Carbon storage in Wadden Sea seagrasses and salt marshes

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HiCAM – M4 - P4.3
Nature-based solution –marine vegetated ecosystems

ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

Ketil Koop-Jakobsen, PhD

Personal Profile

BIOGEOCHEMIST

Salt marsh specialist

Primary Research Topics:

- **Nutrient Cycling in Wetlands**
- **Plant-sediment interactions**
- **Carbon Storage and Sequestration in Salt Marshes and sea grasses**

Fieldwork 2018, Plum Island Estuary, MA, USA

Agenda:

1) Background carbon sequestration in coastal vegetated ecosystems

2) Carbon storage in Salt marshes

3) Carbon storage in Seagrasses

4) The Carbon storage capacity of the Wadden Sea Coast

Wadden Sea blue carbon assessment

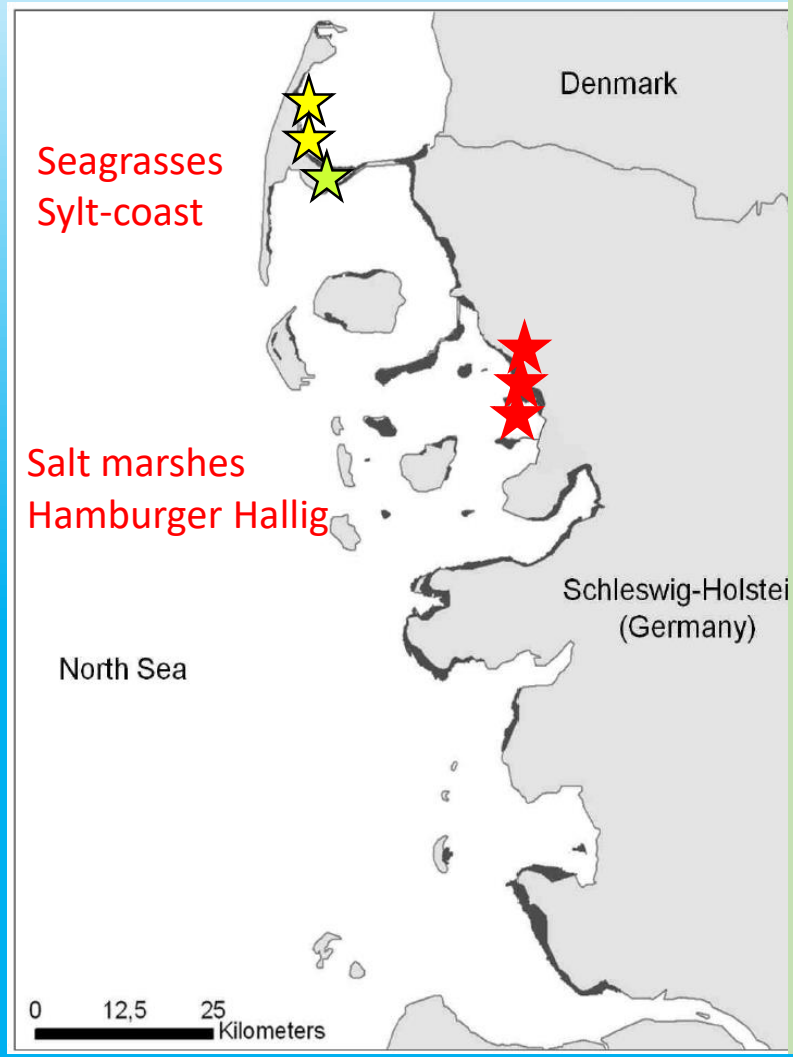
★ Salt marshes (1 location)

☆ Seagrasses (1 location)

- 3 research sites per location
- Deep soil (sediment) cores from salt marshes (1m) and Deep sediment cores from intertidal Seagrass beds (40-50cm)


Seagrass coring

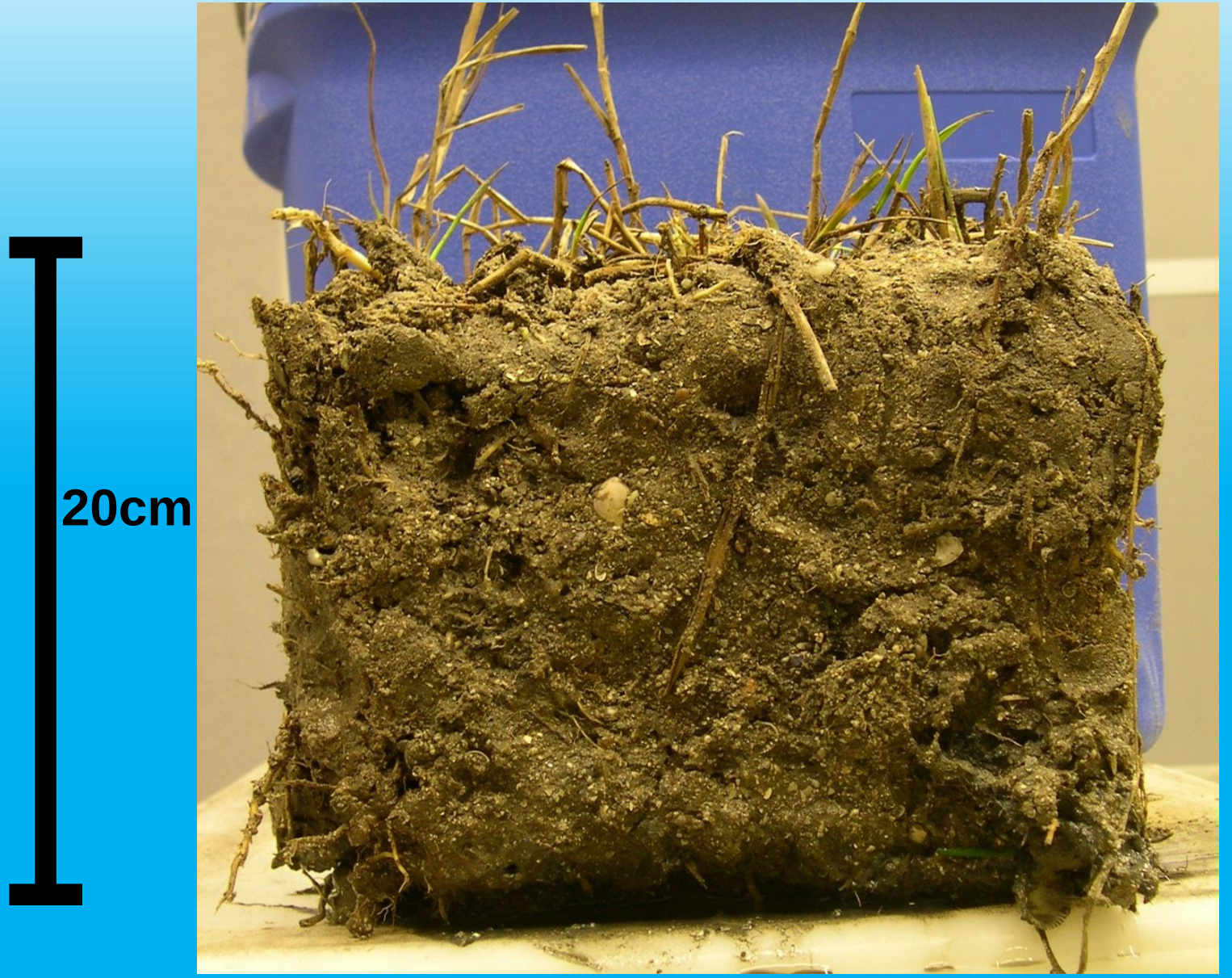

Salt marsh coring



Background carbon sequestration in coastal vegetation

Salt marshes

Morphology of Spartina rhizospheres – structure



Substantial biomass structure in European marshes

CT SCANNING

10% of the soil volume consists of living organic biomass

Granse, Titschlack, Ainouche, Jensen and Koop-Jakobsen "*Subsurface aeration of tidal wetland soils: root-system structure and aerenchyma connectivity in Spartina (Poaceae)*" STOTEN 2021

Salt marsh management - grazing

The impact of sheep-grazing on soil structure in the European marshes

Sheep-grazing in the Wadden sea has been known since the 12th century.

Grazing impact the soil structure and drainage capacity

Under ungrazed conditions the sediment is porous with a high drainage capacity

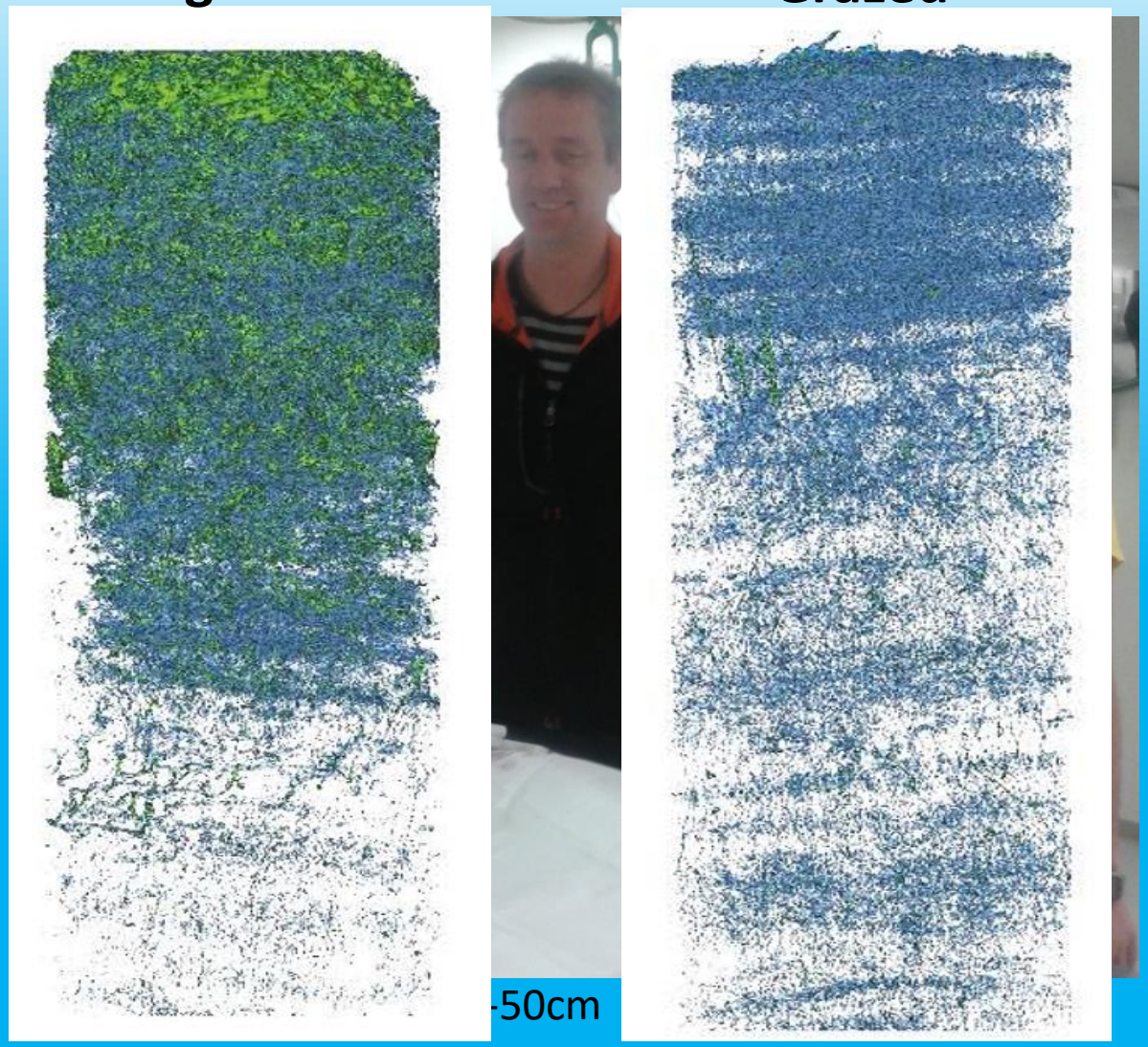
Under grazed conditions, the sediment is trampled sediment is less porous with a low drainage capacity

Salt marsh management – grazing vs non-grazing -macropores

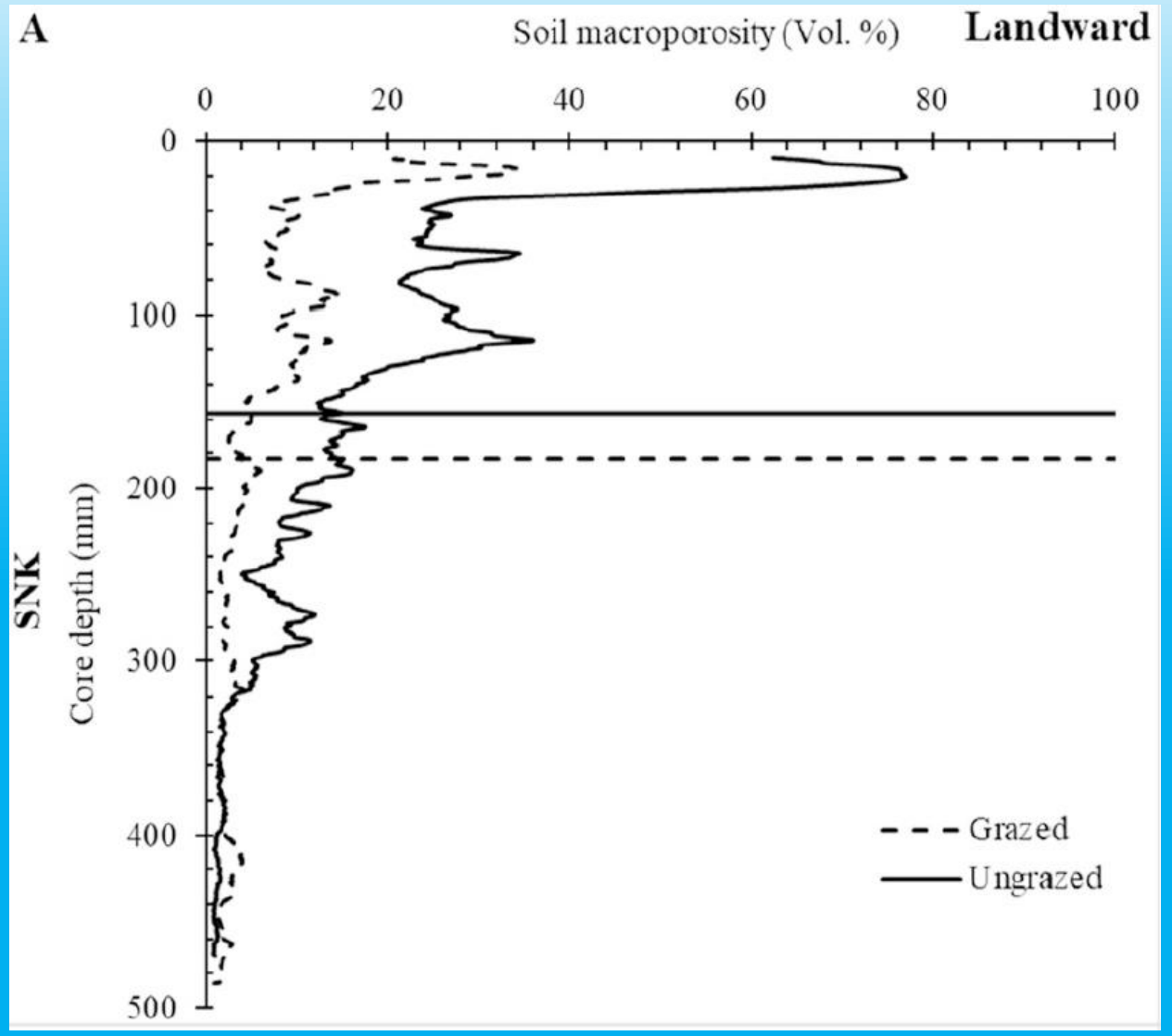
Ungrazed

0cm

Grazed



-50cm

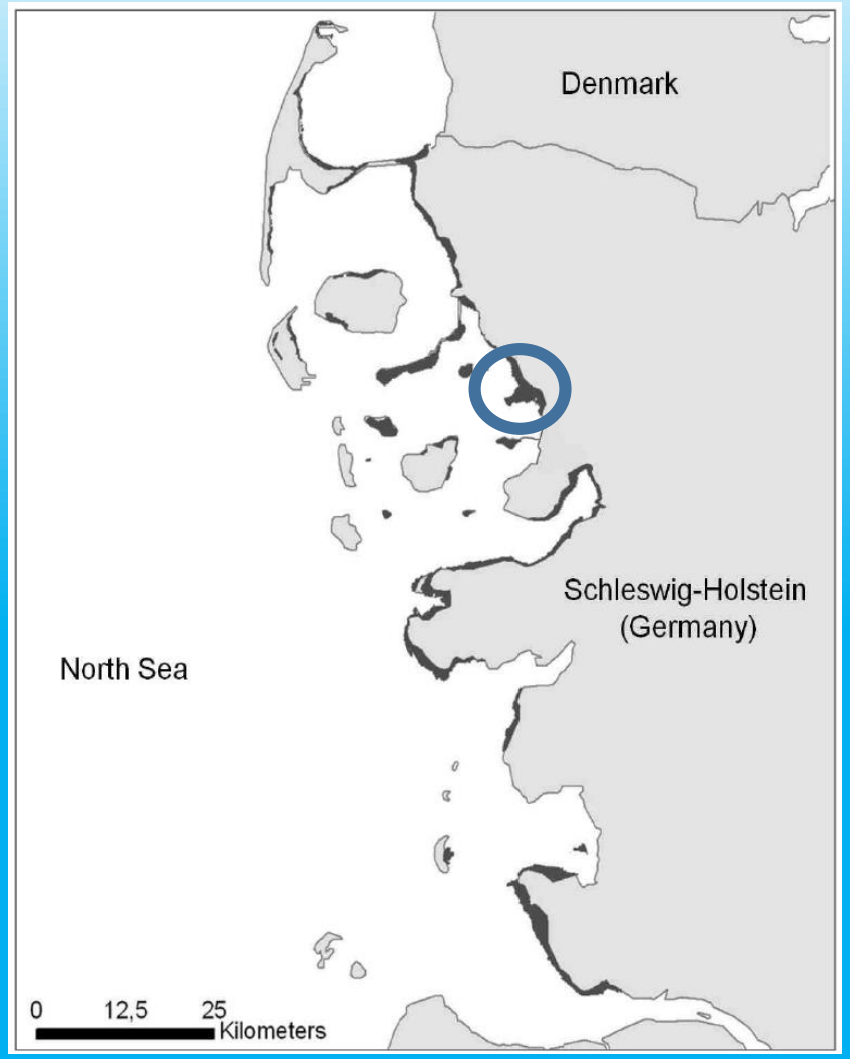


Green: Air-filled pores Blue: Water-filled pores

Kestha and Koop-Jakobsen et al 2020
Estuarine, Coastal and Shelf Science Volume 245, 106987

Carbon storage in Salt marshes – Biomass and porosity

North German Salt marshes



German North Sea Coast

Study site
Hamburger Hallig

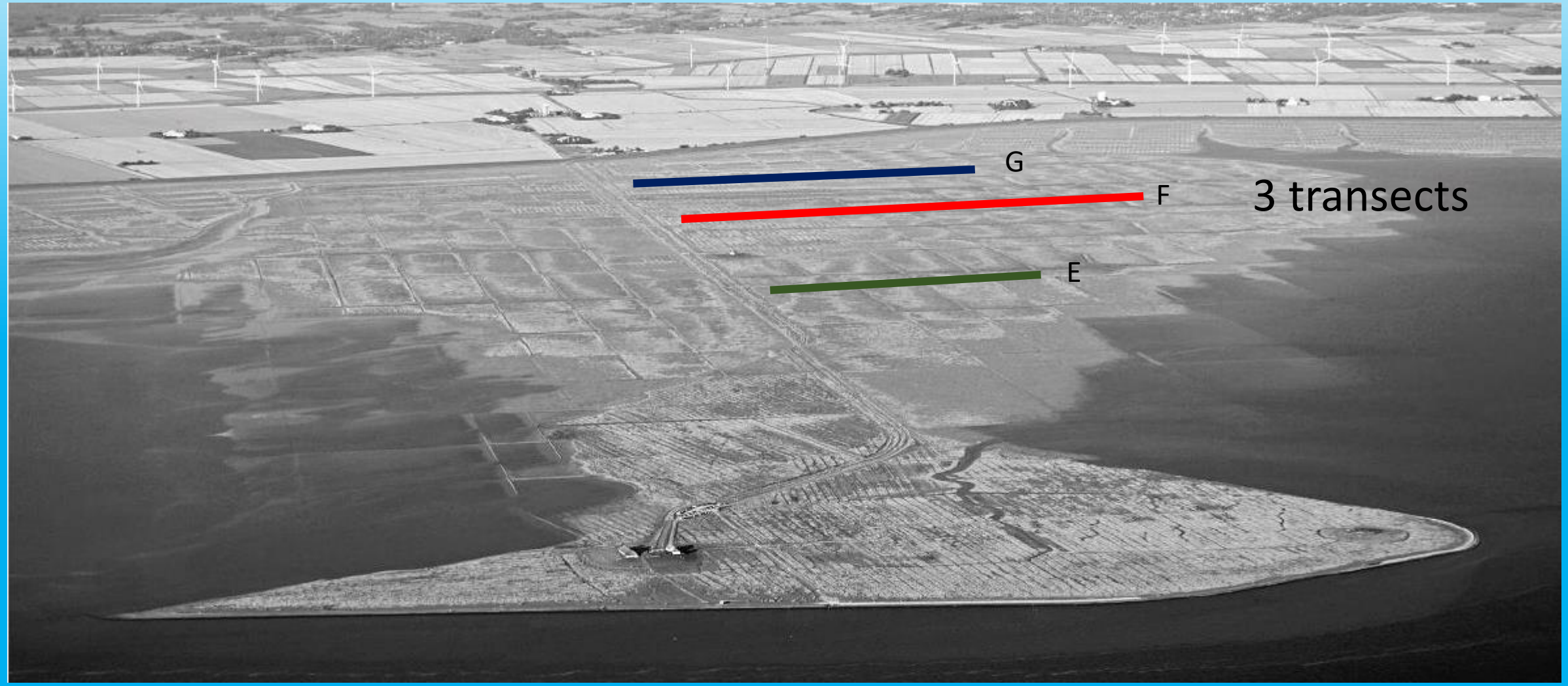
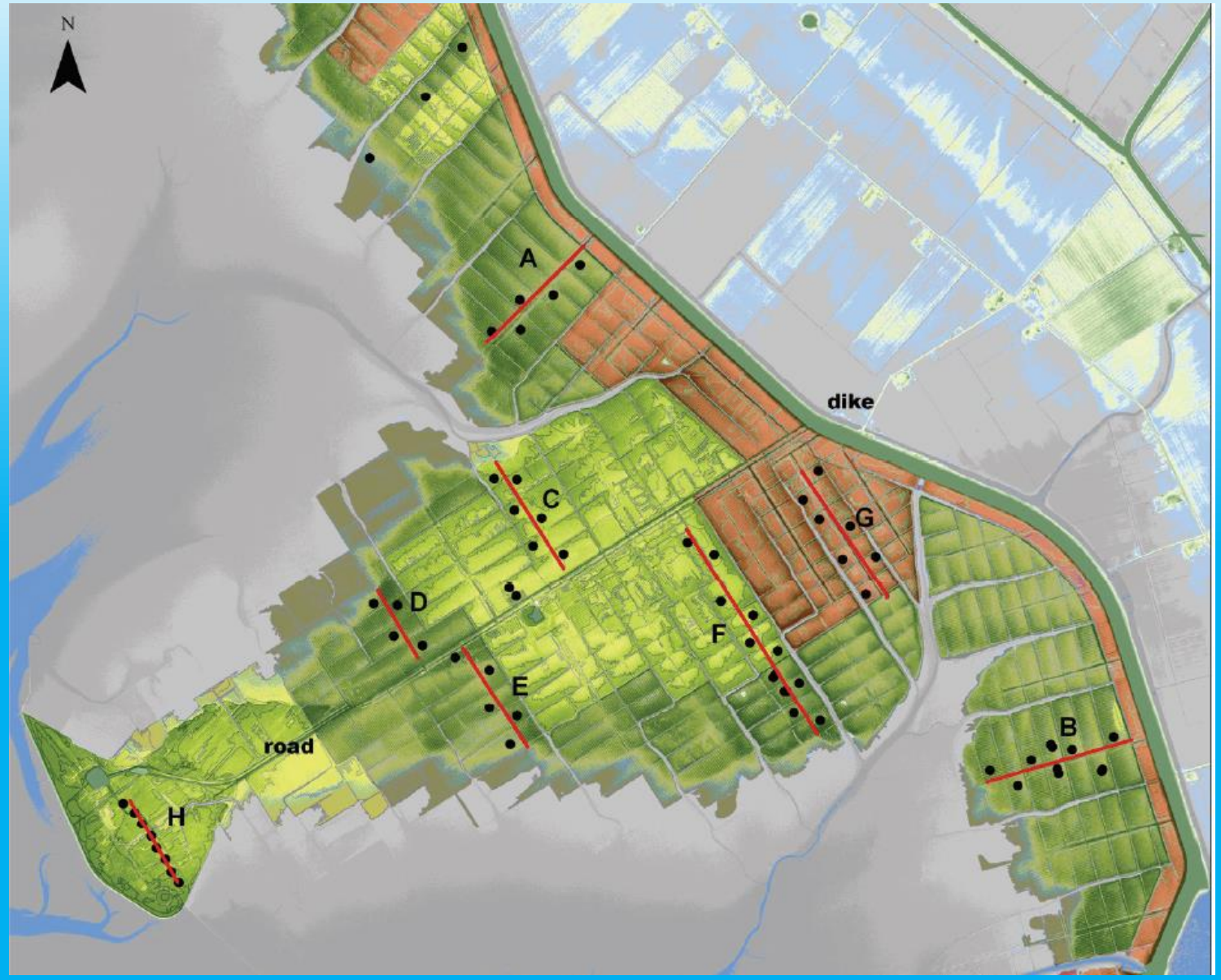


Photo Martin stock; ***Coastline Reports 17 (2011)***, *ISSN 0928-2734, ISBN 978-3-939206-00-2*

Study site - Hamburger Hallig



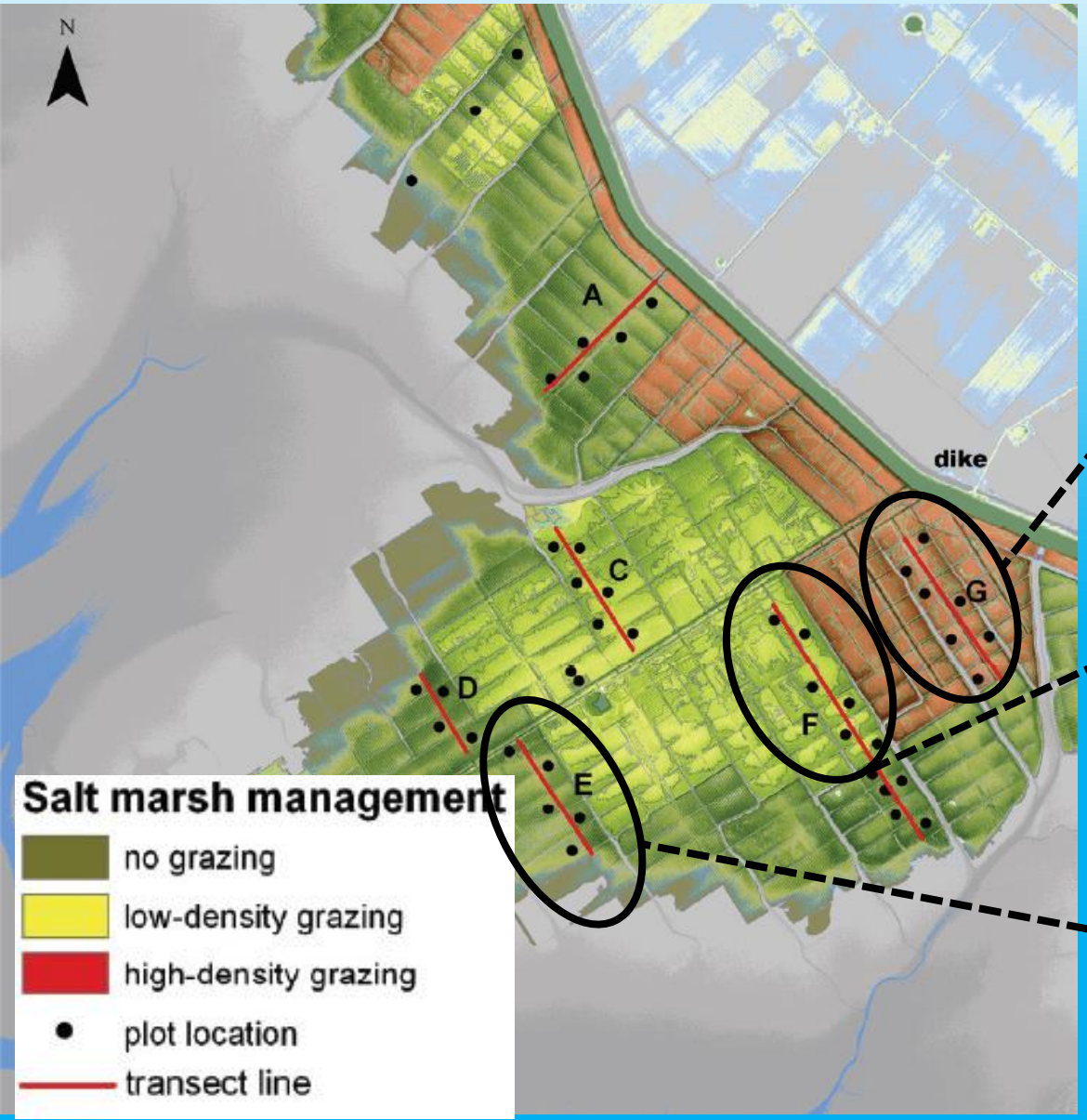
Salt marsh management

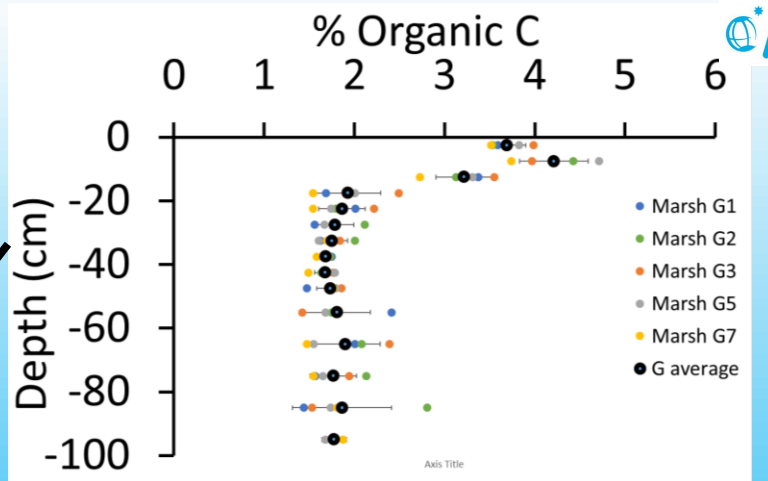
- no grazing
- low-density grazing
- high-density grazing
- plot location
- transect line

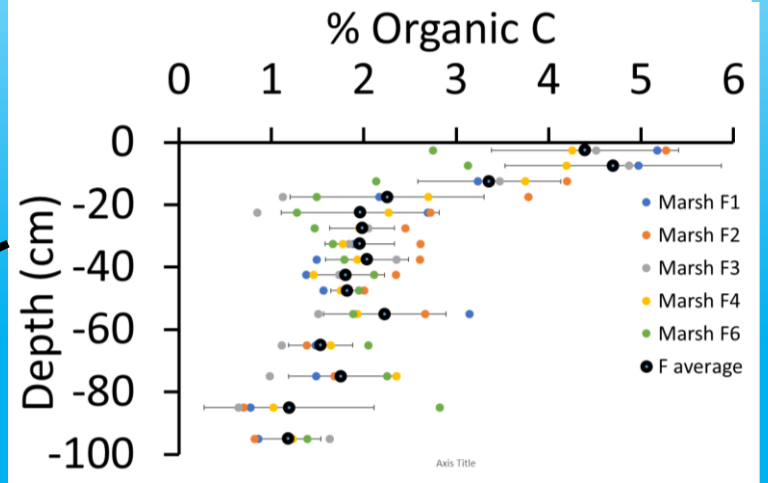
Carbon storage in Salt marshes - grazed and non-grazed

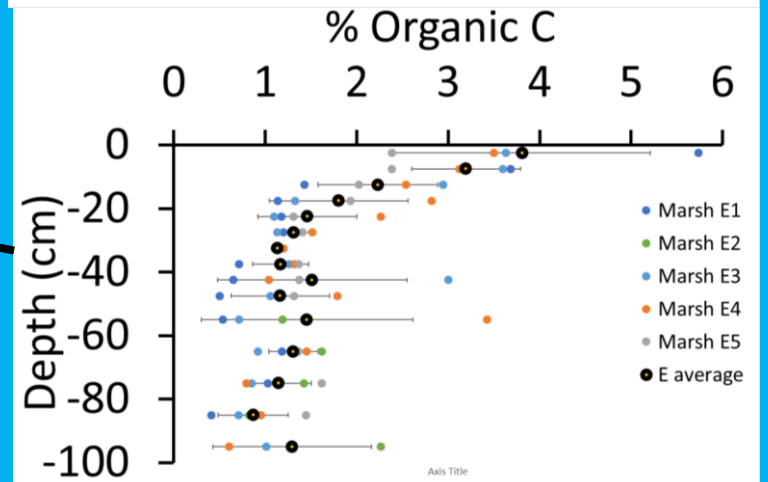
Photo Martin stock; ***Coastline Reports 17 (2011)***, *ISSN 0928-2734, ISBN 978-3-939206-00-2*

Carbon storage in the Wadden sea









high-density grazing

low-density grazing

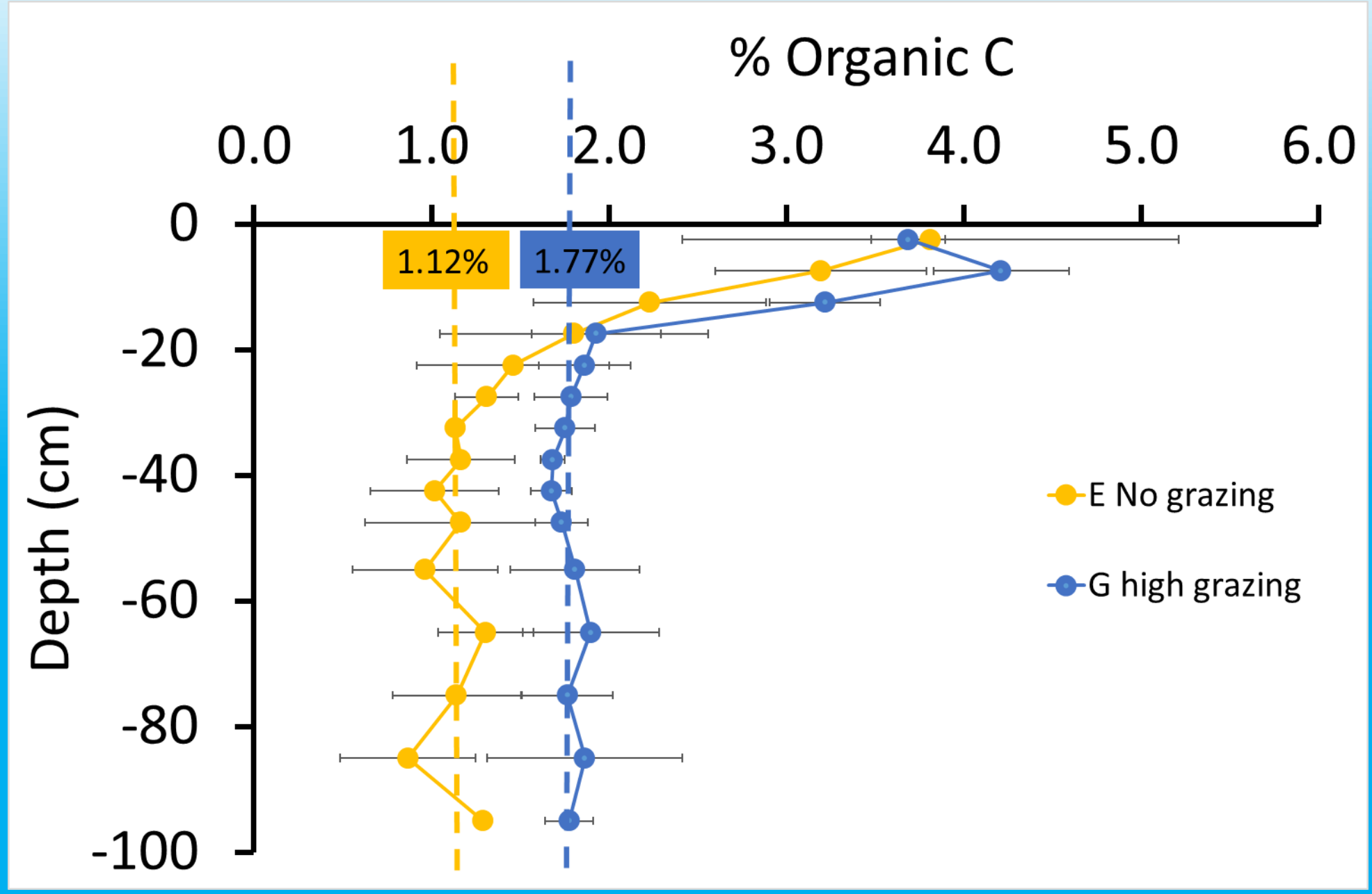
no grazing

Saltmarshes

Carbon storage in Salt marshes - grazed and non-grazed

Map from Martin stock; ***Coastline Reports 17 (2011)***, *ISSN 0928-2734, ISBN 978-3-939206-00-2*

Carbon storage in the Wadden sea



Seagrasses

Seagrasses

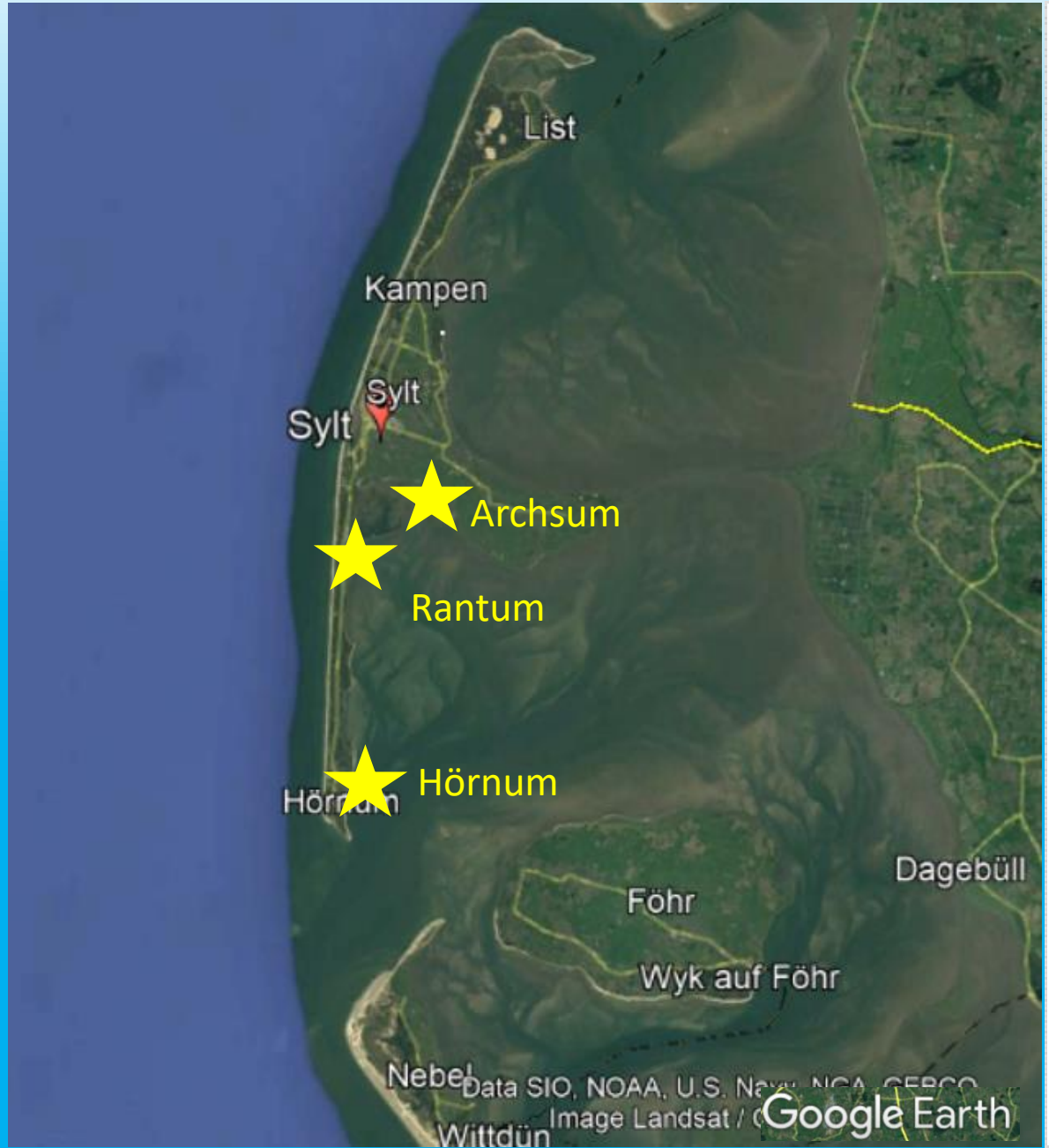
Zostera noltei – Wadden sea

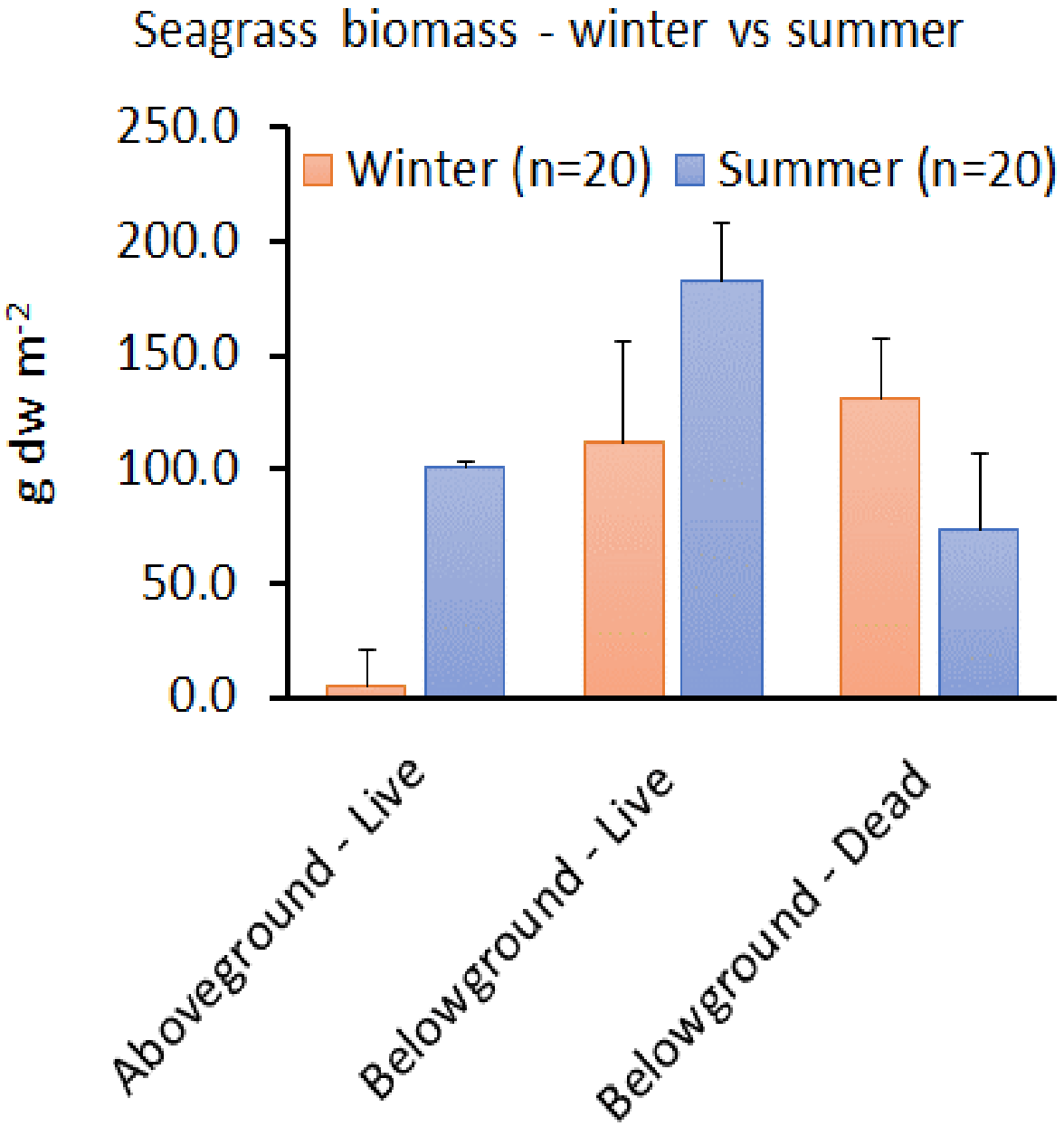
Photo: http://www.freenatureimages.eu/plants/Flora%20S-Z/Zostera%20noltii/index.html

Zostera marina – Baltic sea

Photo: Lindegaard et al Ecological Assessment of Swedish Water DOI 10.13140/RG.2.2.12178.25280

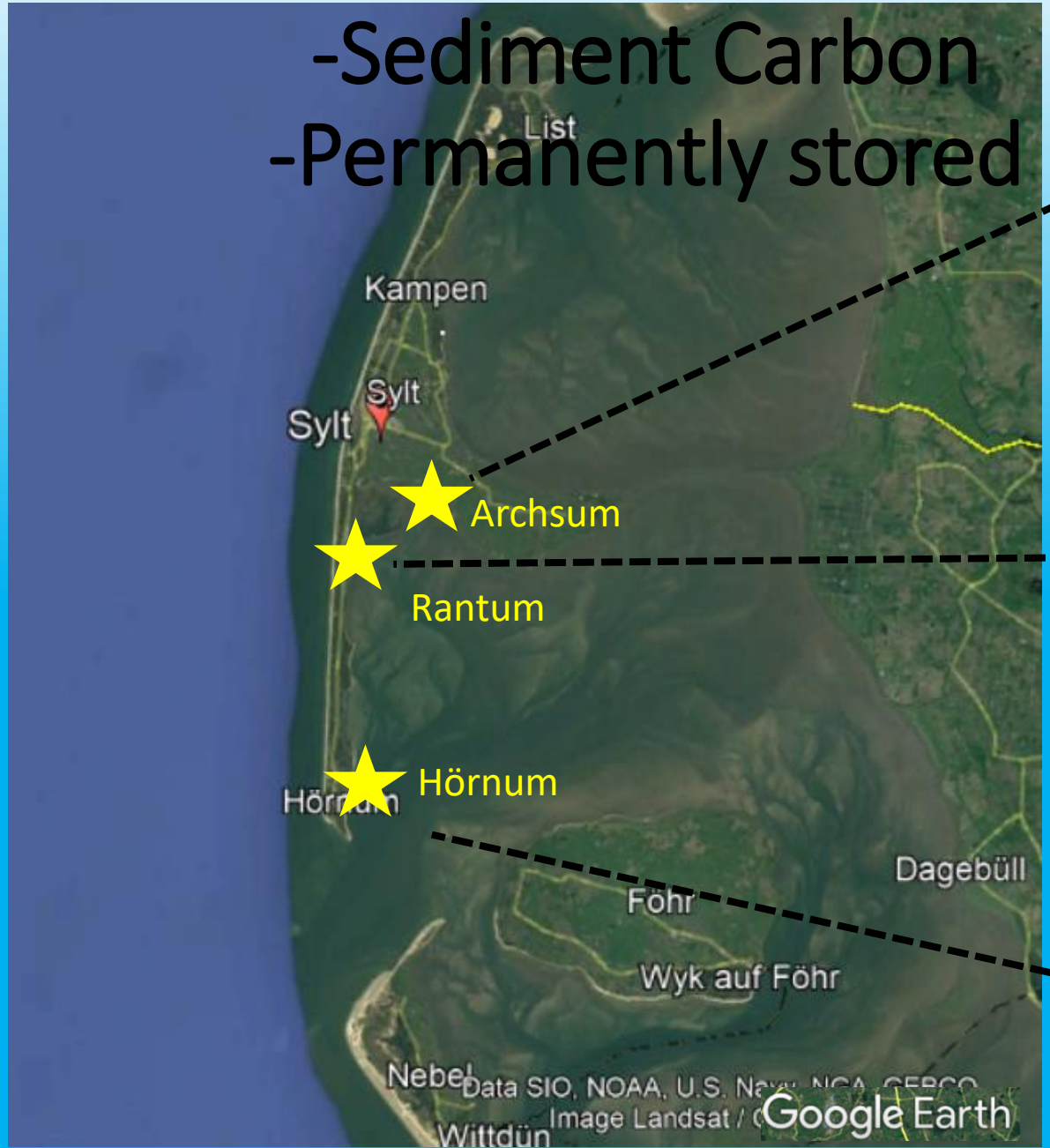
Carbon storage in the Wadden sea Seagrasses

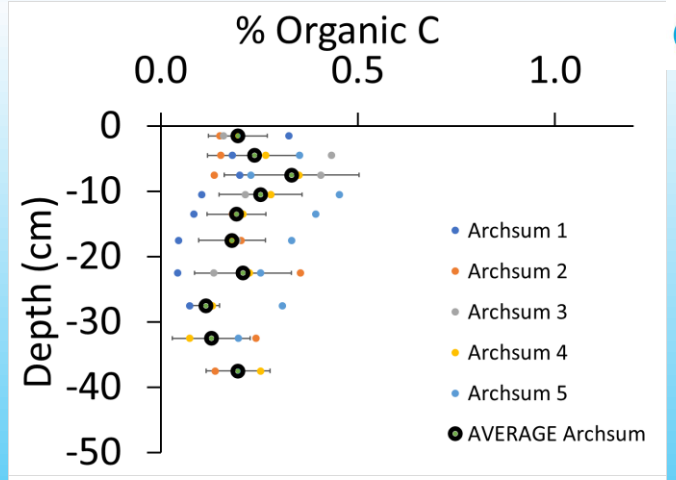


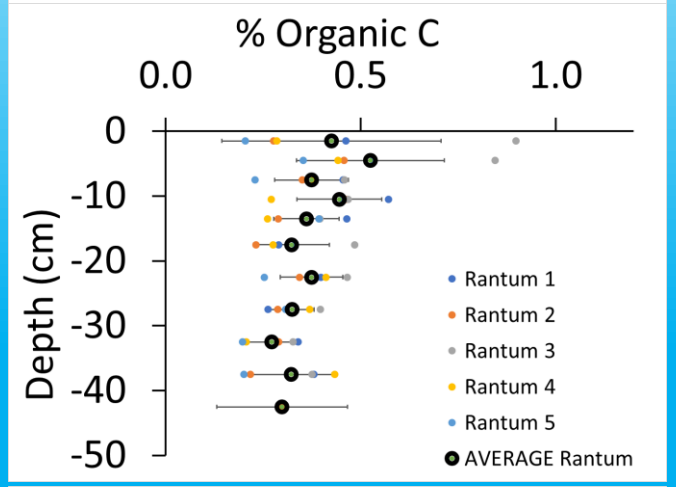


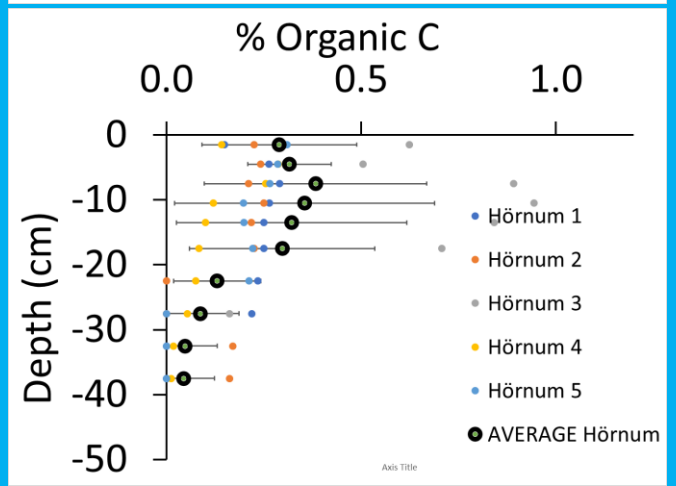
Carbon storage in the Wadden sea

-Sediment Carbon
-Permanently stored







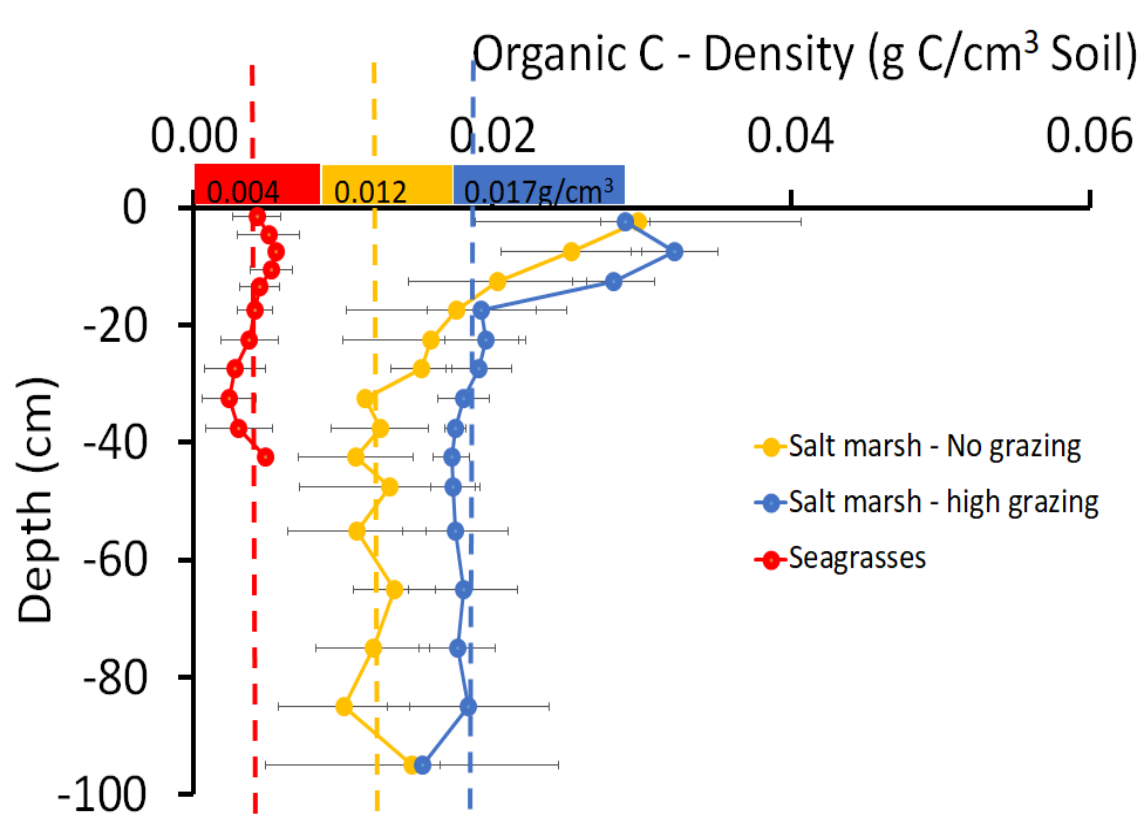


Seagrasses

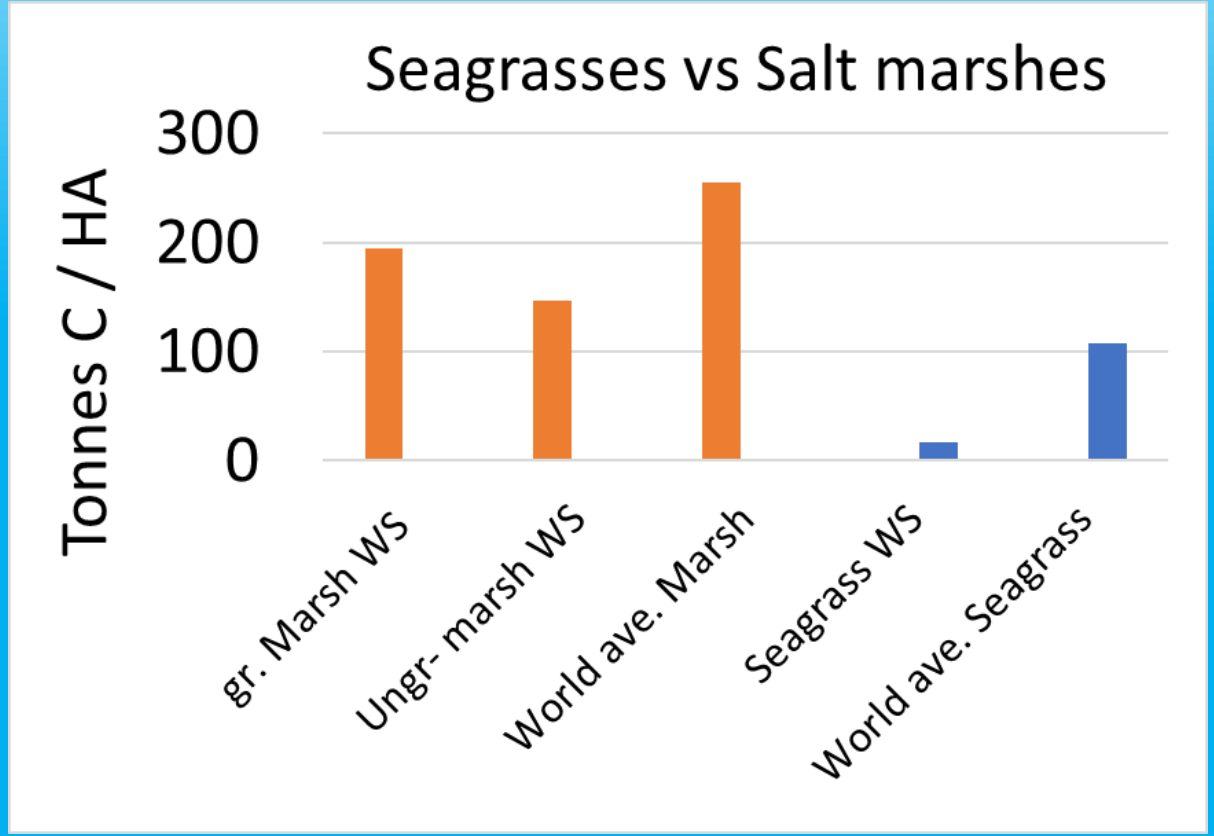
Carbon storage in seagrasses - Carbon stocks

Comparison salt marshes and seagrasses in the Wadden sea

Organic density profiles

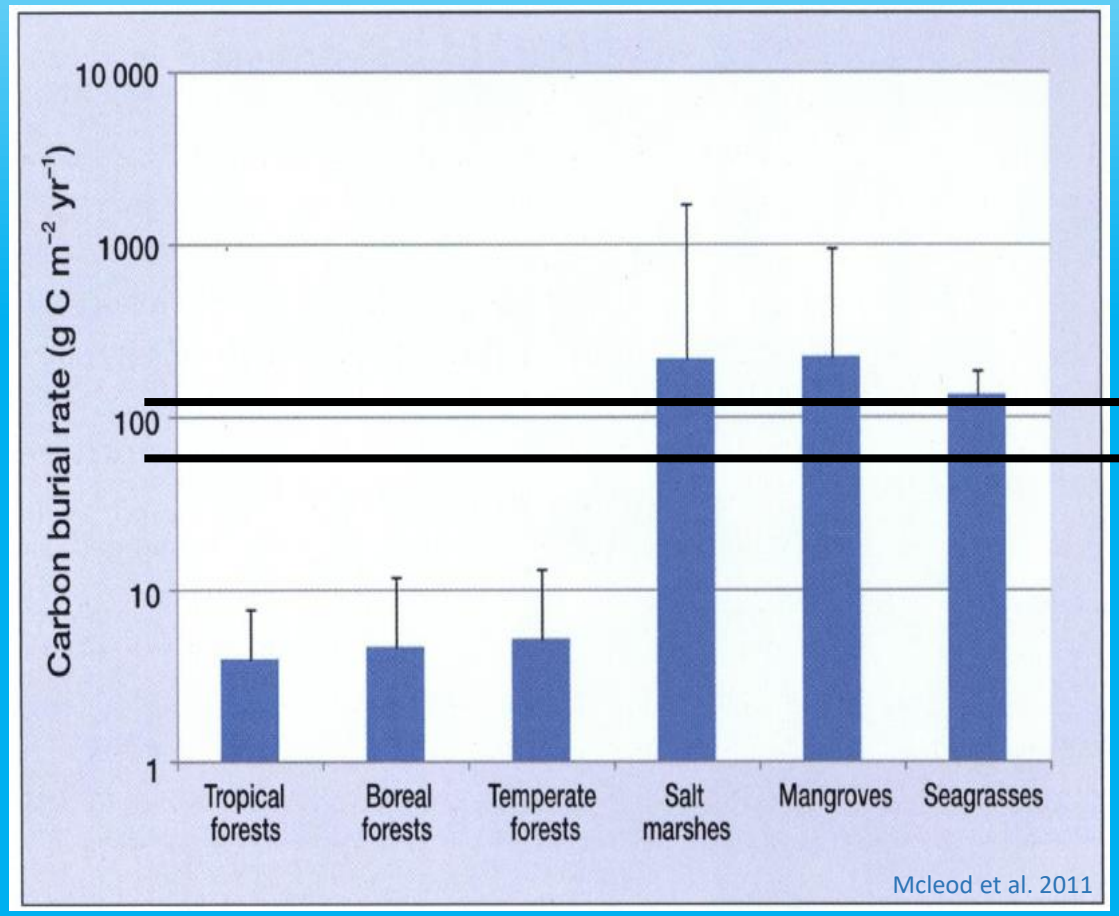


Total Carbon stock



Sequestration Rates in Salt marshes (=stored Carbon x acression rate)

Sediment acression: Average North Sea Salt marshes: 6.2mm/yr (Suchrow, S., N et al 2012)
Grazed marshes: 105 g C m^2 yr^{-1}
Ungrazed marshes: 74 g C m^2 yr^{-1}



Grazed
Ungrazed

Conclusion

In the Wadden Sea …

- **Salt marshes store significantly more carbon than Seagrasses**
- **Grazed marshes store more carbon than ungrazed marshes**
- **The Carbon storage capacity and sequestration rates in marshes are slightly lower than the world average**

Impact of increased Temperature and CO_2 on Carbon capture in Salt marshes

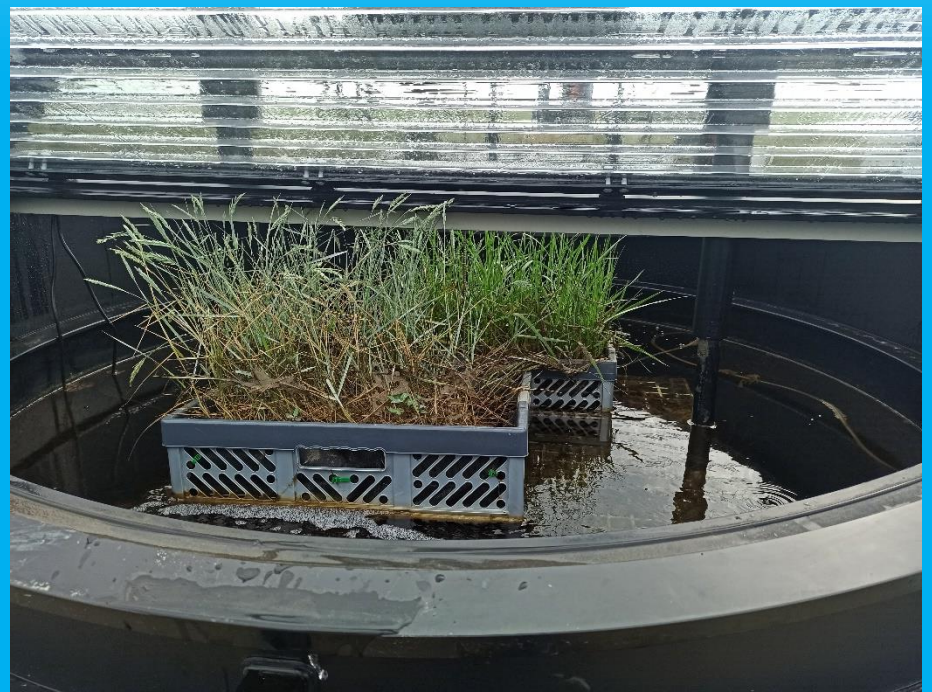
Mesocosm experiment

Mesocosm experiment

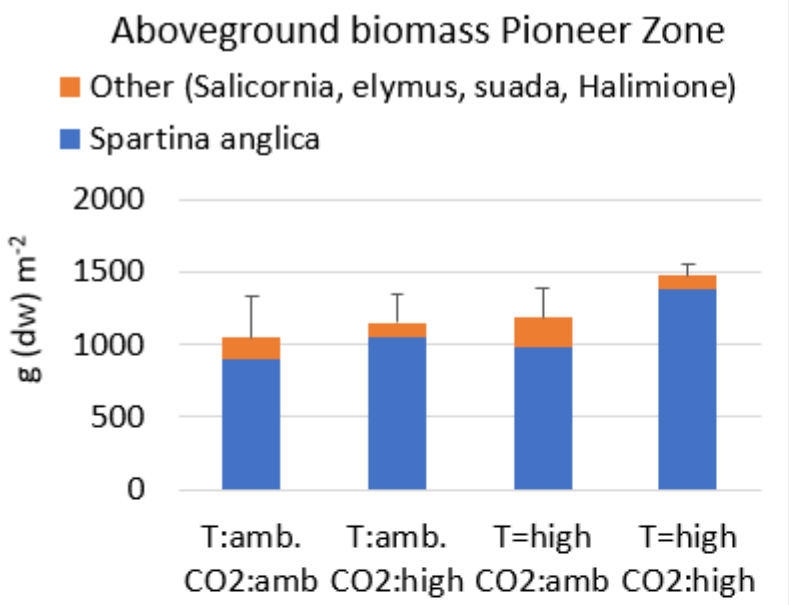
Pioneer zone

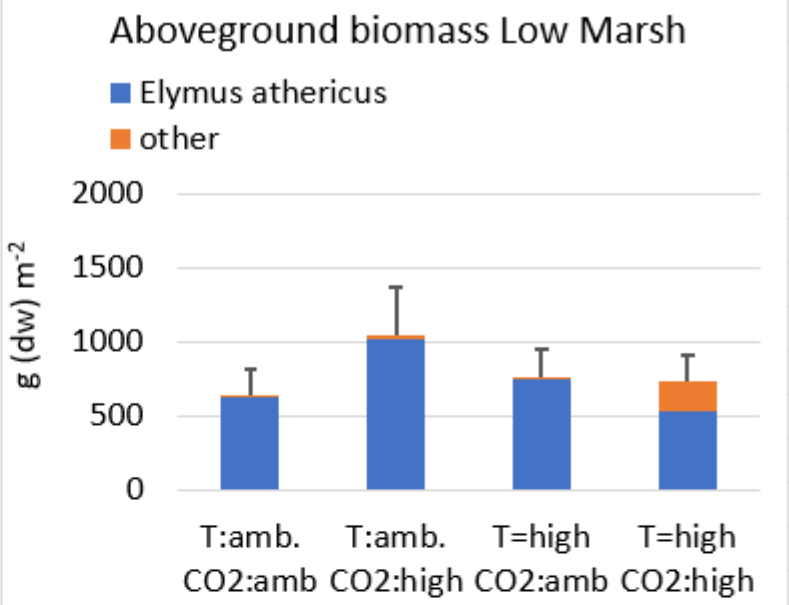
Low marsh

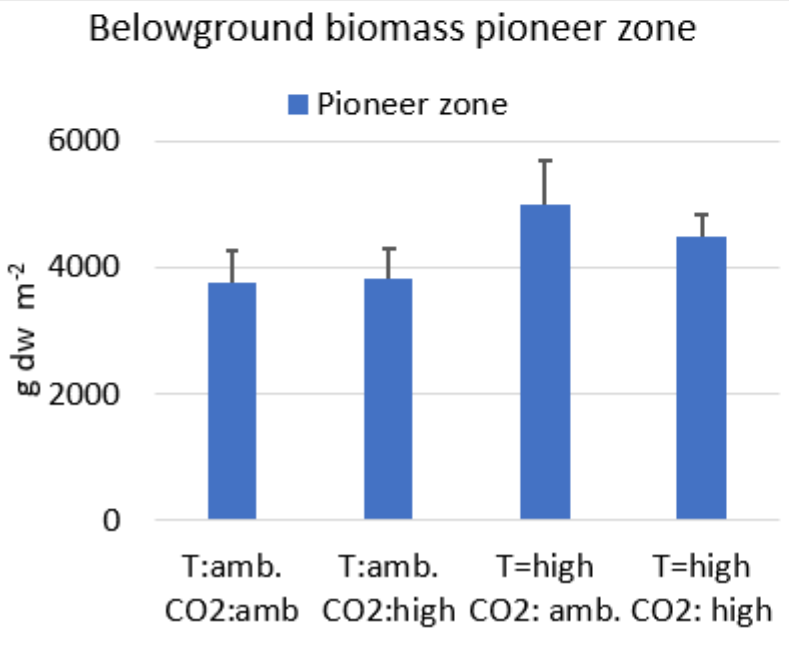
Mesocosm experiment

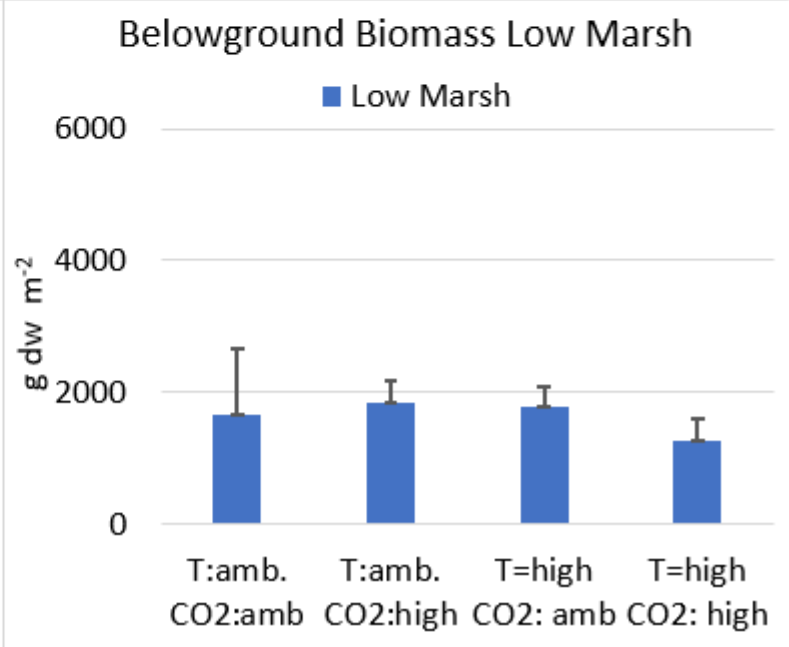


2-factoral design	Ambient CO_2	800 ppm CO_2
Ambient Temp		
+3°C Temp		


Aboveground biomass Pioneer Zone
Other (Salicornia, elymus, suada, Halimione)
Spartina anglica
g (dw) m-2
2000
1500
1000
500
0
T:amb. CO2:amb
T:amb. CO2:high
T=high CO2:amb
T=high CO2:high


Aboveground biomass Low Marsh
Elymus athericus
other
g (dw) m-2
2000
1500
1000
500
0
T:amb. CO2:amb
T:amb. CO2:high
T=high CO2:amb
T=high CO2:high


Belowground biomass pioneer zone
Pioneer zone
g dw m-2
6000
4000
2000
0
T:amb. CO2:amb
T:amb. CO2:high
T=high CO2: amb.
T=high CO2: high


Belowground Biomass Low Marsh
Low Marsh
g dw m-2
6000
4000
2000
0
T:amb. CO2:amb
T:amb. CO2:high
T=high CO2: amb
T=high CO2: high

Salt marshes: Soil structure