



# Assessing and managing impacts of anthropogenic noise on fish and marine invertebrates



**Dr Steve Simpson**



# Anthropogenic noise: Why should we care?

- Fish and invertebrates can hear, and use natural acoustic cues for habitat selection, finding food and avoiding predators, and vocal communication
- Like cetaceans, some fish are protected or are of conservation concern (eels, salmon, shad)
- Many fish and invertebrates are commercially-important for fisheries, providing food security
- Fish and invertebrates underpin marine food webs, including for cetaceans and seabirds



**Dr Steve Simpson (Exeter) &  
Dr Andy Radford (Bristol)**

## **Impacts of anthropogenic noise on fish and marine invertebrates**

Defra contract; NERC KE Fellowship 2011-2014

Ongoing interaction with NERC Marine  
Renewable Energy KEP

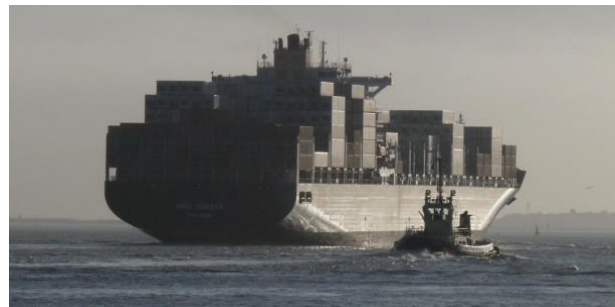
MREKE-funded Marine Noise Workshop in 2011  
underpins much of our work

NERC Cefas-CASE studentship


NERC Marine Scotland-CASE studentship

NERC-Innovate UK KTP with HR Wallingford

International partnerships with Ecocean Ltd (France),  
Australian Institute of Marine Science



# KE Approach: Offshore Renewable Energy Industry



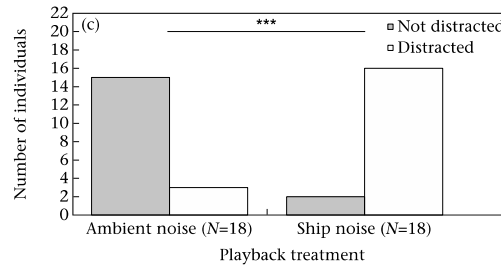
The image shows a YouTube video player interface. At the top left is the YouTube logo with 'GB' and a menu icon. To its right is a search bar with a magnifying glass icon. The video content shows a man, Dr. Steve Simpson, standing on the deck of a blue boat named 'PRINCESS ROYAL'. In the background, there is a long pier extending into the water under a cloudy sky. A purple text box in the lower-left corner of the video frame identifies the speaker as 'DR STEVE SIMPSON' and provides his title: 'Senior Lecturer in Marine Biology and Global Change, Biosciences, University of Exeter'. The video player controls at the bottom show a play button, a progress bar at 0:06 / 2:31, and icons for volume, settings, and full screen.

[https://www.youtube.com/watch?v=ORs\\_G7\\_GGt4](https://www.youtube.com/watch?v=ORs_G7_GGt4)

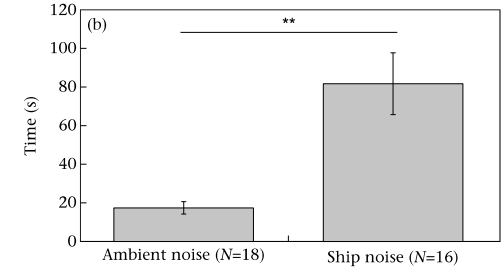
# Impact of underwater noise: invertebrates



Shore crab – *Carcinus maenas*



Distracted from feeding



Take longer to find shelter

Wale et al 2013 Animal Behaviour



**OPEN** Anthropogenic noise playback impairs embryonic development and increases mortality in a marine invertebrate

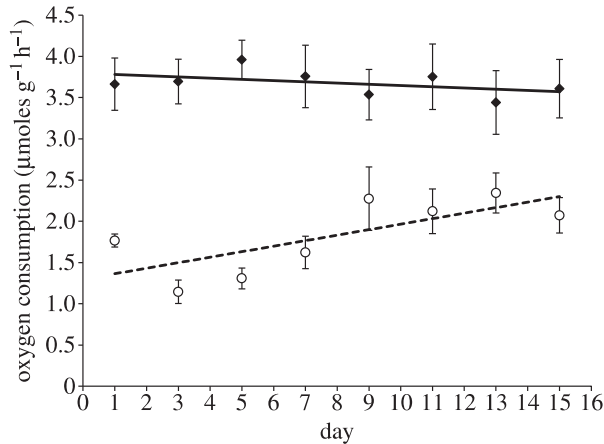
SUBJECT AREAS: EMBRYOLOGY, ECOSYSTEM ECOLOGY

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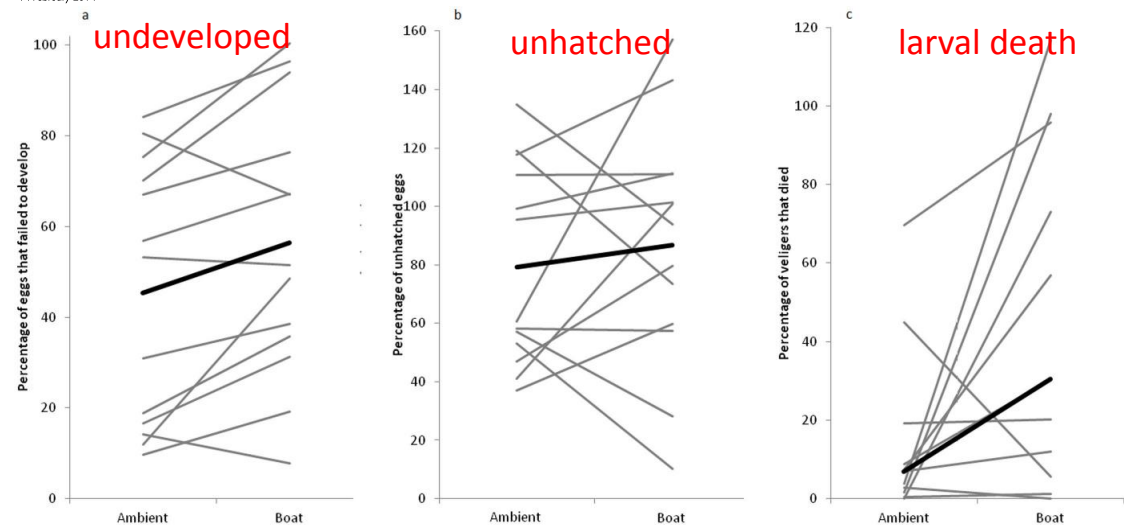
Received 14 February 2014



Increased metabolic rate



Wale et al 2013 Biology Letters



# Impact of ship noise on European eels



Concern from Defra and Cefas about impact of noise on migratory species. Focus on impacts with survival consequences.

Juveniles move through coastal areas to rivers; pass through environments where shipping activity dominates the soundscape



# Potential of noise to affect survival

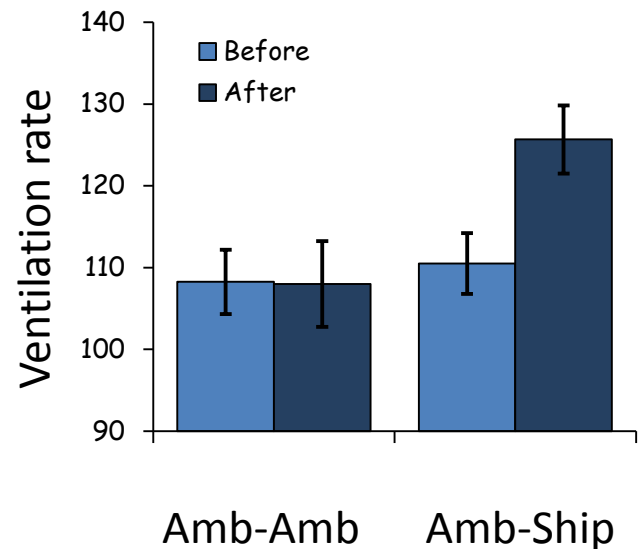
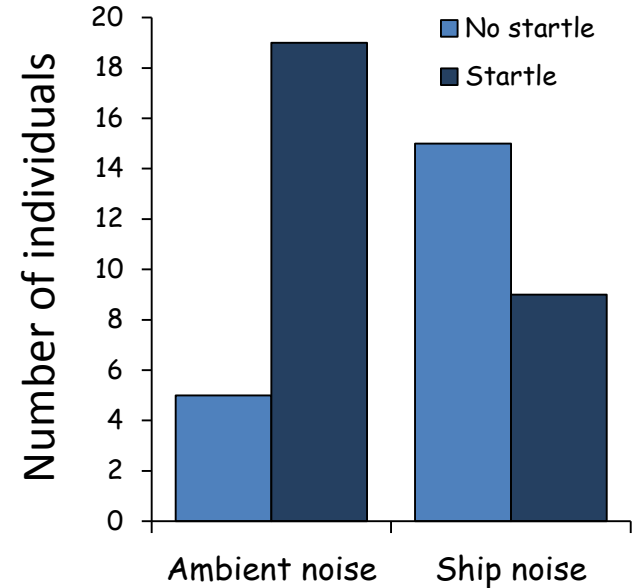
Playback of ship noise negatively affects performance of eels with simulated ambush and pursuit predators.

Playback of noise causes stress, seen in ventilation and metabolic rates

Now working on managing ship noise with:

- European Commission – Task Group Noise
- Convention on Biological Diversity expert group
- IUCN Delegation to the MEPC of the International Maritime Organization

Simpson et al. 2014, Global Change Biology





HR Wallingford  
*Working with water*



## *Impact piling, fish behaviour and physiology: a field experiment*

20-Apr-15

Dr Rick Brintjes – ORE Catapult meeting



# Acknowledgements

Diane Jones  
Kate Rossington  
Tom Benson  
Giovanni Cuomo  
Tom Matthewson  
Ian Townend  
Imran Bashir

Steve Simpson  
Charles Tyler  
Andy Radford  
Dick Hazelwood  
Annie Linley  
John Hatley  
Ian Davies

Tom Bunce  
Harry Harding  
Jessica Lister  
Fiona Birch  
Ilaria Spiga  
Paul Lepper  
Serena Wright  
Tom Pottinger

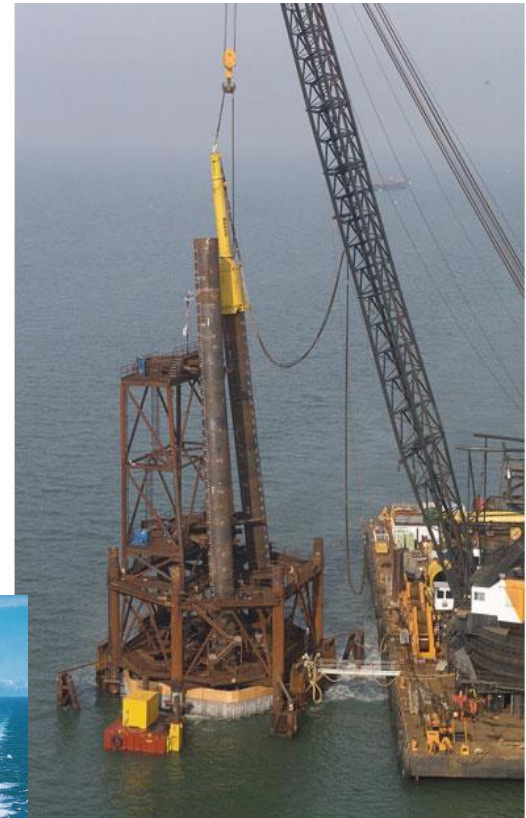


Anthropogenic (man-made) noise is a global problem

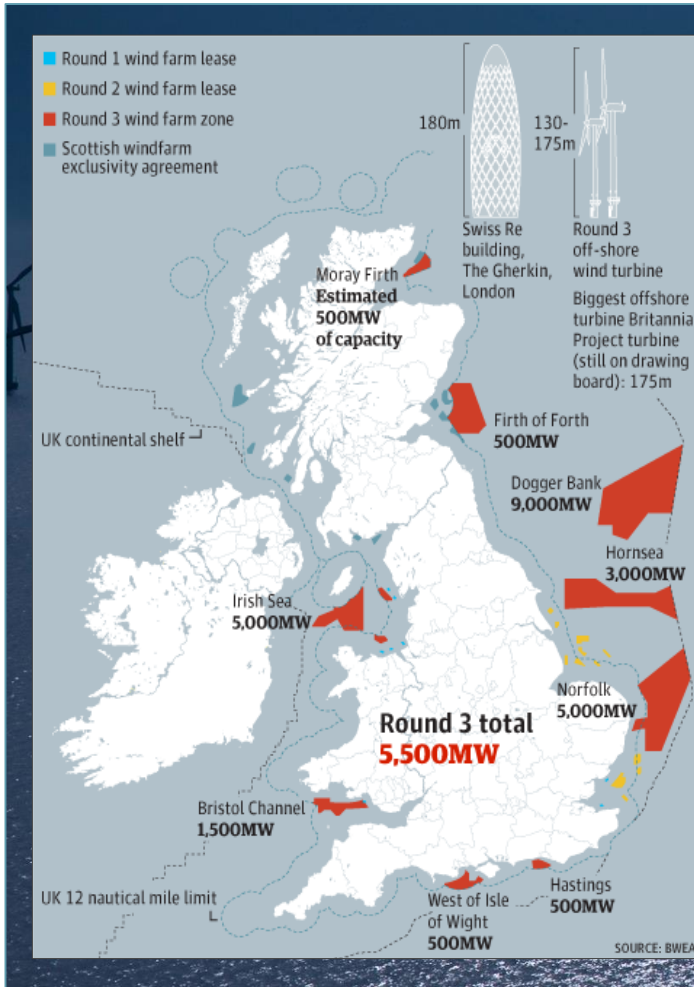


... on land

## Anthropogenic noise is a global problem



... under water



Need for a solid base!



## Stress

(Wysocki et al. 2006)



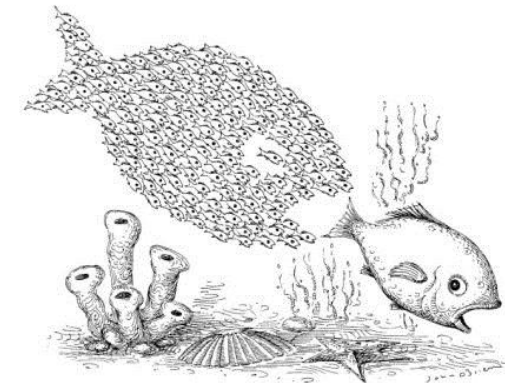
## Damage hearing

(Smith et al. 2004)



## Aggression

(Bruintjes & Radford 2013)



## Impair communication

(Vasconcelos et al. 2007)

## Knowledge Gap

- Accurate assessment of the impacts of underwater noise is missing!
- Impacts of noise on marine environment included in national and international legislation (EU: MSFD, US: NEPA, International: IMO)
  - Important for industry
- HAMMER model predicts movements of aquatic species in relation to noise

## AIM

- Field study to obtain parameters for HAMMER

## Study Aims

- Behaviour - data on movement patterns
  - Swimming speed
  - Swimming distance
  - Noise avoidance
  - Shoaling
  - ...
  
- Physiology
  - Oxygen consumption
  - Blood hormone stress levels
  - ...

## Introduction



Black  
sea  
bream



Atlantic  
cod



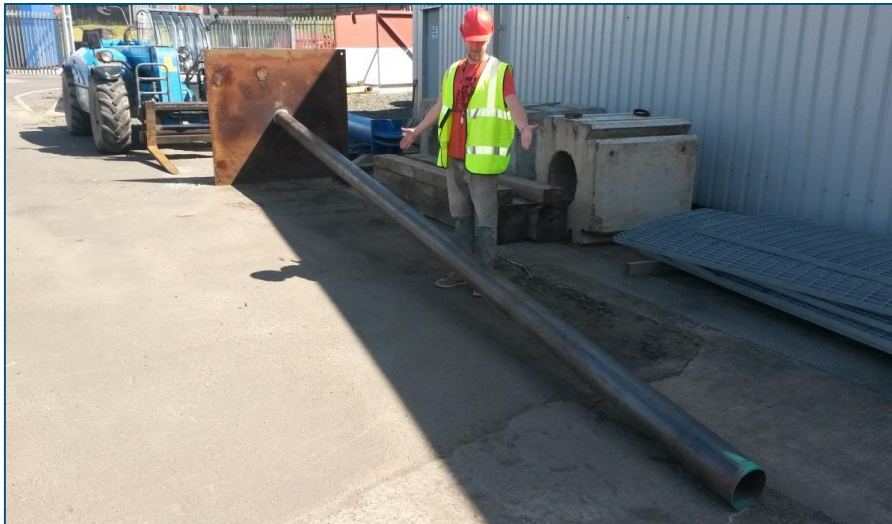
Plaice

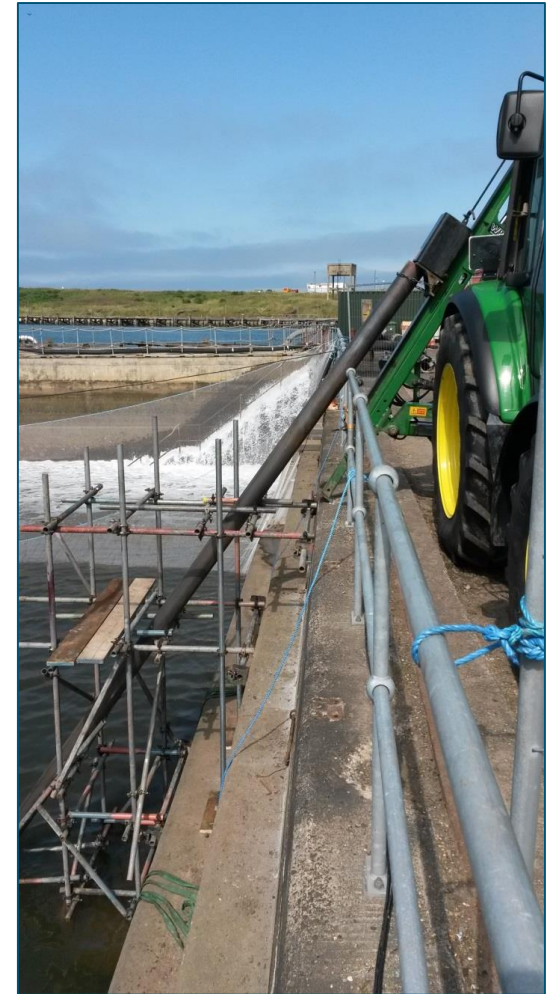




## Sound source - Impact piling

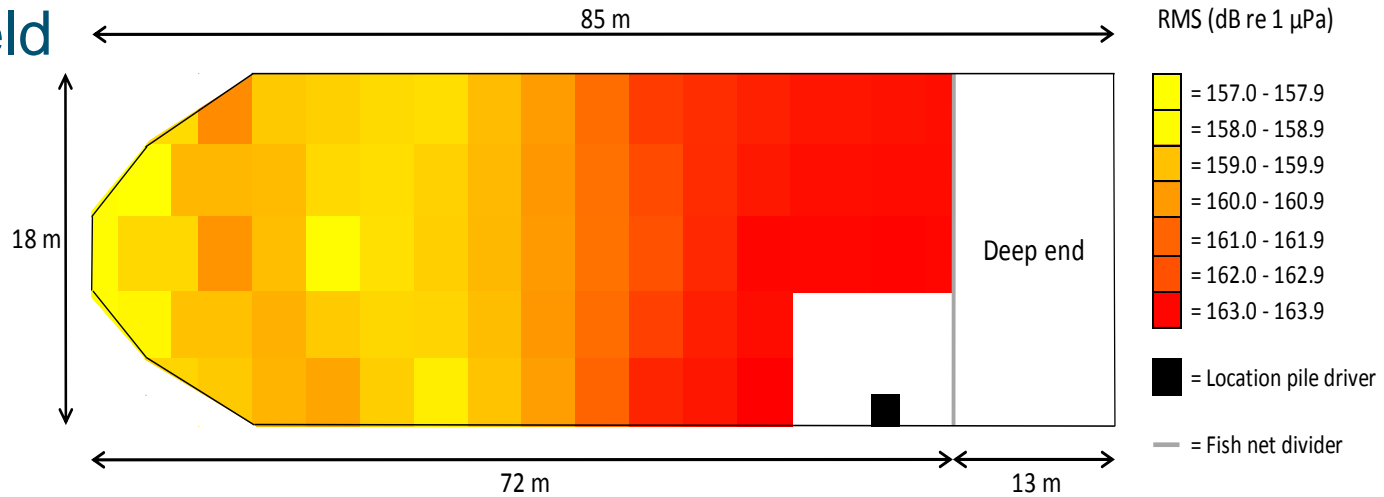
- Hydraulic Post Driver (200 Kg hammer)
- Powered by tractor
- Pile







## Sound field



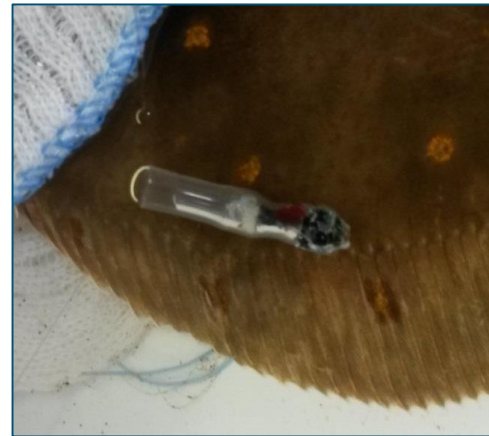
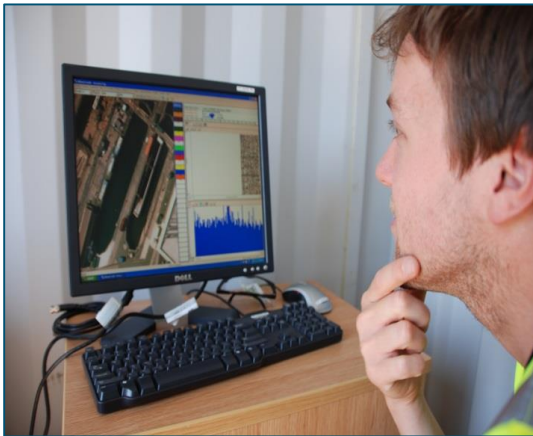
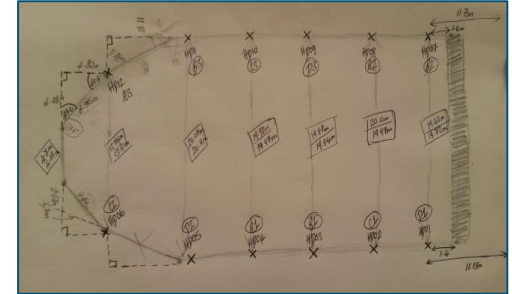
## Schedule

- 2 Trials, lasting 5 days
- 2-hour long piling sequences (5x)
- Piling freq: ca. 10 strikes/min

26/07	27/07	28/07	29/07	30/07	31/07	01/08	02/08	03/08	04/08	05/08	06/08	07/08	08/08
Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri
		treat			Move Pile Rig	Add water					treat		
	Fish In; habituation	Piling: 9-11; 13-15	Piling: 9-11; 13-15	Piling: 9-11					Fish In; habituation	habituation	Piling: 9-11; 13-15	Piling: 9-11; 13-15	Piling: 9-11
		Pile left side									Pile right side		

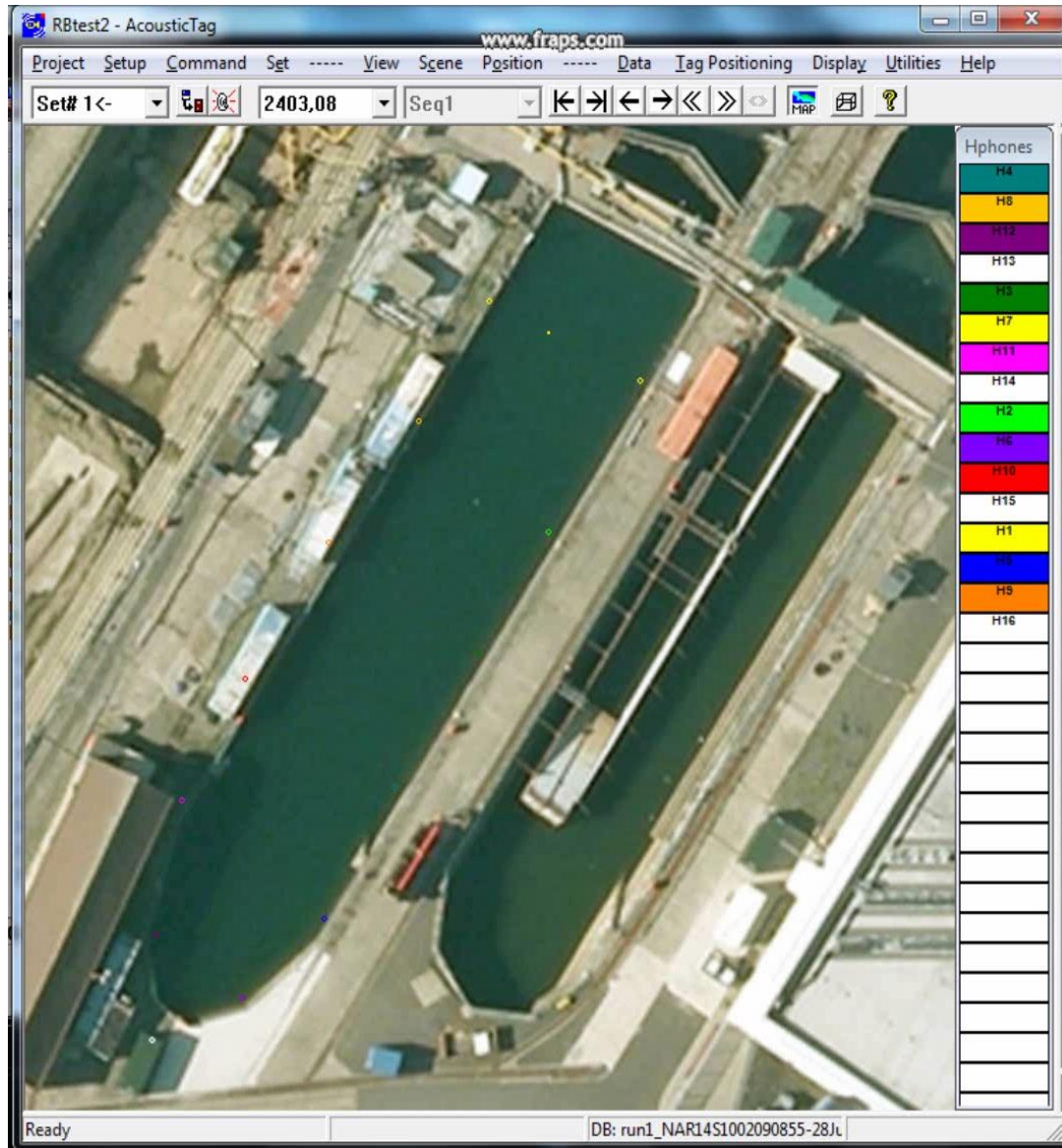
## Positioning system

- Acoustic tags (pinging every 2.5 sec)
  - Bream, cod, plaice
- Hydrophones in the dock
- Acoustic Tag Receiver



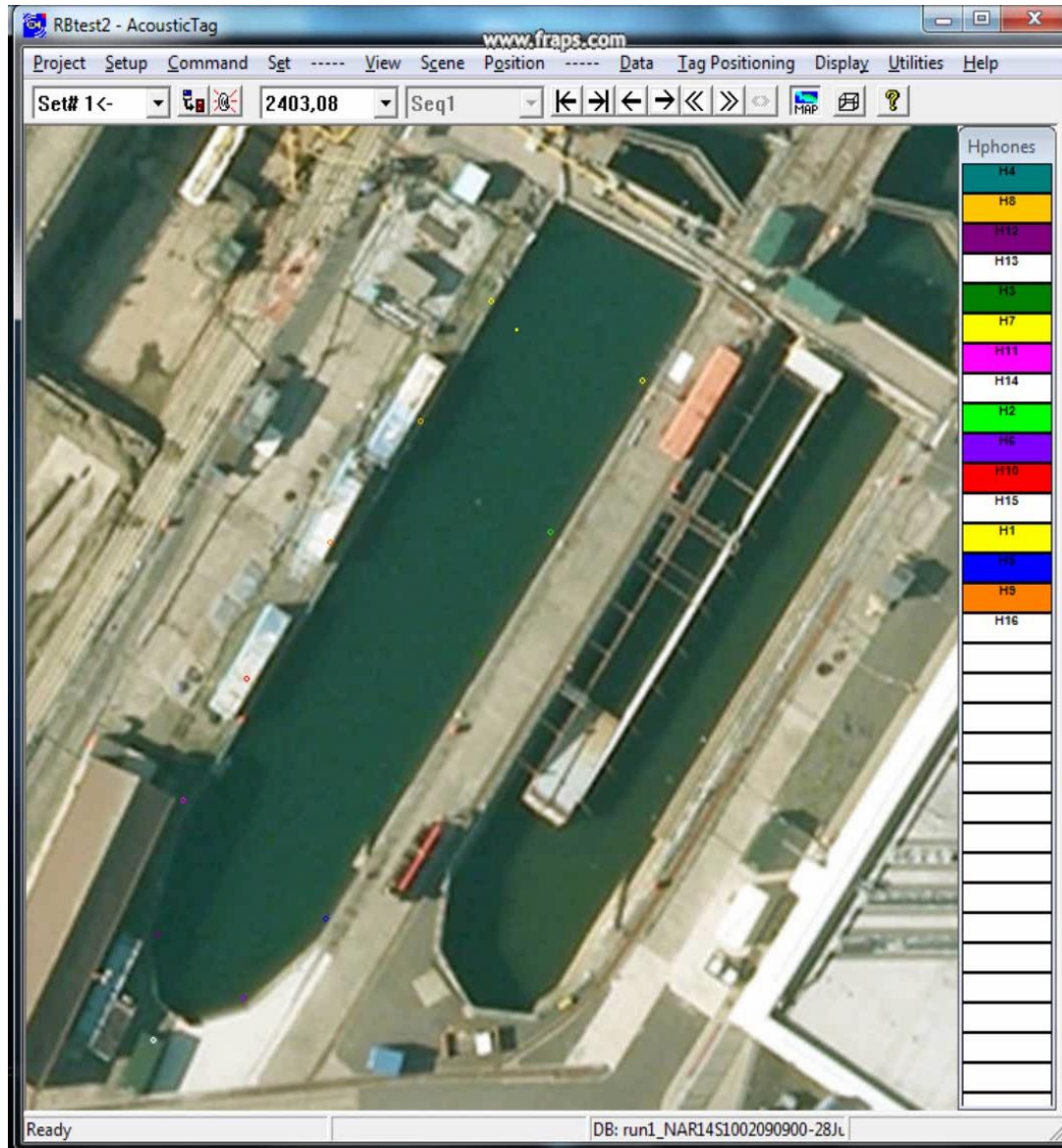
## Movement

Ambient  
conditions



## Movement

Piling  
conditions



## Cod movement – before vs during



About to be submitted for publication,  
therefore graphs are not shown

(contact us if you would like to find out more)



## Oxygen consumption

About to be submitted for publication,  
therefore graphs are not shown

(contact us if you would like to find out more)

Bream



Plaice



\* denotes  $p < 0.05$

## Pile driving can impact:

- Behaviour
  - Swimming speed
  - Swimming distance
  - Distance from piling source
  
- Physiology
  - Oxygen consumption



*Impact is dependent on: species, piling exposure and natural behaviour*

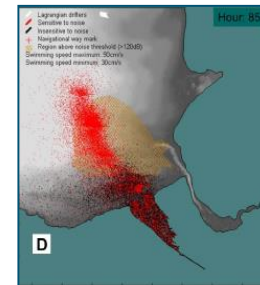
## Field parameters predictive modelling impact noise:

- HAMMER
- Model energetic costs



## Study site successful

- Gather more data
  - Boost sample sizes
  - Different species
  - Target survival consequences
  - Target reproductive success/fry development
- Particle motion
  - Analyse data (accelerometers and vibration monitors on site)
  - Use particle motion in HAMMER
- UW Noise propagation
  - Obtain & analyse noise reverberations (important for harbours)
- Perform experiments offshore @ construction sites!



# Thank you for listening

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