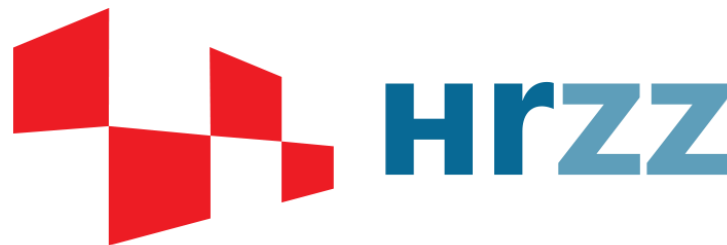


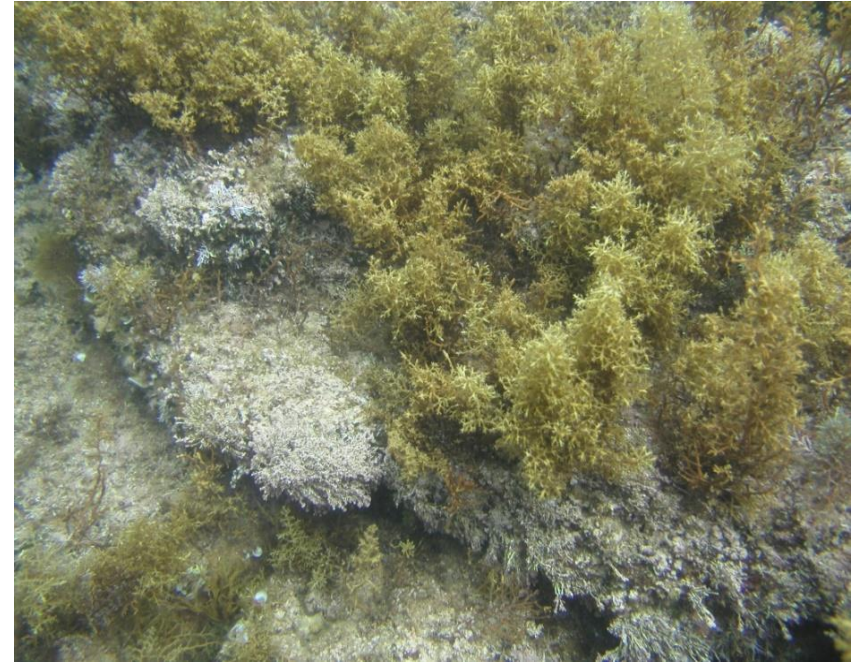
Effects of extreme temperature on fucalean forests in a shallow lagoon in the northern Adriatic

Ljiljana Iveša, Andrea Bilajac, Edi Gljušćić, Shannen Smith

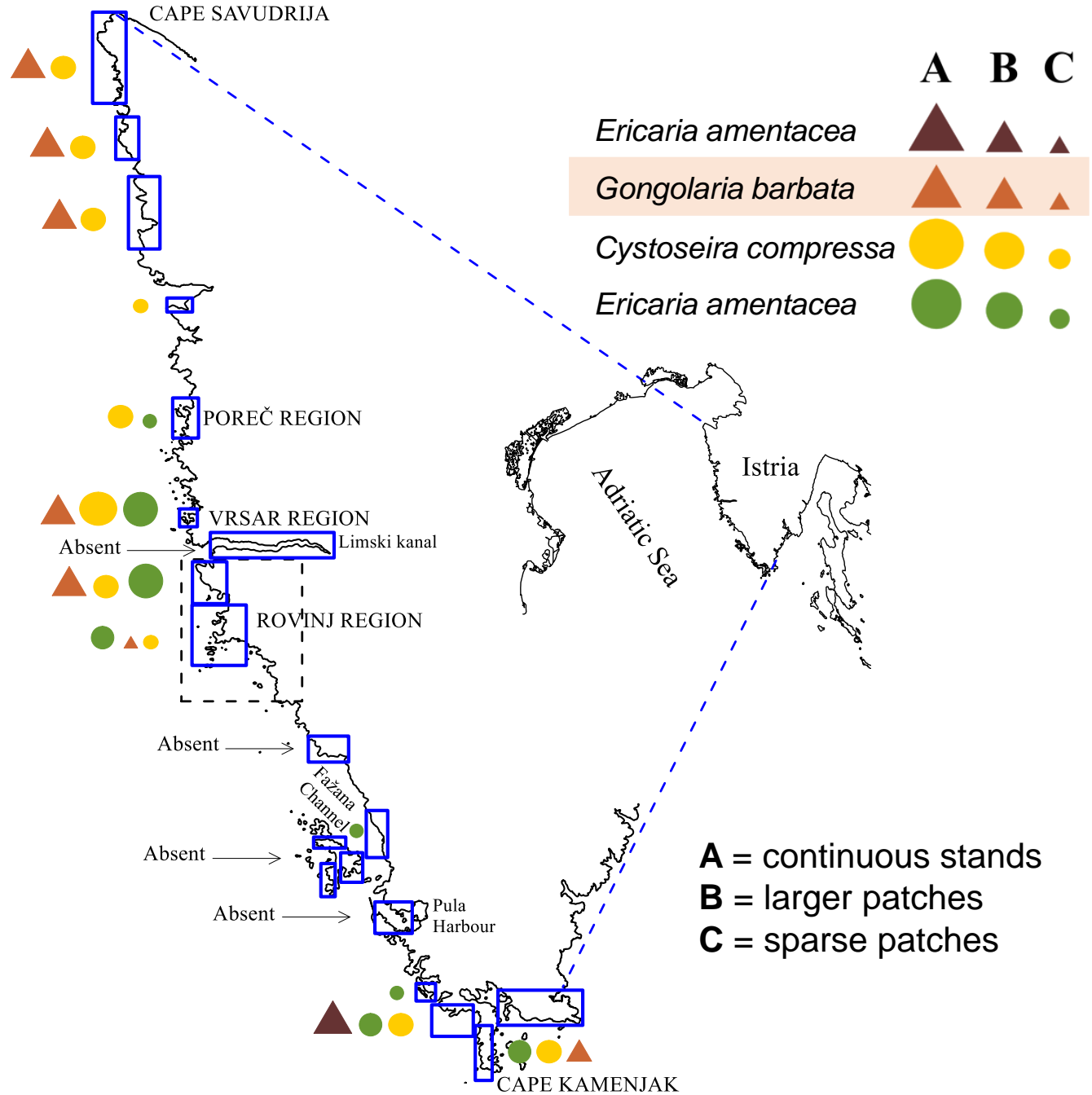
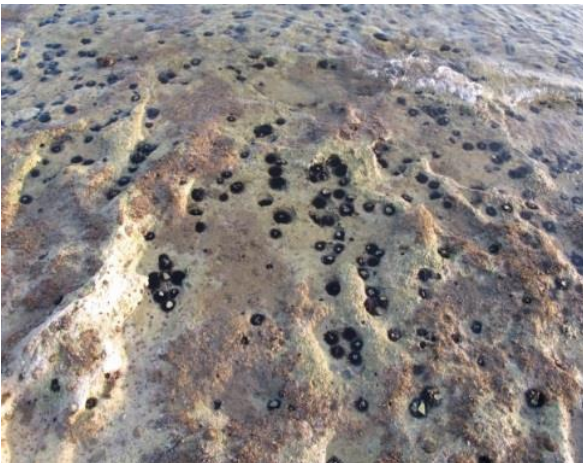
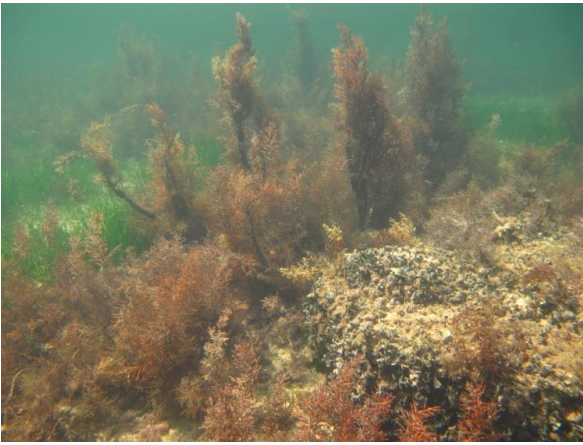


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Fucalean species in the northern Adriatic from 2003 to 2015



Mixed fucalean forests: 2003-2015

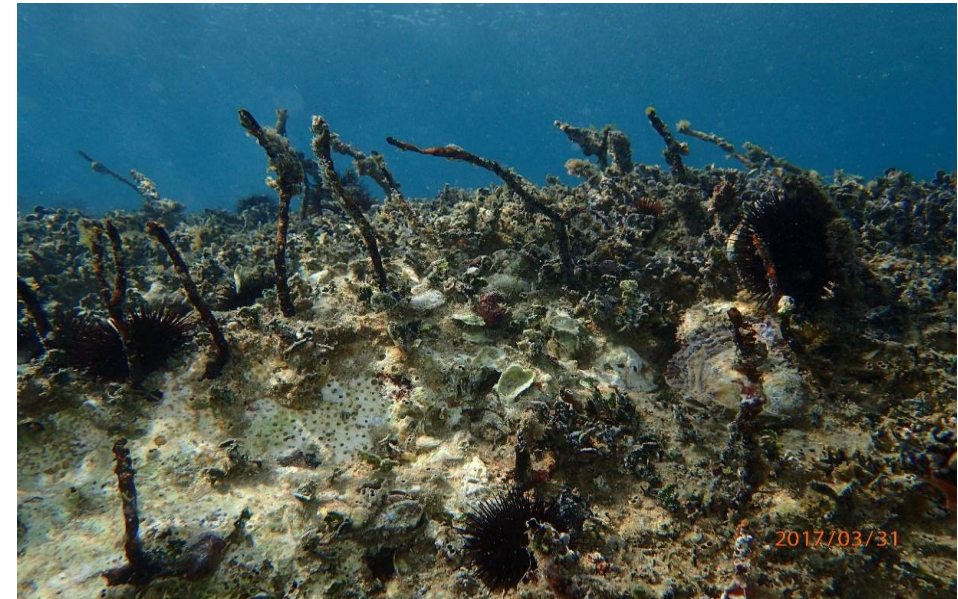
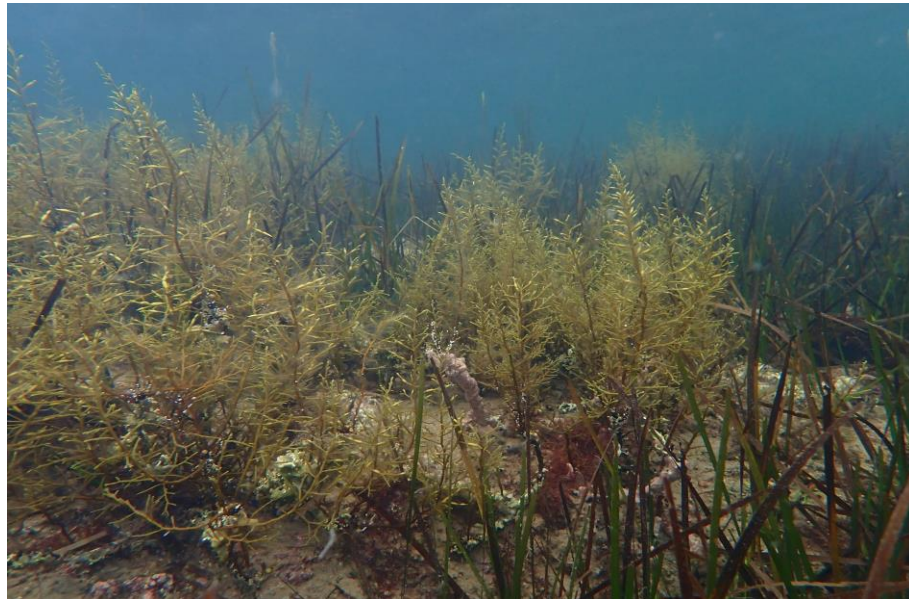


Gongolaria barbata in shallow bays

2003 - 2015



2016 - 2020



PREDICTED

2015!

2020!

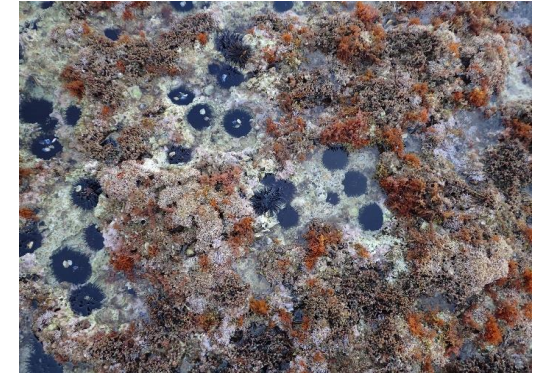
Biomass of *G. barbata*



G. barbata



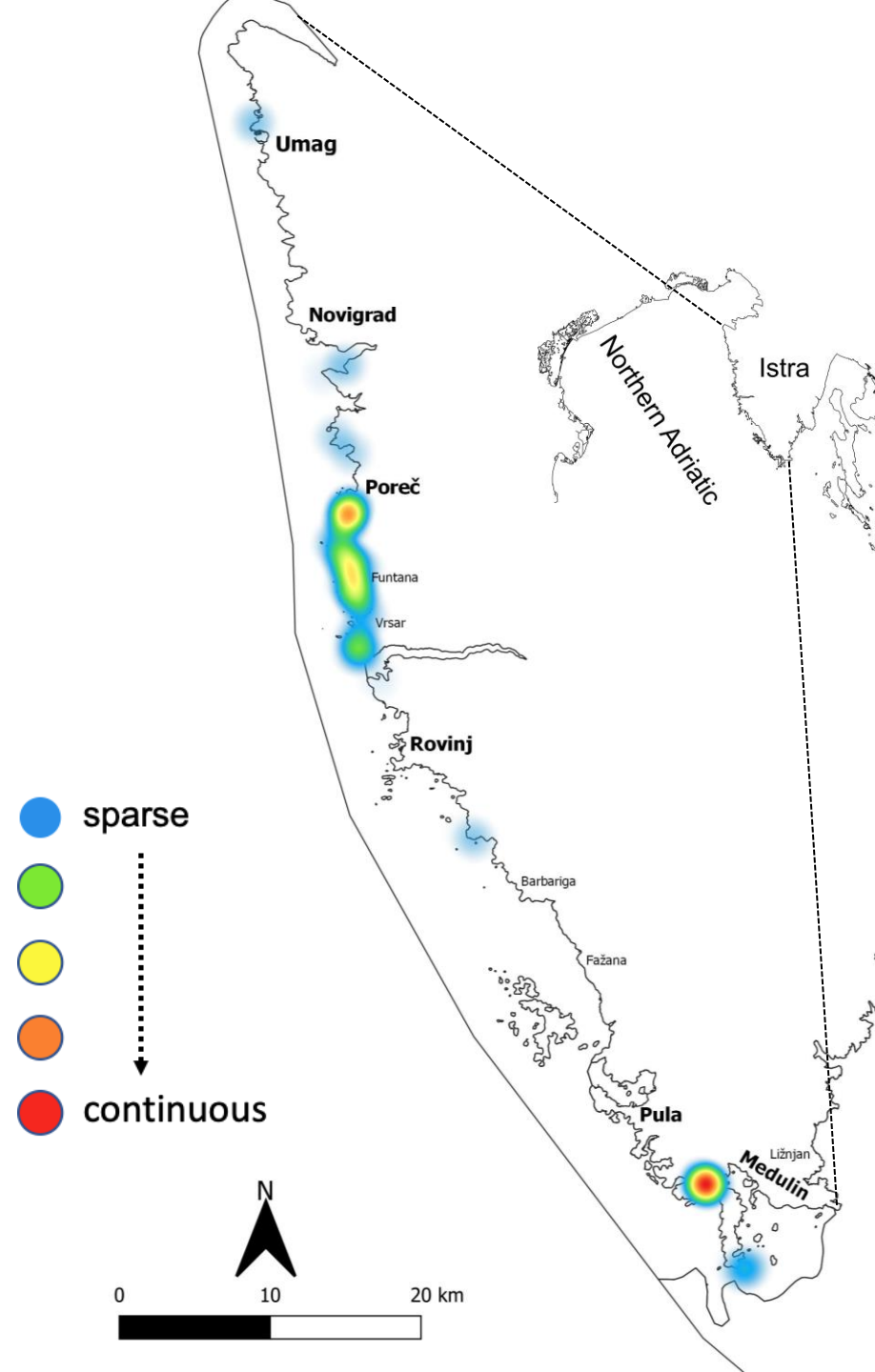
G. barbata



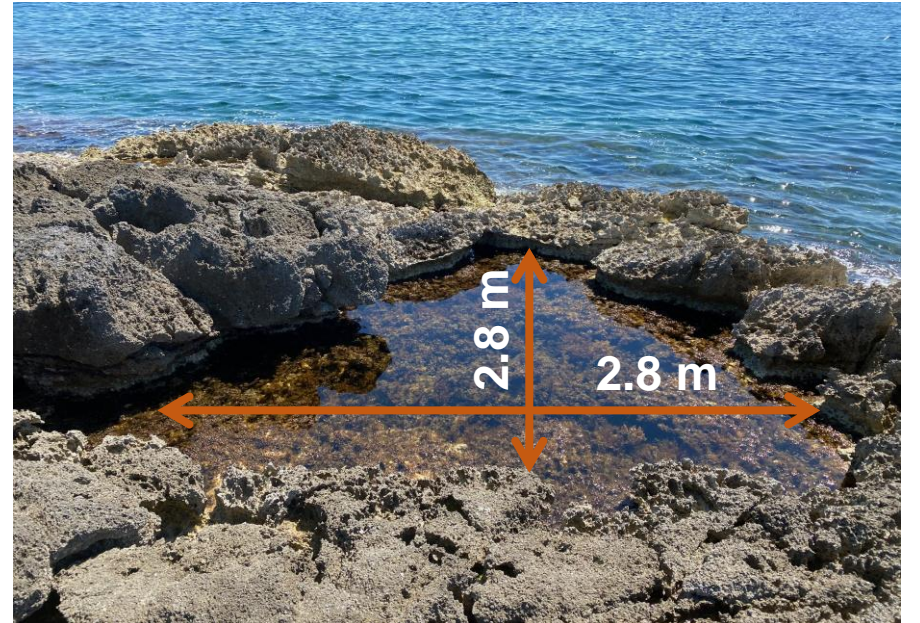
NO *G. barbata* settlement

Shallow bays

2021: Larger scale survey



Gongolaria babata in rockpools



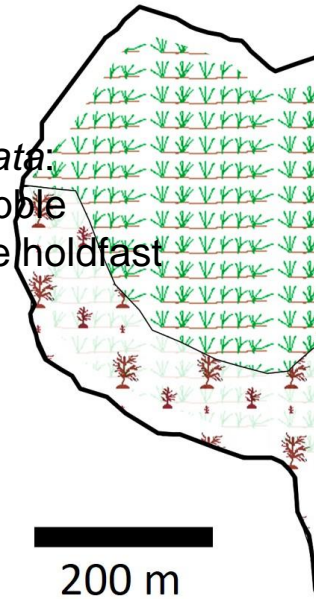
Gongolaria barbata in a coastal lagoon



Thallus of *Gongolaria barbata*

A: Attached thallus on a pebble

B: Detached thallus with the holdfast



200 m

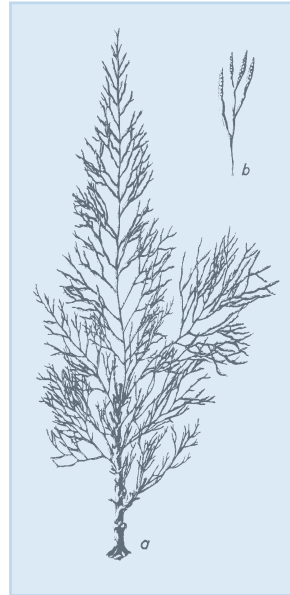


5 cm

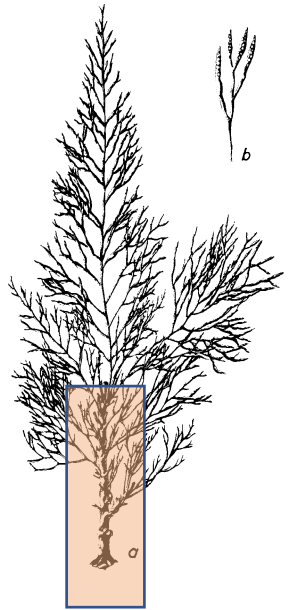


3 cm

Growth phase of *G. barbata* in colder seawater



Dormant phase of *G. barbata* in warm seawater



Extreme temperature conditions in the lagoon

Marine heat waves in the lagoon from 2019 to 2021.



Grey line and green line indicate the seasonal climatology and the seasonally varying threshold (90th percentile) for the identification of MHWs, respectively. Black lines indicate *in situ* seawater temperatures (IST) for *G. barbata* population in Šćuza lagoon.

PREDICTED



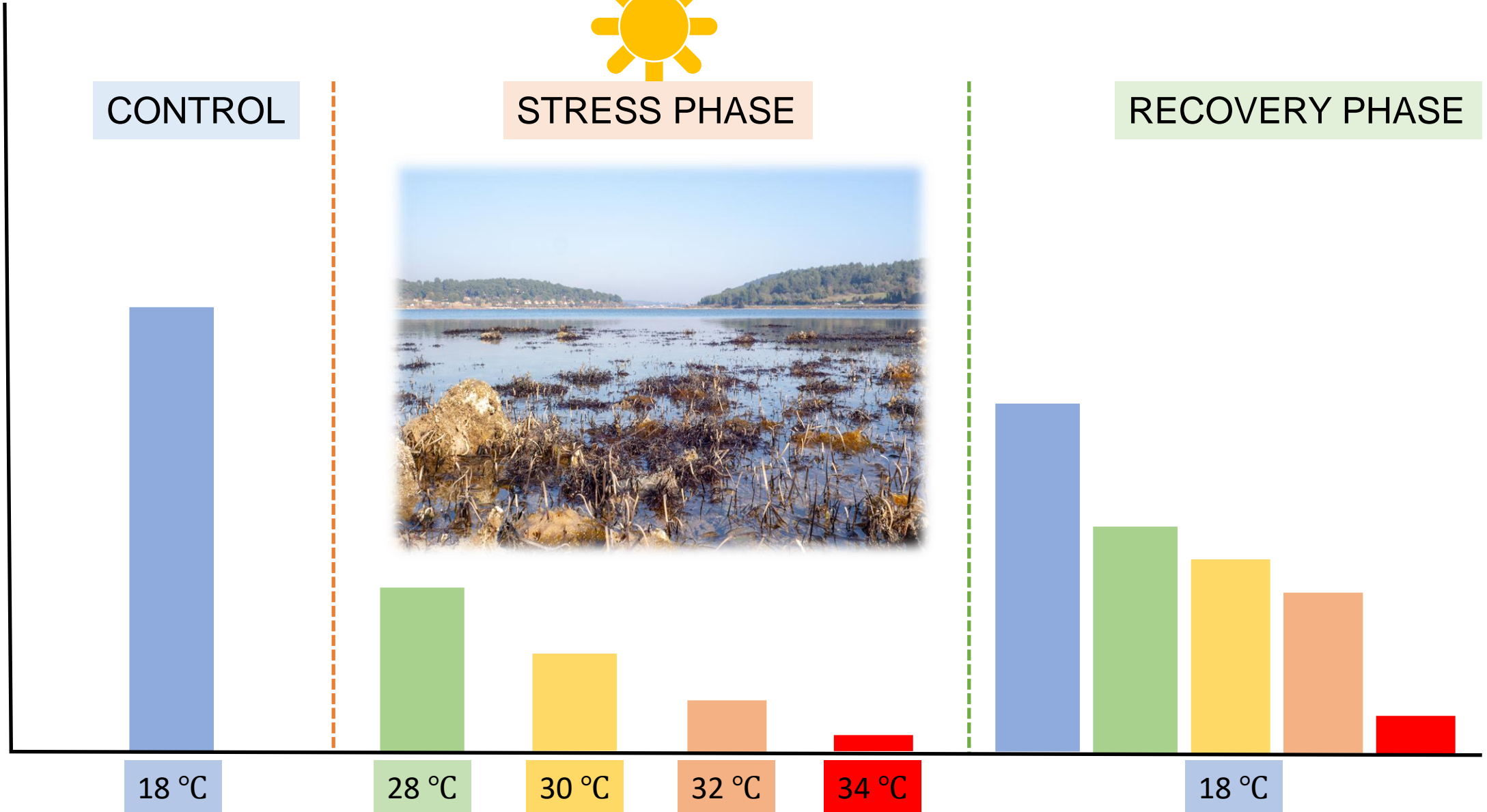
CONTROL

STRESS PHASE

RECOVERY PHASE



Biomass of *Gongolaria barbata*



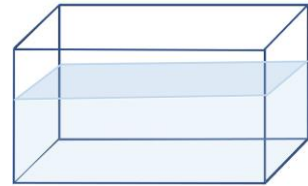
Thermotolerance experimental design

A) STRESS PHASE

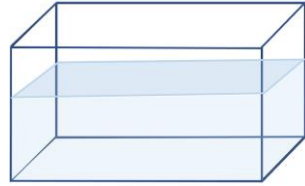


= 5 thalli in each tank

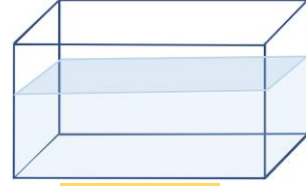
CONTROL



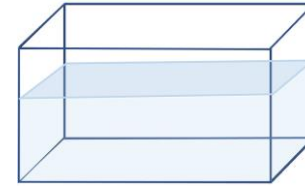
18 °C



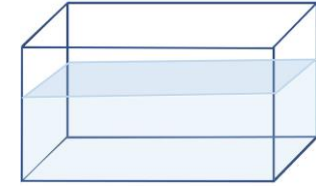
28 °C



30 °C



32 °C



34 °C

Time



Day 0

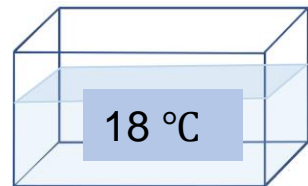
Day 22

Day 29

Day 62

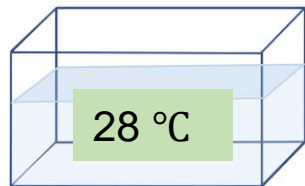
B) RECOVERY PHASE

CONTROL



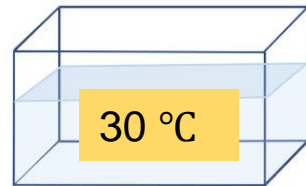
18 °C

18 °C



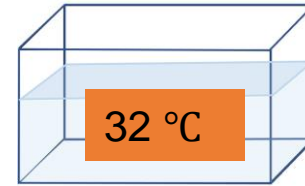
28 °C

18 °C



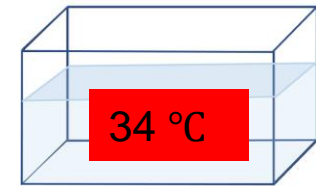
30 °C

18 °C



32 °C

18 °C



34 °C

18 °C

Time

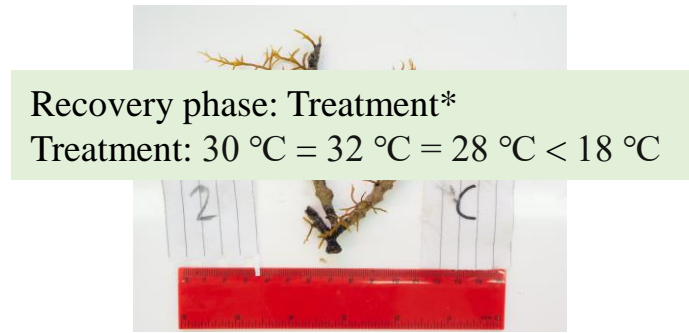
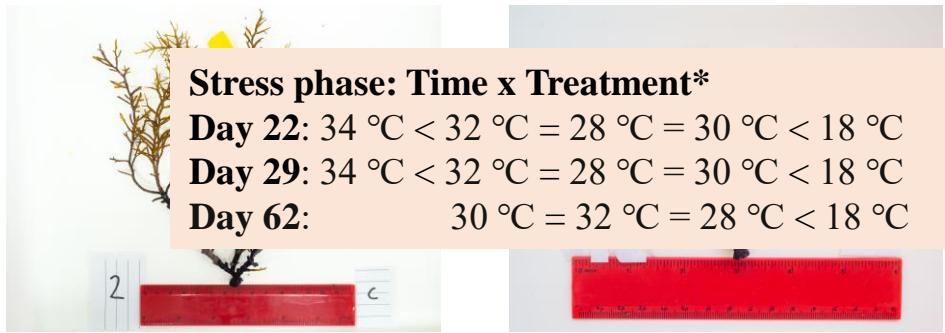
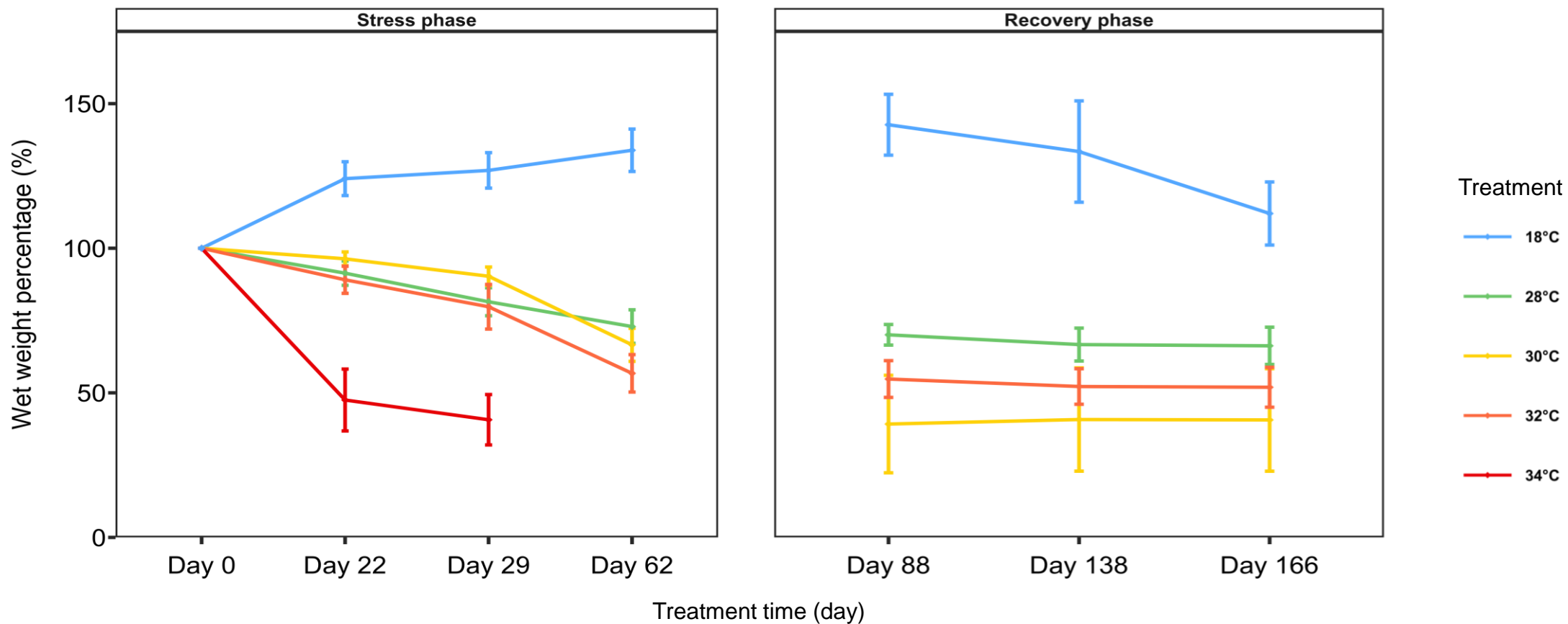


Day 88

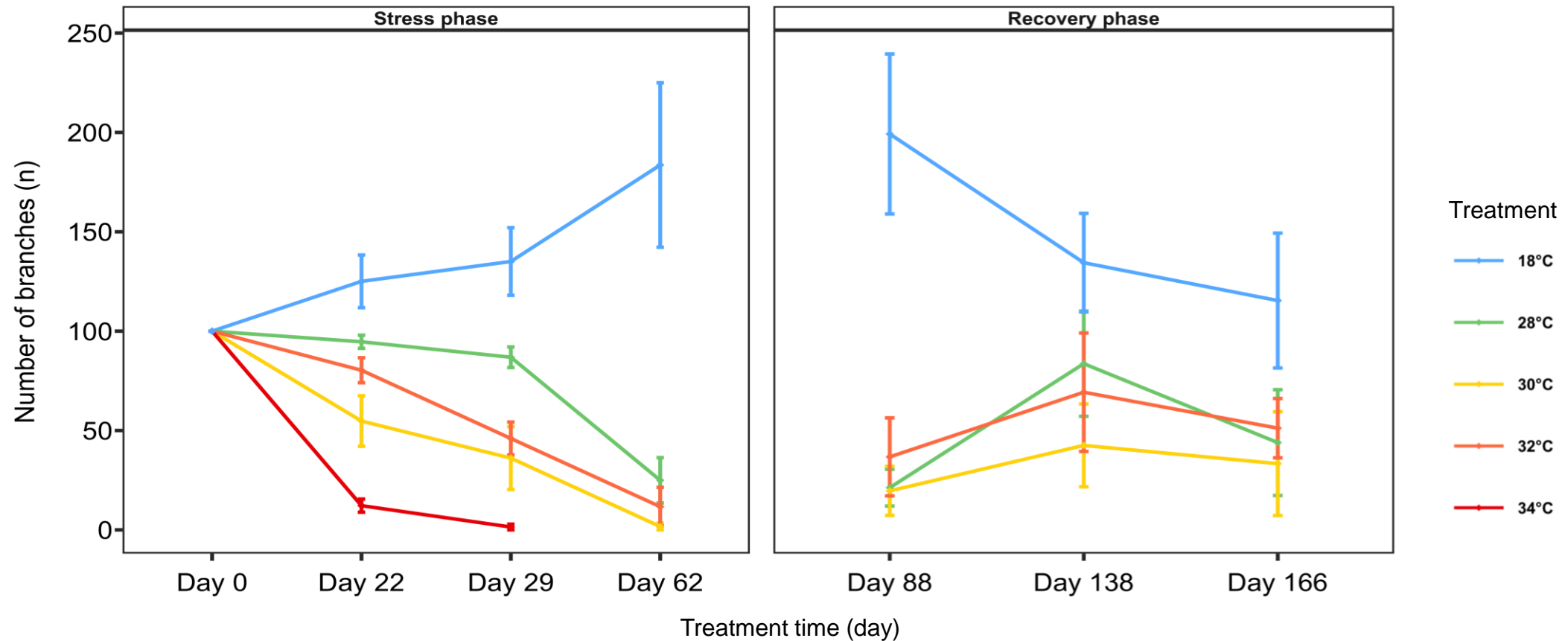
Day 138

Day 166

Temperature effects on the **wet weight** (mean \pm SE) of *Gongolaria barbata* individuals over 62 days of exposure to different warm temperatures (**Stress phase**) and over 88 days of exposure to 18 °C (**Recovery phase**).



Temperature effects on the **number of branches** (mean \pm SE) of *Gongolaria barbata* individuals over 62 days of exposure to different warm temperatures (**Stress phase**) and over 88 days of exposure to 18 °C (**Recovery phase**).



Stress phase: Time x Treatment*

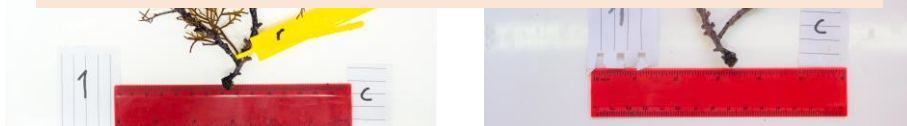
Day 22: 34 °C < 30 °C = 32 °C = 28 °C = 18 °C

Day 29: 34 °C < 30 °C = 32 °C < 28 °C < 18 °C

Day 62: 30 °C = 32 °C = 28 °C < 18 °C

Recovery phase: Treatment*

Treatment: 30 °C = 28 °C = 32 °C < 18 °C



Findings

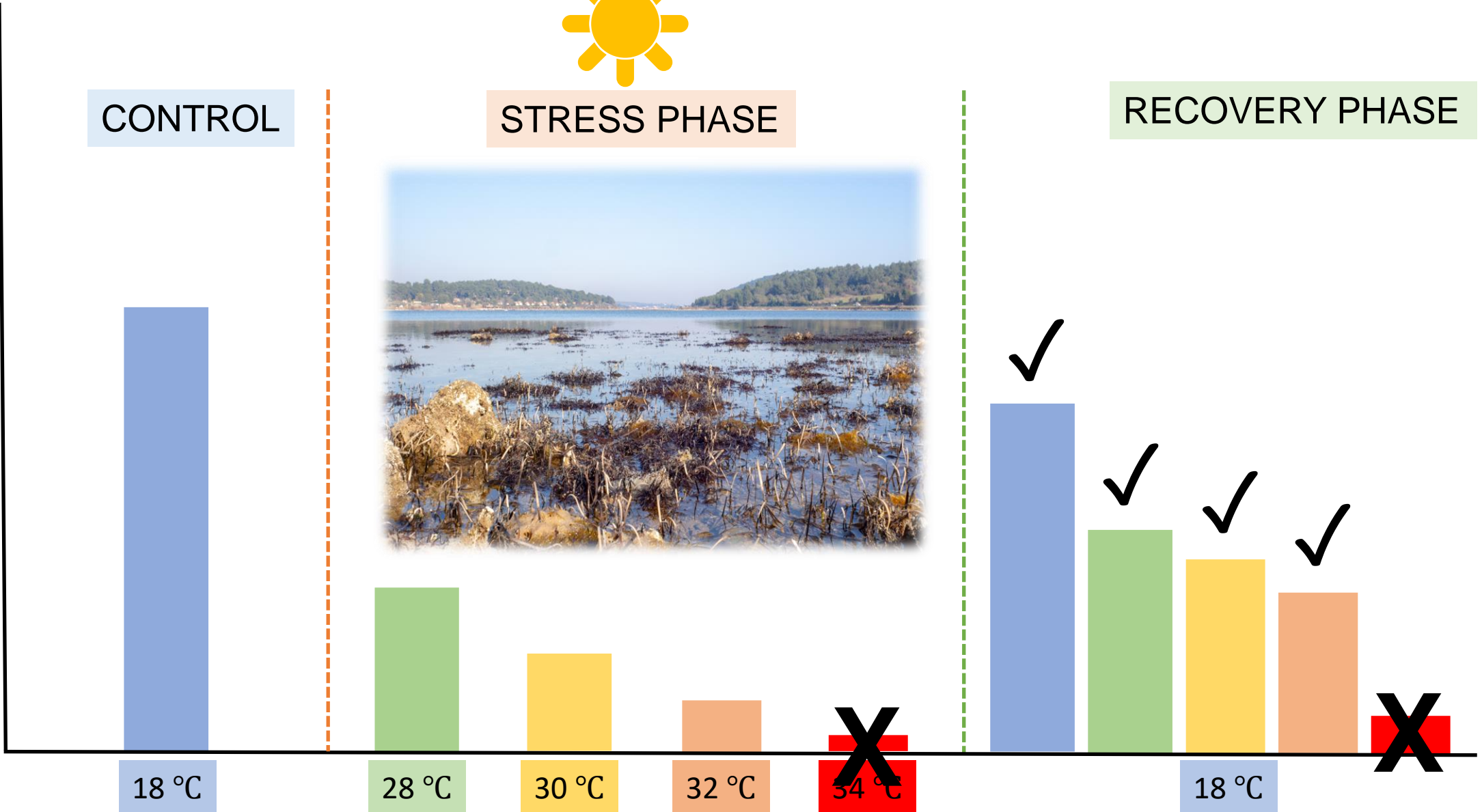


Biomass of *Gongolaria barbata*

CONTROL

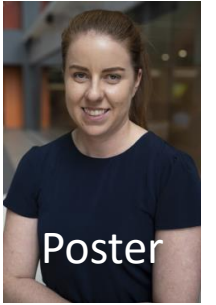
STRESS PHASE

RECOVERY PHASE

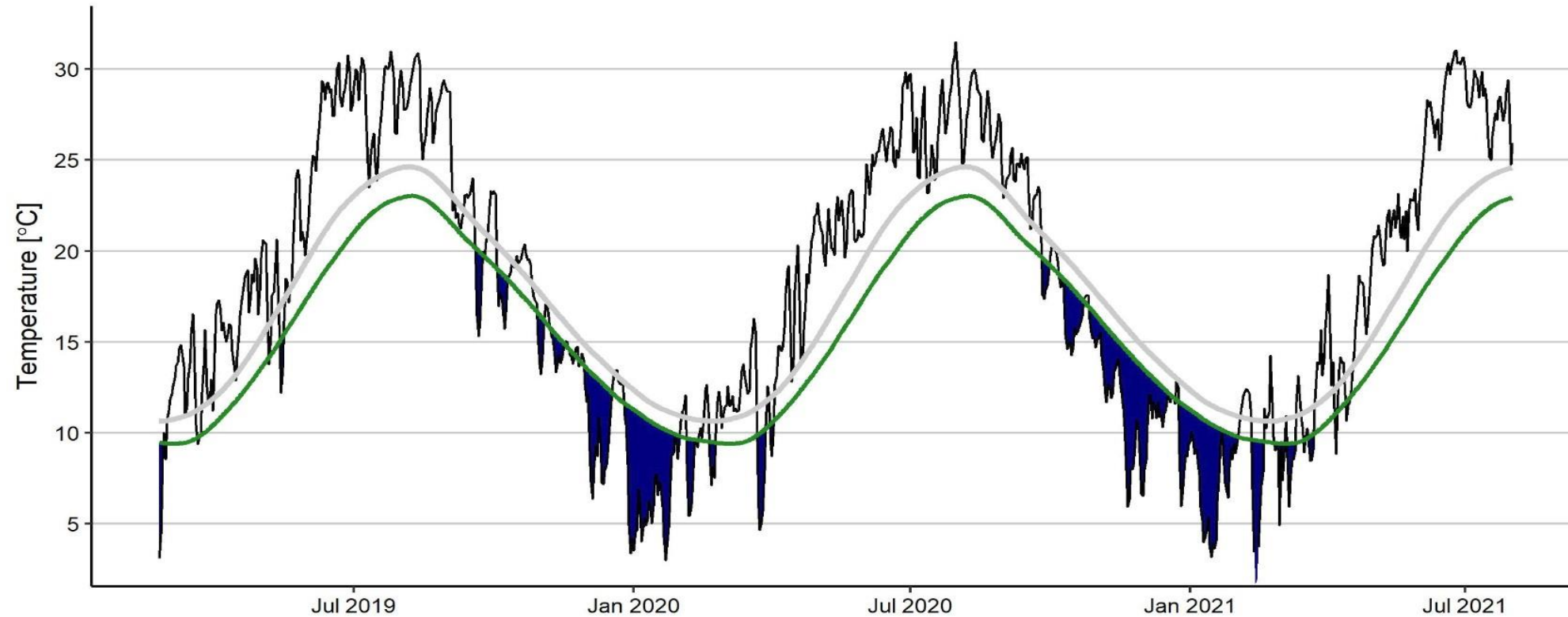


Cold spells

- OBSERVATION:
- Growth and reproduction of *G. barbata* is in the colder season
 - Receptacles and conceptacles are also present in colder months



Dr Shannen Smith



Line Colour

- seas
- temp
- thresh
- event



Conclusions

Temperature drives vegetative cycle of *G. barbata* in Šćuza lagoon.

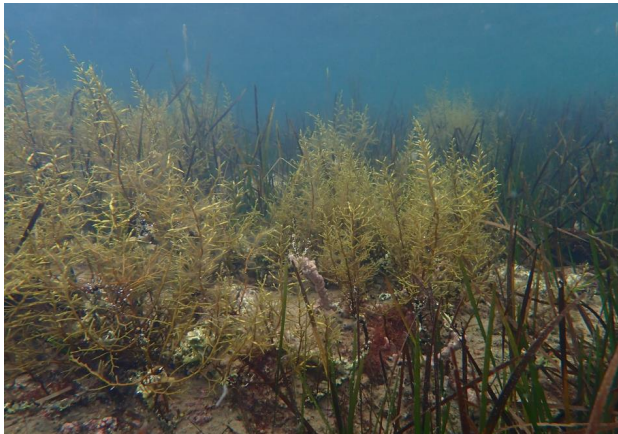
Thermotolerance experiment show that *G. barbata* can survive extremely high temperatures (up to 32 °C) for 2 months.

G. barbata can recover from extremely high temperatures. An onset of the growth phase and a recovery of the branches was observed.

Prolonged exposure (4 weeks) to 34 °C completely decays *G. barbata* thalli.

Further experiments are needed to understand the effects of colder seasons on the growth and reproduction of *G. barbata*.

This is applicable for *ex situ* cultivation, conservation and restoration of marine forests.



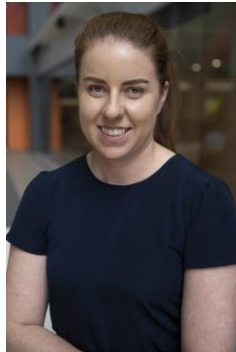
Acknowledgments

Projects: The responses of habitat-forming brown macroalgae of the genus *Cystoseira* on local and global stressors

WICOS Western Istria Coastal Sea



Research team: Andrea Bilajac, Edi Gljušić, Shannen Smith, Ljiljana Iveša



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