CAN WE MODEL CARBON STORAGE FROM MARINE VEGETATION?

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CLIMATE ACCOUNTING

Only terrestrial is mandatory
(Paris Agreement, EU)

TABLE 4.12
ANNUAL EMISSION FACTORS ASSOCIATED WITH REWETTING (EF_{RE}) ON AGGREGATED ORGANIC AND MINERAL SOILS (TONNES C HA^{-1} YR^{-1}) AT INITIATION OF VEGETATION REESTABLISHMENT

Ecosystem	EF_{REWET}[1]	95% CI[5]	range	n
Mangrove	-1.62[2]	1.3, 2.0	0.10-10.2	69
Tidal marsh	-0.91[3]	0.7, 1.1	0.05-4.65	66
Seagrass meadow	-0.43[4]	0.2, 0.7	0.09-1.12	6

[1]Negative values indicate removal (i.e. accumulation) of C

[2]Sources: Breithaupt *et al.*, 2012; Chmura *et al.*, 2003; Fujimoto *et al.*, 1999; Ren *et al.*, 2010

[3]Sources: Anisfeld *et al.*, 1999; Cahoon *et al.*, 1996; Callaway *et al.*, 1996; Callaway *et al.*, 1997; Callaway *et al.*, 1998; Callaway *et al.*, 1999; Callaway *et al.*, 2012; Chmura and Hung, 2003; Hatton, 1981; Craft, 2007; Kearney and Stevenson, 1991; Markewich *et al.*, 1998; Oenema and DeLaune, 1988; Orson *et al.*, 1998; Patrick and DeLaune,1990; Roman *et al.*, 1997

[4]Sources: Mateo and Romero, 1997; Serrano *et al.*, 2012

[5]95% CI of the geometric mean

Marine is optionalA few countries report (USA, Australia)
IPCC guidelines in this area
2013 Wetland Supplement is incomplete and cannot/may not be used

Therefore, national self-development of methods

REPORTING

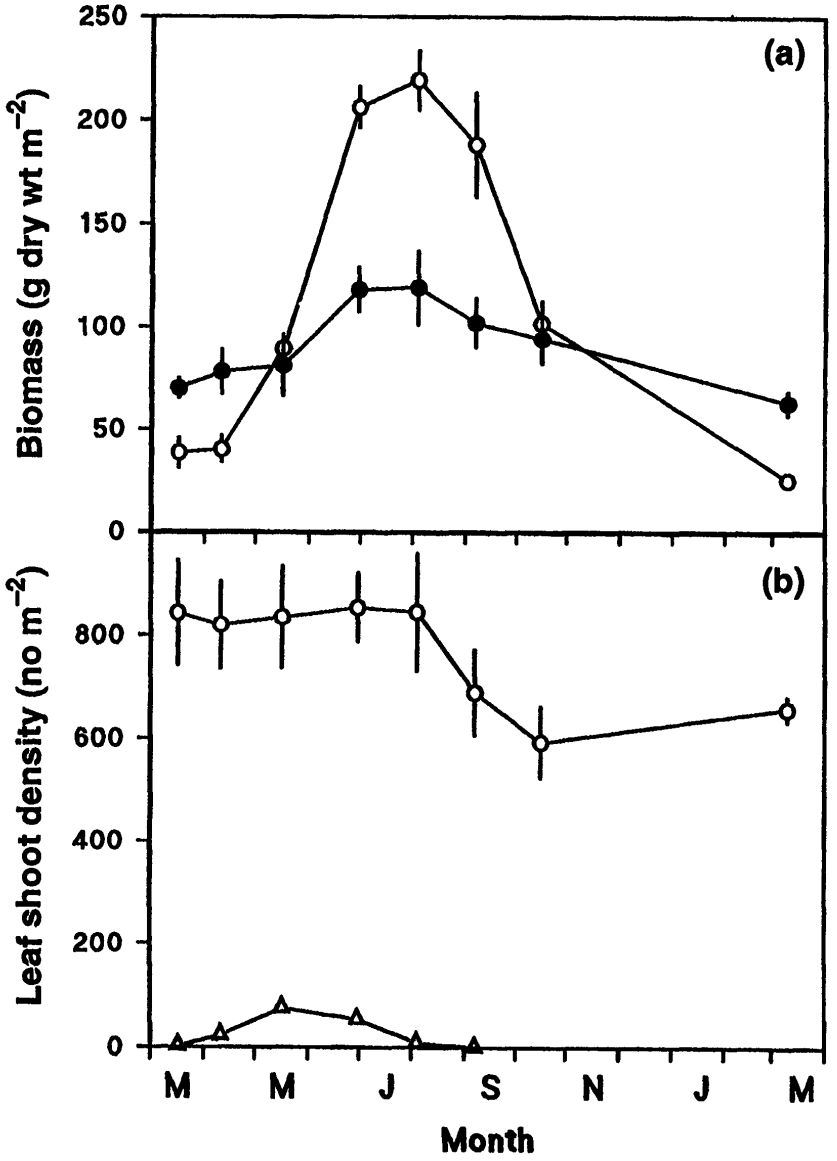
The following must be reported:

Carbon storage/changes in storage	Implementable now
Living biomass above sediment	✓
Living biomass in sediment	✓
Dead organic material (DOM)	✓
Carbon in sediment	(?)

GROWTH OF *ZOSTERA MARINA*

a) Annual variation in live biomass above the sediment during a growing season (open circles). Rhombs indicate biomass in the rhizomes (from Olesen and Sand-Jensen, 1994).

b) Number of shoots per m2 (open circles). Open triangles are number of flowering shoots.



OTHER INFORMATION ON C IN THE SEABED

Almost same % OC within the grass bed as outside the seabed

- app. 1 % OC

Very little information on what is autochtont and what is allochtont

50-60 % of the C in sediment has terrestrial origin

SOURCES OF CARBON TO THE SEDIMENT

Definitions and considerations:

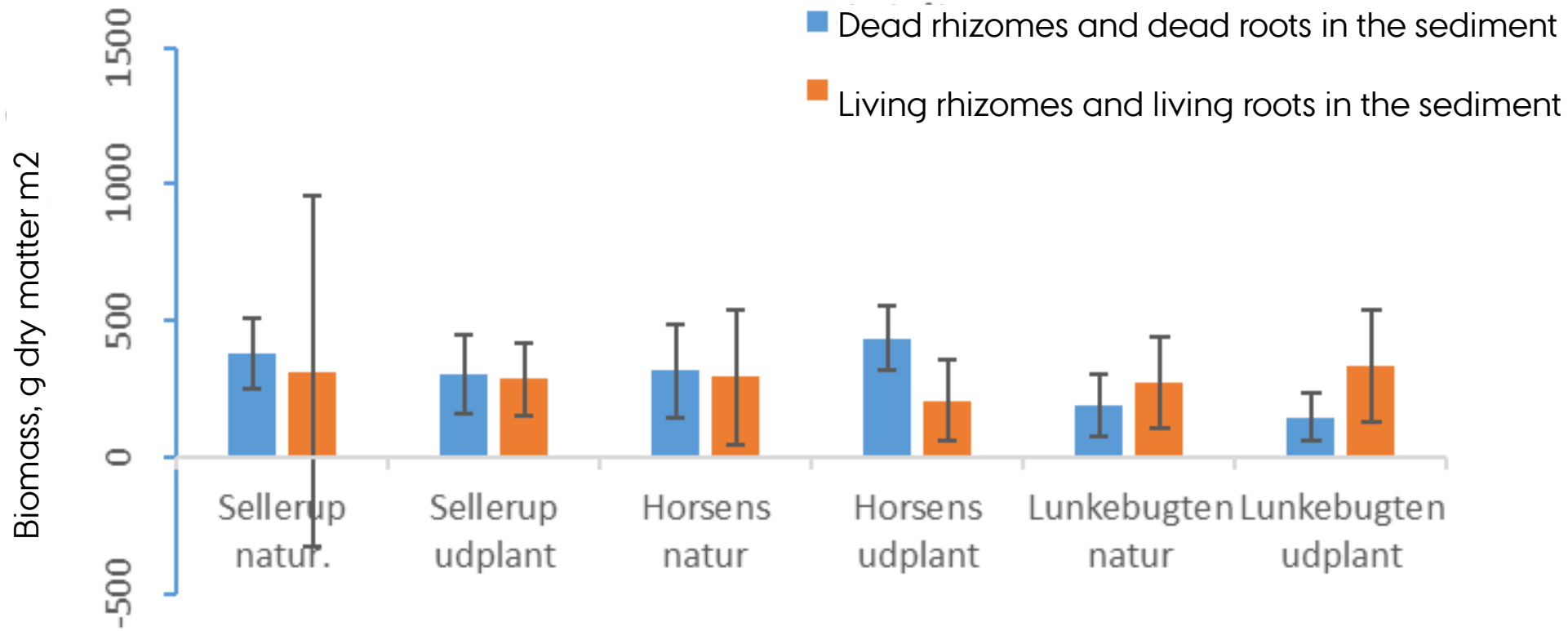
•Leaves and stems: Unlikely – they degrade in the water phase or are washed ashore (instant oxidation)

•Rhizomes and roots: Likely – they remain in the upper layers of the sediment

Definitions:

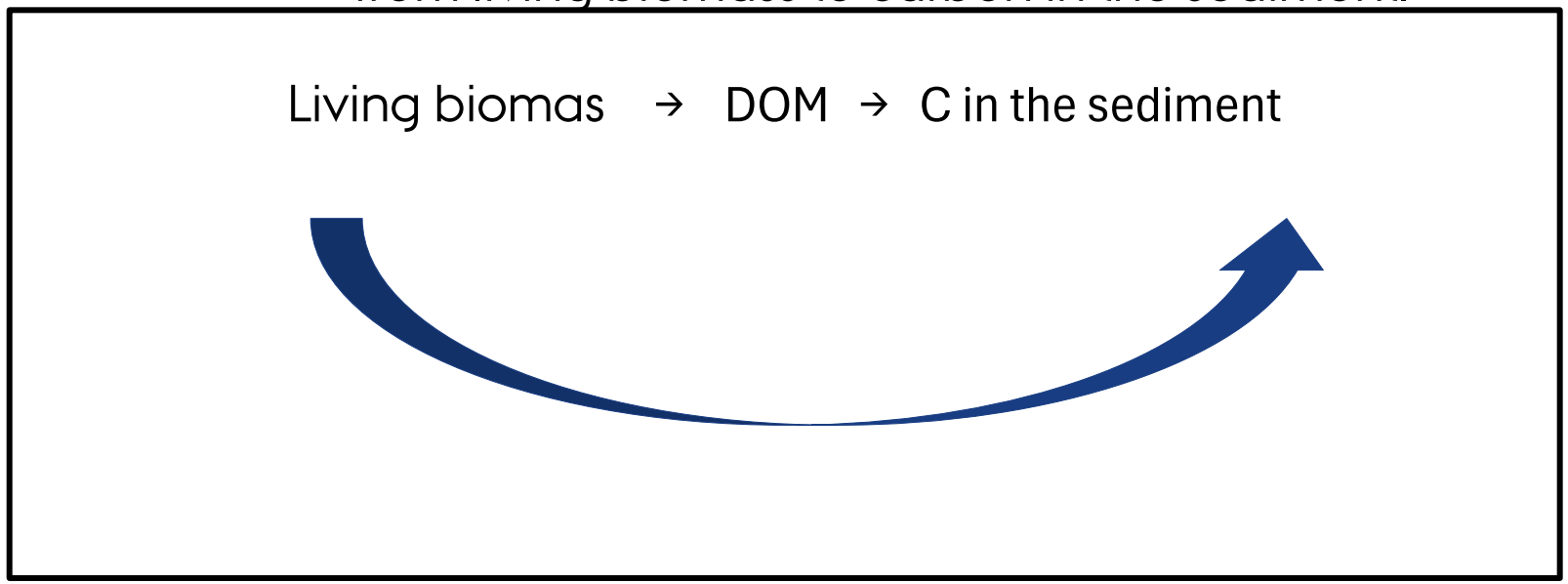
Living biom.: Rhizomes + roots	→	> 2 mm Dead OM	→	≤ 2 mm C in sediment

LIVING AND DEAD BIOMASS IN THE SEDIMENT



INPUT OF CARBON TO THE SEDIMENT

Dead organic material depends on production and degradation rates
– because of the available data we must transits
from living biomass to carbon in the sediment.



PRODUCTION OF ORGANIC CARBON

Living biomass in the sediment	g dry matter m^{-2}	Lifespan (years)	Carbon content	Annual input (g carbon m^{-2})	Annual input (t C ha^{-1})
Olesen et al., 2017	147.1			32.4	
Leiva-Dueñas et al., 2023	146.7	1.5	0.3	32.3	
DK-tur 2023, SDU	324.4			71.4 (44.2)	
Average	206.1			32.3	**0.323**

Lifespan of rhizomes	
Sand-Jensen and Olesen 1994	1-2 yr
Duarte, 1991 (shoot age)	1.52 yr

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DEGRADATION OF ORGANIC MATERIAL:

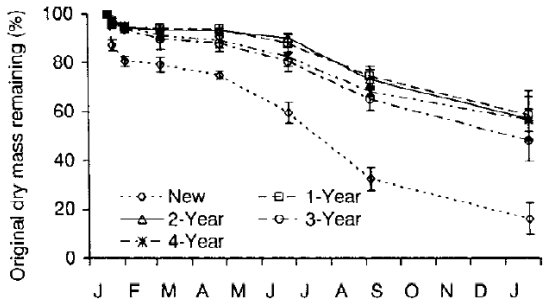
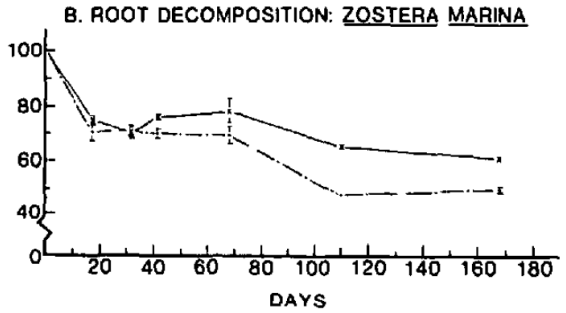
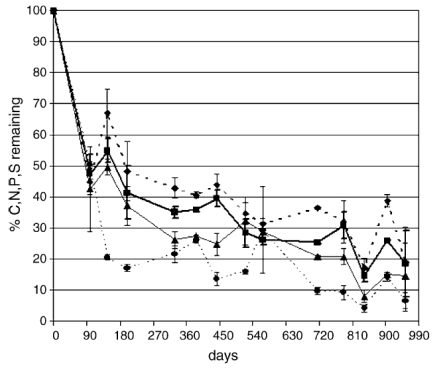


Figure 2. Observation dry mass during decay of *P. australis* rhizomes of different ages. The vertical bars indicate levels of 95% confidence limits ($n = 8$).

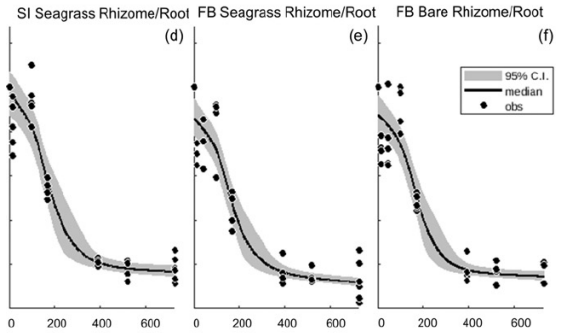
Asaeda and Hung Nam, 2002



Kenworthy and Thayer, 1986



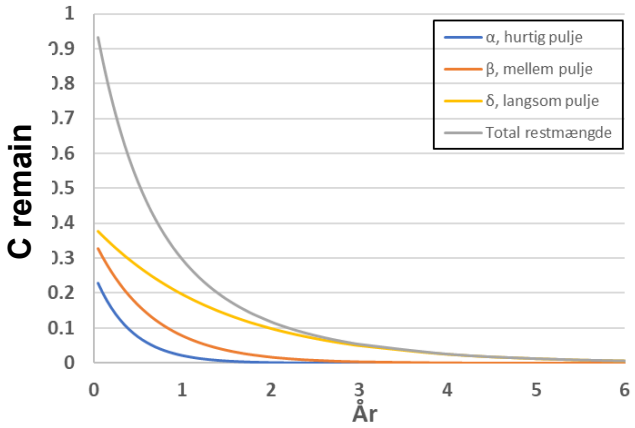
´Àgoston-Szabo et al. 2006



Trevathan-Tackett et al. 2020

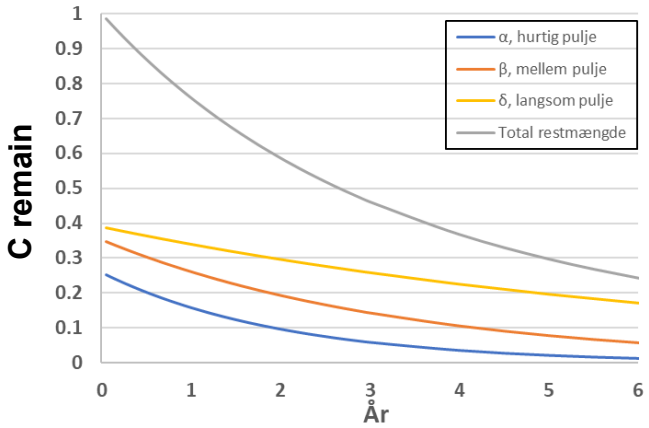
DEGRADATION, 3-POOL MODEL

Trevathan-Tackett et al., 2020



$$\int_0^\infty = 1.6$$

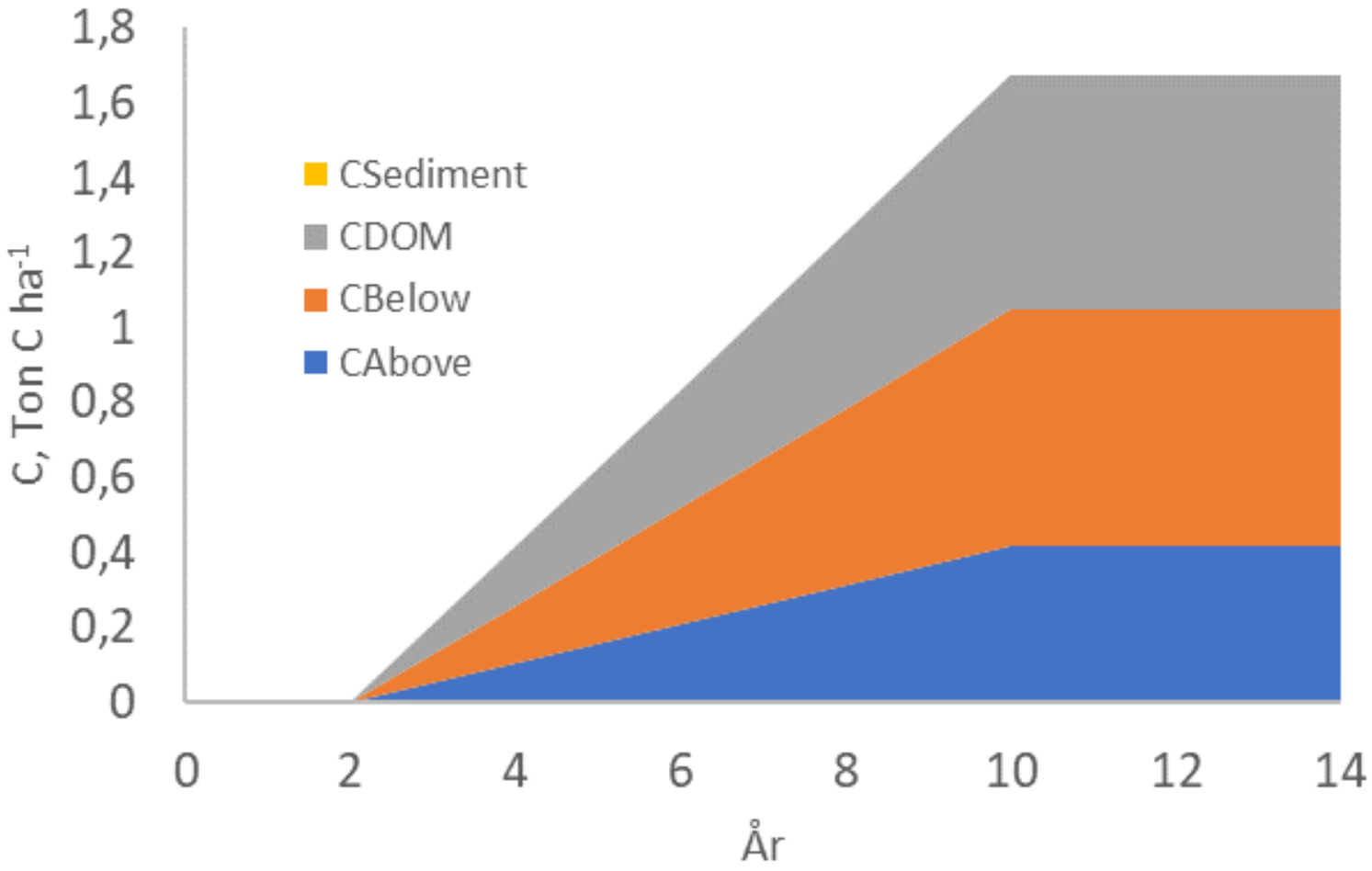
Conversion to Danish climate conditions (app.)
Q10 ≈ 2.0-2.5



$$\int_0^\infty = 5.0$$

For new areas:
Annual input to the sediment = 0.323 ≈
App. increase in avg. sediment C stock = 1.6 t C ha^{-1}

GROWT FOR NEW TRANSPLANTIONS



PRELIMINARY CONCLUSION (NOT FOR CITATION):

- Existing seagrass beds has reached its maximum equlibrium C stock in the sediment – however we do not know where it is
- The contribution of eelgrass to organic content in sediment is limited
- There are limited studies on long-term degradation under Danish climate conditions
- Rhizomes have a high degradation rate due to low lignin, cellulose, and hemicellulose content
- Yes, we can model it
- The climate effect of eelgrass planting is limited
- The numbers are estimates and need to be further verified