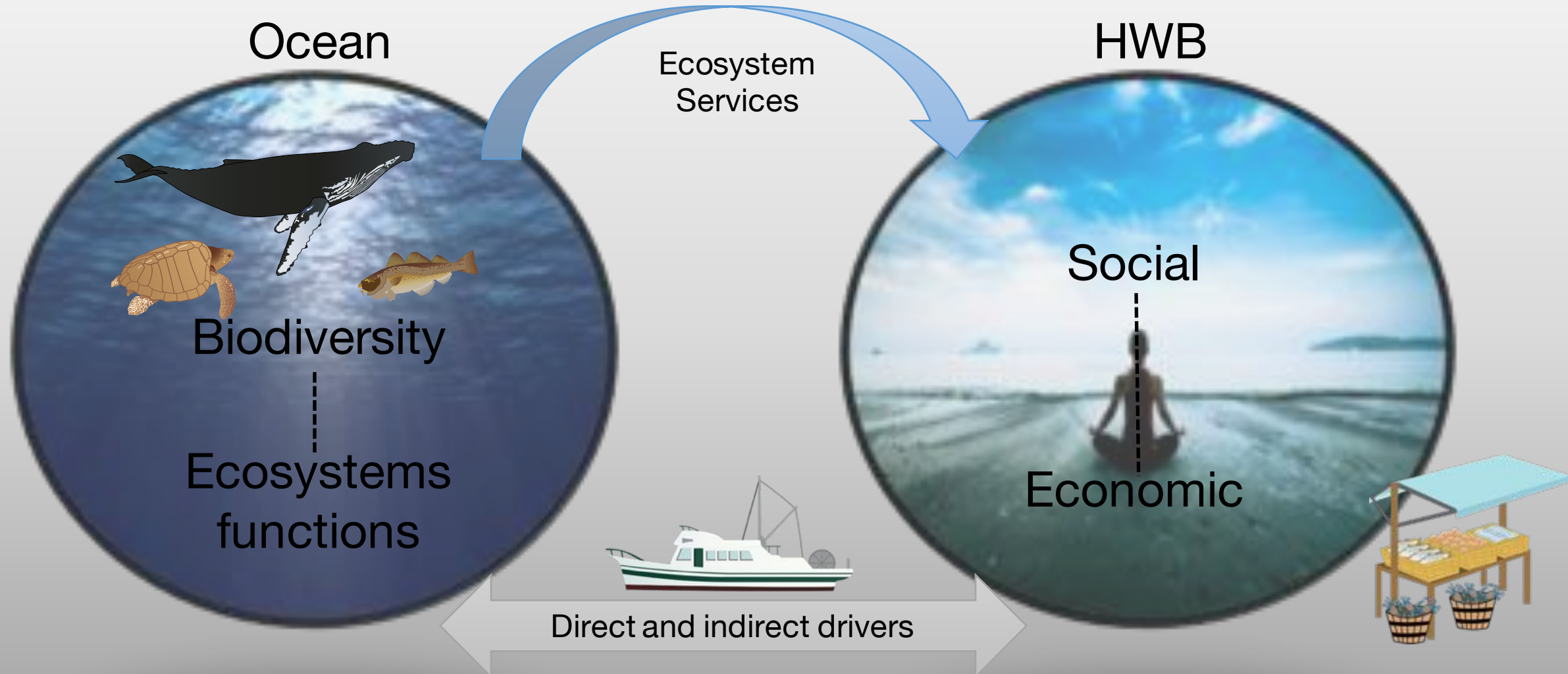# Evaluation and characterisation of marine biodiversity under climate change

Gabriel Reygondeau (NEREUS, UBC)
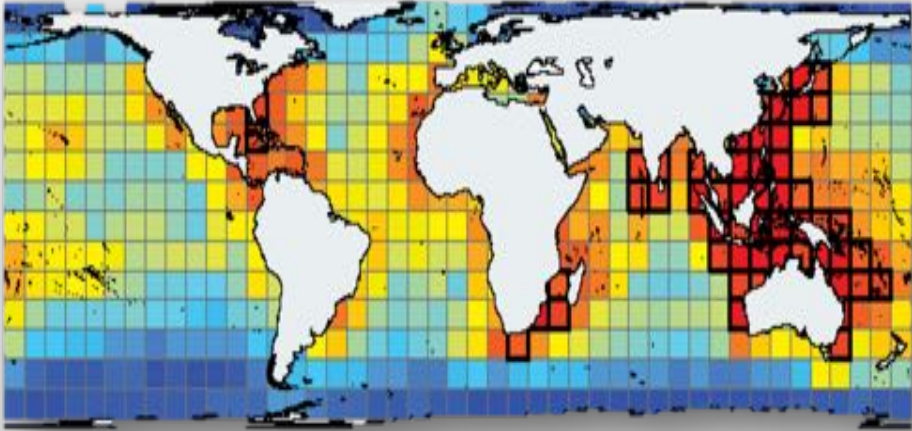
Context

- The Ocean's Contribution to Human Wellbeing


Ocean

HWB

Ecosystem Services

Biodiversity

Ecosystems functions

Social

Economic

Direct and indirect drivers

- Has global marine biodiversity been previous evaluated?

- **2.2 Millions** eukaryotic species in the ocean (Mora et al., 2011)

- Observed distribution of biodiversity for > 10 000 species (Tittensor et al., 2010)

- Several **modelling** attempts

-> exploited species

(Cheung et al., 2009)

-> theoritical (Beaugrand et al. 2015)
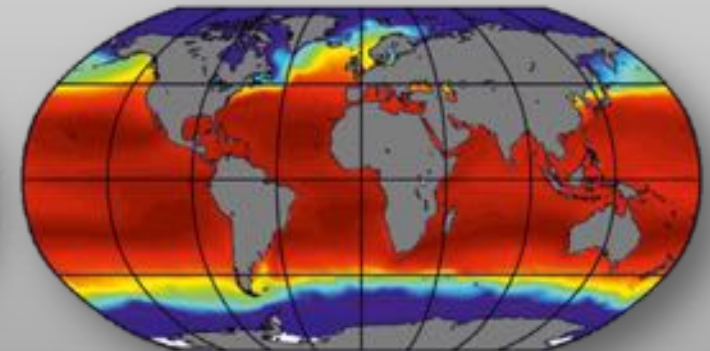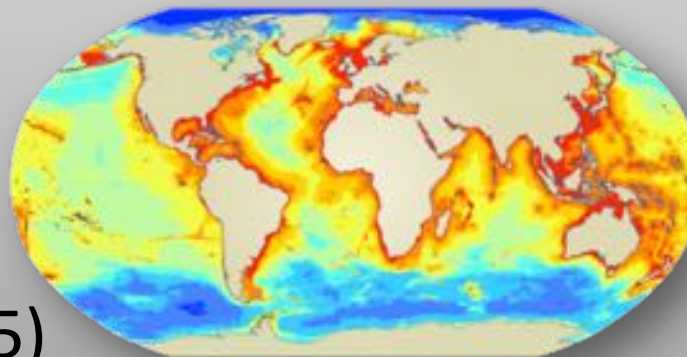
Problematic

- Most of the studies on marine diversity have focused on **specific taxonomic group** (exploited species, coastal or copepods)

- Good comprehension on the terrestrial **Latitudinal Diversity Gradient**, the **mechanisms** driving the pattern of marine biodiversity remains unclear.

- Pattern of marine biodiversity is dependent on **thermal or space occupation strategies of species** ?

Materials

- The NEREUS Biodiversity Database
- Data from international website:
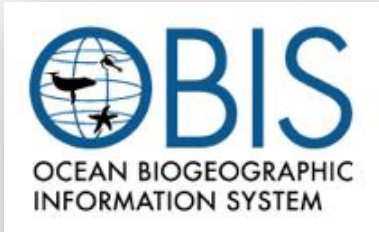
- All occurrence (only) of individual:

+ Species level

+ with >10 different spatio/environmental observations

+ depth and time (month, year) of the sampling (optional)

- Post database treatment has been processed:

Removal of synonyms, replicas, misinformed data point, terrestrial/freshwater species

- >103 000 species, > $1X10^9$ observations from protozoans to mammals
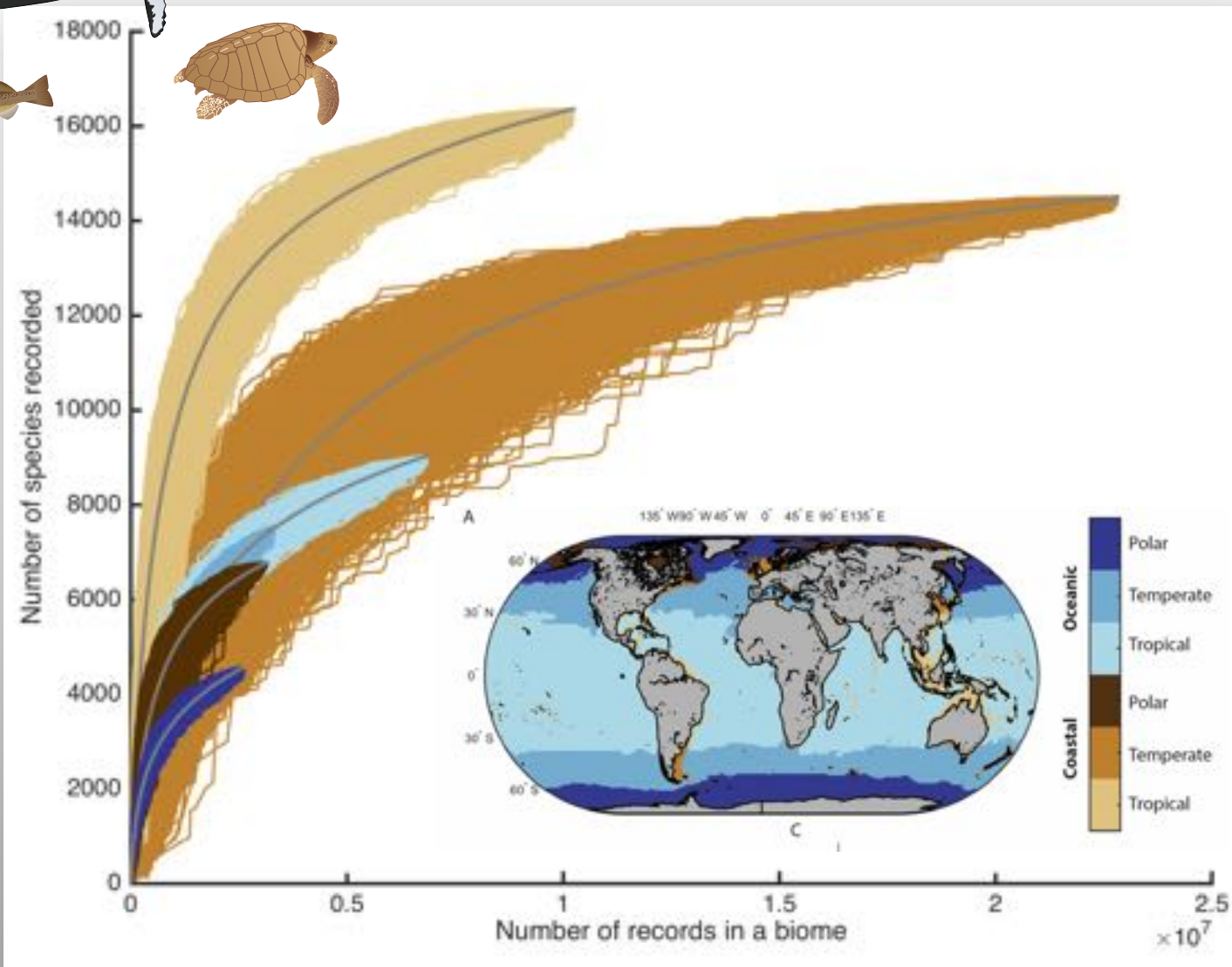
Sampling effort and species richness
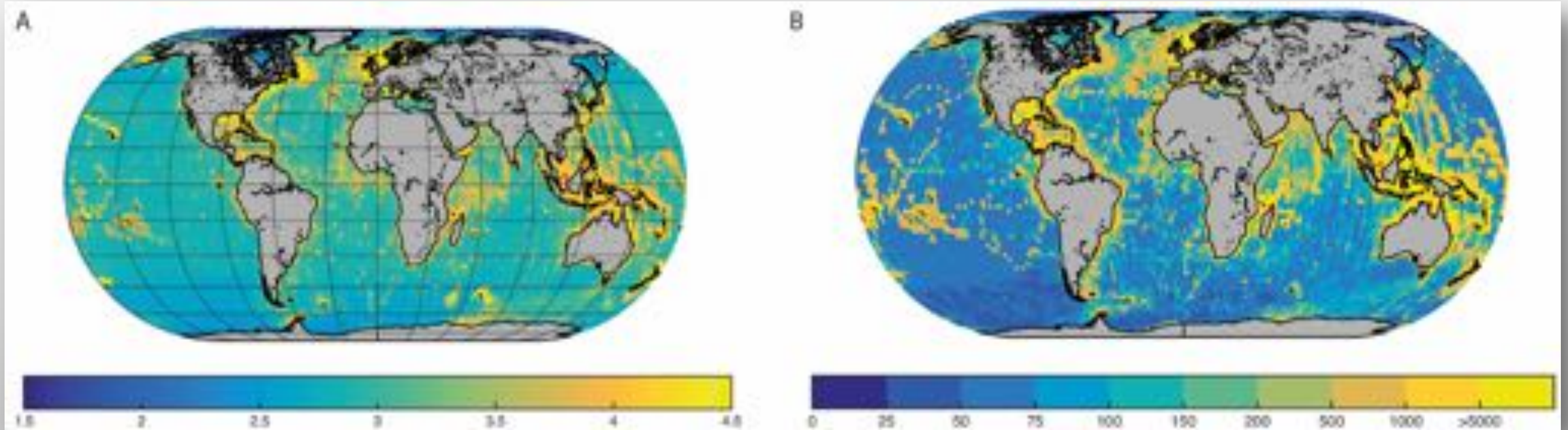
Number of records (log10(x+1))
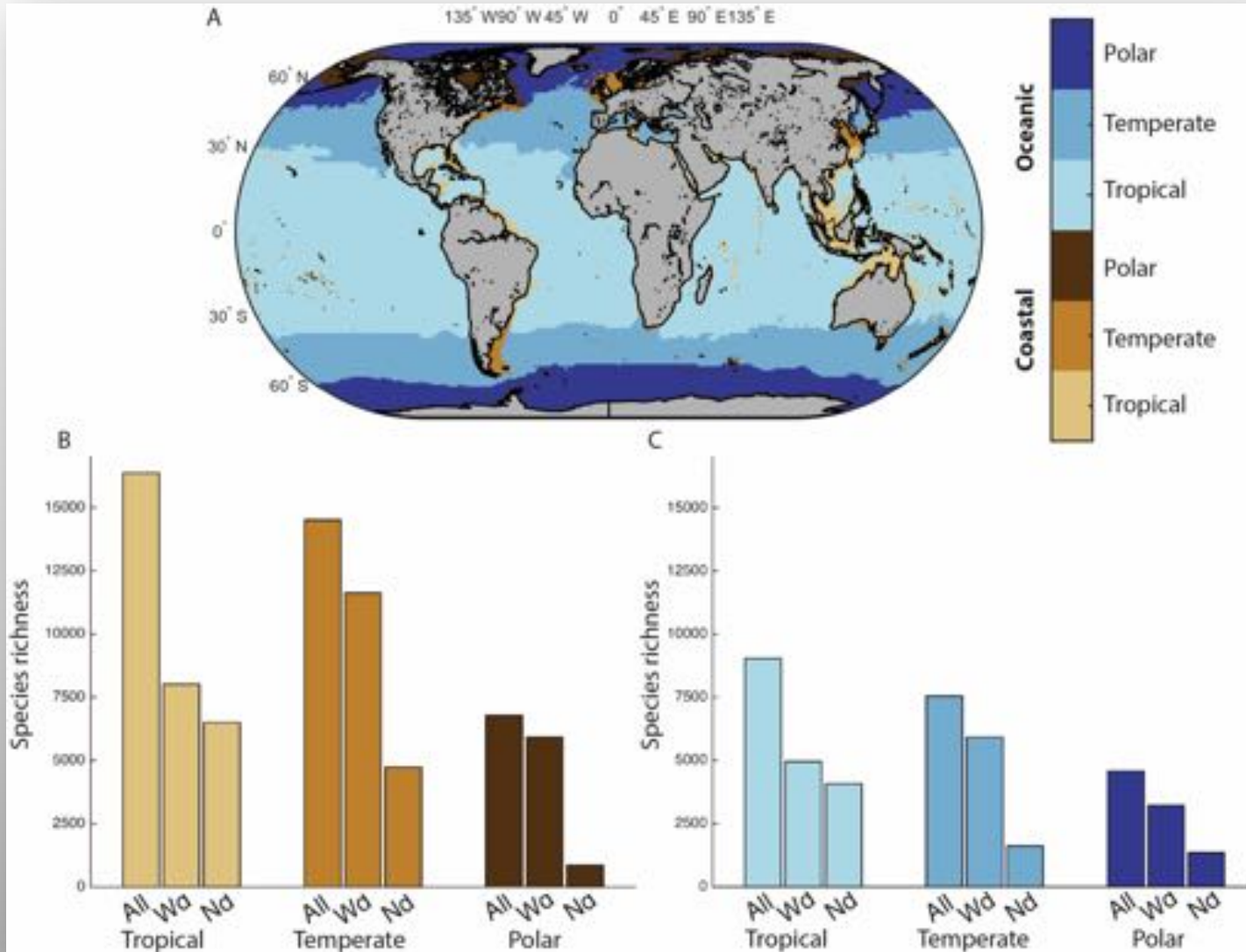
Number of species
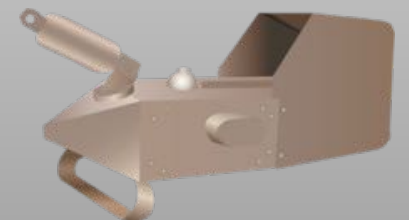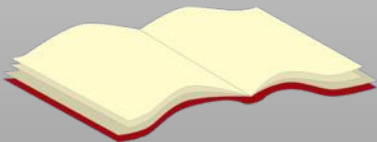
Rarefaction curve

- Clear differences in the distribution of the sampling effort

- The vertical dimension...

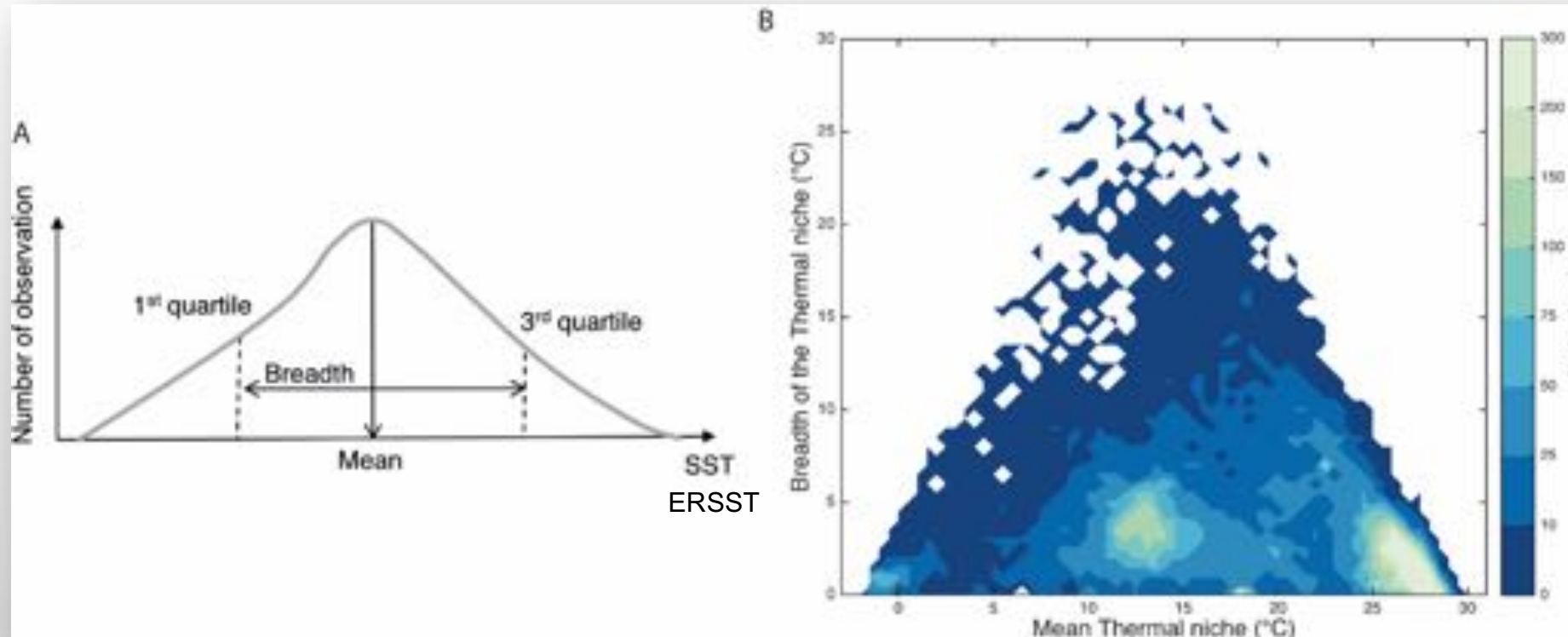- Asymptote reached in 4 of the 6 biomes

Observed biodiversity and distribution strategies

- Latitudinal diversity gradient: a complex composition

- The crucial contribution of widely ditributed species

- Oceanic < Coastal: sampling Bias or real phenomenon

Thermal strategies

- Biodiversity pattern may be driven by SST and thermal strategies of species

or

thermal strategies are products of species evolving to adapt to environment

Thermal strategies
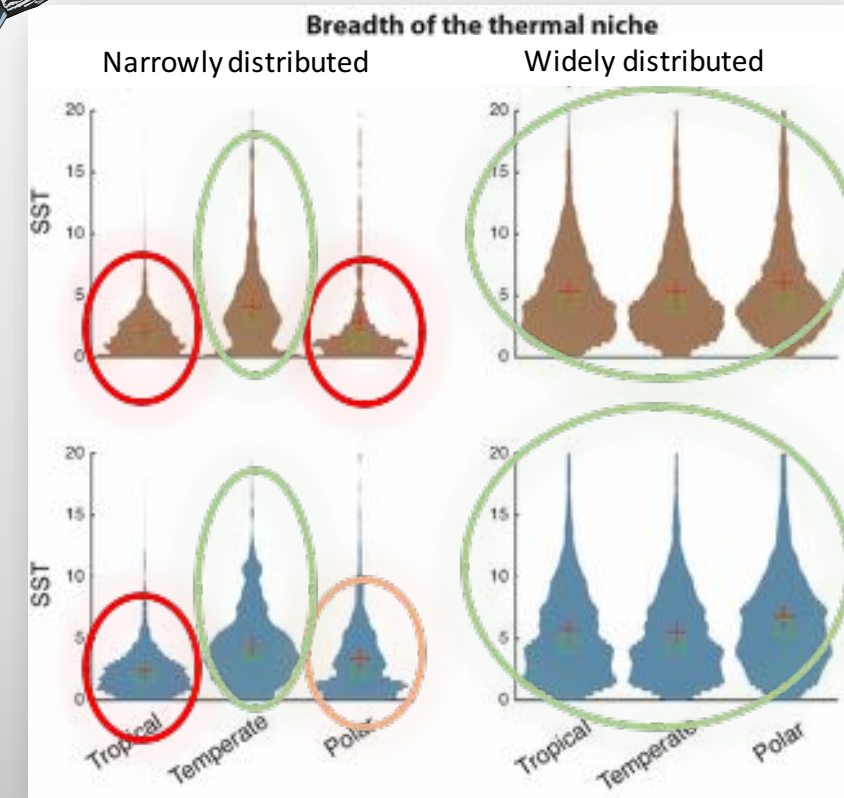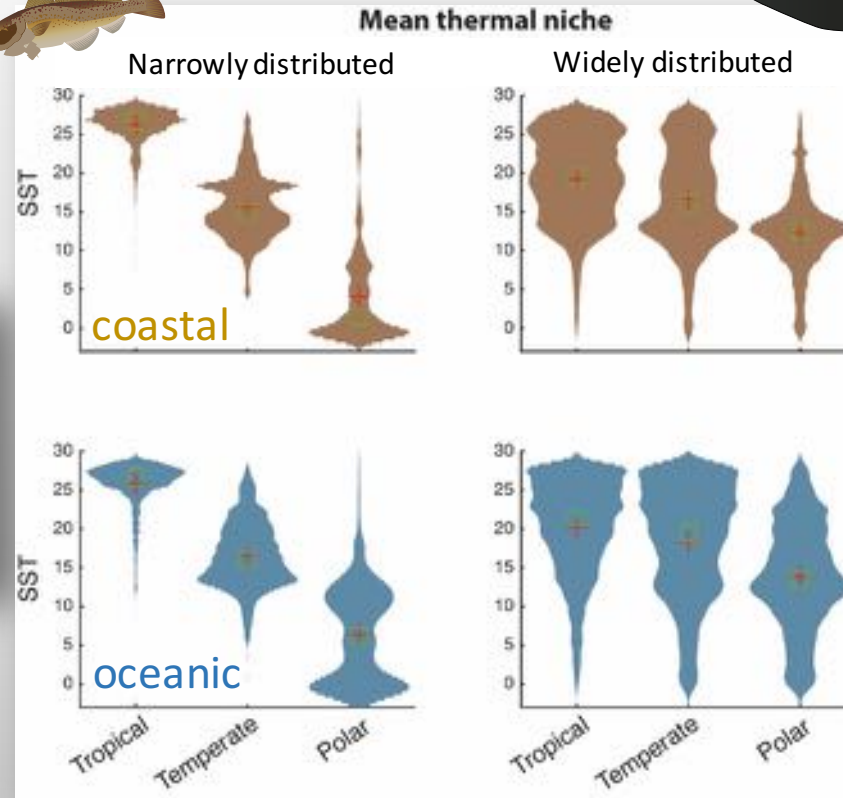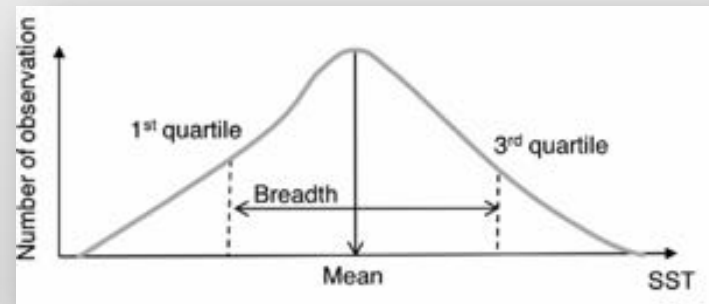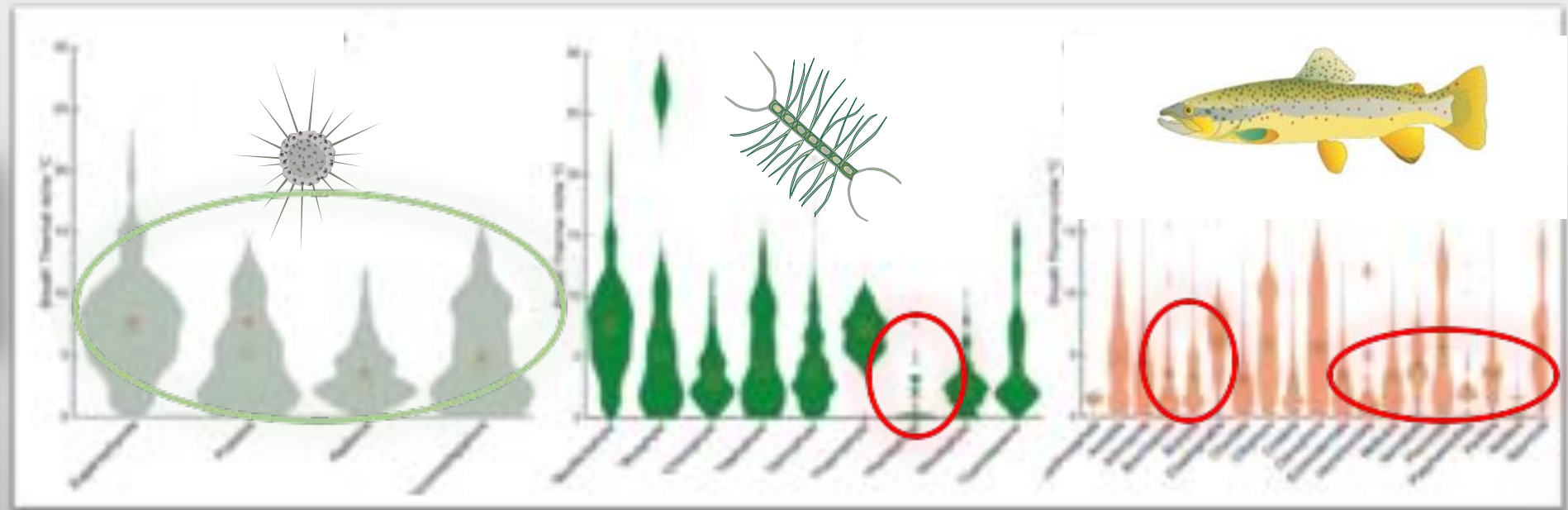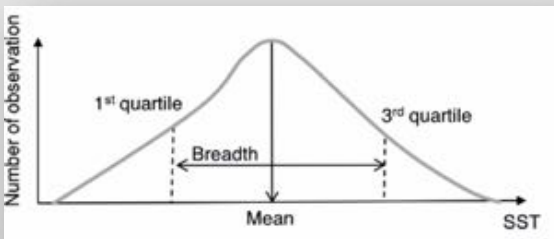

- Mean thermal niche: High differences between **Narrowly and Widely distributed** but same trends

- Breadth of the thermal niche : loser and winners of climate change

Thermal strategies

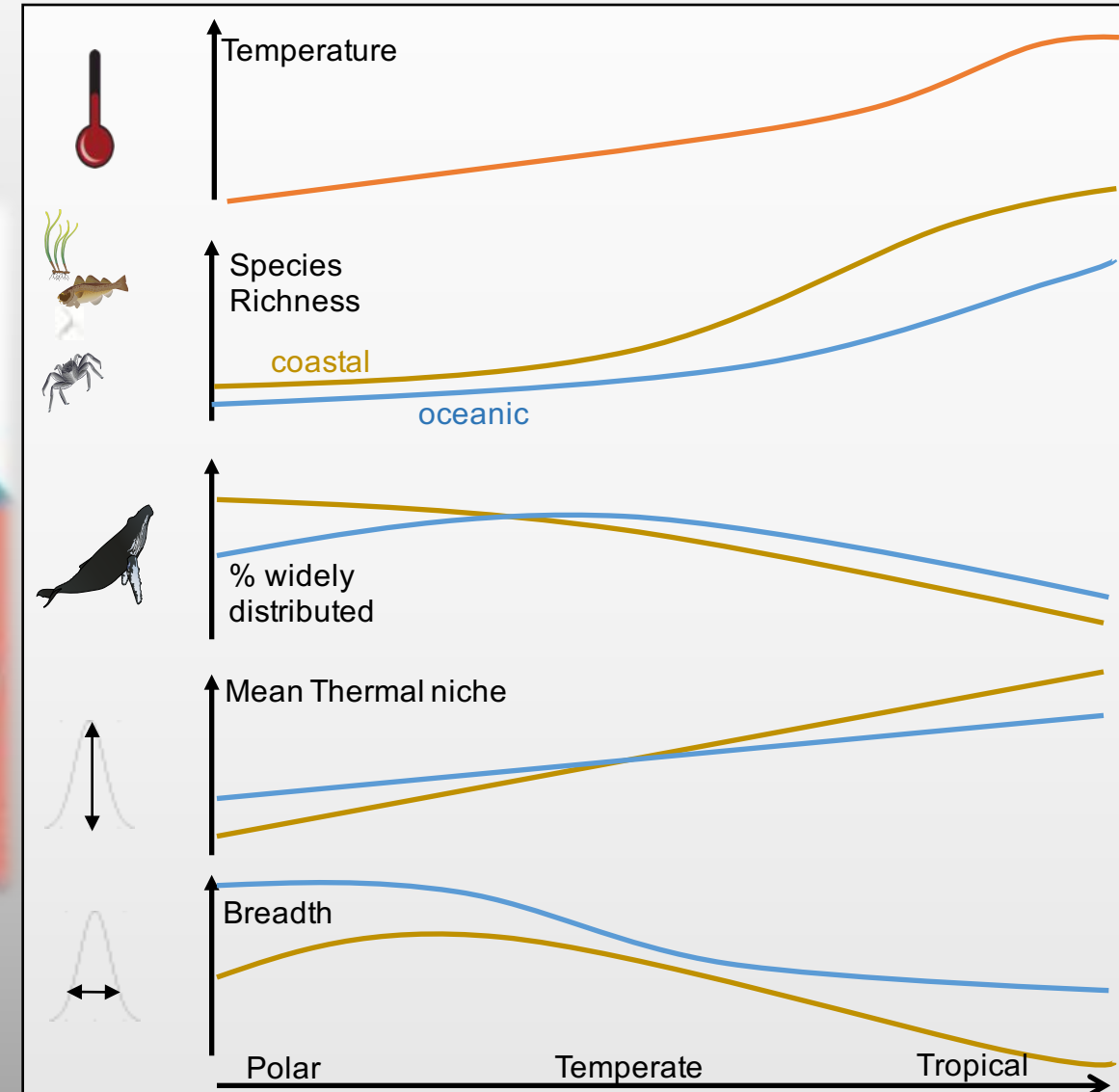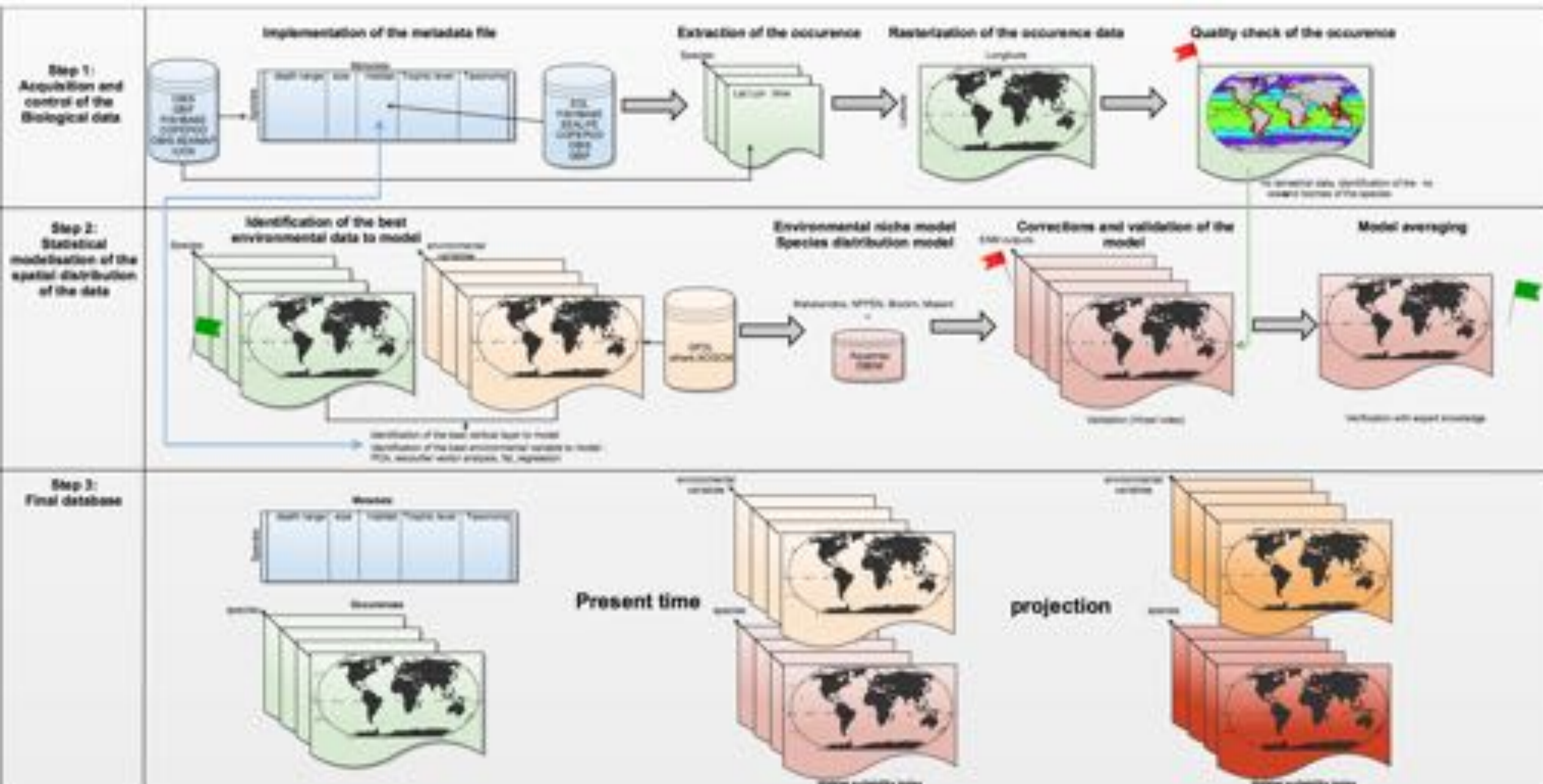*Protozoans* *Flora* *Animalia*

To summarize …

Environmental niche model

Environmental data

- **GFDL model (RCP 2.6 & 8.5) and observed climatological data (NASA, WOA)**:
  + Surface data: SST, SSS, OXY, pH, Zeu, MLD, NO3, PO4, SiO2, NPP, sea ice
  + Seafloor data: Temperature, salinity, oxygen, pH, sediment, NO3, PO4, SiO2

- **Resolution**:

Yearly : exploited species (1950- 2100) : 2080 species

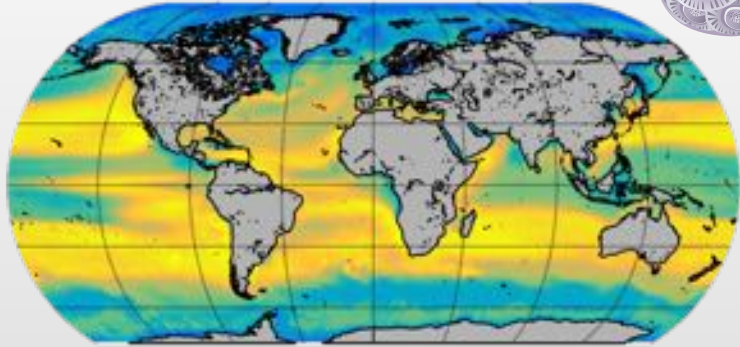Decadal: non- exploited species (1950s-2090s) : 41 095

- **ENM already computed**:
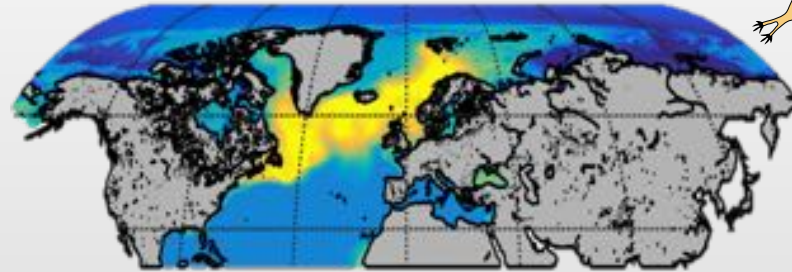
Exploited species: Maxent, BRT, NPPEN, BIOCLIM, ENFA

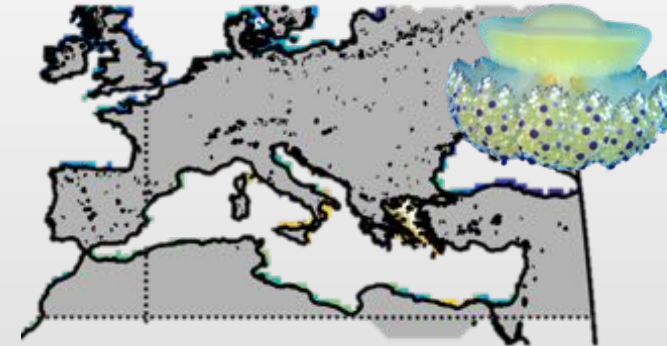Non-exploited species: BIOCLIM, ENFA
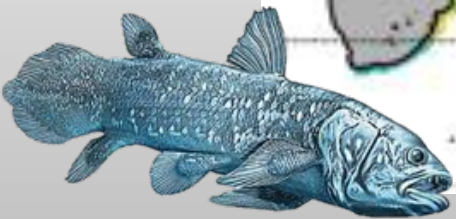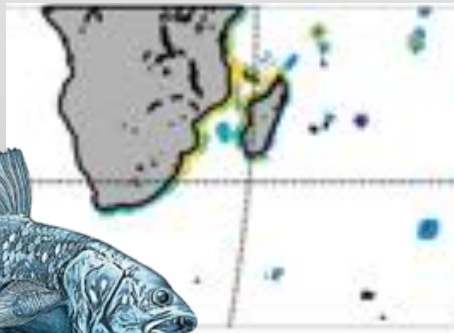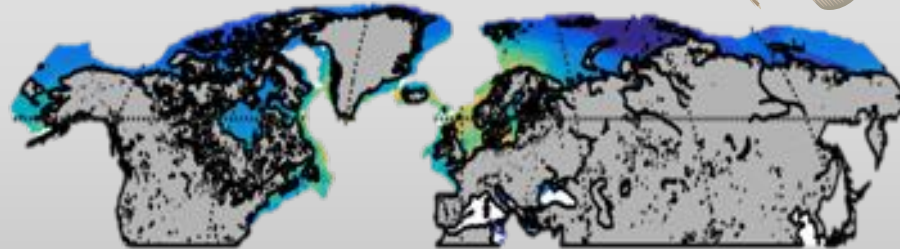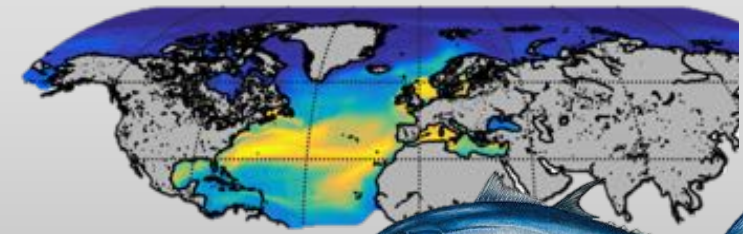
Some modeled distribution

Emiliania huxleyi

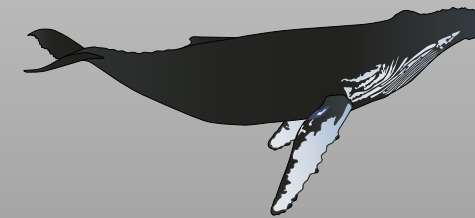Calanus finmarchicus

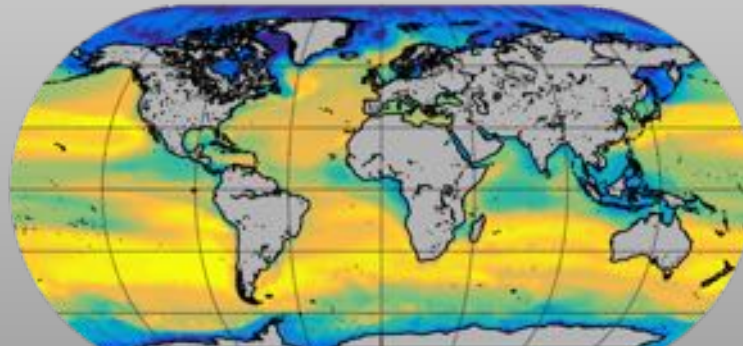Cotylorhiza tuberculata

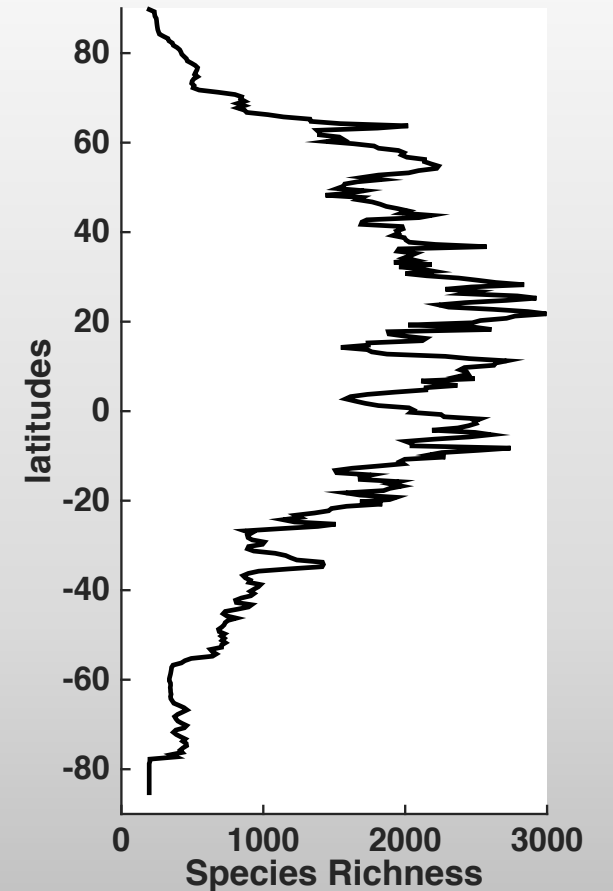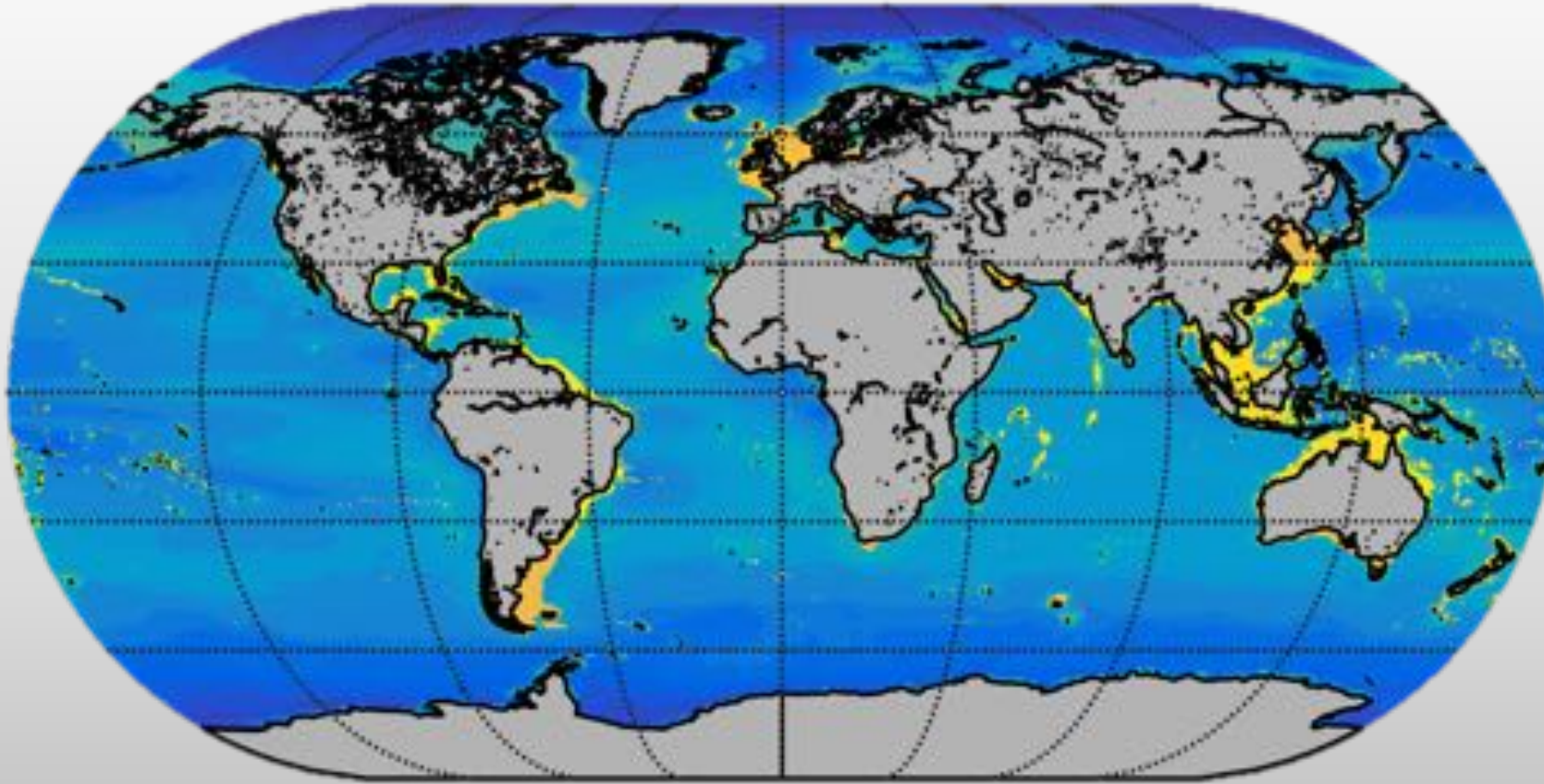Latimeria chalumnae

Gadus morhua

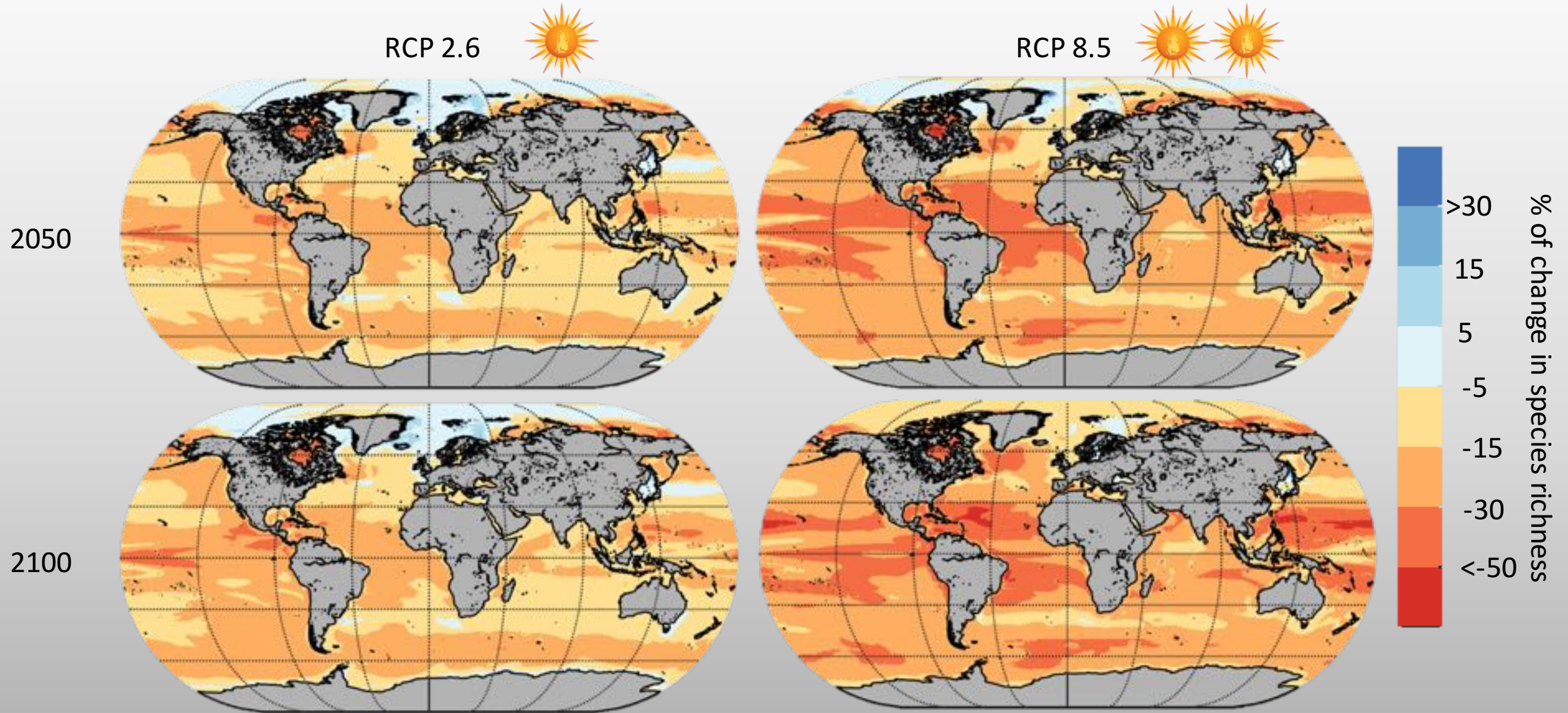Thunnus Thynnus

Physeter macrocephalus

Modelled biodiversity distribution

- Correlation rate with Tittensor et al. (2010) = 0.9233
- Species Richness spatial patterns :

Sub tropical peaks are retrieved as well as LDG in oceanic and coastal regions

Change in marine biodiversity

Some preliminary conclusions and perspective

- **Observed biodiversity**

+ Evaluation of the present sampling and knowledge on species richness

+ LDG is structured by the different distribution and thermal strategies

+ Thermal niche: Loser and winners.. some surprise.

- **Modelled biodiversity**

+ Spatial gradient are retrieved

+ A critical loss of SR at a global level that could be minimized

+ Several indicator are needed to better understand these changes
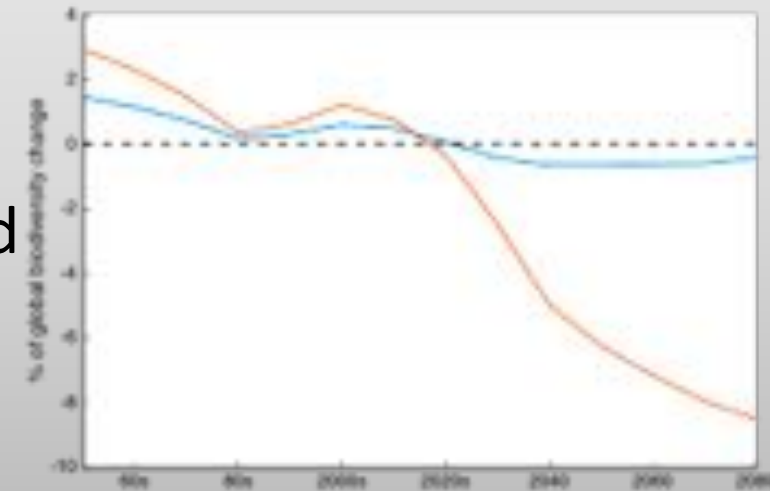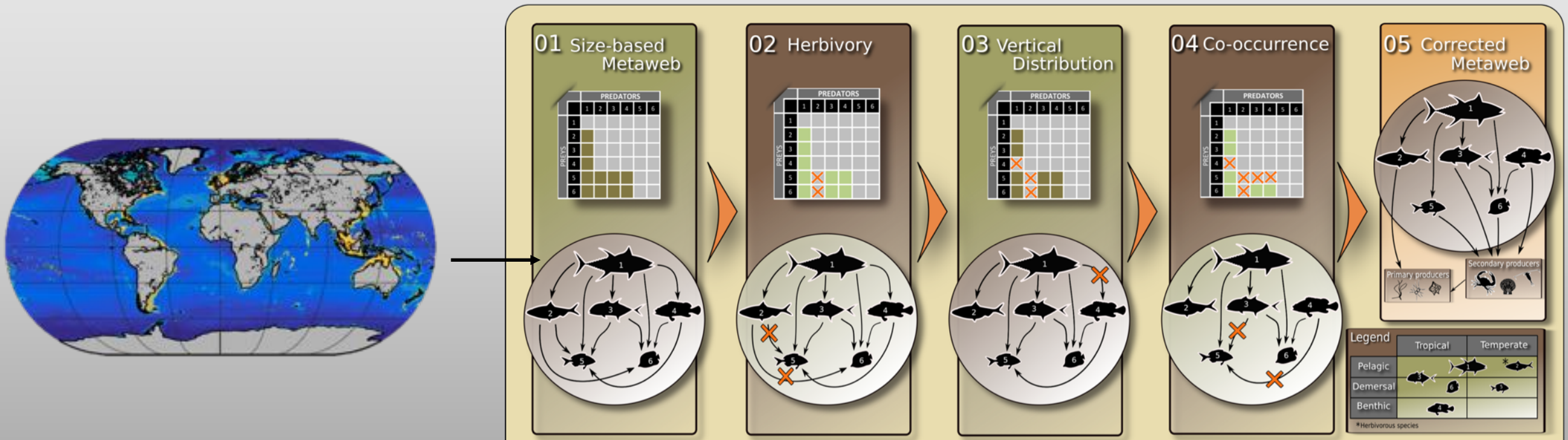
! NPPEN, BRT, ENFA, Maxent need to be run for GFDL

! IPSL and MPI model will be used to compute uncertainties

Study in perspective

- How Interactions between exploited species will be modified?

Consequence for the ecosystem trophodynamic at a global level
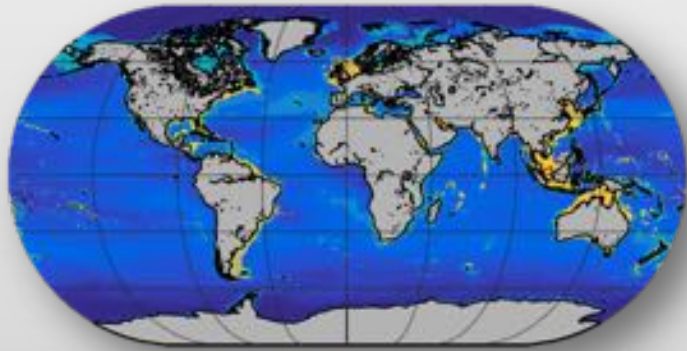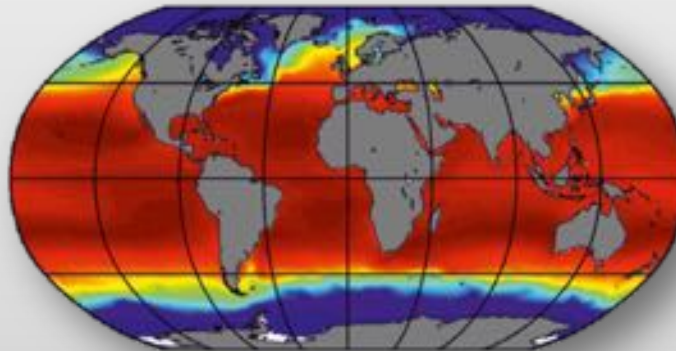
(Camille Albouy ,ETH Zurich)

Study in perspective

- What are the missing species ?
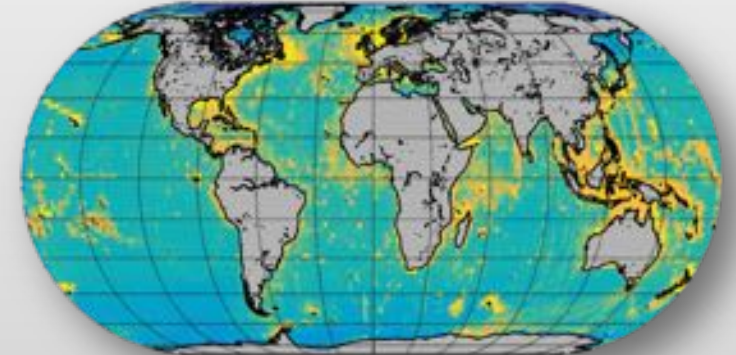 (with Gregory Beaugrand, SMW, france)
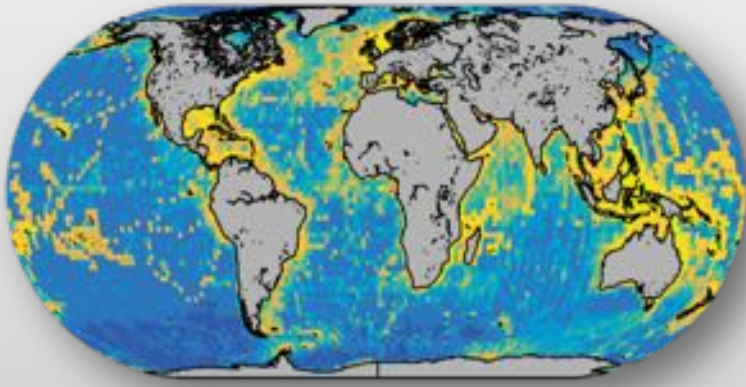
Our estimations

Theory

Sampling

- What are the difference between observed and theoritical model
- Does the missing species are caused :
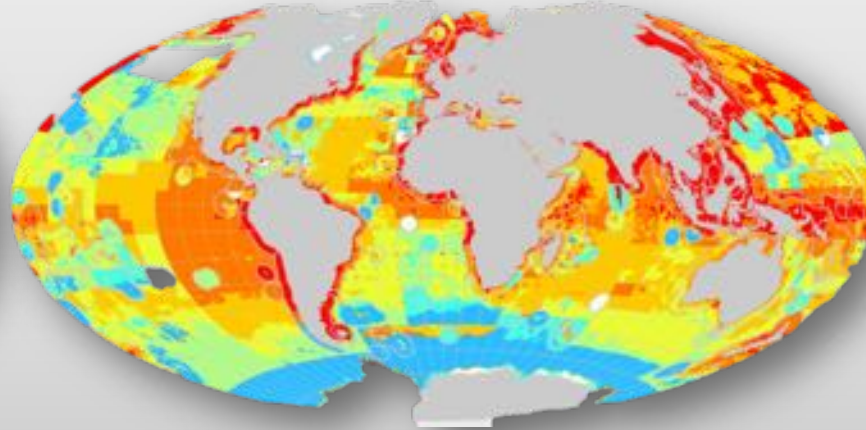
-> sampling ?

-> Niche vacation ?

Study in perspective
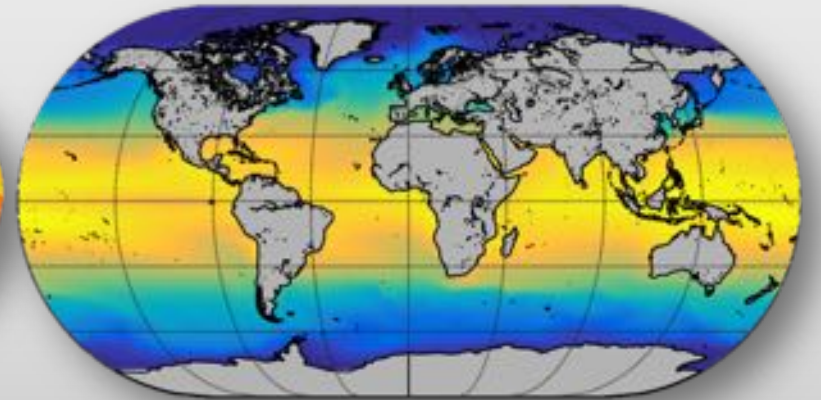
- Biodiversity and Catch (/potential Catch)

SR observations

Catch

Environment

- Is there a relation between Species richness , environment and global catch ?
- Does this relation varies in space (LME) ?
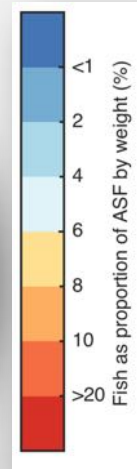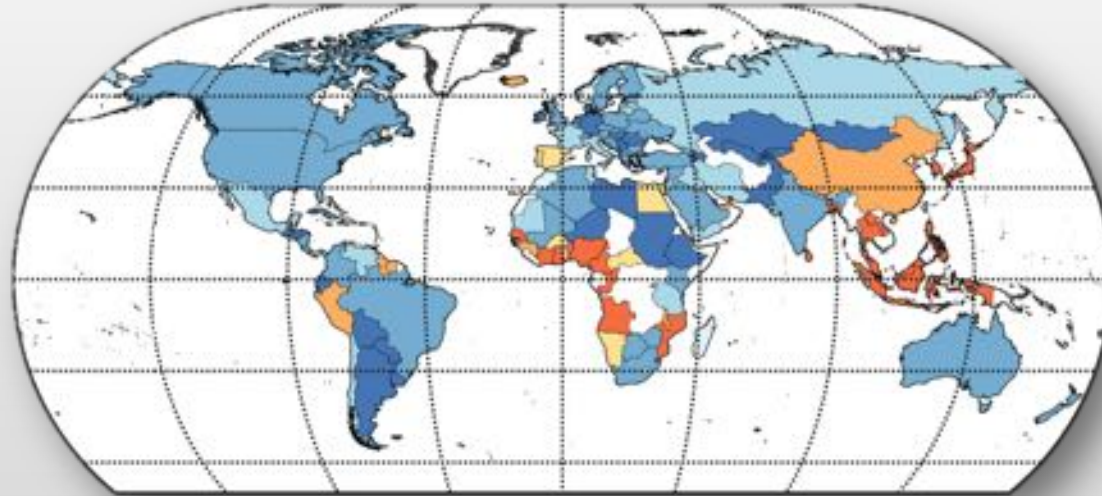- Anthropogenic effects ?

Acknowledgement :

Thank you for your attention.

Context

- The Ocean's Contribution to Human Wellbeing

Fish consumption

Ocean Health Index vs.
Fragile state index