4th International Symposium :
The Effects Of Climate Change on the World's Oceans
Session 11: Benthic and pelagic system responses in a changing ocean: From genes to ecosystem level functioning

Temperature effect on biomass transfers in coastal marine food webs

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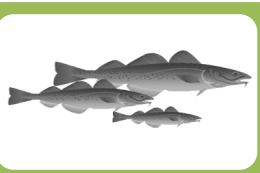
Global changes and ocean warming impact all ecological levels

Species level

- metabolism (Cheung et al. 2017, Lefevre et al., 2017)
- growth (Lefort et al., 2015),
- …



Population level

- reproduction (Perry et al., 2005)
- connectivity (Lett et al., 2010)
- …

Community level

- Species composition (Kaufman et al., 2017),
- distribution (Cheung et al., 2010)
- interactions (Chivers et al., 2016)…
- …

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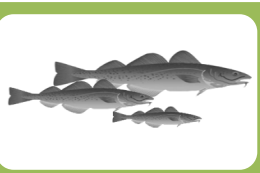

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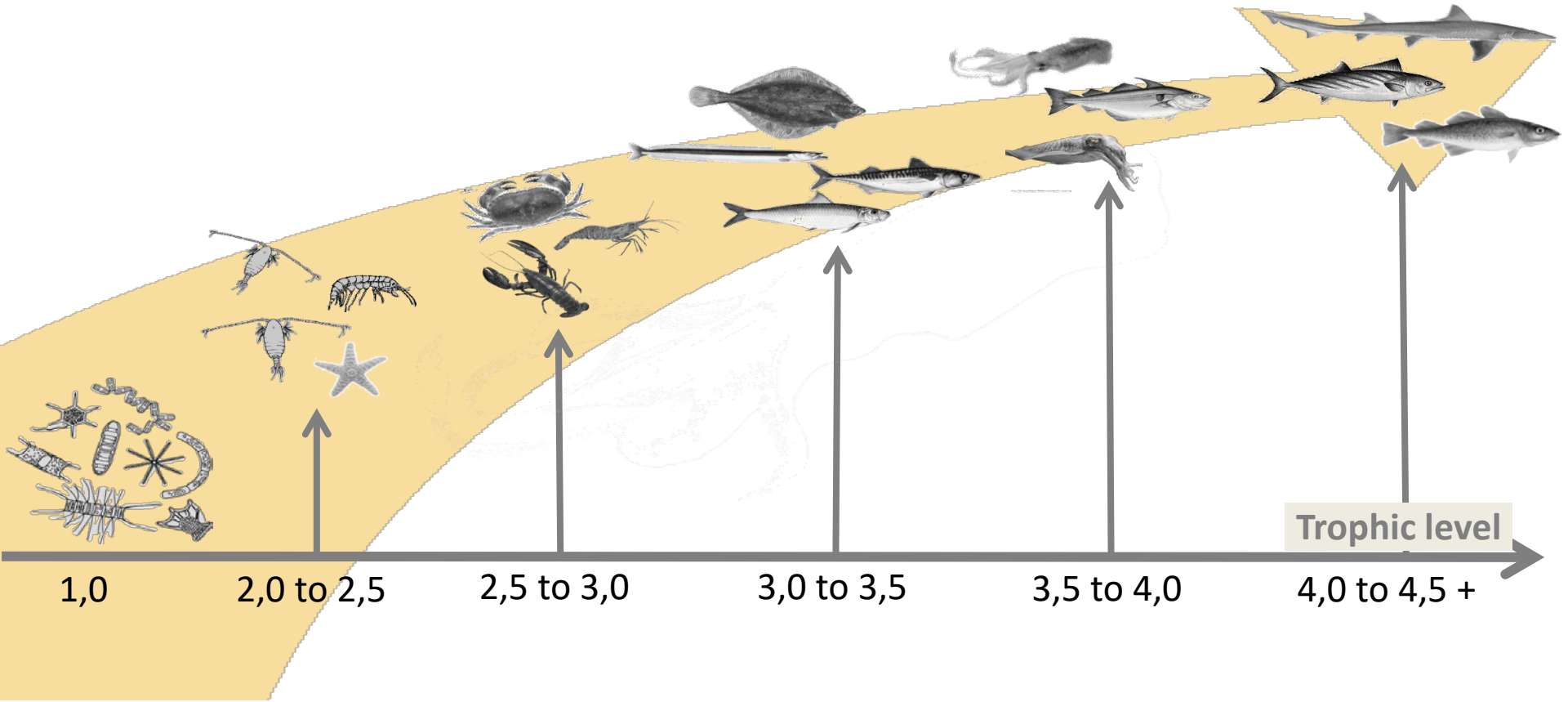
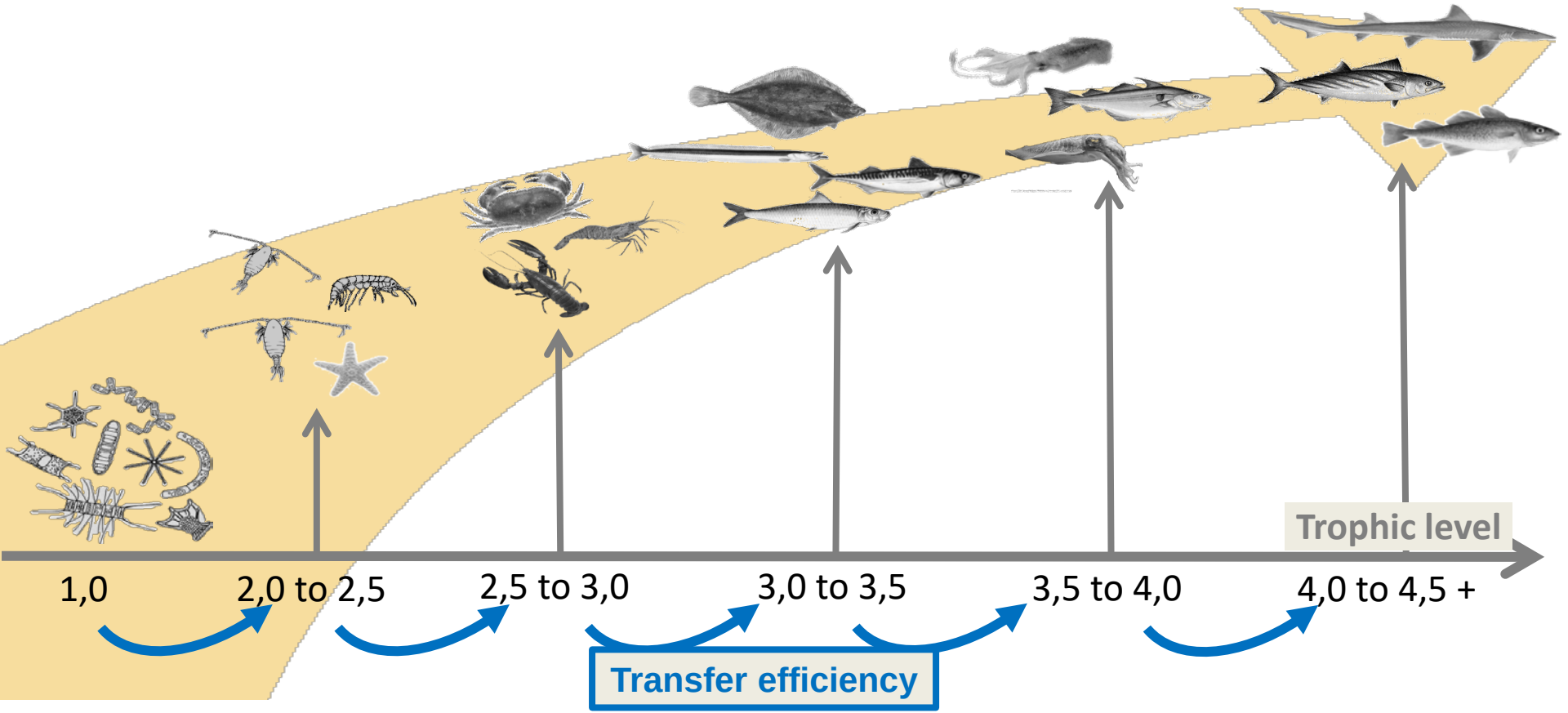
Changes in species assemblages

Looking at the functioning of marine food webs as a biomass flow



Looking at the functioning of marine food webs as a biomass flow



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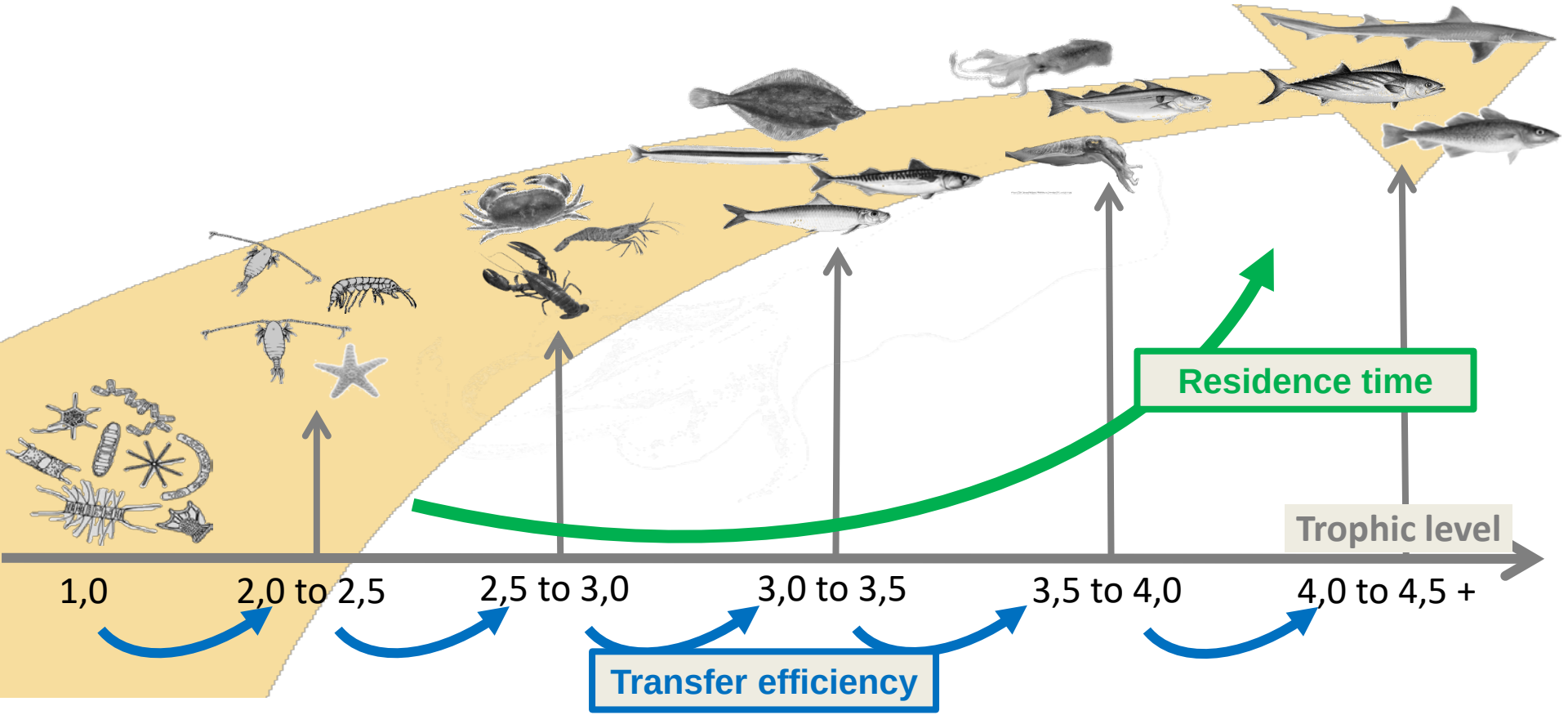

Why these two food web functioning indicators?

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H0 : Increase in Sea Temperature ➔ Toward species with faster metabolism

➔ Changes in **Transfer Efficiency** and **Residence Time**

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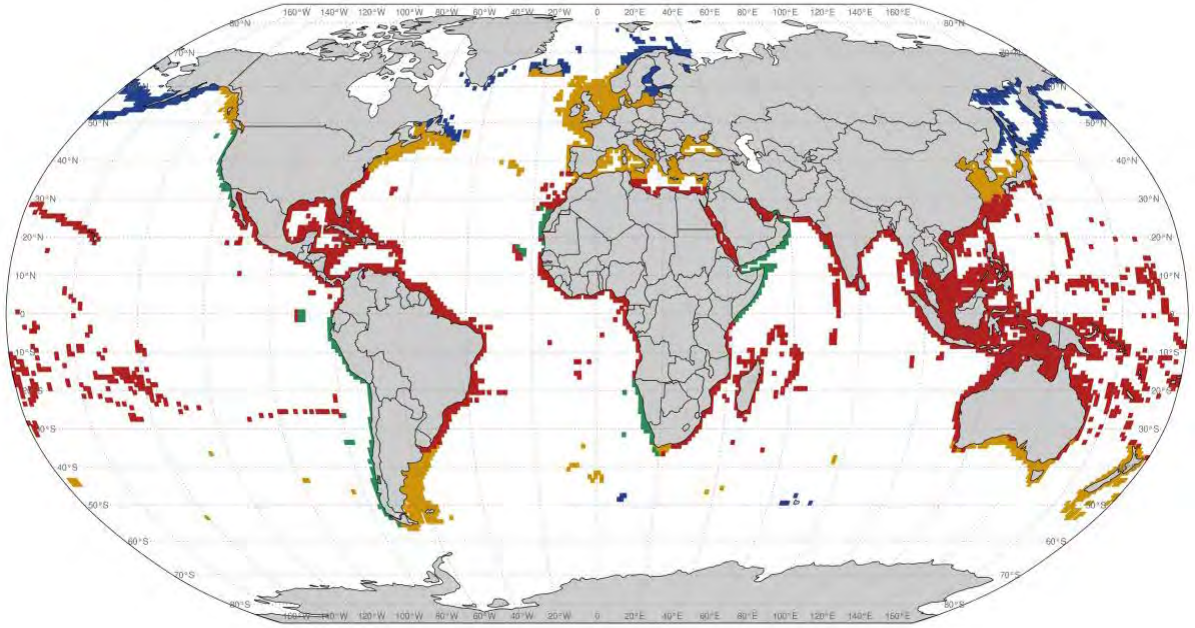
H0 : Increase in Sea Temperature ➔ Toward species with faster metabolism

➔ Changes in **Transfer Efficiency** and **Residence Time**

1) Global trends between 1950 and 2010
2) Temperature effects on these indicators

Study area : Coastal Ecosystems



Polar
Temperate
Tropical
Upwelling

Reygondeau et al. (2013)

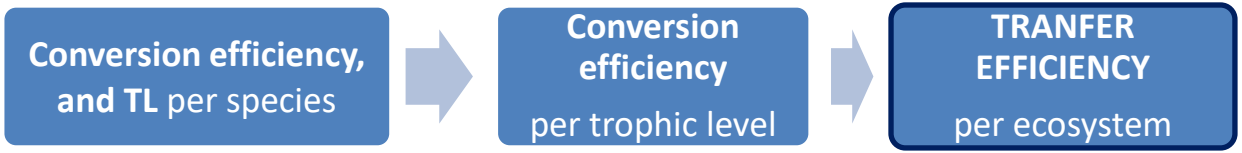
Transfer Efficiency and **Residence Time** were measured

in **every 1 degree coastal cell (5526 cells)**

for **all the years between 1950 and 2010**

Calculating integrated index : From species to communities

Method is detailed in Maureaud et al ., (2017) – PLoS One



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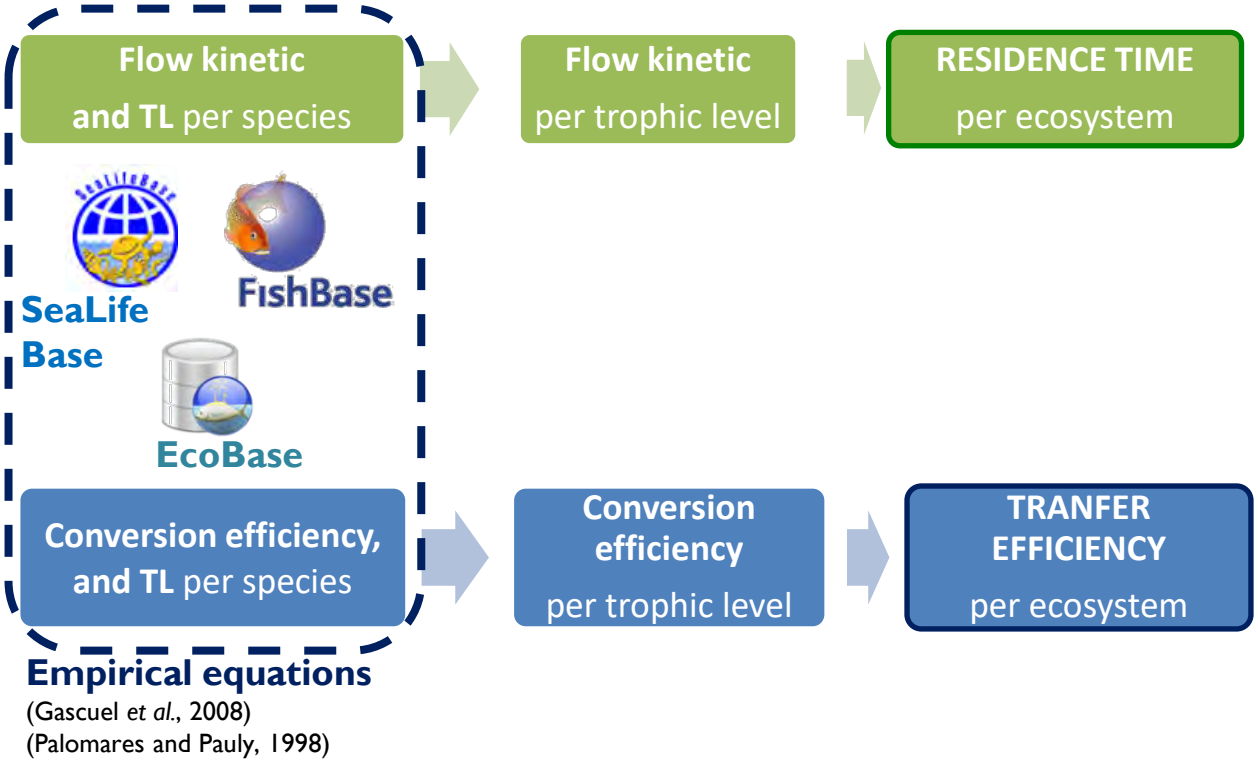

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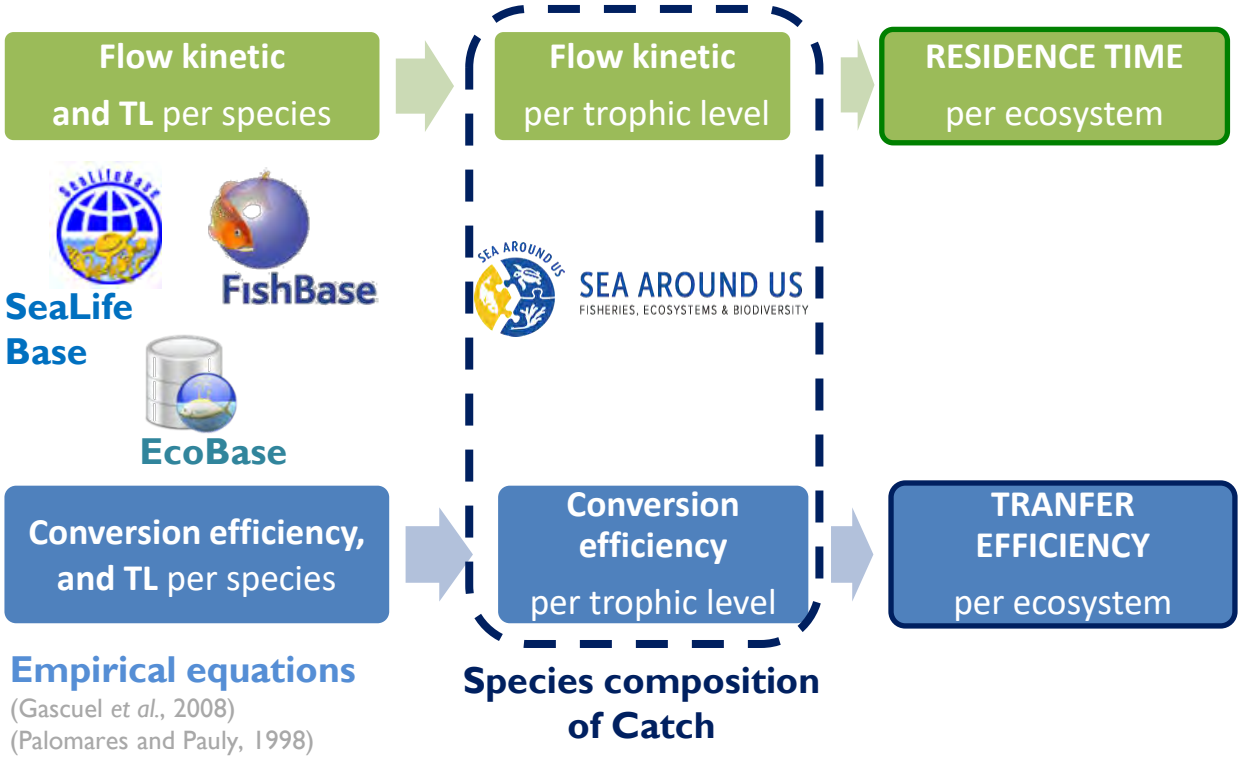

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Flow kinetic and TL per species → **Flow kinetic** per trophic level → **RESIDENCE TIME** per ecosystem

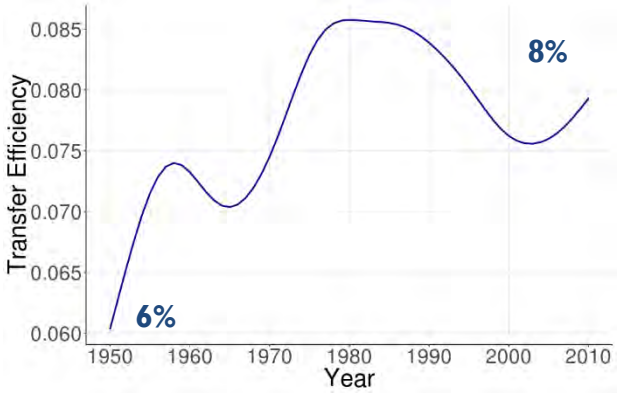
SeaLife Base

FishBase

EcoBase

SEA AROUND US
FISHERIES, ECOSYSTEMS & BIODIVERSITY

Conversion efficiency, and TL per species → **Conversion efficiency** per trophic level → **TRANFER EFFICIENCY** per ecosystem



Empirical equations
(Gascuel *et al.*, 2008)
(Palomares and Pauly, 1998)

Species composition of Catch

Global trends in transfer efficiency and in residence time

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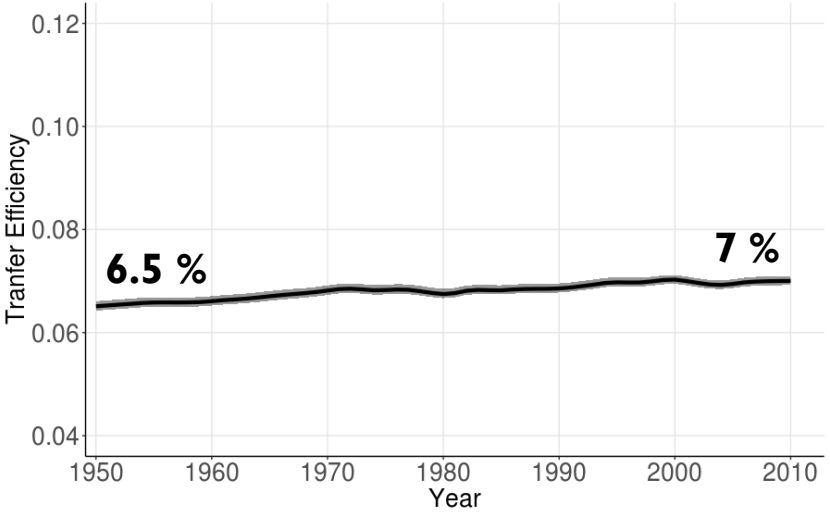
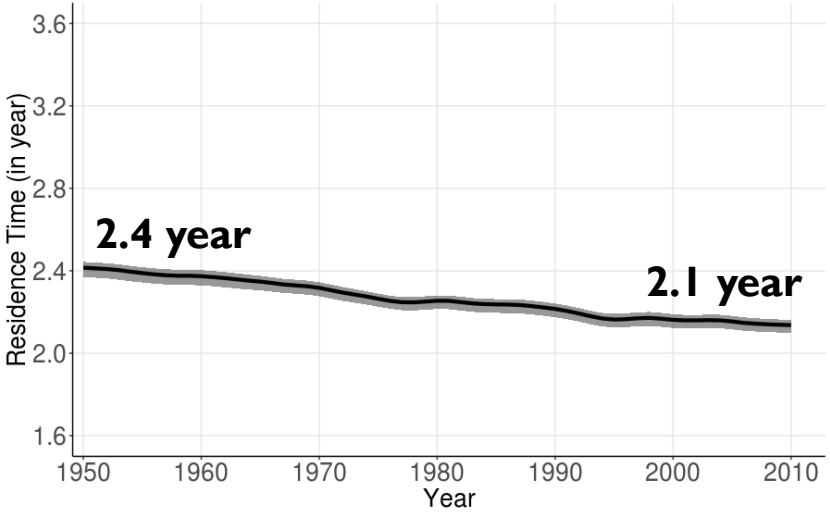
Transfer Efficiency

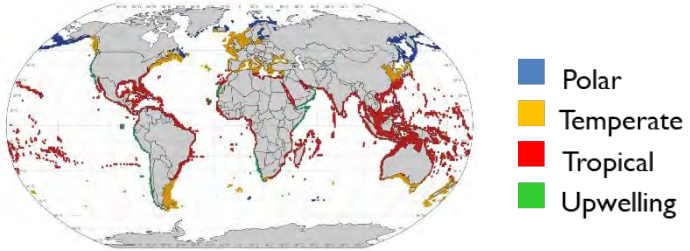


Residence Time



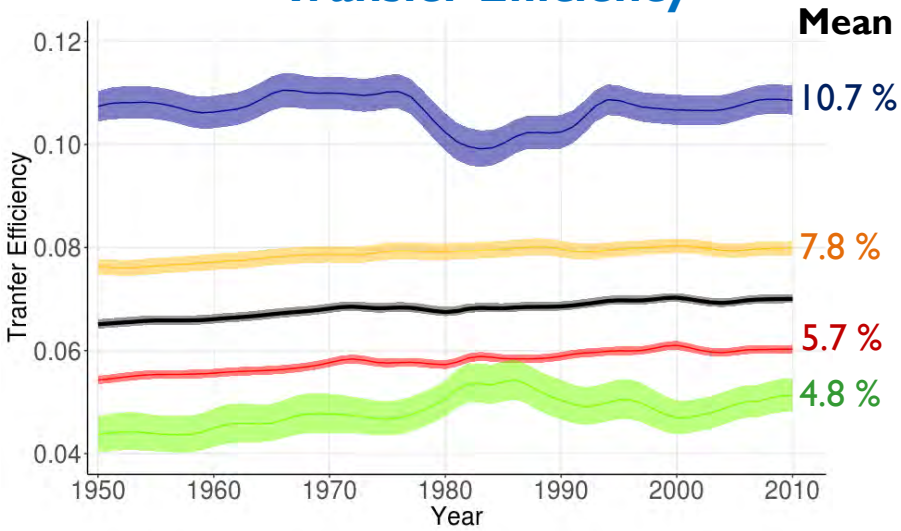
Global trends by ecosystem type

- Increase in Transfer Efficiency
- Decrease in Residence Time

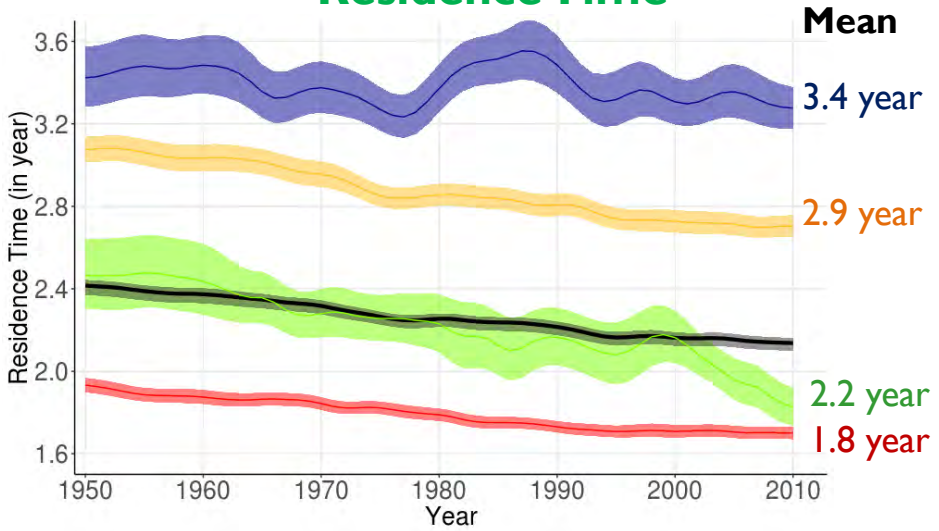


Global trends in transfer efficiency and in residence time

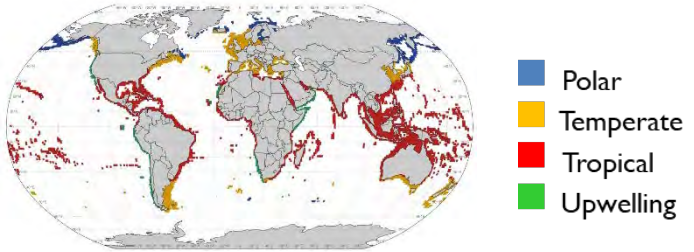
Transfer Efficiency



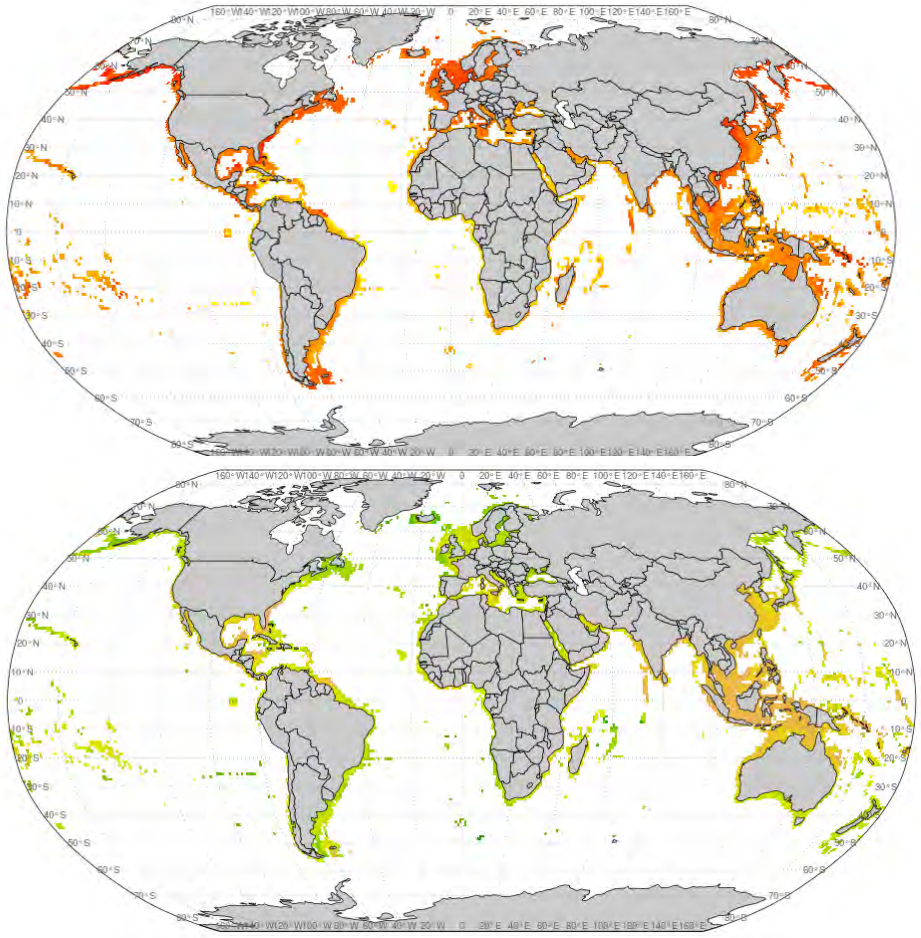
Residence Time



- **Global trends by ecosystem type**
  - Increase in Transfer Efficiency
  - Decrease in Residence Time
- **Indicators estimates by ecosystem type**



Global maps of transfer efficiency and residence time



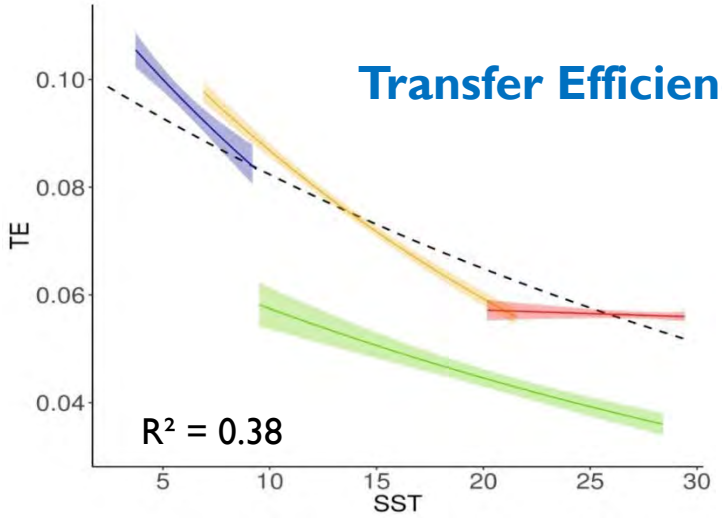
At higher latitude :

→ Higher Transfer Efficiency

→ Higher Residence Time

Temperature effect on transfer efficiency and residence time

Temperature effect on transfer efficiency and residence time

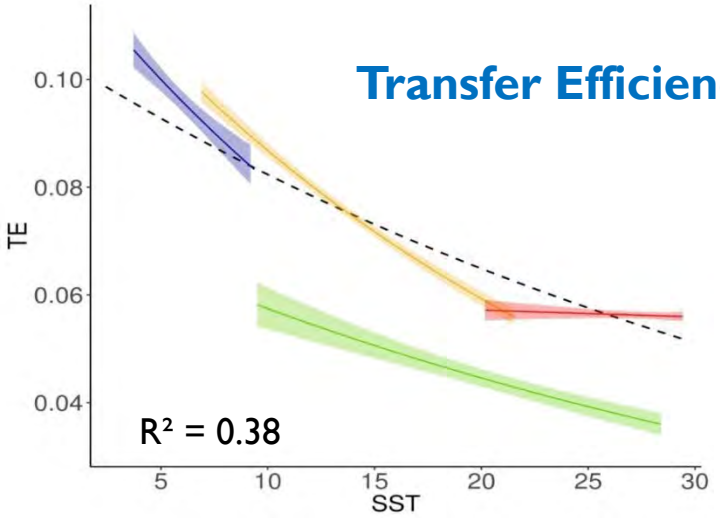


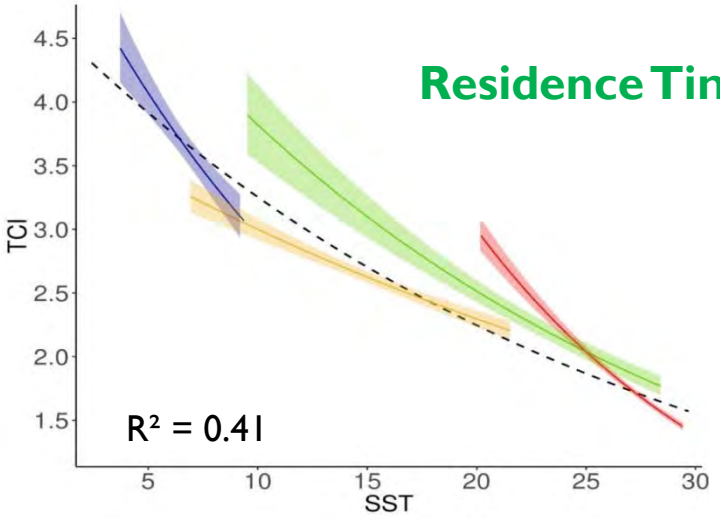
- ↗ Sea Surface Temperature :
  - ↘ Transfer Efficiency

- Lower sea temperature effect in tropical ecosystem for Transfer Efficiency

Polar
Temperate
Tropical
Upwelling

Temperature effect on transfer efficiency and residence time





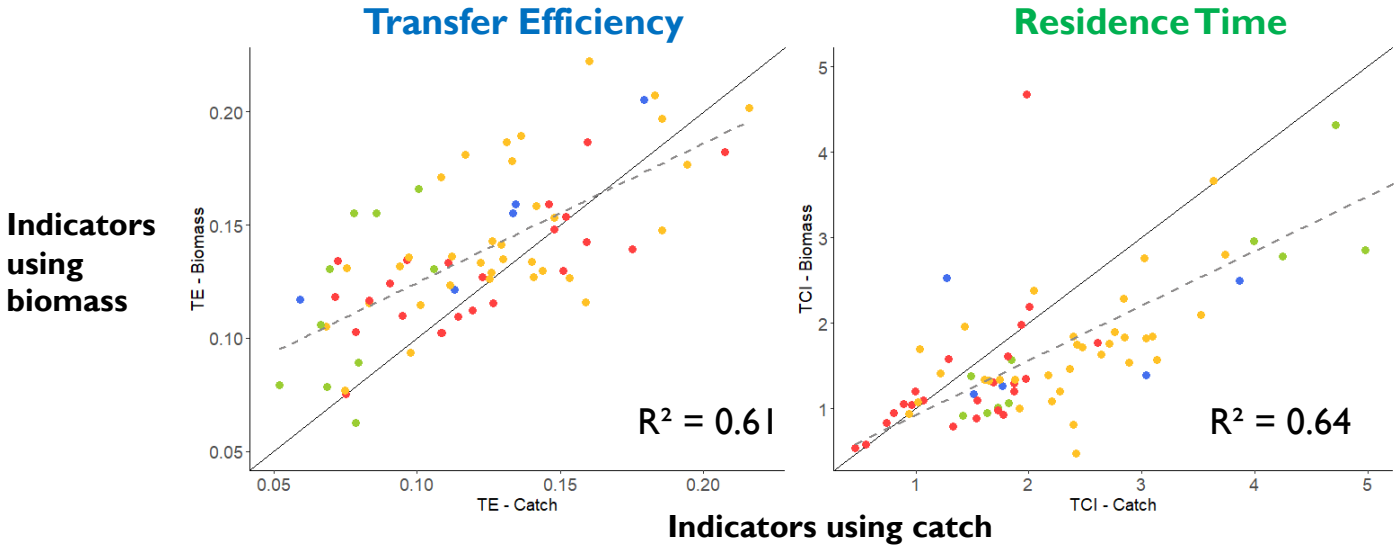
- ↗ Sea Surface Temperature :
  - ↘ Transfer Efficiency
  - ↘ Residence Time
- Lower sea temperature effect in tropical ecosystem for Transfer Efficiency
- Higher sea temperature effect in polar ecosystem

Polar
Temperate
Tropical
Upwelling

Potential bias due to the use of catch data

➢ Indicators based on catch data can bias the perception of the biomass flow

❑ Indicators based on catch vs biomass using a selection of 72 Ecopath models



- Good correlations between catch and biomass estimates

BUT

- Transfer Efficiency is underestimated
- Residence Time is overestimated

Summary

1) Past trend: Increase in Transfer Efficiency and decrease in Residence Time :
   - A fishing pressure effect (Maureaud et al., 2017)

2) Transfer Efficiency and Residence Time are negatively correlated to sea temperature

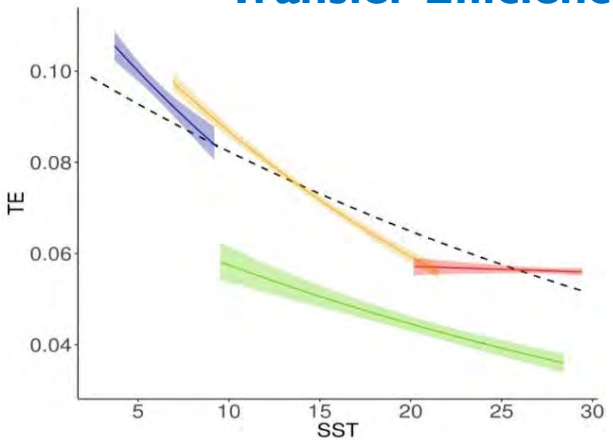
   ➔ due to differences in the species assemblages making up the marine communities
   - Cold ecosystems : slow and more efficient biomass transfers
     with slow growing & low turn-over species
   - Warm ecosystems : fast and less efficient biomass transfers
     with fast growing & high turn-over species

3) Future trend: Toward less efficient and faster biomass transfers in marine food webs

Perspectives

- Warmer ocean may lead to changes in biomass flow in marine food webs
  → Biomass transfers will be faster and less efficient ?

Transfer Efficiency

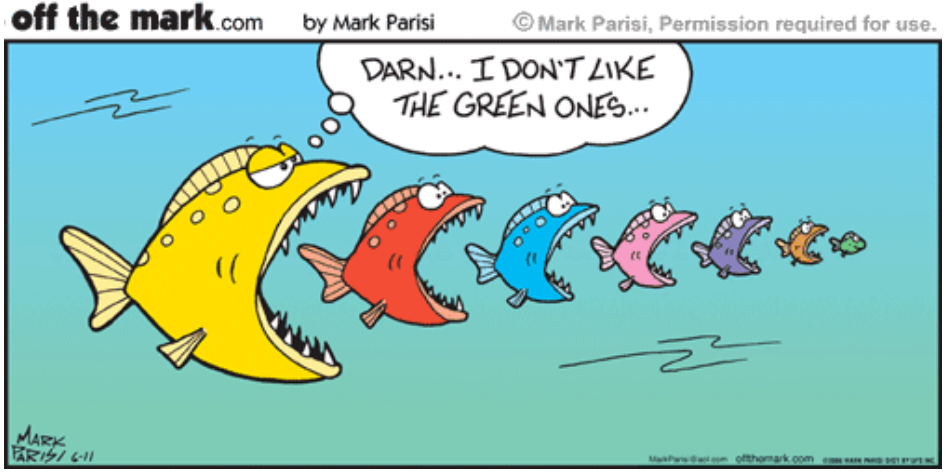


	2010	2100	
		RCP 2.6	**RCP 8.5**
Polar	11.7 %	11.5 %	11 %
Temperate	7.6 %	7.2 %	6.9 %
Tropical	5.6 %	5.6 %	5.5 %

Mean values using GFDL and IPSL

- How will these potential changes impact marine ecosystem in terms of stability and productivity?

Thank you for your attention



Any questions?

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