

# Multimetric Phytoplankton Index (MPI): description of the method and study cases in Mediterranean Sea.

Chiara FACCA<sup>1</sup>, Fabrizio BERNARDI AUBRY<sup>2</sup>, Stefania FINOTTO<sup>2</sup>, Emanuele PONIS<sup>3</sup>, Francesco ACRI<sup>2</sup>, Adriano SFRISO<sup>1</sup>, Antonella LUGLIE'<sup>4</sup>, Anna Maria BAZZONI<sup>5</sup>



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# Multimetric Phytoplankton Index (MPI)

- Literature proposes several formulations based on phytoplankton metrics but most indices don't completely fulfill the WFD requirements, above all in the case of transitional waters.
- To be compliant with the Water Framework Directive (WFD – 2000/60/EC) requirements, **phytoplankton taxonomic composition, abundance and biomass** must be used to assess transitional water ecological quality.



# *Water Framework Directive (2000/60/EC)*

## • Objectives:

- The **protection** of inland surface waters, transitional waters, coastal waters and groundwater
- Member States shall implement the necessary measures to **prevent deterioration** of the status of all bodies of surface water
- Member States shall **protect, enhance and restore all bodies of surface water** with the aim of achieving good surface water status by 2015 (Ecological status: expression of the quality of the structure and functioning of aquatic ecosystems)

## • ANNEX V

### • Biological Quality elements for the classification of ecological status

Composition, abundance and biomass of phytoplankton

Composition and abundance of other aquatic flora

Composition and abundance of benthic invertebrate fauna

Composition and abundance of fish fauna



- Description of the Multimetric Phytoplankton Index
  - Results of the set up
- New results for the validation phase



# Multimetric Phytoplankton Index (MPI)

## Paper describing the index set up

Marine Pollution Bulletin 79 (2014) 145–154

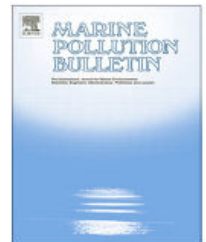


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Marine Pollution Bulletin

journal homepage: [www.elsevier.com/locate/marpolbul](http://www.elsevier.com/locate/marpolbul)



### Description of a Multimetric Phytoplankton Index (MPI) for the assessment of transitional waters



Chiara Facca<sup>a,\*</sup>, Fabrizio Bernardi Aubry<sup>b</sup>, Giorgio Socal<sup>b</sup>, Emanuele Ponis<sup>c</sup>, Francesco Acri<sup>b</sup>,  
Franco Bianchi<sup>b</sup>, Franco Giovanardi<sup>d</sup>, Adriano Sfriso<sup>a</sup>

<sup>a</sup> DAIS, University Ca' Foscari Venice, Dorsoduro 2137, 30123 Venice, Italy

<sup>b</sup> Institute of Marine Science (ISMAR CNR), Arsenale-Tesa 104 Castello 2737/F, 30122 Venice, Italy

<sup>c</sup> ISPRA – Italian National Institute for Environmental Protection and Research, Loc. Brondolo, 30015 Chioggia, Italy

<sup>d</sup> ISPRA – Italian National Institute for Environmental Protection and Research, Via Brancati 60, 00144 Rome, Italy



# Multimetric Phytoplankton Index (MPI)

The dataset to calculate the four metrics must contain data of **chlorophyll a concentrations**, **phytoplankton cell abundances** and **taxonomic composition**, collected seasonally (feb, may, aug, nov) at surface.

The taxonomic list of each sample has to contain only determined species (also as Genus sp. 1 or Class sp. 1) as in the table on the right.

<i>Achnantes brevipes</i>	Yes
<i>Achnantes longipes</i>	Yes
<i>Achnantes microcephala</i>	Yes
<i>Achnantes</i> sp. 1	Yes
<i>Navicula</i> spp.	No
Und. Euglenophyceae	No
<i>Dictyocha fibula</i>	Yes
<i>Dictyocha speculum</i>	Yes
<i>Octactis octonaria</i>	Yes
Nanoflagellates	No
Und. Cyanophyceae	No



# Multimetric Phytoplankton Index (MPI)

## 1. First metric (Hulburt index)

- The first metric is the dominance Hulburt's index:

$$\delta = 100(n_1 + n_2) / N$$

$n_1$ : abundance of the dominant species

$n_2$ : abundance of the second most abundant species

$N$ : total abundance

To assess water quality the value 100 -  $\delta$  is used as indicator of high water quality.

**Theory: dominance phenomena occur in impacted areas**



# Multimetric Phytoplankton Index (MPI)

## 2. Second metric (Blooms)

The second metric is the dominant species frequency:

**how many times in the dataset of each station the dominant species abundance was  $>50\%$ .**

**To assess water quality the value “100 - frequency” is used as indicator of high water quality.**





# Multimetric Phytoplankton Index (MPI)

## 3. Third metric (Menhinick index)

- The third metric is the Menhinick index:

$$S/\sqrt{N}$$

S : number of species

N: total abundance

To reduce the error caused by deletion of multiple indeterminate taxa, a **correction factor** was introduced. For each sample D was multiplied by the taxa)correction factor: determinate/(determinate + indeterminate).



# Multimetric Phytoplankton Index (MPI)

## 4. Fourth metric (Chlorophyll *a* geometric mean )

- ✓ Original data were **log-transformed**.
- ✓ **Outliers** (mean $\pm$ 2.5std.dev.) were **deleted** and the mean recalculated.
- ✓ The final values were re-transformed.

Lowest average Chl *a* value (reference value)

**EQR**=-----

Chl *a* average value for each sampling site



# Multimetric Phytoplankton Index (MPI)

**Reference conditions** are set considering the best conditions of considered water bodies.

to calculate the **Ecological Quality Ratio (EQR)**.






$$\text{EQR} = \frac{\text{1-year average value}}{\text{Reference value}}$$

**MPI = mean of the 4 EQRs**



# Multimetric Phytoplankton Index (MPI)

**Ecological Quality Ratio** ranges between 0 and 1 and class boundaries are set as equidistant division of the EQR gradient

	High 0.81-1
	Good 0.61-0.8
	Moderate 0.41-0.6
	Poor 0.21-0.4
	Bad 0-0.2

Italian transitional systems were classified in the following **typologies** :

✓ restricted ;

✓ choked;



# GEOGRAPHIC AND HYDRODYNAMIC CHARACTERISTICS OF SHALLOW COASTAL LAGOONS

Björn Kjerfve and K.E. Magill, 1989

**Source:** MARINE GEOLOGY Volume: 88 Issue: 3-4 Pages: 187-199

DOI: 10.1016/0025-3227(89)90097-2 Published: AUG 1989

**Choked lagoons** are characterized by one or more long and narrow entrance channels, long residence times, and dominant wind forcing.

**Restricted lagoons** usually exhibit two or more entrance channels or inlets, have a well-defined tidal circulation, are strongly influenced by winds, and are usually vertically mixed. Residence time are shorter than in choked lagoons.



# Set up

From Facca et al., 2014

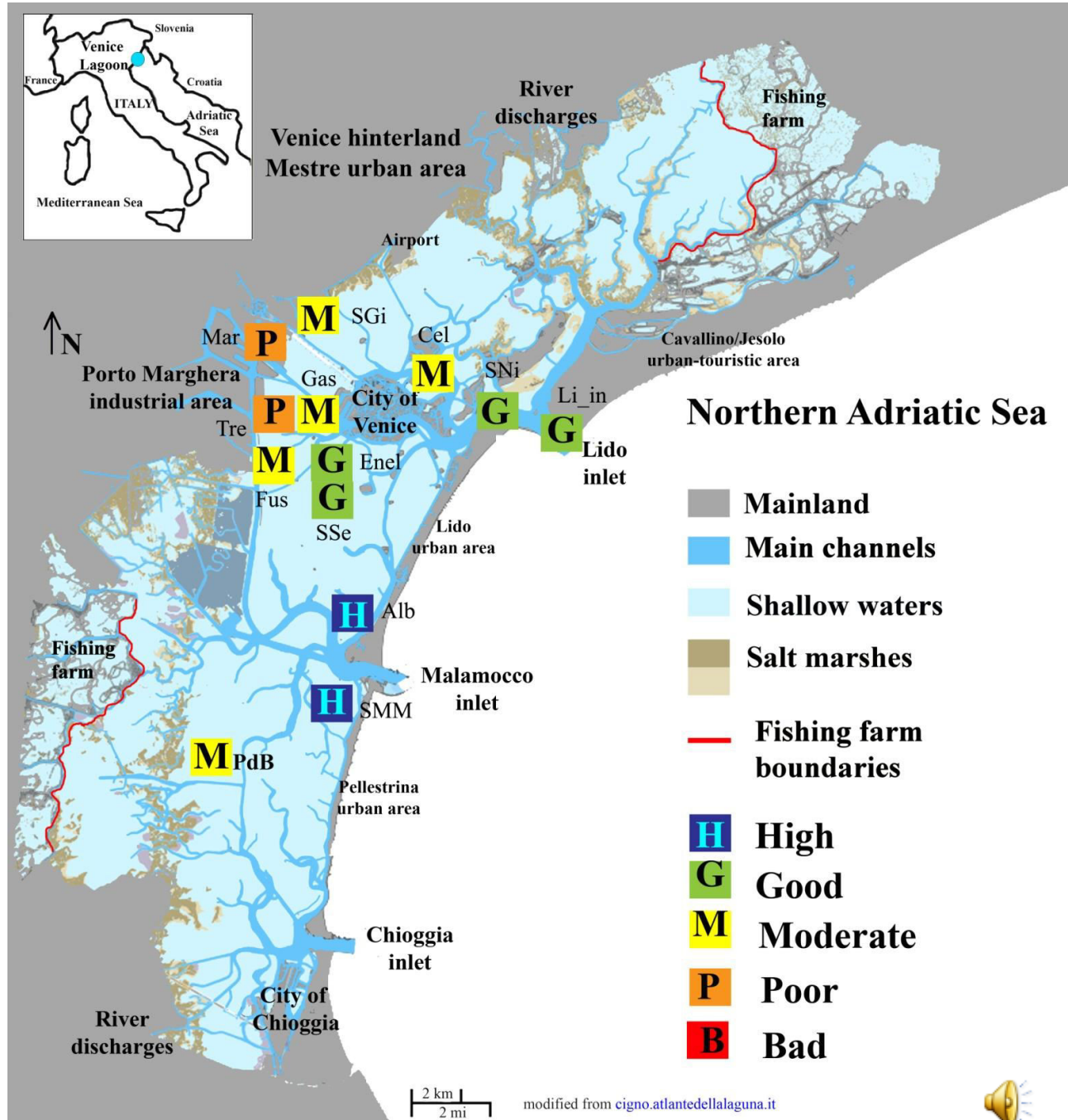
## Venice Lagoon

Surface 550 km<sup>2</sup>

high spatial heterogeneity,

various anthropogenic stressors:

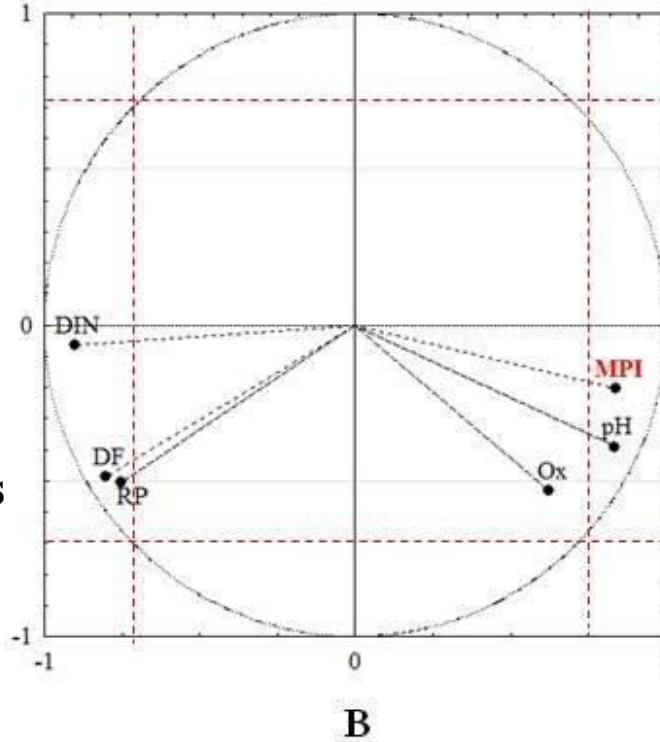
industrial, agricultural discharges, tourism, fishing, hydro-morphological intervention, naval traffic



# Set up

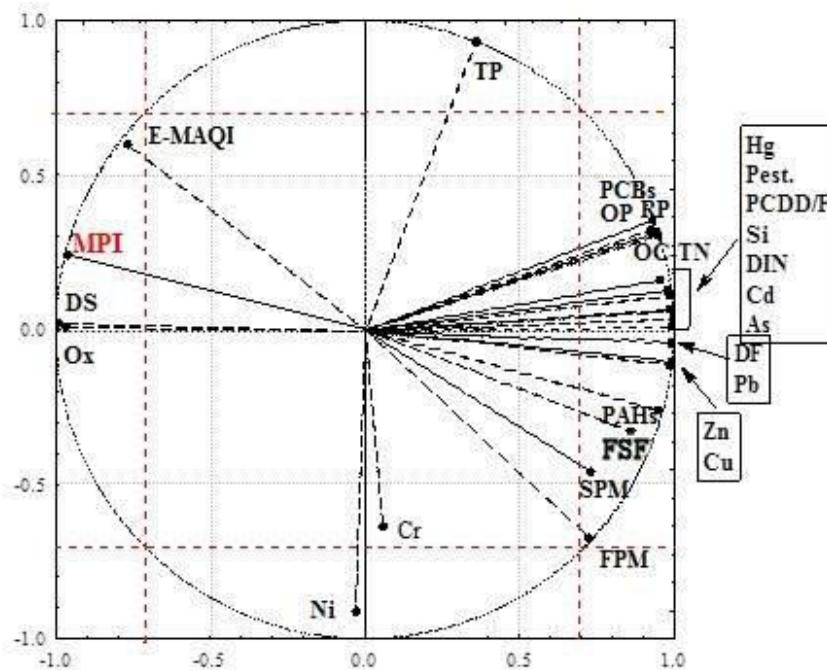
From Facca et al., 2014

All stations with nutrients



Statistical results  
of the index set up

4 stations with contaminants



Validation

# Dataset

Venice lagoon

Monthly samples in 8 stations in choked and restricted areas

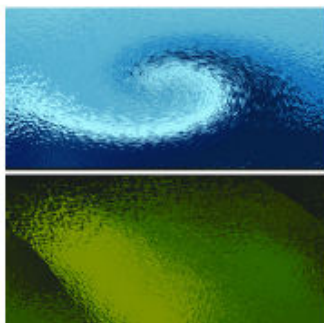
Sardinia ponds

Monthly samples in 11 stations in choked basins

➤ For all observations **phytoplankton taxonomic composition, salinity and nutrient and chlorophyll concentrations** are available







## VIEW POINT

# Water quality evaluation in Mediterranean lagoons using the Multimetric Phytoplankton Index (MPI): Study cases from Sardinia

A.M. Bazzoni<sup>1\*</sup>, S. Pulina<sup>1</sup>, B.M. Padedda<sup>1</sup>, C.T. Satta<sup>1</sup>, A. Lugliè<sup>1</sup>, N. Sechi<sup>1</sup>, C. Facca<sup>2</sup>

<sup>1</sup>University of Sassari, Department of Science for Nature and Environmental Resources, via Piandanna 4, I-07100 Sassari, Italy.

<sup>2</sup>University Ca' Foscari, Department of Environmental Sciences, Informatics and Statistics, Dorsoduro 2137, I-30121 Venezia, Italy.

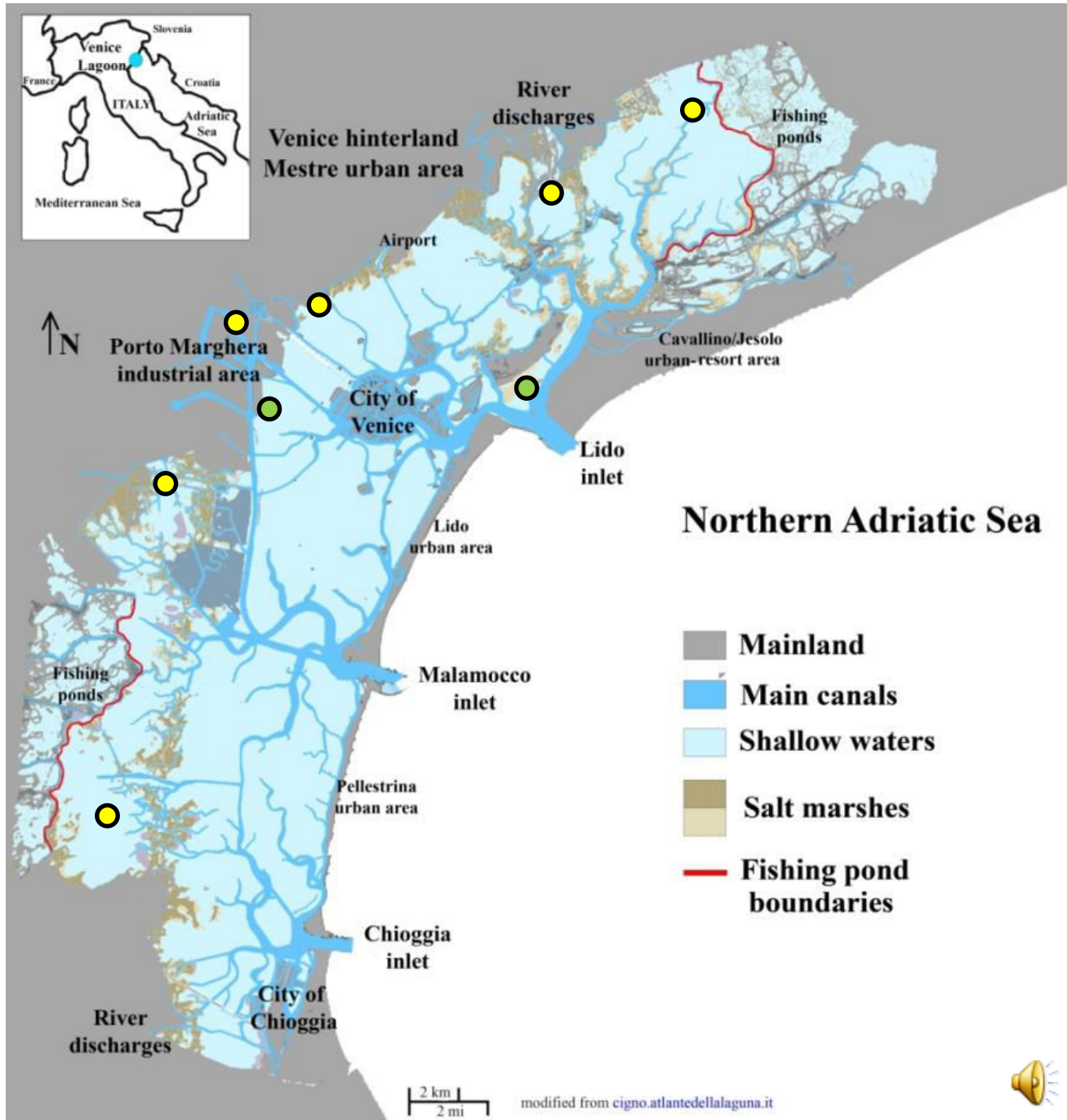
\*Corresponding author: Phone: +39 079 213042; Fax: +39 079 233600; E-mail address: [bazzoniam@uniss.it](mailto:bazzoniam@uniss.it).



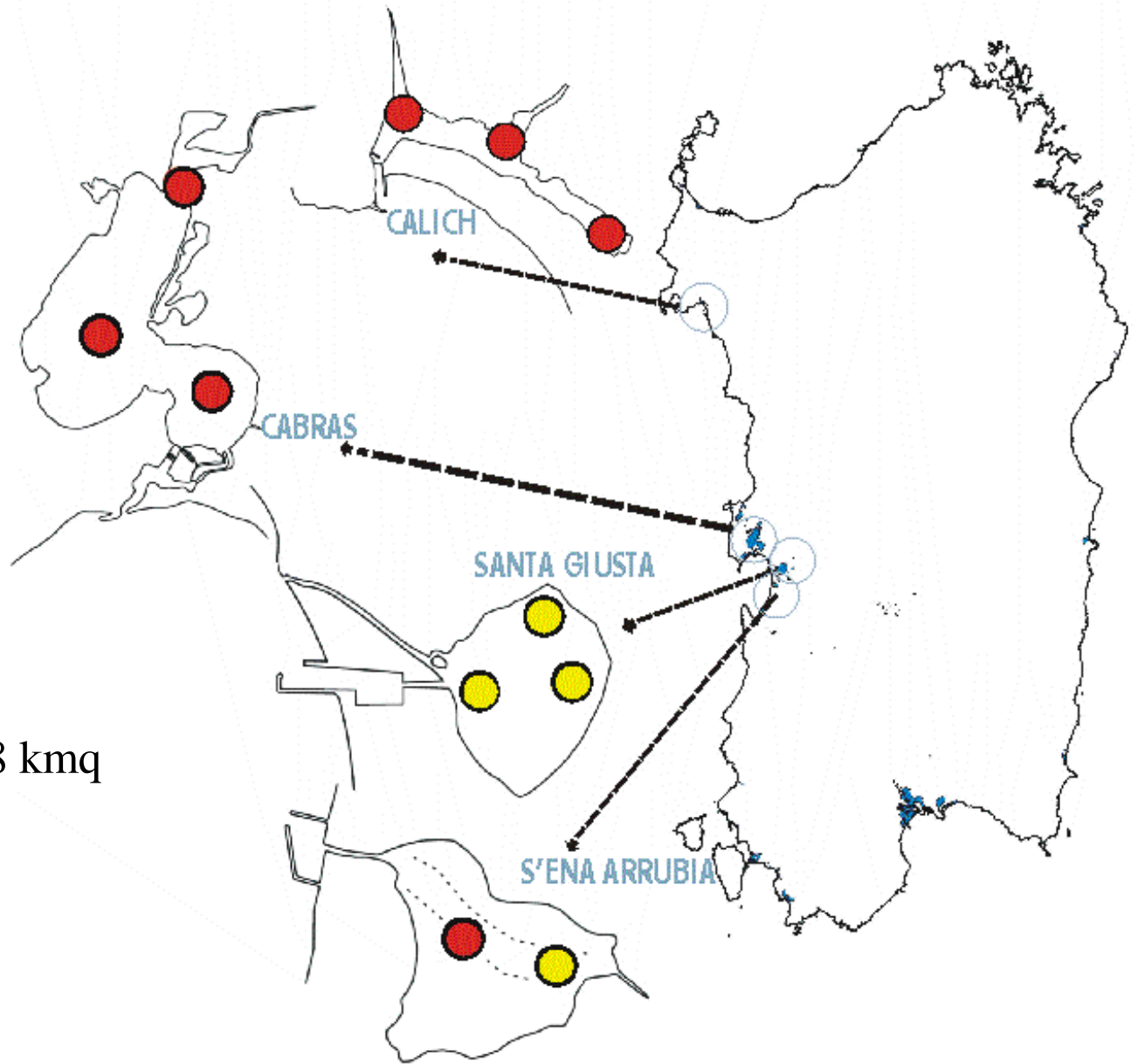


# Validation

# Venice Lagoon



# Validation



## Sardinia ponds

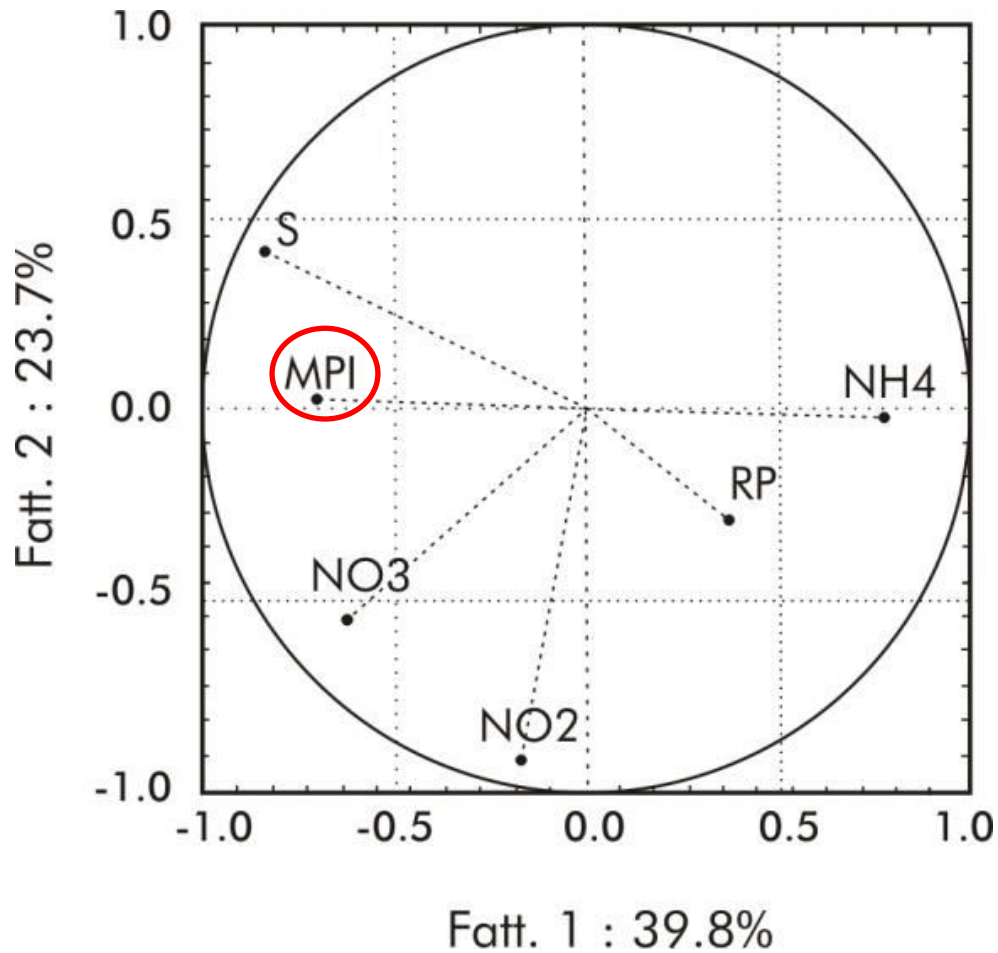
Surface from 0.87 to 27.8 kmq

Direct:  
Fishing and aquaculture

Indirect:  
Agriculture and zootechnics



# Validation



	MPI
SALINITY	0,46*
REACTIVE PHOSPHORUS	-0,52*



# Conclusion

- In restricted zones, water exchanges favour good conditions, whereas in industrial and urban areas moderate conditions were recorded.
- In choked zones, water conditions were more uniform.
- Sardinia ponds had bad/poor conditions.
- Salinity and reactive phosphorus appeared to be the main drivers.





Thank you for the  
attention



facca@unive.it

