Offshore Wind Energy (OWE) Seabed Footprint: An eNGO Perspective

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SEAS AT RISK

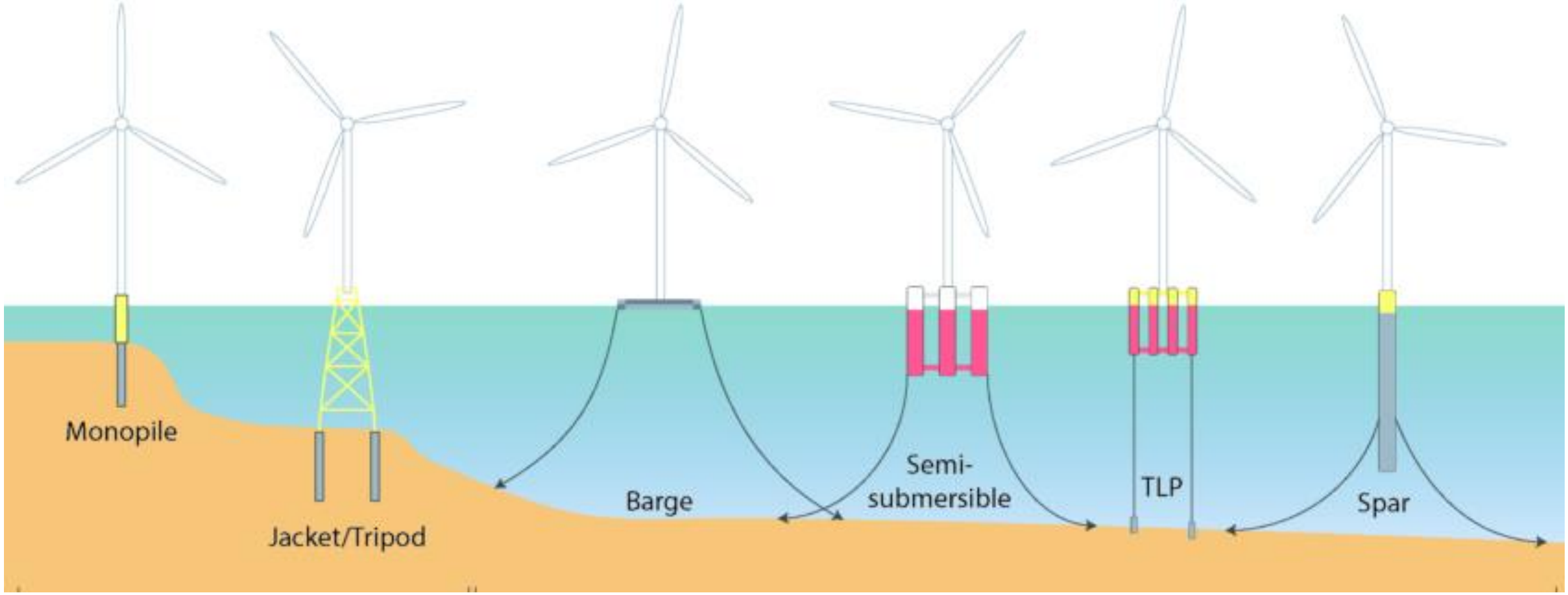
MARINE CONSERVATION SOCIETY

Introduction

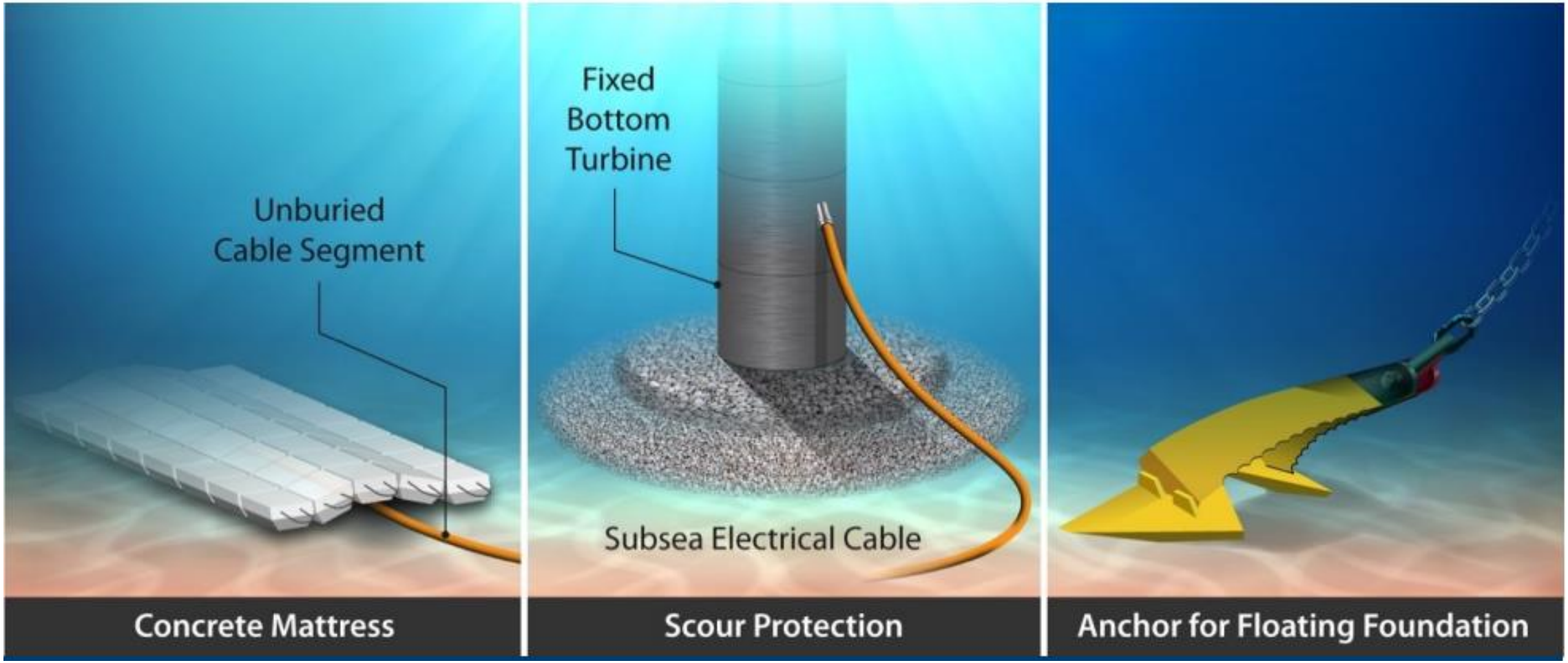
- Offshore Wind Energy (OWE): Renewable Energy – Decarbonising & Reduce Greenhouse Emissions to provide Affordable & Clean Energy (UNSD Goal 7).
- But….are also ***Civil Engineering Projects*** with potential to ***Impact Environment***.
- Should be compatible with ***Biodiversity Protection & Conservation Objectives*** (i.e. Birds and Habitats Directives Natura 2000 sites- UK European Marine Sites)
- ***there are still considerable gaps in scientific knowledge about the ecological impacts of wind turbines*** (WWF 2014, Cook et al 2018, Galparsoro 2022)

Marine Conservation Society concerns:

- Alteration of benthic/ seabed by foundations, anchors and cables
- Changes in benthic habitat and community structure & habitat conversion
- Extent of Impact from infrastructure
- Period of benthic recovery
- Cumulative environmental change



Sources of Direct Benthic Interaction



Alfred Hicks, US National Renewable Energy Laboratory

Benthic Impacts: Project Phases

EFFECT	PROJECT PHASE			
	P	C	O&M	D
Primary Considerations				
Loss of Habitat		●	●	●
Conversion of habitat: introduction of hard substrate		●	●	
Introduction of nonnative species		●	●	●
Seabed disturbance and recovery	●	●		●
Water quality, sediment, and turbidity	●	●		●
Other Considerations				
Contaminant release from sediment and offshore components	●	●	●	●
Noise and vibration		●	●	●
Heat emissions from cable			●	
Electromagnetic field emissions from cable			●	

P = Pre-construction surveys

C = Construction

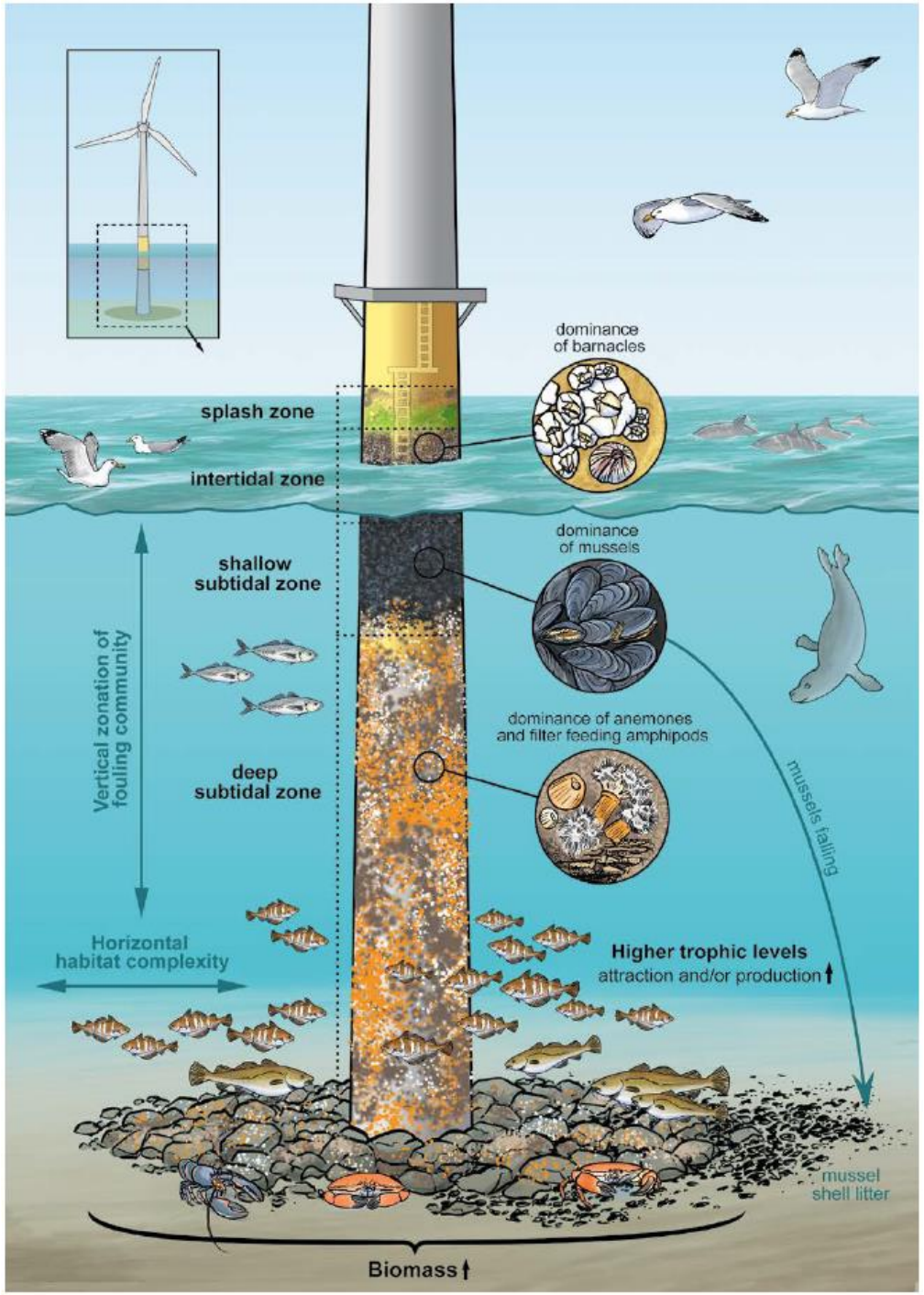
O&M = Operations & Maintenance

D = Decommissioning

US Offshore Wind Synthesis of Environmental Effects Research (SEER)

Habitat Conversion

- Soft sediment to hard complex habitat
- Increased species diversity (artificial reef)
- Biofouling organisms (mussels, barnacles, anemones, etc)
- Attract commercial fish species

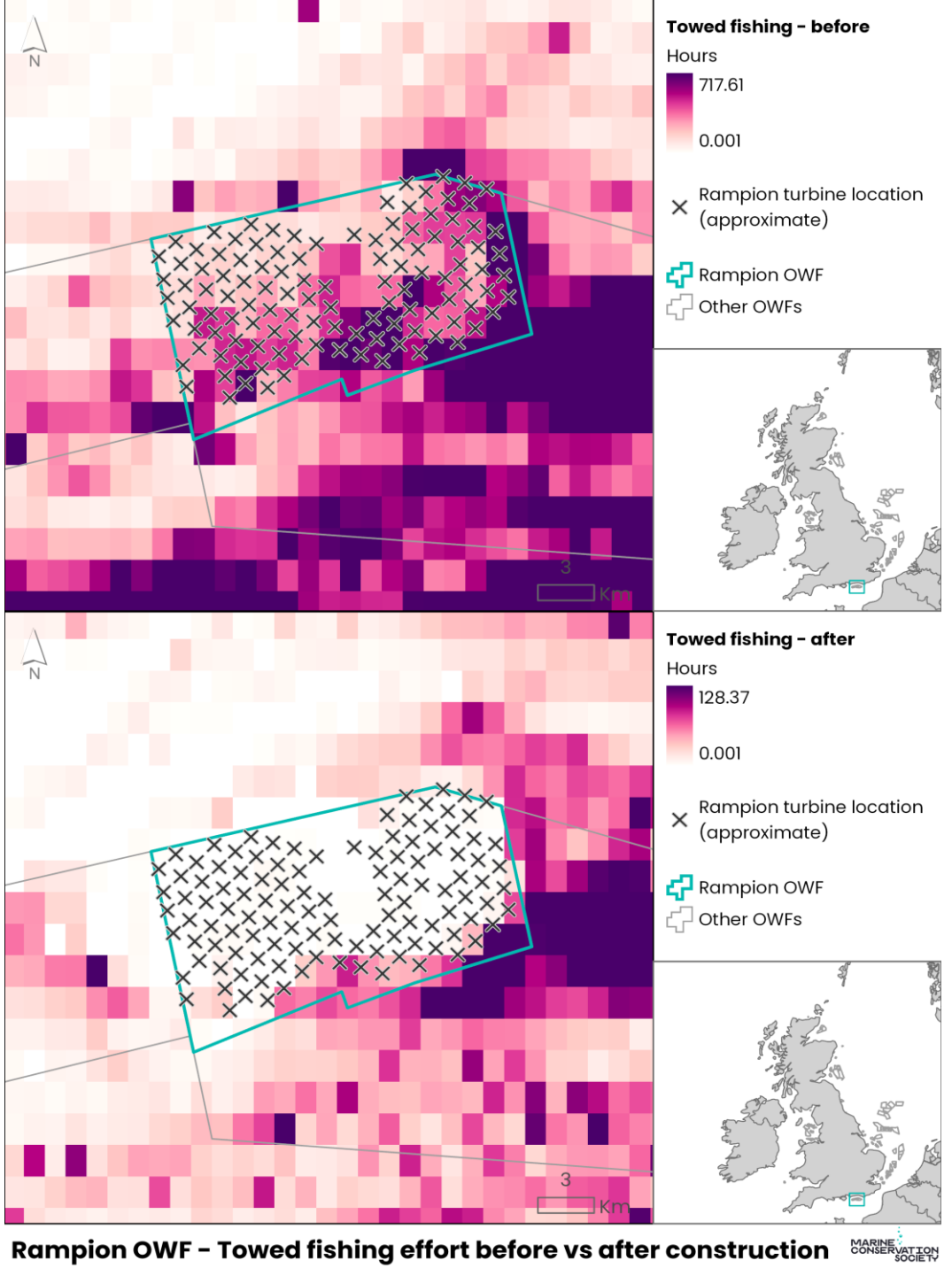


Degraer et al, 2020.

Fishing & Benthic Recovery

- UK OWE sites overlap with historic fishing grounds and MPAs
- Use of bottom towed gear(BTG) (trawls, dredges, demersal seines) decreases 77% following OWE construction
- OWE creates “head room” for marine conservation?
- OWE MPA colocation? Linked to Marine (biodiversity) Net Gain

Dunkley & Solandt 2022: Windfarms, fishing and benthic (Marine Policy).



Rampion OWF – Towed fishing effort before vs after construction

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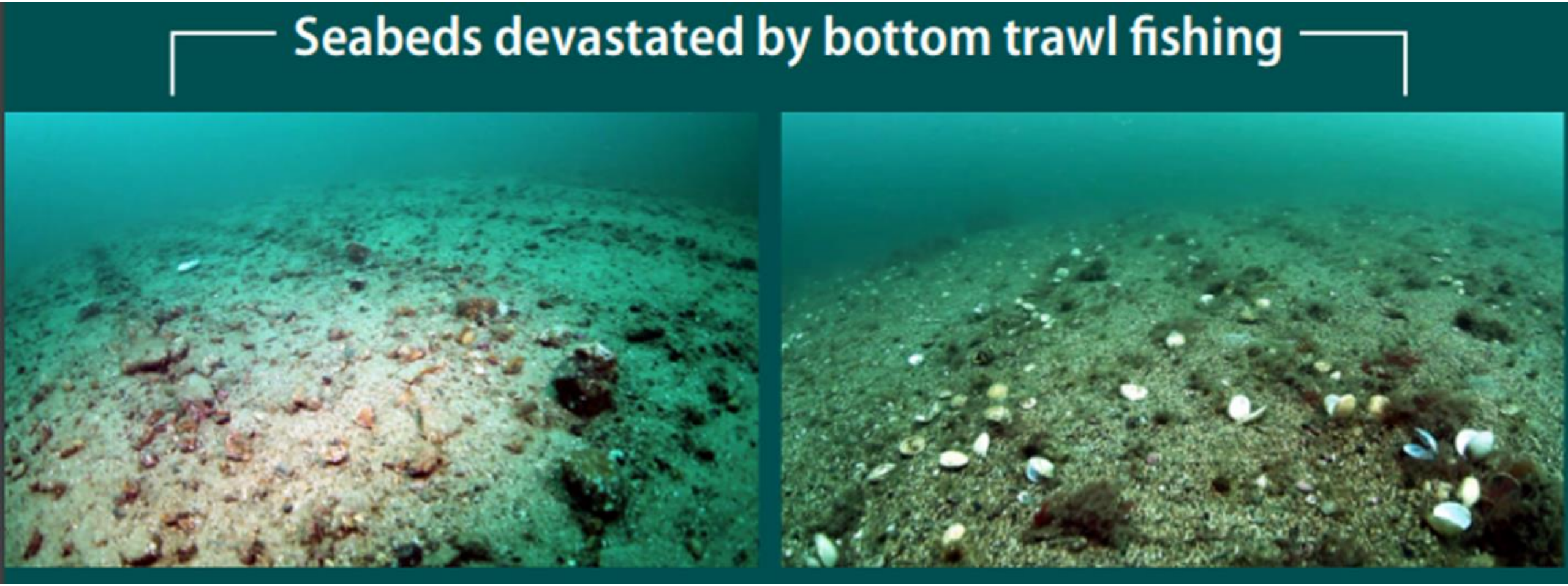
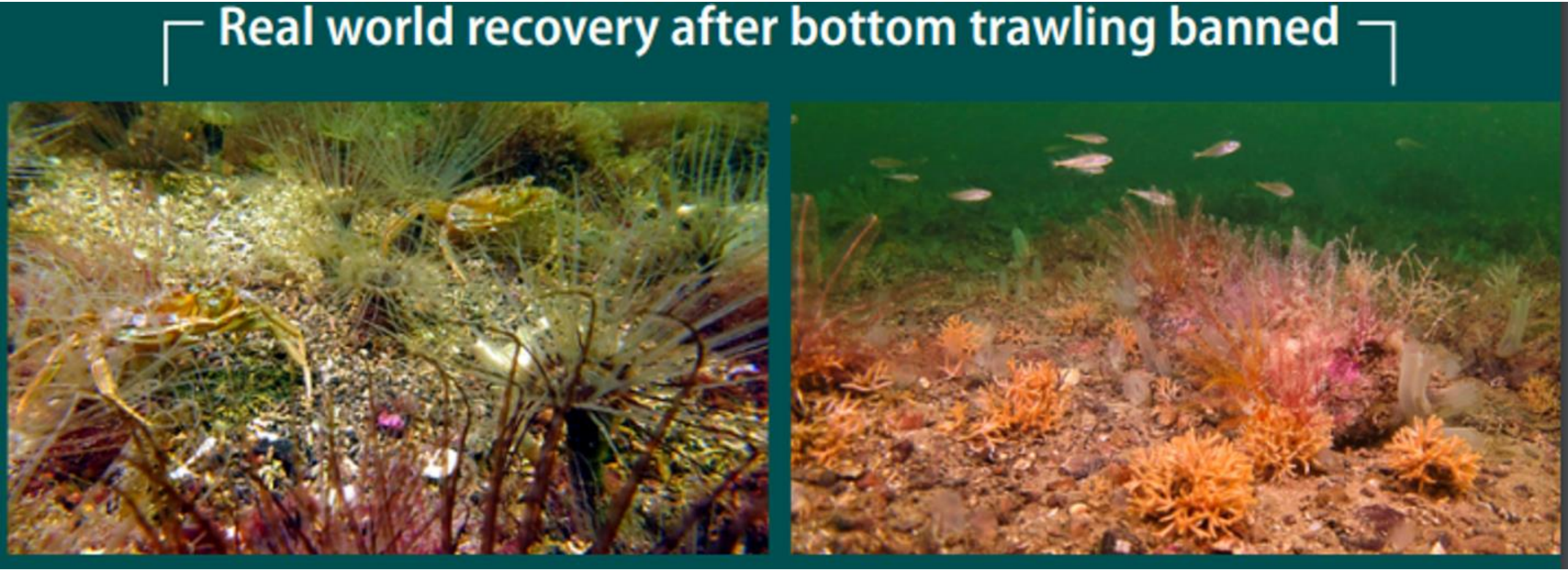
Before…….



Images: Howard Wood, Community of Arran Seabed Trust

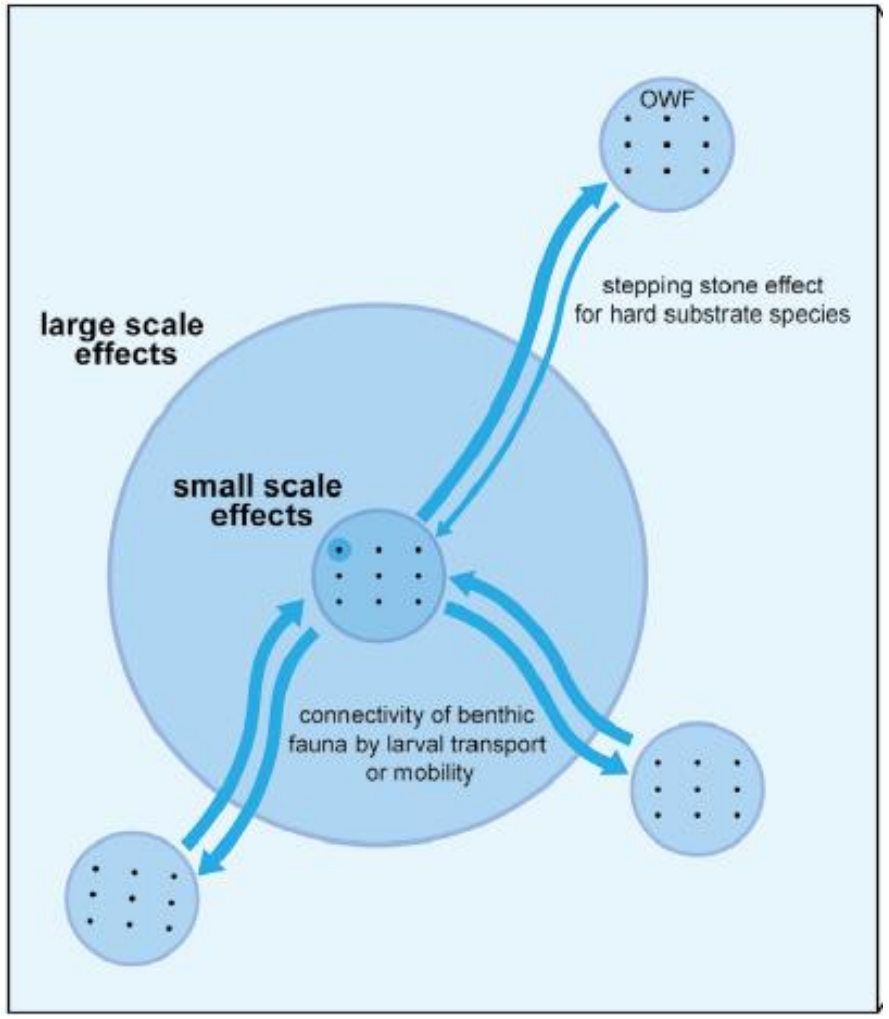
After…….



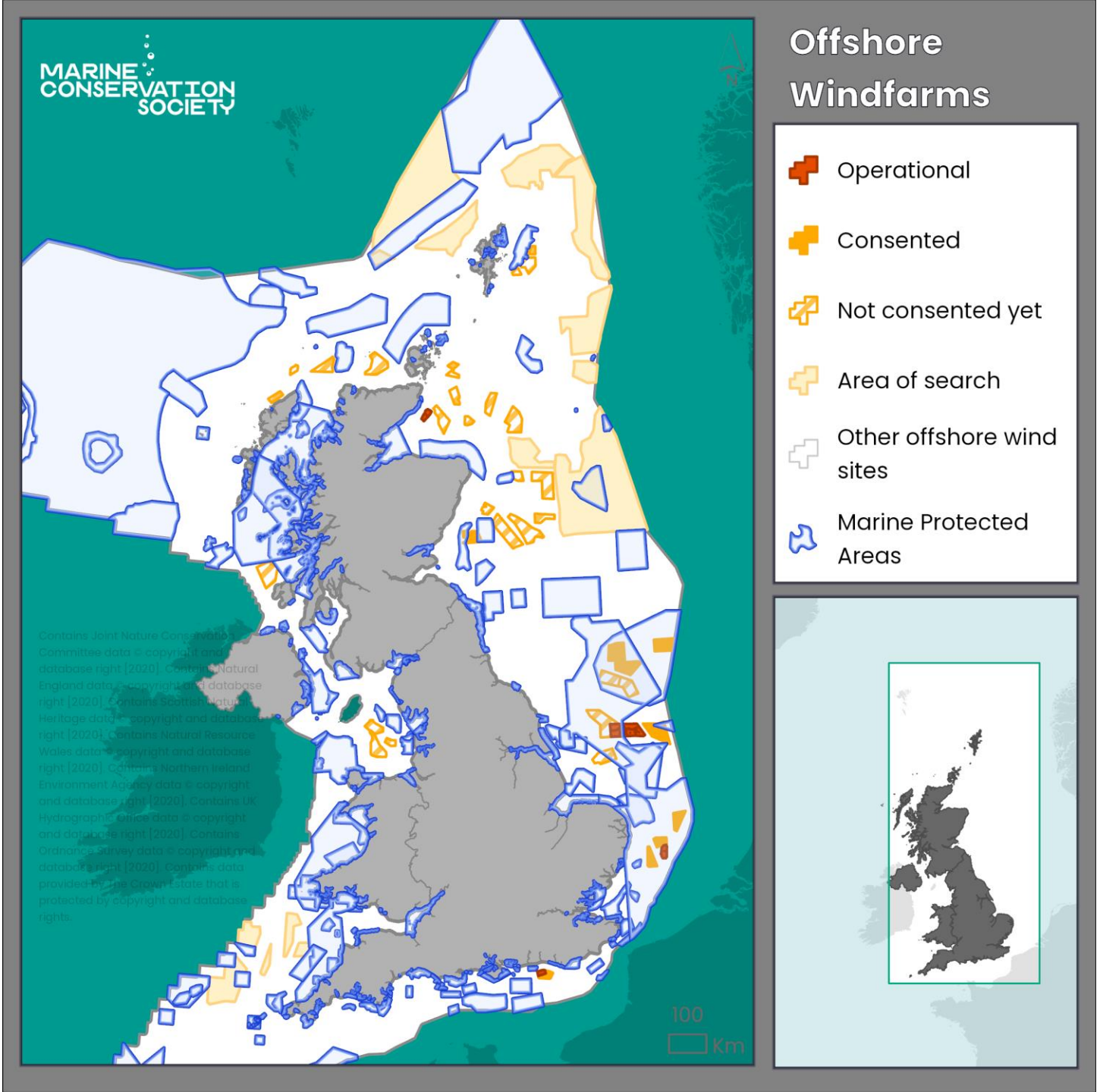
Images: Howard Wood, Community of Arran Seabed Trust

What is the “real” OWE Benthic Footprint?

- Direct habitat loss from OWE within farm boundary = 1% of area (SEER)= small scale effects;
- Design and siting should avoid sensitive/ critical habitat (i.e. MPA features)- need for EIA & HRA as part of licensing/ permission
- Small Scale Habitat Conversion is understood but, what are Large Scale Effects?



Degraer et al, 2020.



Overlap with Seabed/ Benthic Marine Protected Areas

Designation	No. Sites
Special Areas of Conservation (SAC)	5
Nature conservation MPA (Scotland)	5
Marine Conservation Zones (England)	5

UK 242 MPAs designated for benthic communities, 30% EEZ

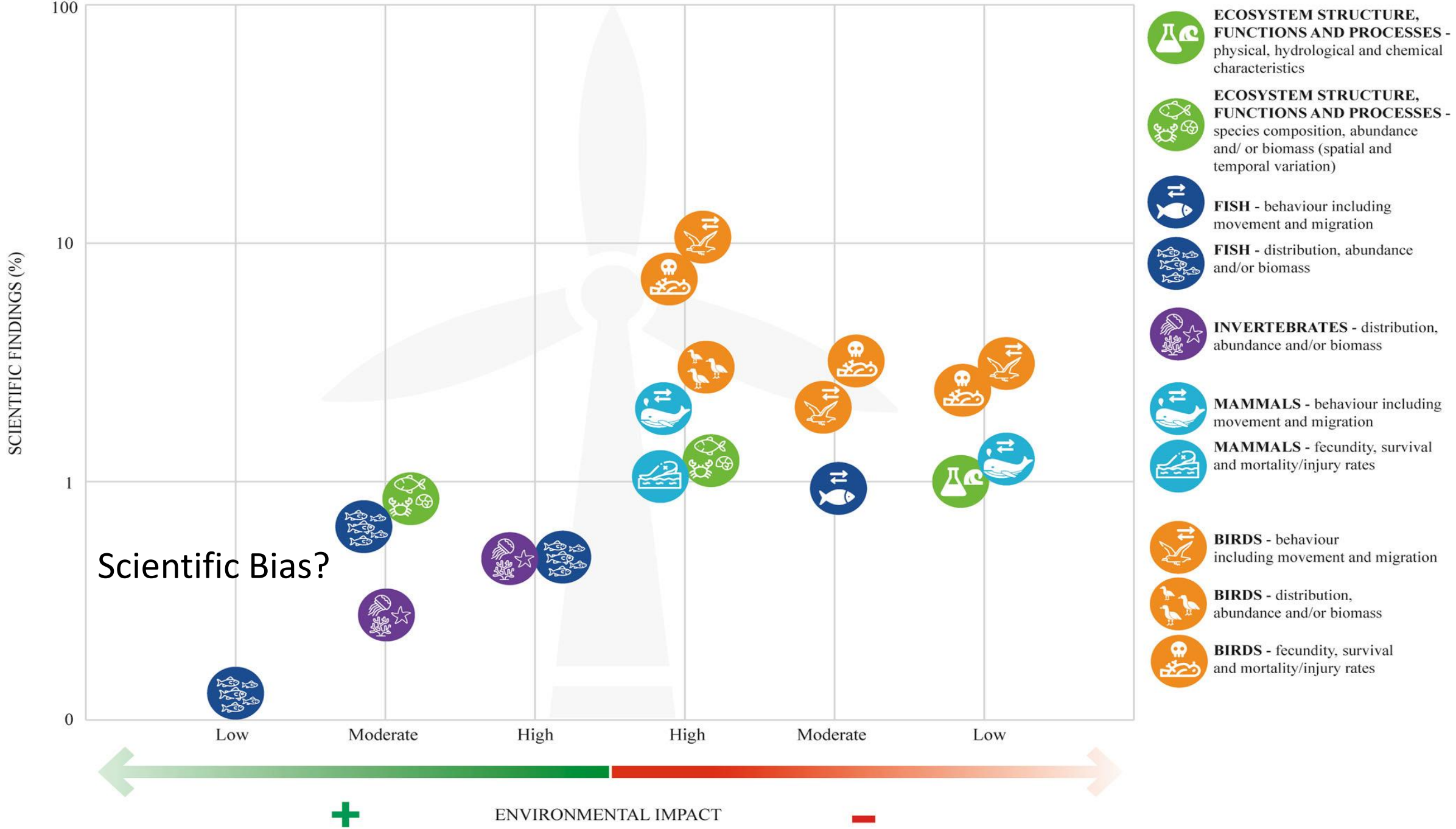
Regional Impacts?

- 66% of OWE Impact Literature based on North Sea studies.
- 56% of studies <20 km from coast, 90% at <30m depth.
- Few studies deal with multiple impacts or deeper offshore waters.

<u>Sea Basin Ecosystem</u>

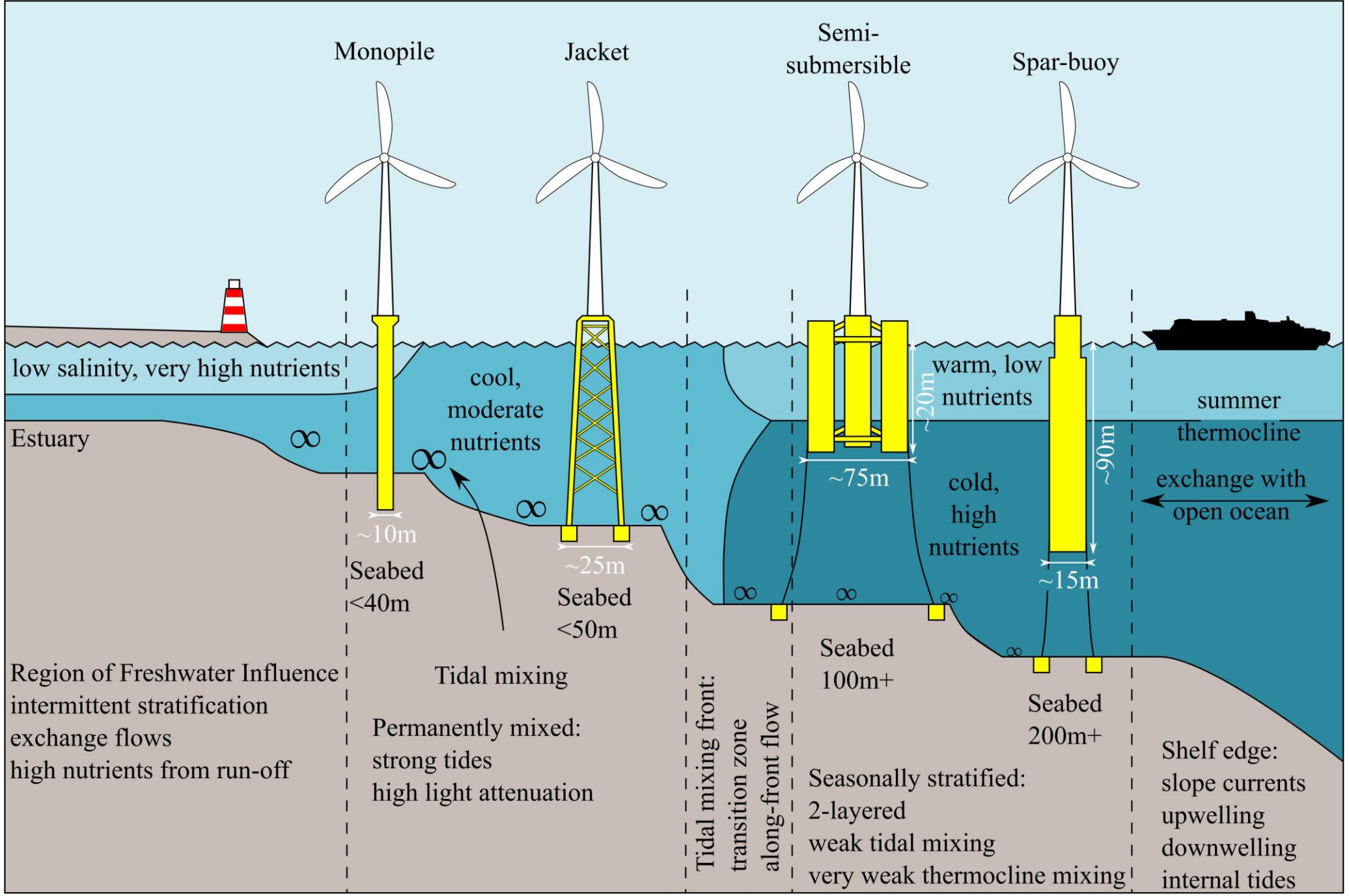
- Spring-Summer conditions maintains a sub-surface phytoplankton layer (10-30m thick) at 10-40m depth across shelf sea.
- Layer supports pelagic food web/ fishery (50% annual primary production in North Sea).

(Galparsoro 2022)



Scientific Bias?

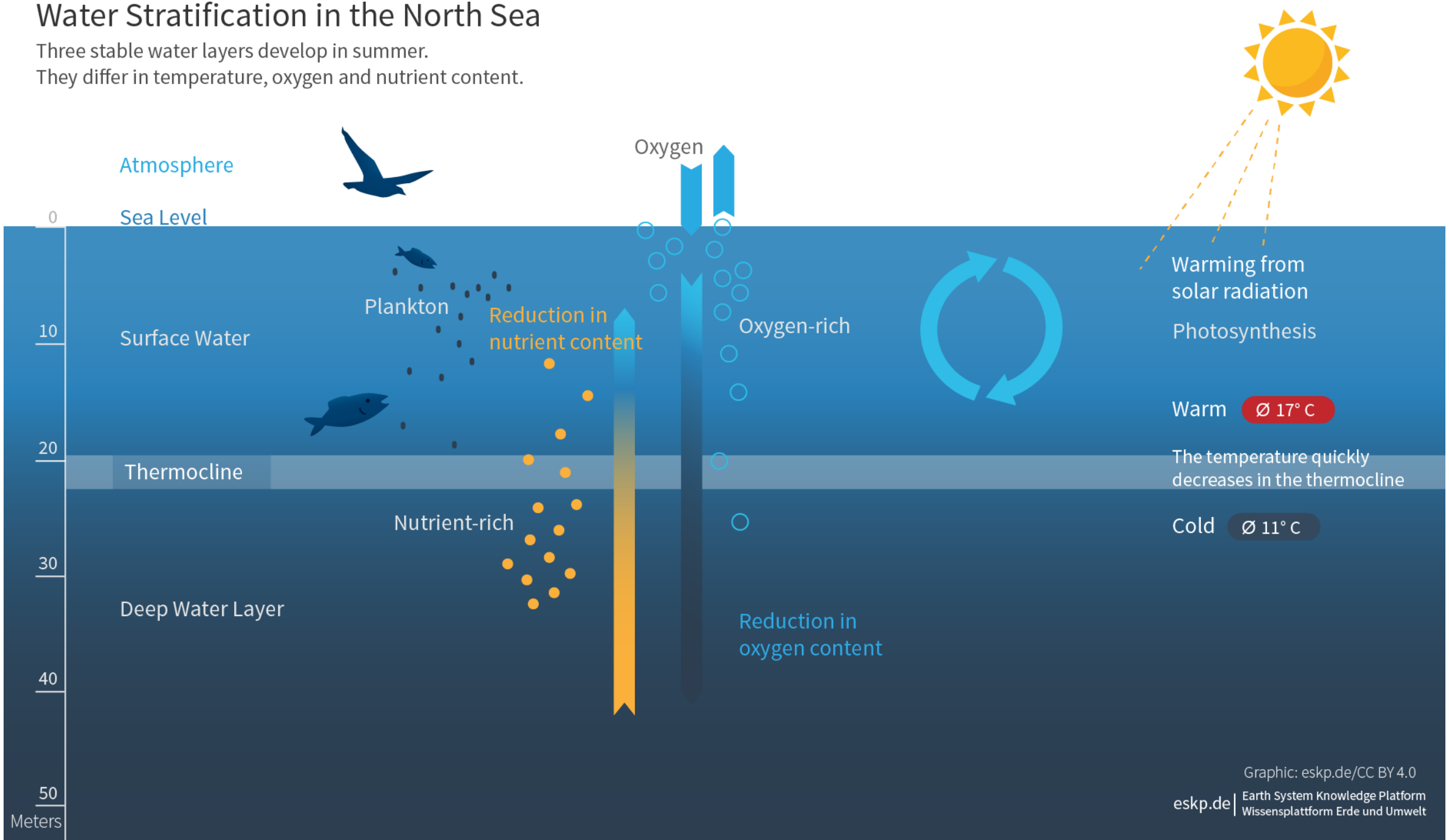
Galparsoro et al, 2022



Dorrell et al, 2022

Water Stratification in the North Sea

Three stable water layers develop in summer.
They differ in temperature, oxygen and nutrient content.



eskp.de | Earth System Knowledge Platform
Wissensplattform Erde und Umwelt

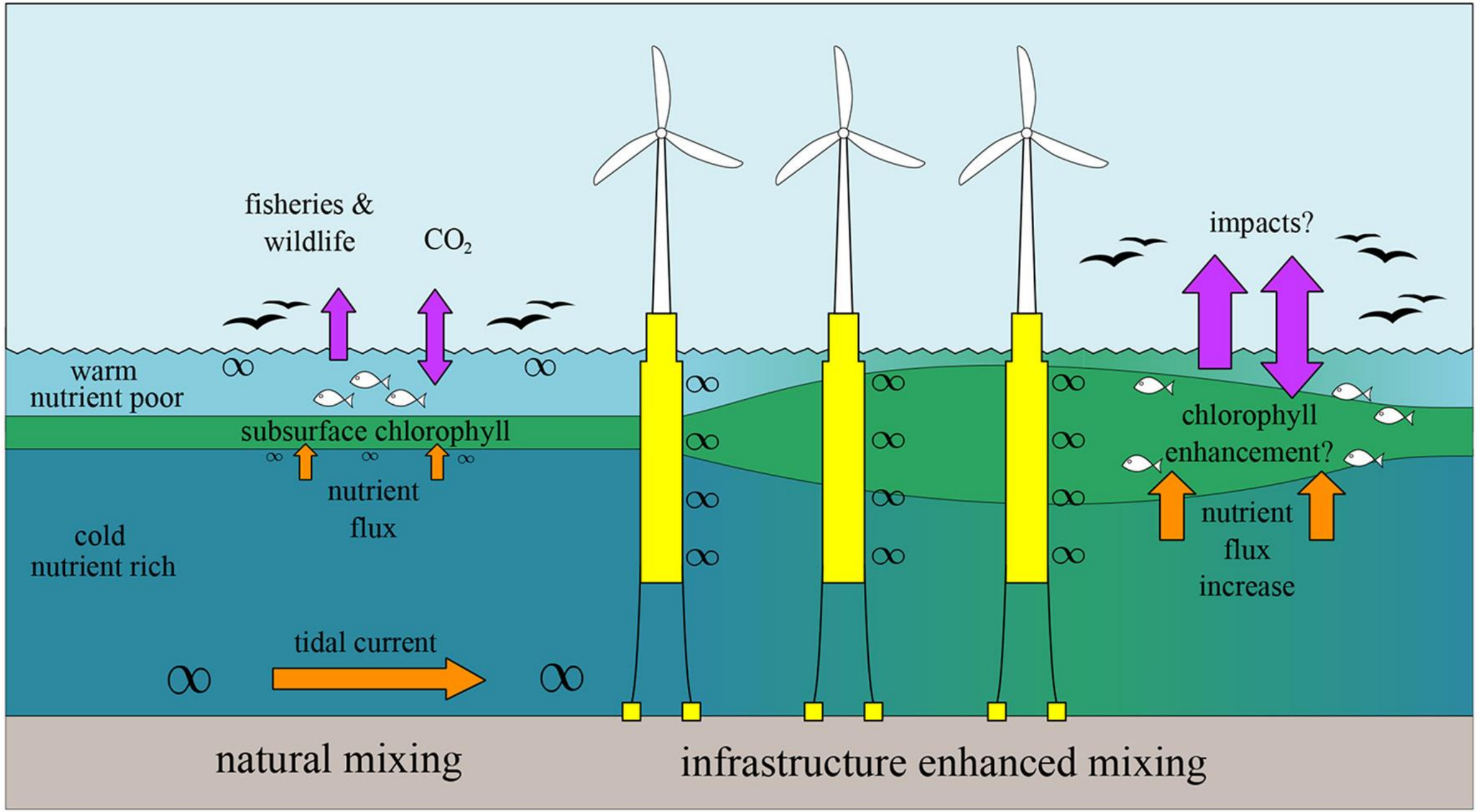
Modelling of OWE Large Scale Impacts

- **Marine Turbulent Current Wake (TCW)**

  Cylindrical structures that cause drag and shed vortices (wake) in water flows. 6m monopile wake = 60m wide, >300m long (not consistently observed). Modelling predicts greater extent

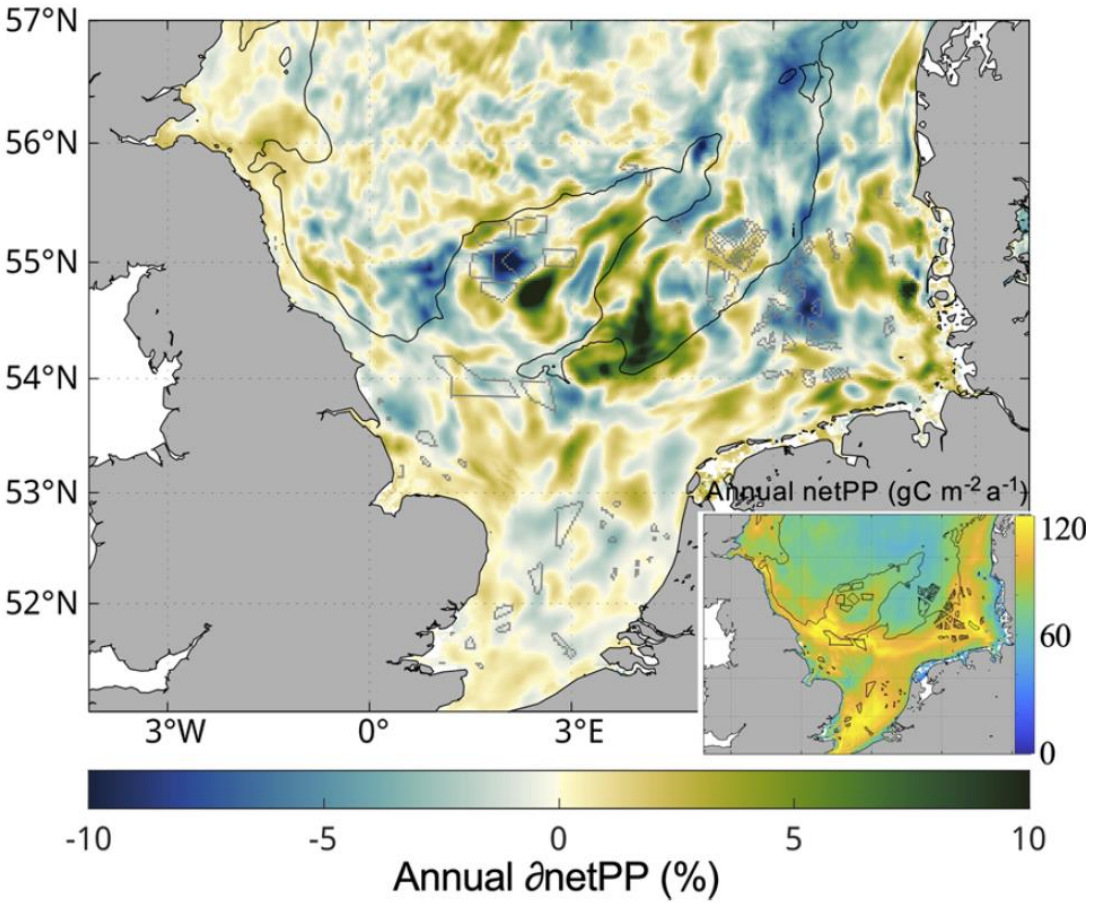
- **Atmospheric (Wind) Wakes (WW)**

  Vortices (dipoles) from turbine blades in air flows. Induce upwelling and downwelling in water column. >65 km in lee of OWF= 43% reduction in windspeed



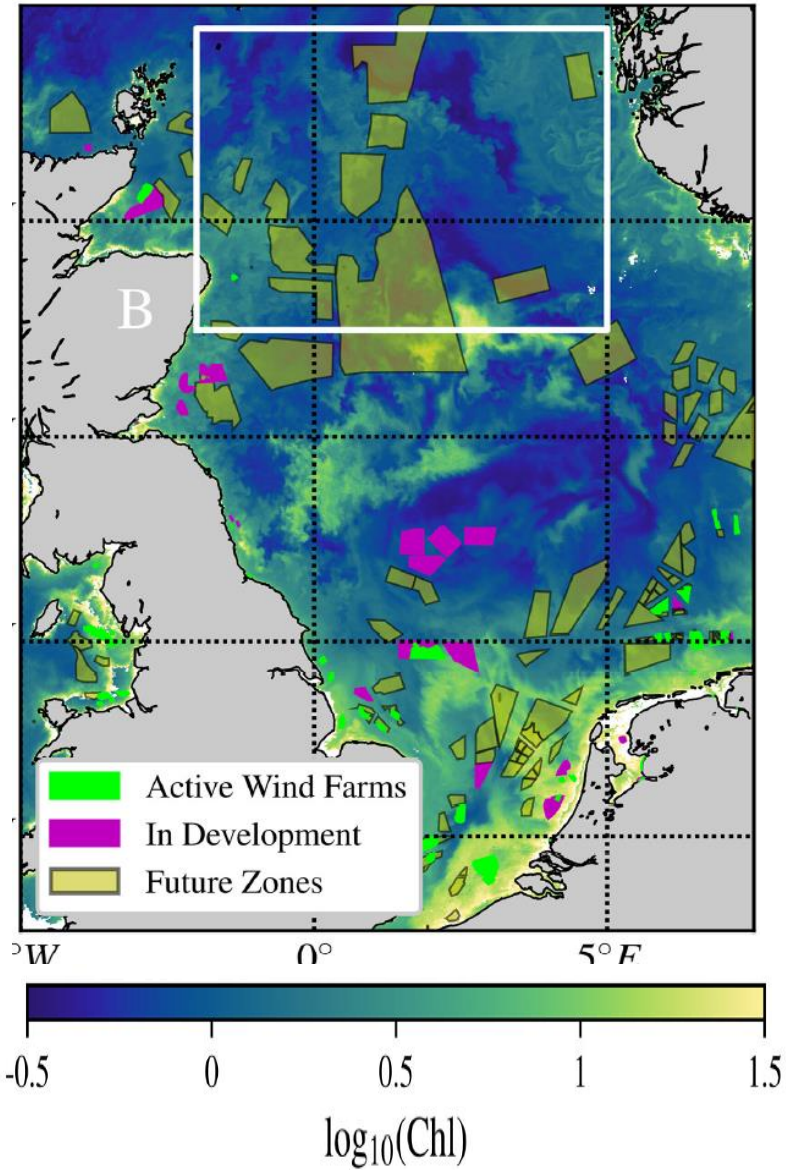
Dorrell et al, 2022

Wind Wake: Primary Production



Daewel, 2022

Turbulent Current Wake: Chlorophyll Concentration



Dorrell et al, 2022

Predicted Large Scale Impacts from Modelling

- Shallowing and/ or widening of seasonal mixed layer
- Localised Increased or decreased primary production (+/- 10%) over large area
- Localised increased sediment carbon (10%) over large area?
- Reduced dissolved oxygen at seabed?
- Commercial fish species? Ecosystem Impacts?

" For the marine ecosystem the effects of OWFs might or might not be severe" (Daewel et al 2022 p2.)

"The potential benefits and risks posed by infrastructure mixing of stratified shelf seas, on top of climate change, represents a combined hazard that has not been considered." (Dorrell et al 2022 p20.)

"Environmental modelling? Sheeesh!" (Hill 2023)

A Question of Scale

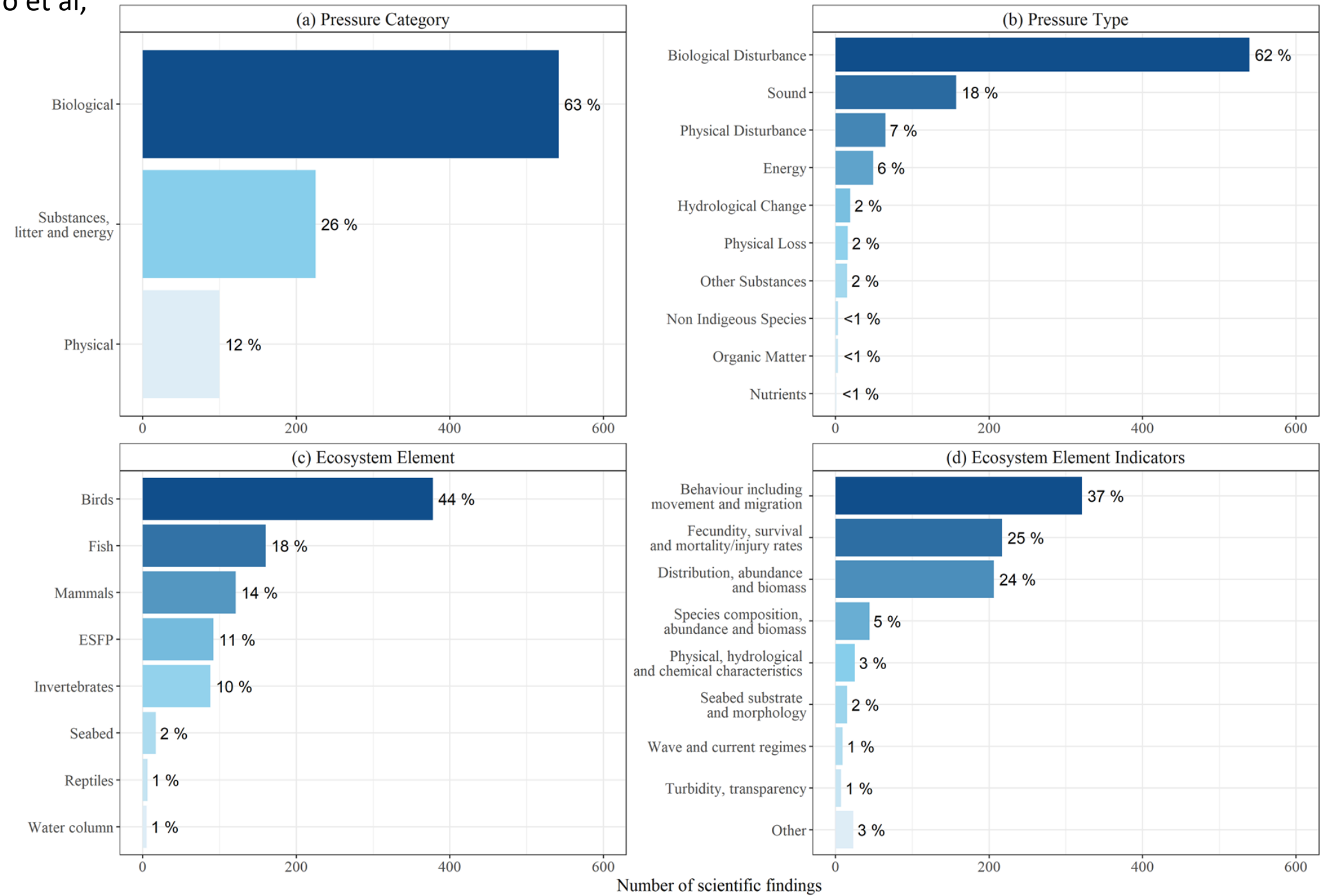
Small Scale/ Site Specific

- Does Habitat Creation = Natural Restoration?
- Does Pressure Removal/ Alleviation (i.e BTFG)= Natural Restoration?
- Does it matter in a denuded ecosystem ?(150yrs industrial fishing)

Large Scale/ Sea Basin

- What are large scale impacts? (ecosystem function/ fisheries)
- Can MPA network/ OWE locations max. positive & min. negative impacts?
- Use Marine Spatial Planning (MSP) to determine OWE/ MPA location & colocation?

Galparsoro et al, 2022



Predicted Extended Footprint

- Turbulent Current Wake (TCW): 6m monopile wake = 60m wide, >300m long (not consistently observed). Modelling predicts greater extent
- Wind Wake (WW): >65 km in lee of OWF= 43% reduction in windspeed
- TCW & WW alter mixing, stratification, temperature and salinity in surrounding waters.
- TCW= increased subsurface mixing WW= reduced wind induced mixing

Stratified Shelf Seas & Anthropogenic Mixing

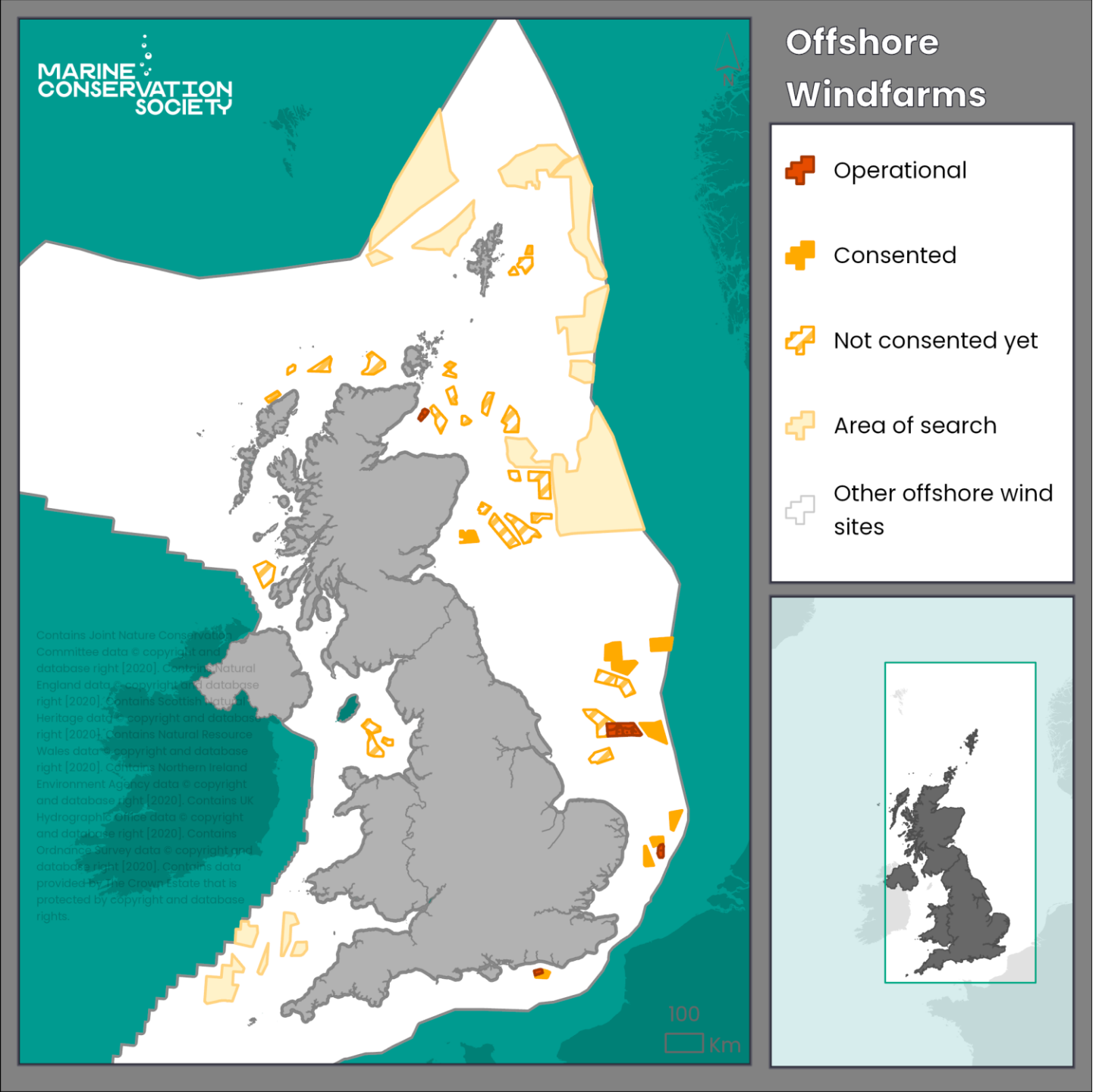
- Most OWE developments & identified impacts within well-mixed near shore and/ or shallow waters: nearshore & shallow sites becoming limited.
- Sparse information on environmental impact: particularly on ecosystem function/ hydrodynamics/ carbon stores in deeper offshore waters
- Seasonally Stratified Shelf Seas (80m to 200m)– dissipate tidal energy; important for biological production, fish stocks and carbon absorption/ natural storage
- Impacts to primary production, marine ecosystem and biogeochemical cycling? (Particularly Floating from OWE)
- Geographical extent of impact?

Habitat Conversion Issues

- Increase diversity and abundance= Ecosystem Change
- Displace existing species & food web (e.g. soft sediment to reef community)
- Benthic recovery within 3-5 years?
- Colonisation trajectory- 6+ years of successional change?
- Implications to MPA features in comparison to a denuded benthic habitat (e.g. bottom towed gear)
- Non-native/ Invasive Species (particularly hard substrates)

Seasonal Stratification

- Seasonal stratification (spring/ summer) in low energy/ low turbulent offshore (>80m) waters controls primary production (marine phytoplankton).
- Warm (15-20°C) surface layer (5-40m) overlies deeper cooler (11°C) water separated by thermocline. Breaks down in Autumn/ Winter due to cooling, convection and storm events.
- Phytoplankton trapped in surface layer (spring bloom), fixes carbon, increases atmospheric CO_2 absorption, zooplankton and fish larvae evolved to use surface food source- drives surface food-web.
- **Subsurface Chlorophyll Maximum (SCM): Thermocline allows limited mixing so surface waters become nutrient poor, but limited mixing from nutrient rich deeper water at the thermocline maintains a sub-surface phytoplankton layer (10-30m thick) at 10-40m depth across shelf sea- supports pelagic food web (50% annual primary production in North Sea).**
- Localised mixing at the shelf break and across mid-shelf sand banks can lead to seasonal fishing hotspots
- Products (nutrients and carbon) from spring – summer primary production sink to seabed- remineralised (oxygen depletion) to natural carbon stores. Remineralisation & Thermocline determine dissolved oxygen for benthic and pelagic species.



Area of UK Exclusive Economic Zone (EEZ)

Status	Area(km²)	% EEZ
Consented	3637	0.5
Not Consented	11185	1.5
Search Area	48754	6.7
Operational	1229	0.2

Questions?

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