



University of Essex

Antifouling in Recreational Boating: Linking Science, Stakeholders and Sustainability

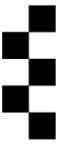
Jacob Cook, Nick Aldred, Natalie Hicks, Zorzeta Bakaki

University of Essex
School of Life Sciences
Department of Government



Brightlingsea
Harbour
Commissioners

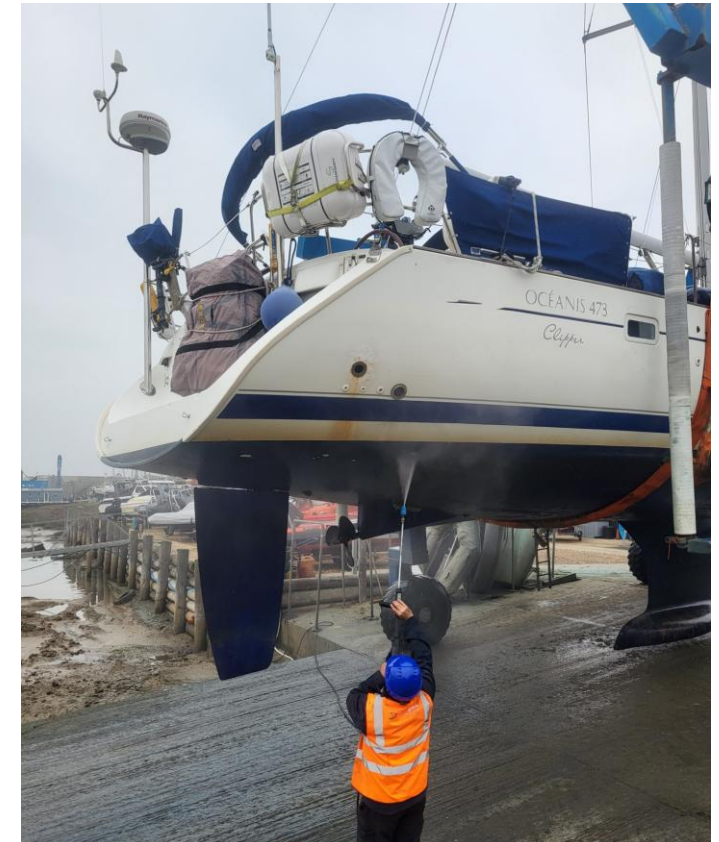
LEVERHULME
TRUST

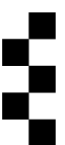


Antifouling in Recreational Boating



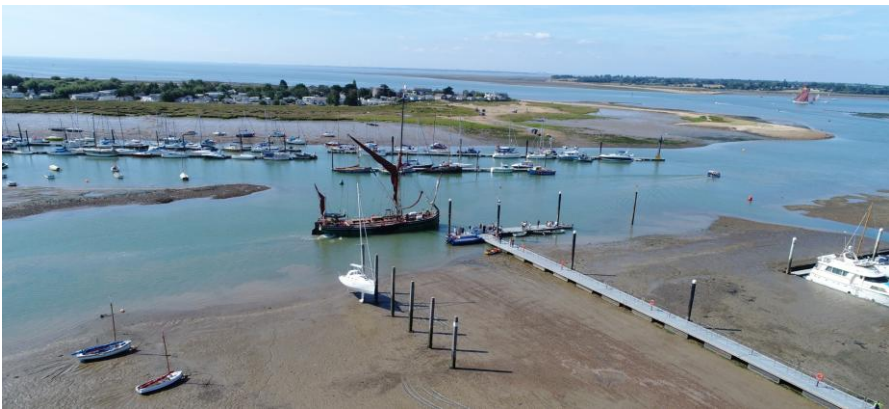
- ~550,000 recreational boats in the UK
- Many operate in environmentally sensitive coastal habitats
- A diverse sector with limited regulation



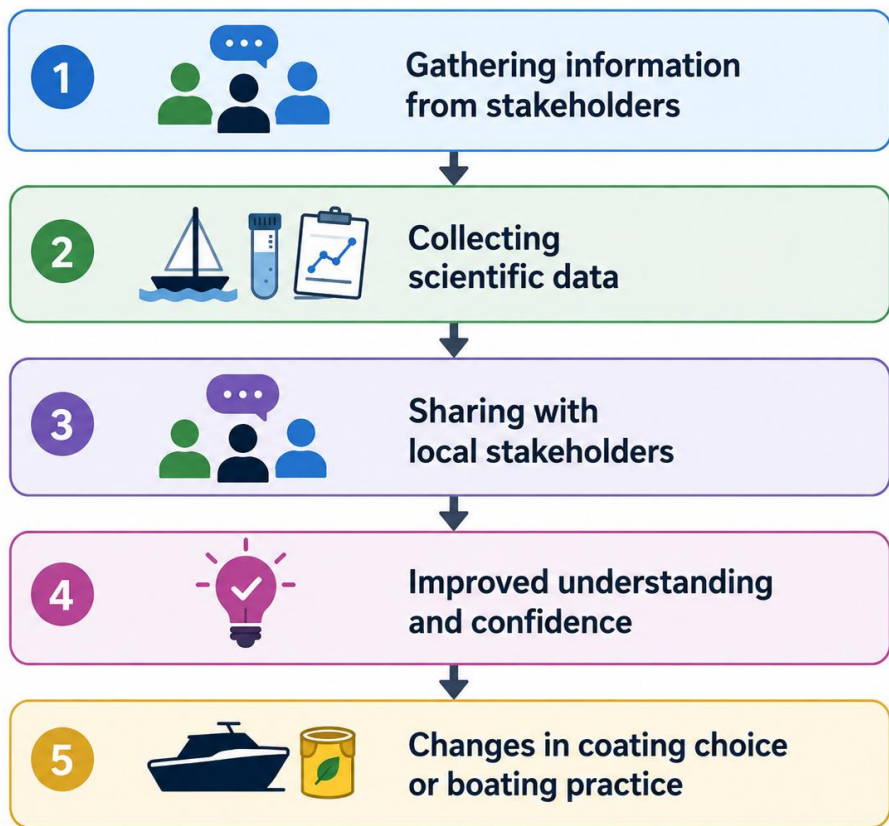
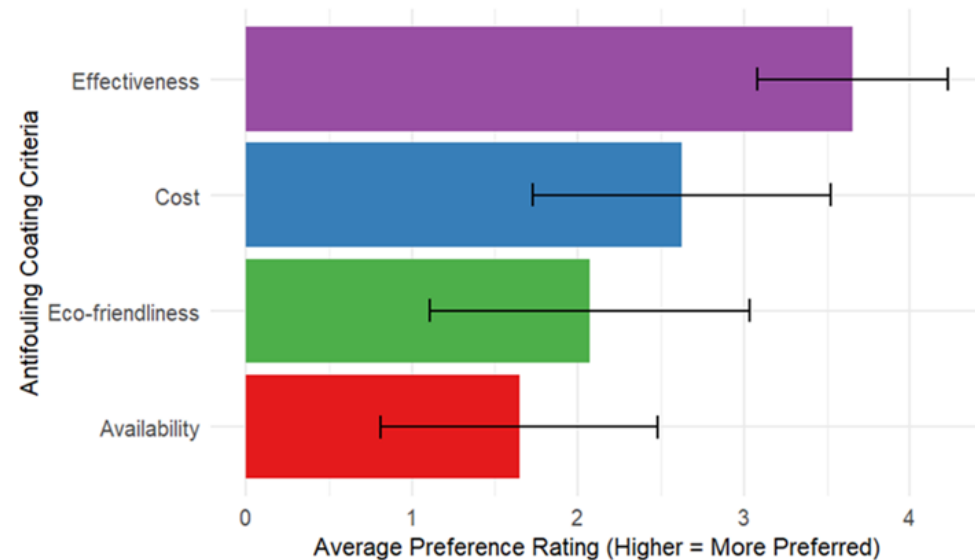


Brightlingsea

- Recreational harbour on the Essex coast
- 550+ moorings and a diverse boating community
- Located within an environmentally sensitive coastal setting
- Brightlingsea Harbour Commissioners



Stakeholder-driven research



Adopting sustainable alternatives



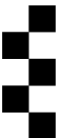
I like the
colour of mine

Someone's
boat slipped
out of the sling

It's too
expensive

I've always
used this stuff

My mate said
his mate didn't
like it



Experimental design



- Panels deployed from March to November at Brightlingsea Harbour
- Photographic monitoring throughout deployment
- Two cleaning regimes:
 - Regular monthly cleaning
 - Seasonal cleaning

	Hempel Light Primer (control)		Coppercoat (metallic copper)
	Hempel Hard Racing (copper oxide)		Hempel Silic One (non-biocidal foul-release coating)
	Flag Cruising Antifouling (copper oxide)		



April



May



June



July



August



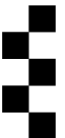
September



October

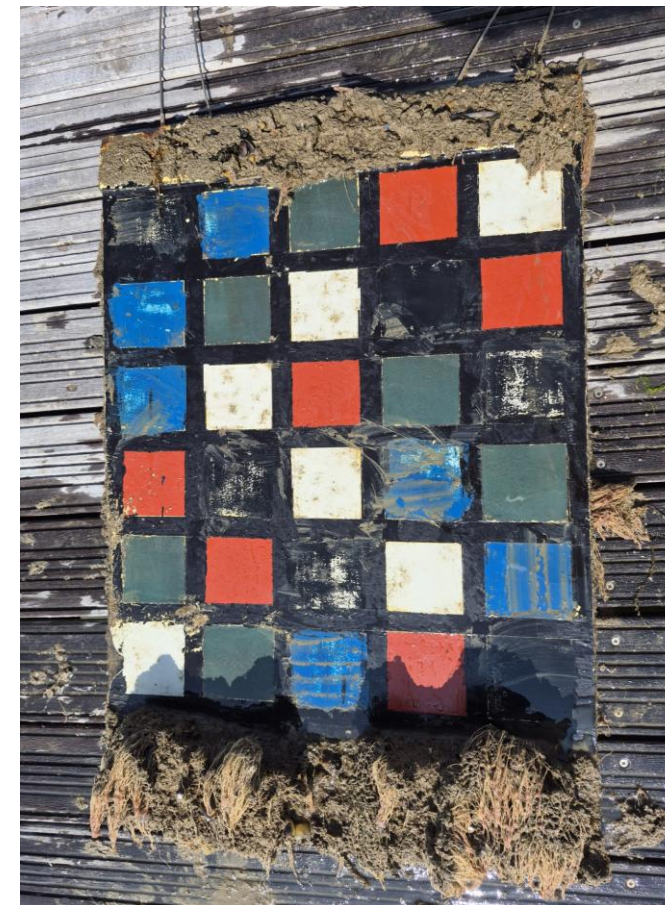


November

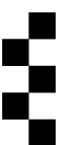
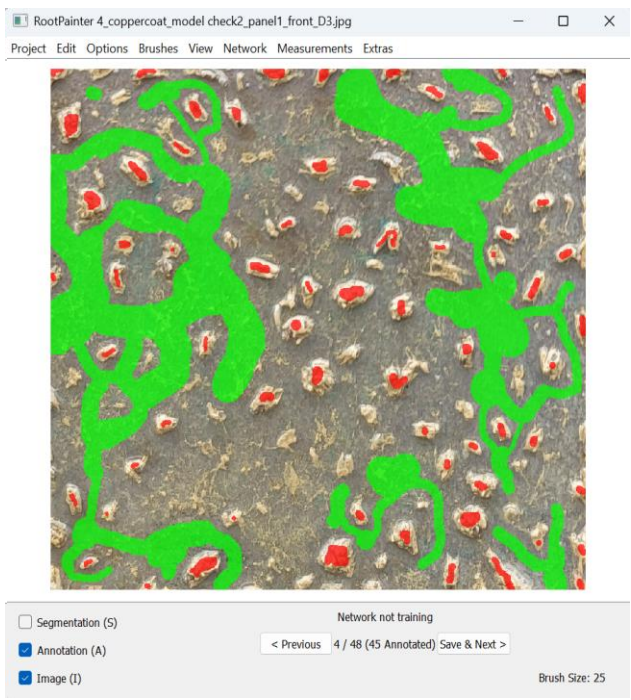
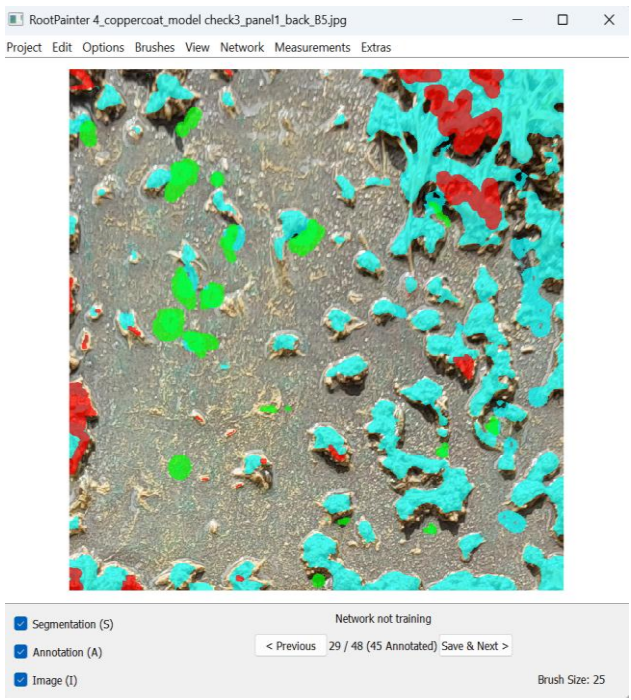


Machine learning solution

- Images analysed using a convolutional neural network (CNN)
- CNN trained to distinguish macrofouling from background surfaces
- Produces quantitative estimates of macrofouling coverage
- Enables fast, standardised and repeatable analysis of large image datasets



Smith, A.G., Han, E., Petersen, J., Olsen, N.A.F., Giese, C., Athmann, M., Dresbøll, D.B. and Thorup-Kristensen, K., "RootPainter: deep learning segmentation of biological images with corrective annotation", 2022



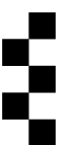
TRAIN 



REFINE 

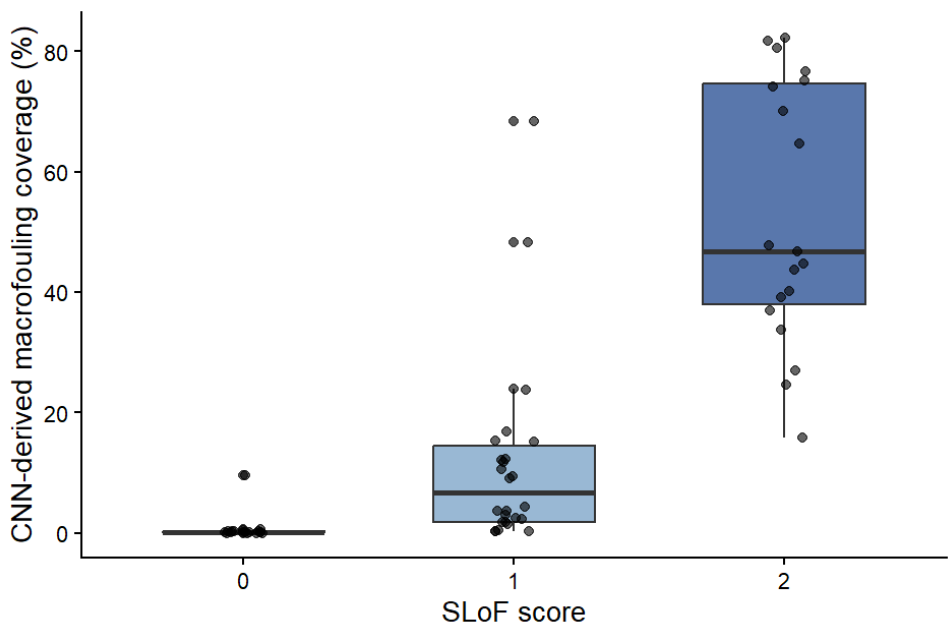


PREDICT 



Validating the CNN

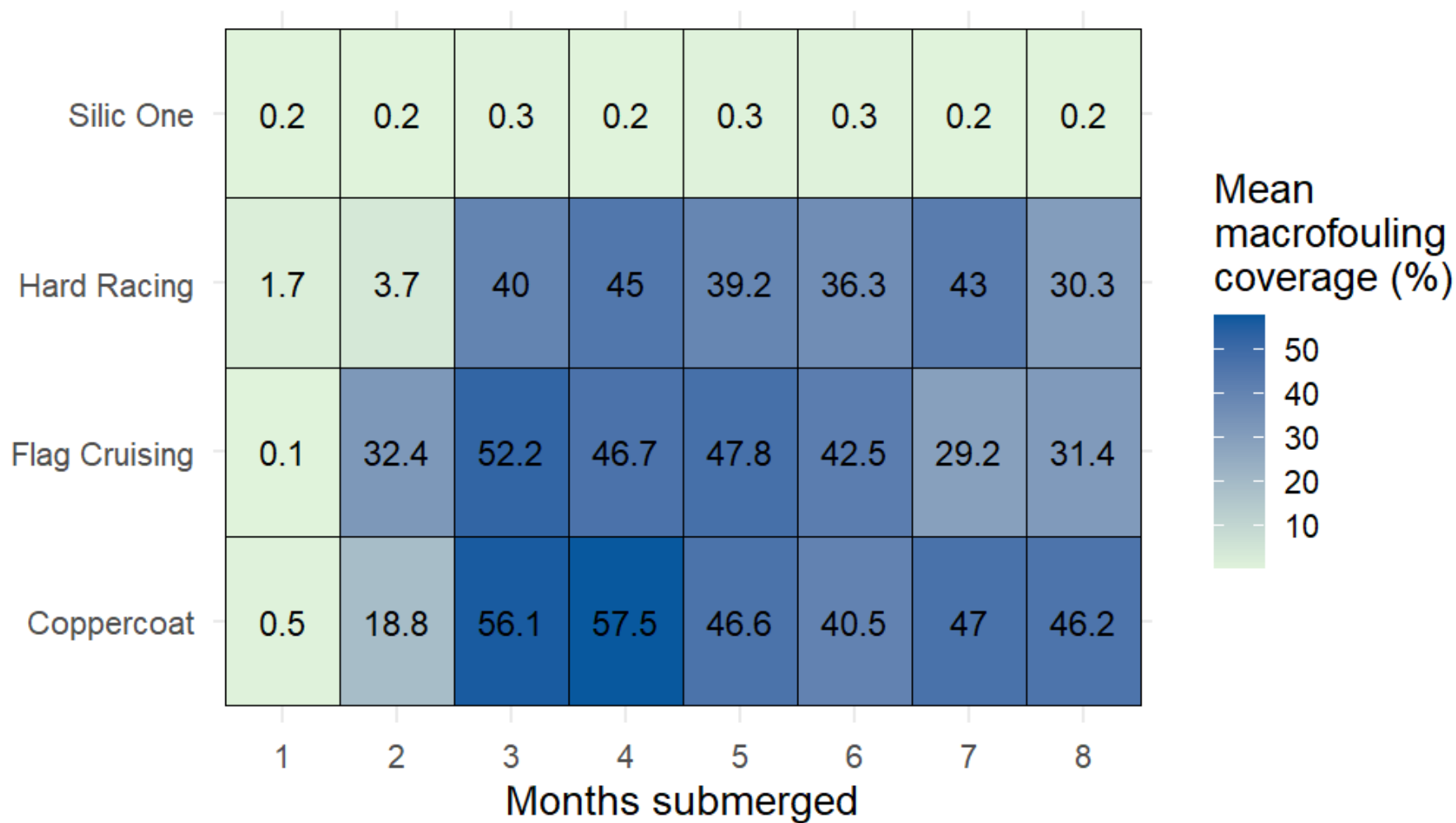
- Strong positive association between CNN-derived fouling coverage and Simplified Level of Fouling (SLoF) score:
- Spearman's rank correlation (ρ) = 0.88

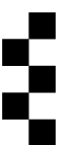


SLoF	Mean CNN fouling coverage	n
0 (0%)	0.7%	19
1 (1-15%)	11.6%	26
2 (16-100%)	52.9%	19

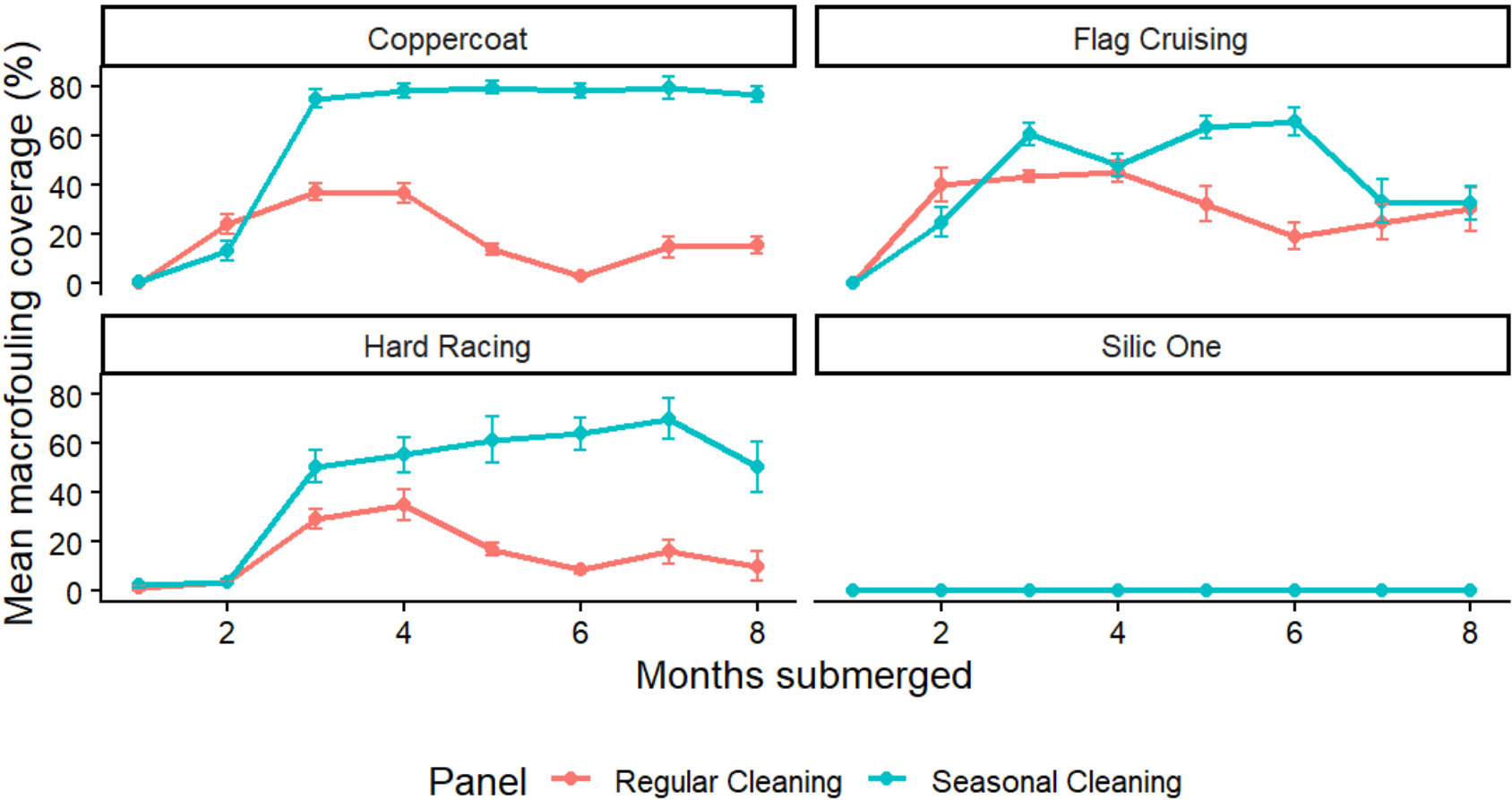
Mannix, E.J., Wei, S., A. Woodham, B., Wilkinson, P. and Robinson, A.P., “Automating the assessment of biofouling in images using expert agreement as a gold standard”, 2011

Results – coating performance



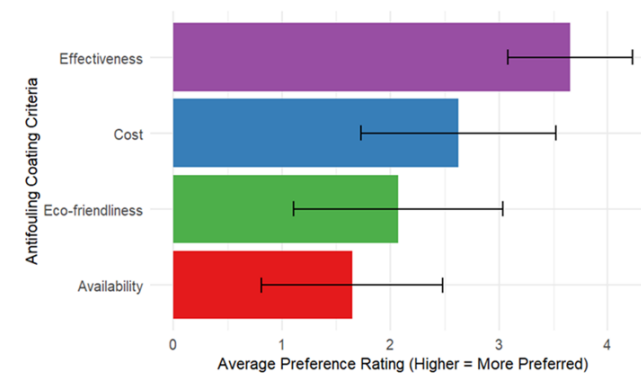


Results – cleaning regime



From evidence to action

If sustainable alternatives are effective,
what is preventing their adoption?



Measure change

Track changes in
stakeholder
antifouling
perceptions and
practices

Build evidence

Continue gathering
locally relevant
scientific evidence

Support action

Can changes in
local behaviour
provide evidence to
inform future
antifouling guidance
or policy?



University of Essex

Thank you

jacob.cook@essex.ac.uk

essex.ac.uk

LinkedIn

