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3rd ECOPOTENTIAL General Meeting
Matalascañas, Spain – June 18-22 2018

Salmo letnica in Lake Ohrid under multiple threats

Storyline M5: **Ecosystem services and biodiversity crisis across mountain lakes**

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National Research Council of Italy -CNR, Pisa & Bari, Italy

Barbara Zennaro – *University of Bayeruth*

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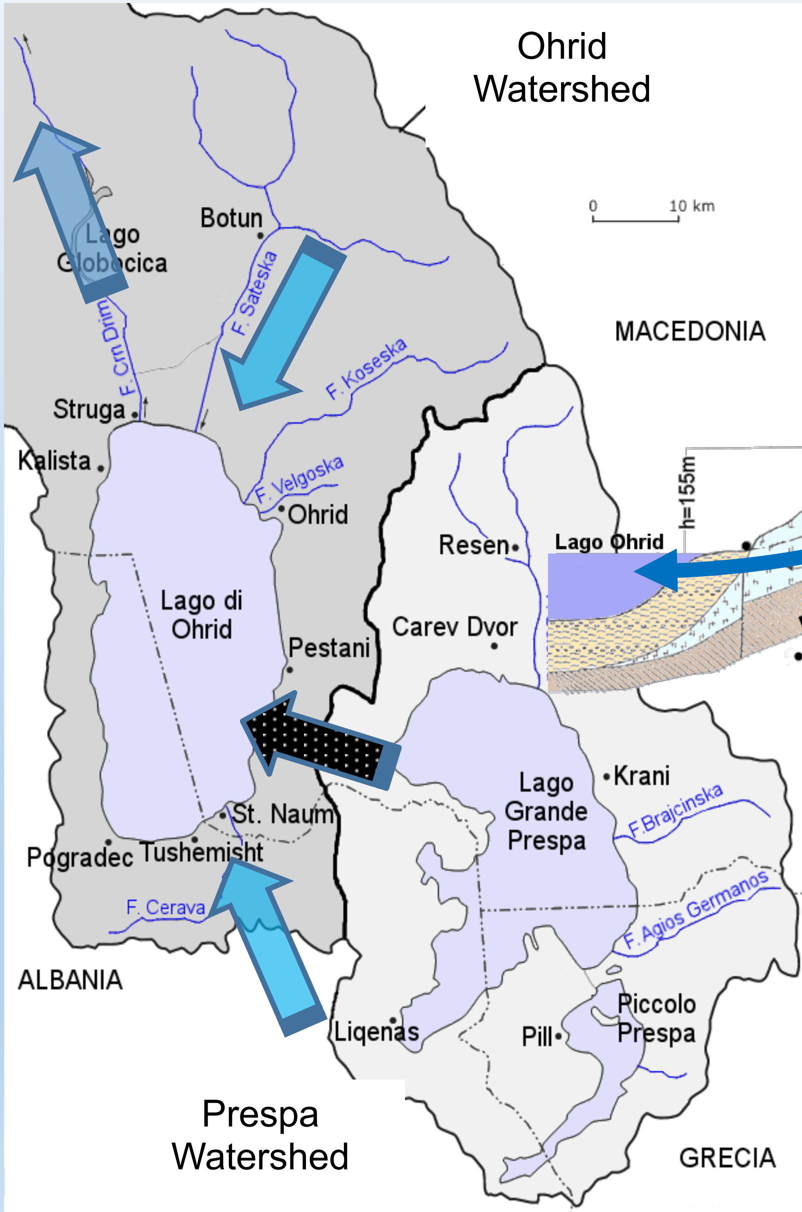
LAKE OHRID

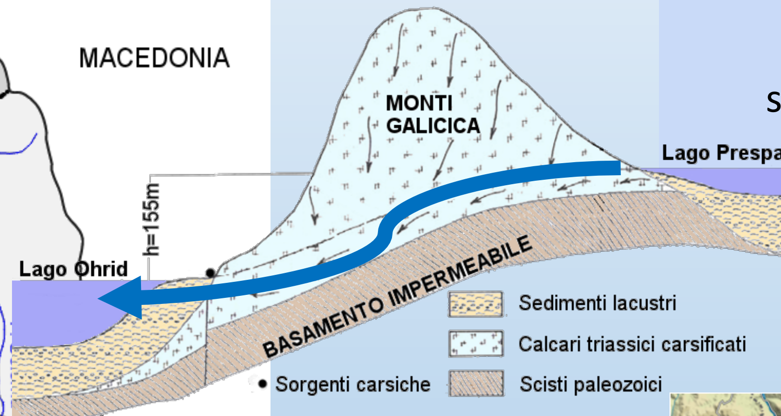
358.2 km^2

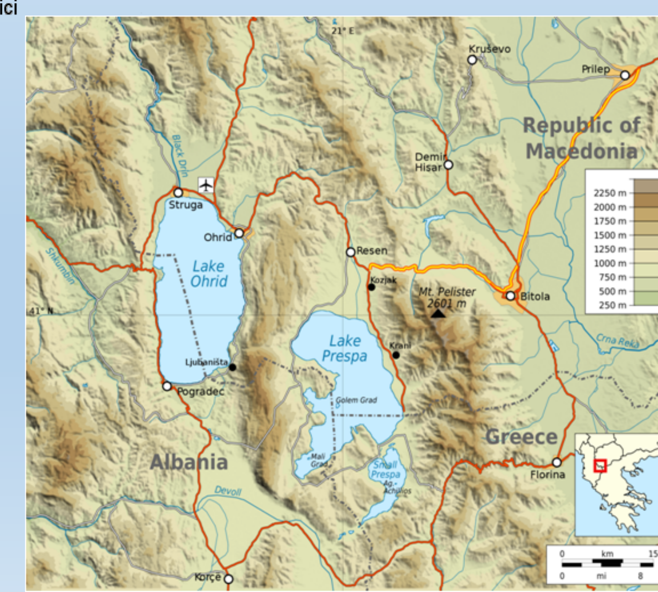
Max depth : 288.7 m
Mean depth: 163.71 m

58.6 km^3water volume

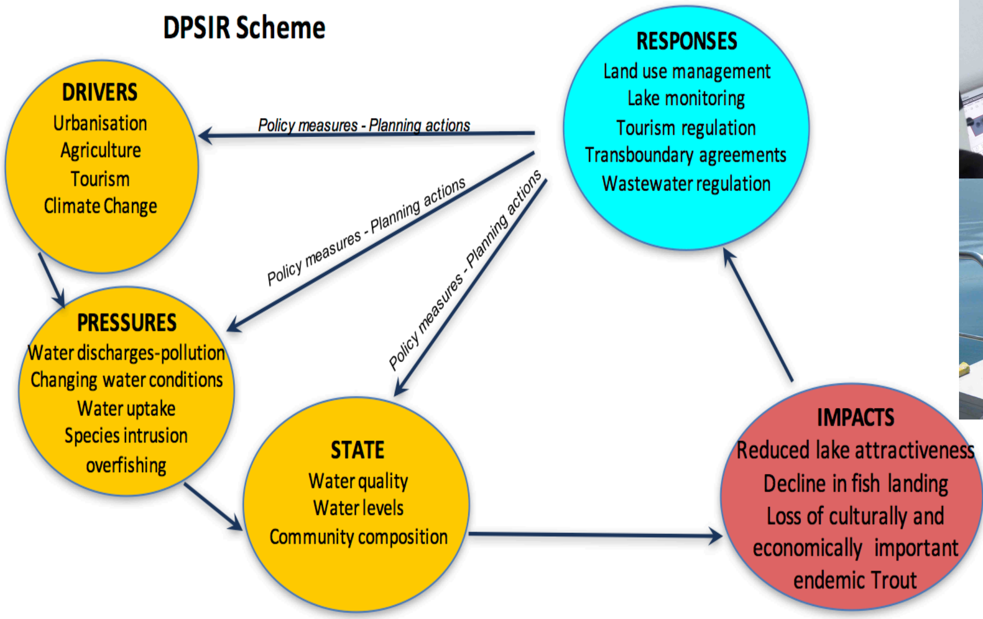
shoreline length 87.53 km

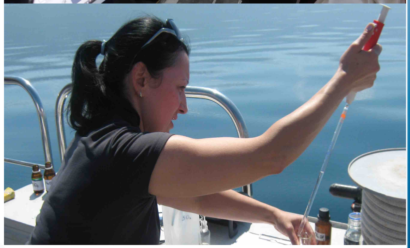


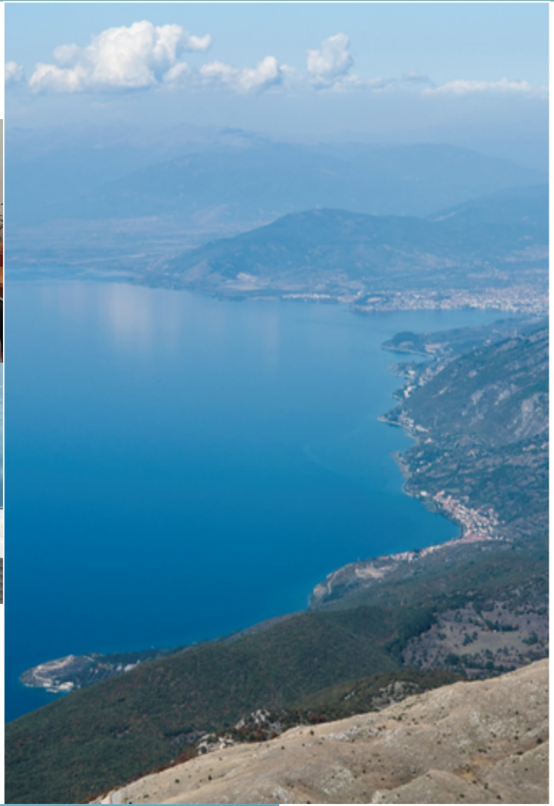




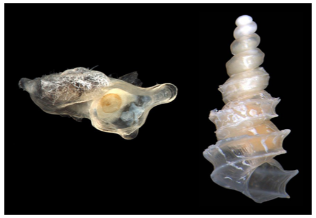
Lake Ohrid: a unique aquatic ecosystem







The most diverse lake in the world: more than 200 endemic species



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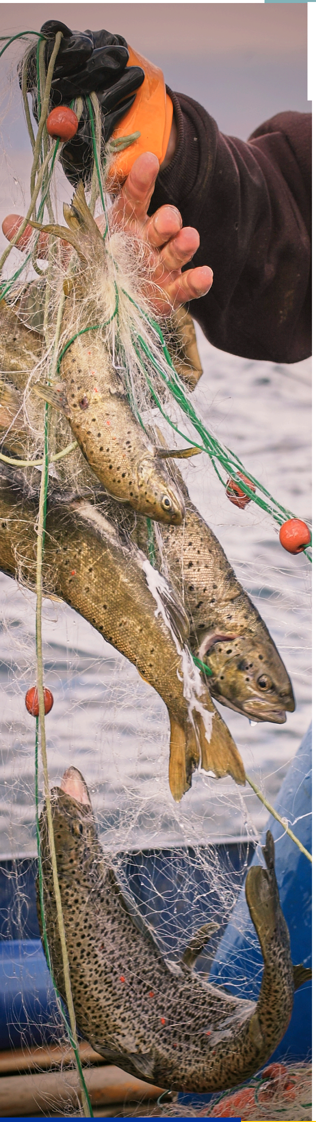
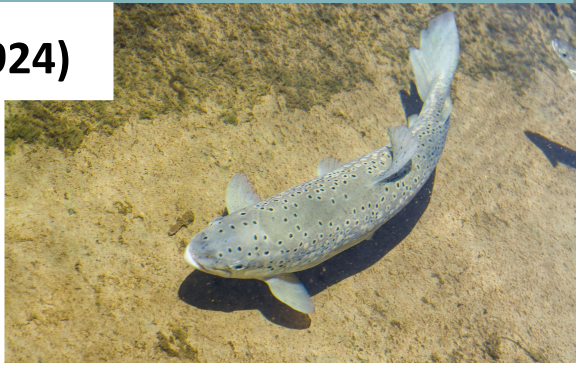
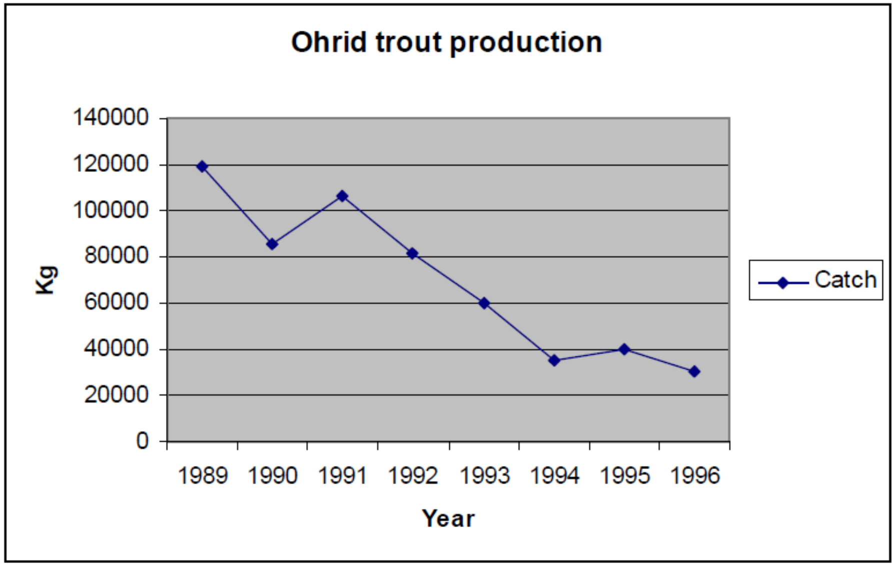


The Orhrid trout (*Salmo letnica* - Karaman, 1924)



- endemic species
- "living fossil"
- drastic decline of population from the beginning of 90's
- Nesting shifted from upper littoral to greatest depths (lives at 70-80 m)



Threats:

Unsustainable fishing

Modification of shoreline

Tourism and population

Non-indigenous species

Water pollution

& eutrophication

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POINT AND DIFFUSE SOURCES OF POLLUTION

Industries

Water Treatment Plant

Settlements

Fish Farms

Tributaries

AGRICULTURE

TOURISM

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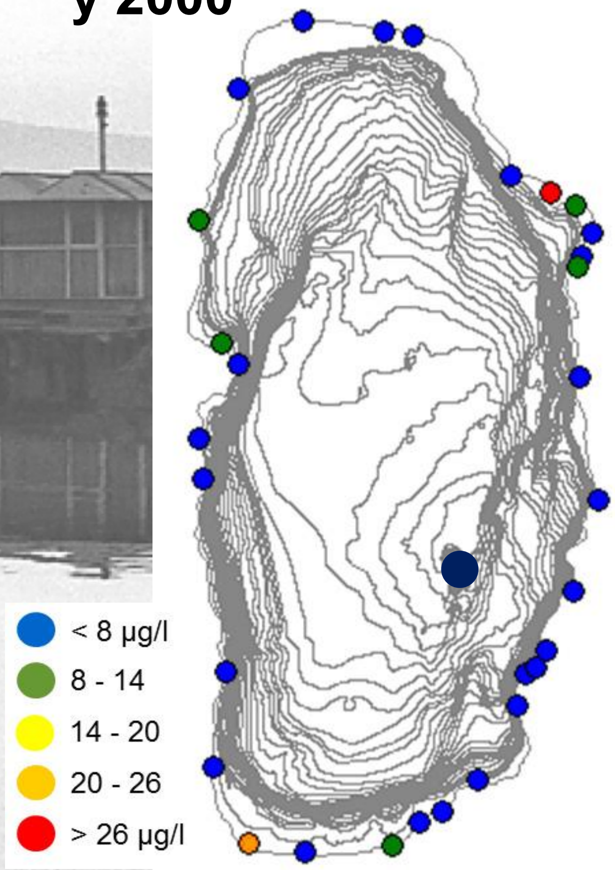
Total phosphorus

0.5 m depth

y 2000



TI	Chl_a ug/l	TP ug/l	SD m	Trophic Clas
< 30—40	0—2.6	0—12	> 8—4	Oligotrophic
40—50	2.6—20	12—24	4—2	Mesotrophic
50—70	20—56	24—96	2—0.5	Eutrophic
	3.2	15	12	OHRID mean values littoral 2011
	1	6	15	OHRID mean values pelagic 0m

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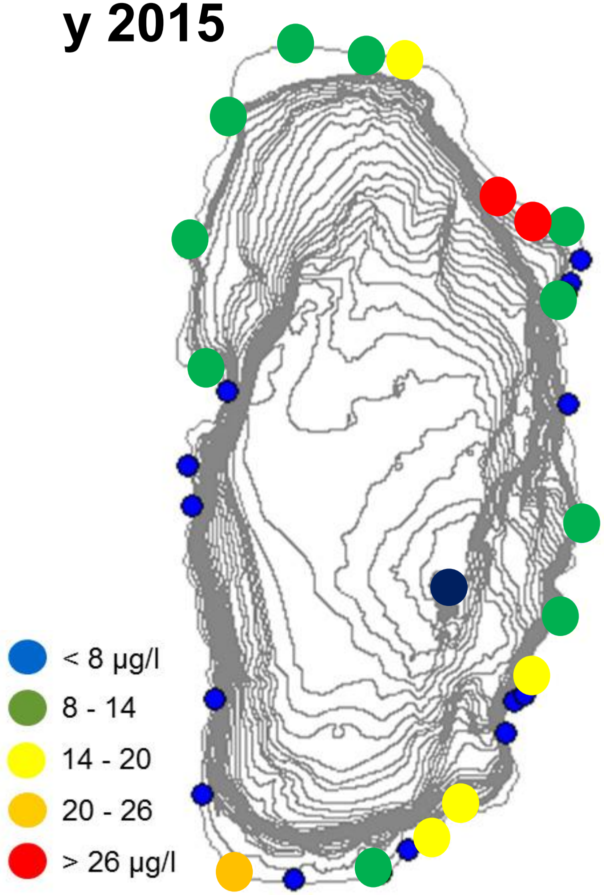
Total phosphorus

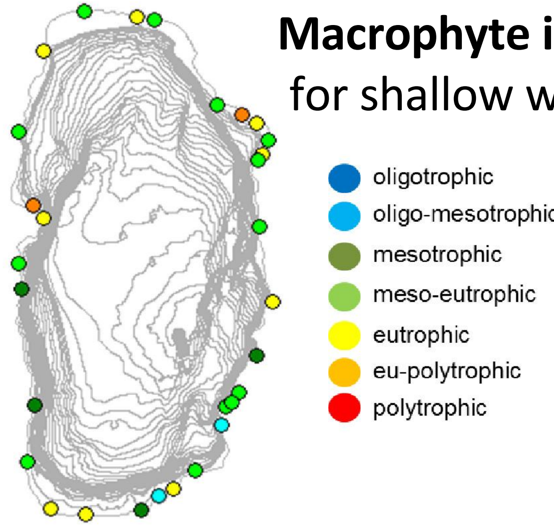
0.5 m depth

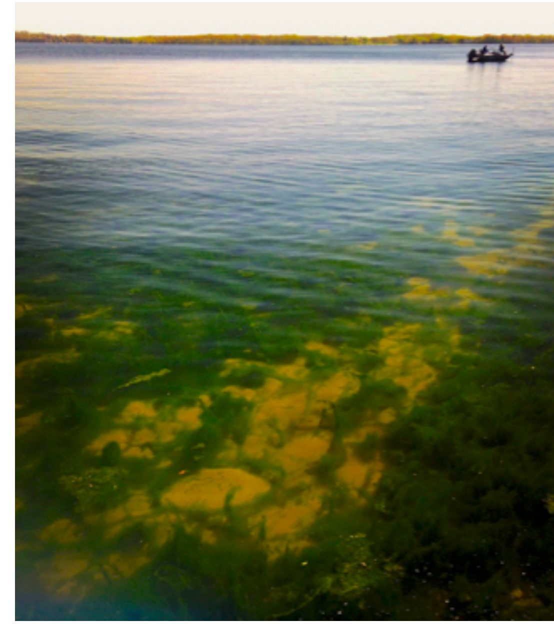
y 2015



Macrophyte index

for shallow water





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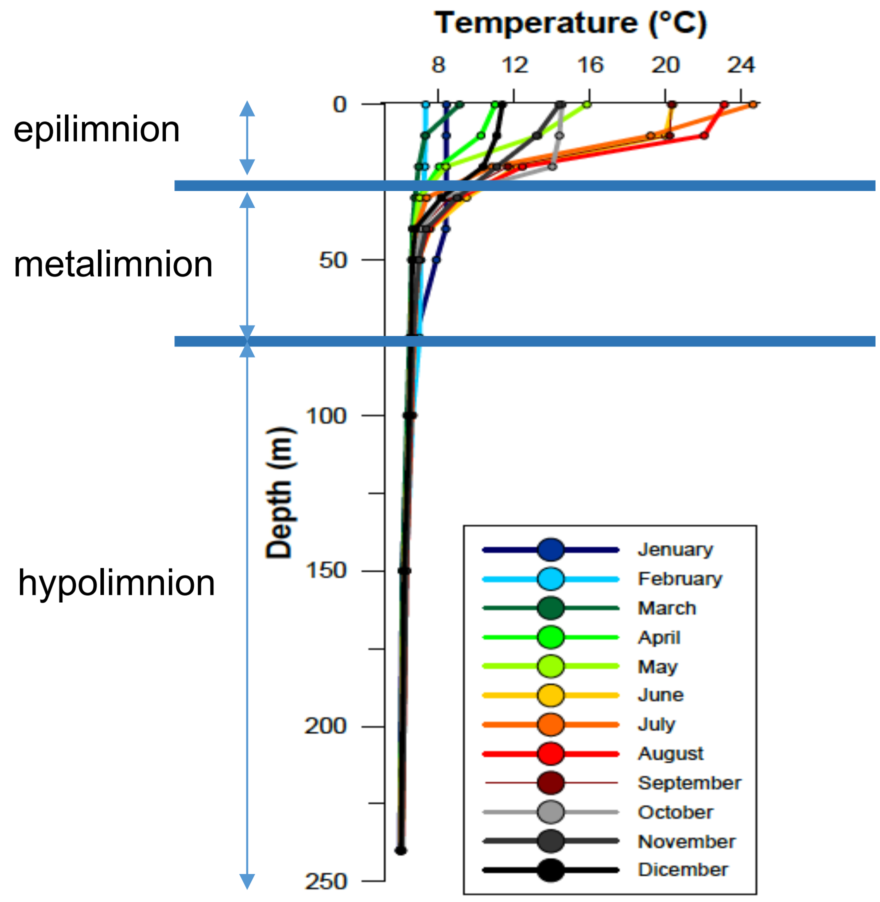
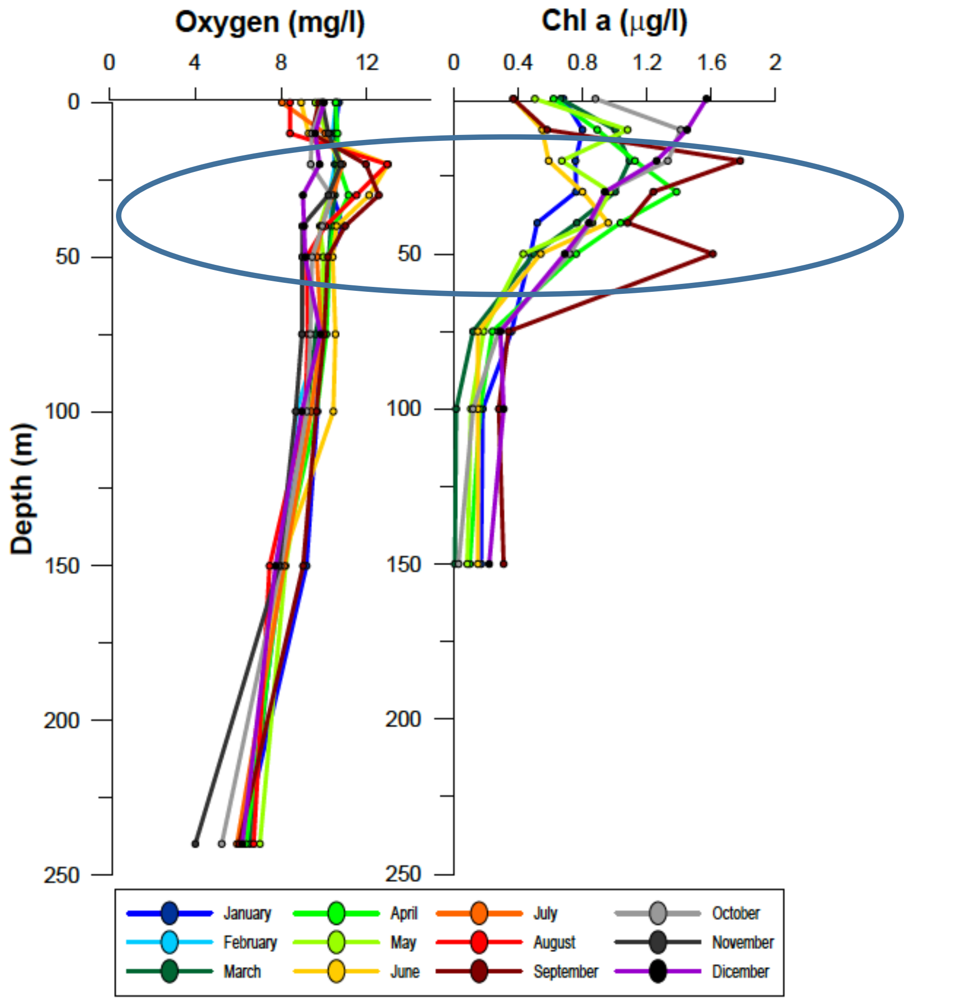
Lake structure – epilimnion – metalimnion – hypolimnion





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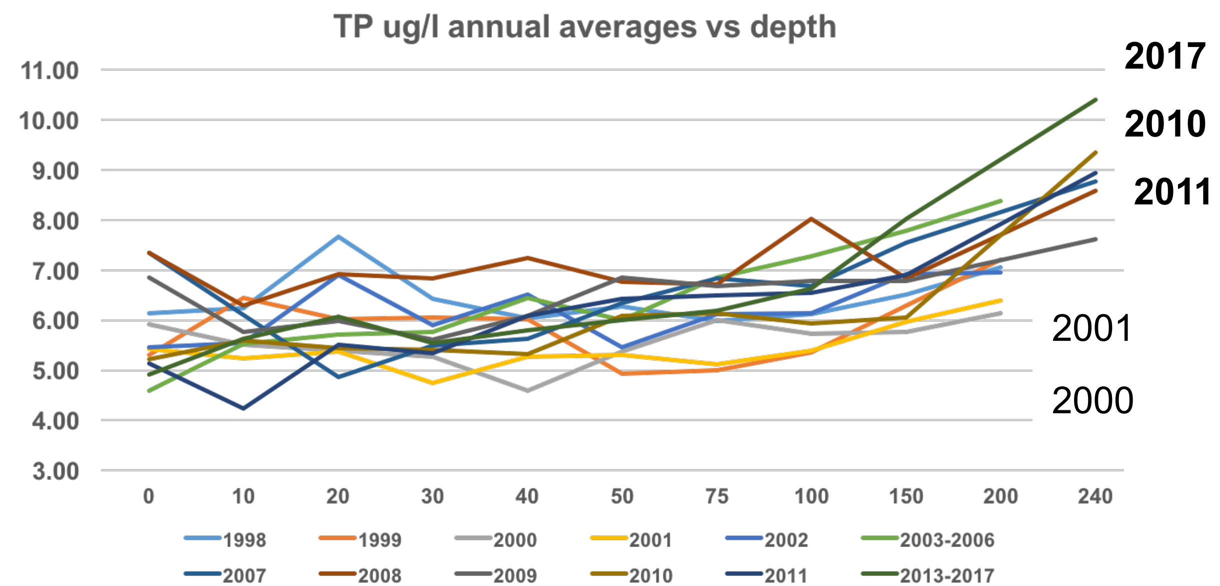
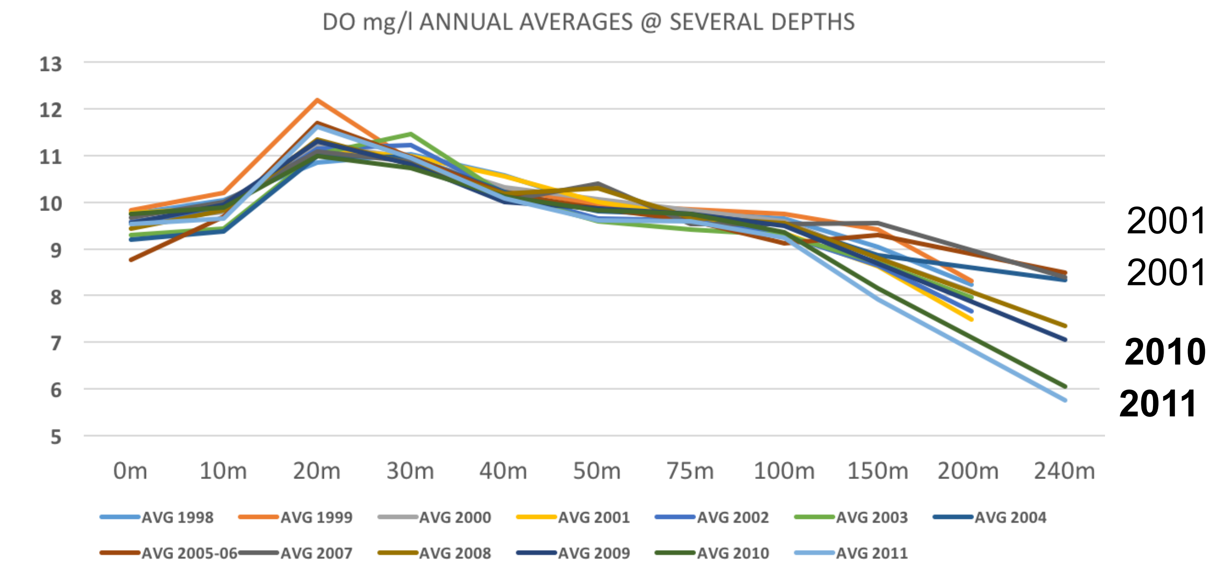
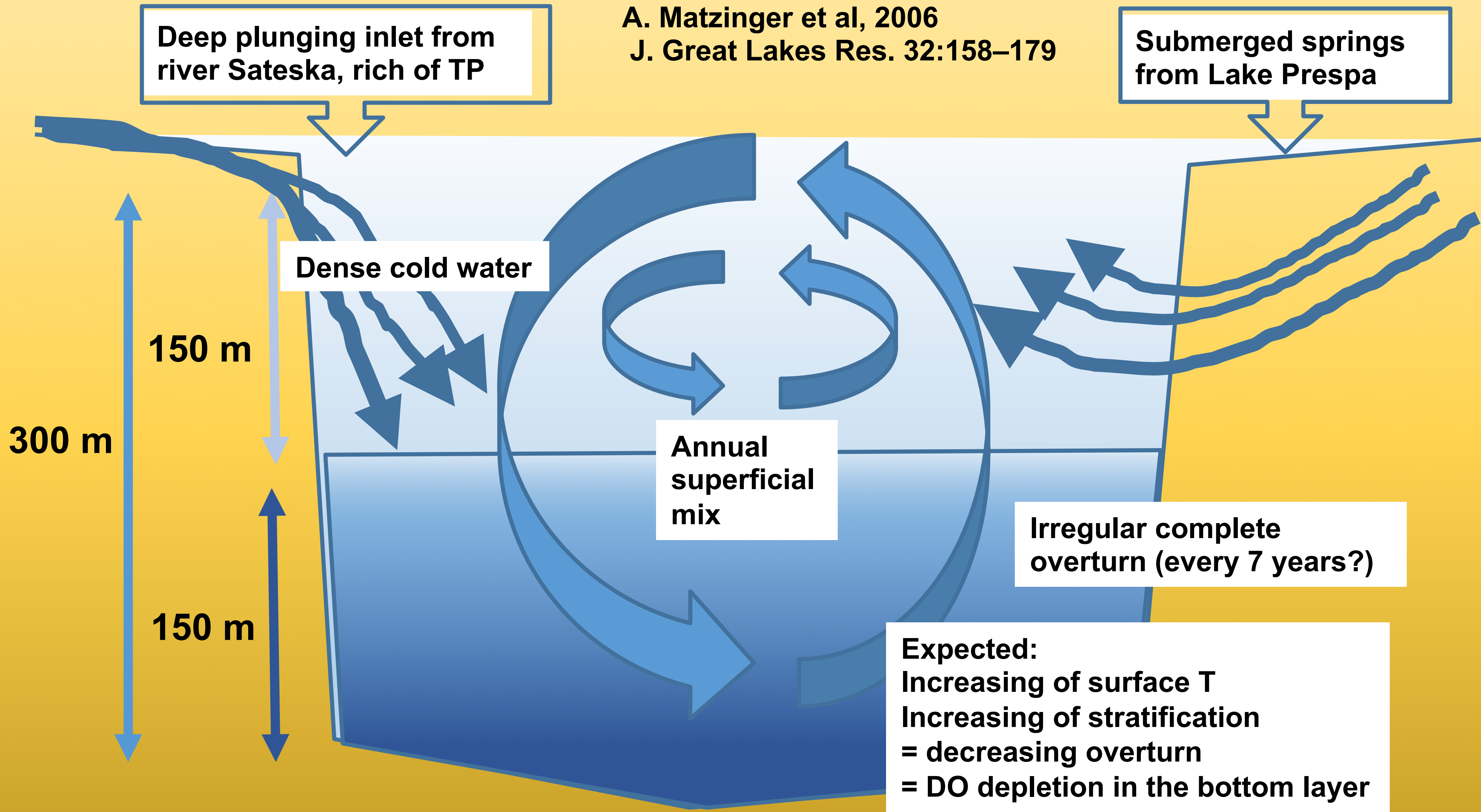
TP increases with depth and with time



DO decreases with depth and with time



The fate of the iconic Salmo letnica in Lake Ohrid under multiple threats



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Resuming:

How does the increase of Phosphorus affect the trout's health?

The lake is overall oligotrophic, but:

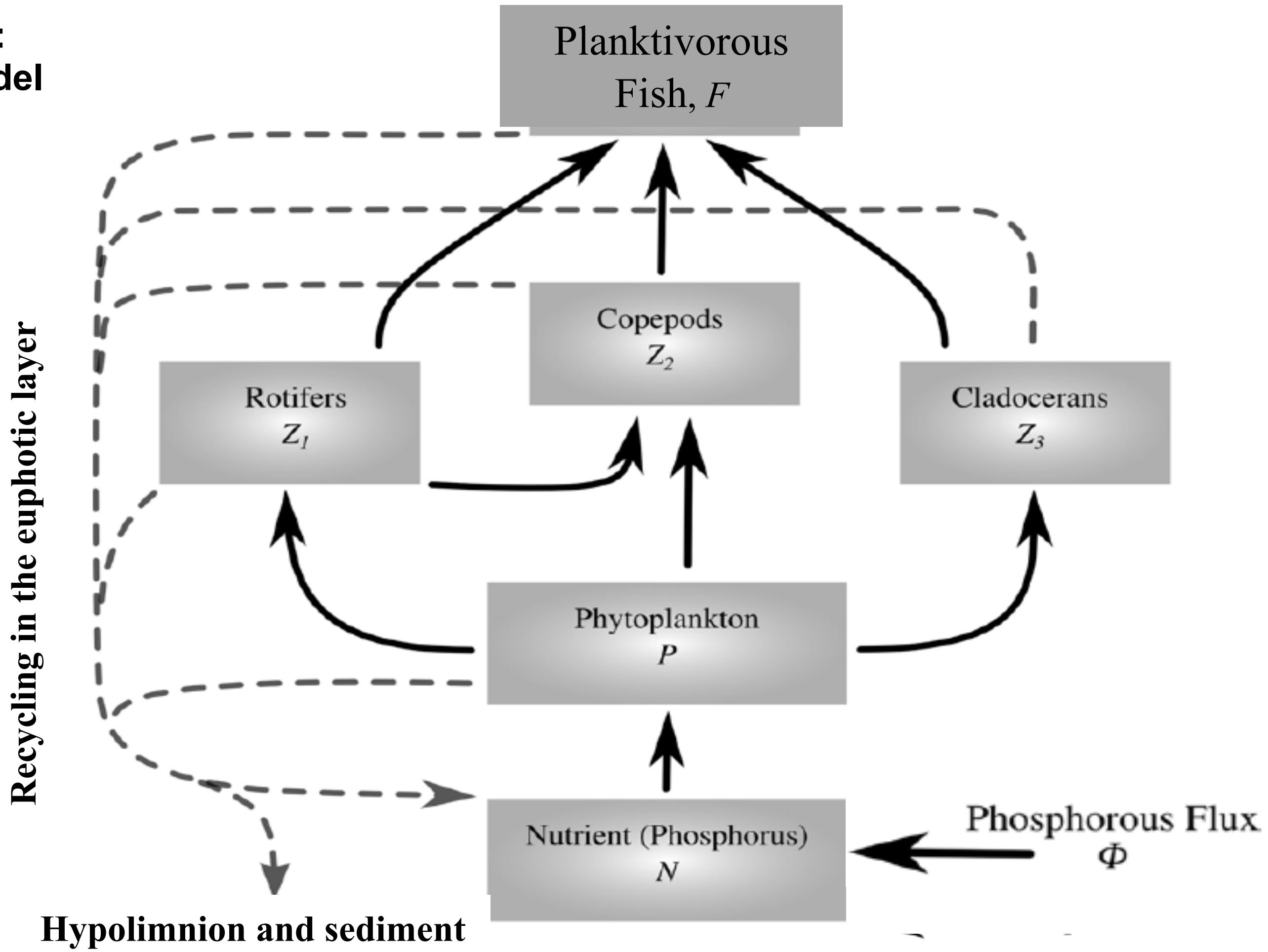
Changes in the littoral concentrations of P and DO reveal spots at higher trophic state (mesotrophic)

INVESTIGATE THE INCREASE of TP:

1) How much is the Phosphorous load?
2) Does it affects the trophic chain, and how?

A simplified lake ecosystem model for lake dynamics

Magnea et al, doi: 10.1016/j.ecolmodel.2012.12.014



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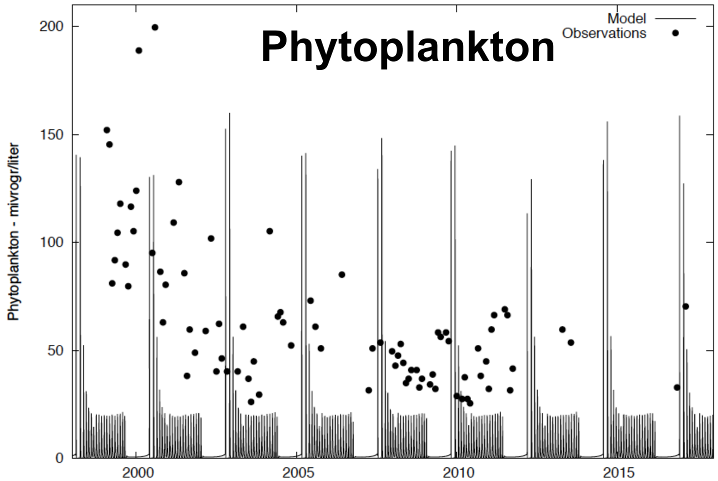
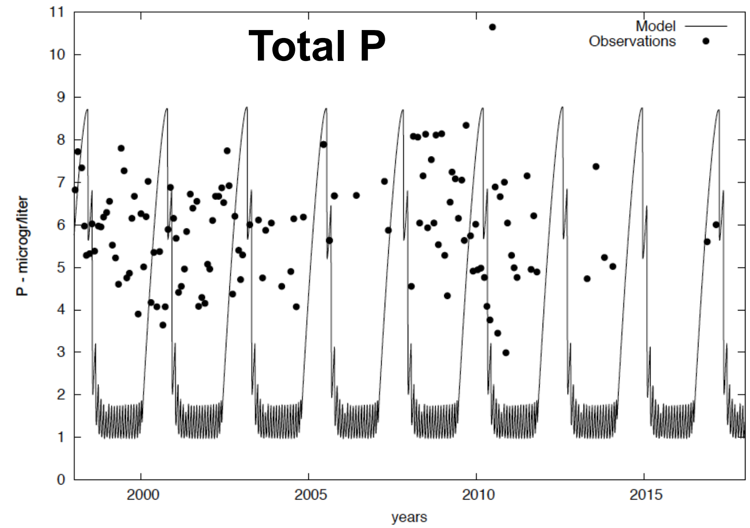
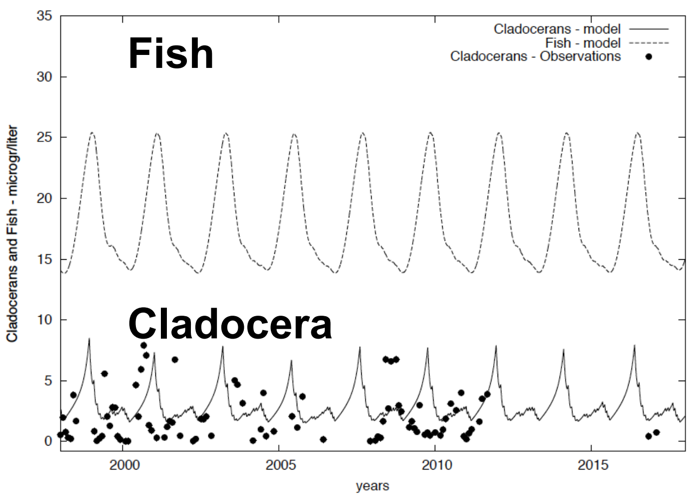
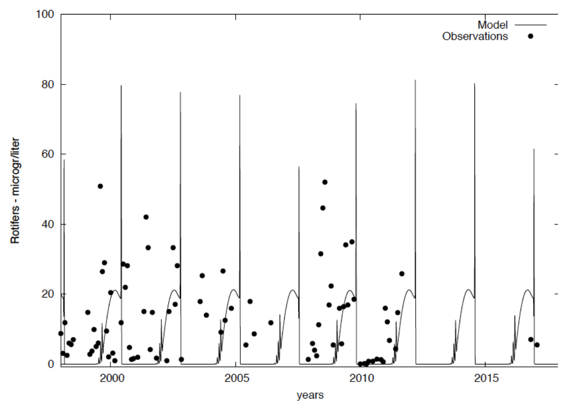
Model first simulations

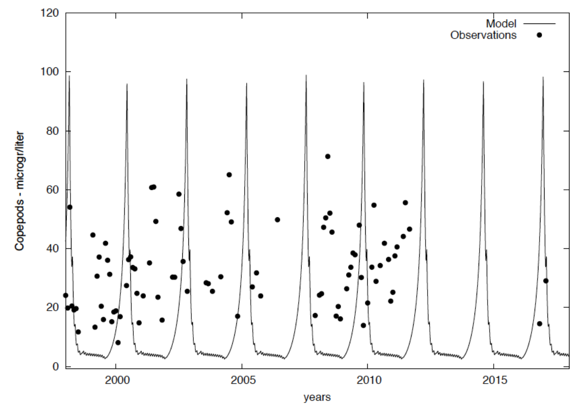






Zooplankton – Rotifera and Copepoda





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MS Giamberini O.
Tasevska B. Zennaro

To refine the trophic chain model we need reliable P load data

Phosphorus concentration (limiting factor) depends on

1)P release from soil and water to the lake
2)attenuation (filtering capacity of the shorezone - aquifer)
3)bio and chemical cycling inside the lake's water.

P concentration in the lake is available only in spot places
P load is needed in the trophic chain model

but

P input is not known / difficult to measure.
We may attempt a modelling of P input

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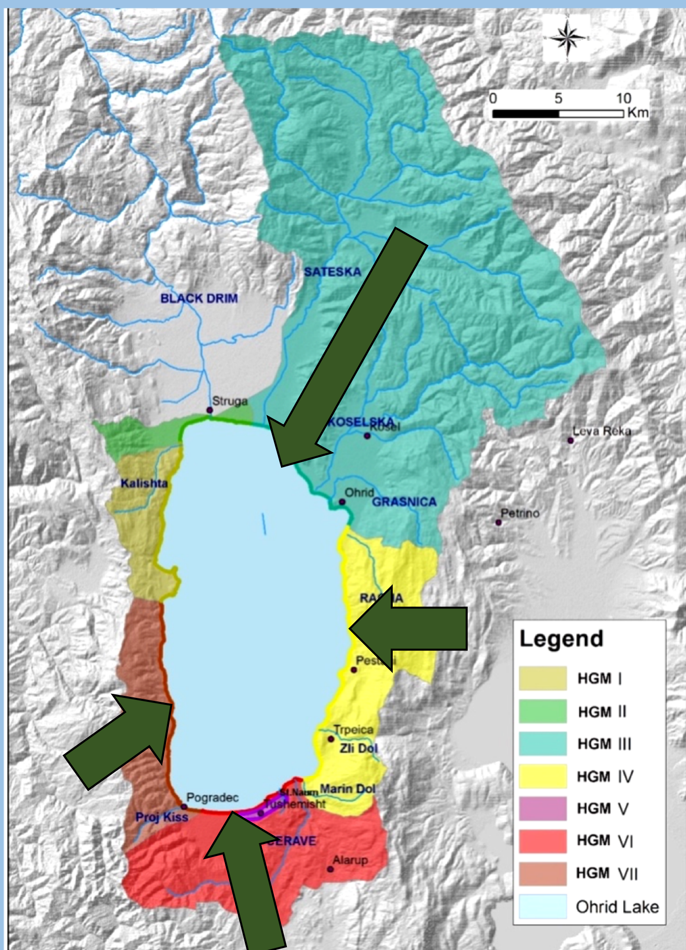
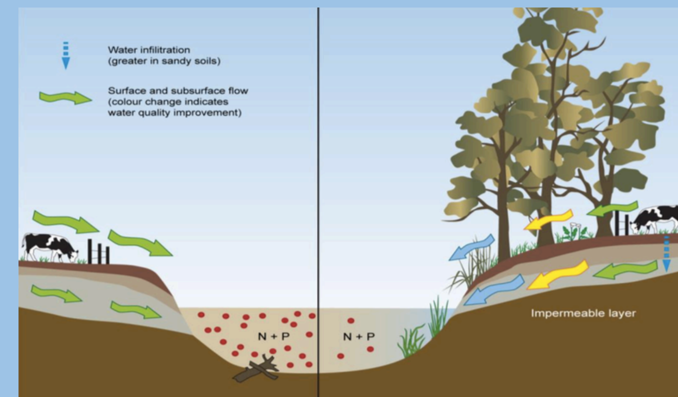
Hydro-geomorphological (HGM) areas are areas with similar geology, morphology (presence of flat areas/only mountainous) and similar hydrology (rainfall, river watersheds)

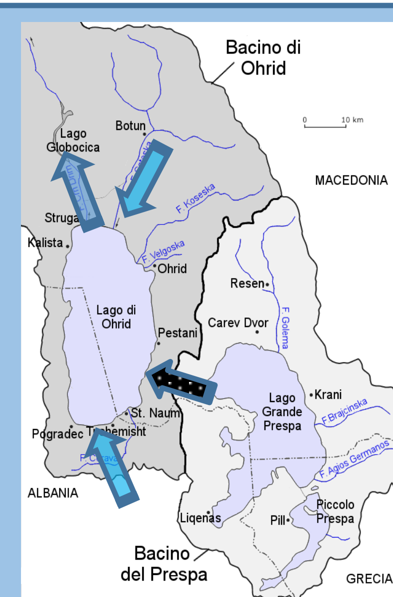


Within HGM, P input varies depending on land use

No-point source P input may be filtered by an healthy shorezone - Model should consider buffering



Hydrological balance of the lake: 30+ % of water from eutrophic lake Prespa: filtering capacity of the karst aquifer needs to be considered



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Modelling P release from soil using LC/LU data derived from RS

P input: point input + diffuse input
Point input = water discharge (wastewater plants, sewage) + input from rivers

P from rivers: depend on release from soil
P from diffuse input: depend on release from soil

→ **P-input = water discharge + release from soil**

Assumption: the amount of P released from soil is a function of land use/geology/topography/climate -> Use of hydro-geomorphological areas.

Models available: SWAT + STEPL (US-EPA)
Land use: from land cover maps + in situ validation of land use

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DATA REQUIRED

LAND USE DATA: (different degree of detail depending on the model chosen)

METEO DATA: available from the Hydrometeorological service of Macedonia

SOIL & GEO DATA: (different degree of detail depending on the model chosen)

Results: Computed P release for Hydro-Geo-Morphological areas

Results will need to be validated with in situ information available

Models chosen: SWAT + STEPL (US-EPA)

COMPARISON SWAT – STEPL:

- **Model approach**
- **Data needed**
- **Feasibility to use**
- **Calibration with lake in-situ data (P concentration / macrophytes presence)**

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Models chosen # 1: STEPL

Work done:

- **land cover calculated – shape file**
- **In situ data collected**

- **Next step: calculate the polygon areas for the landcover classes required in the model**

- **Calibrate the model equations to the lake characteristics**

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Improvement needed for the model:

- Refine vital parameters with accurate calibration
- Calibrate the ratio Chl-a – phytoplankton
- Data on trout are needed for calibration

- Try vertical structure (maybe not needed)
- Horizontal mixing/advection
- Seasonality (light, TP input) – refine estimate of TP input
- 2 fish compartments
- Add oxygen as a dynamical variable

-> Then test different TP inputs to check sensitivity with the growth of nutrients

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