A case study of ecological goods and seagrass ecosystems: The *Posidonia oceanica* seagrass ecosystem



Charles-François Boudouresque (1)



Gérard Pergent (2)



Sébastien Personnic (1)



Thierry Thibaut (1)





advancing the frontiers

(1) Mediterranean Institute of Oceanography (MIO, OSU Pythéas), Aix-Marseille University and Toulon University

(2) Coastal Ecosystem Team, Pasquale Paoli Corsican University, Corti

#### A Posidonia oceanica meadow

# A seagrass endemic to the Mediterranean Sea

Photo Sandrine Ruitton



Arrival of a cutting (or a seed)



## The leaf canopy traps sediment



The *matte* =

alive and dead rhizomes and roots + sediment which fills the interstices





The actual density of the rhizomes within the matte

(strongly reduced for clarity of the drawings)

Pinna nobilis (mollusk)

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Conceptual model of ecosystem functioning



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9 services

1. A huge primary production (seagrass and epibionts) and a basis for lushy food webs

From Boudouresque *et al.,* 2015. *Hydrobiologia* 



Why such a huge primary production and lushy food webs? A feature unique to seagrass ecosystems: the juxtaposition of two sets of primary production 2. Leaf epibionts: highly palatable, highly consumed, quickly remineralized (weeks)

Sardinia, photo E. Emery

1. Seagrass leaves: structural and chemical defences, weakly consumed, slowly remineralized (years)



(for fish and other species of fishery value)

From Boudouresque *et al.,* 2015. *Hydrobiologia* 



# (where it represents a valuable feeding resource)

From Boudouresque **et al.,** 2015. **Hydrobiologia** 

#### Dead *Posidonia oceanica* leaves. Canyon of Toulon (eastern Provence), 625 m depth

Oceanographic campaign MedSeaCan, Agence des Aires Marines Protégées. Adrien Goujard and Maïa Fourt, 2013





# (decrease in turbidity because of reduced particle re-suspension)

From Boudouresque **et al.,** 2015. **Hydrobiologia** 



Seagrasses: a real carbon sink (i.e. at a geological time scale) that contributes to mitigate carbon dioxide emissions due to Humans

**Posidonia oceanica**: 27 % of the NPP (Net Primary Production) permanently buried within the matte (i.e.: at a geological time scale)

Seagrasses are estimated to account for 40 % of the carbon stored each year by coastal vegetation



Globally, seagrasses store 4.2 to 8.4 billon metric tonnes/year



#### From:

Pergent *et al.,* 2012. *Mediterranean seagrass meadows: resilience and contribution to climate change mitigation. A short summary*. IUCN, 40 pp. Fourqurean *et al.,* 2012. *Nature Geoscience*. Pergent *et al.,* 2014. *Medit. Mar. Sci.*, 15(2): 462-473. Boudouresque *et al.,* 2015. *Hydrobiologia.*  CO<sub>2</sub> emissions offset by *Posidonia oceanica* in the Balearic Islands

Balearic Islands: ca. 67 000 ha of *P.* oceanica meadows

Accretion rate is estimated at:

- 230 000 tC/a
- $(= 840\ 000\ tCO_2/a)$

→Balearic *P. oceanica* meadows offset 9 % of the Balearic Islands current CO<sub>2</sub> emissions

→ True carbon sequestration within a true reservoir



Pergent G., Bazairi H., Bianchi C.N., Boudouresque C.F., Buia M.C. *et al.*, 2012. Mediterranean seagrass meadows: resilience and contribution to climate change mitigation. Short summary. IUCN publ., Gland: 1-40.







A *banquette* of drift *Posidonia oceanica* leaves and rhizomes on Barcaghju beach (Capicorsu, Corsica) The figure gives the scale

Photo C.F. Boudouresque



(*Posidonia oceanica* leaves: dune stabilization and a relevant source of nirogen for the vegetation of the dune and foredune)

Plage d'Argent, Porquerolles Island, eastern Provence

From Cardona and García, 2008. *Acta Oecologica*, 34: 97-103

Photo Sandrine Ruitton

# The value of the world's ecosystem services and natural capital

BIOME	10 times 1	ho	Area (Mha)	Value/ha/a	Total global flow
TERRESTRIAL ECOSYSTEMS	value of tro	nical			
Temperate and boreal forests	forests	pical	2 955	302 \$	894 G\$
Tropical forests			1 909	2 007 \$	3 813 G\$
Grass and rangelands			3 898	232 \$	906 G\$
Wetlands (tidal marsh, mangroves, swamps)		330		14 785 \$	4 879 G\$
Lakes and rivers		200		8 498 \$	1 700 G\$
Others (desert, tundra, ice, cropland, etc.)			6 040		
	TOTAL		15 323	804 \$	12 319 G\$
MARINE ECOSYSTEMS					
Open ocean			33 200	252 \$	8 381 G\$
Shelf			2 660	1 610 \$	4 283 G\$
Estuaries			180	22 832 \$	4 110 G\$
Seagrass and macroalgal beds			200	19 004 \$	3 801 G\$
Coral reefs			62	6 075 \$	375 G\$
	TOTAL		36 302	577 \$	20 949 G\$
om Costanza et al., 1997. Nature, 387: 253-260 3 times the value of coral reefs				reefs 25	

Value of (some of) the ecoloical goods and ecosystem services of the *Posidonia oceanica* ecosystem

5 ecosystem services:

- Primary production (1)
- Spawning ground and nursery (2)
- Sediment stabilization (4)
- Net production of oxygen (6)
- Reduction in swell and wave strength (protection of beaches from erosion) (7)

From Vassallo **et al.,** 2013. *Mar. Poll. Bull*., 75: 157-167

172 €/m²/an

(= <mark>1 720 000</mark> €/ha/annum)

#### Thank you for your attention

# Supplementary slides





Ecosystem type	Long-term rate of	f SAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA	A CAL
Tropical forests	2.3 to 2.5		
Temperate forests	1.4 to 12.0		
Boreal forests	0.8 to 2.2		10 B
Temperate grasslands	2.2		1 AM
Temperate deserts	0.8		
Tundra	0.2 to 5.7		
Wetlands	20.0		1
Posidonia oceanica	9.0 to 112.0		1000
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From: Laffoley and Grimsditch, 2009. IUCN publ., Gland : i-vii + 1-53

## Removal of dead leaves from the beaches: a kind of vicious circle



The stay of the **Posidonia** necromass on beaches is provisional: sooner of later, it will return to underwater habitats

- → Participate in the detritus food webs
- → Nutrient budget of the meadow

To the garbage dump? A serious loss



A further ecosystem service:

*Pétanque*: a Mediterranean form of *boules* where the goal is to throw hollow metal balls as close as possible to a small *cochonnet* (literally: piglet)

**Pastis**: an anise-flavoured spirit (*apéritif*) from Marseilles and Corsica, France

# Thank you for your attention

*Merci pour votre attention* (French) *Gracias por su atención* (Spanish) *Grazie di stà attentu* (Corsican) Measuring the distance between the **cochonnet** and the ball, with a dead leaf of **Posidonia** 

Photos: © Denis Bonhomme