Workshop: Activities with Interference In Areas with Presence of Rhodoliths
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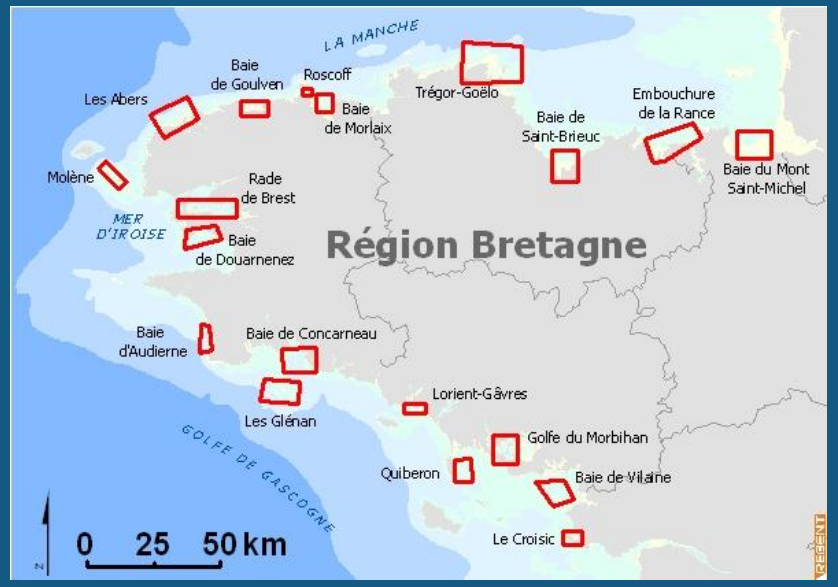
Impacts on deep rhodolith beds

THE LESSON LEARNT IN EUROPE AND THE BRAZILIAN OPPORTUNITY

RBs in Europe

can be grouped in two categories:

1) shallow Atlantic RBs (*maerl* of France, UK, Spain)



Along the Atlantic European coasts the twig-like branched forms dominate (maerl s.s.).

Mainly *L. corallioides* and *P. calcareum*

Distributed in patches of <1 to few km^2 ,
about 24 km^2 in Galicia, Spain (Peña & Barbara 2007),
about 100 km^2 in Britain, France
At a depth of 0 to 20 m (exceptionally 30 m), frequently in turbid water

2) deep Mediterranean RBs

RBs composed of mixed shapes and species of rhodoliths

Distributed in patches of <1 to few km^2 , from 9 to 150 m, mean depth 55 m.
18% of the Mediterranean RBs are deeper than 75 m
Largest continuous RB is about 90 km^2 in the Menorca Channel (Balearic Islands) at 60-90 m (Barbera et al 2012), in clear water

Main threats

- Direct exploitation of maerl beds (Atlantic only)

Soil conditioner in agriculture (25%),
Natural filter and biopurification of wastewater (40%)
Integrator for animal food (35%),
Pharmaceutical industry

Récolte du maerl en Bretagne
au début du XXe siècle

Drague aspiratrice de maerl
St Nicolas des Glenan

- Indirect exploitation of maerl beds (Atlantic and Mediterranean)

Fisheries: scallop dredging and trawling

Direct exploitation of maerl beds (Atlantic only)

Case histories

Falmouth Estuary, Cornwall, UK

maerl extracted since XVII century.
In 2003 still extracting dead maerl 20,000 t yr-1, at depth 10-18 m.

Extraction of dead maerl causes a decrease of infaunal biomass.

Live and dead maerl have similar epifaunal richness (Sheehan et al.2015)

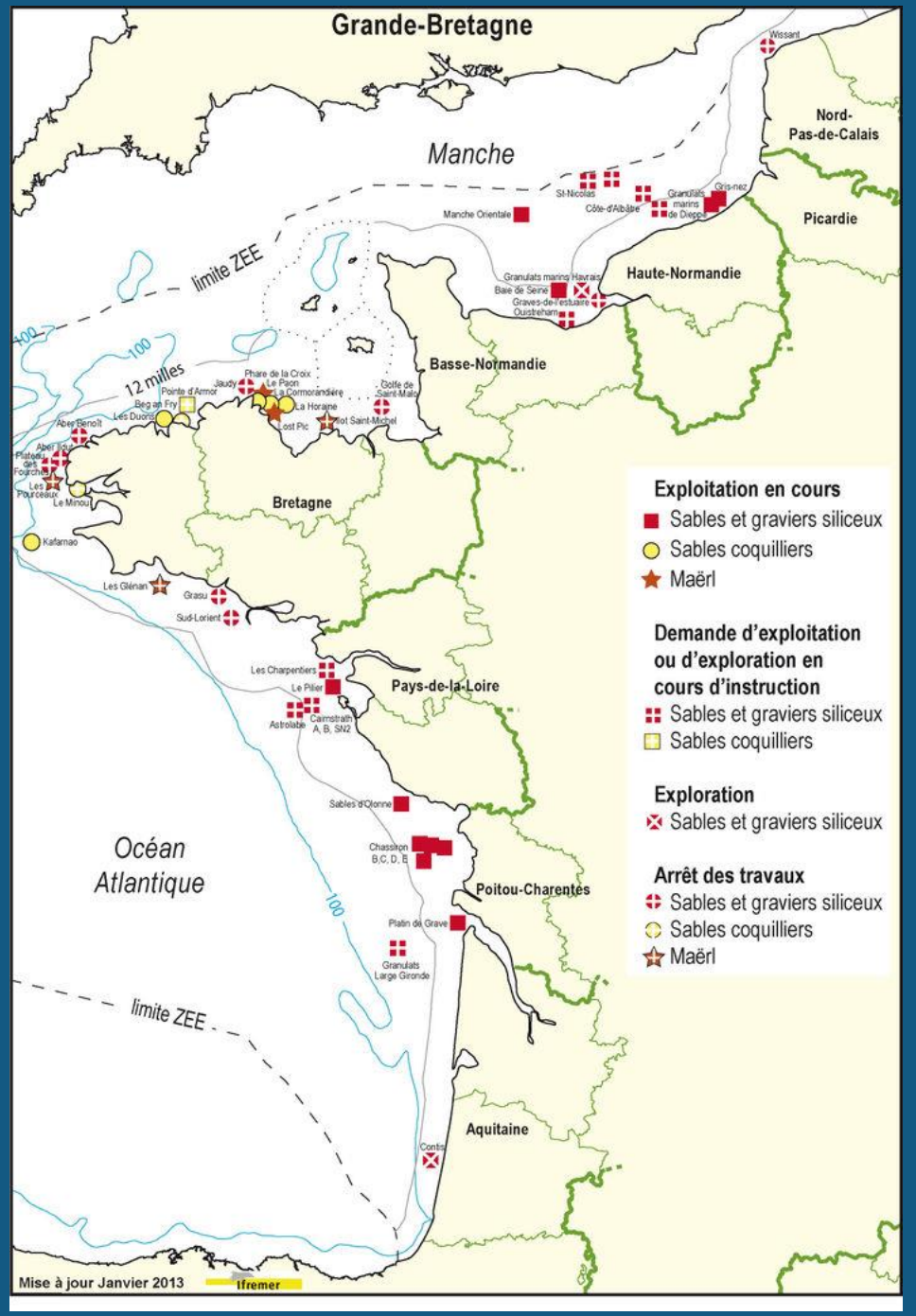
Maerl protected from demersal towed fishing gears in 2014

Direct exploitation of maerl beds (Atlantic only)

Bretagne, Ilot S. Michel (France)
Extraction of 76,000 m^3 of maerl yr^{-1} for about 50 years leads to RB destruction, sedimentary disequilibrium (lack of carbonate production by coralline algae), and erosion of up to 30 m of coastal dunes.

Bretagne, Glenan Islands (France)
120,000 t yr^{-1} extracted lead to complete defaunation (Grall & Glemarec 1997).

Following the European Directives, all extraction was terminated at the end of 2013



- Indirect exploitation of maerl beds (Atlantic and Mediterranean)

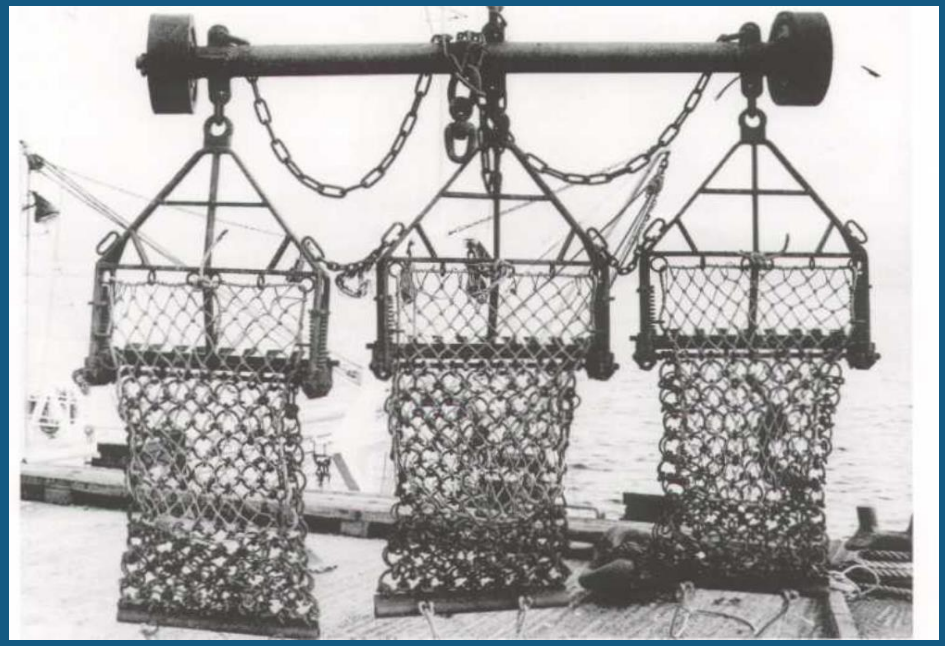
Fisheries: scallop dredging and trawling

Clyde Sea area, SW Scotland, UK
~ 70% reduction in live corallines after scallop dredging (*Aequipecten opercularis* (L.) and *Pecten maximus* (L.)

Dredged plots with no signs of recovery over the subsequent 5 years.

Extensive physical disturbance along ~2.5 rn wide tracks with excavation of persistent furrows after dredging.
Live maerl buried up to 8 cm below the sediment surface
Biogenic carbonates crushed and compacted (Hall-Spencer 1999).

Following European Directives, trawling is illegal on maerl made of *L. corallioides* and *P. calcareum*, that are protected…..



scallop dredges, each dredge mouth measures 75 cm across

- Indirect exploitation of maerl beds (Atlantic and Mediterranean)

Fisheries: scallop dredging and trawling

SE Iberian Peninsula
Comparison between protected (Tabarca) and impacted (Benidorm) sites:

Sediment mixing and loss of stratification after trawling

Reduced live rhodolith cover and rhodolith mean size
Reduced species richness and epifaunal abundance
Algal shift from corallines to fleshy algae (Bordehore et al 2003)

Italy
Towed fishing gears are illegal within 3 nm from coast and 50 m depth, and always illegal within 1.5 nm from coast, but controls are insufficient.

Boats are remotely controlled, but several ways to escape controls

Unknown distribution, areal extent and composition of RBs.

Legal protection inadequate because of equivocal definitions in the European directive (Basso et al, in press).

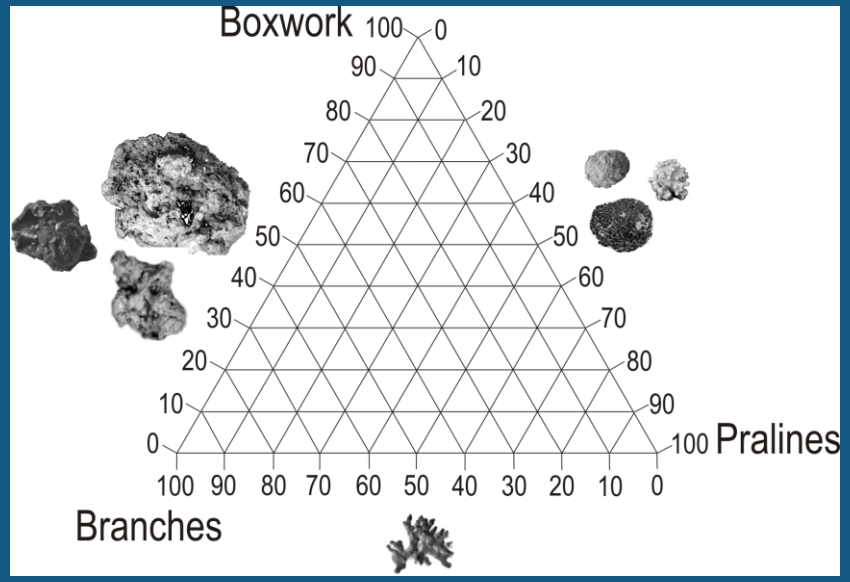
Environmental impacts on RBs in Europe

Source	Impact	Effect	Duration	Extension	Knowledge to be improved
Anchoring, pipelines, cables	Disturbance to seabed	Displacement, turbidity, smothering	Short-terme (?)	local	yes
Harbour dredging, construction	Disturbance to seabed	Displacement, turbidity, smothering	Long-term	local	
Discharge of solid waste	Disturbance to seabed	Shadowing, smothering, change of substrate, habitat loss	Medium to long-term	local	
Sewage, Aquaculture	Organic enrichment, chemical pollution from fish farming	Turbidity, water quality deterioration, oxygen depletion	Short to medium-term (?)	?	Yes
Maerl mining	Disturbance to seabed and coralline removal	Depletion of maerl deposit, live and dead substrate removal, fragmentation, siltation, sedimentary loss, coastal erosion	Long-term	local	
Bottom trawling	Disturbance to seabed	Displacement, fragmentation, turbidity, smothering, habitat loss	Medium to long-term	local	
Marine acidification	decreased thallus growth; structural weakness		Long-term	northern and shallow RBs of Europe	Yes

European RBs
heterogeneous habitats for biogeographic and ecological reasons.
Community β diversity (compositional dissimilarity) not explored yet.

small and patchy, with obvious differences between Atlantic and Mediterranean.

in the Mediterranean, heterogeneous RBs also because of variable 3D and species composition.

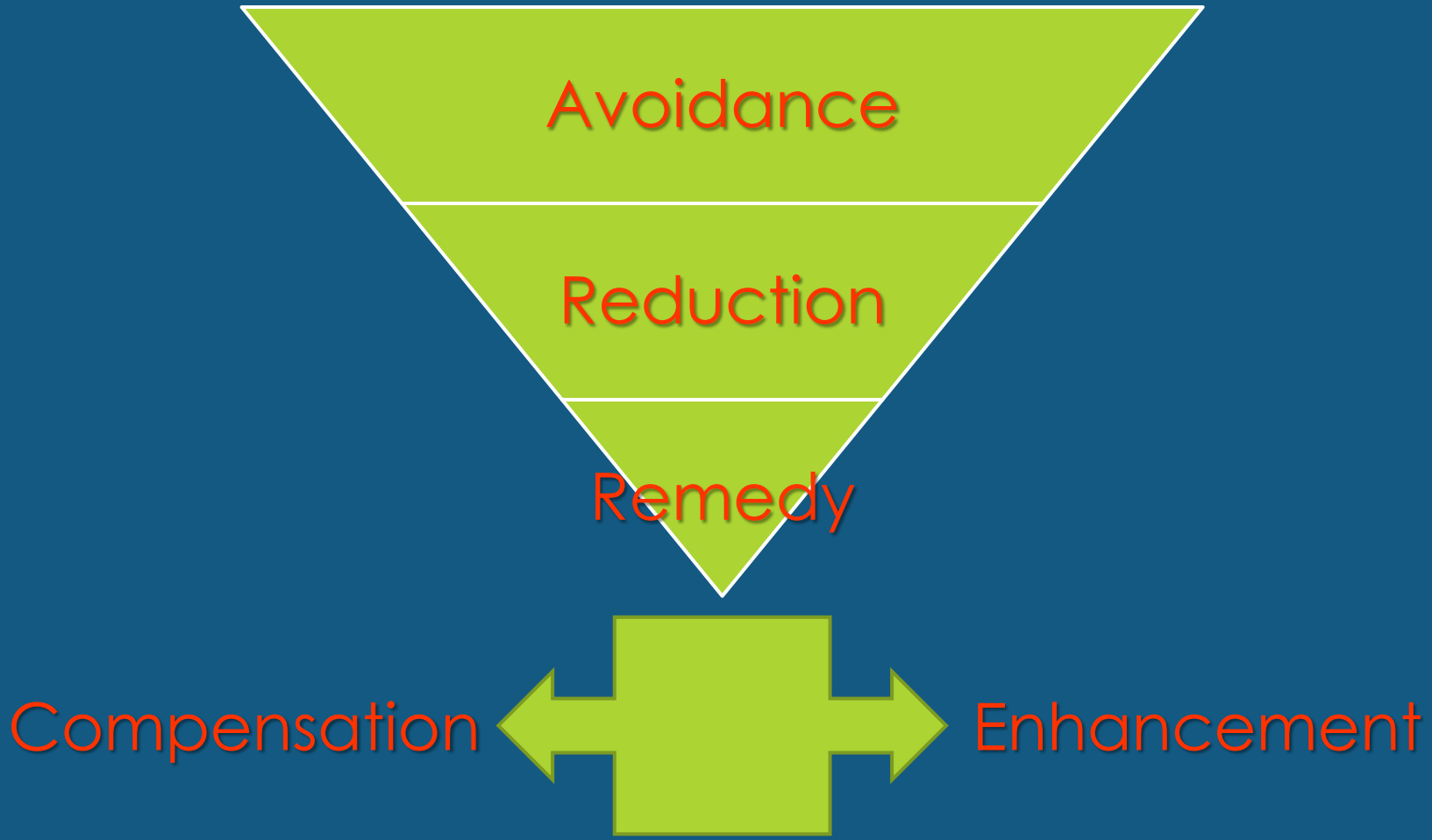


Different combinations of rhodolith 3D structures likely support different benthic associations (Figueiredo et al., 2007, Berlandi et al 2012)

A proxy for interbed diversity

Basso et al in press, Aquatic Cons. Mar. & Fresh. Ecosyst.

Hierarchy of mitigaton measures



European legal protection is aimed at keeping Good Environmental Status (GES) of European seas (Habitat Directive)

Selected habitats to be monitored every 6 years to prevent loss of habitat diversity and consequent loss of biodiversity.

The European way to mitigation is avoidance of pressure

Maerl among targeted habitats for special protection, but definition unclear (see also EUNIS habitat classification)

Problems for implementation of a very ambitious law

Low-cost solution: GES for maerl beds when no reduction in areal extent occurs during monitoring (!)

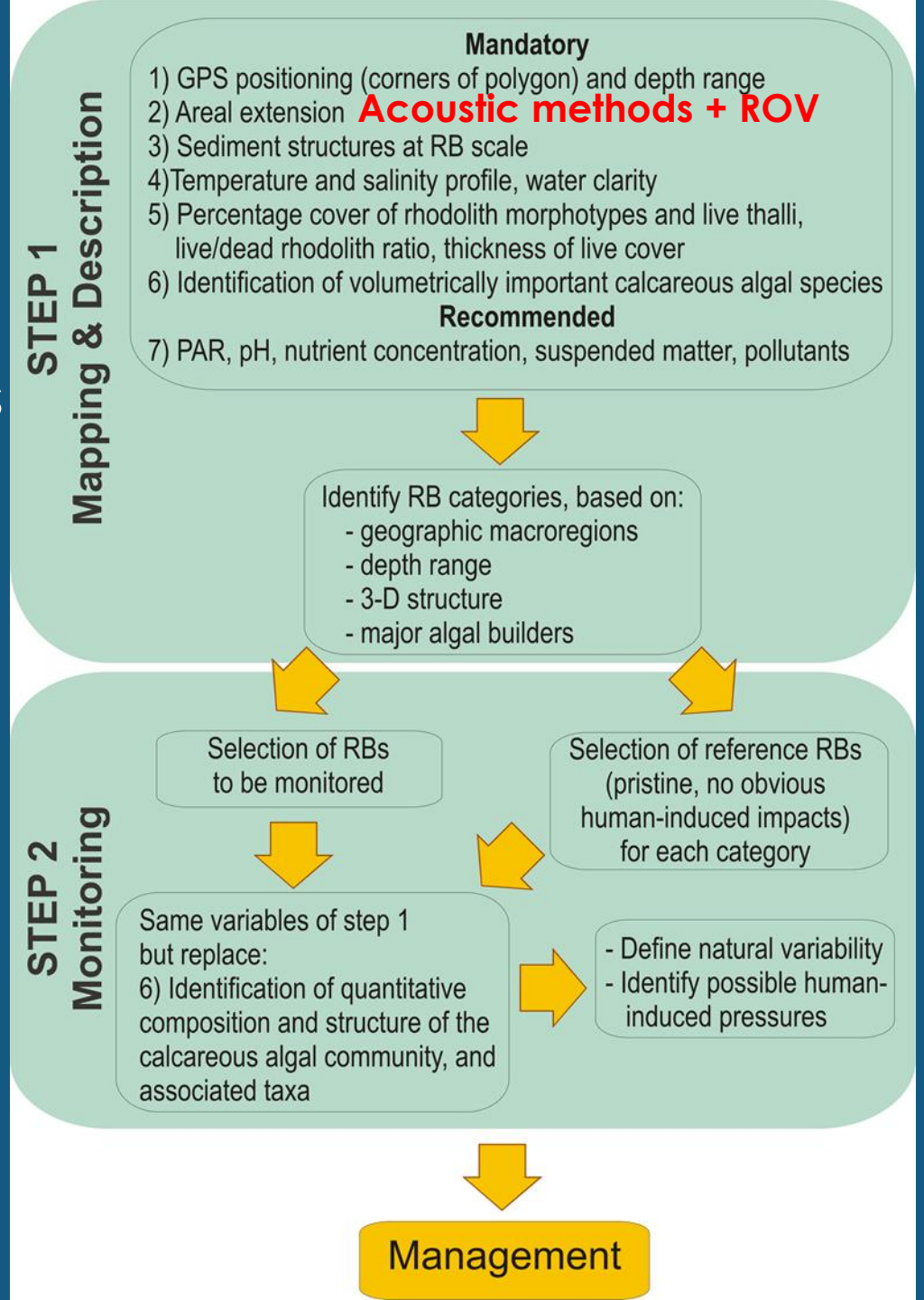
BUT….

spatial extent alone not a sufficient descriptor:
Inter-bed heterogeneity (location, depth, species composition, 3D)
Seasonal changes
Possible non apparent shift in dominant species

Selection of pristine RBs for reference?
Reference for which other maerl bed?

A two-steps strategy is needed:

- financially affordable
- **considering the β diversity of RBs**
  (Basso et al in press)



Some definitions:

live RB when live cover > 10%

Minimum area to be considered for mapping: 500 m^2 (1:10000)

Rhodolith when >50% is coralline algae, but coated grains can be included for mapping (no need to cut them all!).

Box-corers with opening = 0,16 m^2. Dredging to be avoided (destructive, no quantitative data).

SUSTAINABLE EXPLOITATION AND MANAGEMENT OF NATURAL RESOURCES (coralline mining)

Europe

small
patchy
diverse
slow growth rate

non-renewable resource
overexploited

Type of mitigation:
AVOIDANCE

Brazil

large
continuous (?)
diverse
slow growth rate (???)

non-renewable resource (?)
exploited

Type of mitigation:
REDUCTION (???)

SUSTAINABLE EXPLOITATION AND MANAGEMENT OF NATURAL RESOURCES (coralline mining)

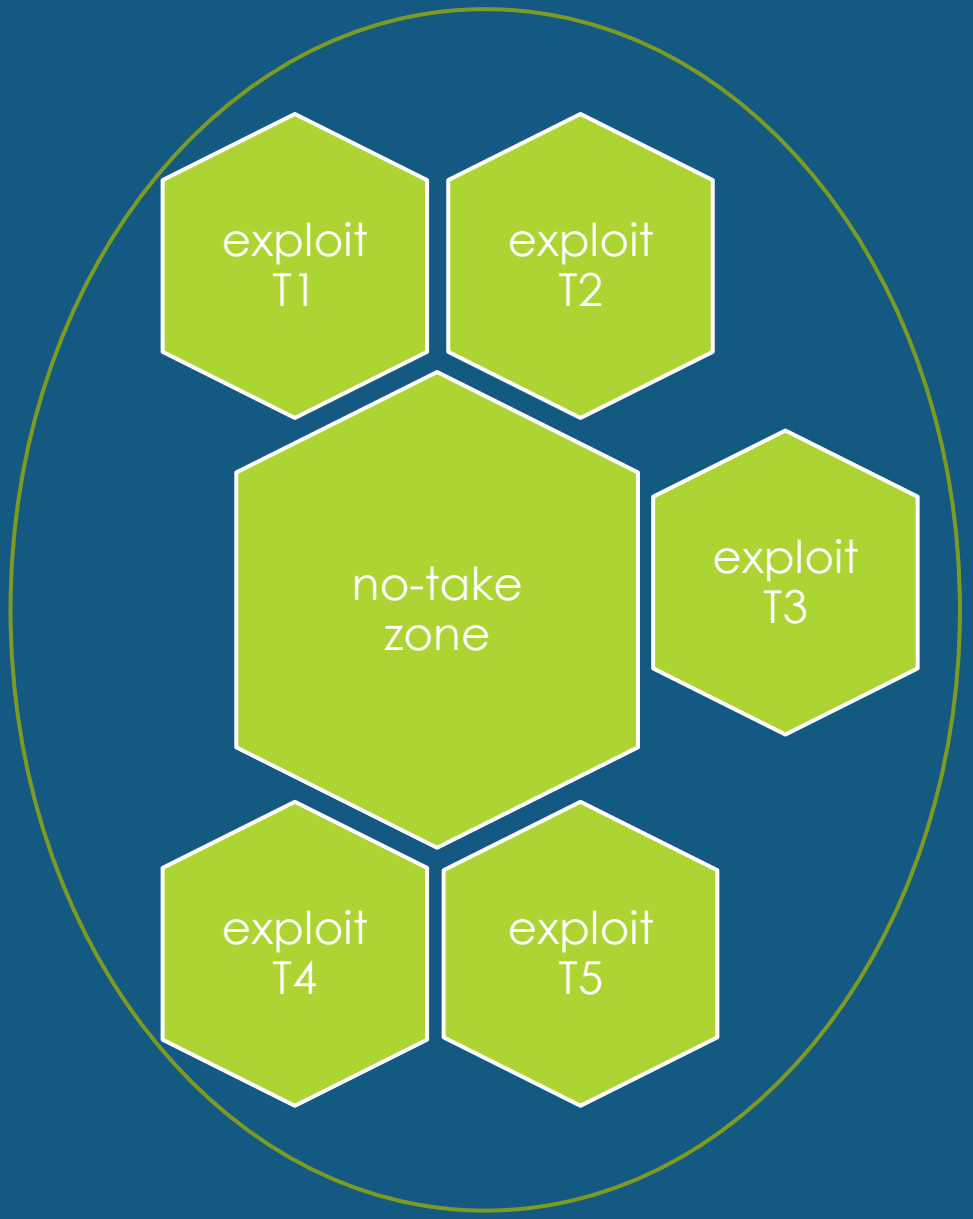
Production/ Uptake >> 1 for each unique kind of natural resource (unit)

Identify and characterize units and their production (β diversity, RBs site and boundaries, growth rate, mean rhodolith size etc.)

Identify no-take zone of total protection

Explore possibility of moderate exploitation (no industrial dredging) outside the no take zone, in small, circumscribed areas, for short periods (T1…T5 few years each). Explore possibility of turn over

Organize monitoring and controls



Potential environmental impacts on RBs from O&G

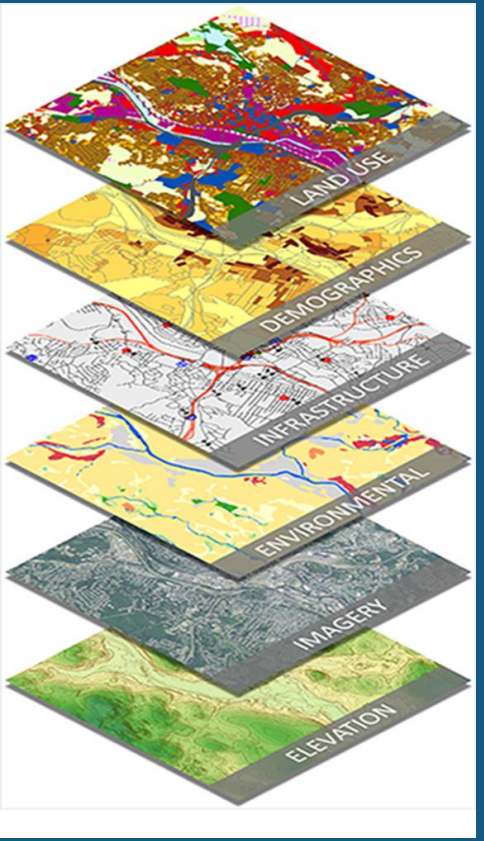
Source	Impact	Effect	Duration	Extension	Knowledge to be improved
Anchoring, pipelines	Disturbance to seabed	Displacement, turbidity, smothering	Short-term (?)	local	yes
Activity of support vessels	Discharges	Reduction of water quality	Short-term	local	
Produced water	Chemical pollution	Bioaccumulation, toxicity	Medium-term	?	yes, from clustered or multiple impacts
Cuttings discharge	Physical disturbance, chemical pollution	Turbidity, smothering, Reduction of water quality	Medium to long-term	?	yes, from clustered or multiple impacts
Drilling fluids (WBM)	Chemical pollution	Bioaccumulation, toxicity	Short-term	local (?)	
Drilling fluids (OBM)	Chemical pollution	Bioaccumulation, toxicity,Turbidity, smothering, Reduction of water quality	Medium to long term	local	
Drilling fluids (SBM, EBM)	Chemical pollution	Bioaccumulation, toxicity	Short-term	local	
Discharge of solid waste	Disturbance to seabed	Shadowing, smothering, habitat loss	Medium to long-term	local	
Oil spills	Chemical pollution, disturbante to seabed	Toxicity, smothering, chance of substrate property	Long-term	diffuse	yes, see ITOPF

Priority actions

- Mapping as strategic tool for the management of National resources. Creation of a multilayered database in GIS to improve evaluation of multiple/clustered impacts in a complex natural + socioeconomic context.

- A National repository for marine samples ? (waiting for specialists in Academia)

- Main impact on RBs from sedimentation, inducing smothering: explore species-specific tolerance to burial (Figueiredo et al 2015).



- Describe pathways of sediment transport across the shelf (dominant and seasonal currents, model of transport and settlement of particles), also for industrial mining

- Explore interbed heterogeneity in species composition (foundation species and associate community), possibly related to different 3D of RBs.