

An underwater photograph showing several fish swimming in a clear, blue-green environment. The fish are of various species, including what appear to be cod and haddock. The background is filled with coral and other marine life, creating a rich, textured scene. The lighting is soft, highlighting the details of the fish and the surrounding ecosystem.

# *ANChor*

## Appraisal of network connectivity between North Sea oil and gas platforms

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**INSITE**

# High Level Ambitions

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

Rationale behind environmental management decisions must be rigorously tested

Can INSITE's different approaches come to a consensus about connectivity?



# Project Overview

(1) Analysis of industry marine growth surveys



(2) Biologically realistic particle tracking



(3) Network analyses



(4) Decommissioning scenarios



**INSITE**



# ArcGIS geodatabase of marine growth from 66 North Sea platforms

- depth range, peak abundance
- agreements to share/publish data coming in place
- focus on 5 common, native marine growth species

soft coral



stony coral  
(*Lophelia*)



barnacle



blue mussel

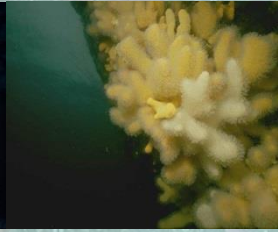


anemone



Spawning season  
Depth range on rig  
Pre- & post competency  
Pelagic larval duration  
Swimming behaviours





	Stony coral	Soft coral	Blue mussel	Barnacle	Anemone
Pre-competency period (days)	32	10	20	10	15
Competency period (days)	28	8	10	8	7
Planktonic larval duration (days)	60	18	30	18	22
Spawning season	Jan-Feb	Dec-Jan	Apr-Sep	Mar-May	Aug-Sep
References	<a href="http://www.marlin.ac.uk/biotic">www.marlin.ac.uk/biotic</a> ; Larsson et al., 2014; Strömberg, 2016	<a href="http://www.marlin.ac.uk/biotic">www.marlin.ac.uk/biotic</a> ; Hartnoll, 1975	<a href="http://www.marlin.ac.uk/biotic">www.marlin.ac.uk/biotic</a> ; Sprung, 1984; Fuchs and DiBacco, 2011	<a href="http://www.marlin.ac.uk/biotic">www.marlin.ac.uk/biotic</a> ; Rainbow, 1984; DiBacco et al., 2011; Miller et al., 2013 compiled data from various sources; mostly observations from other species	<a href="http://www.marlin.ac.uk/biotic">www.marlin.ac.uk/biotic</a> ; Scott and Harrison, 2007 for the anemones <i>Entacmaea quadricolor</i> and <i>Heteractis crispa</i>
Total # particles released	61180	166376	408408	283374	218736

## SCIENCE GAP: Relevant larval biology studies

An underwater scene featuring several fish swimming over a coral reef. The water is clear and blue, with sunlight filtering through. The coral is diverse in color and shape, including some yellow and orange patches. The fish are of various species, including what appear to be snappers and groupers.

**Industry data and biological traits used to make simulations realistic**

**5 x Individual-Based Models (i.e., species-specific simulations)**

Ocean circulation model: NEMO 3D ocean circulation model of the Atlantic Margin Model 1/60°, 1.8 km horizontal resolution

Particle tracking model: LTRANS, a particle-tracking code that can include complex larval behaviours

Simulations run for the year 2010 (a conservative base-case)\*

**\*for protected coral *Lophelia*, 2010-2012 to cover range of circulation patterns**



# Major Findings

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



Man-made structures show strong potential to form large inter-connected systems: **ANChor** measured clustering, centrality, betweenness, in- & out-degree

- some species more than others
- some years more than others
- some structures more important than others

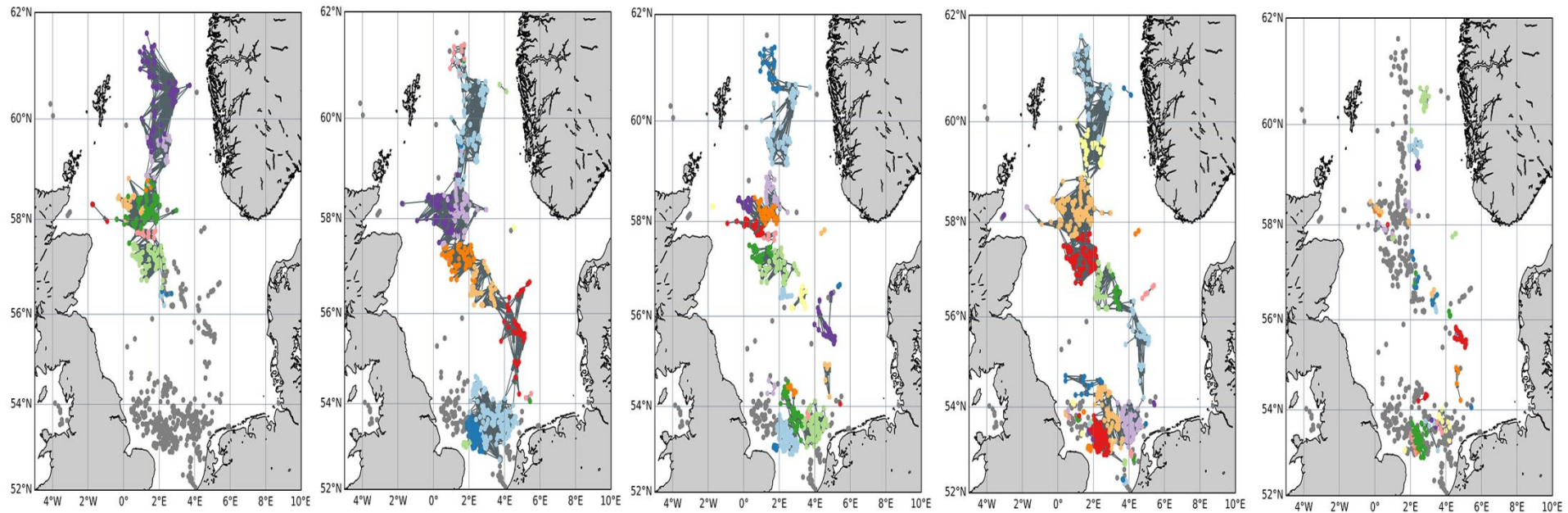
# Major Findings

*“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”*

- **Man-made structures have potential to contribute to natural ecosystems downstream**
- **Platform ecosystems are evolving to mimic those in the wild**



# Major Findings - Connectivity



**Stony coral**  
*Lophelia pertusa*

**Blue mussel**  
*Mytilus edulis*

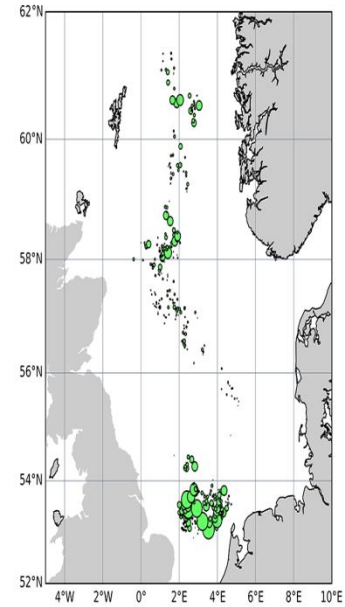
**Soft coral**  
*Alcyonium digitatum*

**Anemone**  
*Metridium senile*

**Barnacle**  
*Chirona hameri*

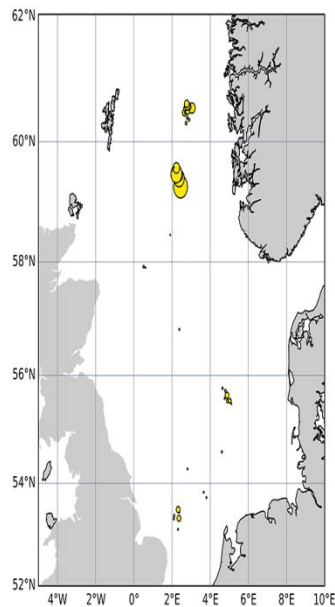
**“Clusters” – groups of highly connected structures:  
*Lophelia* had fewest, *Chirona* had the most**

# Major Findings - Connectivity



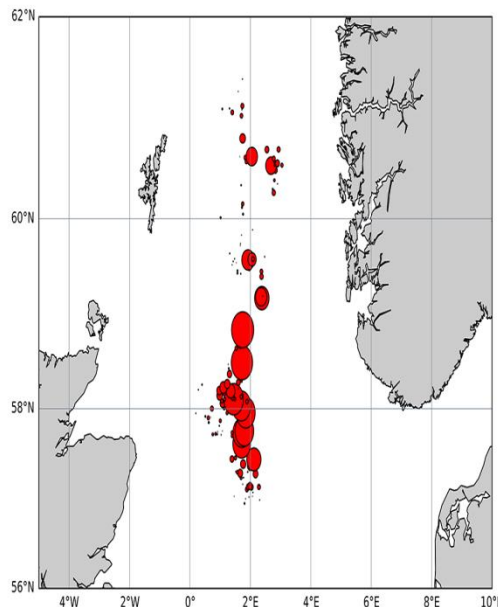
**Soft coral**

*Alcyonium digitatum*



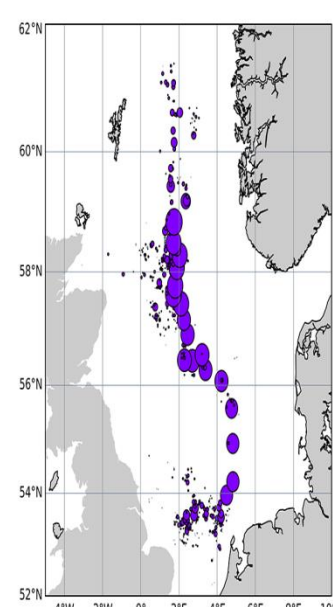
**Barnacle**

*Chirona hameri*



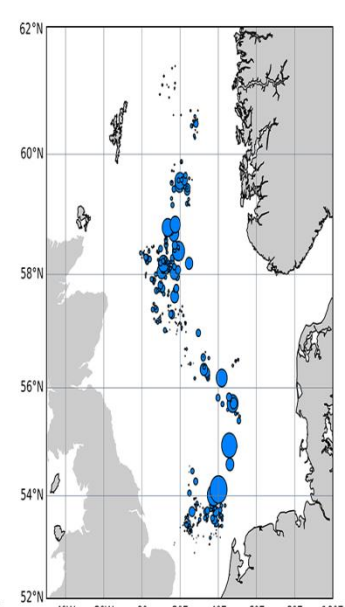
**Stony coral**

*Lophelia pertusa*



**Anemone**

*Metridium senile*



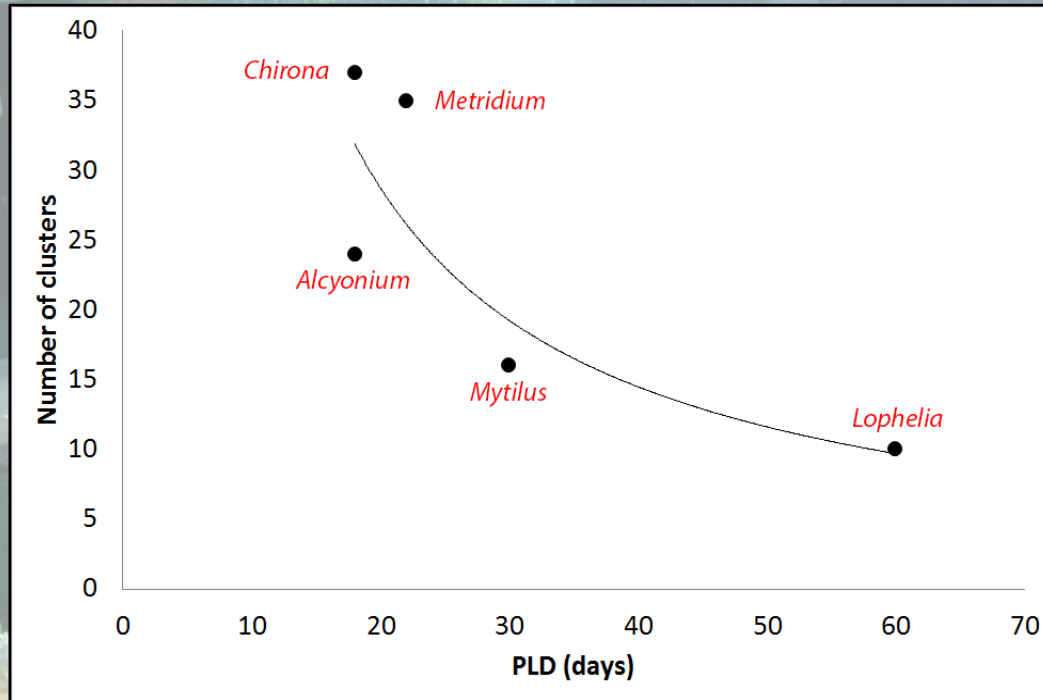
**Blue mussel**

*Mytilus edulis*

**“Betweenness” – structures that act as bridges linking clusters:  
Important for the soft and hard coral species**

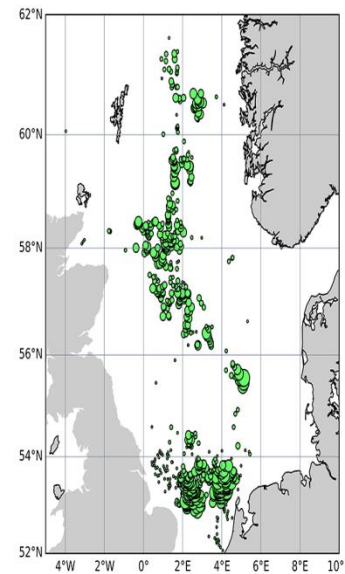


# Major Findings - Connectivity



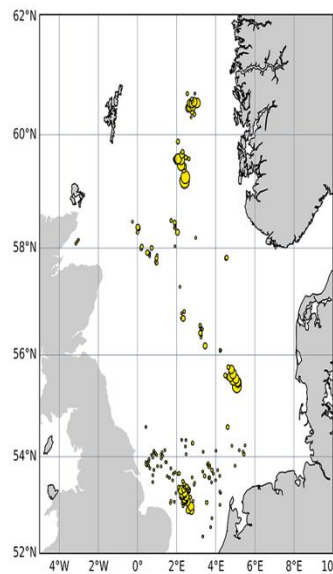
**SCIENCE GAP: Spawning season & planktonic larval duration will vary with climate change**

# Major Findings - Connectivity



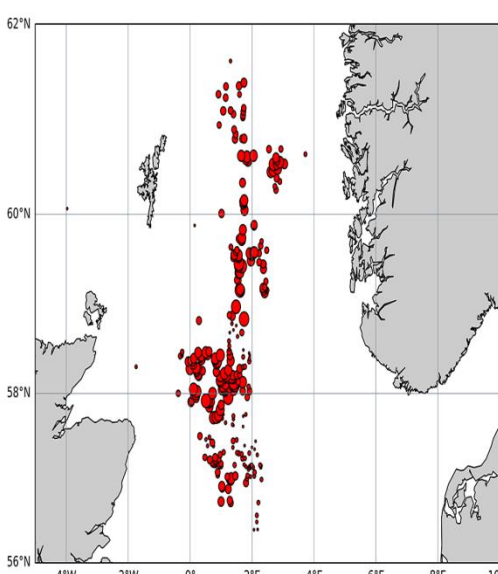
**Soft coral**

*Alcyonium digitatum*



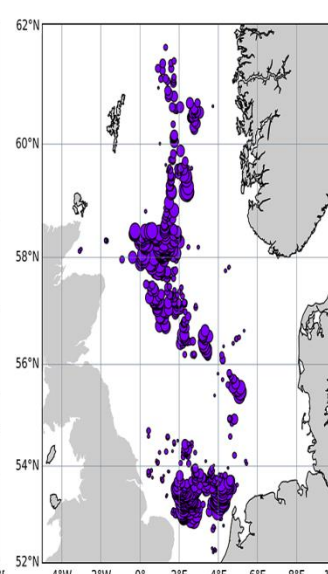
**Barnacle**

*Chirona hameri*



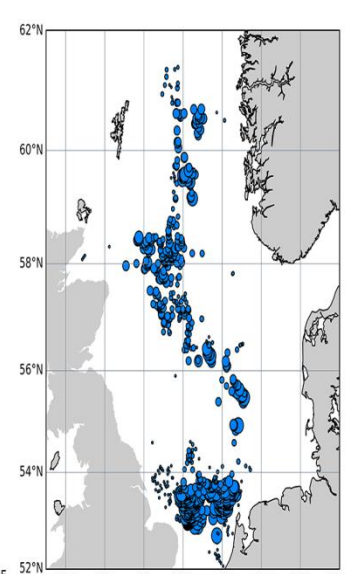
**Stony coral**

*Lophelia pertusa*



**Anemone**

*Metridium senile*



**Blue mussel**

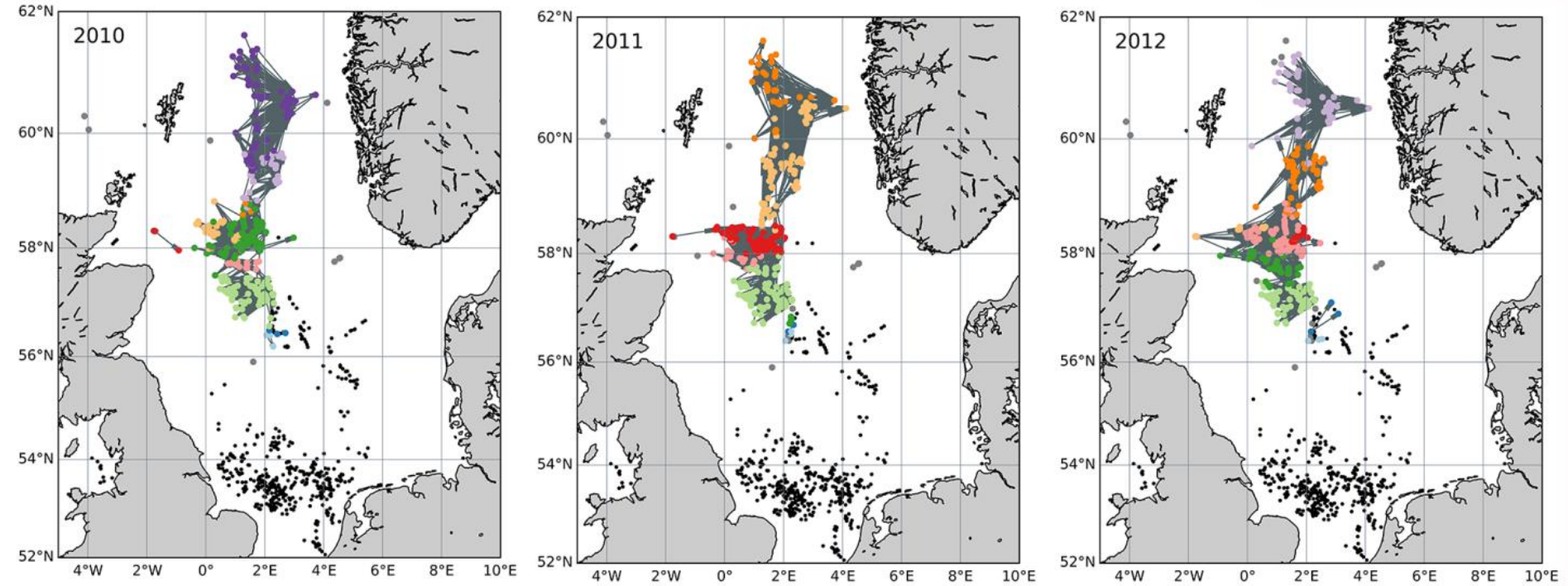
*Mytilus edulis*

**“Out-degree” – importance of structure as a larval source:**

**Generally, offshore structures were more important than those closer to land**

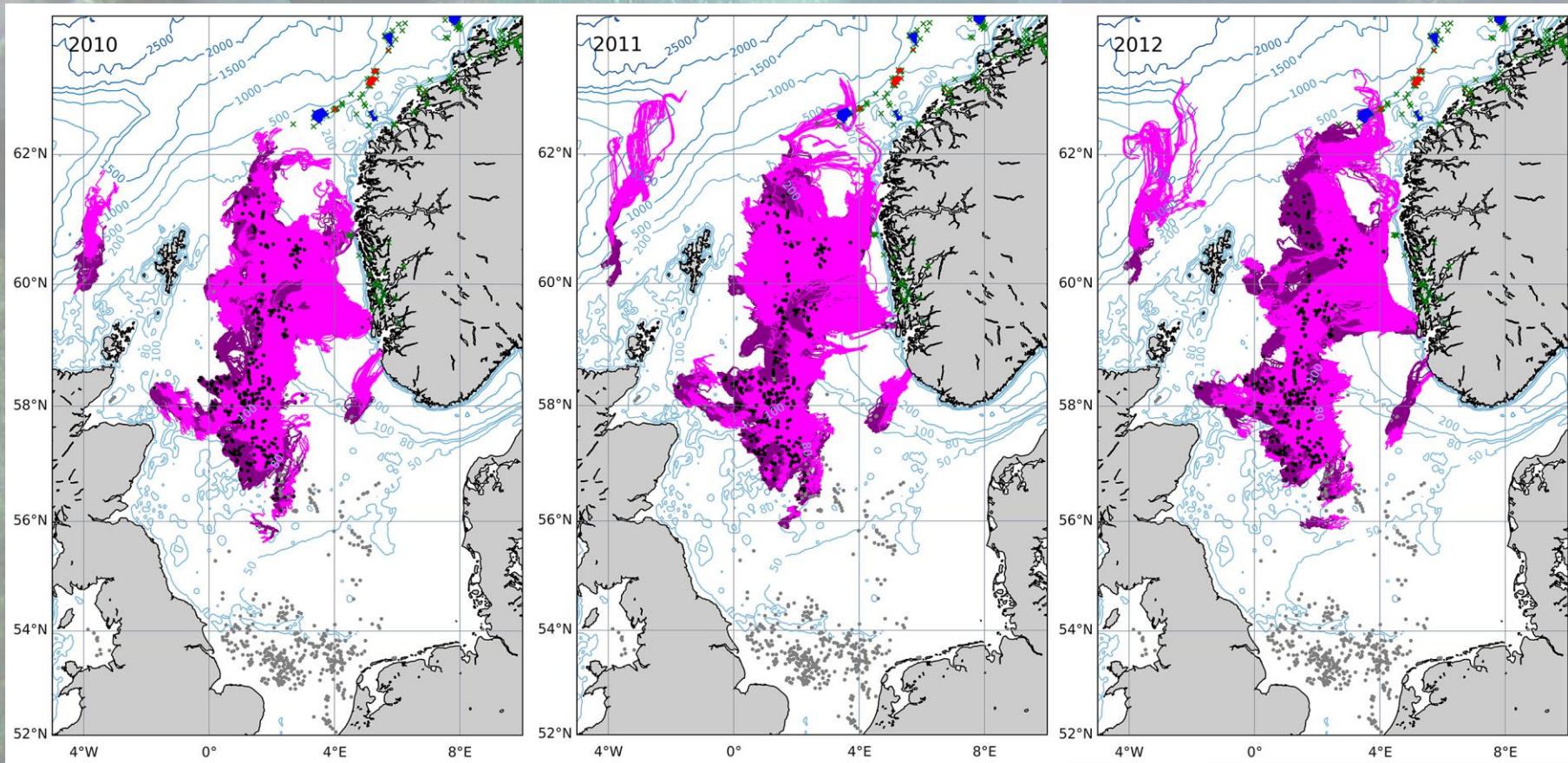


# Major Findings - Connectivity



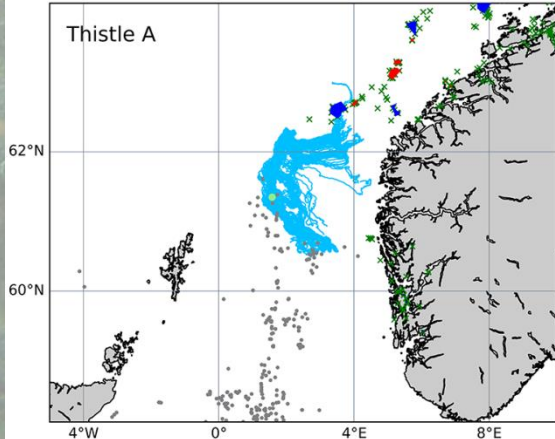
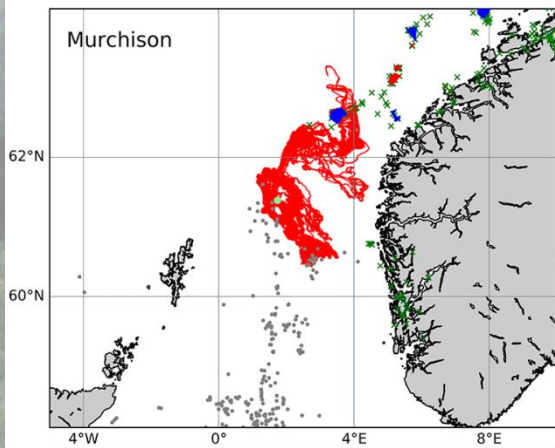
***Lophelia* remains fairly well-connected as circulation patterns changed (2010-2012), but connectivity was lower in 2010 when Atlantic inflow and wind-driven currents would have been weaker**

# Major Findings - Magnitude





# Major Findings - Magnitude



Murchison now decommissioned:

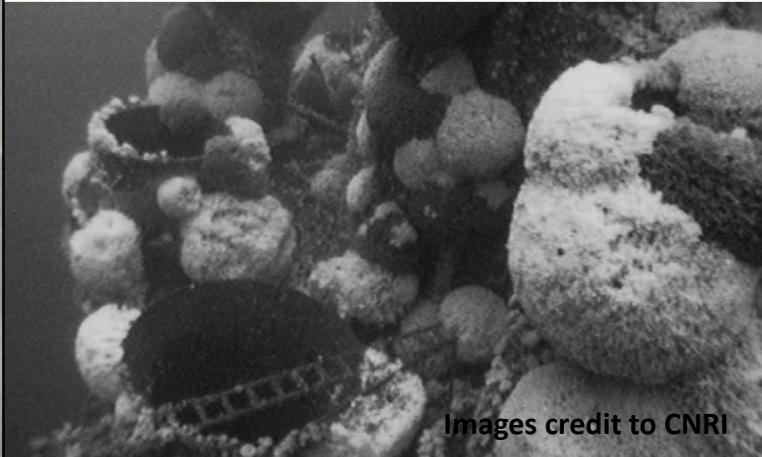
jacket footings remain at 108m (derogation height),  
sufficient to keep supplying larvae to the Aktivneset MPA

# Major Findings - Magnitude



Platform ecosystems have evolved to mimic those in the wild:

these are as biodiverse and morphologically similar as natural coral ecosystems, & also host the same characteristic coral-worm symbiosis



Images credit to CNRI



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1<sup>st</sup> record of coral-worm (*Lophelia-Eunice*) symbiosis from man-made structures



# Products

- Anonymised marine growth data (agreements to share in progress)
- Bespoke species connectivity maps of assets for all INSITE Foundation Phase sponsors
- Connectivity data for any particular offshore oil and gas structure in the North Sea e.g., data can be used for any regulatory/permitting requirement if desired or just to scope out connectivity

# ANChor's Next Steps

- Consensus on clusters & important structures for connectivity
- **SCIENCE GAP:** like *Lophelia*, do man-made structures potentially support other iconic North Sea species
- **SCIENCE GAP:** Continue to ground-truth data (collection of samples for genetics; ROV inspection surveys)
- Scenario-test impact of structure removal under OSPAR 98/3 on connectivity

A woman with brown hair, wearing a white lab coat over a white polka-dot shirt and a dark bow tie, is adjusting the bow tie with both hands. She is looking directly at the camera. The background is a dark blue wall covered in white chalk-drawn chemical structures and formulas. In the bottom left corner, there are glass laboratory flasks and a magnifying glass. In the bottom right corner, there is a framed specimen of a brown butterfly on a skull.

**SCIENCE GAP 1:**  
Relevant larval biology studies

**SCIENCE GAP 2:**  
Spawning season & planktonic  
larval duration will vary with  
climate change

**SCIENCE GAP 3:**  
ground-truth data

**SCIENCE GAP 4:**  
other iconic North  
Sea species



...GIRLS JUST  
...ANT TO HAVE  
...FUNDAMENTAL

What do we Want?  
EVIDENCE BASED SCIENCE  
When do we Want It?  
AFTER PEER REVIEW





An underwater photograph showing several fish swimming over a deep-sea coral reef. The coral is green and yellow, and the water is dark blue. The fish are silvery and have a white stripe along their sides.

**Thank you**

**INSITE Sponsors**

**Richard Heard**

**INSITE ISAB**

**Eileen Rogerson**

**Other INSITE project teams**

**Institute for Marine Research, Bergen**

Original photograph courtesy of Lundin Britain Ltd. Reproduced from  
"Cold-Water Corals: The Biology and Geology of Deep-Sea Coral  
Habitats", by J.M. Roberts, A. Wheeler, A. Freiwald, and S. Cairns,  
Cambridge University Press, 2009.