From halos to barrens: main factors driving sea urchin herbivory in the Mediterranean Sea

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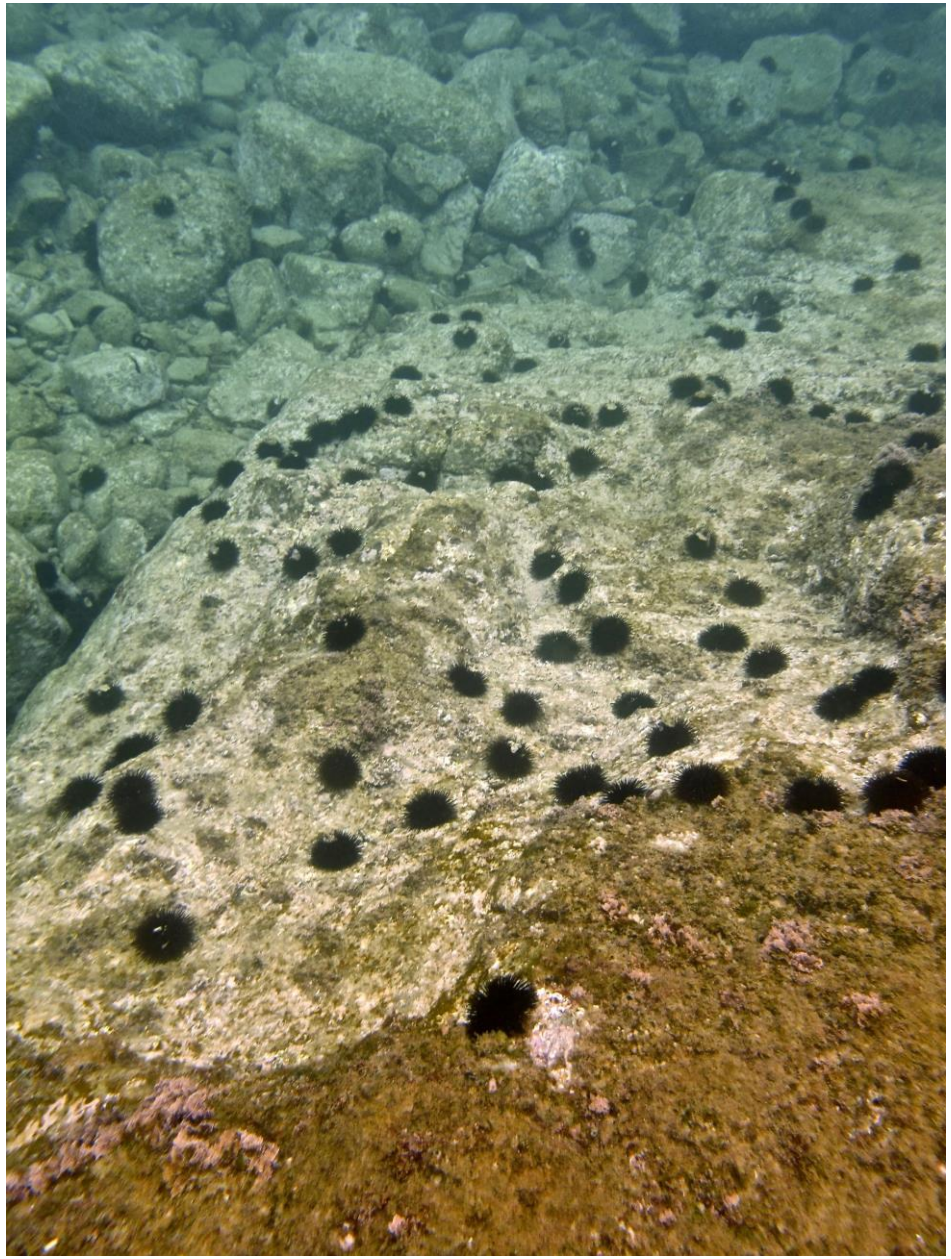
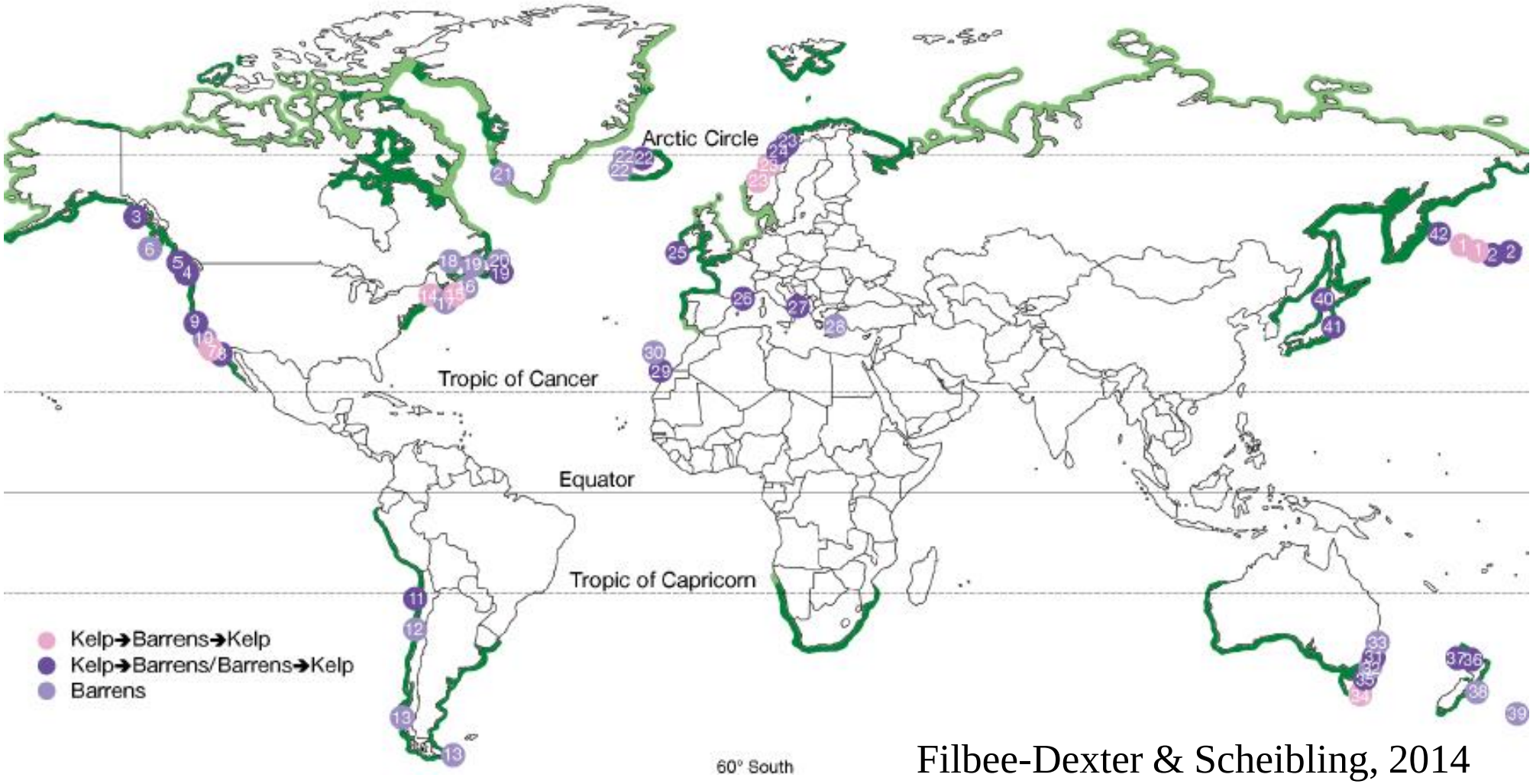
Sea urchin overgrazing threatens marine forests on temperate rocky reefs



Photos by: Kike Ballesteros and Jordi Boada

Barrens formed by sea urchin overgrazing have spread in kelp forests around the world

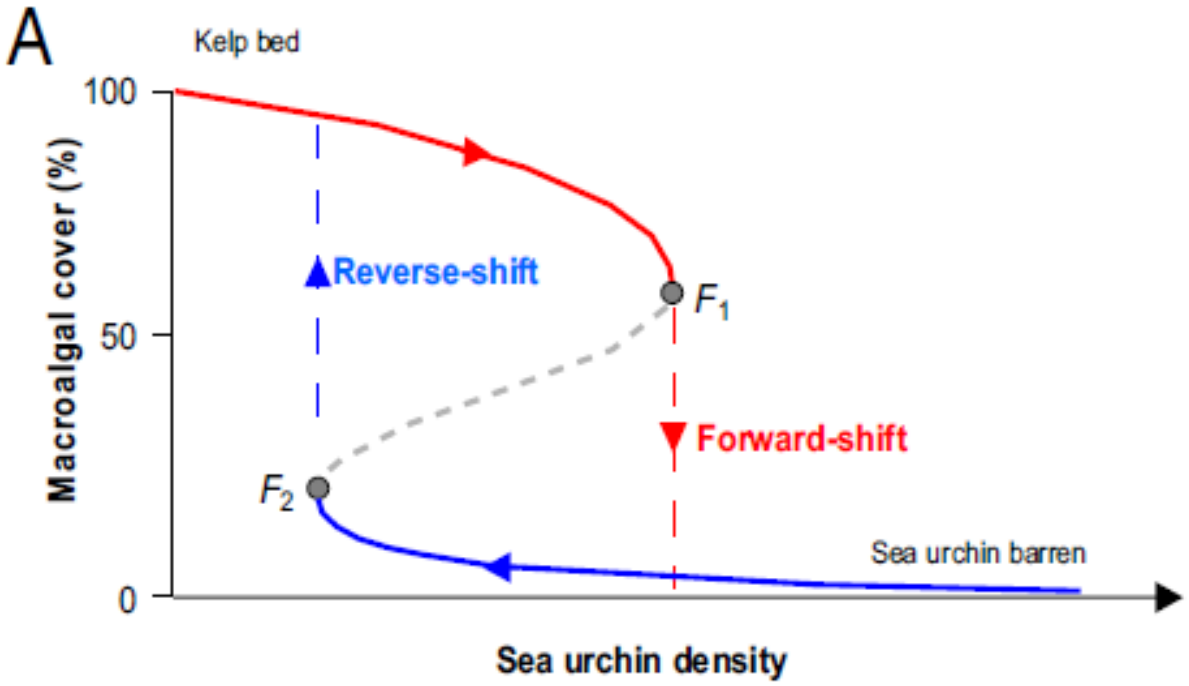


Filbee-Dexter & Scheibling, 2014

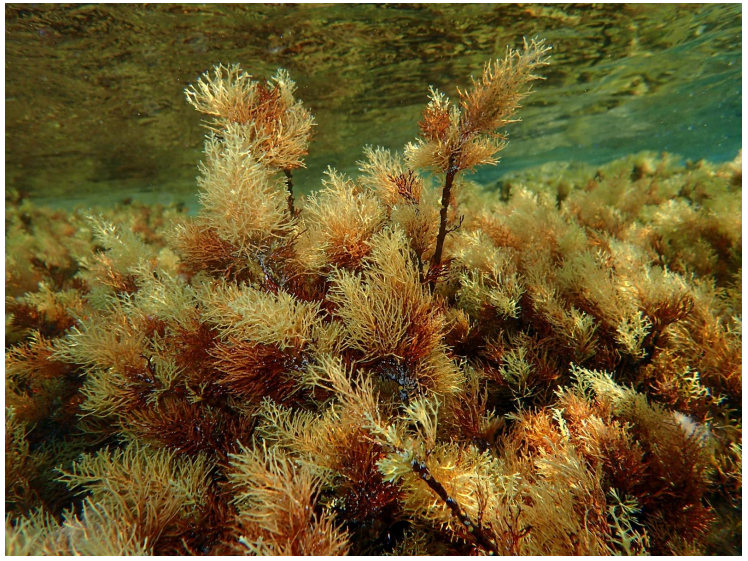
Sea urchins in the Mediterranean Sea have also created barrens in marine forest dominated by erect macroalgae

Hidden Deserts project: https://www.observadoresdelmar.es/Map/Project/15

Abrupt regime shift between alternative stable states



Ling et al., 2009



How are barrens formed?

Barren Formation = **Population Dynamics**

Healthy Ecosystem

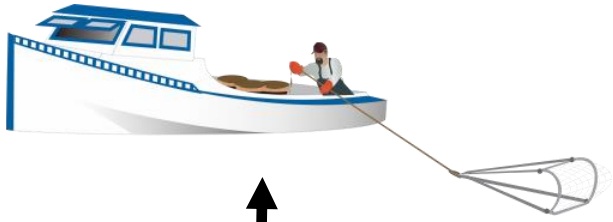
Top-down control

Cascade effects

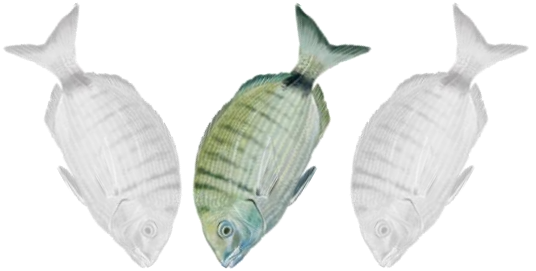
Lower herbivory rates

How are barrens formed?

Barren Formation = **Population Dynamics**



Overfishing

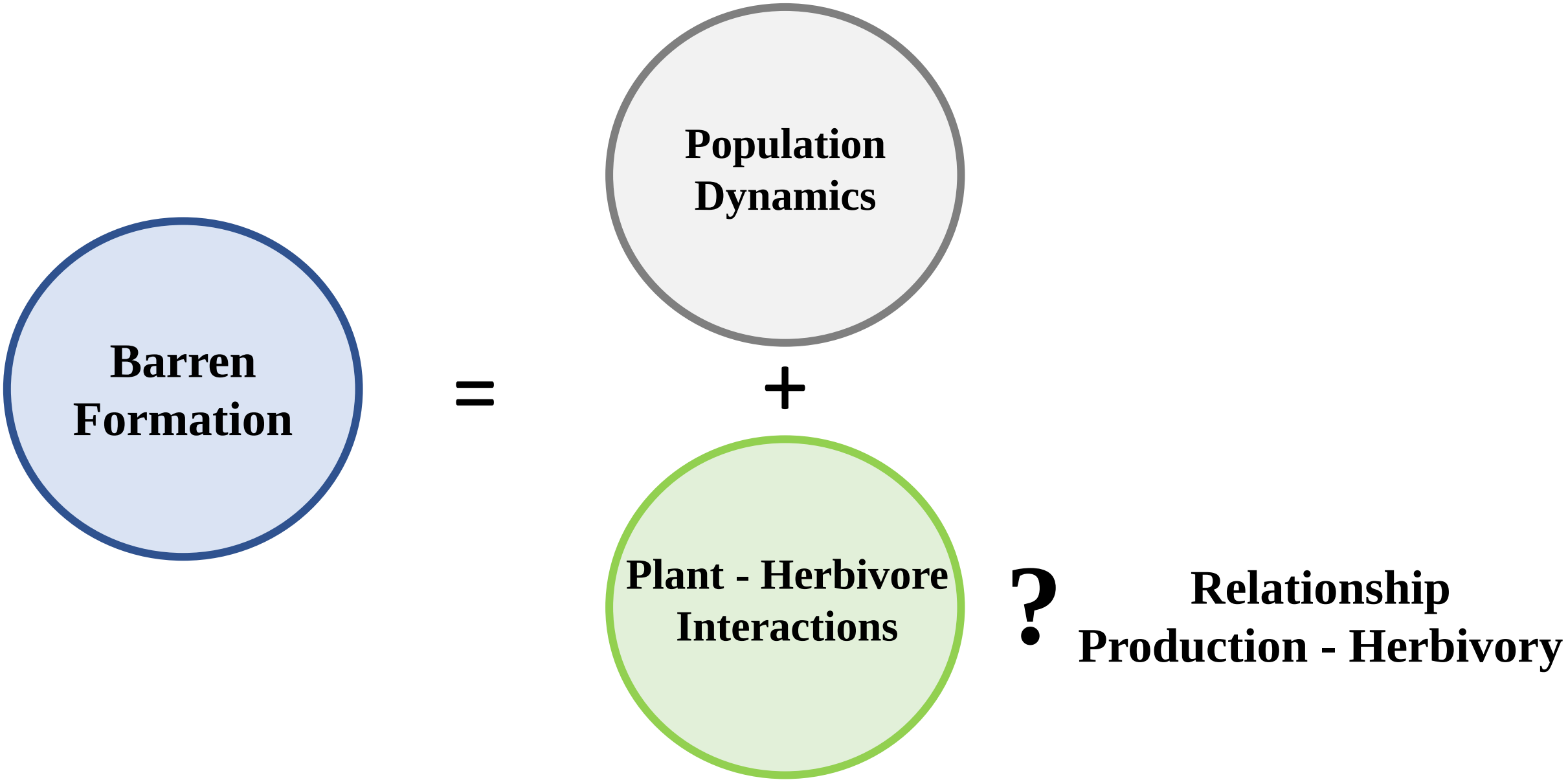


Cascade effects

Sea urchin outbreaks

Overgrazing / Barrens

How are barrens formed?



How are barrens formed?

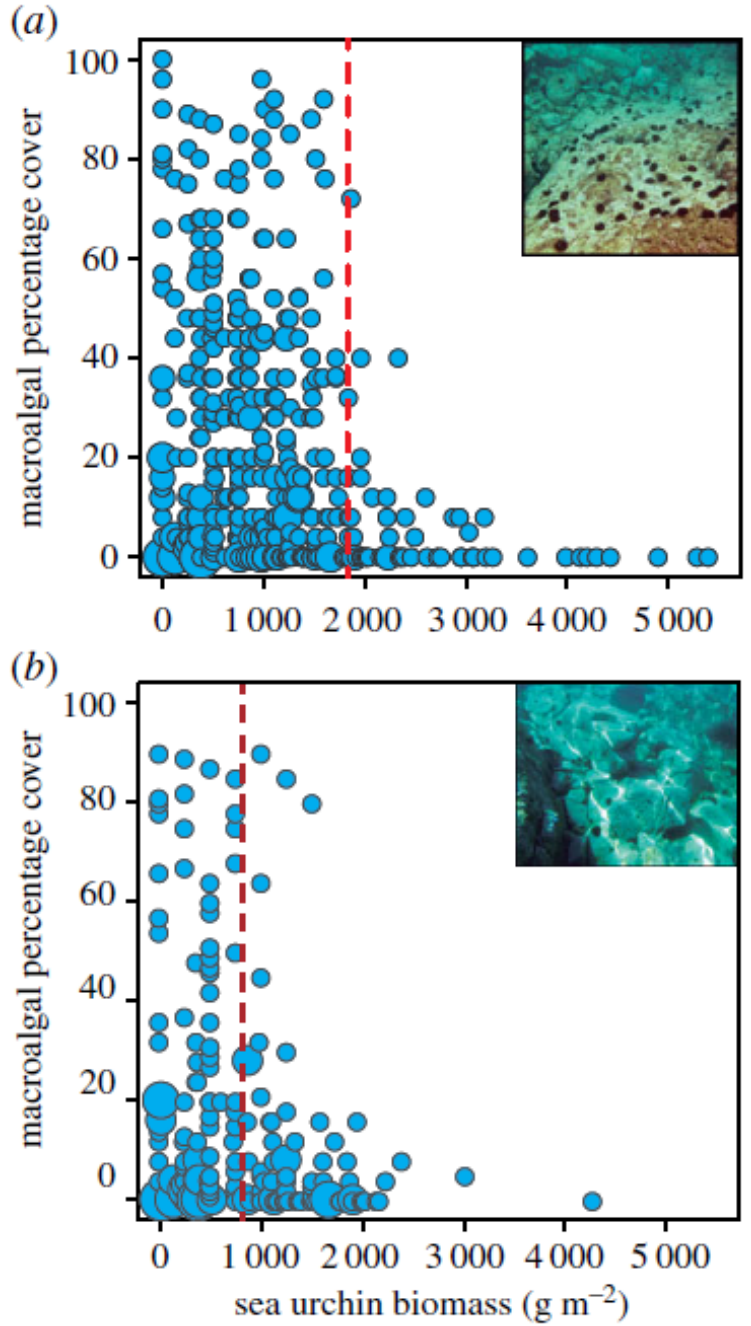
Barren Formation

=

Population Dynamics

+

Plant - Herbivore Interactions



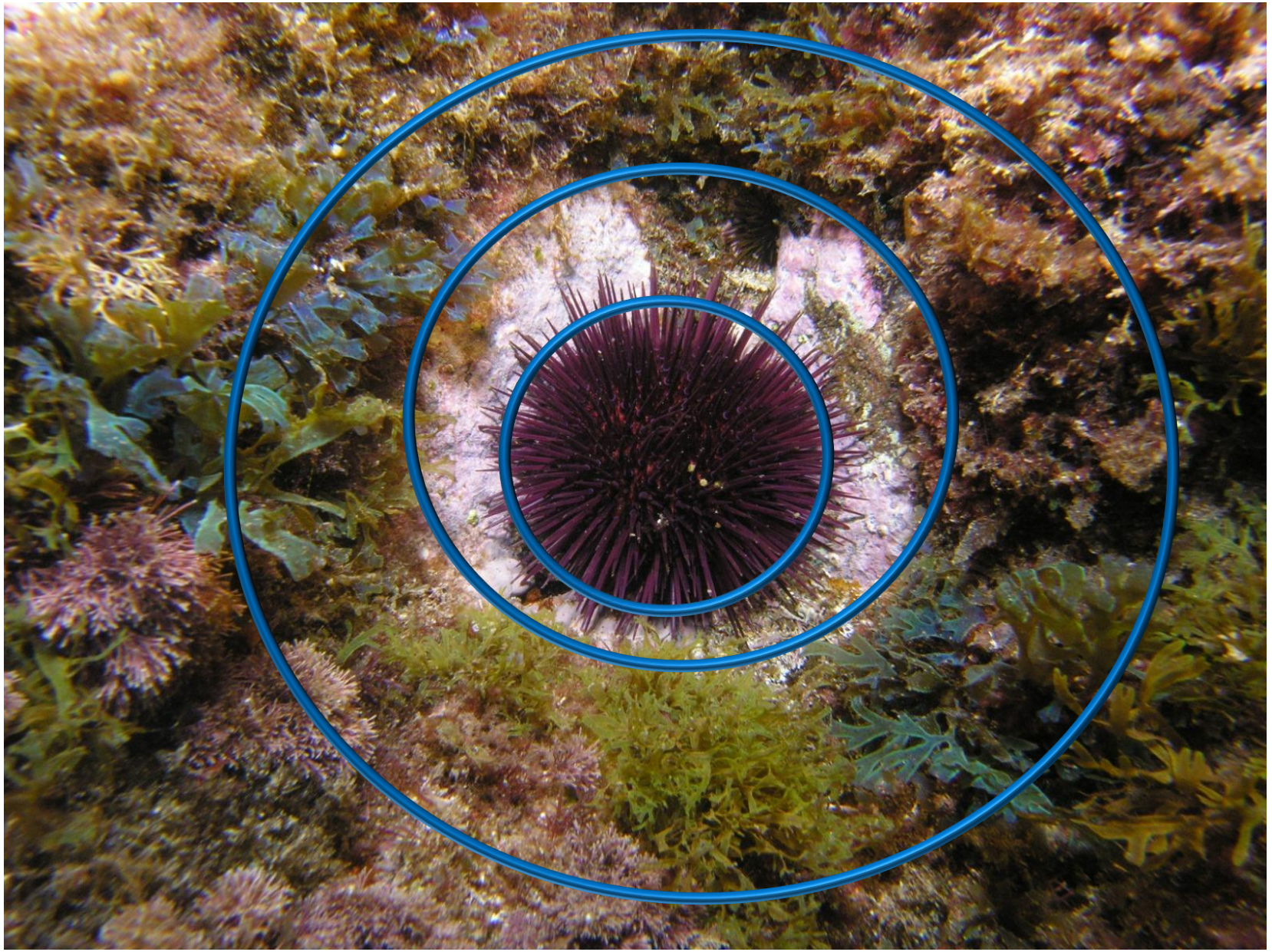
Boada et al., 2017

Halos

Relationship
Production - Herbivory

Photo by: Manuel Maldonado

Halos



Relationship
Production - Herbivory

Species

Individual Size

Fear (behaviour)

Depth

Habitat type

Nutrients

Temperature

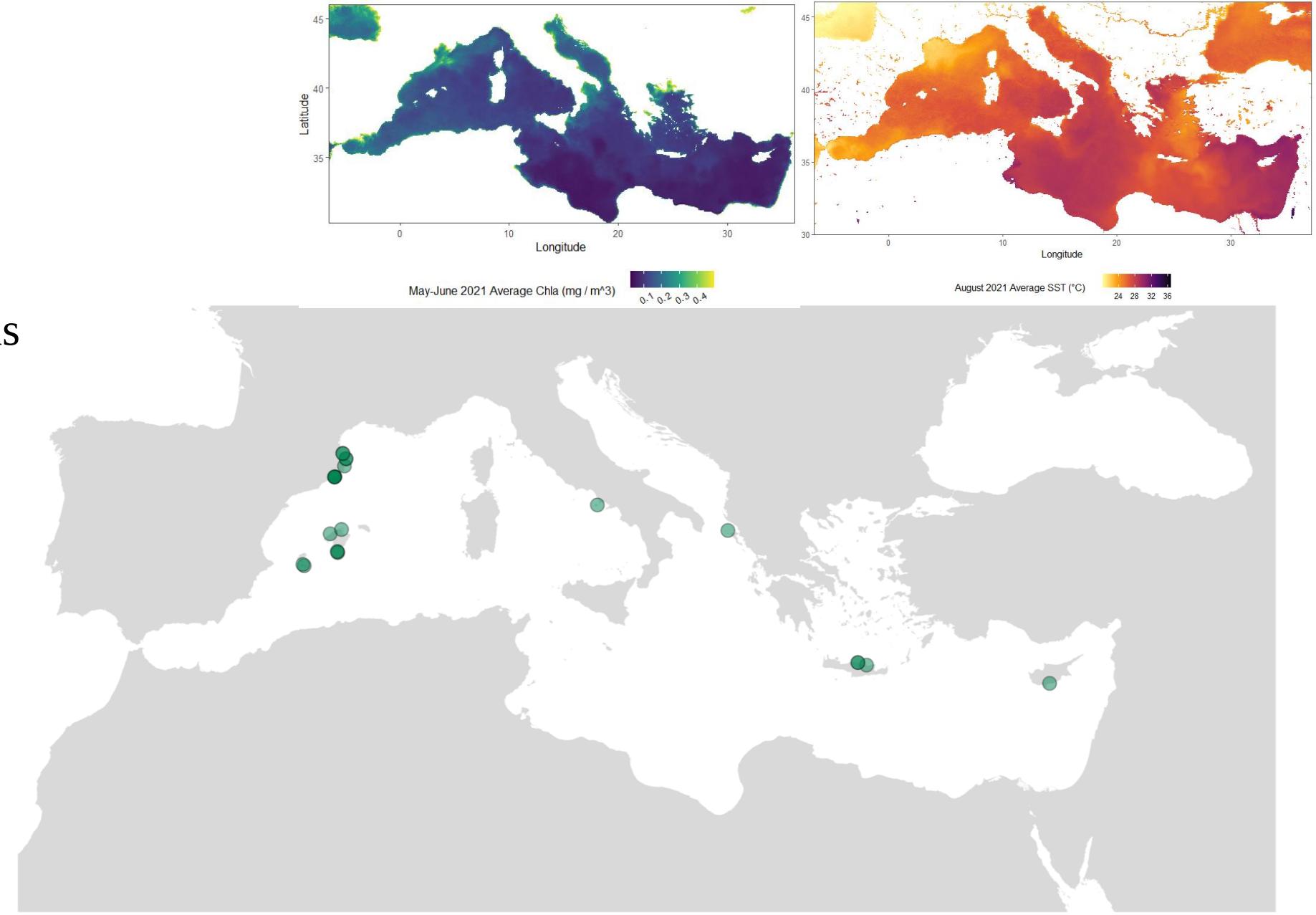
Sampling

Halo diameter.

Sampling

Halo diameter.

25 sampled locations



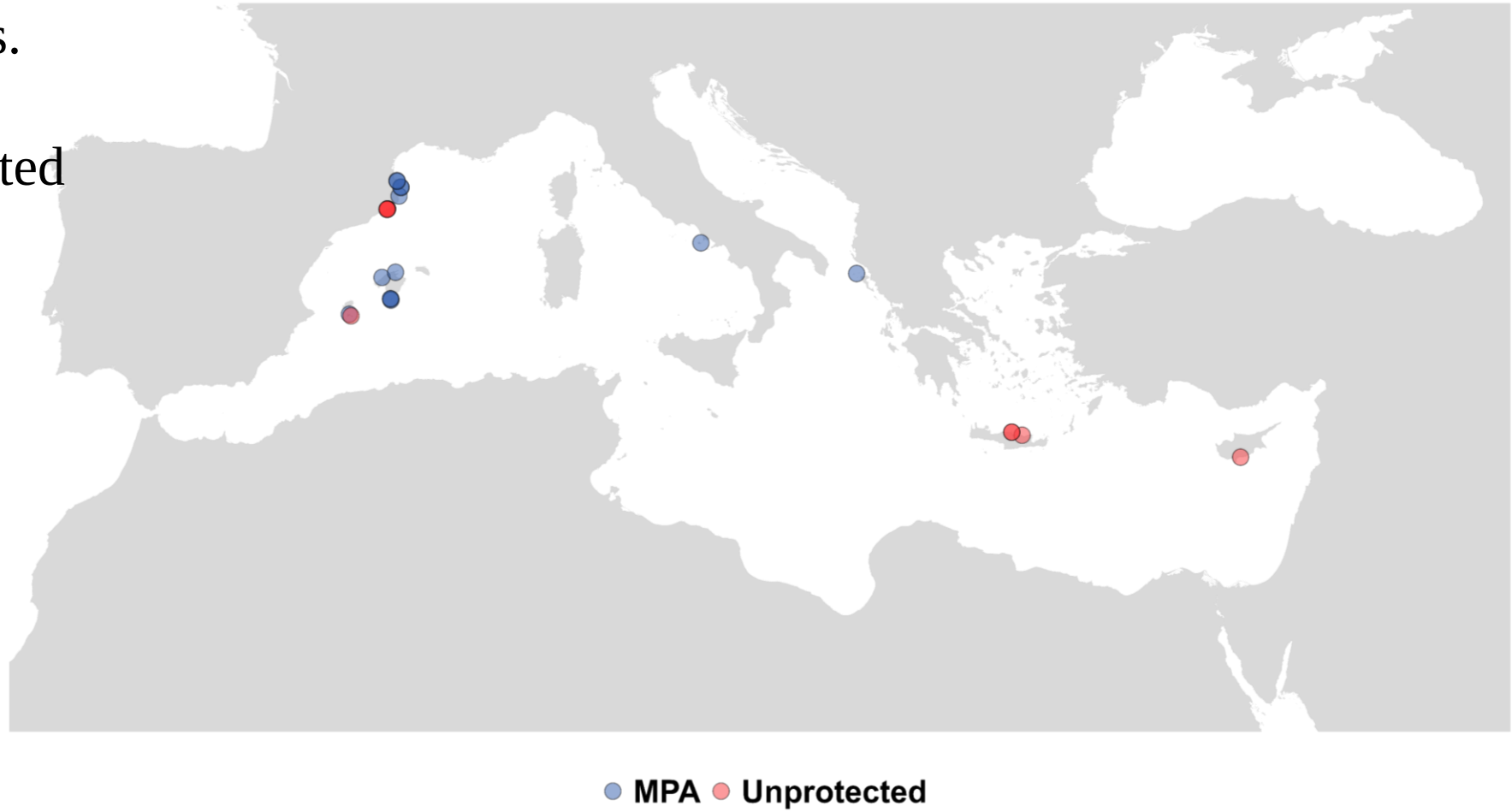
Oligotrophy / Temperature

Sampling

Halo diameter.

25 sampled locations.

Protected / Unprotected areas.



Sampling

Halo diameter.

25 sampled locations.

Protected / Unprotected
areas.

Paracentrotus lividus and *Arbacia lixula*.

Photo by: Grigorios Skouradakis

Sampling

Halo diameter.

25 sampled locations.

Protected / Unprotected
areas.

Paracentrotus lividus and *Arbacia lixula*.

Data Analysis

Generalized Linear Mixed Models (GLMMs).

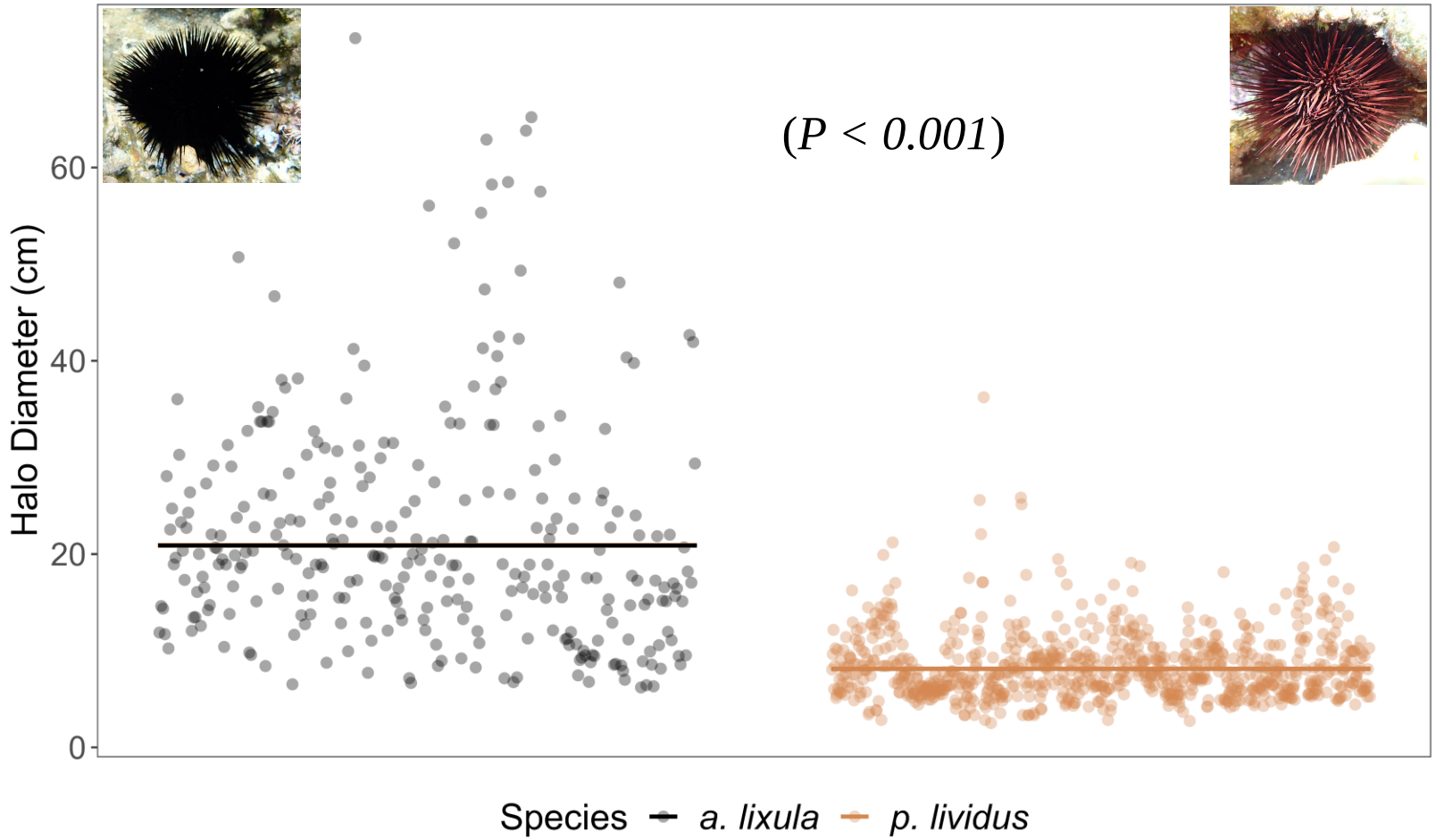
Results: Species

The species clearly affects the size of halos.

≠ morphologies.

≠ behavior.

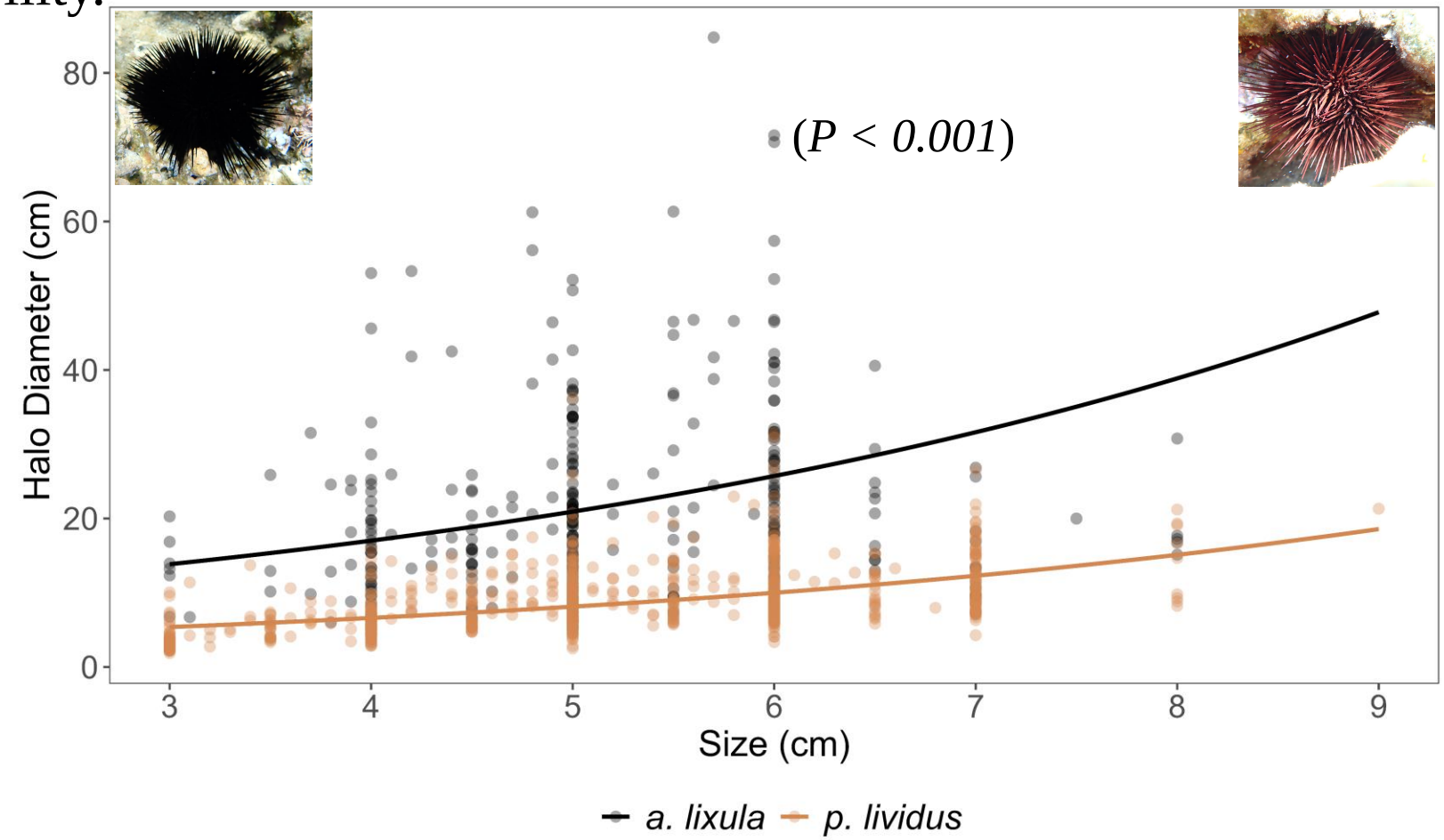
≠ diet.



Results: Size

Individual size strongly affects the dimension of halos → 0.20 cm / mm of sea urchin^{-1}.

↑ Size = ↓ predation vulnerability.

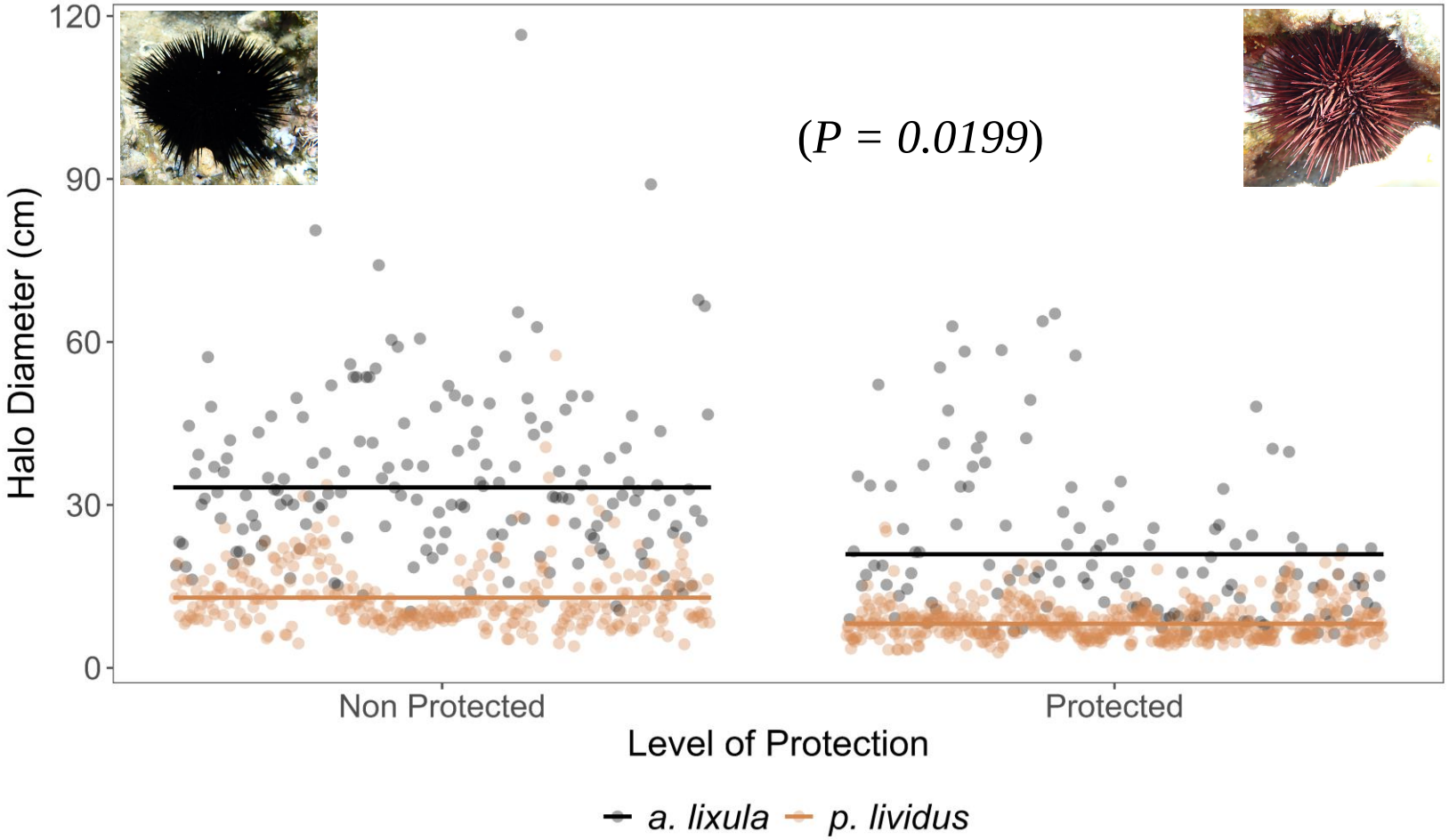


Results: Protection

Protected areas with higher abundances of medium and top-predators can promote marine forests conservation through landscape of fear.

Pattern for both species.

Not only no-take areas.



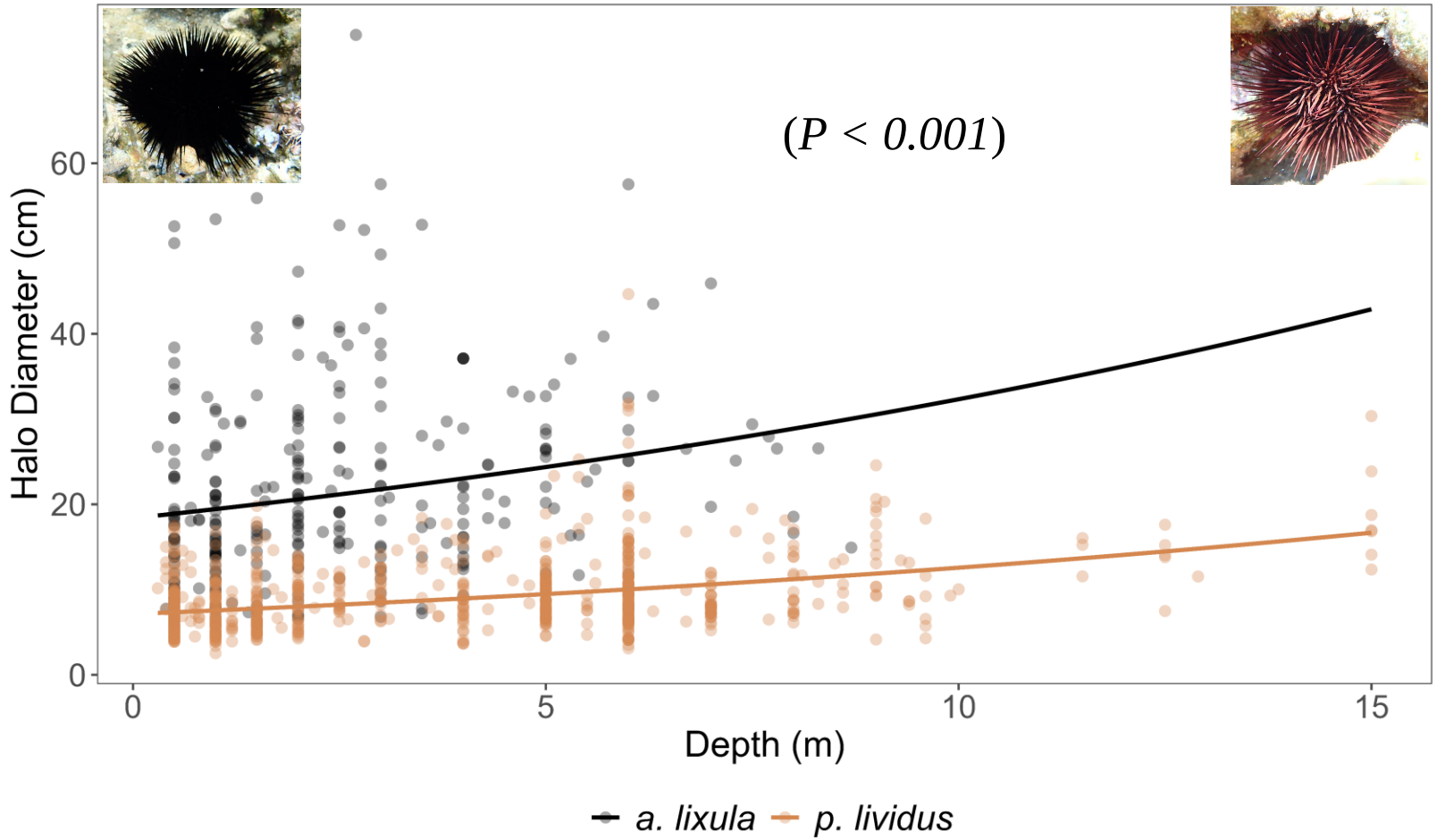
Results: Depth

Size of halos increases with depth.

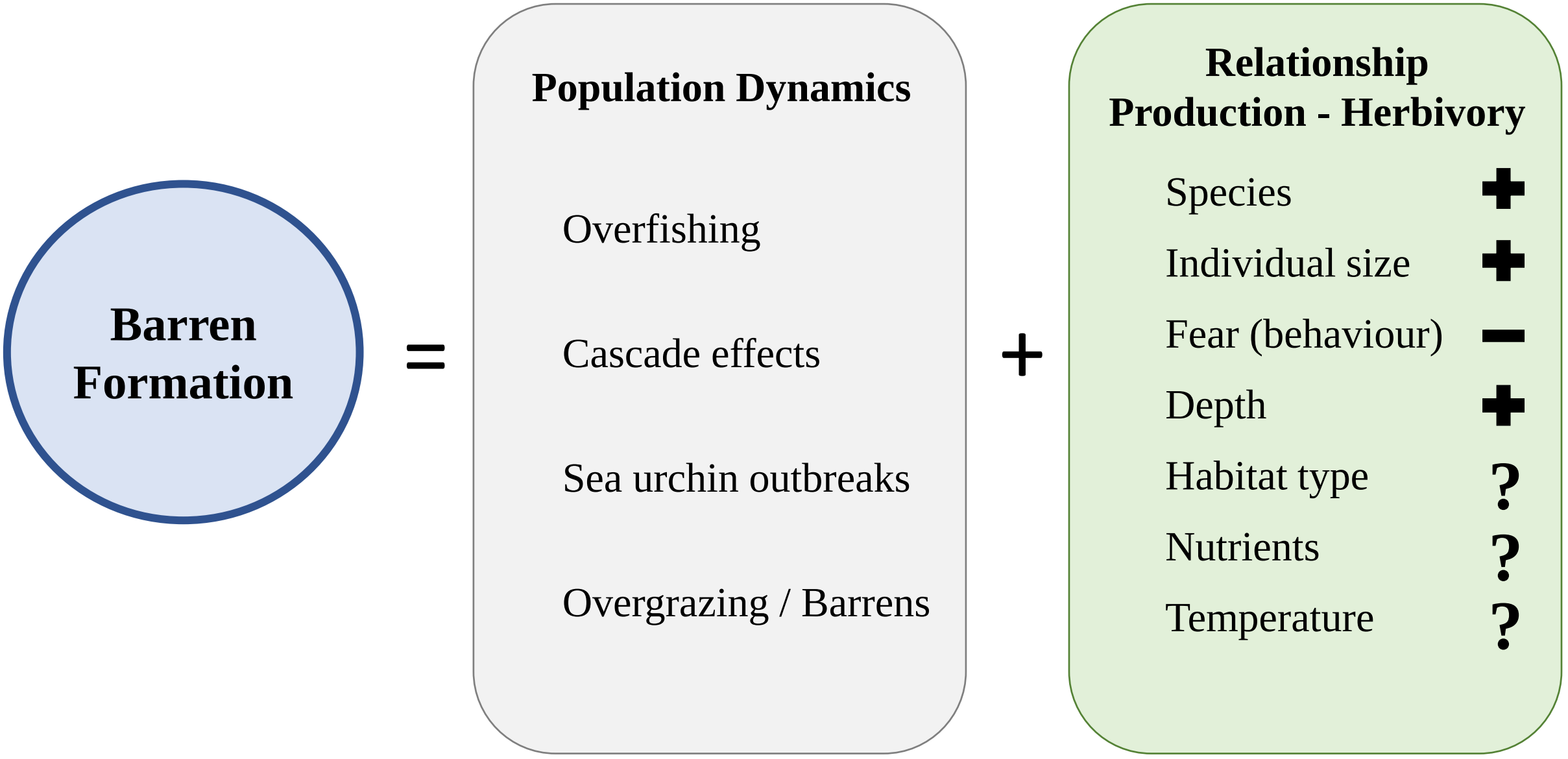
Lower production at depth.

Greater sea urchin sizes.

Apex predators.



Discussion: the importance of Context



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THANKS FOR YOUR ATTENTION!

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