Assessing the Ecological Connectivity between man-made structures in the North Sea (EcoConnect)

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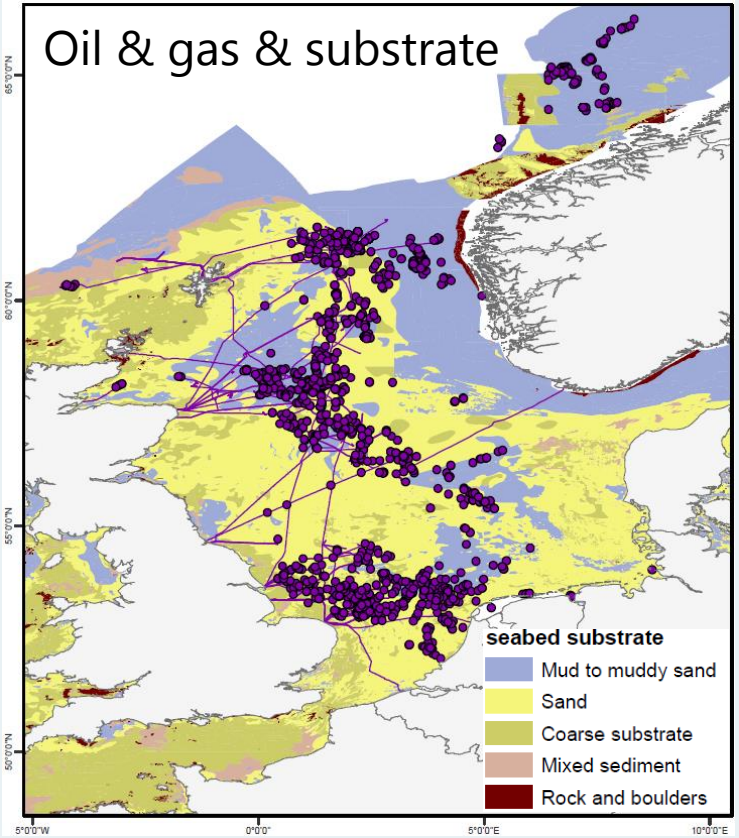
Overview

- Role of man-made structures in the North Sea
- EcoConnect: objectives, team, data, methods, & key findings
- Recommendations for decommissioning
- Summary

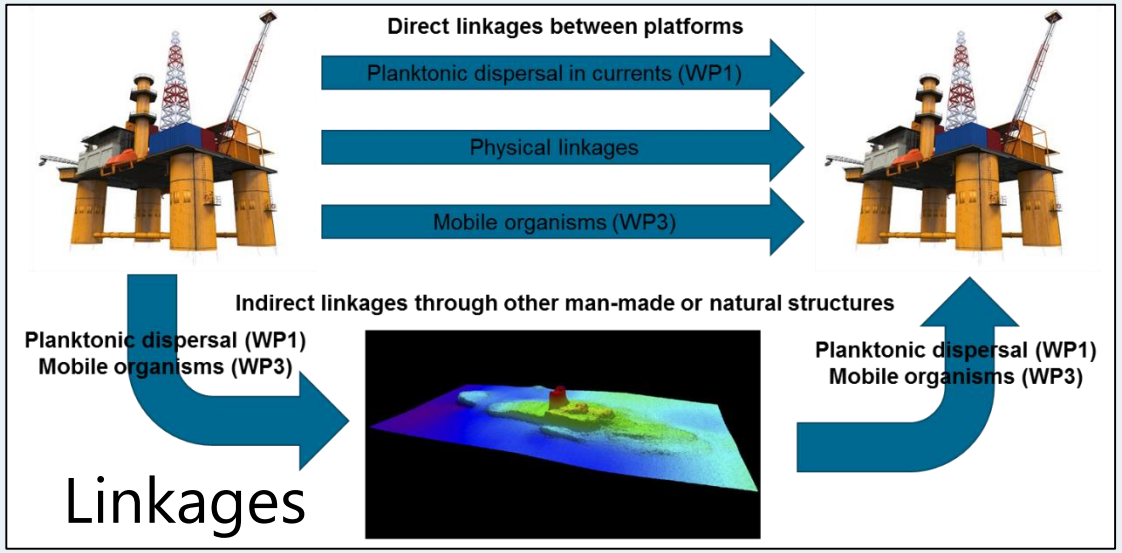
Man-made structures in the North Sea



- Decommissioning: £47B (UK shelf) & £17.6B (North Sea).
- Many decommissioning options with derogations if beneficial to environment (e.g. 'Rigs-to-Reefs').
- North Sea mainly soft sediment – limited hard substrate.
- Man-made structures provide substrate & connectivity (e.g. wrecks, wind farms, platforms, pipelines, cables).
- Important to understand effects of man-made structures on the ecosystem when decommissioning.

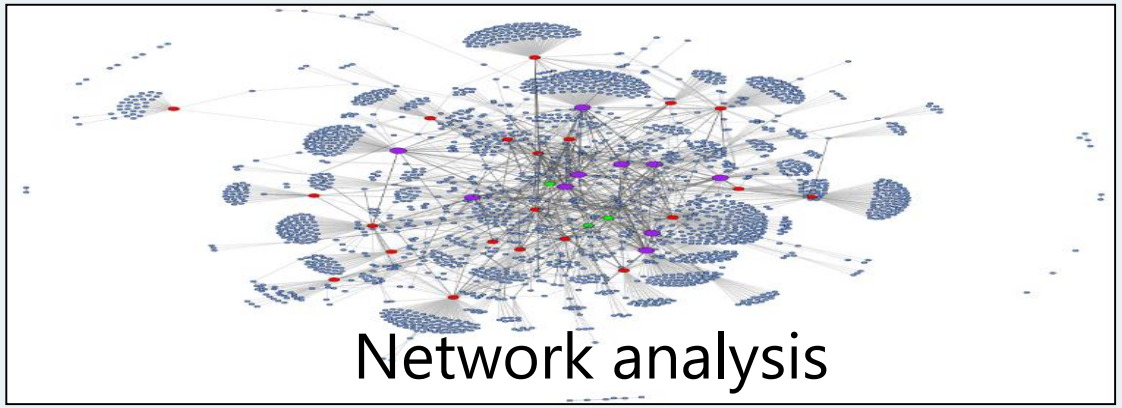
EcoConnect – objectives

Understand connectivity between hard substrates, role of man-made structures, & effects of changing the network on structure & function of North Sea ecosystem.



Objectives:

1. Collate data & knowledge on linkages.
2. Assess importance of pelagic dispersal.
3. Use by mobile organisms (fish, birds & mammals).
4. Evaluate the impact of oil & gas infrastructure & compare natural substrate.



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Supports delivery of second INSITE objective on ecological connectivity

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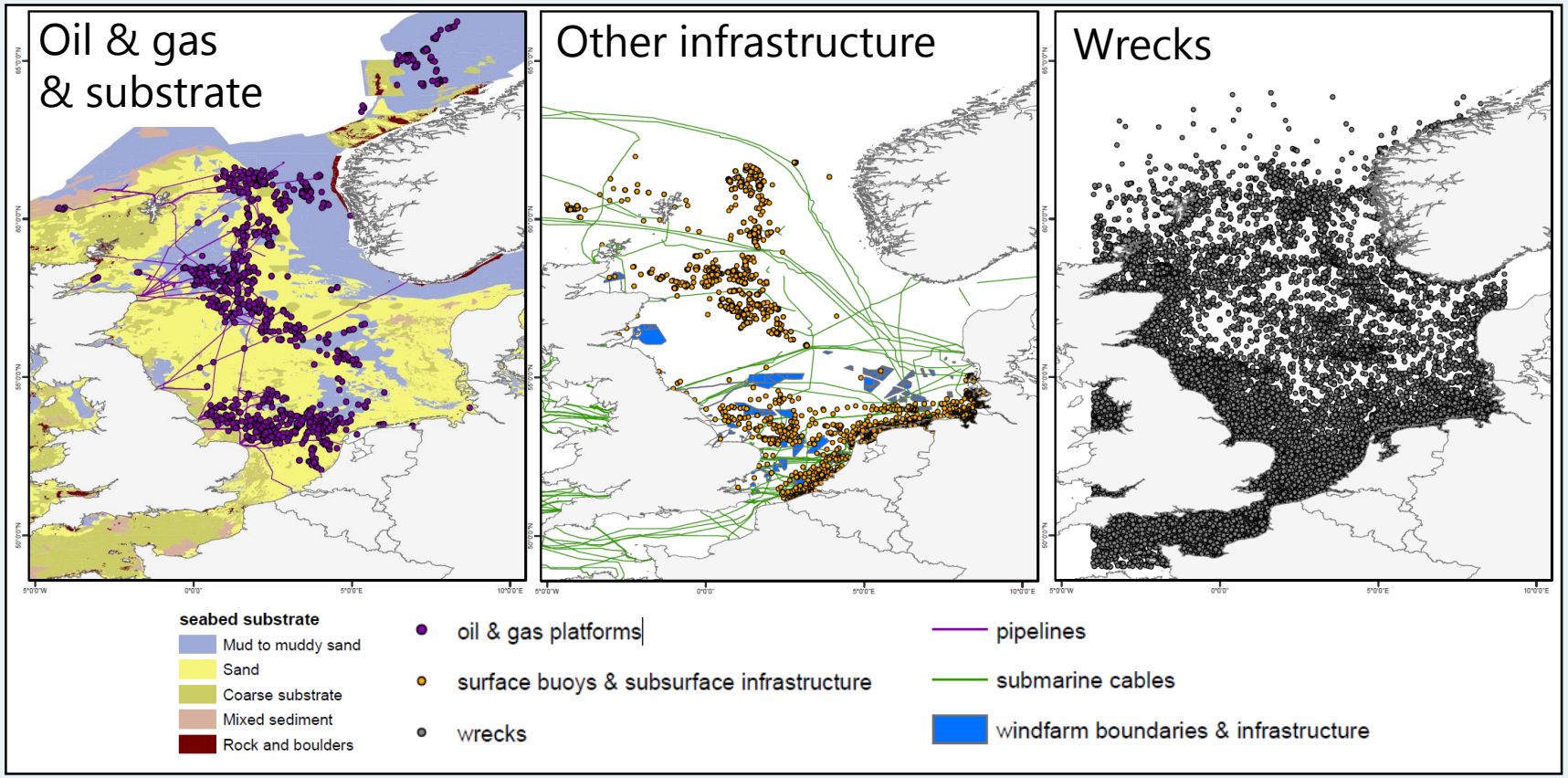
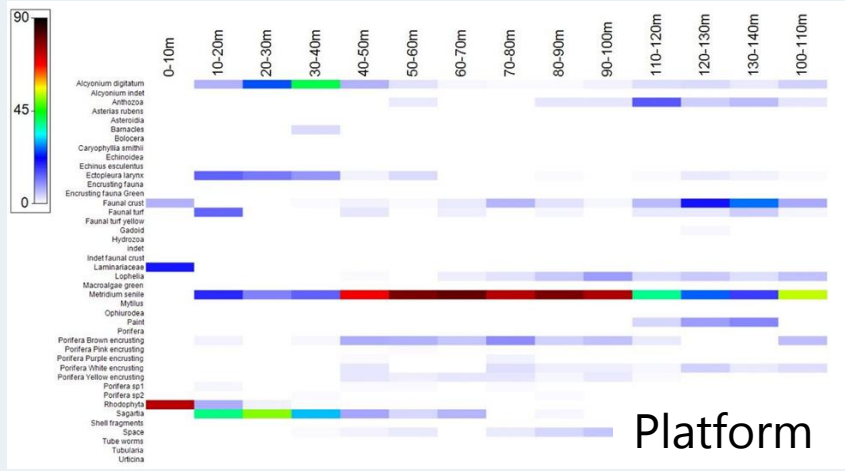
Data – infrastructure & substrate

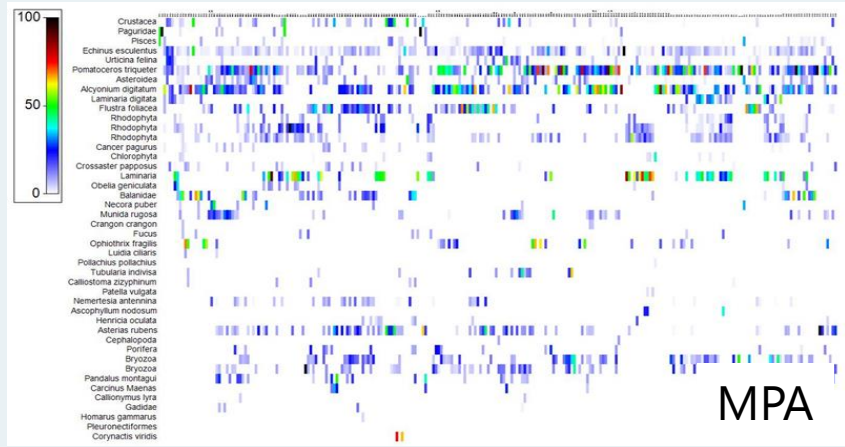


Feature	Area (km^2)	% total	% natural
Natural:	2,483,080	100	
Mud	796,654	32.1	
Sand	1,152,375	46.4	
Coarse substrate	410,273	16.5	
Mixed sediment	86,518	3.5	
Rock & boulders	37,261	1.5	
Man-made :	5,227	0.2	14.1
Oil & gas	81	0.0033	0.217
Wind turbines	7	0.0003	0.020
Pipelines	2,578	0.1038	**6.919**
Cables	2,774	0.1117	**7.445**
Wrecks	23	0.0009	0.061

Data – community structure

- Limited data on community structures on platforms & comparisons with natural substrate.
- Analysed ROV footage from 3 platforms & photos from Berwickshire & North Northumberland EMS.
- Findings:
  - Platforms similar, but vary levels of abundance.
  - *Alcyonium digitatum*, *Pomatoceros triqueter,* & *Echinus esculentus* most prevalent taxa on the natural reef .
  - Greater variety of large echinoderms on the natural reef.
  - Less predominance of a single taxon on the natural reef.





Data – species selection

- Representative of community & behaviour.
- Native & non-native.
- Collected data around duration & behaviour.
- Selected seven – urchin, coral (soft & cold water), anemone, limpet, sponge, & mussel.

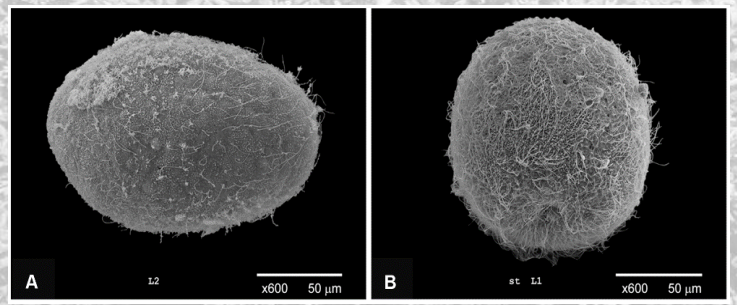
Cold water coral (Lophelia)

Planktonic phase:
2 weeks mid-upper water column; bottom-probing 21 days onward

Spawning period:
31 Jan - 31 March

Community role:
habitat forming

Ciliated embryo | Planula larvae



Larsson et al., 2014. Embryogenesis and Larval Biology of the Cold-Water Coral *Lophelia pertusa*. http://dx.doi.org/10.1371/journal.pone.0102222

Larval duration:
30-57 days
egg 0-7 days; planula larvae 7 days onwards

Vertical migration:
positively buoyant
up to 50 m VM possible
swimming speed 0.5 mm s-1

Larval feeding behaviour:
planktotrophic

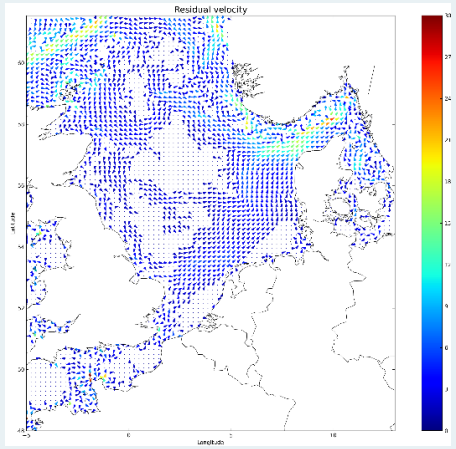
Invasive?:
Native

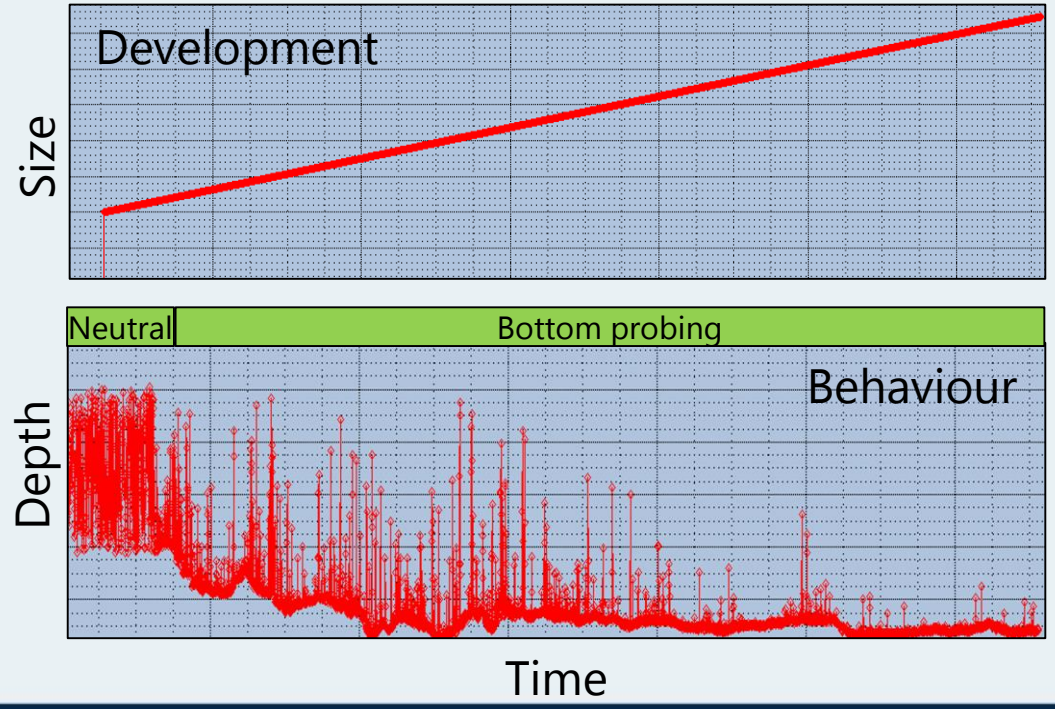
Community function:
Filter feeding

Indicator:
No fishing activity
High productivity

Pelagic dispersal modelling

Modelled current velocity (varies by depth) from GETM

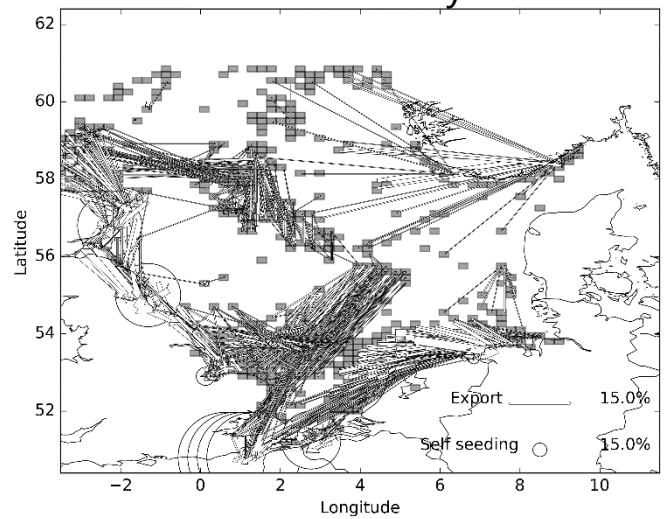




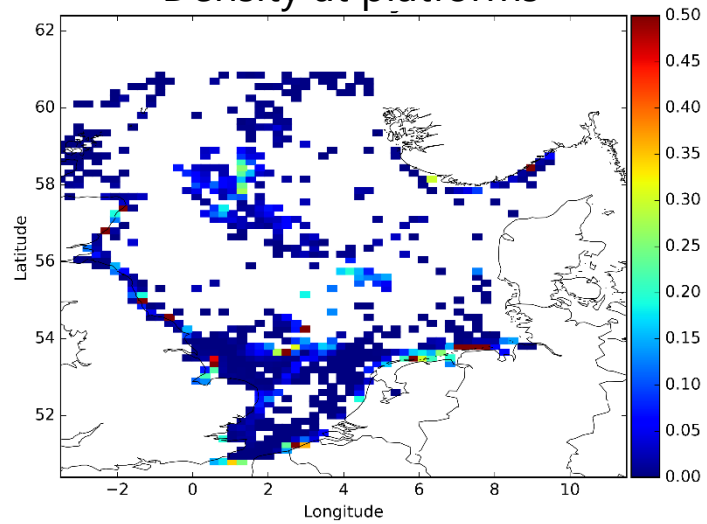
Run model 2001-10

Structures – oil & gas, windfarms, wrecks

Connectivity



Density at platforms



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van der Molen et al. (submitted.). Modelling connectivity of larval stages of sedentary marine communities between offshore structures in the North Sea. Scientific Reports.

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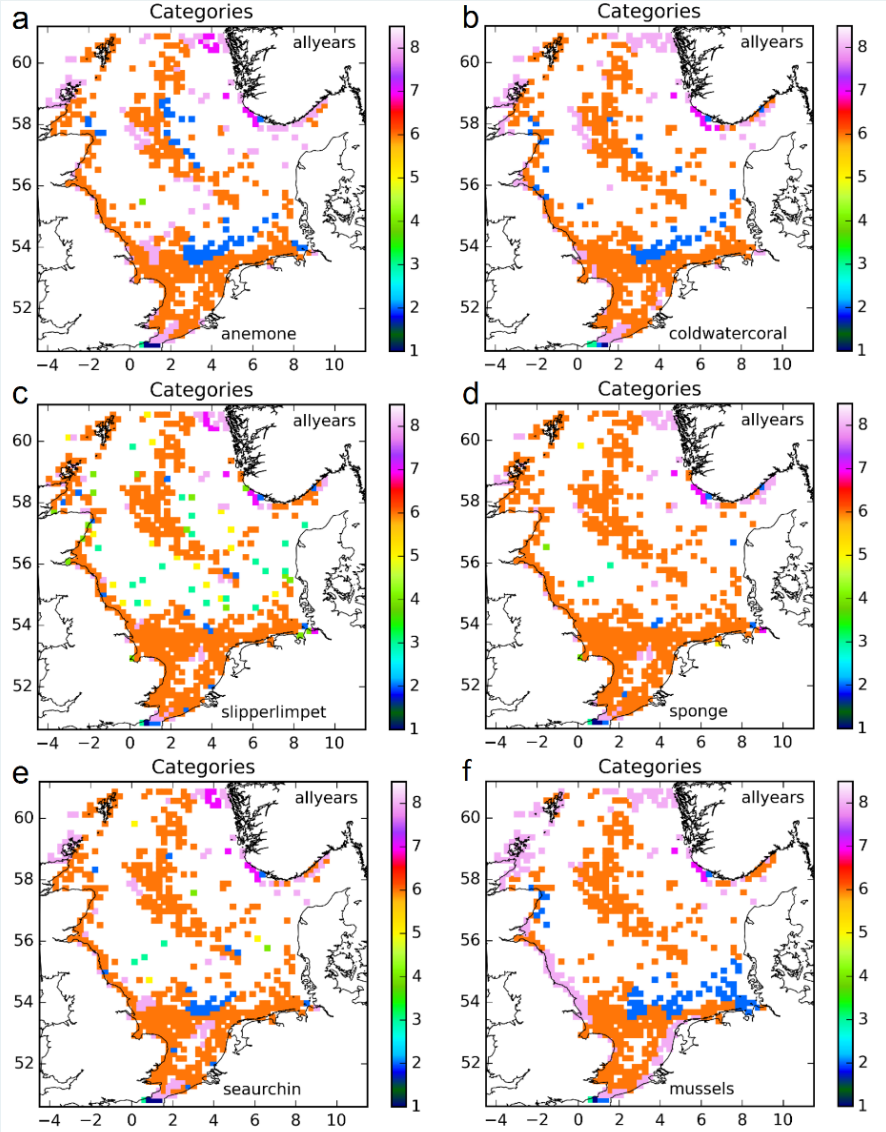
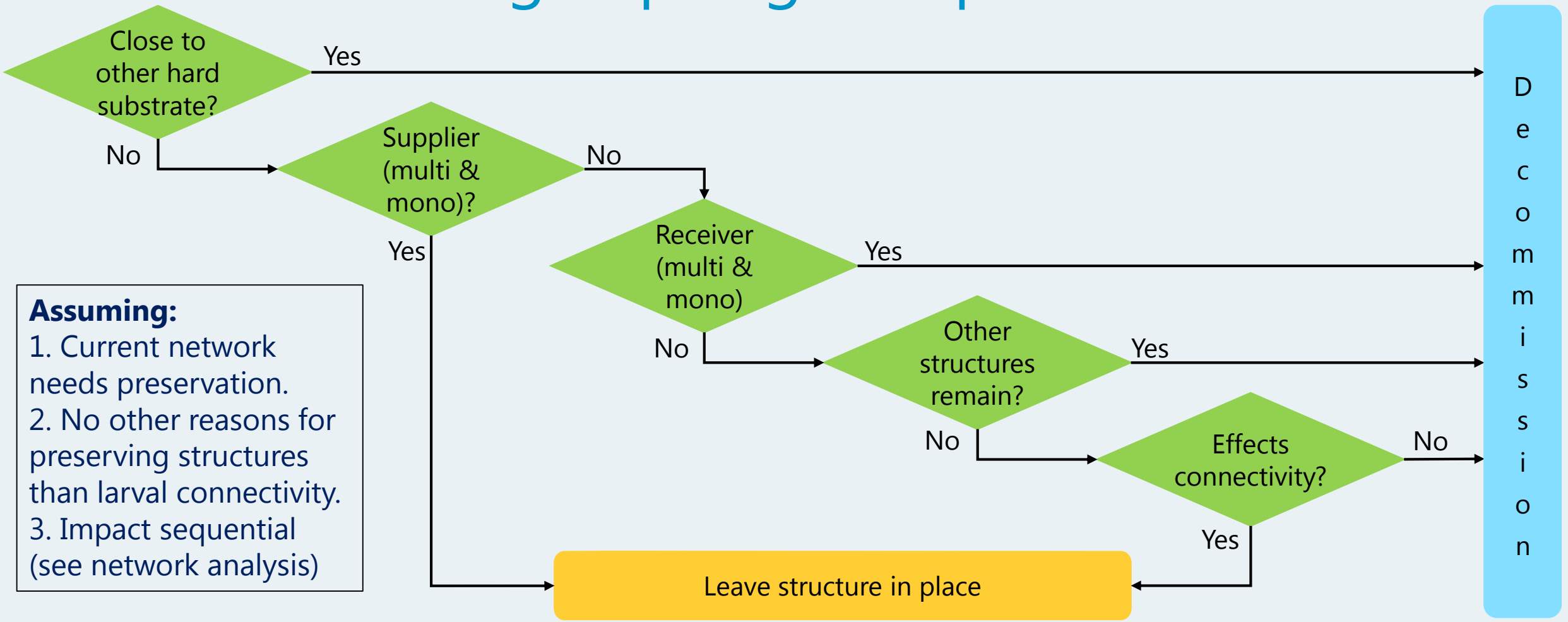
Pelagic dispersal model – outcomes

- Species: representative of community.
- Sectors categorised by number of linkages as suppliers, conductors, or receivers.
- Distinct patterns for species & years:
  - Suppliers on coasts & some platforms (e.g. mussels).
  - Conductors generally man-made (e.g. sponge).
  - Receivers often platforms, but differences between species (e.g. anemone vs slipper limpet).
- Decommission strategies proposed based on categories & proximity to other hard substrate.



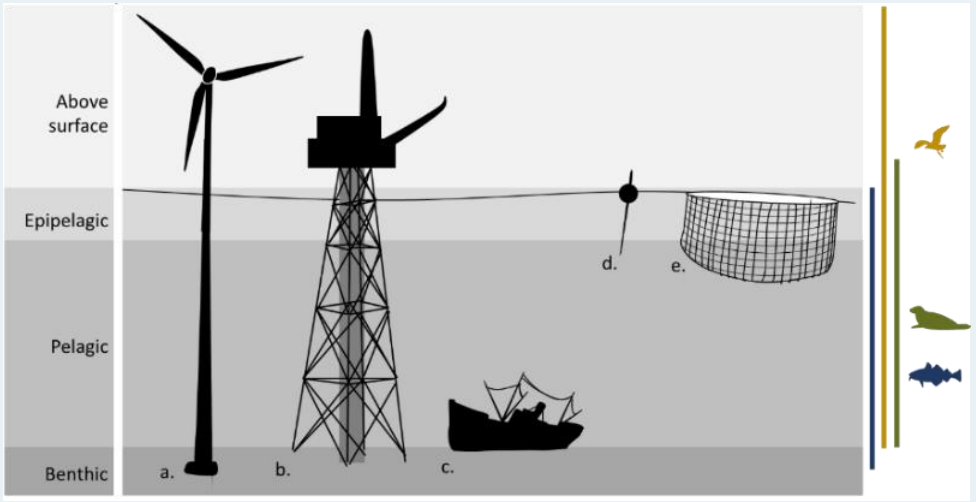
Decommissioning & pelagic dispersal

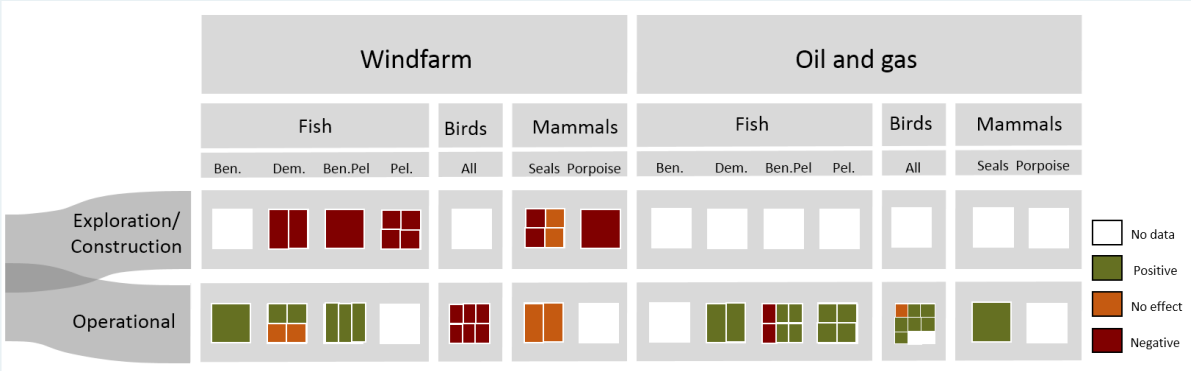


Assuming:
1. Current network needs preservation.
2. No other reasons for preserving structures than larval connectivity.
3. Impact sequential (see network analysis)

Mobile predators & man-made structures

- Scientific literature & EIAs to assess pressures during life-cycle of structure.
- Impact matrix:
  - Large gaps & varied findings.
  - Construction negative & operation positive.
  - Decommission limited, but construction similar.
- EIAs:
  - 2 / 11 predicted impacts (benthic ecology & conservation sites from seabed impacts, & birds from hydrocarbon releases)
  - Brent - habitat changes, increased turbidity, & noise from cutting activities.
- Standard receptor-based approach needed (e.g. operations tables produced by SCNBs)

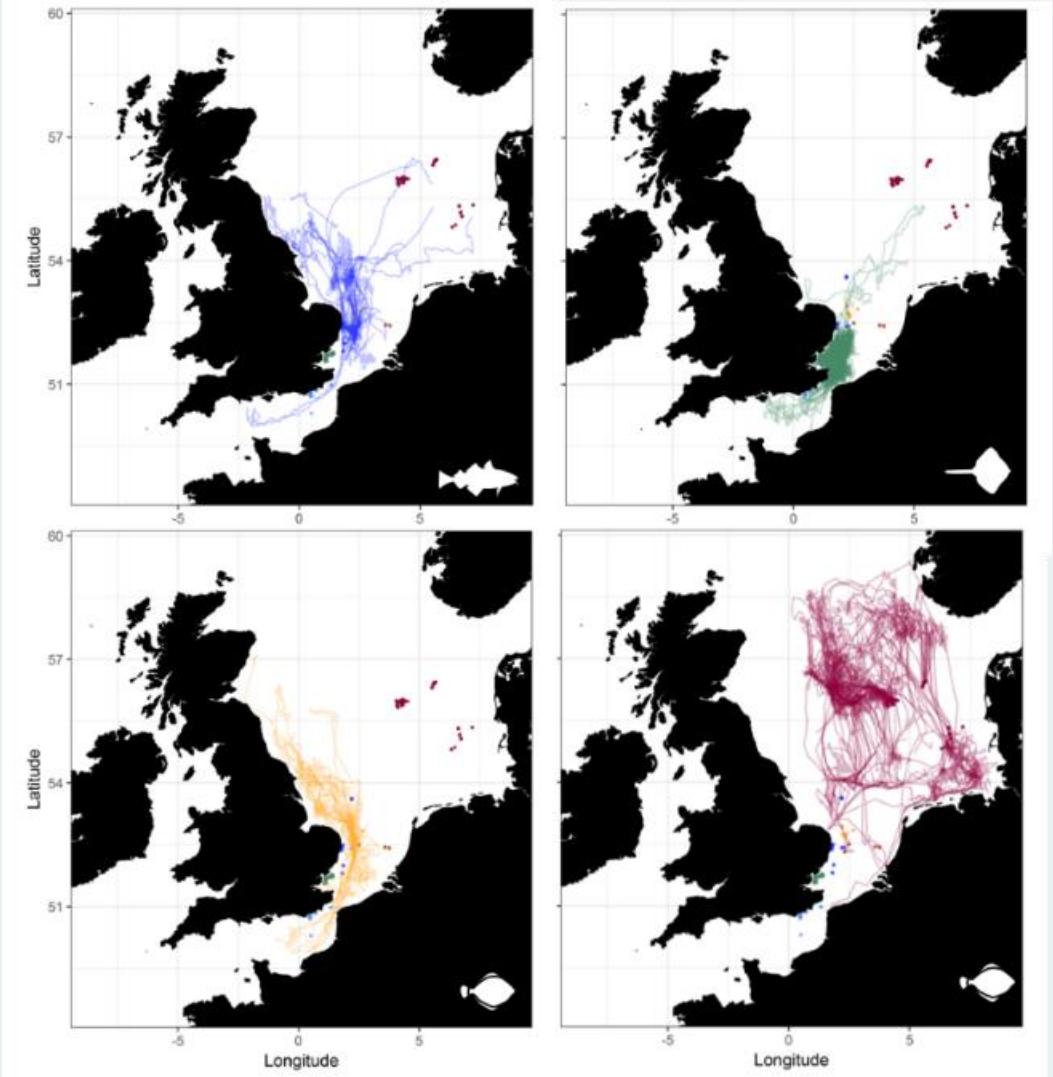




Randall et al. (in prep.) A review of the influence of man-made structures on fish, seabirds and marine mammals. Marine Pollution Bulletin.

Mobile predators – fish

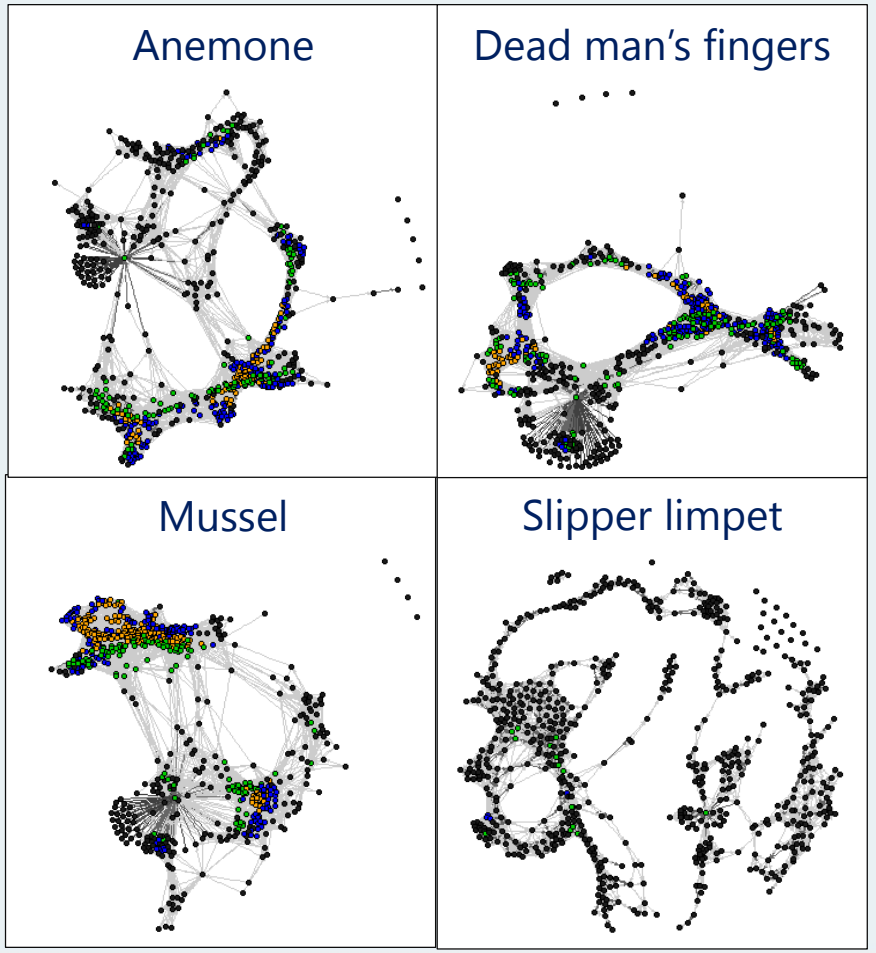
- Association of cod, plaice & rays with man-made structures from surveys & tagging.
- Compared fish distribution with physical, biological & man-made structures (GAMs).
- Models explained 12-50% (tagging) or 3-36% (survey) of deviance.
- Depth & temperature important, but wrecks, platforms, & cables also for cod, plaice, & rays.
- Cables important, so identification of condition & level of colonisation important



Wright et al. (in prep.) Structure in a sea of sand: The importance of man-made structures to fish assemblages in the North Sea. ICES Journal of Marine Science.

Impact of structures & decommissioning

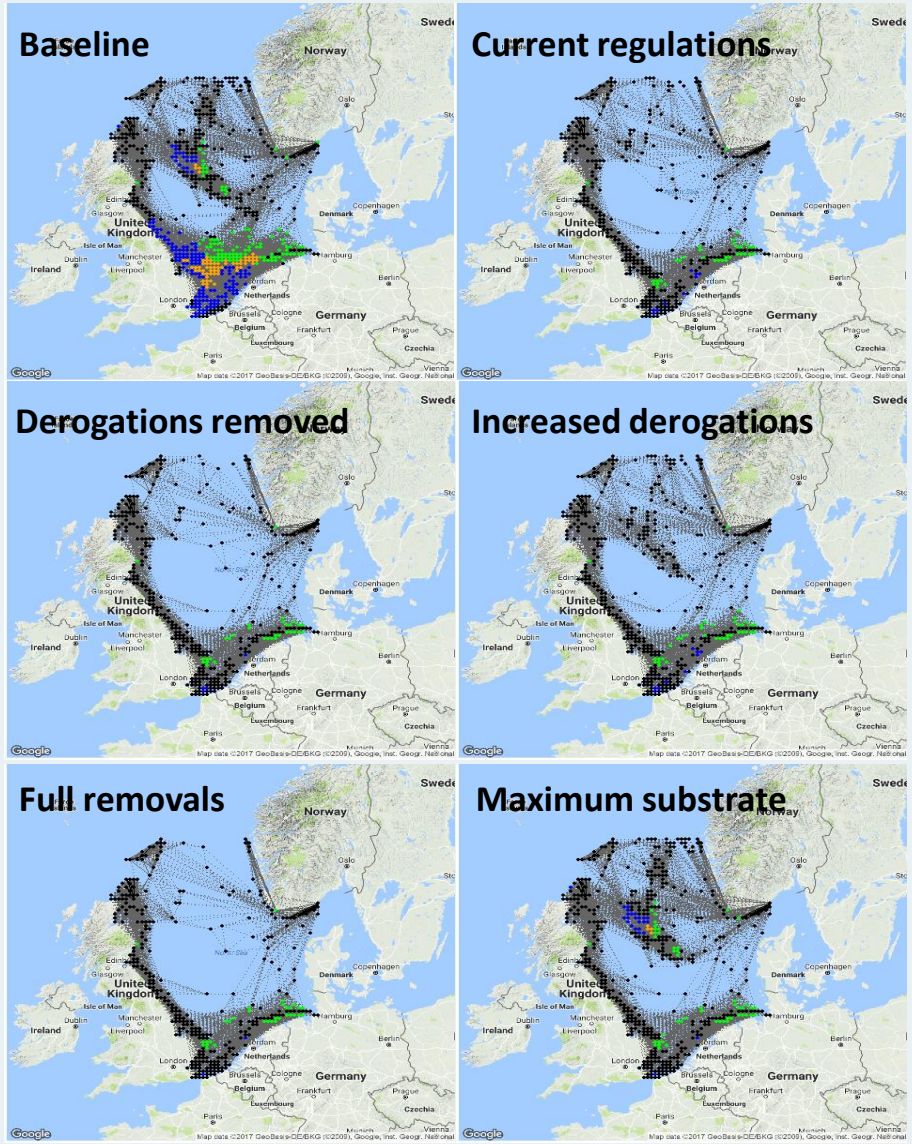
- Network analysis to compare structure & function:
  - Proportion of structures & substrate.
  - Community connectivity from particle tracking.
  - Establishment probabilities (successful if arrives)
  - Network attributes & models (26,269 edges, 625 nodes)
- 5 decommissioning strategies:
  - Current regulations.
  - Derogation removed.
  - Increased derogation.
  - Full removal.
  - Maximum substrate.



Tidbury et al. (in prep.). The impact of oil and gas decommissioning on ecological connectivity between hard substrate in the North Sea. Journal of applied ecology.

Impact of decommissioning

- Removal of oil & gas platforms led to less hard substrate & reduced connectivity:
  - Fewer edges, superspreaders & hotspots
  - Lower density, assortativity, in-degree & out-degree
  - Higher clustering
- More decommissioning led to larger reductions in connectivity in the northern North Sea.
- Largest effects between baseline, maximum substrate, & removals, but little effect of generic derogations – consider specific locations.



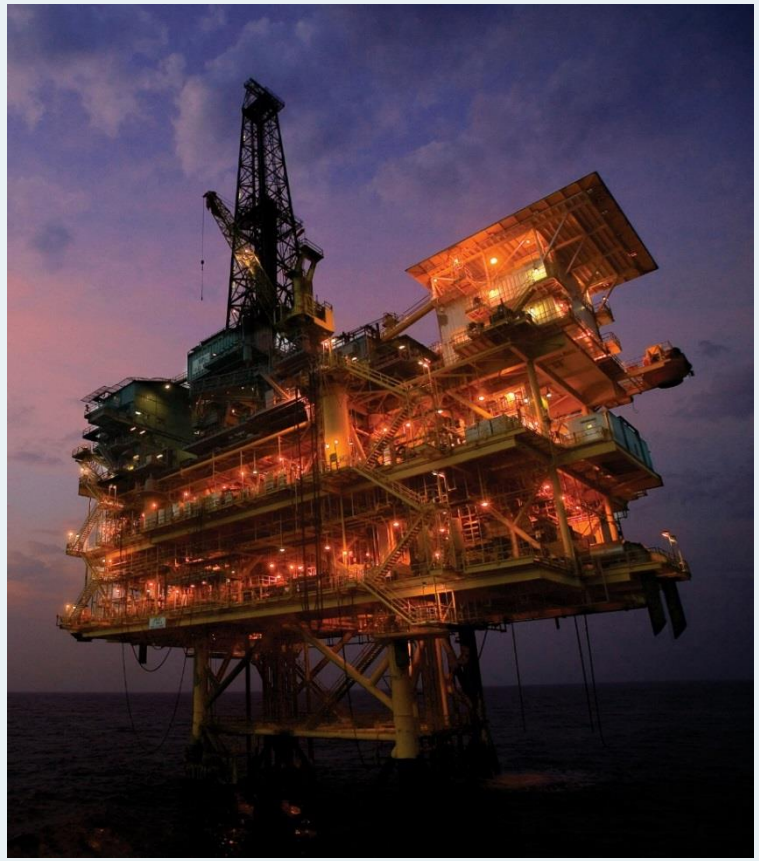
Tidbury et al. (in prep.). The impact of oil and gas decommissioning on ecological connectivity between hard substrate in the North Sea. Journal of applied ecology.

Recommendations for decommissioning

- Platforms have different impacts on connectivity, but consider retention of structures on western edge of central bank.
- Removal reduced connectivity, but generic derogations had limited effect - bespoke derogations required.
- Data needed lacking, so studies needed (industry data, reanalysis, ecological experiments, & genetics).
- Modelling network thinning, alongside network analysis & cumulative risk assessment needed to combine additional mechanisms & account for impacts.
- Cost-benefit of decommissioning on natural capital & ecosystem services, & costs of monitoring needed.

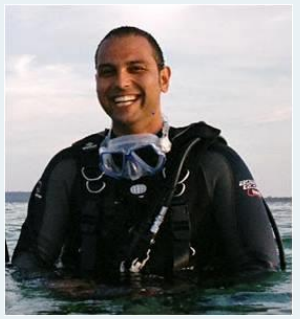
Summary

- Assessed influence of man-made structures on connectivity & impacts of decommissioning, but data were lacking & difficult to compile.
- Pelagic dispersal models showed variations in connectivity & indicated decommissioning decisions should be based on role & location of the structure.
- Network analysis showed man-made structures affect connectivity, with significant impacts on the network.
- Largest effects of decommissioning were with maximum substrate & full removal structures, with little impact of generic derogation – need bespoke approaches.
- Recommendations for decommission made based on EcoConnect findings (data, modelling, monitoring)



EcoConnect – multidisciplinary team

Kieran Hyder
EcoConnect Lead

Pelagic dispersal	Species selection	Data & GIS	Mobile Predators	Marine Licensing	Network Analysis	Synthesis
Johan van der Molen	Alex Callaway	Paulette Posen	Serena Wright	Karenna Randall	Hannah Tidbury	Kieran Hyder
						
Luz Garcia	Paul Whomersley	Chris Lynam	Susana Lincoln	Mark Kirby	Nick Taylor	Silvana Birchenough
						

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Thanks for your attention!

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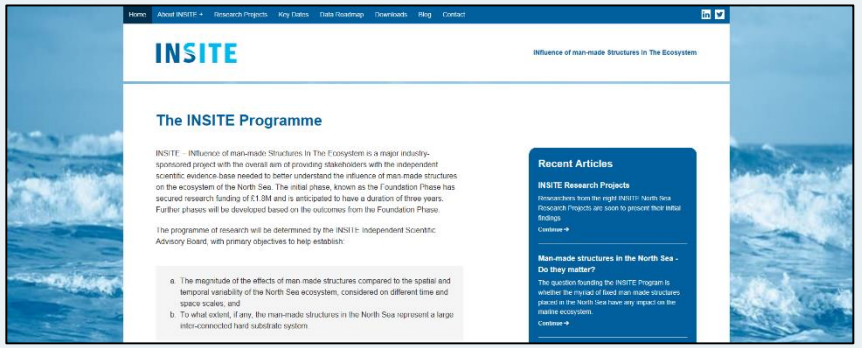

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