

“Science in support of ecologically sound decommissioning strategies for offshore man-made structures”: taking stock of current knowledge and considering future challenges”

Silvana Birchenough, Jennifer Dannheim, Clement Garcia, Jan Beermann, Joop Coolen, Ilse de Mesel & Steven Degraer, Kieran Hyder, Serena Wright, Christopher Lynam, Paulette Posen, Susana Lincoln and Joana Whittle.



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Background

ICES Journal of Marine Science



International Council for
the Exploration of the Sea
Conseil International pour
l'Exploration de la Mer

ICES Journal of Marine Science (2020), doi:10.1093/icesjms/fsaa039 doi:10.1093/icesjms/fsaa039

Introduction to the Themed Section: ‘Decommissioned offshore man-made installations’ Introduction

Science in support of ecologically sound decommissioning strategies for offshore man-made structures: taking stock of current knowledge and considering future challenges

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- A total of 15 papers published (04/2020)
- Several papers combining ecology, fisheries, modelling,
- Oil and Gas
- Offshore windfarms and wrecks.
- INSITE phase I
- Birchenough and Degraer (Eds.)



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Funded projects



RECON quantification of epifouling, connectivity between structures

EcoConnect larvae, epifouling and mobile species → network analysis

COSM food web of benthic and pelagic ecosystem

UNIDINE benthic structures, function and connectivity

ANChor dispersal potential of common rig species, connectivity

Shadow organic matter changes, larvae production

Data provision of relevant data for our analysis

SAHFOS quantification of plankton community related to MMS

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Introduction: Context

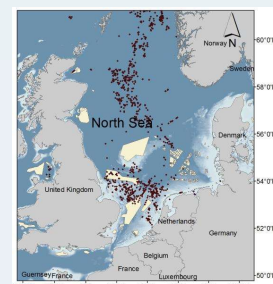
- Fundamental community differences between hard substrates and soft sediments;
- Rapid expansion of man-made structures (MMS) in the North Sea → offshore wind farms, wrecks & oil and gas platforms;
- The magnitude of structural and functional faunal changes induced by the introduction and decommissioning of MMS in the marine system.



Soft bottom

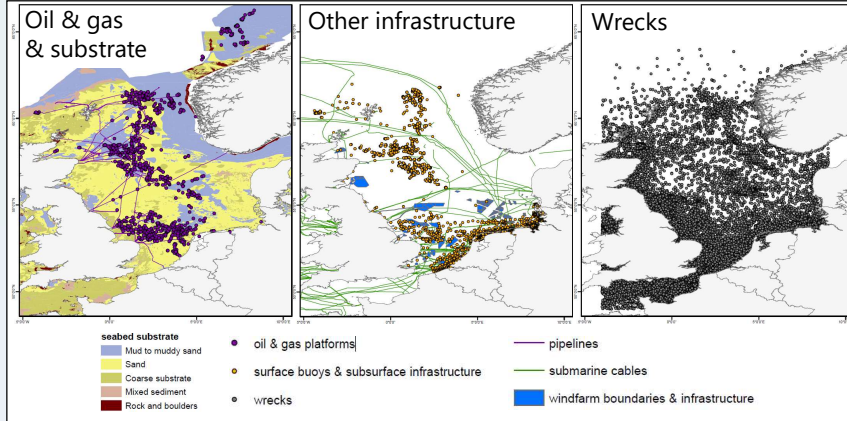


Hard substrate



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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

Evaluating the effects of man-made structures on the functioning of the benthic system in the North Sea

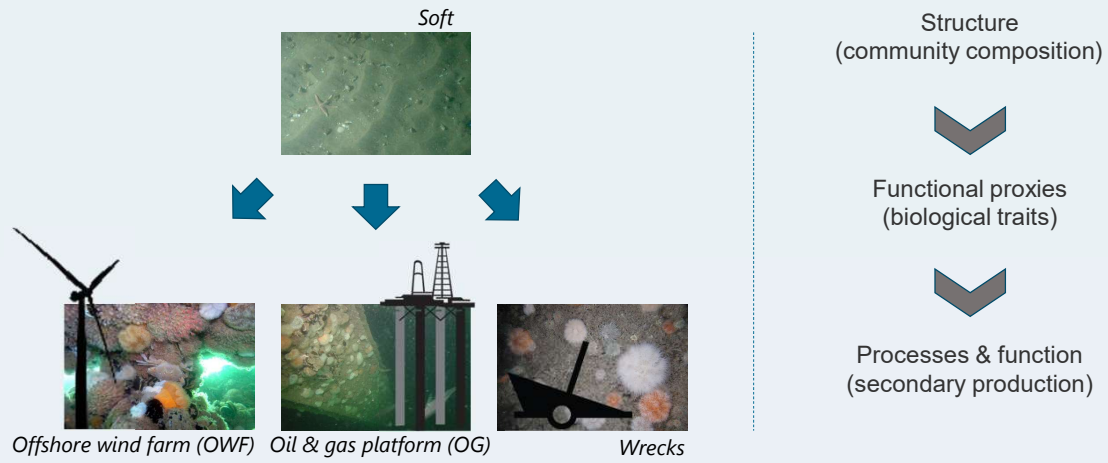
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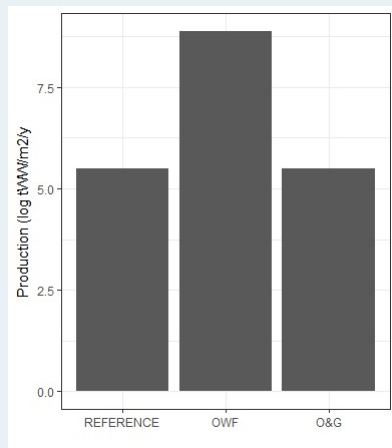


Introduction: UNDINE

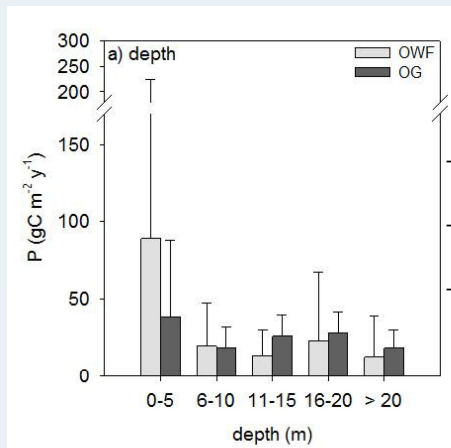
(Understanding the Influence of man-made structures on the Ecosystem functions of the North Sea)



Ecological process – Secondary production



Mass-balance estimation



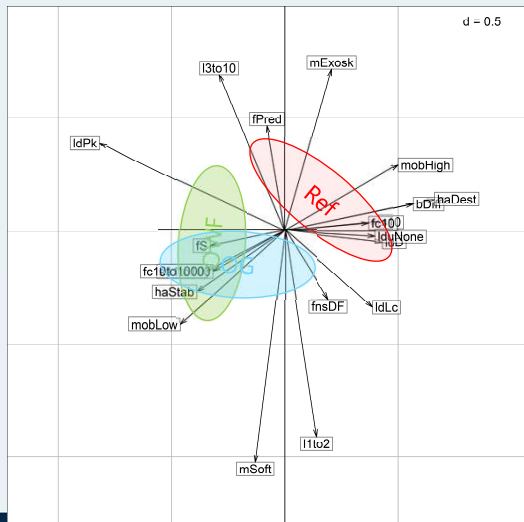
Artificial Neural Network estimation

Consistent between methods

Soft ~ OG < OWF

Only for shallow depths

Functional proxy: Biological traits

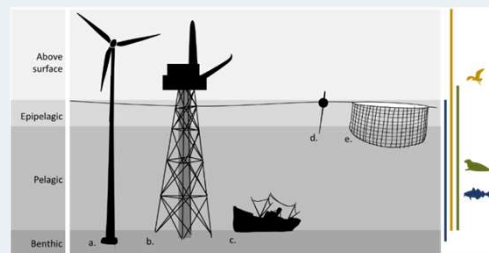


- Difference between soft sediment and MMS;
- Similar trait response from structure;
- No or marginal differences between OWF & OG.

Traits	Function
Habitat stabiliser Habitat creator	Habitat/Species diversity
Planktotropic Fecundity	Dispersal - Connectivity Recovery - Resilience
Filter feeder Biodeposition	OM supply Mineralisation – C recycling
Low mobility Soft body (?)	Food supply

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 similar to construction.
- EIAs:
 - 2 / 11 projects 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)

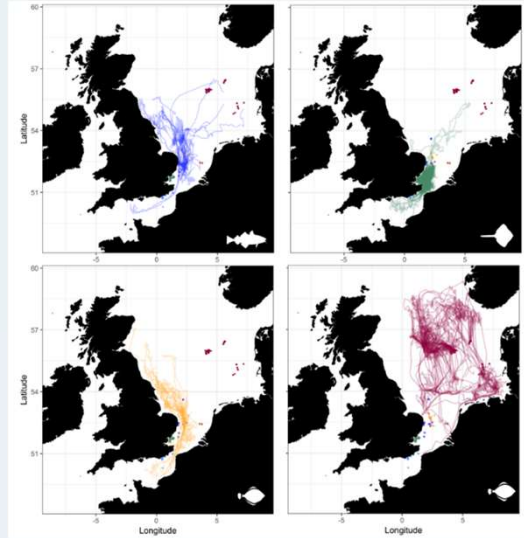


	Windfarm					Oil and gas									
	Fish		Birds	Mammals		Fish		Birds	Mammals						
	Bem.	Dem.	Bem.Pel.	Pel.	All	Seals	Porpoise	Bem.	Dem.	Bem.Pel.	Pel.	All	Seals	Porpoise	
Exploration/ Construction	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Operational	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

Legend: ■ No data, ■ Positive, ■ No effect, ■ Negative

Mobile predators – fish

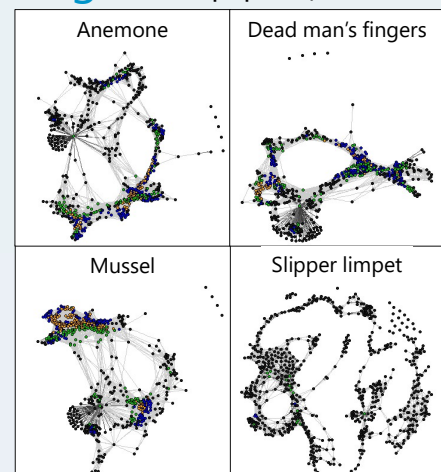
- Association of cod, plaice & rays with man-made structures from surveys & tagging.
- Compared fish distribution with physical, biological & man-made structures (GAMs).
- Models explained 12-50% (tagging) or 3-36% (survey) of deviance.
- Depth & temperature important, but wrecks, platforms, & cables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



Impact of structures & decommissioning

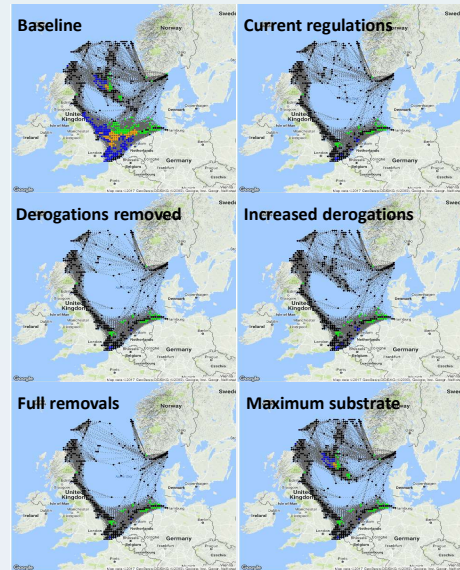
- Network analysis to compare structure & function:
 - Proportion of structures & substrate.
 - Community connectivity from particle tracking.
 - Establishment probabilities (successful if arrives)
 - Network attributes & models (26,269 edges, 625 nodes)
- 5 decommissioning strategies:
 - Current regulations.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

- Superspreaders (outdegree >20)
- Supersinks (indegree >20)
- Hotspots (supersinks & superspreaders)



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.



Recommendations (decommissioning)

- Platforms have different impacts on connectivity (species & years), **consider retention of structures at certain areas.**
- Removal reduced connectivity. **Maximise ecological benefits based on platform location & function.**
- **INSITE Data initiative**, so new data sets, new studies needed (industry data, reanalysis, ecological experiments, & genetics).
- **Modelling needed of network thinning, network analysis & cumulative risk assessment that combine additional mechanisms & account to assess both positive & negative impacts.**
- **Cost-benefit analysis of decommissioning on natural capital & ecosystem services, & costs of monitoring needed.**





EcoSTAR (Ecosystem level importance of STructures as Artificial Reefs)

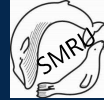
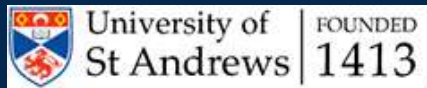
- EcoSTAR aims to:

"Investigate the impact of man-made structures (including oil and gas platforms, pipelines, and marine renewable energy installations) on marine ecosystems in the North Sea"

- PI's: Debbie Russell (St Andrews) Silvana Birchenough (Cefas)



EcoSTAR | SMRU (st-andrews.ac.uk)



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Thank you for your attention!



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