Tom Cameron

University of Essex

@SAGB

Shellfish Association of Great Britain

Llywodraeth Cymru Welsh Government

Department for Environment Food & Rural Affairs

The Fishmongers' Company's Fisheries Charitable Trust

SEPAmatic

Natural England

Crown Estate Scotland

Oighreachd a' Chrùin Alba

seafish

Marine Management Organisation

University of Essex

Eco-service delivery from native and non-native shellfish habitats and aquaculture

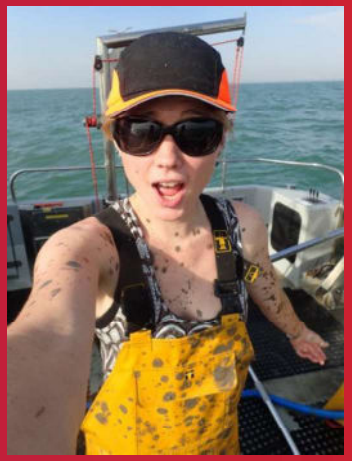
Dr Tom Cameron, Essex Life Sciences

University of Essex

School of Life Sciences

Lucy McGinley

Dr Alice Lown



Professor Graham Underwood, Professor Leanne Hepburn, Dr Michael Steinke, Professor Corinne Whitby, Professor Alex Dumbrell

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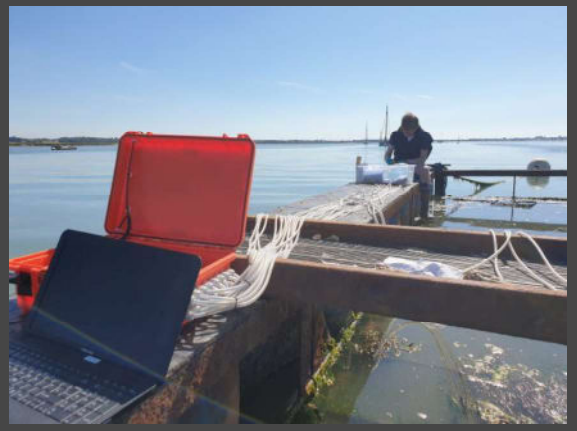
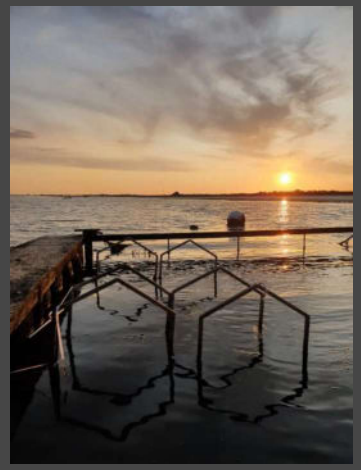
Non-invasive Oyster Sensor System – NOSy

Field deployed sensor of oyster valve behaviour and growth





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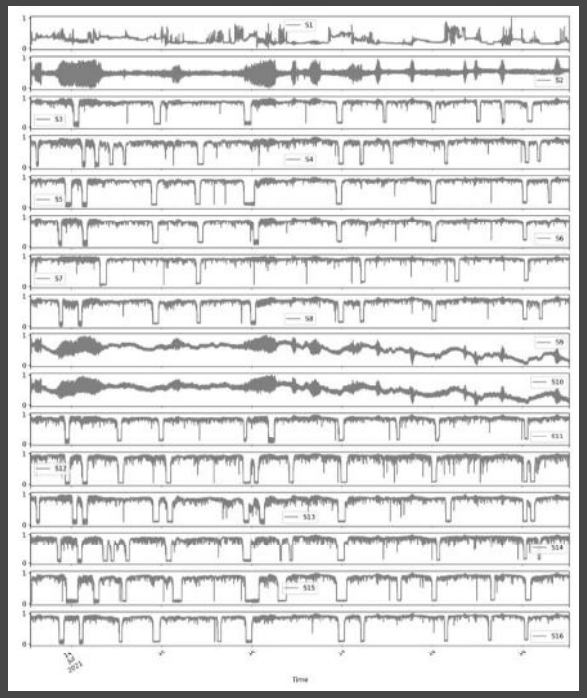
NOSy – detecting Spawning for Oyster recruitment

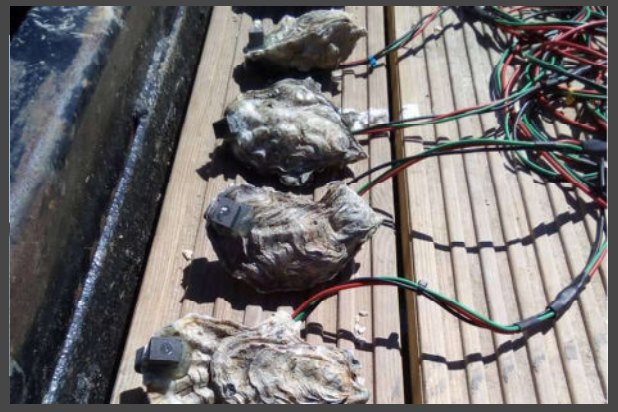
Client: Colchester Oyster Fishery

Valve spawning behaviour to predict reproduction – “spatfall”



Colchester Oyster Fishery

SUPPLIERS OF THE FINEST SEAFOOD



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Deploying NOSy – Water Quality, Dumdrum,
Client: AFBI, Northern Ireland

Water quality declines – are mussels exposed?

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Land based Marine Aquaculture

Client : Colchester Oyster Fishery

The upweller system in situ at COF

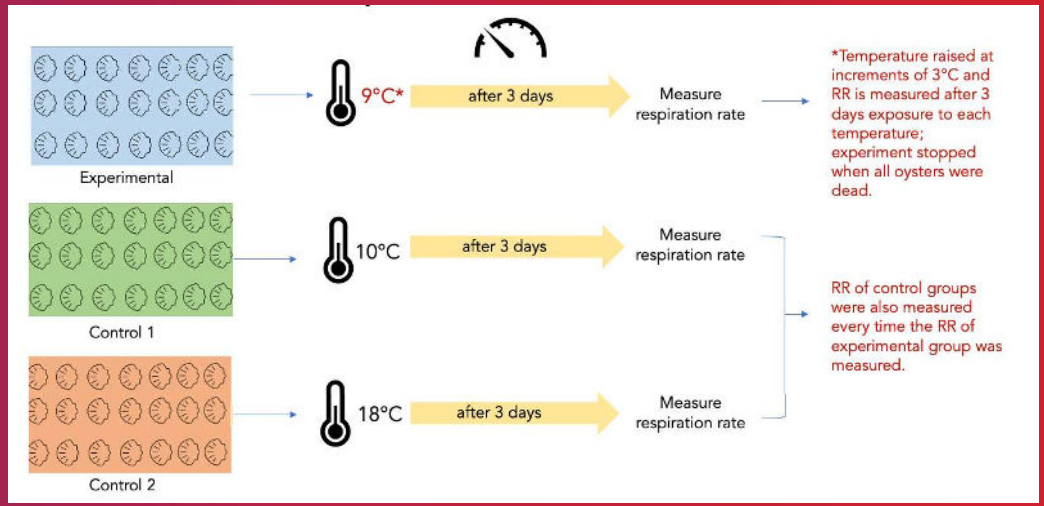
Alex Shakspeare, PhD student

University of Essex

Shellfish Metabolic Rates – Stress responses

Client – CEFAS/ Sec of State

When do flat oysters experience environmental stress?



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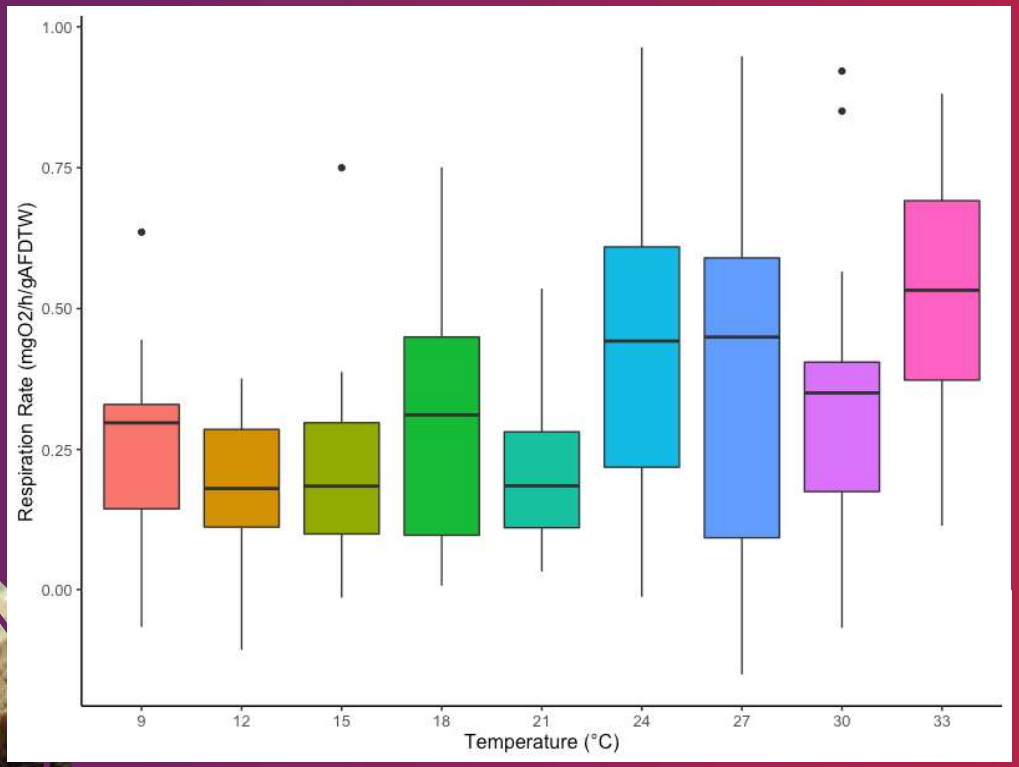
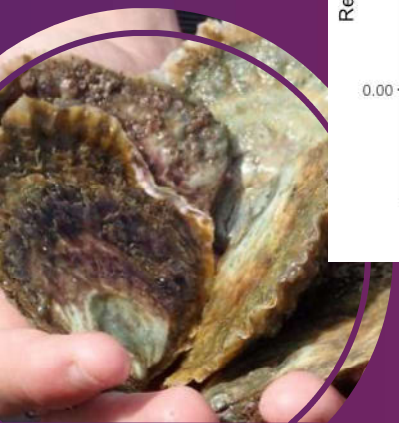
Shellfish Metabolic Rates – Stress responses

Client – CEFAS/ Sec of State

Respiration rate significantly doubles from 24ºC



- Mortality is first observed at 27ºC
- **Lethal temperature** is identified at **36ºC**



Dr Alice Lown
Dr Ellen Funesto


Field based studies of shellfish
….. grey & muddy
West Mersea
Bradwell Waterside
East End
Bradwell-on-Sea
Google Earth
Image © 2019 DigitalGlobe
3 km
N

Estuaries are grey and muddy…..
And a mix of native & non-native species

Bradwell-on-Sea
3 km
N

Estuaries are grey and muddy…..
Highly productive sources of food and employment

Bradwell Wate

Google Earth

Bradwell-on-Sea

mage © 2019 DigitalGlobe

N

3 km

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Importance of natives to Essex

Remaining stronghold – 10s Millions

- Declined
- Low recruitment
- Poor habitat
- Several Order healthy
- Public Fishery Closed
- 16-61 years to recover
- Unviable

Blackwater Oysterman's Association

Lown, AE, Hepburn, LJ, Dyer, R, Cameron, TC. From individual vital rates to population dynamics: An integral projection model for European native oysters in a marine protected area. Aquatic Conserv: Mar Freshw Ecosyst. 2020; 30: 2191– 2206. https://doi.org/10.1002/aqc.3445

Allison, S., Hardy, M., Hayward, K., Cameron, T., & Underwood, G. (2020). Strongholds of Ostrea edulis populations in estuaries in Essex, SE England and their association with traditional oyster aquaculture: Evidence to support a MPA designation. Journal of the Marine Biological Association of the United Kingdom, 100(1), 27-36. **doi:10.1017/S0025315419001048**

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Justification for Restoration

Restoration is expensive

Billions required (as per US investments, Army Corps etc)
We have max 100s 1000s in UK
Benefits to sea defence unclear from native oysters

WHY DO RESTORATION?

- Ecosystem engineer – biodiversity
- Provisioning - jobs
- Water quality – denitrification
- Water quality – filtering
- Carbon

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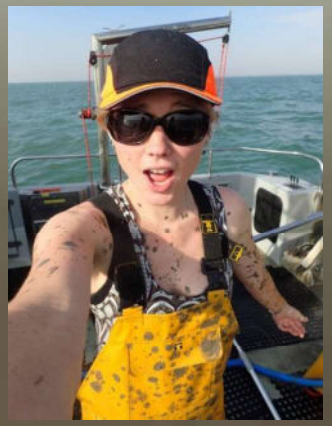
Could recovering native oysters provide benefits to biodiversity?



Alice E. Lown[1], Leanne Hepburn[1], Jane Heywood[2], Tom C. Cameron[1]

1 – University of Essex.
2 – Kent & Essex Inshore Fisheries and Conservation Authority/ now CEFAS
@alicelown
@ecoevoenviro

Kent & Essex IFCA Inshore Fisheries and Conservation Authority

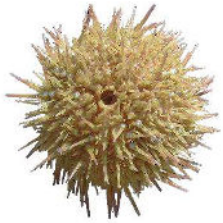
ARIES DOCTORAL TRAINING PARTNERSHIP

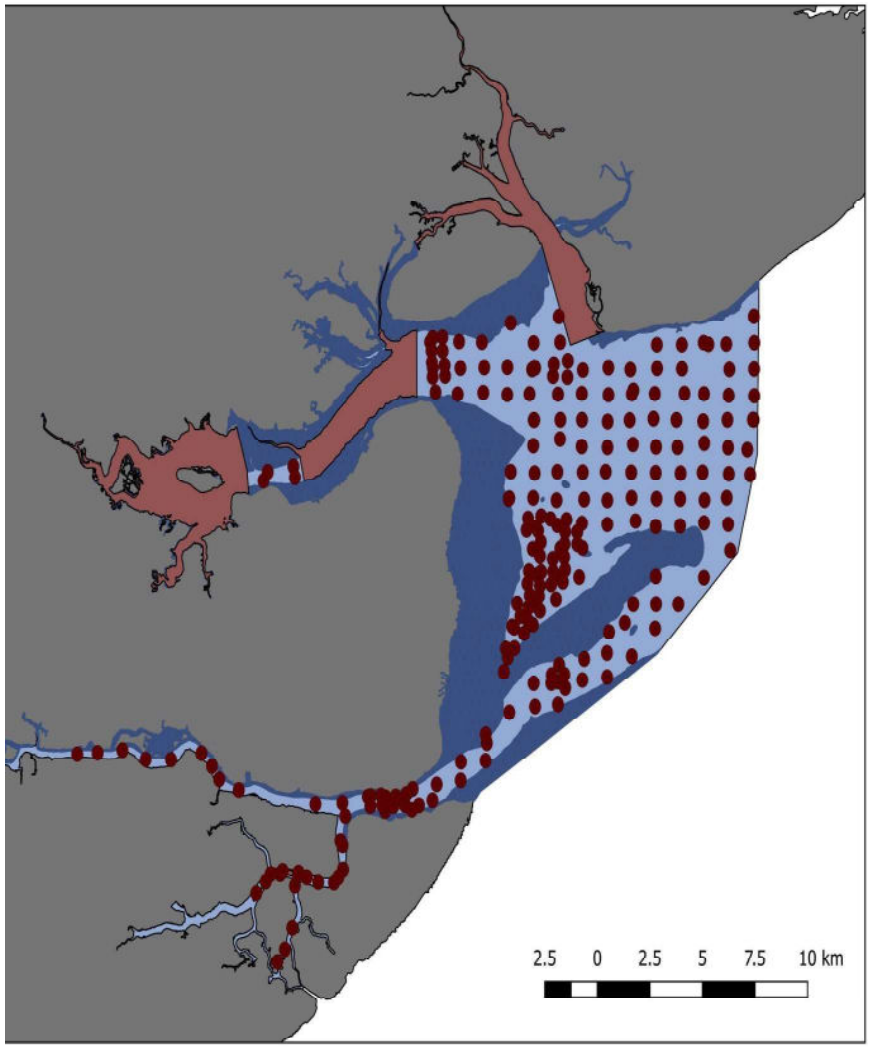
UKRI Natural Environment Research Council

University of Essex

Methods

- Modified ladder dredge survey
- Biannually from March 2016 to Aug 2018
- Point and transect survey – GPS
- 47 species identified
- Dead shell weighed
- Live native and rock oysters counted





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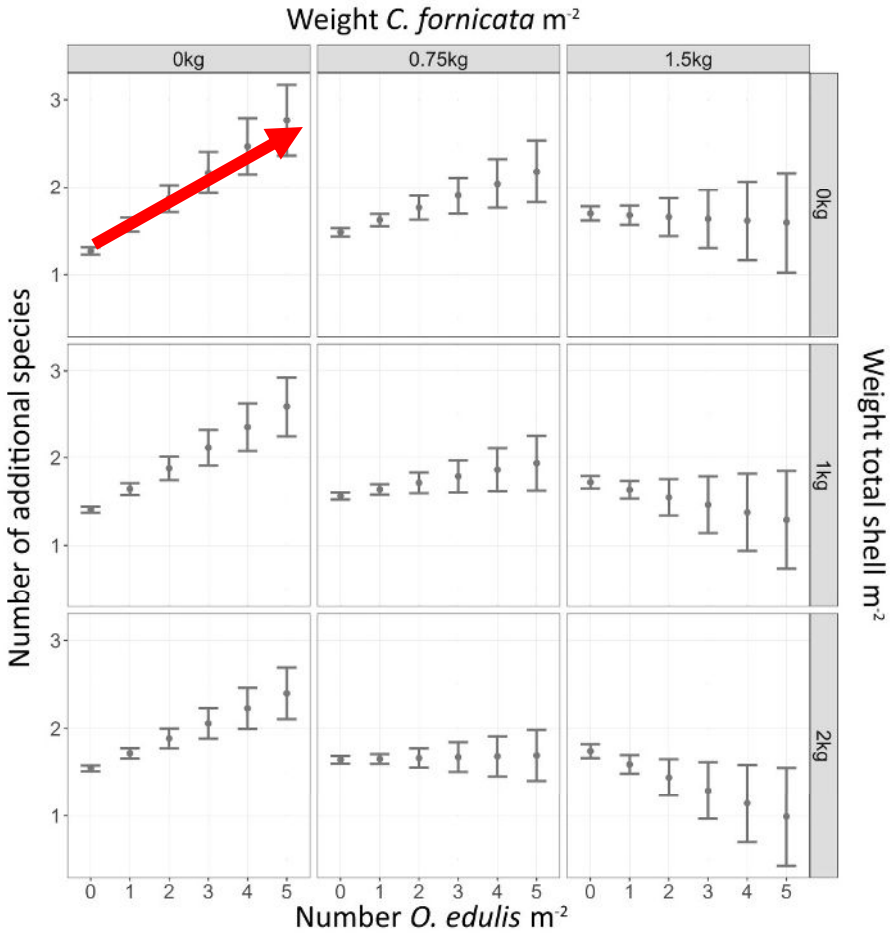
Biodiversity responses



Data

396 dredges over

2 years and

2 seasons

More Oysters – More Biodiversity

Low diversity – large effect – 80%

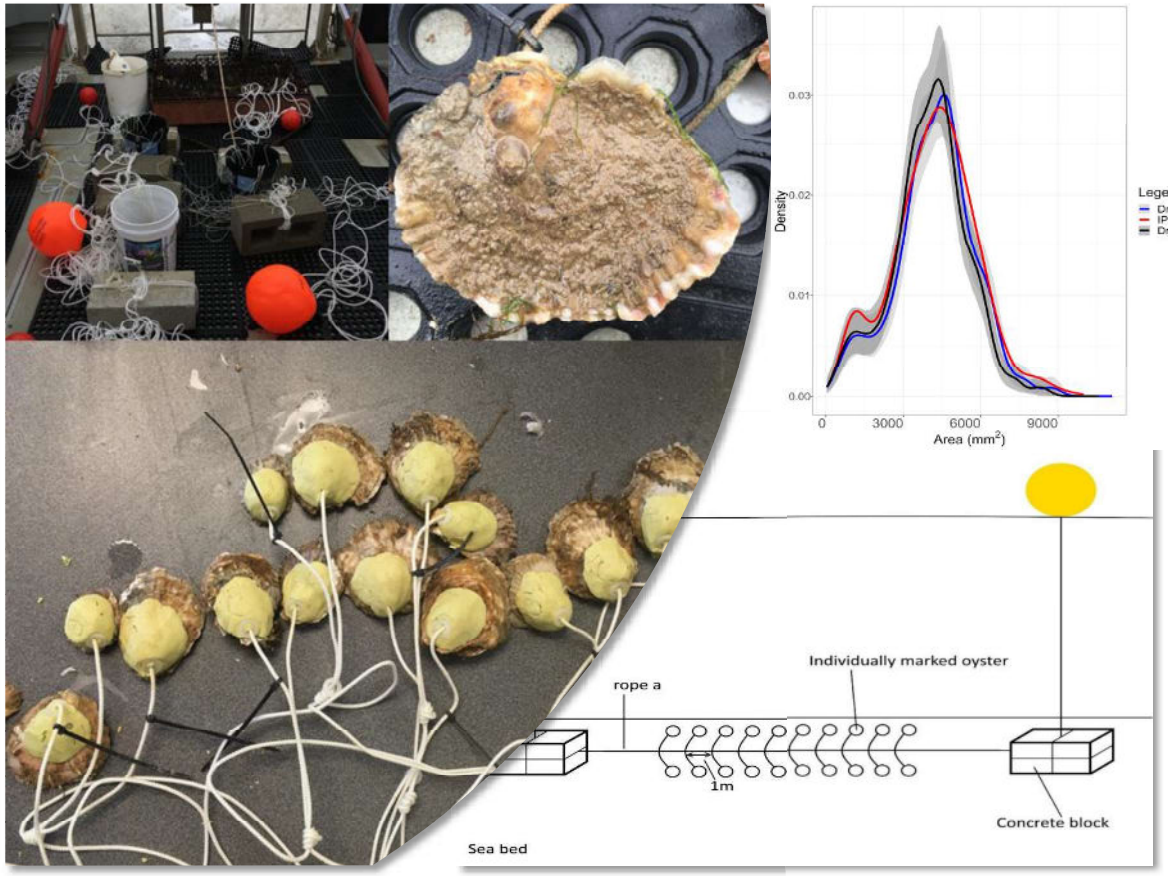
Non-native effects

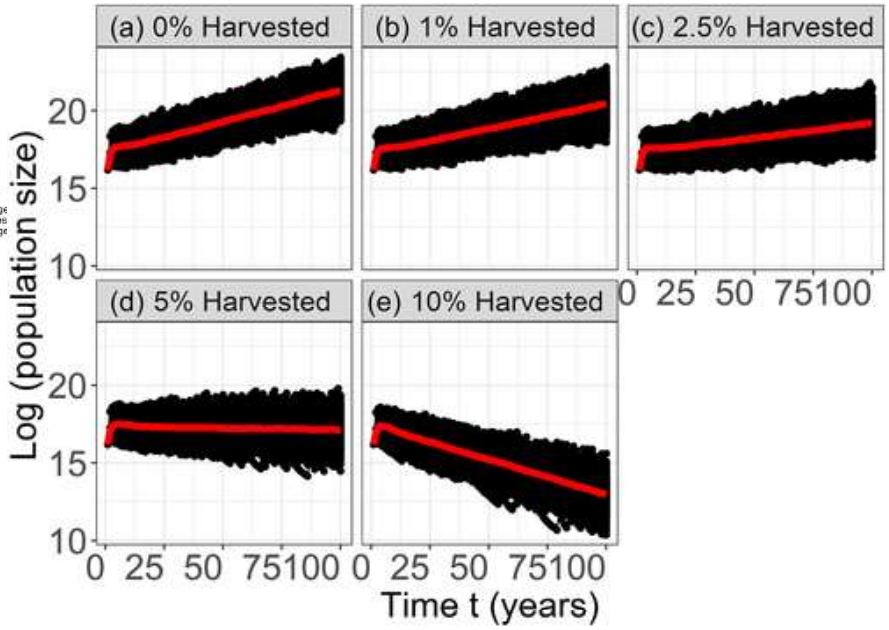
Shell type matters

Scallop, Edible crab, Anenome

Lown, AE, Hepburn, LJ, Heywood, JL, Cameron, TC. European native oysters and associated species richness in the presence of non-native species in a southern North Sea estuary complex. *Conservation Science and Practice*. 2021; 3:e361. https://doi.org/10.1111/csp2.361

Field Data to Modelled Population





- **Once recovered – population sustains harvest**
- **Part of diverse income**

Lown, AE, Hepburn, LJ, Dyer, R, Cameron, TC. From individual vital rates to population dynamics: An integral projection model for European native oysters in a marine protected area. *Aquatic Conserv: Mar Freshw Ecosyst*. 2020; 30: 2191–2206 https://doi.org/10.1002/aqc.3445

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Without Income – no community to restore oysters for!

Rock Oyster Mariculture and Aquaculture

Dredging rock oysters

Farmed rocks

Rock oysters

- Non-native
- Introduced by UKgov in 1920s and 60s
- Thought not to reproduce
- Warming waters – now self sufficient
- Concern of INNS/detrimental effects
- Policy and Licence restrictions
- “Red line”
- UK wide spread guaranteed *Clubley

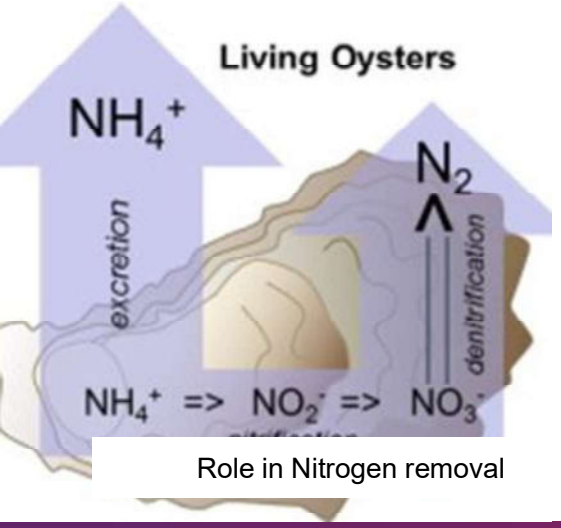
Benefits of rock oysters

Non-native species have benefits & costs

- Engineers - Sea defence (X)
- Engineers – biodiversity ?
- Water Quality – denitrification ?
- Provisioning – jobs ?

Living breakwaters, NL

Periwinkle heaven – oyster reef



Role in Nitrogen removal

Rural & Coastal jobs

Richard Haward Oysters

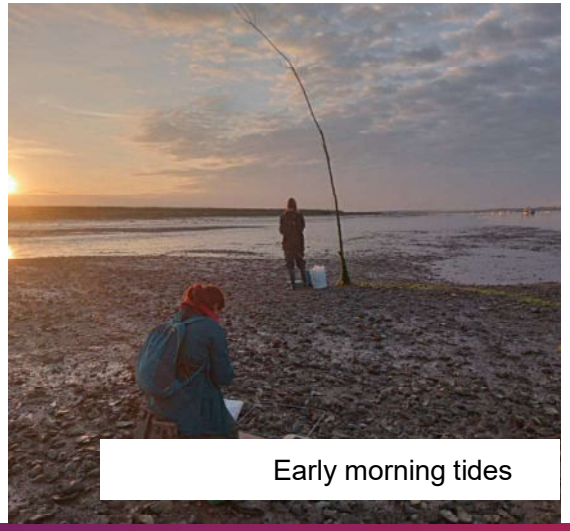
Colchester Oyster Fishery
SUPPLIERS OF THE FINEST SEAFOOD

NATURAL ENGLAND

Lucy McGinley, Pyefleet

Live Natives and dead shell

Live Rocks and dead shell



Early morning tides

Experimental Reefs, Beds, Farms

- Density dependent plots – 1, 5, 10 & 15 oysters m^2
- 4 shell pieces added per live oyster
- 5m * 5m plots, 3 replicate sites
- 775 oysters per species per site
- 3100 pieces dead shell – hand laid
- Associated species
- Sediments and Swabs – N-cycle

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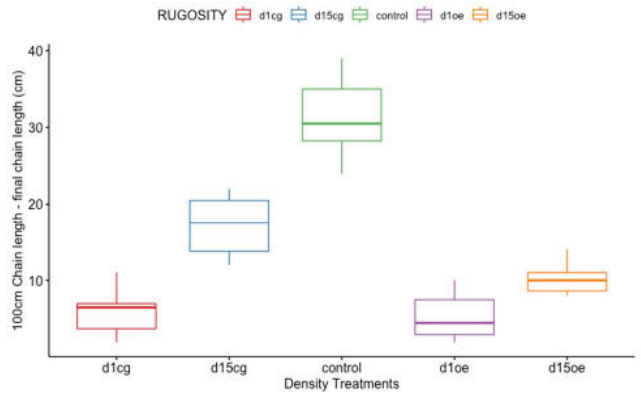
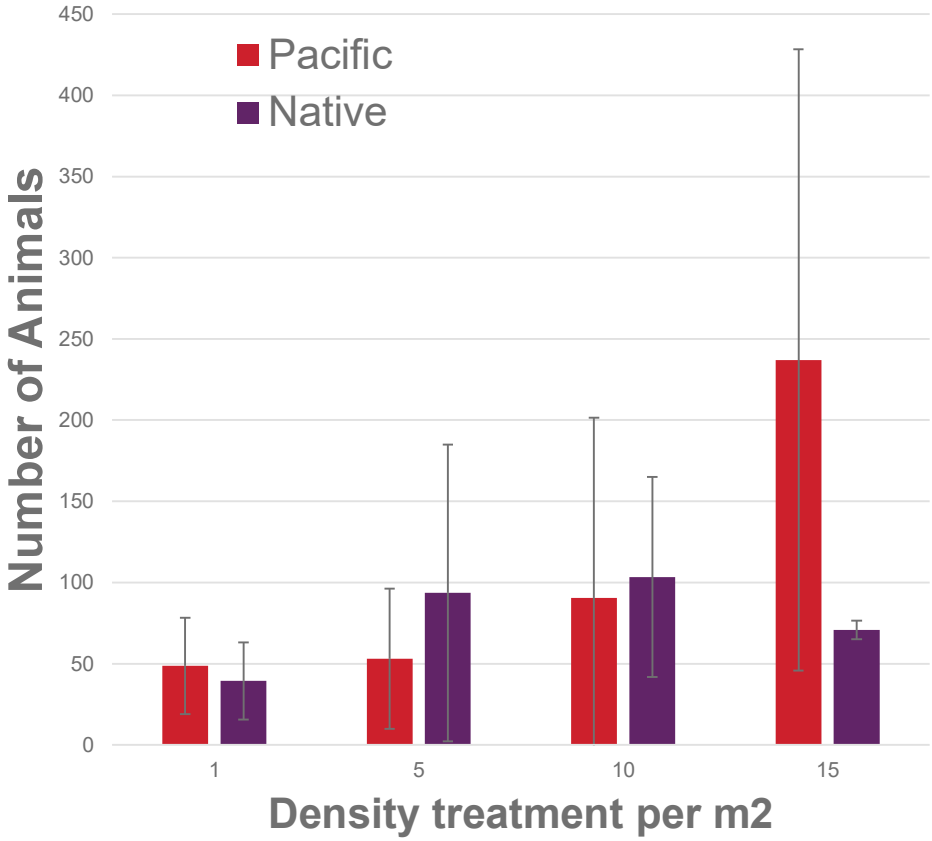
Results - biodiversity

June – 4-6 weeks

- Increase density leads to more associated animals
- Lots of variation
- More evident in rock oysters
- Rock oyster beds are more complex
- Rugosity =



Abundance of individual animals



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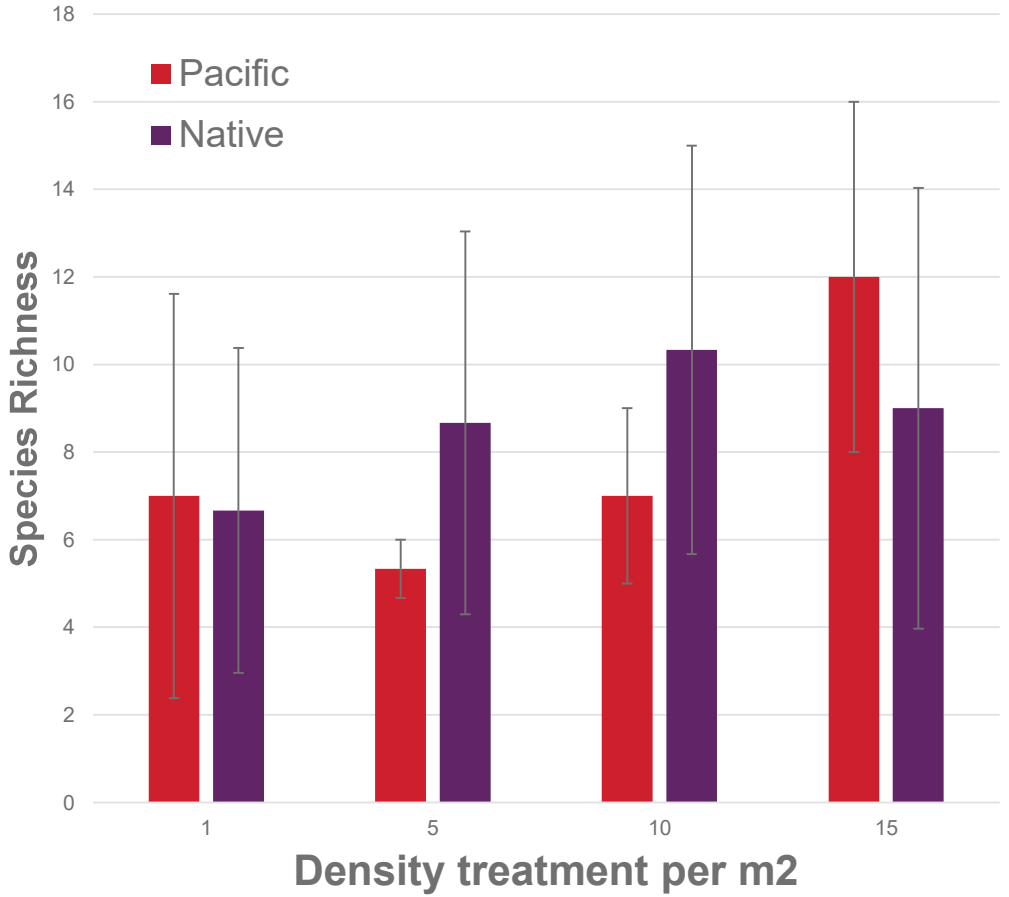
Results - biodiversity

- No difference in June – early stage
- Some evidence of increase with density

Species Richness



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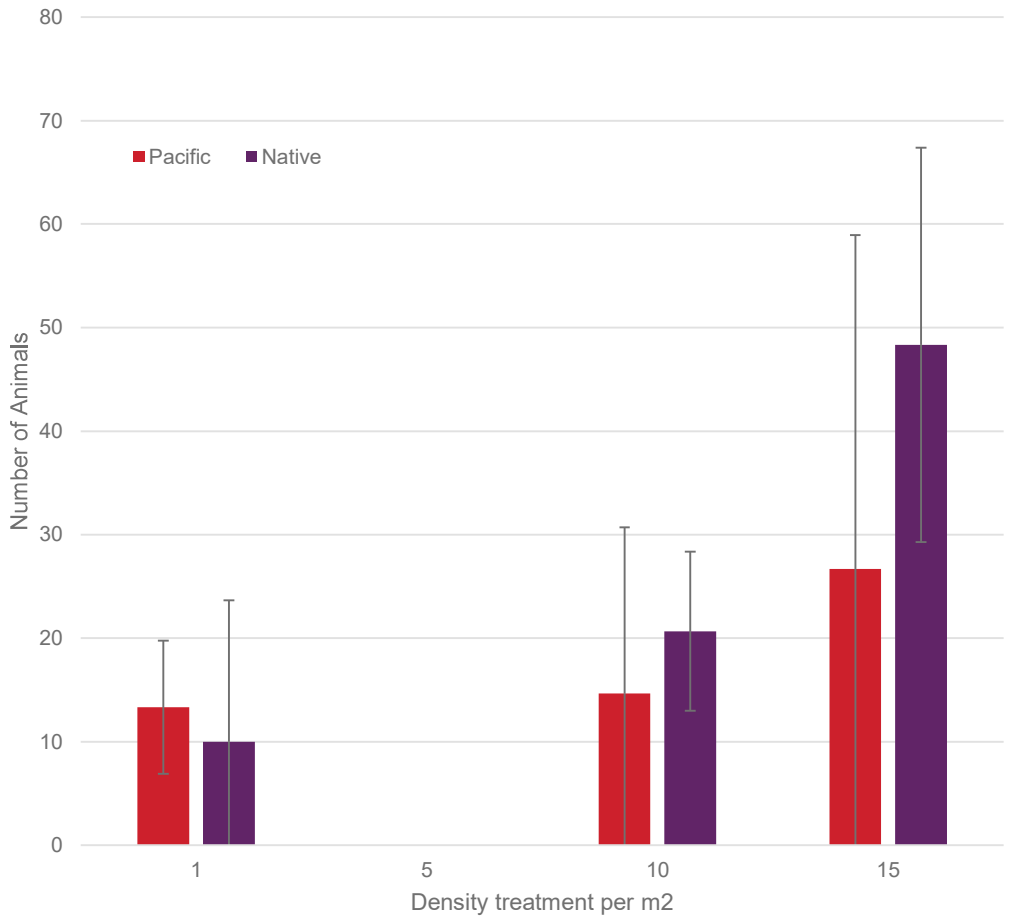
August - HEATWAVE

Results - biodiversity

August – 3 months and in heatwave

- Note massive decline in animals – max 70 vs 250-400
- Lots of variation – again
- Increase with density
- Rock oysters beds more exposed
- Native oysters more wet/muddy?
- Estuary creeks reach 26°C



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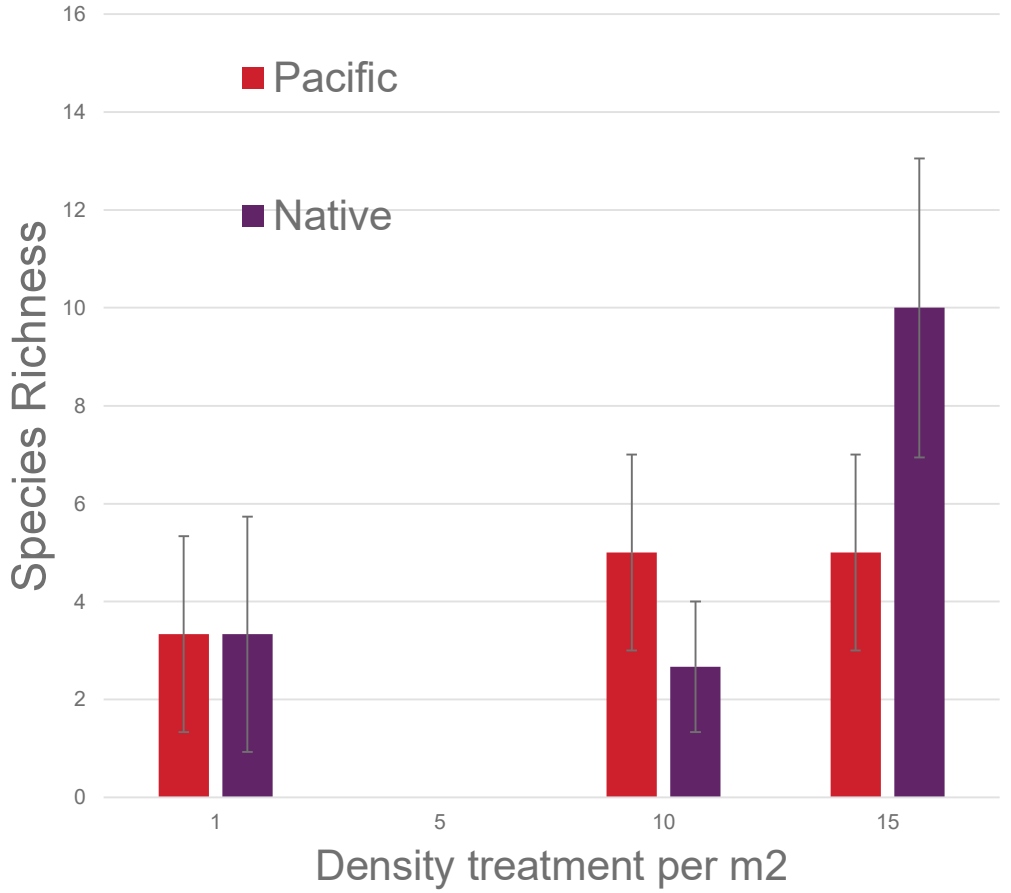
August - HEATWAVE

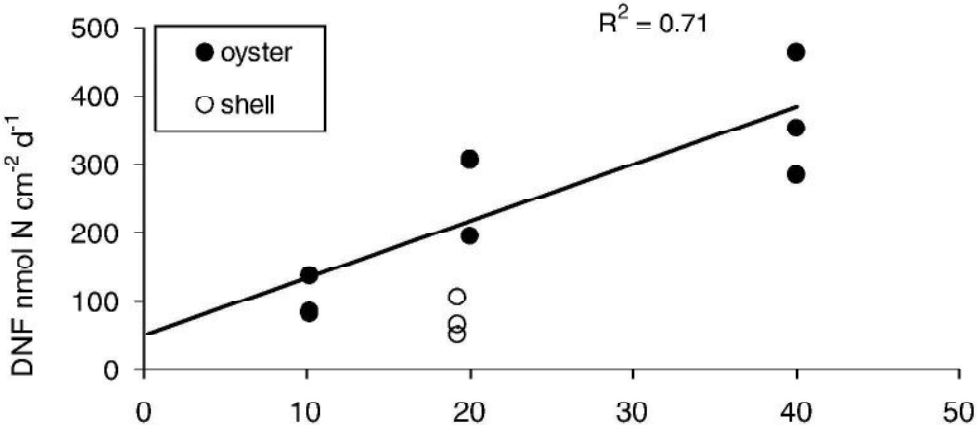
Results - biodiversity

- Associated species number similar
- Some evidence of increase with density
- Increased species richness at high density natives – heatwave effect?

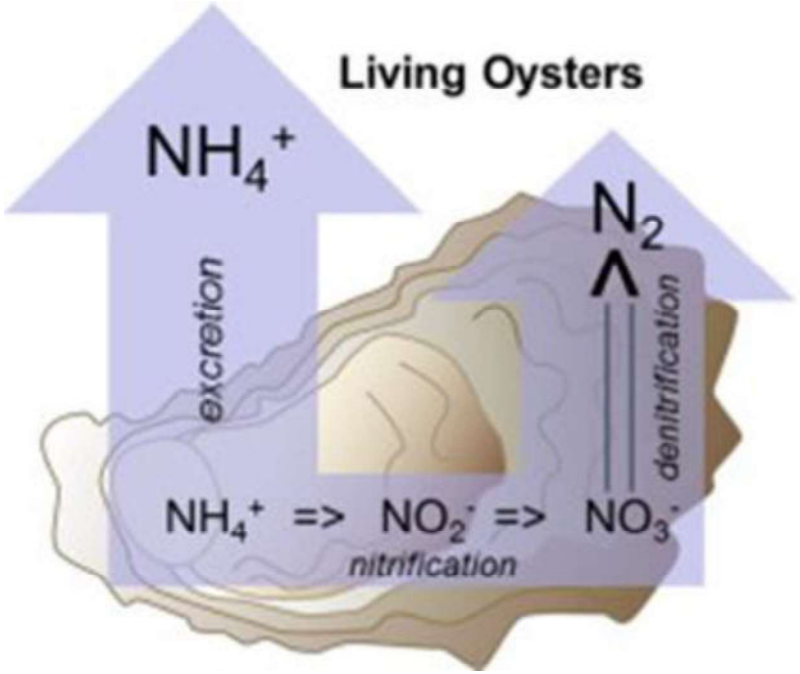


Too early for our work but……

Results - Denitrification



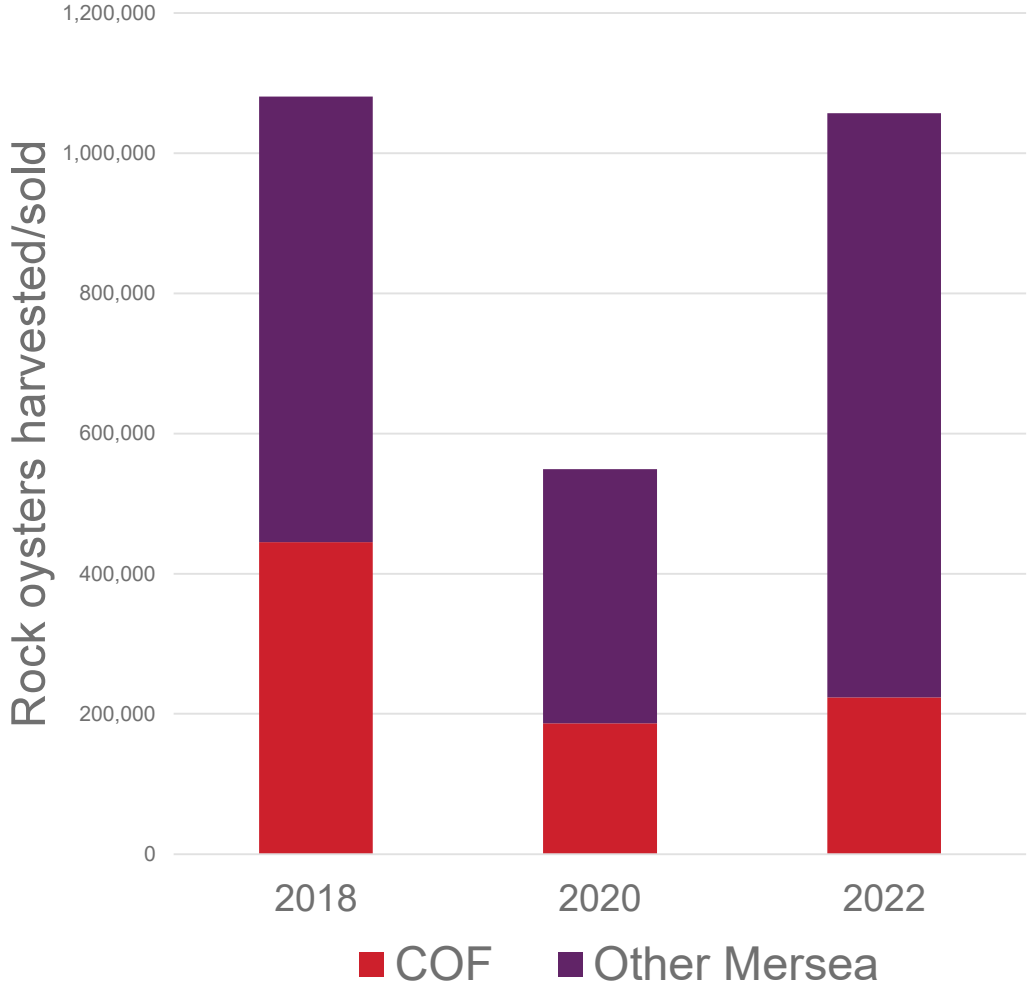
Nitrate flux nmols cm2



- Denitrification – N removal – Three times higher in live oysters to dead shell
- Caffrey et al., 2016

Results – One Company

- 1.1M rock oysters sold
- £650-700K of a £4M turnover
- 20% of business
- Half of this supports other households
- Non-branded “oystermen”
- 1. One Father, two brothers – three households
- 2. One owner, two employees – three households



Mercenaria mercenaria

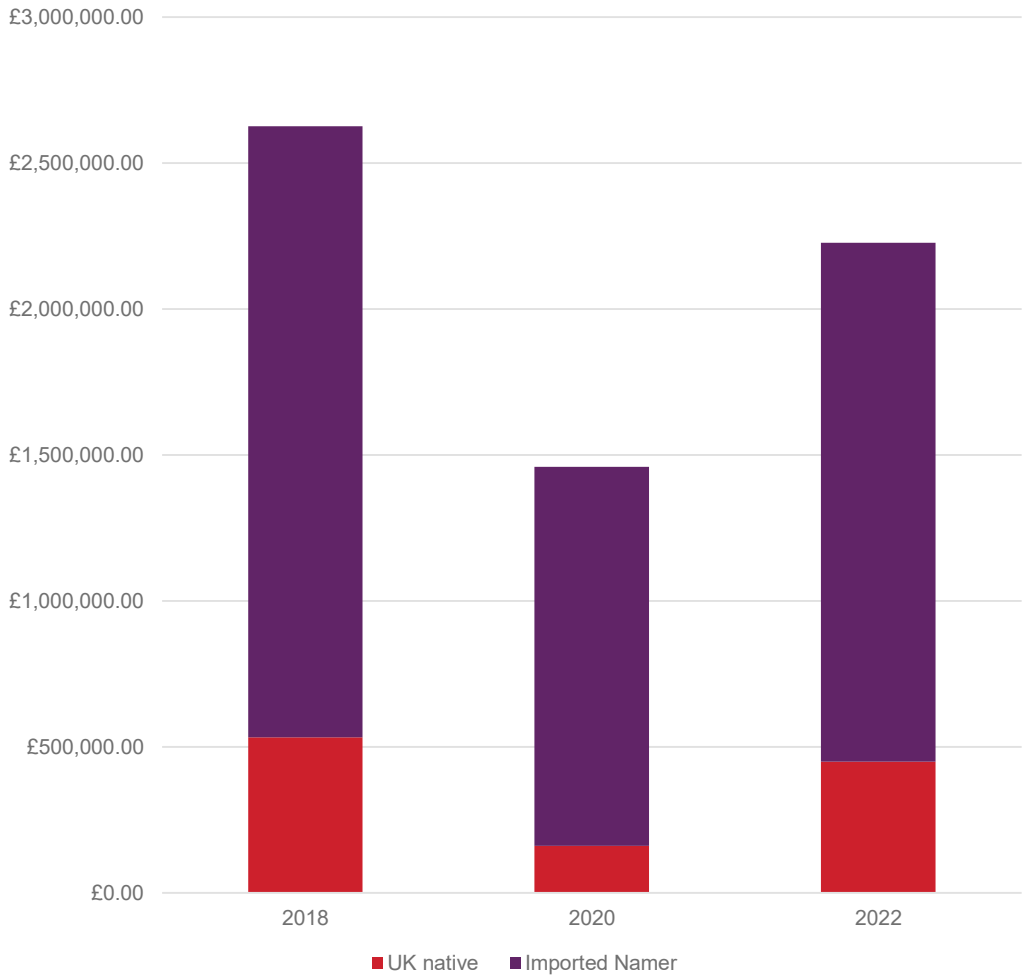
Clam dredging – small vessel 1 man

American hardshell clam

- Deliberate introductions as well as accidental
- Successfully introduced in 1925, S'Hampton
- Large export value – especially in Spain
- £66K, £32K and £92K contributions to turnover – one permanent staff

Results – Lobster

- Native lobster supply – cannot service demand
- 50% business turnover in 2018
- £2M annually



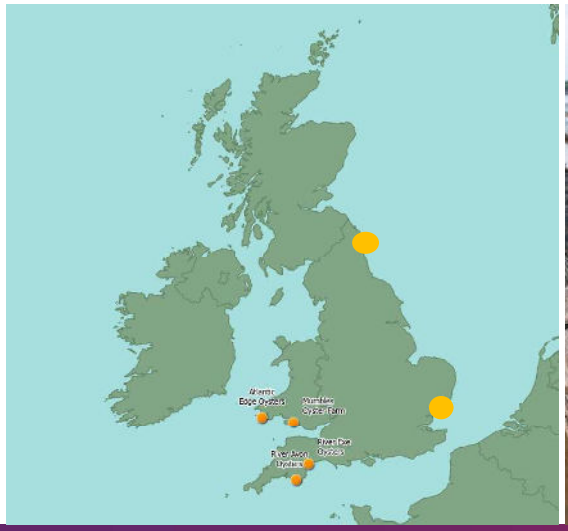
Oyster purification, Mersea, UK

Conclusion

- Non-native rock oysters already providing Ecosystem Function & Services
- Biodiversity increases – and changes
- Improved Beta diversity at estuary scale?
- Nitrogen cycling services – needs quantified
- Rocks – 20-100% of rural business turnover
- NNS – 60% of total turnover
- 31 employees in just one business (pre-covid)
- Benefits many more households

DEFRA – FISP – 2023-24

- Ecosystem Function of Shellfish Aquaculture
- 8 farms – all rock oyster
- Biodiversity – inc video
- Denitrification



Andy Woolmer

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Thank you

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