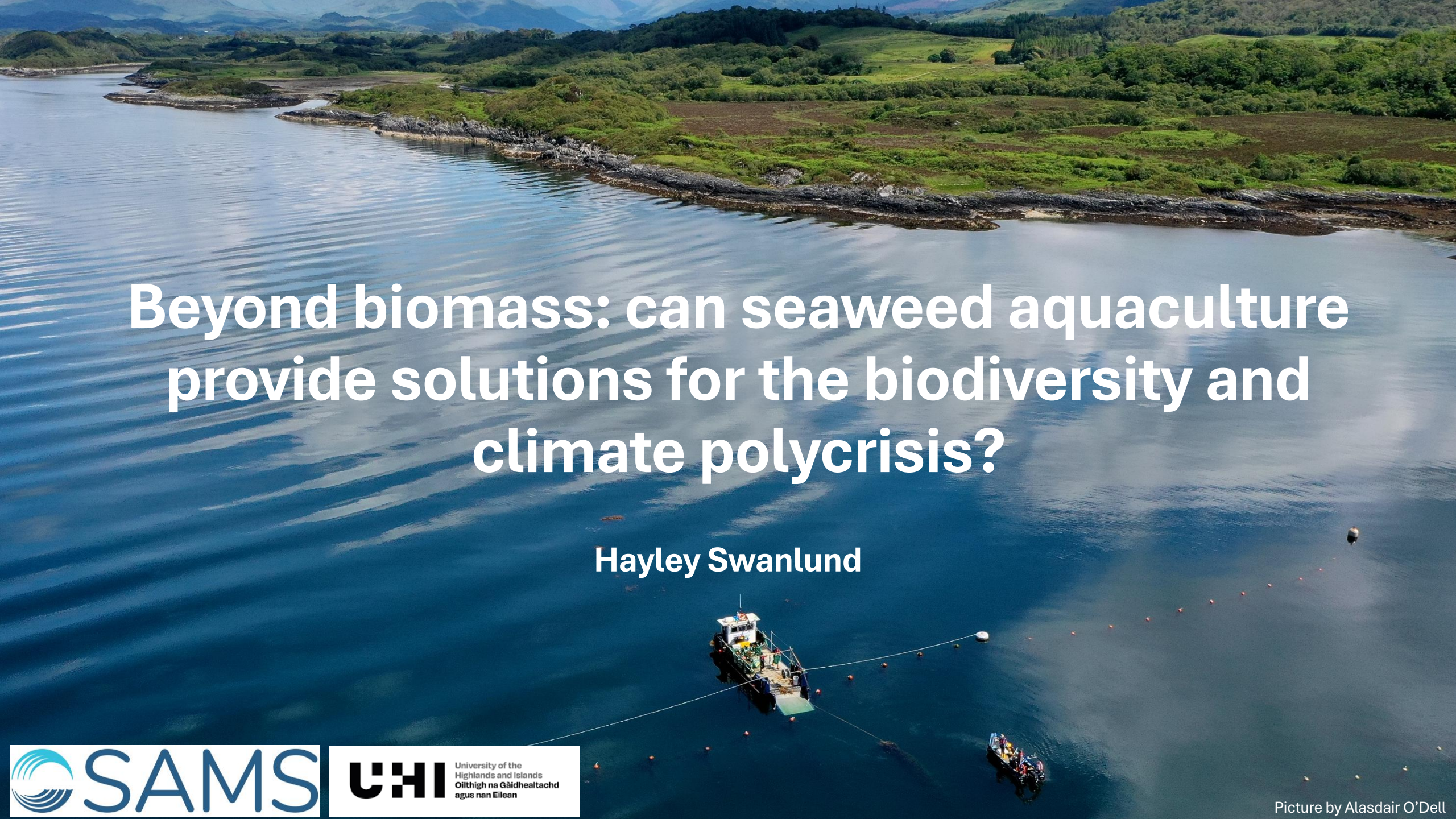




Beyond biomass: can seaweed aquaculture provide solutions for the biodiversity and climate polycrisis?

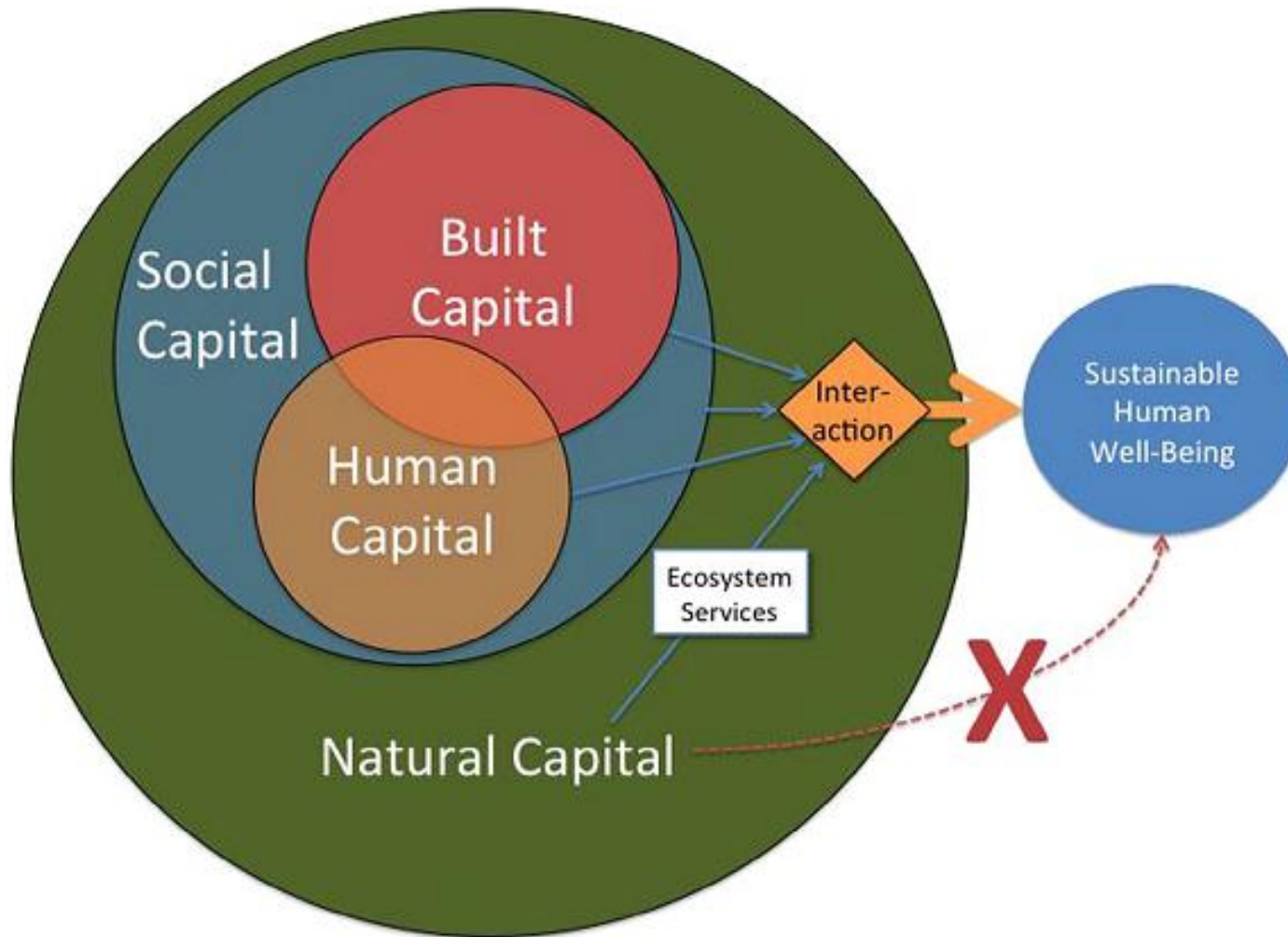
Hayley Swanlund

Ecosystem service:

“the benefits people obtain from ecosystems” (MEA, 2005)



Ecosystem services and natural capital



Ecosystem services of seaweed aquaculture

CICES category of ecosystem service	Ecosystem services associated with seaweed farming
Provisioning	• Foods and supplements • Feed ingredient • Thickening agent • Fertilizer • Medicinal resources • Biofuel
Regulating and Maintenance	• Climate regulation • Habitat provision • Water quality regulation • Coastal protection
Cultural	• Science and education • Recreation and ecotourism • Creation of jobs • Cultural heritage for coastal communities

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Review Article

A Review and Meta-Analysis of the Ecosystem Service Enhancement from Seaweed Aquaculture: Limited Evidence to Support Climate and Biodiversity Gains

Hayley Swanlund , Michael T. Burrows , Jeffrey Fedenko , Alasdair O'Dell  & Adam D. Hughes  

Published online: 02 Apr 2026

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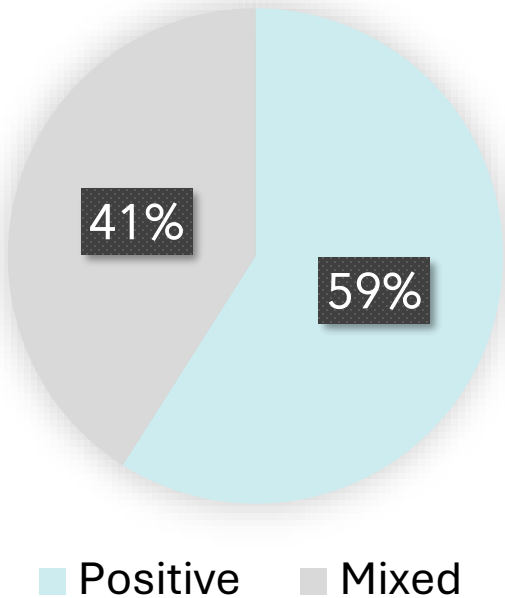
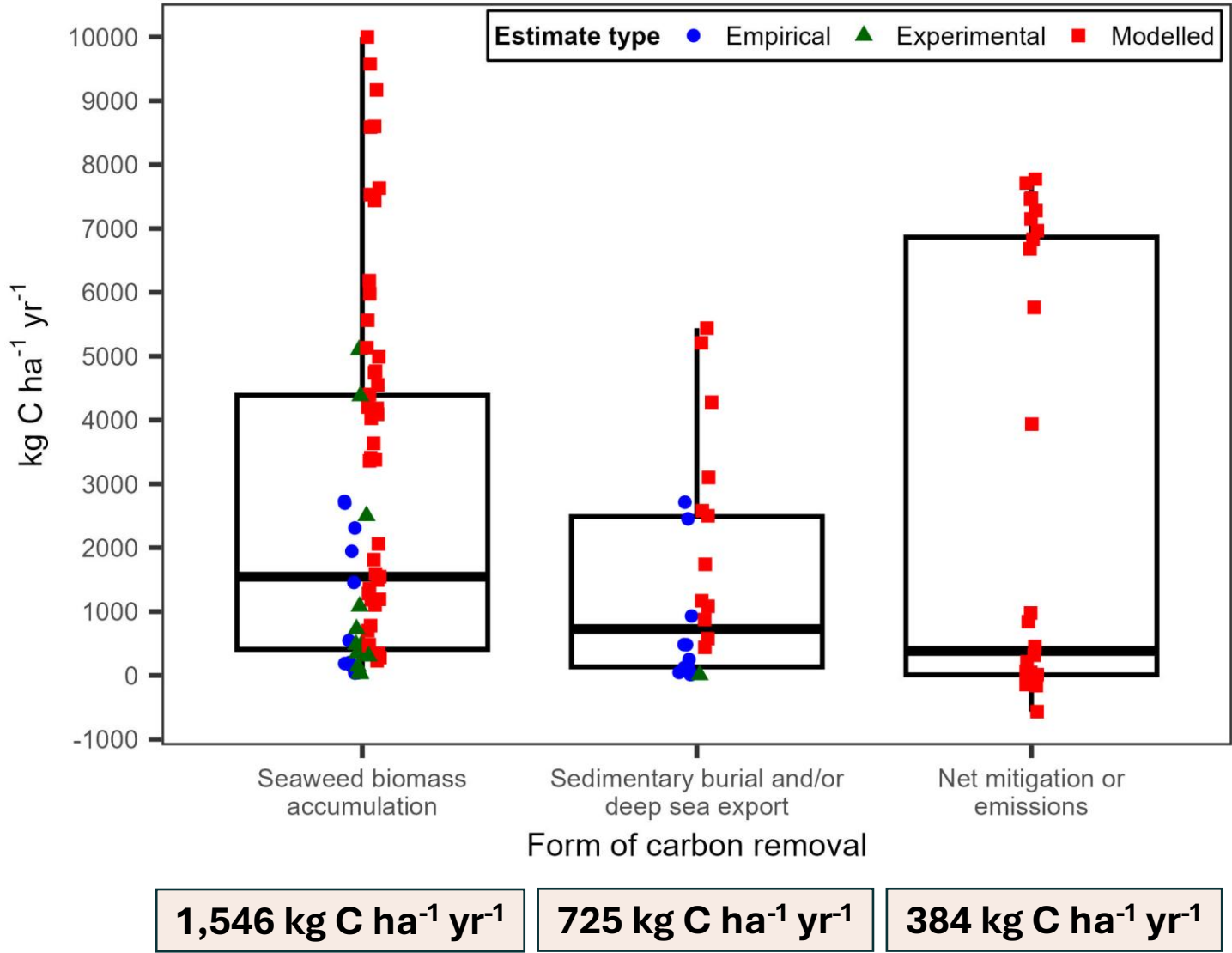
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Seaweed aquaculture shows limited evidence of climate and biodiversity benefits, global meta-analysis finds

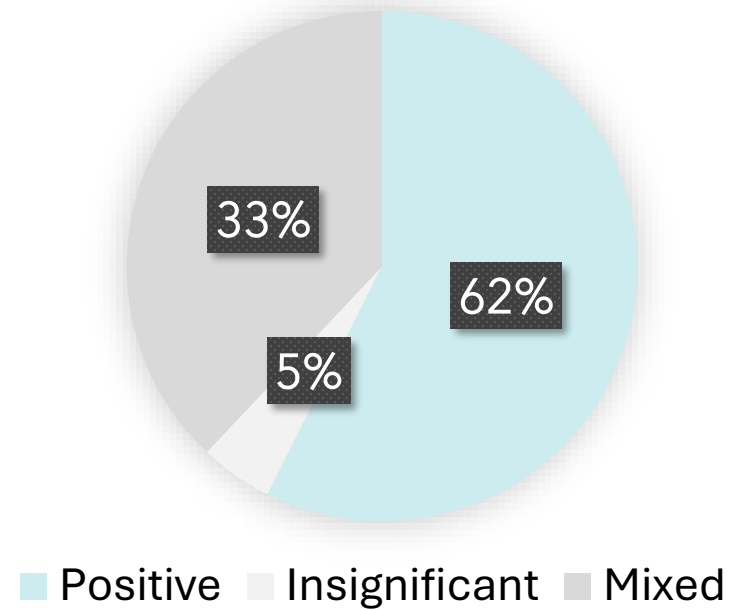
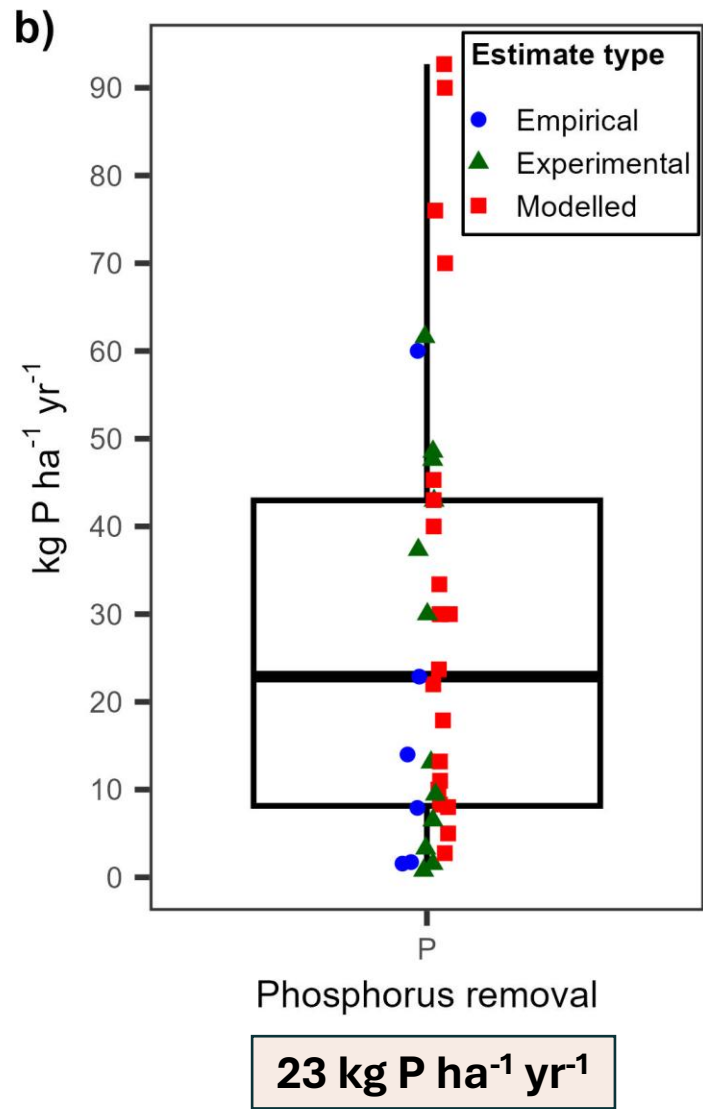
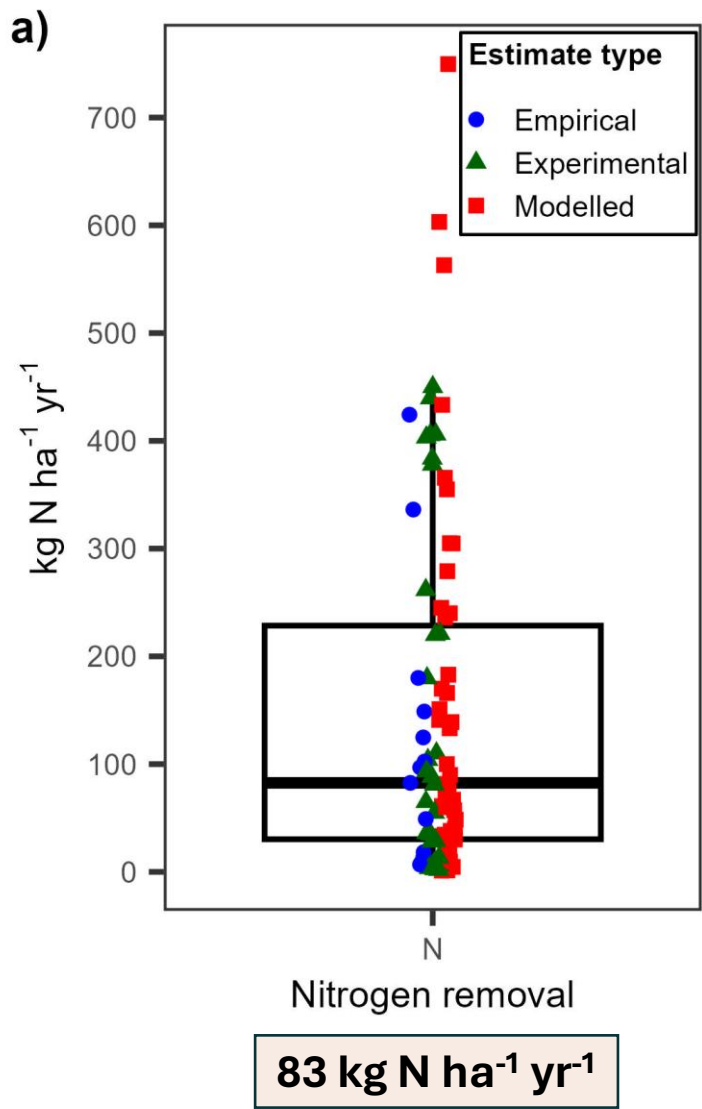
UK, 13 April 2026 | A review of 134 studies challenges the dominant narrative around seaweed farming as a climate solution



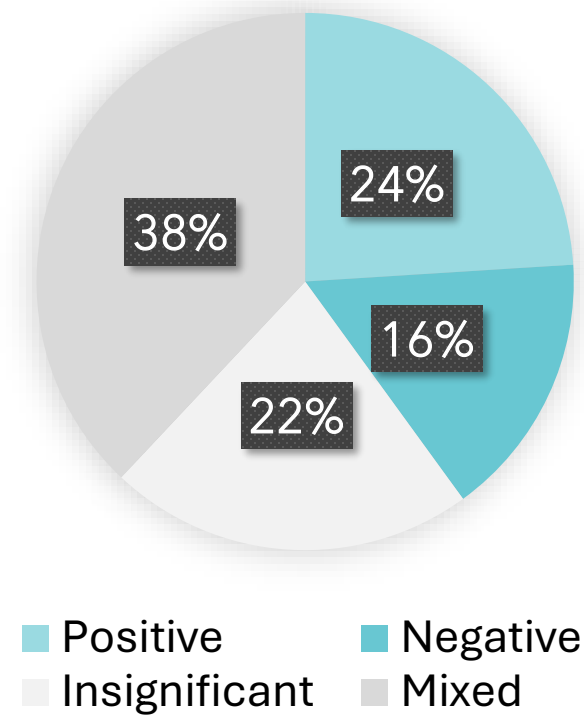
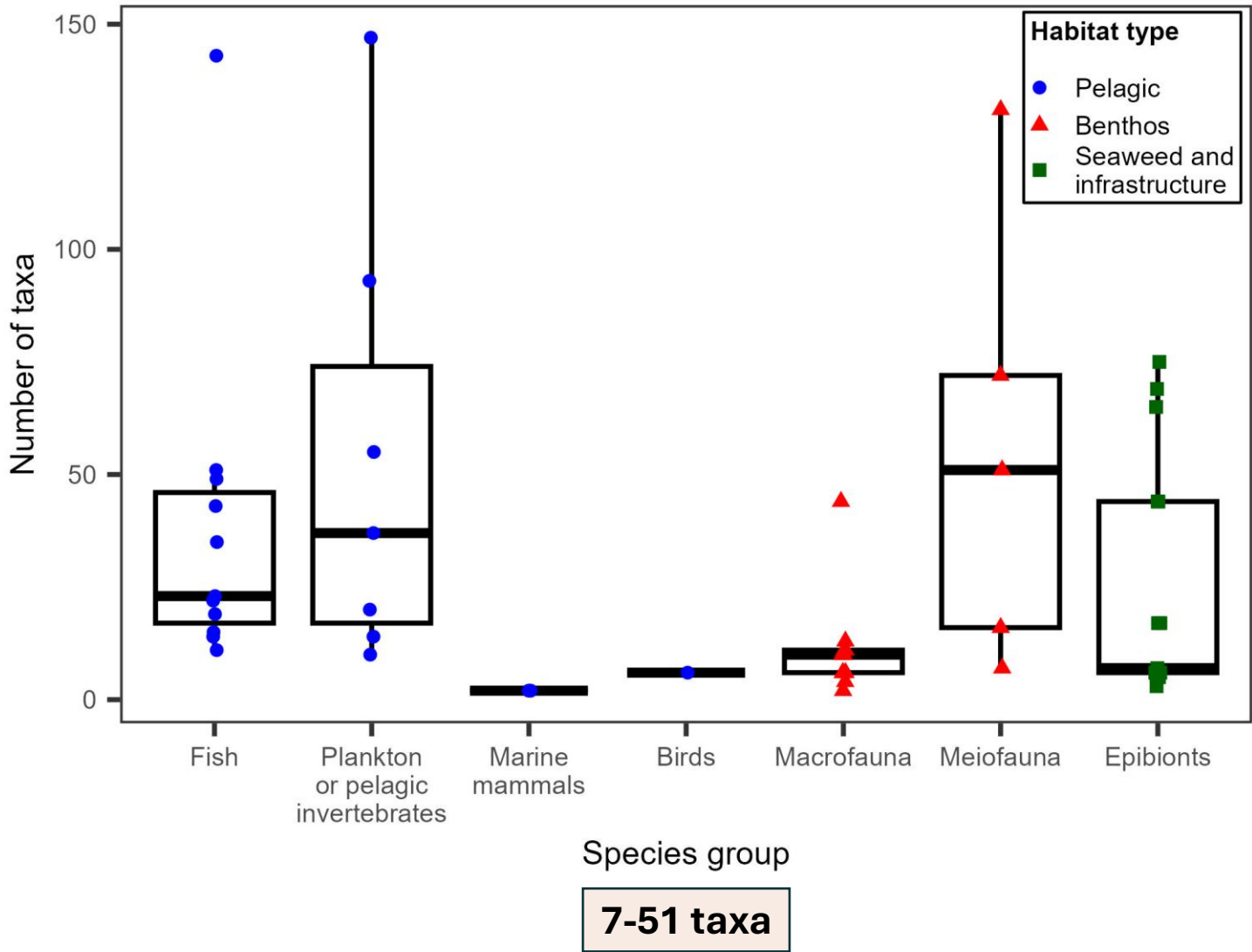
Climate regulation



Water quality regulation



Habitat provision



Conclusions – what does the current evidence say?



Climate regulation: **Not enough evidence** to currently support enhancement, given the **complexities** of carbon sequestration and receipt of benefits across varying spatiotemporal scales

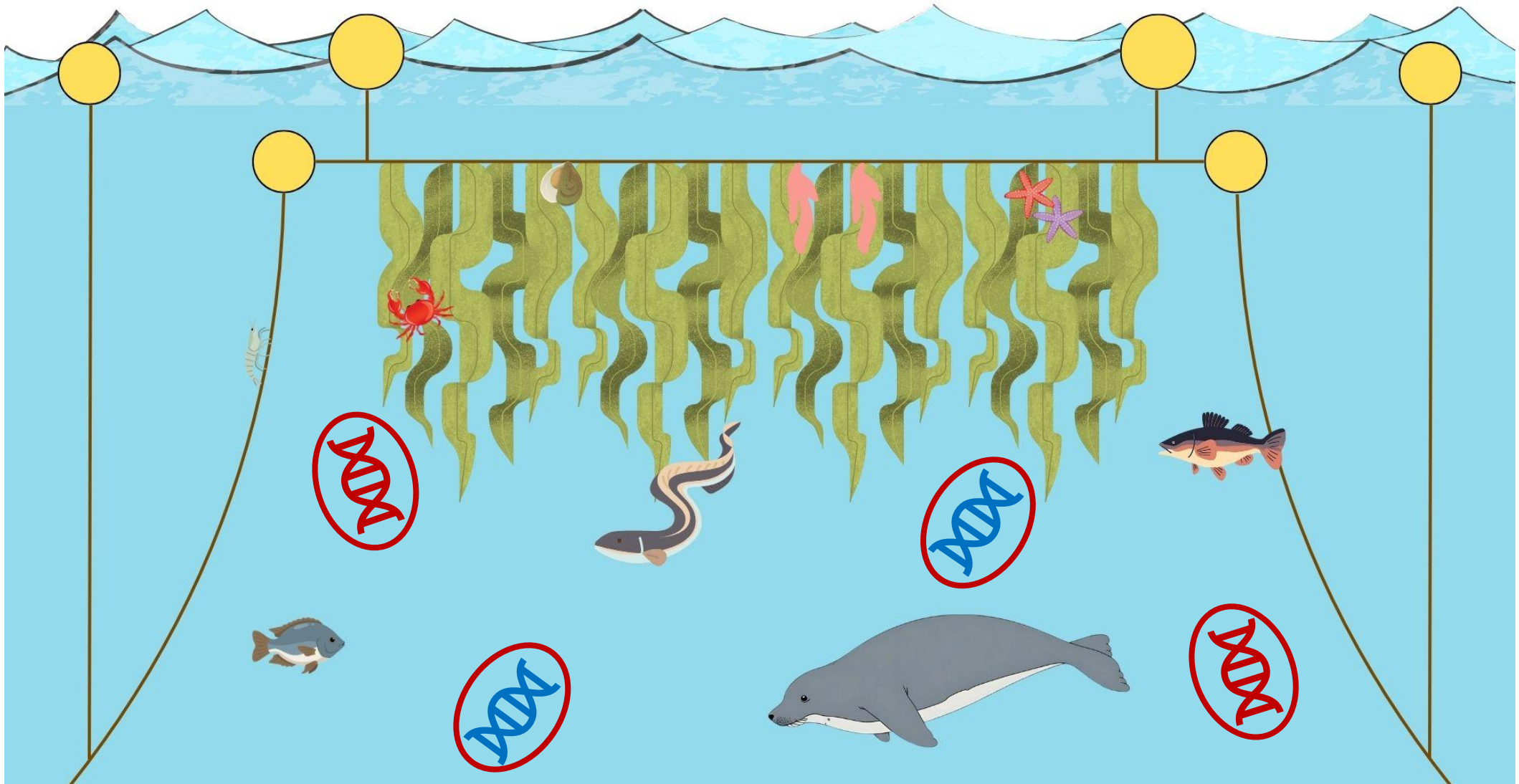


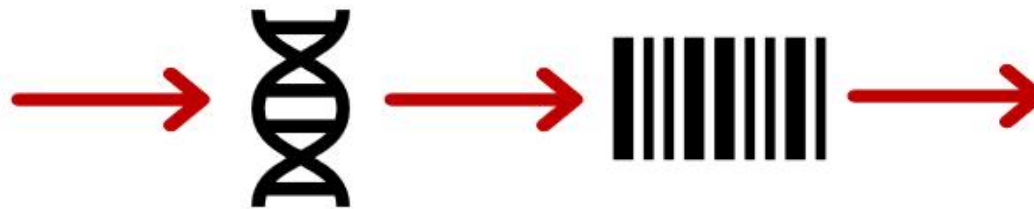
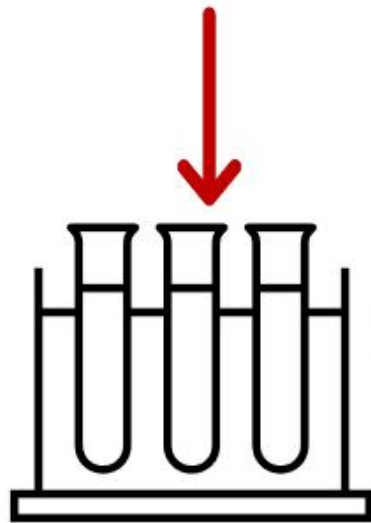
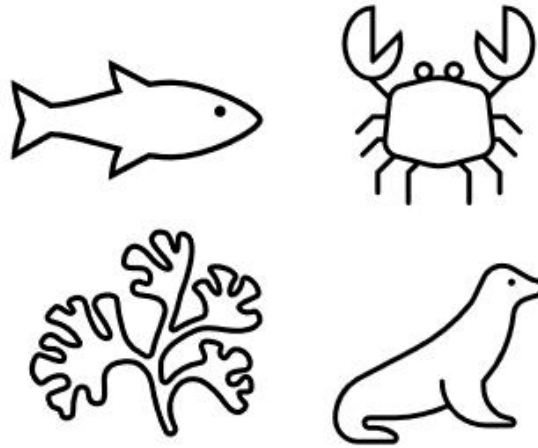
Water quality regulation: **Good evidence** for nutrient removal from the immediate environment, but the wider effects remain **unclear**



Habitat equivalence: **Insufficient data** to conclude biodiversity enhancements or provision of habitats comparable to natural equivalents

Method: Environmental DNA (eDNA)





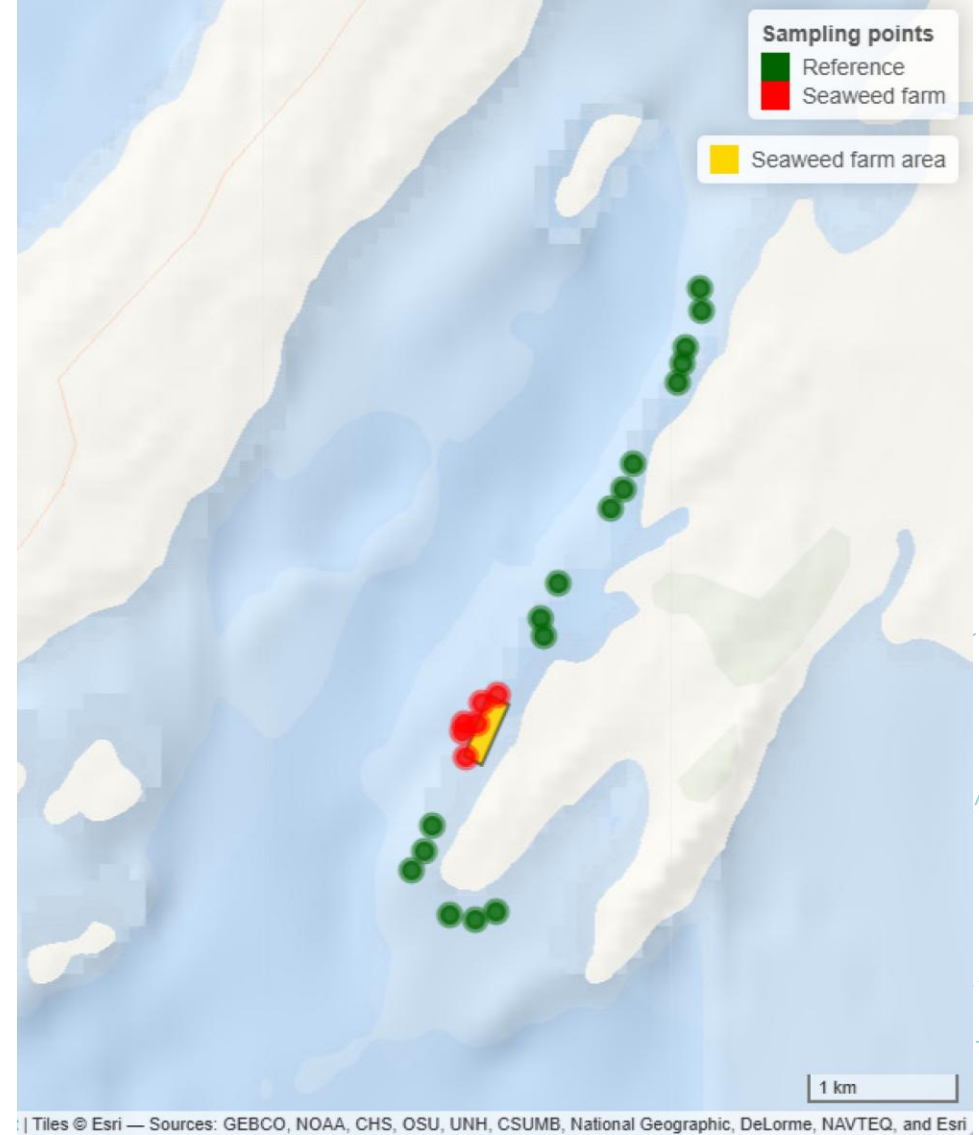
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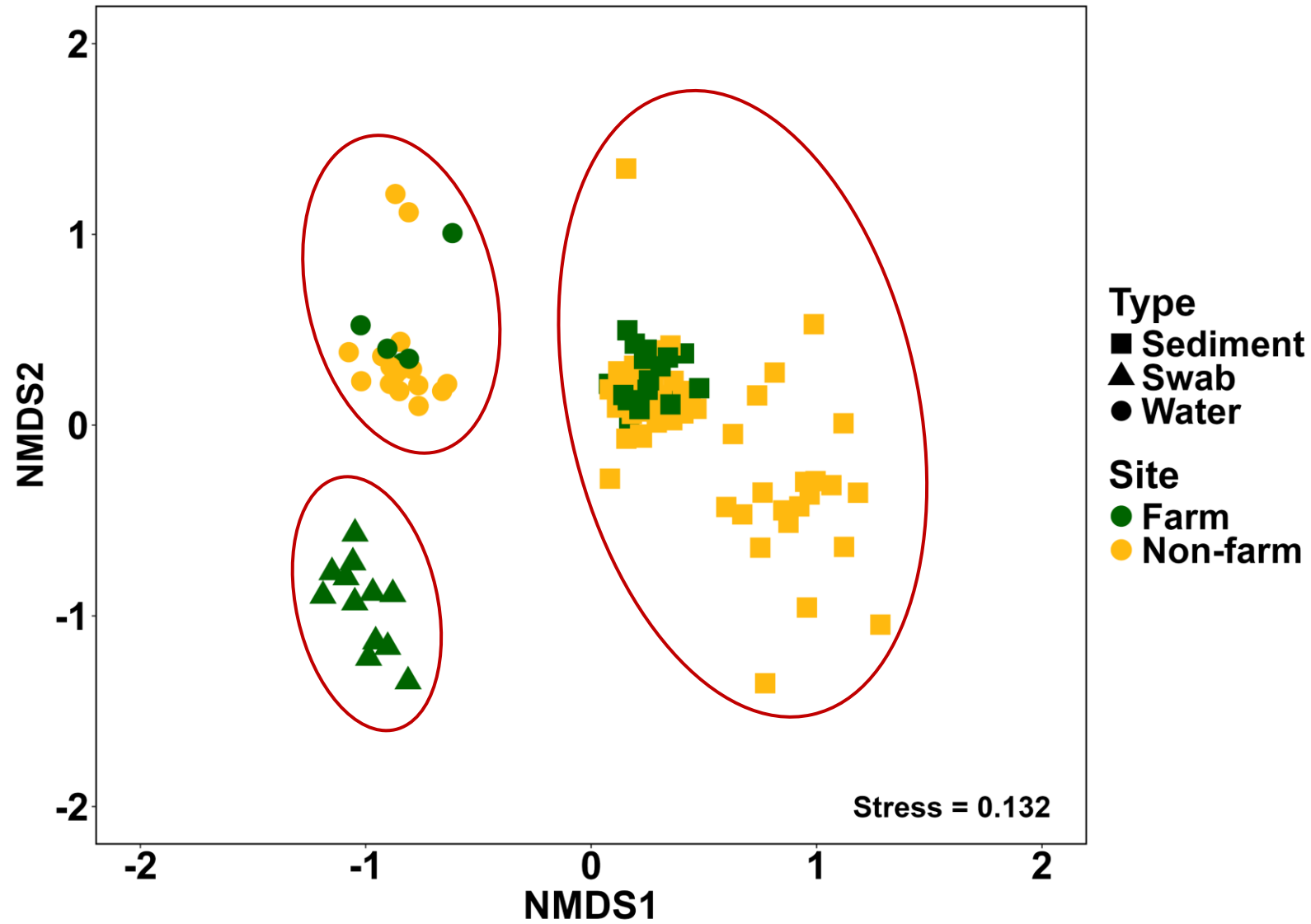


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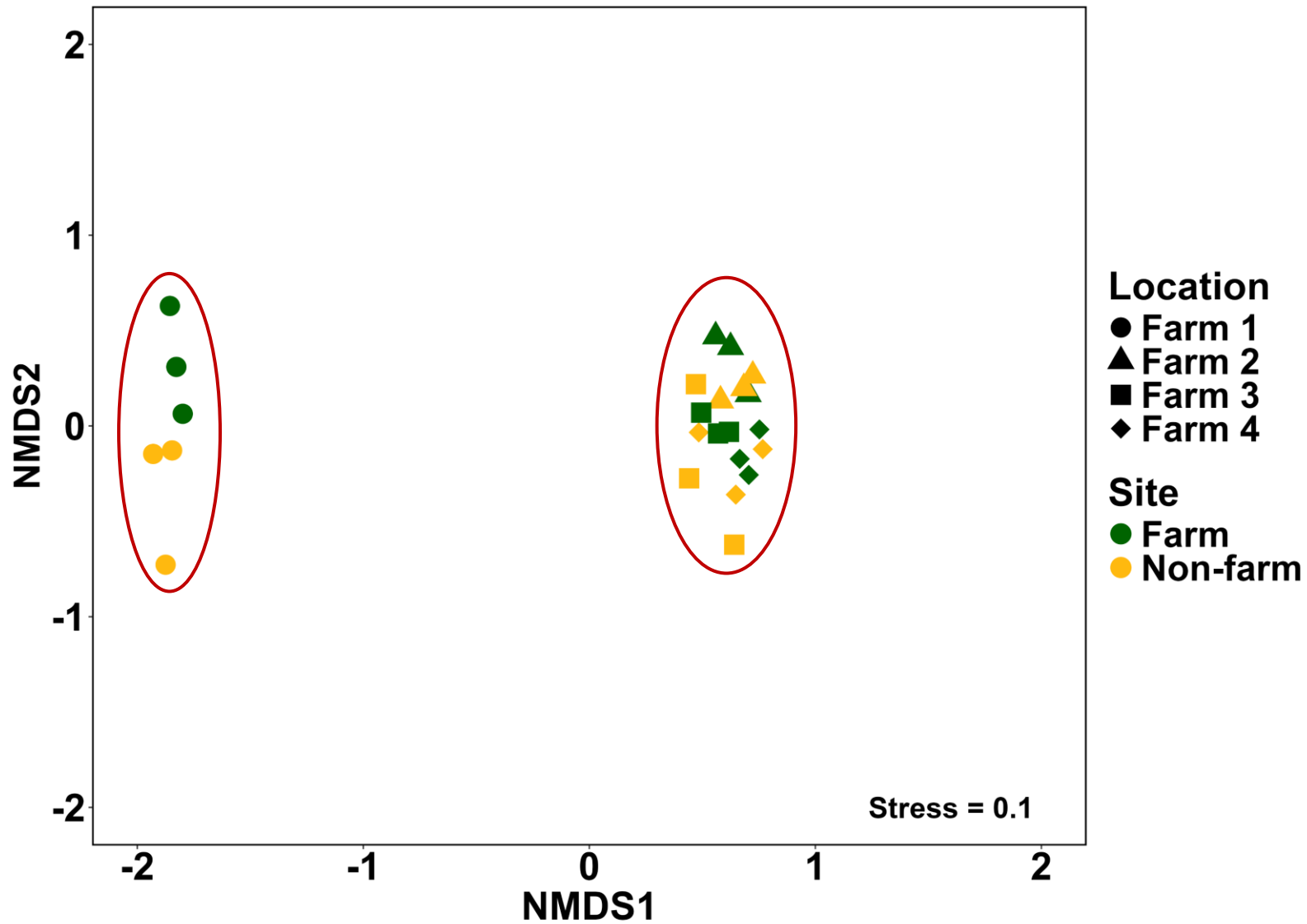
3





Significant differences in community composition in sediment samples between **sites** ($F = 3.7$, $p = 0.0001$ (COI); $F = 1.9$, $p = 0.042$ (18S)).

Figure. Non-metric multidimensional scaling (NMDS) plot based on Jaccard dissimilarity of family-level presence/absence data.

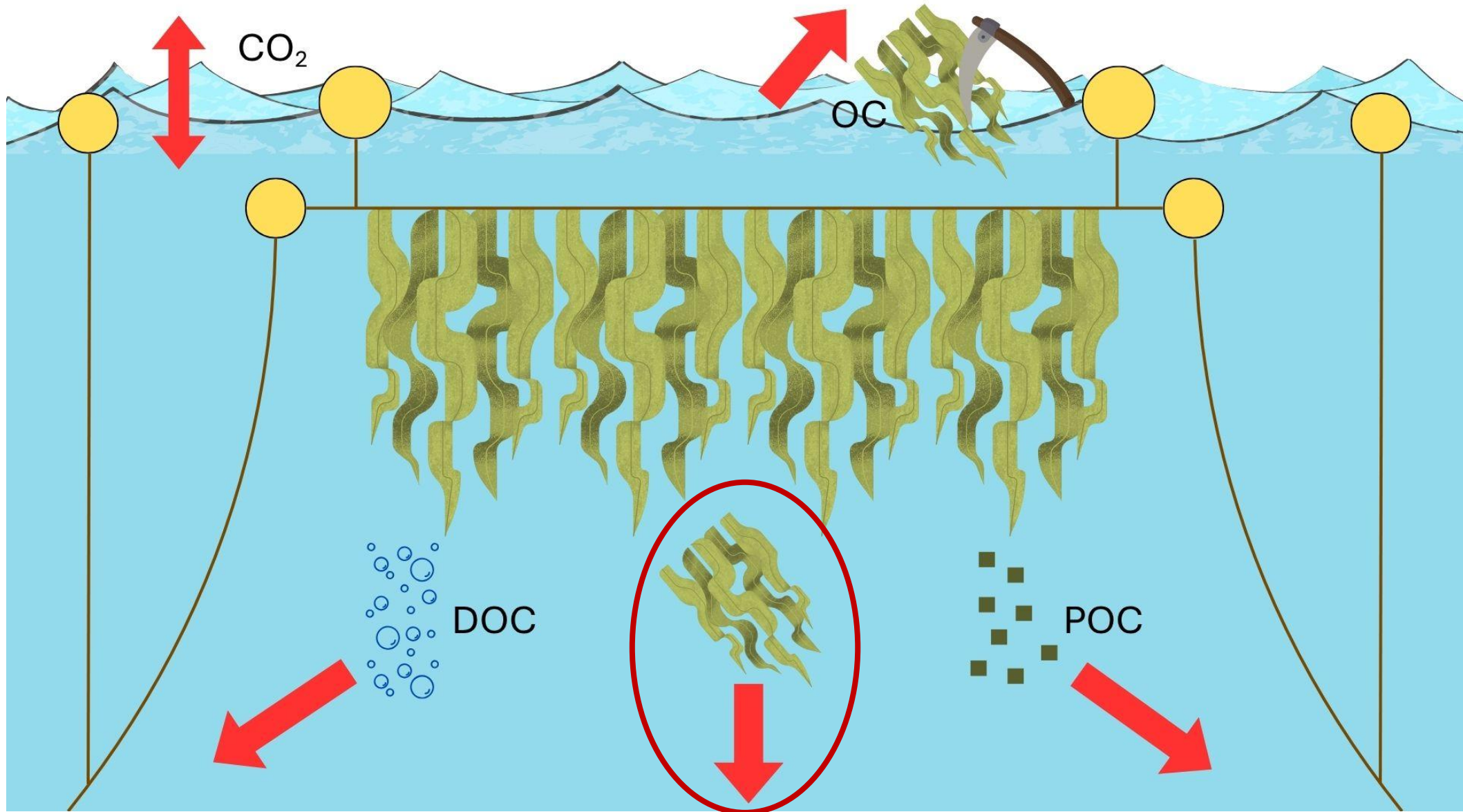


Significant differences in community composition between **locations** ($F =$, $p =$ (COI); $F =$, $p =$ (18S)), but not between sites.

Older farms were associated with more diverse communities ($r_s(10) = 0.79$, $p = 0.0025$).

Figure. NMDS plot based on Jaccard dissimilarity of family-level presence/absence data.

Method: Sedimentary carbon quantification

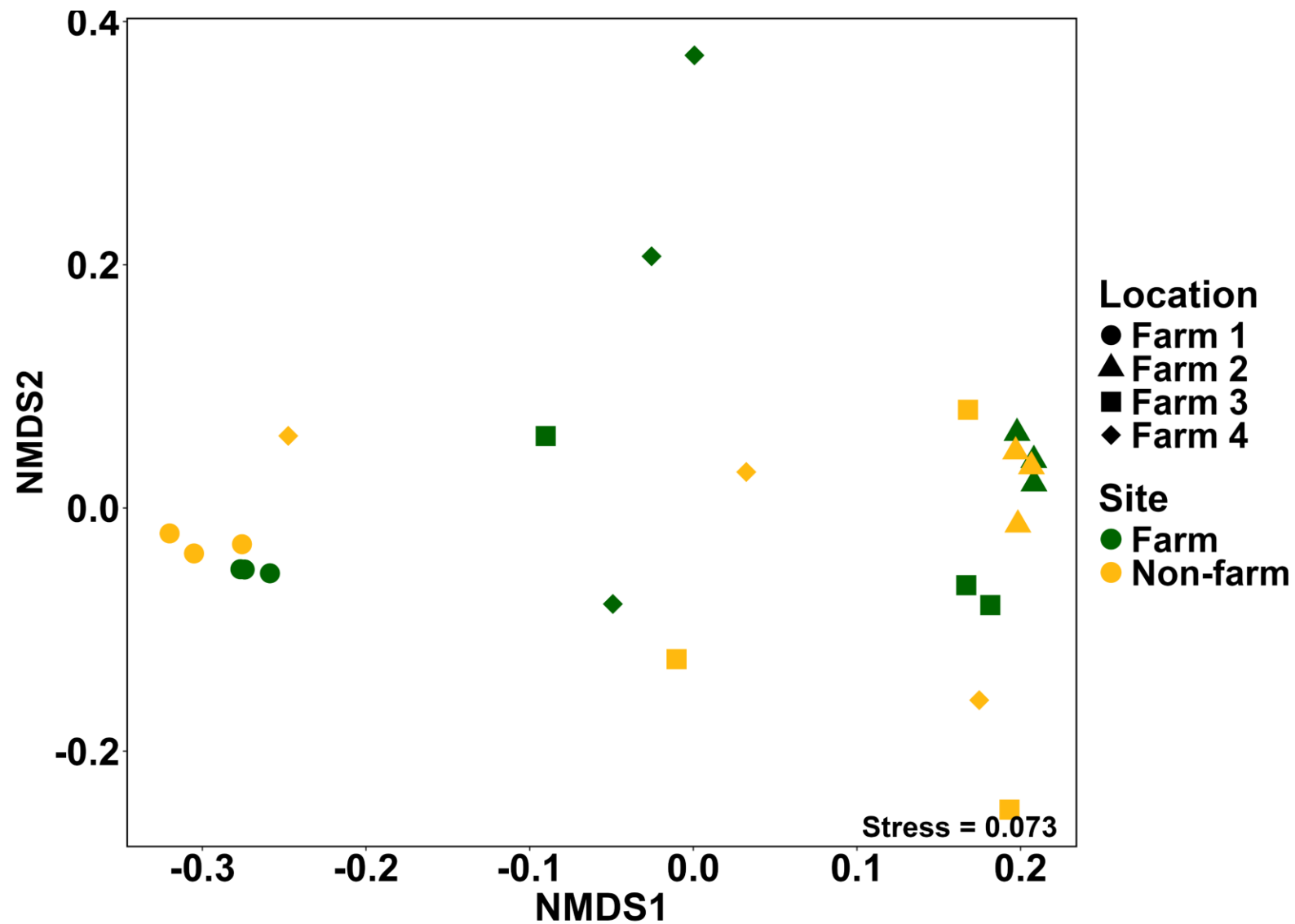


Biomarkers and carbon measures



1. Phaeophyceae DNA concentration
2. *S. latissima* DNA concentration
3. Organic matter content
4. Organic carbon content
5. C/N
6. $\delta^{13}\text{C}$





Significant differences between **locations** ($F(3,37) = 30, p = 0.001$) but not between sites overall ($F(1,37) = 0.57, p = 0.55$).

Figure. NMDS plot based on Gower's distance for $\delta^{13}\text{C}$, % OC, OC:N, % OM, Phaeophyceae DNA concentrations and *S. latissima* DNA concentrations.

Conclusions

- Seaweed aquaculture has the capacity to enhance ES, but this enhancement is highly variable and context-specific
- Study of UK farms showed differentiation in farm locations captured by methods used, but natural variation was larger than the impacts of the farms
- Evidence of no negative impacts – biodiversity and climate ES as a potential co-benefits to biomass production
- Need for standardisation of MRV to inform ES market development

Thank you

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Michael Burrows
Jeffrey Fedenko

NERC Environmental Omics Facility (NEOF)

National Environmental Isotope Facility (NEIF)

Scottish Universities Environmental Research
Centre (SUERC) - Centre for the Isotope Sciences

Participating seaweed farms

UHI Aquaculture Support Scheme



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