CLIMATE CHANGE AND ANTIFOULING COATINGS: IMPACTS ON PERFORMANCE AND BIOFOULING COMMUNITIES

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BIOFOULING JOURNAL – LEADING JOURNAL IN THE FIELD

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OUTLINE

- Biofouling and antifouling
- Climate change
- Climate change and micro- and macrofouling
- Climate change and antifouling coatings
- Conclusions

Micro- and macro-fouling

Micro-fouling

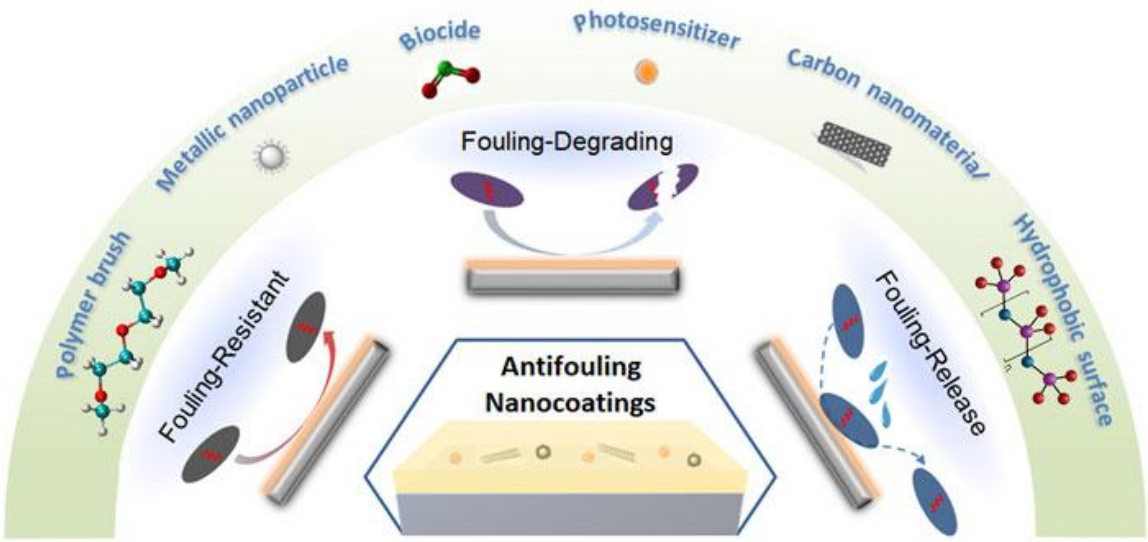
less than1 mm

Macro-fouling

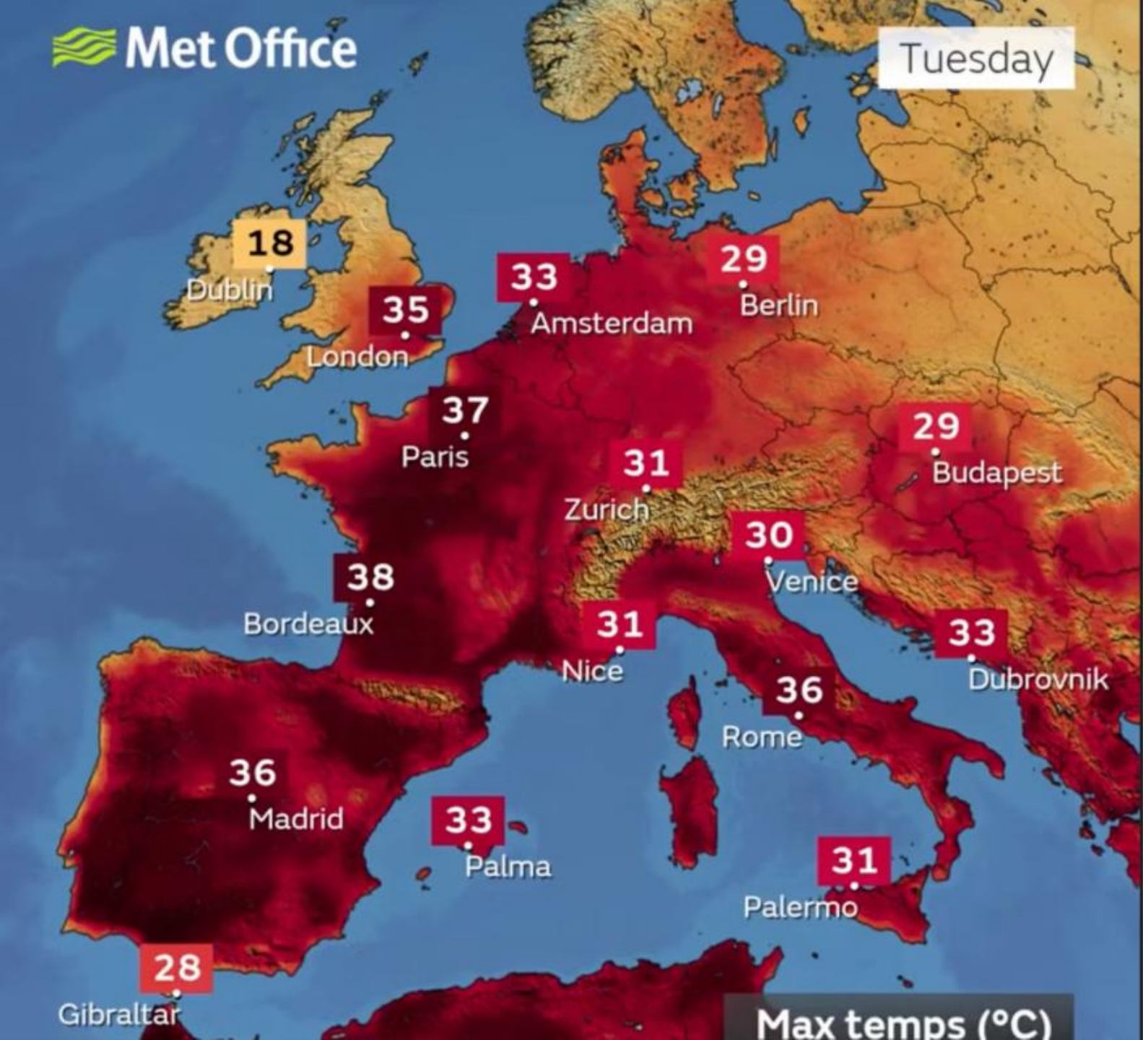
more than 1 mm

BIOFOULING PREVENTION

- Antifouling coatings can be toxic and non-toxic
- Toxic biocides used to control the growth of marine organisms
- Non-toxic or FR coatings using non-stick surface



Kumar et al. 2021 Front Nanotech



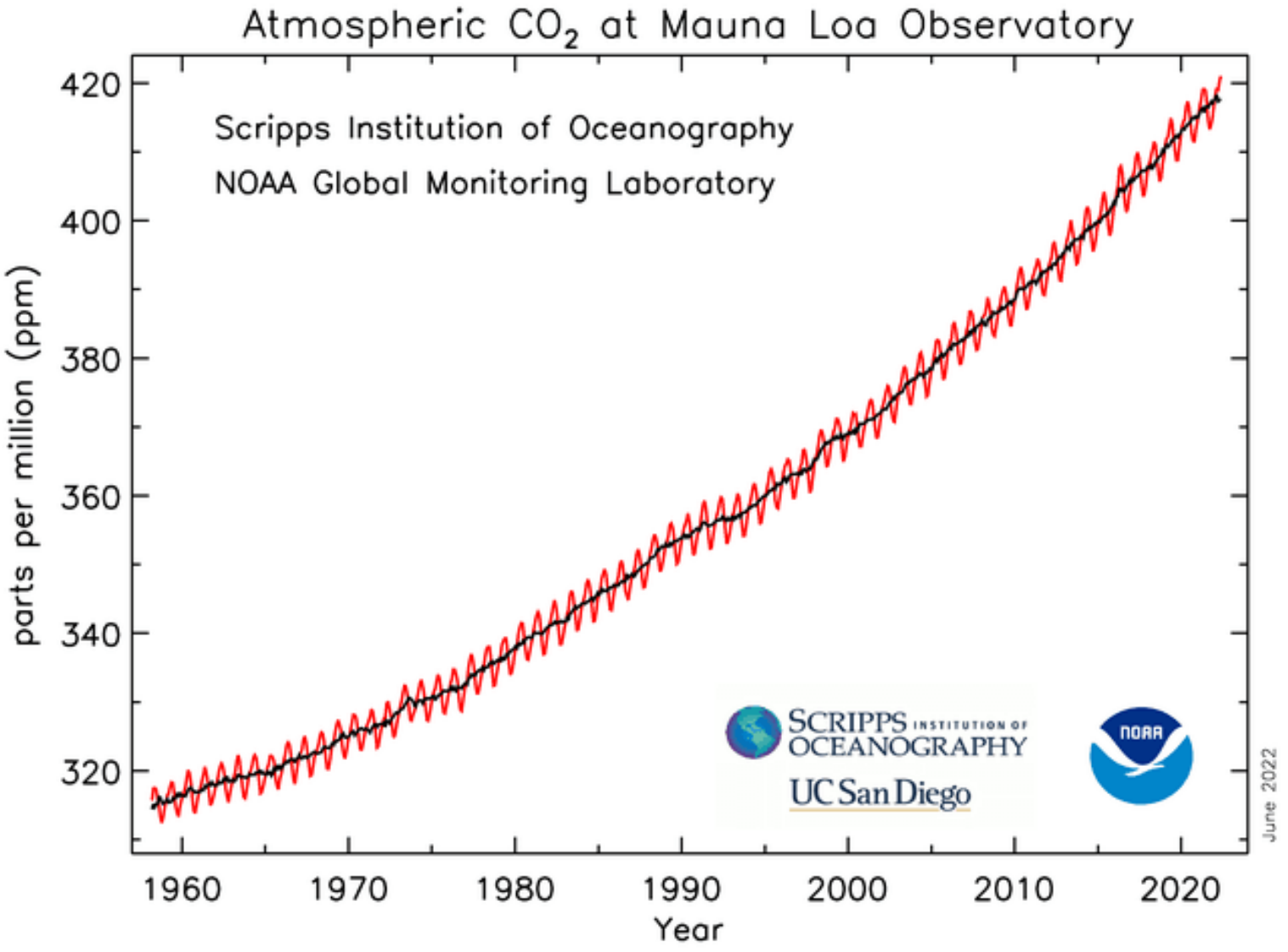
CLIMATE CHANGE

- Recent heat waive in Europe in summer 2025

INCREASE OF ATMOSPHERIC CO_2

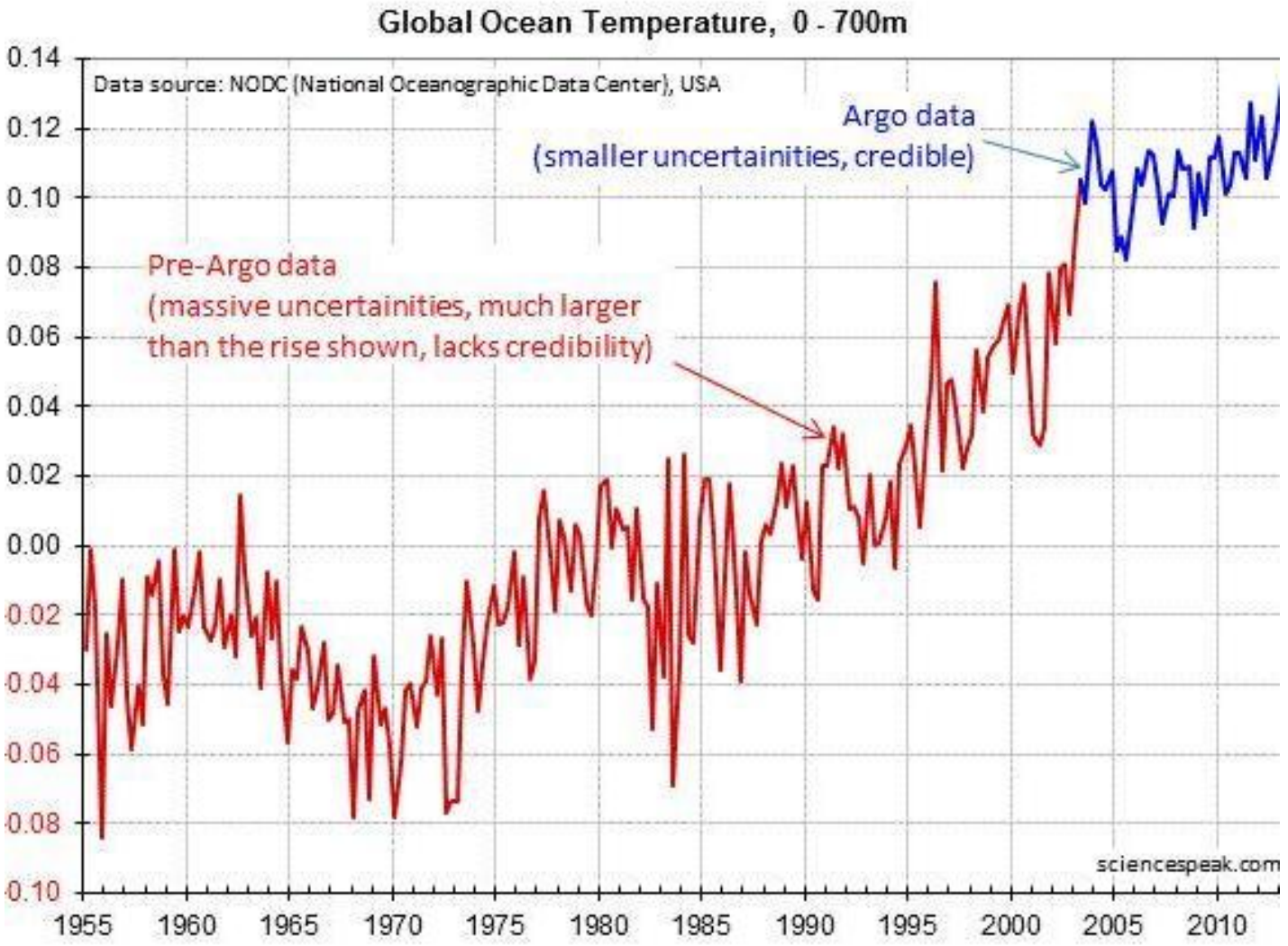
Carbon dioxide now is more than 50% higher than in pre-industrial levels

Leads to green house effect (warming) and ocean acidification

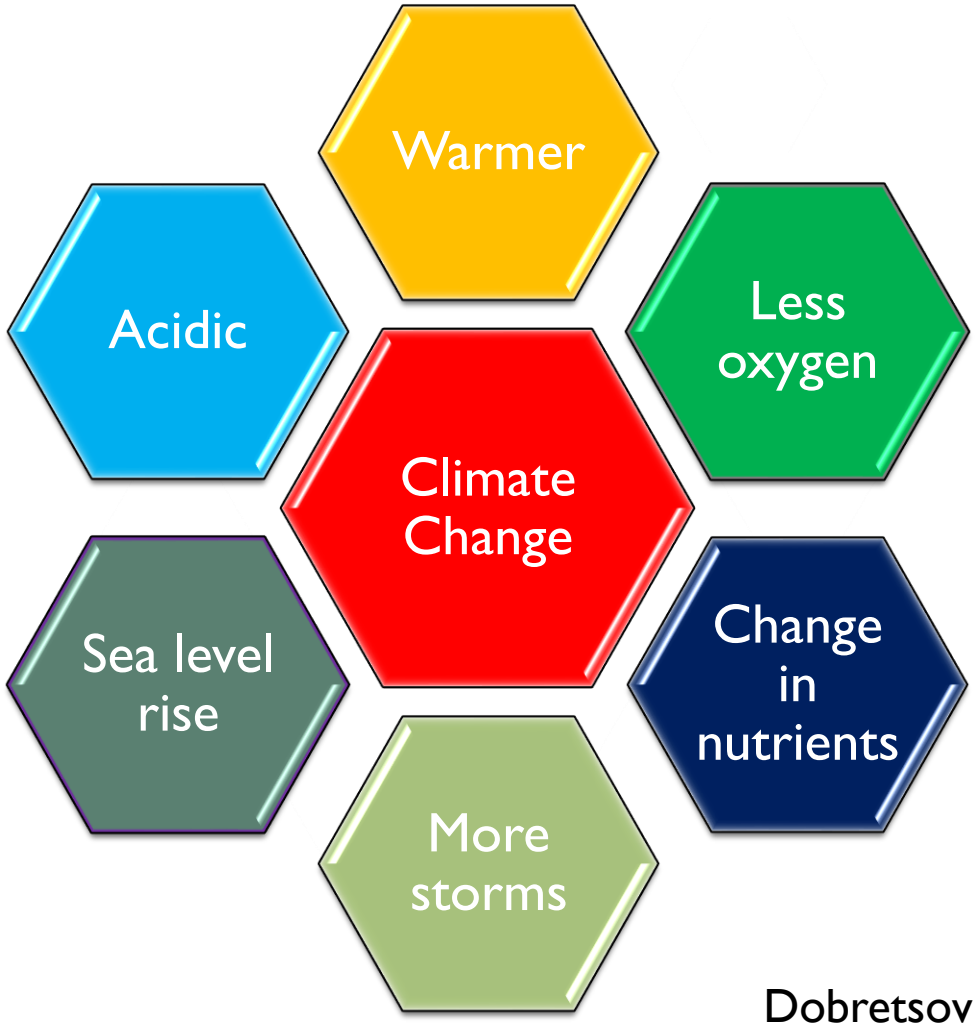


OCEAN TEMPERATURE IS RISING

- 90% of heat absorbed by the ocean
- Leads to melting ice and sea level rise



IMPACT OF CLIMATE CHANGE ON OCEANS



Dobretsov et al. 2019 Biofouling

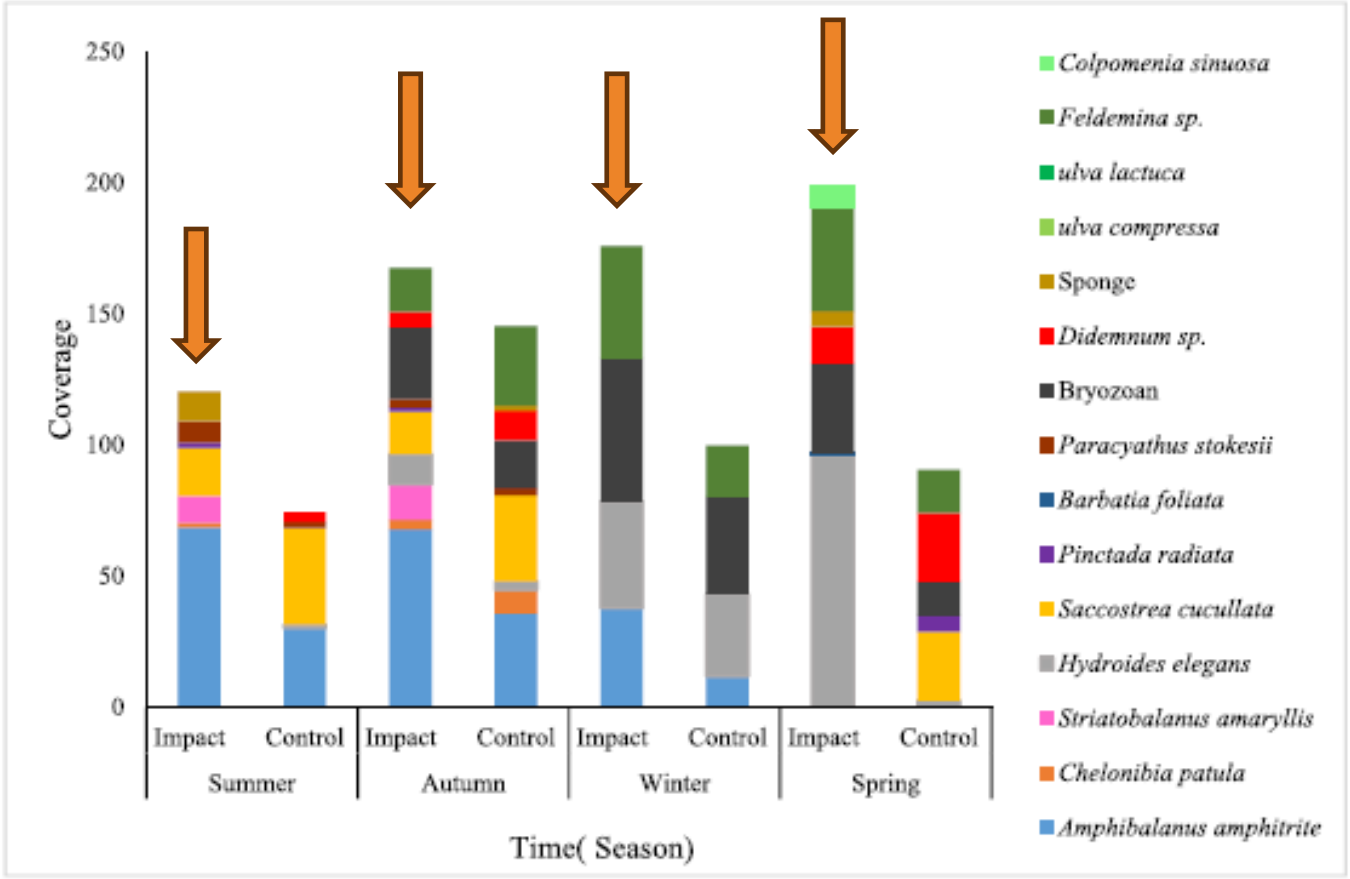
CLIMATE CHANGE AND MARINE COMMUNITIES

CREDIT: NASA

IMPACT OF CLIMATE CHANGE ON BIOFOULING COMMUNITIES AND PERFORMANCE OF AF COATINGS

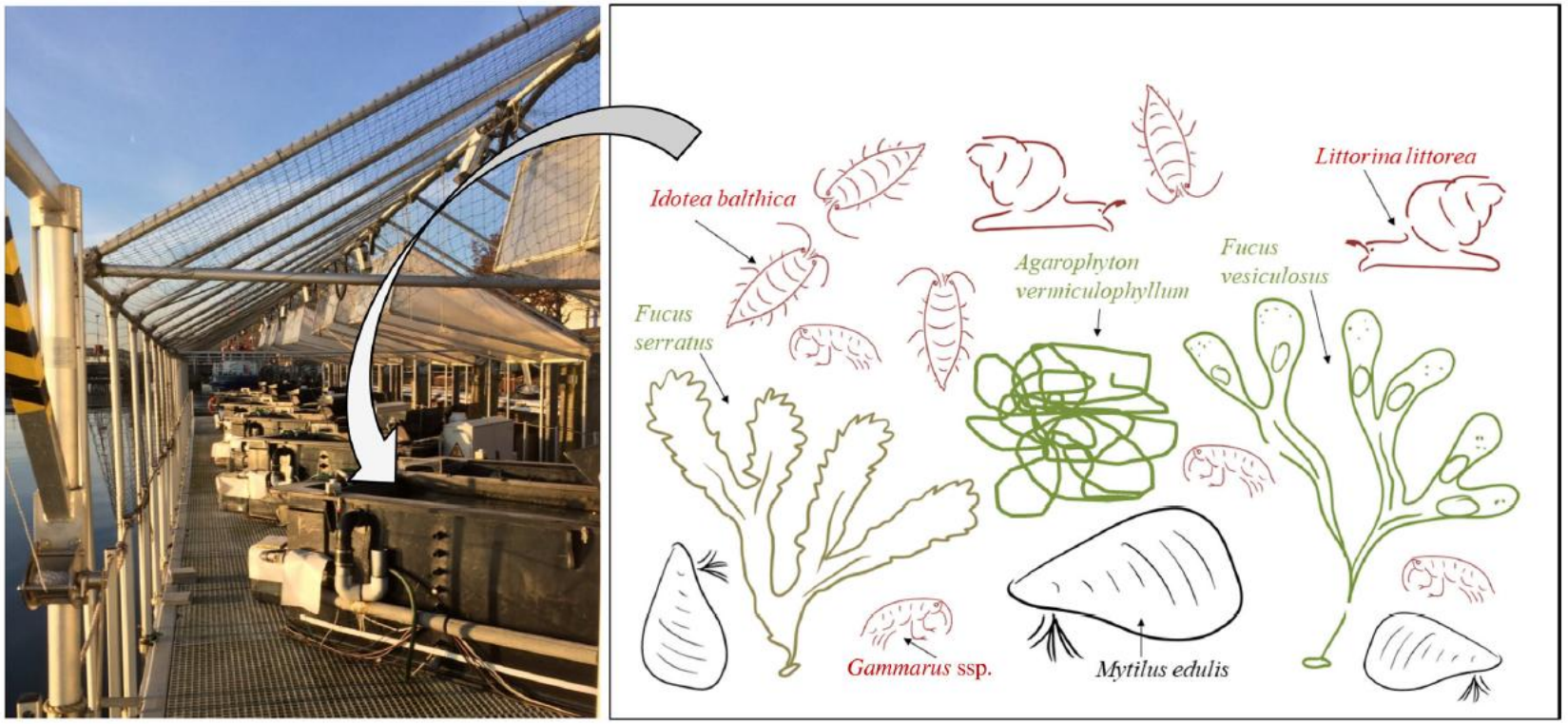
IMPACT OF ELEVATED TEMPERATURE ON MACROFOULING. TROPICAL WATERS

- Experiment was conducted in the vicinity of a nuclear power plant that increases by 2-3 ^{0}C water temperature (impact)
- Temperature increases percent of biofouling cover
- The composition of biofouling species was different



Khosravi et al. 2019 J Thermal Biol

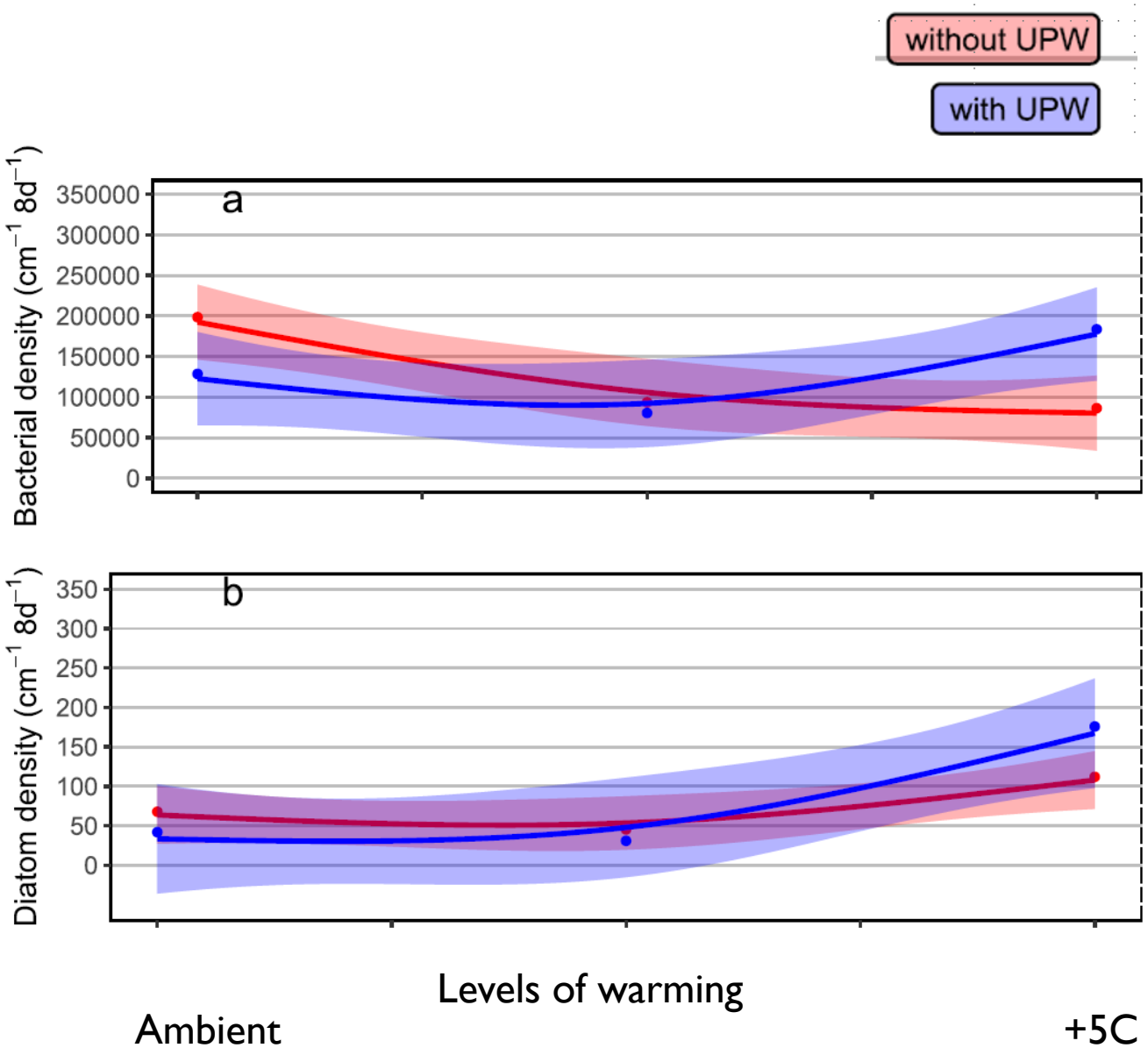
IMPACT OF WARMING AND UPWELLING ON BIOFOULING: EXPERIMENT IN KIEL, GERMANY



1 month experiment with antifouling coatings and 3 months experiment with clean PVC plates

BACTERIA AND DIATOMS

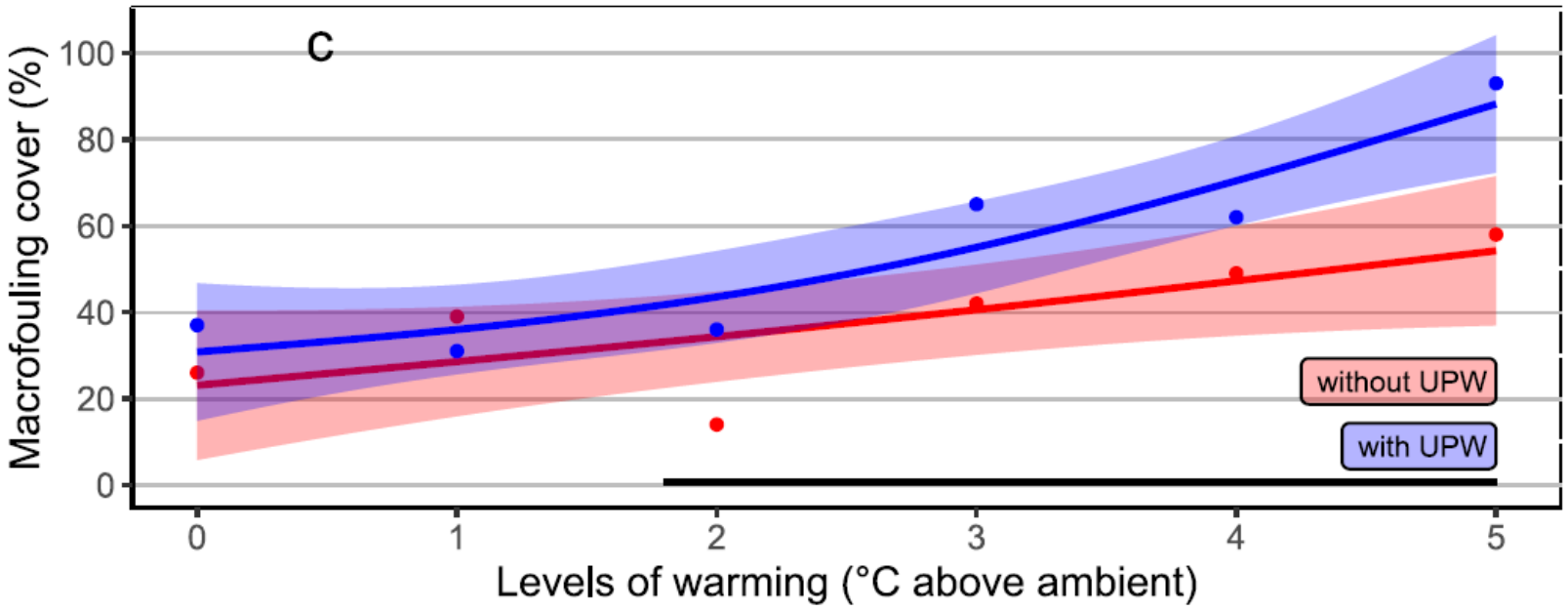
- Bacterial densities increased during upwelling effects and temperature increase
- Diatom densities increases during temperature increase and with and without upwelling



Wahl et al. 2021 Limnol & Ocean

MACROFOULING

- Settlement of macrofouling (barnacles, algae) organisms and % of cover were higher (60%) in the presence of upwelling and elevated temperatures

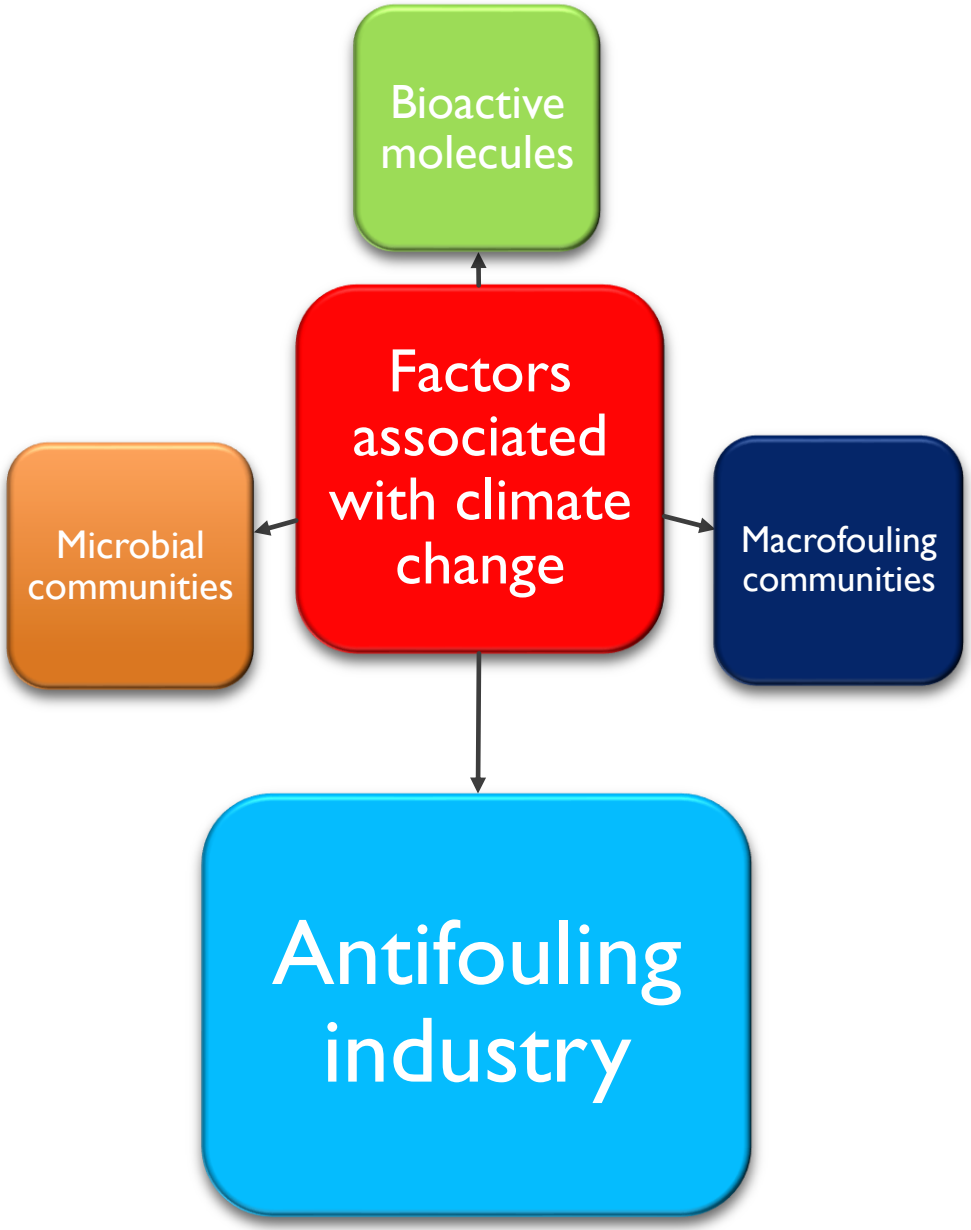


Wahl et al. 2021 Limnol & Ocean

IMPACT OF CLIMATE CHANGE ON BIOFOULING

Climate change impact:

- Composition and densities of micro- and macrofouling communities
- Their metabolites
- Performance of antifouling coatings



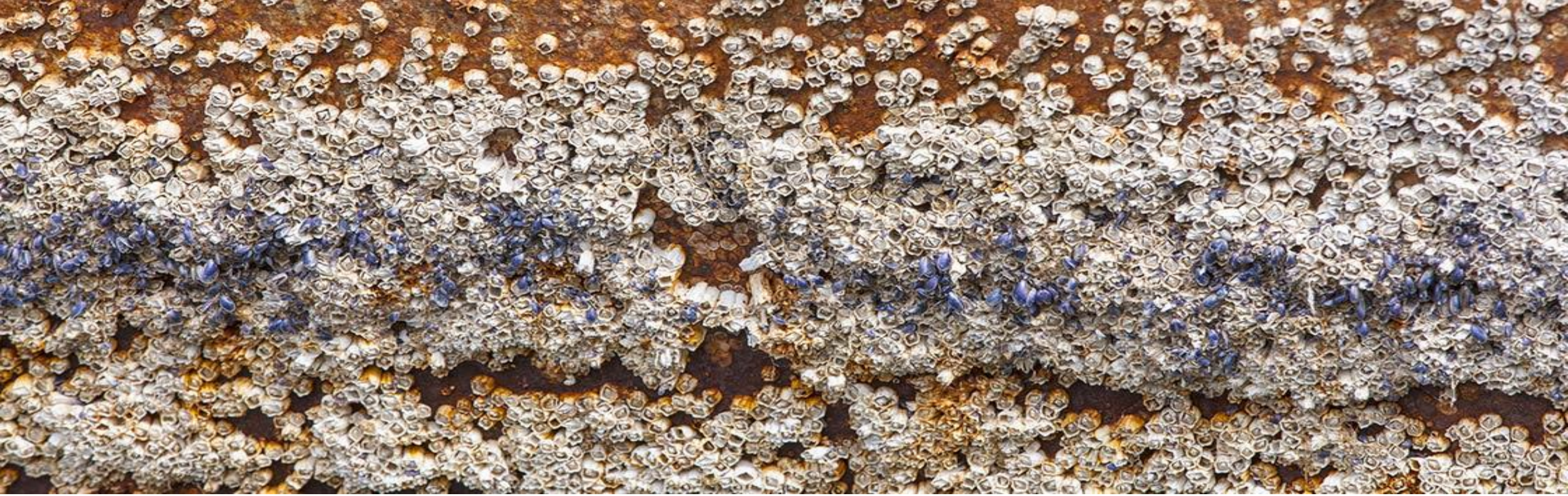
IMPACT OF CLIMATE CHANGE ON ANTIFOULING COATINGS

Factors associated with climate change	Proposed effect on antifouling coatings
Sea water temperature rise	Increase in polishing and biocide leaching rates; earlier coating exhaustion; changes in coating efficiency and leached layer thickness
Sea water acidification	Decrease in hydrolysis reaction rate for both acrylate- and rosin-based binders with decrease of polishing rates; potentially lower dissolution rates for hydrolyzing particulate organic biocides; increase in Cu_2O and ZnO dissolution rates; increase in thickness of biocide-leached layer, with negative effects on antifouling performance
Sea water salinity increase	Lower Cu_2O dissolution rates; potential changes on the hydrolysis rate of specific binders
Intensification of water turbulence and upwelling	Increase biocide dissolution rates; earlier coating exhaustion
New Arctic ship traffic routes	Lower antifouling performance due to the introduction of invasive antifouling species; potential changes in coating efficiency and durability due to harsh environmental conditions

Dobretsov et al. 2019 Biofouling

CONCLUSIONS

- Warming increases macrofouling and diatoms densities
- Warming could change the composition of microfouling communities on some coatings (FR)
- Climate change affected the performance of antifouling coatings
- New solutions are needed



Does anyone have any questions?

THANKS!

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