Blue Carbon and Climate Change

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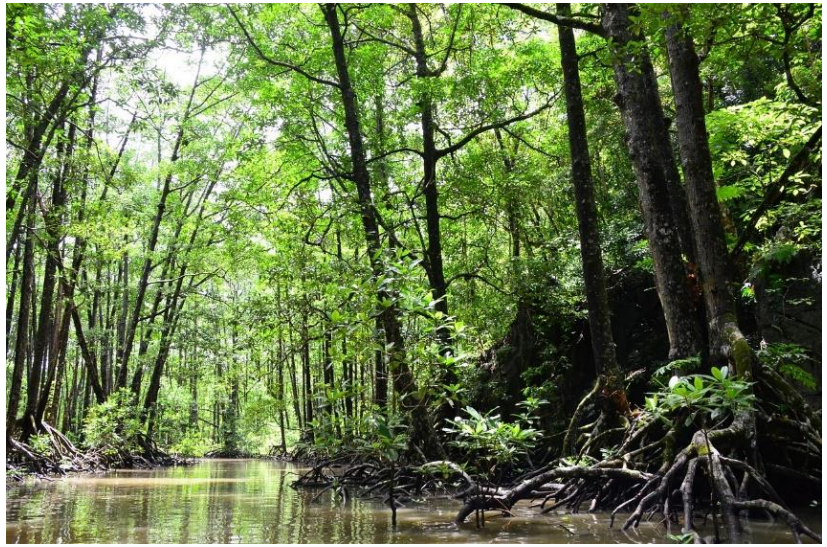
The colour of carbon

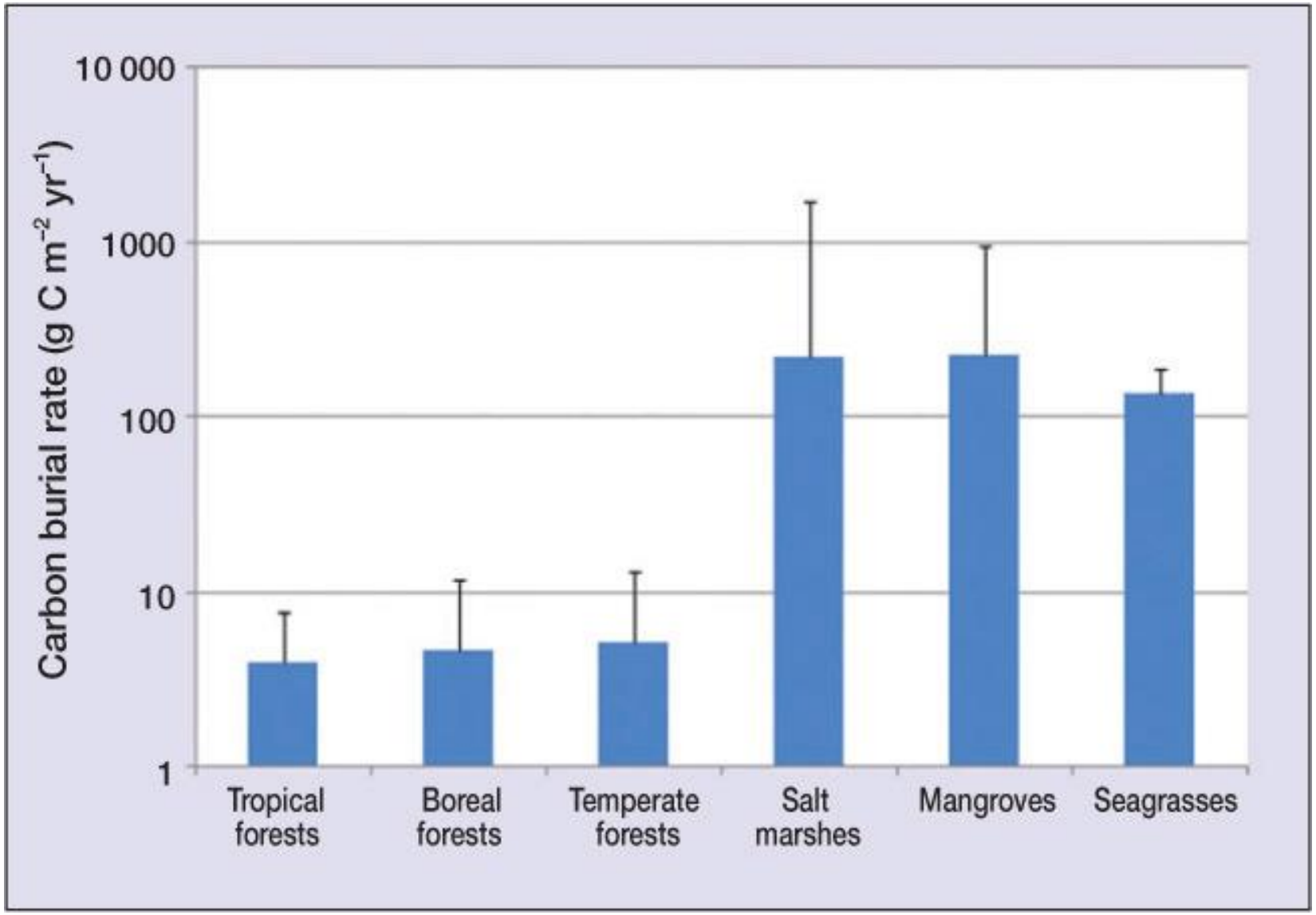
Blue carbon – carbon captured by world's oceans

Oceans take up 55% of all carbon captured through photosynthesis

Blue carbon ecosystem = carbon taken up in a marine ecosystems (***leading to sequestration***)



Blue carbon vegetated habitats



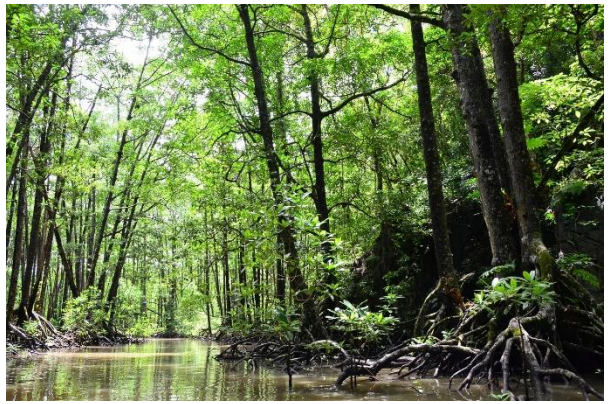
Mcleod et al (2011) Frontiers in Ecology and the Environment

Blue carbon – more than just an inventory

- Carbon stock (standing stock) – how much carbon there is
- Flow between carbon stocks (origin / source; sink)

(*age, vulnerability, accumulation / burial rate, provenance, sequestration*)

Potential to become part of Nationally Determined Contributions (NDCs?)



Blue carbon – more than just an inventory

CPO CLIMATE PROGRAM OFFICE | Helping people, businesses, and the environment thrive in a changing climate

NOAA BLUE CARBON INVENTORY PROJECT

ENHANCING CAPACITY TO INTEGRATE COASTAL WETLANDS DATA IN NATIONAL GREENHOUSE GAS INVENTORIES

Coastal wetlands, such as mangroves, salt marshes, and seagrasses, significant role in carbon stor sequestration around the wor providing some of the highest stores of carbon in the biosph This long-term storage is kno "coastal blue carbon."

Scottish Natural Heritage
Commissioned Report No. 957

Assessment of Blue Carbon Resources in Scotland's Inshore Marine Protected Area Network

IUCN

Manual for the Creation of Blue Carbon Projects in Europe and the Mediterranean

ARTICLES
https://doi.org/10.1038/s41558-021-01089-4

nature climate change

Check for updates

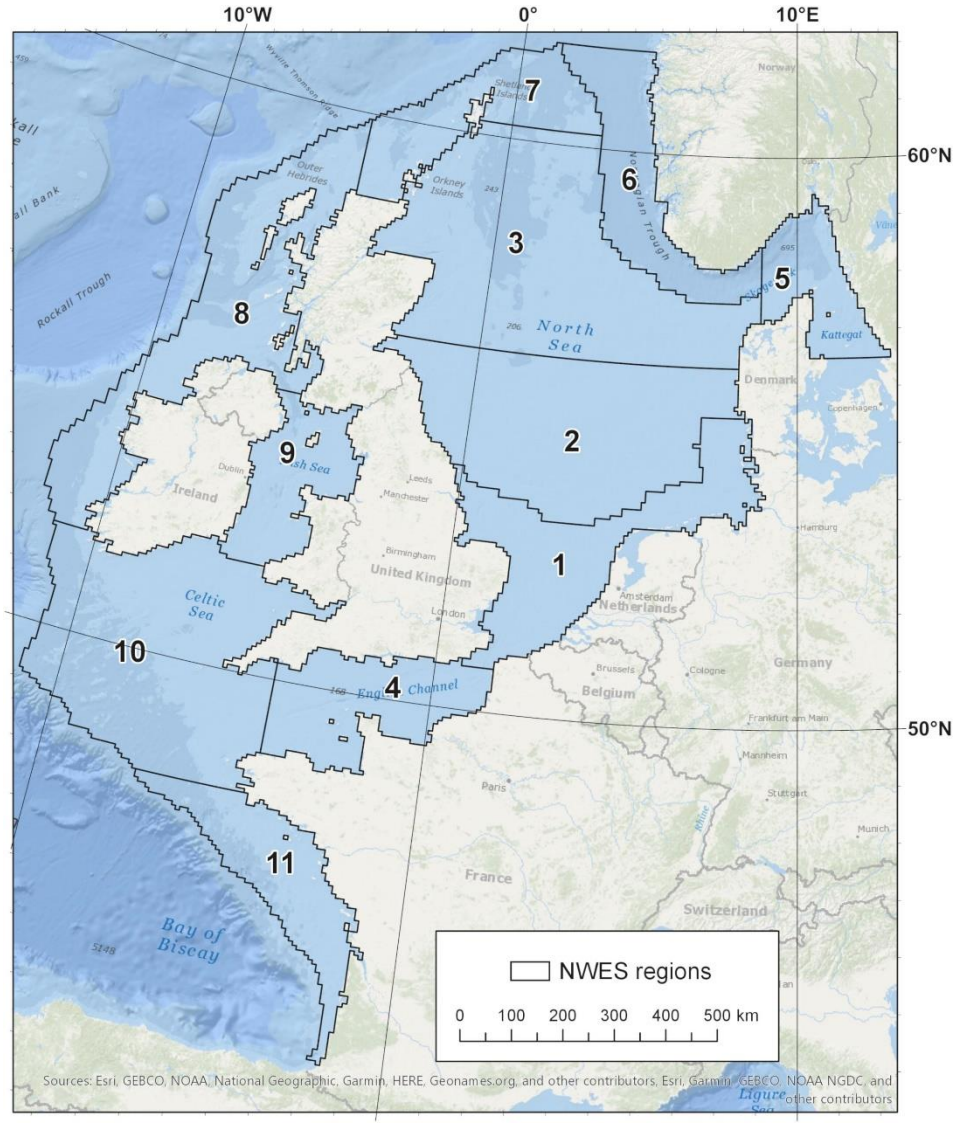
OPEN

The blue carbon wealth of nations

Christine Bertram[1], Martin Quaas[2], Thorsten B. H. Reusch[3], Athanasios T. Vafeidis[4], Claudia Wolff[4] and Wilfried Rickels[1]

Carbon sequestration and storage in mangroves, salt marshes and seagrass meadows is an essential coastal 'blue carbon' ecosystem service for climate change mitigation. Here we offer a comprehensive, global and spatially explicit economic assess-

Carbon budget of North West European Shelf

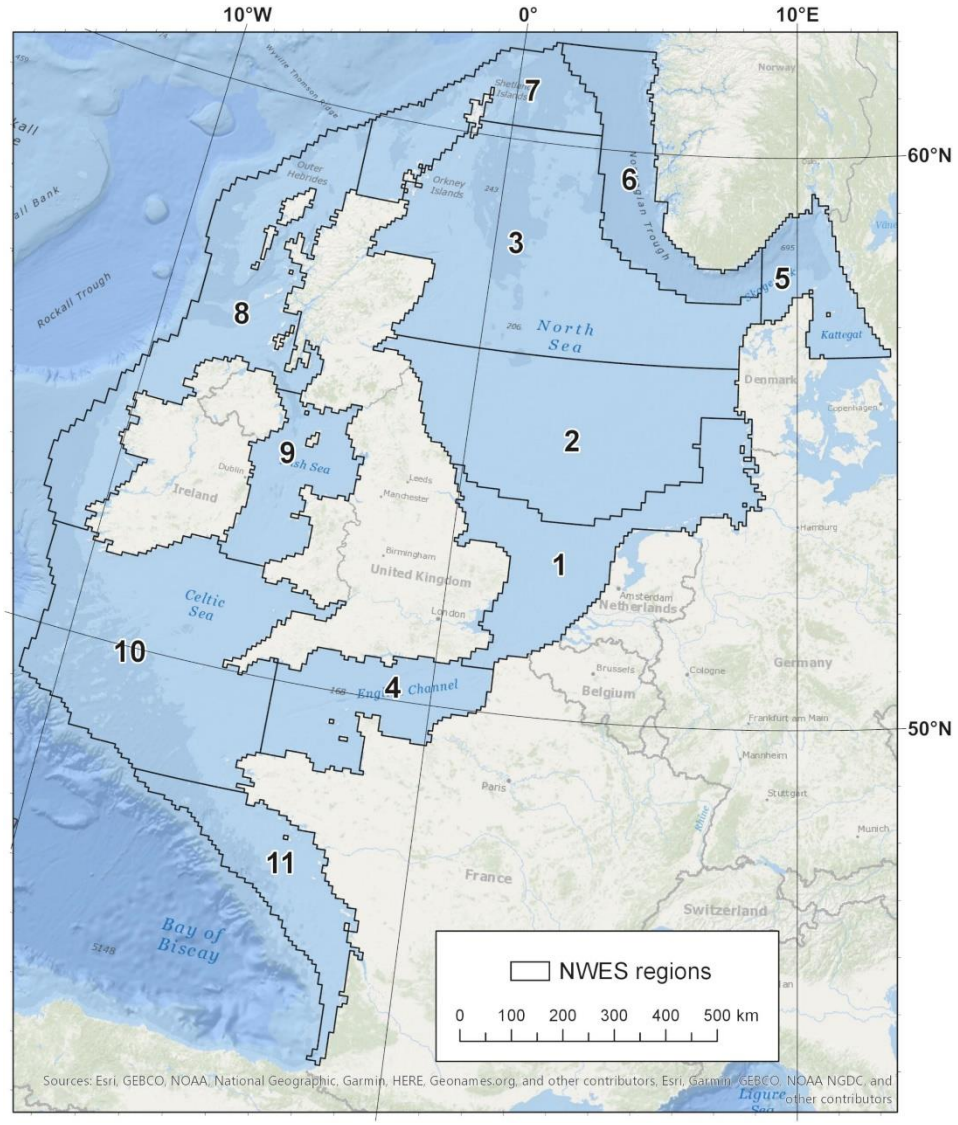


Split into three components:

- **Benthic** (shelf sea sediments, fjords)
- **Pelagic** (particulate and dissolved carbon)
- **Coastal** (salt marsh, seagrass, kelp, mud flats, sand flats)

Legge et al (2020) Frontiers in Marine Science

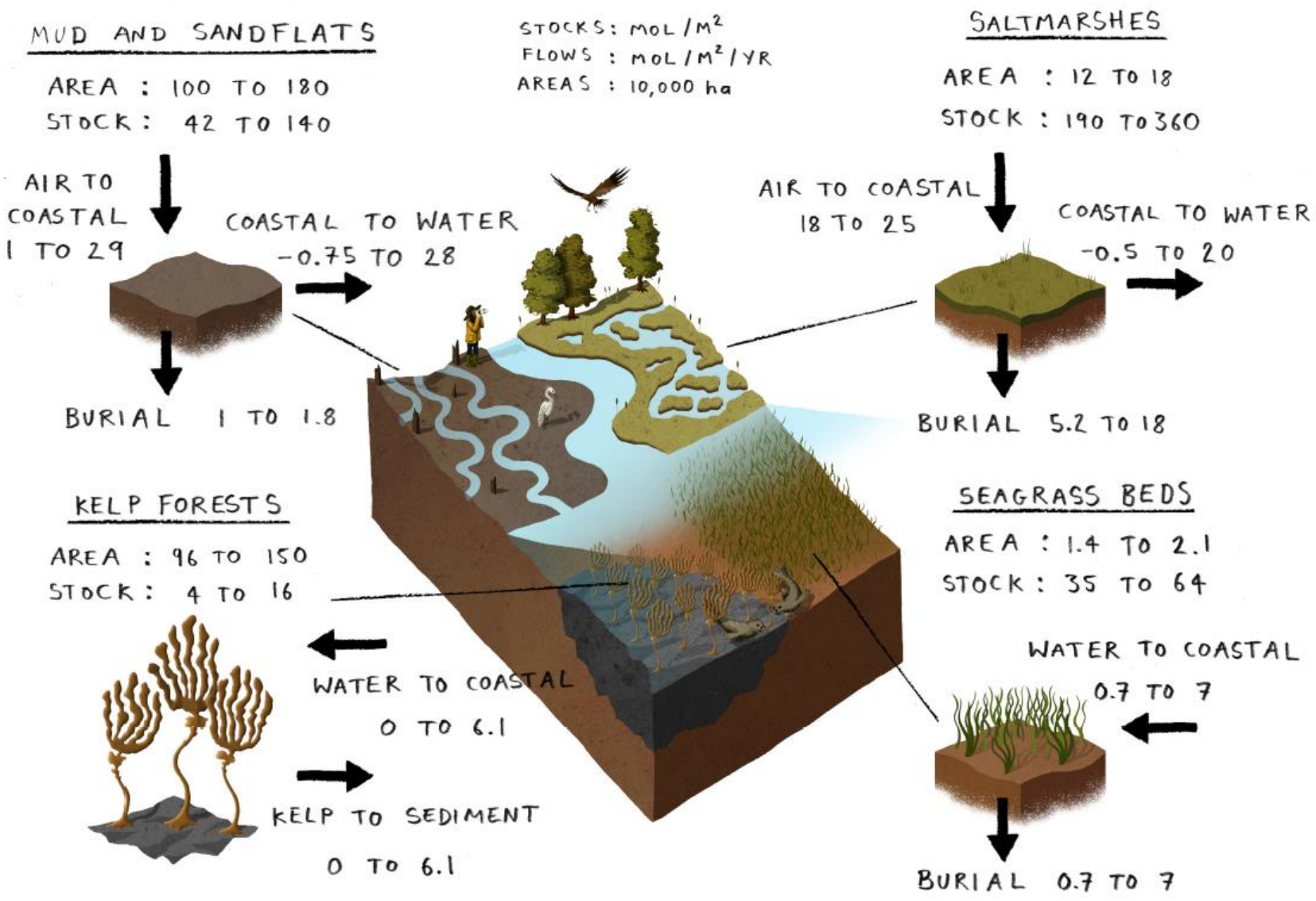
Carbon budget of North West European Shelf



- Quantify stocks and flow (observations, modelling)
  - (*Including river input and atmospheric CO_2 uptake*)
- Identify gaps in knowledge / data
- Potential for climate mitigation
- Key future impacts on shelf carbon

Legge et al (2020) Frontiers in Marine Science

Carbon in coastal habitats (NWES)



Legge et al (2020) Frontiers in Marine Science

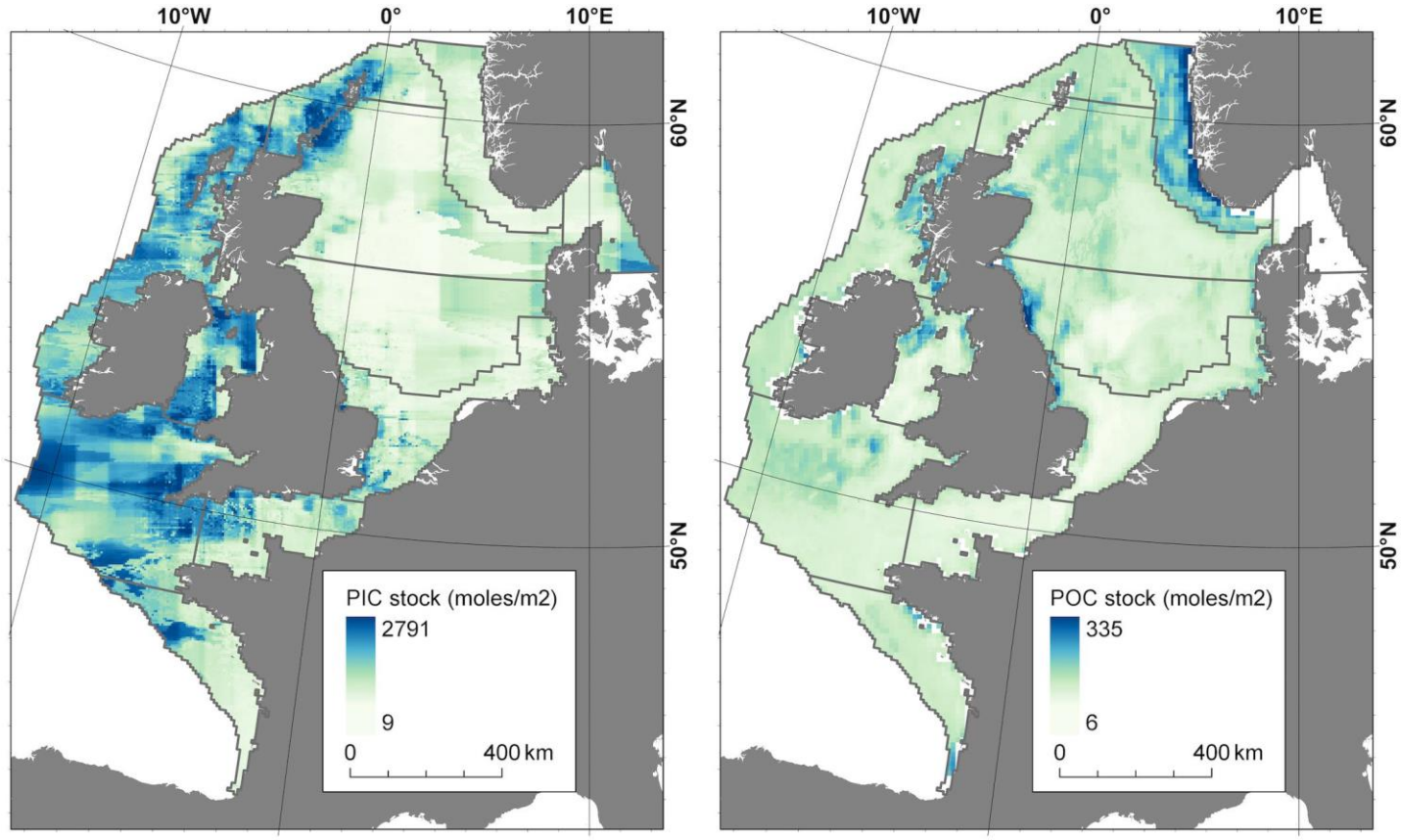
Black arrows = carbon flows

Carbon budget of North West European Shelf

Total carbon stock: 730 – 1800 Tmol (10^{12} moles of carbon)

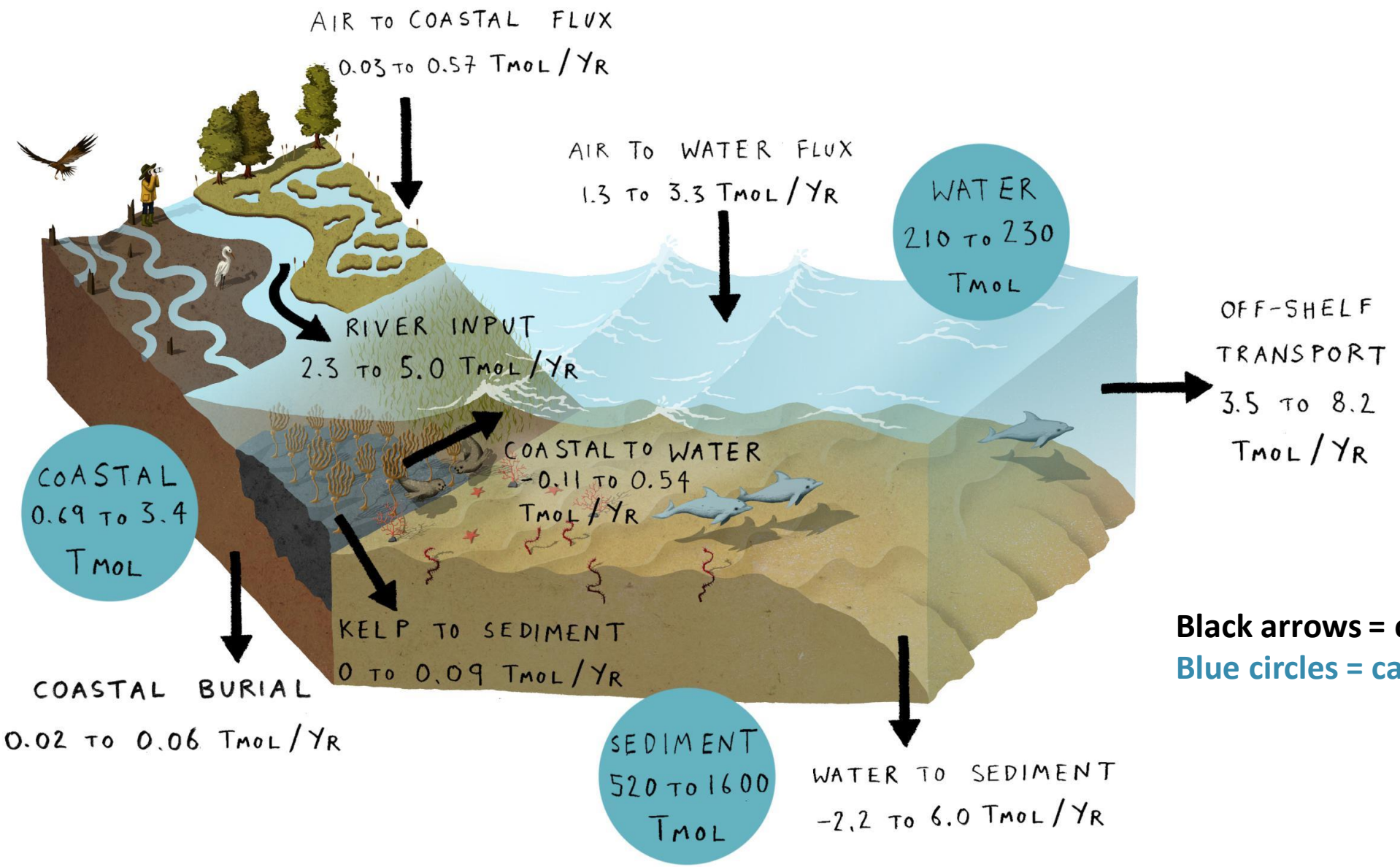
- **Benthic**: 71–87%
- **Pelagic**: 13–29%
- **Coastal**: 0.1–0.2%

Riverine input 3.2–7.1%,
Air-sea exchange 3.5–8.8%
Off shelf transport 4.9–12%



Legge et al (2020) Frontiers in Marine Science

Carbon budget of North West European Shelf

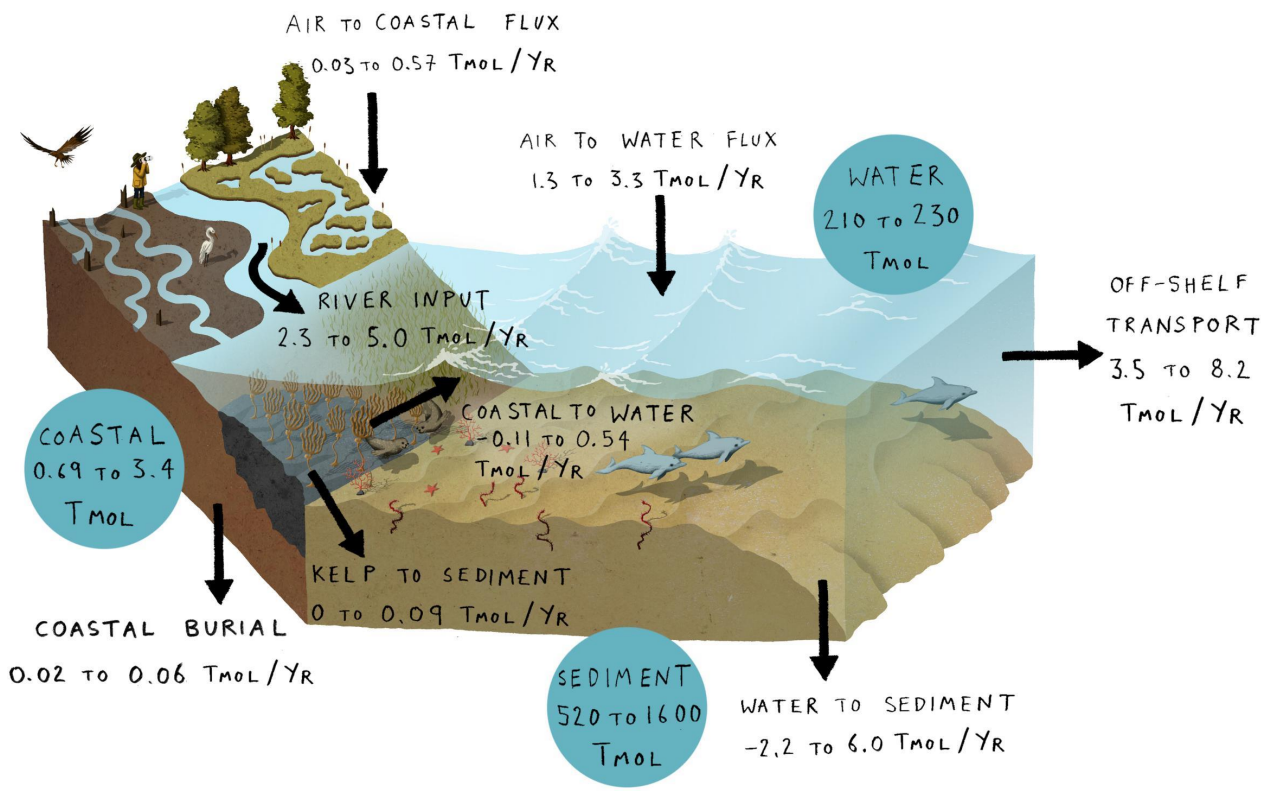


Black arrows = carbon flows

Blue circles = carbon stock

Legge et al (2020) Frontiers in Marine Science

Key findings on NWES carbon



- **Benthic** 71–87%

largest stock and area, least observations, driven by particulate inorganic carbon

- **Pelagic** 13–29%

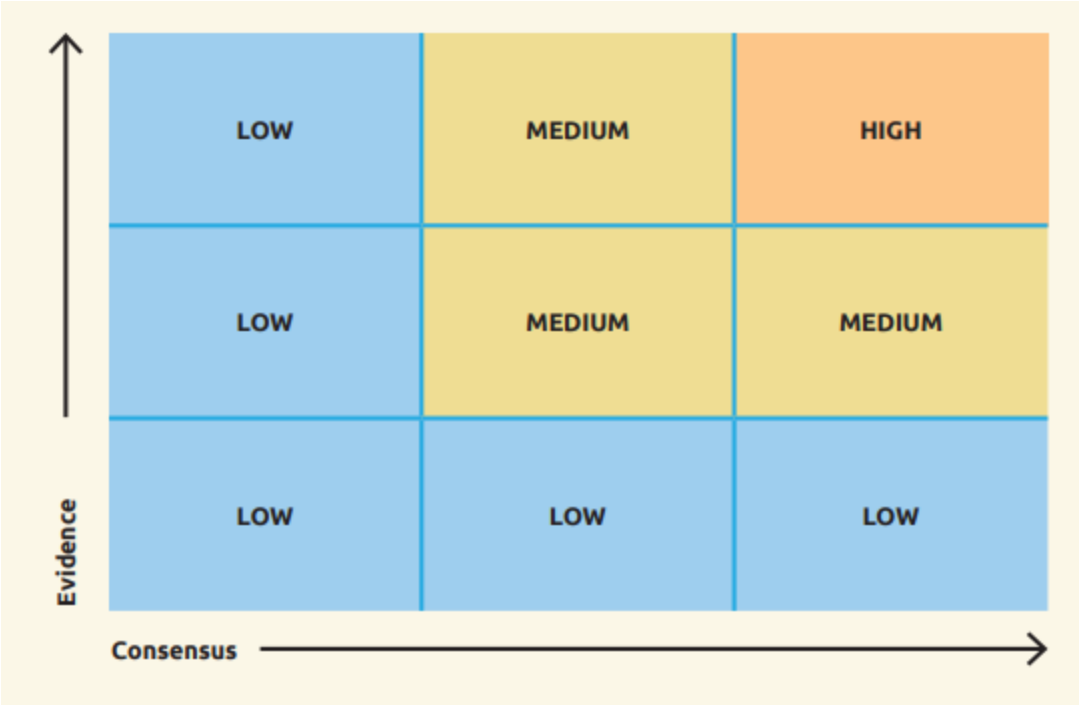
DIC dominates carbon budget

- **Coastal** 0.1–0.2%

Smallest area, most intensive carbon store per unit area

Legge et al (2020) Frontiers in Marine Science

Anthropogenic influences on shelf sea carbon



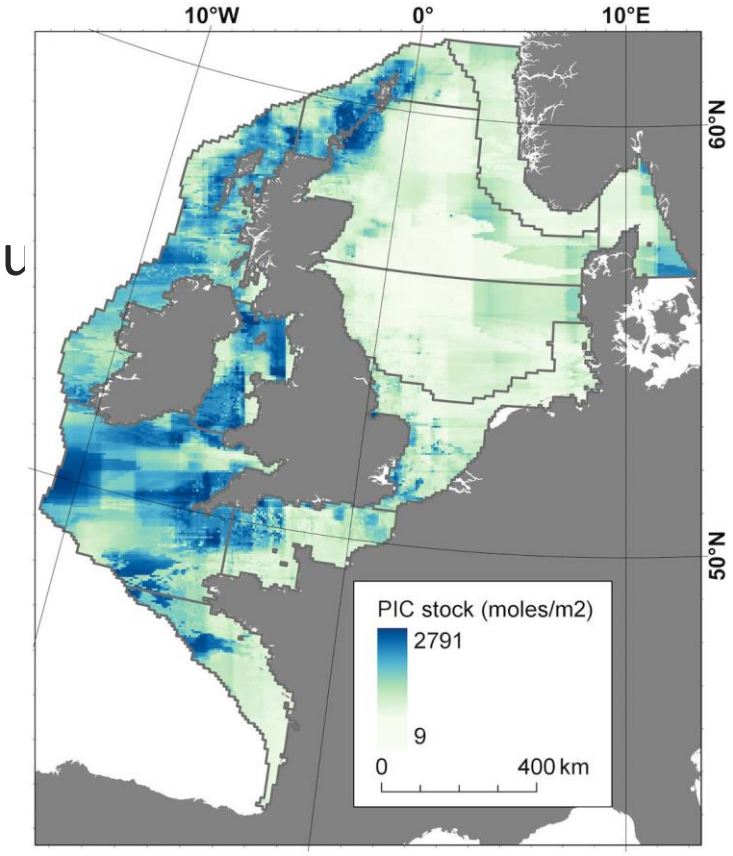
	Coastal	Pelagic	Benthic
CO_2 increase	↑	↑	?
Warming	↓	↓	↓
Increased storminess	↓	?	
Sea level rise	↓		
Decreasing oxygen			↑
Increased nutrient input	↑	↑	↑
Conservation/MPAs	↑		↑
Trawling			?

Kröger et al (2018) *Shelf Seas: The Engine of Productivity*
https://www.uk-ssb.org/shelf_seas_report.pdf

Criteria of ‘climate actionable’ Blue Carbon

- Significant removal greenhouse gases
- Long-term storage for fixed CO_2 (not enough to just fix it)
- Negatively impacted by anthropogenic activities
- Management could maintain/enhance carbon services withou

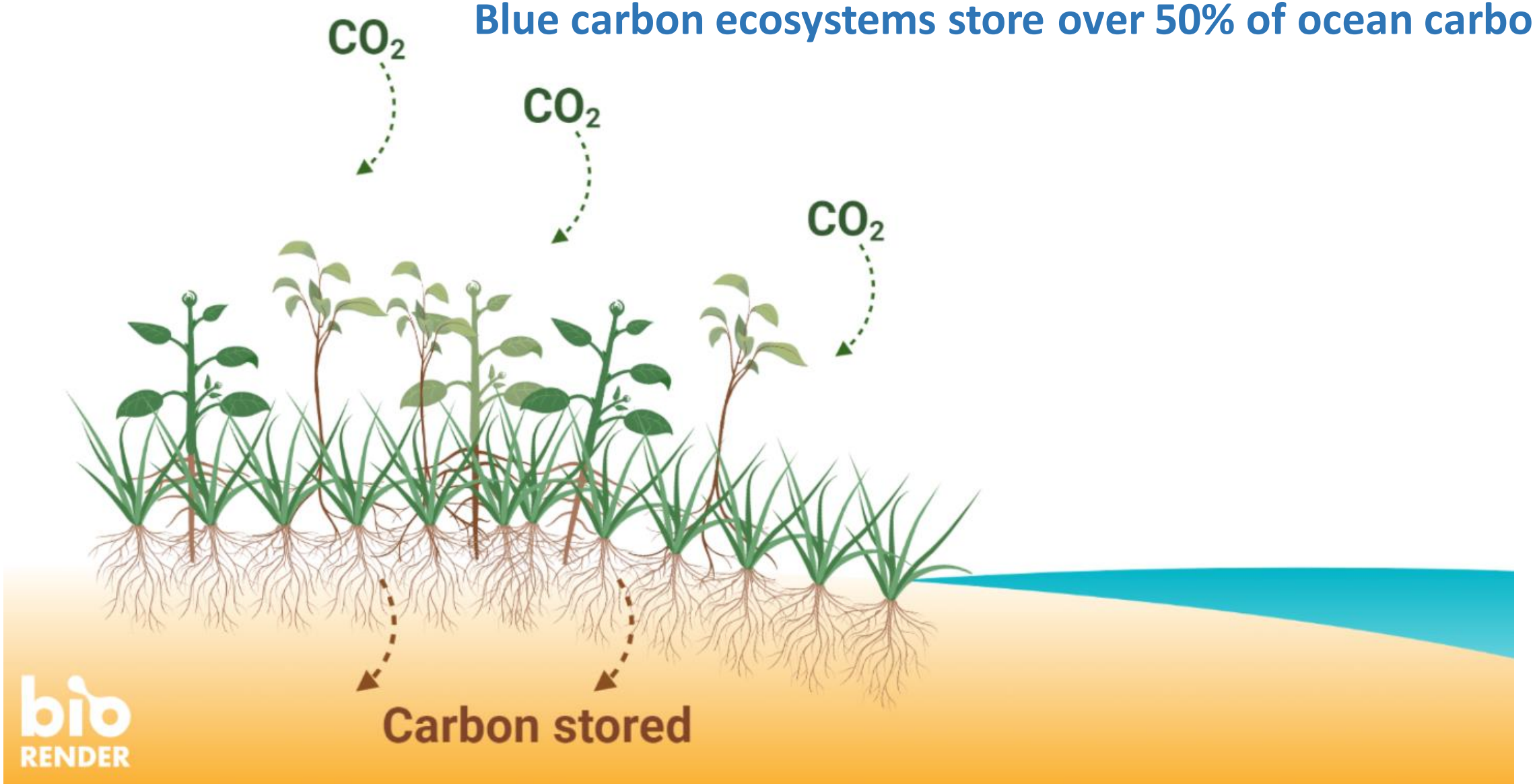
  social / environmental harm



Lovelock and Duarte (2019) Biology Letters

Caution with ‘blue carbon’

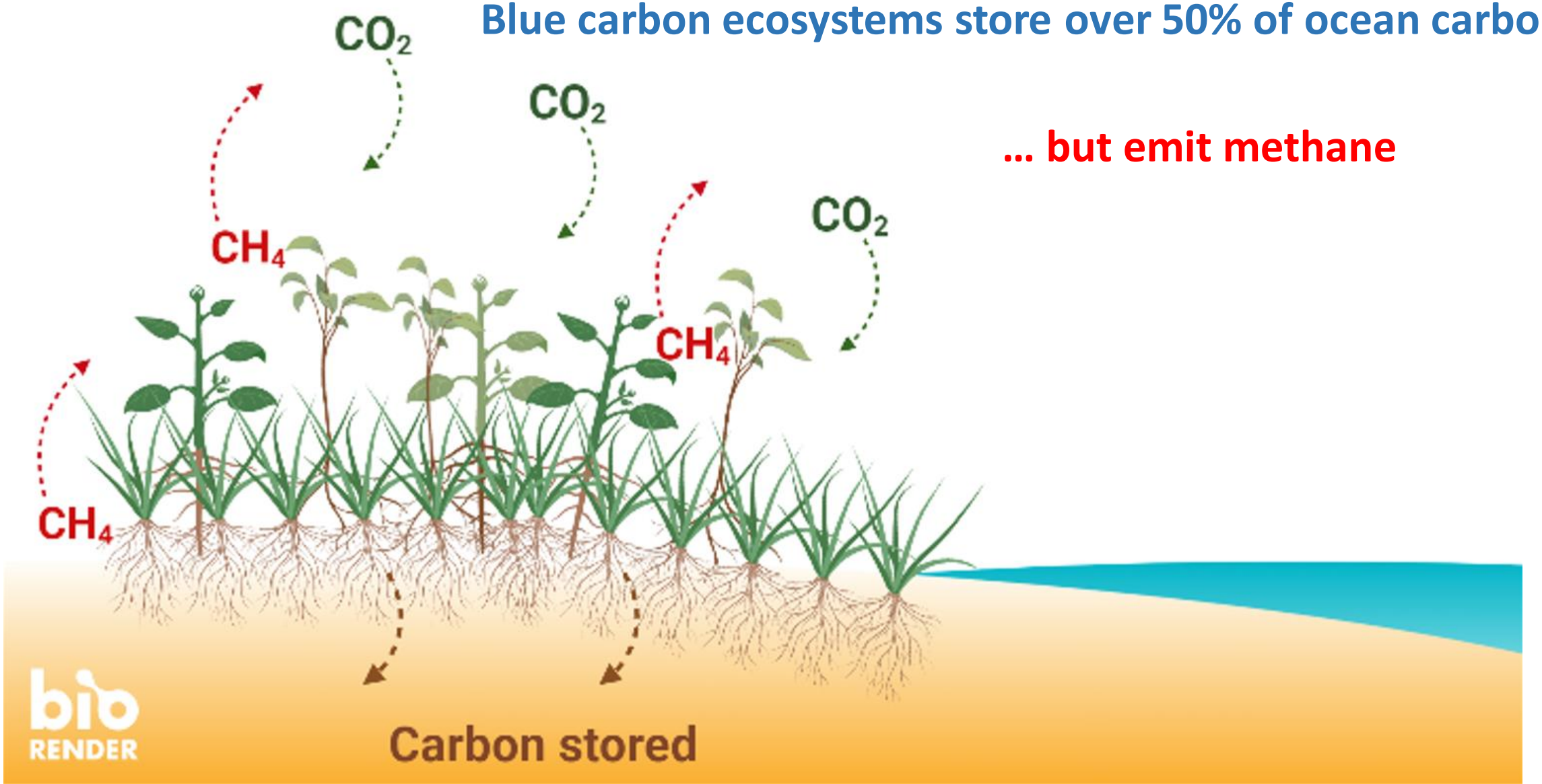
Blue carbon ecosystems store over 50% of ocean carbon



Caution with ‘blue carbon’

Blue carbon ecosystems store over 50% of ocean carbon

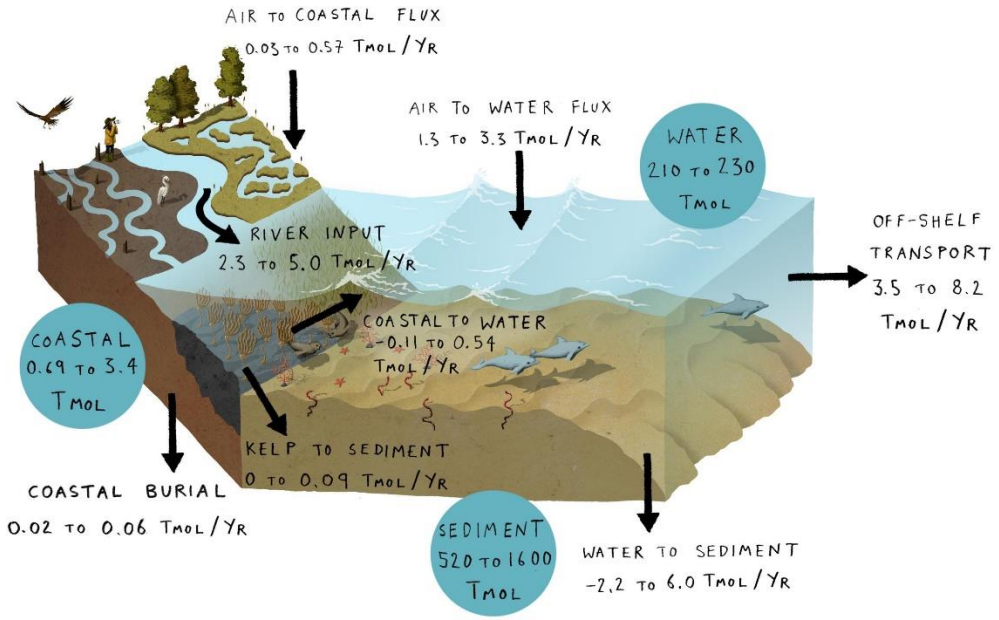
… but emit methane



Challenges for blue carbon climate mitigation

Large knowledge gaps – paucity of data constrains estimates

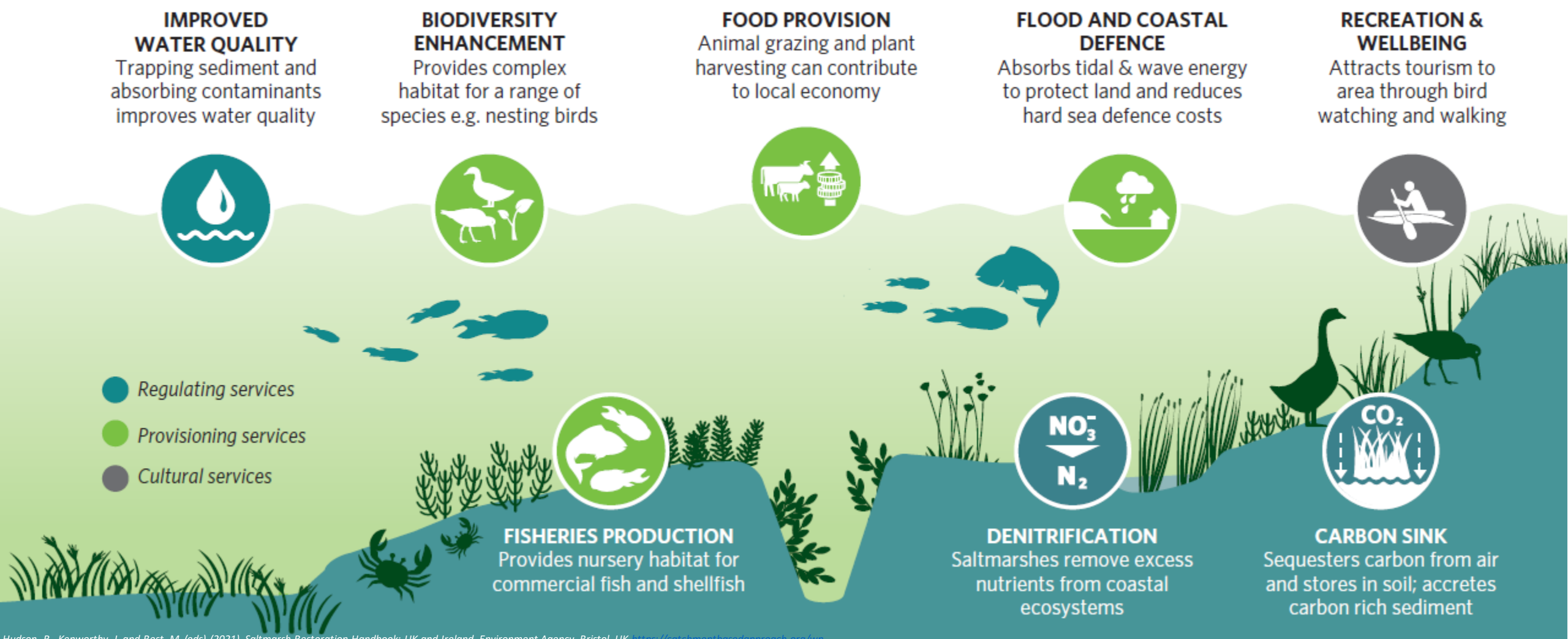
- *Age of carbon (recent, relict?)*
- *Vulnerability (easily impacted)*
- *Accumulation / burial rate (gain or loss)*
- *Sequestration (challenging to measure)*
- *Provenance (labile, refractory)*



CH_4 and N_2O data needed for inclusion in greenhouse gas inventories (eventually NDC's)

(for overview see Williamson and Gattuso (2022) Frontiers in Climate)

Multi-benefits of blue carbon habitats



Hudson, R., Kenworthy, J. and Best, M. (eds) (2021). Saltmarsh Restoration Handbook: UK and Ireland. Environment Agency, Bristol, UK https://catchmentbasedapproach.org/wp-content/uploads/2021/10/Saltmarsh_Restoration_Handbook_FINAL_20210311.pdf

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Questions?

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