Value of Ecosystem Services – Bivalves

Aquaculture for a Thriving Future

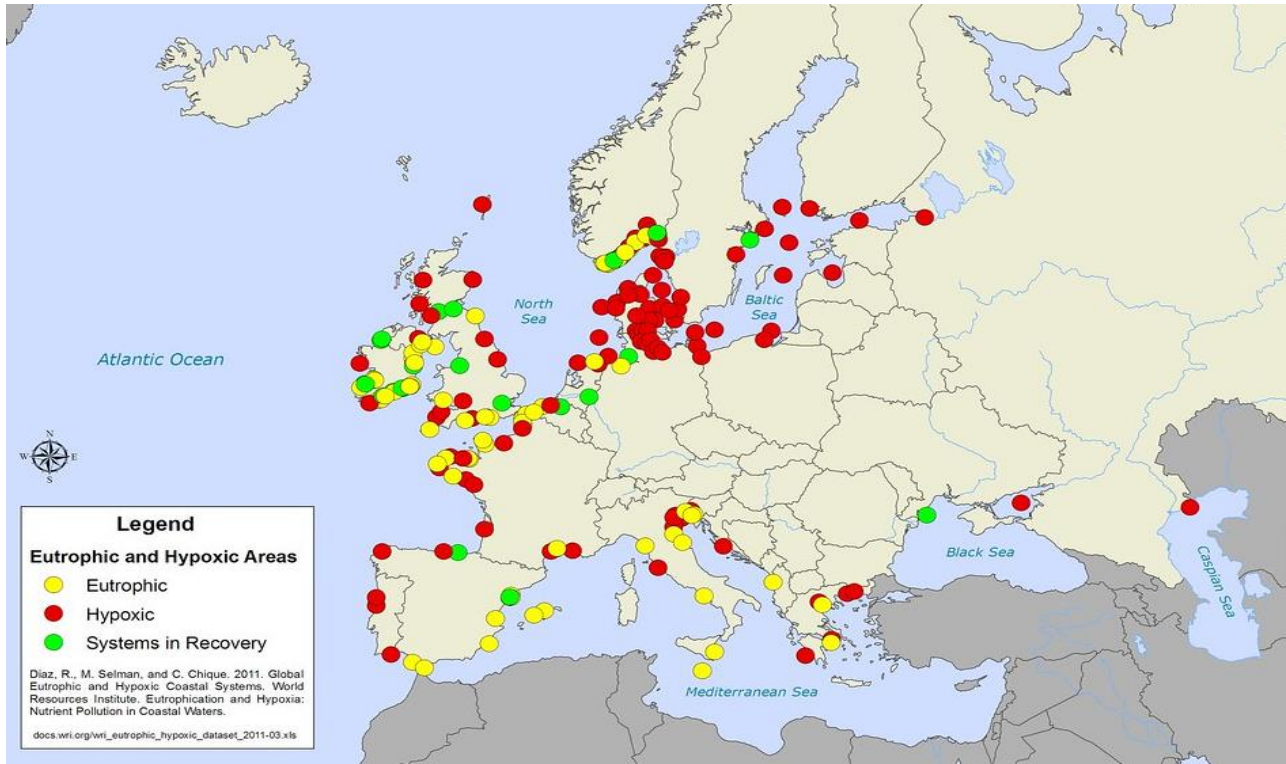
30 November 2023

Too much of a good thing: the problem with nitrogen

- Nitrogen is a building block for all life
- Excess nitrogen has been linked to a variety of problems: **algal blooms, loss of seagrass, low dissolved oxygen, fish death**
- As coastal populations increase, larger amounts of nitrogen are getting washed into our waterways

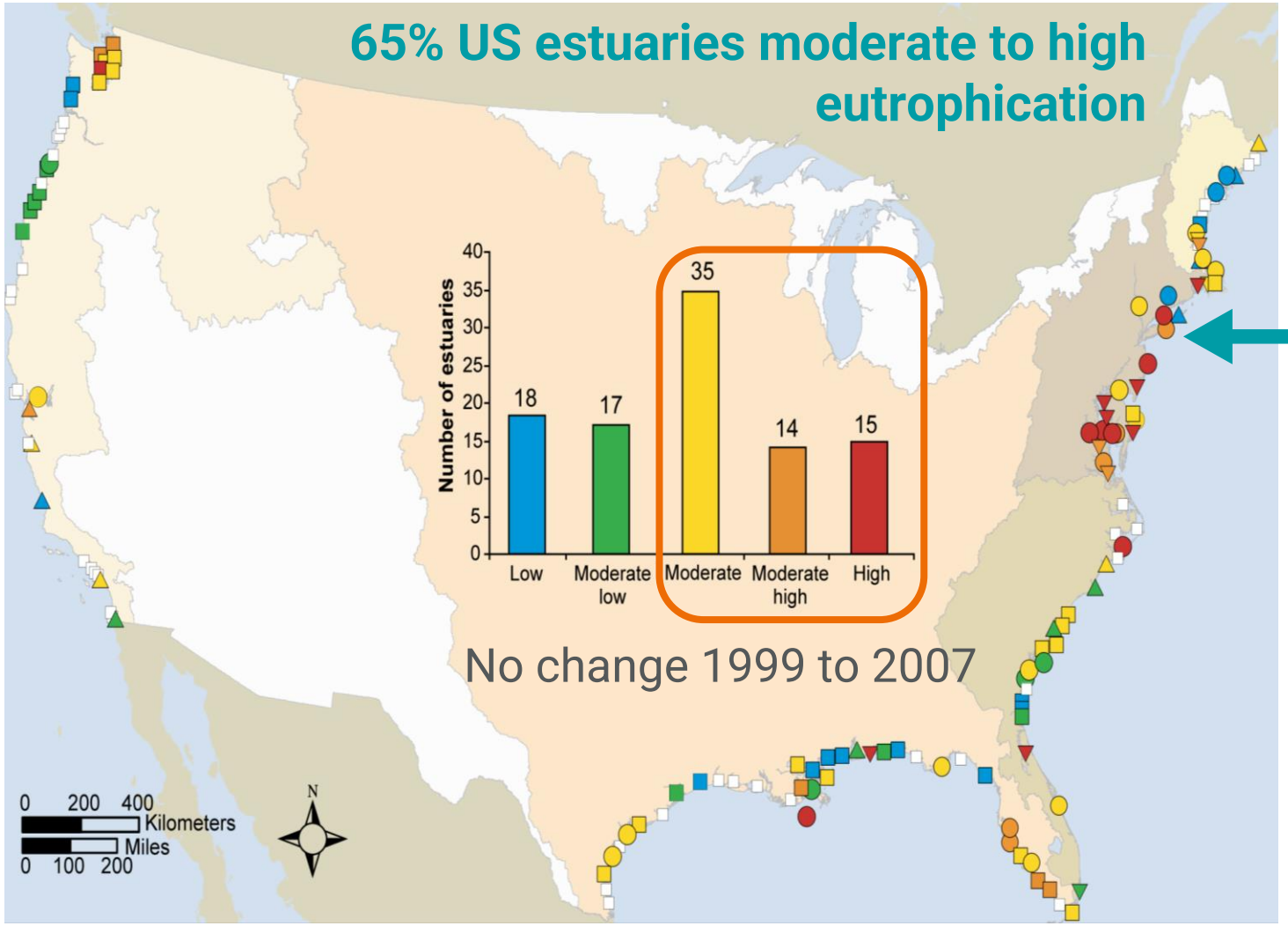
- **Global challenge**
- Major issue in **European** coastal waterbodies
  - Nutrient loading was reduced in recent years but additional nutrient management is needed.
- Nutrient reduction strategies focused on point-sources

Eutrophic and Hypoxic Coastal Areas of Europe



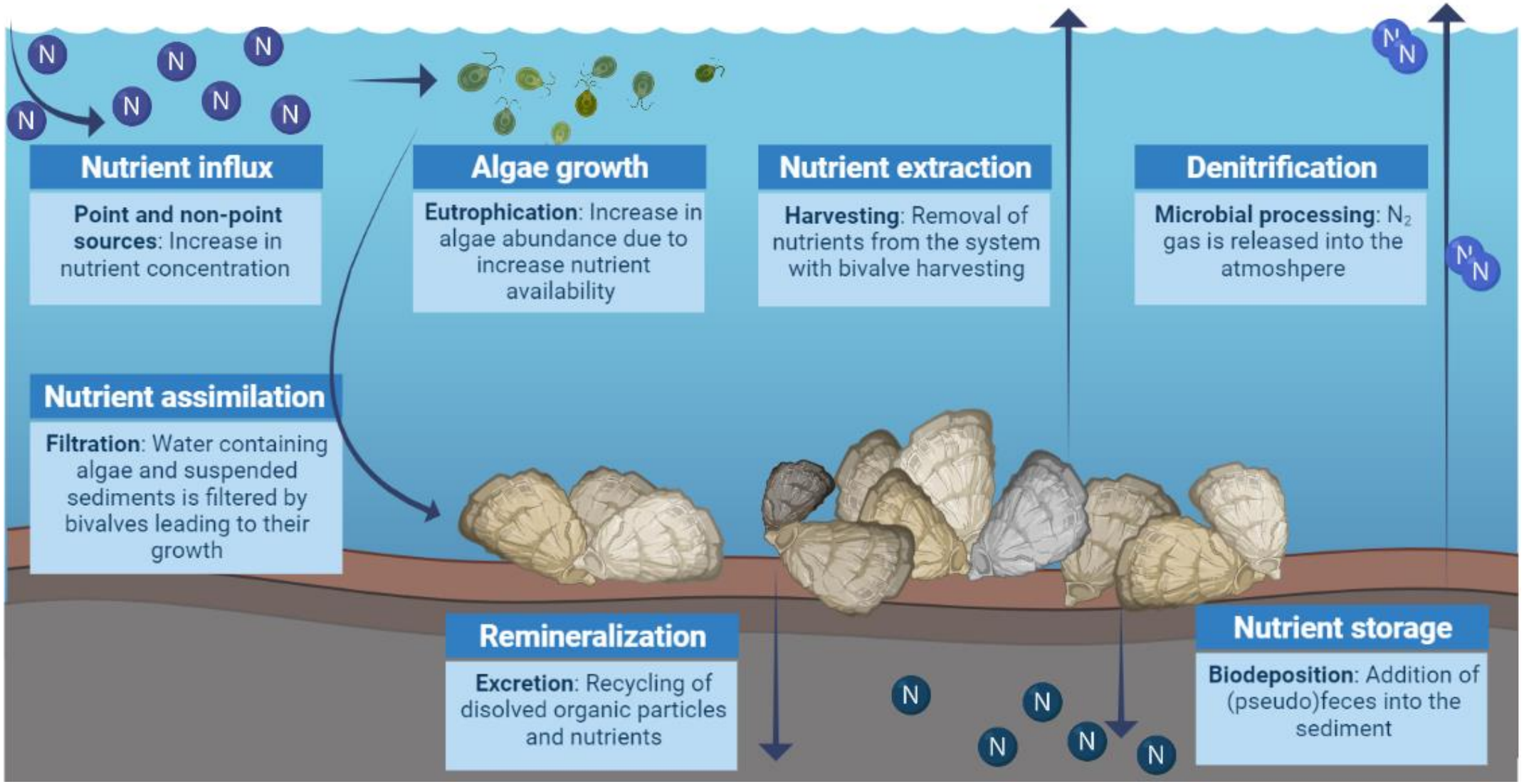
Eutrophication challenge

- Management has reduced inputs but impacts persist
- 65% of studied estuaries experience moderate to high eutrophication
- **Long Island Sound**
- N inputs were reduced by 40%
- Low dissolved oxygen problems improved
- With the population increase, improvements slowed considerably

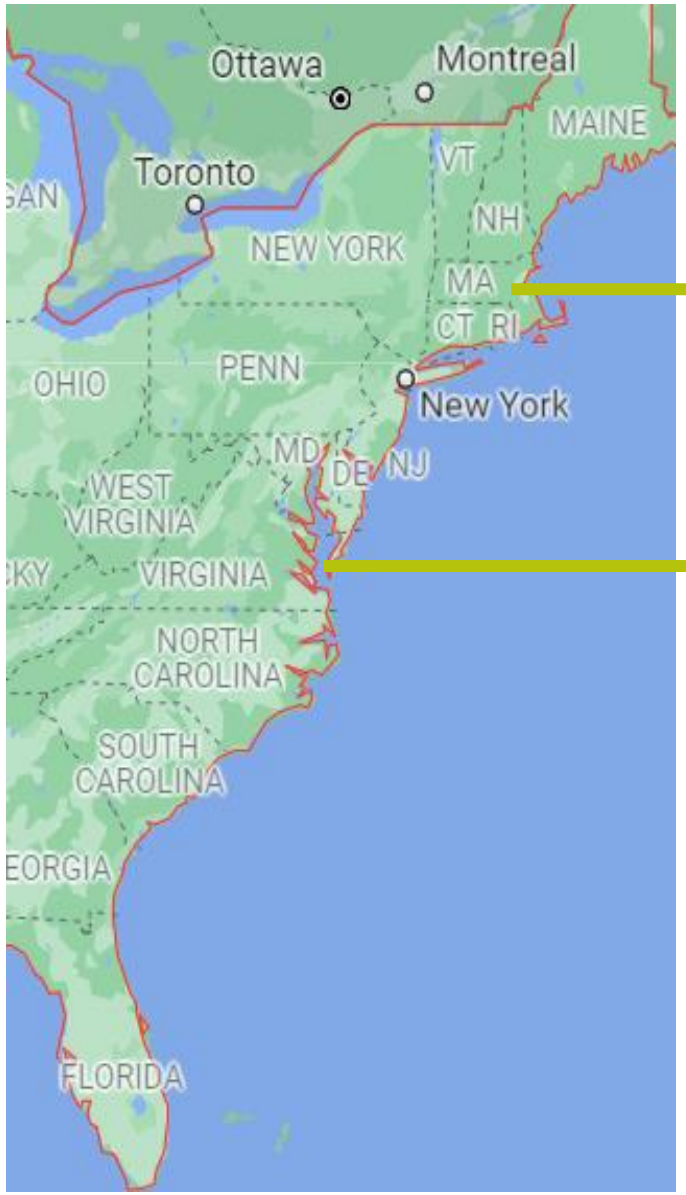


Shellfish can help by filtering plankton from the water

- Because shellfish can remove algae from the environment, states and municipalities would like to **include shellfish in their eutrophication management programs**



Nutrient credits and valuation in the US



Management "credits" for nutrient removal

Cape Cod, Massachusetts:
Oysters & clams, tissue & shell N content investigated (Reitsma 2017)
2017 clam harvest = **30%** required nitrogen reductions

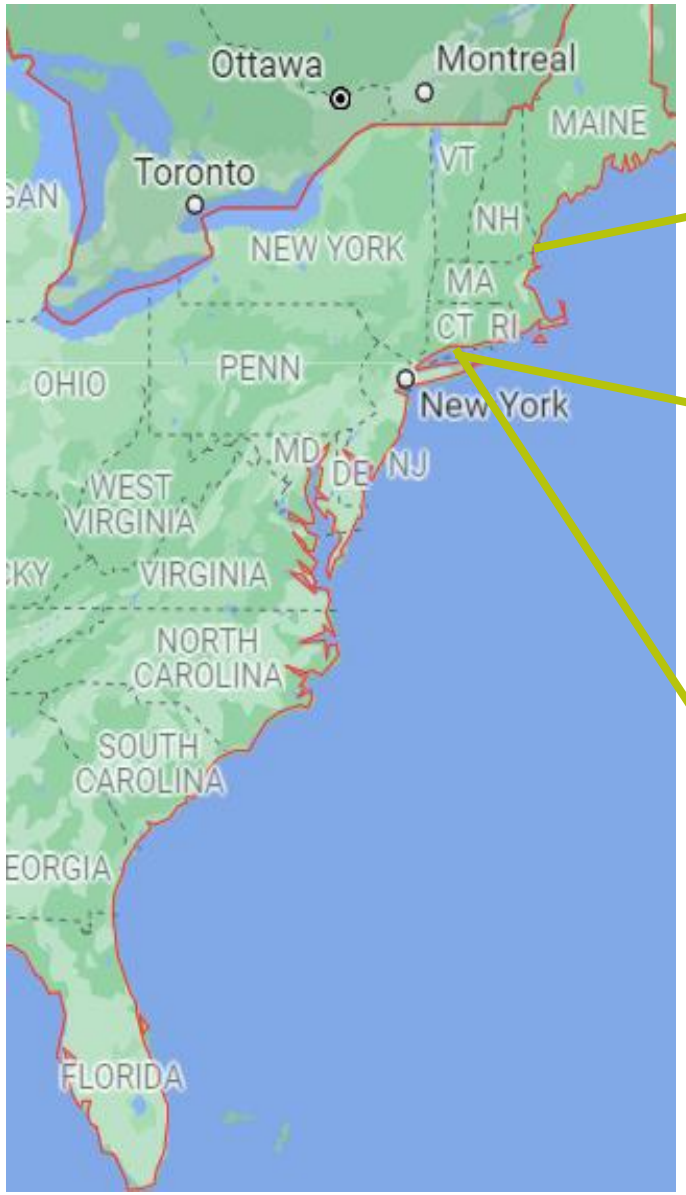
Northern Quahog,
Mercenaria mercenaria

Chesapeake Bay, Maryland and Virginia:
Oyster tissue, N & P content investigated (Cornwell 2016)
Tissue* of 1 million 7.62 cm diploid oysters = **90 kg N** and **10 kg P**
Denitrification BMP approved 2023 for Chesapeake Bay

Eastern Oyster,
Crassostrea virginica

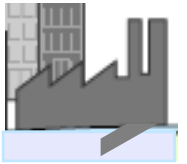
** Only tissue as shell are to be returned to the water*

Nutrient credits and valuation in the US



Economic value = costs saved

Great Bay Piscataqua, New Hampshire:
avoided WWTP costs = **$92,000 - $105,000**



Eastern Oyster,
Crassostrea virginica

Greenwich Bay, Connecticut:
avoided WWTP, Ag & Urban BMP costs = **$2.3 million - $5.8 million**

Eastern Oyster,
Crassostrea virginica

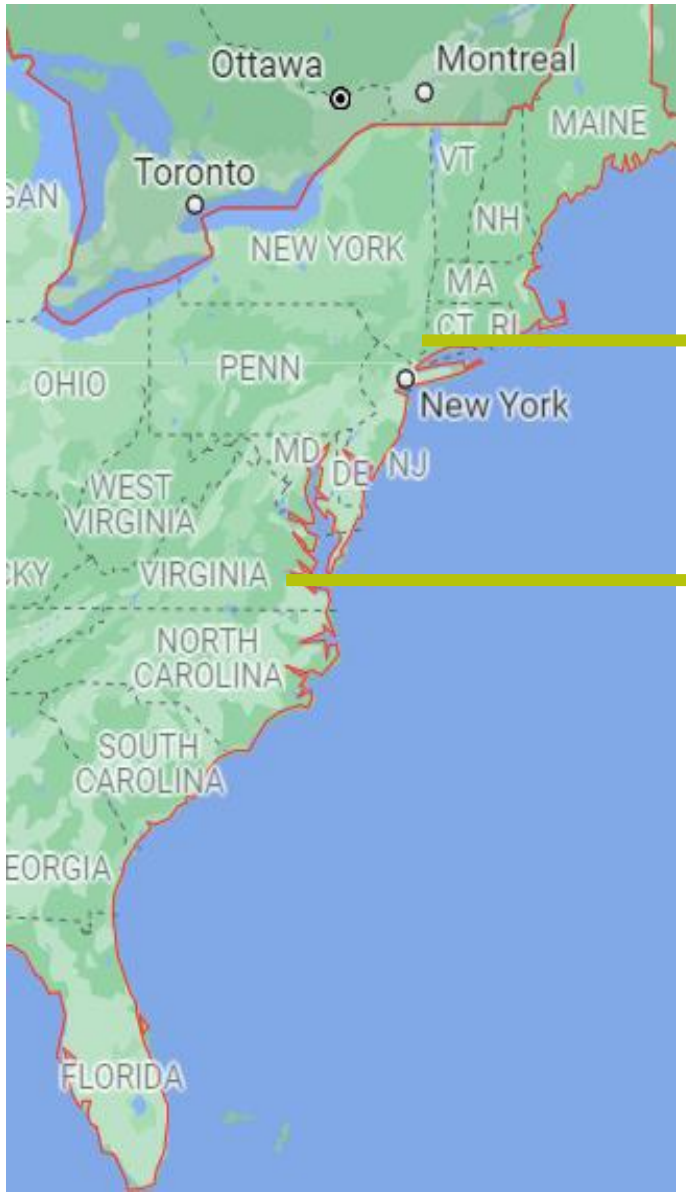
+

Northern Quahog,
Mercenaria mercenaria

Long Island Sound, New York and Connecticut:
avoided WWTP, Ag & Urban BMP costs = **$8.5 million - $230 million**

Eastern Oyster,
Crassostrea virginica

Nutrient credits and valuation in the US



Nutrient credit trading program compensation = costs paid

Connecticut Nitrogen Credit Exchange
2018 credit price = $14.81

Virginia Nutrient Credit Exchange
2018 credit price = $8.33

1 credit = 1 Kg N removed

Seafish work on bivalve water bioremediation

Previous evaluation (for UK region) done at:

- Valuing oyster beds in the Solent (Plymouth Marine Laboratory) | Watson et al. 2020
- Shellfish in nutrient management at Dundrum Bay | GAIN 2021

GAIN
Green Aquaculture Intensification

- How much N can bivalves remove from their environment on a UK scale?
  - **Two analyses**:
    - **Proximate analysis** (nutrient content of bivalves * production of bivalves)
    - **Modelling** using FARM population model

- **Area**: England, Northern Ireland, Scotland, Wales
- **Organisms**: Commercially important bivalves
  - Mussels (*Mytilus edulis*)
  - Oysters (*Crassostrea gigas*, *Ostrea edulis*)
  - Clams (*Tapes philippinarum*)

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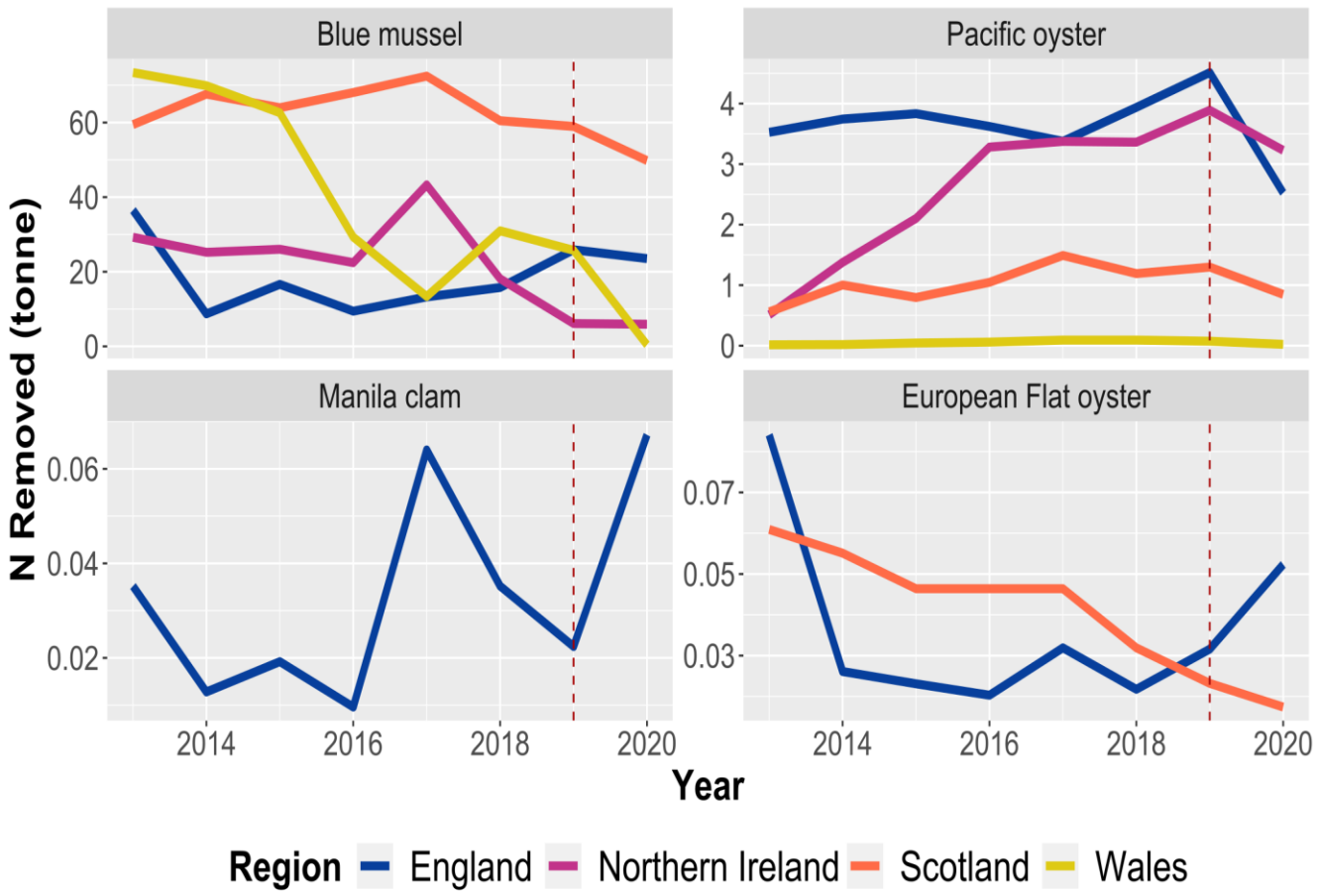
Proximate analysis results (N * Production)



- % of N in Total Fresh weight (mean)
  - **Mussels – 0.88 %**
  - Pacific oyster – 0.37 %
  - Native oyster – 0.29 %
  - Manila clam – 0.32%
- Total Nitrogen Removed (*2019*) – **126.57 t**
  0.034 %
- Total Nitrogen loading into the UK seas (*2014*):

Country	N-Total input [t]
England	266 088.31
Northern Ireland	9 206.83
Scotland	72 305.60
Wales	21 561.33
Grand Total	**401 427.00**

- Based on shellfish production data 2015 -2020 data from Cefas

NTB – Different Y scales

Value of bivalve water bioremediation

- What is the potential economic value of the water quality improvement services provided by bivalves?
- Value estimated based on the cost of alternative N removal strategies (avoided cost)

(not the compensation paid to growers)

- **N removal through sand filters and Methanol dosing (Wessex Water data):**
  - £58,300 / tonne of N removed annually
  - Estimated saving – £7,379,031 annually

Total N Removed by shellfish (2019)
126.57 tonnes

- **Replacement and Abatement:**
  - £ 295,000 /tonne of N removed annually (average)
    - Estimated saving – £37,241,150
  - £ 500 -1,100,000 /tonne of N removed (min-max)
    - Estimated saving – £63,285 – 139,227,000

Thank you

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