



The structuring role of three types of macrophytes on the planktonic communities of lake San Pablo, a tropical freshwater Andean system in Northern Ecuador

Francisco Caicedo, Iris Stiers, Ludwig Triest

Photo source: the author

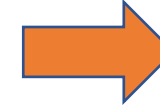
Lake San Pablo: an *Andean-monomictic* system



Figure 1: Upper part: modified from (Casallas, 2005)
Lower photo: author's photo

Human threats

- Intensive agriculture
- Exotic fish
- “Totora” harvesting
- No environmental awareness



Current state

- Eutrophic lake
- Almost dead bellow 15 meters of depth
- Practically anoxic bottom

Lake San Pablo: *its littoral zone*

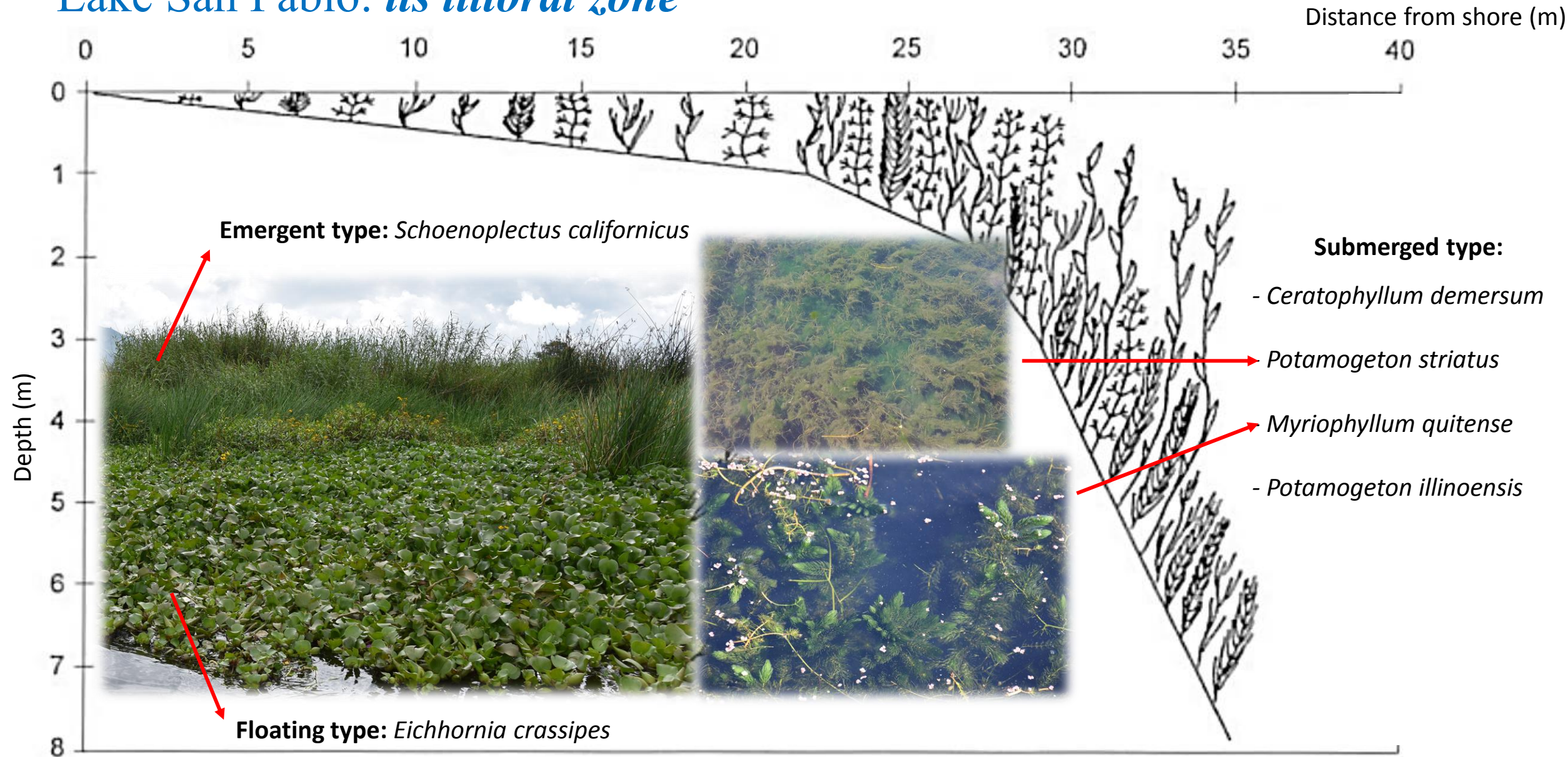


Figure 2: Schematic profile of macrophyte distribution in Lake San Pablo during 1996. Modified from Gunkel (2000).

The role of macrophytes (*specially the submerged type*)

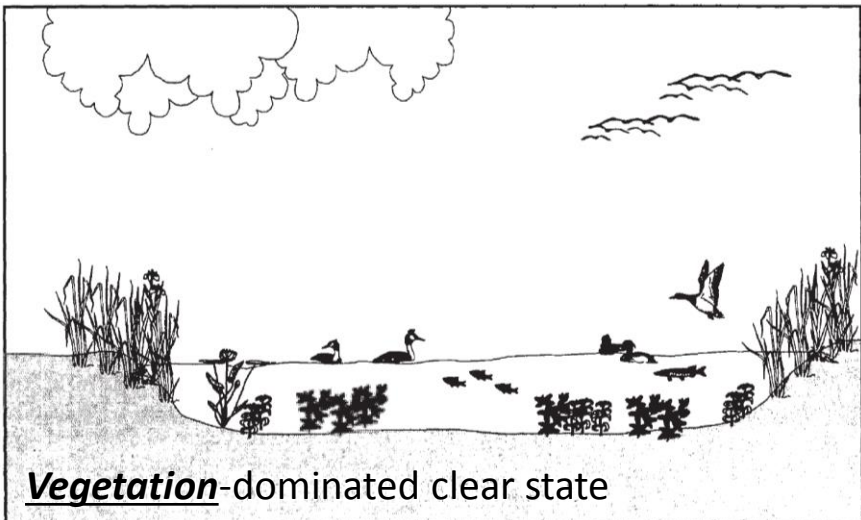
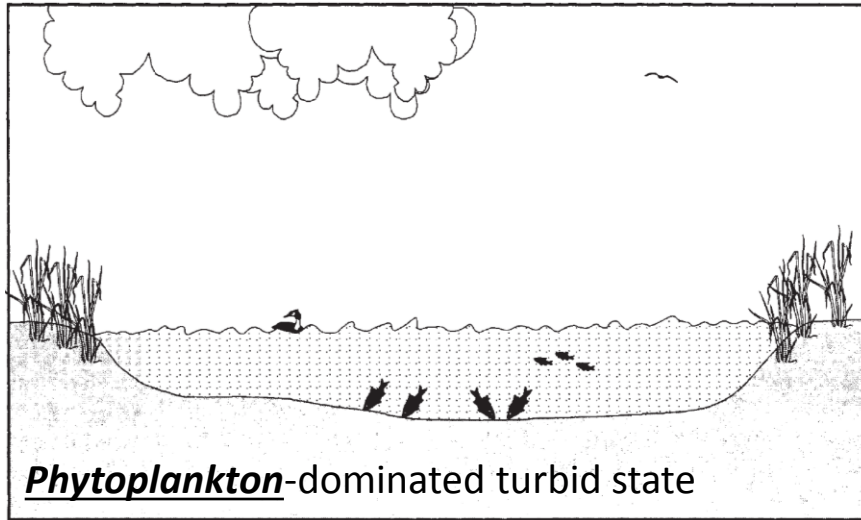
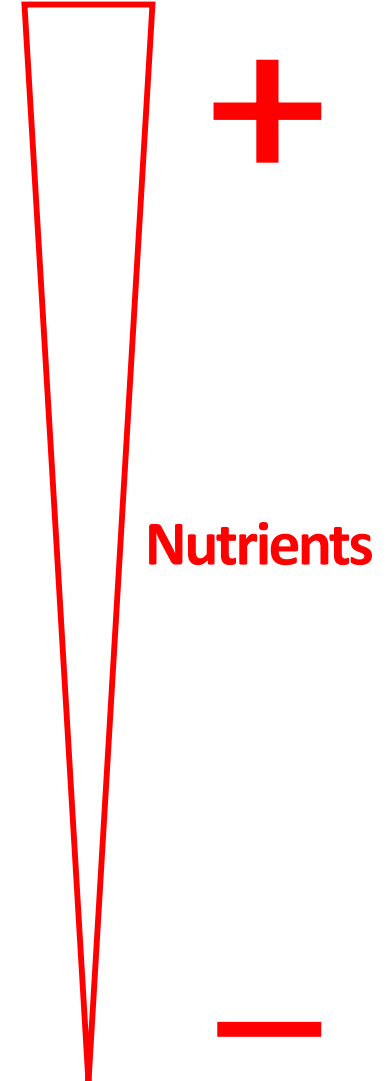


Figure 3: Schematic representation of a shallow lake. Modified from Scheffer (2004).

Figure 4: author's photos.



Objective: To investigate the role of emergent, submerged and floating macrophytes, their coverage and associated environmental variables on the phytoplankton and zooplankton community structures

Methodology:

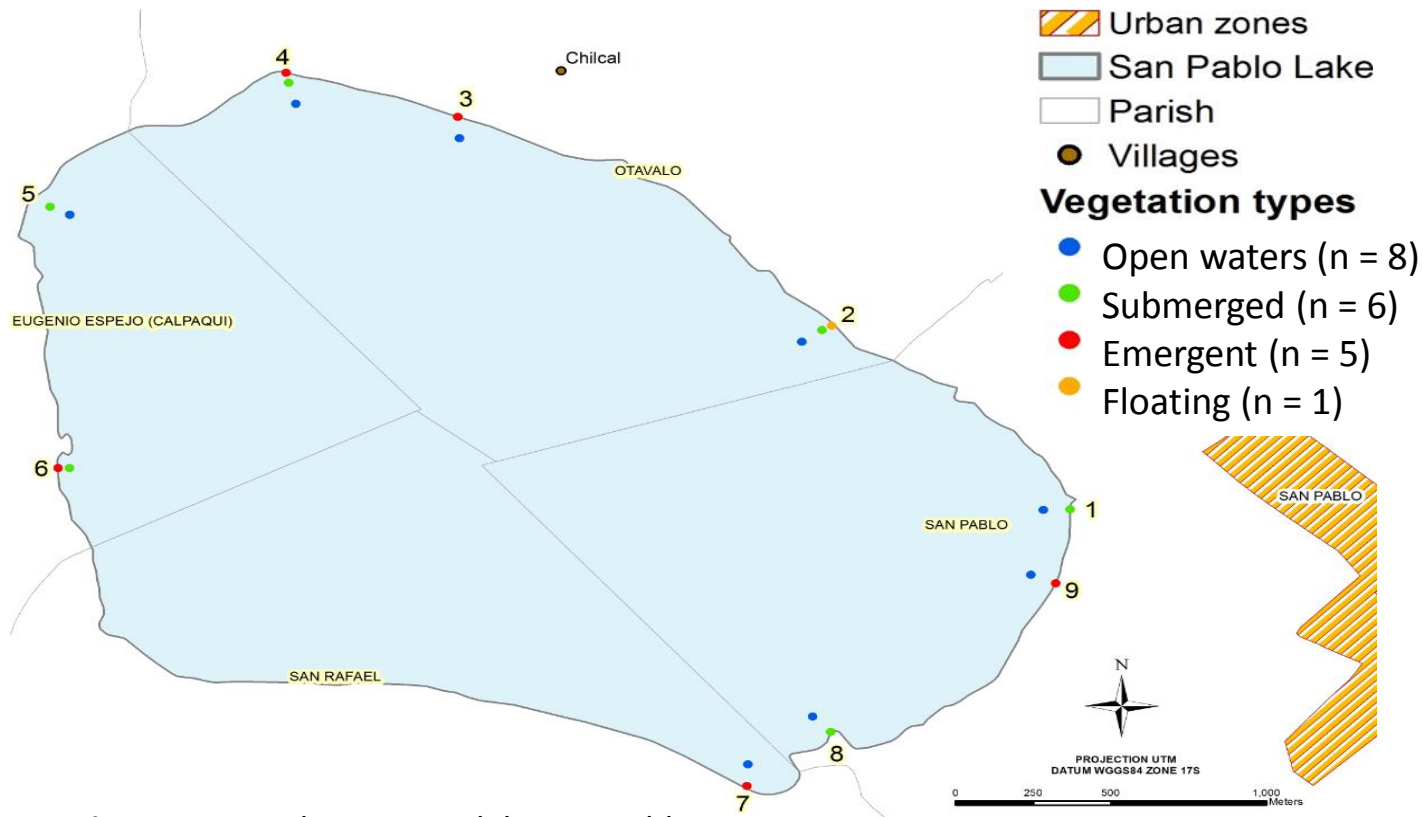


Figure 5: Sampling sites in lake San Pablo

- **Environmental parameters**
- **Phytoplankton** biovolume
- **Zooplankton** density
- Non-parametric statistics
- Species richness and diversity (Shannon-Wiener)
- Principal Component Analysis (PCA)
- Variation partitioning

Results:

Phytoplankton biovolume

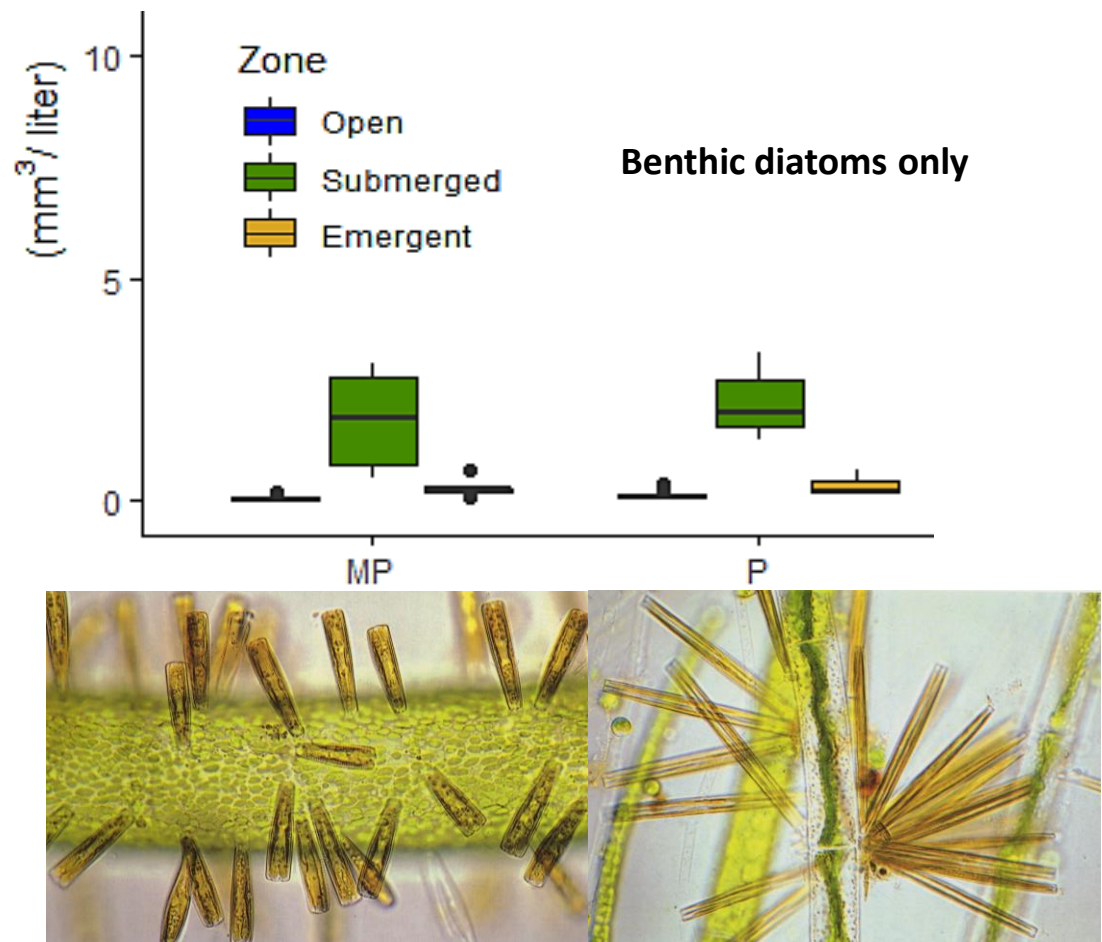


Figure 6: Upper plot: boxplots of the most important RFGs. Lower photos: taken from Canter-Lund, H. Lund, J.(1995).

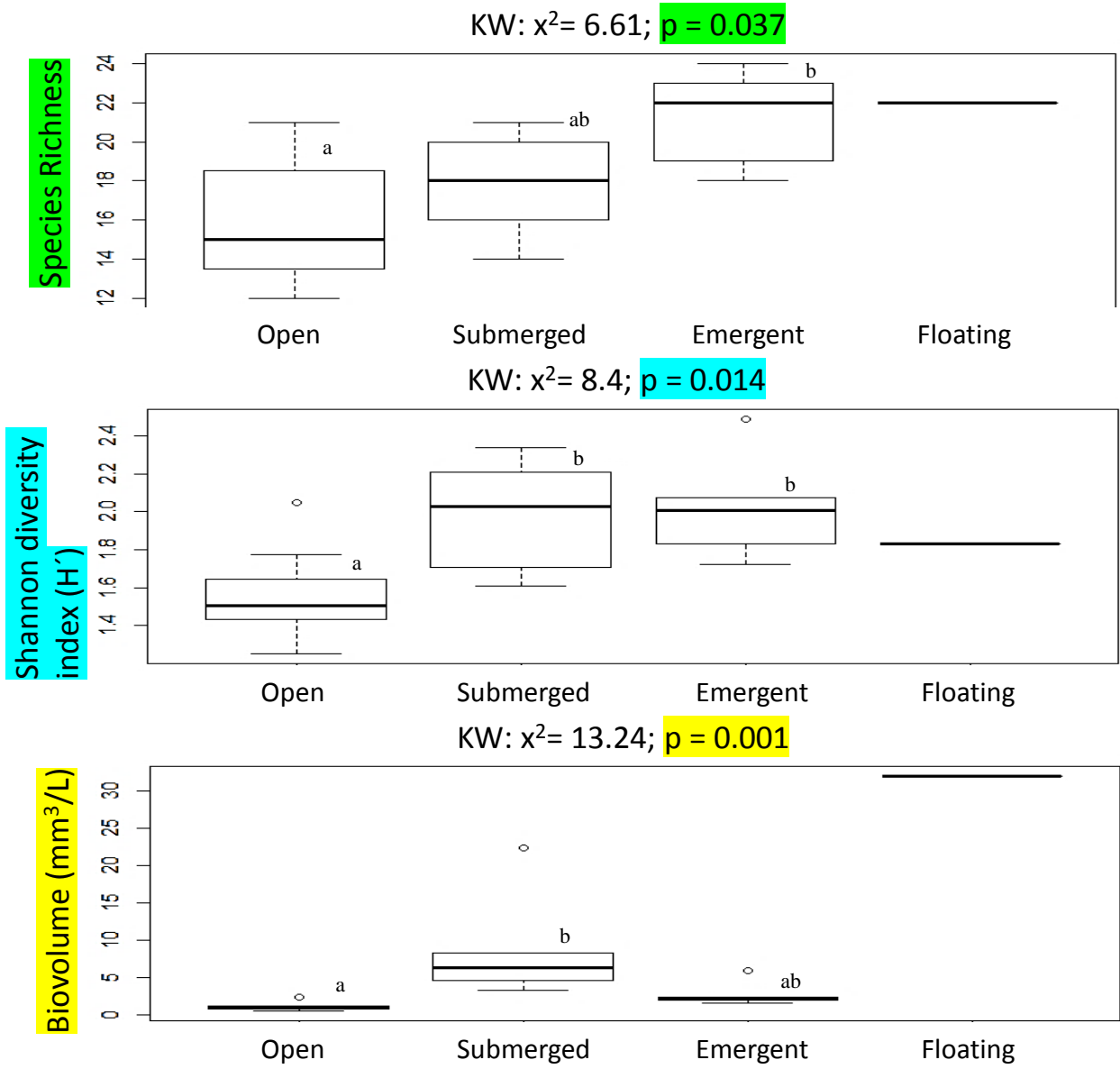


Figure 7: Boxplots of phytoplankton richness, diversity and biovolume along the open water-vegetation gradient.

Results:

Zooplankton density and environmental parameters

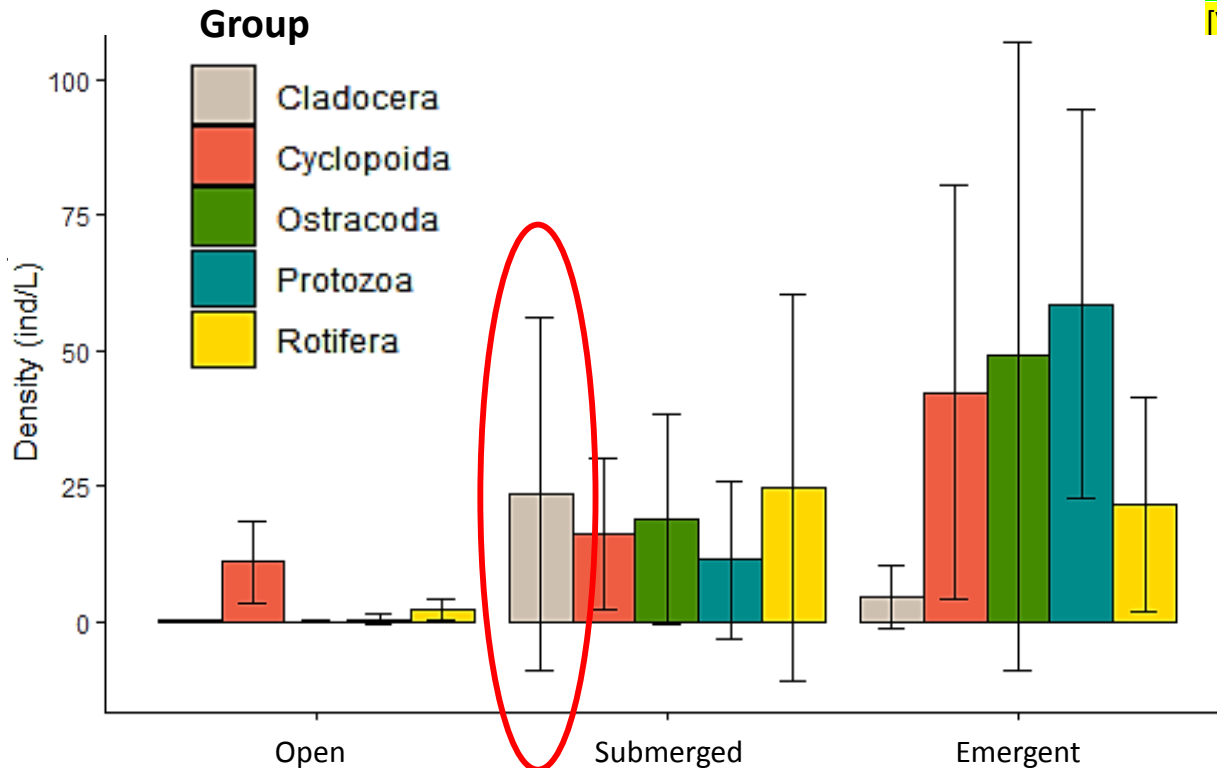


Figure 8 Grouped barplot of the zooplankton density along the open water-vegetated gradient.

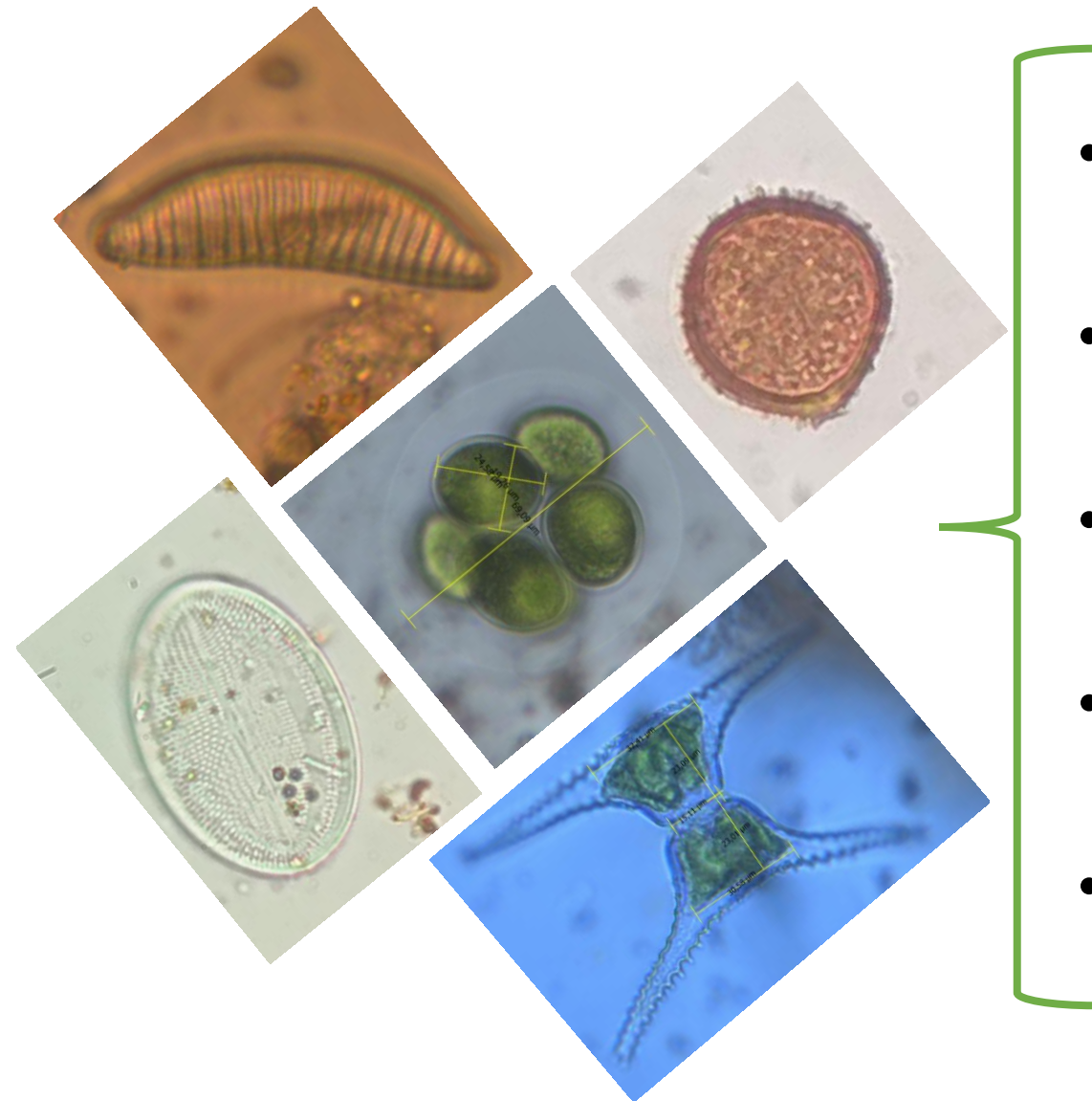
Table 1: Variation partitioning and associated p-values of phytoplankton biovolume and zooplankton densities into the different factors

Factors	Phytoplankton		Zooplankton	
	Variation explained (%)	p-value	Variation explained (%)	p-value
[ENV + VECO]	48.5	0.001	66	0.001
[ENV]	25.3	0.007	15.7	0.003
[VECO]	14.1	0.010	40	0.001
[ENV VECO]	33.4	0.004	26	0.019
[VECO ENV]	23.2	0.011	50.3	0.001
NV ∩ VECO]	9.1	N/T	10.3	N/T
- [ENV + VECO]	51.5	N/T	34	N/T

Table 2: Limnological parameters displaying significant differences among sampling zones

	DO (mg)	Turbidity (NTU)
Open Water	2.74 (0.08) ^a	1.45 (0.15) ^a
Submerged	3.18 (0.18) ^a	2.65 (0.46) ^b
Emergent	2.03 (0.17) ^b	2.532 (0.5) ^b
p-value	0.0023	0.024

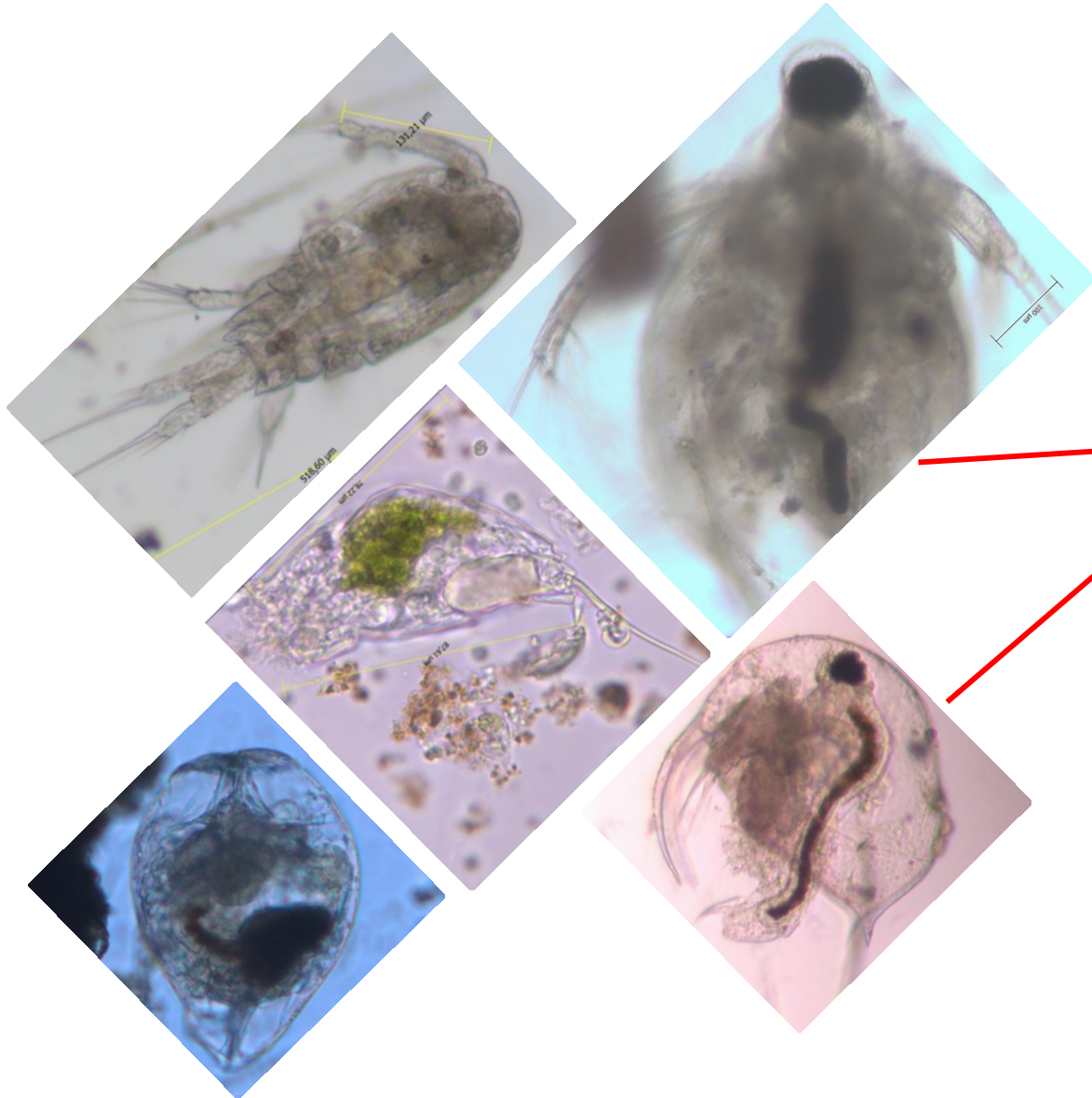
Conclusions: effects of macrophytes on the *phytoplankton community*



- Enhanced **diversity** and species **richness**
- **Benthic** algae (adapted to turbulence)
- Negligible cyanobacteria (July 2017)
- Cyanobacteria periodicity (2017, 2018, 2019)
- **Nutrient uptake** (resilience mechanism)

Figure 9: phytoplankton from lake San Pablo (author's photos)

Conclusions: effects of macrophytes on the zooplankton community



- Higher **diversity** and **density**
- Cladocerans find shelter and food
- **Oxygen** attracts other aquatic organisms
- Horizontal replaced vertical migration

Figure 10: zooplankton from lake San Pablo (author's photos)

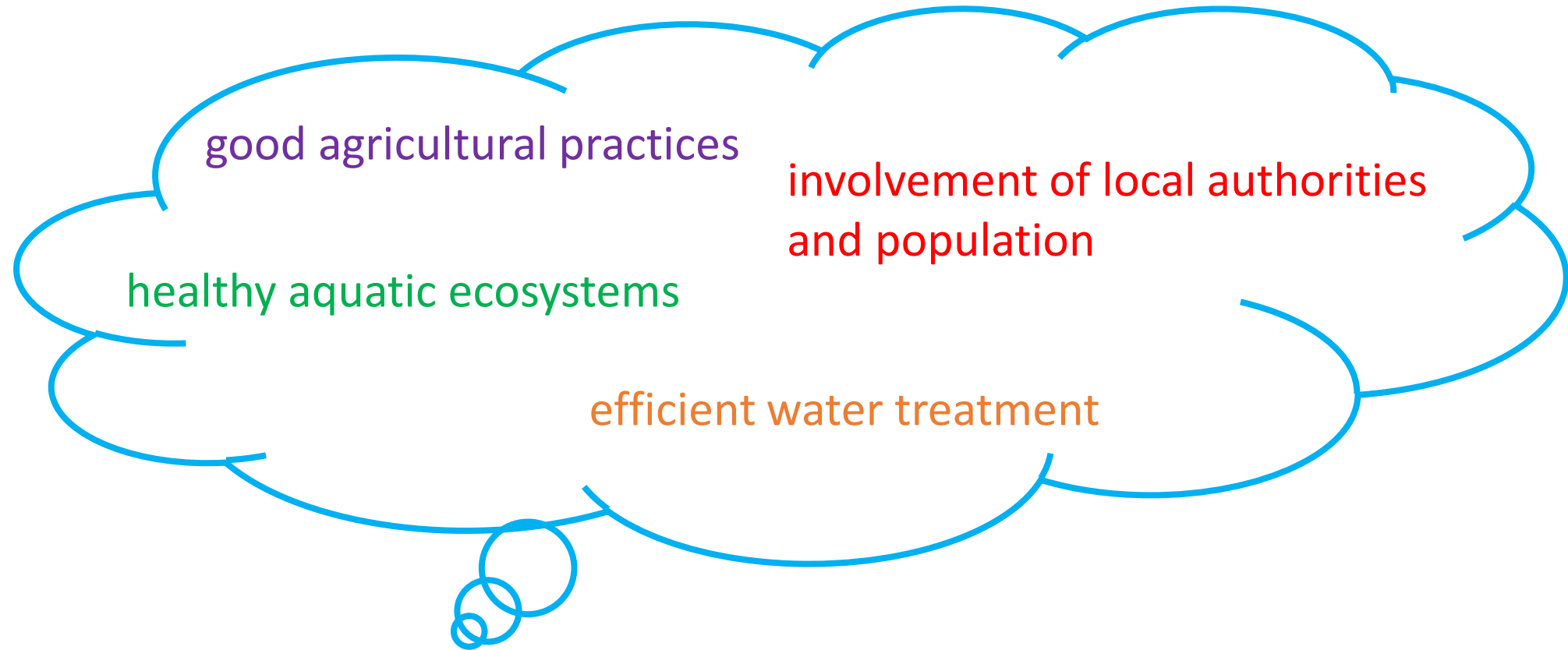
Research is needed!

- The impacts of **global warming**
- **Fish baseline** and their feeding behavior
- **Environmental awareness** and law enforcement
- To expand this investigation in a **temporal scale**
- Potential of **constructed wetlands** for water treatment



Figure 11: Author's photo

Management of *lake San Pablo*



Coupling of different approaches and inter-institutional cooperation are required to achieve a wise management of an aquatic system (Hampel *et al.*, 2015).

References

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Thank you for your attention!

