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Interactions between climate change, biodiversity and ecosystem processes in transitional waters

Climate change, biodiversity and ecosystem functioning

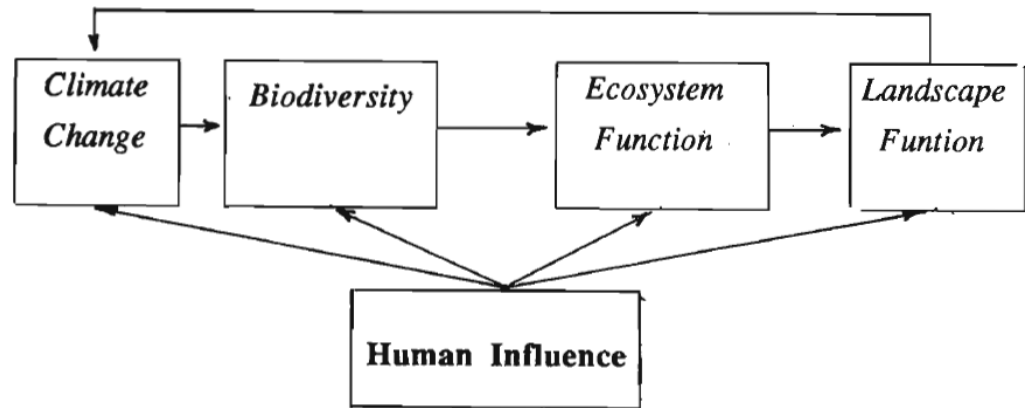
How do climate change affect biodiversity?

How large must the changes be?

Are other factors mediating these responses?

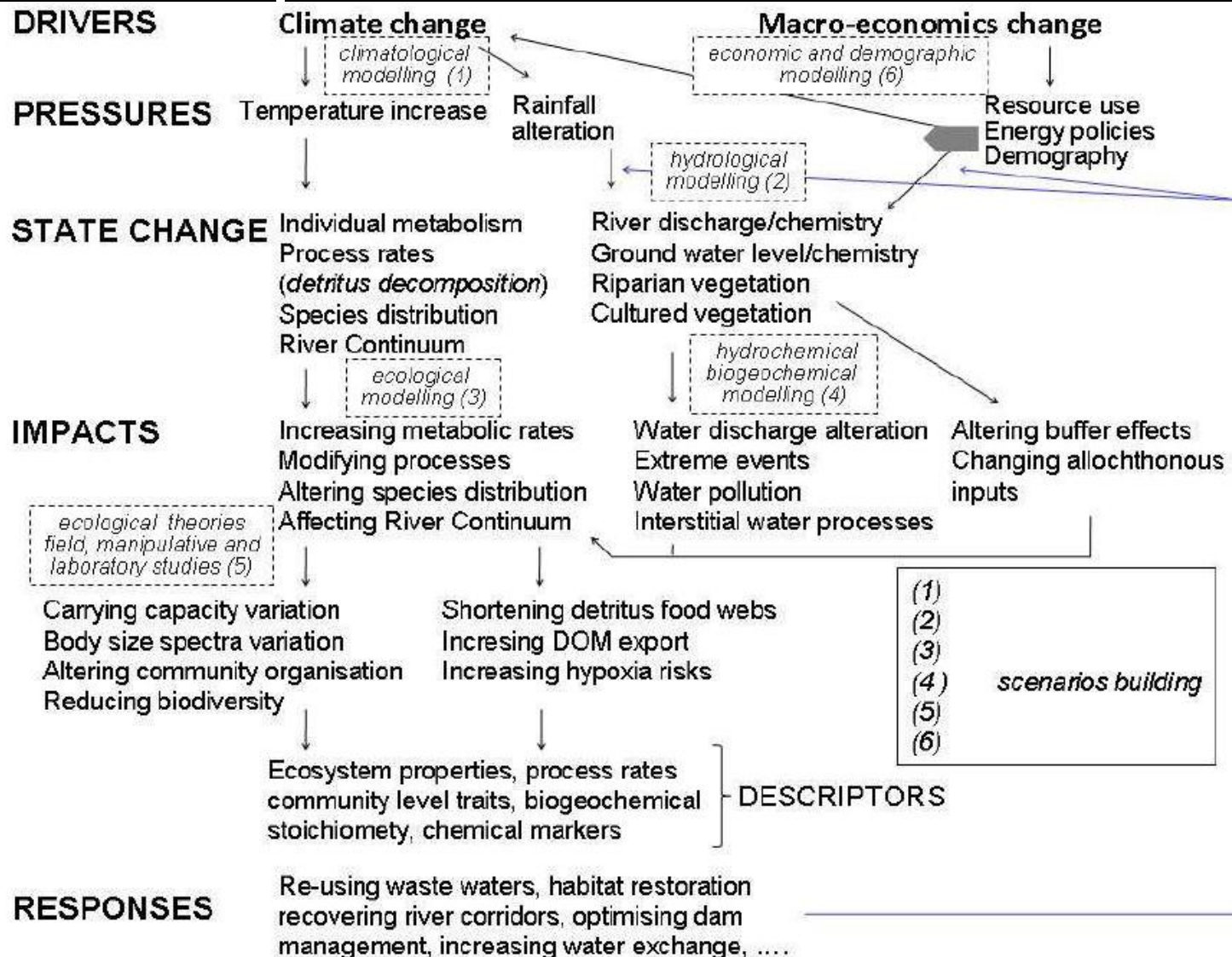
How are these biotic structural changes related to ecosystem processes?

Are biodiversity changes affecting processes? Or do processes affect biodiversity?

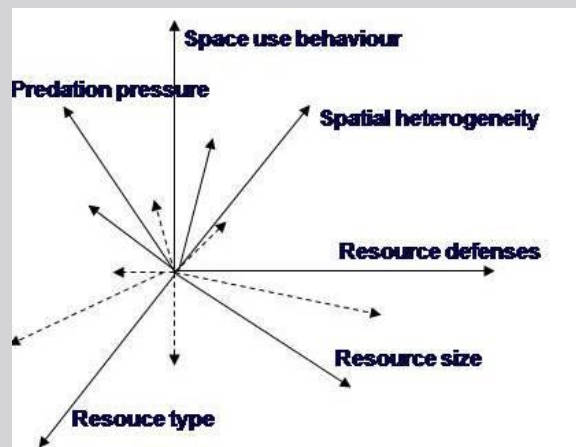
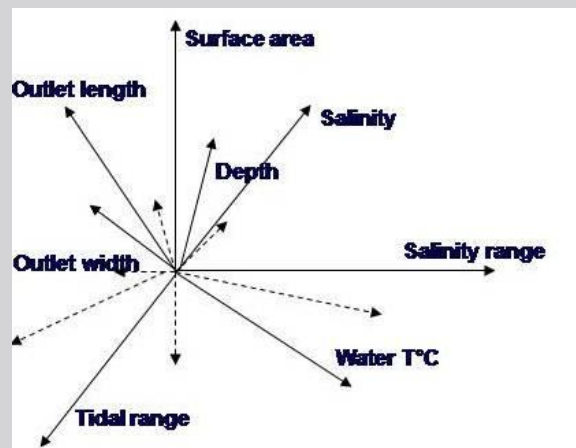


IUSB/SCOPE Workshop (29-30 June 1989 Washington D.C. USA) di Castri & Younes Eds

Climate change, biodiversity and ecosystem functioning



Niche theory



Niche theory merged the two main approaches of ecology:

Autoecology

- interaction with abiotic factors
- colonisation patterns
- individual performances

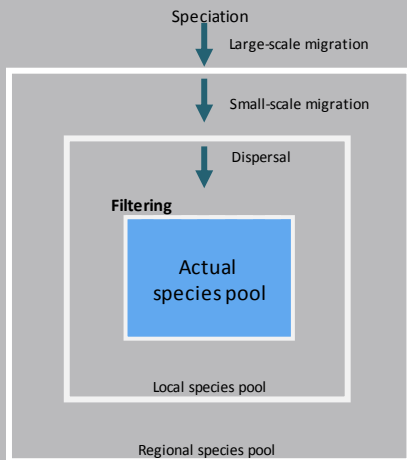
Sinecology

- biotic interactions
- competitive coexistence
- community organisation

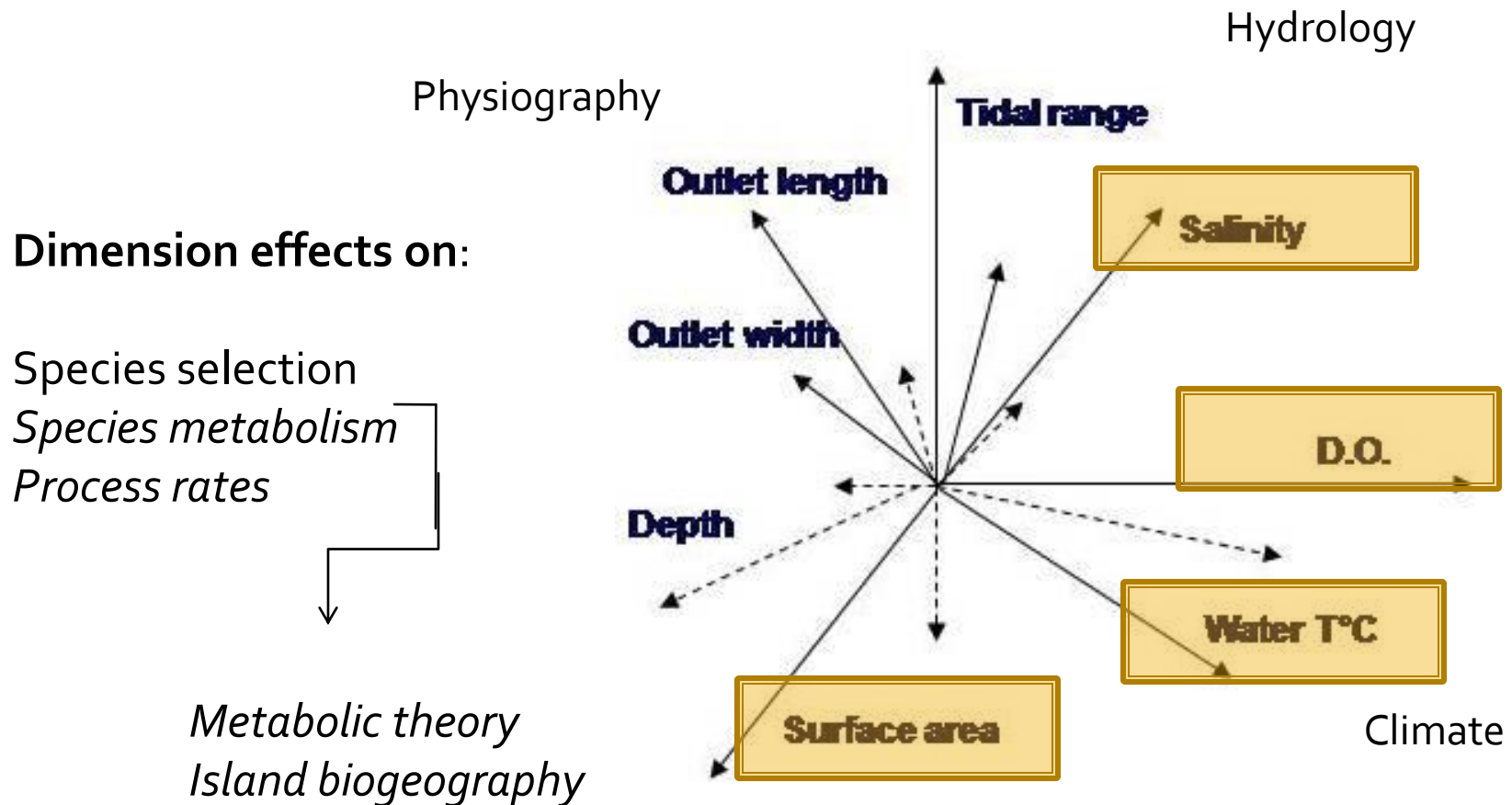
Niche theory

Niche is:

- An ecosystem property:
 - the niche space available
- A property of individuals:
 - The individual requirements
 - The potential individual niche space
- A property of interaction
 - The realised individual niche space



Niche space of lagoon ecosystems



Metabolic theory

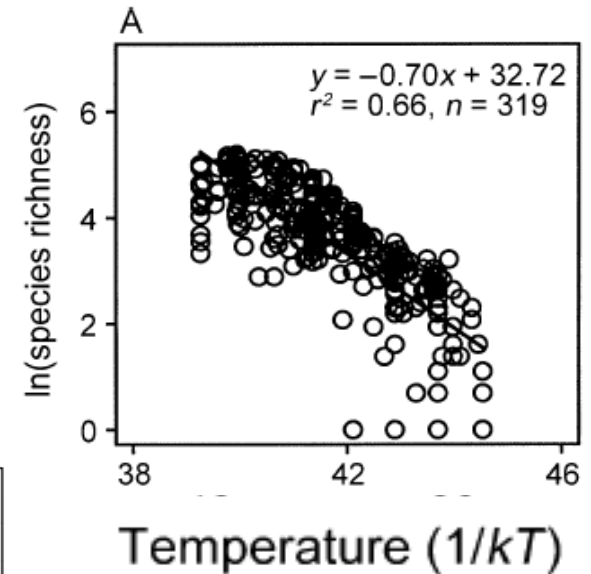
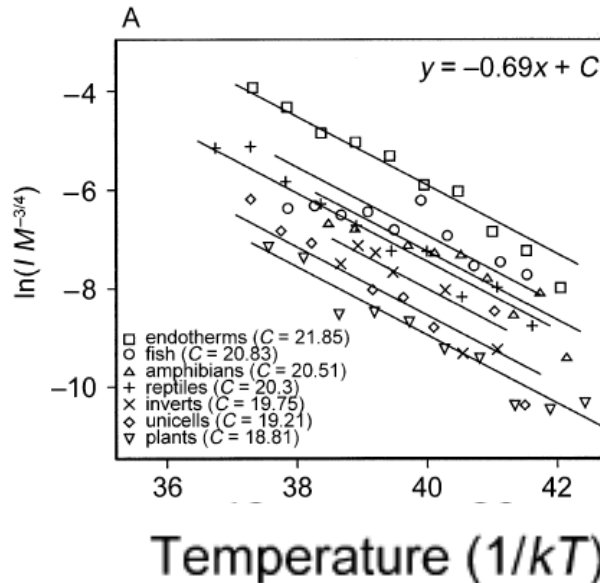
Expectations

J.H. Brown *et al.*, 2004

“Toward a metabolic theory of ecology”

$$I = i_0 M^{3/4} e^{-E/KT}$$

Biodiversity decreases with increasing temperature



Individual size decreases with increasing temperature

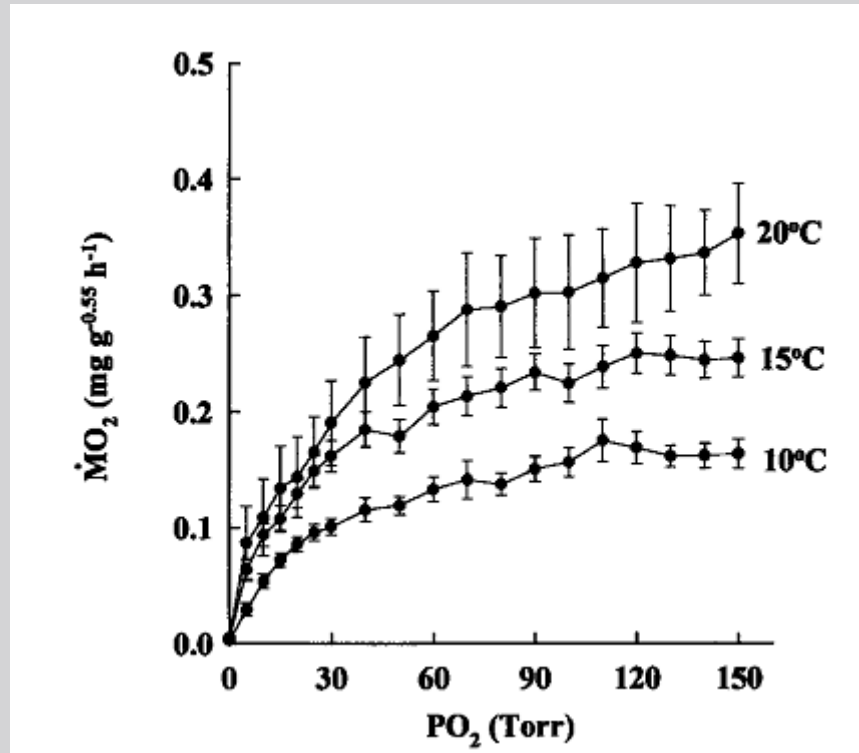
Metabolic theory

Aquatic ecosystems

Oxygen control: of metabolism:

Oxygen availability affects:

- Oxygen utilisation
- Individual metabolism
- Process rates



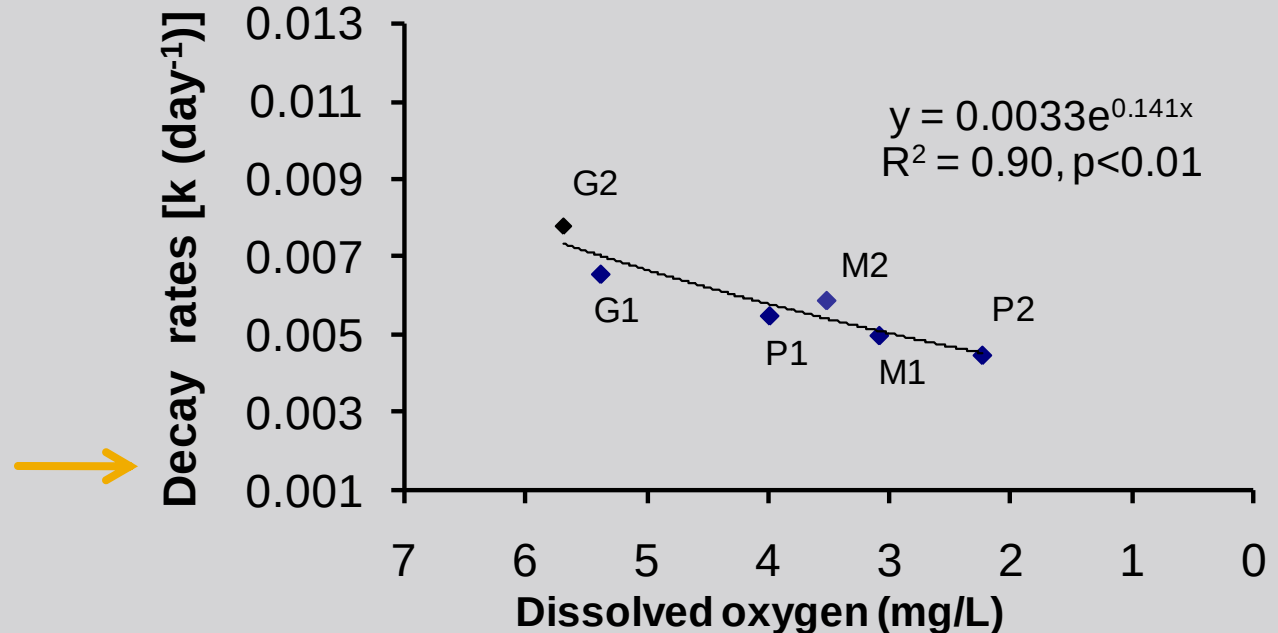
Metabolic theory

Aquatic ecosystems

Oxygen control: of metabolism:

Oxygen availability affects:

- Oxygen utilisation
- Individual metabolism
- Process rates



Lagoon ecosystems

Data-base on Italian lagoons

ID	Lagoon
1	Grado Marano Lagoon
2	Venezia Lagoon
3	Canarin Lagoon
4	Scardovari Lagoon
5	Lake Nazioni
6	Goro Lagoon
7	Valli di Comacchio
8	Piallassa Baiona Lagoon
9	Lake Massaciuccoli
10	Orbetello Lagoon
11	Lake Lesina
12	Lake Varano
13	Lake Fogliano
14	Lake Monaci
15	Lake Caprolace
16	Lake Sabaudia
17	Lake Fondi
18	Lake Lungo
19	Lake Fusaro
20	Torre Guaceto Brackish Area
21	Acquatina Lagoon
22	Lake Alimini Grande
23	Oliveri Tindari Brackish Area
24	Saltern of Marsala
25	Marsala Lagoon
26	Rada di Augusta



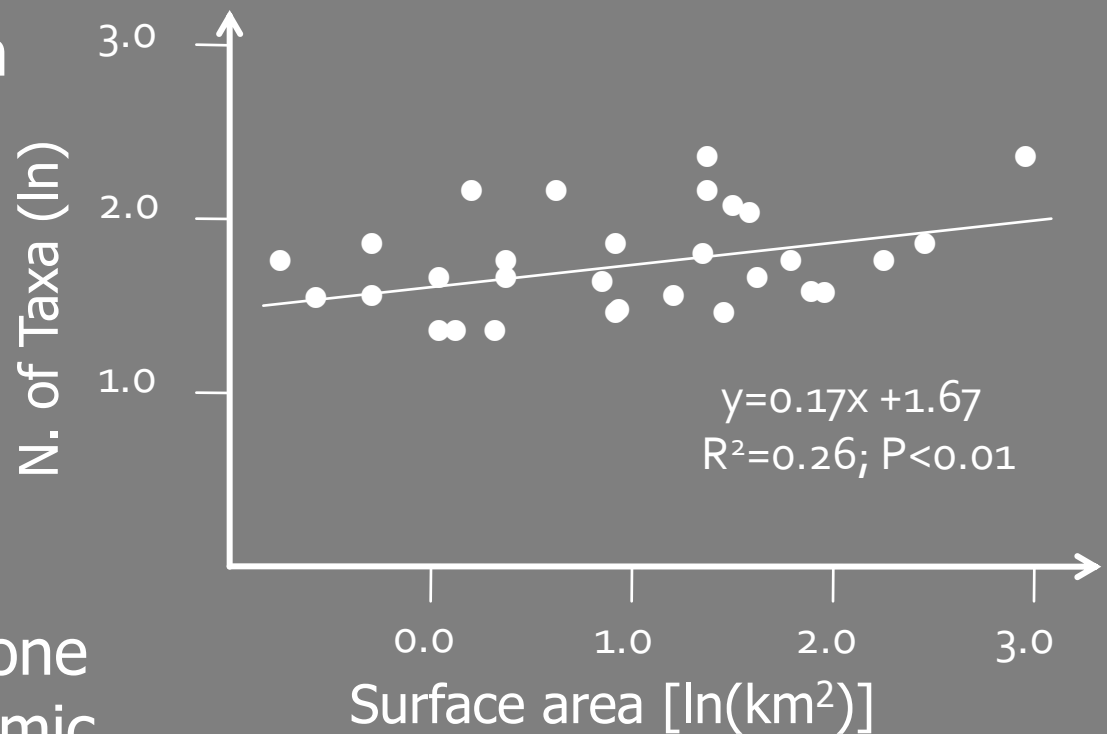
Biodiversity abiotic drivers

REGIONAL SCALE OF BIODIVERSITY IN ITALIAN LAGOONS

Hydro-morphology explains 68% of variance in taxonomic richness with only three factors:

- outlet width
- surface area
- salinity

A species area effect alone explains 26% of taxonomic variance



Climate change influence

ERANET – CIRCLE project on
Climate change influence on biodiversity at Mediterranean level

Space used as a proxy of time

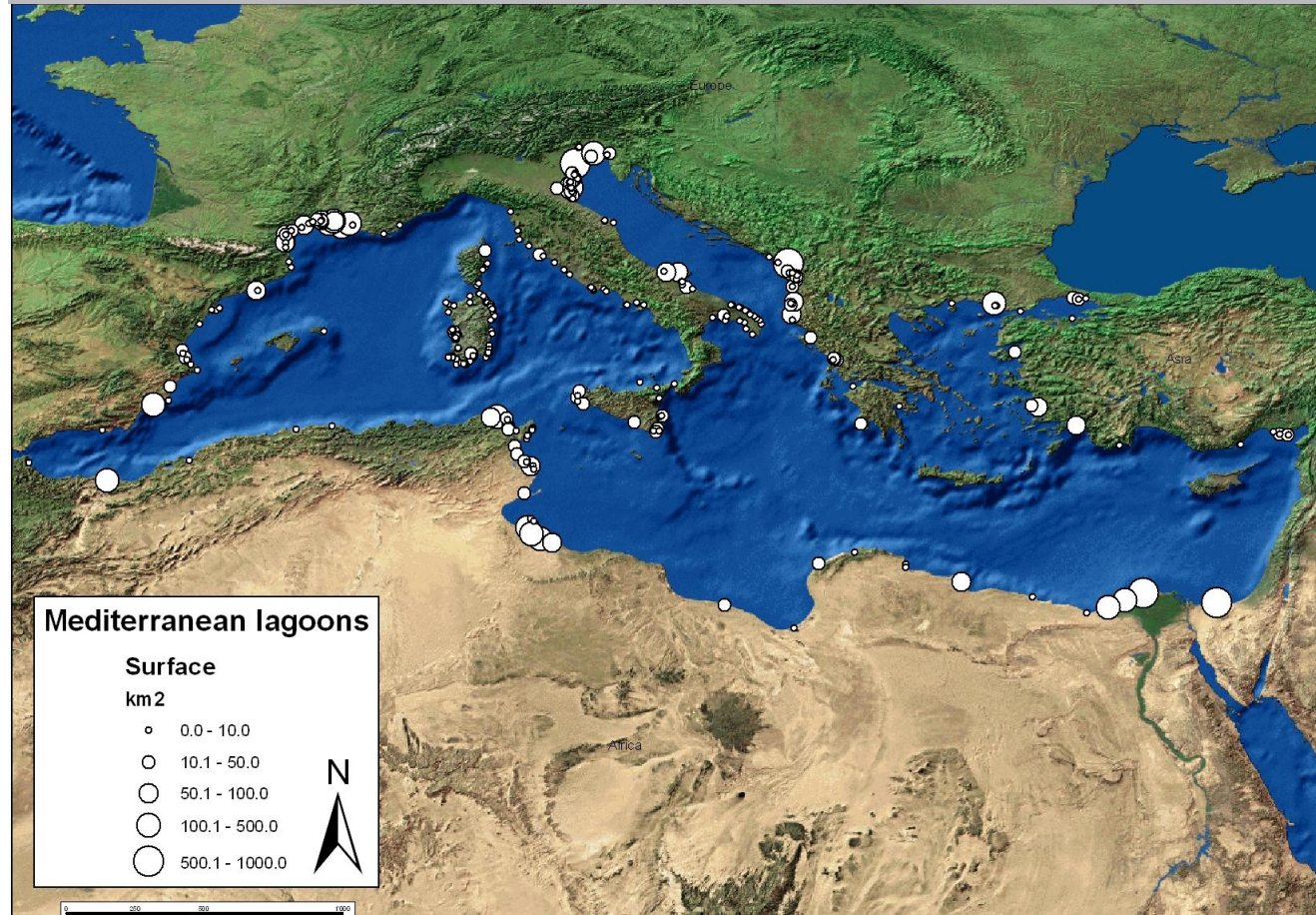
Temperature and salinity – main drivers

Surface area – conditioning factor

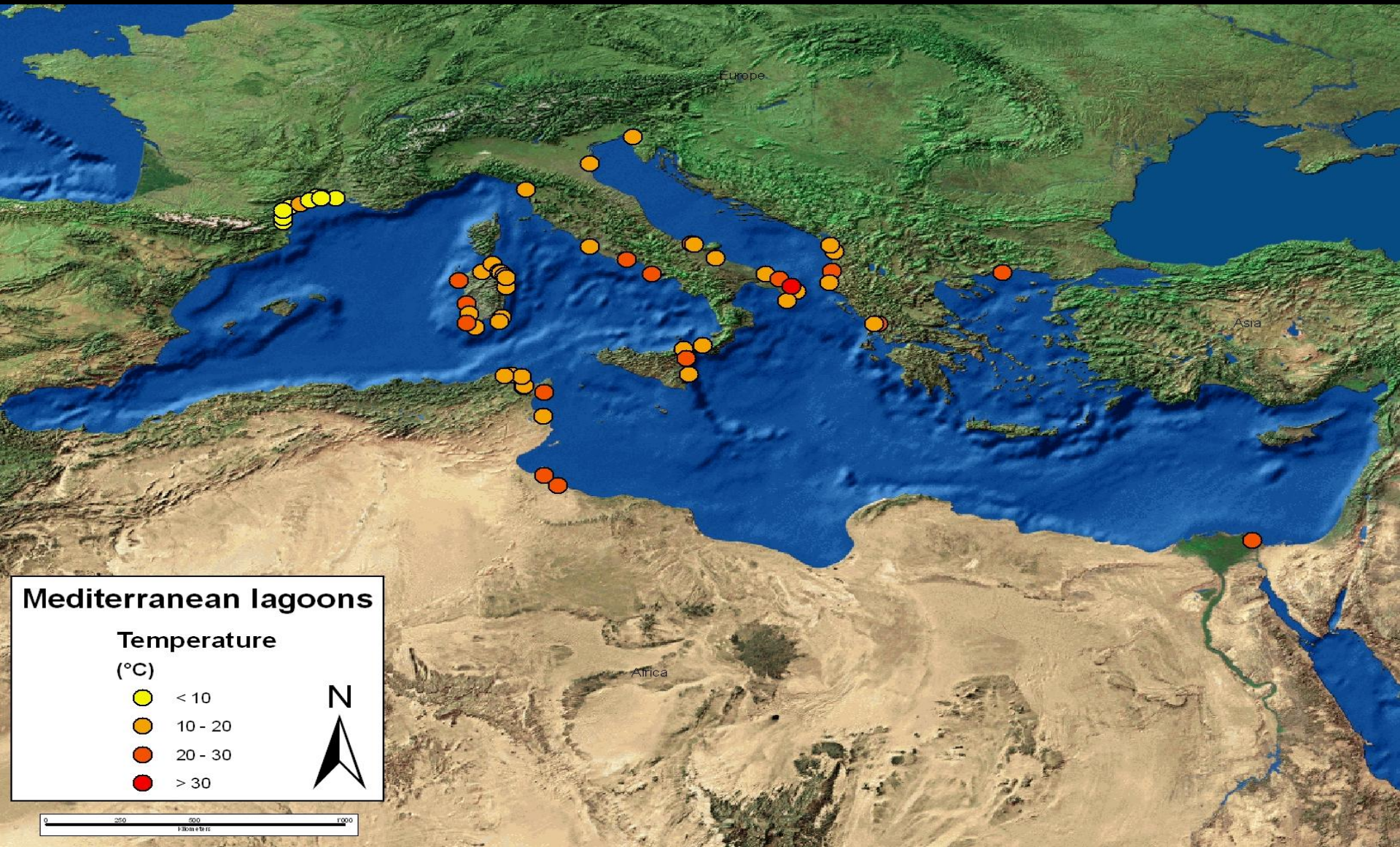
Data-base on Med-TW

I

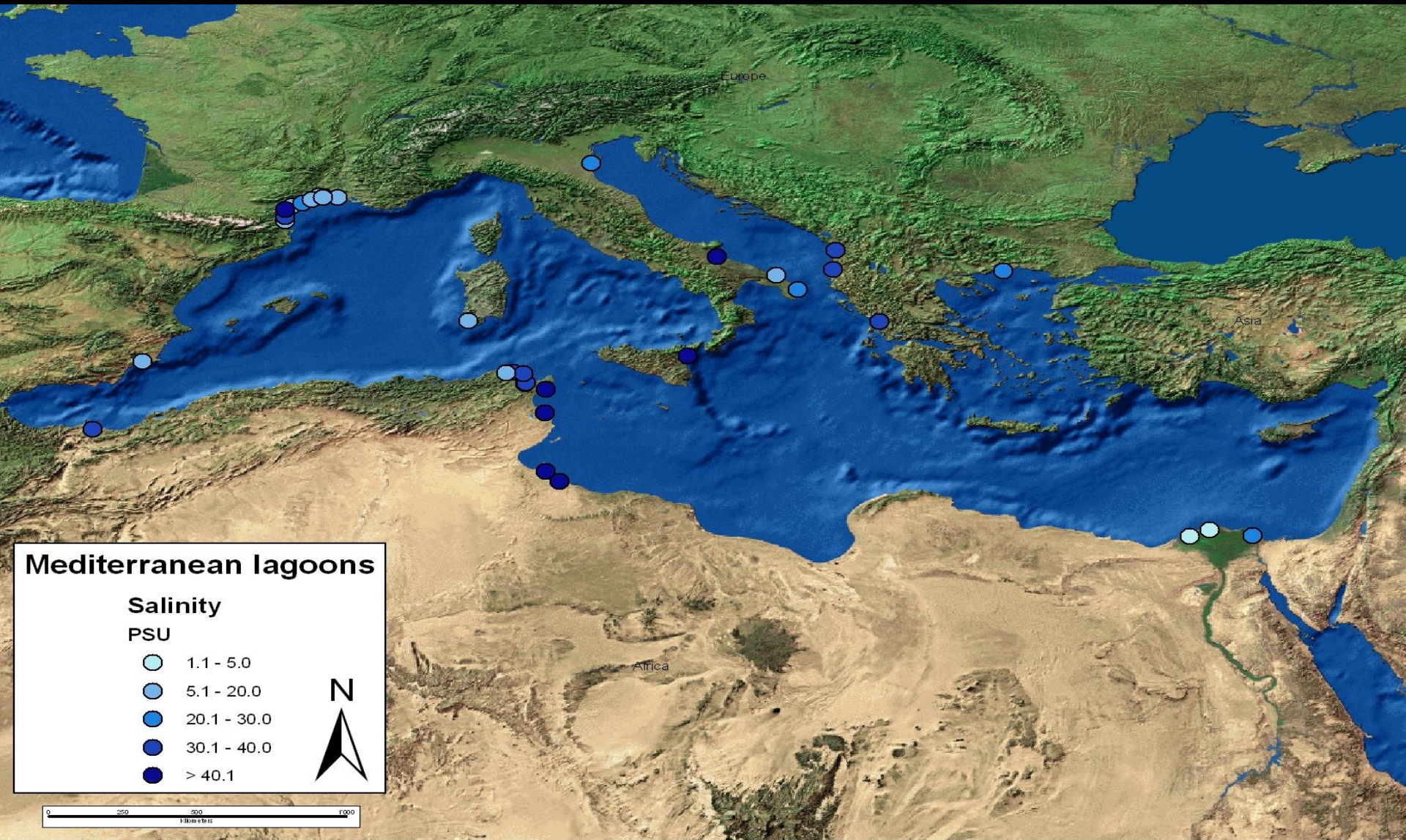
REGION	COUNTRY	N.
ASIA	TURKEY	27
		27
EUROPE	ALBANIA	20
	FRANCE	50
	GREECE	13
	ITALY	182
	MONTENEGRO	3
	SPAIN	24
		292
NORTH AFRICA	ALGERIA	3
	EGYPT	7
	LYBIA	7
	MOROCCO	6
	TUNISIA	33
		56
		375



Temperature pattern in Med-TW



Salinity pattern in Med-TW



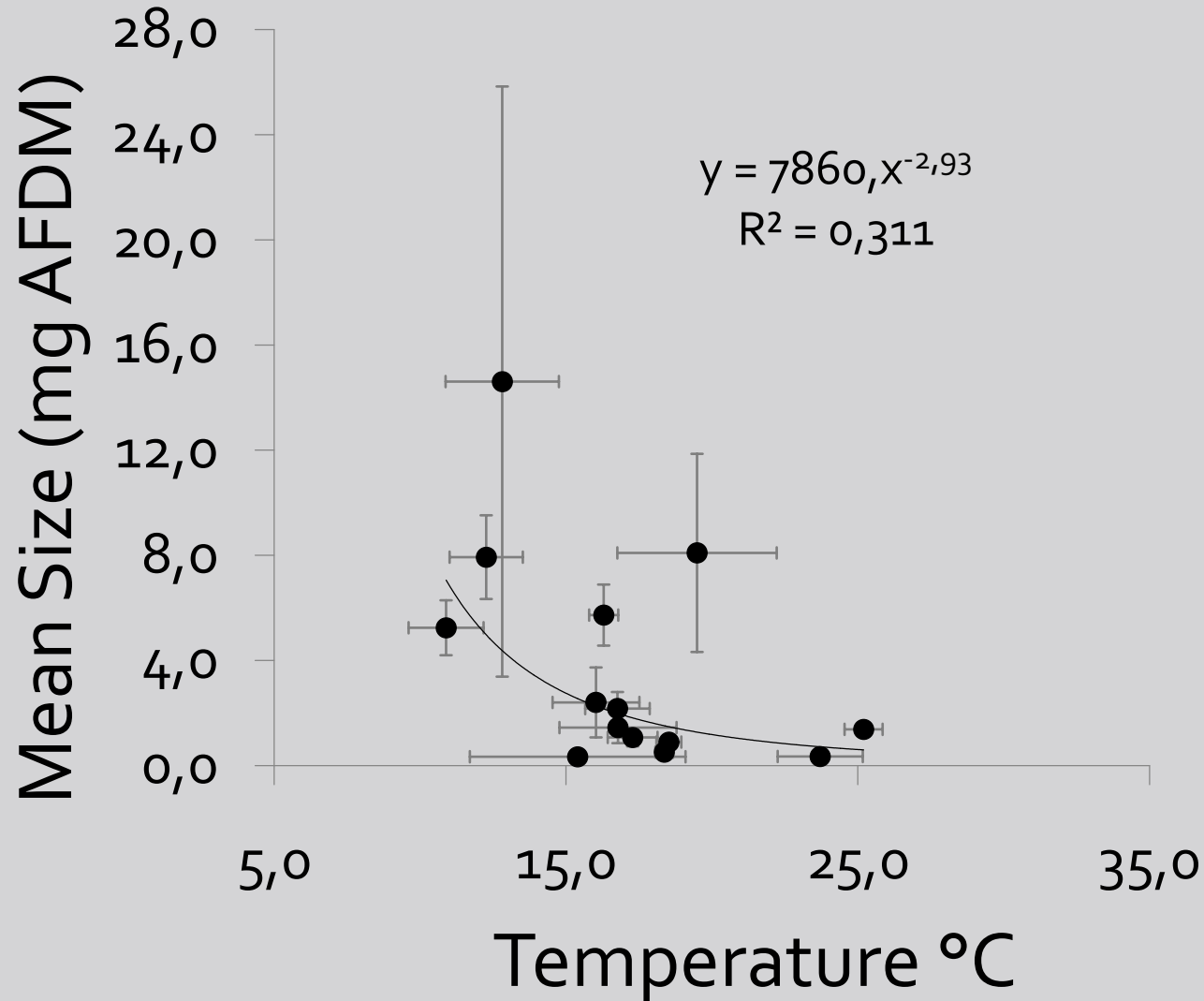
Spatial inference - Temperature effects

Macroinvertebrate guild

List of taxa available
on 64 lagoons

List of individual size
available on 16
lagoons

Mean individual size
decreases with
increasing
temperature



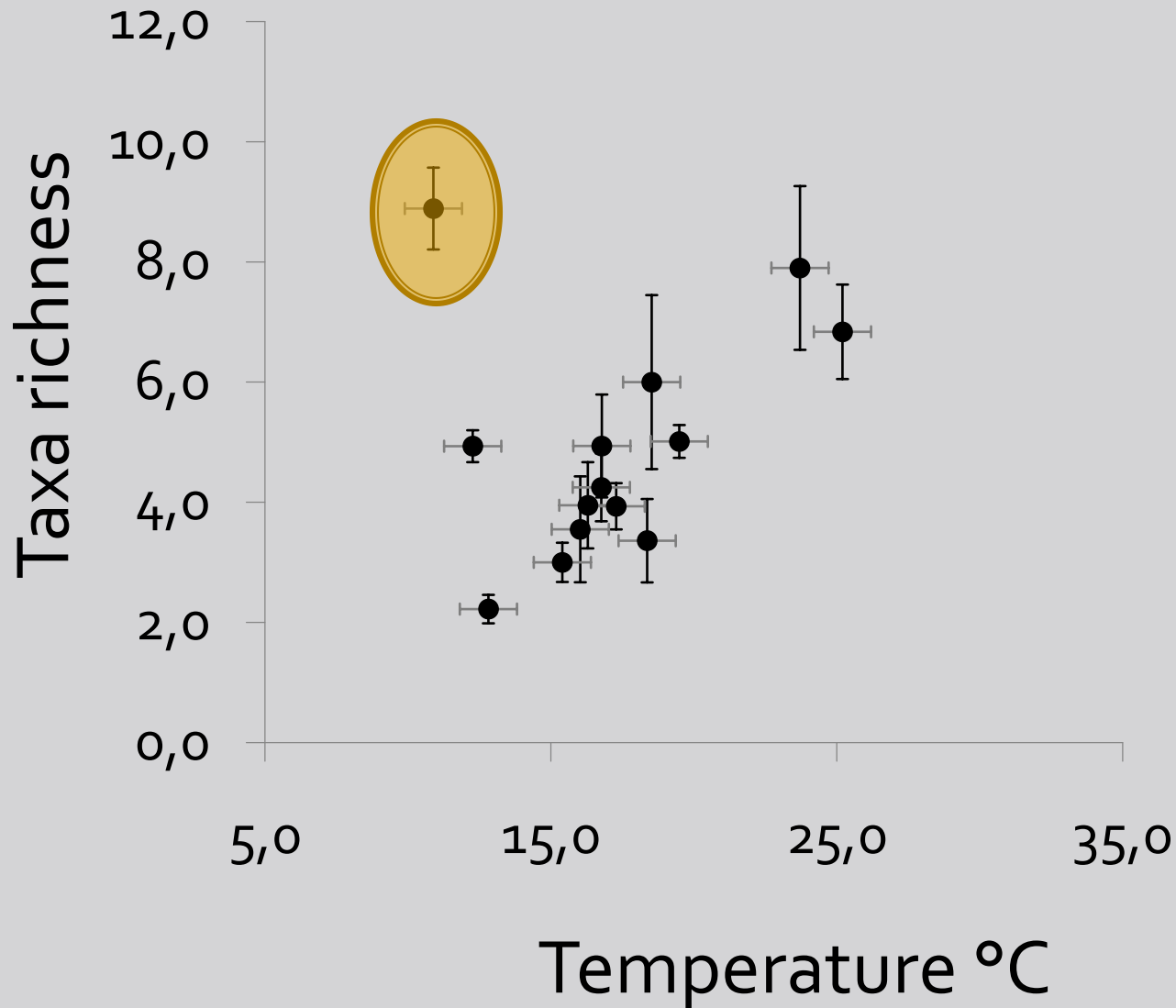
Spatial inference - Temperature effects

Macroinvertebrate guild

List of taxa available on
64 lagoons

List of individual size
available on 16 lagoons

Species richness
seems to be
independent of
temperature ... or
increasing with
temperature



Conclusions

Space as a proxy
has limitations



Eutrophication:



What we would need from models:

- A watershed/regional spatial scale
- A relatively short temporal scale describing limited changes
- Simulations of climate components including wind direction and strength

then

- We can define better scenarios of change for ecosystem processes and biodiversity