

# Salinization enhances eutrophication symptoms in a cold temperate urban lake

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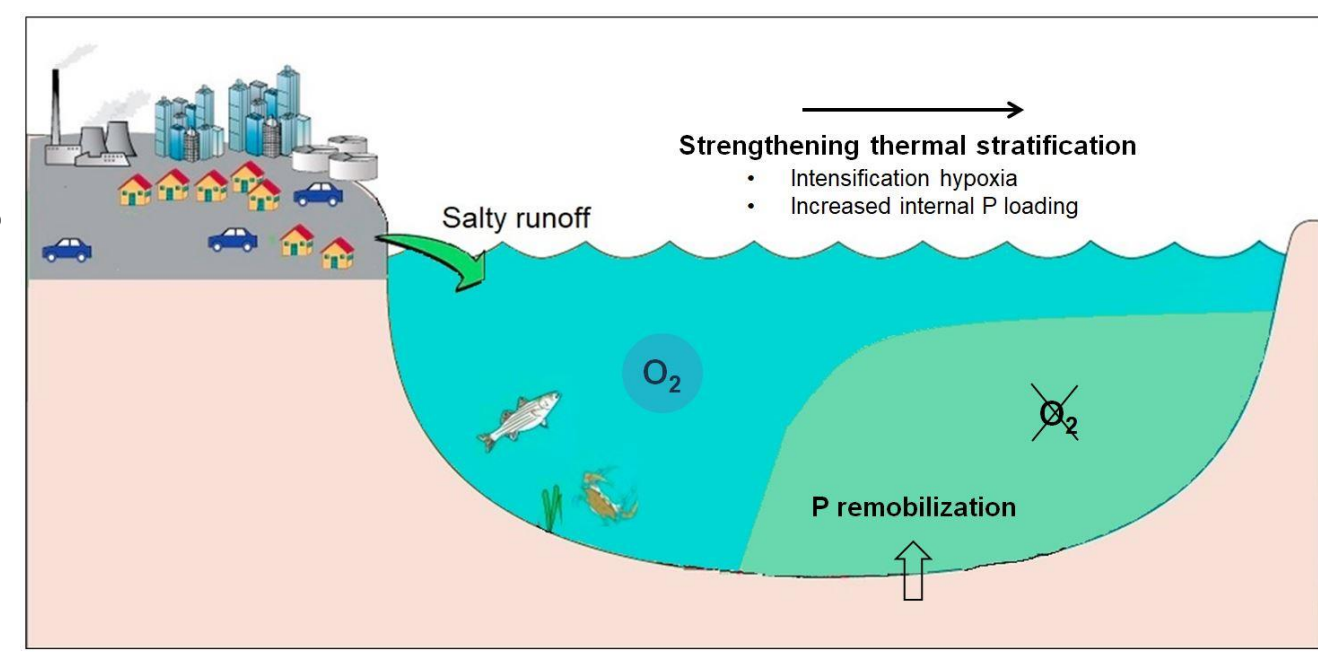


## Motivation & Objective

Salinization → increasing problem for freshwater ecosystems in cold regions

Negative effects of excess salt ions in freshwater lakes:

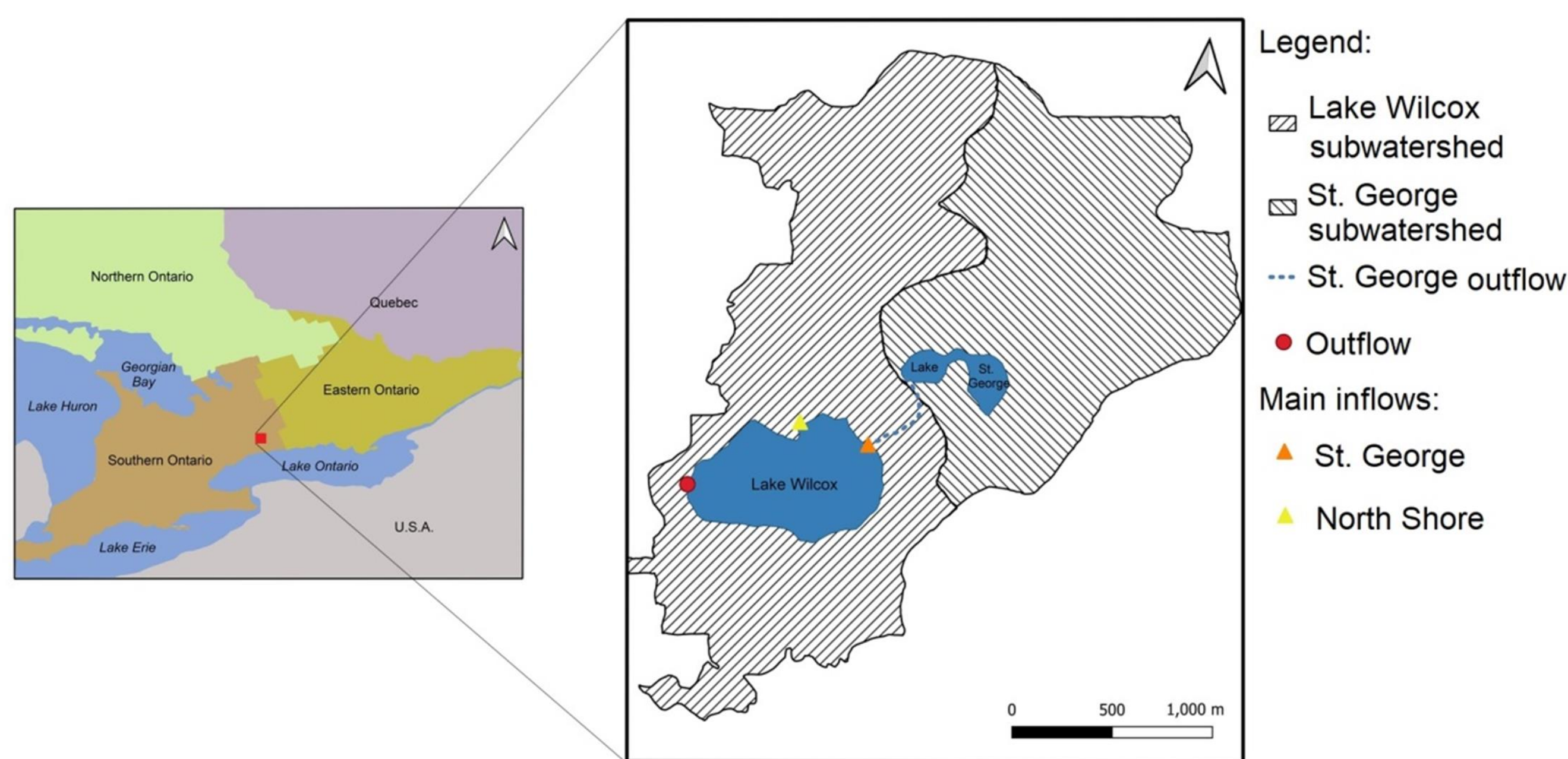
- Impairs ecosystem health
- Modifies water chemistry
- Increases thermo-stratification → promotes anoxic conditions → impacts nutrient cycling



Conceptual figure showing impact of salinization on thermal stratification, hypoxia and sediment P recycling.

**Objective:** Assess the changes in water chemistry and eutrophic symptoms in Lake Wilcox (LW) during the period 1996–2018 and identify drivers of these changes using statistical analysis methods.

## Study site & Dataset



Location of Lake Wilcox in Ontario, Canada (left), and outline of its watershed (right).

Rapid urbanization of the lake's watershed since 1990s.

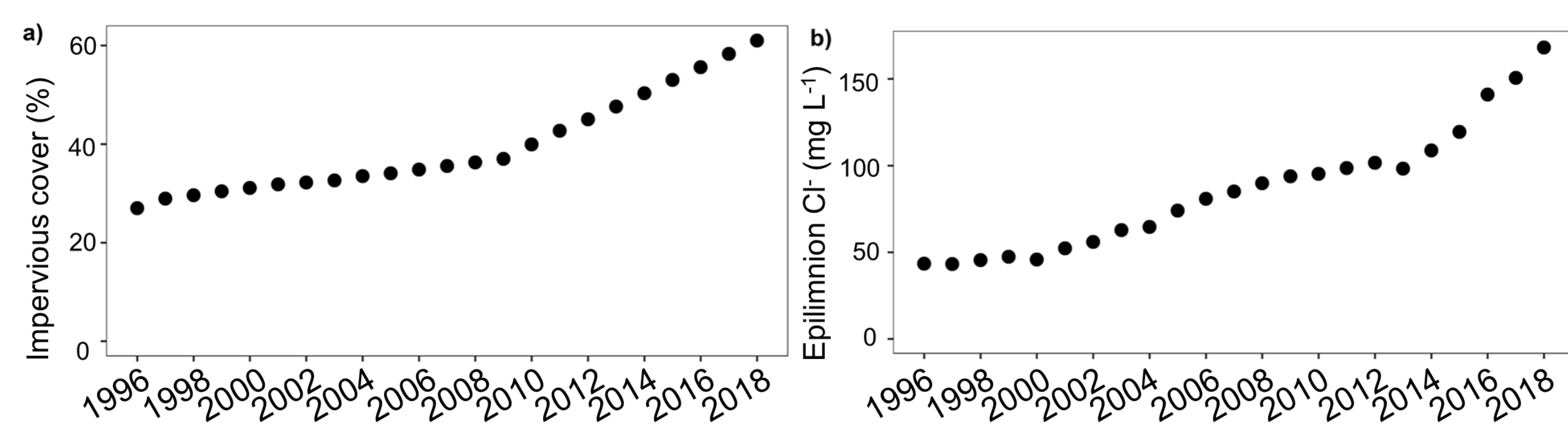
**Datasets** (provided by City of Richmond Hill):

Total phosphorus (TP), dissolved inorganic P (DIP), nitrate ( $\text{NO}_3^{2-}$ ), ammonium ( $\text{NH}_4^+$ ), dissolved inorganic nitrogen (DIN), chloride ( $\text{Cl}^-$ ) and DO concentrations.

**Statistical analyses:**

Principal Component Analysis (PCA) and Multiple Linear Regression (MLR) among variables of interest.

Chloride concentrations (as proxy for salinization) follows urbanization.



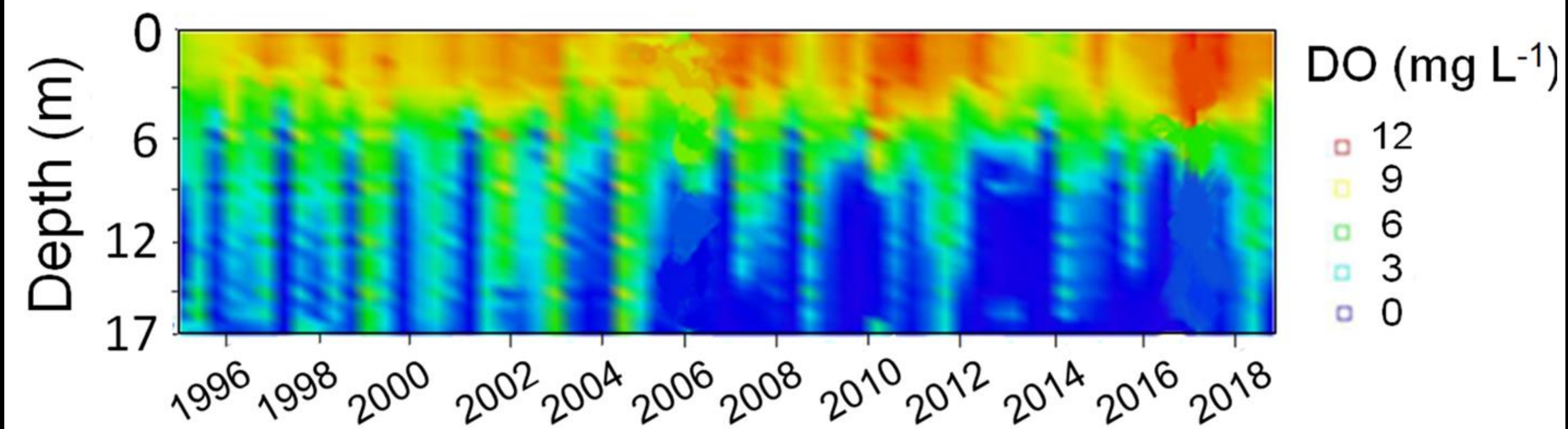
Timeseries of increasing of imperviousness in the Lake Wilcox watershed (right) and concentrations of chloride in Lake Wilcox from 1996 to 2018 (b).

## Conclusions

- Stratification and eutrophication symptoms are linked to urbanization via increased salinization rather than increased external P loading.
- Progressive salinization strengthens water column stratification and drives the accompanying changes in water chemistry → expansion of hypolimnion anoxia and enhancement of internal P loading → salinization contributes to maintaining eutrophic state.

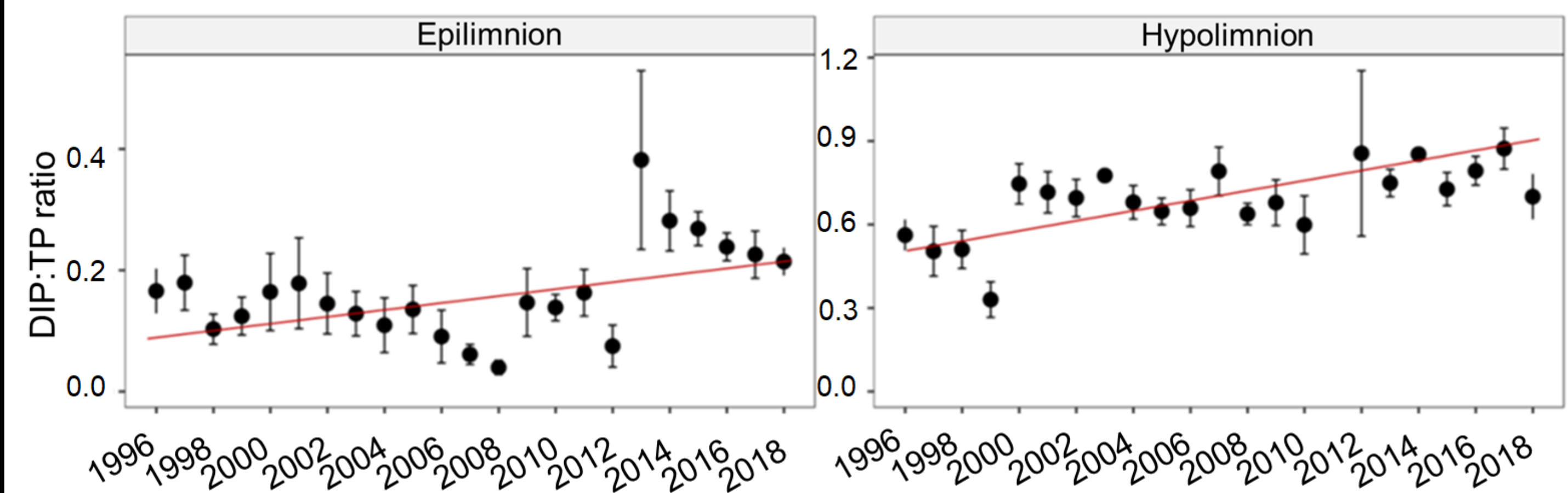
## Results

More intense periods of hypolimnion anoxia since 2005.



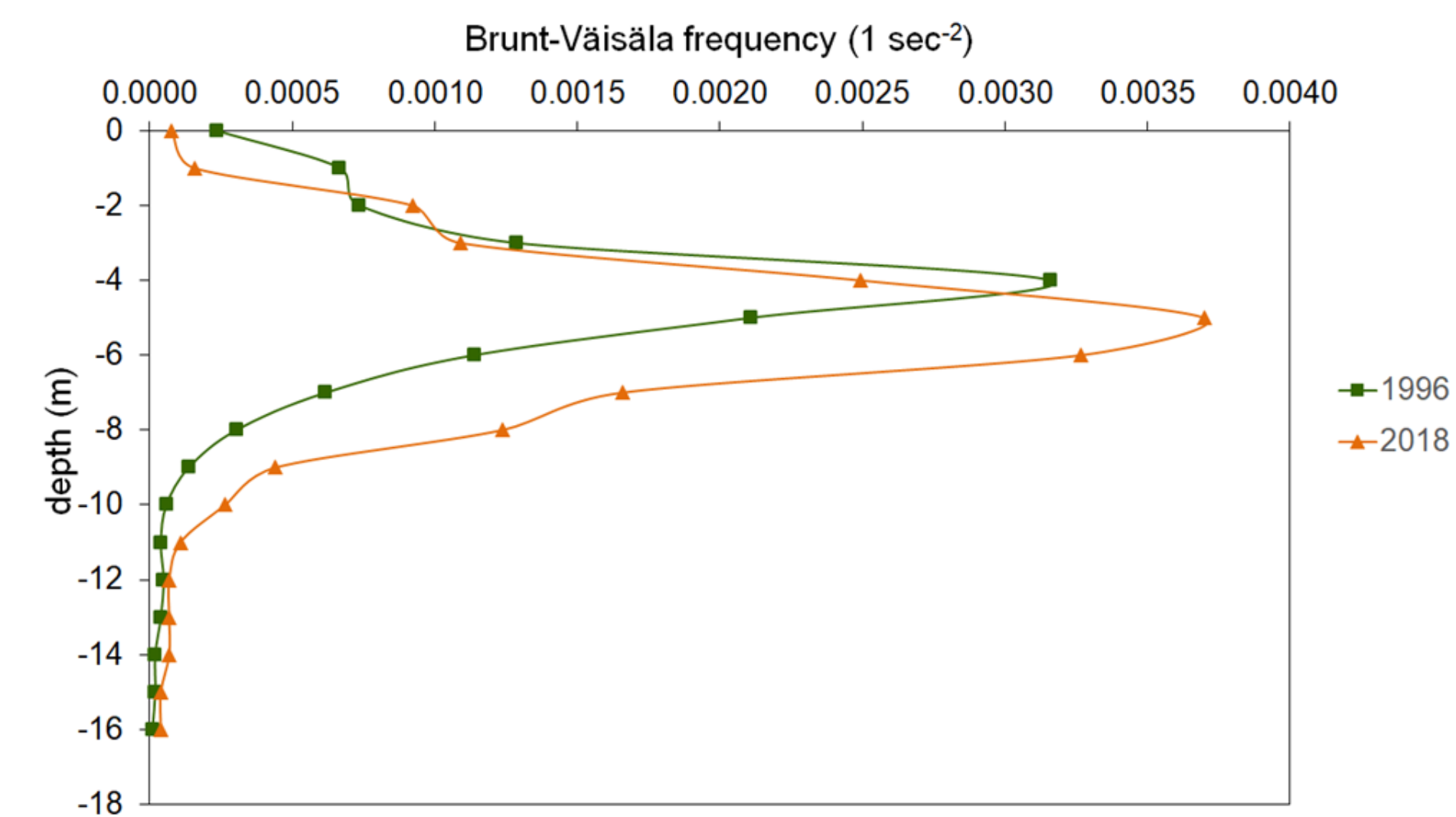
Heat map showing changes with depth and time in water column DO.

External TP loadings and TP concentrations overall decreased; increased proportion of bioavailable DIP: increased internal loading.

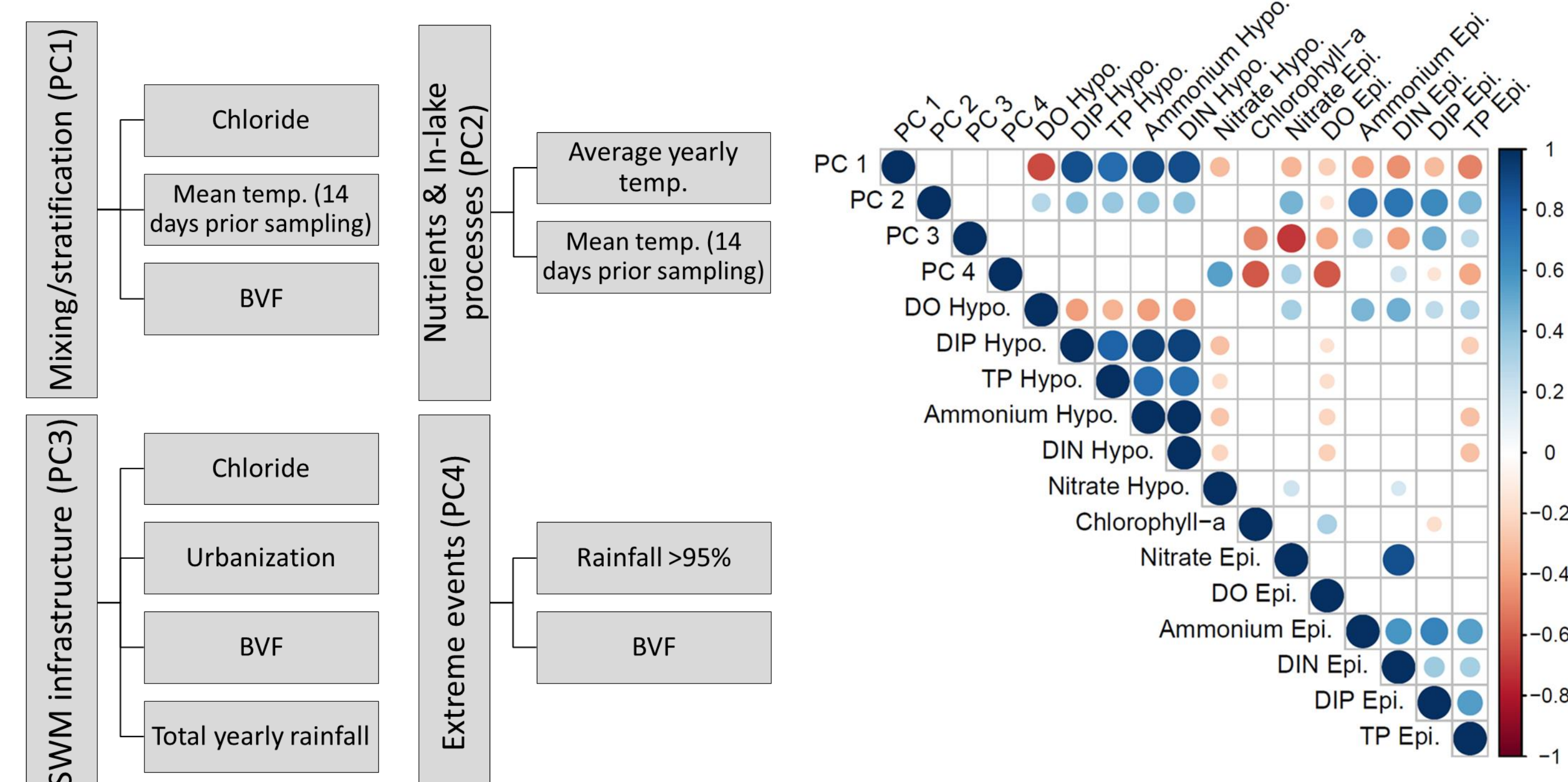


Time series of DIP:TP ratios in epilimnion and hypolimnion.

Rising salinity promotes water column stratification (quantified by the Brunt-Väisälä frequency (BVF)).



## Statistical Analyses:



Results of MLR with distinguished most important explanatory variables of PCs.

Pearson's correlation between the PCs and variables included in the analysis.