



Using the FLOWBEC seabed frame to understand underwater interactions between diving seabirds, prey, hydrodynamics and MREDs

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NE/J004308/1, NE/J004200/1, NE/J004332/1

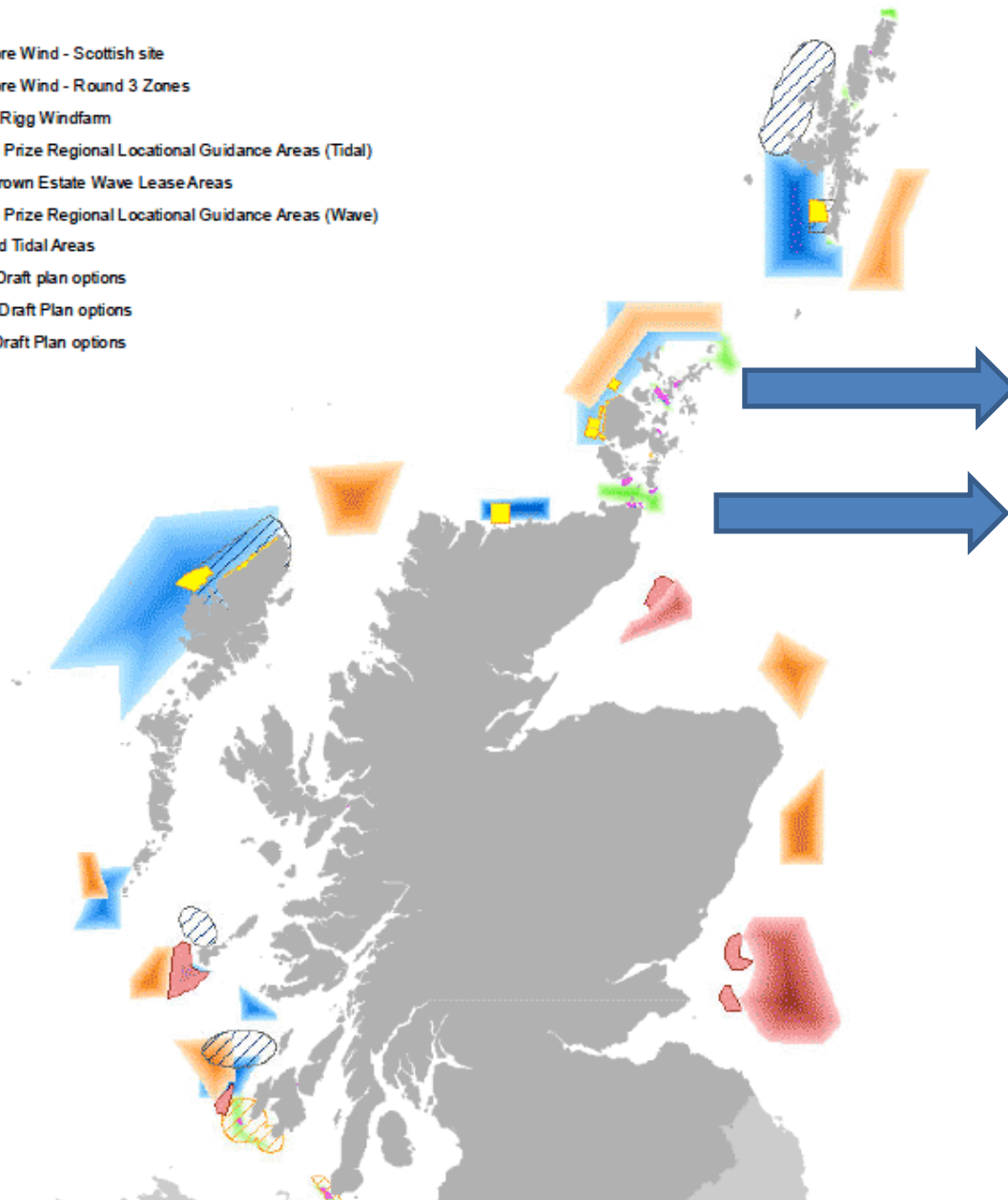
NERC MREKE Internship

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Key:

- Offshore Wind - Scottish site
- Offshore Wind - Round 3 Zones
- Robin Rigg Windfarm
- Saltire Prize Regional Locational Guidance Areas (Tidal)
- The Crown Estate Wave Lease Areas
- Saltire Prize Regional Locational Guidance Areas (Wave)
- Leased Tidal Areas
- Wind Draft plan options
- Wave Draft Plan options
- Tidal Draft Plan options



Scotland:

100% renewable by 2020

≈67.2% as of 2014

EMEC ORKNEY[®]
The European Marine Energy Centre Ltd

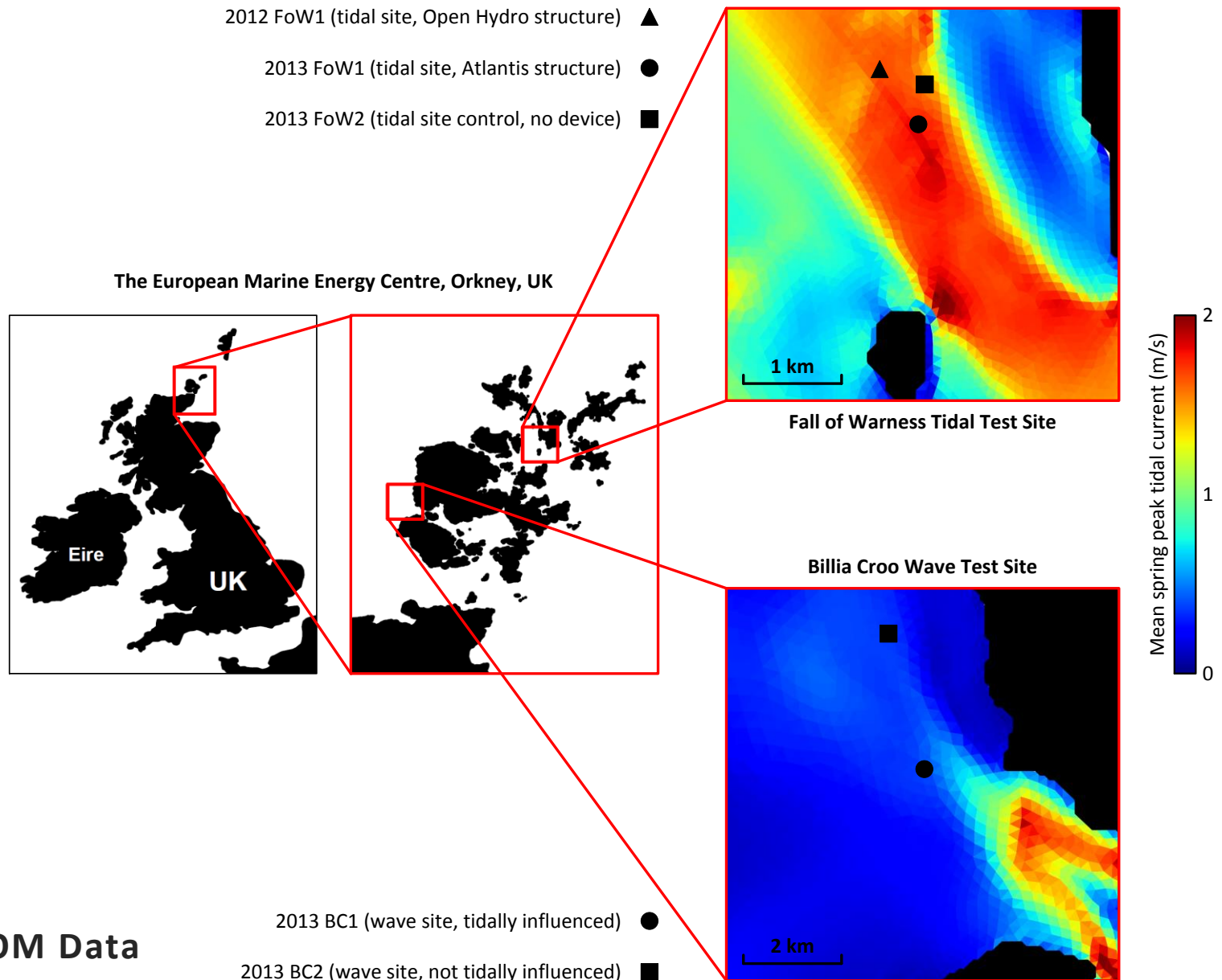


MEYGEN
THE TIDE OF CHANGE IN CAITHNESS

FLOWBEC Frame

- **Entire water column** (plankton, fish, seabirds, marine mammals)
- Captures **movement, behaviour and interactions** with MREDs
- Self-contained, portable between sites
- Continuously samples spring/neap 2-week period
- Complemented by concurrent:
 - hydrodynamic model data
 - above water radar and bird observations

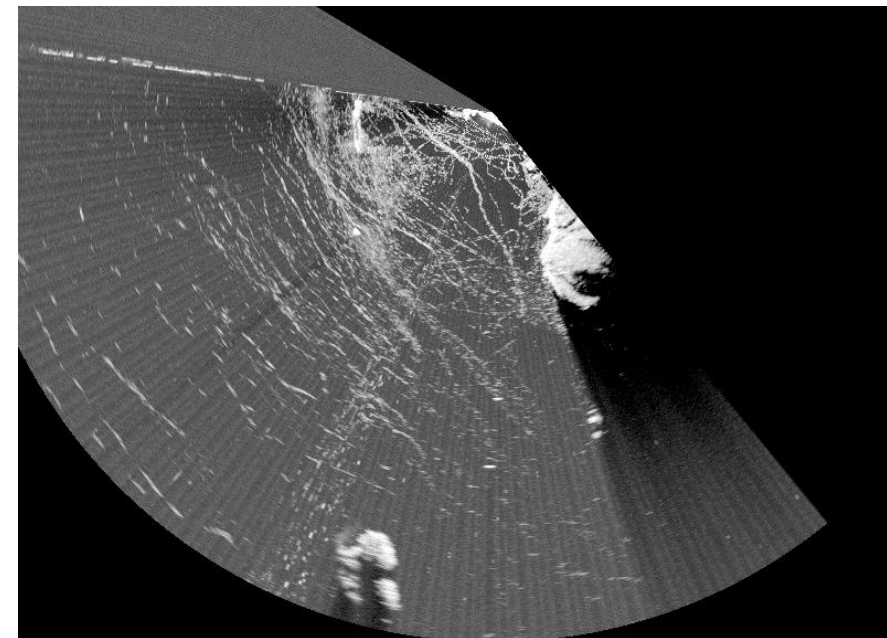
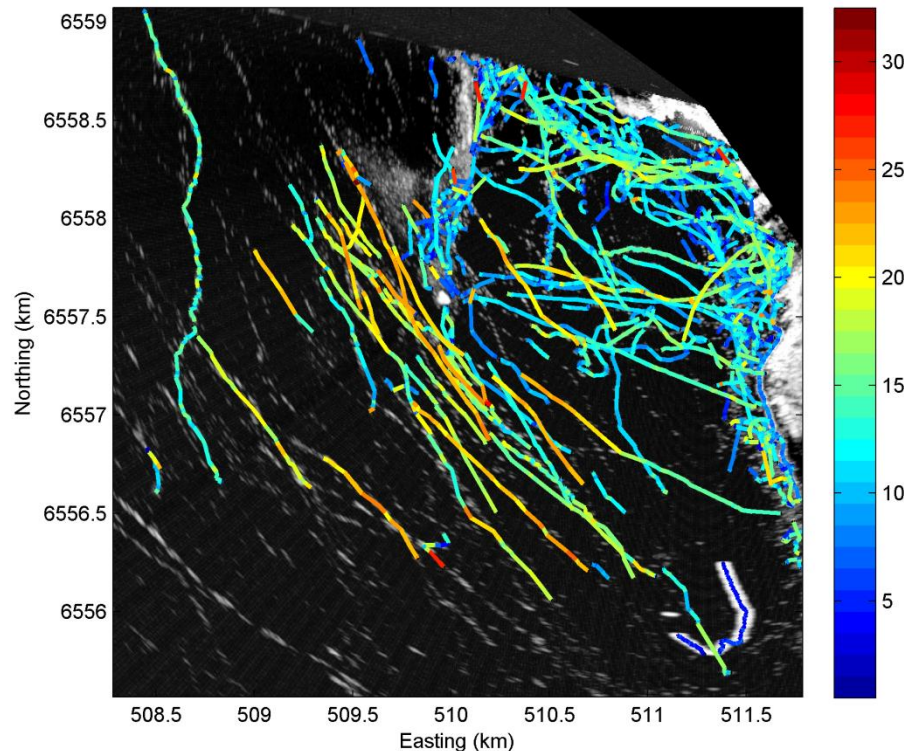




Marine X-band Radar (Bell and McCann)

- Sea-surface currents and roughness
- Target tracking (birds, mammals)
- Live stream noc.ac.uk/project/flowbec

Track speeds (m/s), 14/06/2012 11:00am

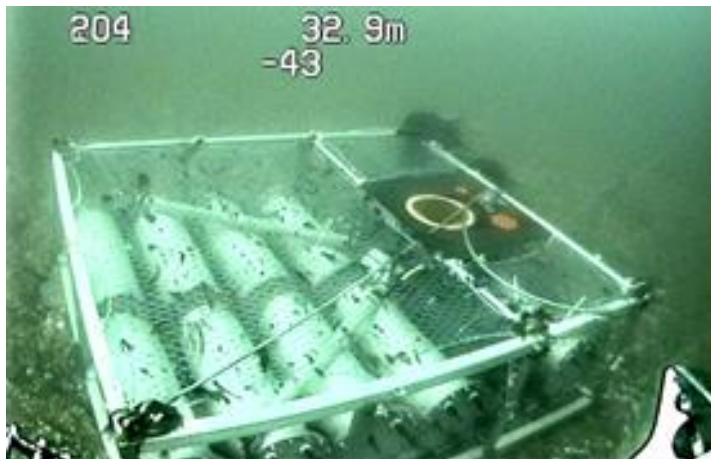


Simrad EK60 echosounder (38, 120, 200 kHz)

- bird and fish abundance, school behaviour
- multi-frequency target identification
- morphology of turbulence, plankton

Imagenex multibeam sonar (260 kHz)

- interactions of fish, diving seabirds, marine mammals with MREDs
- target tracking, evasion behaviour

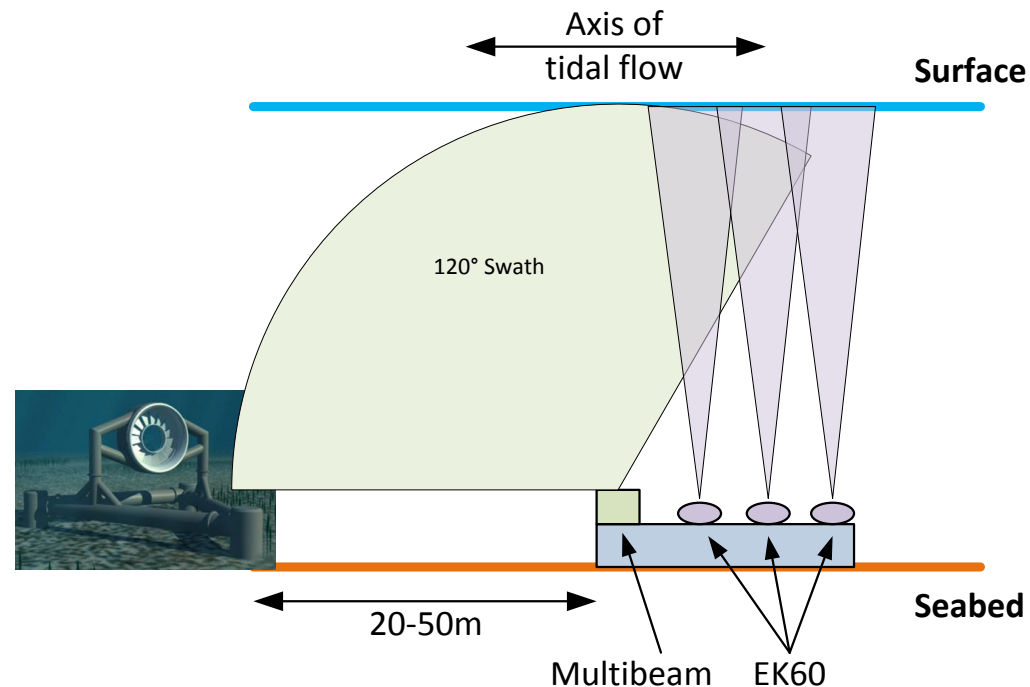


ADV

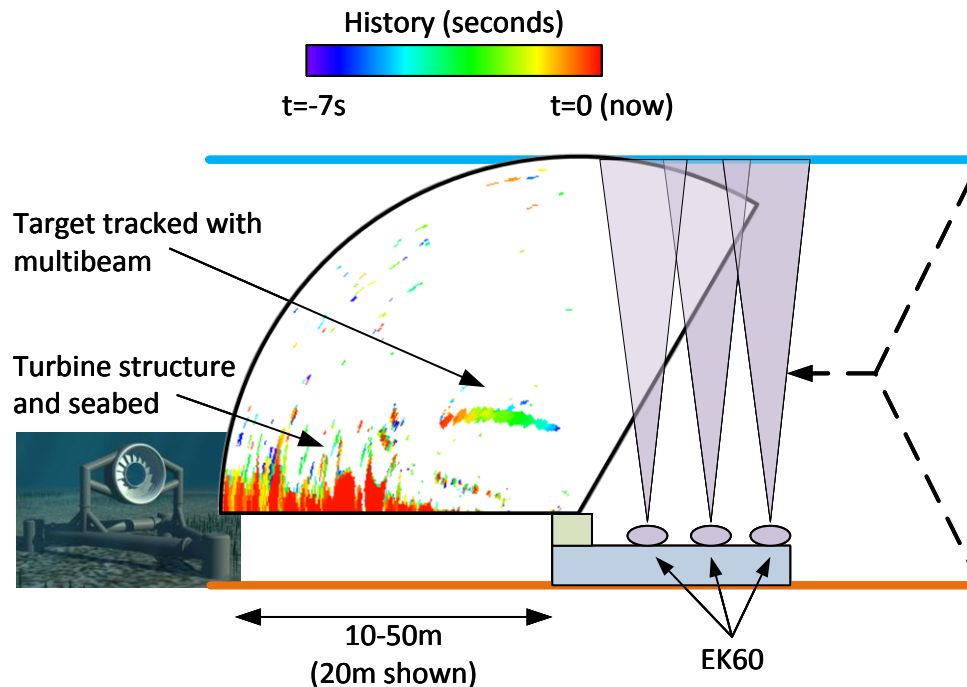
- flow, turbulence, temperature, water height

Fluorometer

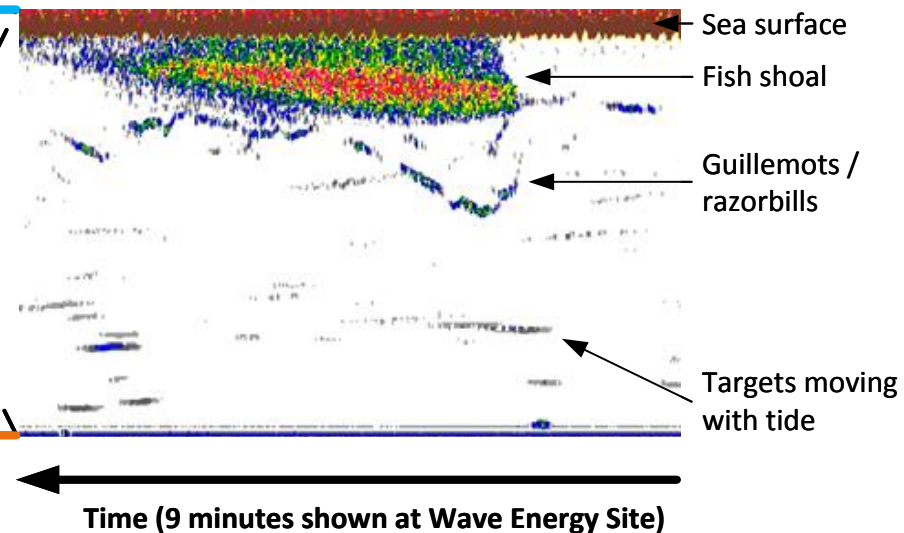
- chlorophyll (phytoplankton)
- turbidity



Multibeam for target tracking

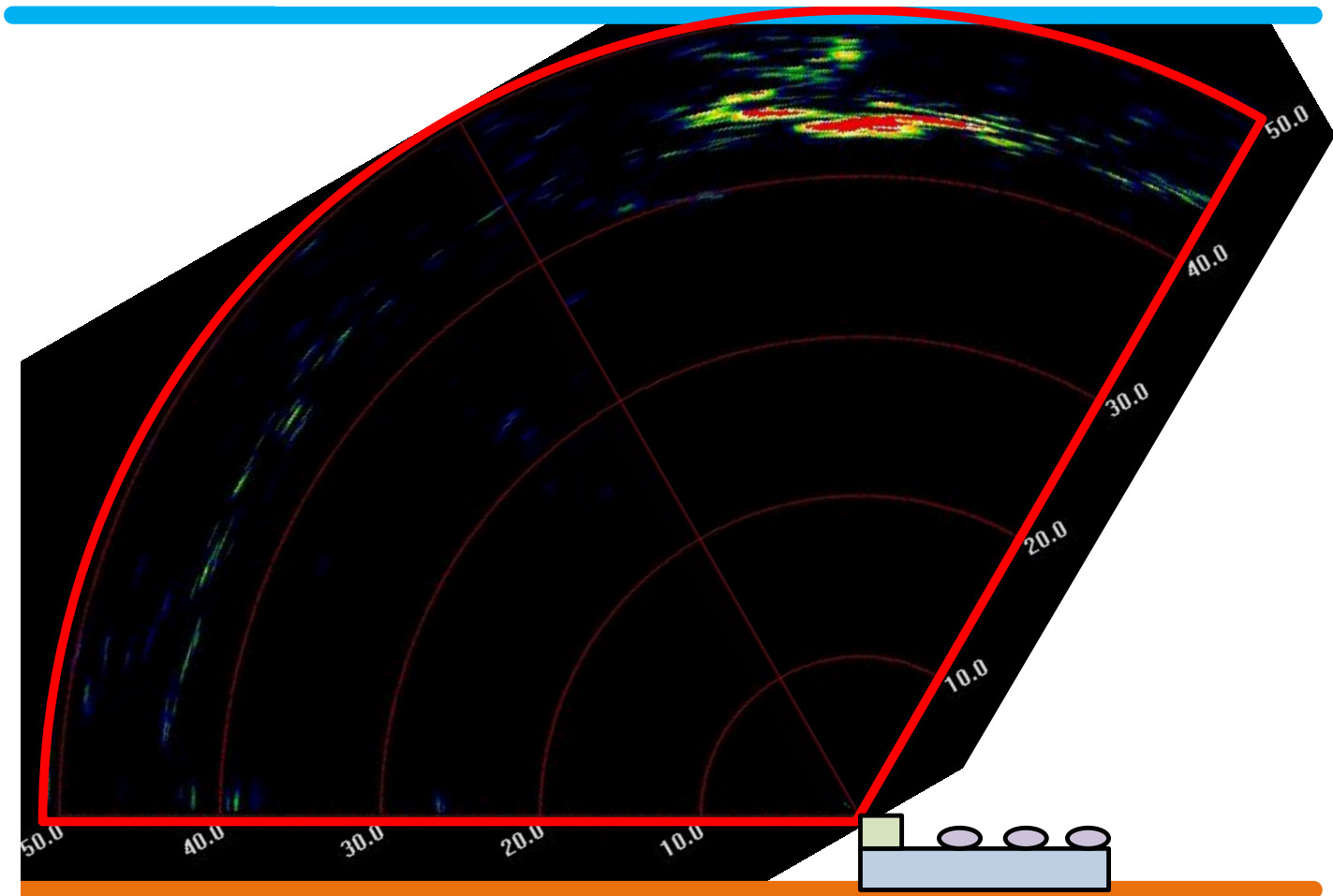


EK60 for multifrequency ID

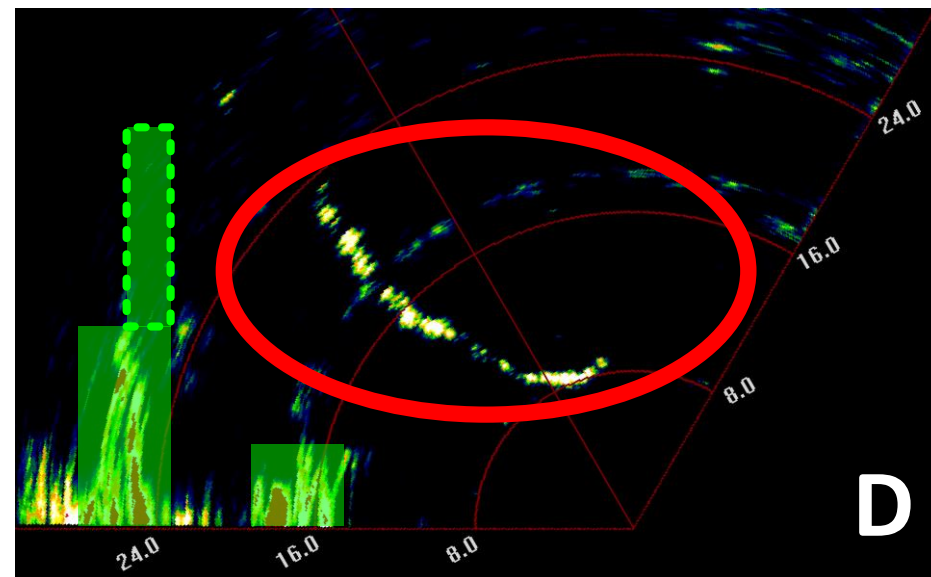
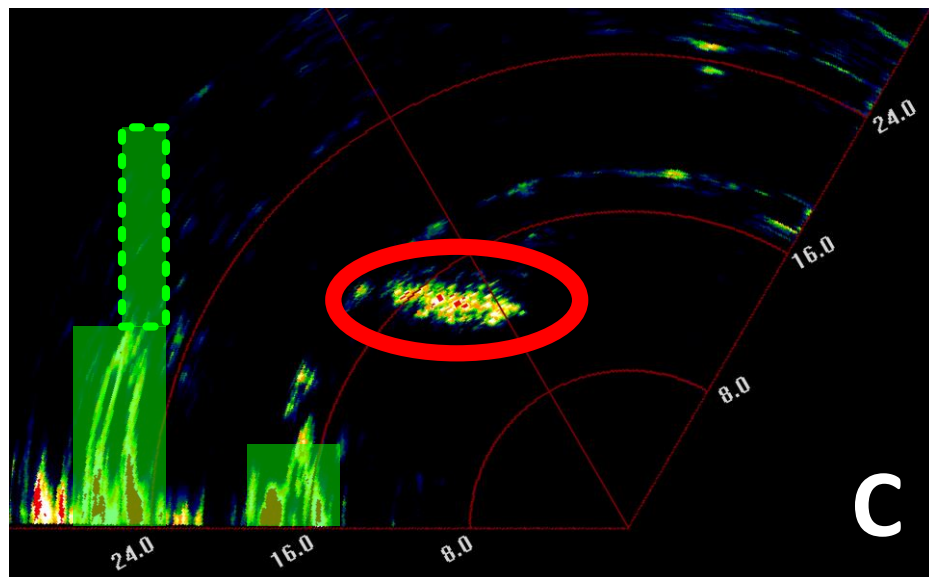
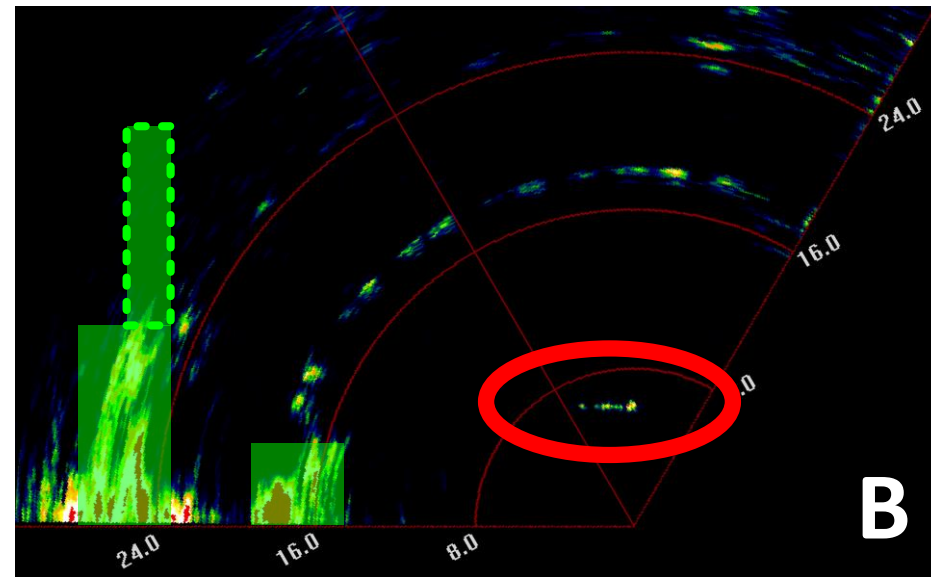
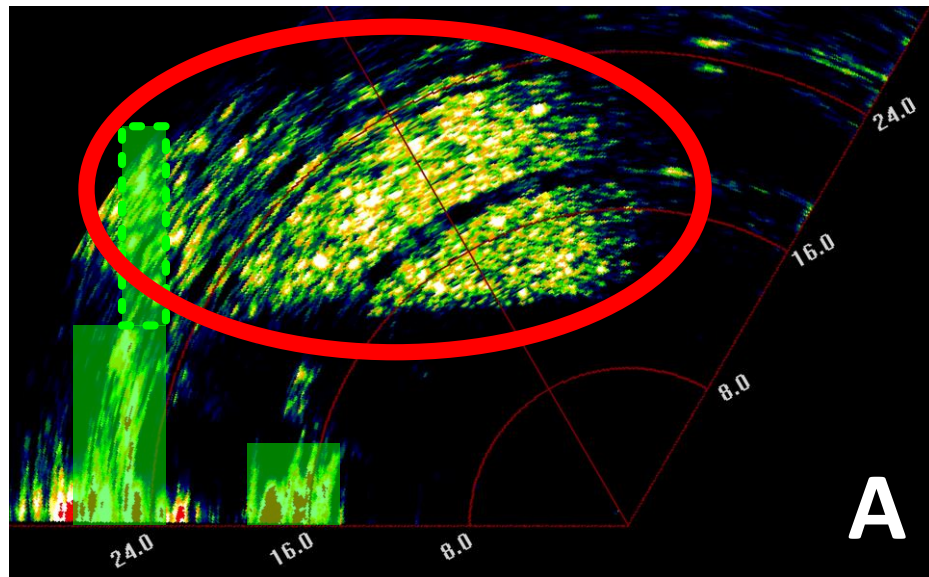


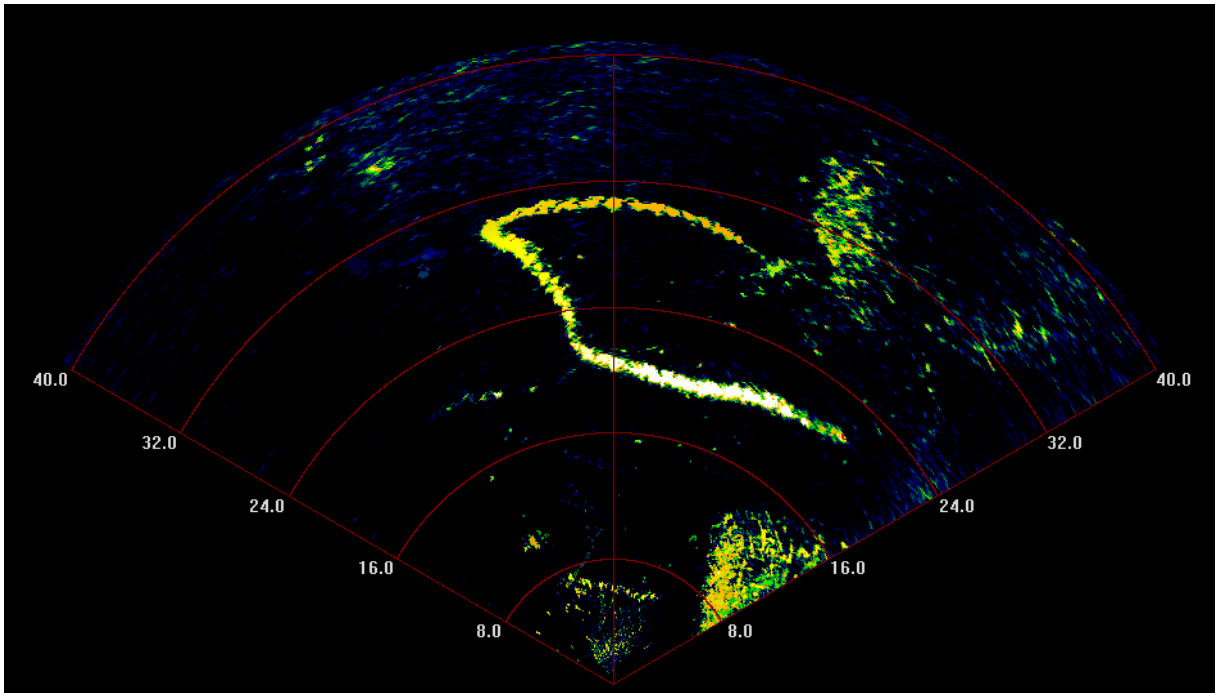
Acoustic classification ground truthed by shore observations

Multibeam sonar tracking of diving guillemots/razorbills feeding beneath a fish shoal at a wave energy site



Green = Turbine structure, **Dashed** = Expected blade radius



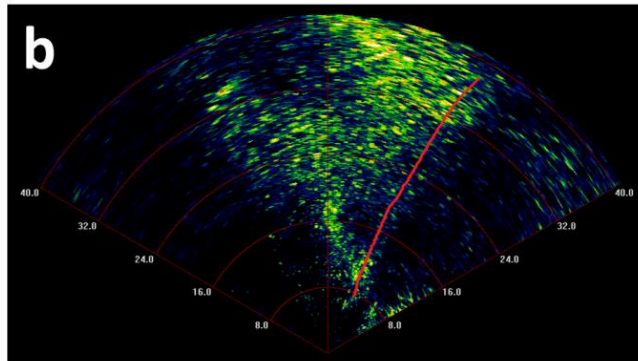
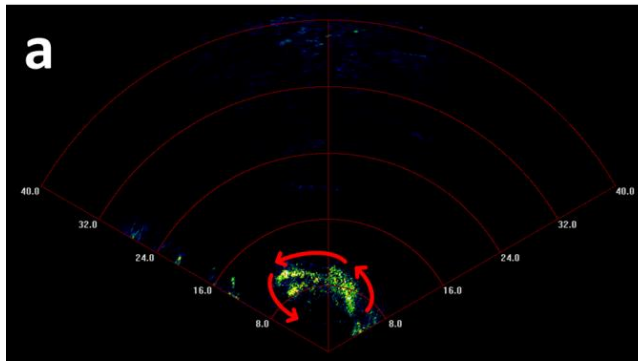


Multibeam sonar 3D seal and prey tracking at tidal passes



Co-registered video and sonar tracking (above)
with concurrent prey, turbulence and photo ID (right)





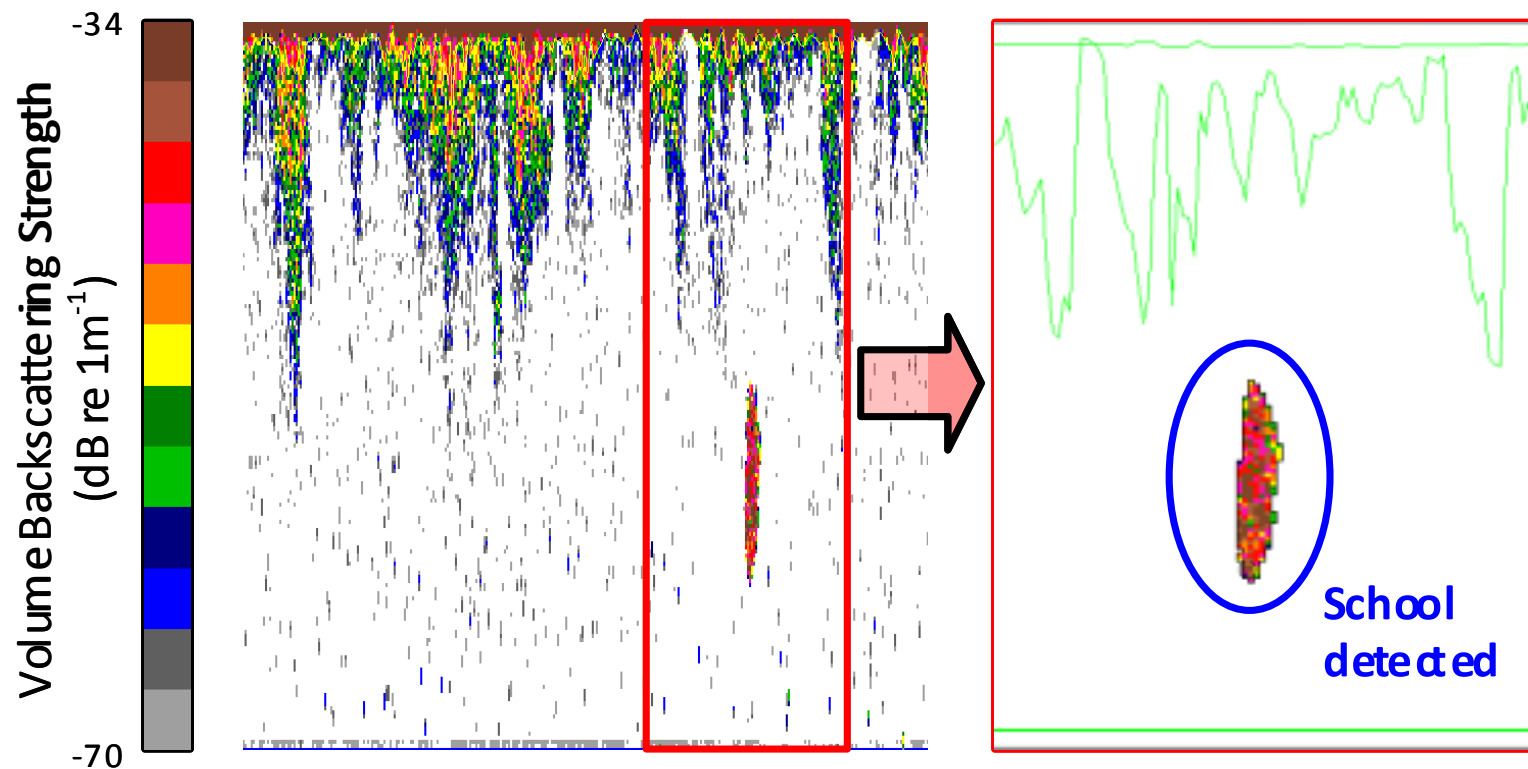
Concurrent video/sonar of
predator-prey interactions
and ecologically-relevant
turbulent features

Turbulence mask and parameterisation:

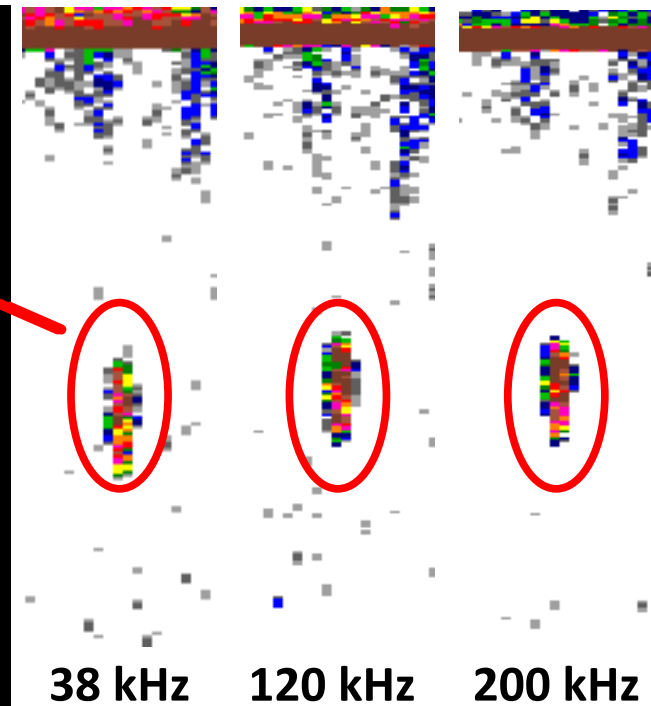
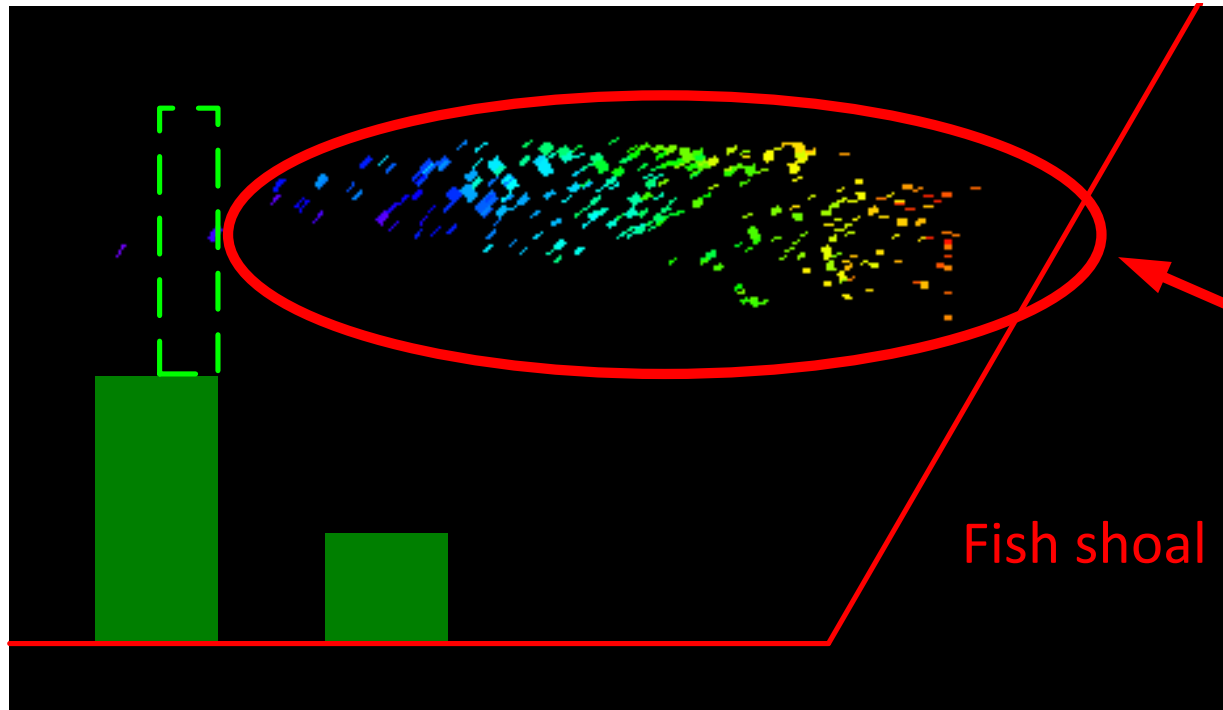
- excluded from biological data, useful as a covariate

School detection:

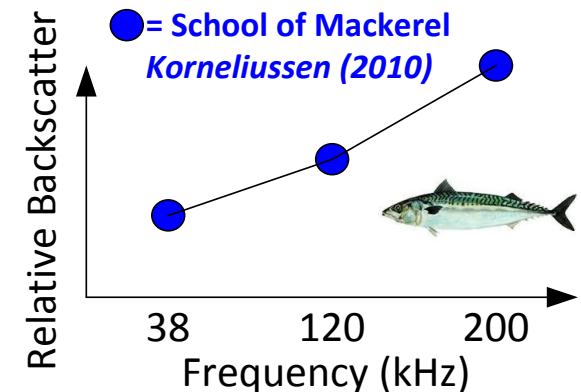
- quantitative parameterisation of biological targets



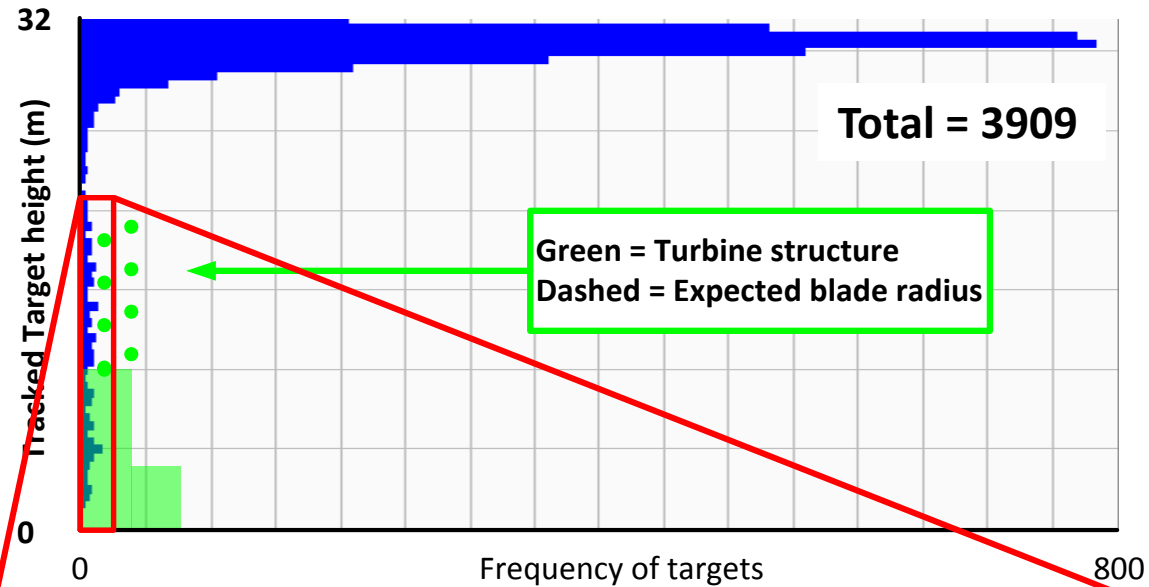
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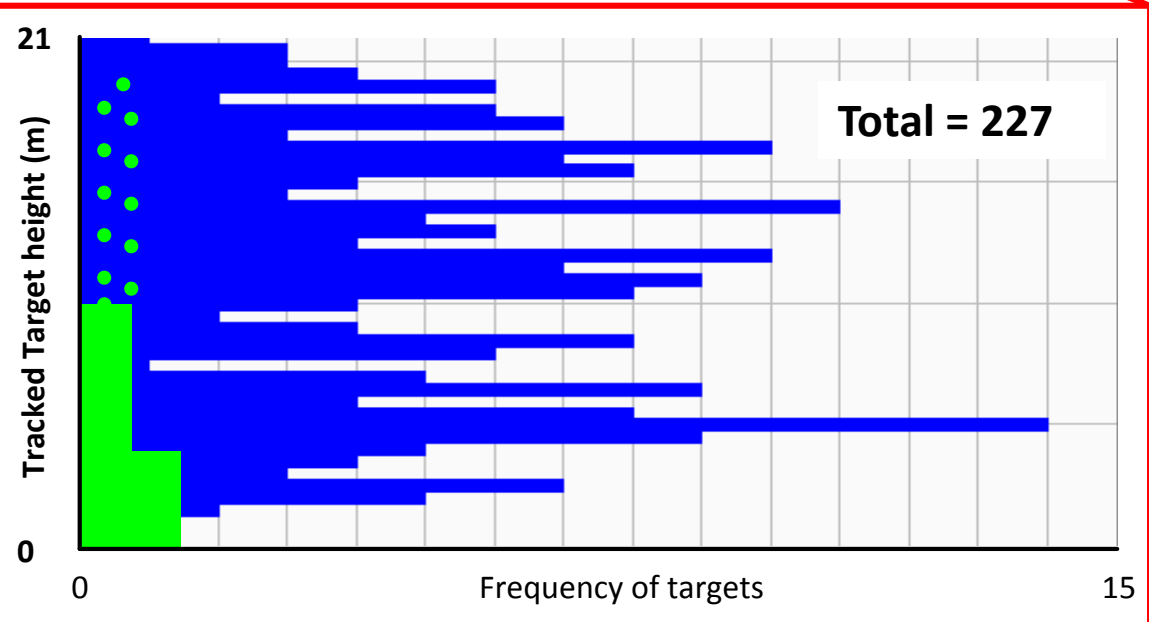
- **Target detection** using the multibeam and EK60
- **Target tracking** using the multibeam
- **Multifrequency analysis** using the EK60



All tracked targets (mammals, birds, fish schools, individual fish) next to Atlantis turbine structure = 3909 tracks over 2 week period

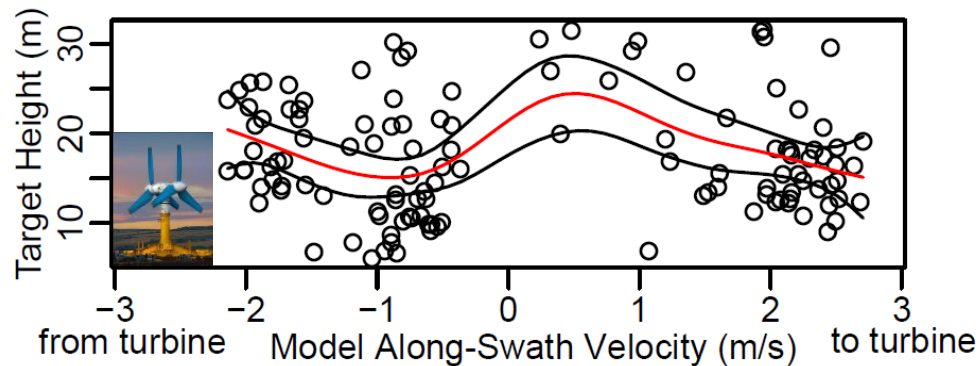


Vertical overlap with turbine height = 227 tracks over 2 week period

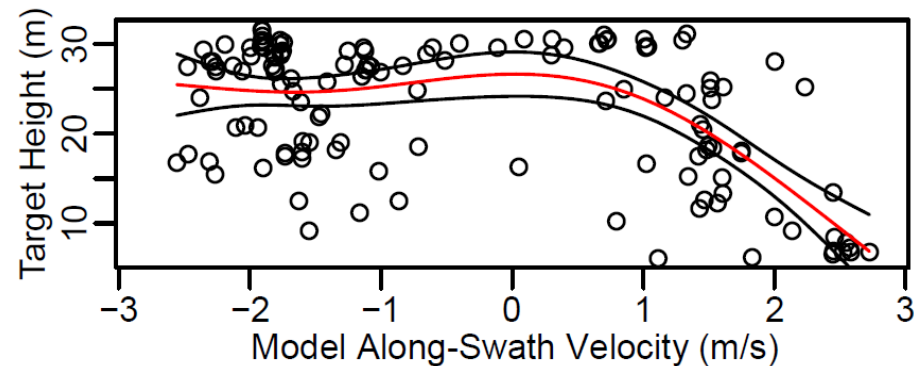


Co-registered MBES (behaviour and turbine interaction) and EK60 (multi-frequency and turbulence metrics)

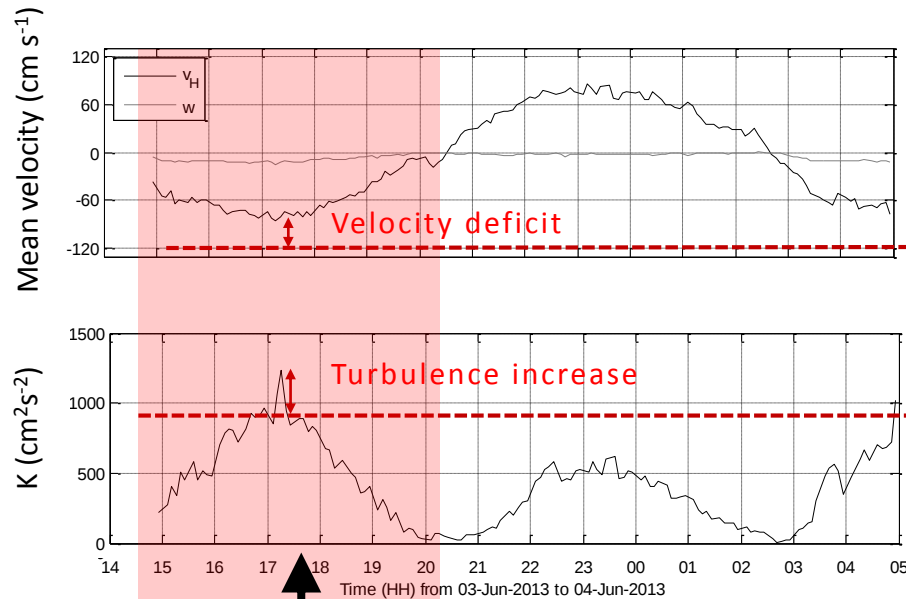
Turbine Structure



Control Site (no turbine)

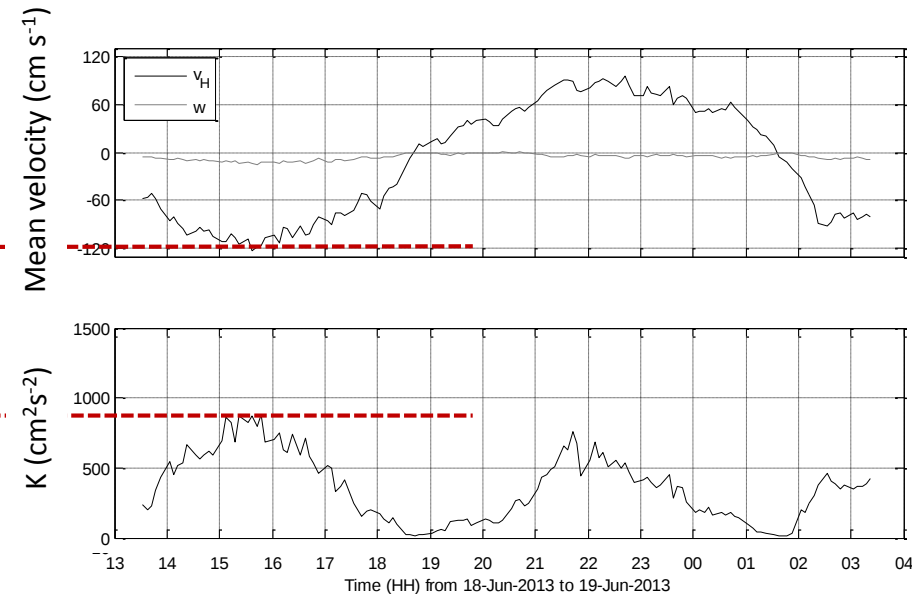


Turbine Structure



Period in turbine
structure wake

Control Site (no turbine)



- Comparable hydrodynamic conditions
- Velocity deficit when in structure wake (ADV)
- But TKE (typically correlated with velocity) is higher in wake
- Suggests different mechanism (smaller-scale intense turbulence rather than natural larger-scale turbulence)

FLOWBEC frame (single point,
temporal persistence)

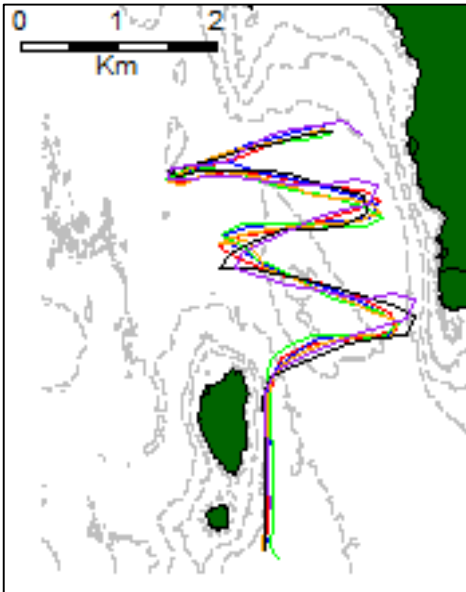
complemented by

RESPONSE boat surveys
(entire site, temporal
snapshot)

Waggitt *et al.* (2014) EIMR

**Suitable Physical
Conditions**

**Increased Prey
Availability**



**Presence of
Foraging Seabirds**



Investigating the ecological effects of installing and operating MREDs

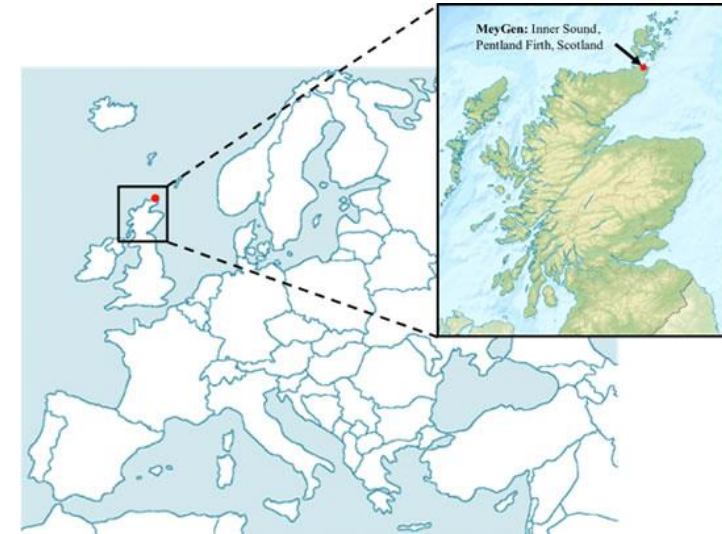
- Investigate collision risk probabilities
- Define vertical habitat use and any changes in habitat use pre & post installation for a range of species
- Increase overall environmental understanding of mobile animal use of high energy sites
- Inform marine spatial planning, device design, licensing and operation
- Guide scaling-up to arrays and new site selection
- Increase predictive power to eventually reduce monitoring



Environmental Monitoring at MeyGen (UK)

Staged consent:

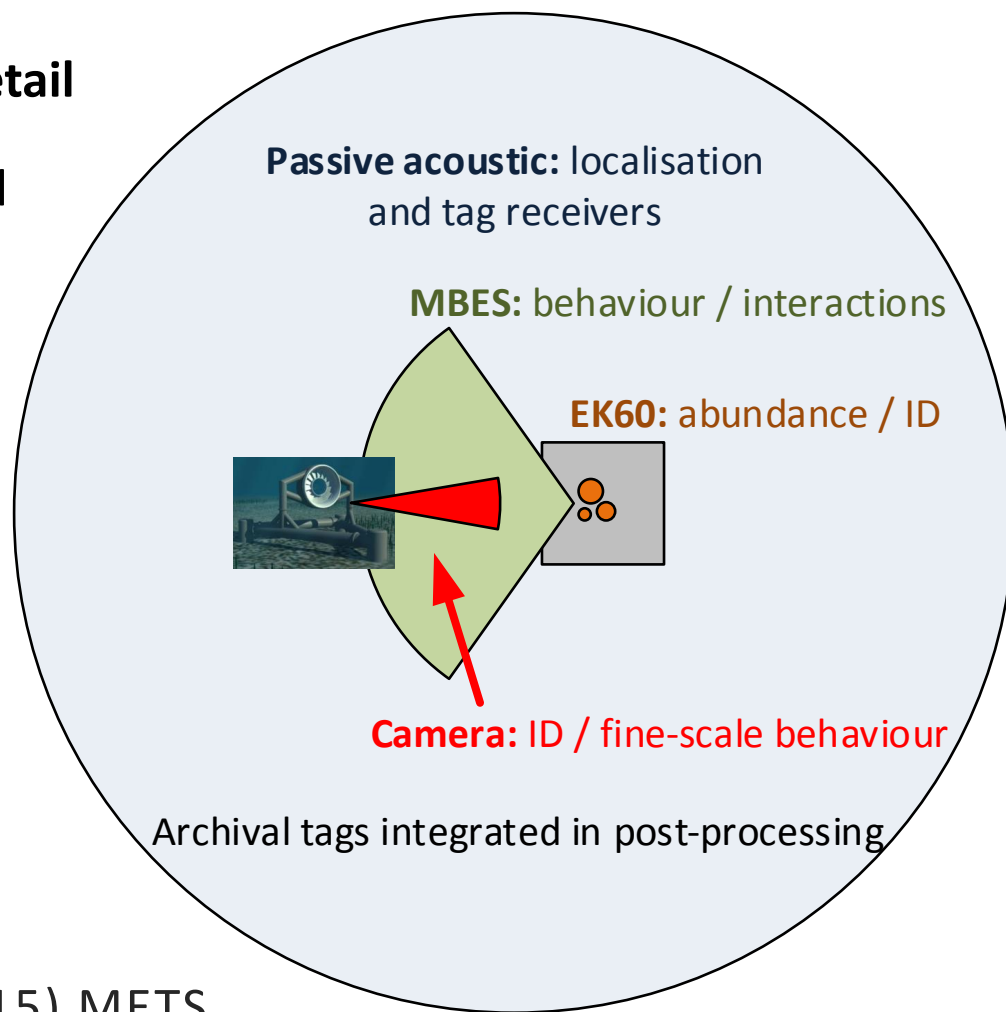
- 4 turbines, construction started
- then 61 turbines (86 MW)
- eventually 398 MW



Environmental Monitoring at MeyGen (UK)

Intelligent triggering of instruments across **multiple scales**

- Combines **large-scale** with **fine-detail**
- Reduces data processing / archival
- Cycle passive / active acoustics
- Trigger camera for ID / detail



Williamson, B.J. *et al.* 2015. A Self-Contained Subsea Platform for Acoustic Monitoring of the Environment Around Marine Renewable Energy Devices – Field Deployments at Wave and Tidal Energy Sites in Orkney, Scotland. *IEEE Journal of Oceanic Engineering* [10.1109/JOE.2015.2410851](https://doi.org/10.1109/JOE.2015.2410851)



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