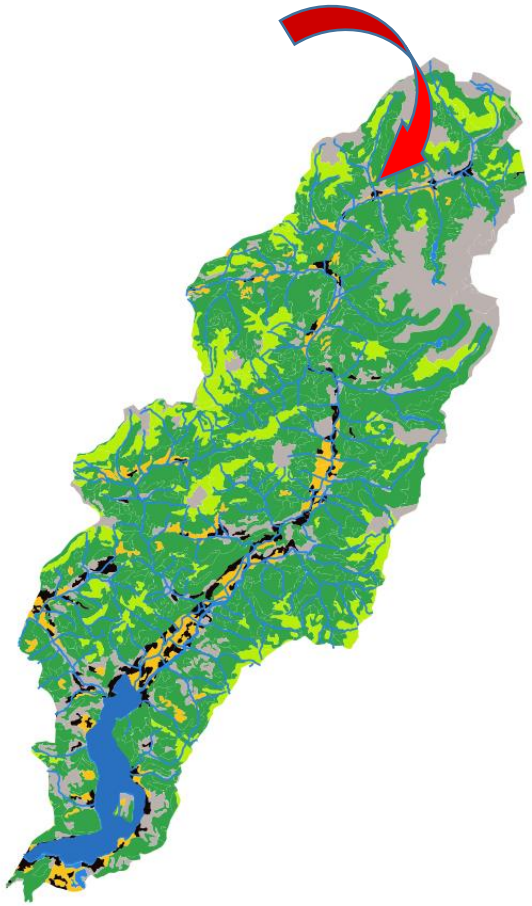
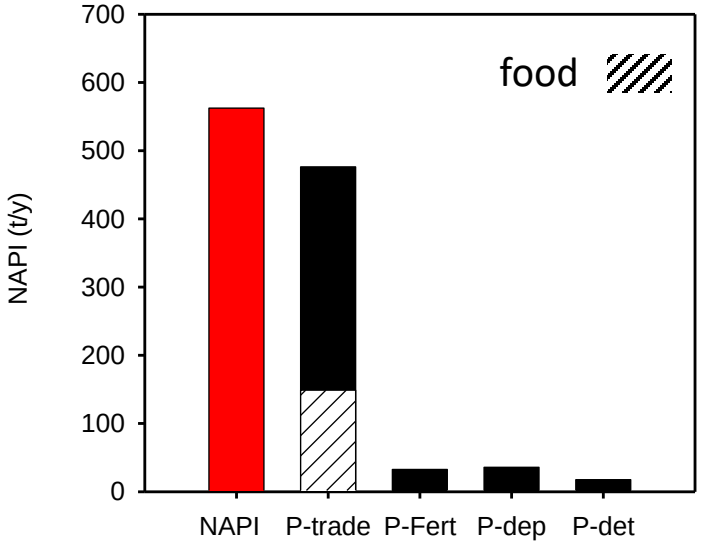
ISEO: **I**mproving the lake **S**tatus from **E**utrophy towards **O**ligotrophy

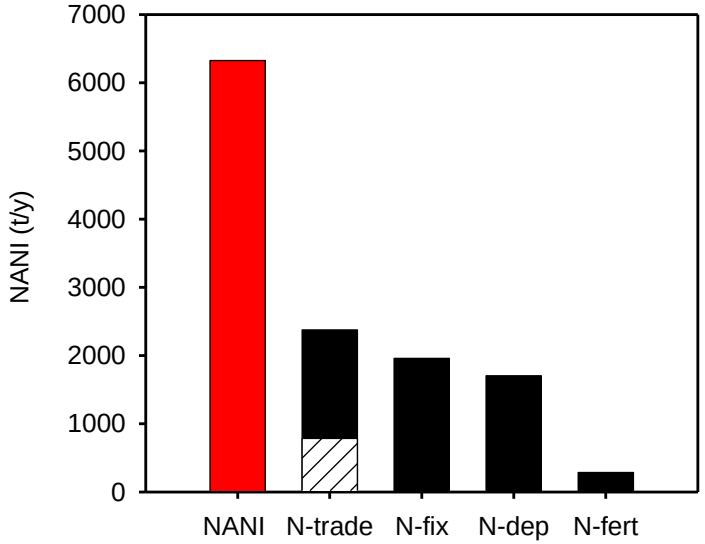
University of Parma

Nutrient loads, factors affecting
their availability and response of submerged vegetation

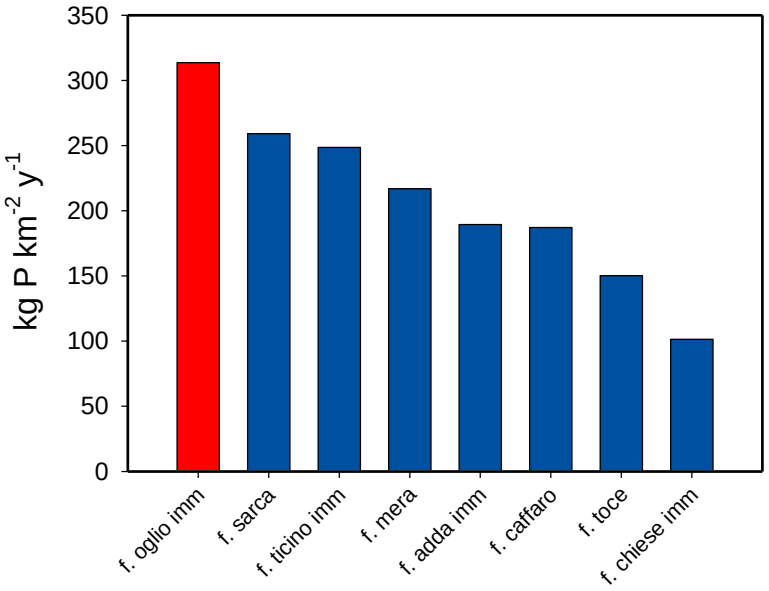
Net anthropogenic P and N input to lake Iseo watershed

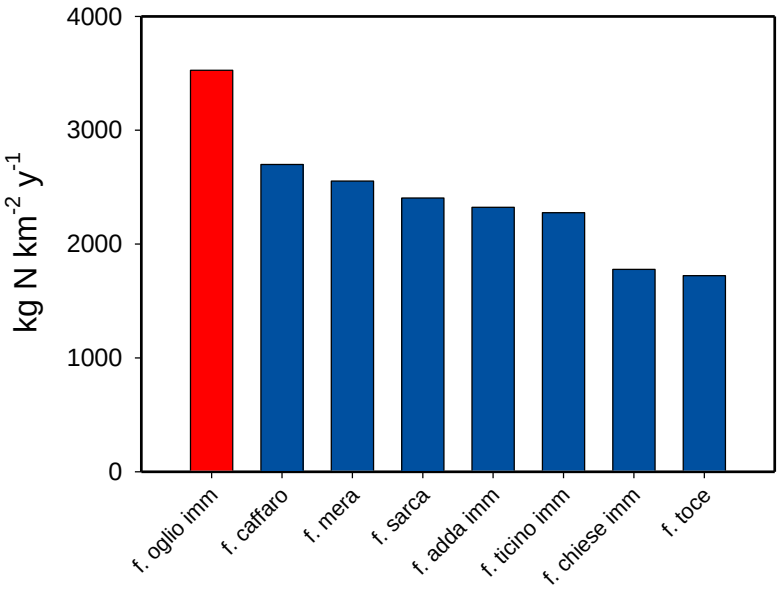






Net anthropogenic P and N input to watersheds: a comparison





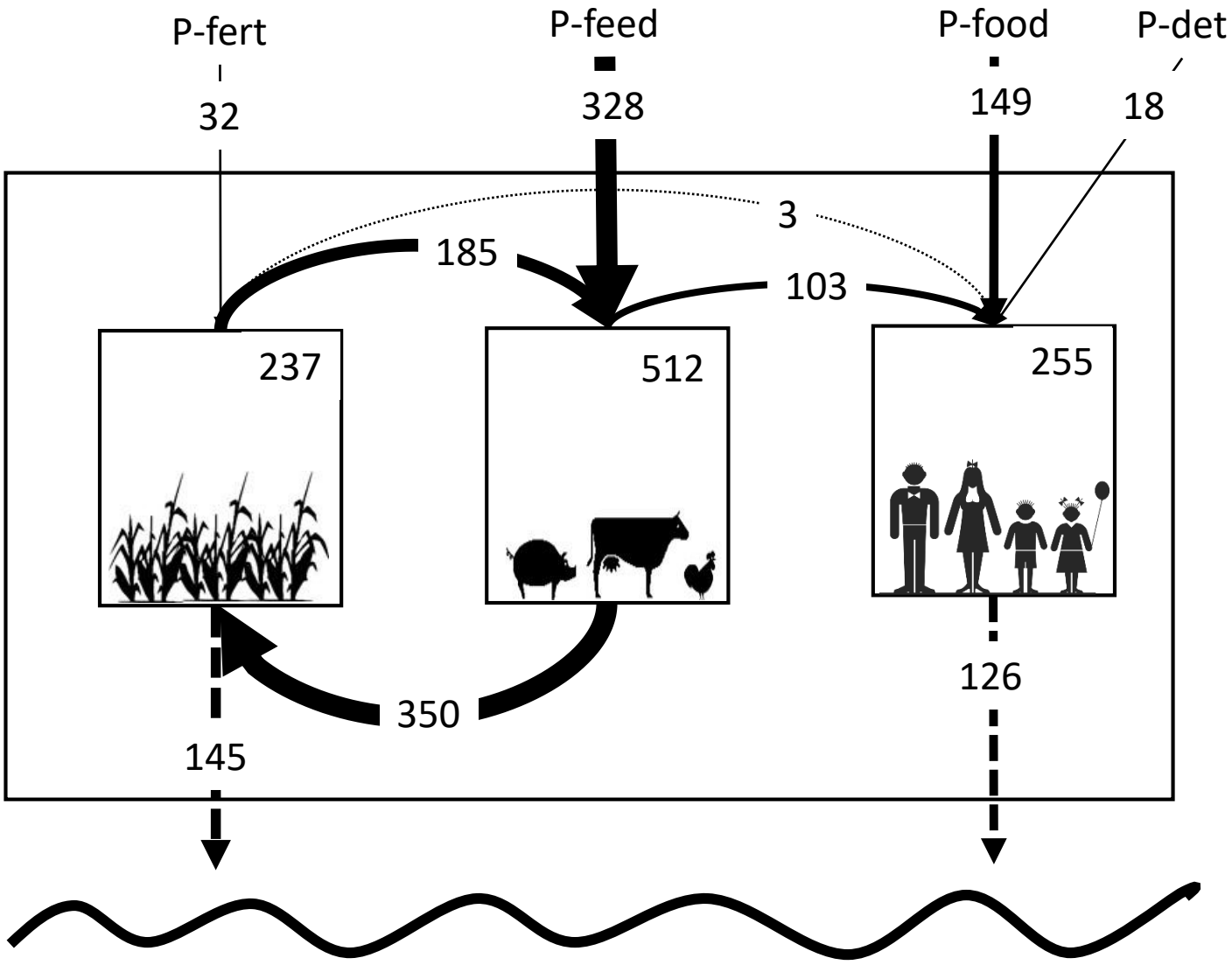
Net anthropogenic phosphorus input = **562 t P y^{-1}**,
(areal load of 314 kg P km^{-2} y^{-1})

average Po river watershed: 800 kg N km^{-2} y^{-1}

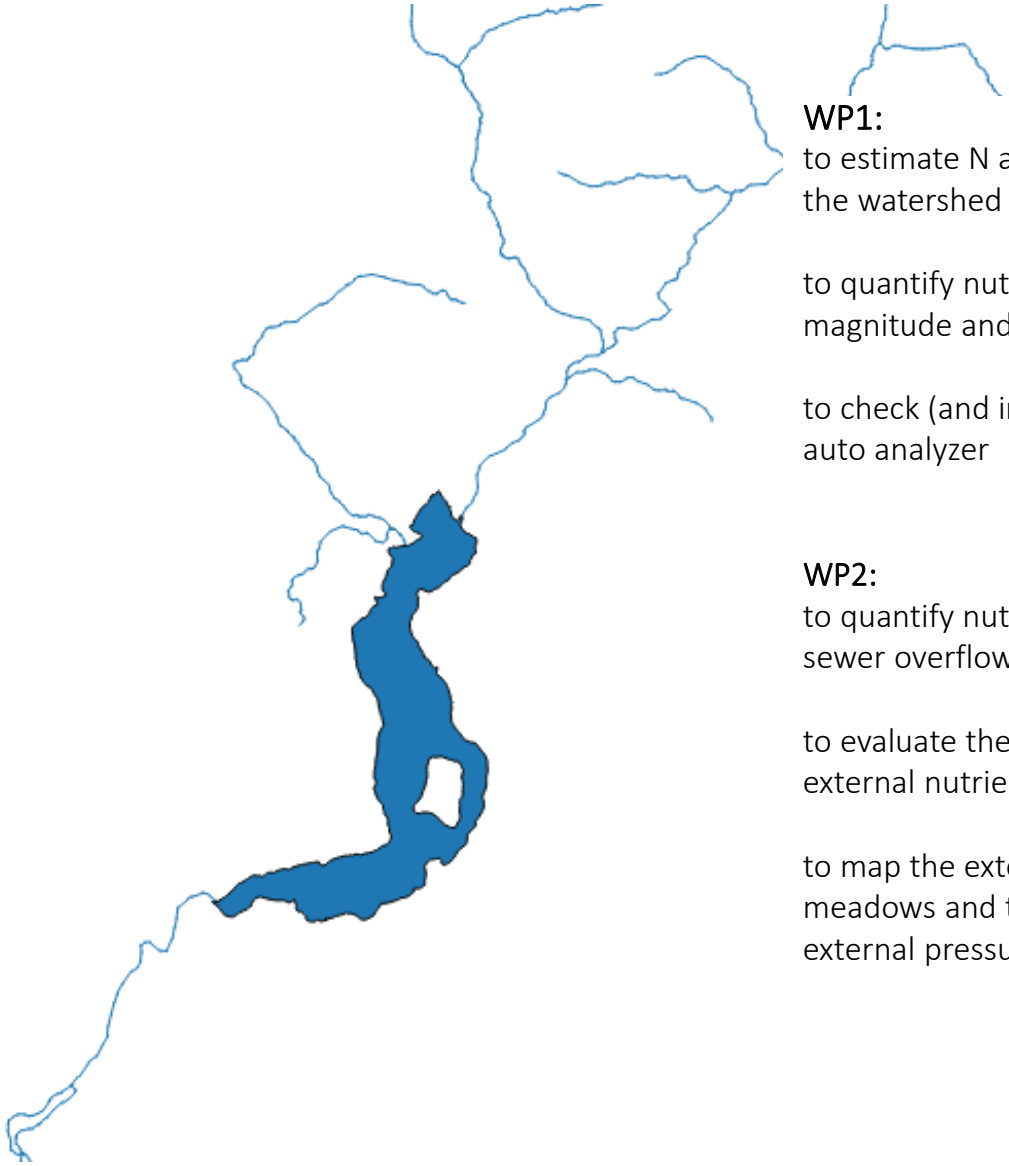
Net anthropogenic nitrogen input = **6325 t N y^{-1}**
(areal load of 3526 kg N km^{-2} y^{-1})

average Po river watershed: 8000 kg N km^{-2} y^{-1}

all fluxes are tons/y



Main activities



WP1:
to estimate N and P potential loads of the different anthropic activities in the watershed

to quantify nutrients (P, N and Si) loads to lake Iseo, evaluate how their magnitude and bioavailability are affected by hydrological conditions

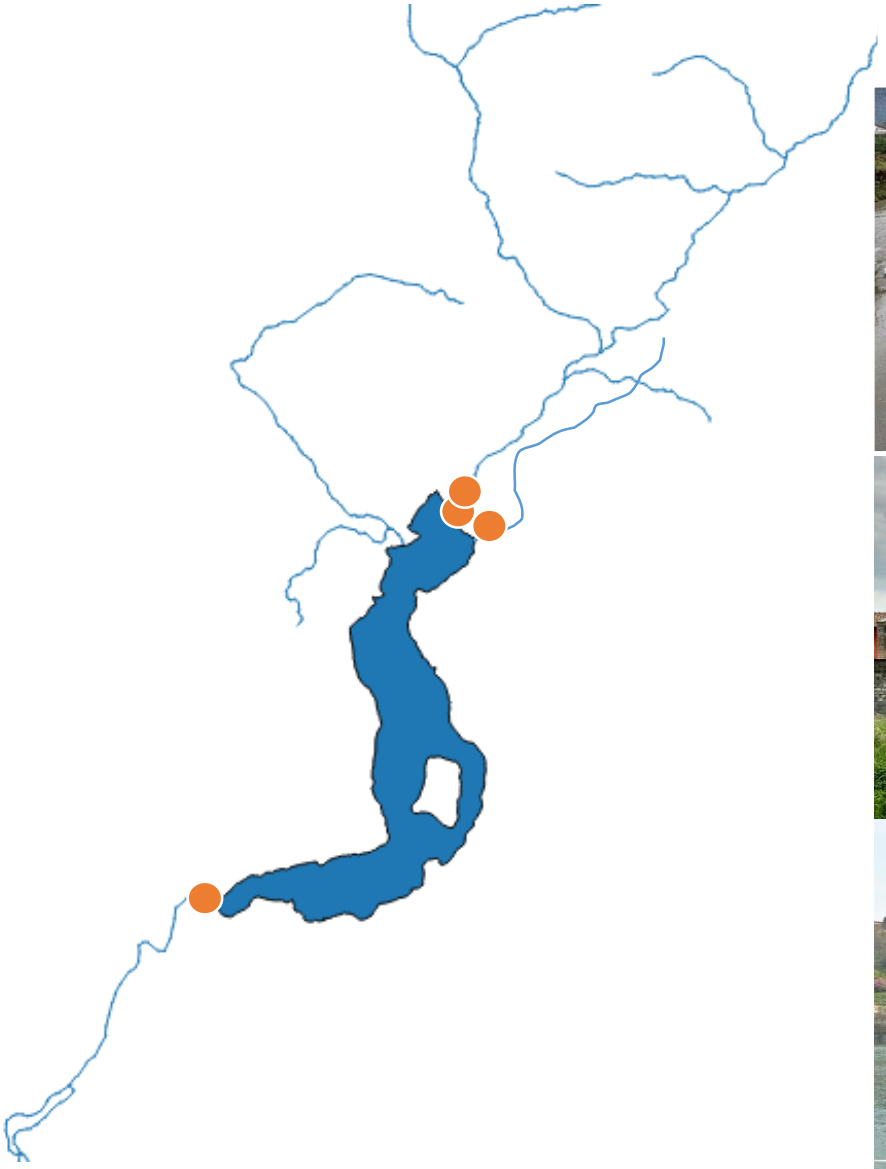
to check (and improve) the accuracy of P determination by the *in situ* auto analyzer

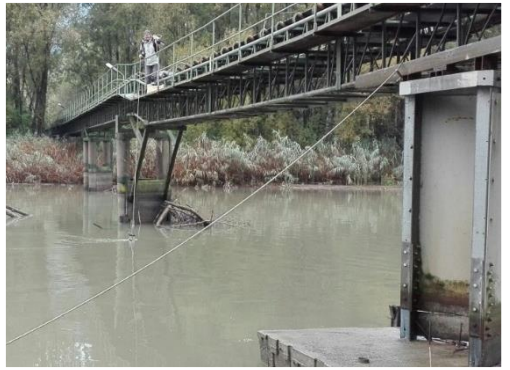
WP2:
to quantify nutrients (P, N and Si) concentrations in waters discharged by sewer overflows

to evaluate the functioning of the littoral areas as a buffer of the external nutrients loads

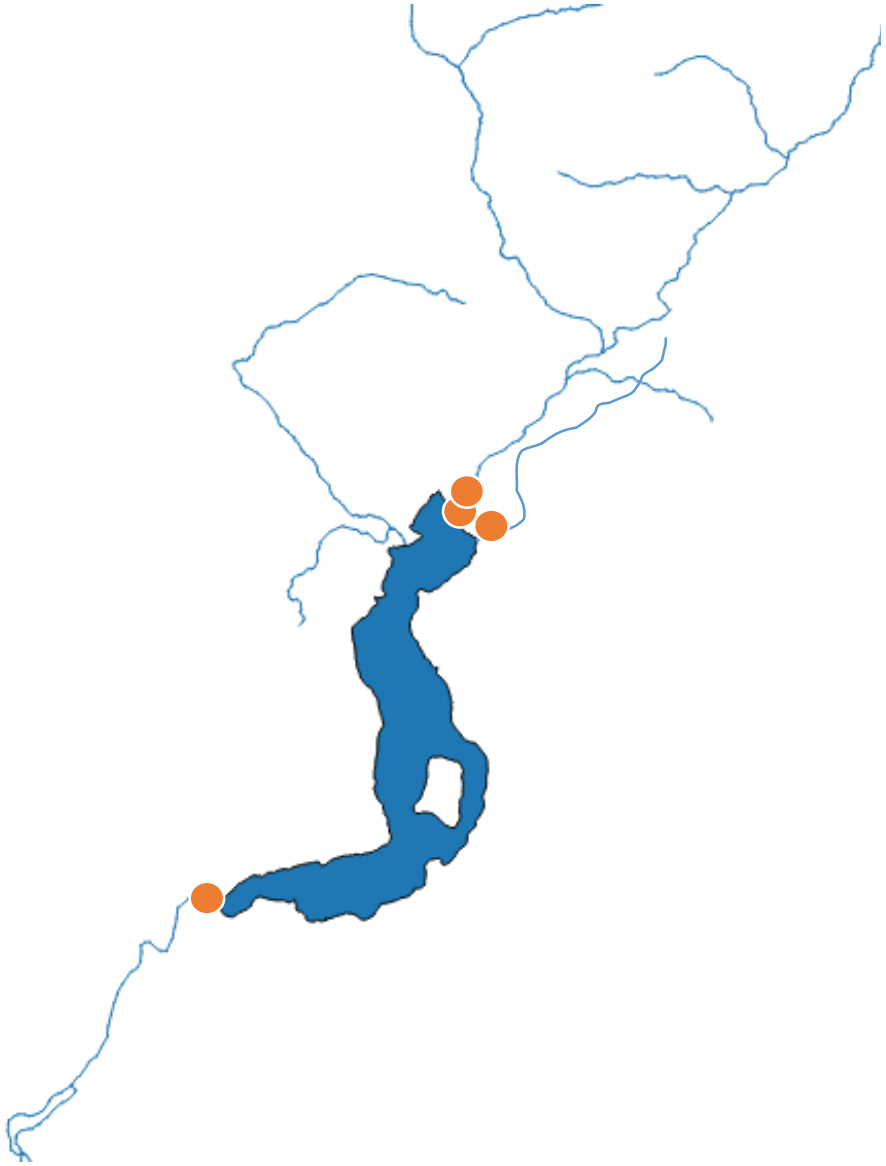
to map the extension and composition of submerged macrophytes meadows and their nutrients content and how they change in relation to external pressures

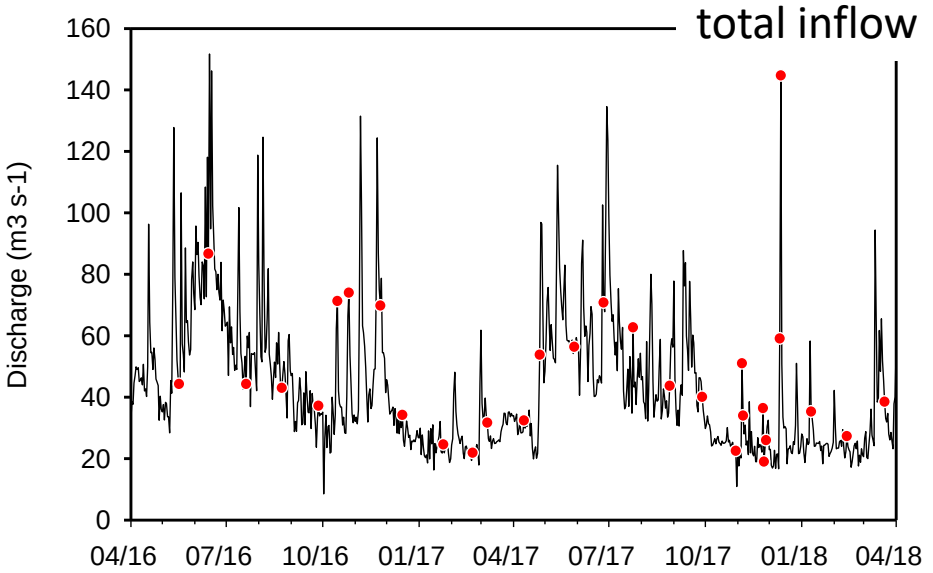
Water quality and P, N and Si loads: where

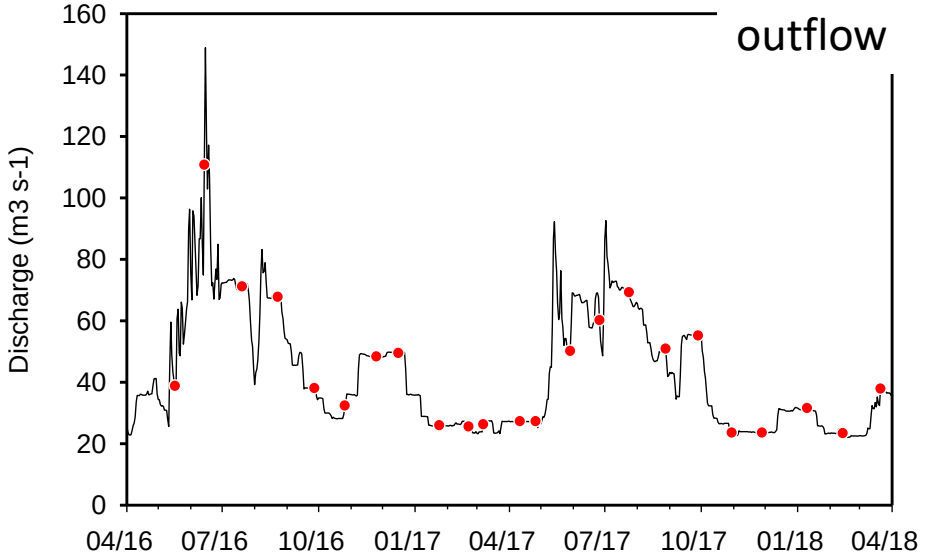




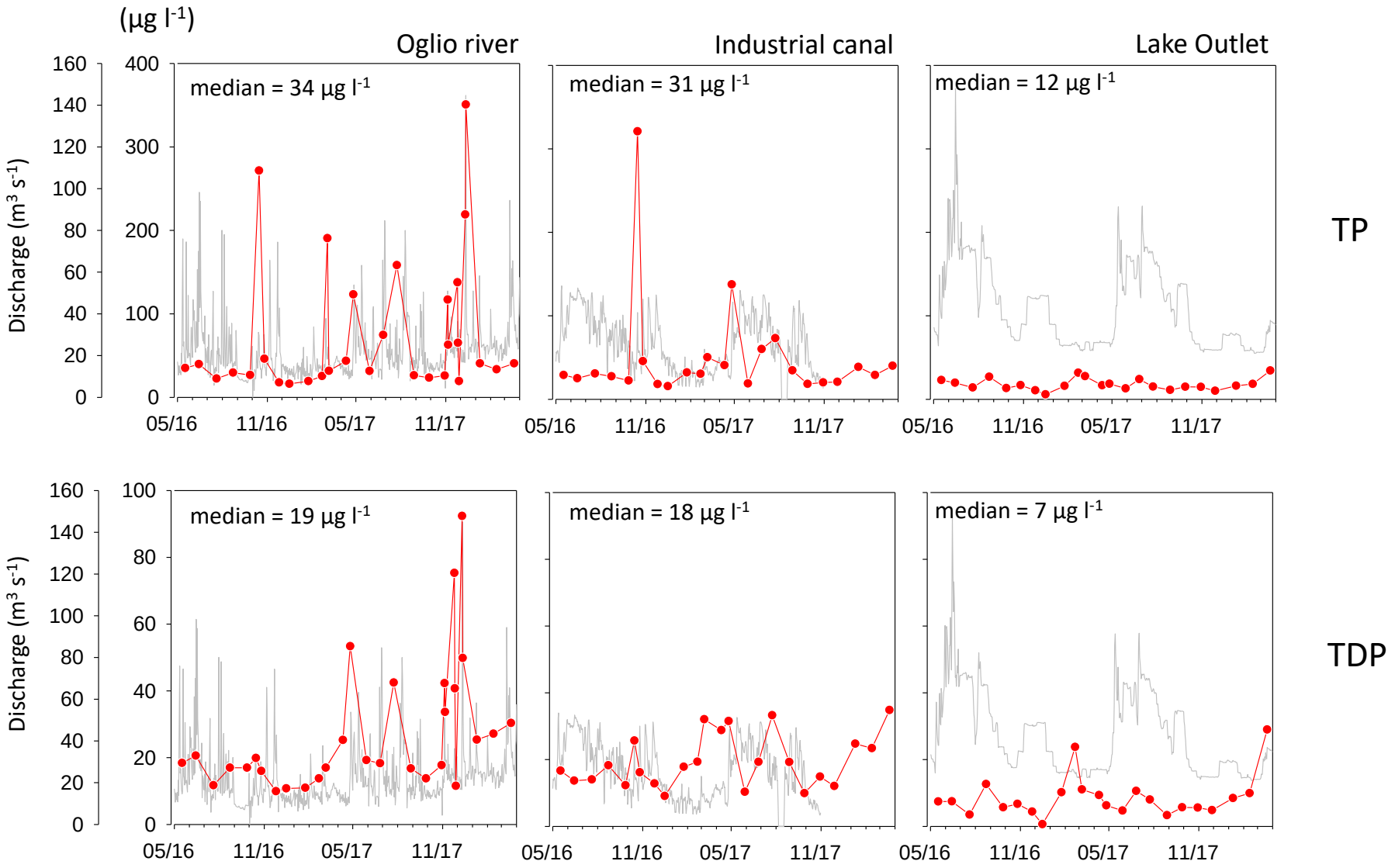
Water quality and P, N and Si loads: where and when



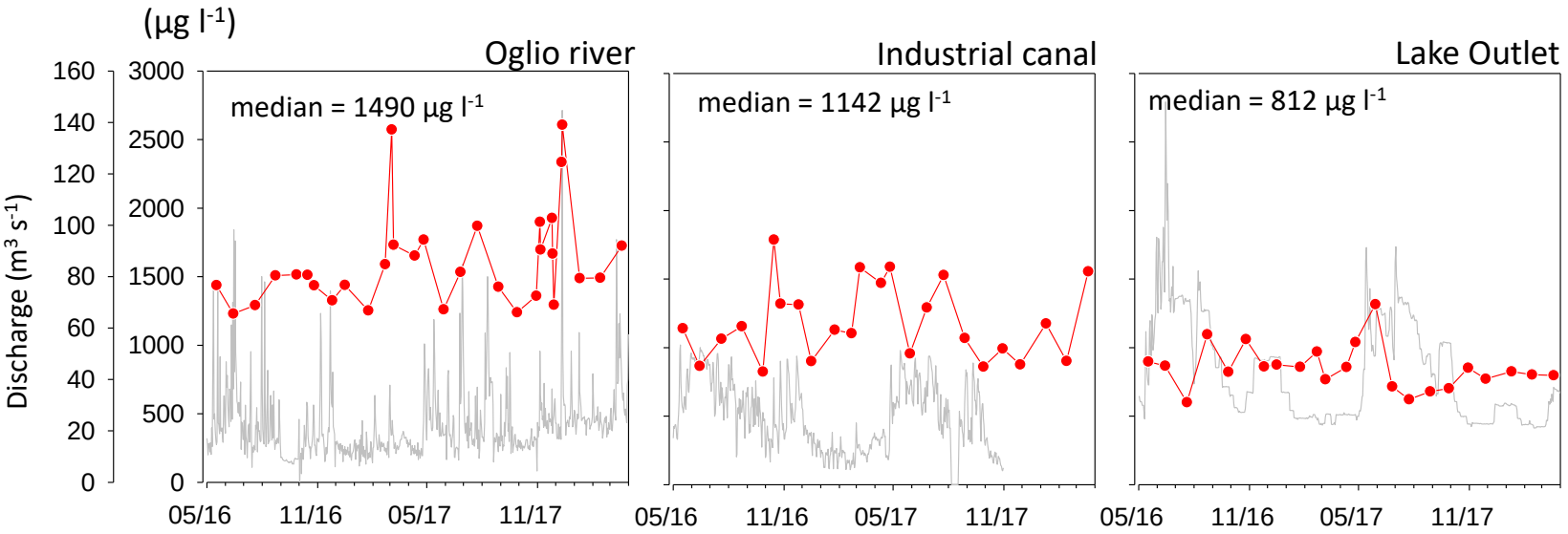




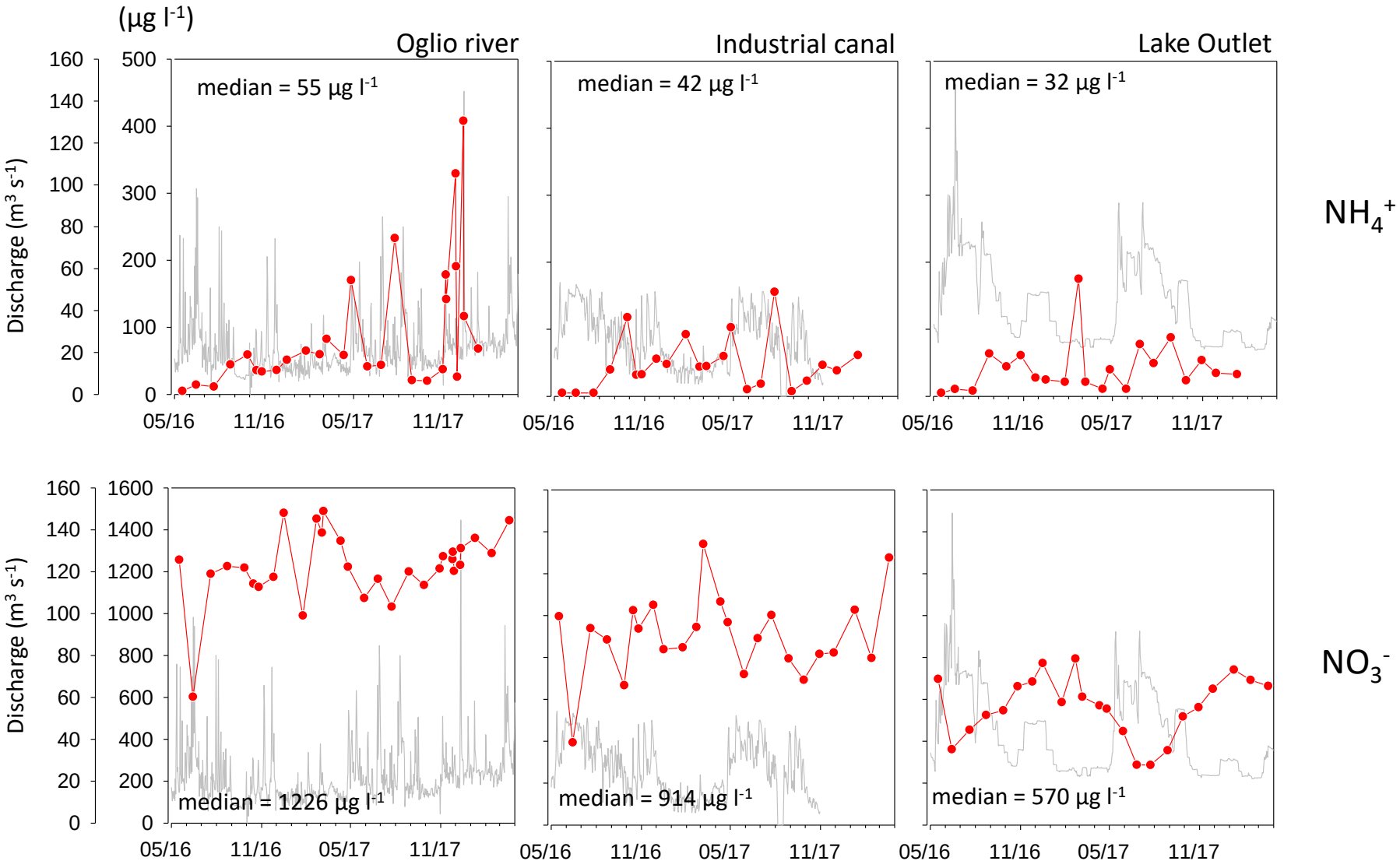
Temporal and spatial variability of total and dissolved P concentrations



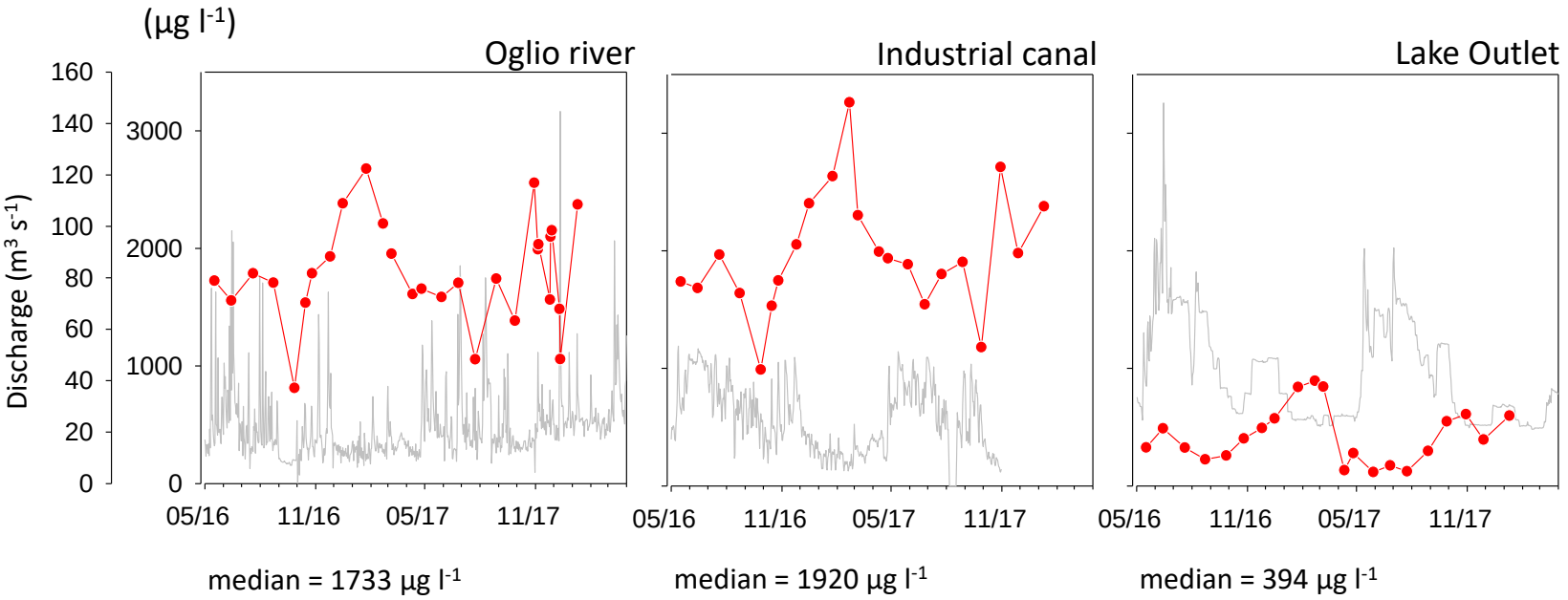
Temporal and spatial variability of total N concentrations



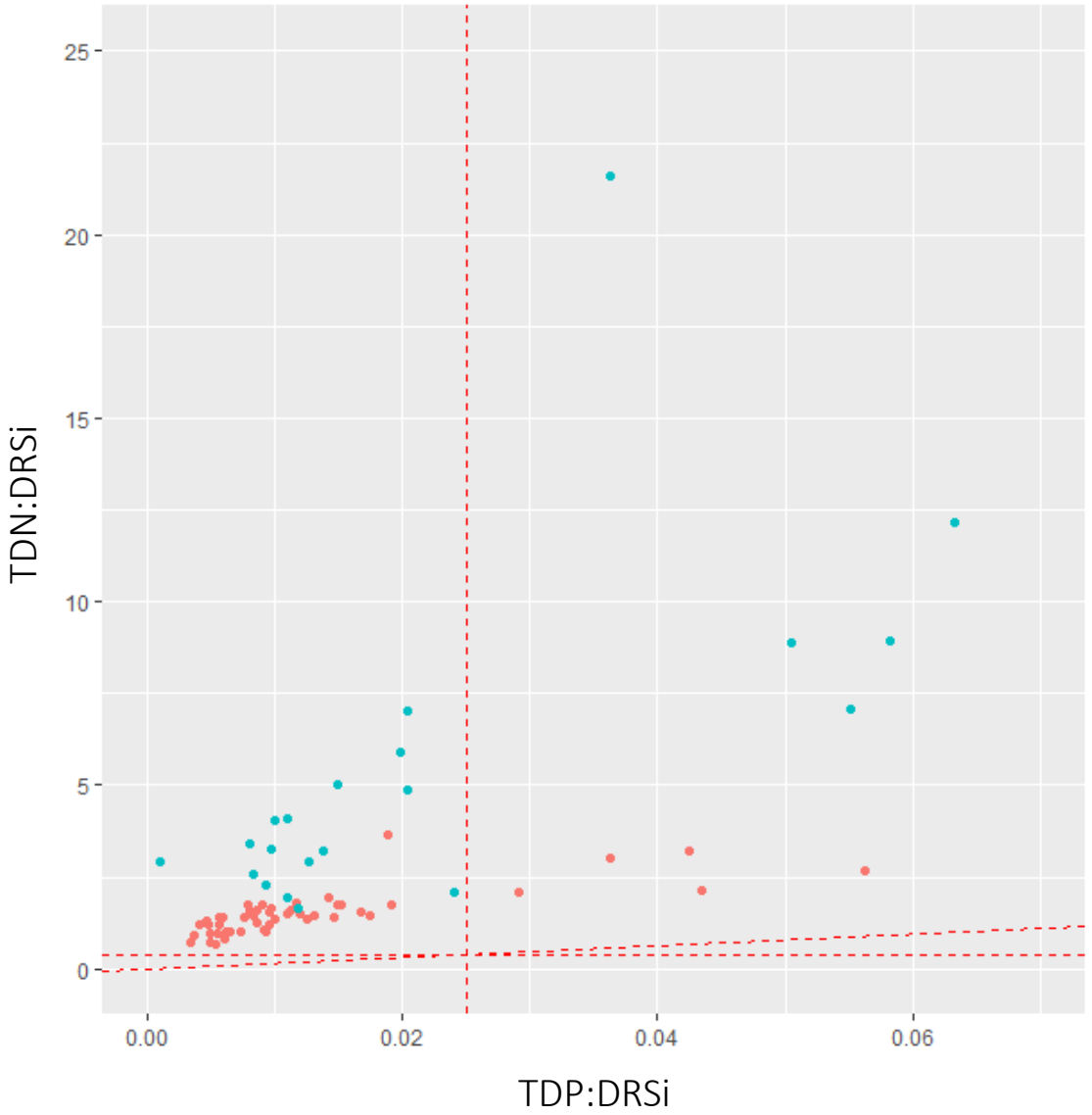
Temporal and spatial variability of ammonium and nitrate concentrations



Temporal and spatial variability of dissolved silica concentrations



Dissolved nutrients stoichiometry



P limiting compared to N and Si

Si limiting compared to N

In lake biogeochemical processes increase both P and Si limitation compared to N

Nutrient loads calculation: a first tentative

$$L = \frac{\sum(Qi * Ci)}{\sum Qi} * \overline{Q_{tot}} * k$$

nutrient loadings to and exports from the lake were computed as the product of the discharge weighted mean concentration by the average annual discharge of the two years.

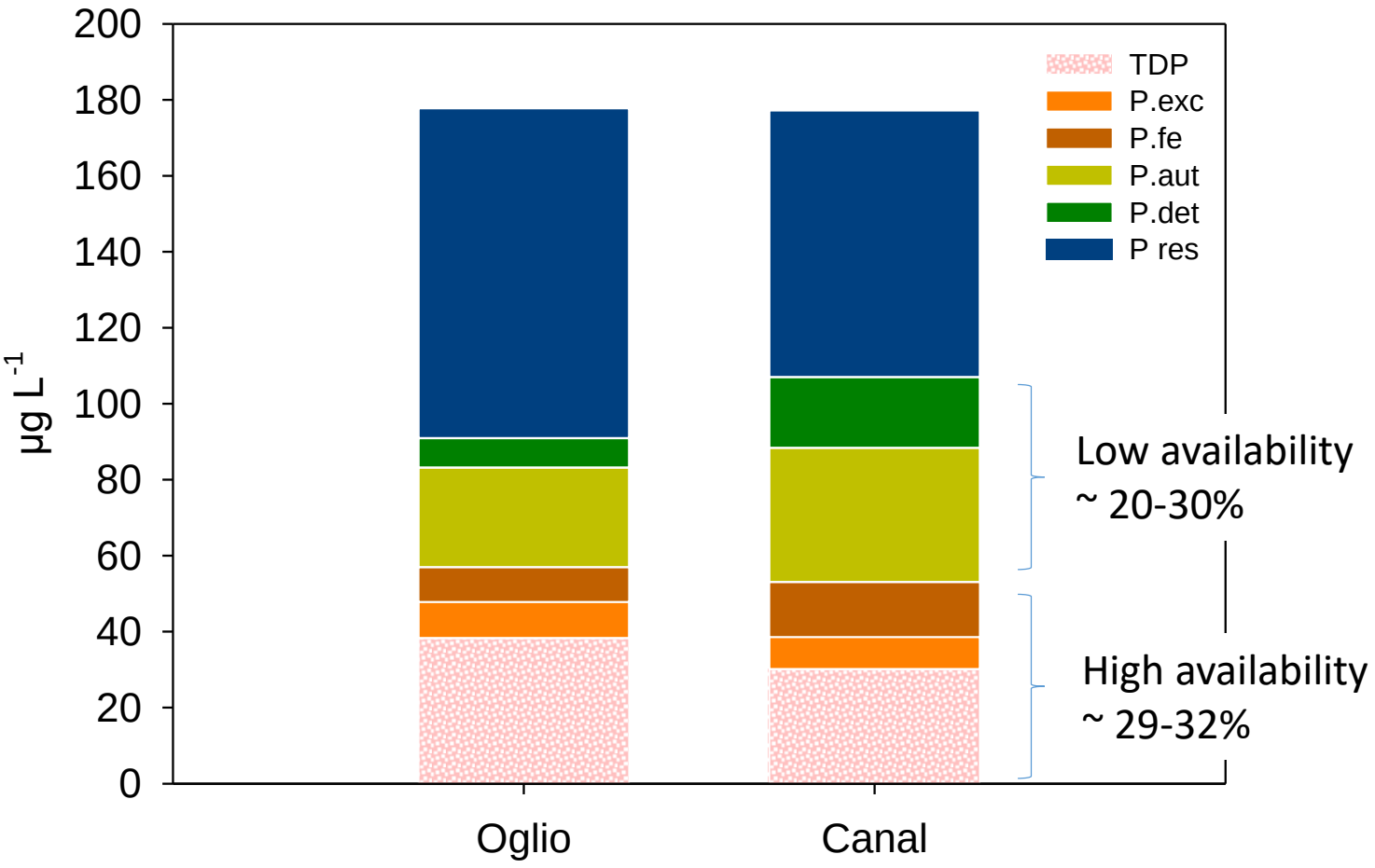
t year^{-1}

	TDP	PP	TP	NH4	NO3	TDN	PN	TN	DRSi
Oglio river	16	49	65	53	691	857	127	990	981
I. Canal	14	29	44	33	692	883	61	939	1467
Total	31	78	110	86	1384	1740	188	1930	2448
Outlet	11	13	24	54	714	1075	85	1153	548

P bioavailability during high flow

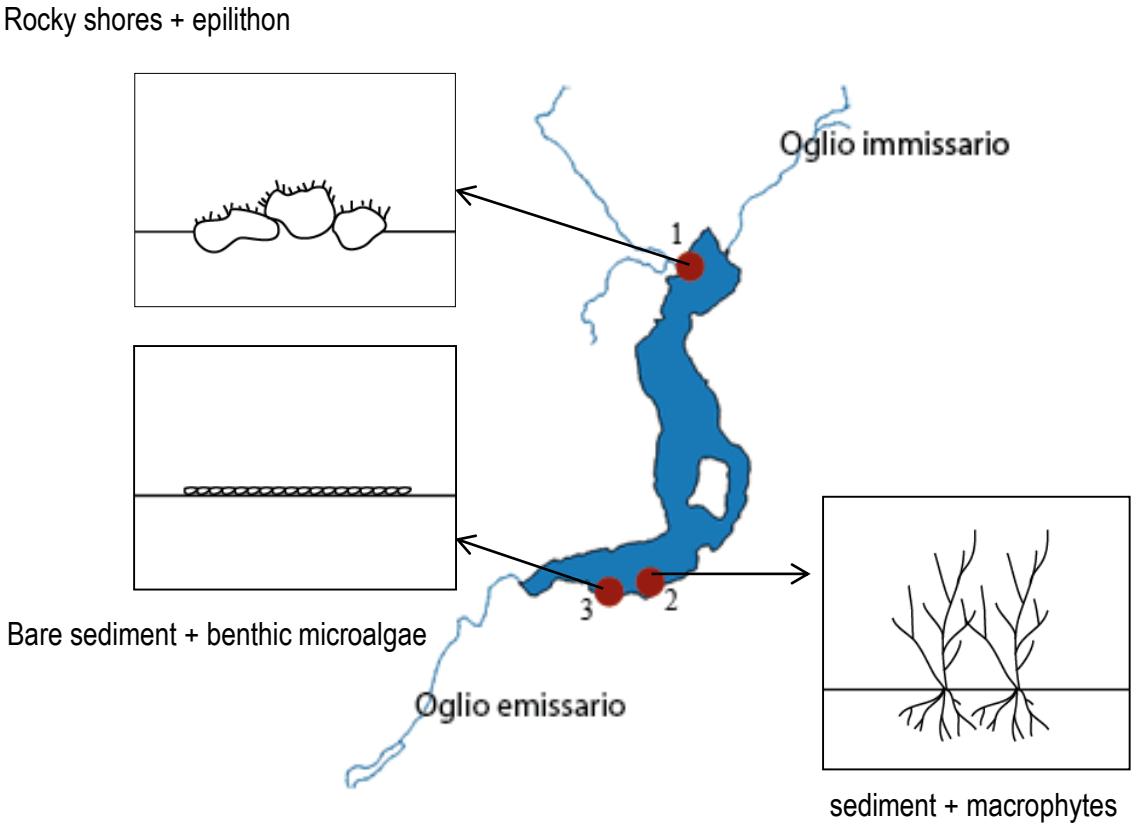
Bioavailability	Extracted fraction	Extraents
HIGH	P-exchangeable	$MgCl_2$ (pH=8)
	P-Fe	CDB (citrate-dithionite-bicarbonate) (pH=7)
	P-Ca (authigenic)	Sodium Acetate (pH=4)
LOW	P-Ca (detrital)	HCl (pH=1)

P bioavailability during high flows



Biogeochemical functioning of the littoral zone

to evaluate if the littoral zone is a net P and N sink or source in relation to habitat heterogeneity



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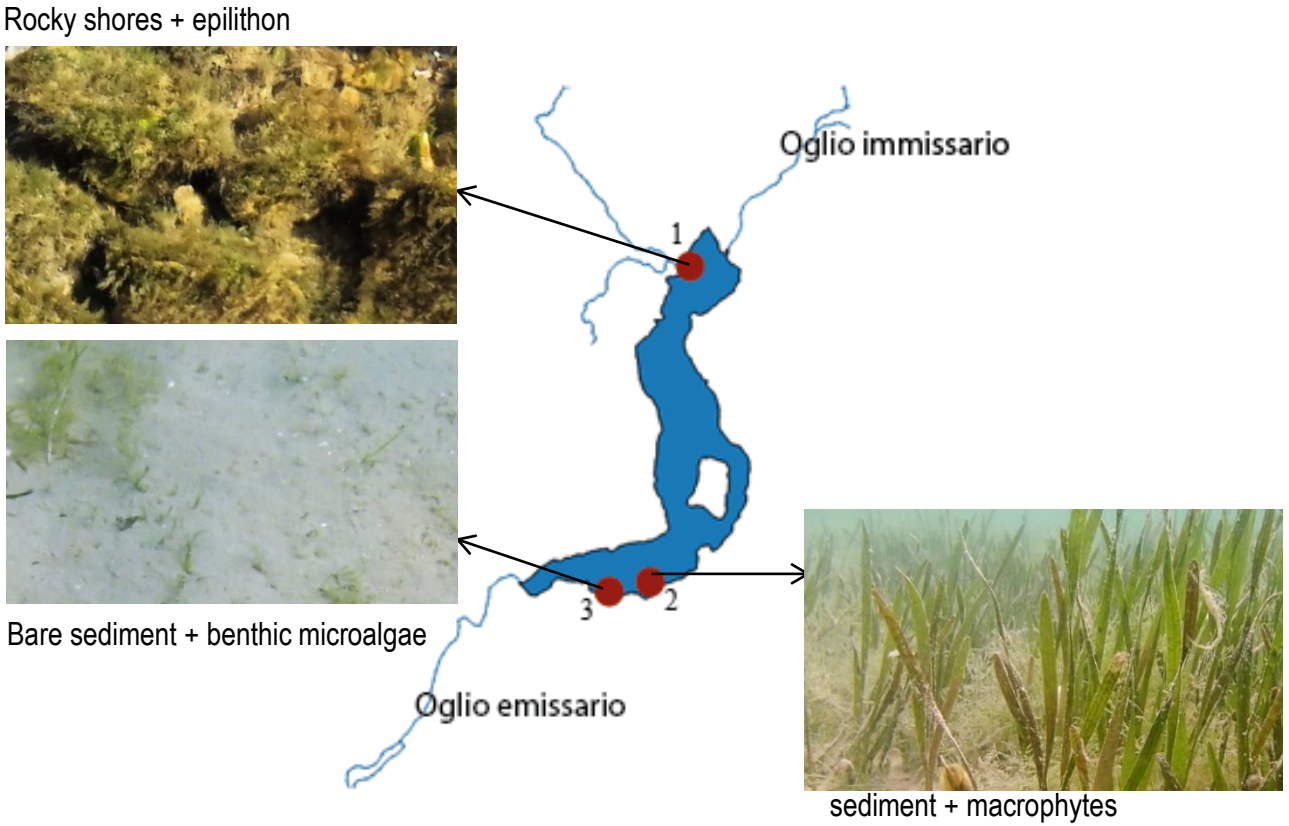


Sampling activities

Sampling activities during the summer growing season, from early to late summer (May-October)

Six cores (or six stones) collected for flux and denitrification measurements

Additional five sediment cores collected for sediment characterization

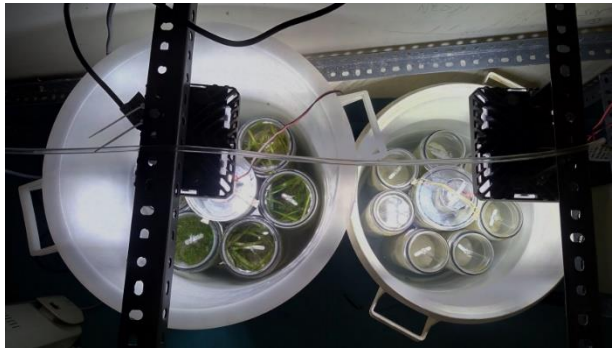
Biomass estimation

Biogeochemical functioning of the littoral zone

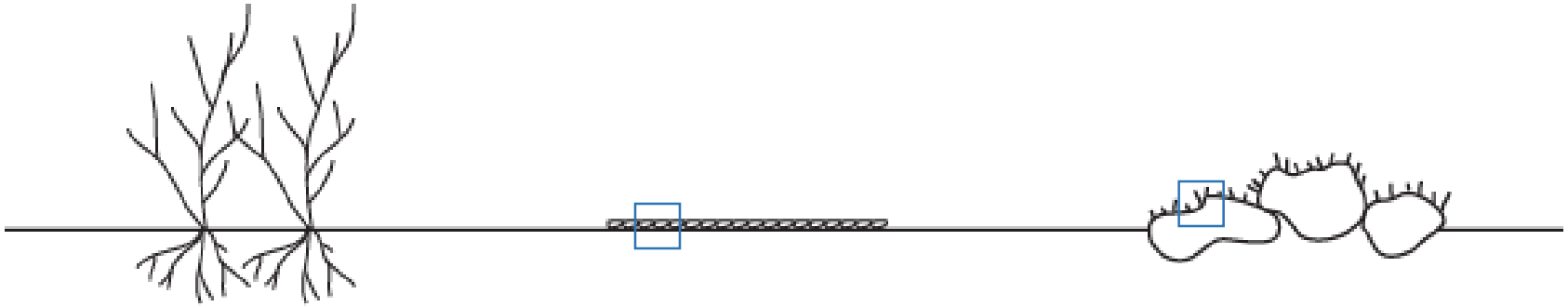
In the laboratory cores were submersed in lake water at the *in situ* temperature (±1), under a dark/light cycle close to that of the sampling period.

The day after the samplings, dark/light incubations were conducted to determine NEP, R and GPP, inorganic P and N net fluxes.

After the dark/light cycle, incubations with nutrient addiction were conducted to determine the potential nutrient assimilation of the three different sites.



Biomass of primary producers and nutrient content



Sediment + macrophyte meadows

In situ macrophyte biomass was estimated at each sampling date by scuba divers using a square PVC frame of 2500 cm^2 randomly positioned in triplicate.

The collected material was sorted into living leaves and roots+rhizomes and dried at 70°C and powdered to be analyzed for C, P and N content.

Bare sediment + benthic microalgae

Biomass of benthic microalgae was determined as chl-a extracted from 1 cm^3 of sediment.
A C:Chl = 30, a C:N = 9 and a C:P = 158 were assumed to calculate N and P retention in biomass.

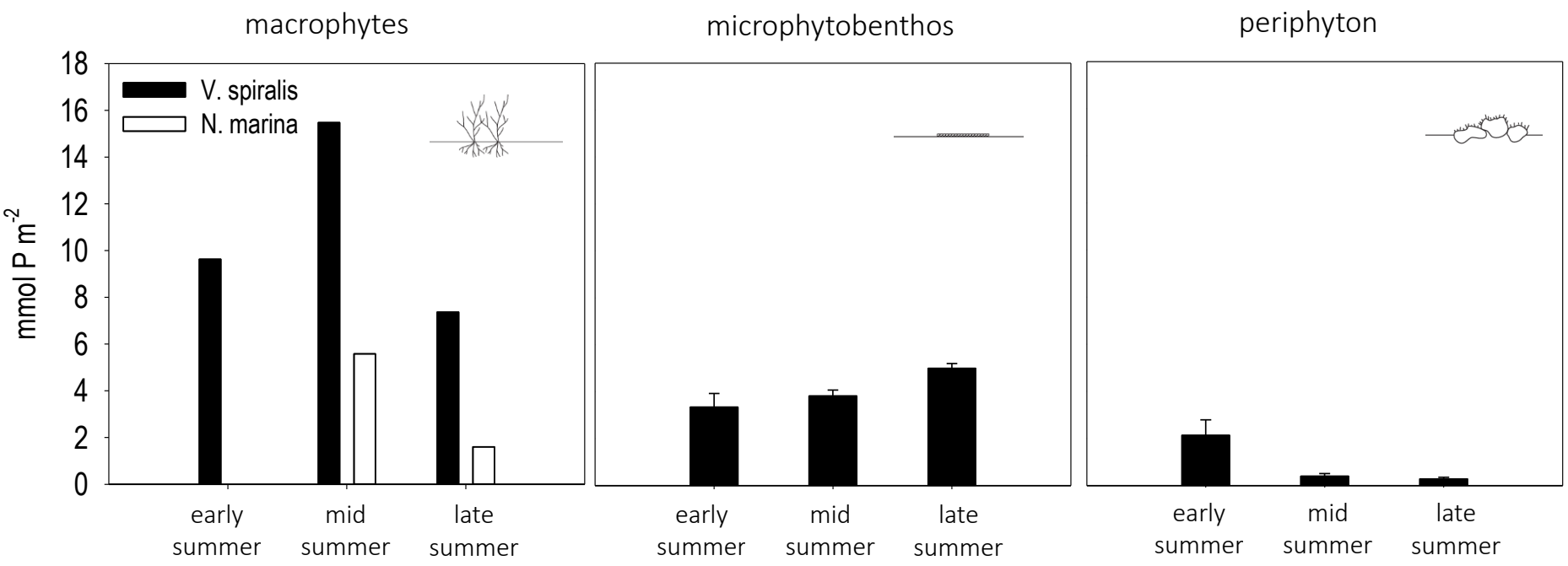
Rocky shores + epilithon

Periphyton was divided into filamentous algae and epilithic material.

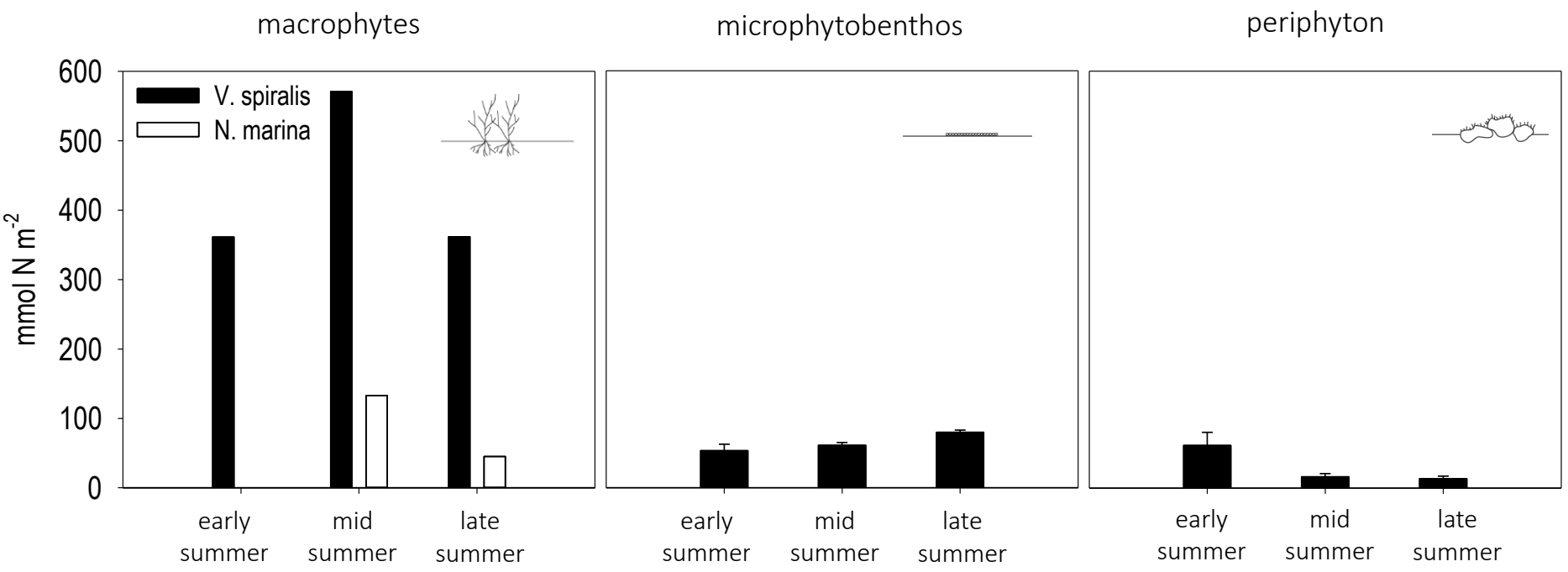
Biomass of periphyton was determined as chl-a on the material collected from the surface of each rock.

The collected material was dried at 70°C, powdered and analyzed for C, P and N content.

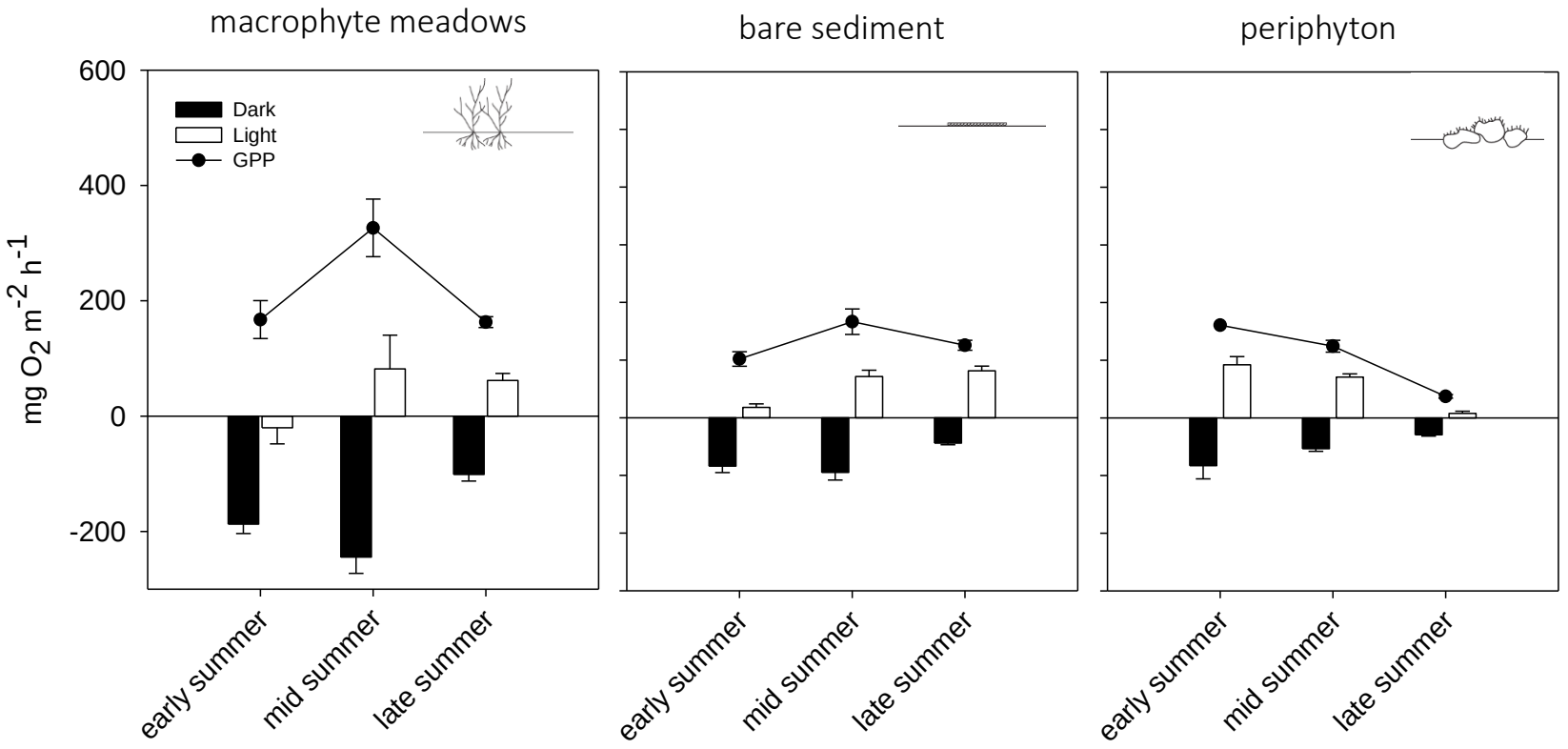
Phosphorus content in biomass



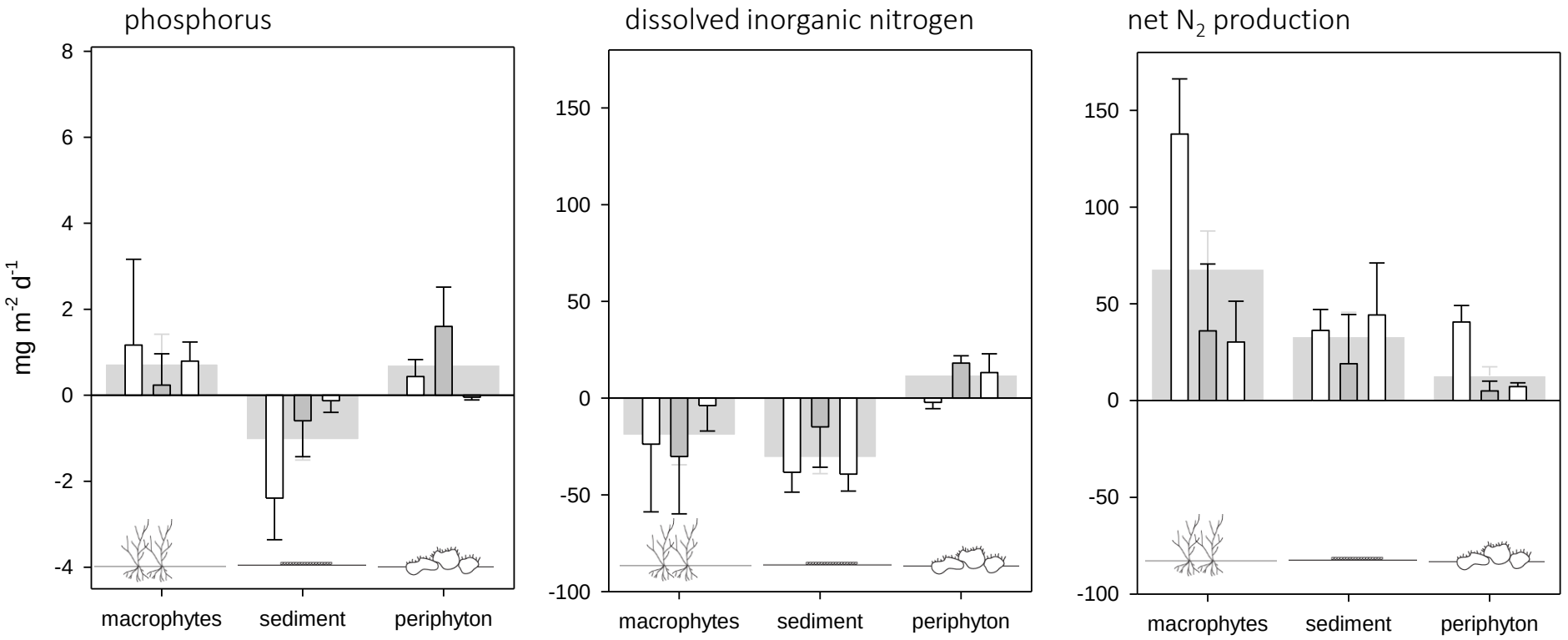
Nitrogen content in biomass



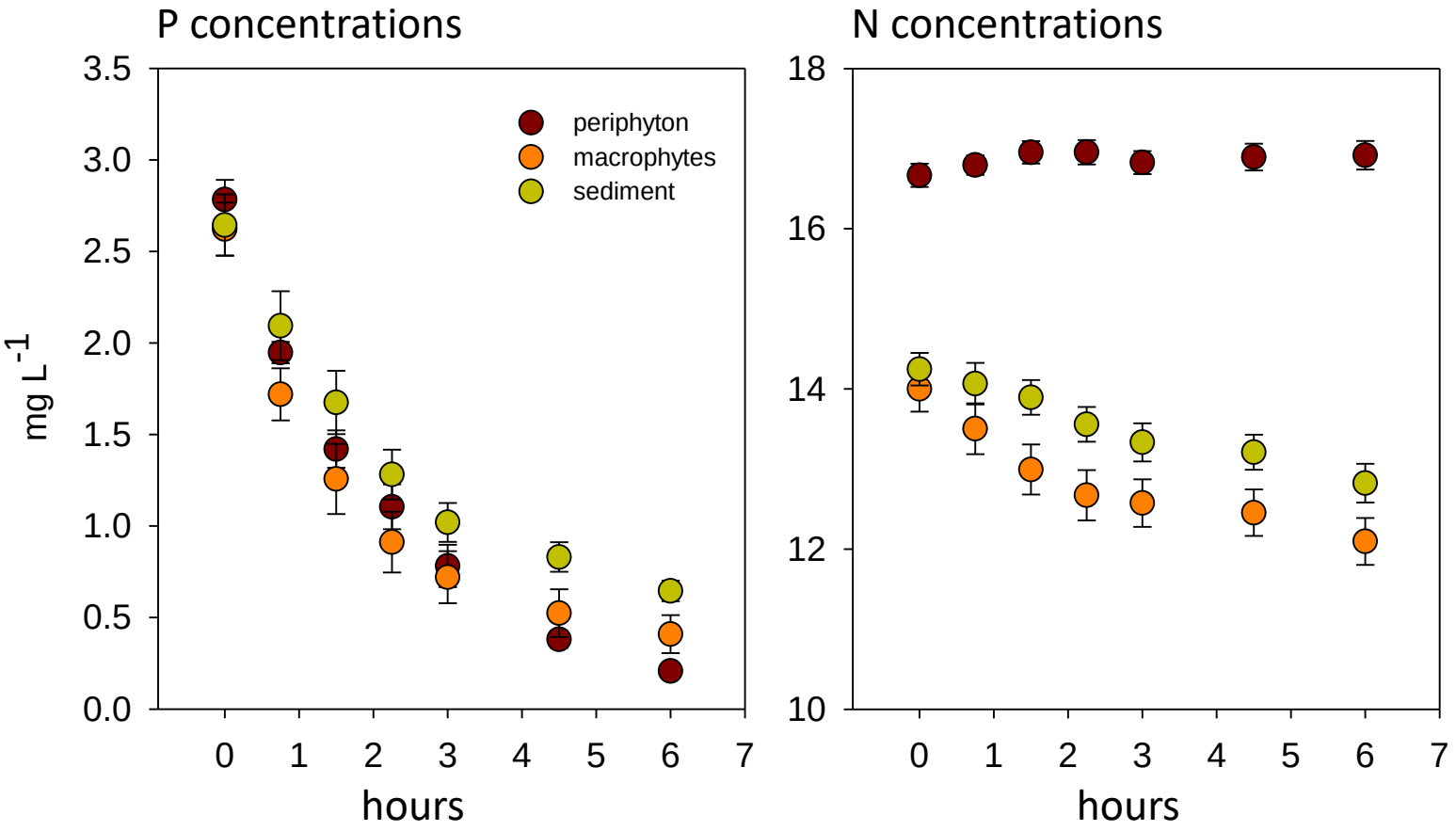
Benthic metabolism



Phosphorus and nitrogen fluxes across the sediment water interface



Response of littoral habitats to P and N enrichment



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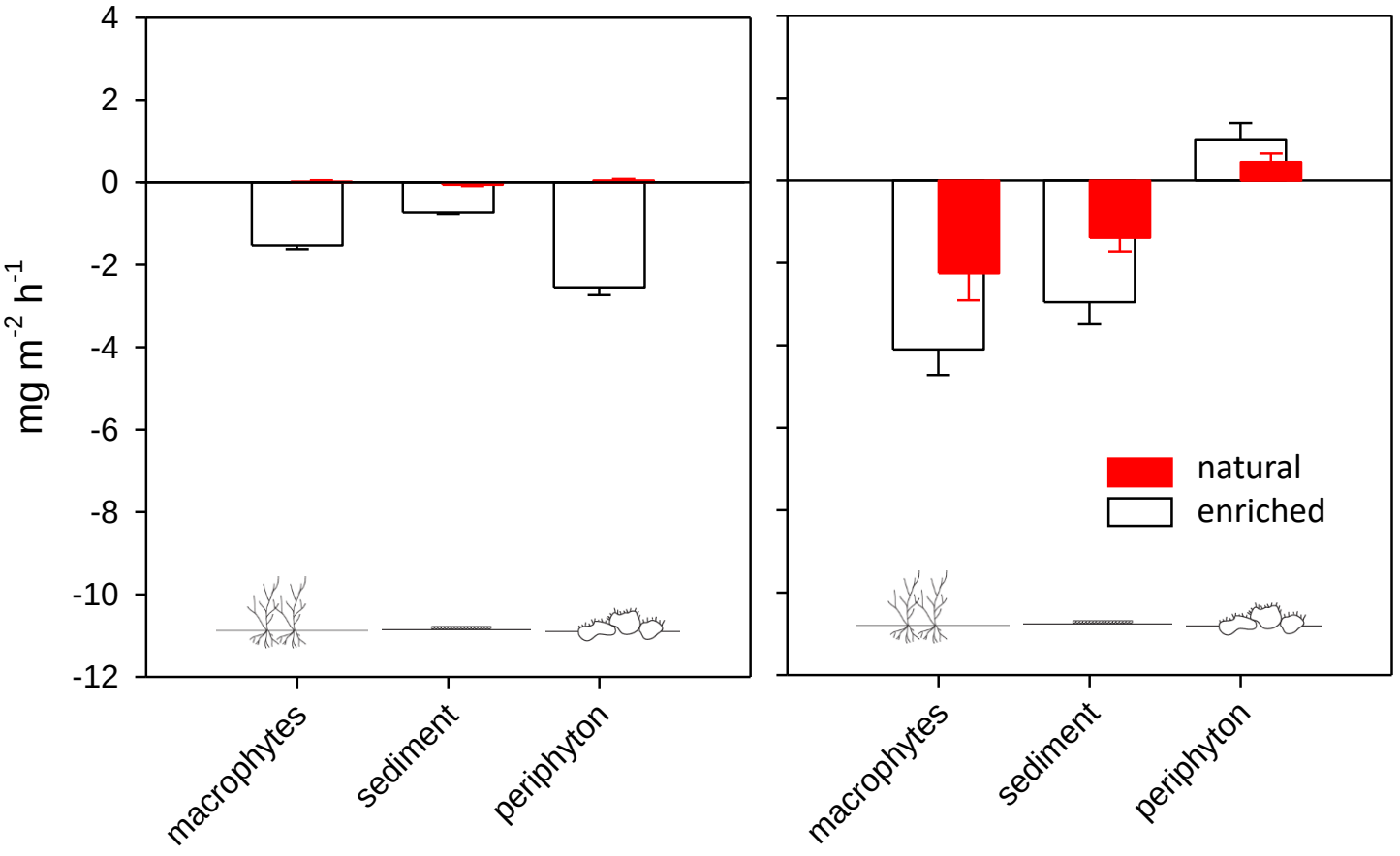
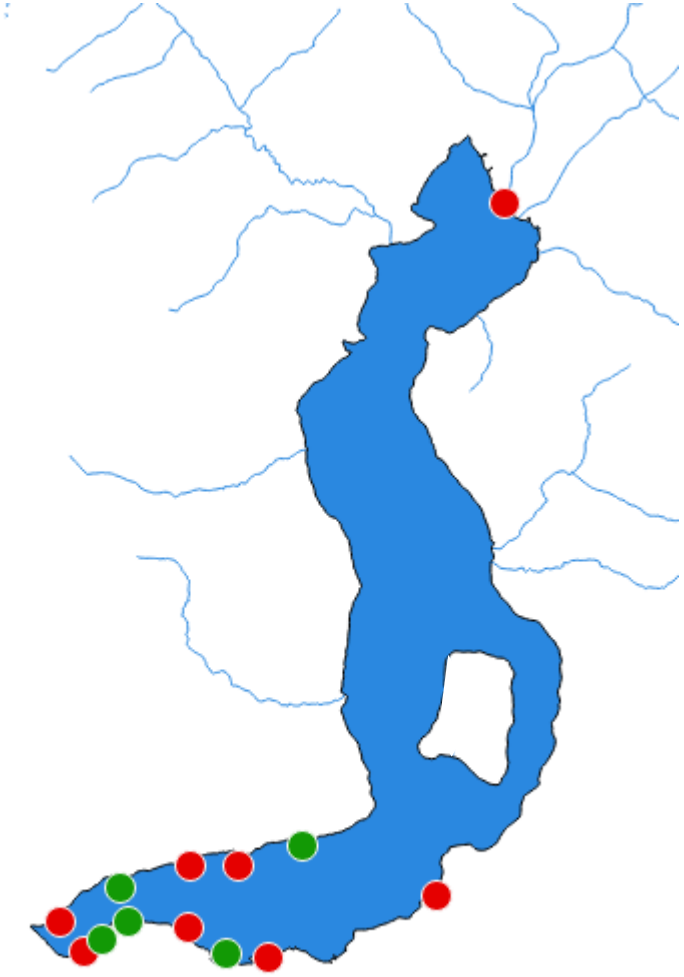
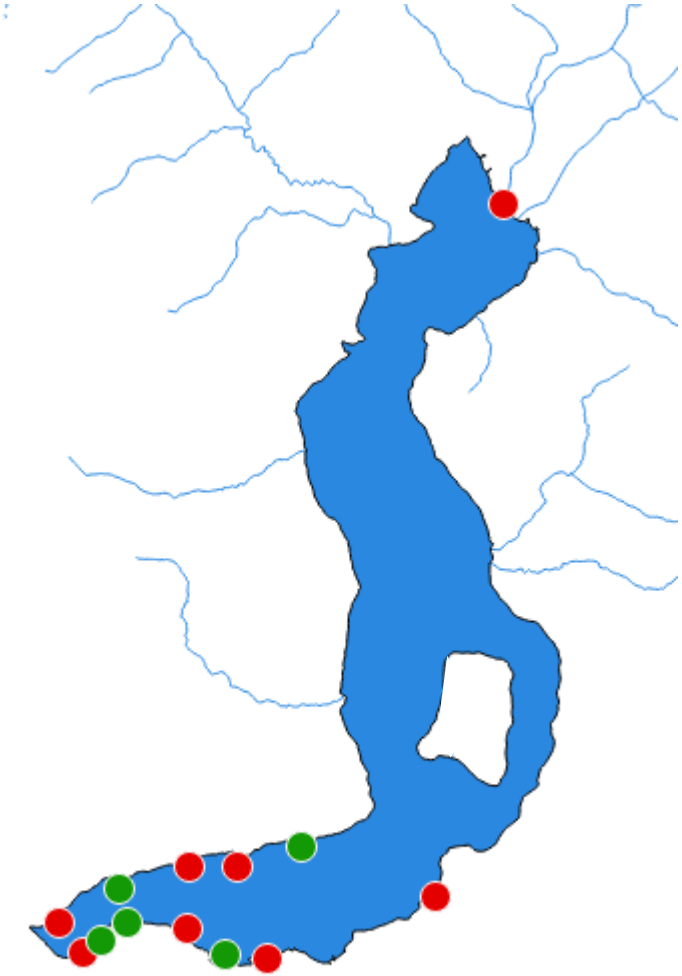


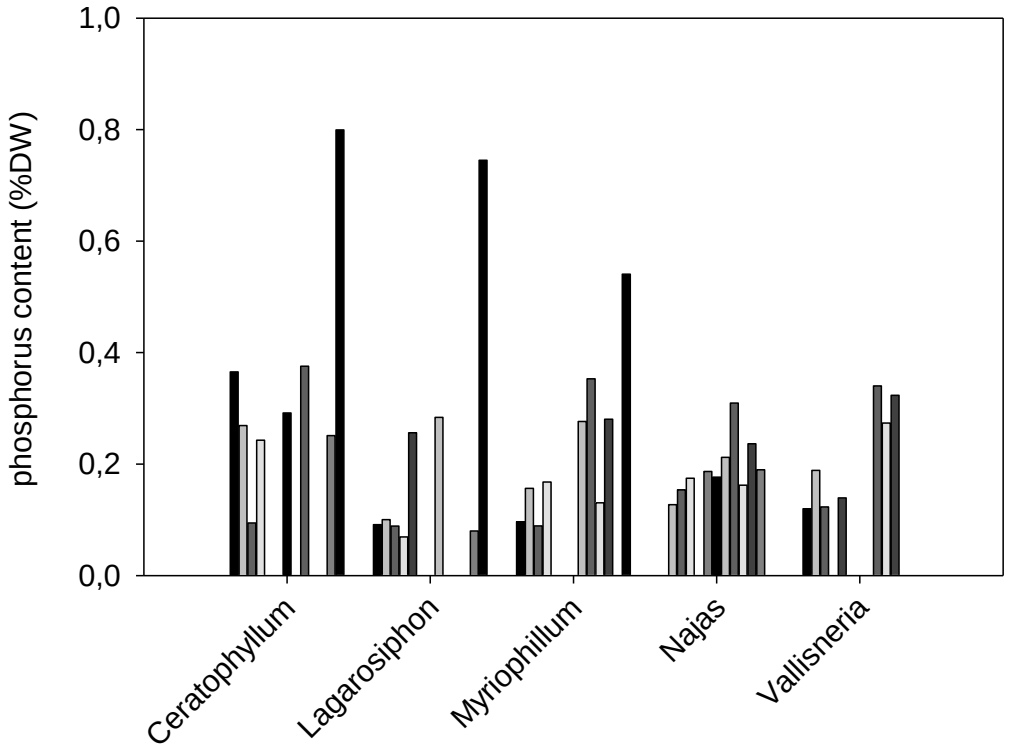
Spatial variability of nutrients content in macrophytes



We collected SAV samples to quantify elemental composition (C, N, P), ^{13}C and ^{15}N fractionation

Spatial variability of nutrients content in macrophytes





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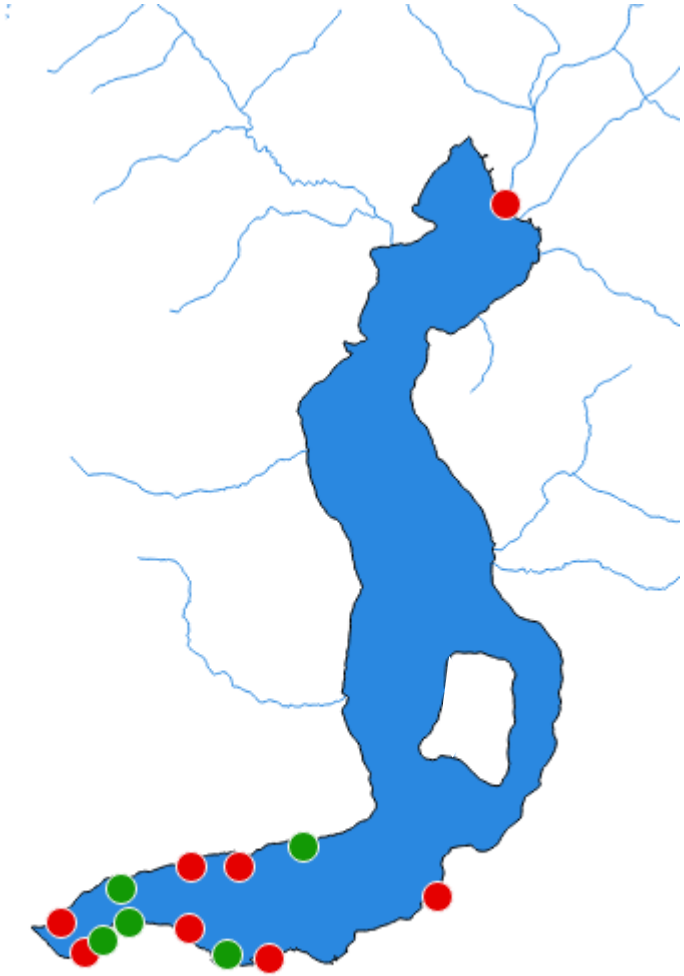

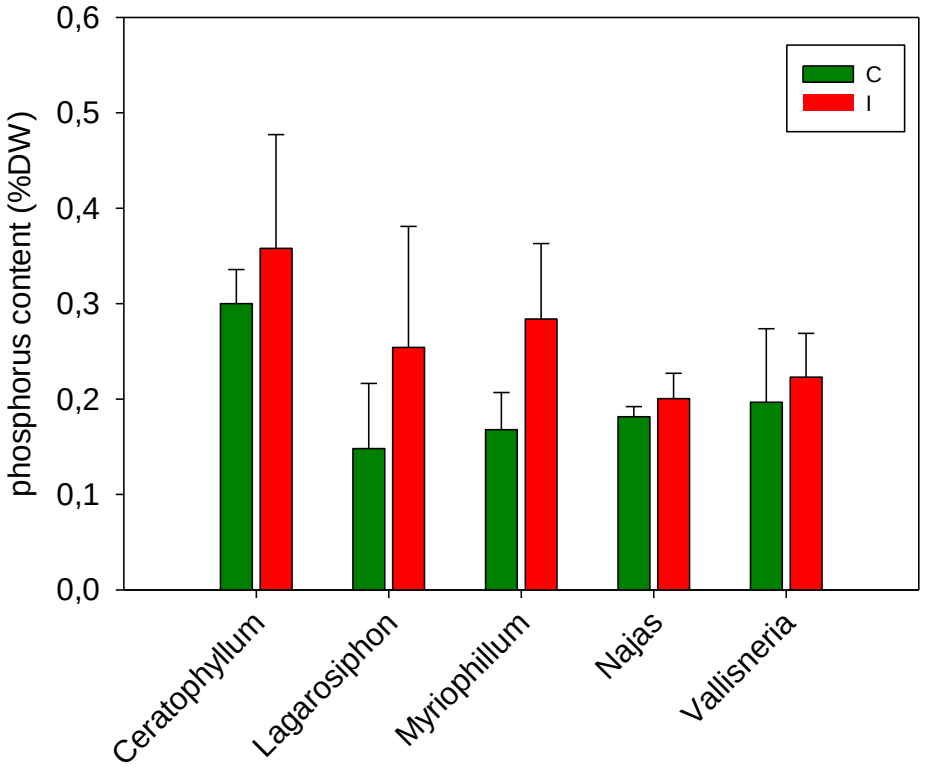

1 first level degree thesis, Natural and environmental Sciences
Ferrari Alessandro, Water quality in the Oglio river flowing into the Iseo Lake.

2 second level degree thesis
Ceccon Silvia, Origin and transfer of phosphorus and nitrogen loadings in the Lake Iseo watershed.
Cristini Domiziana, Evaluation of nitrogen and phosphorus loads and benthic metabolism in the littoral zone of Lake Iseo.

1 PhD thesis in Ecology
Scibona Alessandro Influence of hydrology and primary producers activity on silica biogeochemistry in shallow aquatic environments

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