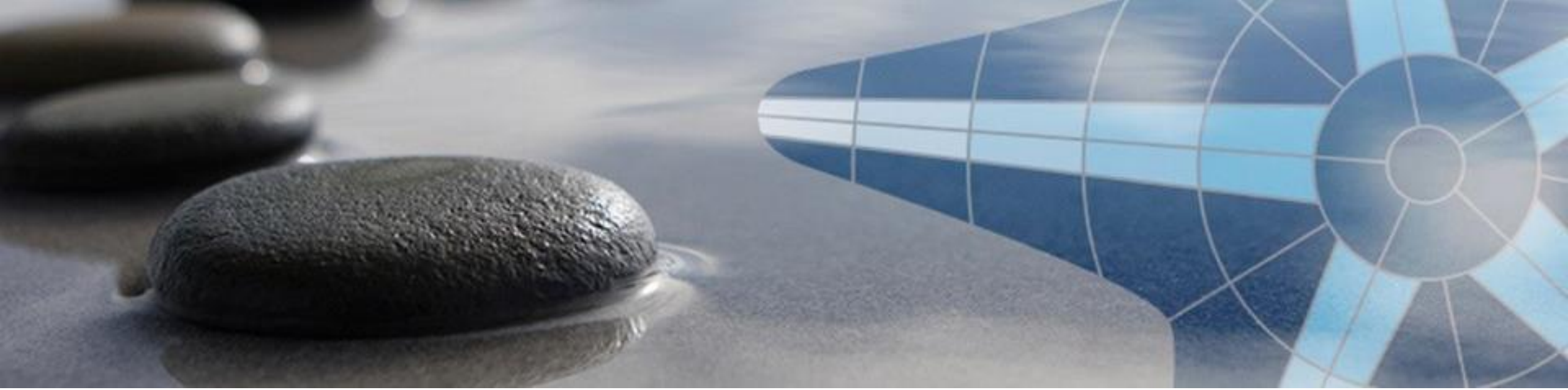

Improve water quality and provide economic stimulus through co-location of mariculture within an inshore wind farm

Charlotte Hebditch, Tees Rivers Trust

Tees Estuary

- Tees Estuary holds a lot of ecological and socio-economic importance.
- Historic industrialisation of the Tees has led to the natural estuary environment to be heavily modified.
- Pollutants were broadly discharged into the local environment - natural estuary ecology has been negatively impacted.
- Protected designation areas - Teesmouth and Cleveland Coast Special Protected Area (SPA), Teesmouth and Cleveland Coast Site of Special Scientific Interest (SSSI).

Pressure – current of Tees Estuary waterbody

- Lower Tees and Estuary currently has 18 reasons for not achieving good Water Framework Directive (WFD) status.
- One failing element – Tributyltin compounds present in sediment.
  - Other elements listed as moderate.
- Majority of pollutants present as a result of poor industry practices.

Classification Status	Classification Element	Category Certainty	Business Sector	Activity
Moderate or less	Mitigation Measures Assessment	Confirmed	Not applicable	Other
Fail	Tributyltin Compounds	Confirmed	Not applicable	Contaminated water body bed sediments
Moderate	Angiosperms	Confirmed	Not applicable	Coastal squeeze
Fail	Polybrominated diphenyl ethers (PBDE)	Not applicable	Not applicable	Unknown (pending investigation)
Moderate	Dissolved Inorganic Nitrogen	Suspected	Agriculture - Livestock	Poor nutrient management
Moderate	Macroalgae	Suspected	Agriculture - Livestock	Poor nutrient management
Moderate	Invertebrates	Probable	Other industry	Trade/Industry discharge
Moderate	Macroalgae	Suspected	Ports and harbour authorities	Ports and harbours - structures
Moderate	Macroalgae	Probable	Other industry	Coastal squeeze
Moderate	Invertebrates	Confirmed	Waste water treatment	Sewage discharge (continuous)
Moderate	Dissolved Inorganic Nitrogen	Confirmed	Waste water treatment	Sewage discharge (continuous)
Moderate	Dissolved Inorganic Nitrogen	Confirmed	Other industry	Trade/Industry discharge
Moderate	Macroalgae	Probable	Not applicable	Recreation
Moderate	Macroalgae	Confirmed	Other industry	Trade/Industry discharge
Moderate	Macroalgae	Confirmed	Waste water treatment	Sewage discharge (continuous)
Moderate or less	Mitigation Measures Assessment	Confirmed	Not applicable	Other
Moderate or less	Mitigation Measures Assessment	Confirmed	Not applicable	Other
Moderate or less	Mitigation Measures Assessment	Confirmed	Not applicable	Other

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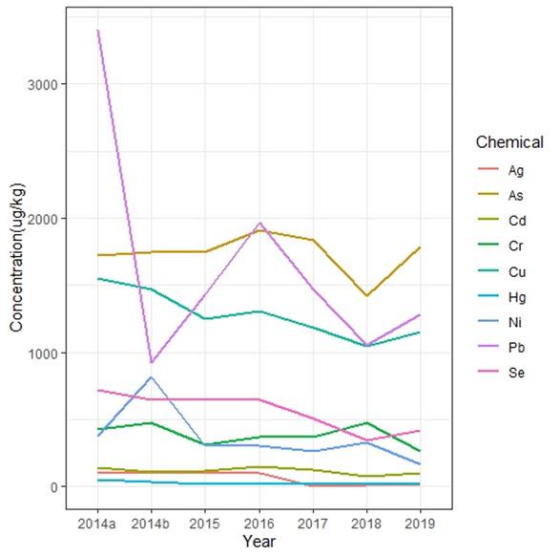
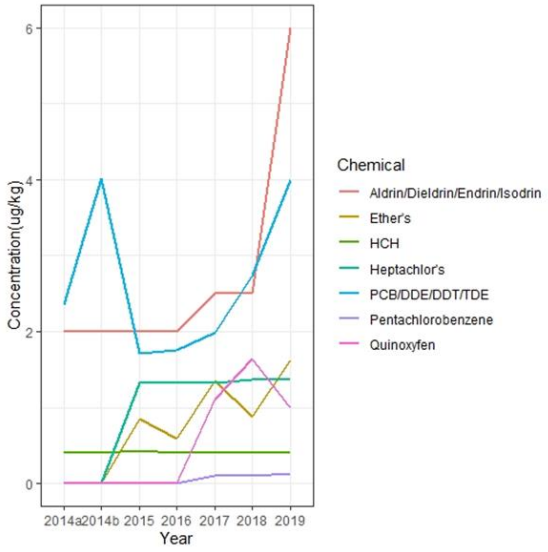
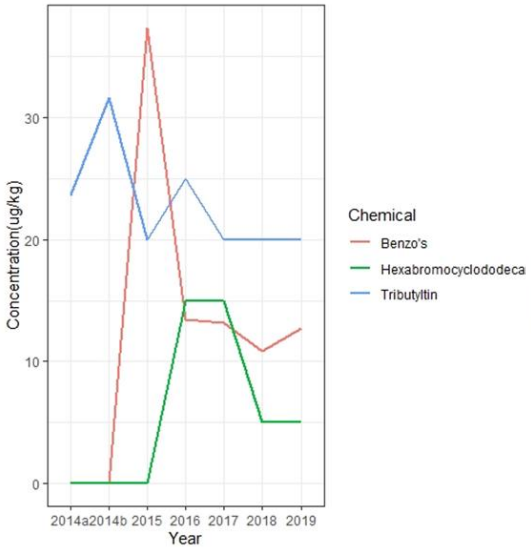
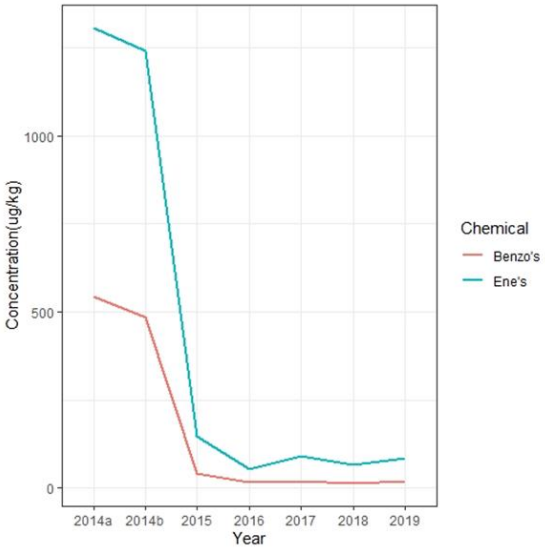
Pollutants identified inside Tees Estuary

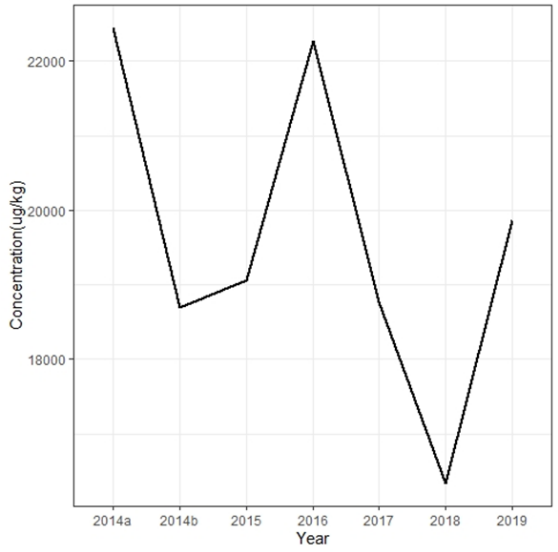
- Number of inorganic and organic pollutants and 10 heavy metals identified within Tees estuary waterbody to varying concentrations.
- Many pollutants identified as in decline or remaining stable. Some still increasing in concentration.
- Positive steps are needed to address key water quality issues to alleviate negative environmental health impacts.





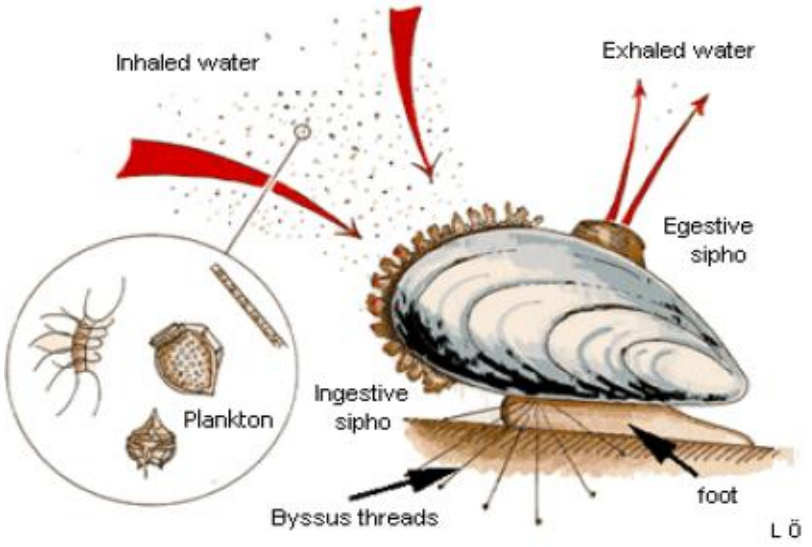






Measure – co-locate mariculture inside Teesside Inshore Wind Farm

- Bivalve shellfish and macroalgae species naturally improve water quality in their local environment.
- Bivalve shellfish remove pollutants present and permanently store these toxins within their bodies.
- Macroalgae absorbs inorganic nutrients during photosynthesis.
- Need to address water quality issues is negated by the economic benefits of pollution creating industries.



Teesside Wind Farm

Location: 1.5km offshore

Set up: 27 turbines, area 10km^2

Operational: 2013 to present (decommission due in 20+ years).

Feasibility of co-locating mariculture inside wind farm

- Study focused on viability of rearing European flat oyster, blue mussels, scallop species and kelp species inside Teesside Wind Farm.
- Environmental conditions inside Teesside Wind Farm identified as suitable to culture all study bivalve shellfish species and macroalgae.
- Consider site abiotic factors, species environmental tolerances, site habitat dynamics.

Feasibility of co-locating mariculture inside wind farm

- Both surface-suspended and seafloor-based mariculture installation techniques suitable within wind farm.
- Environmental conditions and viable fishing methods dictate appropriate installation set up.
- Must avoid disturbing wind farm operations - locate installations away from wind farm infrastructure to reduce conflict.

Arc Marine - Rich North Sea

Direct benefits of mariculture co-location

- Water quality improvement.
- Cultivate stock as fishery resource or restore native species.
- Support rapidly expanding mariculture industry.
- Direct economic benefit of farm creation.
- Demonstrate effective co-location and collaboration between two offshore industries.
- The UK currently accounts for nearly 35% of the global offshore wind capacity.
- Achieving planned net zero emissions goal by 2050, equals a 13x increase in the current operational generating capacity of the UK offshore wind industry.

Indirect benefits of mariculture co-location

- Increase habitat complexity leading to biodiversity net gain.
- Support commercial fish populations.
  - Shellfish fisheries around Tees Estuary area.
- Carbon sequestration.
- Protect against coastal erosion.
- Indirect economic benefits through local environmental improvements.

Co-location of mariculture within Teesside inshore wind farm

- Concluding thoughts:
  - Study has determined it is feasible to co-locate mariculture inside the Teesside Wind Farm.
  - Improved estuary water quality could be achieved.
  - Multiple economic benefits could be generated from the set up of a mariculture enterprise.
  - Pilot study advised to test survival rate of species and site operational logistics.

Thank you

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TEES RIVERS TRUST

Native Oyster Restoration

Green Recovery Challenge Fund

Department for Environment Food & Rural Affairs

The National Lottery Heritage Fund

Environment Agency

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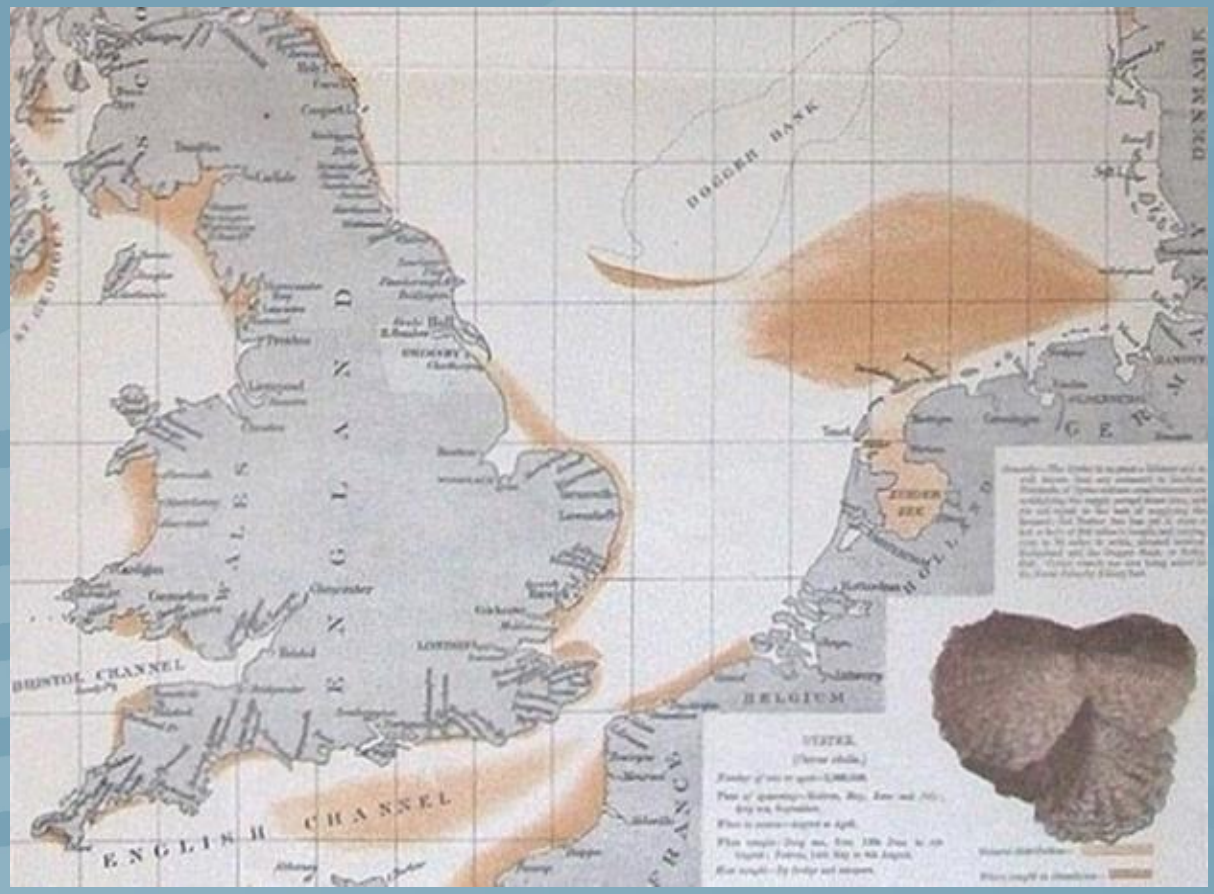
Native Oyster History

- Once widespread around the UK
- Found in Roman Archaeological Digs
- In 1864, 700 Million native Oysters were eaten in London



Olsen's 1883 Piscatorial Atlas of the former distribution of the native oyster (Olsen, 1883)

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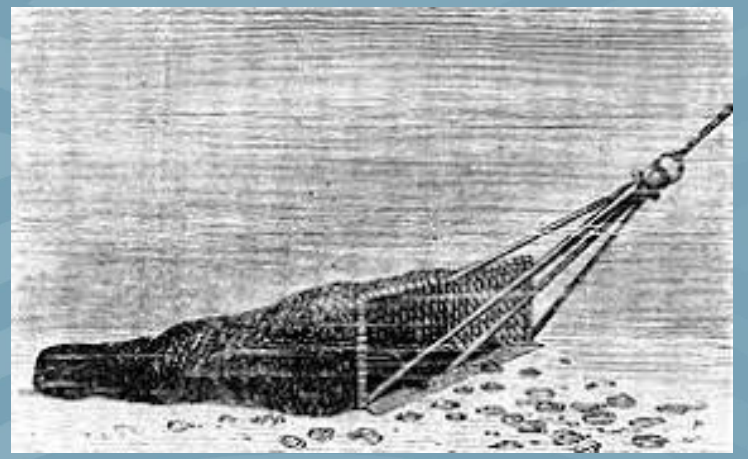
Threats to Native Oysters

- UK Native oyster populations have dropped by 95% since the Mid 1800s
- Overfishing
- Deteriorating water quality
- Invasive species
  - Pacific Oysters
  - American Oyster Drill



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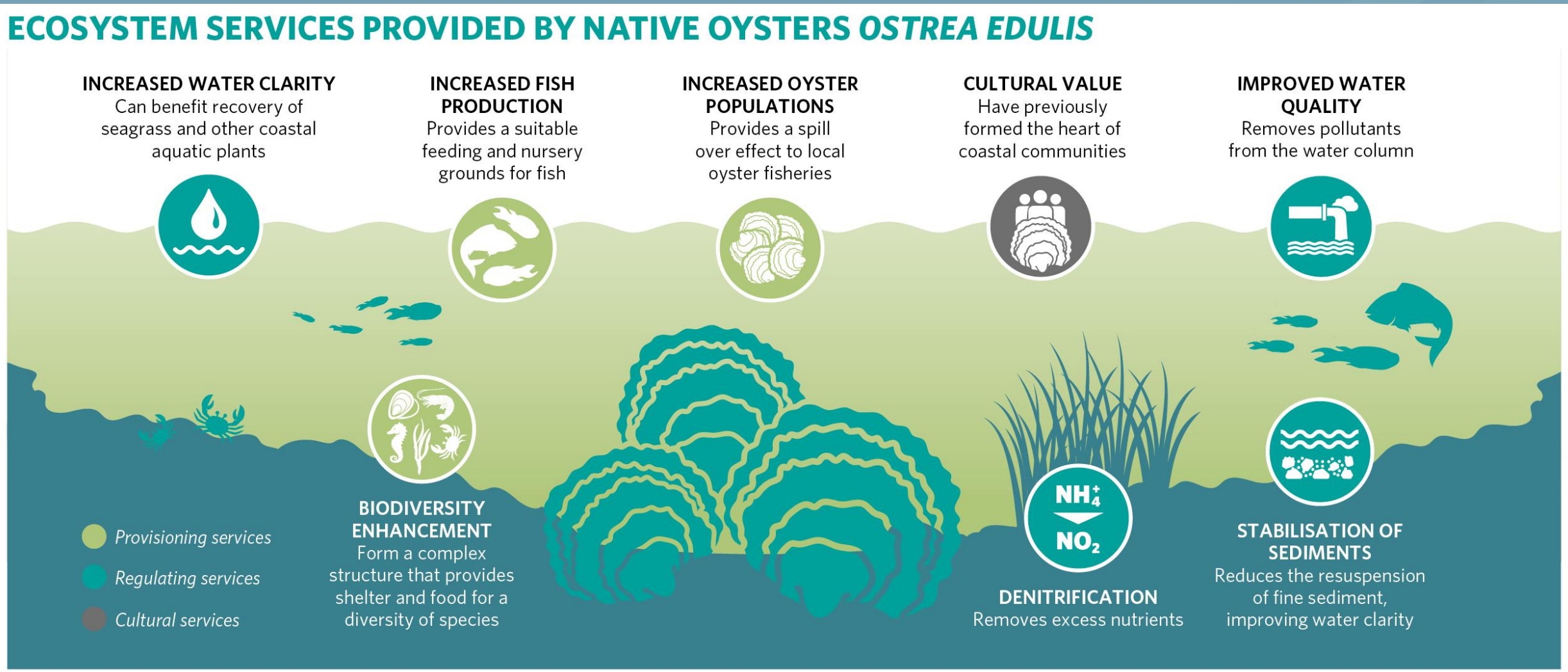
Why Restore Native Oysters



NATIVE OYSTER NETWORK UK & IRELAND | NORA

sea-changers

Methods of Restoration

- Broodstock limited
  - Not enough larvae produced by wild populations

- Recruitment Limited
  - Not enough suitable habitat for larvae to settle

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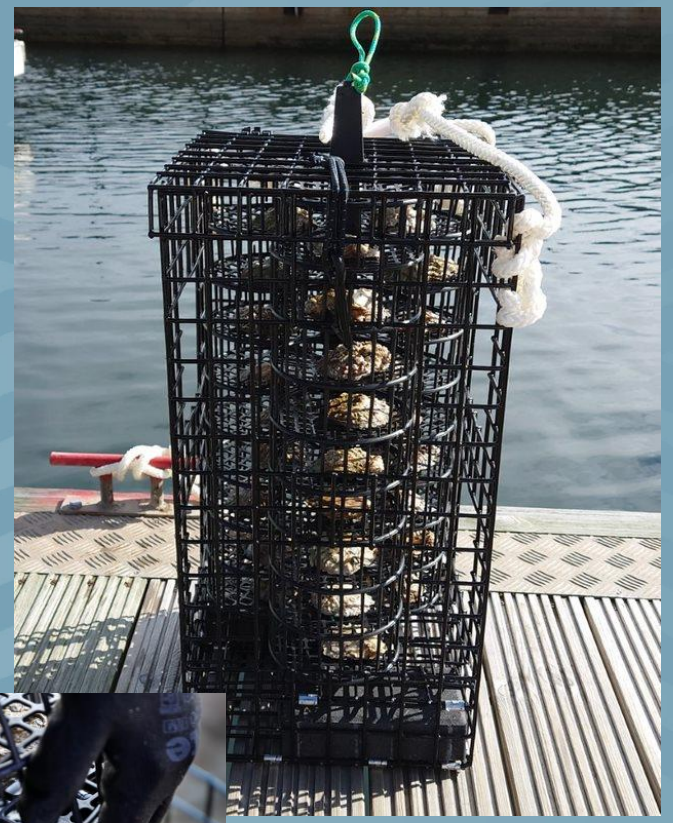
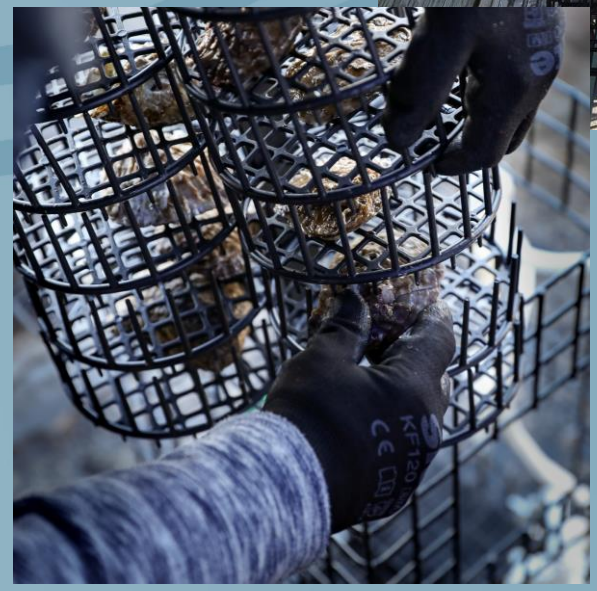
Increase Larvae Production

- 20 Oyster nurseries in Hartlepool Marina
- More than 600 Oysters
- A single oyster can produce 20 Million larvae a year





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Monthly Monitoring

- Checking for mortalities
- Biodiversity monitoring
- Monitor environmental conditions

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Increase Available Habitat

- Seabed restoration
- Deploy Cultch onto the seabed
- Provide suitable substrate for Larvae to settle
- Looking into Potential Cultch alternatives

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Spatting Ponds

- Keep spawning oysters and settlement material in a closed system
- Higher chance of larval development into Spat
- Deploy Spatted shell onto restored seabed

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Thank you!
Any Questions

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