

An underwater photograph showing a large school of small, silvery fish swimming in clear blue water above a rocky seabed covered in green algae. Sunlight rays are visible at the top of the frame.

GLOBAL CHANGE ECOLOGY AND SUSTAINABILITY
a.a. 2025-2026

Conservation and Management of Marine Ecosystems
Prof. Stanislao Bevilacqua (sbevilacqua@units.it)

Intertidal and subtidal rocky habitats

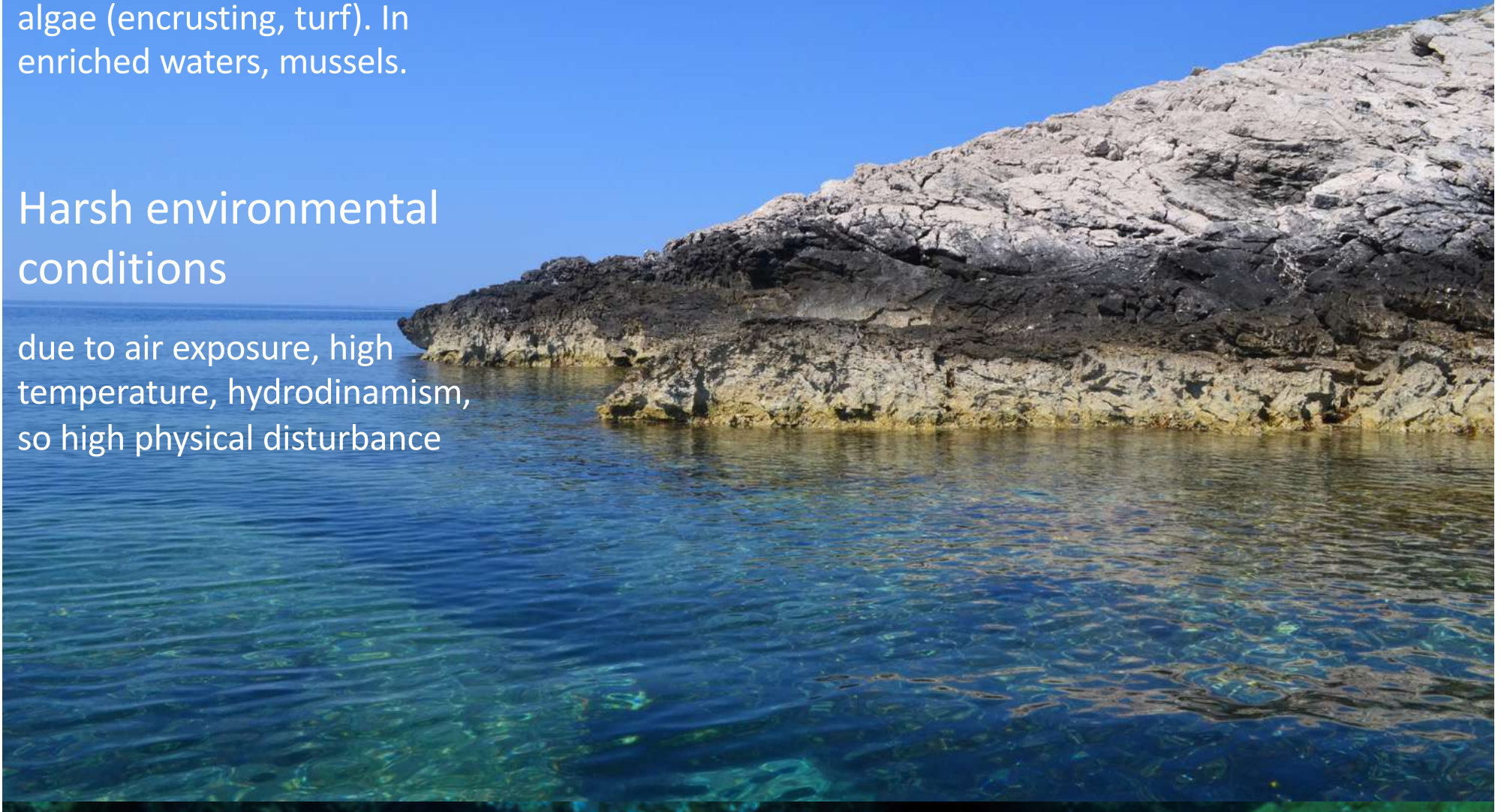
Intertidal rocky reefs

Reduced diversity

Barnacles, littorinids, limpets, cyanobacteria, anthozoans, algae (encrusting, turf). In enriched waters, mussels.

Harsh environmental conditions

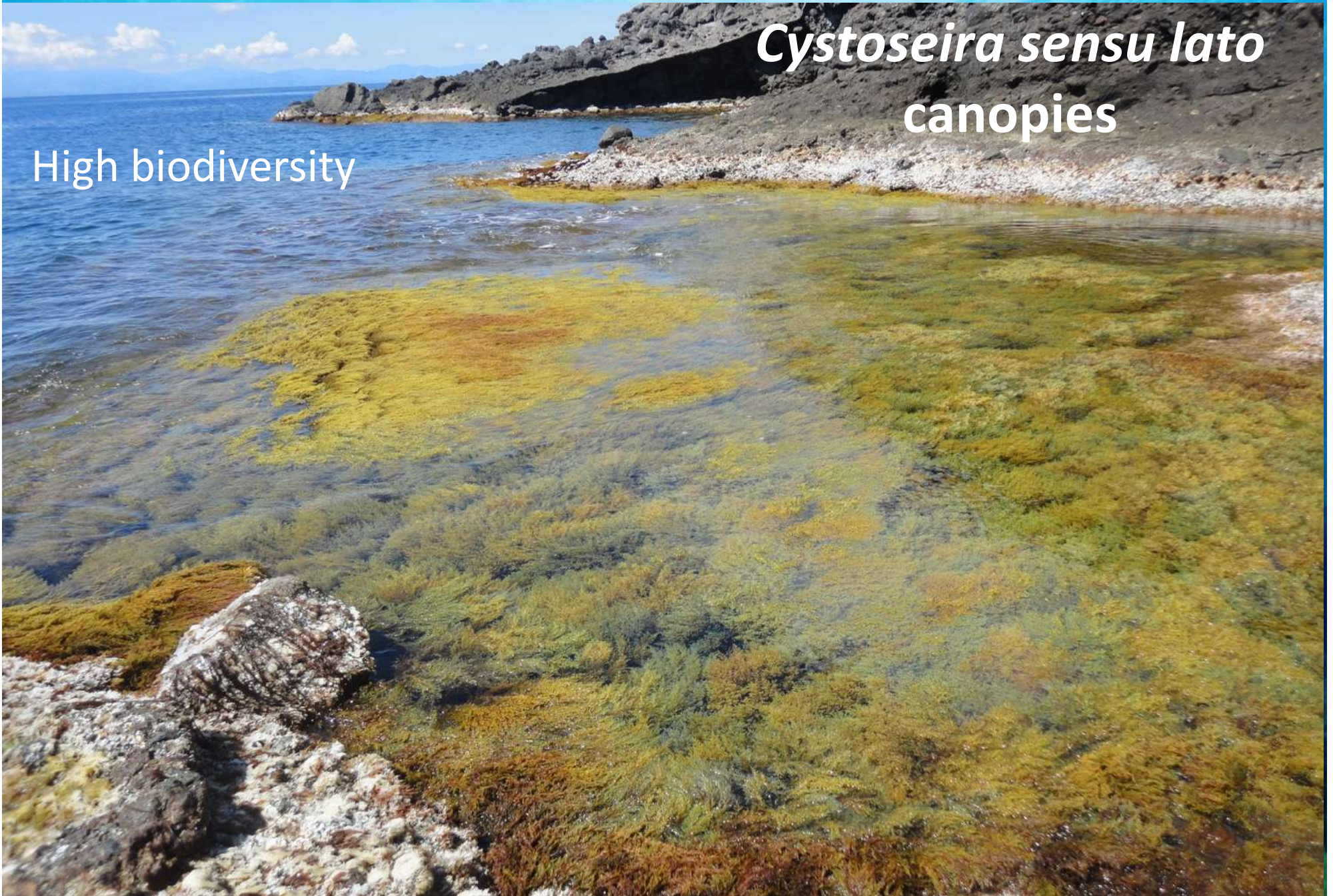
due to air exposure, high temperature, hydrodynamism, so high physical disturbance



Intertidal rocky reefs

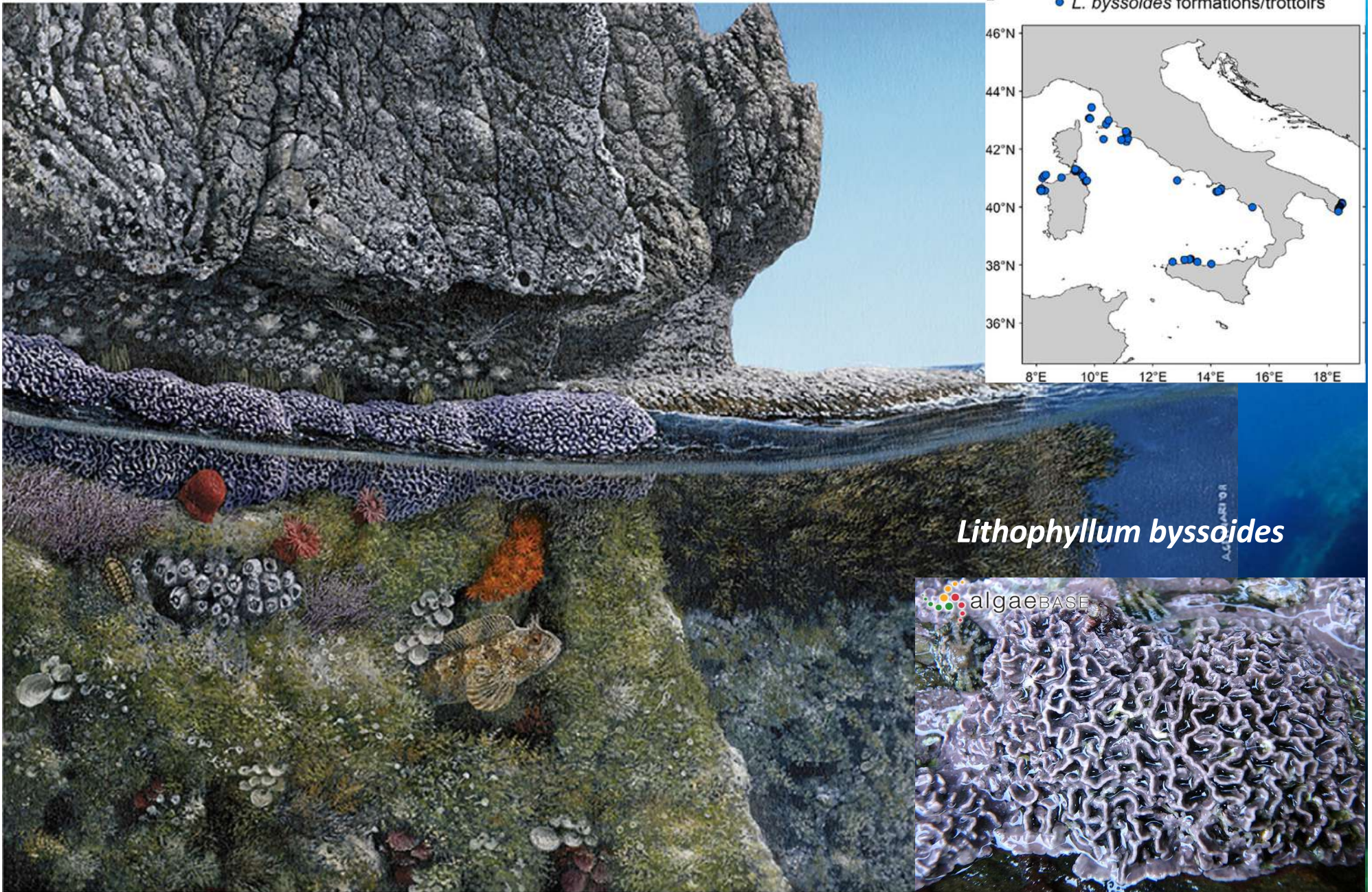
Cystoseira sensu lato
canopies

High biodiversity



Lithophyllum rims

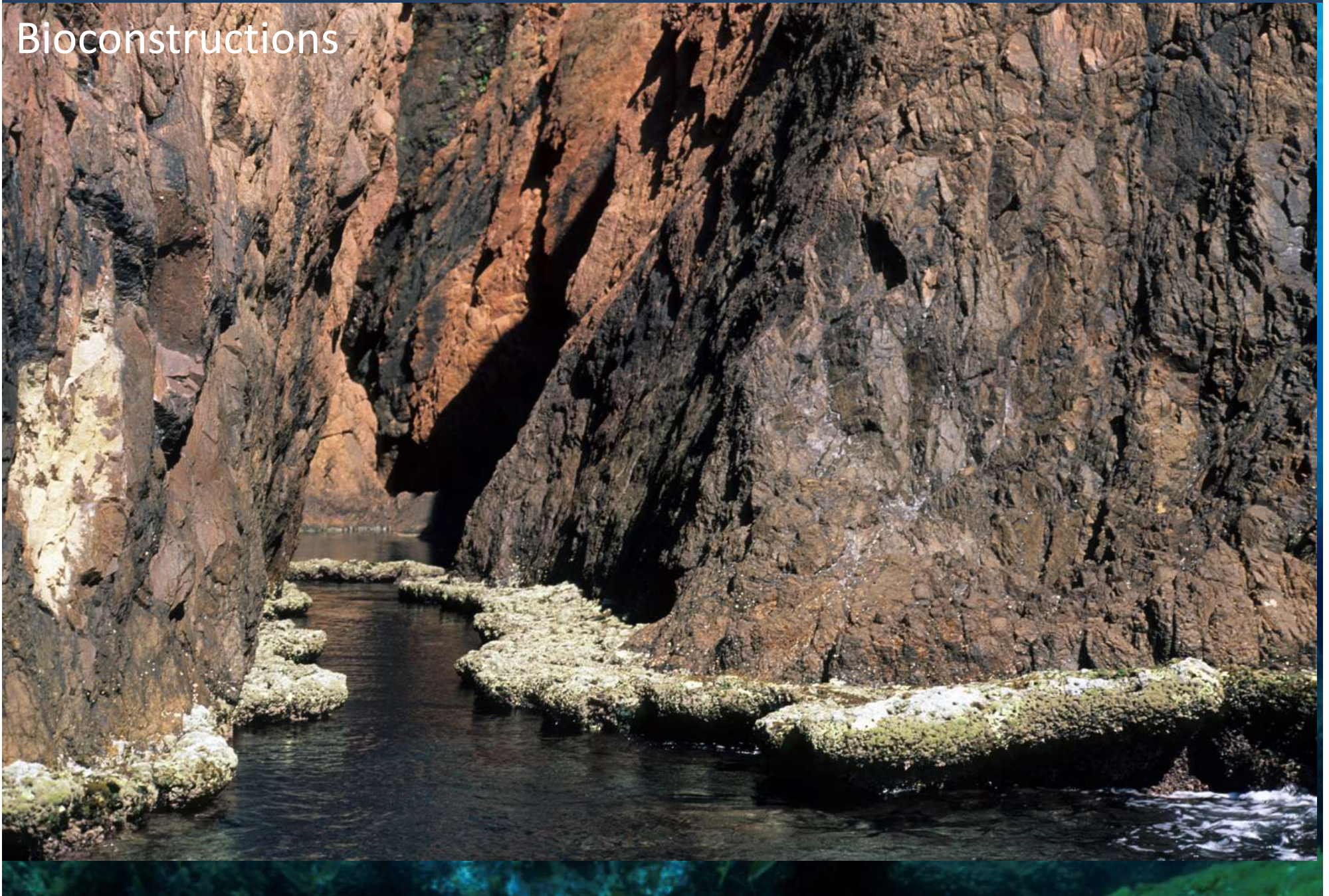
A



Lithophyllum byssoides

Lithophyllum rims

Bioconstructions



Vermetid reefs



algaeBASE

Lithophyllum incrustans



Dendropoma (Novastoa) petraeum



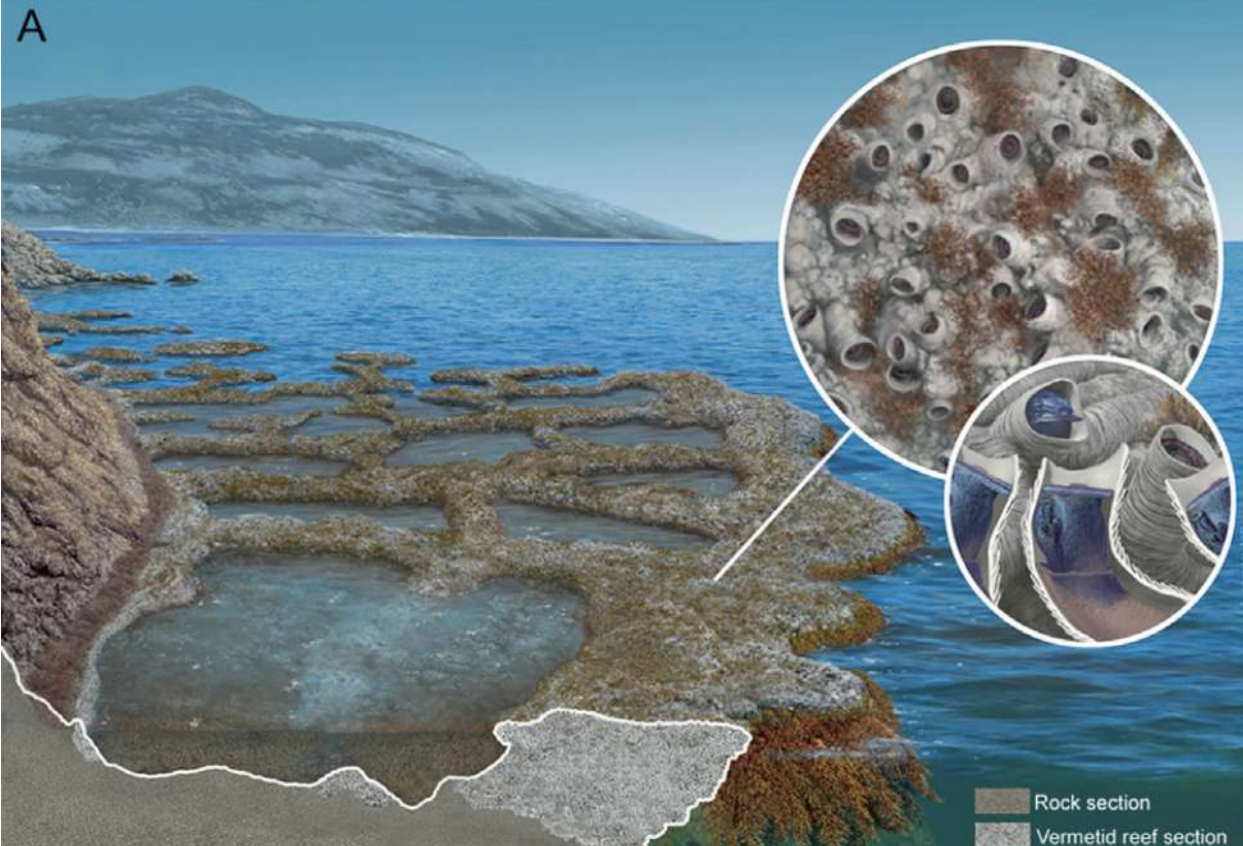
algaeBASE

Lithophyllum byssoides

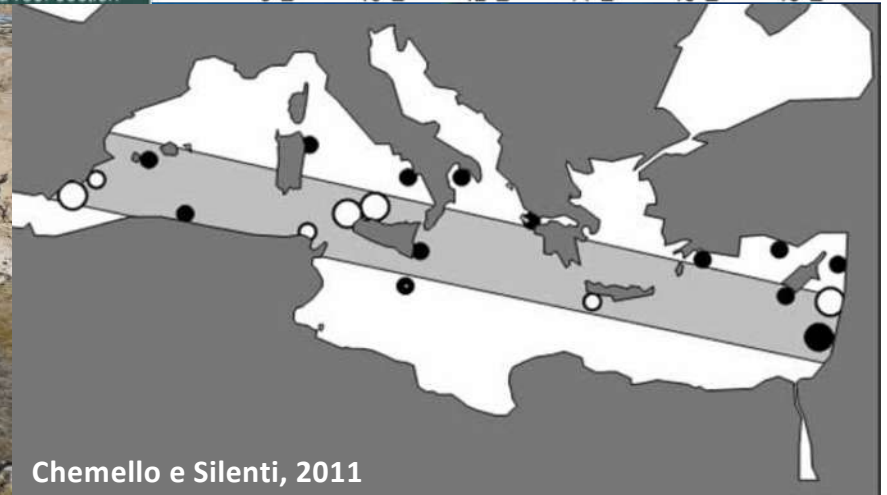
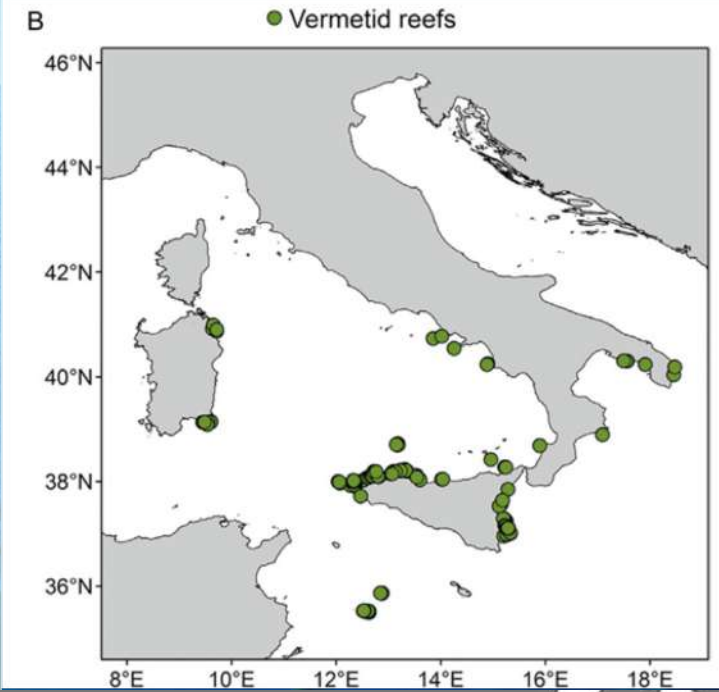


Neogoniolithon brassica-florida

Vermetid reefs



Distribution in Italy and the Mediterranean Sea



Vermetid reefs

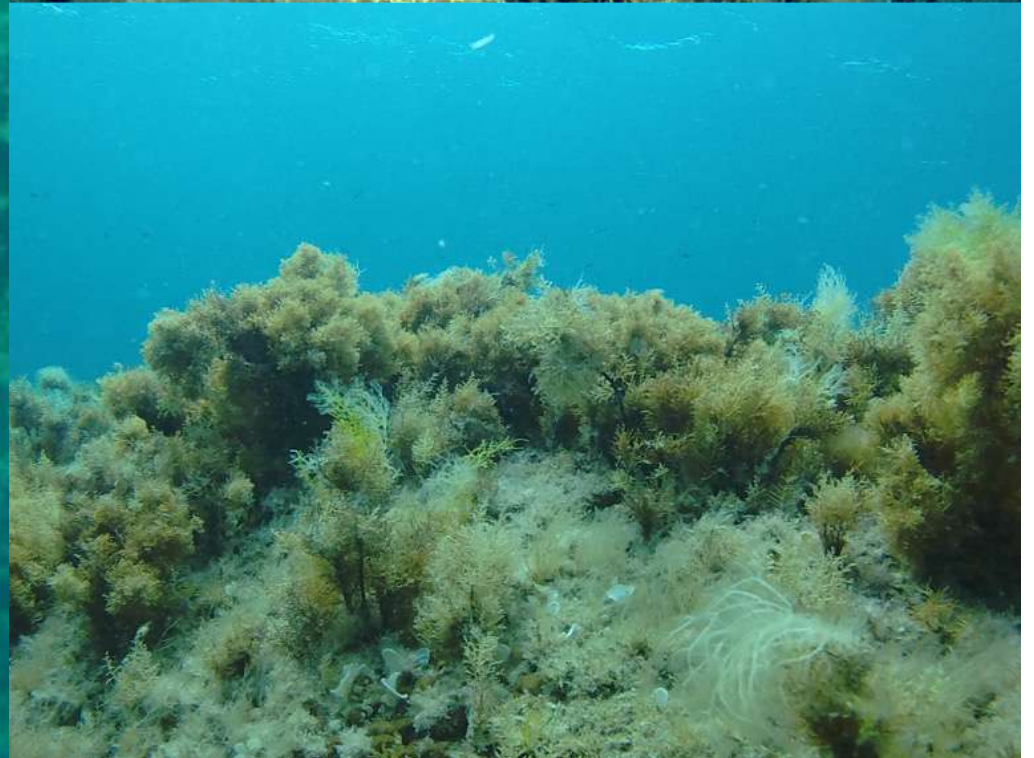


Subtidal macroalgal stands



Cystoseira s.l. forests

Fucales (*Ericaria*, *Gongolaria*, *Cystoseira*)



Subtidal macroalgal stands

Sargassum forests



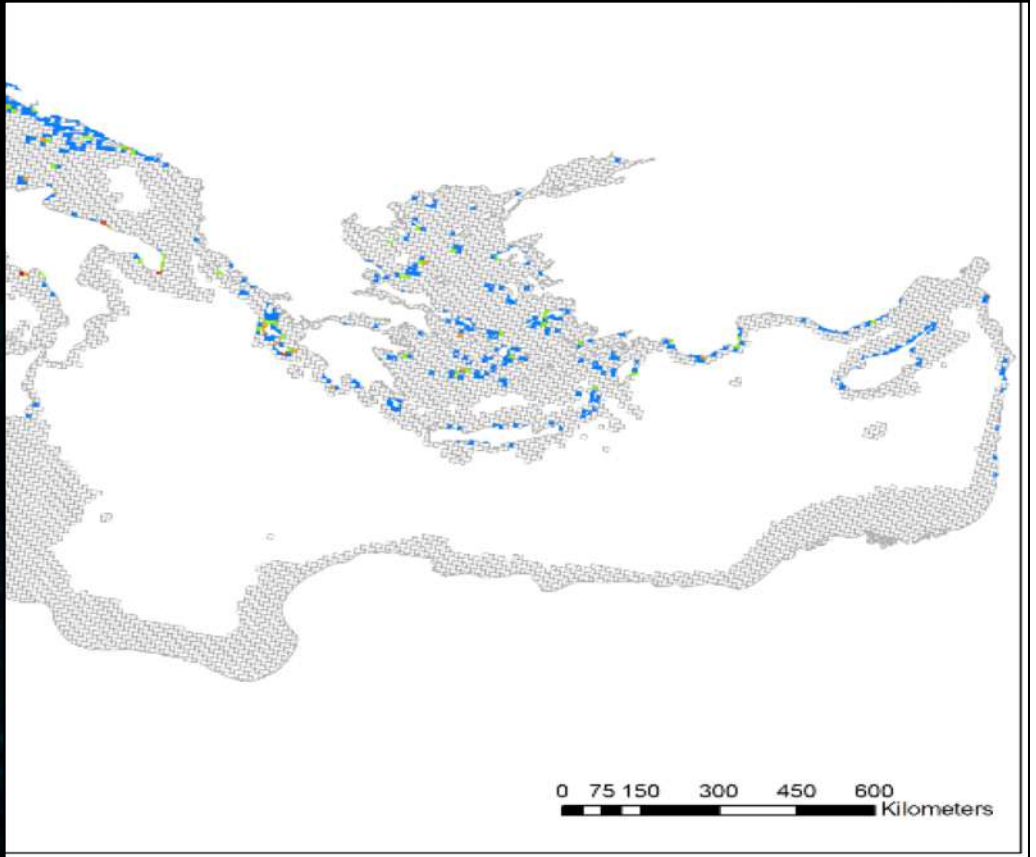
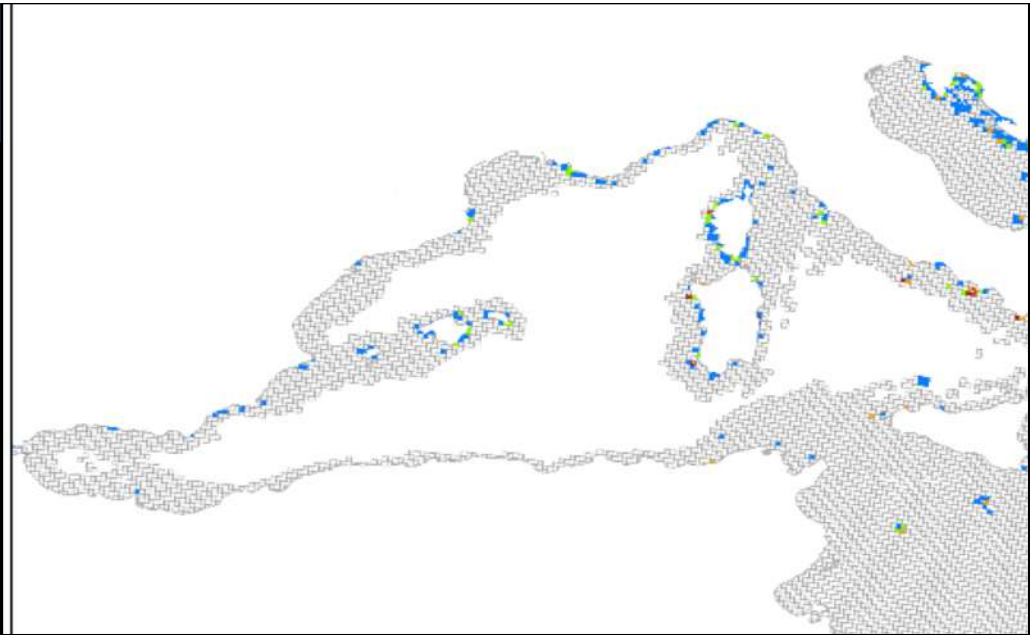
Subtidal rocky cliffs



Subtidal rocky cliffs



Submarine caves



Fish assemblages



Main human threats

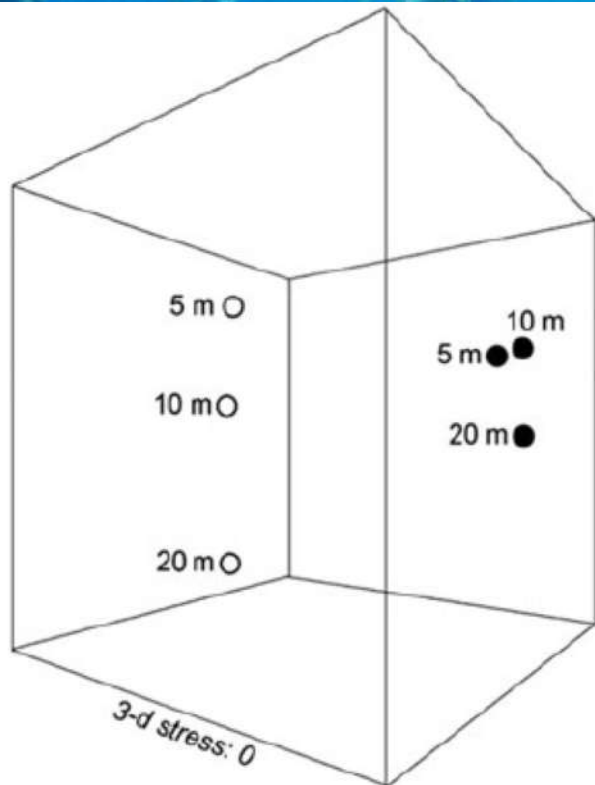
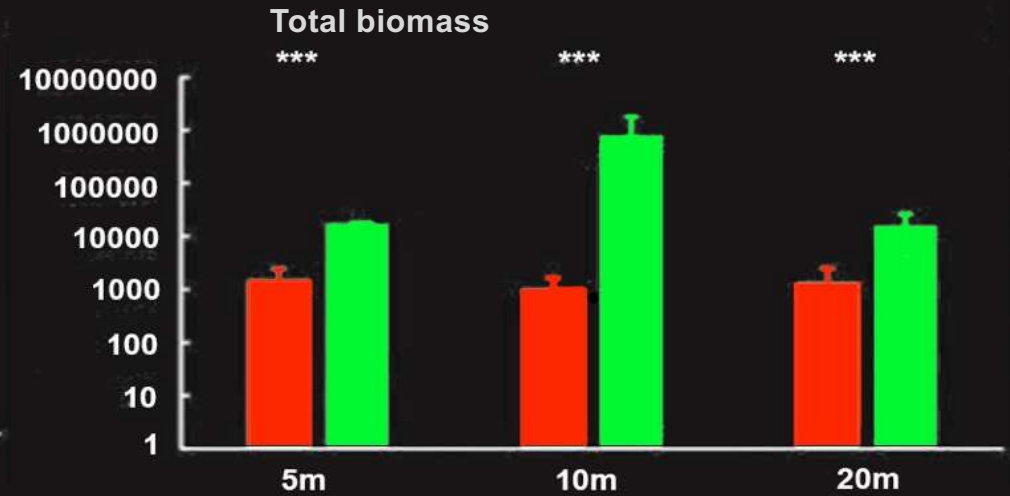
- Pollution
- Direct physical habitat disruption and artificialisation
- Overfishing
- Bioinvasions
- Climate change



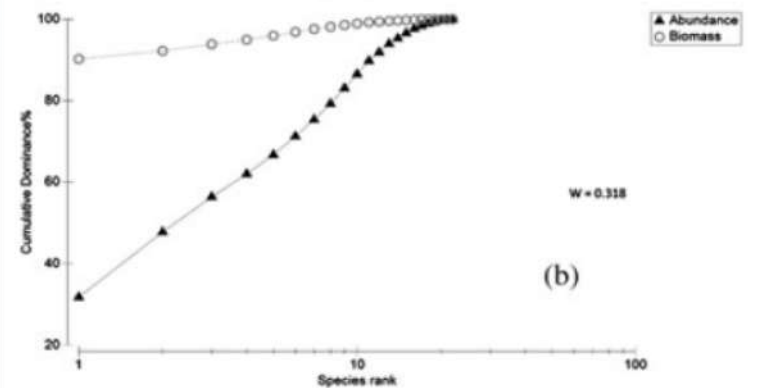
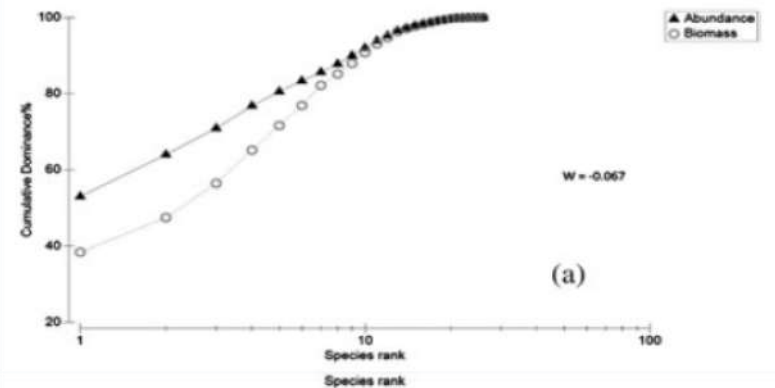
Effects of overfishing



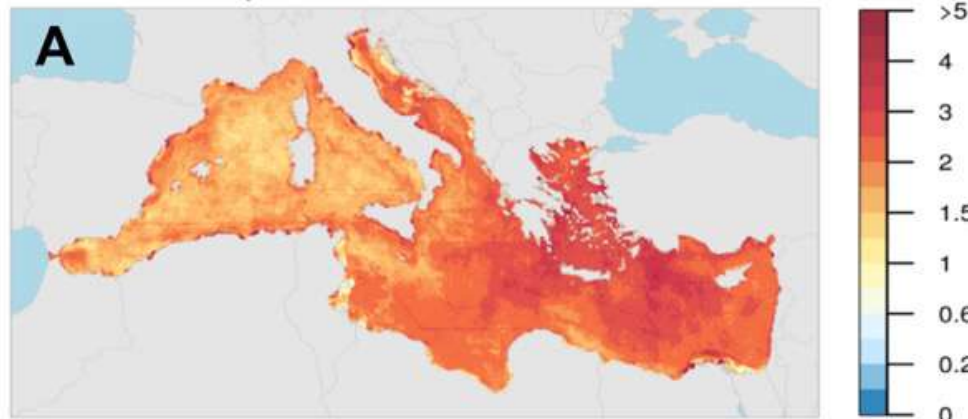
Appolloni et al., 2017.



Maintainance of depth structure in fish assemblages. Abundance-biomass patterns typical of healthy conditions



Trends in cumulative impact



Climate drivers are the main contributors to increased cumulative impact to rocky reefs, but pollution is also key driver of increased impact. Rocky reefs are impacted by the largest suite of different stressors

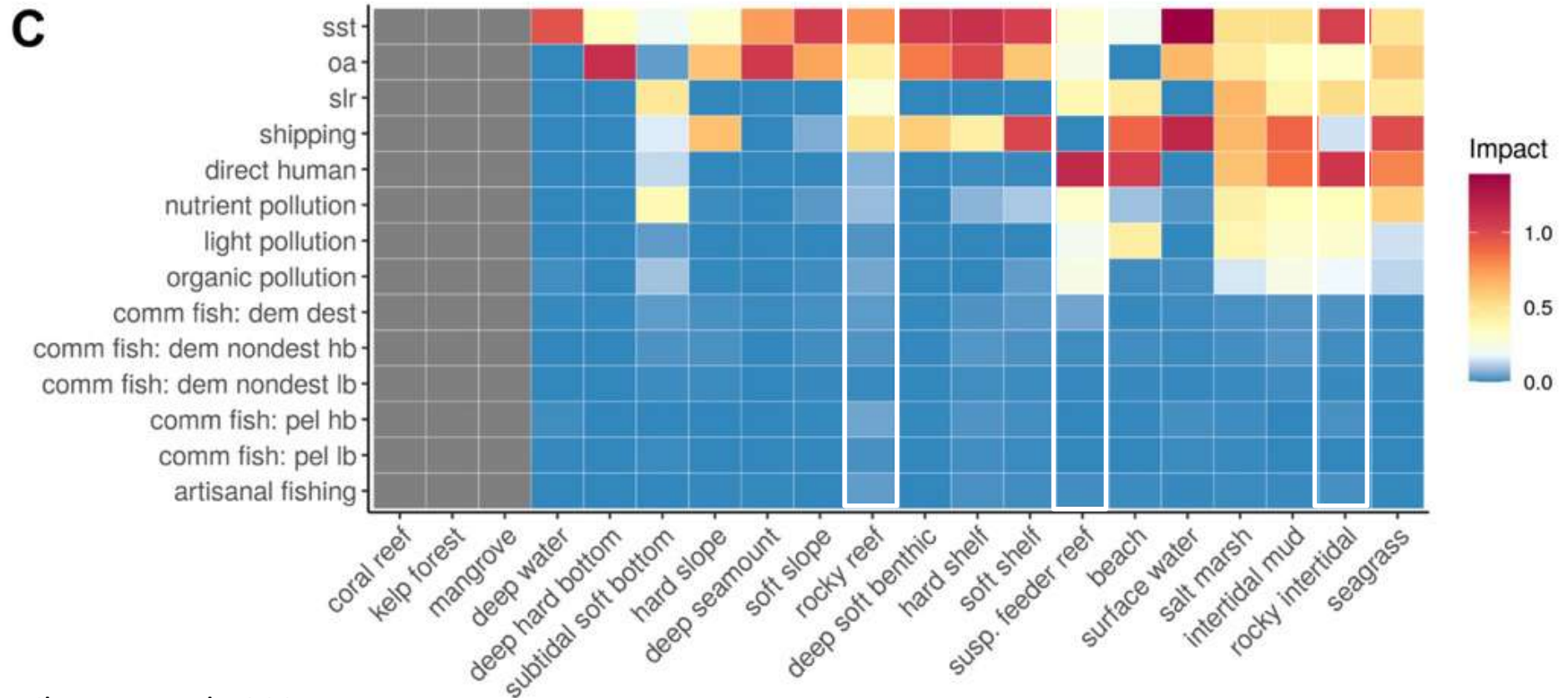


Table 1
Summarized description and sensitivity levels of the main community categories distinguished in the monitored coasts

Category	Description	Sensitivity level
<i>Cystoseira mediterranea</i> 5	Continuous belt of <i>C. mediterranea/stricta</i>	20
<i>Cystoseira crinita</i>	Populations of <i>C. crinita</i>	20
<i>Cystoseira balearica</i>	Populations of <i>C. balearica</i>	20
<i>Cystoseira sheltered</i>	Populations of <i>Cystoseira foeniculacealbarbatalspinosa</i> v. <i>tenuior/compressav.pustulata</i>	20
<i>Posidonia</i> reef	Barrier and fringing reefs of <i>Posidonia oceanica</i>	20
<i>Cymodocea nodosa</i>	<i>Cymodocea nodosa</i> meadows	20
<i>Zostera noltii</i>	<i>Zostera noltii</i> meadows	20
Trottoir	Build-ups of <i>Lithophyllum byssoides</i>	20
<i>Cystoseira mediterranea</i> 4	Almost continuous belt of <i>C. mediterranea/stricta</i>	19
<i>Cystoseira mediterranea</i> 3	Abundant patches of dense stands of <i>C. mediterranea/stricta</i>	15
<i>Cystoseira mediterranea</i> 2	Abundant scattered plants of <i>C. mediterranea/stricta</i>	12
<i>Cystoseira compressa</i>	Populations of <i>C. compressa</i> v. <i>compressa</i>	12
<i>Cystoseira mediterranea</i> 1	Rare scattered plants of <i>C. mediterranea/stricta</i>	10
<i>Corallina</i>	Belt of <i>Corallina elongata</i> without <i>Cystoseira</i>	8
<i>Haliptilon</i>	Belt of <i>Haliptilon virgatum</i> , without <i>Cystoseira</i>	8
<i>Mytilus</i>	Mussel (<i>Mytilus galloprovincialis</i>) beds, without <i>Cystoseira</i>	6
Encrusting corallines	Belt of <i>Lithophyllum incrustans</i> , <i>Neogoniolithon brassica-florida</i> and other encrusting corallines	6
Green algae	Upper sublittoral belts of <i>Ulva</i> and <i>Cladophora</i>	3
Blue greens	Communities dominated by Cyanobacteria and <i>Derbesia tenuissima</i>	1

Index of ecological status of intertidal rocky fringe based on sensitivity levels (SL) of different macroalgae associations and their abundance. Value calculated as the ratio between the weighted mean of SL and the reference value for the area.

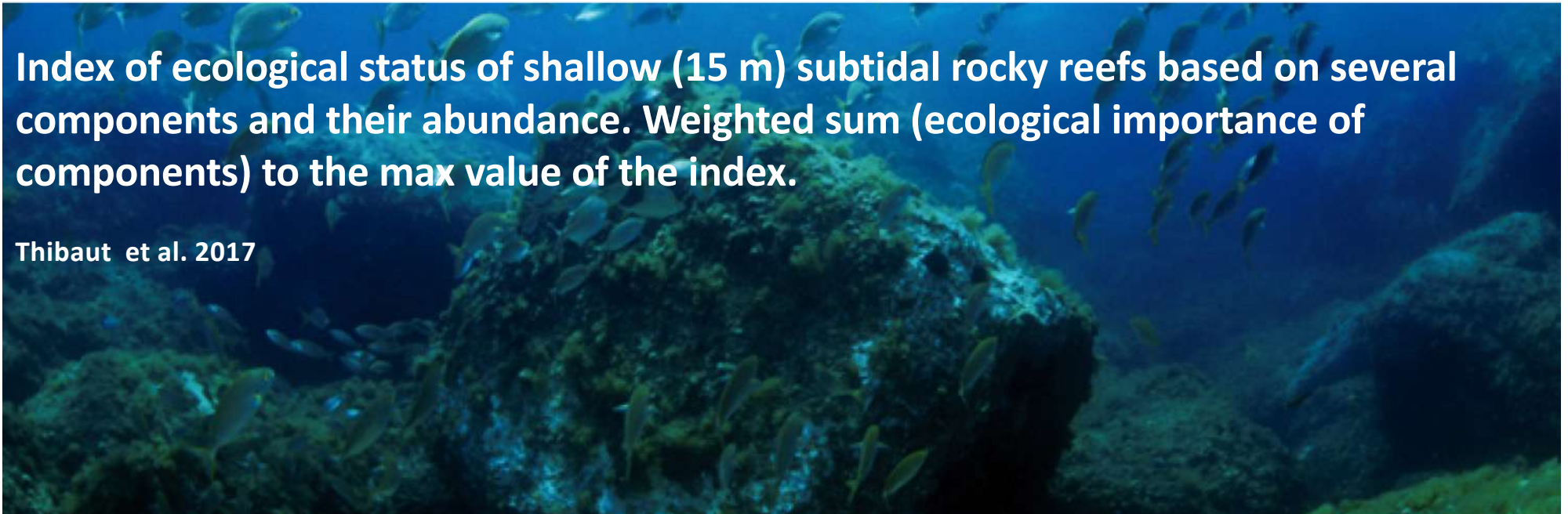
Ballesteros et al. 2007

Reef-EBQI

Functional compartment	Weighting (W)	Parameter	4	3	2	1	0
1- MPOs	15	Cover type	Arborescent perennial $\geq 50\%$	Arborescent perennial 5 to $<50\%$	Shrubby $\geq 50\%$	Shrubby 5 to $<50\%$	Turf Encrusting
2- Detritus-feeders	3	Density (individuals 10 m^{-2})	<0.5	0.5 to 1.0	1.1 to 2.0	2.1 to 5.0	>5.0
3- Filter- and suspension-feeders	2	Density (individuals 10 m^{-2})	<2.5	2.5 to 5.0	5.1 to 10.0	10.1 to 20.0	>20.0
4- Sea urchins	2	Density (individuals m^{-2})	0.05 to 1.0	<0.05	1.1 to 5.0	5.1 to 10.0	>10.0
5- Invertivorous invertebrates	3						
- <i>Octopus vulgaris</i> , <i>Marthasterias glacialis</i>		Density (individuals 200 m^{-2})	>1.0	0.6 to 1.0	0.3 to 0.5	0.1 to 0.2	<0.1
- <i>Hexaplex trunculus</i>		Density (individuals 10 m^{-2})	<0.5	0.6 to 1.0	1.1 to 2.0	2.1 to 4.0	>4.0
6- Herbivorous teleosts	4	Biomass kg teleosts WM 100 m^{-2}	1.1 to 3.0	3.1 to 4.0	>4.0	0.25 to 1.0	<0.25
7-8- Omnivorous and Invertivorous teleosts	4	Biomass kg teleosts WM 100 m^{-2}	>3.5	2.6 to 3.5	1.6 to 2.5	0.8 to 1.5	<0.8
9- Piscivorous teleosts	7	Biomass kg teleosts WM 100 m^{-2}	>5.0	1.0 to 5.0	0.5 to 0.9	0.4 to 0.1	<0.1
10- Planktivorous teleosts	1	Biomass kg teleosts WM 100 m^{-2}	>2.0	2.0 to 1.5	1.5 to 0.9	0.9 to 0.3	<0.3
11- Sea birds	1						
- <i>Phalacrocorax</i> spp.		Distance to the nearest nesting site (km)	<4.0	4.0 to 7.9	8.0 to 12.9	13.0 to 17.0	>17.0
- <i>Pandion haliaetus</i>		Distance to the nearest nesting site (km)	<4.0	4.0 to 7.9	8.0 to 12.9	13.0 to 17.0	>17.0

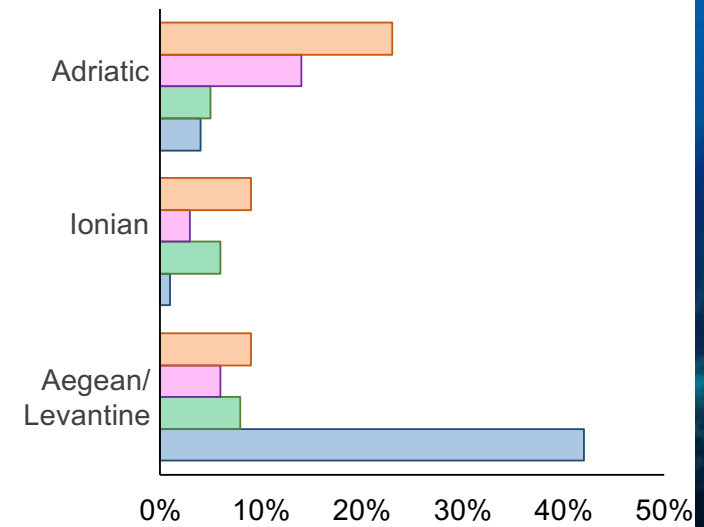
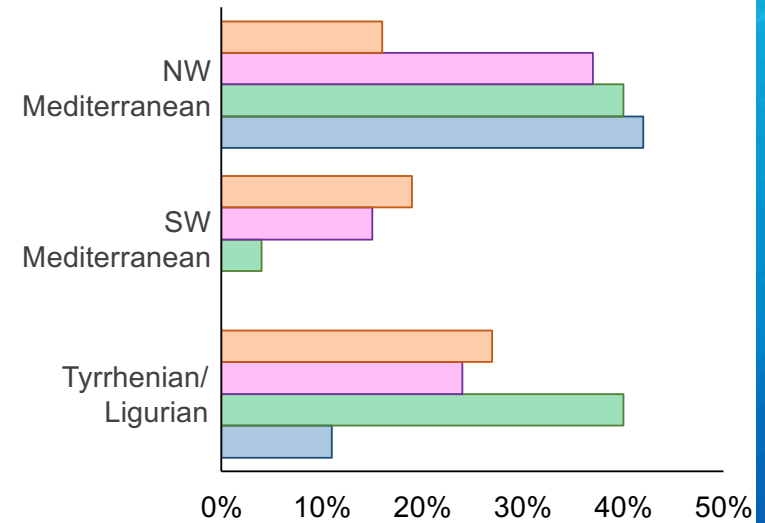
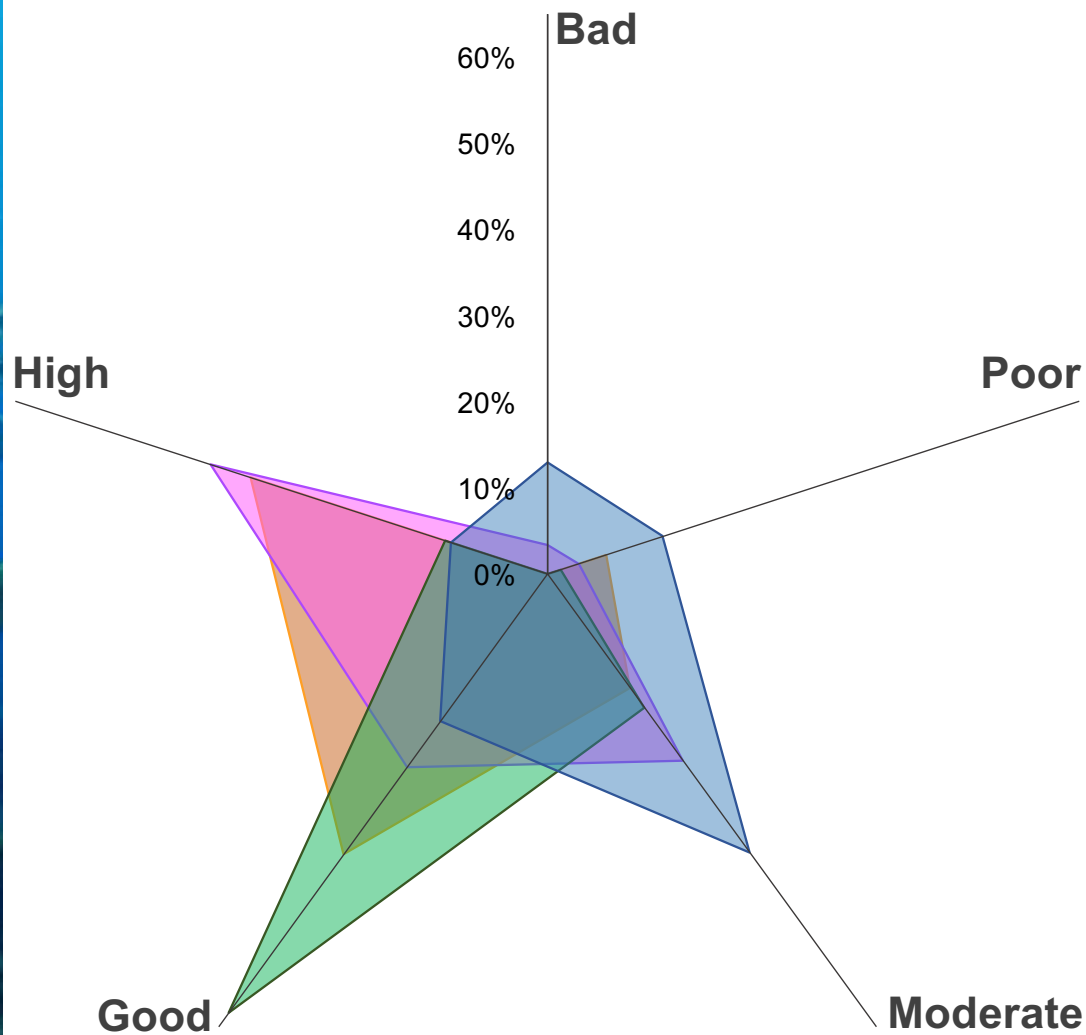
Index of ecological status of shallow (15 m) subtidal rocky reefs based on several components and their abundance. Weighted sum (ecological importance of components) to the max value of the index.

Thibaut et al. 2017



Ecological status

Bevilacqua et al., 2020



Coastal soft bottoms (CSB)

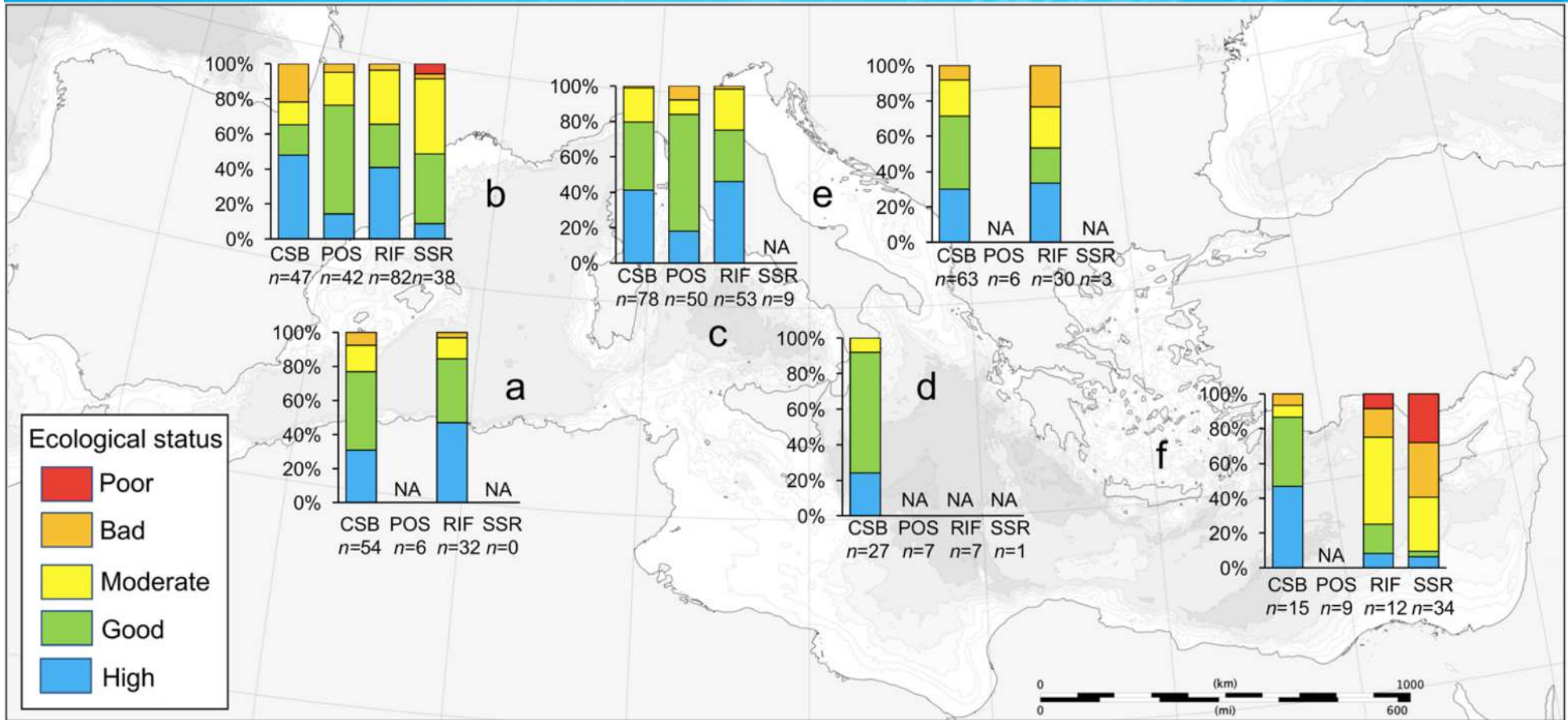
Rocky intertidal fringe (RIF)

P. oceanica beds (POS)

Shallow subtidal reefs (SSR)

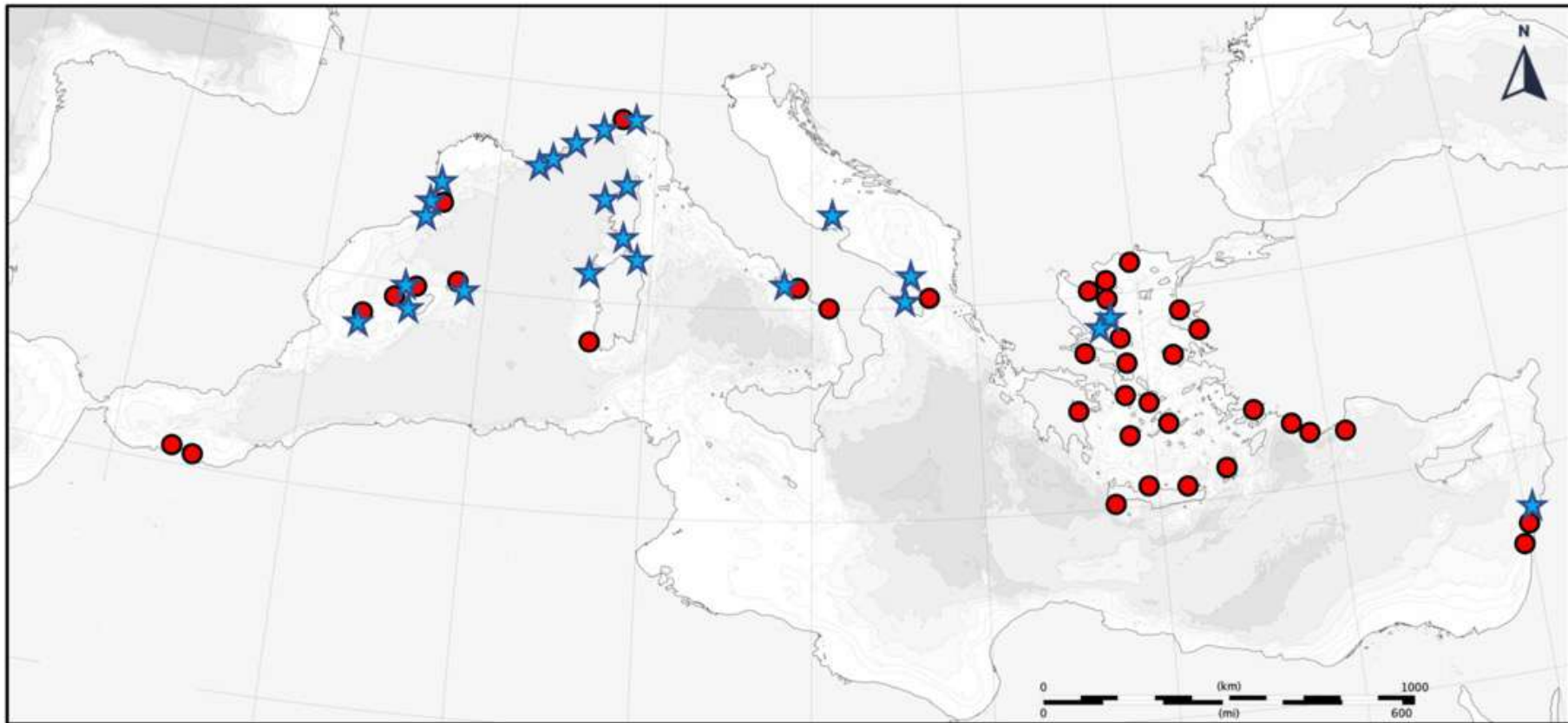


Ecological status



Lack of data in several areas. Apparently, rocky reefs in the Levantine basin are those in worse conditions

Ecological status



Ecological status

Poor

MPAs or N2000
Sites ($n = 44$) ★

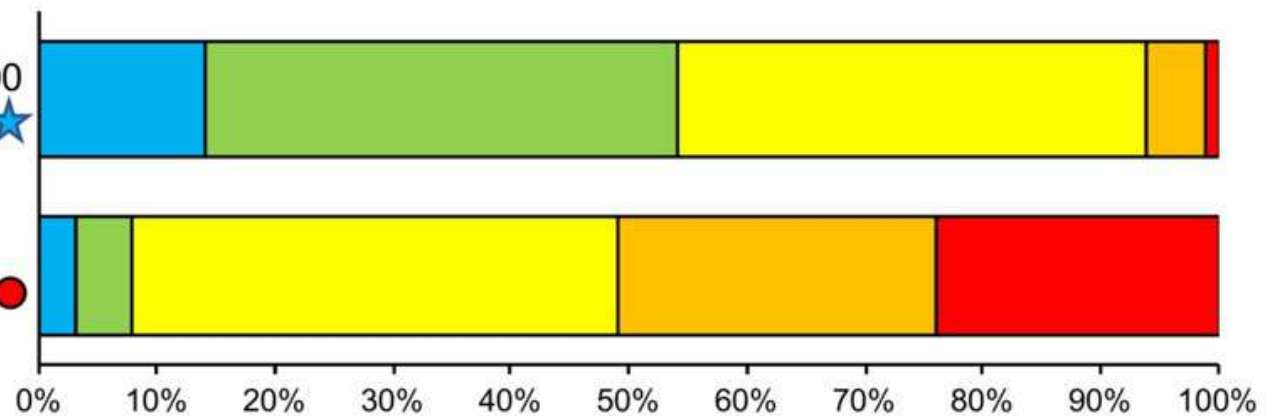
Bad

Moderate

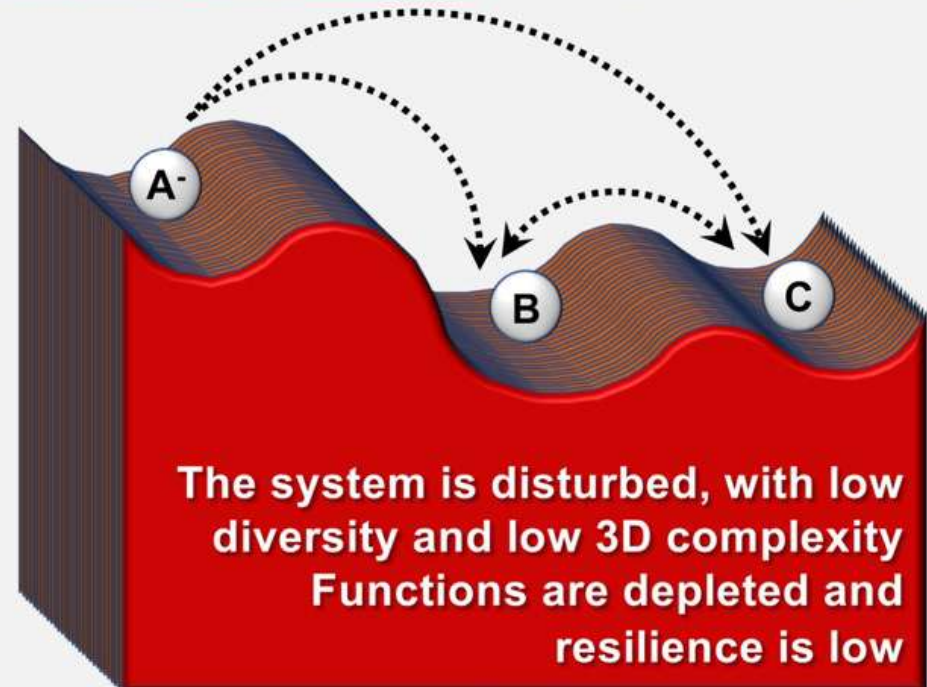
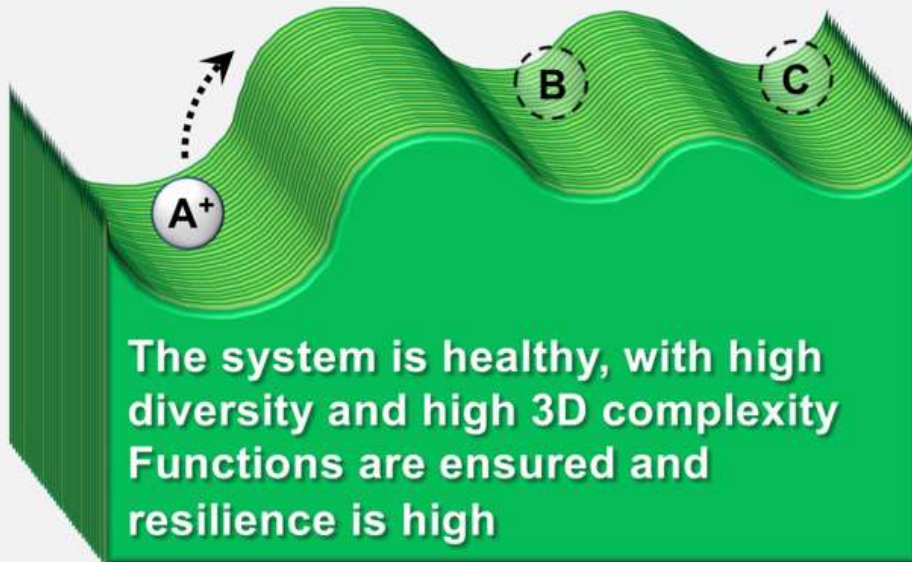
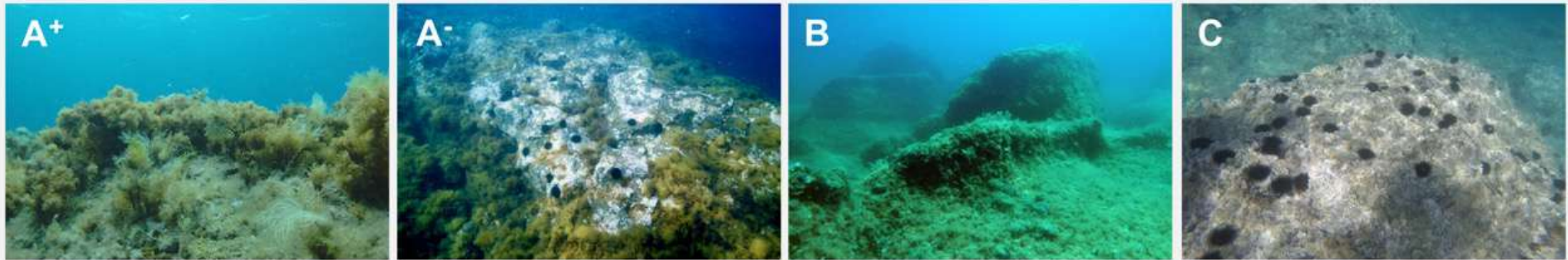
Unprotected
Sites ($n = 41$) ●

Good

High



Phase shifts

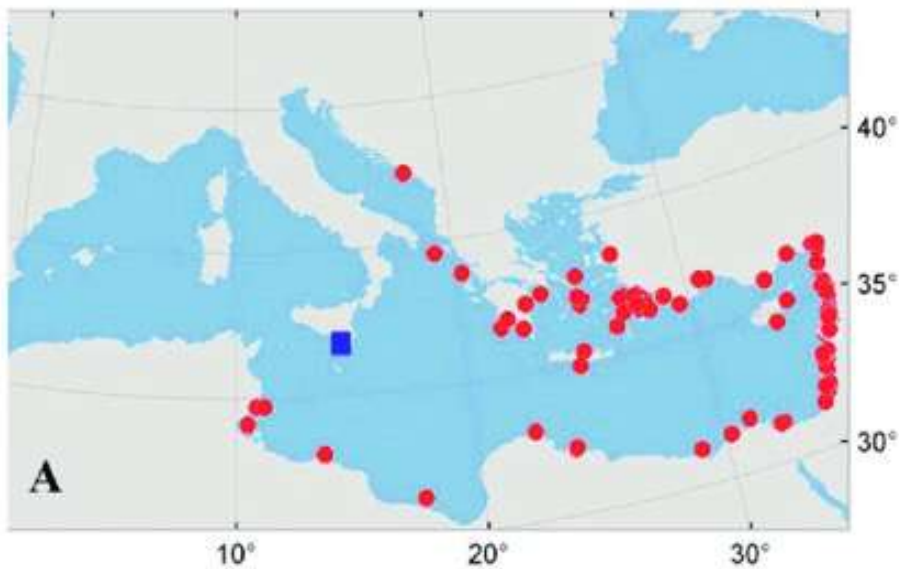


Deterioration of environmental conditions and biological components

The role of climate change: invasions



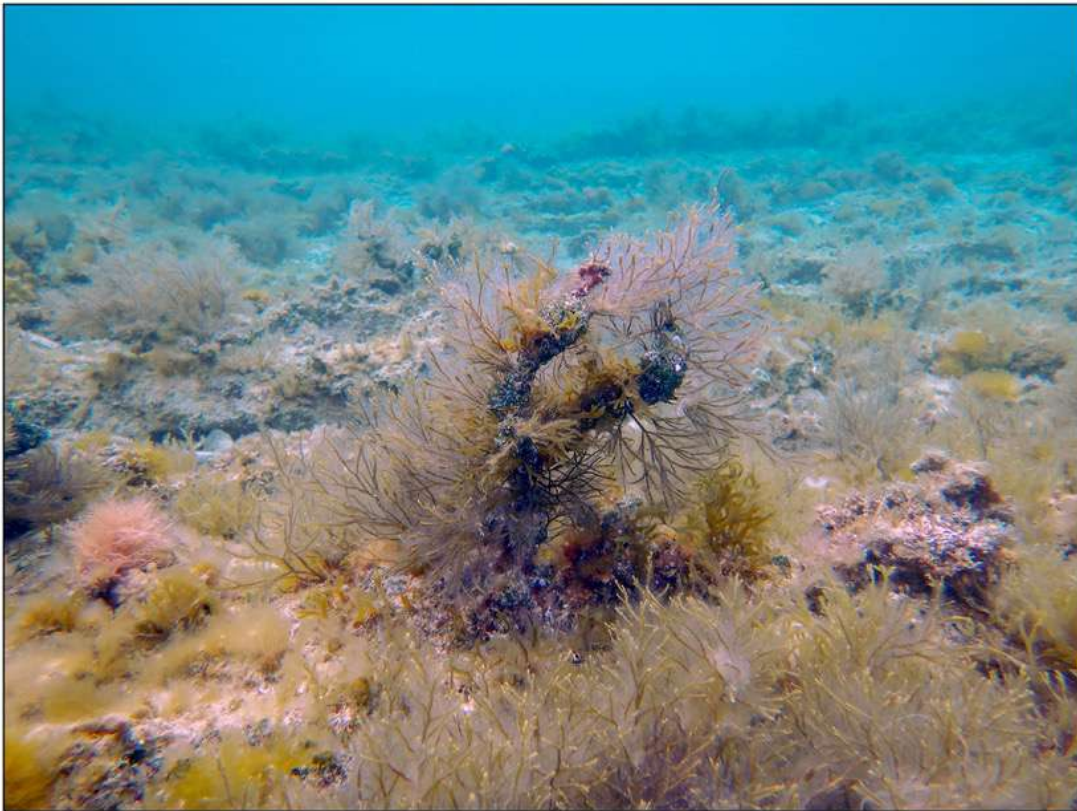
shutterstock.com · 10913293



The role of climate change: heatwaves



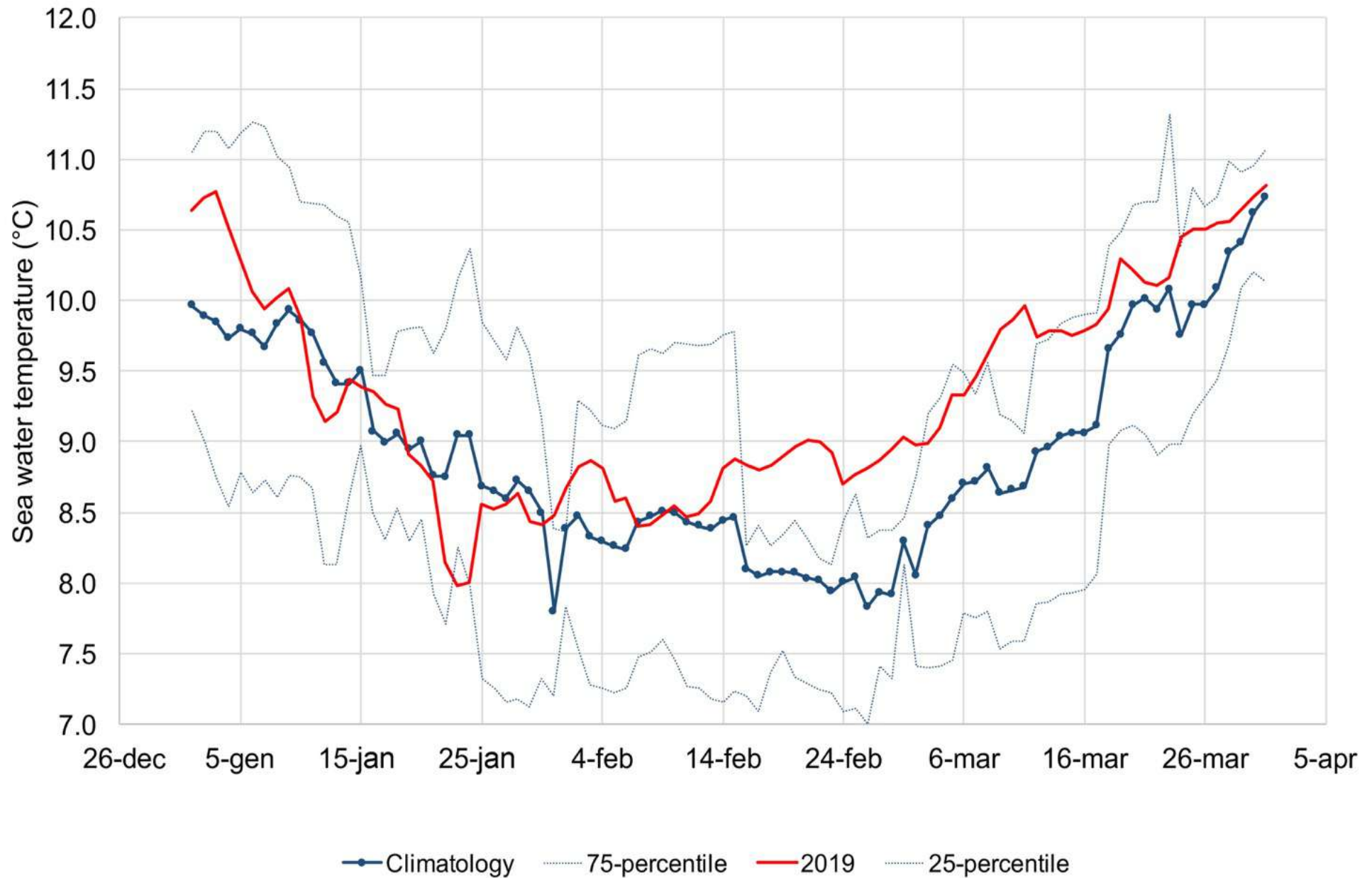
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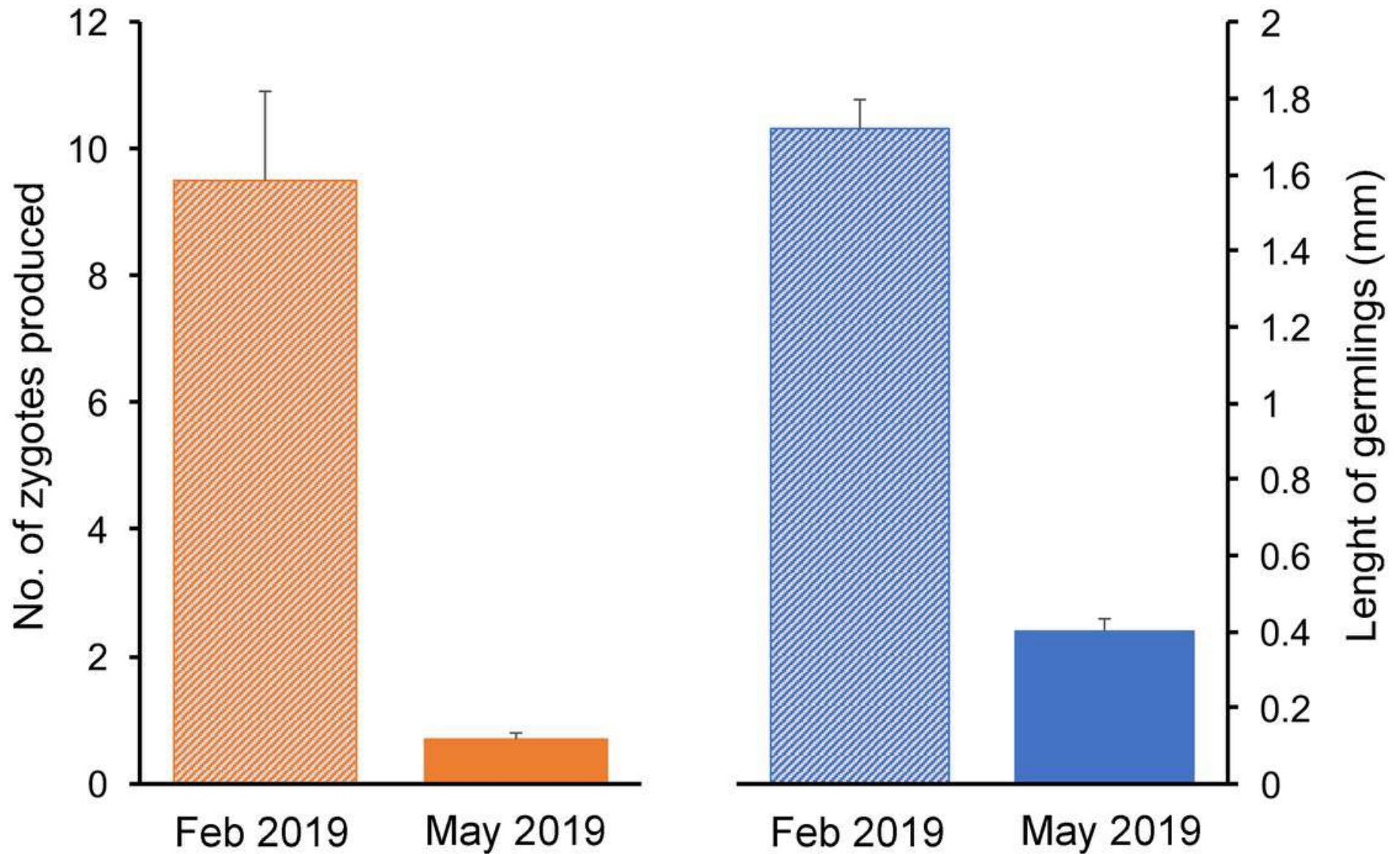
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The role of climate change



The role of climate change



The role of climate change

