

# Antifouling solutions for recreational boats: effectiveness and implications for biofouling management in the context of bioinvasions

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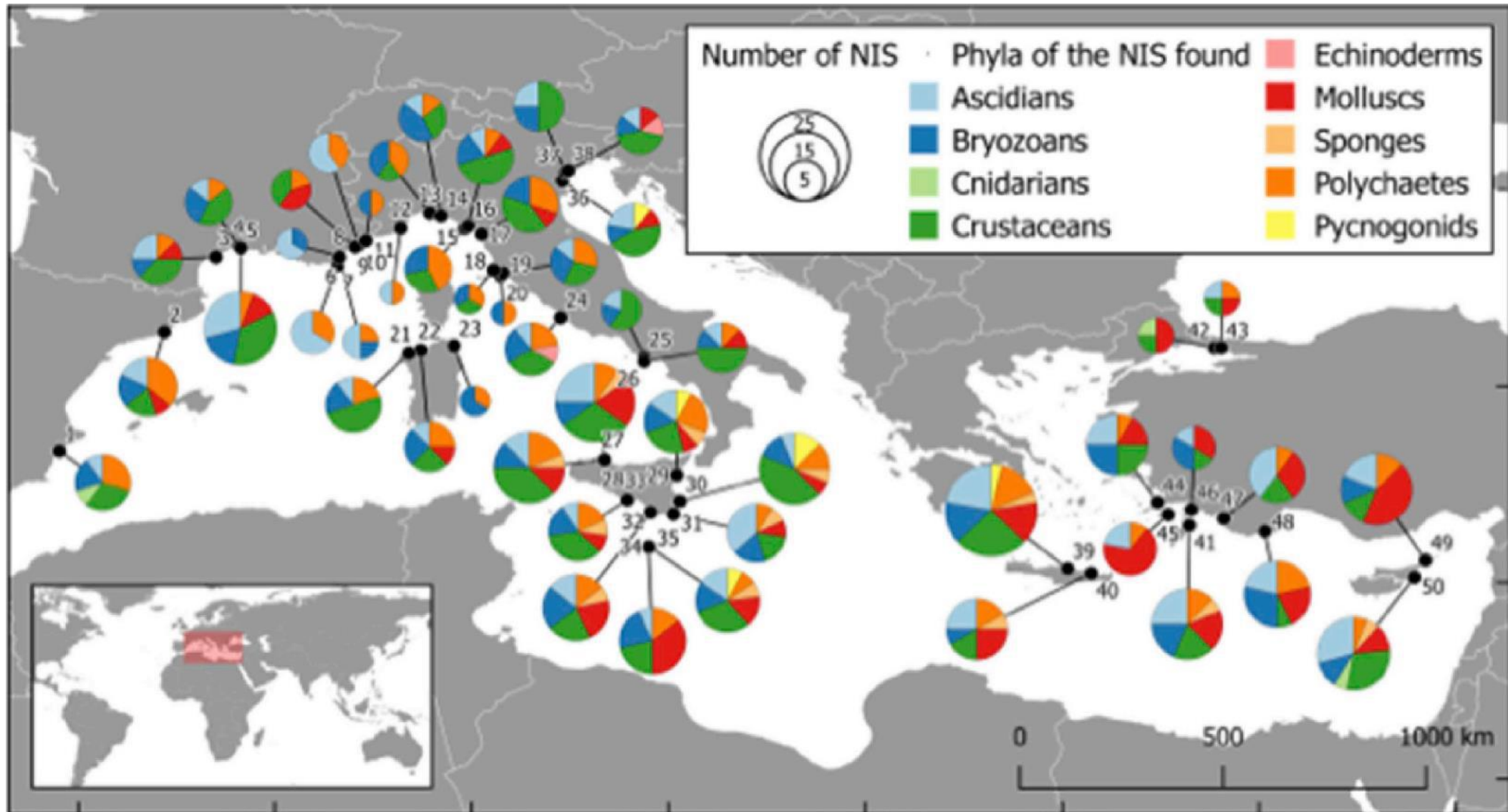
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# Marinas as high risk sites for NIS introduction



Ulman et al. 2019 *J Environ Manag*

# Recreational boats as vectors of NIS

71% boats have at least 1 NIS

Up to 11 NIS in a single boat

Sampling outcome	Total	%
No. vessels sampled	583	
No. vessels clean hull (= no fouling)	105	18
No. fouled vessels	480	82
No. sampled vessels hosting at least 1 NIS	413	71

NIS found also on recently cleaned boats!

Marina locality	Last cleaning (weeks)	Cleaning mode	% fouled hull	% fouled niche areas	# NIS	NIS found on the hull
<u>Agde</u>	4	D	0	30	3	<u>Caprella scaura</u> , <u>Hydroides elegans</u> , <u>Paranthura japonica</u>
<u>Famagusta</u>	1.3	IW	10	30	5	<u>Amathia verticillata</u> , <u>Clavelina lepadiformis</u> , <u>H. elegans</u> , <u>Phallusia nigra</u> , <u>Paraleucilla magna</u>
<u>Fethiye</u>	1	IW	30	NA	5	<u>H. dirampha</u> , <u>H. elegans</u> , <u>B. pharaonis</u> , <u>Dendostrea folium</u> , <u>Sphaeroma walkeri</u>
<u>Heraklion</u>	2	IW	5	NA	7	<u>A. verticillata</u> , <u>C. scaura</u> , <u>Cymodoce fuscina</u> , <u>H. elegans</u> , <u>Paradella diana</u> , <u>P. sculpta</u> , <u>S. walkeri</u>
<u>Ischia Island</u>	4	D	0	1	2	<u>C. scaura</u>
<u>Karpaz</u>	1	IW	0	2	3	<u>B. bairdi</u> , <u>D. folium</u> , <u>Malleus regula</u>
<u>Le Grau-du-Roi</u>	4	IW	100	100	4	<u>C. scaura</u> , <u>H. elegans</u> , <u>P. japonica</u> , <u>S. plicata</u>
<u>Licata</u>	1	D	2	NA	3	<u>A. verticillata</u> , <u>C. brunnea</u> , <u>H. elegans</u>
<u>Sorrento</u>	2	D	0	1	2	<u>A. verticillata</u> , <u>Tricellaria inopinata</u>

# Commonly adopted antifouling solutions

Antifouling coatings applied every year

- Biocide-based (BC)
- Foul-release (FR)



# Commonly adopted antifouling solutions

Antifouling coatings applied every year

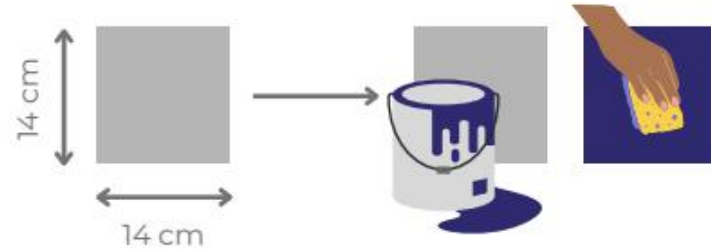
- Biocide-based (BC)
- Foul-release (FR)

supplemented by  
**in-water manual cleaning**



# Effectiveness of antifouling solutions

Manipulative experiment to simulate boaters behaviour



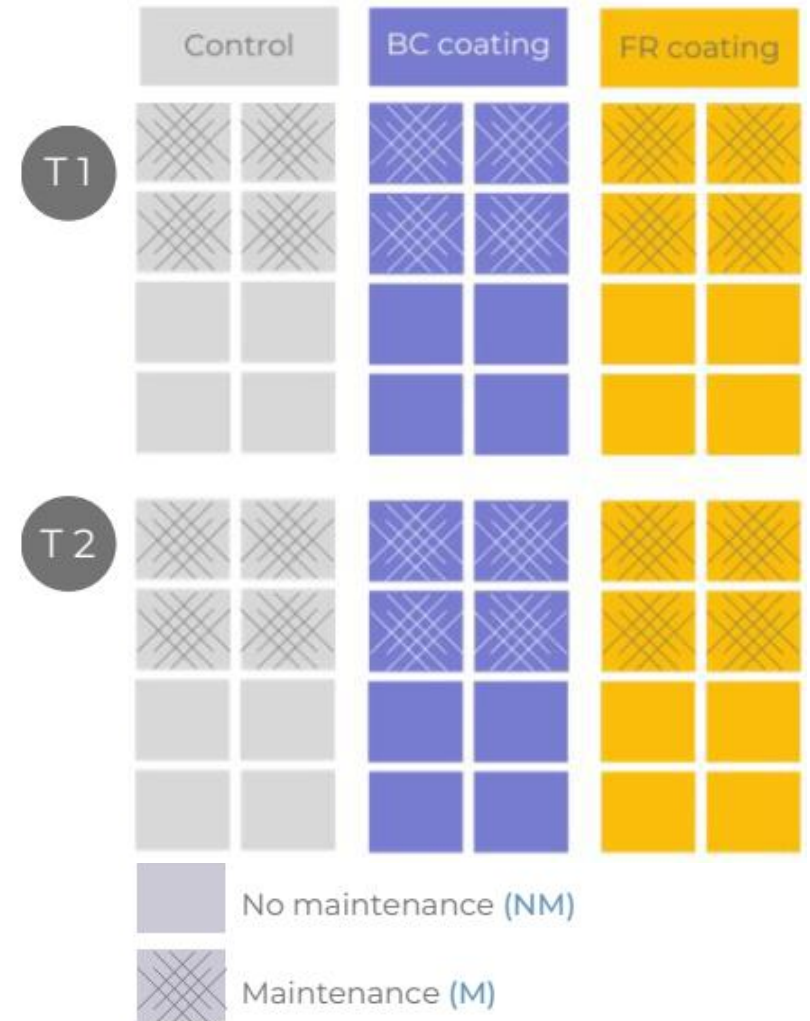
BC coating

- *premium polishing*
- Copper and zinc based
- 2 yr durability



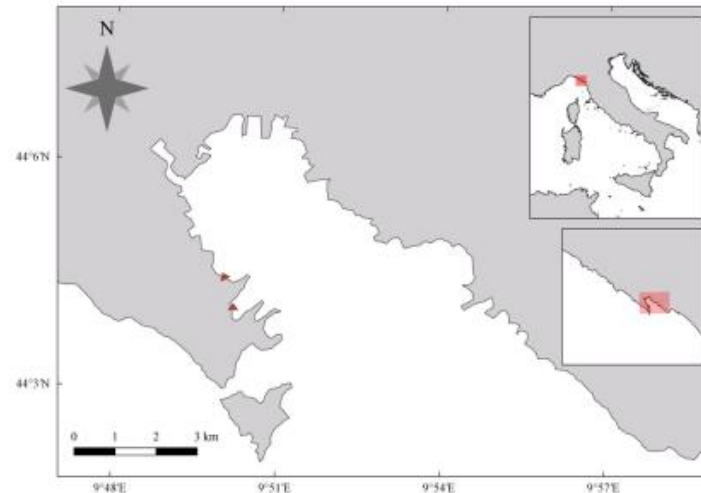
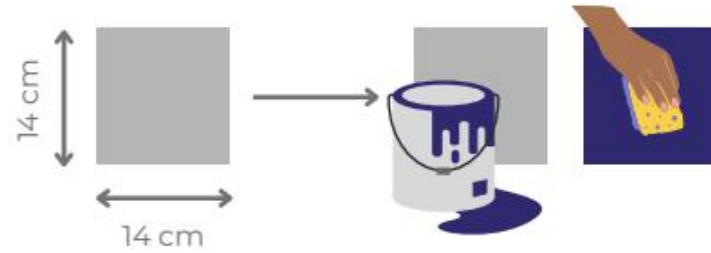
FR coating

- Foul-release
- Silicone (silane-siloxane) based
- 1-2 yr durability

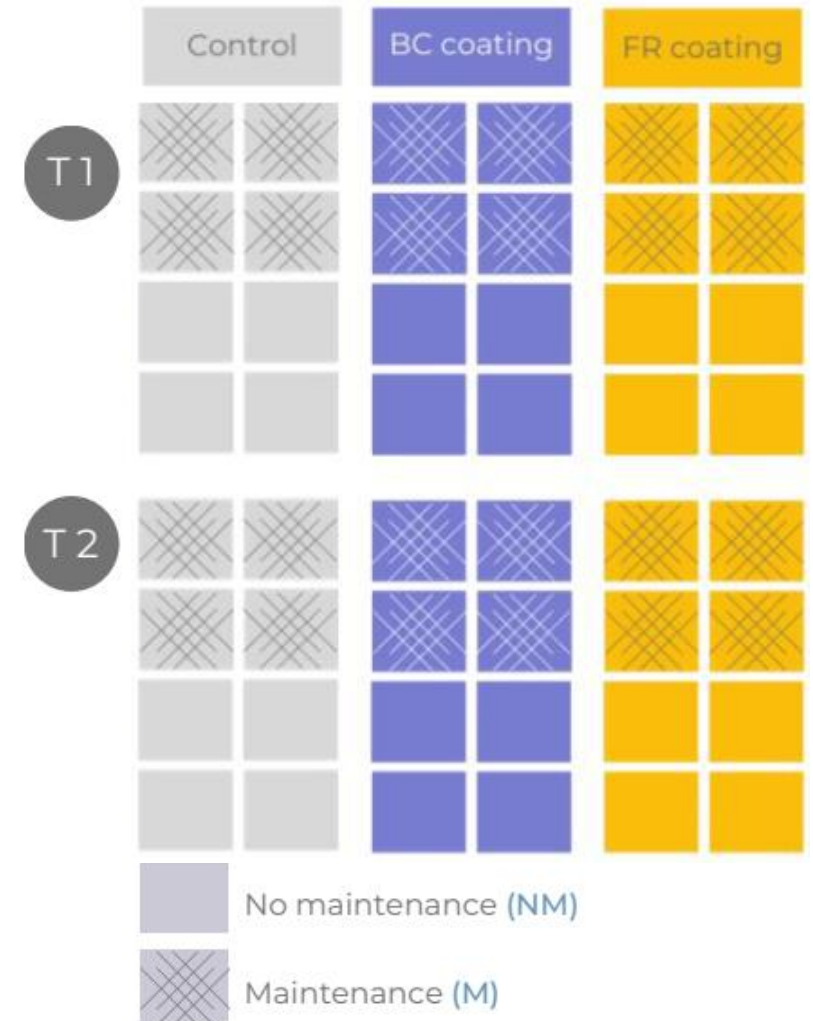


# Effectiveness of antifouling solutions

Manipulative experiment to simulate boaters behaviour

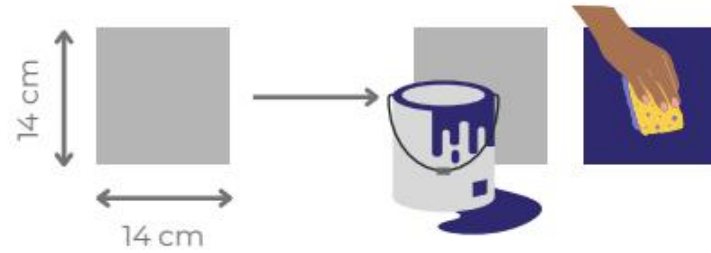


Site selection based in Tamburini et al., 2021.

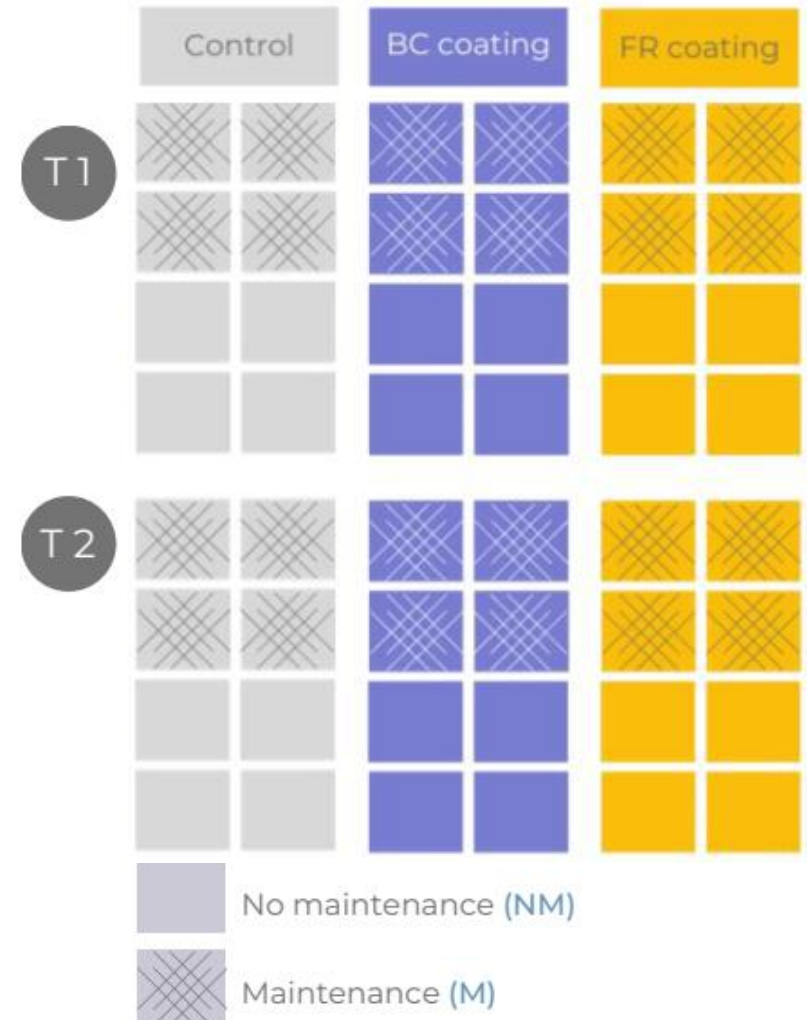
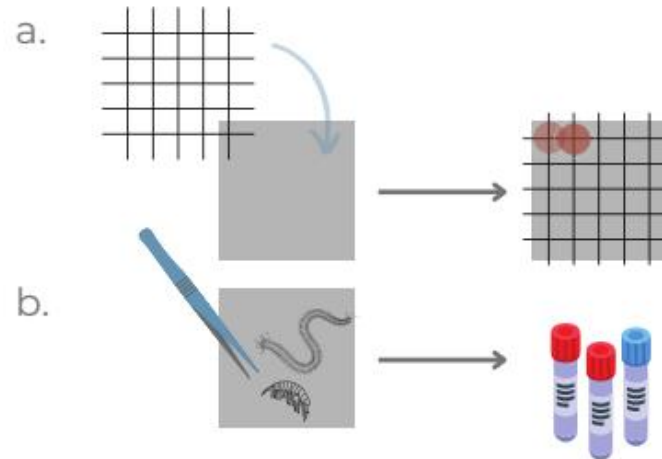


# Effectiveness of antifouling solutions

Manipulative experiment to simulate boaters behaviour



- Lab analysis:
  - a. Sessile community
  - b. Mobile community





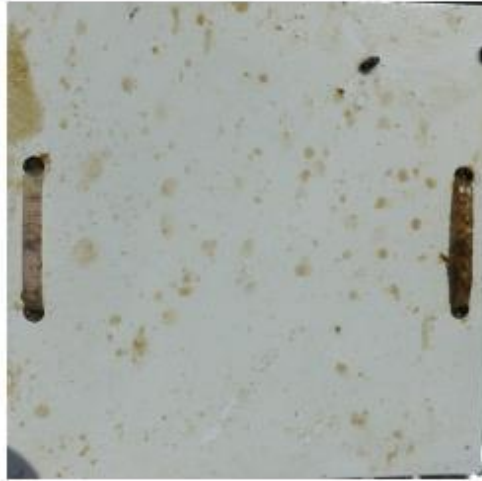
# Effectiveness of antifouling solutions

Control

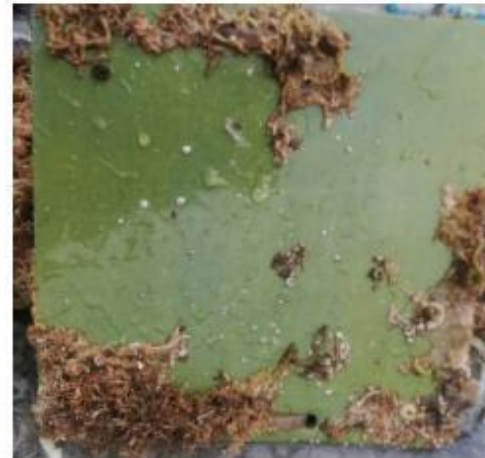
BC coating

FR coating

T1

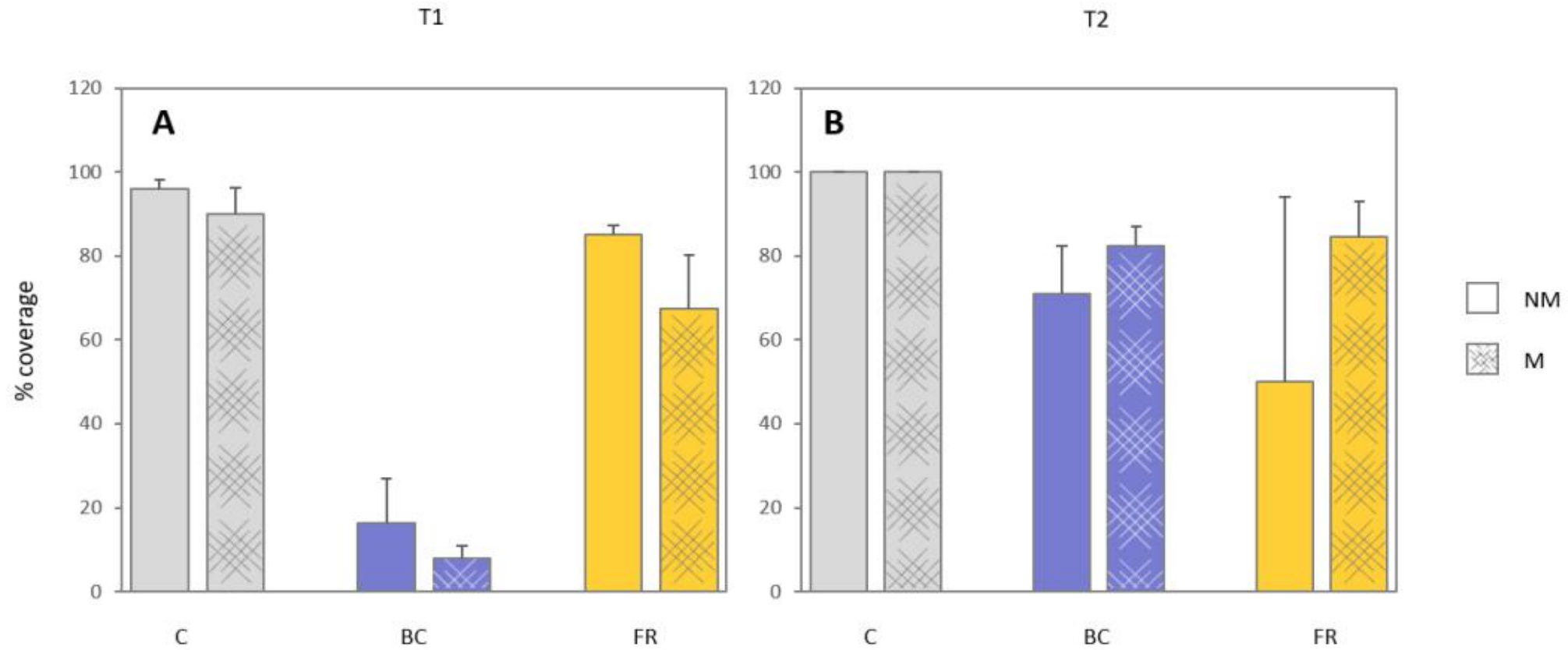
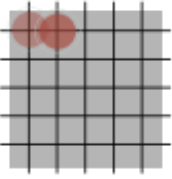


T2



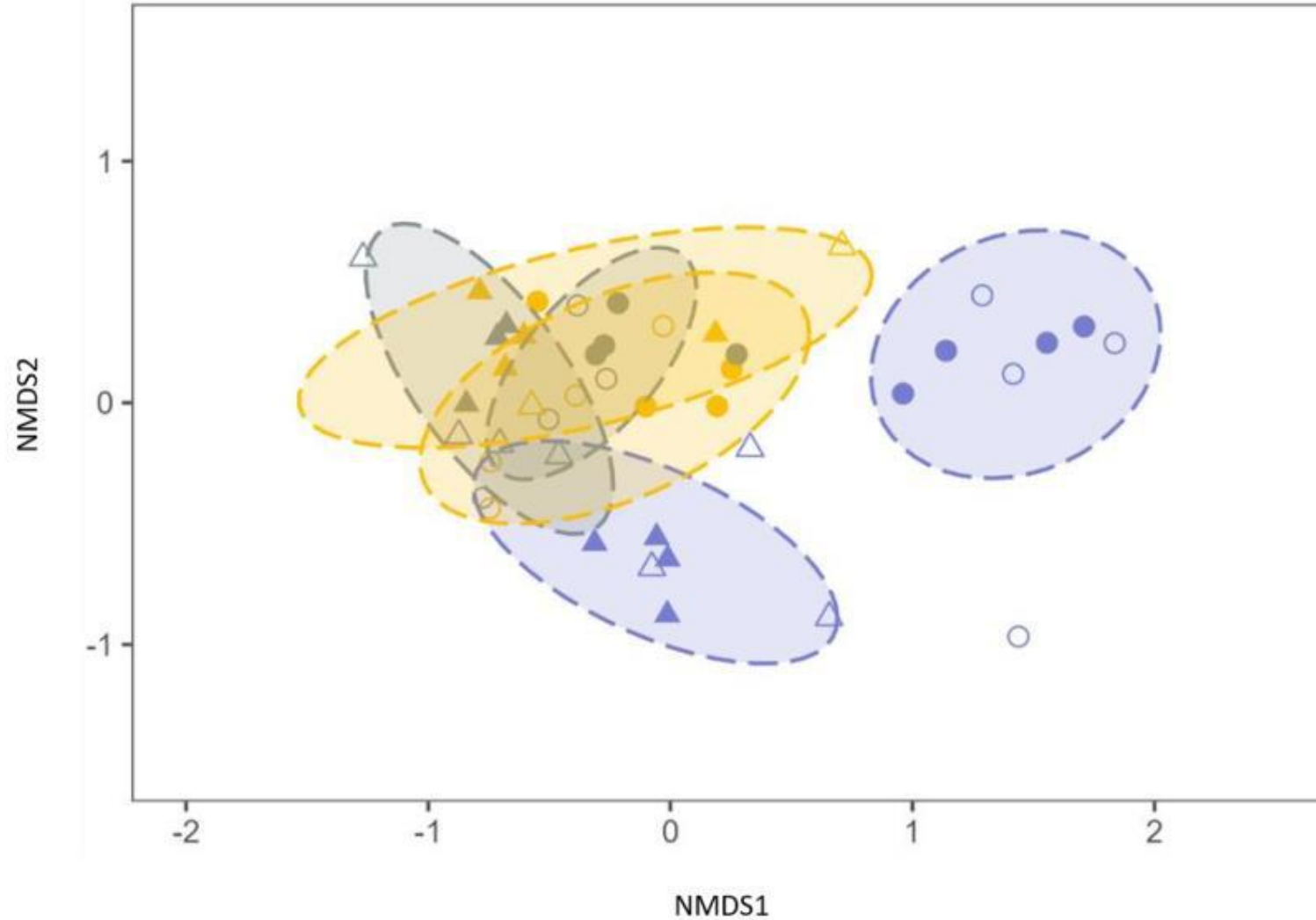
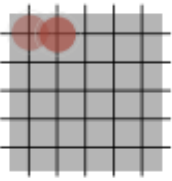
# Effectiveness of antifouling solutions

Sessile community



# Effectiveness of antifouling solutions

Sessile community



Colour = Paint

- C
- BC
- FR

Shape = Time

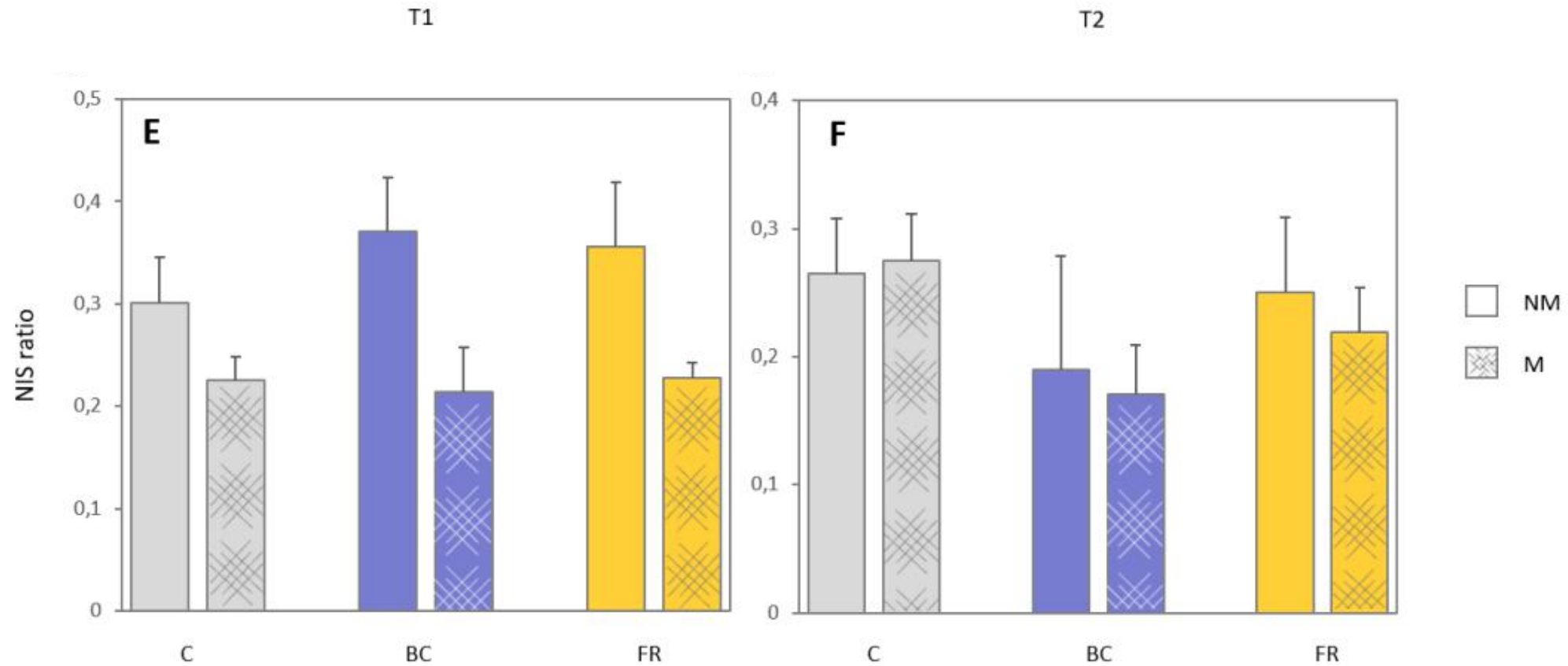
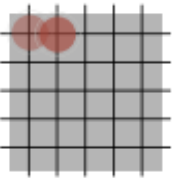
- T1
- ▲ T2

Shape fill = Maintenance

- △ NM
- ▲ M

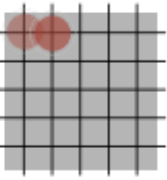
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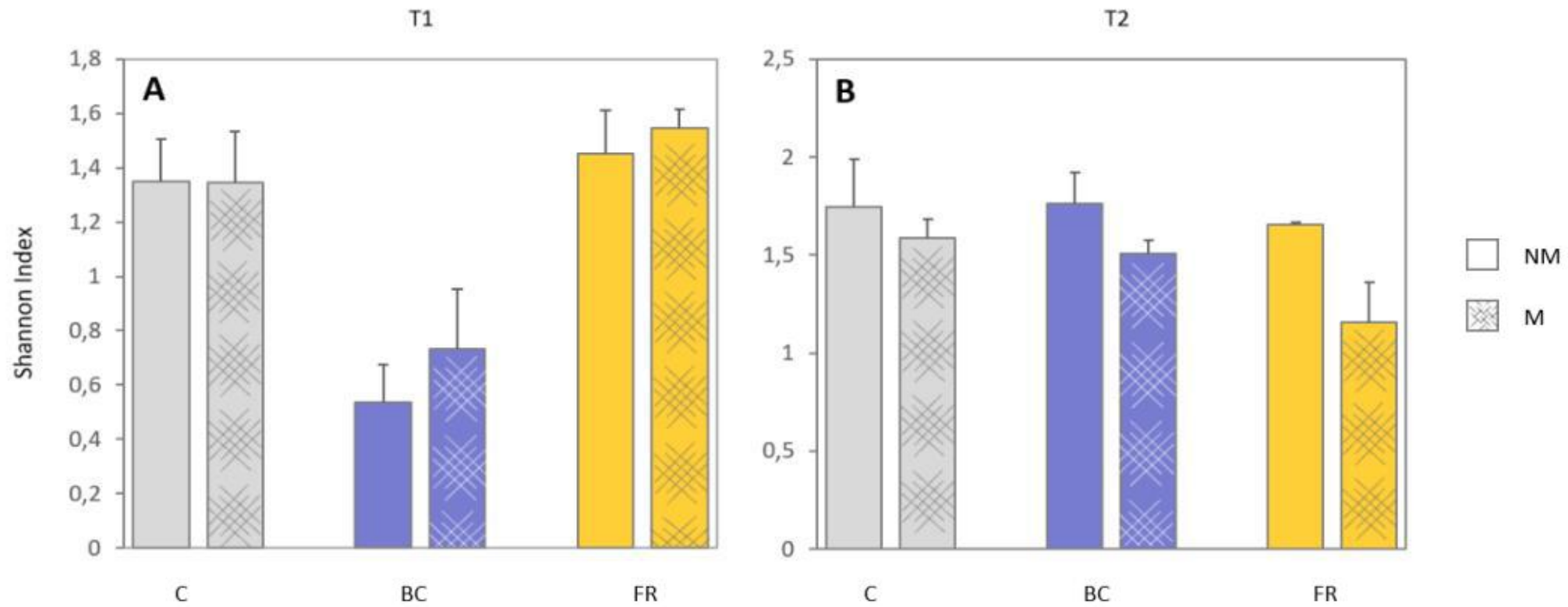
**Primary fouling mainly composed by**  
*Watersipora subtorquata*

- cryptogenic species
- copper-tolerant
- facilitating secondary colonisers



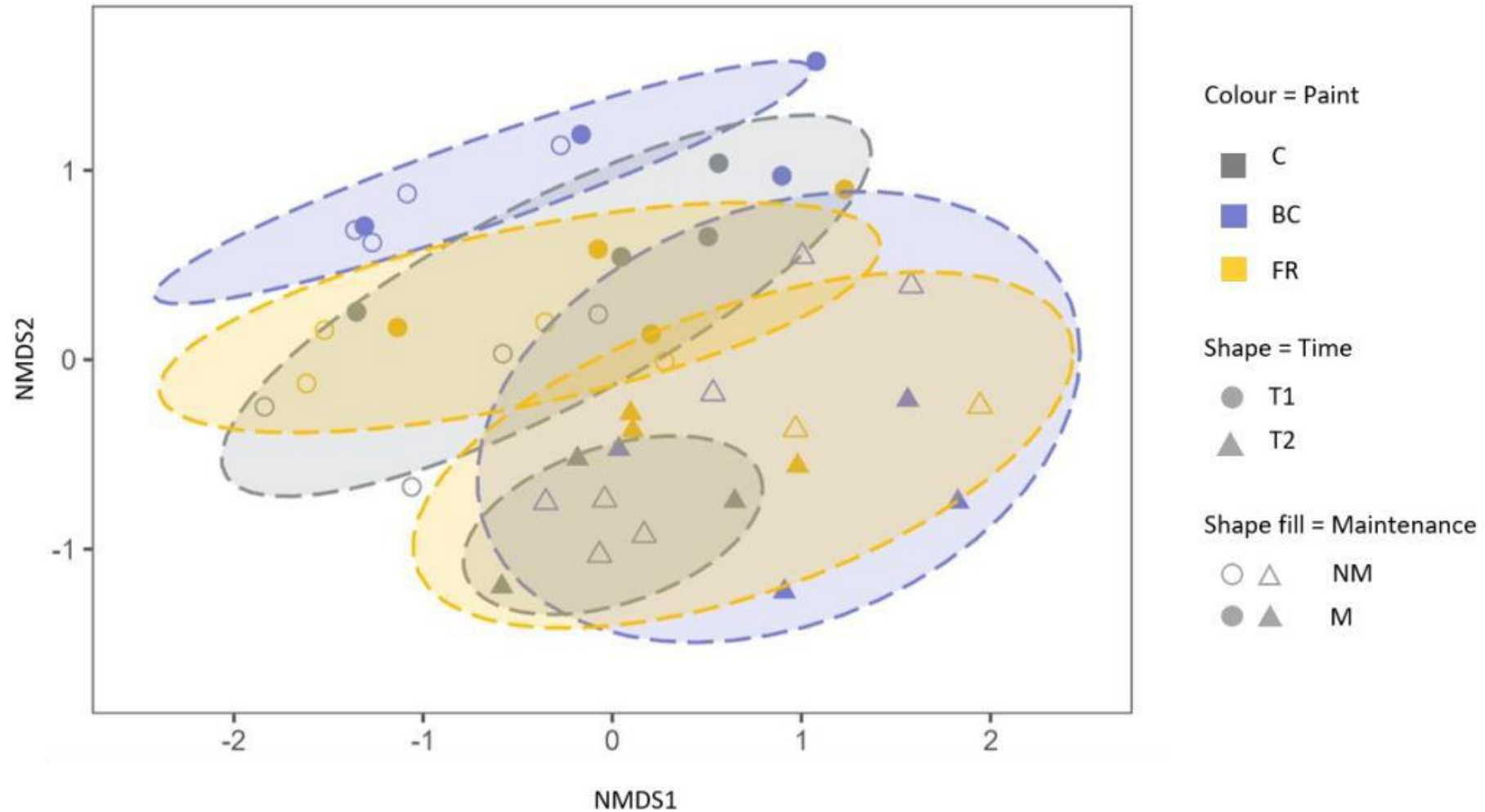
# Effectiveness of antifouling solutions

Mobile community



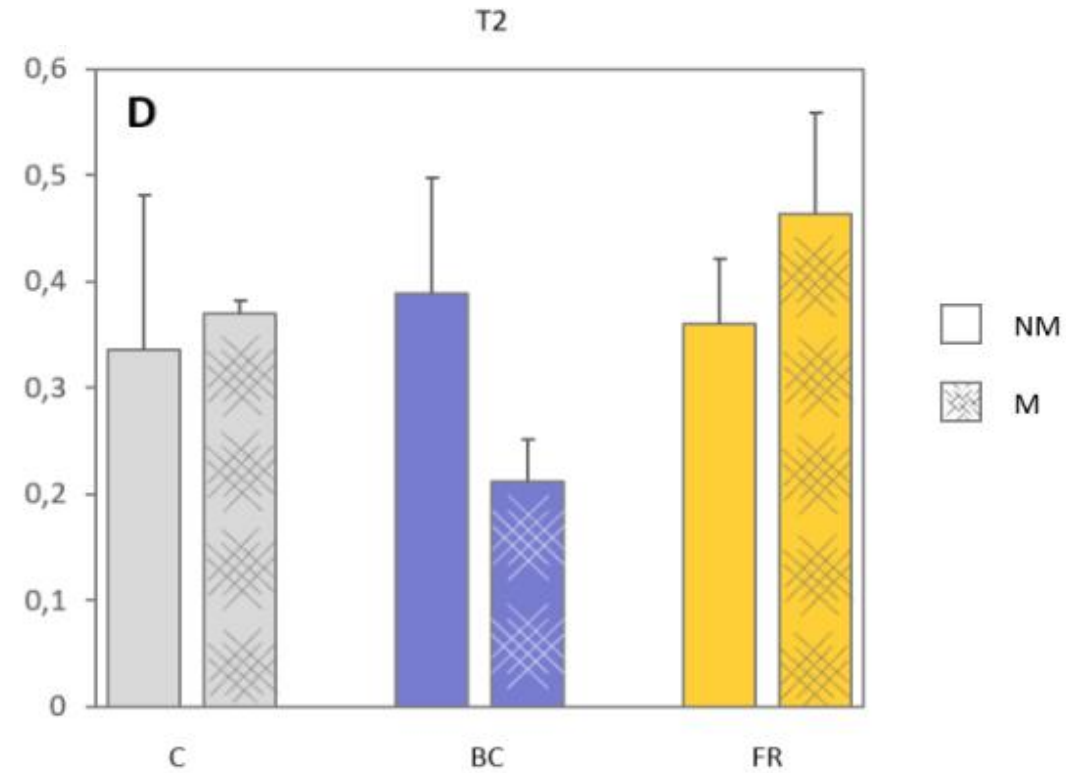
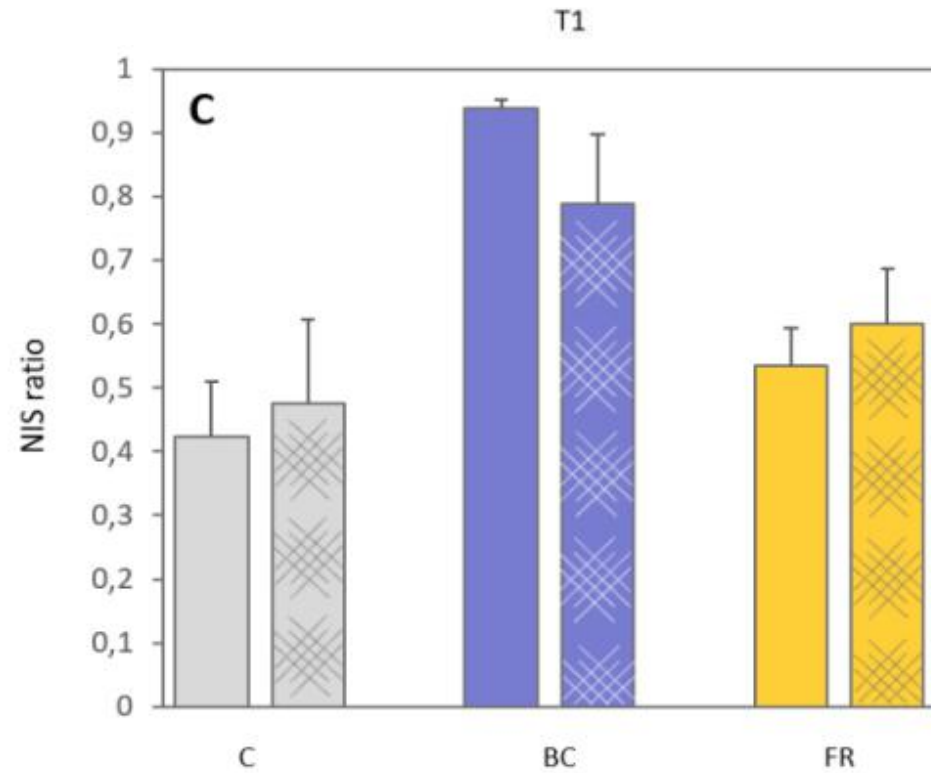
# Effectiveness of antifouling solutions

Mobile community



# Effectiveness of antifouling solutions

Mobile community

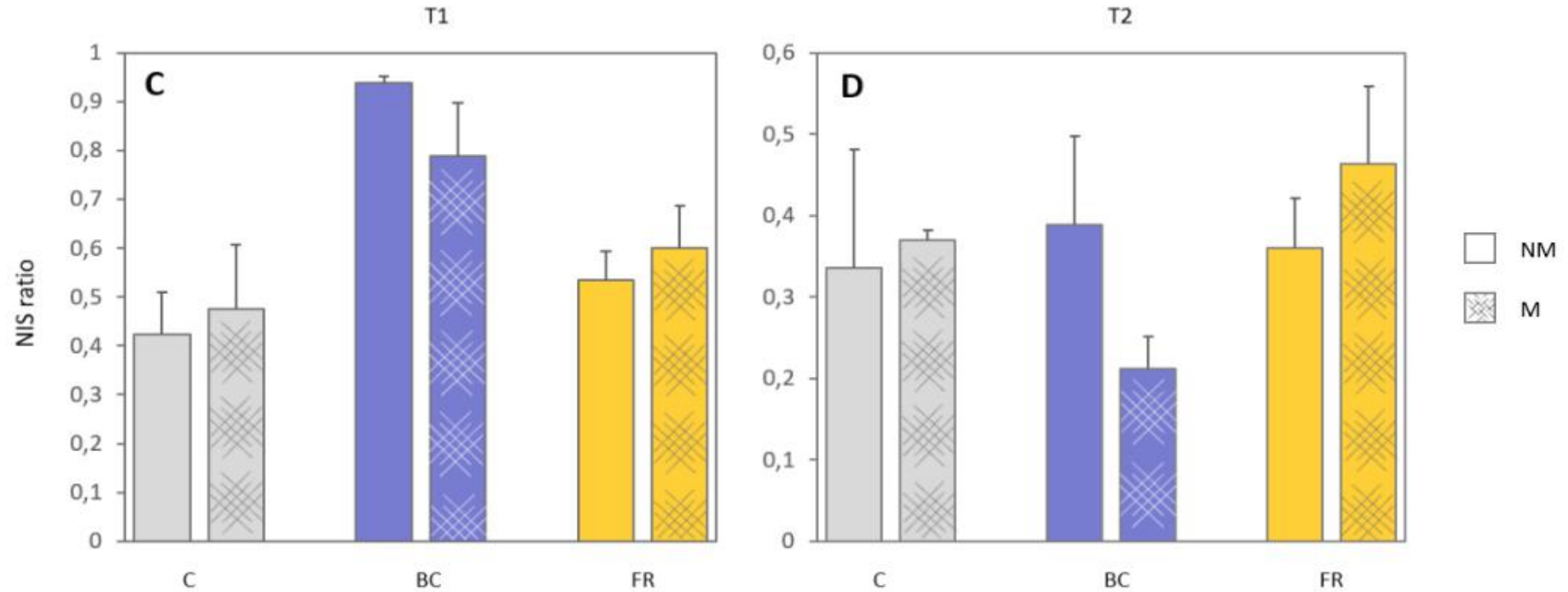


□ NM  
▣ M



# Effectiveness of antifouling solutions

Mobile community



*Caprella scaura*



*Laticorophium  
baconi*



*Paranthura  
japonica*



*Stenothoe  
georgiana*



*Jassa slatteryi*

# Key messages

- **BC** coatings not effective against NIS
- Anti-fouling effectiveness of **BC** coatings shorter than declared
- **FR** coatings favour spontaneous detachment
- Effectiveness of periodic in-water cleaning unclear

# Conclusion



**Novel technologies**  
**Education**  
**Economic support**