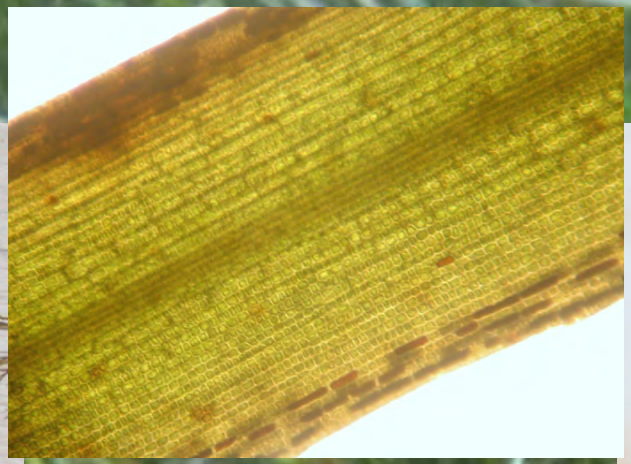
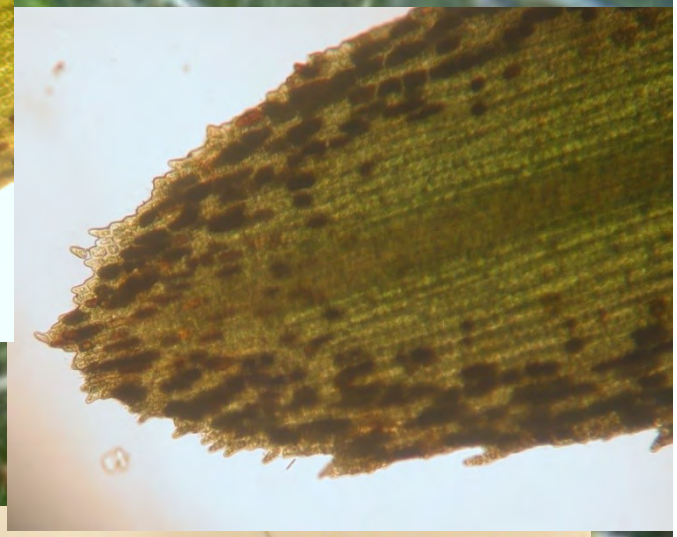
Ruppia cirrhosa





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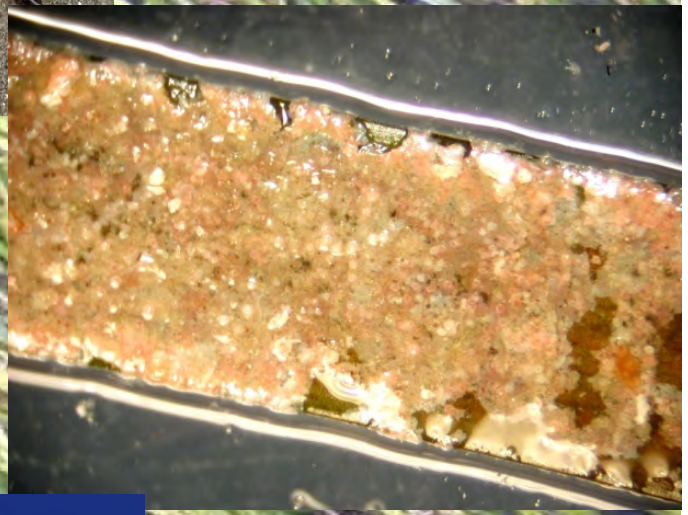
Cymodocea nodosa



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C1- Sods transplantation

Corer with a diameter of ca.30 cm

Sods in perforated buckets

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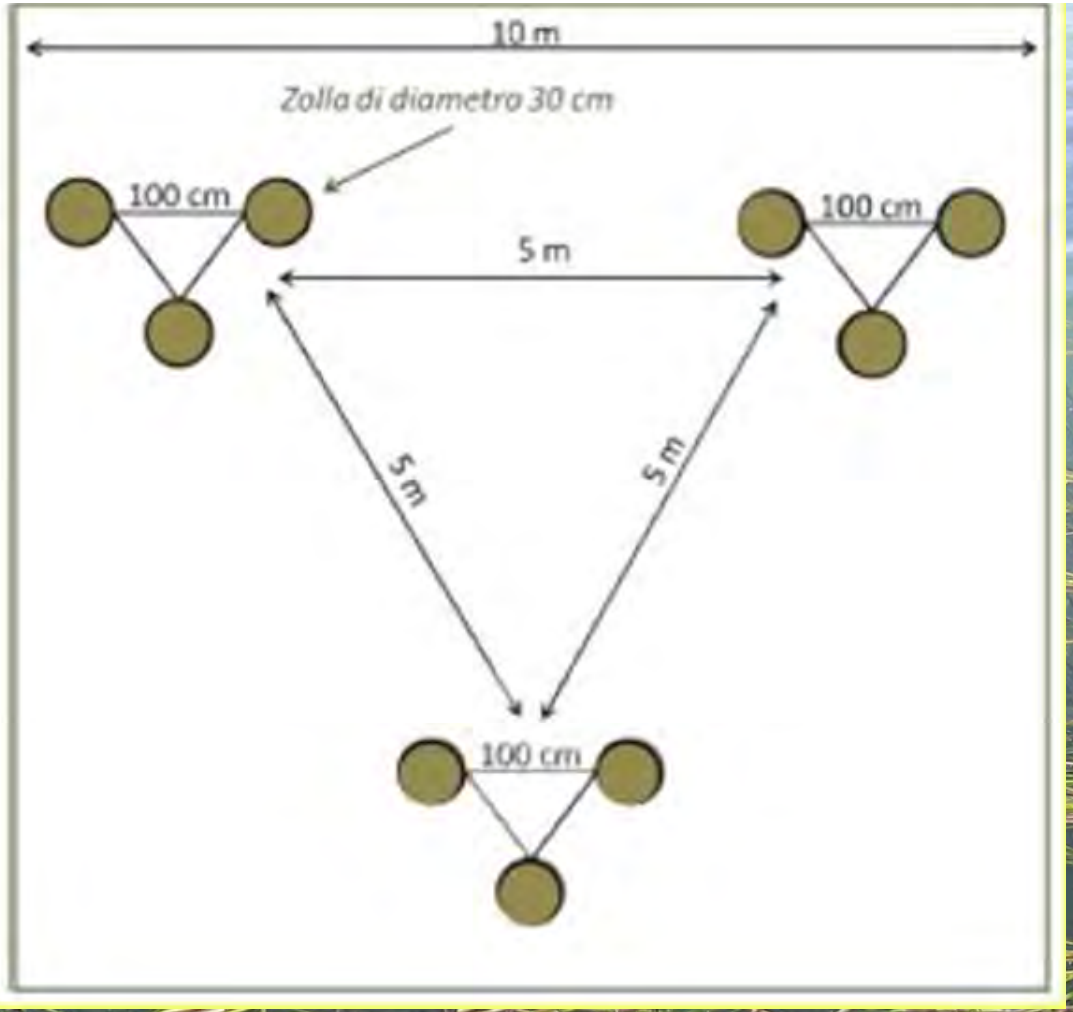

Transplantation scheme
9 sods in each site of 10x10 m

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Protection with bundles of *Tamarix*

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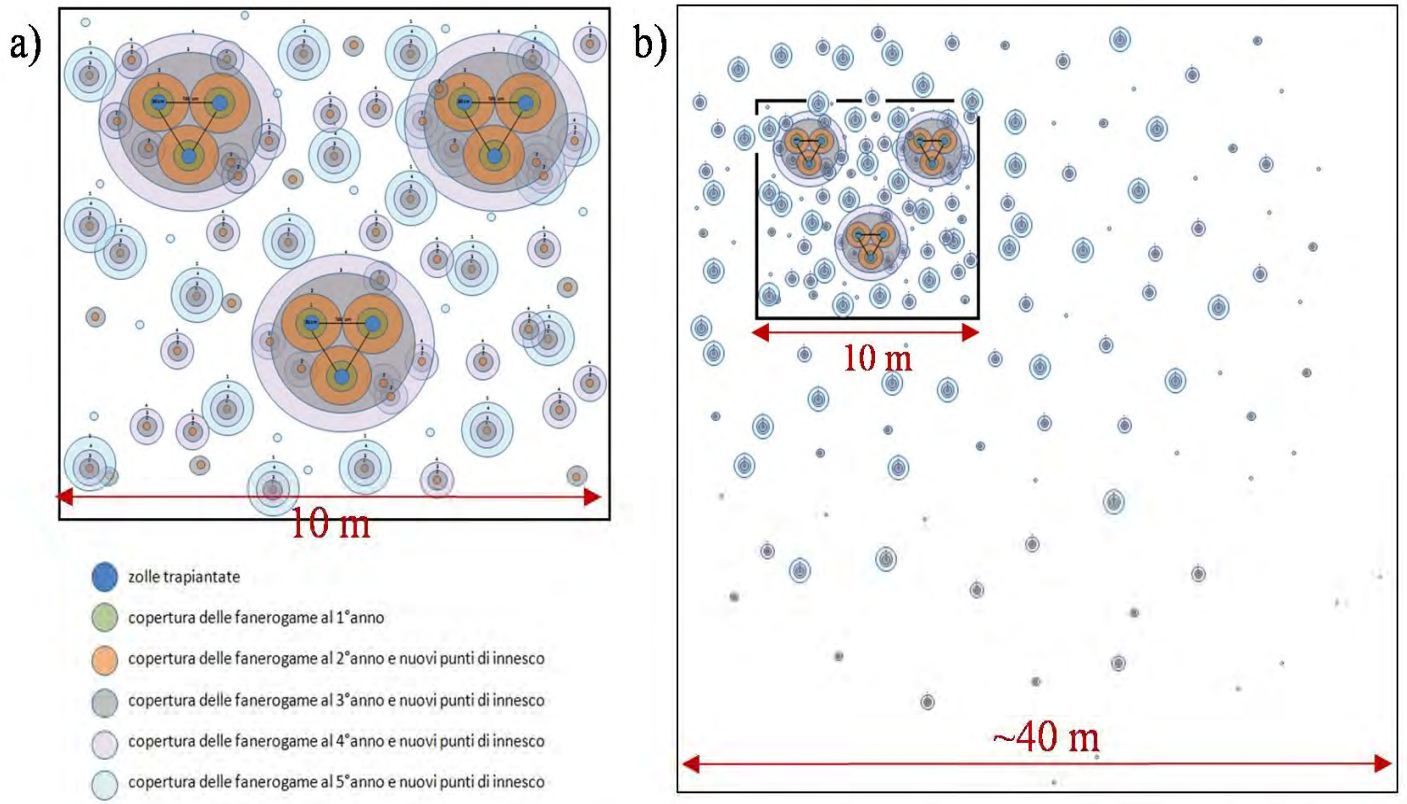
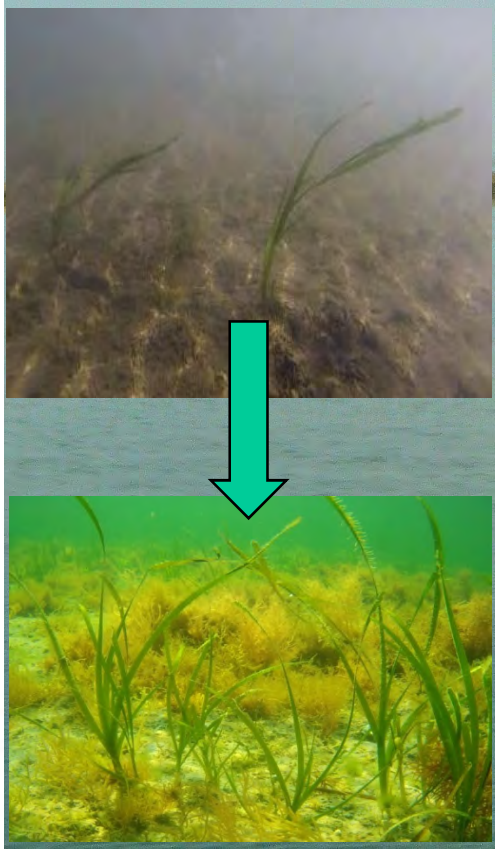
Expected growth





a) Schematizzazione della diffusione delle praterie tramite dispersione di semi e diffusione dei rizomi (azione C2) in prossimità delle zolle trapiantate (area 10m x 10m).

b) Schematizzazione della diffusione delle praterie tramite dispersione di semi e diffusione dei rizomi (azione C2) su scala vasta (circa 1.000 m2 per ciascun sito dopo 4 anni).

C2- Rhizome transplantation

It is possible to operate directly from the boat with pliers in all tide conditions or by manually operating while diving.

The spread of some species can also be done by transplanting seeds or by diffusion of those produced by transplanted plants.

Seeds of *Zostera marina*

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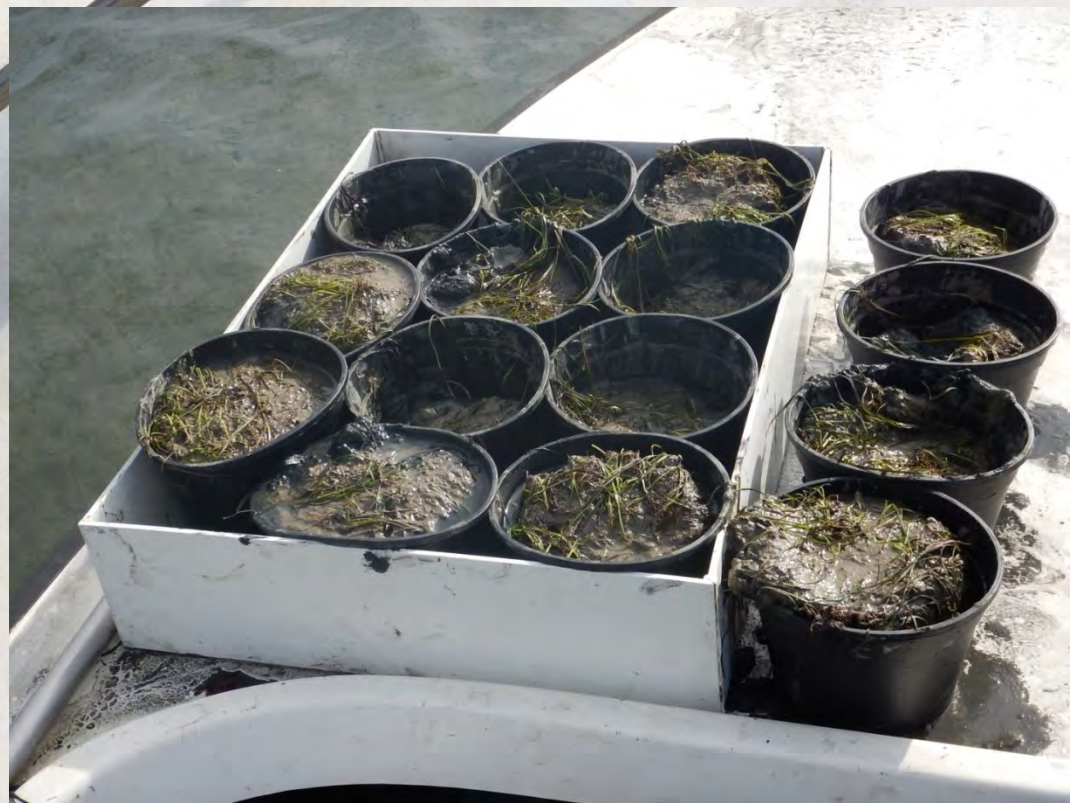
Rhizome transplantation

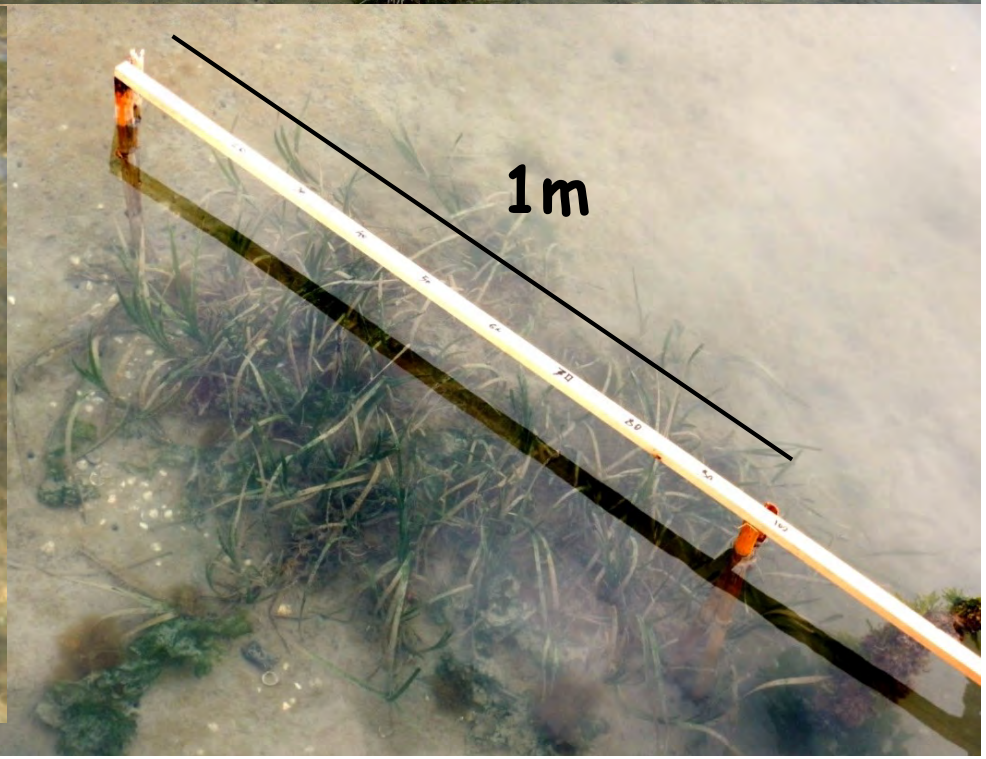
A minimum of 400 rhizomes have been transplanted in each station every year, especially in spring and autumn in order to promote the spread of plants.

The rhizomes are collected with a rake or manually and transplanted by means of pliers directly from the boat

In the case of *Zostera noltei* and *Ruppia cirrhosa*, due to the small size of the rhizomes, it is preferable to carry out transplants using small sods of 15 cm easily made by means of a small size corer. Each sod corresponds to a minimum of approx. 15 rhizomes for *Z. noltei* and 17 for *Ruppia cirrhosa*



Sod growth after 8-9 months



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Rhizome growth after 6 months

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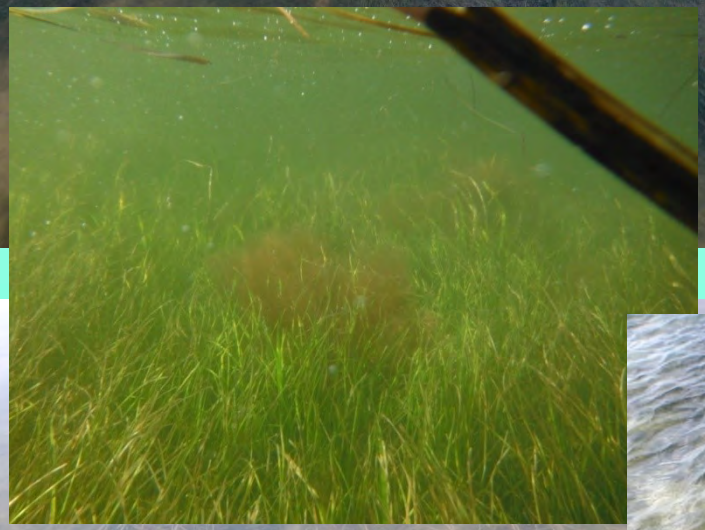
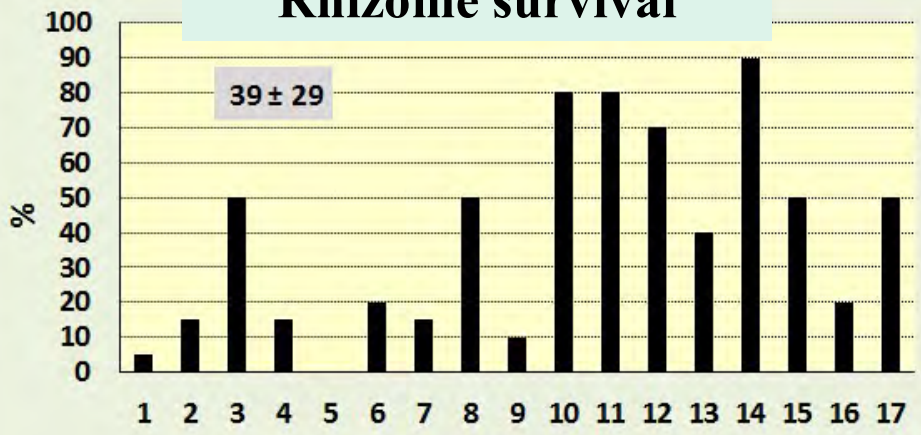
Plant growth after 18-30 mesi

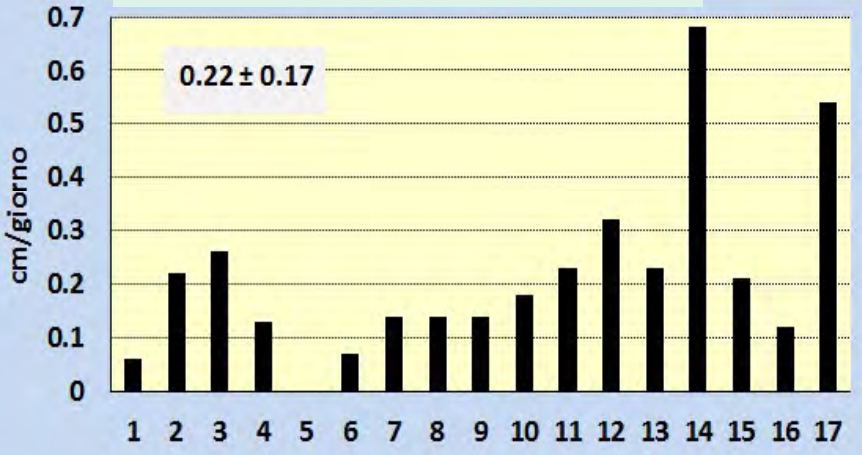


Rhizome survival

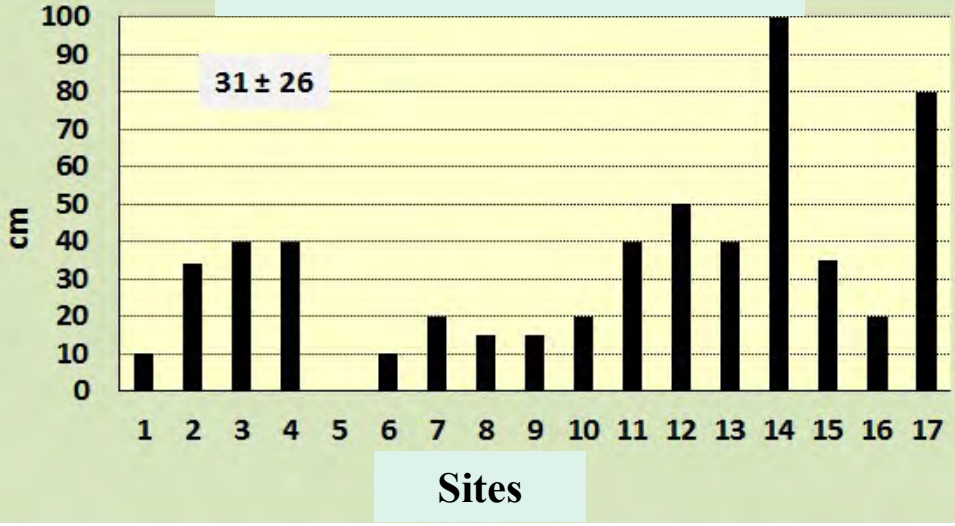


Rhizome growth after one year

Rhizome growth



Rhizome diameter



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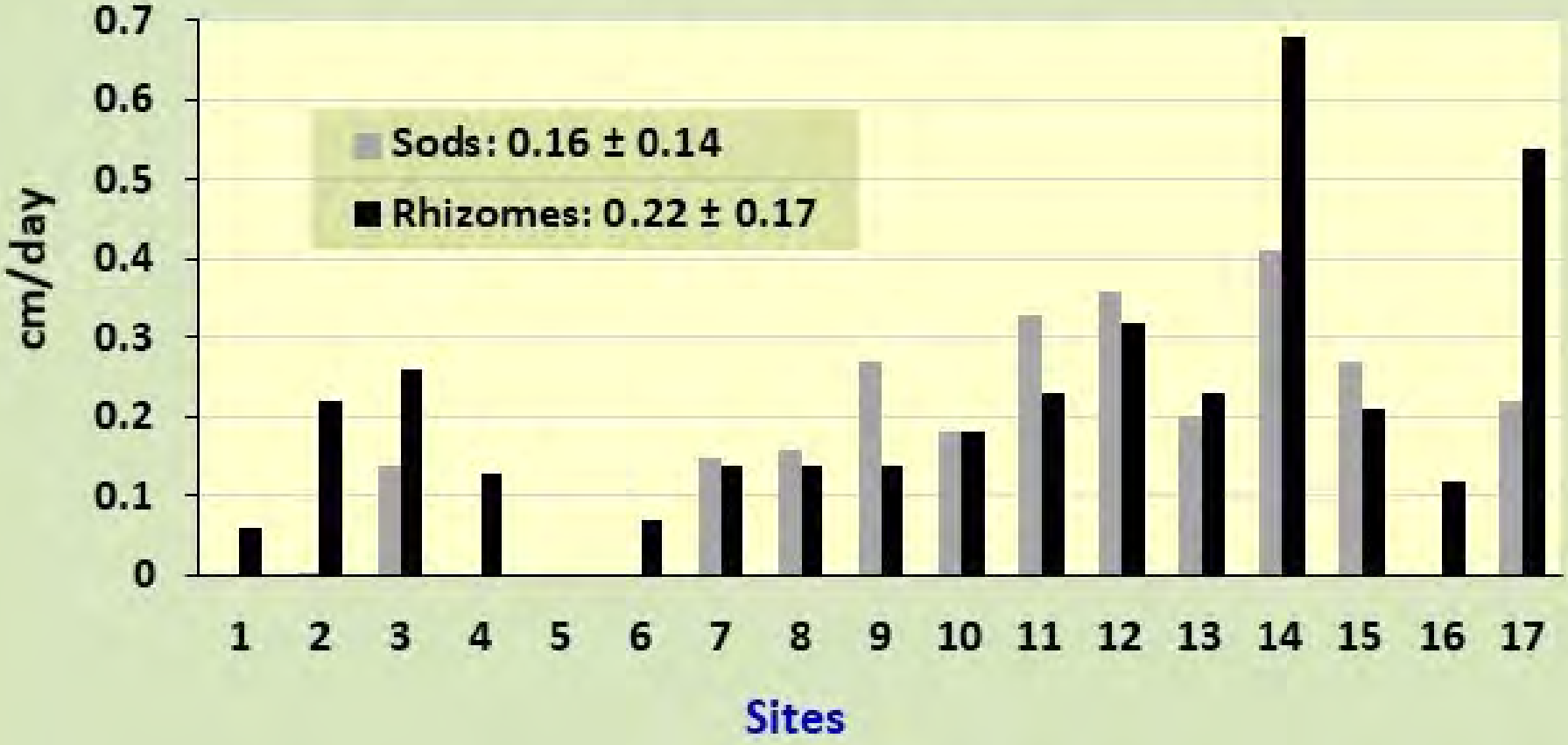
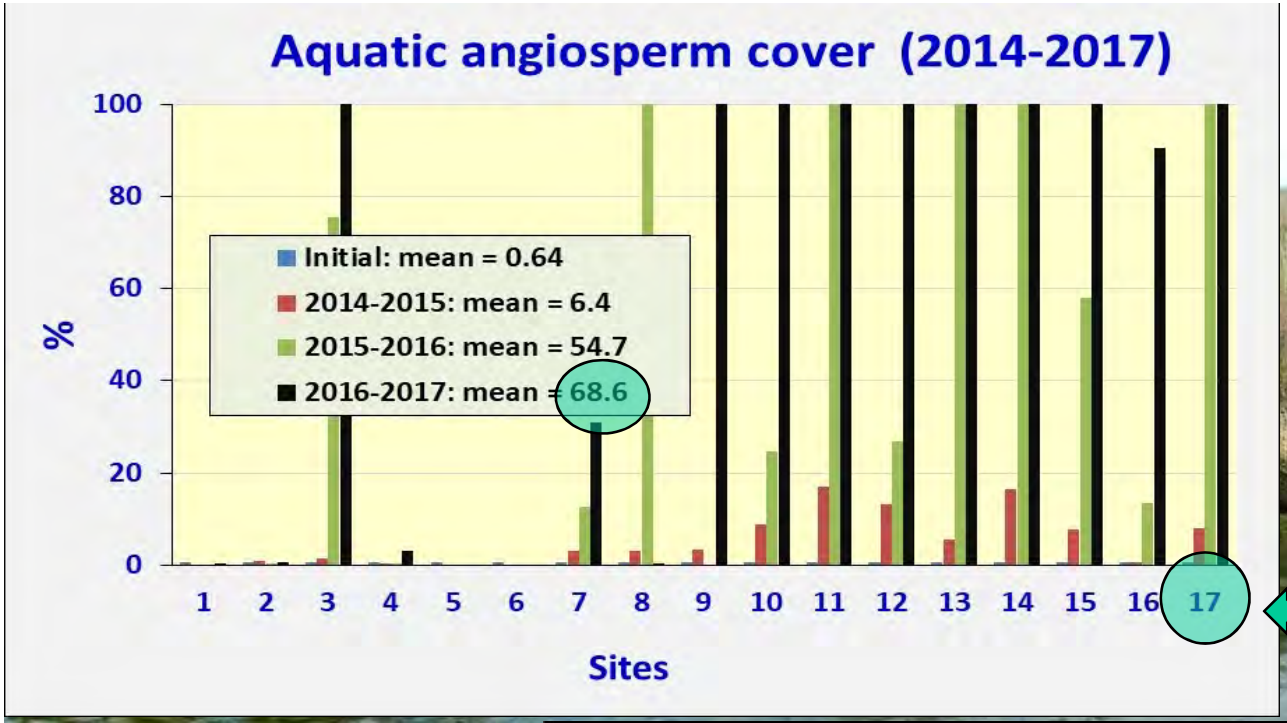
Growth of sods and rhizomes

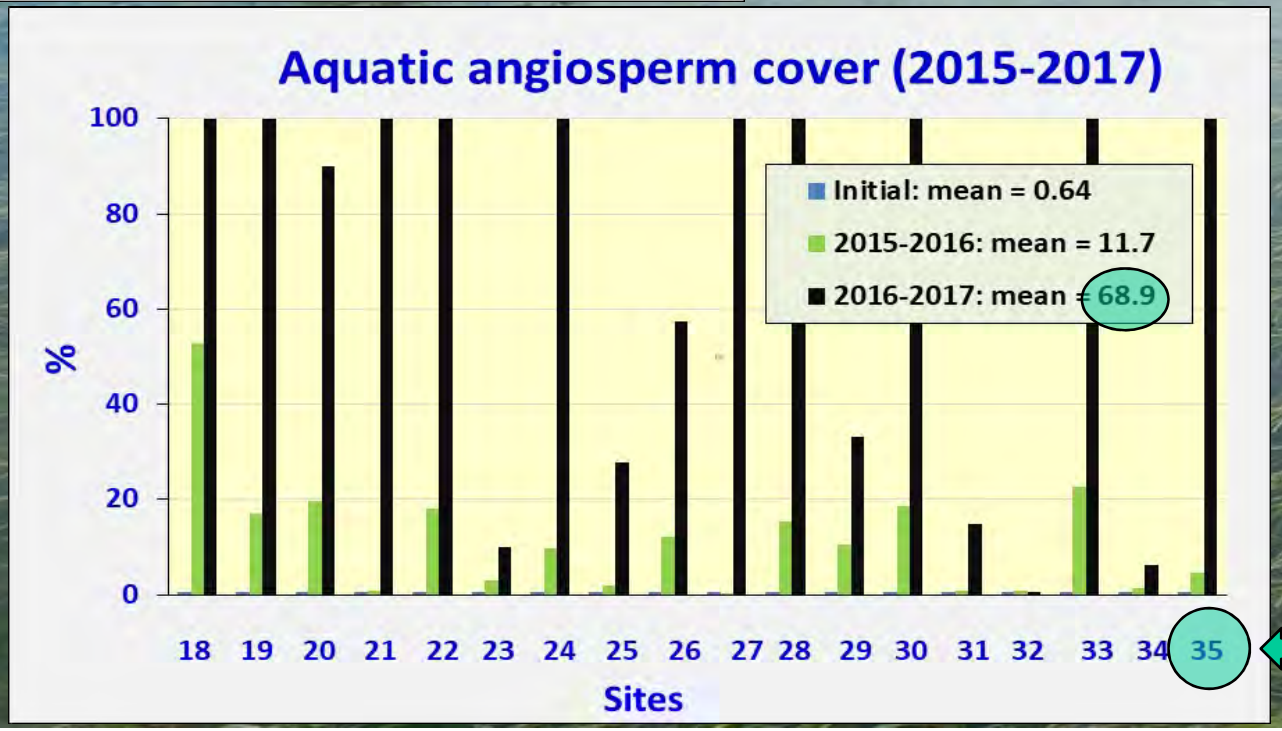




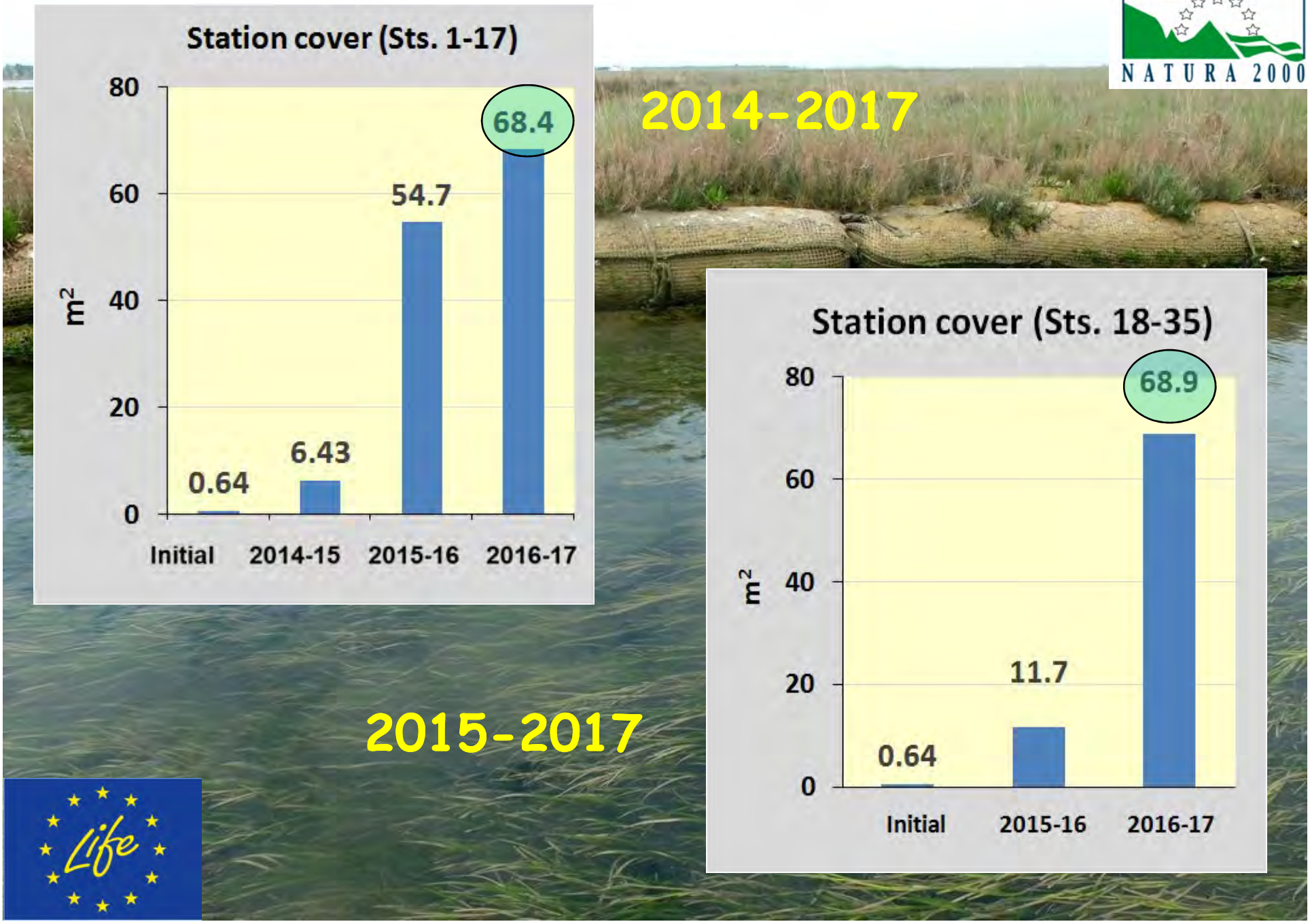
NATURA 2000

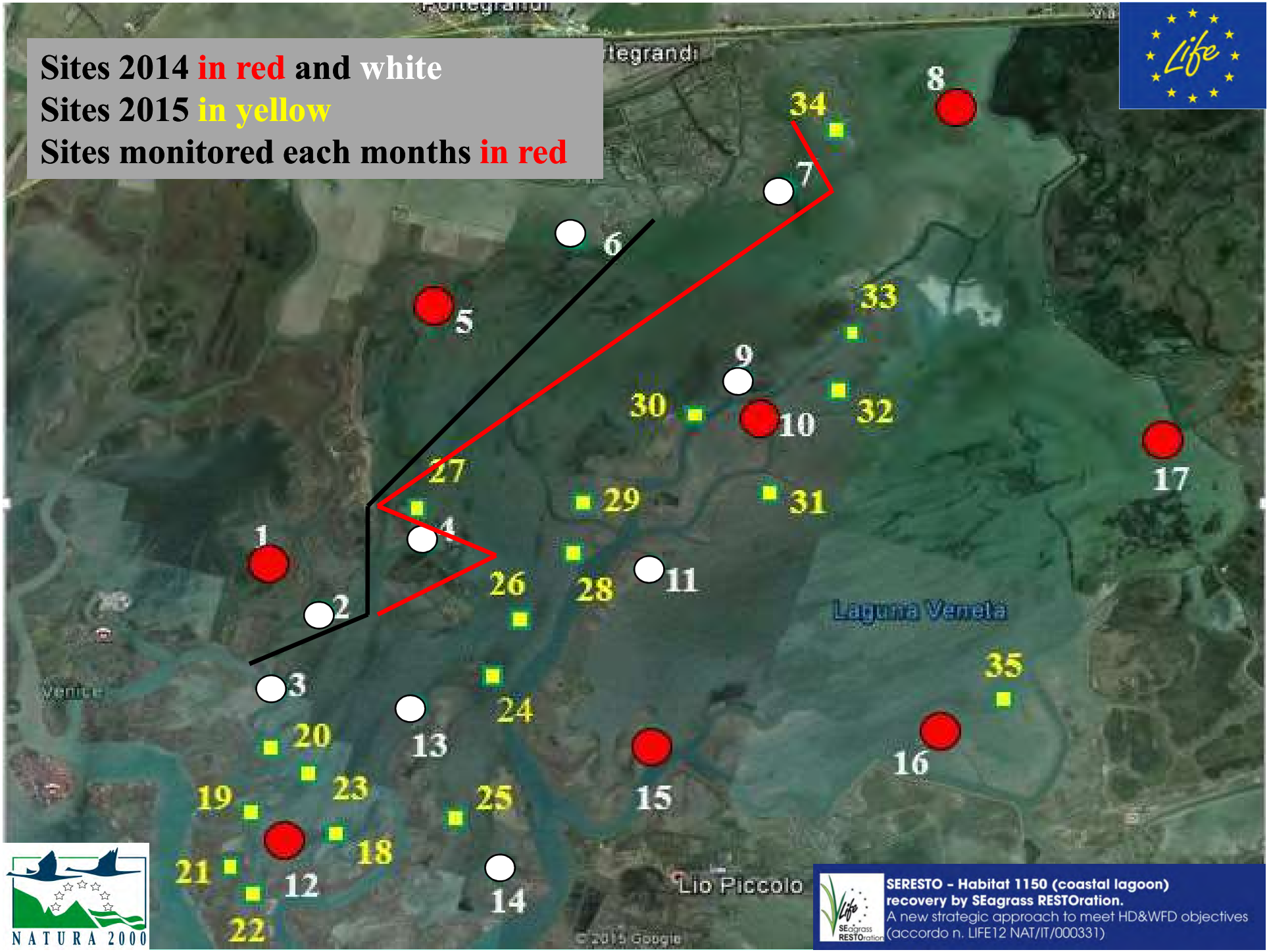
2014-2017
3 years + 8 months

2015-2017
2 years + 8 months



Life


Station cover (Sts. 1-17)
80
60
40
20
0
m2
68.4
54.7
6.43
0.64
Initial
2014-15
2015-16
2016-17
2014-2017
Station cover (Sts. 18-35)
80
60
40
20
0
m2
68.9
11.7
0.64
Initial
2015-16
2016-17
2015-2017
NATURA 2000
Life


Sites 2014 in red and white
Sites 2015 in yellow
Sites monitored each months in red
Lagoon Venezia
Lio Piccolo
NATURA 2000
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Transplanted rhizomes during the first three years

		Stakeholders	DAIS-UNIVE	Total	Mean number per site
First year	April 2014-April 2015	5430	2380	7810	459
Second year	April 2015-April 2016	10285	5230	15515	443
Third year	April 2016- April 2017	19445	2000	21445	613
	Total	35160	9610	44770	

Rhizomes by sods

	specie	N° rhizomes		
9 sods per site	*Z. marina*	315	Sites	Total
	Z. noltei	225		
	mean	270	35	9450

Total rhizome
54220
+ 10310
May-Dec 2017
=
64530

Dispersal of plants by seeds

First year

Rhizomes		seeds for rhizome	Rhizome survival	Total	
	N°	N°	%	N°	millions
From sods	4590	50	39	241800	0.24
Single	7810				
	12400				

2nd year

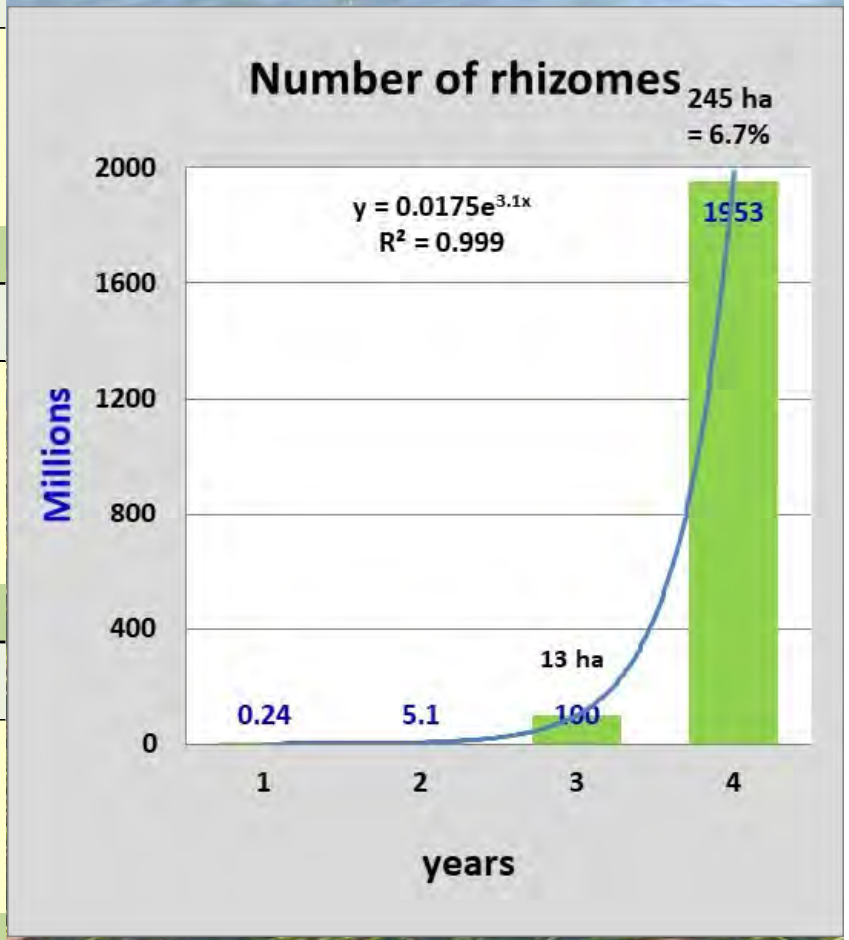
Rhizomes		seeds for rhizome	Rhizome survival	Total	
	N°	N°	%	N°	millions
From seeds	241800				
From sods	4860	50	39	5112413	5.1
Single	15515				
	262175				

3rd year

Rhizomes		seeds for rhizome	Rhizome survival	Total	
	N°	N°	%	N°	millions
From seeds	5112413	50	39	100110221.3	100
Single	21445				
	5133858				

4th year

Rhizomes		seeds for rhizome	Rhizome survival	Total	
	N°	N°	%	N°	millions
From seeds	100110221				1953
Single	21445	50	39	1952567492	
	100131666				



Exponential production

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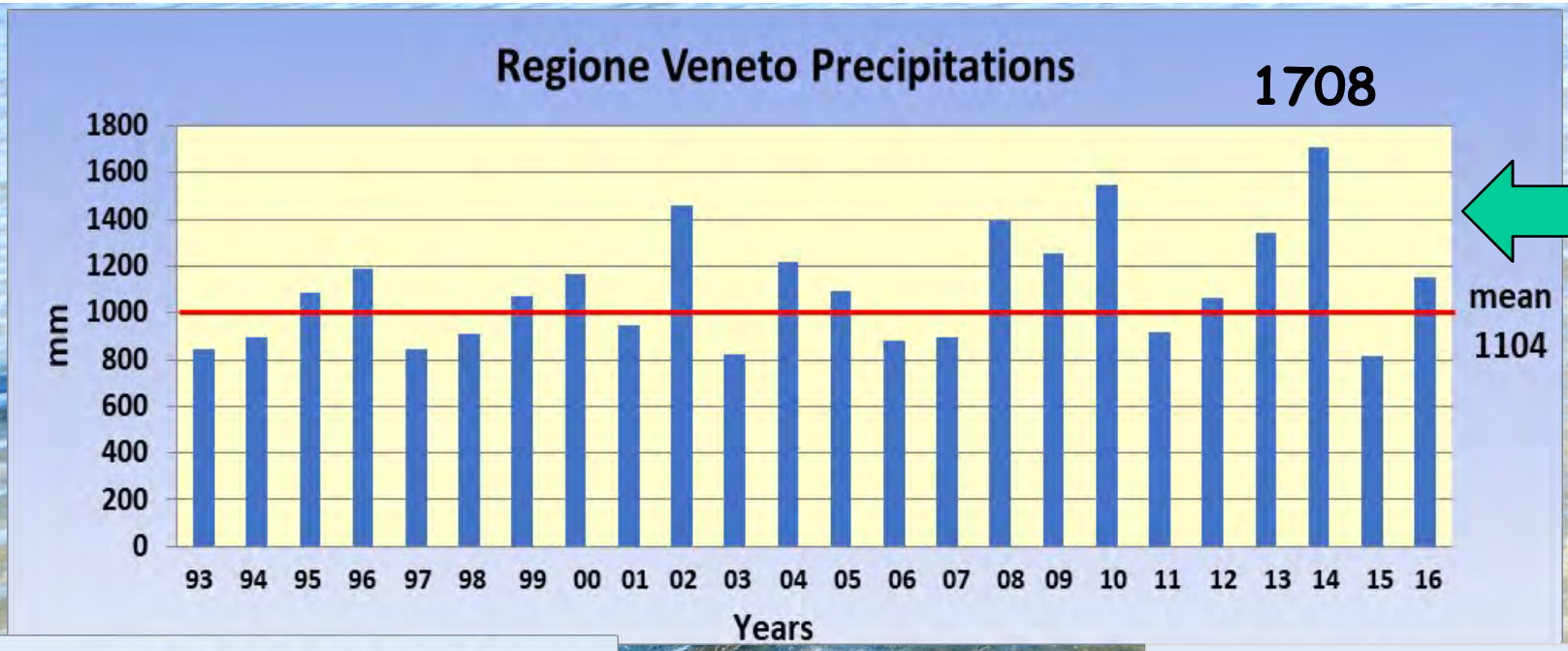
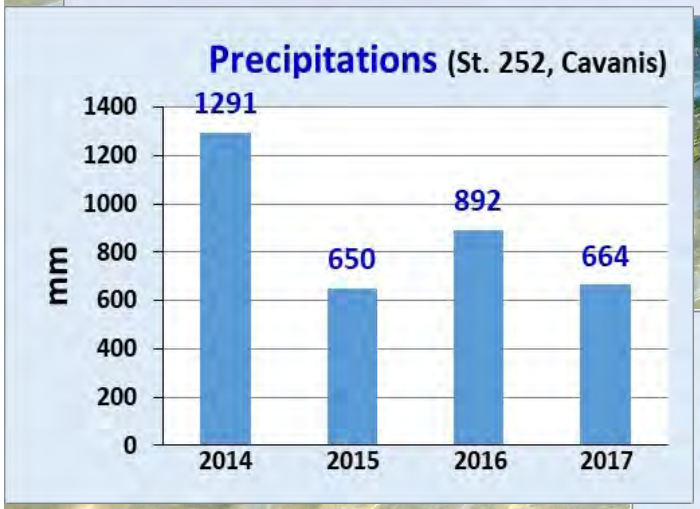
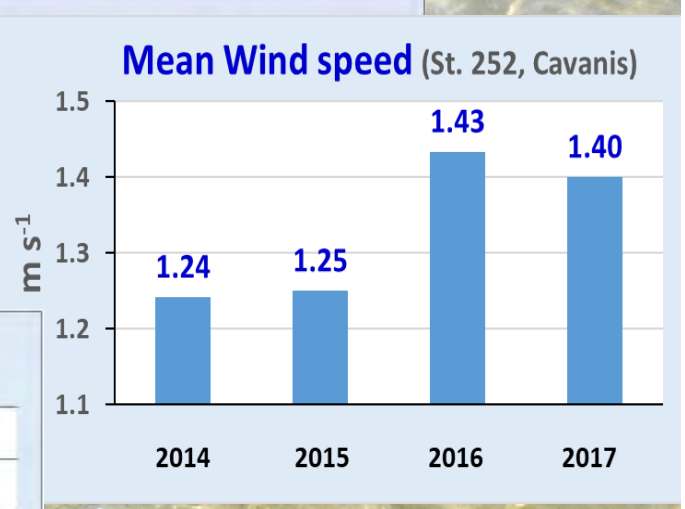
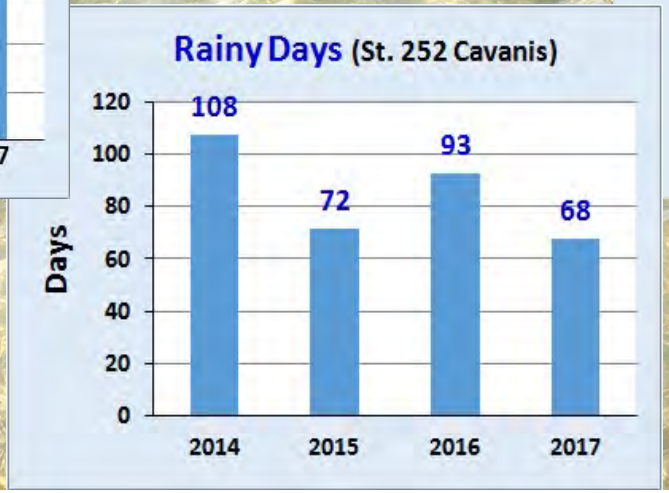
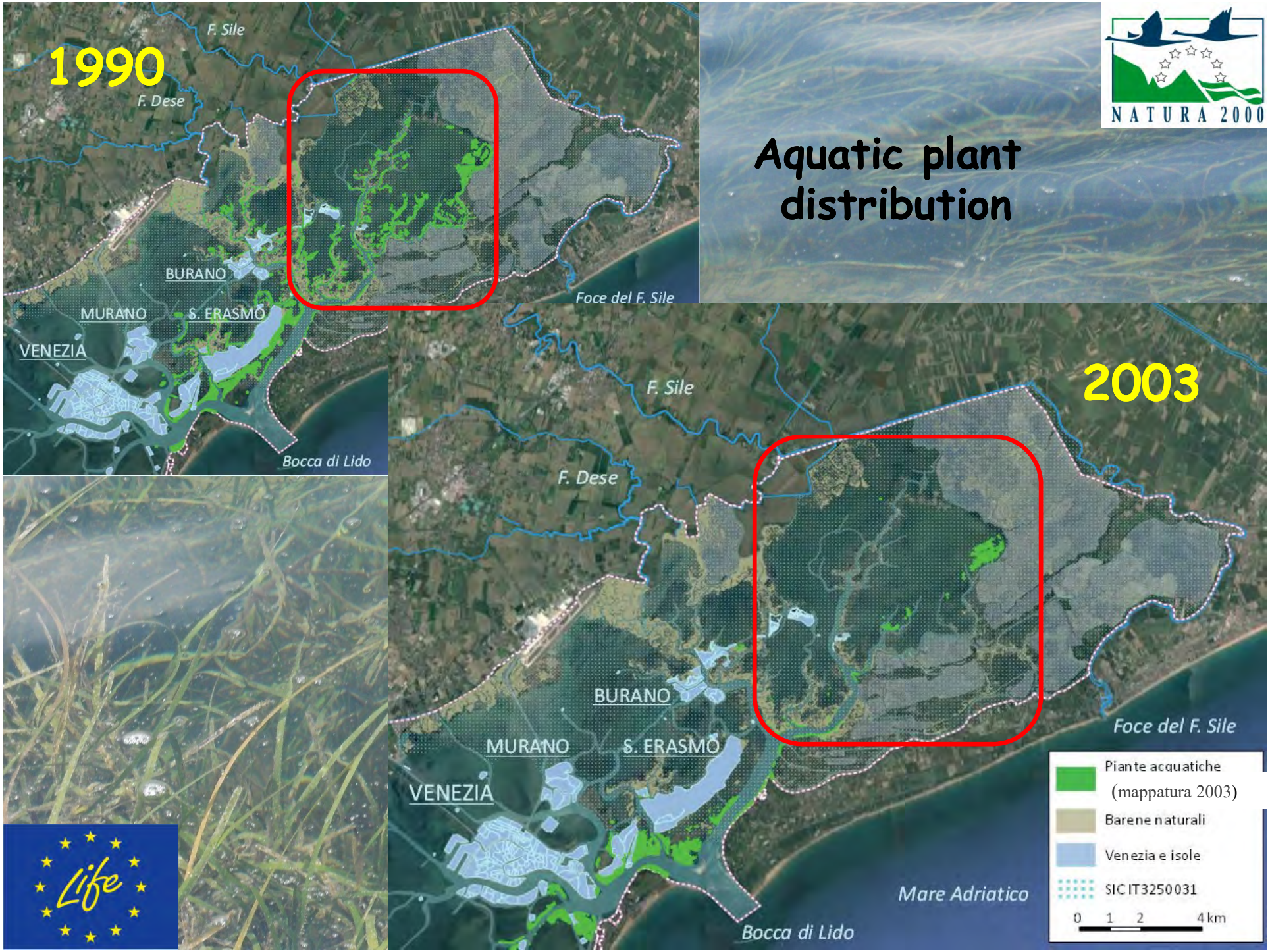

Regione Veneto Precipitations
1708
mm
1800
1600
1400
1200
1000
800
600
400
200
0
93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16
Years
mean
1104

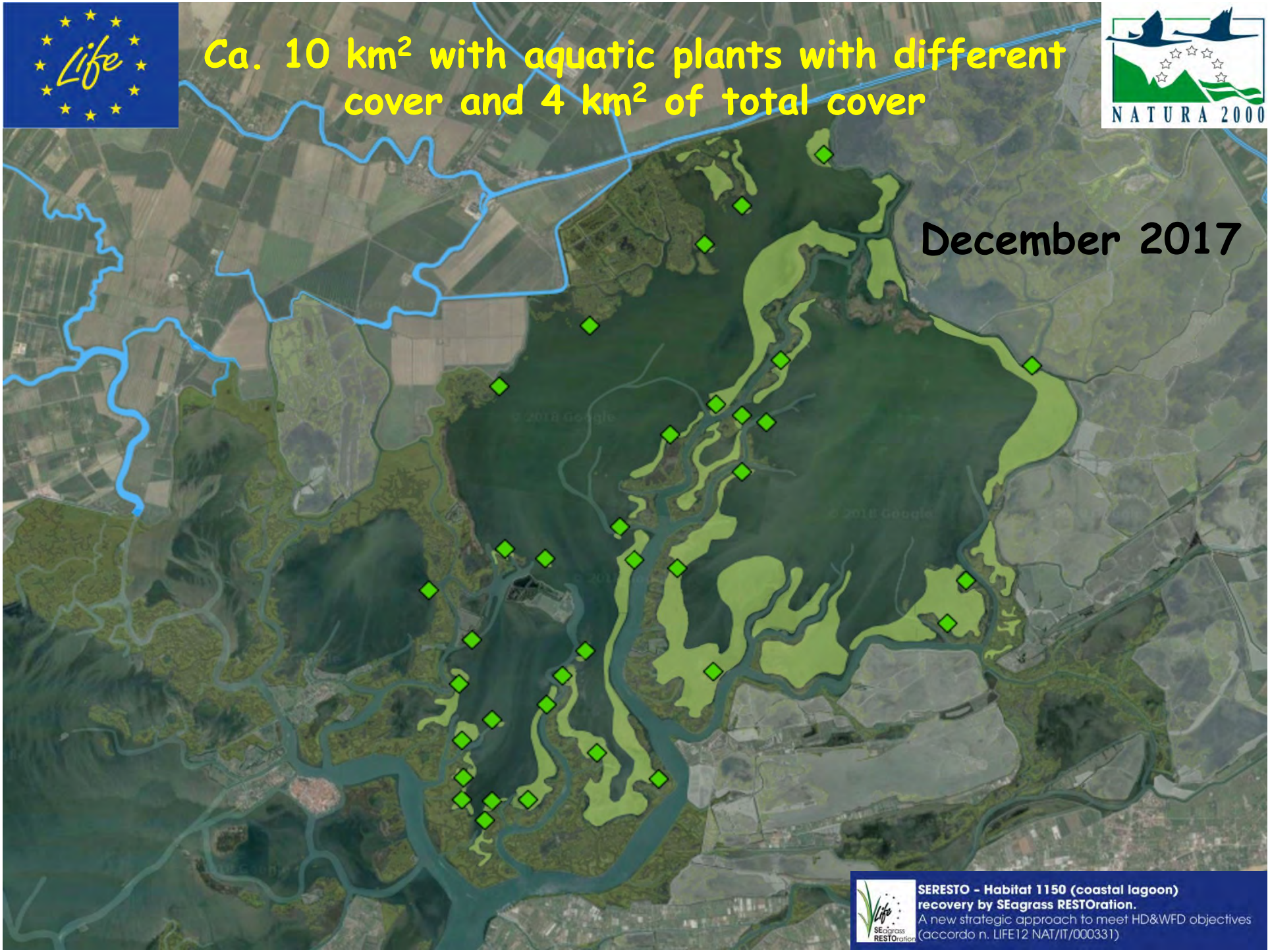

Precipitations (St. 252, Cavanis)
mm
1400
1200
1000
800
600
400
200
0
1291
650
892
664
2014
2015
2016
2017


Mean Wind speed (St. 252, Cavanis)
m s-1
1.5
1.4
1.3
1.2
1.1
1.24
1.25
1.43
1.40
2014
2015
2016
2017


Rainy Days (St. 252 Cavanis)
Days
120
100
80
60
40
20
0
108
72
93
68
2014
2015
2016
2017


http://www.arpa.
veneto.it


1990
F. Sile
F. Dese
BURANO
MURANO
S. ERASMO
VENEZIA
Foce del F. Sile
Bocca di Lido
Aquatic plant distribution
NATURA 2000
2003
F. Sile
F. Dese
BURANO
MURANO
S. ERASMO
VENEZIA
Foce del F. Sile
Mare Adriatico
Bocca di Lido
Piante acquatiche (mappatura 2003)
Barene naturali
Venezia e isole
SIC IT3250031
0 1 2 4 km
Life


Ca. 10 km² with aquatic plants with different cover and 4 km² of total cover
December 2017
NATURA 2000
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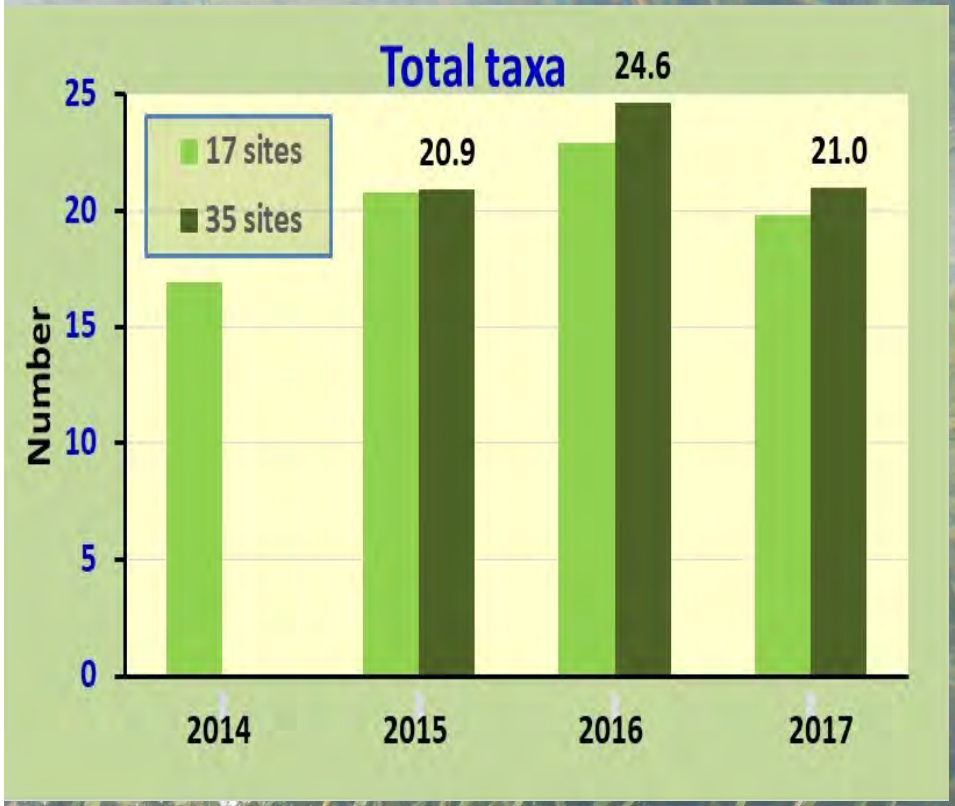
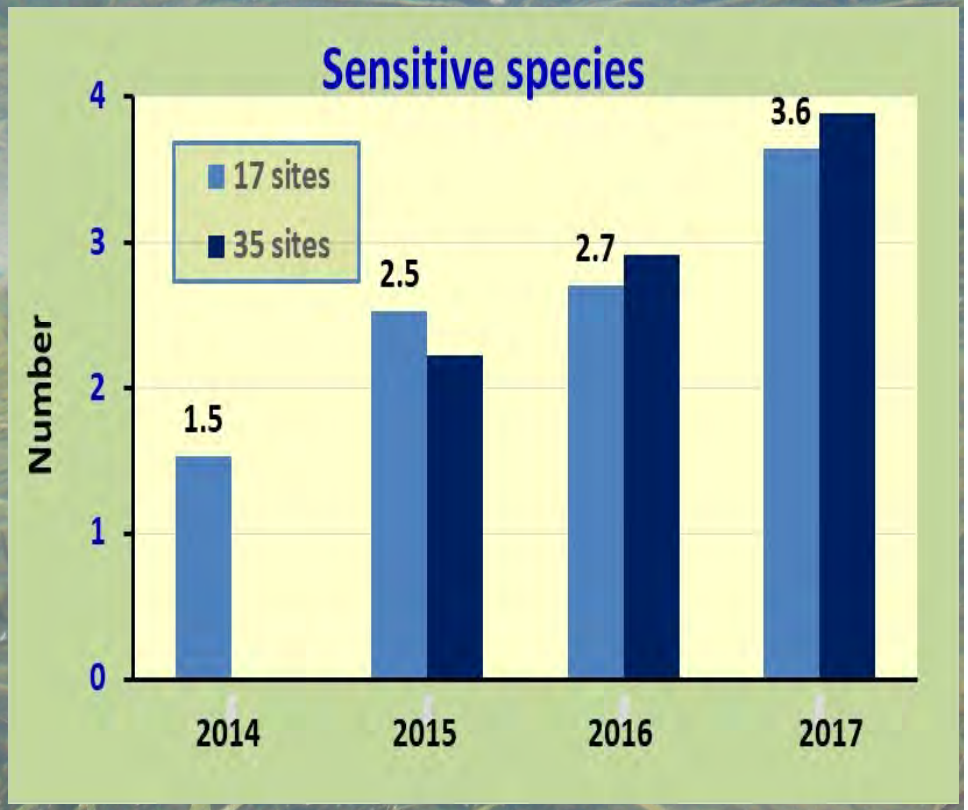
As far as macroalgae





SERESTO – Habitat 1150 (coastal lagoon) recovery by SEagrass RESTOration.
A new strategic approach to meet HD&WFD objectives
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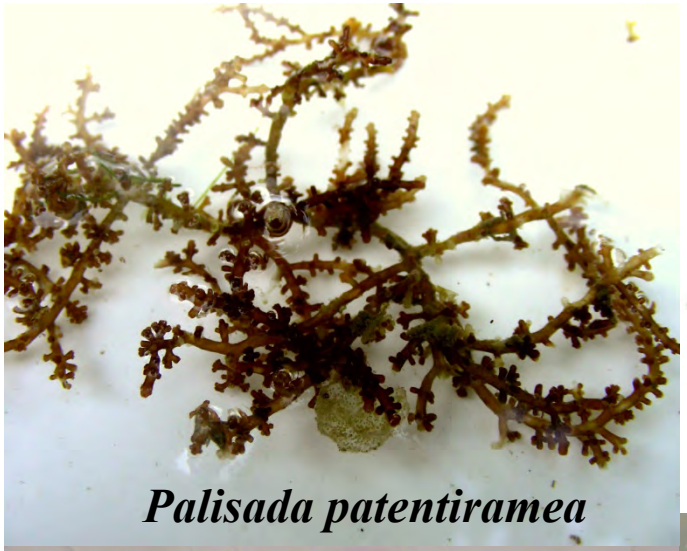
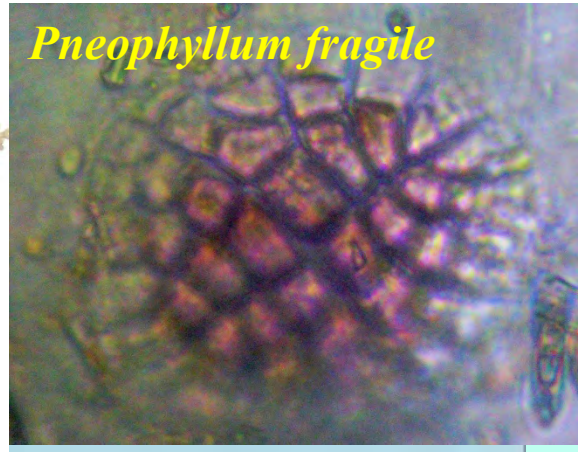


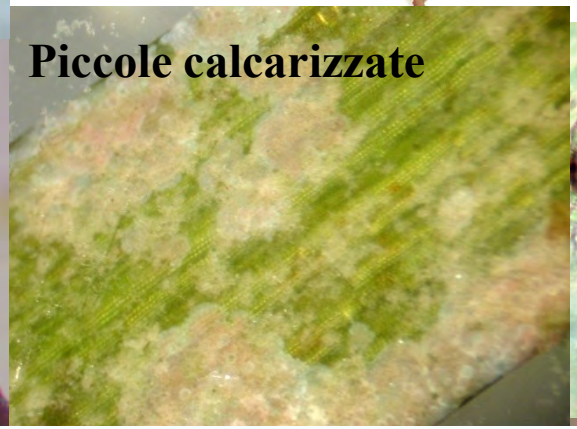
Palisada patentiramea

Osmundea truncata



Pneophyllum fragile

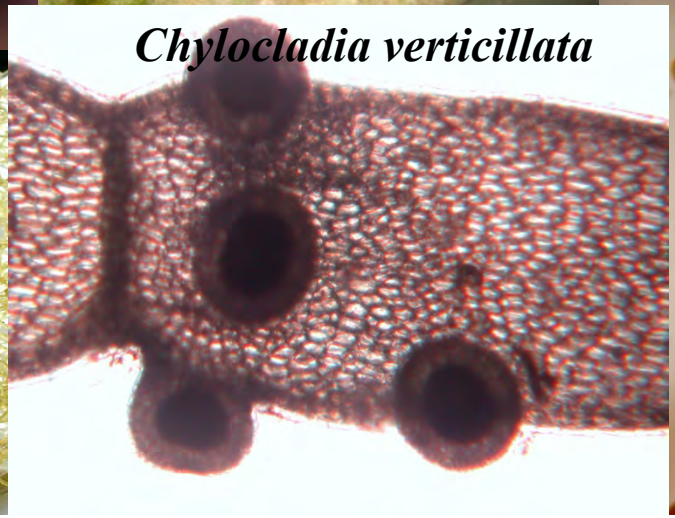
Centroceras gasparrinii



Piccole calcarizzate

Hydrolithon boreale

Chaetomorpha linum

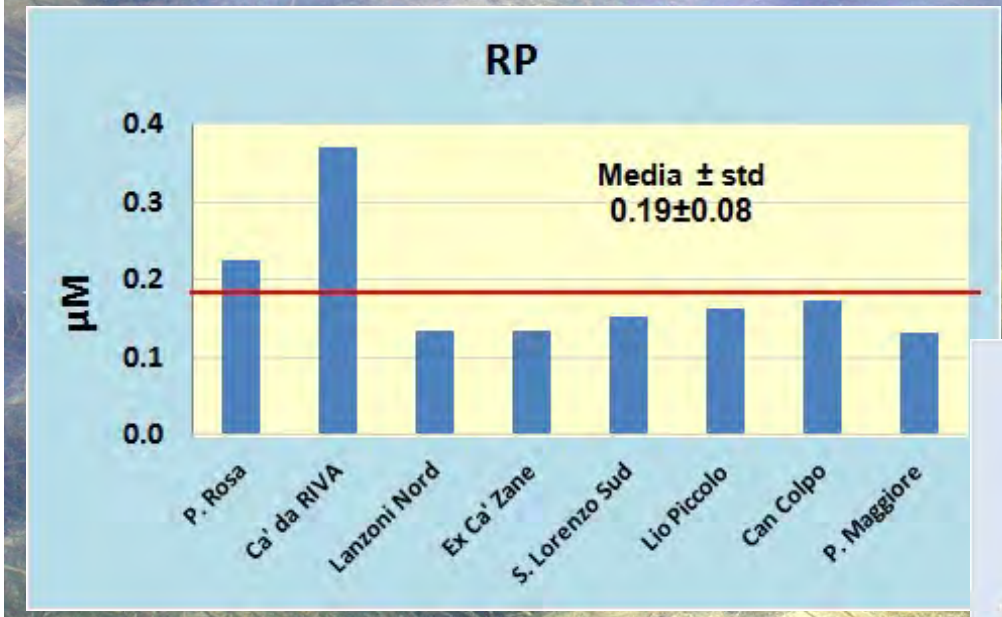


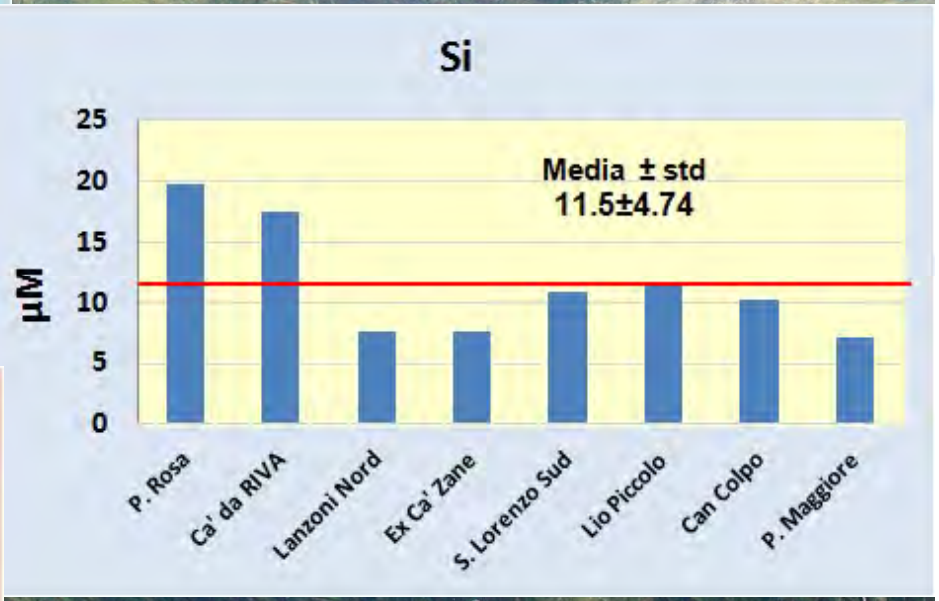
Chylocladia verticillata

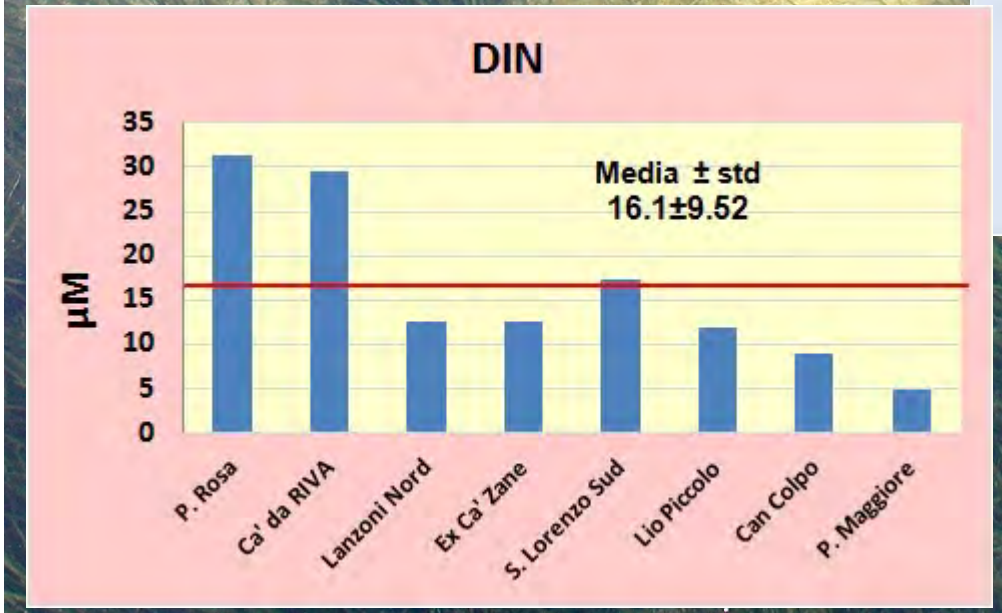
Laurencia obtusa

D2 – Monitoring of biodiversity and ecological quality

Water Column
8 sites
12 months







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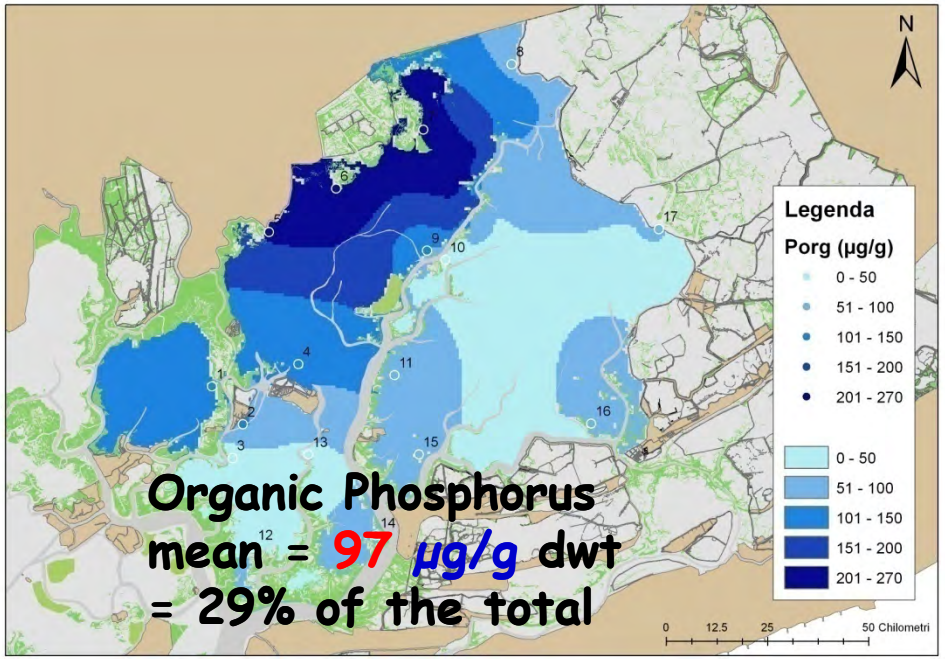
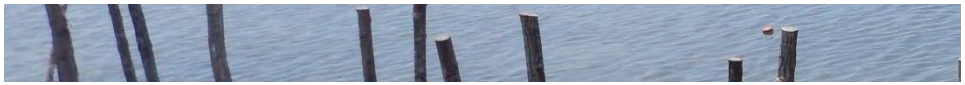
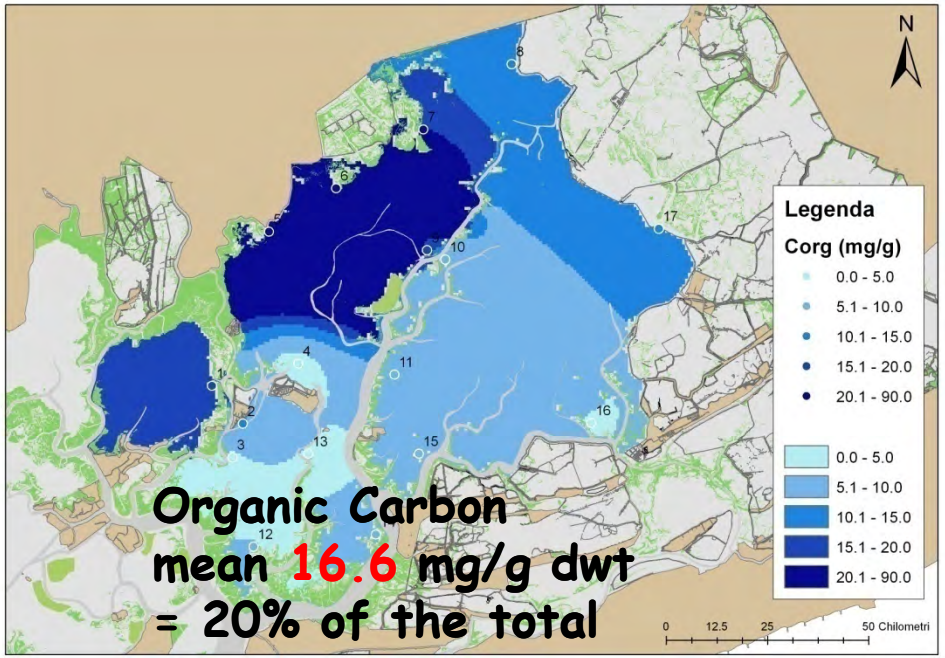
Nutrients (2014)

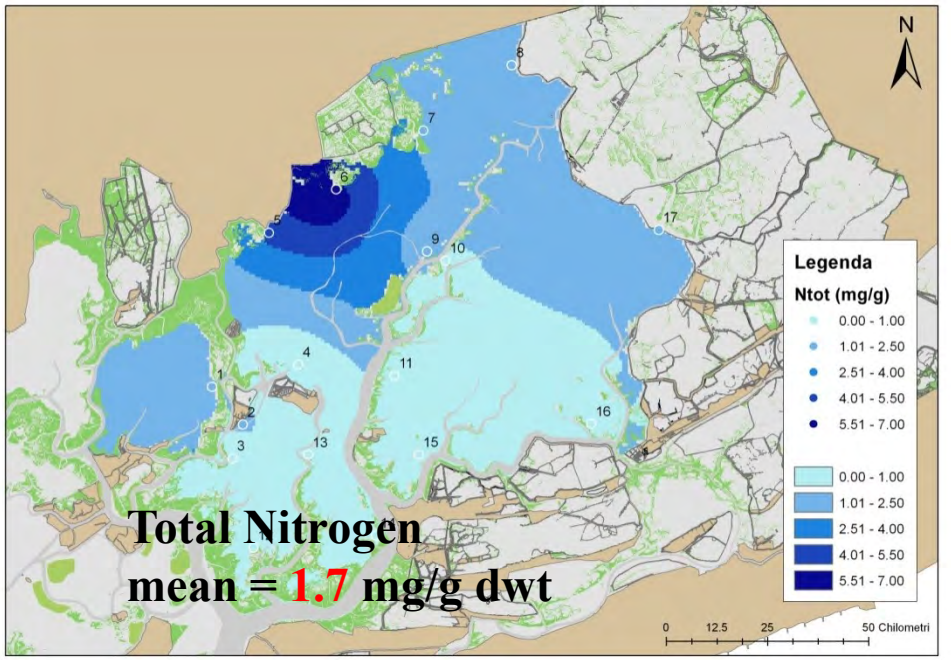


Organic Phosphorus
mean = 97 µg/g dwt
= 29% of the total





Organic Carbon
mean 16.6 mg/g dwt
= 20% of the total



Total Nitrogen
mean = 1.7 mg/g dwt

in surficial sediments
(17 stazioni)

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Non-parametric Correlations

8 sites

Red = negative

Blue = positive

* p<0.05

** p<0.001

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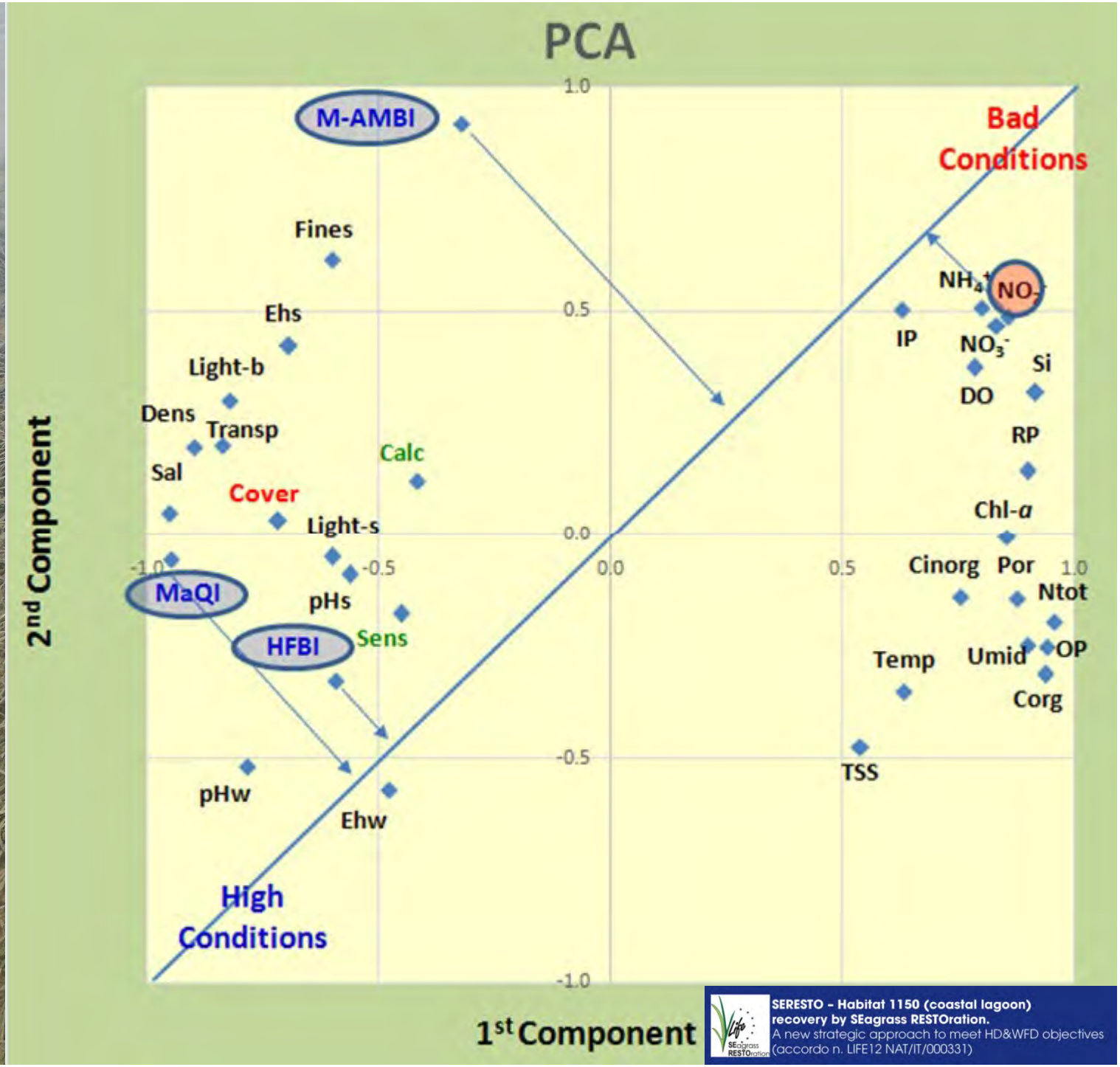
Environmental Parameters on the 8 sites

2017



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Life SeResto
8 sites 2015

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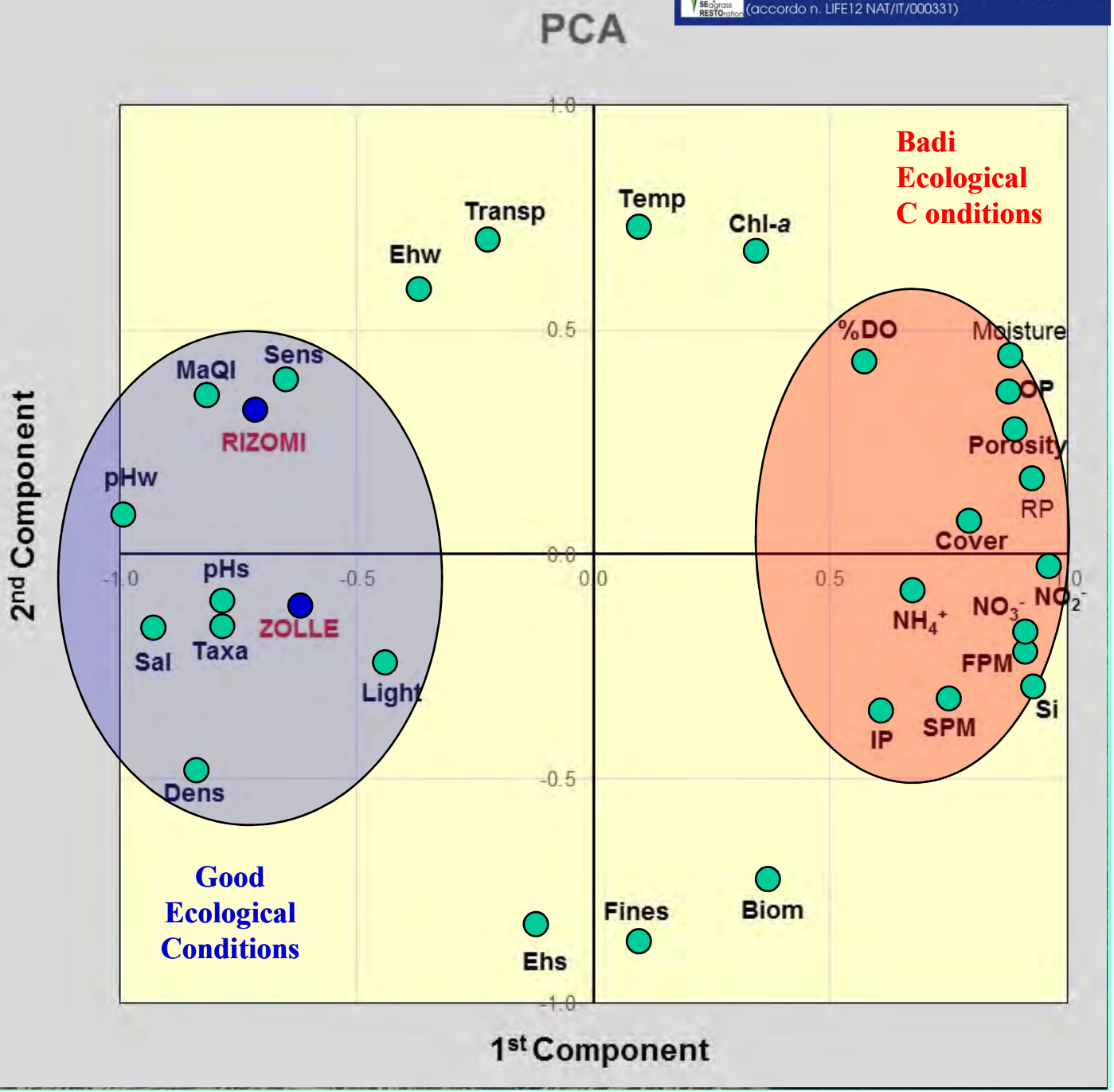
Environmental Quality and Aquatic Angiosperms



The Improvement

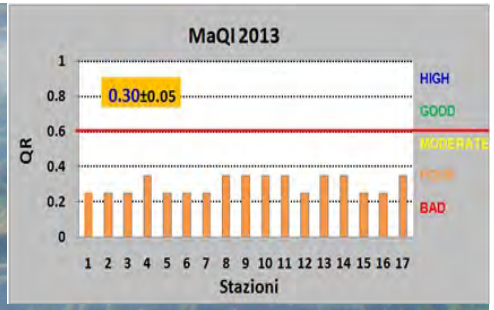
of the environmental quality was determined by applying Ecological Status Indices based on the sampling of:

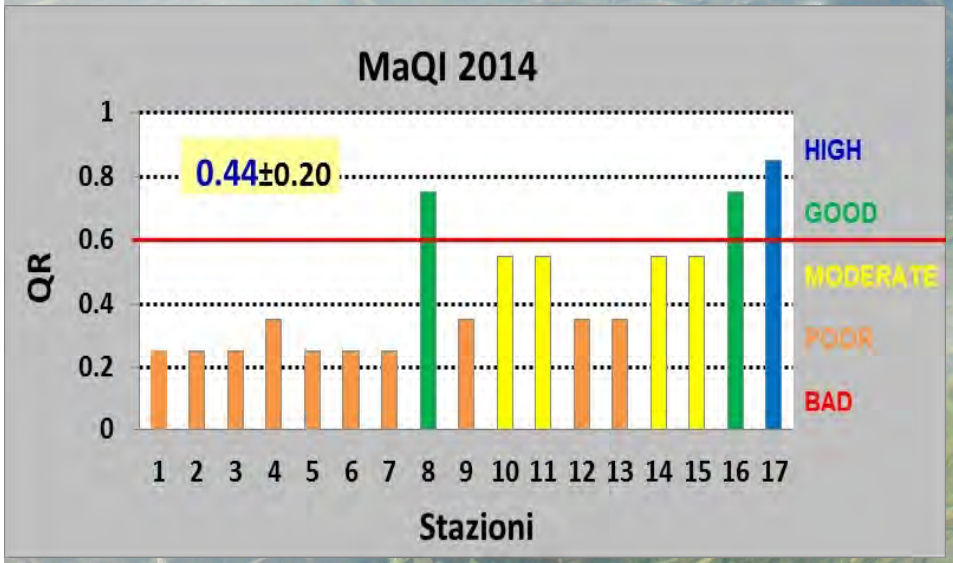
- ✓ Macrophytes,
- ✓ Benthic macrofauna,
- ✓ Fish Macrofauna,

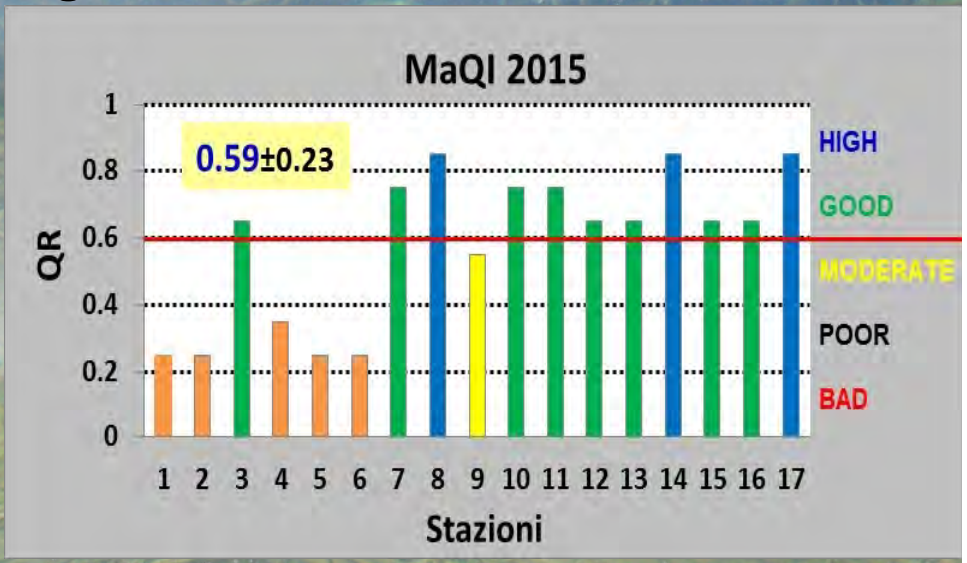
in agreement with the requirements of the WFD (2000/60/EC)

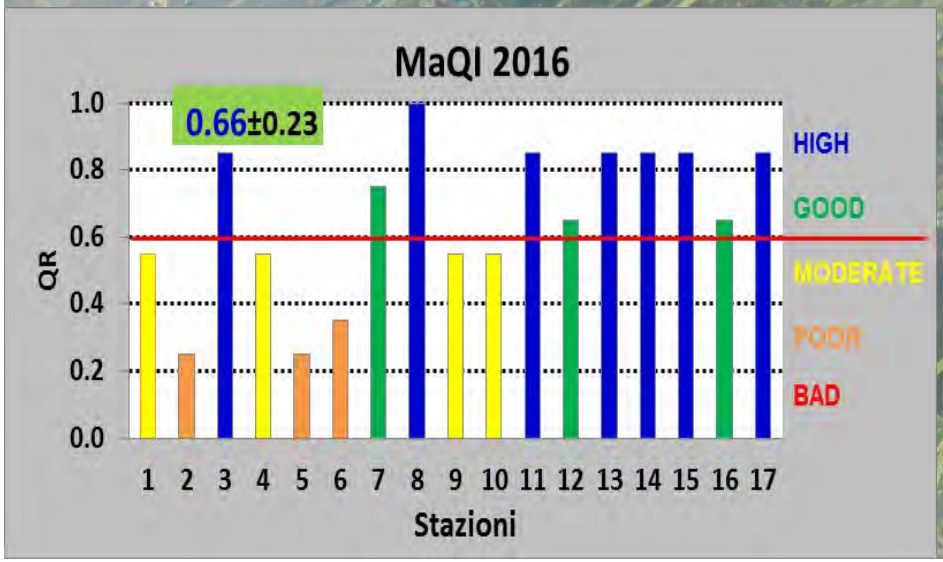
Macrophyte Quality Index (2014)

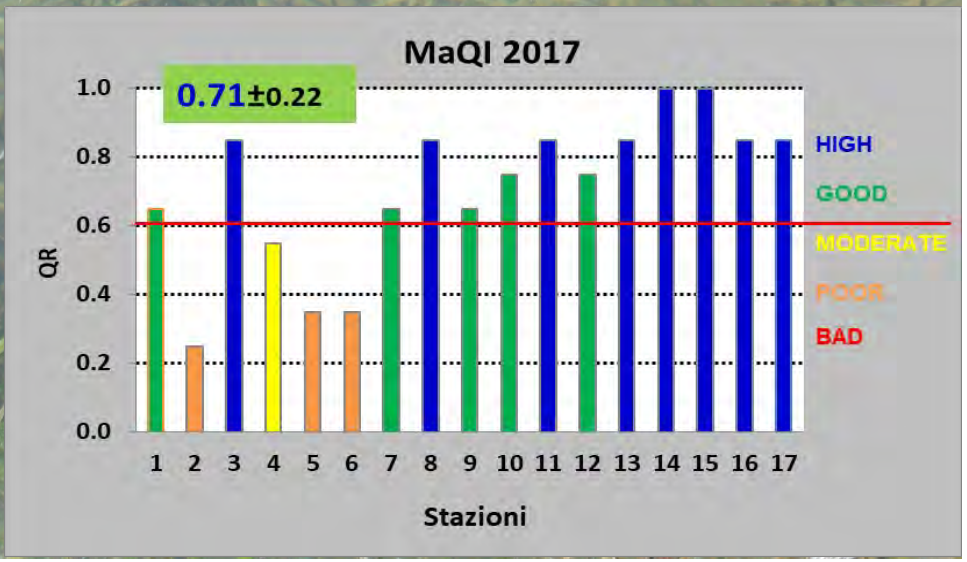
*The BQI that responds more quickly to **environmental changes***

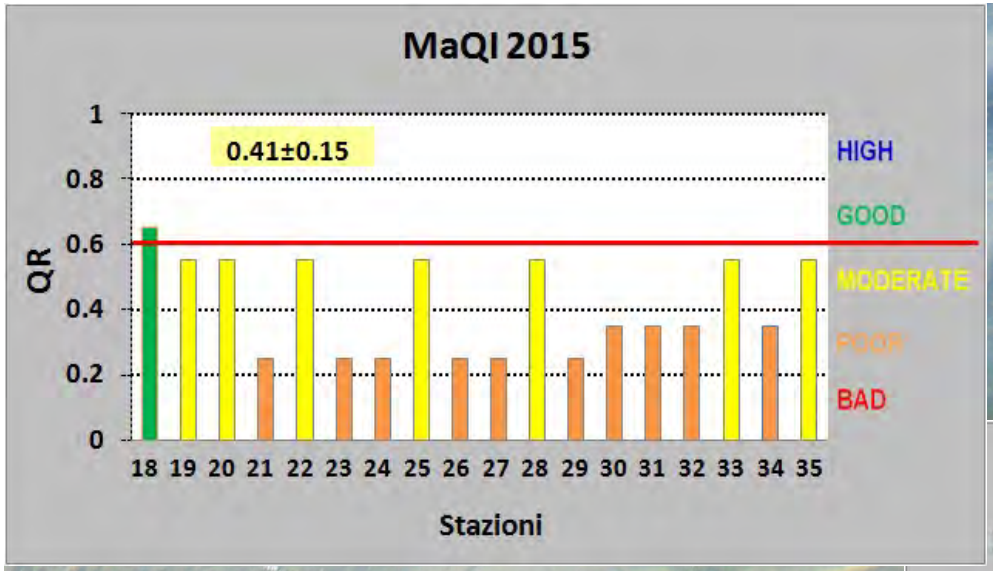


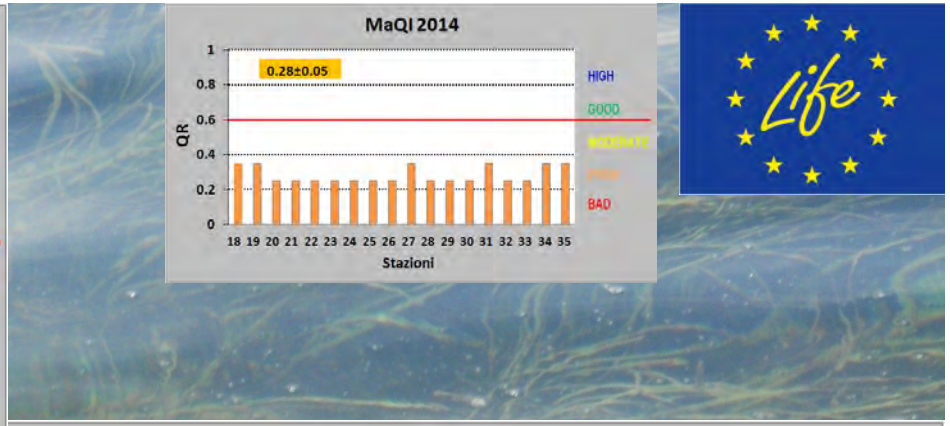




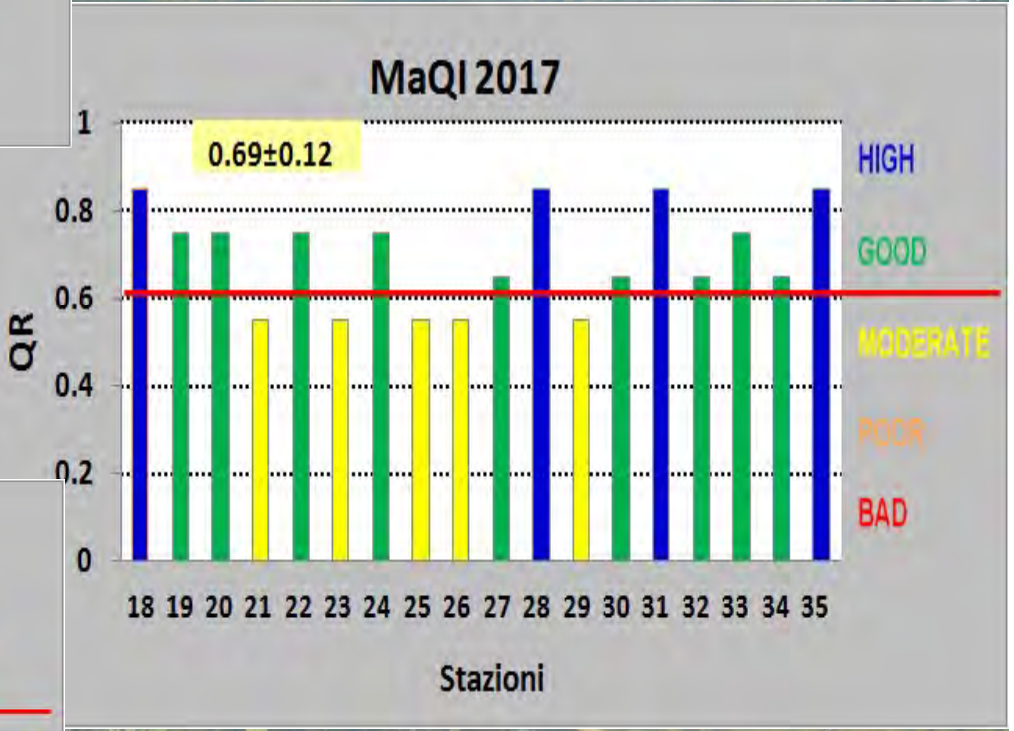


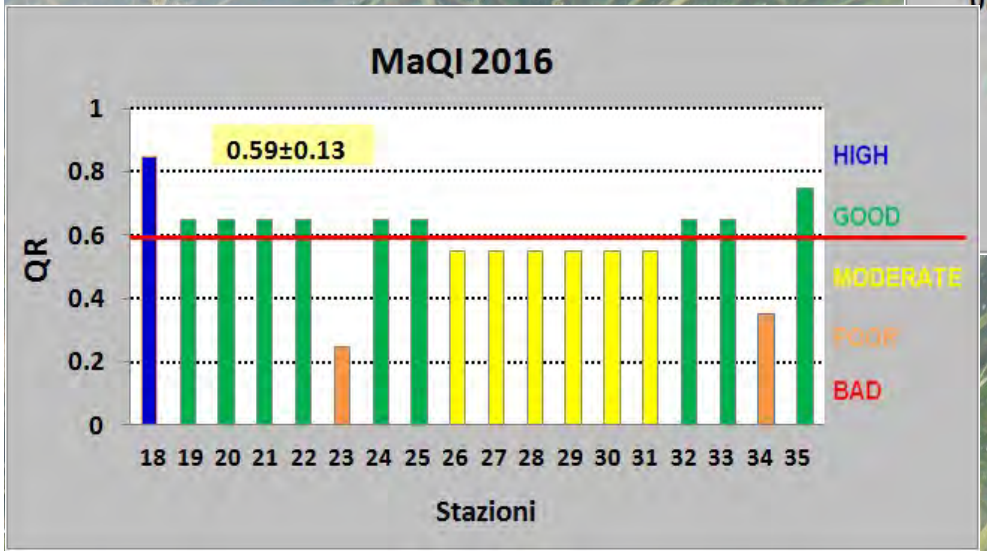


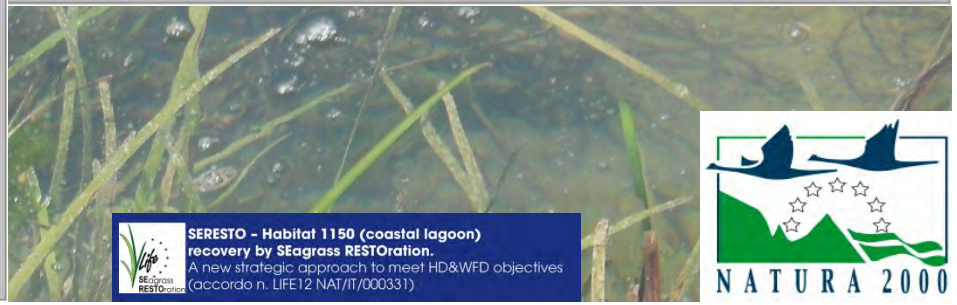




Macrophyte Quality Index







Ecosystem services

We have recorded an increase of:

✓The Primary Production;
✓The Biodiversity and the Presence of Sensitive Taxa;
✓The Nursery areas and Food sources for juveniles of benthic fauna, fish fauna and bird fauna;
✓Conservationist and commercial fish species;
✓Water Transparency;
✓CO_2 abatement.

In addition, more long-term will occur

✓Sediment compaction;
✓Contrast to erosion processes.

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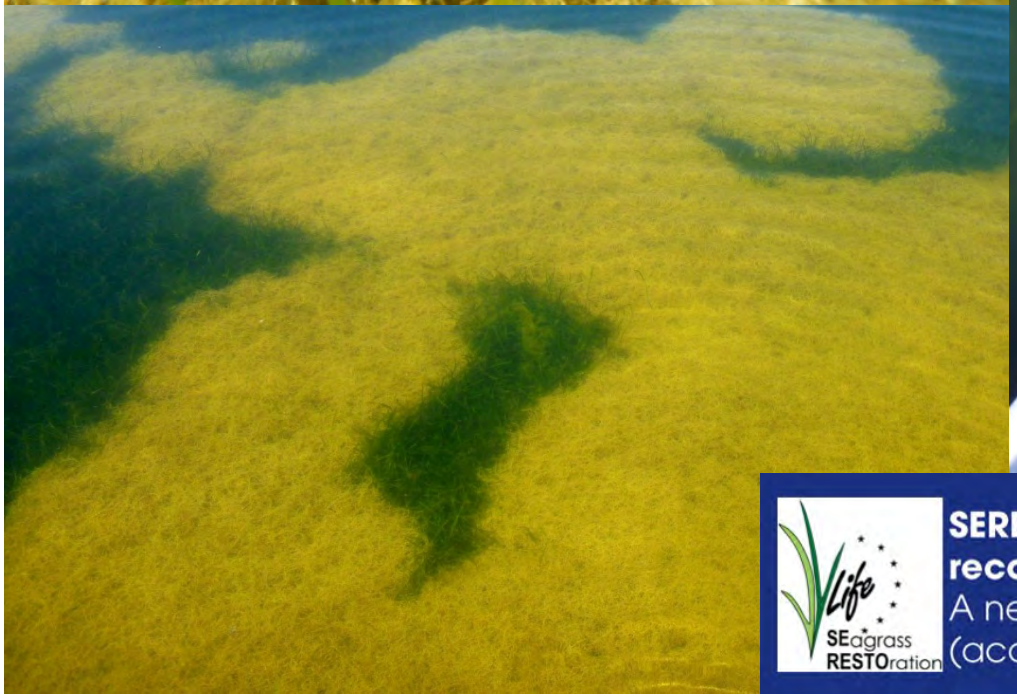
CO_2 sequestration

Based on the mappings of aquatic phanerogams made in 2003 (with exclusion of the fishing valleys), it can be calculated that these plants retain permanently ca. 40,000 tonnes di CO_2.
(+ ca.1500 tonnes by this project)
A value at least 2 times higher is obtained by considering the algae and the calcarized organisms that live in the prairies



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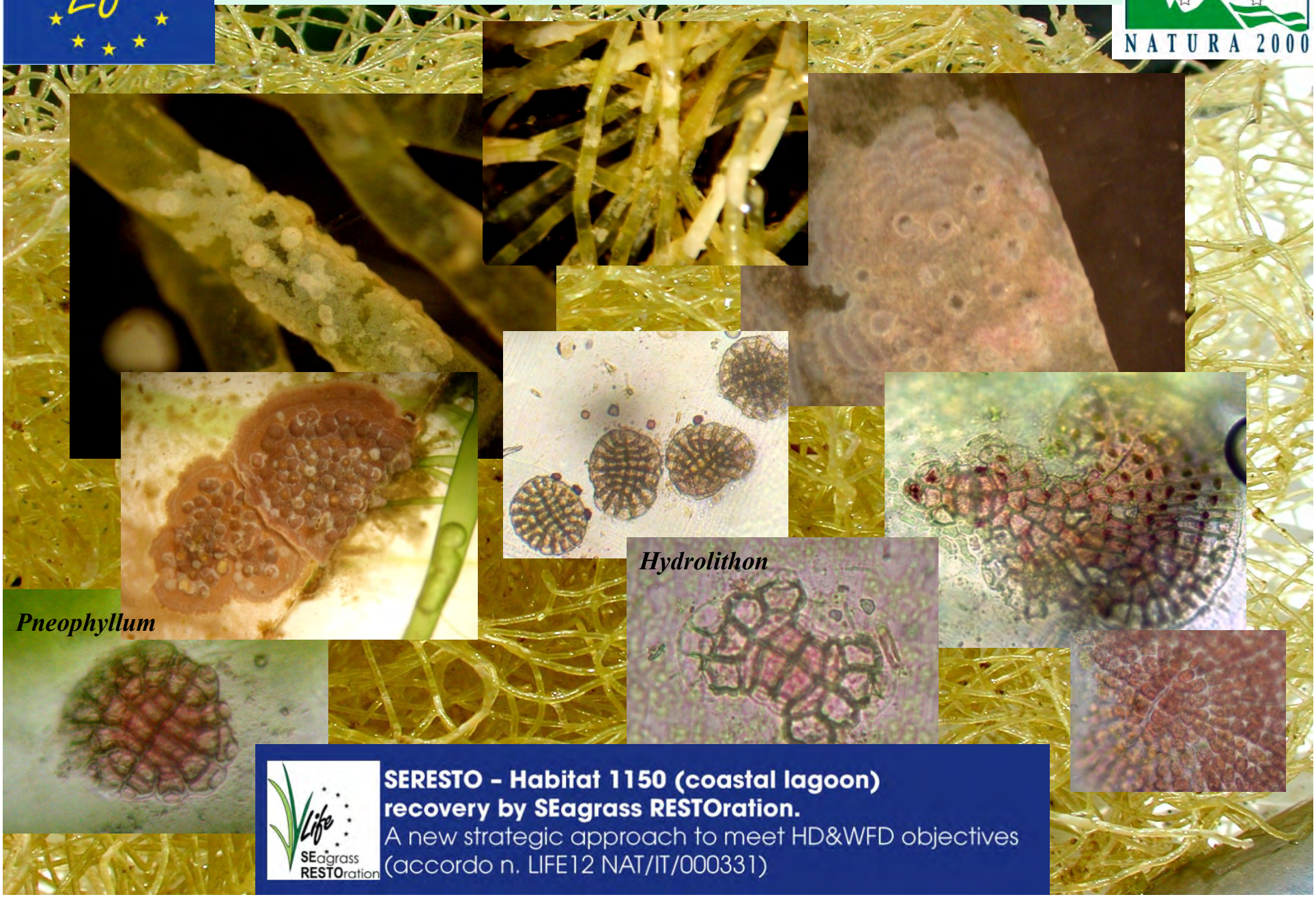
Calcified species



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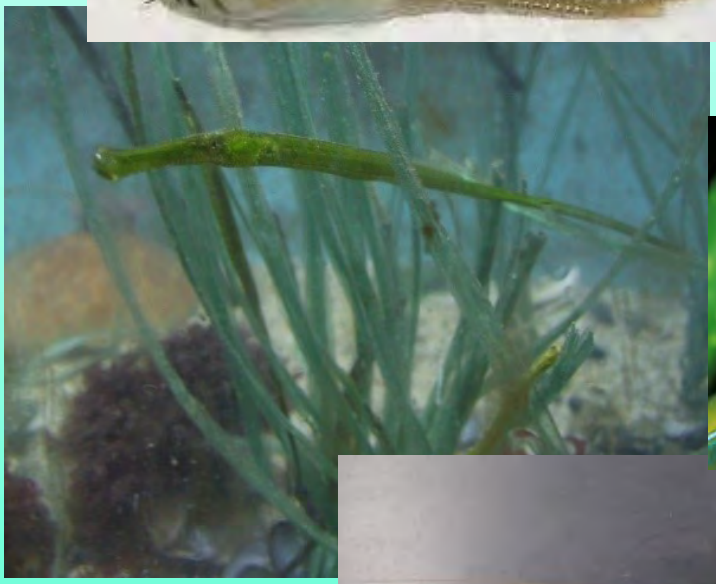
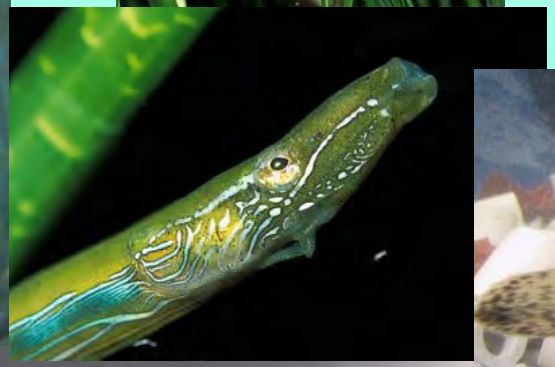
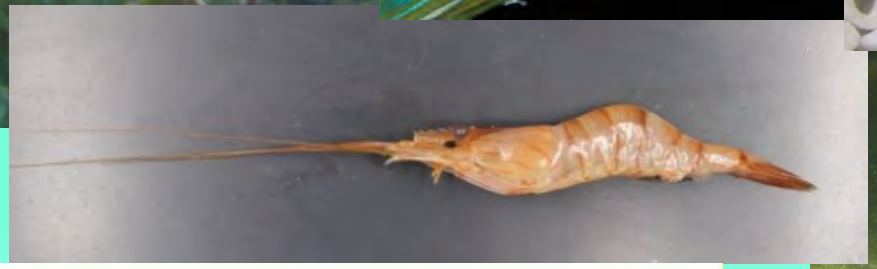
Increase of the nekton species







Conclusions

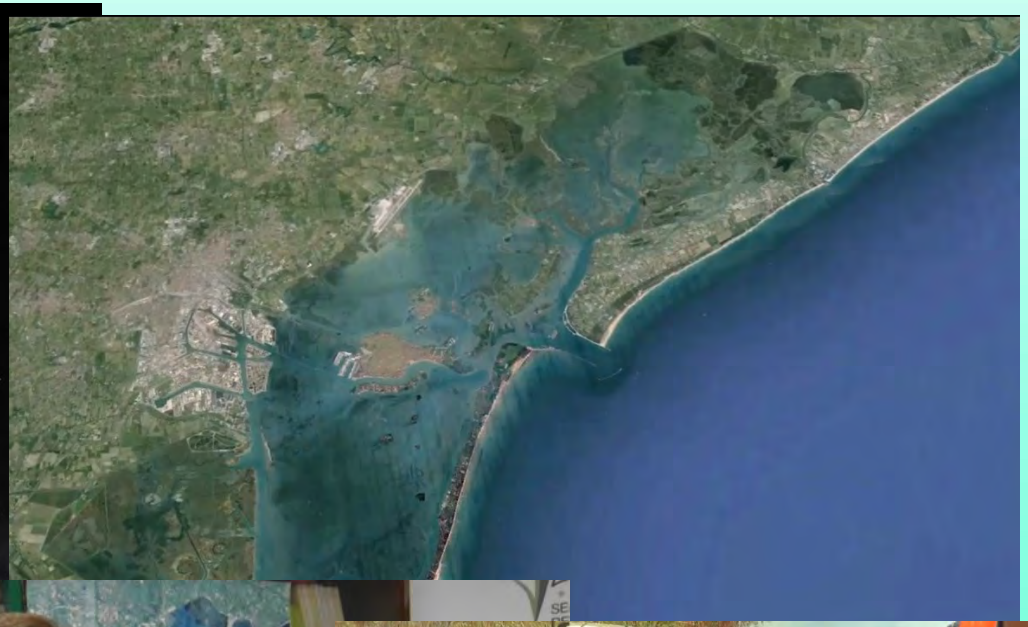
At ca. 4 years since the beginning of the aquatic angiosperm transplantation the results obtained show the success of the SeResto project in 31 sites out of 35 and a more or less rapid diffusion on ca. 10 km^2 with different meadow densities, for a total cover of ca. 4 km^2 spread in the whole area off intervention

The seeds produced by the transplanted plants are exponentially colonizing the edges of the salt marshes, small canals "ghebbi" and deep canals expanding towards the open and deep areas.

The environmental quality has increased in most of the sites of 2-3 (4) classes of ecological status. Overall, the whole area of intervention changed from Poor conditions to Good conditions

The phases and results of the SeResto project are shown i in

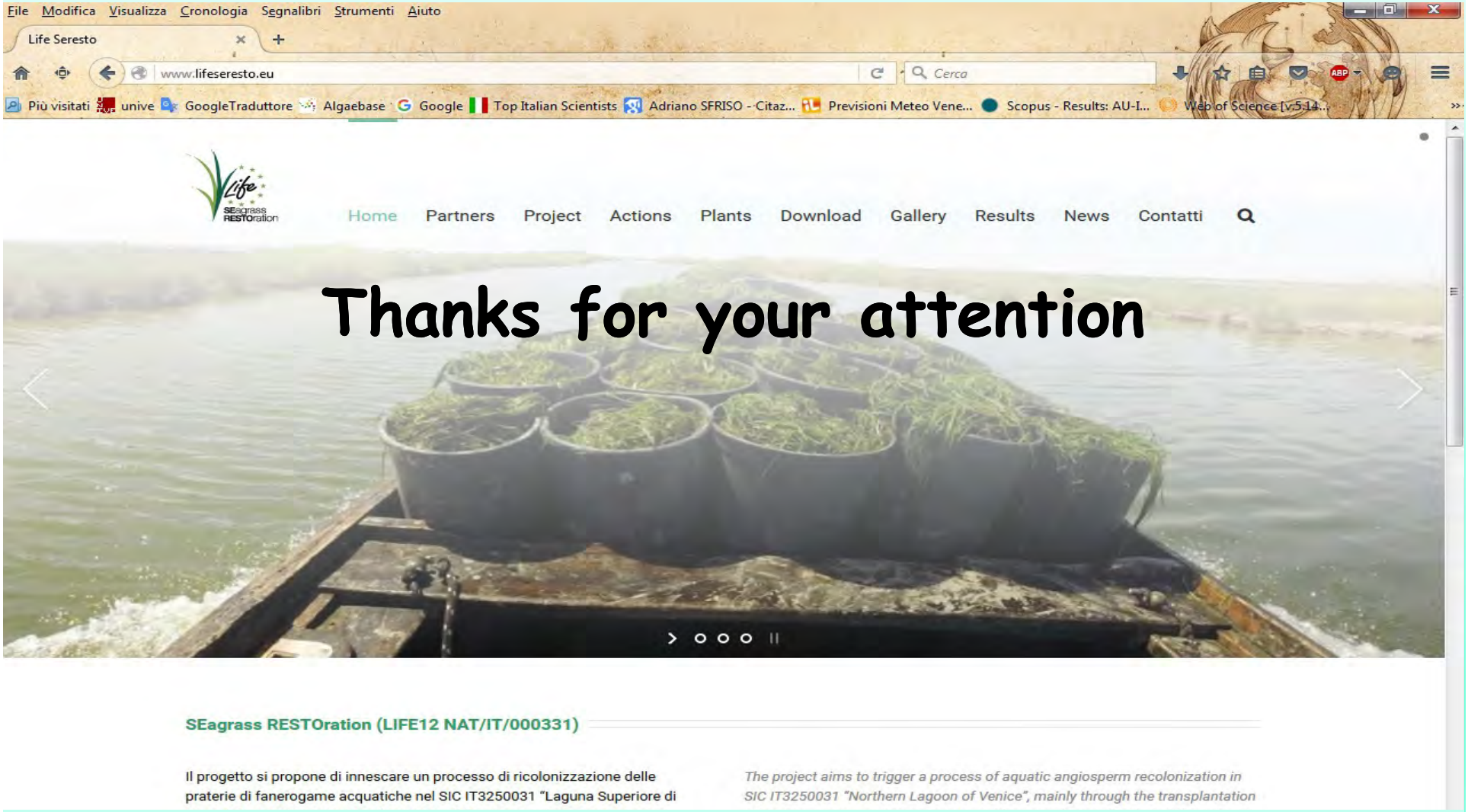
2 Integral Videos of ca. 20 minutes
2 Short Videos of ca. 5 minutes



SEagrass RESTOration

SERESTO

Sito WEB: www.lifeseresto.eu



The project enjoys the contribution of the LIFE financial instrument of the European Union and contributes to the improvement of an ecological site of Community importance of the Natura 2000 network (SIC IT3250031 – Northern Venetian Lagoon)

For my Department DAIS

The Project Manager: Chiara Facca.

The Administrative staff: Stefania Quaderni; Serenella Rizzieri, Elena Centanni, Eugenia Delaney, Miotto Claudia.

The Scientific Colleagues: Buosi Alessandro, Piero Franzoi, Roberto Pastres, Daniele Brigolin and many others.