

# *ANChor*

## Appraisal of Network Connectivity between North Sea oil and gas platorms

PI: Dr. Lea-Anne Henry, University of Edinburgh, UK

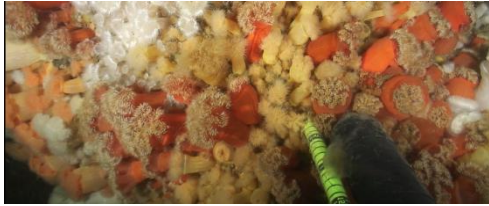
Presented By: Prof. J. Murray Roberts, University of Edinburgh, UK

INSITE Science Day, 1 December 2016, Great Hall, Imperial College, London, UK

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# Higher level ambitions



***ANChor*** is part of a suite of INSITE projects that appraise whether platforms can anchor (connect) species, populations and whole ecosystems across the North Sea

The rationale behind environmental management decisions in the North Sea must be rigorously tested

Can all the different approaches in INSITE come to a consensus about man-made “hubs” of connectivity?





# ANChor work programme

Phased over a 2-year programme (Jan 2016-Dec 2017)

Uses industry *marine growth data* to create species-specific ocean simulations of *larval trajectories* that will be interrogated with different removal scenarios using *network analysis*



# Marine growth data

January – November 2016

GIS inventory of North Sea platform marine growth data  
and biological trait matrix



Joe Ferris  
Faron McLellan  
Chris McCabe



Lea-Anne Henry (*ANChor* PI)  
J. Murray Roberts  
Kate Gormley

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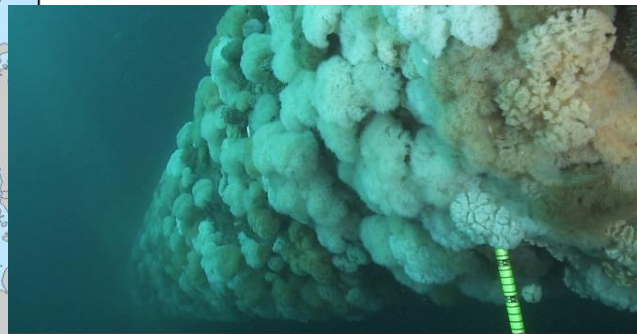
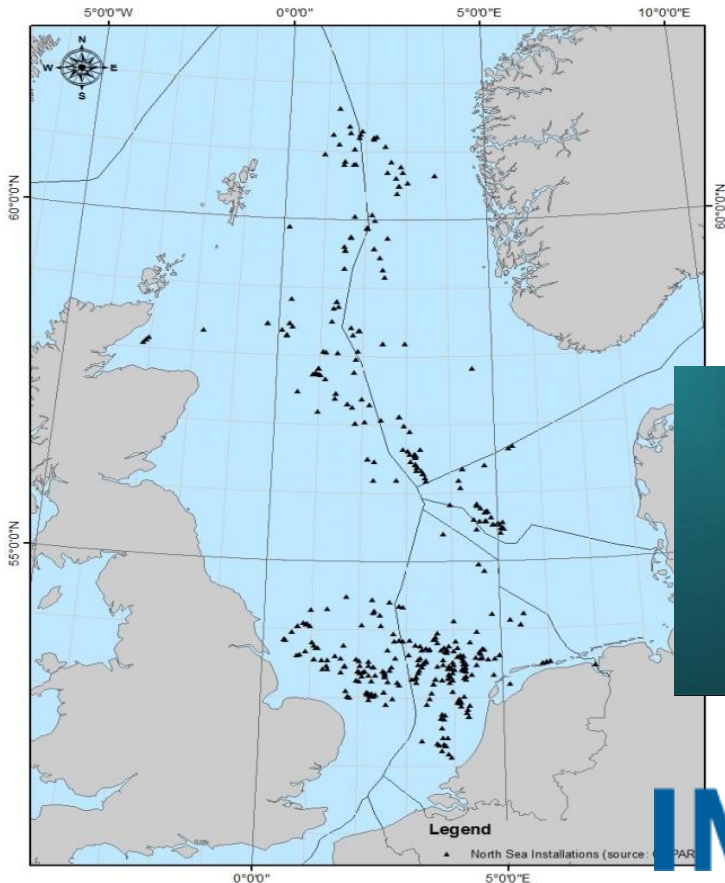


# Compilation

Industry ROV surveys (1981-2015), published data, archived coral collections, and RECON

OSPAR lists **487** installations in the North Sea, *ANChor* compiled **57**:

- ✓ 15 NNS
- ✓ 10 CNS
- ✓ 32 SNS



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# Annotation & selection

**Annotation:** determine depth of occurrence for each species on each platform (depth range and peak zone)

– more biologically realistic

**Selection:** subset of marine growth species selected based on representivity on platforms and their different dispersal potentials

– more rigorous

2 Corals, 1 Mussel, 1 Barnacle,  
1 Anemone

(*Lophelia pertusa*, *Alcyonium digitatum*, *Mytilus edulis*,  
*Chirona hameri*, *Metridium sessile*)



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# Biological trait matrix

## Dispersal depends on:

- Sexual reproductive mode
- Reproductive season
- Lifespan
- Developmental mode
- Fertilisation
- Age at maturity
- Embryo buoyancy
- Swimming behaviour (vertical)
- Swimming behaviour (horizontal)
- Larval dispersal potential
- Larval duration



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# Larval trajectories

April 2016 – March 2017

Simulate dispersal of larvae away from North Sea platforms to estimate connectivity levels between platforms and the wider region



**National  
Oceanography Centre**  
NATURAL ENVIRONMENT RESEARCH COUNCIL



Jeff Polton  
Gabriela Mayorga Adame

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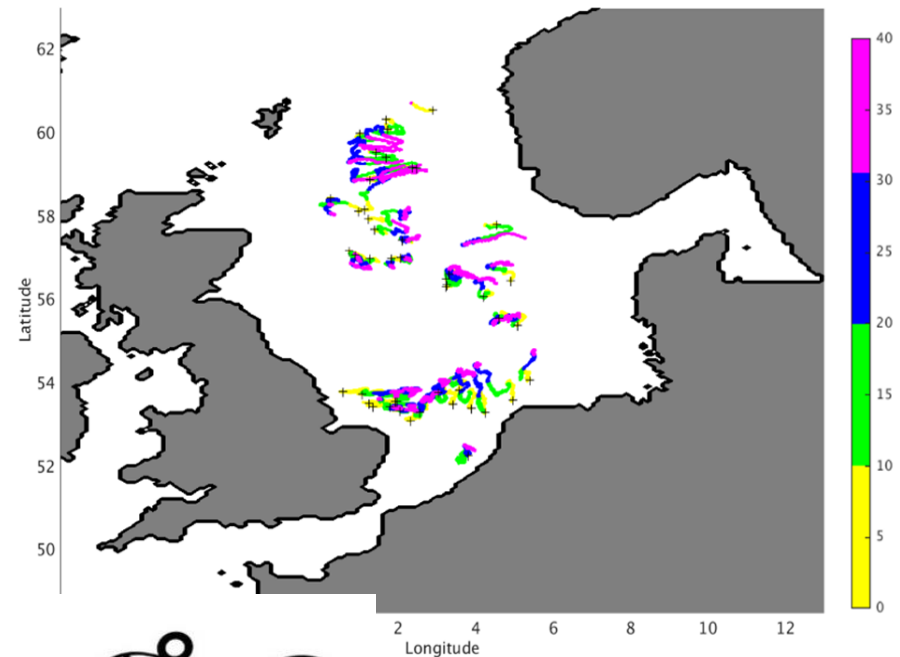




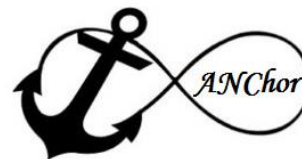
# Biologically realistic NEMO simulations

Simulations are being based on a 1.8km horizontal resolution 3D hydrodynamic ocean model, Nucleus for European Modelling of the Ocean (NEMO)

Even without adding complex behaviours (e.g. swimming, migrations), larvae tracked from platforms over 40 days travel 100s of kms and show **high connectivity, especially in the SNS**



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# And now..biological realism

## Updated 1.8km NEMO model

Using the trait matrix, the high-resolution 1.8km NEMO output is now coupled to a Lagrangian TRANSport model (LTRANS) and is driving biologically-realistic Individual Based Model (IBMs) for each selected species, from each of the **57** platforms and depth zone from where it was recorded

IBMs are now being re-run for several generations to estimate settlement percentage rates within 50 m from all North Sea platforms



# Links to other INSITE projects

**Model inter-comparison (EcoConnect, ANChor, UNDINE)**

**Framework to compare ocean models –**

- 10 passive particles from all OSPAR platforms, released daily at midnight on the first day of Feb and July 2010
- connectivity matrices could be shared between projects
- additional funding sought to determine effects of ocean model

**Additional ways *ANChor* can help –**

- if some MGD can be shared, it can be modelled by all
- sharing the Biological Traits Matrix to standardise realism scenarios



# Network analysis

January – December 2017

Use network approach to appraise the extent to which platforms form a larger hard substrate system across the North Sea and finding “hubs” under different removal (or installation) scenarios



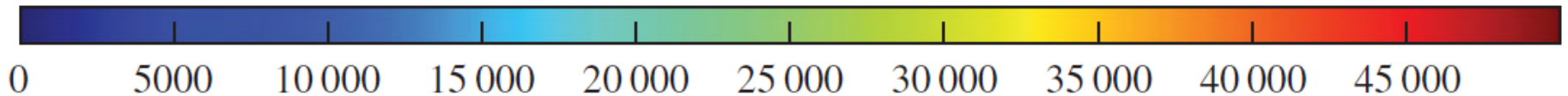
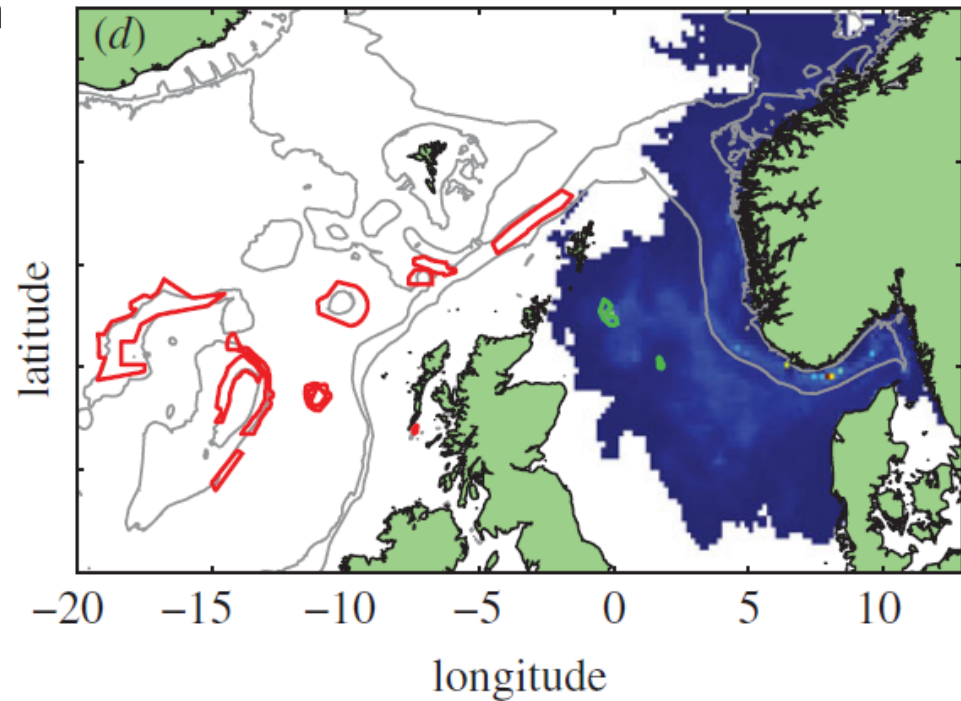
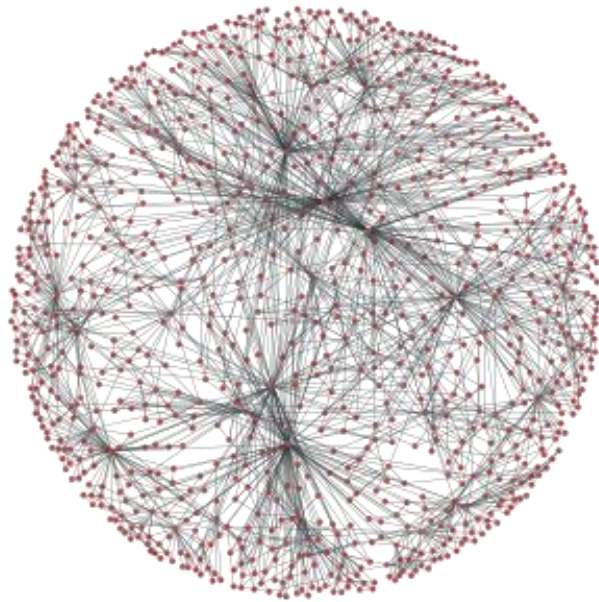
Alan Fox  
David Corne





# Platforms as “stepping-stones”

*Lophelia pertusa* coral larvae released from 2 North Sea MPAs (close to some platforms) can end up off Scandinavia



Fox, Henry, Corne & Roberts (2016) Sensitivity of marine protected area network connectivity to atmospheric variability. *Royal Society Open Science* 3, 160494

# Metrics that could change when platform configuration is manipulated in *ANChor*

Graph Theory	Relevance to INSITE
Laplacian matrix	If sum of $L=0$ , platforms are unconnected
# of connected nodes	# and names of connected platforms
Node degree	# connections involving a platform
In-degree	# other platforms supplying by a platform
Out-degree	# other platforms supplied by a platform
Centrality	Importance of a platform to connectivity
Isolated vertex	A platform unconnected to all others
Spanning tree	Minimal platform configuration maintaining network connectivity
Cliques	Subsets of platforms that are connected
Degree distributions	Identifies platform “hubs”



# Progress towards INSITE objectives

**INSITE Obj.1 – magnitude of effects of man-made structures compared to background variation in time and space**

- New GIS inventory of MGD
- Platforms significantly extend biogeographic range of the EU Habitats Directive and CITES-listed coral *Lophelia pertusa*

**INSITE Obj.2 – to what extent do man-made structures represent an inter-connected hard substrate system?**

- Connectivity highly sensitive to larval behaviour, climate state
- Regional differences in connectivity, SNS highly connected



# Scope beyond INSITE



**Potential role of platforms for sources of coral**  
(deep-sea coral restoration science features in large European H2020 projects like ATLAS and MERCES as possible mitigation/restoration actions)

**Role of platforms in MPA connectivity**

**Evidence base for OSPAR Decision 98/3 review**

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Thank you for your attention

