

Uncertainties associated to bio-indicator in rivers

Consequences of global warming

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- European Fish Index
- Uncertainties
- Global warming

European Fish Index

- A **multimetric index** (metrics based on ecological functions)

IBI family: Karr et al. 1981, Angermeier et al. 2000

- A **reference condition approach:**

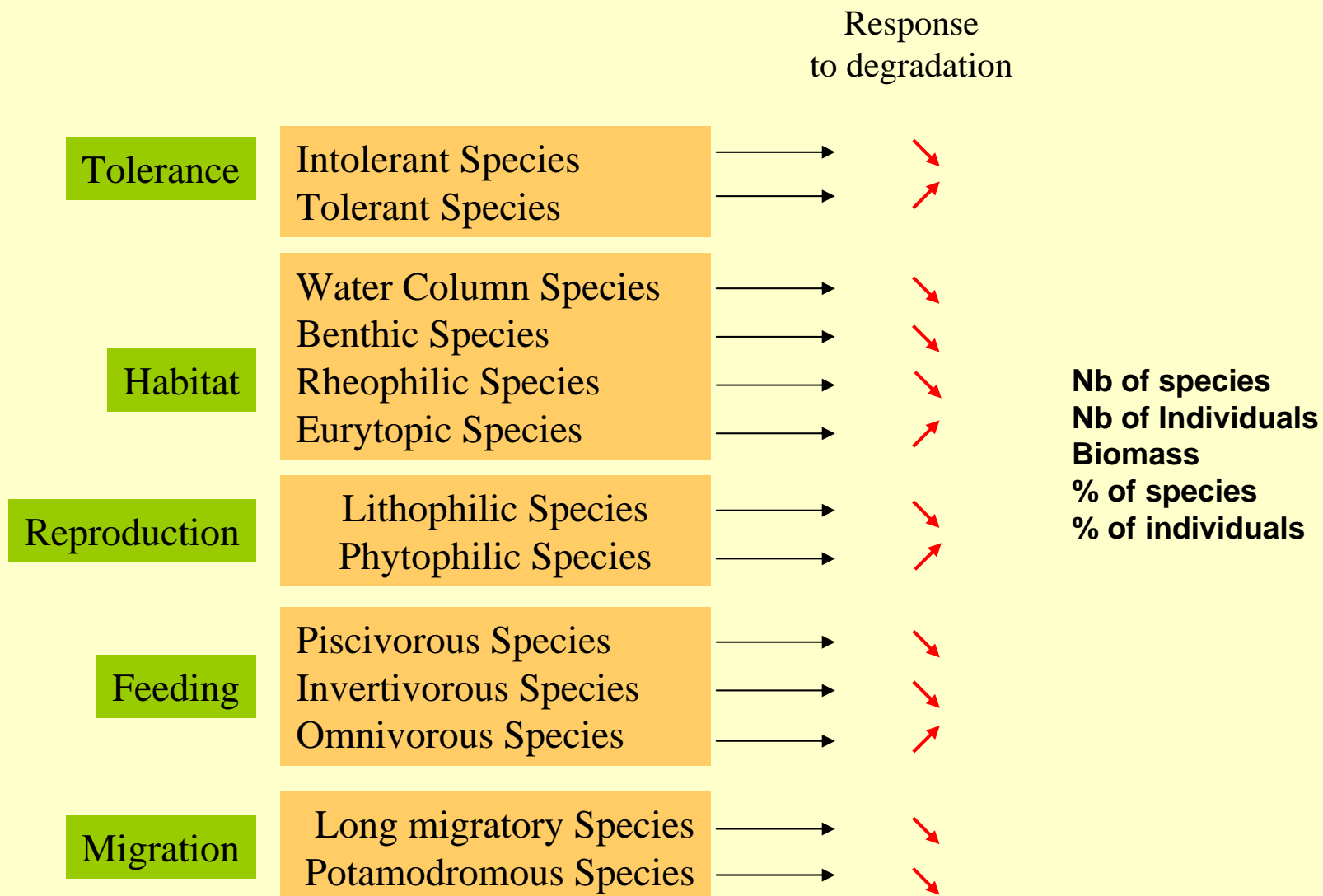
Pre-classification of sites based on human disturbance intensity

- A **modelling approach**

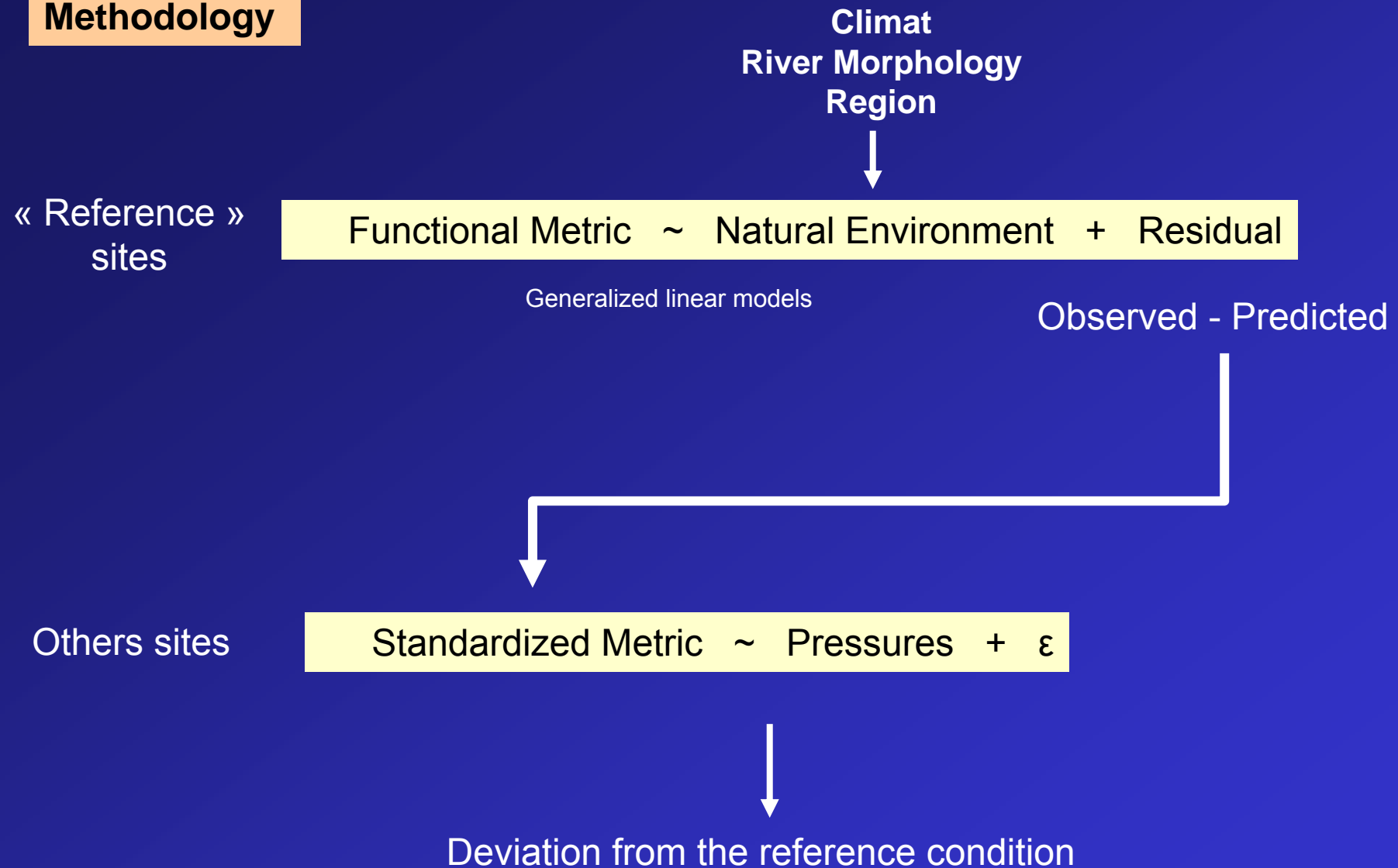
Theoretical fish community expected at a given river site under natural condition

Quantification, for any site, of its deviation from a reference condition site

Functional metrics

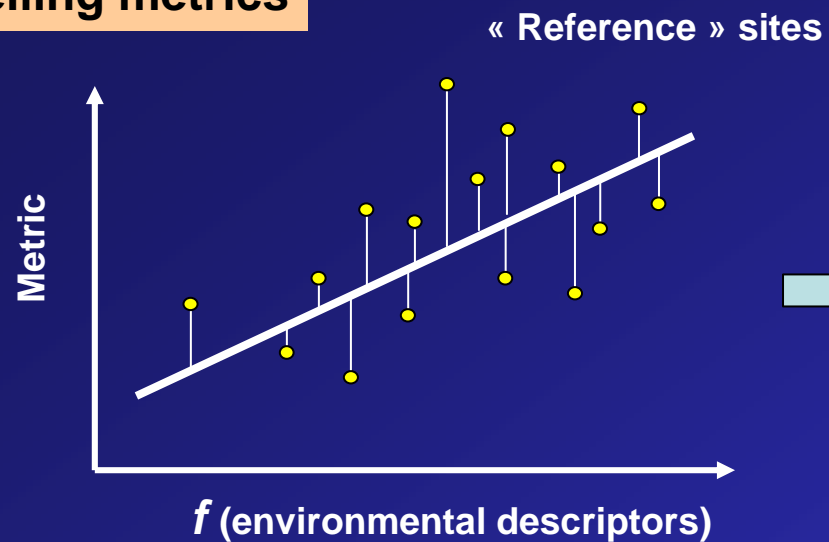


Methodology

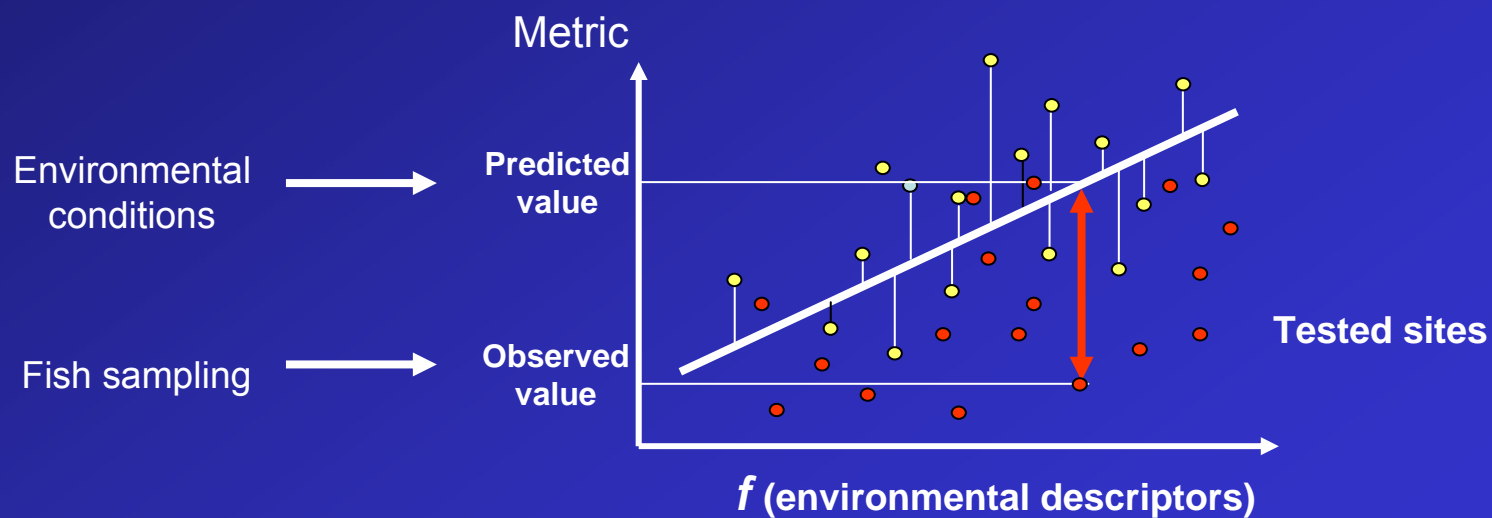
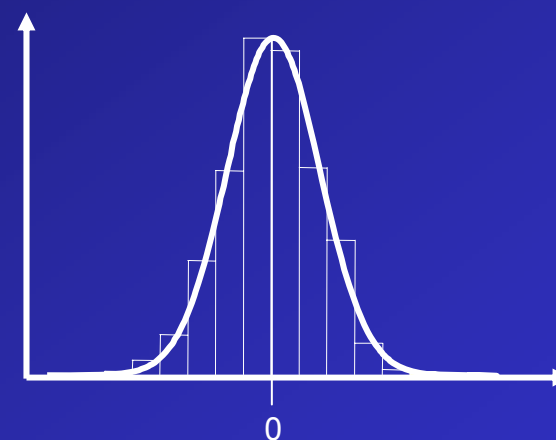


Pont et al. 2006
Pont et al. 2007

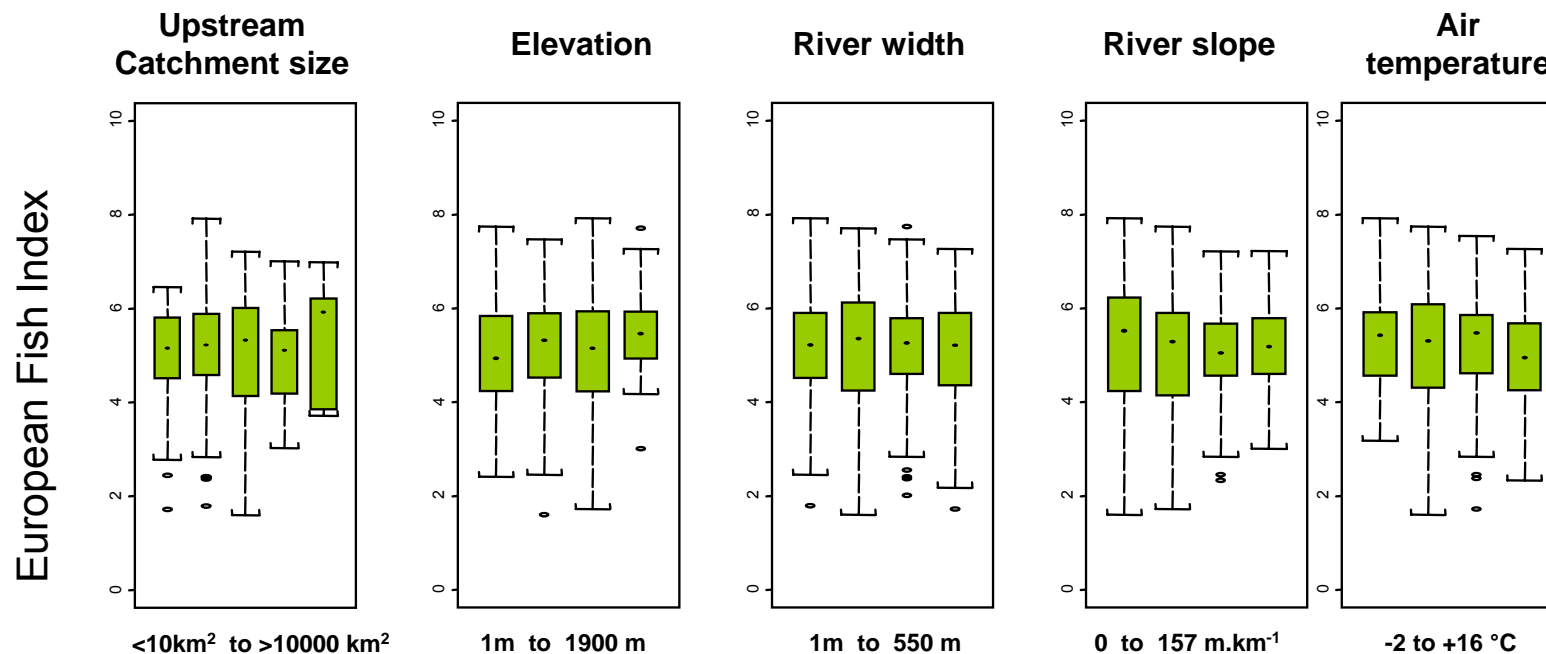
Modelling metrics



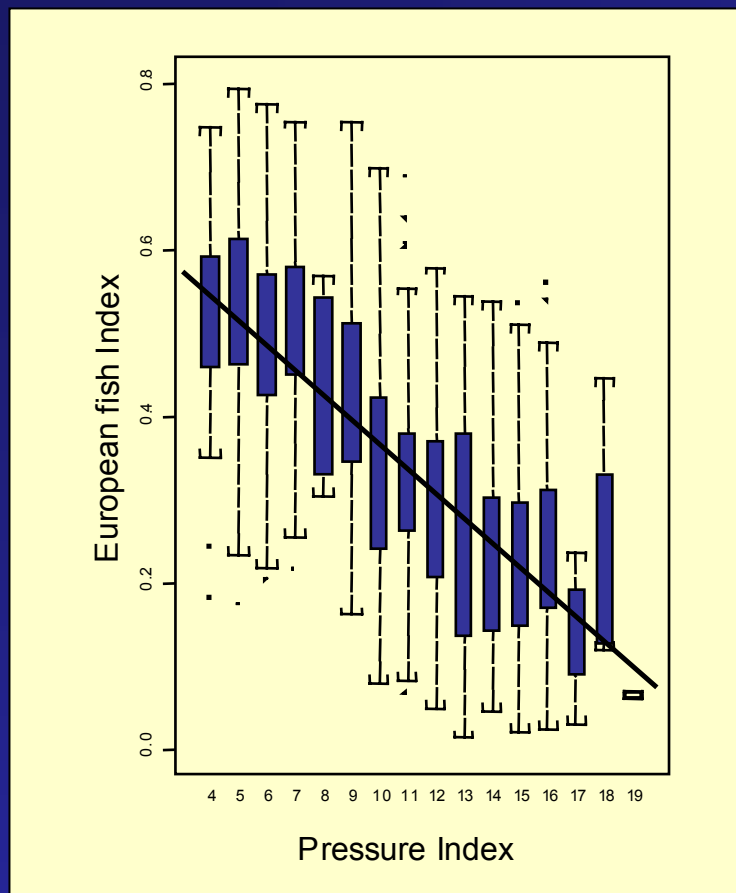
Residuals distribution
for reference sites



« Reference sites »: Independency from natural environmental conditions



Index responses to human pressures

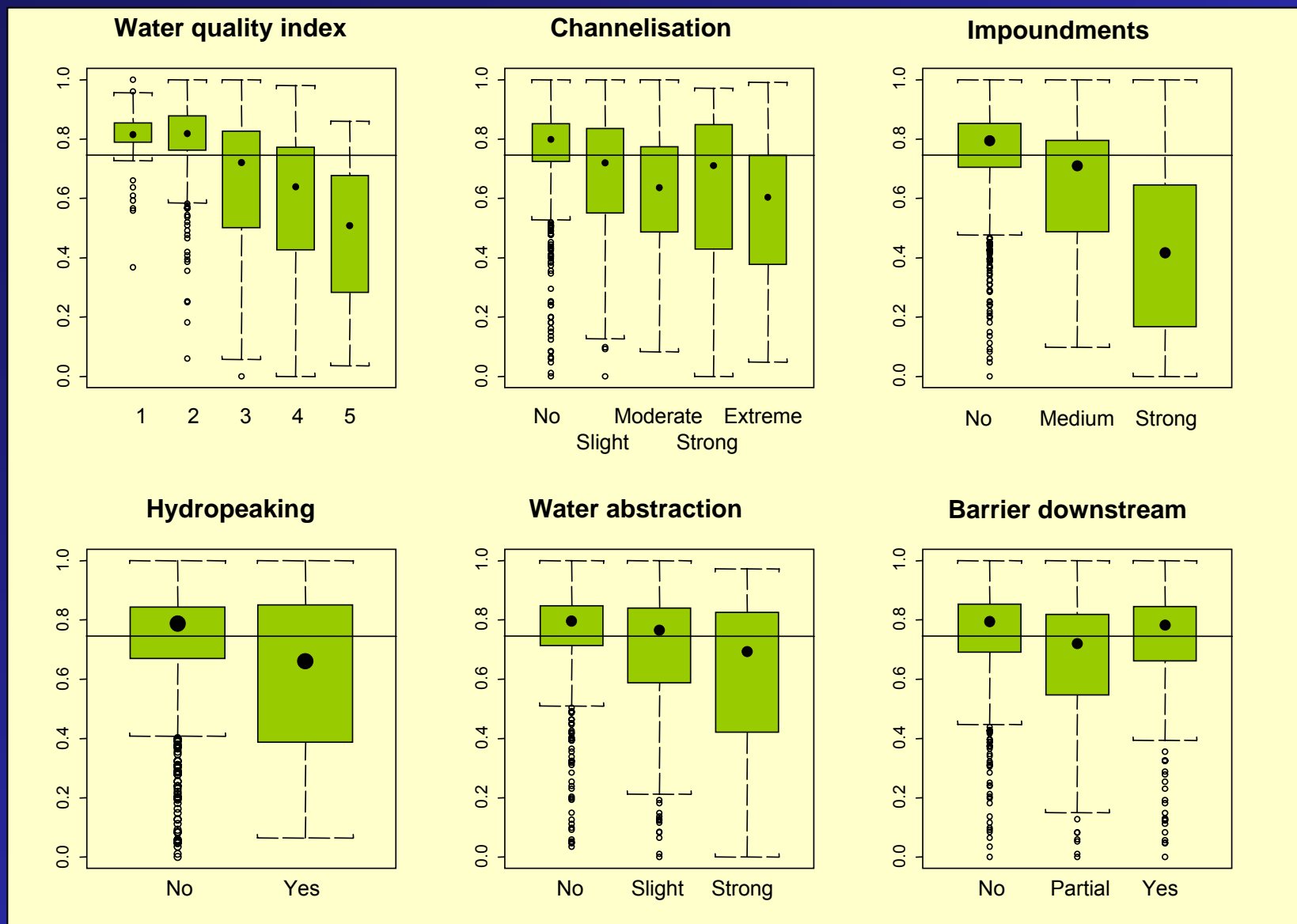


Responses to different
pressures types ?



EFI+ project (2007 – 2008)

Responses to different pressures types (France)



UNCERTAINTIES

EFI+ project (2007 – 2008)

Simulated Intervals based on normal distribution

- Error associated to the glm model (dispersion parameter)

$$\hat{\sigma}^2 = \frac{1}{n-p-1} \sum_{i=1}^n \left(\frac{w_i (y_i - \hat{y}_i)}{\text{var}(\hat{y}_i)} \right)^2$$

n-p-1: degree of freedom

- Error associated to one value of the « reference dataset »

$$\hat{\sigma}^2(\hat{\eta}_x) = \hat{\sigma}^2 \left(\mathbf{X}_x' (\mathbf{X}' \mathbf{X})^{-1} \mathbf{X}_x \right)$$

$\hat{\eta}_x$: predicted value

\mathbf{X}_x : explanatory variables matrix

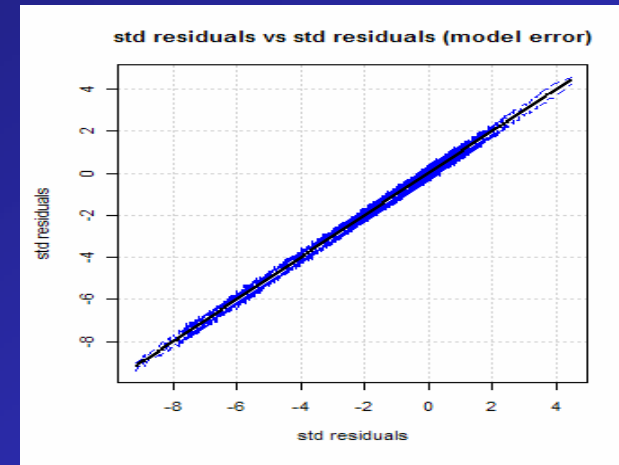
99 random samples in a normal distribution (mean: $\hat{\eta}_x$; Std deviation: $\hat{\sigma}(\hat{\eta}_x)$)

Quantile values (0.10 and 0.90) of the distribution

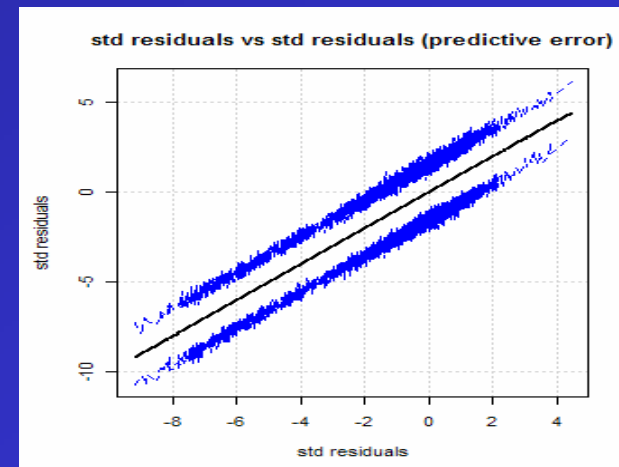
- Error associated to one independant new observation (Prediction error)

$$\hat{\sigma}^2(\hat{\eta}_x) = \hat{\sigma}^2 \left(\frac{1}{m} + \mathbf{X}_x' (\mathbf{X}' \mathbf{X})^{-1} \mathbf{X}_x \right)$$

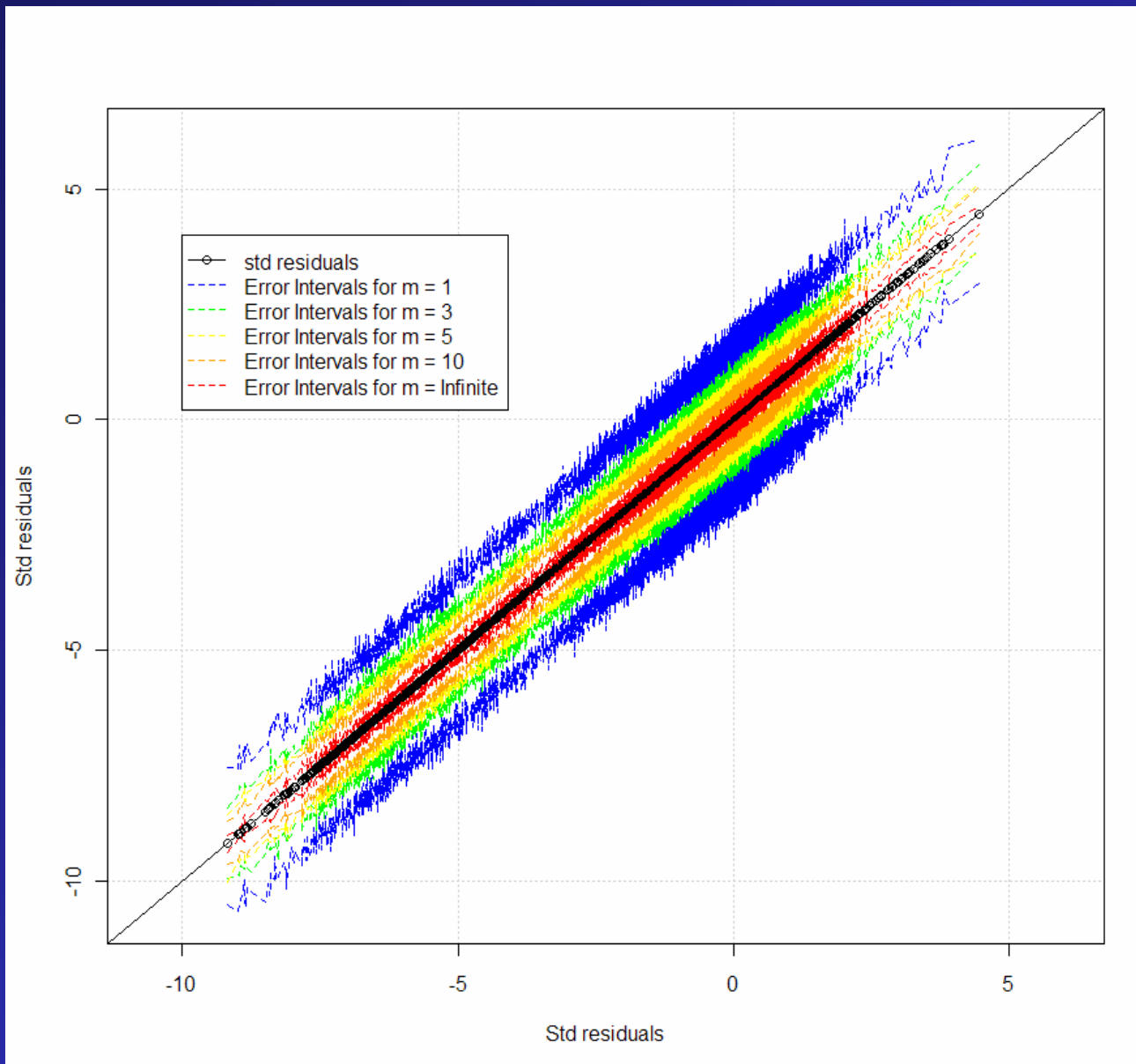
m: number of observations



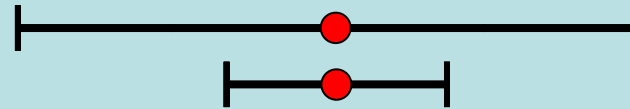
O2 Intolerant species metric



Influence of number of observations on the prediction error interval estimation

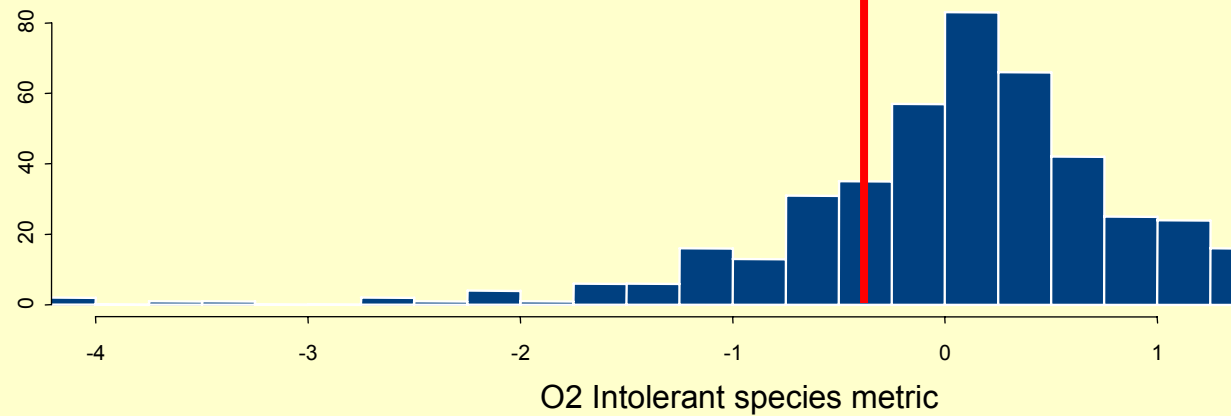


Prediction error interval

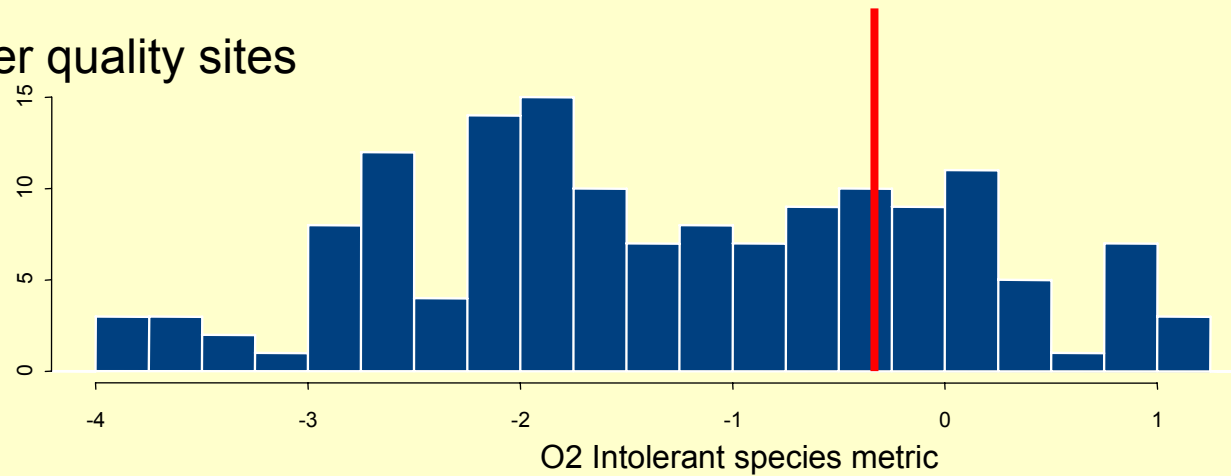


1 observation
10 observations

Undisturbed sites



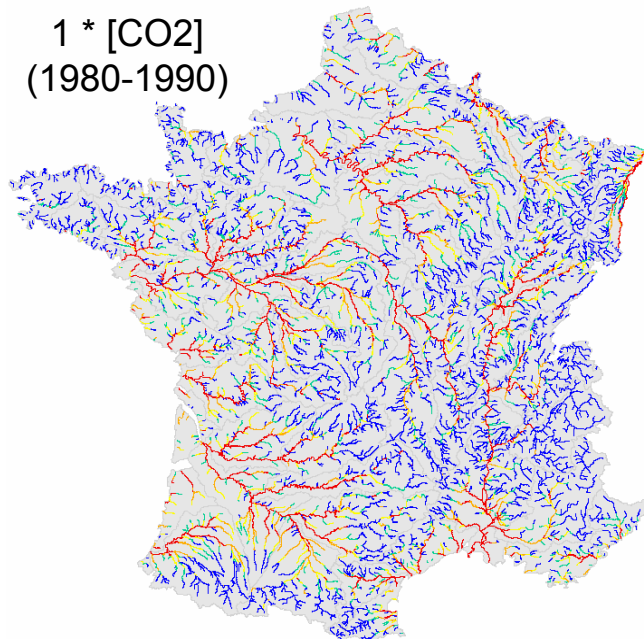
Low water quality sites



Climate change impact on river assessment

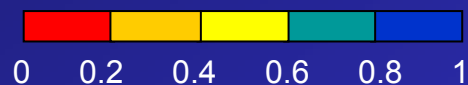
Brown trout distribution (France)

1 * [CO2]
(1980-1990)



Presence: 45 900 km
(among ~ 65000 km)

Probability of Presence

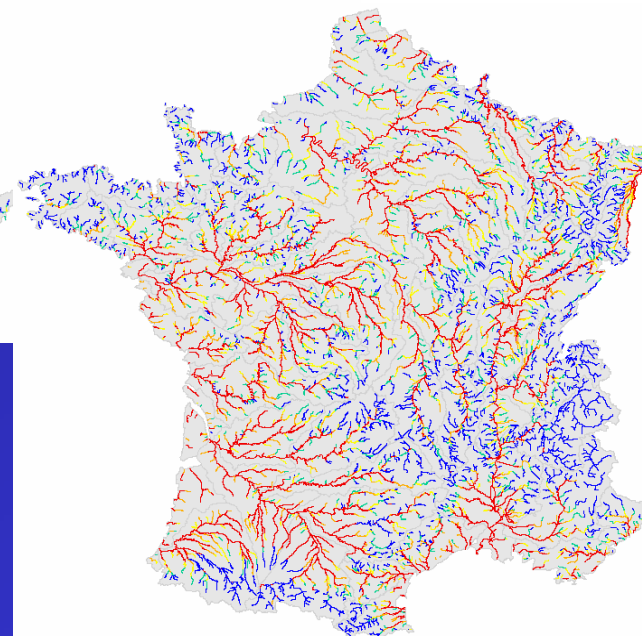
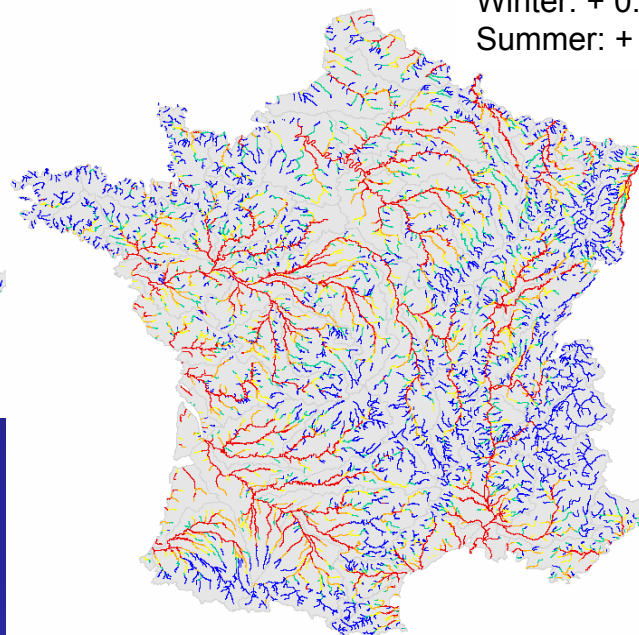


Potential Habitat Loss: 16 %

Salmo trutta

Winter: + 0.54°C
Summer: + 1.06°C

Winter: + 1.07°C
Summer: + 2.12°C

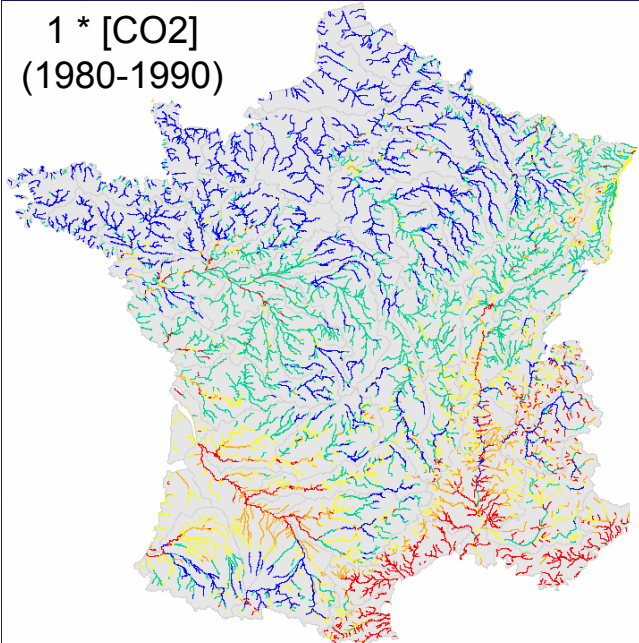


Potential Habitat Loss: 33 %

Climate Envelop Models

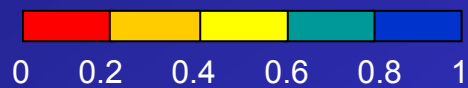
ARPEGE Climate Model (French Weather Forecaster Institut)
Pont et al. 2006. Progr. French Institut for Biodiversity - MEEDDAT-GICC

1 * [CO₂]
(1980-1990)



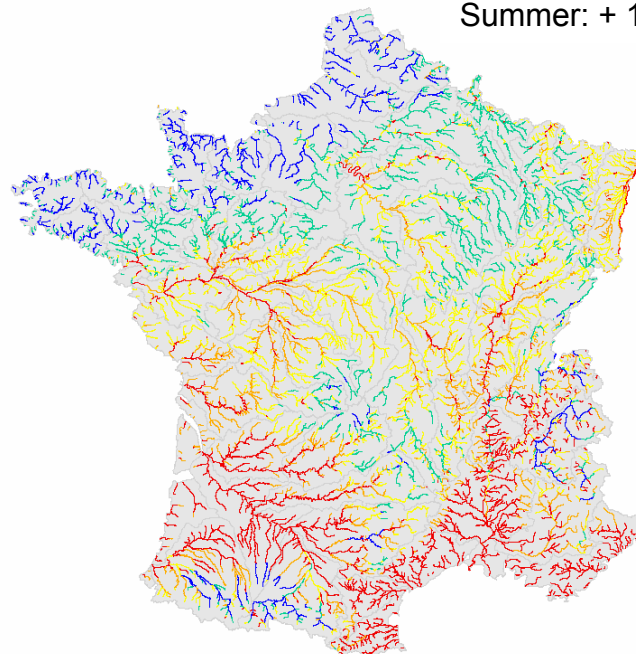
Présence: 49 100 km

Probability of presence



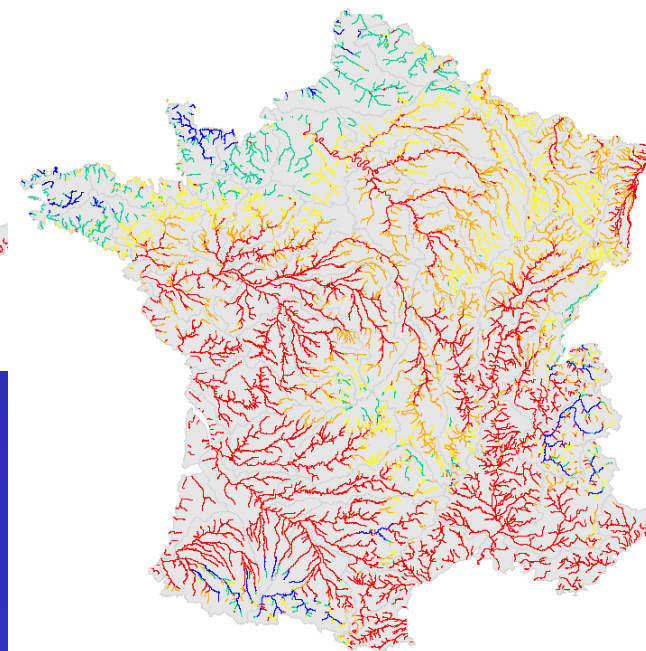
Sculpin: Cottus gobio

Winter: + 0.54°C
Summer: + 1.06°C



Potential Habitat Loss : 37 %

Winter: + 1.07°C
Summer: + 2.12°C



Potential Habitat Loss : 77 %

Global warming and bio-indicators

Slight shift:

Modification of community structure but « no » change in species list
Same functional groups

Main implications for Bio-indicators:

Shift of reference conditions

Modification of thresholds between H/G and G/M classes

Important shift (several degrees)

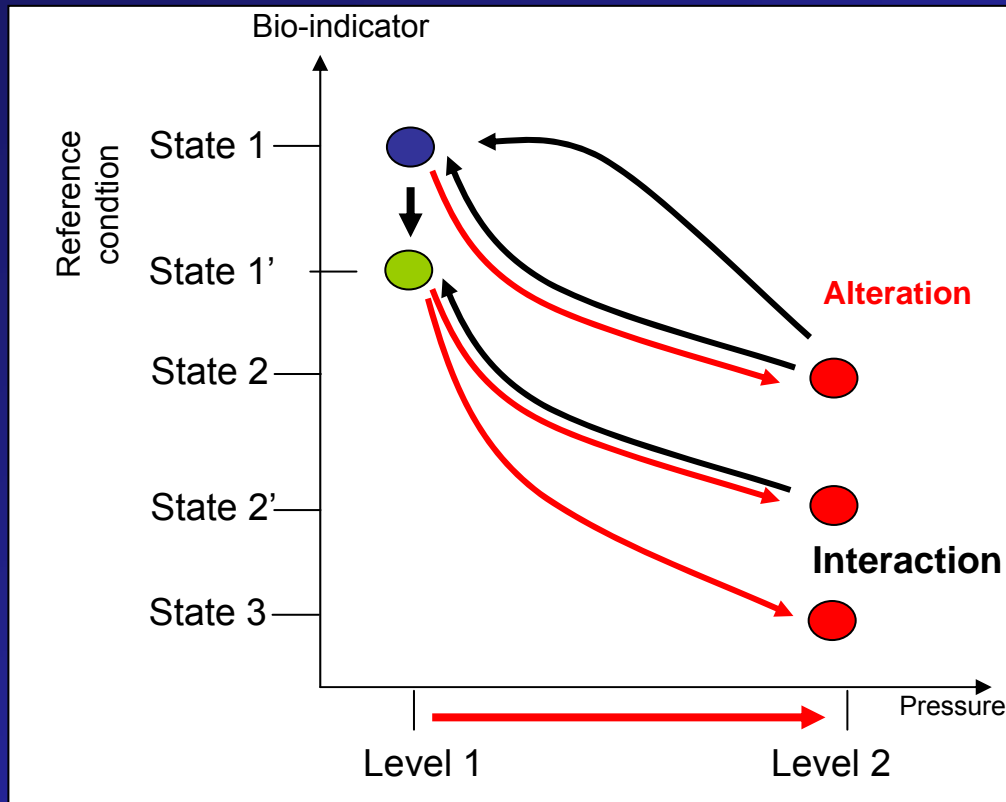
Change in species composition

???

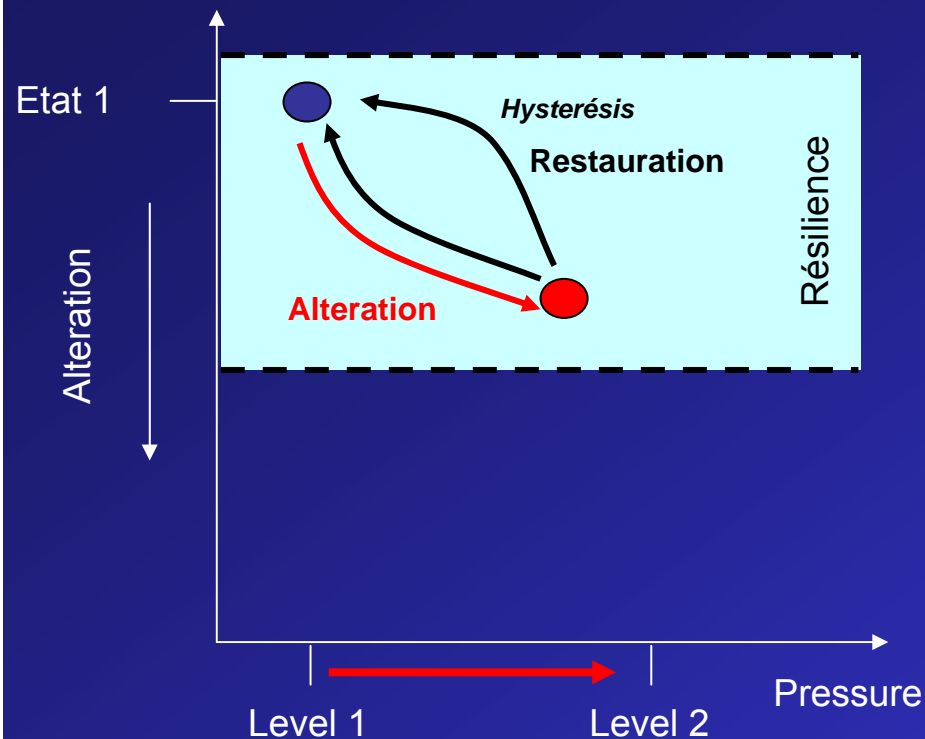
Changes in functional groups

Change in the global functioning of the whole river system

Impact of Global Change on River Assessment

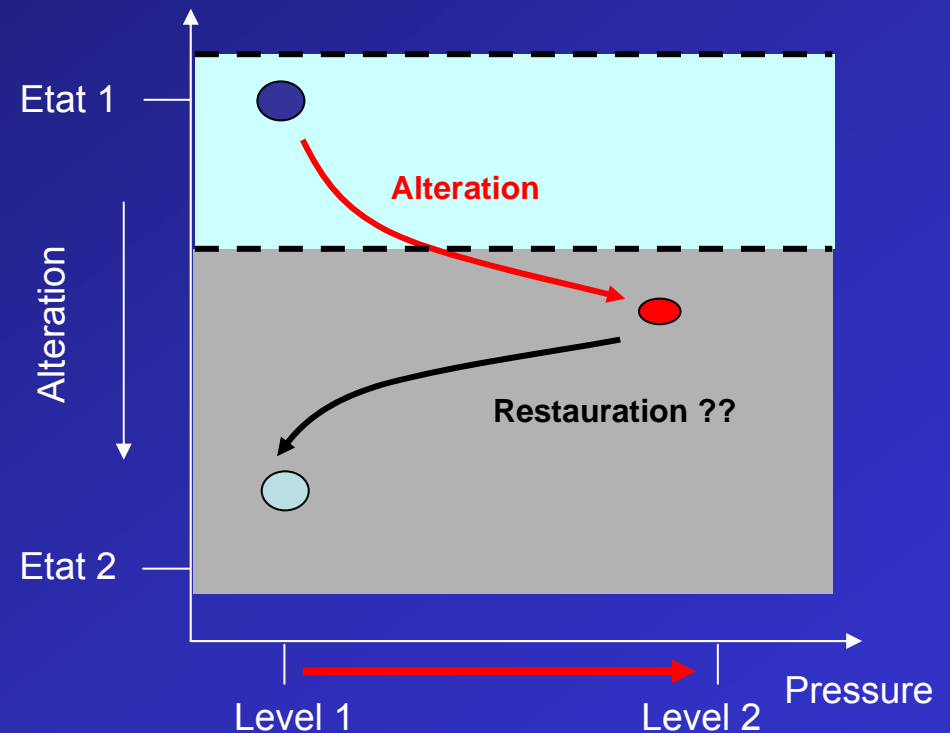


Resilience (Holling, 1996) and Restoration



Reservable state – Restoration
 Successional based management effort
 Restoring previous abiotic conditions is enough

CC: Resilience reduction ?



Alternative Ecosystem State
 (Sunding et al, 2004)
 Species list modified (extinction, invasion)
 Connectivity alteration
 Major alteration at the catchment scale
 New biotic-abiotic feed back feed back

How to deal with ?

Long term survey of reference site network

Continuous water temperature recording

Water flow recording

Regular fauna/flora sampling

To include climate conditions in the characterization of the « reference condition » community

waterflow, temperature

European Fish Index, **WISER Project**

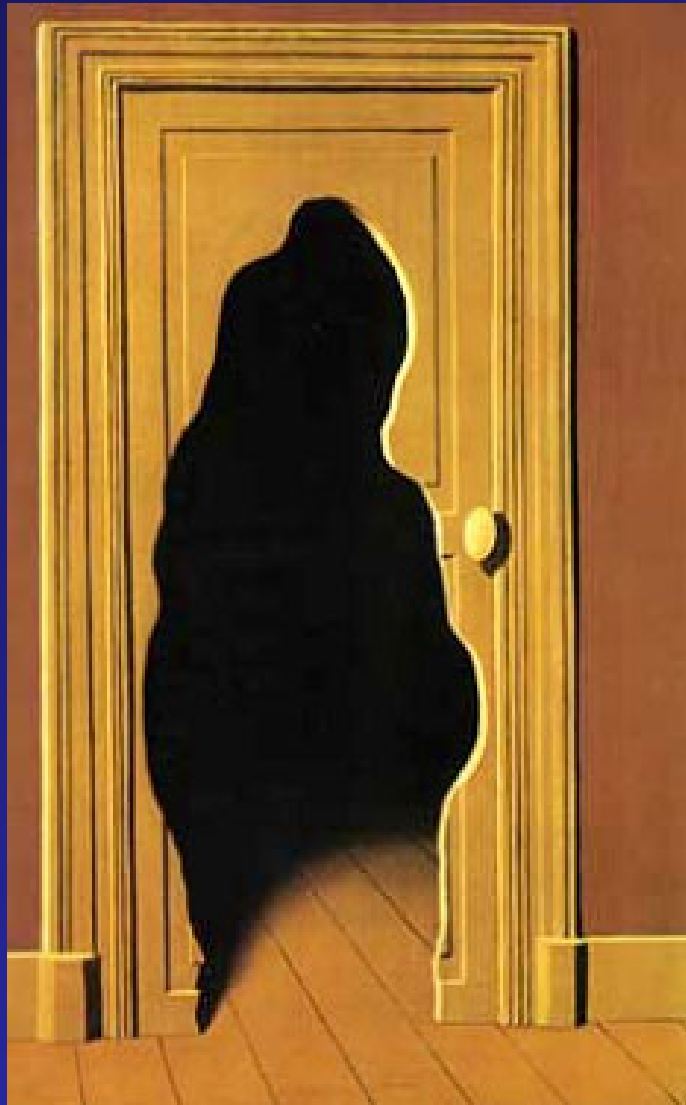
Climat
River Morphology
Region



Functional Metric ~ Natural Environment * Pressures + error

In co-evolving systems of humans and nature,
surprises are the rule, not the exception.

(Gunderson et al. 1999)



The unexpected response

René Magritte

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