A step back on the conservation of a highly threatened species: opposite signs of recovery on *Pinna nobilis* population from Mar Menor lagoon

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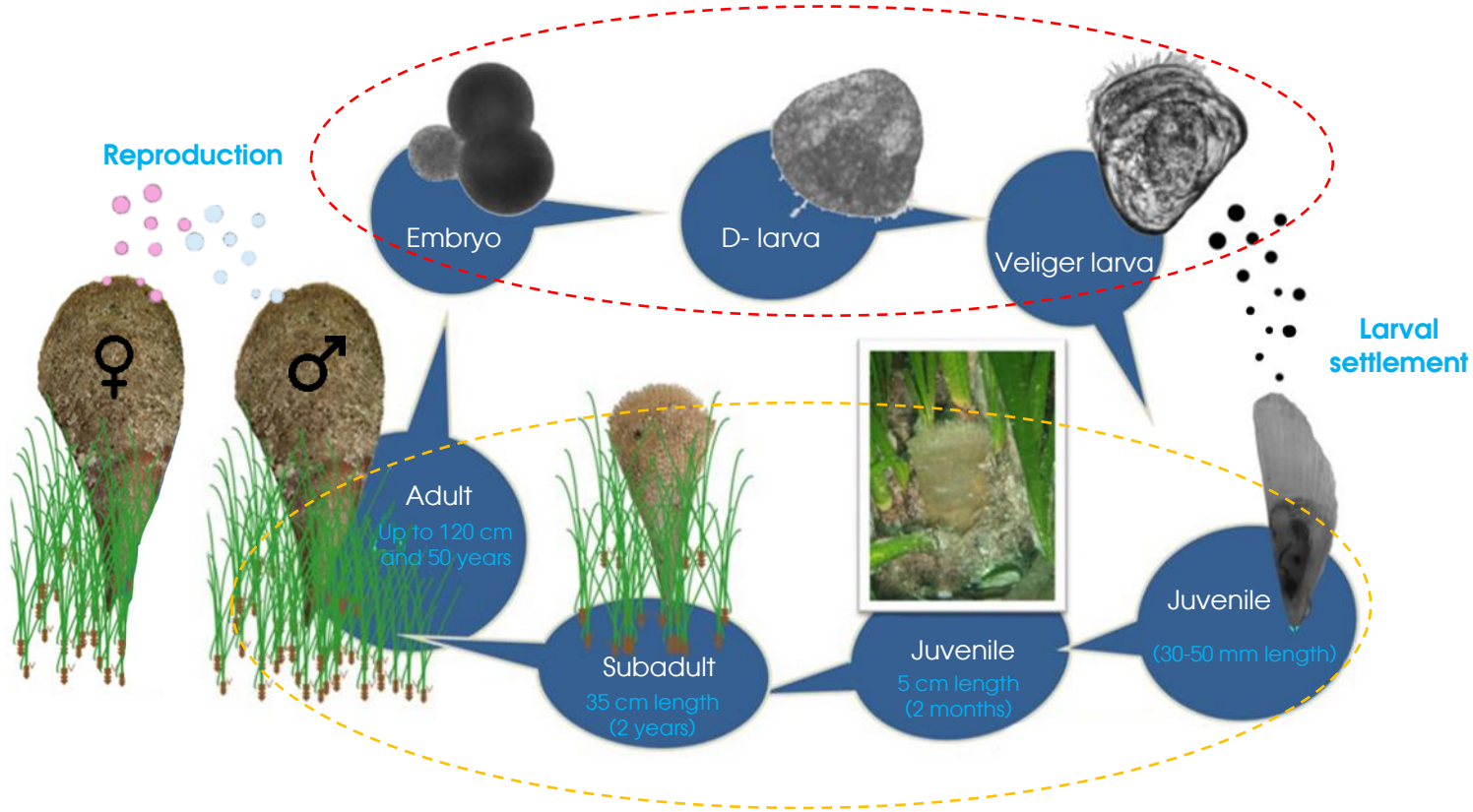
***Pinna nobilis* or noble Pen shell:**

- Largest bivalve of the Mediterranean Sea (120 cm length)
- Endemic from the Mediterranean Sea
- Long-lived species (50 years)
- Bathymetric range from 0.5 to 60 m
- Inhabiting mostly *Posidonia oceanica* meadows

- Reproductive season (April/May – September/October)
- Planktonic and benthic life stages
- Catalogued since 1992 as vulnerable species by IUCN
- Mass Mortality Event 2016 → *Haplosporidium pinnae* and *Mycobacterium sp.*



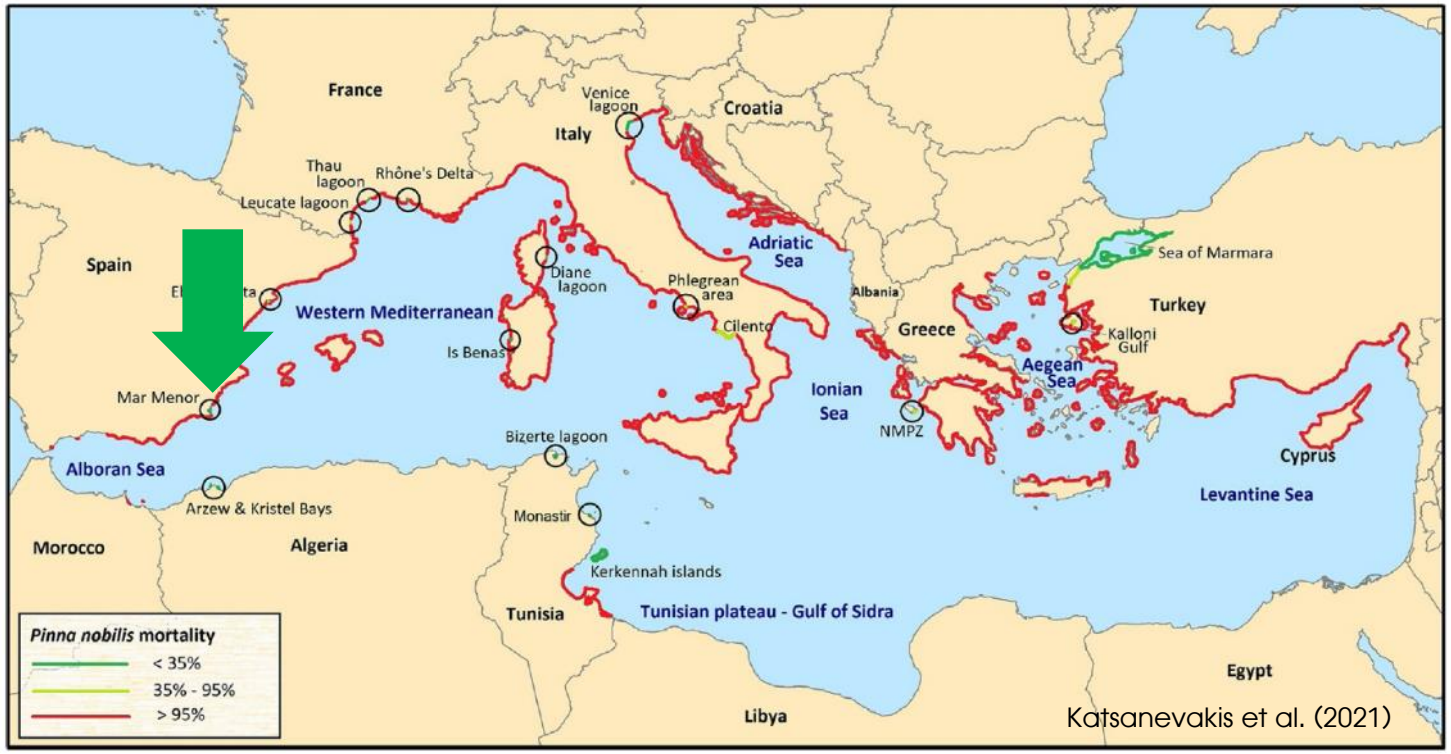
Current conservation status:

- Open Sea: ~ 100% populations extinct
- Few and isolated resistant individuals in open Sea
- Only found in coastal lagoons
- **Critically endangered species IUCN**

Conservation actions required for the recovery of the species

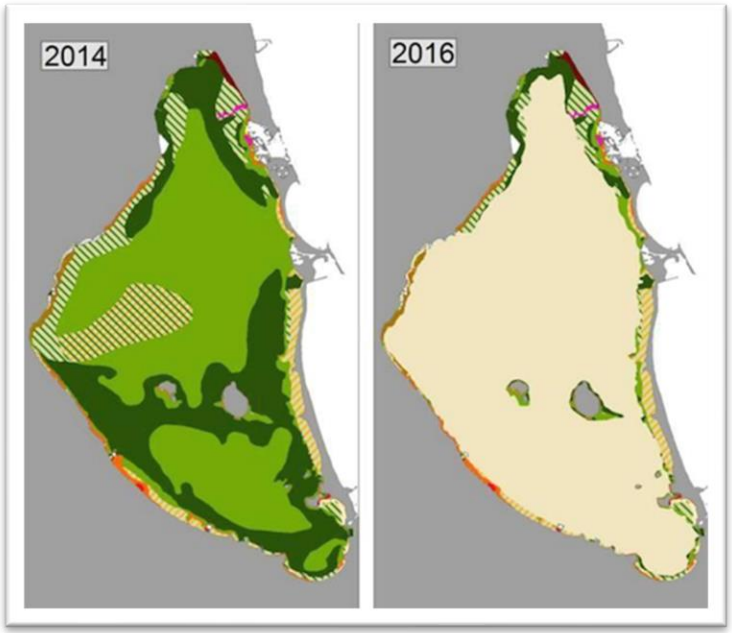
Conservation measures in progress:

- Captive breeding program
- Search of resistant individuals
- Study *P. nobilis* populations from coastal lagoons



Katsanevakis et al. (2021)

- **Mar Menor's population**
  - Hypersaline lagoon: 42 to 47.
  - Maximum depth: 7 m
  - Estimated *P. nobilis* abundance in 2014: ~1.5-1.8 million individuals (Belando et al., 2014, and Giménez-Casalduero et al., 2020)
  - Significant decrease on densities due to: (Nebot-Colomer et al. 2021)
    - Deep eutrophication crisis in 2016



© Belando et al (2019)/IEO

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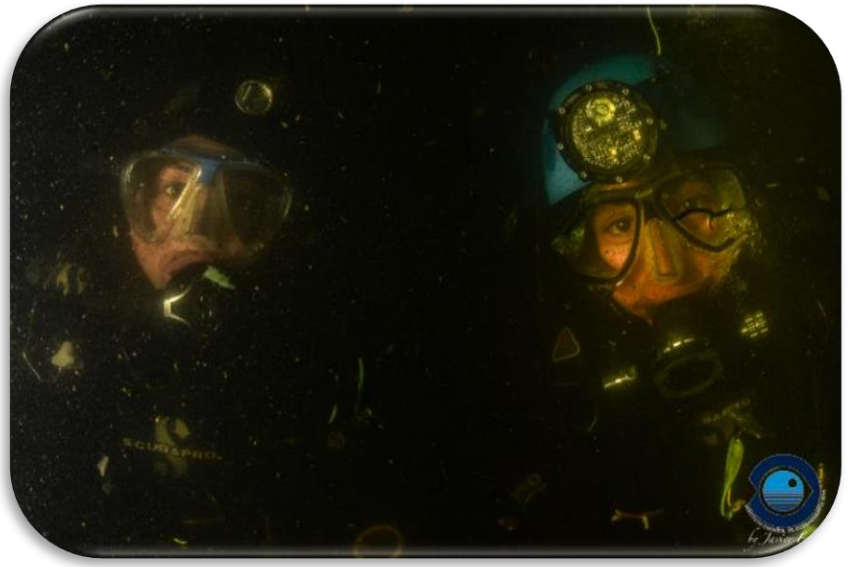
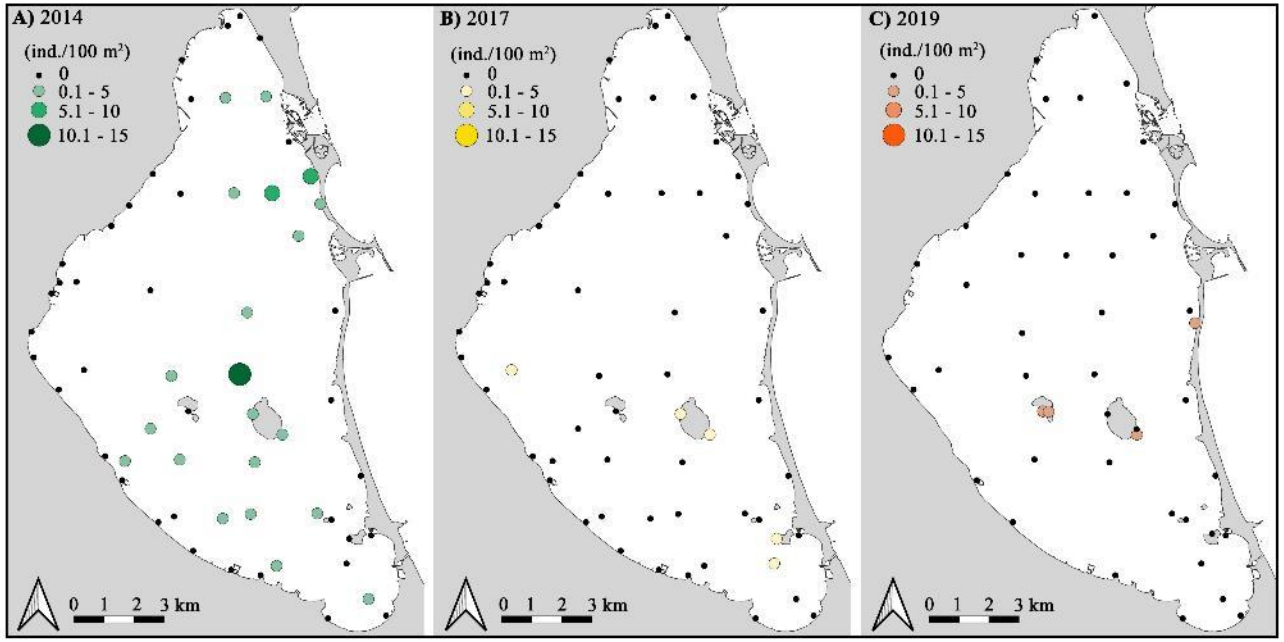
    - Deep eutrophication crisis in 2016
    - Extreme rainfall event in 2019 ("DANA-cold drop") → 14 units salinity drop



Eutrophication event

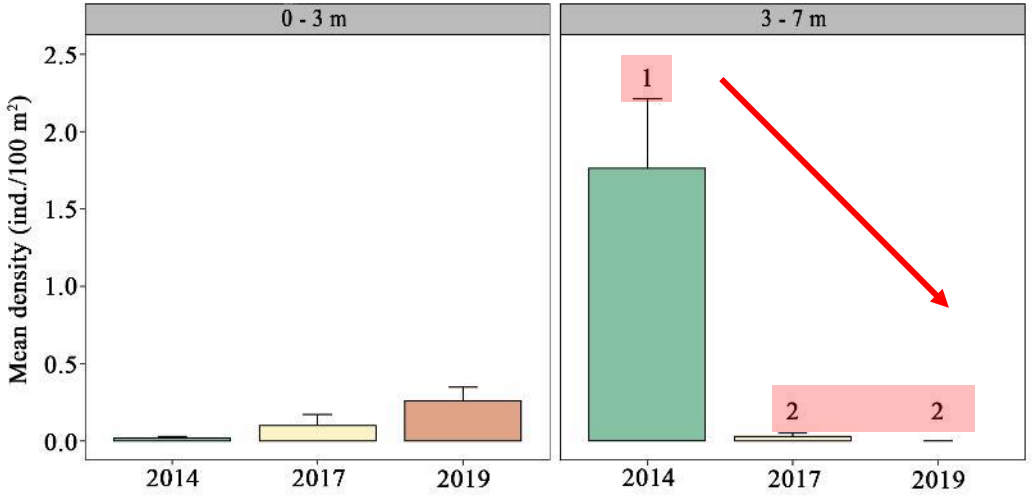
Extrem rainfall event

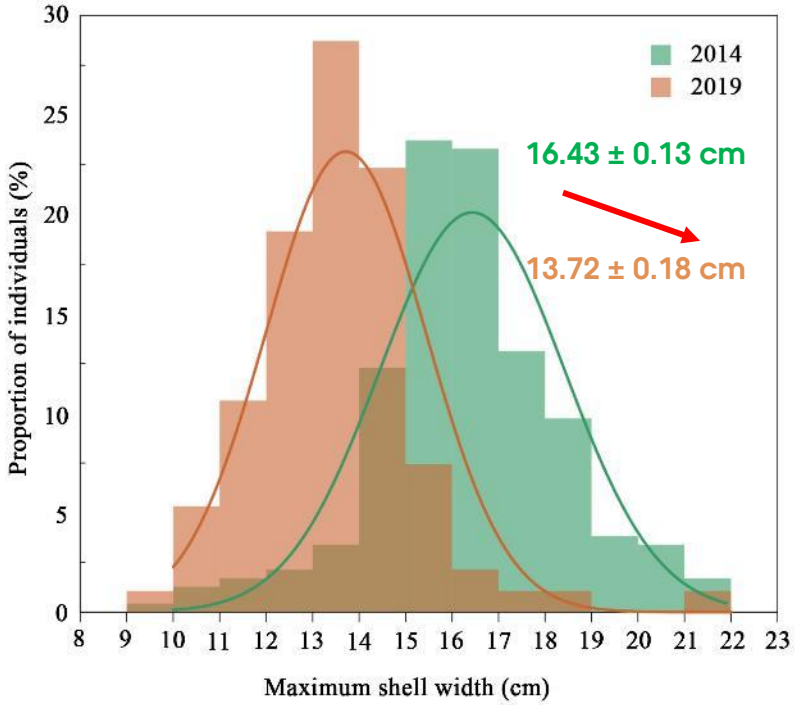


21/57 sites
0.71 ± 0.19 ind./100 m²

5/57 sites
0.07 ± 0.04 ind./100 m²

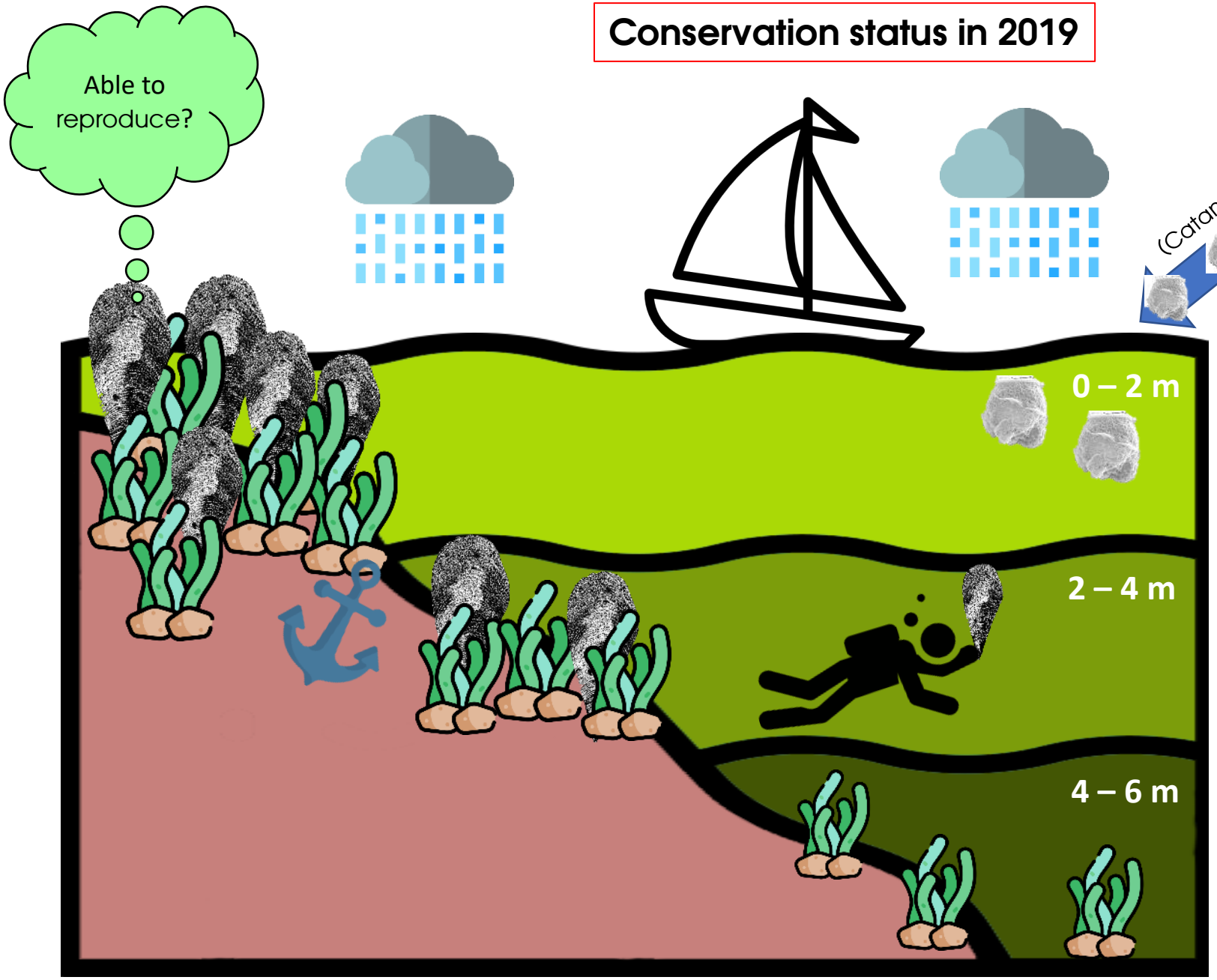
4/47 sites
0.19 ± 0.07 ind./100 m²





(Nebot-Colomer et al. 2021)

Conservation status in 2019



- ✓ **Current population really vulnerable to extinction**
  - ✓ Low densities
  - ✓ Low reproductive capacity
  - ✓ Environmental threats and lagoon instability

(Nebot-Colomer et al. 2021)

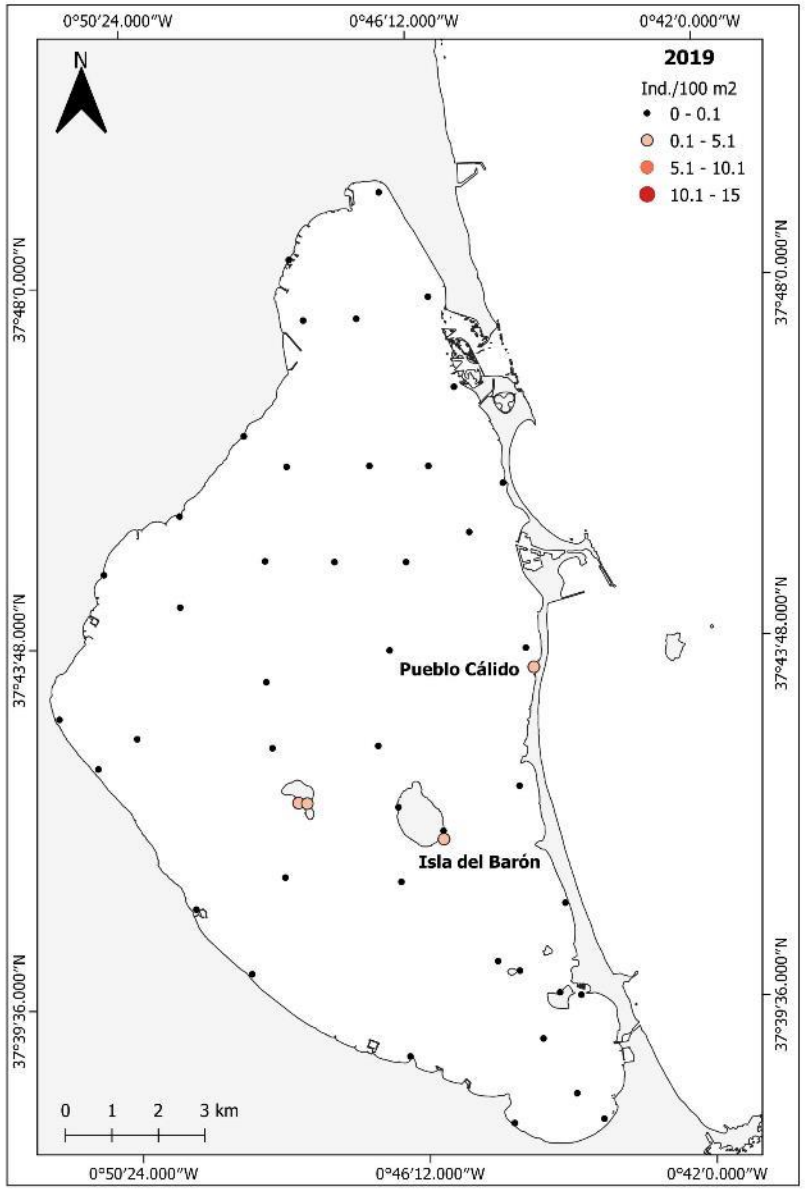
To evaluate the resilience of the population to recover from a disturbance state (2016 - 2019) by assessing its population maintenance and growth, and reproductive success

i) To determine changes on population density, abundance over the years (2019-2022)

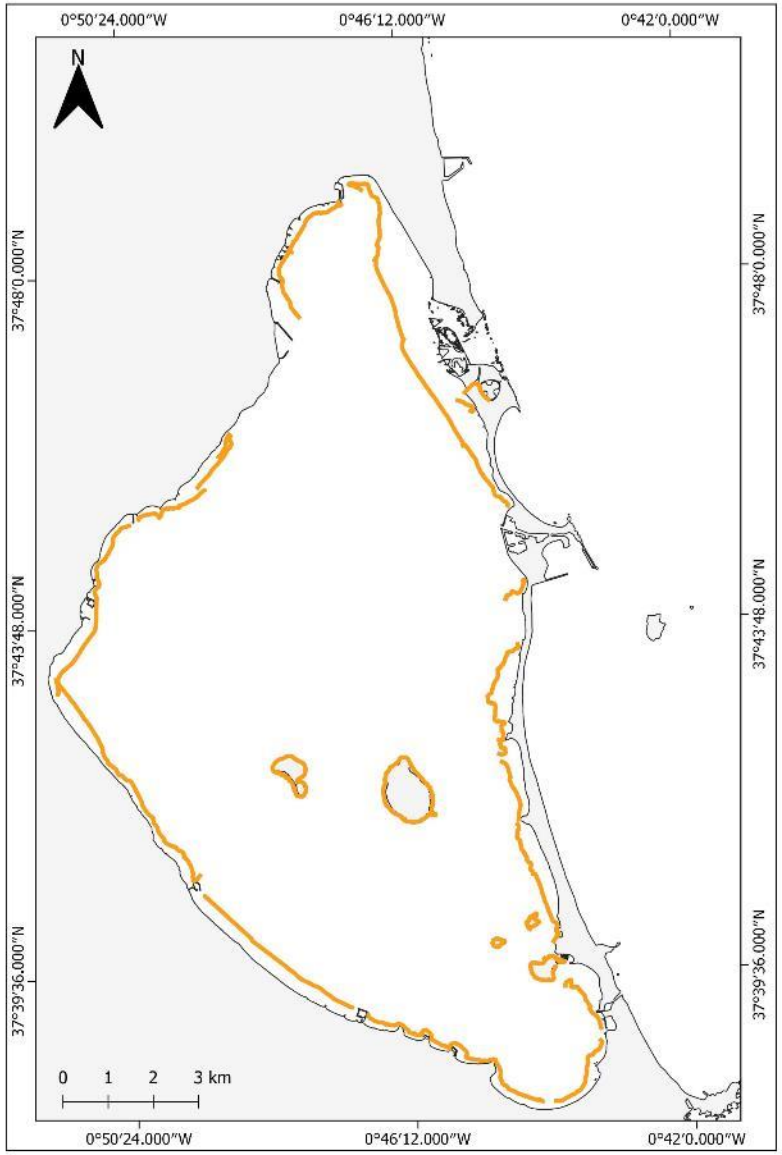
ii) To determine changes on population shell size structure over the years (2019-2022)

iii) To evaluate the reproductive success of the species in the lagoon

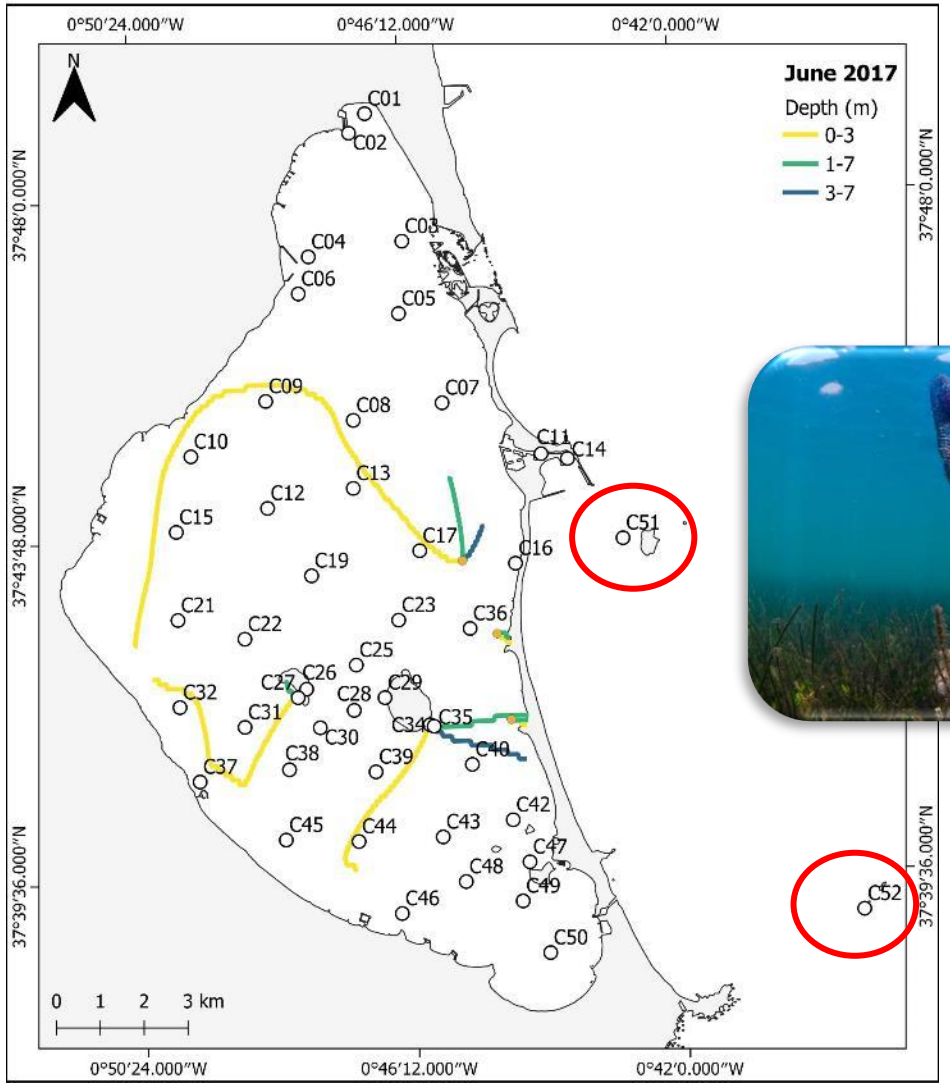
Population maintenance – Visual censuses and growth



2019 - 2022



Reproductive success – larval collectors

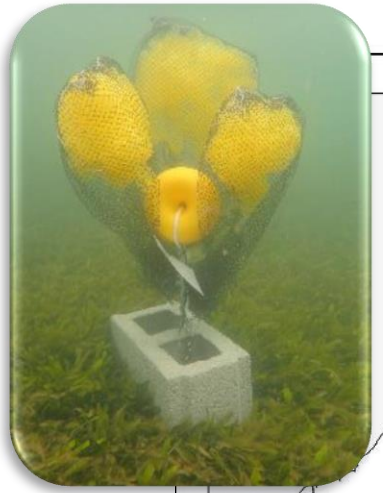


June - October

2020

45 larval collectors (13 shallow and 34 deep)

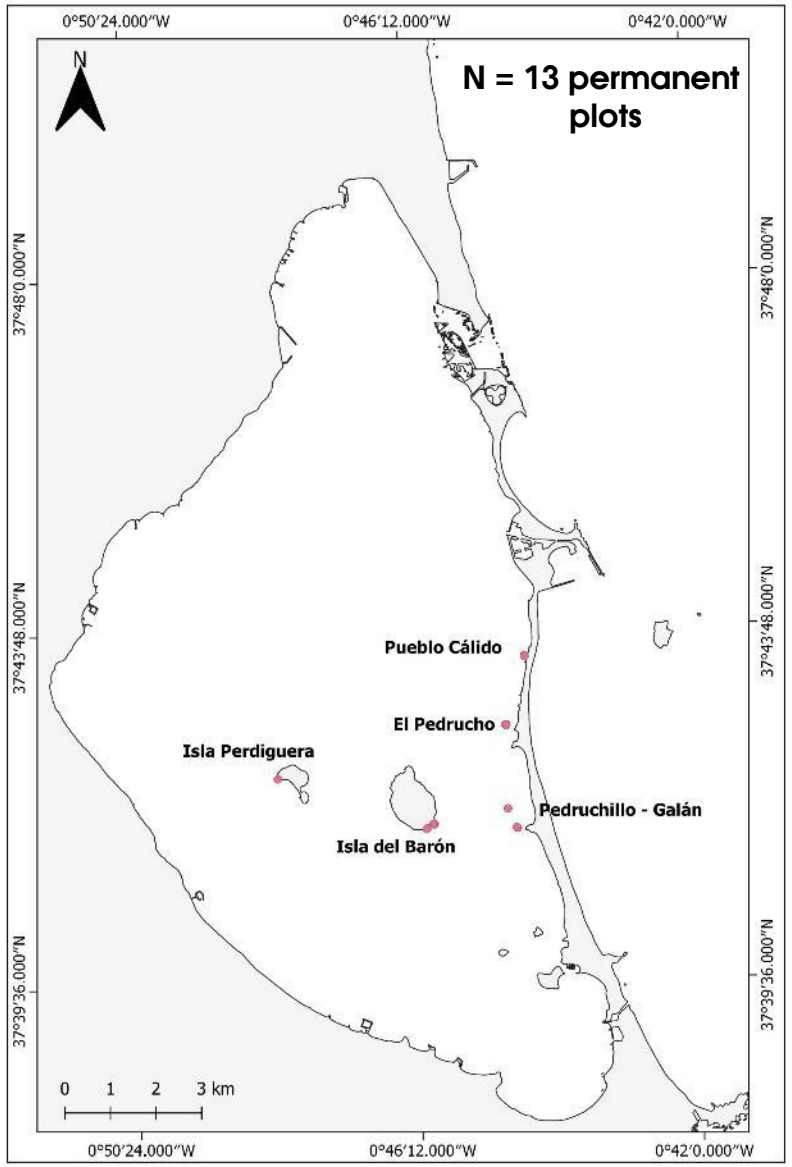
April - September



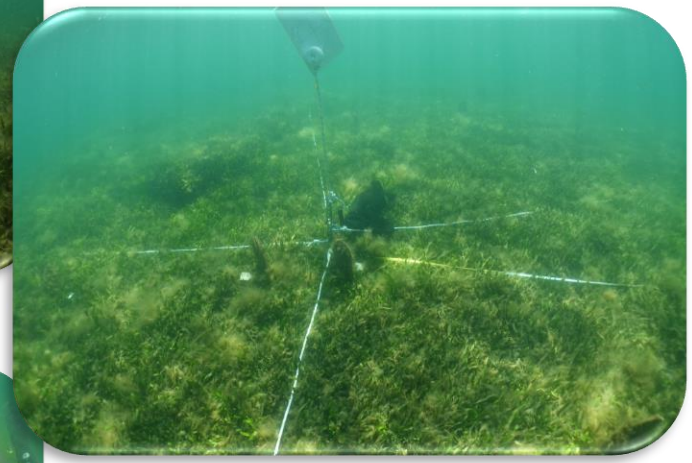
2021

23 larval collectors (18 shallow and 7 deep)

Population maintenance - Reproductive success



Installed in April 2021

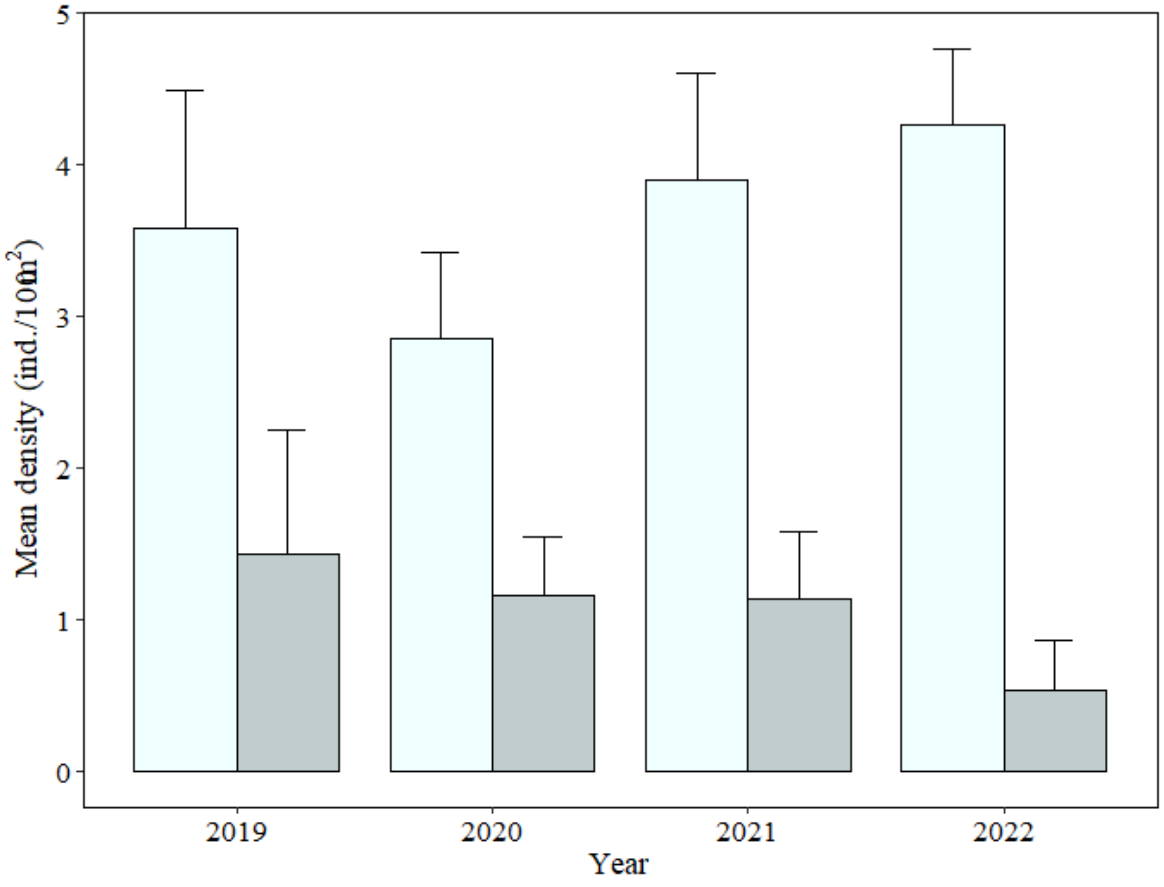


Follow up in September 2021

Follow up in May 2022

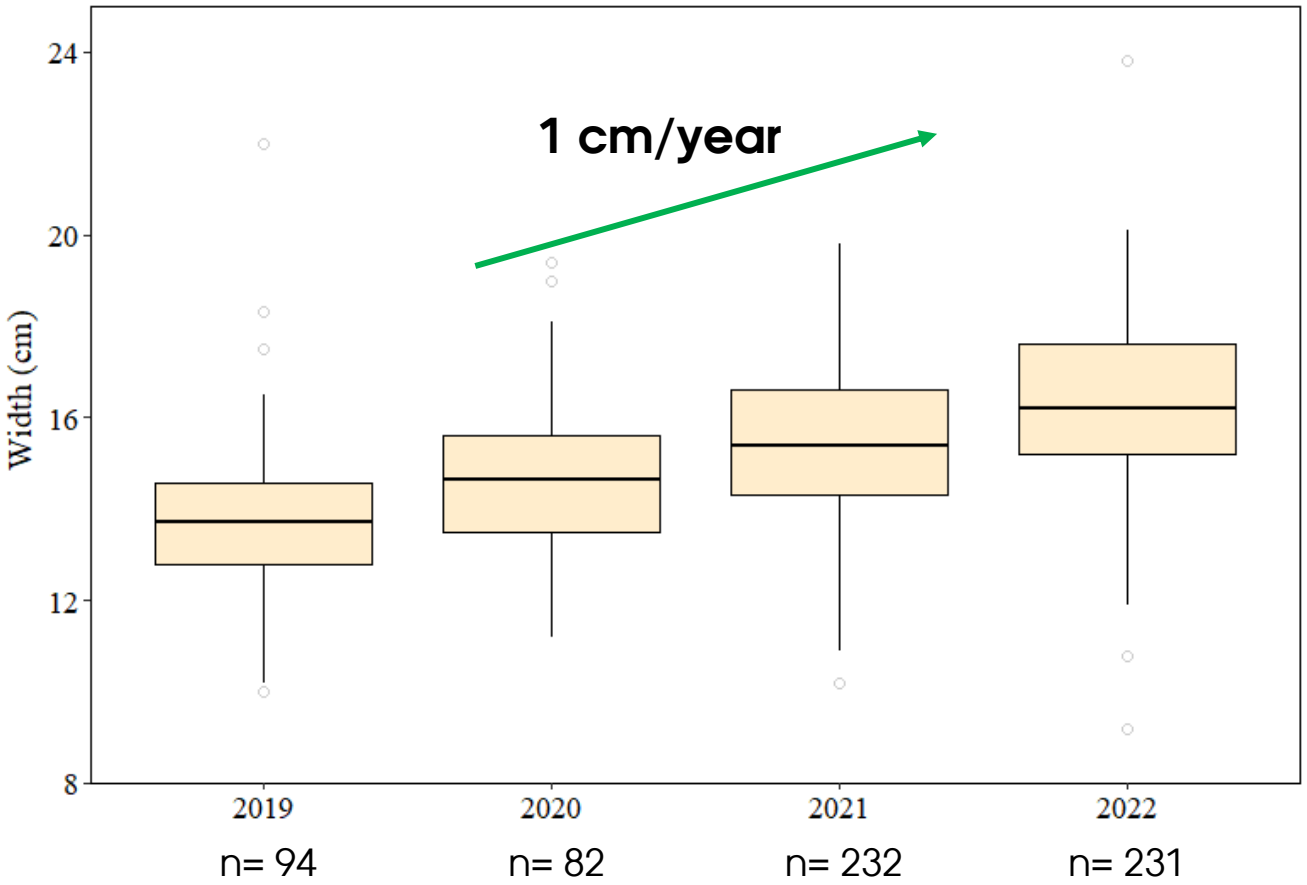
Population maintenance

Population density



2019=2020=2021=2022

Population growth



2019<2020<2021<2022

Population maintenance - Reproductive success

Global demographic rates
N= 161

April 2021

- Alive, n = 14
- Dead, n = 0
- Recruit, n = 0

Survival: 93.79%
Mortality: 6.21%
Recruitment: 0%

September 2021

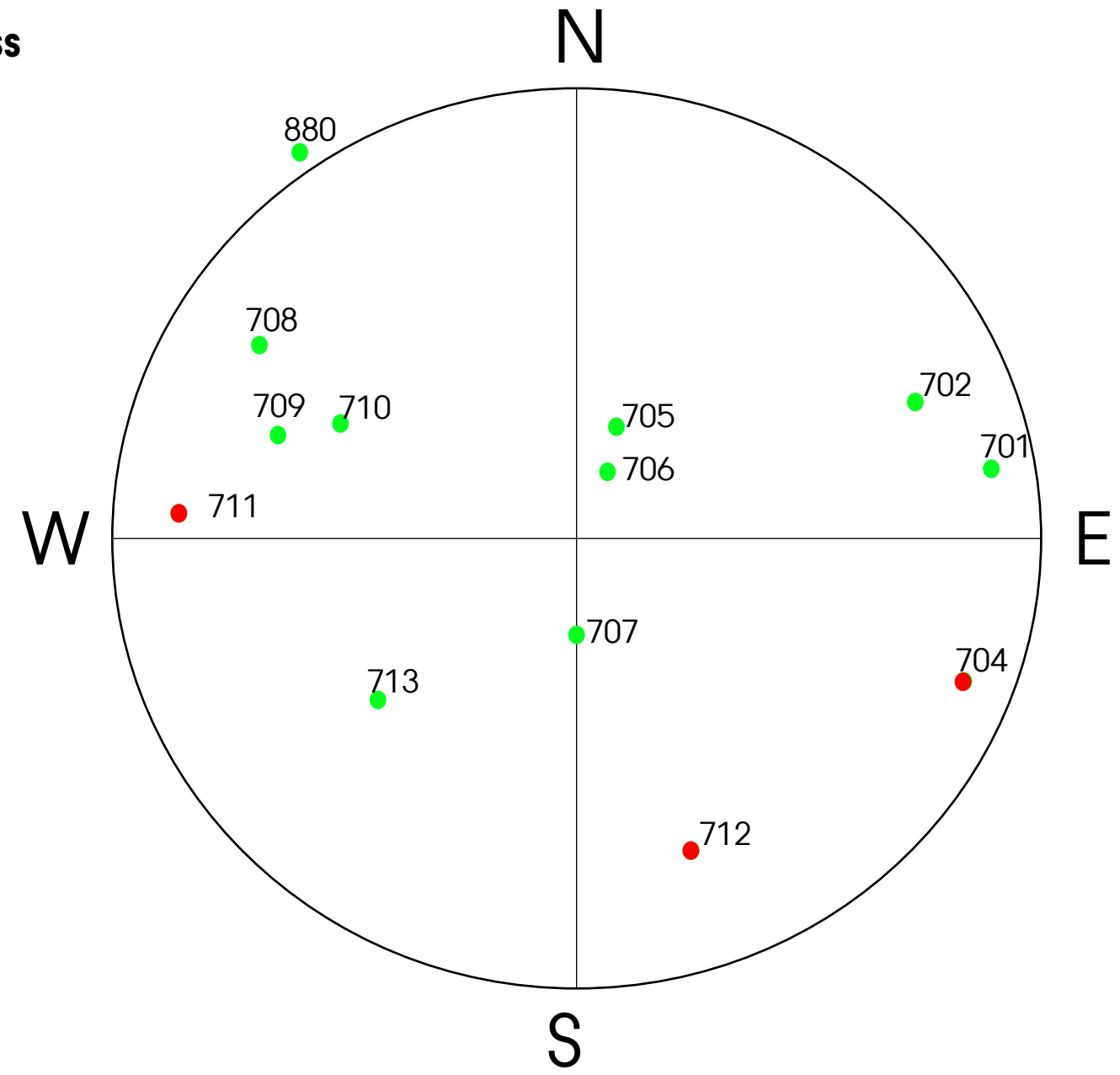
- Alive, n = 12
- Dead, n = 2
- Recruit, n = 0

Survival: 94.04%
Mortality: 5.96%
Recruitment: 0%

May 2022

- Alive, n = 10
- Dead, n = 4
- Recruit, n = 0

758



Reproductive success

Styela plicata

Branchiomma boholense

Botrylloides leachi

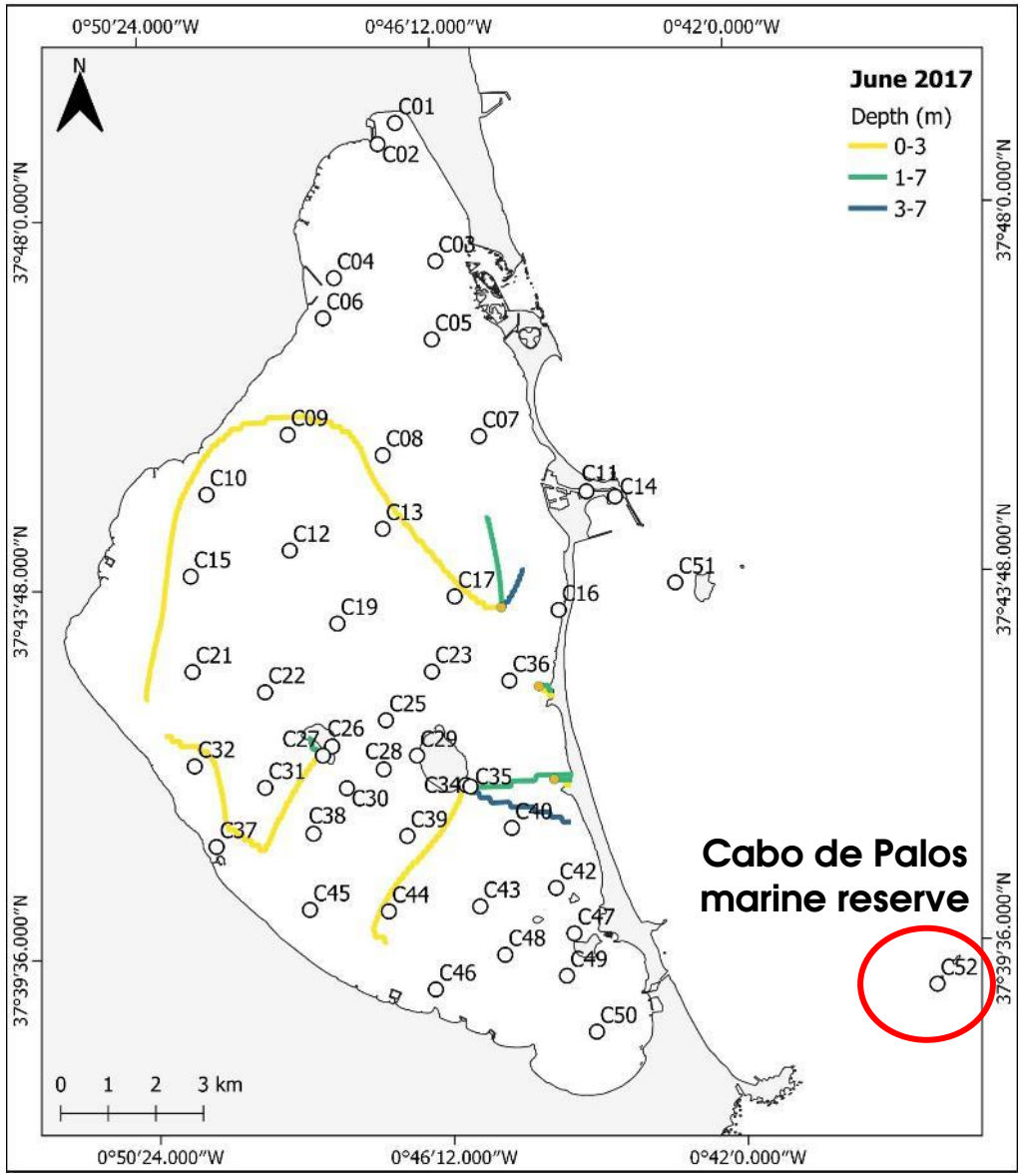
Larval collectors 2020 -2021

Hexaplex trunculus

Anemone

Ostrea stentina

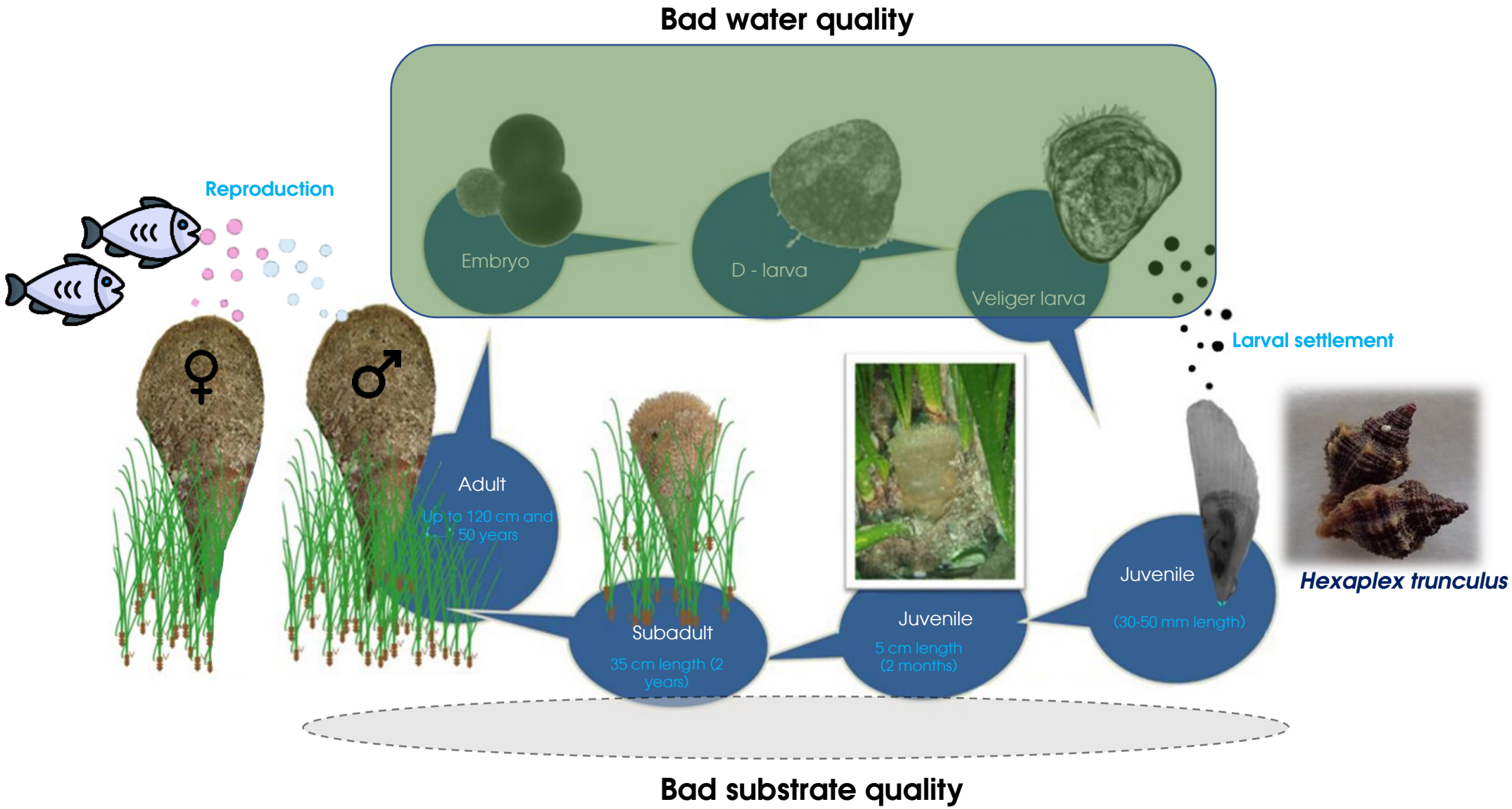
Reproductive success



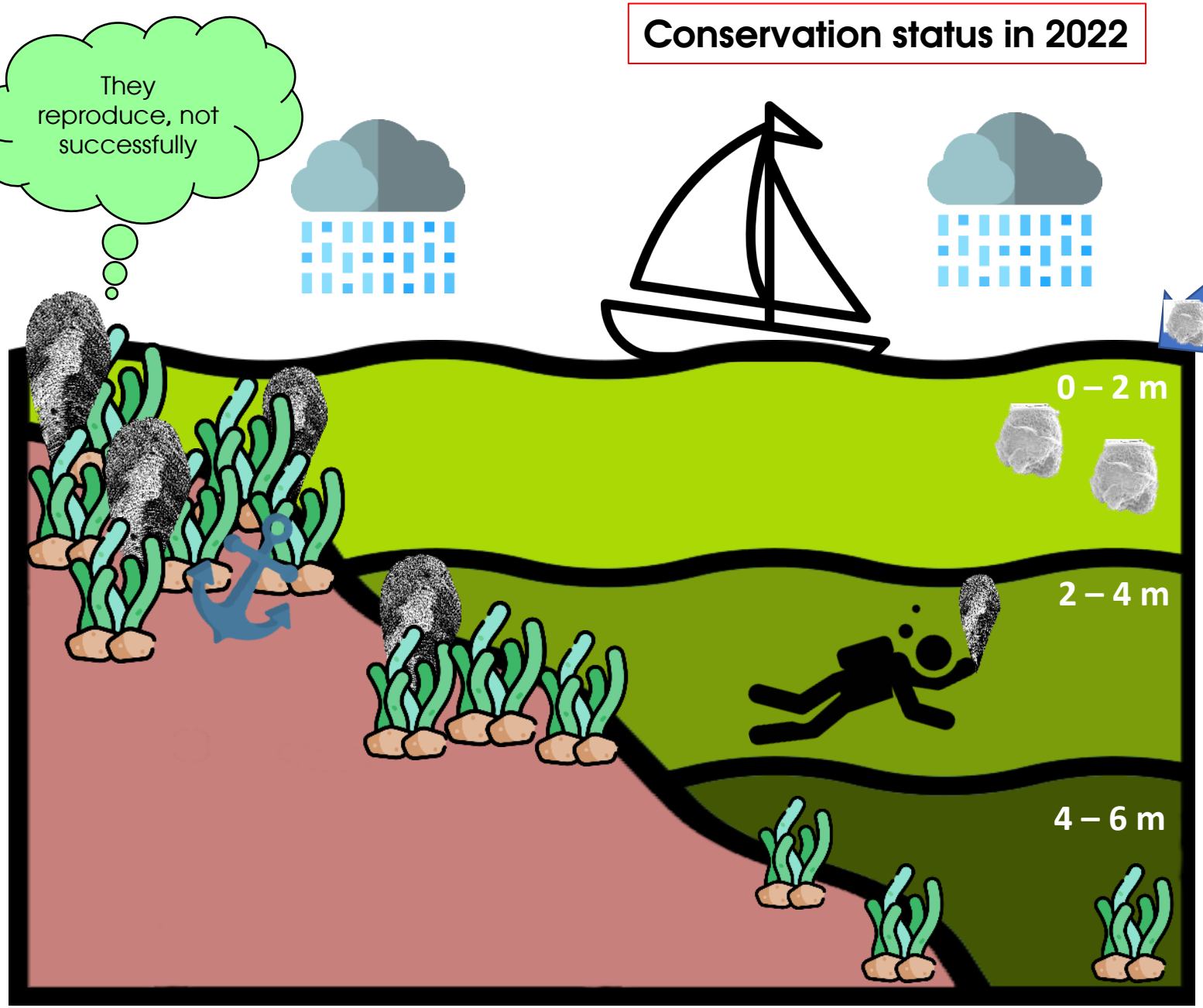
Larval collectors 2021

2021

Pinna rudis

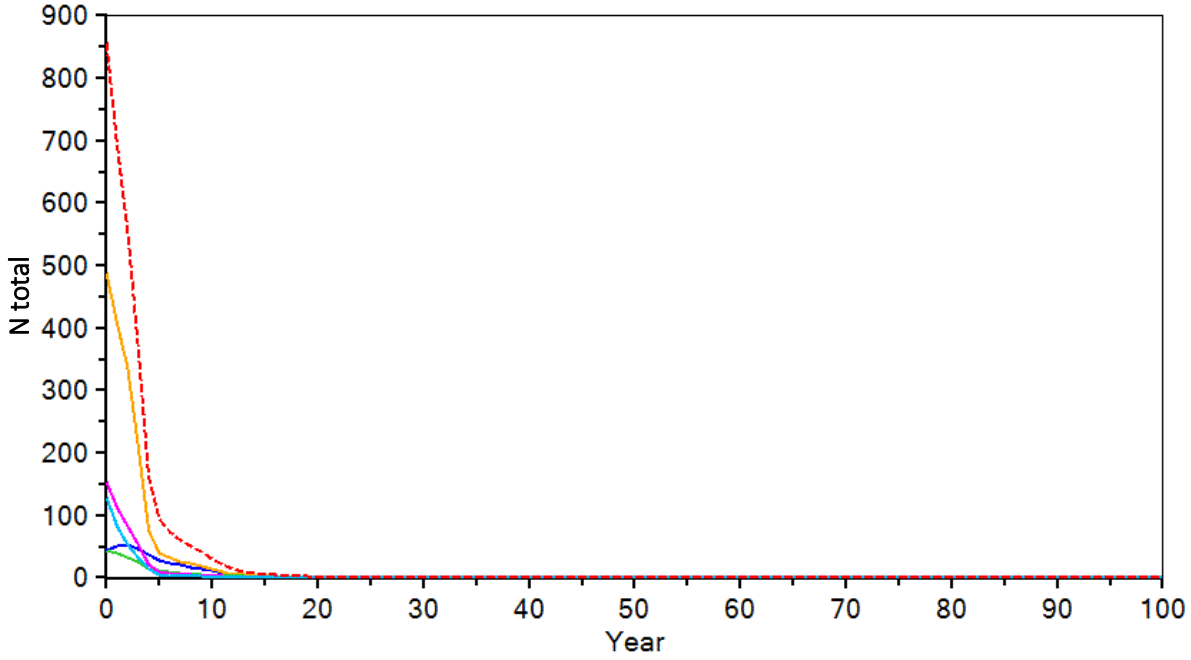

Bad water quality
Reproduction
Embryo
D - larva
Veliger larva
Larval settlement
Adult
Up to 120 cm and 50 years
Subadult
35 cm length (2 years)
Juvenile
5 cm length (2 months)
Juvenile
(30-50 mm length)
Hexaplex trunculus
Bad substrate quality

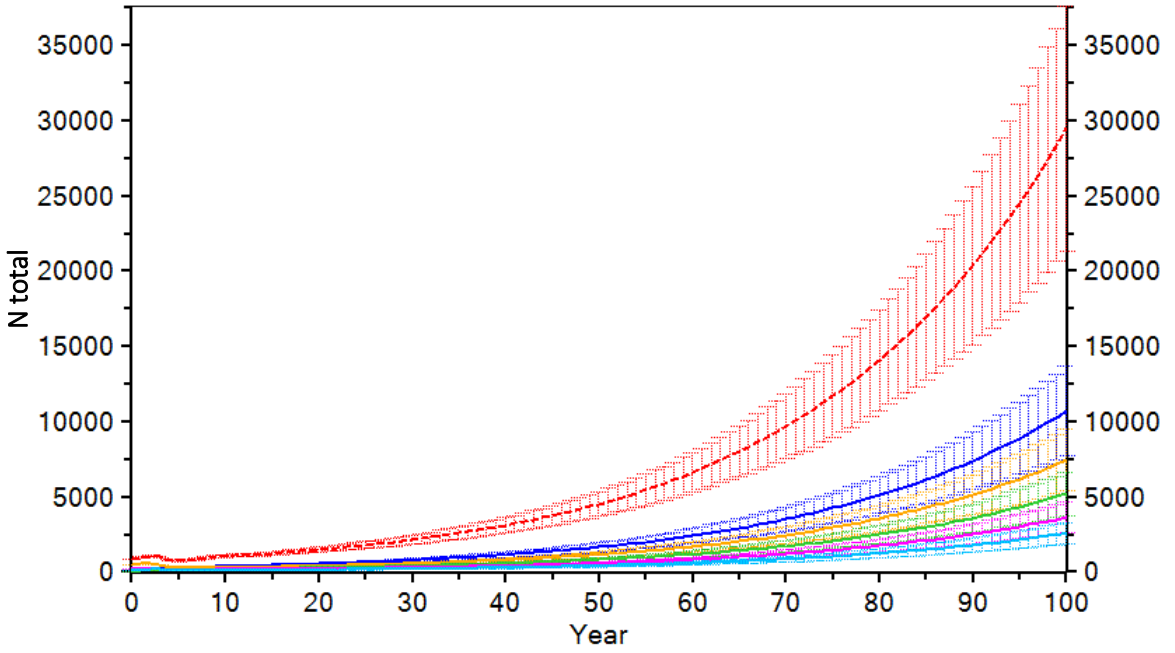
Conservation status in 2022



- **Current population vulnerable to extinction**
  - ✓ Fewer abundance than in 2019
  - ✓ No reproductive success
  - ✓ Same environmental threats

Population viability analysis





Isla Perdiguera
Isla del Barón
Pueblo Cálido
El Pedrucho
Pedruchillo-Galán
Metapopulation

Extinction probability = 100%
- Recruitment 10%
- All catastrophes (eutrophication, rainfall event, etc)

Extinction probability = 0%
- Recruitment 10%
- Removing catastrophes (eutrophication, rainfall event, etc)

- ✓ **Conservation-management actions proposed:**
  - ✓ Restauration of the habitat (water quality and substrate quality).
  - ✓ Protection of the remaining individuals.
  - ✓ Legally protect and limit the access to the area where *P. nobilis* individuals inhabit.
  - ✓ Increase genetic knowledge of the population for future reinforcement actions.

- ✓ **Take-home messages:**
  - ✓ One of the last *P. nobilis* reservoirs.
  - ✓ Current population really vulnerable to extinction.
  - ✓ Conservation actions needed to restore this population.
  - ✓ Population possible needed for future reintroduction programs.

Thank you for your attention!

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