

Development of an effect factor for marine plastics' impact on marine carbon sequestration

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ATLANTIS



Industrial
Ecology
Programme



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Introduction

- Marine Ecosystem Service (EMS) - Provisioning



Food provision



Raw materials

Introduction

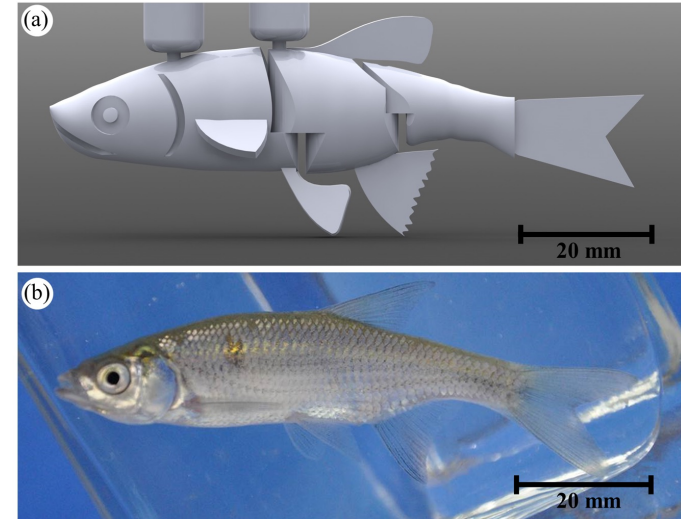
- Marine Ecosystem Service (EMS) - Cultural



Cultural heritage



Leisure and recreation



Cognitive benefits*

*: <https://everyone.plos.org/2013/11/21/robotfish-how-color-and-tail-wagging-helped-bring-a-robot-fish-to-life/>

Introduction

- Marine Ecosystem Service (EMS) - Regulating



Climate regulation



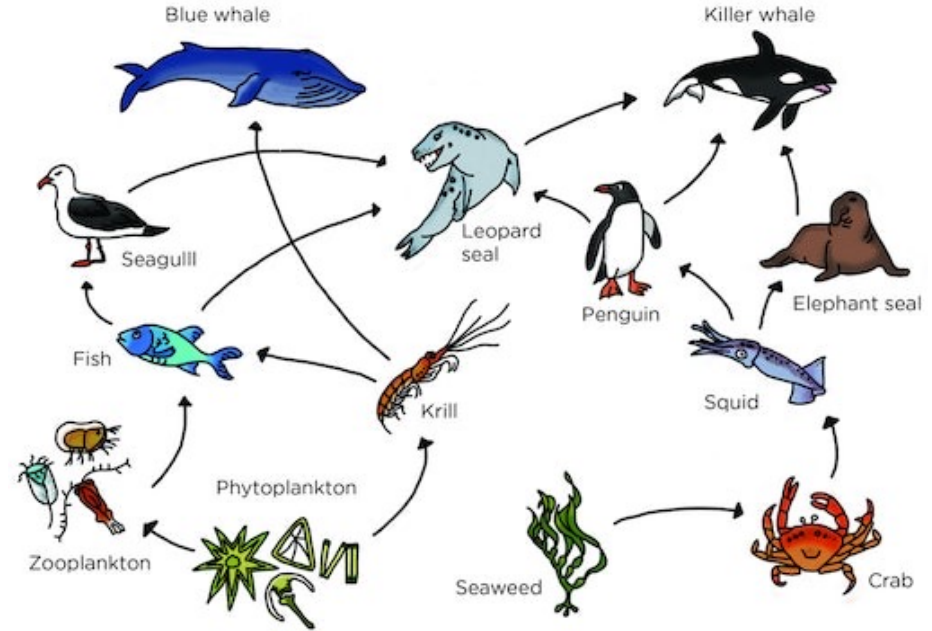
Disturbance prevention

Introduction

- Marine Ecosystem Service (EMS) - Supporting



Habitat



Nutrient cycling

Introduction

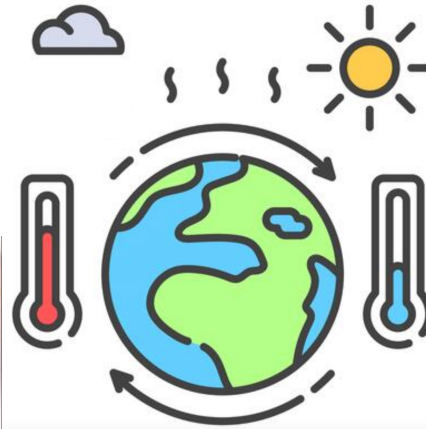
- Marine Ecosystem Service (EMS)



Provisioning



Cultural



Regulating

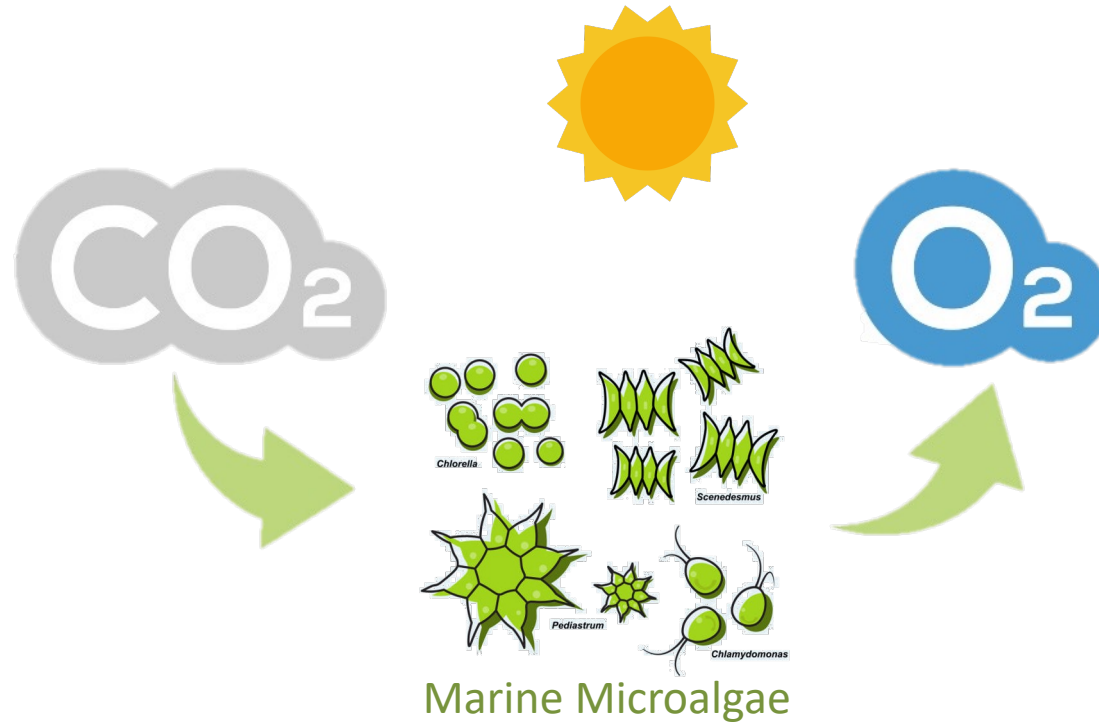


Supporting

LCIA areas of protection (AoPs) of ecosystem service in is still missing

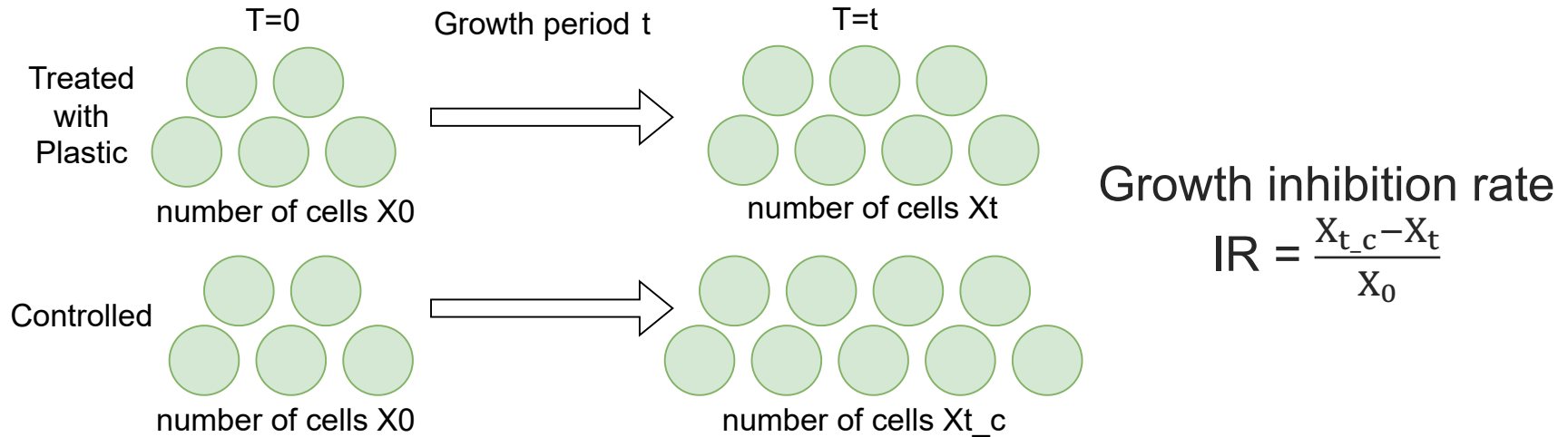
Introduction

- Marine carbon sequestration (regulating service)

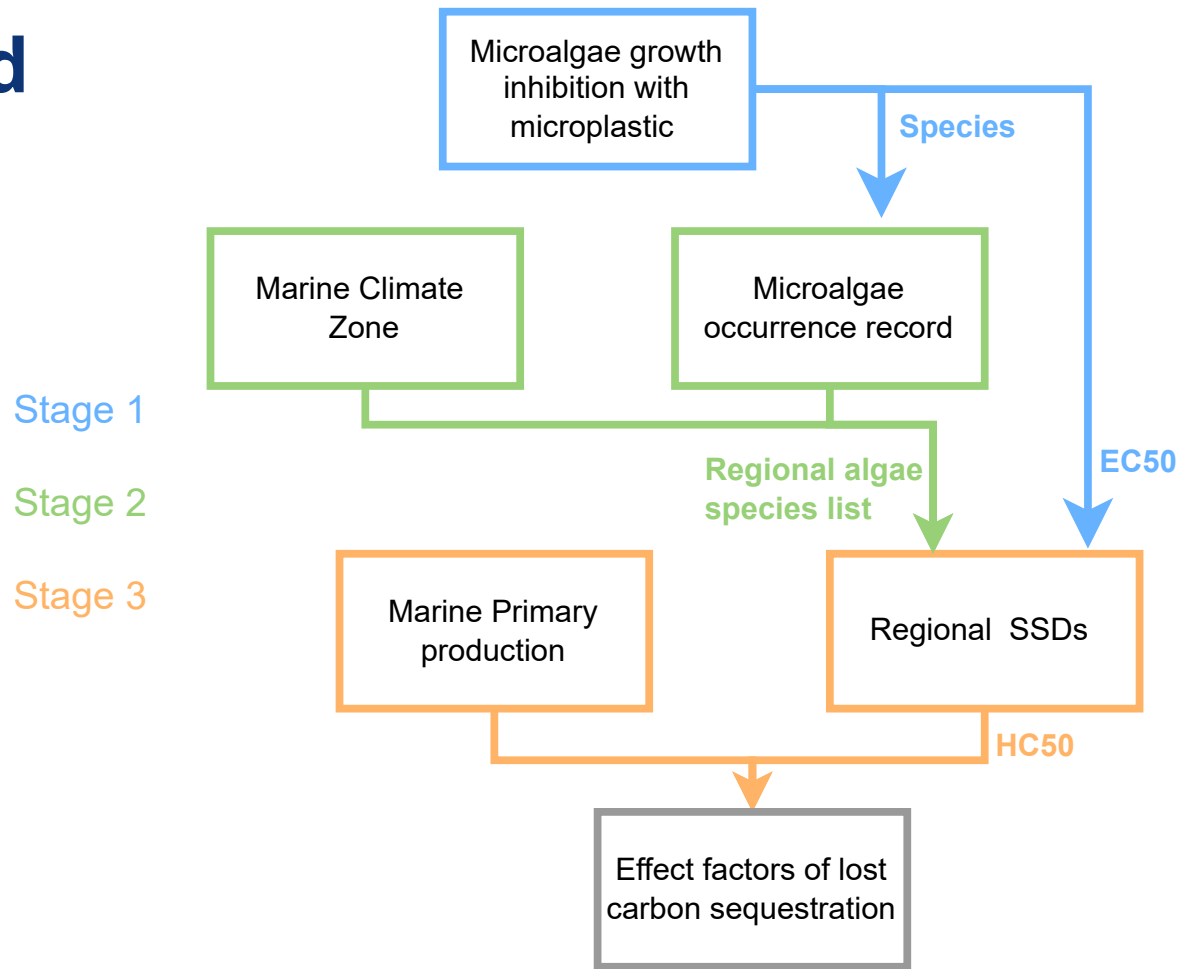


Introduction

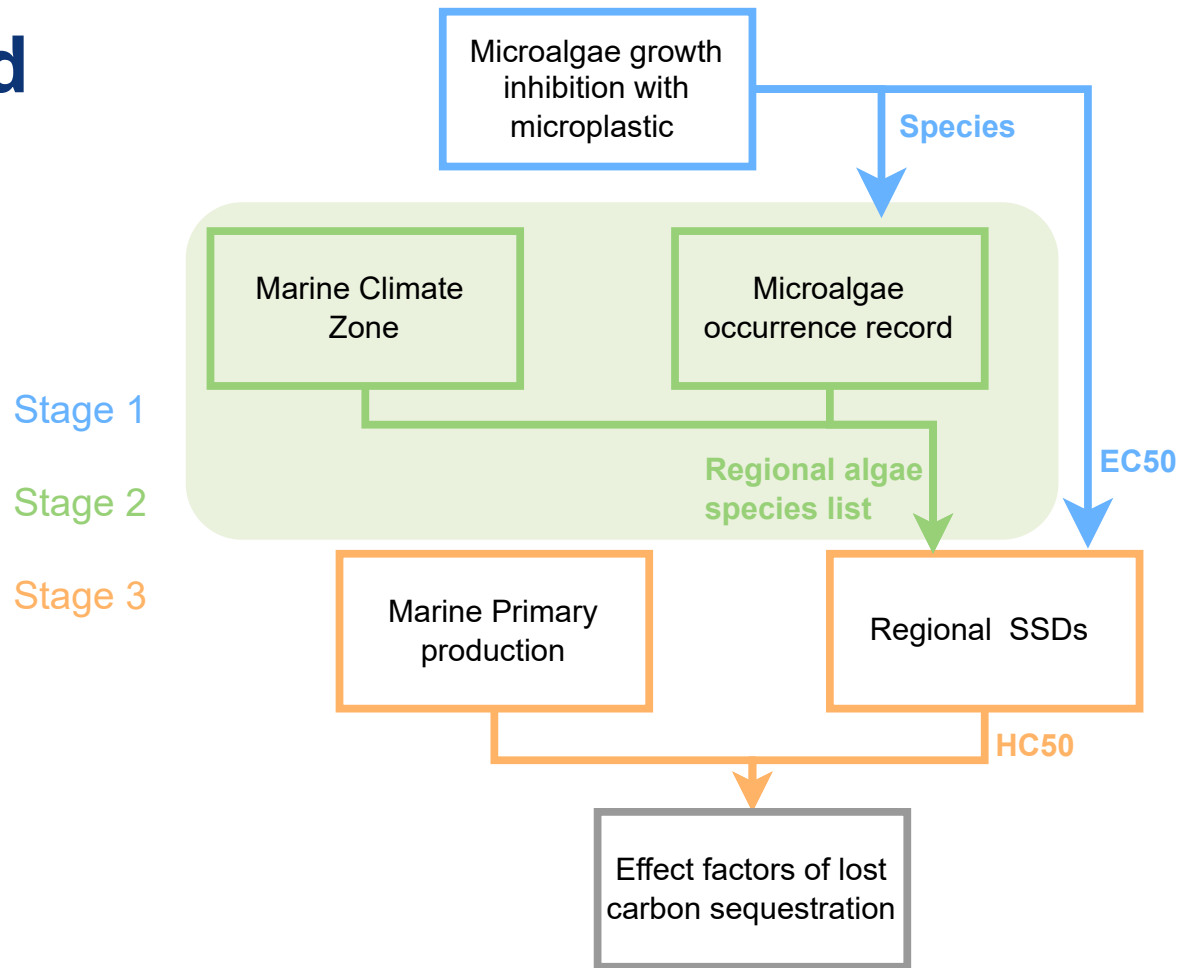
- Plastics inhibit microalgae growth



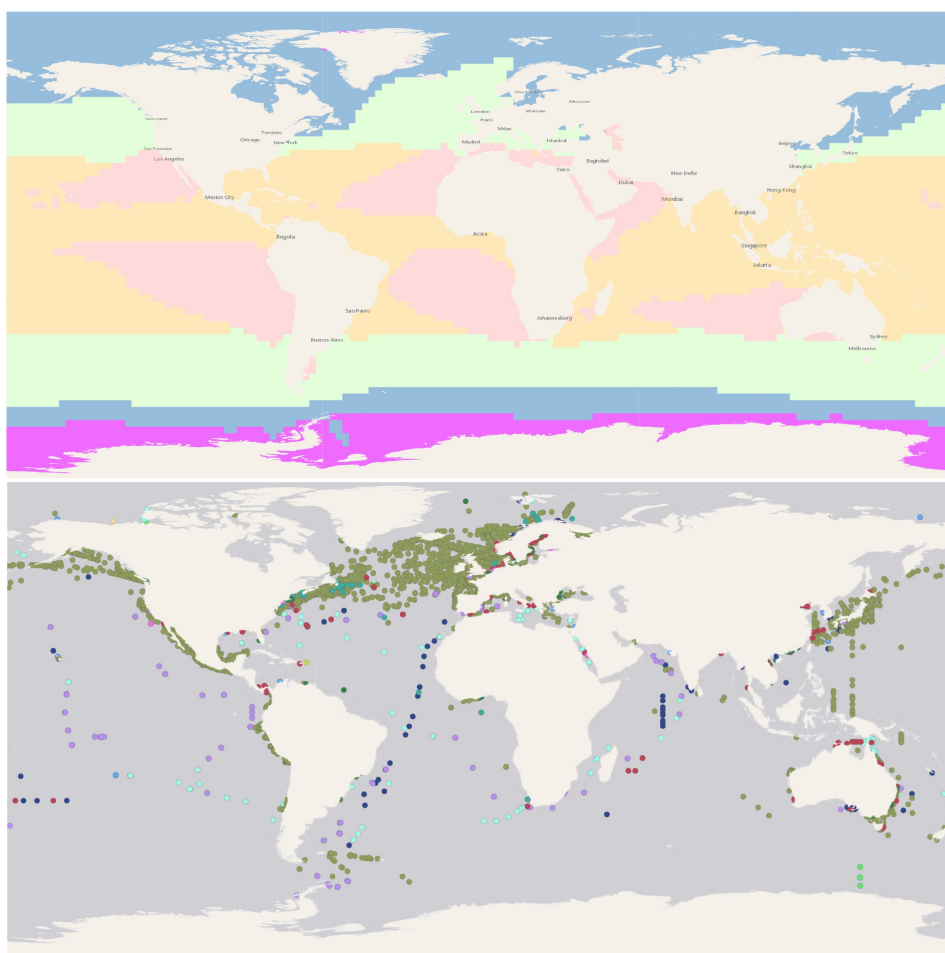
Method



Method



Algae distribution



Köppen–Geiger
Climate Class

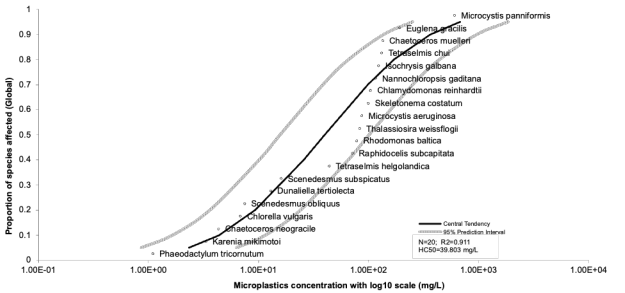
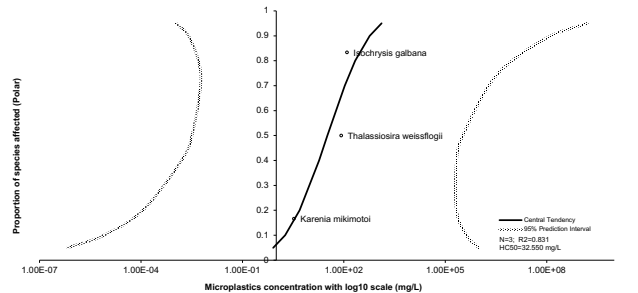
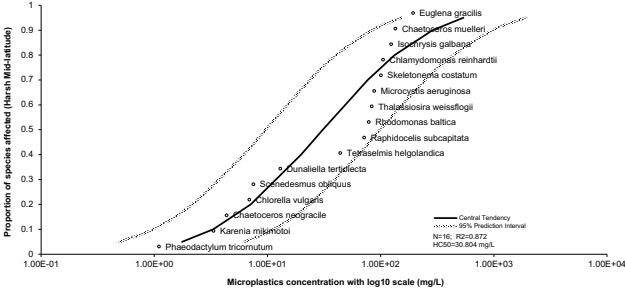
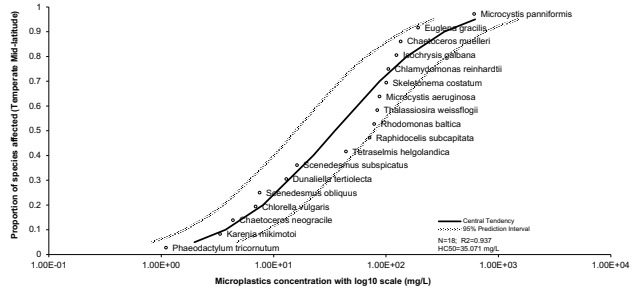
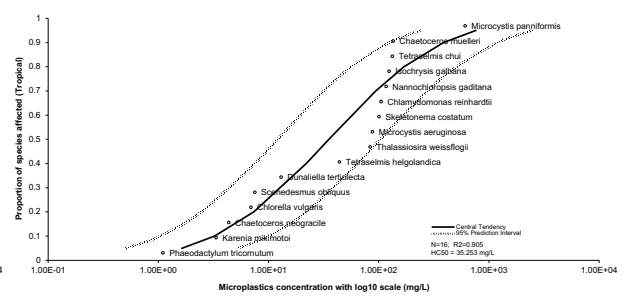
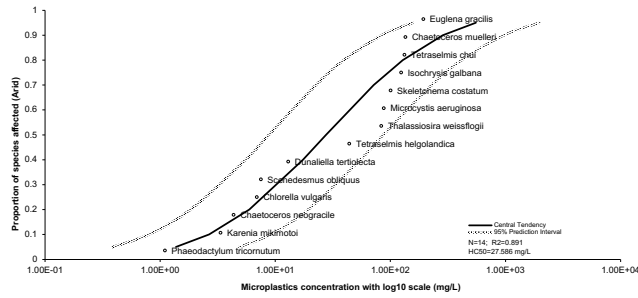
- Arid
- Tropical
- Temperate Mid-latitude
- Harsh Mid-latitude
- Polar

Microalgae
Occurrence

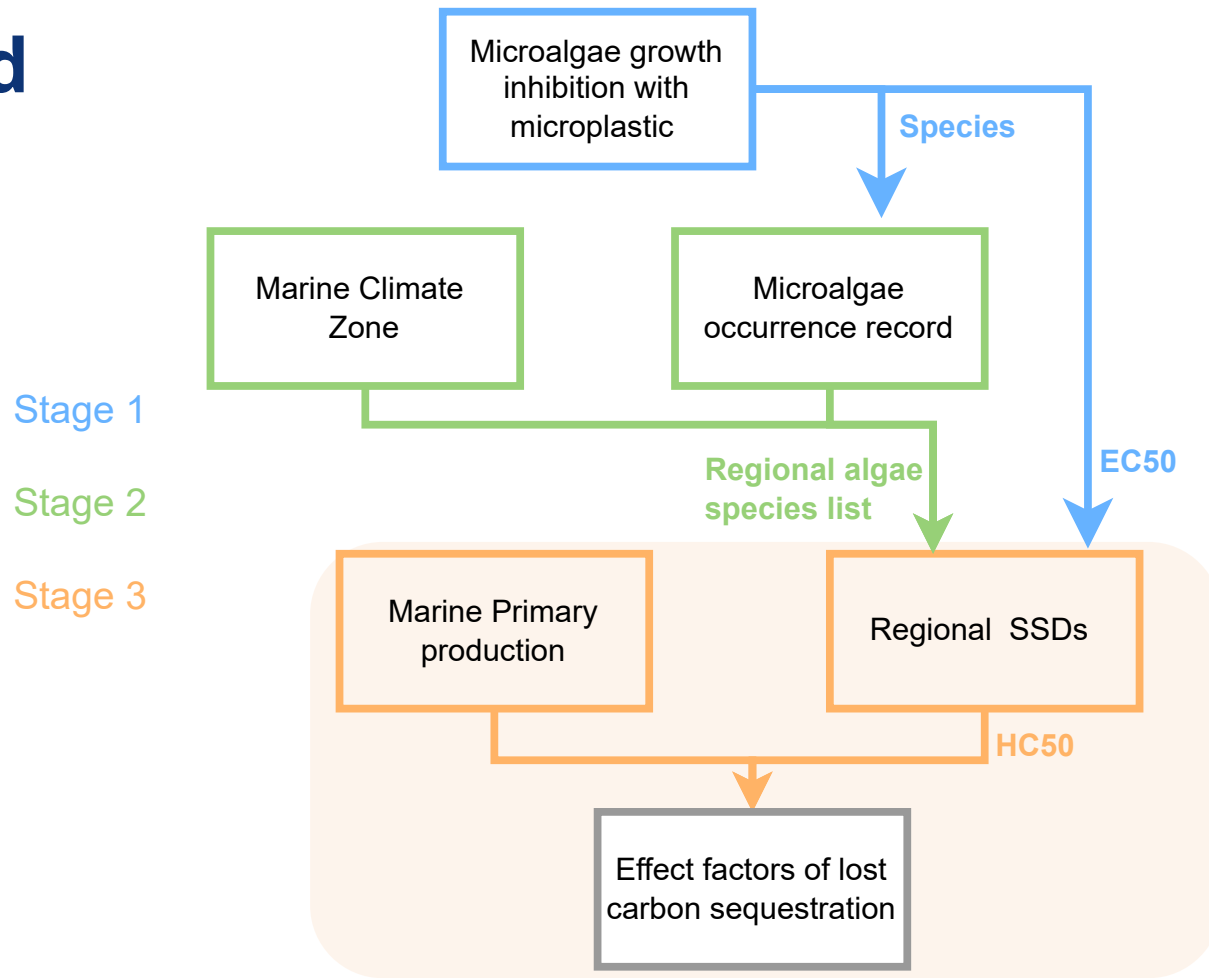
(1) Based on Rohli, Robert V., et al. "extended Köppen–Geiger climate classification and temporal shifts in terrestrial climatic types." *Physical Geography* 36.2 (2015): 142-157.

(2) Occurrence from GBIF, OBISGlobally

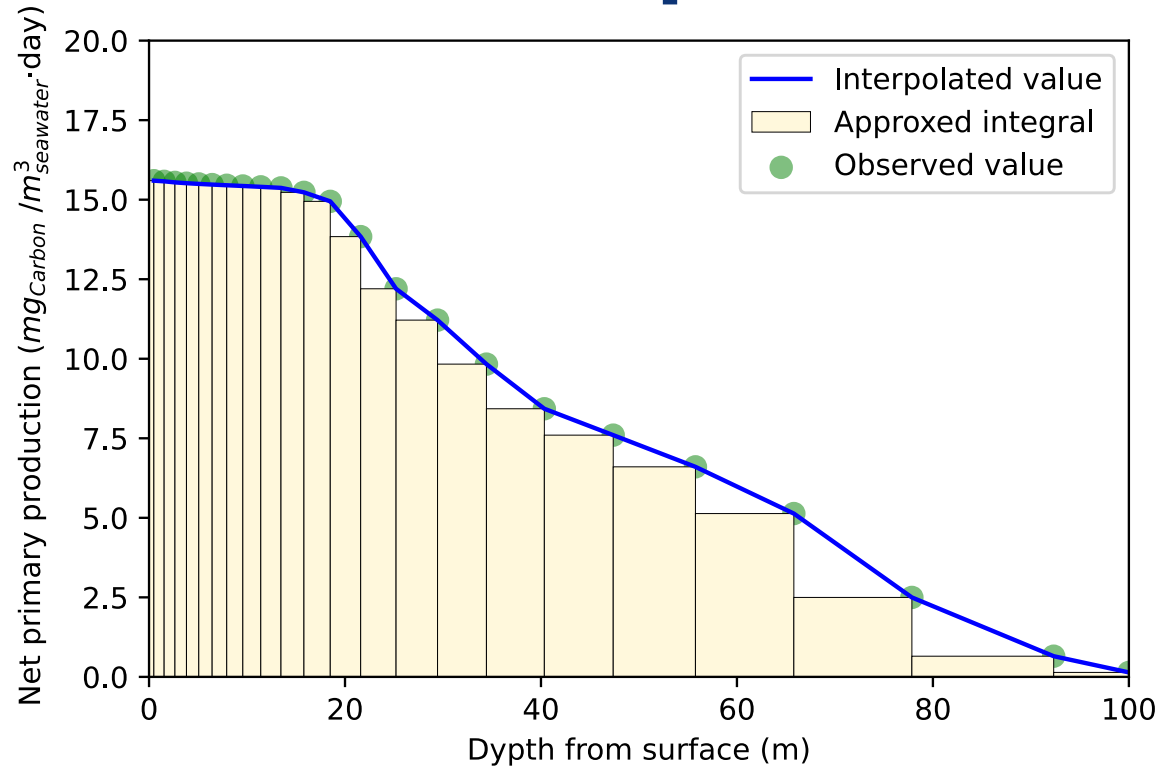
Regional SSDs



Method

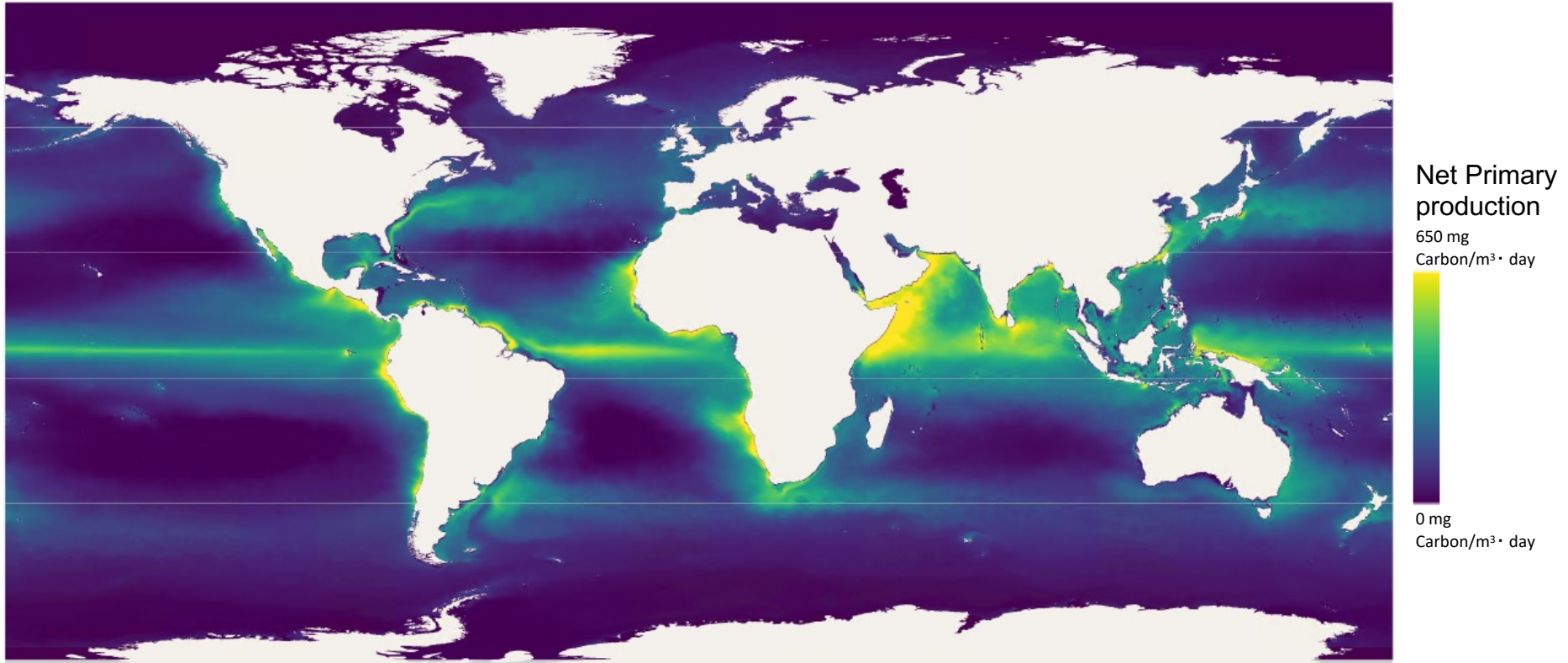


Regional carbon sequestration



[1] E.U. Copernicus Marine Service Information - Global Ocean Biogeochemistry Analysis and Forecast :<https://resources.marine.copernicus.eu>

Primary production



[1] E.U. Copernicus Marine Service Information - Global Ocean Biogeochemistry Analysis and Forecast :<https://resources.marine.copernicus.eu>

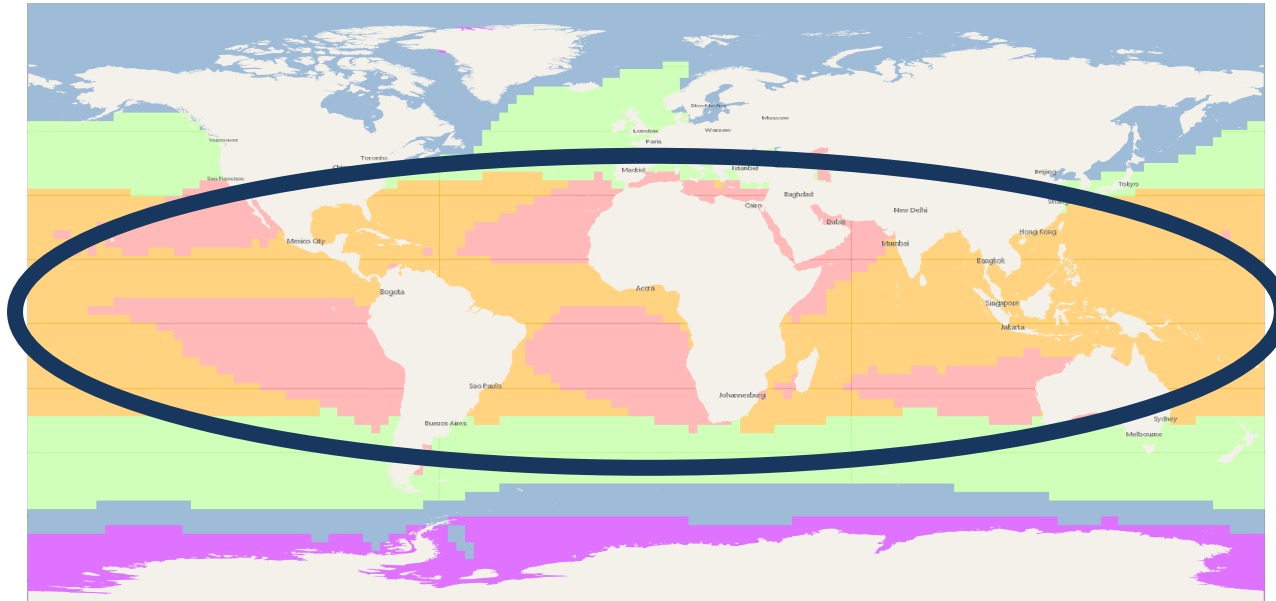
Effect factor

Lost carbon sequestration

$$EF = \frac{a * CS}{HC_{50}}$$

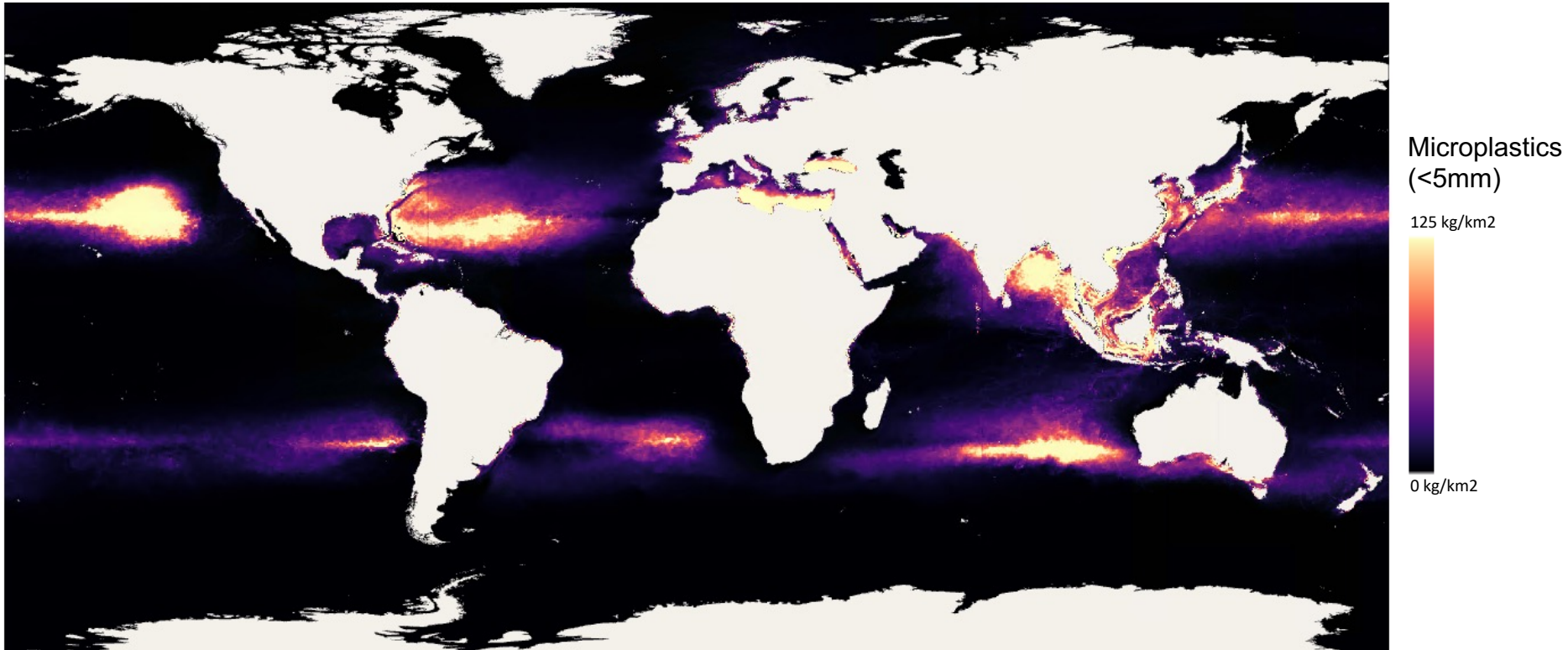
$g\ CO_2/g\ \text{marine microplastic}$

Effect factor



Climate Zone	Effect factor (g CO ₂ /g plastic-year)
Polar	0.118
Harsh Mid-latitude	0.234
Temperate Mid-latitude	0.545
Arid	0.941
Tropical	1.021

Global Marine Plastic



[1] Eriksen, Marcus, et al. "Plastic pollution in the world's oceans: more than 5 trillion plastic pieces weighing over 250,000 tons afloat at sea." PloS one 9.12 (2014): e111913. <https://doi.org/10.1371/journal.pone.0111913>

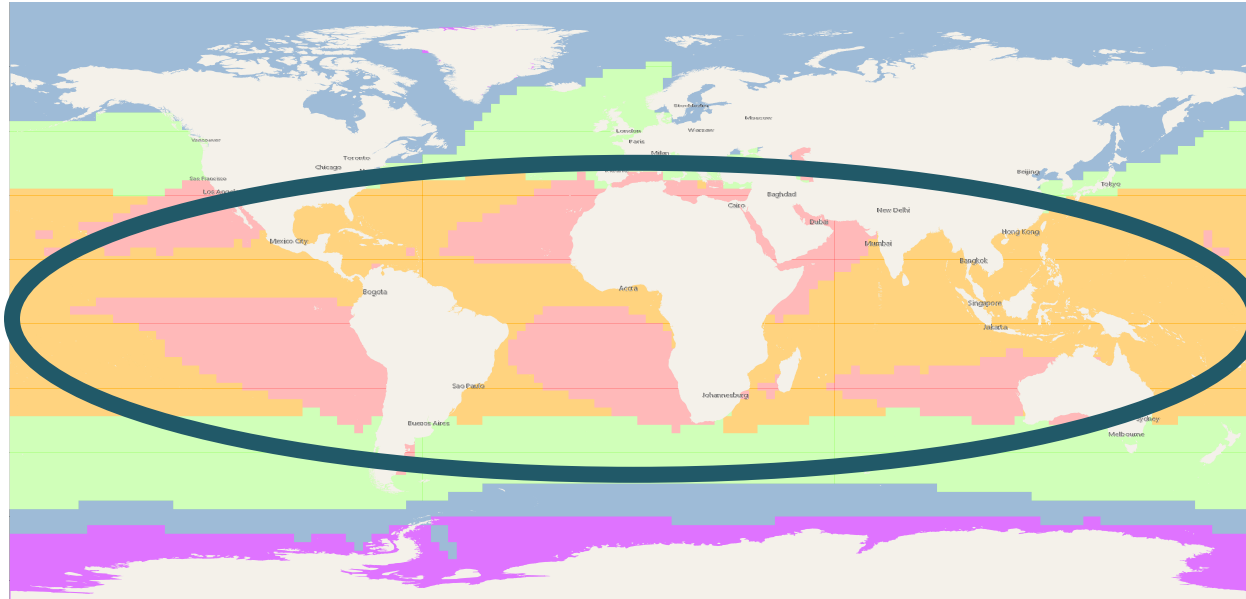
Global value loss in \$

Cost of
carbon capture
and storage

Total Regional
Microplastic weight

$$VL = Cost_{CCS} * EF * (PS * \sum WD_{i,j})$$

Global case – Value lost



Climate Zone	Value Lost
	(\$/year)
Polar	1.3E+00
Harsh Mid-latitude	5.7E+03
Temperate Mid-latitude	1.6E+05
Arid	3.9E+05
Tropical	1.1E+06

Conclusion

- 1st study quantifying MES on global scale
- Arid and Tropical are more exposed