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An Insight into INSITE

Professor Dickon Howell

Howell Marine Consulting,
Visiting Professor of Practice, Newcastle University
INSITE Programme Director

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The Programme

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INSITE:

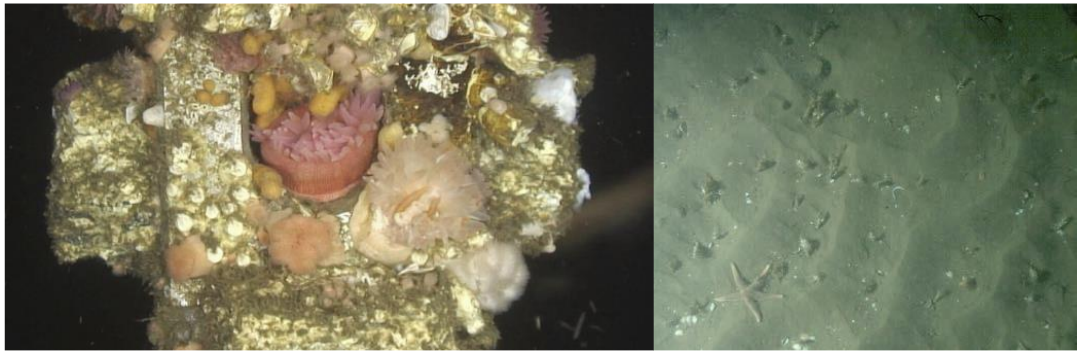
INfluence of man-made Structures In the Ecosystem

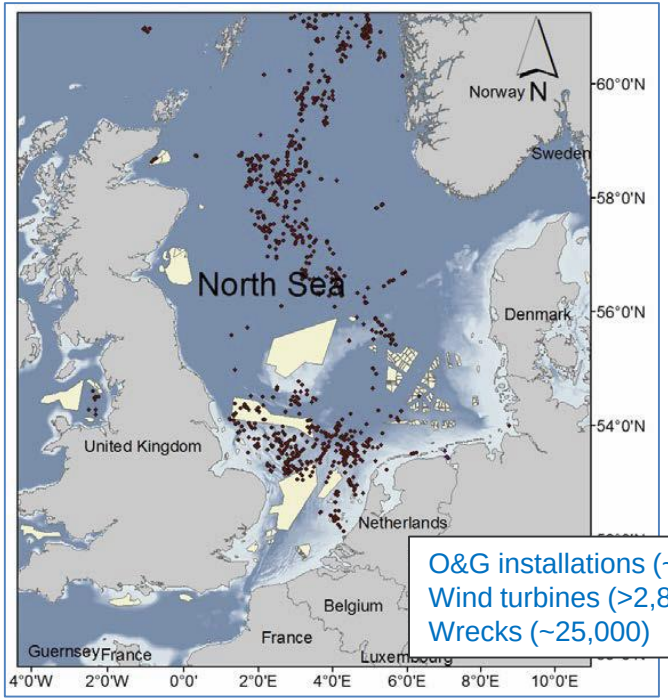
Objective:

“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”

North Sea Habitat: Natural and Artificial

- Large number of artificial hard substrates on natural sandy and muddy bottoms
- Extend from the seafloor to the surface
- Fundamental fauna difference on hard and soft bottom substrates





Source: INSITE RECON

INSITE Programme: 2014 to 2023

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INSITE Phase 1

INSITE Phase 2

2014	2015	2016	2017	2018	2019	2020	2021	2022	2023

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INSITE Sponsors: £2.4Million

8 Research Projects

1 Data Project

Cefas · SAHFOS · The University of Edinburgh · NIOZ · Sea Mammal Research Unit · AWI · Heriot-Watt University · Wageningen University & Research

INSITE · NERC Science of the Environment · Cefas20 1902–1997–2017

NERC: £5.0Million

CEFAS: £600K

7 Research Projects

Synthesis Project

Sea Mammal Research Unit · Cefas20 · University of Southampton · National Oceanography Centre · University of Aberdeen · University of Strathclyde Glasgow · University of Essex · Heriot-Watt University · PML Plymouth Marine Laboratory · SAMS Scottish Association for Marine Science

INSITE Sponsors: £1.9Million

INSITE Interactive – Data Sharing Initiative

PhD Scholarship Programme (6 PhD's)

INSITE Phase 2: NERC-Funded Programme: 2020-2023

Dr Debbie Russell St Andrews University	**EcoSTAR** Ecosystem level importance of Structures as Artificial Reefs	• Improve our understanding of the importance of MMS as habitat for benthic communities such as mussels, anemones and starfish; • Measure how MMS influence the distribution and movement patterns of marine mammals in the North Sea
Dr Daniel Jones National Oceanography Centre	**ATSEA** Autonomous Techniques for anthropogenic Structure Ecological Assessment	• Fully autonomous environmental monitoring of multiple man-made structures without the aid of a support vessel
Prof Paul Fernandes University of Aberdeen	**FISHSPAMMS** Aggregation, production and spillover: the cumulative effect of man-made offshore structures on fish	• Analyse new and legacy acoustic data to estimate the density of fish as a function of distance to MMS and other covariates, and estimate abundance of fish at all MMS

INSITE Phase 2: NERC-Funded Programme: 2020-2023

Dr Natalie Hicks University of Essex	**FuECoMMS** Functionality and Ecological Connectivity of Man-Made Structures	• Determine how the removal or placement of MMS will affect marine biodiversity and ecosystem function (including services and economic value) of associated benthic habitats
Dr Paul Somerfield Plymouth Marine Lab	**DREAMS** Decommissioning - Relative Effects of Alternative Management Strategies	• To conduct comprehensive and systematic analyses of all available relevant information to understand the roles of installations in the sea, how these vary under decommissioning scenarios
Dr Joanne Porter Heriot Watt University	**CHASANS** Connectivity of Hard Substrate Assemblages in the North Sea	• What role does substrate type have on connectivity of epifaunal populations? • How will network connectivity be altered by future changes following decommissioning and/or installation?
Dr Tom Wilding Scottish Association of Marine Science	**NS3D** Novel 3D imaging to quantify biomass and secondary production on artificial structures	• How can novel 3D imaging techniques be used to provide date to model the relationship between ecosystem function and artificial structures within the North Sea according to structure type, location, depth, age and food supply?

Highlights of research so far

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EcoSTAR	Marine predators are showing preferential use of structures for foraging, but also seals may be using them for navigation
ATSEA	Planned autonomous vehicle voyage over 1500km, travelling from Shetland around the North Sea, visiting three decommissioning fields and a marine protected area, before returning to Shetland.
FISHSPAMMS	Fish densities may be elevated over much greater ranges from MMS than previously reported. Instead of 10s of metres from platforms, preliminary North Sea findings suggest they may remain elevated to several kilometers
FuECoMMS	500m exclusion zone of MMS protects the seabed from much human activity (e.g. trawling). These sediments are vital stores of blue carbon, and sediment disruption could have implications for climate change.

Highlights of research so far

DREAMS	Although the evidence has grown exponentially since the 1970s, there are key gaps in critical areas required for the design of sustainable ecosystem decommissioning options considering environmental, social and economic benefits. Greater understanding of these impacts is required to ensure decommissioning options deliver optimal ecosystem outcomes
CHASANS	The project has been working with the oil and gas industry to understand mitigation for environmental risk associated with the removal and deployment of infrastructure
NS3D	Trained computers to identify most elements of marine growth and superimpose the ID onto 3D models generated from ROV footage. The anemone Metridium dianthus is dominant taxa on North Sea MMS and MMS host communities of cold-water corals.

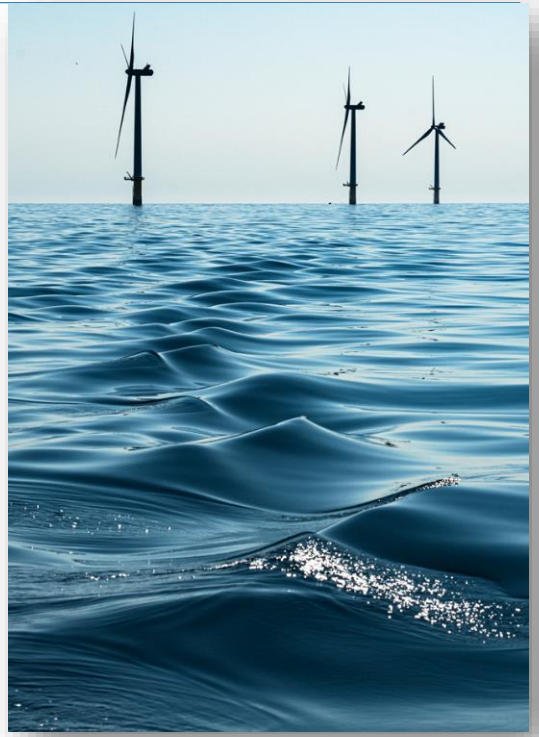
North Sea 3D

Estimations of biofouling biomass on North Sea Man Made Structures (MMS)

Joe Marlow, John Halpin and Tom Wilding
Tom.wilding@sams.ac.uk

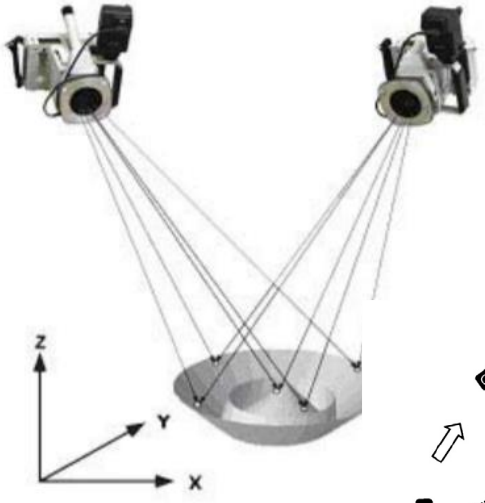
North Sea 3D

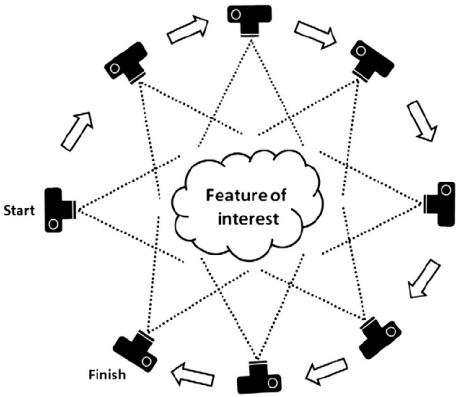
- **Aim:** improve marine growth biomass estimates for North Sea MMS
- **Methods:** combining photogrammetry & machine learning
- **Data source:** industry/SAMS ROV footage, and supported by our aquarium data
- **Deliverable:** statistical (predictive) model for marine growth biomass on MMS across the North Sea.



3D photogrammetry - how does it work?

- Common points in overlapping 2D images are identified
- The points are used to construct a line of sight from each point to camera
- The lines of sight intersect to give 3D co-ordinates of points
- Accuracy of measurements improves as more observations (photos) added





Machine learning

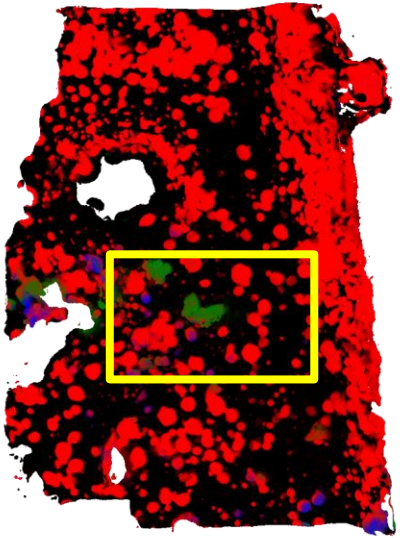
- Modern machine learning, via convolutional neural nets, has revolutionised image analysis
- We are training machines to identify marine growth
- Machines can be trained to identify if an image contains an object, how many objects are contained or to classify each pixel in an image

Combined 3D models and autoID

ROV Footage

3D Model

AI Annotated 3D Model



ROV survey supported by Marine Scotland Science.

Extracting volume- closing the mesh.

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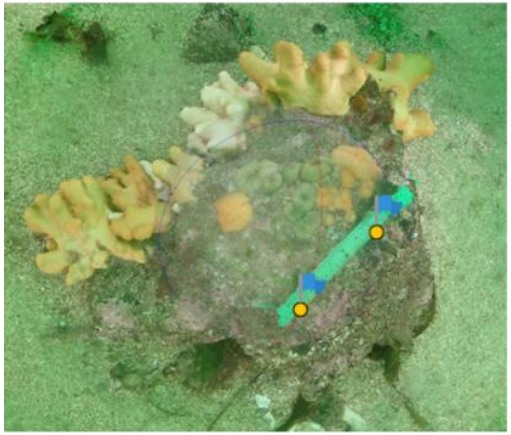
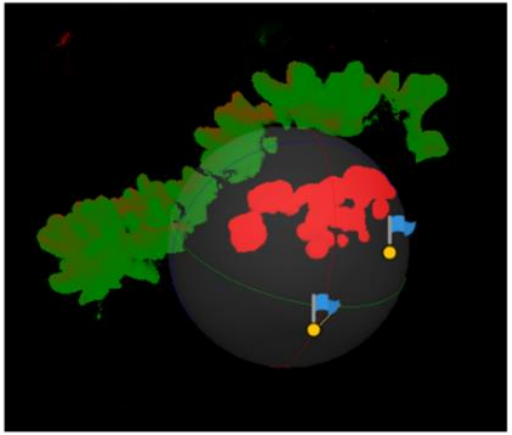
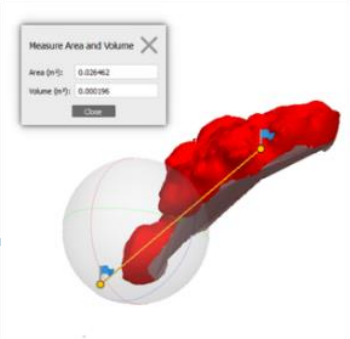
Model



Auto Id



Extracted Species Volumes



Summary

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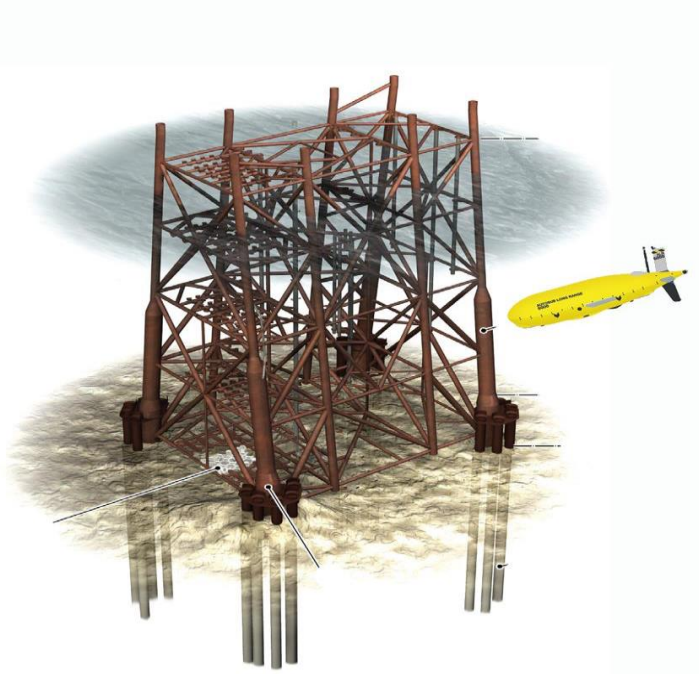
- From the ROV footage that we have acquired we are
  - Successfully generating 3D models from industry ROV footage
  - Successfully training models to ID marine growth
  - Successfully linking autoID 3D models
- We are meeting the technical challenges
- Our major challenge is obtaining sufficient ROV footage from across the North Sea

National Oceanography Centre

Autonomous Techniques for infraStructure Ecological Assessment (AT-SEA) Update

Daniel Jones, Andrew Gates, Veerle Huvenne, Mike Clare, Douglas Connelly, Anna Lichtschlag, Phil Bagley, Erik Simon-Lledo (National Oceanography Centre)
Blair Thornton (University of Southampton)



Project objectives

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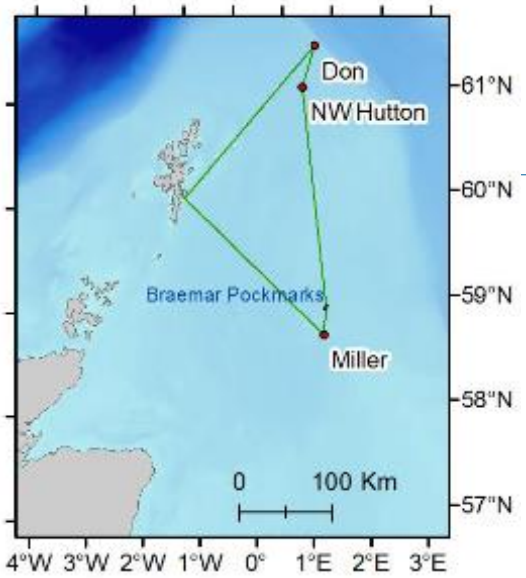
- Carry out the first **fully autonomous environmental monitoring** of multiple decommissioning-related sites **without the aid of a support vessel**.
- Combine autonomously collected seafloor visual imagery, mapping and water column sensor-based measurements to produce an **integrated environmental assessment** at sites relevant to decommissioning.
- **Directly compare** the **autonomously-collected data** with corresponding data obtained by current **standard methods** in the same areas.
- **Demonstrate** how a **fully autonomous approach** can lead to major advances in data quality, quantity and cost savings over traditional approaches.

Fully Autonomous Survey

- Shore launch - Shetland
- Don
  - 160m depth, produced oil, an entirely subsea development with pipelines, set for decommissioning during the project
- NW Hutton
  - 144m water depth, produced oil and gas, a steel jacket platform partly removed during decommissioning in 2009
- Braemar Pockmarks Special Area of Conservation
  - 120m depth. An area with known persistent hydrocarbon seepage
  - act as an analogue for a decommissioning leakage scenario
- Miller
  - 102m depth, produced oil and gas, a steel jacket platform (upper jacket already removed)
- Return Shetland
- Total transit length 750 km, ~20 days



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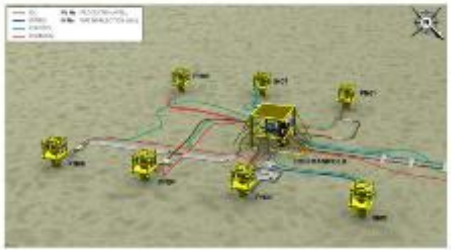
NW Hutton

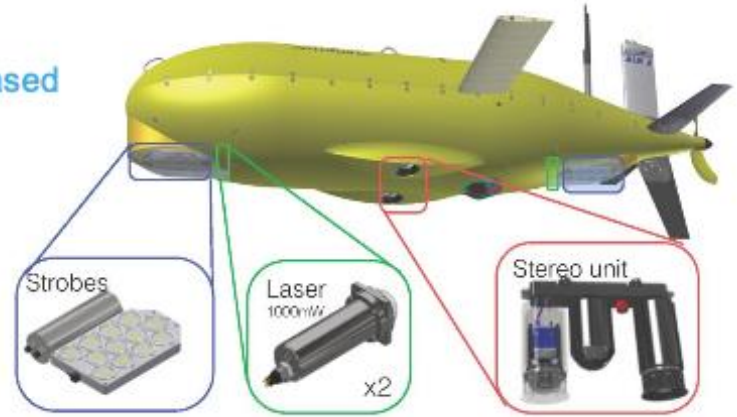
Miller



Don

Autonomous Platform

- NOC Autosub Long Range vehicle
- Range: 6000km (ALR1500); 1600km (ALR6000)
- Sensors
  - Seabird SBE 52 MP conductivity, temperature, depth, with SBE43F dissolved oxygen;
  - 300 kHz RDI workhorse acoustic Doppler current profiler (ADCP) with bottom tracking capabilities)
  - Hydrocarbon sensors
    - Wetlabs seaOWL UV-A fluorescence-based oil-in-water sensor
    - Chelsea Technology UV AquaTracka
    - Franatech METS Methane sensor)
  - BIOCAM seabed imager.



Scale

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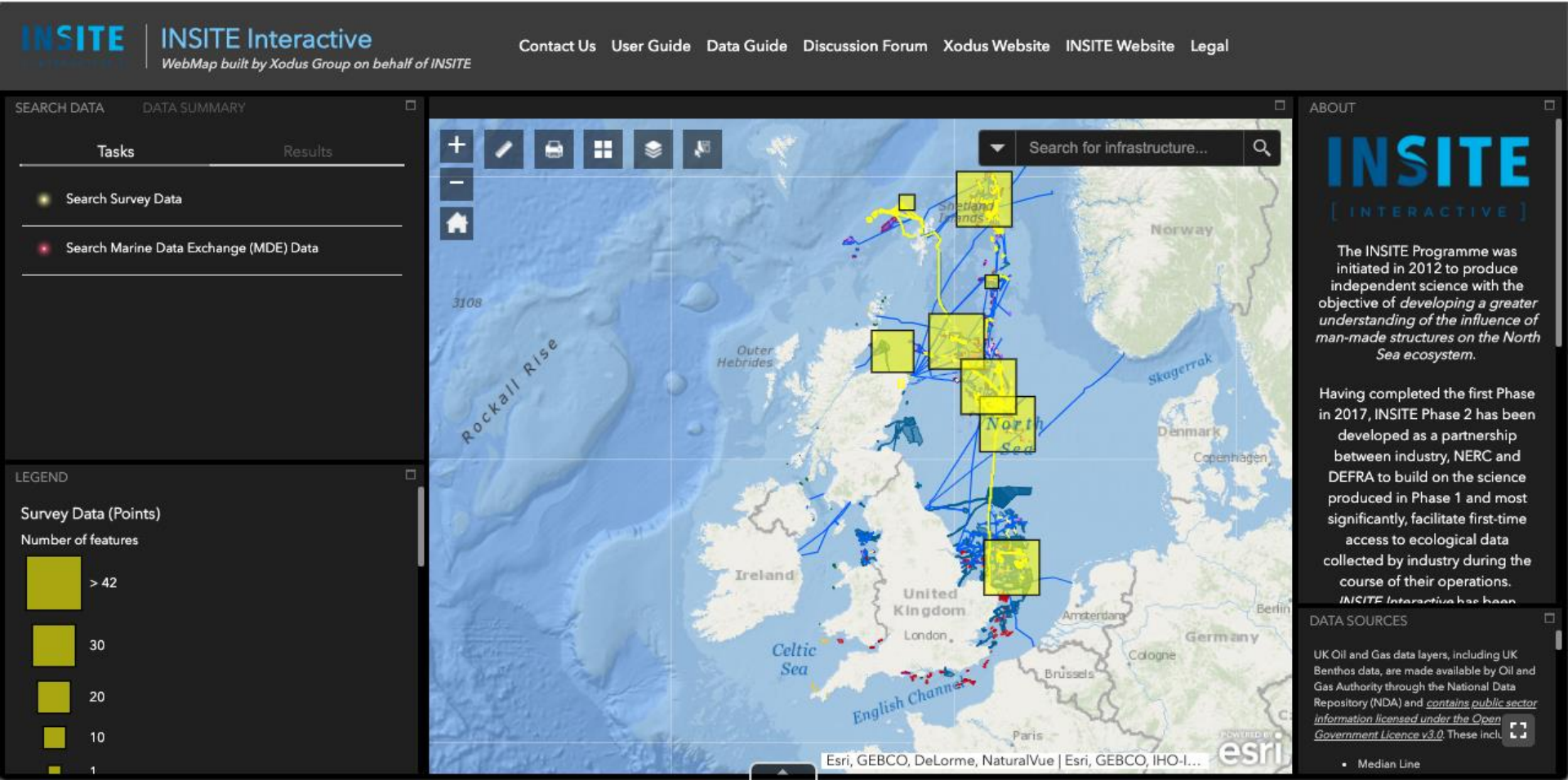
INSITE Industry-Funded Programme: 2020-2023

- ***INSITE Interactive***
  - GIS-based Data sharing project
  - Making Industry data available for scientific research
- ***INSITE PhD Scholarship Programme***
  - Six PhD Scholarships awarded
  - Four institutions
- ***INSITE Synthesis Project – Co-funded with NERC***
  - Synthesis of all INSITE-related research
  - Performed by a team of international scientists
  - Aimed to produce policy relevant publications based on the scientific evidence

INSITE Interactive – The Data Sharing portal



INSITE Synthesis

To understand the scientific consensus **on the environmental implications of deploying MMS at scale, leaving non-operational MMS in situ, or removing non-operational MMS** based on the existing evidence base being established under INSITE I and II and other relevant global studies.

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DELIVERY ASSUMPTIONS

- Understanding on the role of man-made structures in the marine environment
- Cover all relevant industries, and all stages of the project lifecycle
- Coalition of UK and international scientists to ensure focus is global
- Provide science advice to the international policy and commercial landscape
- The synthesis will consider evidence of many kinds but will be focused on the science
- Results must be accessible to key stakeholders from policy and industry

Key tasks

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Project inception	• Assemble the scientific community (circa 50) • Workshop to explore conceptual models and cause-effect relationships • Consult stakeholders on what they believe to be key science questions • Agree scenarios, key science questions and criteria for comparing and ranking different outcomes
Development of consensus	• Community members independently score and rank pathways within scenarios • Draft review paper based upon based upon the priority science questions • Submit paper to peer reviewed journal
Dissemination	• Develop policy relevant science advice communications • Digital dissemination products • Engagement with key stakeholders

Thank you

https://www.insitenorthsea.org/

@insitenorthsea

www.linkedin.com/company/insitenorthsea/

dickon@howellmarine.co.uk

tarquin@howellmarine.co.uk