Marine Ecosystem Restoration
in Changing European Seas

WP5

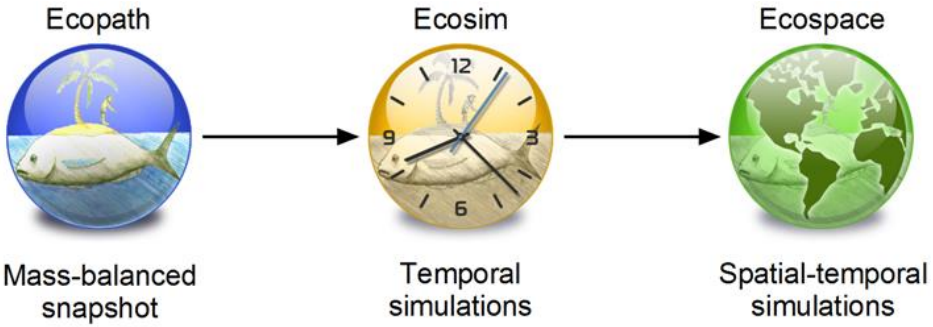
Dynamic food web models reveal potential effects of ecosystem restoration

MERCES final meeting
10th-11th November 2020
Sabine Horn and Marta Coll

MERCES

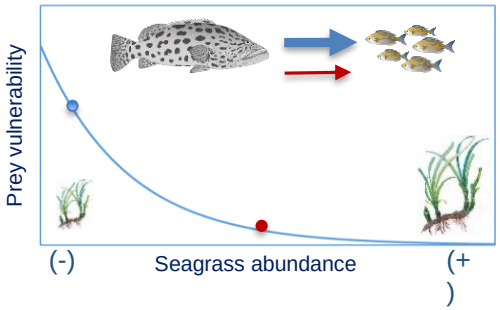
Food web modelling

- Quantitative (marine) ecosystem modelling (MEM) approach
- Tracking path of energy through food web components
- Different methodologies -> Ecopath with Ecosim and Ecospace
- Dynamic (spatial-) temporal model
- Includes environmental data and human activities
- Trophic and non-trophic interactions
- Future scenarios of change



Modelling habitat-forming species

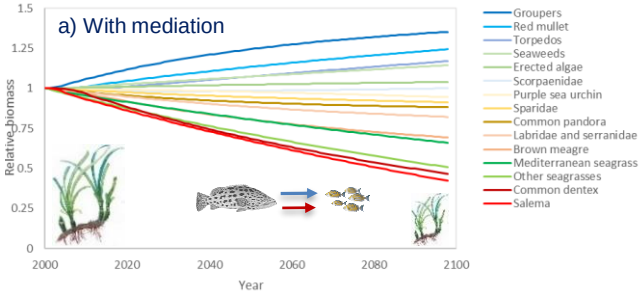
HABITAT ROLE

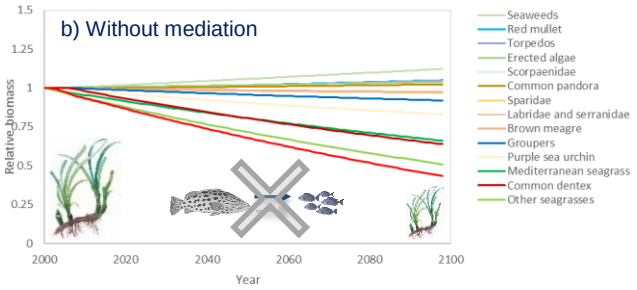


Positive ecological relationships (e.g. mediation) are parameterized using fieldwork data to model key interactions between species, considering density-dependencies.

- HFS provide key services and functions
- When HFS are degraded, their roles erode and can even disappear
- Conservation and recovery of HFS essentiel to maintain key processes

HABITAT CHANGE





- Non-trophic interactions of HFS are essential and need to be included in model (mediation)

MERCES

Three pilot case studies

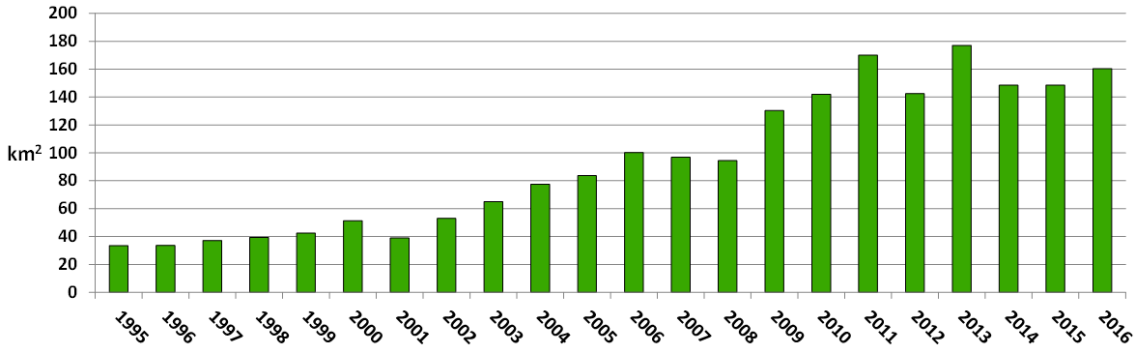
Seagrass meadows in the Wadden Sea

Kelp belts in Arctic Norway and deep sea ecosystems

Coastal areas of the NW Mediterranean Sea

Influence of seagrass recovery on Wadden Sea ecosystem

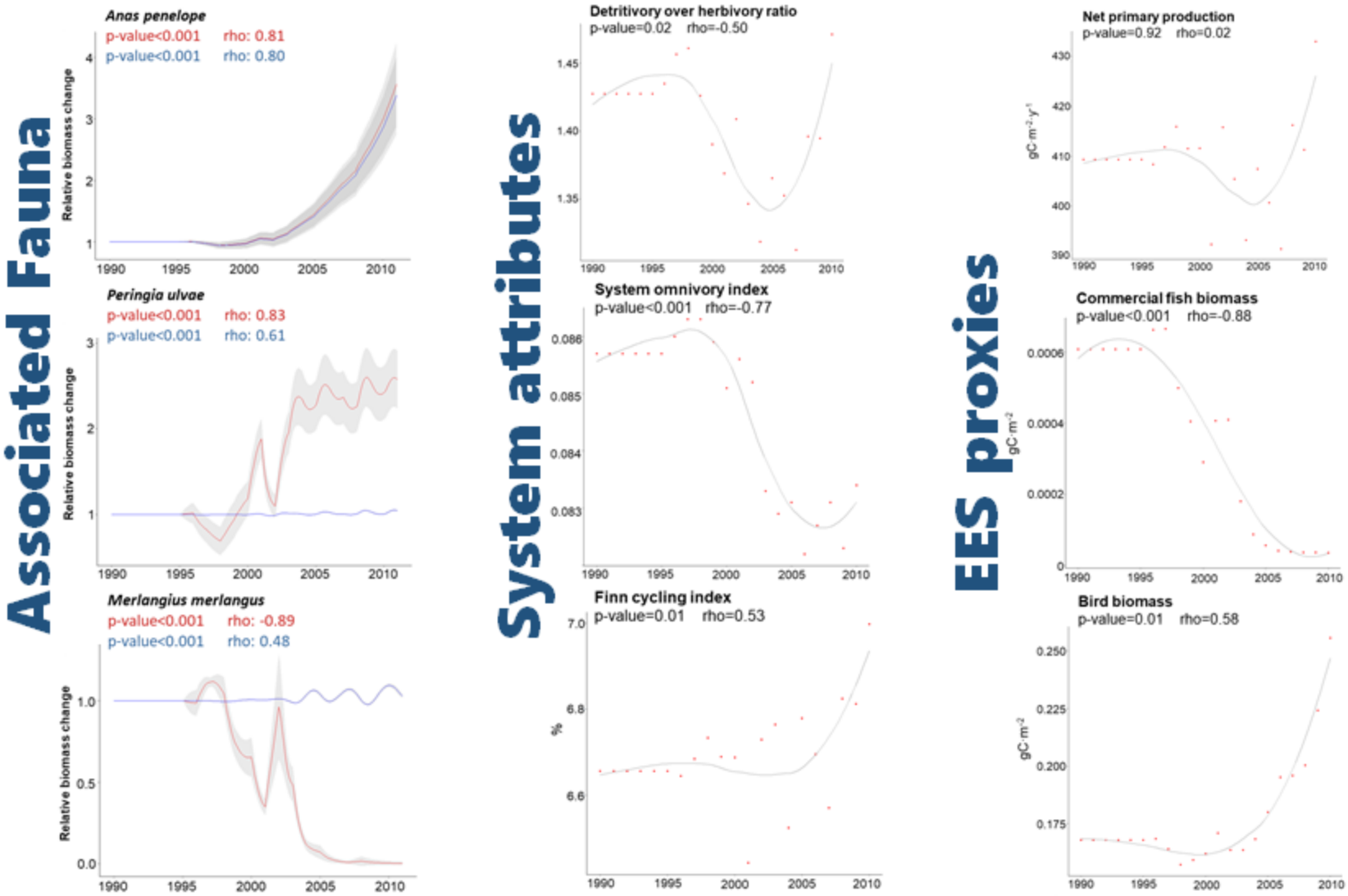
- Passive recovery of seagrass in northern part
- Potential effects on ecosystem-level
- Basic food web model of 1990s
- Inclusion of mediation
- Dynamic modelling over time



Wadden Sea Quality Status report, Dolch et al. (2018)

Horn et al. (in revision)

Predicted recovery effects



Horn et al. (in revision)

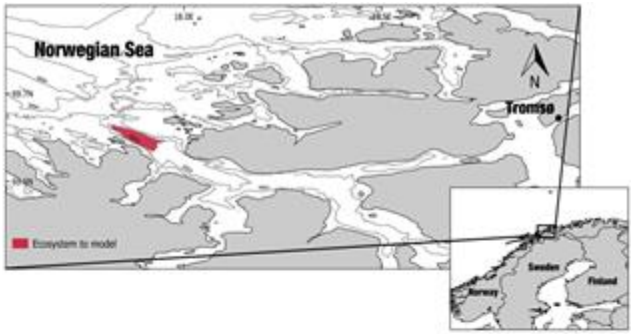
Conclusions from food web models

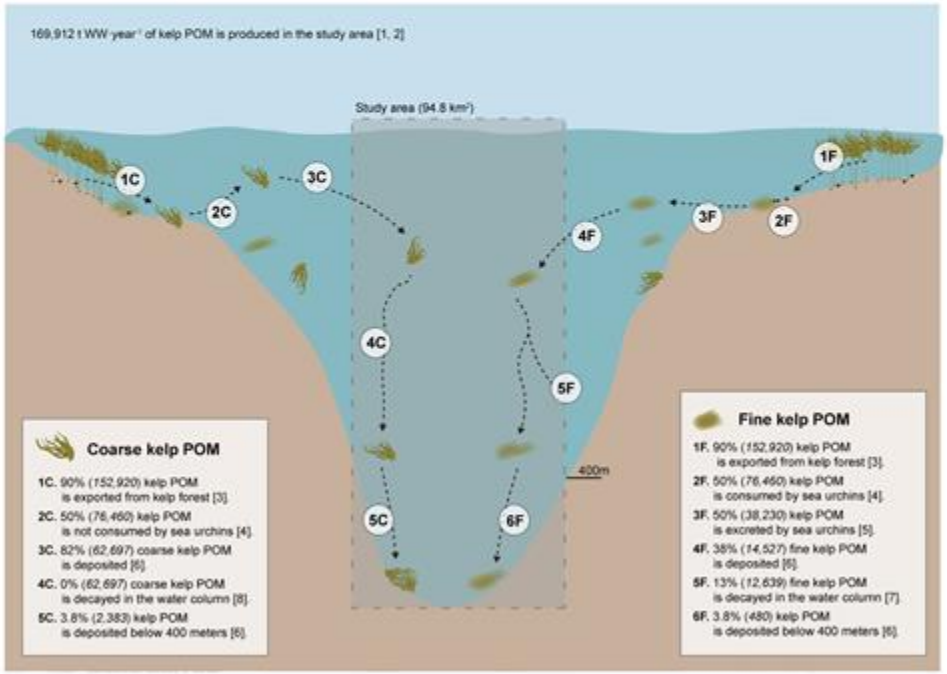
- Positive effect on consumers (more food)
- Mostly positive effects on inhabitants (enhanced protection)
- Indirect effects might influence trend
- Negative effect on inhabitants' predators
- Mediation is important
- Results can differ from reality
- Effect on system functioning inconclusive

Horn et al. (in revision)

Arctic deep sea ecosystem connected to coastal kelp forests

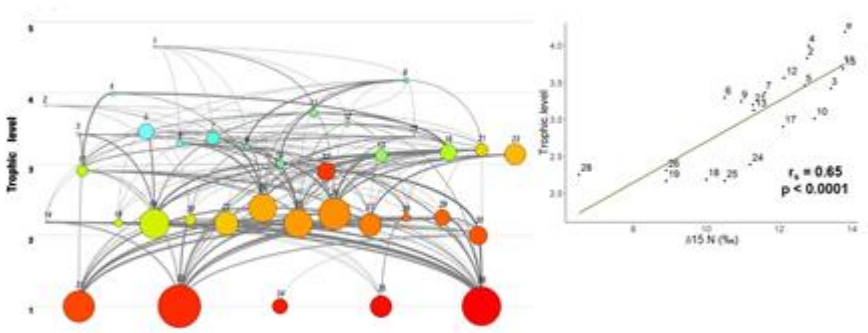
Study area located in Malangen fjord, Northern Norway, and the Arctic deep ecosystem associated with kelp exports (ADEAKE)



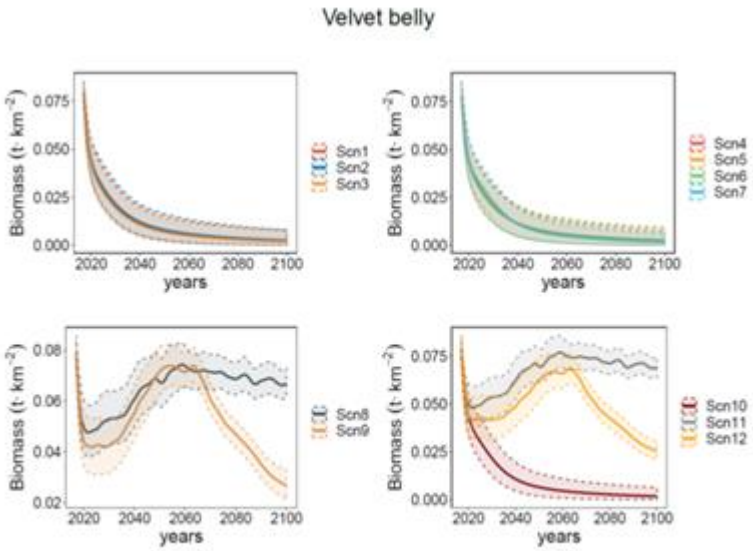


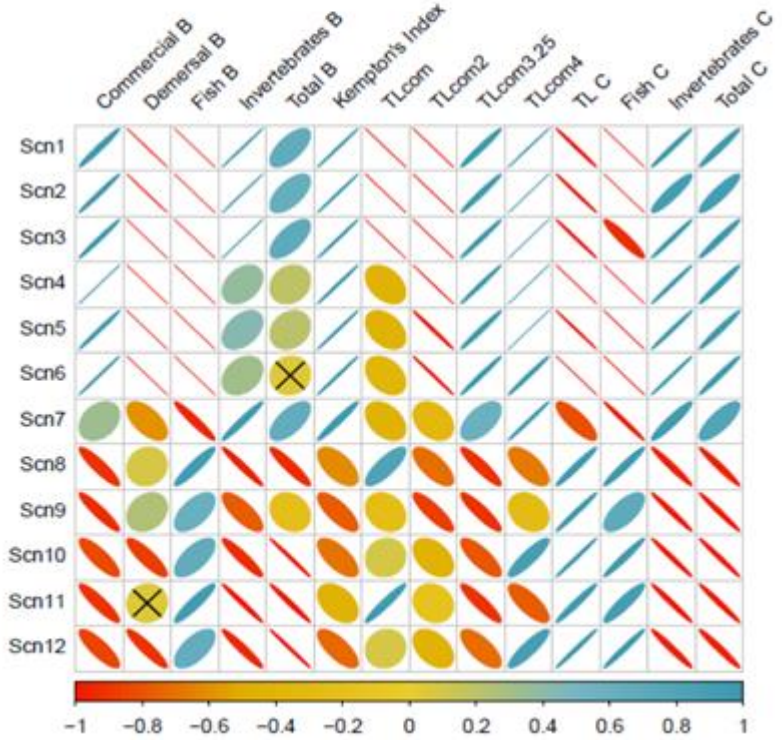
Vilas et al. 2020a, submitted

Predicted future cumulative effects



	Fishing effort	Coarse kelp POM biomass	Fine kelp POM biomass	Red king crab invasion	Sea bottom temperature
Scn1	=2017	=2017	=2017	Non	=2017
Scn2	-50%	=2017	=2017	Non	=2017
Scn3	+50%	=2017	=2017	Non	=2017
Scn4	=2017	-50%	-50%	Non	=2017
Scn5	=2017	+100%	-50%	Non	=2017
Scn6	=2017	-50%	-100%	Non	=2017
Scn7	=2017	=2017	=2017	Yes	=2017
Scn8	=2017	=2017	=2017	Non	RCP4.5
Scn9	=2017	=2017	=2017	Non	RCP8.5
Scn10	=2017	+100%	-50%	Yes	=2017
Scn11	-50%	+100%	-50%	Non	RCP4.5
Scn12	+50%	-50%	-100%	Yes	RCP8.5





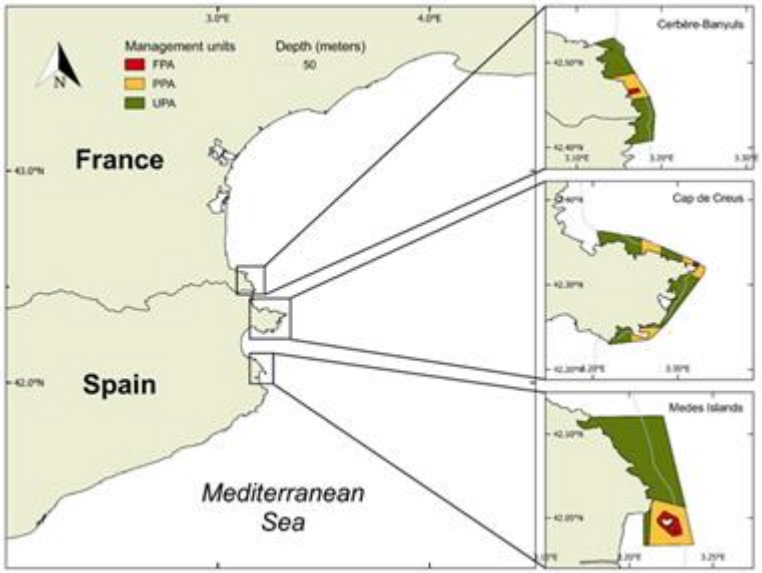
Vilas et al. 2020a, submitted

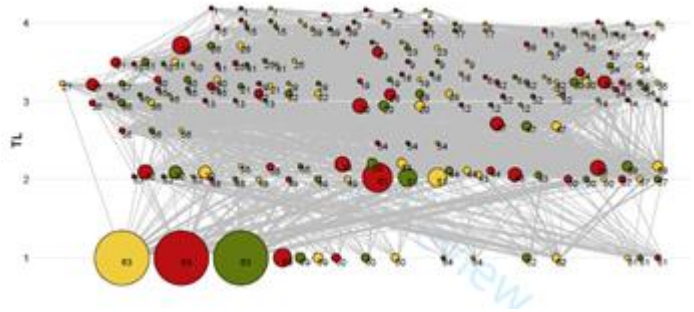
Conclusion from food web models

- Kelp detritus from shallow coastal areas has a small but noticeable role structuring the deep-sea ecosystem
- Mediation is important to assess this role and future changes
- Depletion of kelp detritus can have noticeable impact on the deep-sea ecosystem structure
- The impact of climate change and cumulative effects of stressors will be large
- To assess the future changes of the Arctic deep-sea ecosystems dependencies with adjacent ecosystems and cumulative effects are essential to be considered

Vilas et al. 2020a, submitted

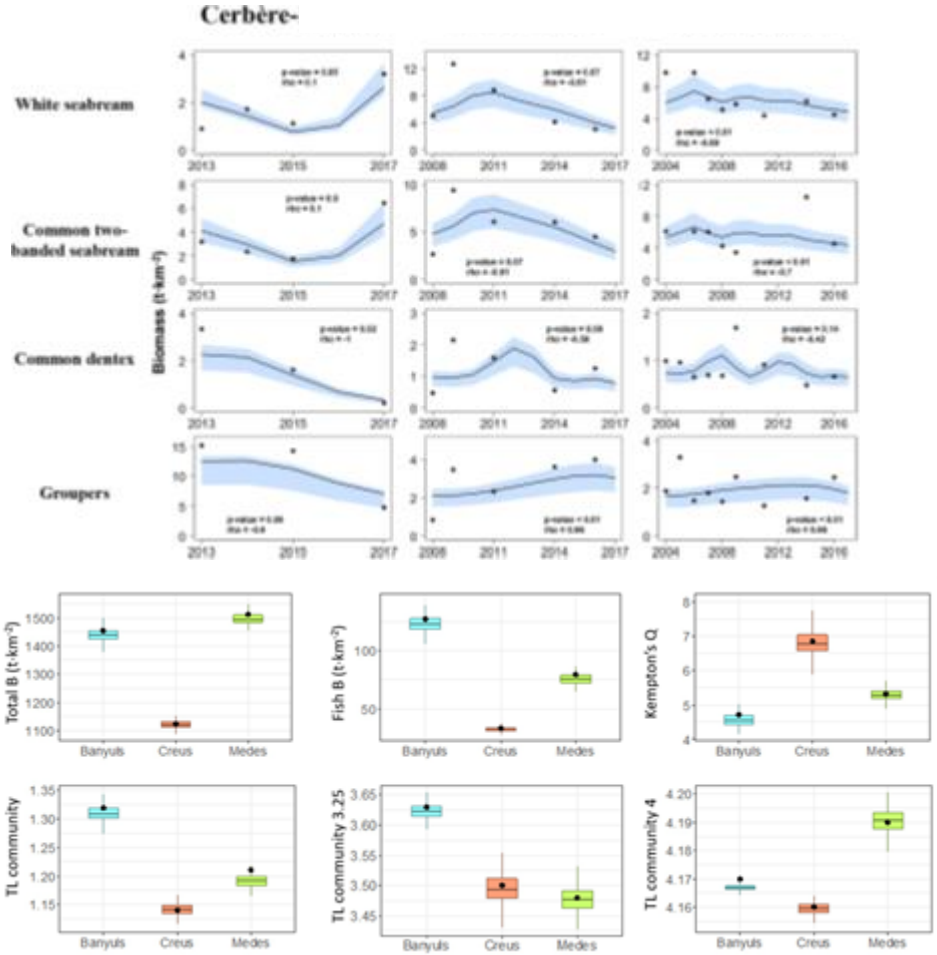
Coastal habitats of the NW Mediterranean Sea



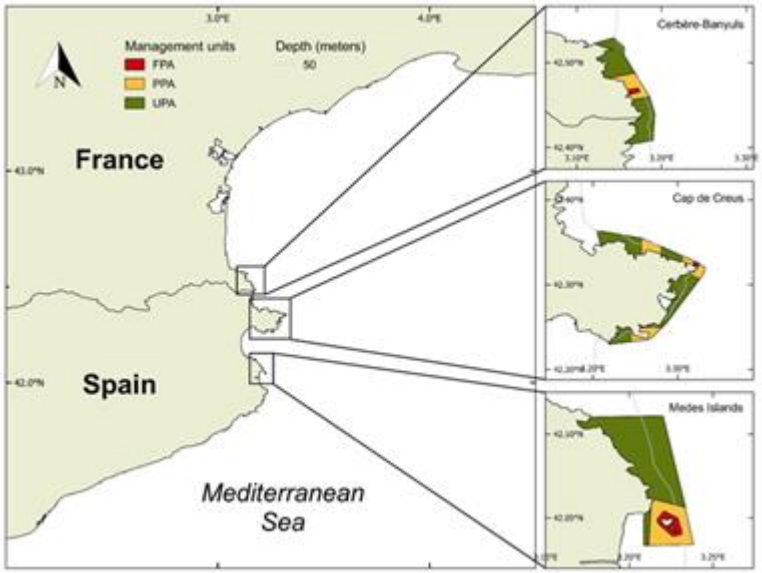


Vilas et al. 2020b; Corrales et al. 2020, in preparation

Study areas located in NW Mediterranean Sea, linked with multi-zone MPAs

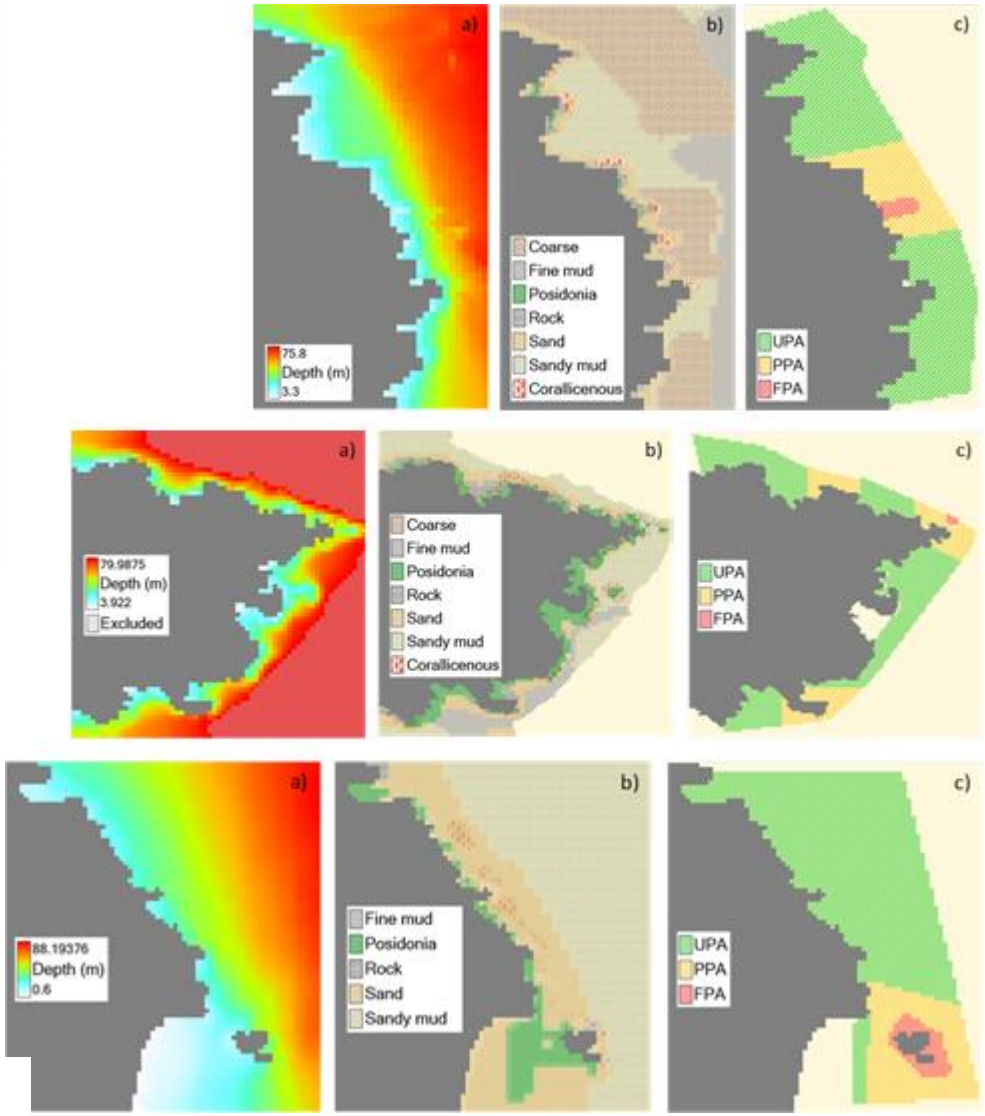


Predicted recovery effects



We are testing recovery scenarios for the three areas:

- Turning PPA into FPA
- Expanding MPAs
- Increasing HFS complexity



Vilas et al. 2020b; Corrales et al. 2020, in preparation

Conclusion from food web models

- Multi-zone MPAs advocated to reconcile conservation and fisheries
- The provision of both benefits is uncertain
- Our three MPAs in the NW Mediterranean Sea showed different ecological effectiveness
- Temporal increase of benefits were small with small recoveries of commercial and non-commercial species
- Currently testing spatial-temporal scenarios that include changes in protection, sustainable management of fisheries and HFS recovery to assess their potential
- Local data is scattered and scarce!

Vilas et al. 2020b; Corrales et al. 2020, in preparation

Lessons learned in MERCES

- MEMs represent structure and functioning of ecosystems well
- Pilot studies show MEMs potential to assess the link between species recovery and ecosystem services
- Some gaps highlighted when focusing on restoration/recovery effects
- Need more knowledge on trophic and non-trophic links
- Response functions need to be developed with local knowledge
- Need field data on ecosystem services provided by HFS to validate modelling results
- We are facing the challenges ahead to further develop these case studies and link the recovery of HFS to ecosystem services and, in general, to a diversity of Nature-based solutions (NBS)

References

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Thank you & close

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