

INSITE

Influence of
man-made
structures in
the ecosystem

The Influence of Man-made Structures in the North Sea INSITE Phase 1 – Summary of Outcomes

ISAB Independent Scientific Advisory Board

Aberdeen Symposium,
Aberdeen, 11 December 2017



- Oil & Gas UK Decommissioning Baseline Study JIP (2011-2012):
 - Serious **lack of data** to describe the influence of man-made structures (MMS) on the North Sea ecosystem
- 2013: **Oil & Gas UK facilitated INSITE**, a JIP to improve knowledge on the influence of MMS on the North Sea ecology
 - Provide scientific **evidence to understand the effects of MMS**
 - Better information for future **decommissioning** decisions
- **Man-made structures (MMS) cover**
 - Fixed steel and concrete **oil and gas installations & pipelines**
 - Renewable energy structures (e.g. **windfarms**).
 - **Shipwrecks**
 - (Shipping and fishing activity is only included if it has a direct impact on the influence of MMS)

Overall objective:

“To provide stakeholders with the independent scientific evidence-base needed to better understand the influence of man-made structures on the ecosystem of the North Sea”

SPECIFIC OBJECTIVE 1: ‘EFFECTS’






Investigate the magnitude of the effects of man-made structures compared to the spatial and temporal variability of the North Sea ecosystem, considered on different time and space scales.





SPECIFIC OBJECTIVE 2: ‘CONNECTIVITY’

To what extent, if any, do the man-made structures in the North Sea represent a large inter-connected hard substrate system?

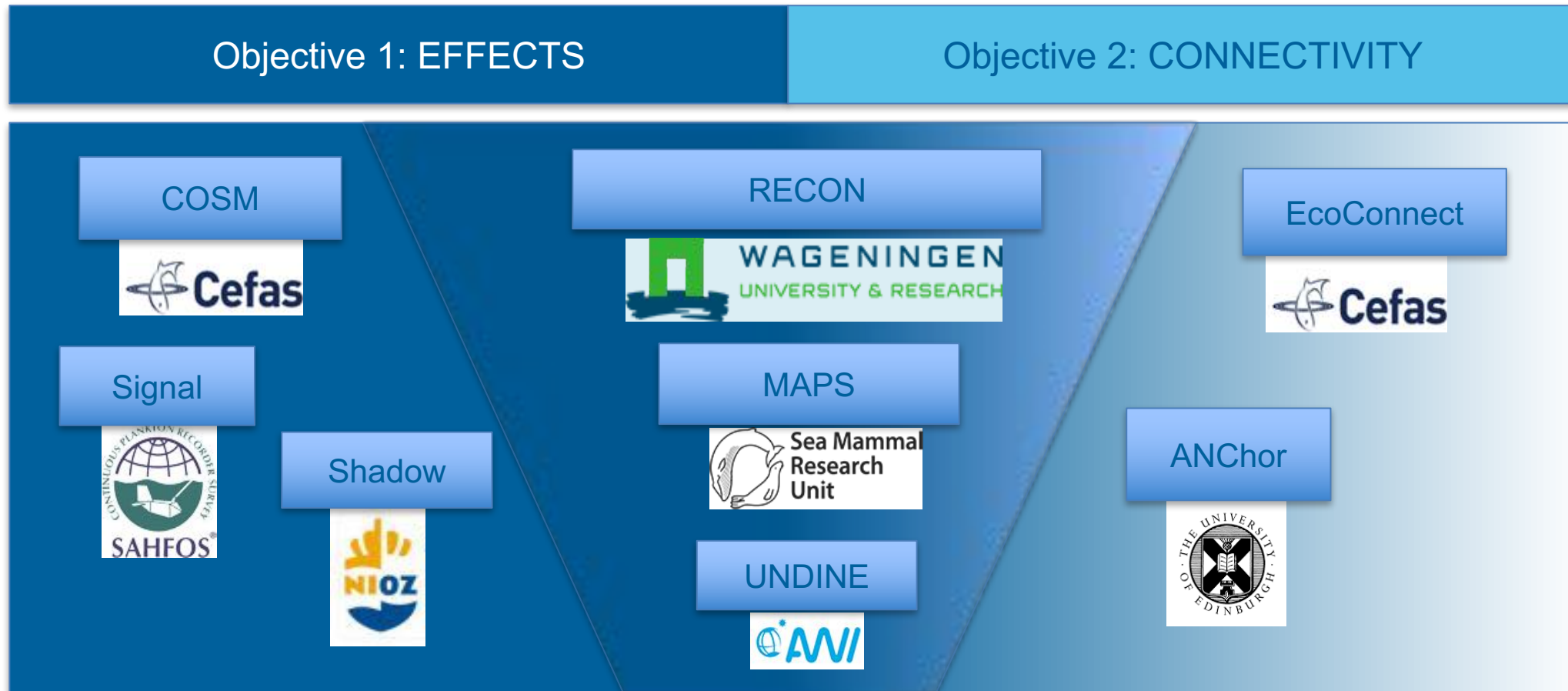
Focus on

- identification, **collection, synthesis, and analysis of available data**
- to a lesser extent **generation of new data,**
- **model development,** implementation, and testing,
- **preliminary model runs** with available data to achieve INSITE objectives

Primary Institution		Countries	Title of Research
Alfred Wegener Institute (AWI), Helmholtz Centre for Polar and Marine Research		Germany, Belgium, UK, Netherlands	UNDerstanding the INfluence of man-made structures on the Ecosystem functions of the North Sea (UNDINE)
CEFAS Laboratory		UK	Assessing the Ecological Connectivity between man-made structures in the North Sea (EcoConnect)
CEFAS Laboratory		UK	Coupled Spatial Modelling (COSM) – trophic effects due to structures and habitat change in the North Sea
IMARES		Netherlands	Reef effects of structures in the North Sea: Islands or connections? (RECON)
Royal Netherlands Institute for Sea Research (NIOZ)		Netherlands Norway	Measuring the shadow effect of artificial structures in the North Sea on the surrounding soft bottom community (Shadow)

Primary Institution	Country	Title of Research
University of Edinburgh 	UK	Appraisal of network connectivity between North Sea subsea oil and gas platforms (ANChor)
Sea Mammal Research Unit (SMRU), University of St Andrews 	UK	Man-made structures and Apex Predators: Spatial interactions and overlap (MAPS).
Sir Alistair Hardy Foundation for Ocean Science (SAHFOS) 	UK	Influence of Man-Made Structures in the ecosystem: Is there a planktonic signal? (Signal)
University of Edinburgh 	UK	INSITE Data Initiative

Mapping the Programme to the INSITE Objectives



Effects on hard bottom communities

- **Installation of MMS have changed the geographical distribution of hard bottom communities** in the NS, and altered the structure of NS biodiversity.
- **Data on species composition have been compiled** from about 80 UK, Dutch, and Danish O&G and wind farm installations.
- **Detailed description of epigrowth communities** only from MMS in the southern NS.
 - **3 geographical clusters** of installations with similar community structure
 - Community structures on **wind farms differ from that on O&G installations** and wrecks.

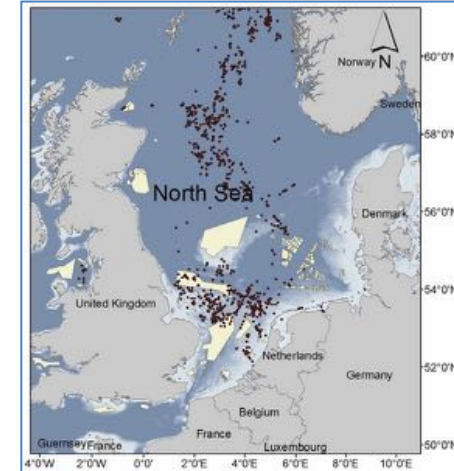


Photo: J. Coolen

Effects on the surrounding benthos

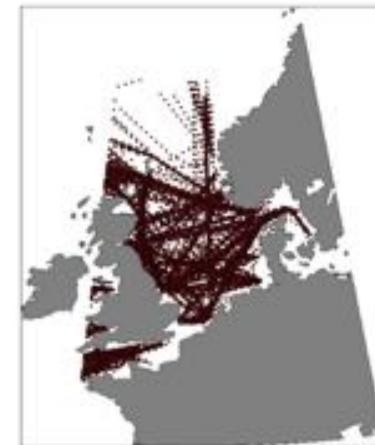
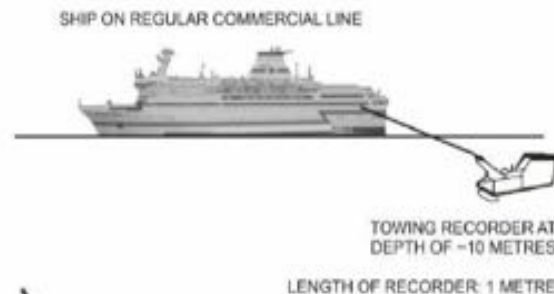
- Model and field studies at MMS in the **southern North Sea**.
- Presence of installations **affects the surrounding soft bottom community**
 - (not just from discharges)
- Changes in sediment **chemical composition, production, organic turnover, and species abundance**
- Effects on species **composition, taxonomic diversity, and biological trait structure** are suggested
- The effects are subtle and generally detectable **inside a 1 km periphery**
- **Validation of model results** by observations has **not yet been sufficient**
- **Validity of extrapolation** to the greater North Sea is **not yet known**



Effects on plankton

- Long term and seasonal North Sea plankton variations **correlate mainly with surface temperature and wind**. Effects of MMS on the plankton community including larvae of benthic species **appear to be marginal**.
- The present **plankton sampling regime** (CPR ¹⁾) was not designed for (and is **not adequate for**) assessing the **local effects** of MMS

1) Continuous Plankton Recorder



Source: Signal

Effects on top predators

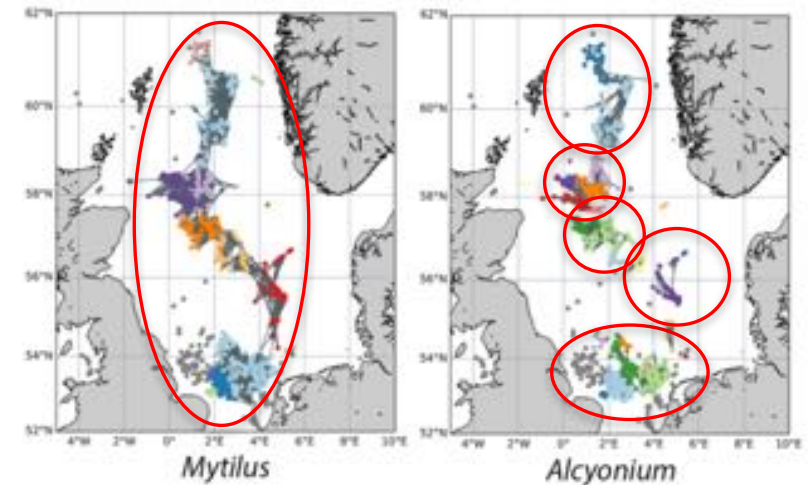
- **Distribution and behaviour** of fish, birds and mammals are **mainly regulated by environmental factors**, with only a weak association with MMS.
- The **removal of oil and gas platforms and pipelines** may ultimately contribute to **declines in some aggregated organism groups, but increases in others**
- MMS may have an influence on individual behaviour, but **effects at the population level are not likely.**



Source: MAPS

Conclusions **Objective 2**: *To what extent, if any, do the man-made structures in the North Sea represent a large **inter-connected hard substrate system**?* 1/3

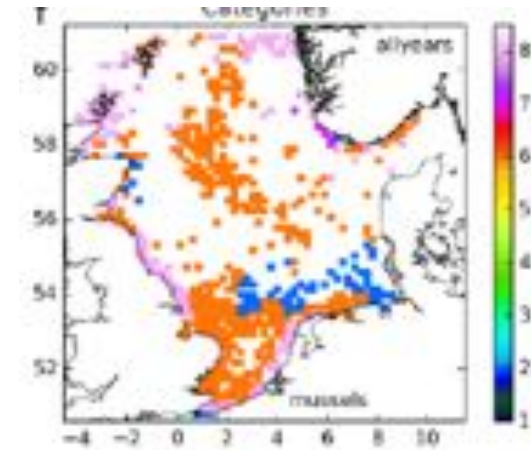
- Network analysis **confirms two well-connected networks of larval exchange** for selected hard bottom species across the greater North Sea:
 - One in the south region
 - One in the north, central region (subdivided into clusters of MMS)
- For certain species and oceanographic conditions a **North Sea-wide network of hard bottom substrates** is indicated
- There are likely **interconnections between the open ocean networks and coastal biotopes** (MMS and natural)
- Connectivity pattern is **species specific** and strongly dependent on reproductive traits
 - **Spawning season, duration of larval pelagic life**
- Networks **vary between years** as function of oceanographic conditions



Source: ANChor

Conclusions Objective 2: *To what extent, if any, do the man-made structures in the North Sea represent a large **inter-connected hard substrate system**? 2/3*

- Regions and clusters of MMS have been identified as being **“Suppliers/sources”, “Conductors”, and “Receivers”** of hard bottom larvae.
 - Certain MMS may act as **critical bridges between separated networks**.
 - “Source” MMS generally along the central axis of the North Sea, “Receivers” more coastal
- **No evaluation yet as to whether these connectivity roles or functions are significant**



Source: EcoConnect

Conclusions **Objective 2**: *To what extent, if any, do the man-made structures in the North Sea represent a large inter-connected hard substrate system?* 3/3

- Interconnection studied by **genetic fingerprinting** (southern North Sea)
 - *Mytilus edulis* (blue mussel)
 - **Long larval stage**
 - Population genetics results confusing
 - Larval transport contributed to initial mussel colonization on MMS.
 - No support for ongoing connectivity
 - *Jassa herdmani* (amphipod crustacean)
 - **No pelagic larval stage**
 - Genetic pattern shows isolated populations on most sampled MMS
 - Hypothesis is that *J. herdmani* colonized the MMS once and then developed genetically distinct populations
 - No explanation for why larval exchange occurred in the past and not now



Is the MMS impact on the NS ecosystem sensitive to decommissioning options? (preliminary results from model predictions)

- An important driver for industry engagement in INSITE is to **improve the knowledge base that can inform decommissioning strategy**
- INSITE Objective 1
 - The **marginal impact of MMS** on the overall North Sea ecosystem structure **suggests resilience against decommissioning options.**
 - Removal of installations will most likely **have a local impact on the soft bottom ecosystem.**
- INSITE Objective 2
 - Scenarios that **remove more oil and gas structures have a larger negative impact** on connectivity networks of MMS
 - **Generic derogation (OSPAR 98/3) has little impact**, probably due to the small changes in size of the hard substrate areas
 - Some clusters and sites of MMS seem **more important than others in keeping the networks connected**

- A major step has been made to **compile available data** on the **physical features** of MMS, their associated **flora and fauna**, and **biological characteristics** of the surrounding benthos.
- These are crucial for Phase 2 and should be extended. Need to add Norwegian data.
- **Still a major challenge to make existing environmental data available** to the projects
- Studies of the available data have **improved our knowledge of the geographical and depth distribution of offshore hard bottom biodiversity** in the North Sea.
- Another major step has been to **identify, adopt, implement, test, and run a range of dispersion and ecosystem numerical models**, separately or in concert to achieve the INSITE objectives

- INSITE has **provided model and field evidence that the physical presence of MMS and their epigrowth influence the surrounding benthos**, but only locally.
- INSITE has provided **the first estimates of the scale of ecological influence** of MMS on plankton communities and top predators. The influence is marginal relative to natural factors.
- In spite of different modelling approaches INSITE results indicate **that several common species do form interconnected networks** through larval dispersion between MMS
- The networks are **dependent on species specific reproductive traits** as well as oceanographic conditions
- INSITE has demonstrated **the value of DNA barcoding and population genetic fingerprinting** to support species specific connectivity modelling.
- The connectivity and network analysis modelling tools developed within INSITE are potentially **useful to support decommissioning decisions** (but need to be quantified).

- **Ground-truthing (validation) of model results** has been done in some instances, but needs to be encouraged. Validation is **hampered by insufficient field data**.
- **Phase 1 research is geographically unbalanced.**
 - Only four projects cover the whole North Sea (including the Norwegian sector)
 - The others have only dealt with the southern part of the North Sea, or the British sector.
 - Validity of extrapolation to the greater North Sea has not been assessed
- The **project results** need to be **quantified** more thoroughly, e.g.
 - Short-term vs long-term effects
 - local vs regional effects,
 - NS-wide influences of MMS

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- Phase 1 was intentionally designed as the **Foundation Phase**
 - **A good foundation has been laid...**
 - **Much relevant data** has been collected and collated
 - **Appropriate models** have been developed and implemented
 - Some *preliminary analysis* has been undertaken
 - **No major surprises**: impacts exist but appear to be small
 - **Connectivity can be detected**, but model validation is insufficient and significance is undetermined
 - **No firm evidence** relevant to decommissioning yet
 - Need to **proceed with Phase 2**: Data analysis & quantitative modelling
 - Need for **continuing industry support** to match NERC (science-led) funding, and to maintain the **international nature** of the programme