Ecological community thresholds as a basis to set water quality targets for lake restoration

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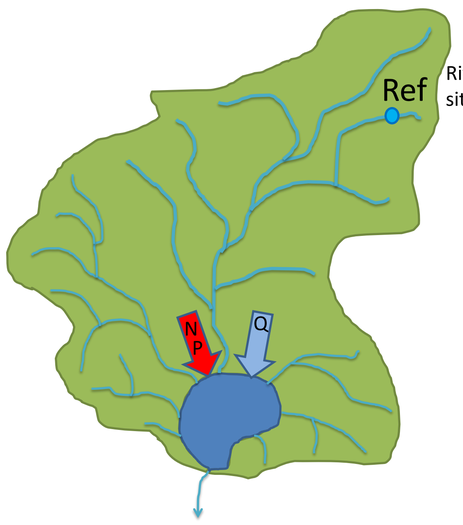
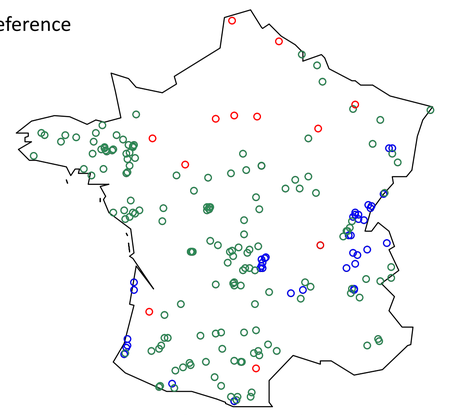
INTRODUCTION

➢ Lakes provide many ecosystem services such as drinking-water supply and recreation. Therefore it is crucial to protect them and apply restoration measures to the most impacted ones. Eutrophication is the major cause of lake alteration and requires the reduction of nutrient input to the lakes. Prior to the application of expensive restoration measures, precise objectives expressed in terms of quantitative water quality targets have to be set. The use of ecological thresholds (Groffman et al, 2006) can provide meaningful restoration targets, especially if they involve many species from different aquatic communities. We present here an approach of physico-chemical lake restoration based on the definition of site-specific reference conditions and the identification of community thresholds. The preliminary results concern the parameters water transparency (Secchi) and total phosphorus (TP).

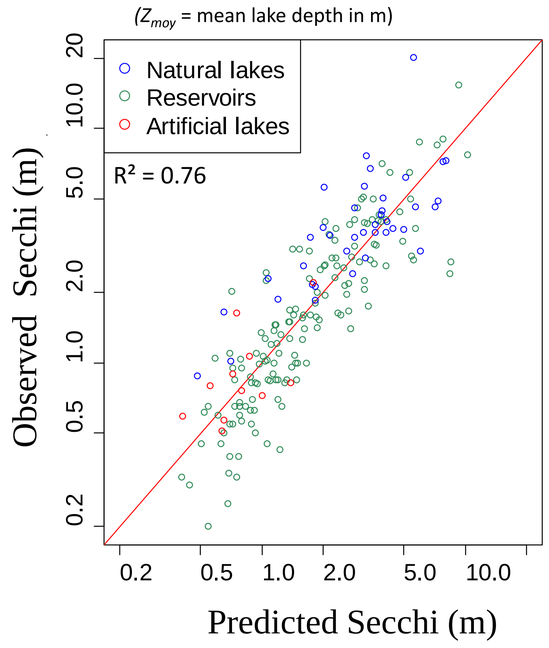
REFERENCE CONDITIONS




Lakes of the French WFD network

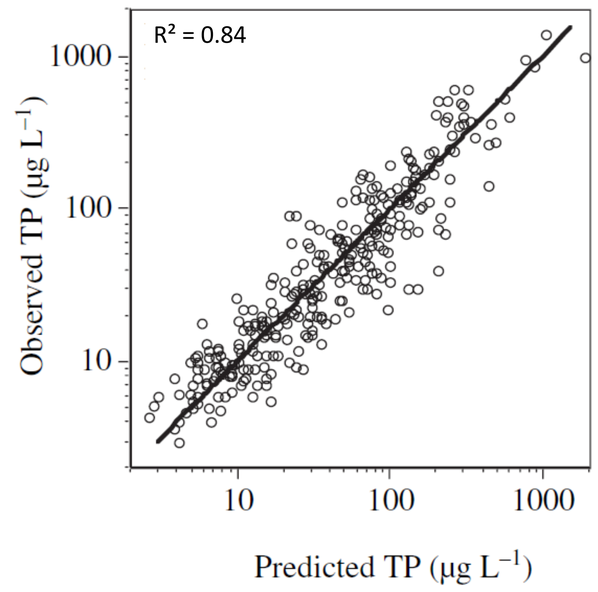
$$log_{10}(Secchi) = -0.25\ log_{10}(TN_{trib}) + 0.46\ log_{10}(Z_{moy})$$

(Z_{moy} = mean lake depth in m)



$$log_{10}(TP_{lake}) = log_{10}\left(\frac{TP_{trib}}{\left(1 + 1.12\ T_{res}^{-0.53}\right)}\right)$$

(T_{res} = lake water residence time in year)



(Brett and Benjamin, 2008)

Biogeochemical and hydrological models :

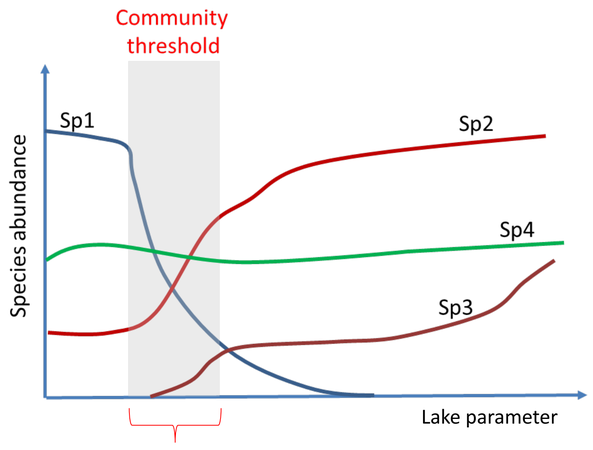
- N and P input (F_N , F_P) to the lakes : Nutting N&P (F. Moatar, com. pers .; Dupas et al, 2015)
- Water discharge (Q) : LoiEau (Folton et Lavabre, 2006)

-> Total nitrogen and phoshorus concentrations (µg.L^{-1}) in the tributaries:

$$TN_{trib}\ or\ TP_{trib} = \frac{F_N\ or\ F_P}{Q}$$

- River reference sites => $(TN_{trib})_{Ref}$ and $(TP_{trib})_{Ref}$ => $(\boldsymbol{Secchi})_{\boldsymbol{Ref}}$ and $(\boldsymbol{TP_{lake}})_{\boldsymbol{Ref}}$

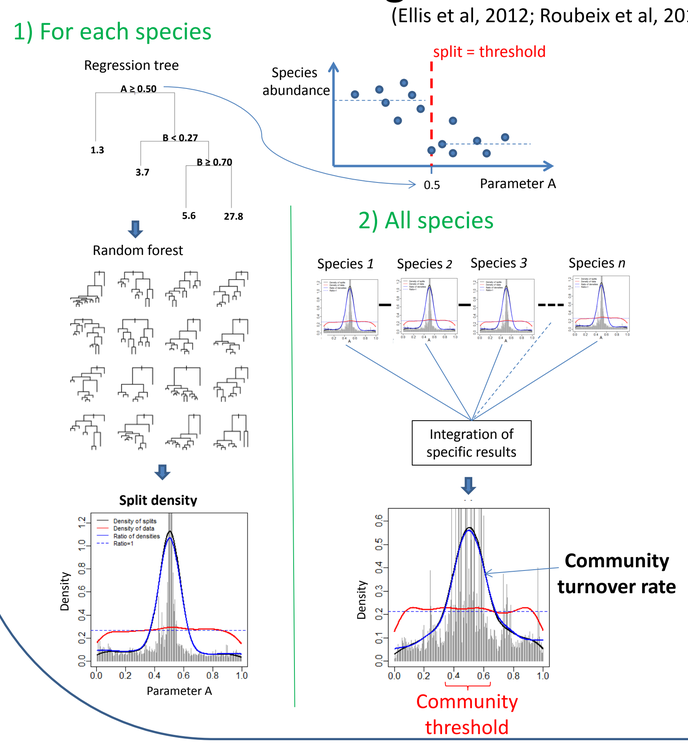
COMMUNITY THRESHOLDS



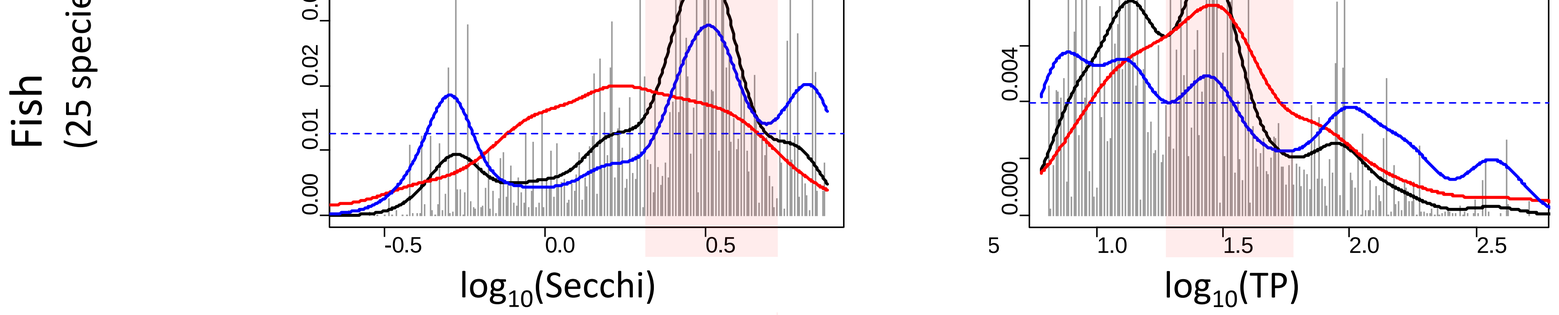
A critical zone in an environmental gradient in which the rate of change in community structure is enhanced relative to the rest of the gradient, as a result of sharp increases or decreases in the abundances of several species (King and Baker, 2010).

Detection method = gradient forest

(Ellis et al, 2012; Roubeix et al, 2016)



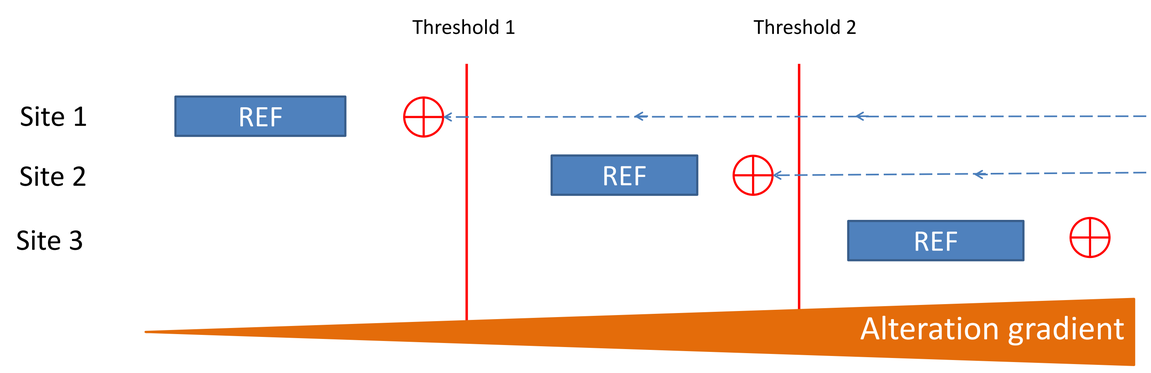
Gradient forest : 3 biological groups, about 200 lakes (all types)



➢ Some thresholds are similar among biological groups revealing possible important ecological thresholds, whereas others are more specific of one particular group.

RESTORATION TARGETS

• The identified community thresholds may be used as restoration targets after considering the relative location in an alteration gradient of site-specific reference conditions (Soranno et al, 2008). A lake physico-chemical parameter should be reduced to a level lower than the first important threshold above reference conditions.



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