

1.02 Carbon sinks / Practicum (P2)



Posidonia oceanica

- Endemic Mediterranean
- Low turnover (P/B)
- Refractory debris (high C/N)
- Mat formation (high B/A)



Zostera marina

- Wide distribution
- High turnover (P/B)
- Refractory debris (Low C/N)
- No mat formation (low B/A)

The model

$$dX/dt = L - kX$$

$$X = (L/k) * (1 - e^{-kt})$$

$$\text{If } dX/dt = 0$$

$$\text{then } X_{ss} = L/k$$

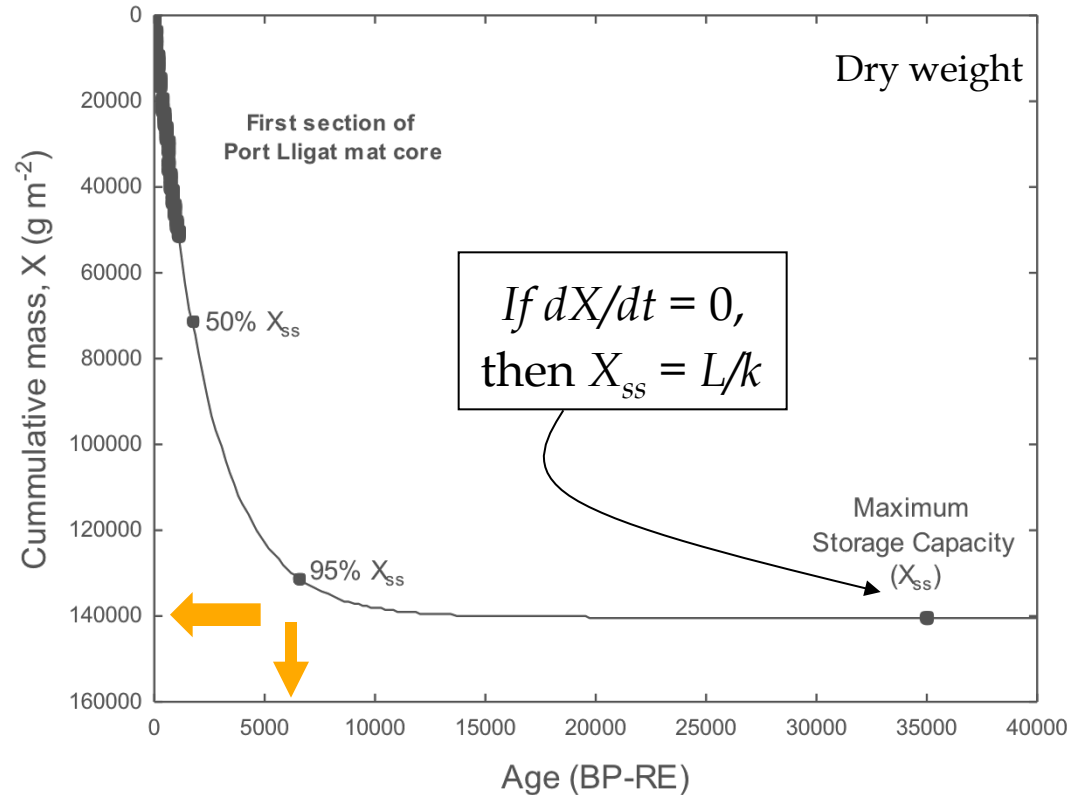
$$t_{0.5} = 0.693/k, \quad t_{0.95} = 3/k, \quad t_{0.99} = 5/k$$

$$t = -\ln(1 - (kX/L)) / k$$

Practicum (P2)

Accumulation equation:

- Describes **balance** between **inputs** (accretion) and **outputs** (decomposition/erosion).
- Allows estimating the **maximum storage capacity**.
- Sink 'maturity'



* Olson JS (1963) Energy storage and the balance of producers and decomposers in ecological systems. *Ecology* 44:322-331

$$X = \frac{L}{k} \times (1 - e^{-k \times t})^*$$

X = Cumulative biomass
 L = accretion rate
 K = fractional loss

Practicum (P2)

Characterize the **carbon sink** constituted by *P. oceanica* and by *Z. marina*

- L (accretion rate; $\text{g/m}^2 \text{ y}$) and k (fractional loss; y^{-1})
- Turnover and residence time
- 50%, 95% and 99% storage capacity (g/m^2)
- Maximum storage capacity (MSC; g/m^2)
- Provide results in DW and in C
- Time to all three levels of storage (y)
- Time to MSC (maturity)
- Maximum sink thickness (MST)
- Stocks at MST
- Any other relevant variable you can think of.
- Compare both seagrasses and discuss differences

Provide tables and graphs in a small presentation

Practicum (P2)

Material needed

Databases:

https://imedea.uib-csic.es/master/cambioglobal/Modulo_1_02/Practicum_P2_Data.xlsx

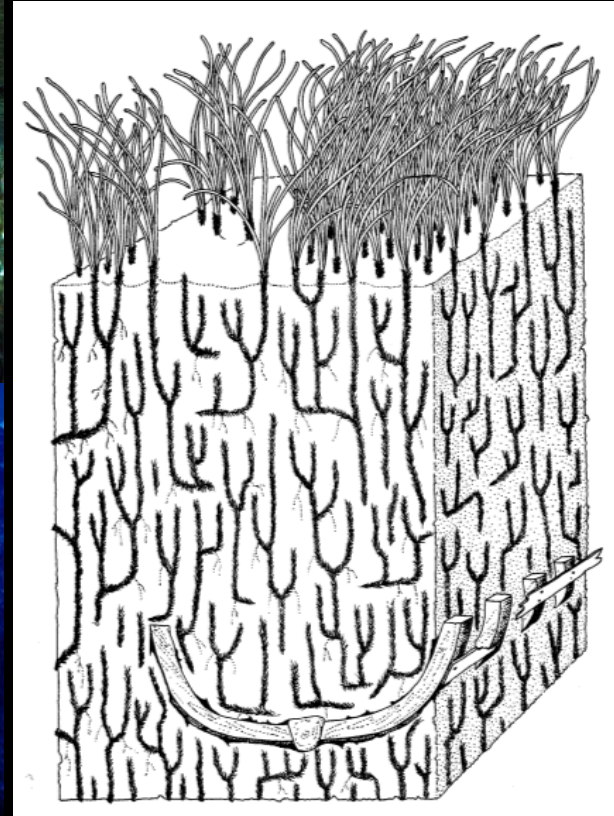
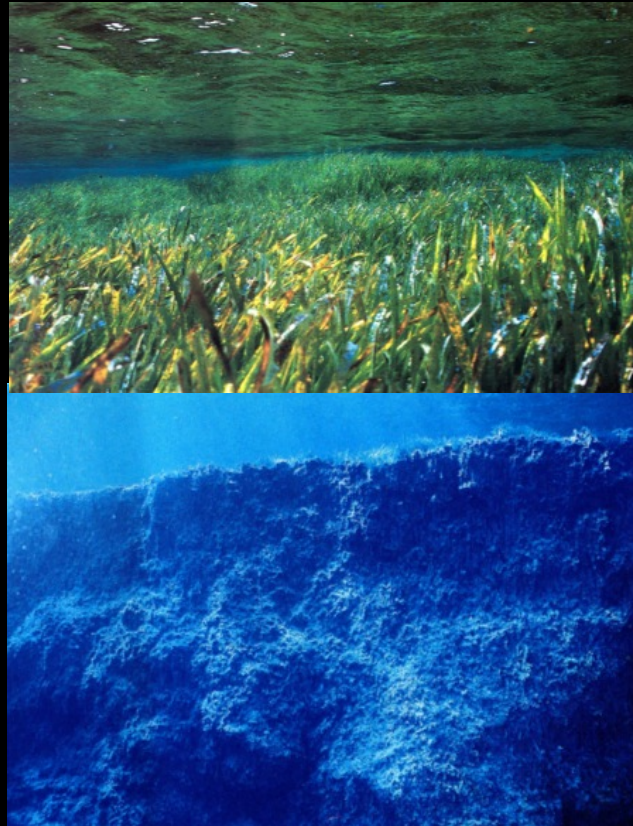
Equation and questions:

https://imedea.uib-csic.es/master/cambioglobal/Modulo_1_02/Practicum_P2_Explanations.pdf

Spreadsheet and stats program that allows to fit custom functions (SPSS, STATISTICA, PRIMER, etc.).

Software for presentations

Posidonia oceanica L. (Delile)



Endémica del Mediterráneo – 0 a 40 m – 5 millones de ha

Registro paleo: La Mata

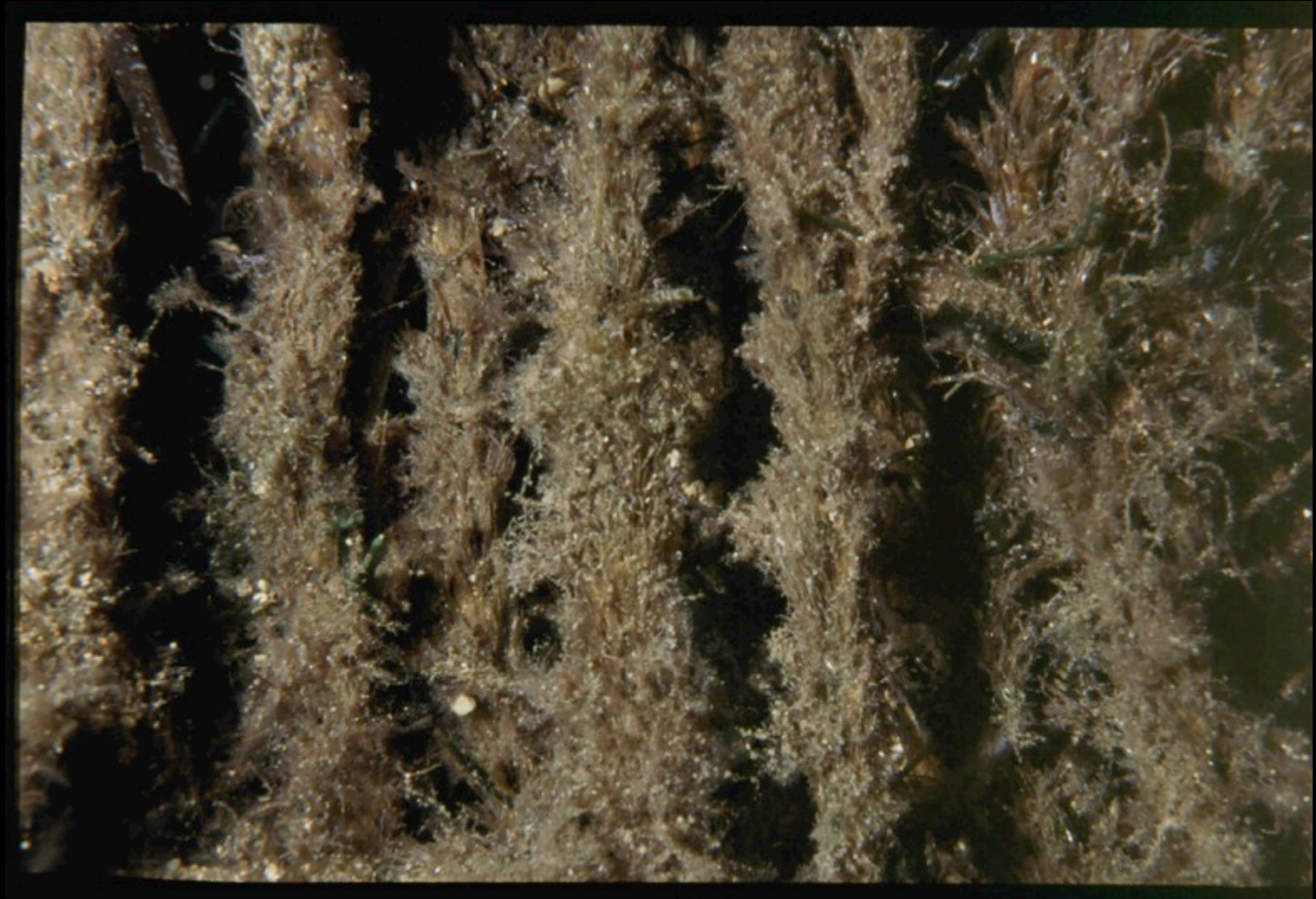
Milenario / 10 años cm^{-1} / 6000 años ?



MA Mateo

Arrecife Barrera de *Posidonia oceanica* en Es Pujols,
Formentera, Illes Balears (2008)

Miguel Ángel Mateo Mínguez - Centro de Estudios Avanzados de Blanes - CSIC



**Close up of a *Posidonia oceanica* mat in Slugs Bay, Malta
By Joseph A. Borg**

‘Cores de *Posidonia oceanica*’



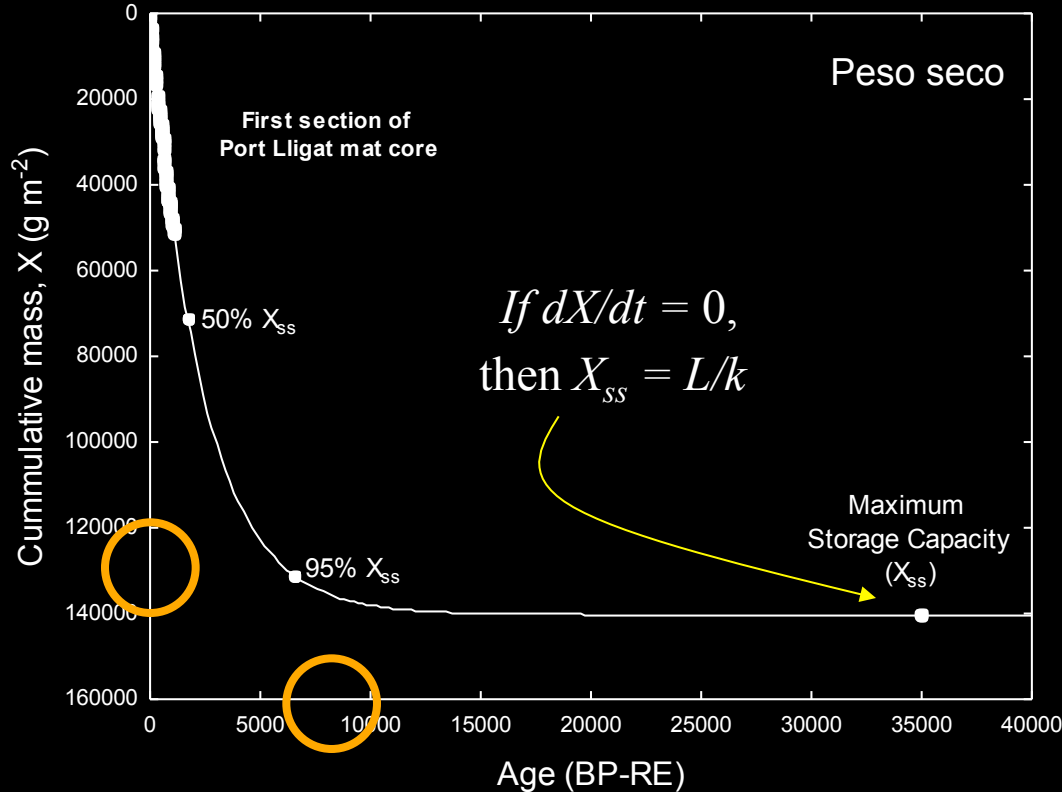
1ª Sección
(800 BP)



2ª Sección
(3000 BP)

Posidonia oceanica

Capacidad de acumulación máxima



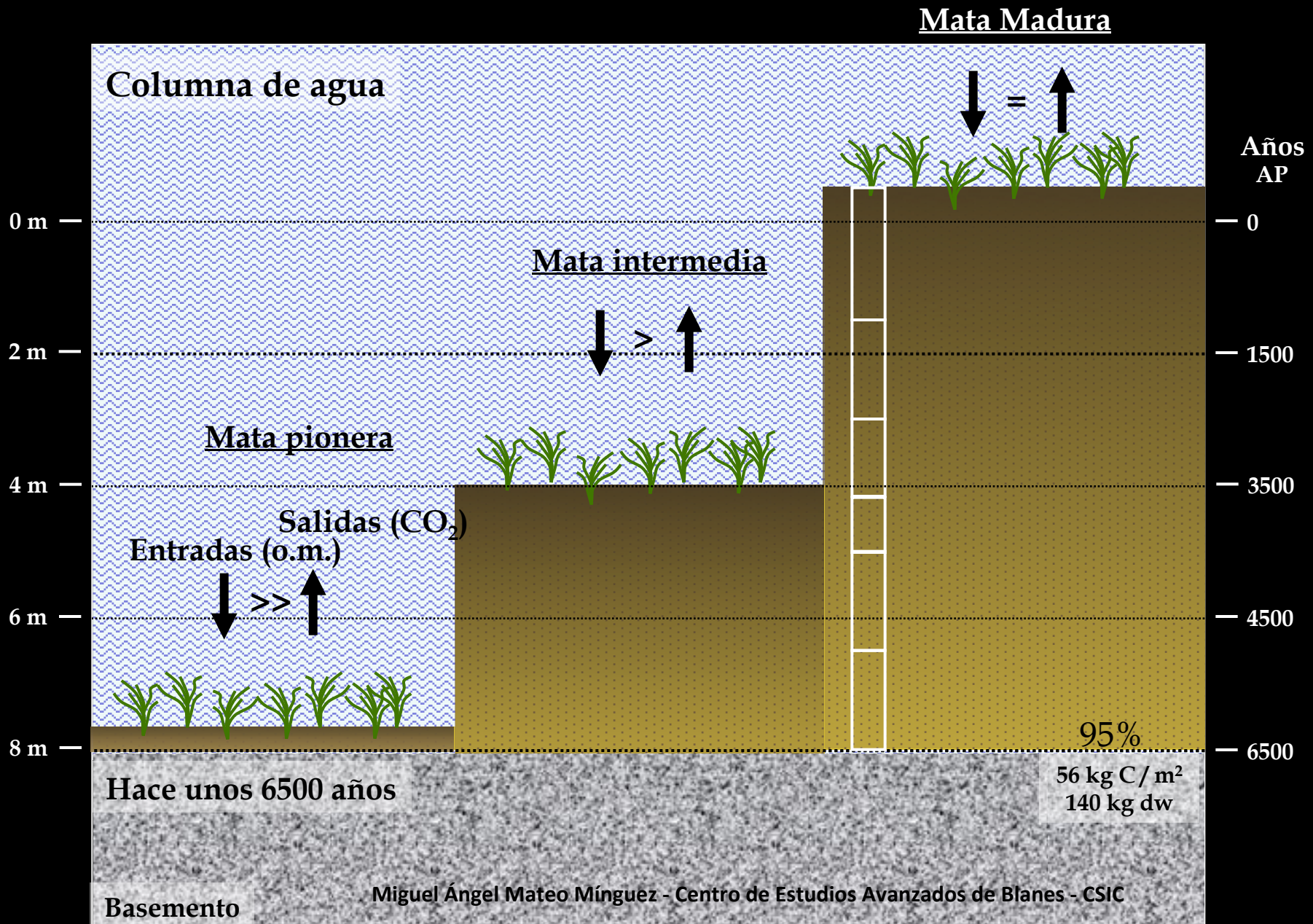
Modelo
Exponencial
Modificado

$$X = \frac{L}{k} \times (1 - e^{-k \times t})$$

X = Biomasa
acumulada por unidad
de superficie
 L = tasa de acreción
 K = pérdida
fraccional por unidad
de tiempo

$$k = 0.00008 \text{ a } 0.00055 \text{ año}^{-1}$$

De forma más didáctica ...



Variability between mats and 'peats'

	Species	Site	L (g C m ⁻² y ⁻¹)	k (y ⁻¹)	Xss (g C m ⁻²)	n
Mat	<i>P. oceanica</i>	Port Lligat (1)	24.6	0.00042	58 901	62
	"	Villajoyosa	18.1	0.00055	32 981	18
	"	Ischia	40.2	0.00036	111 667	5
	"	Culip	9.1	0.00008	113 400	9
	"	Port Lligat (2)	75.0	-	-	3
	"	Tabarca (1)	61.7	-	-	4
	"	Tabarca (2)	104.2	-	-	3
	"	Campello	112.1	-	-	5
	"	Medes	12.6	-	-	10
	Peat	<i>Sphagnum</i>	New Brunswick	98.8	0.00010	988 000
<i>Molinia</i>		Exmoor	286.0	0.06770	4224	-
<i>Chorisodontium</i>		Signy Is.	84.2	0.00460	18 304	4
<i>Polytrichum</i>		Argentine Is.	110.8	0.00520	21 307	5
<i>Poa</i>		Beauchêne Is.	322.4	0.00020	1 612 000	10

Zostera spp

Capacidad de acumulación máxima



CARBOMED: *Zostera marina* y *Z. noltii* – Bahía de Santander (Mayo 2007)

Comparativa



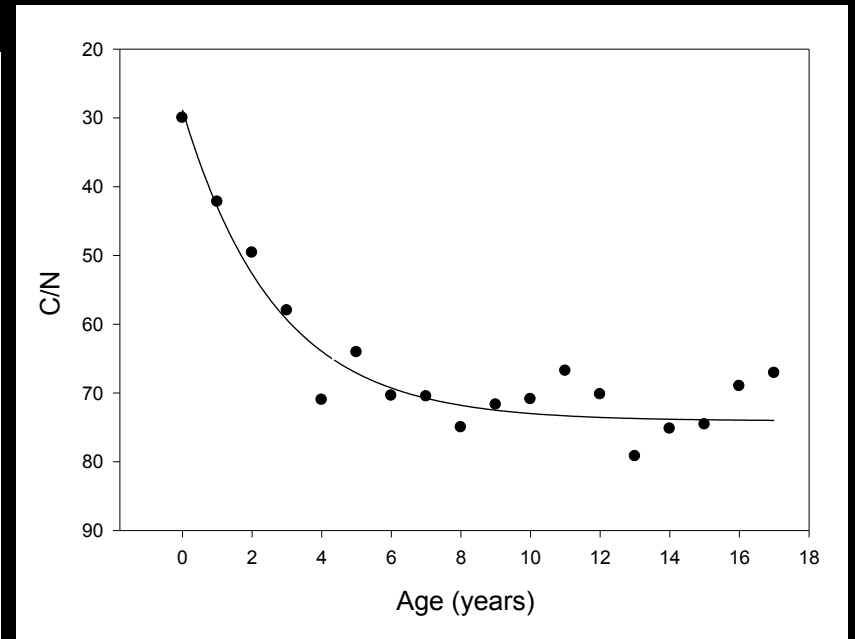
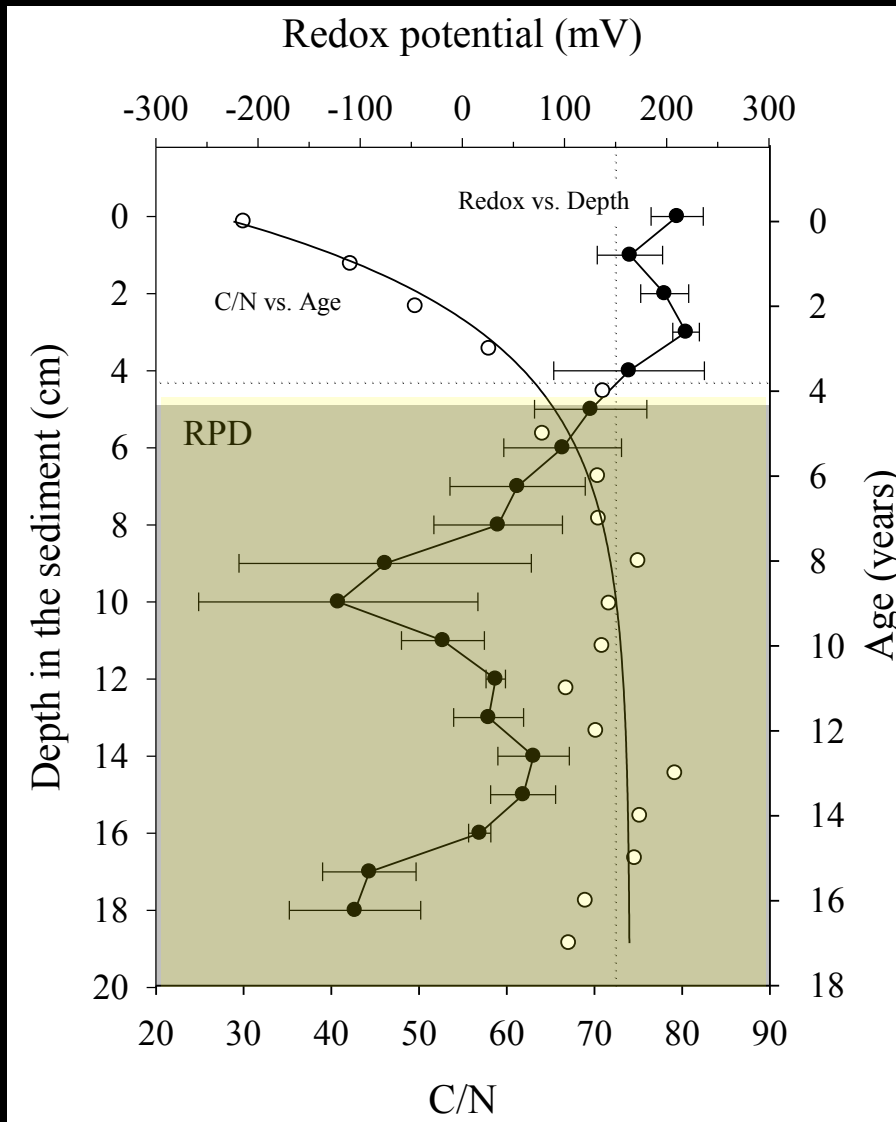
Posidonia oceanica
Bahía de Portlligat



Zostera marina
Bahía de Santander

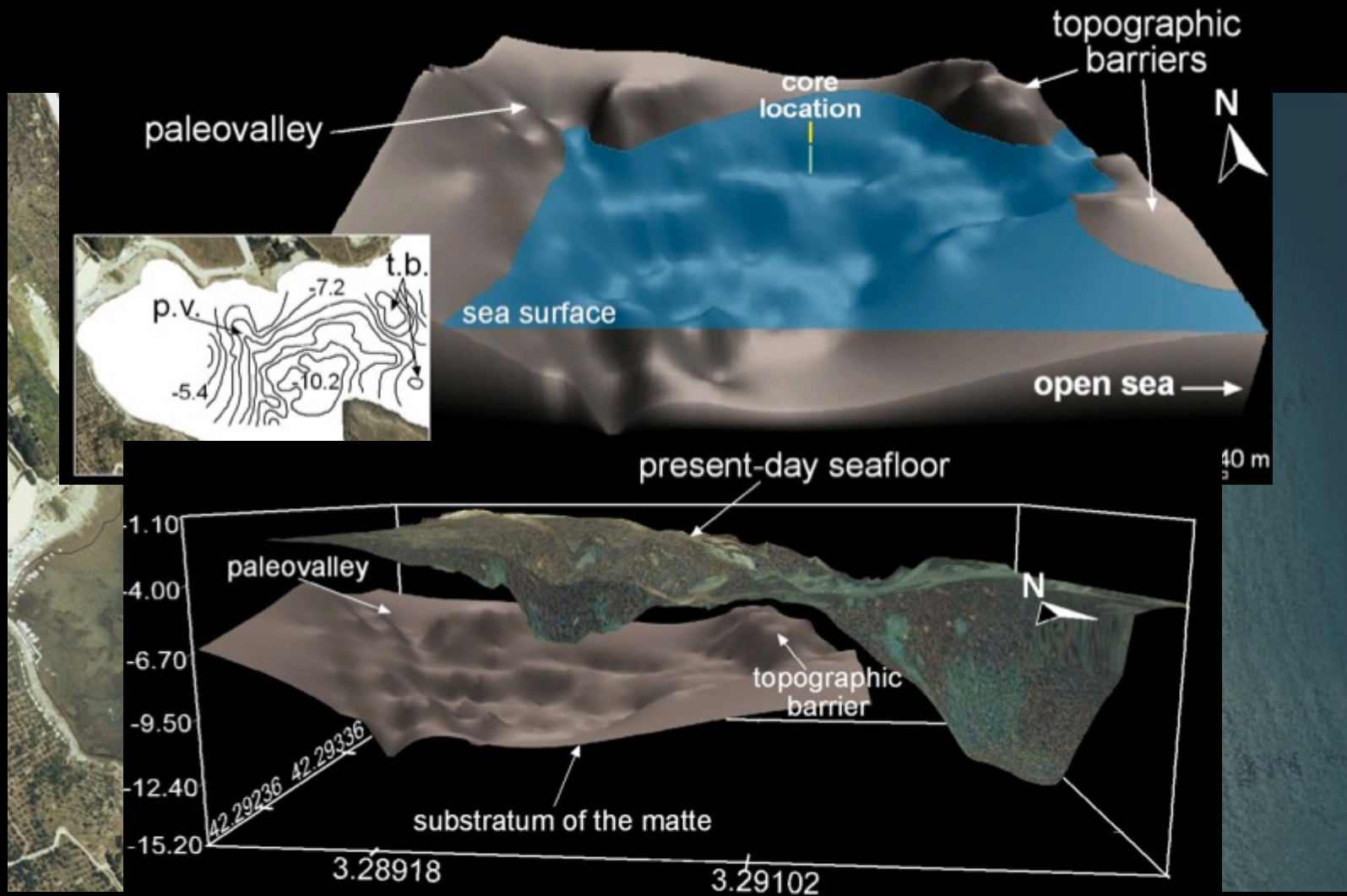
123.1	Acreción (g DW m ⁻² y ⁻¹)	113.7	=
130 000	Acumul. Máx. (g DW m ⁻²)	5500	/ 25
8 000	Edad de madurez	200	/ 40
0.000008	Tasa descomp. (y ⁻¹)	0.02	x 250

El por qué de la preservación



Contenido insólitamente elevado de ligninas
(pirolisis GC-MS), particularmente en los órganos
hipogeos de la planta (raíz y rizomas)

“Ecografiando” la mata de *Posidonia*



CARBOMED: Bahía de Portlligat, Gerona

Estimas globales preliminares

5 millones de ha en el Mediterráneo

Detritos <i>P. oceanica</i>	13.6 Pg CO ₂	} Stock 40 Pg CO ₂
Materia orgánica fina	9 Pg CO ₂	
Carbonatos	17 Pg CO ₂	

~ 5 años de emisiones globales de CO₂

Captación anual

0.0224 - 0.0280 Pg CO₂ año⁻¹

~ 5.6 – 7.0 % de emisiones anuales de CO₂ Europa Occ.

CDIAC (Carbon Dioxide Information Analysis Center, 2007)

Miguel Ángel Mateo Mínguez - Centro de Estudios Avanzados de Blanes - CSIC

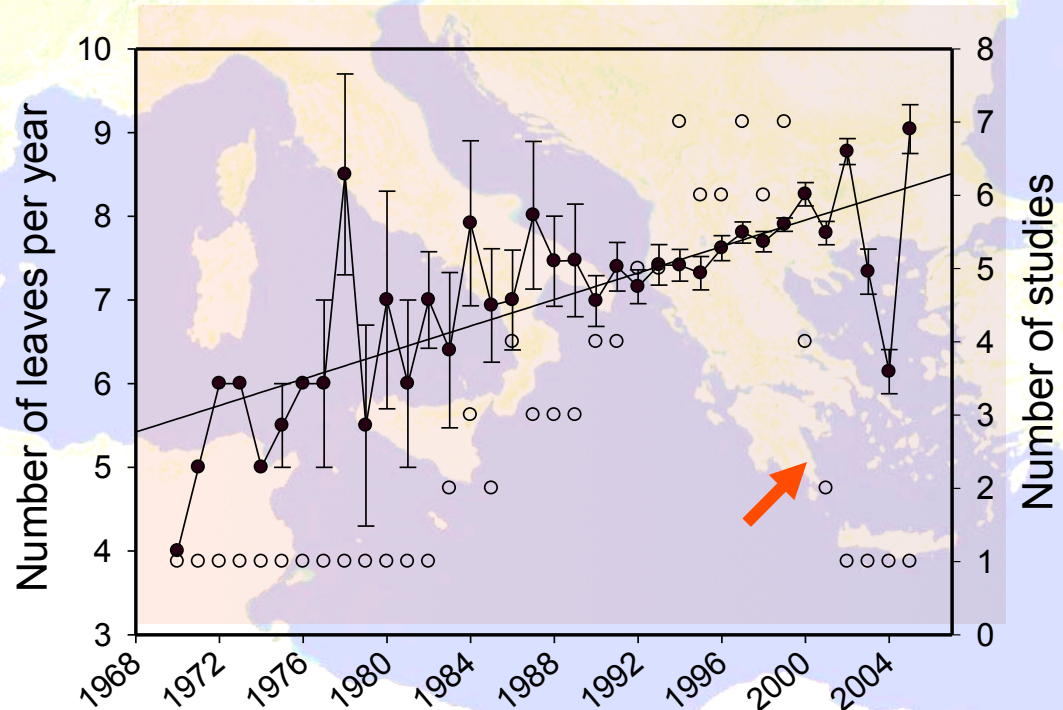
Macrófitos (Smith)
0.5 – 5 Pg CO₂ / año

0.45 – 5.6 %
Posidonia oceanica

1.3 – 13.4 %
Fanerógamas marinas

6 – 60 %
Macrófitos marinos

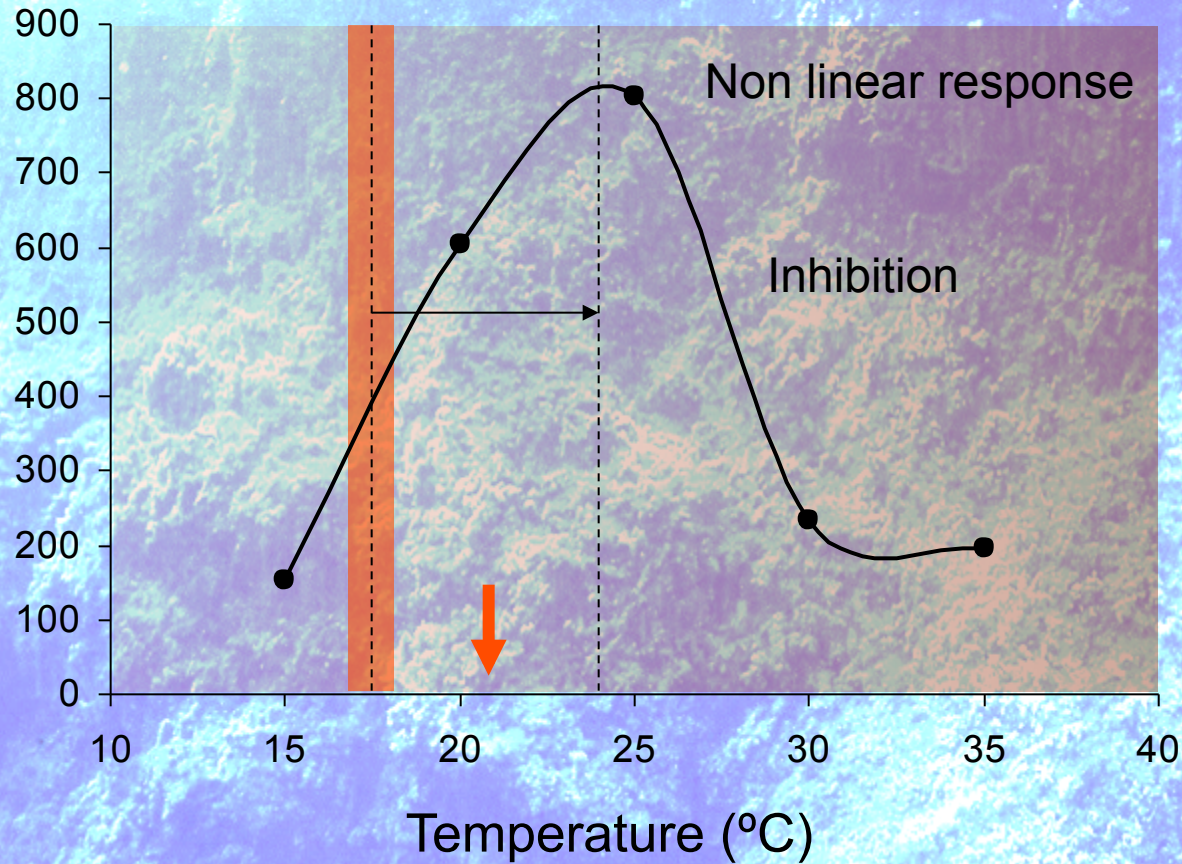
Production and temperature



Posidonia oceanica

Posidonia oceanica CO₂ emissions from the mat in a Mediterranean SST warming setting

Mat respiration
mmol CO₂ m⁻² d⁻¹



**Year 2100
+ 4 °C**

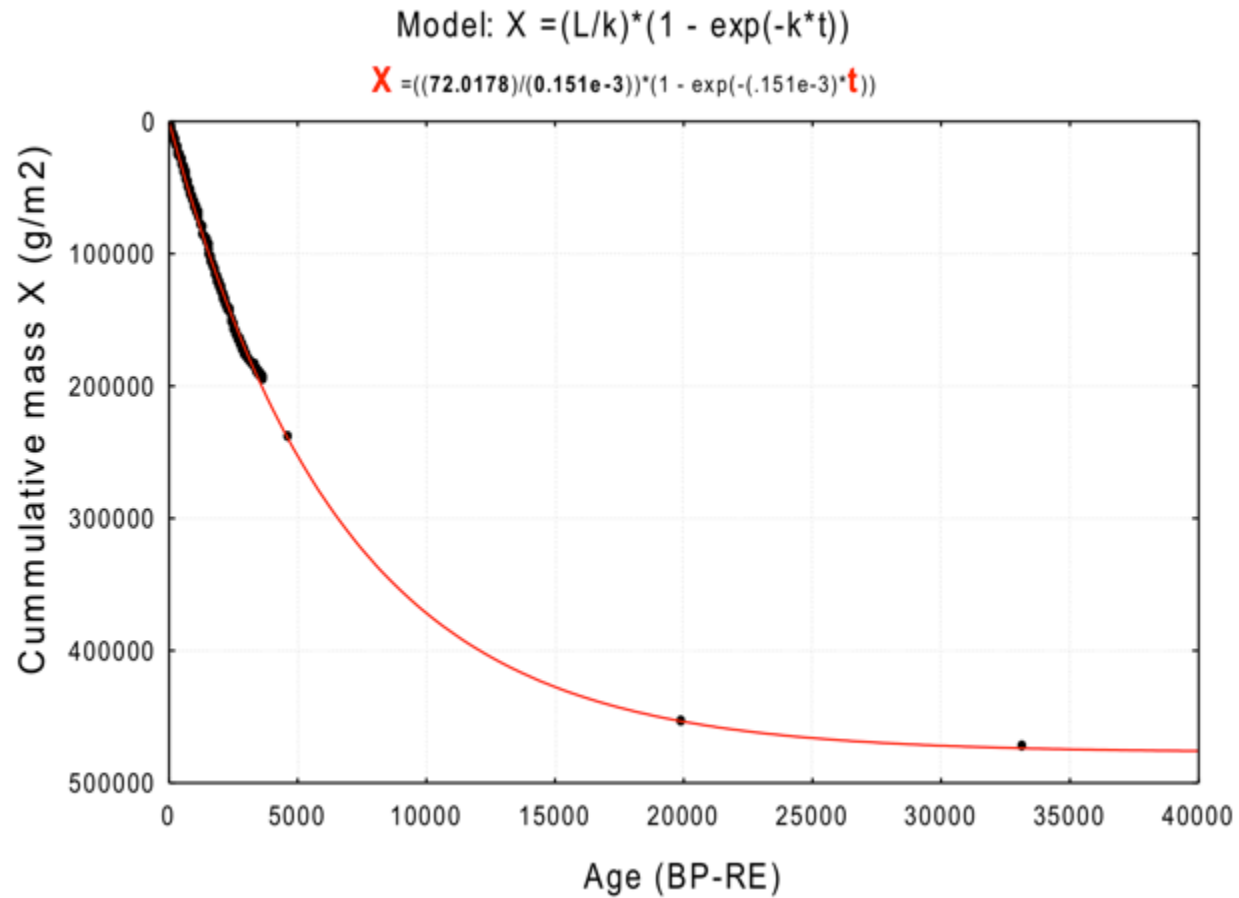
**Production:
- 30 %**

**Decomp:
+300 %
(83 % / degree)**

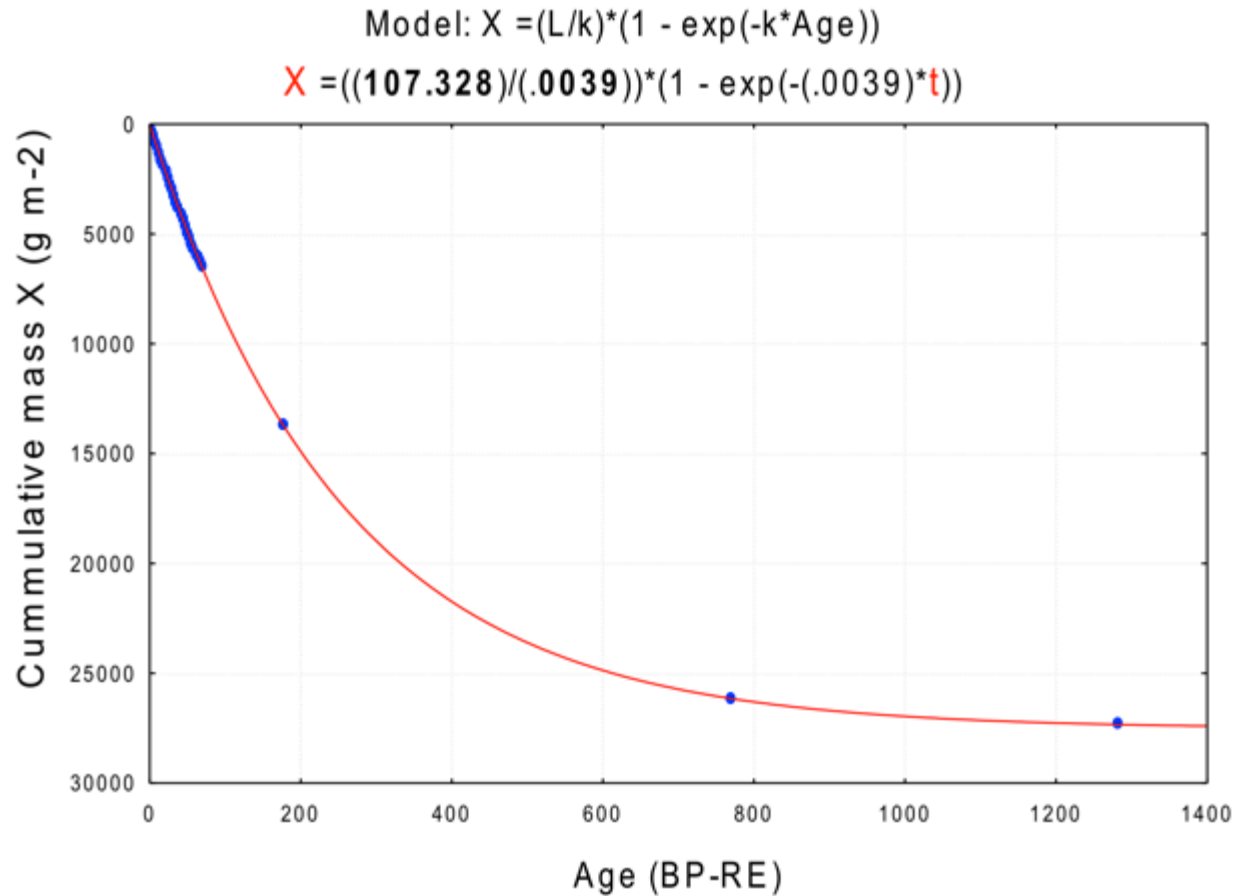
Collaboration
Syddansk Universiteit - CEAB

Pedersen MØ, Serrano O, Mateo MÁ, Holmer M (2011)
Temperature effects on decomposition of a *Posidonia oceanica*
mat. *Aquat Microb Ecol* 65:169-182

Acc. model for *Posidonia oceanica*



Acc. model for *Zostera marina*



Acc. model for *Z. marina* in *P. oceanica* scale

