Development of the FLOWBEC seabed platform

Monitoring wildlife interactions and hydrodynamics around tidal turbines

Benjamin Williamson, Philippe Blondel,
James Waggitt, Shaun Fraser,
Chris Hall, Eric Armstrong,
Paul Bell, Beth Scott

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*
http://dx.doi.org/10.1109/JOE.2015.2410851

NE/J004308/1, NE/J004200/1, NE/J004332/1
NERC MREKE Internship
Innovate UK KTP / MeyGen Ltd.

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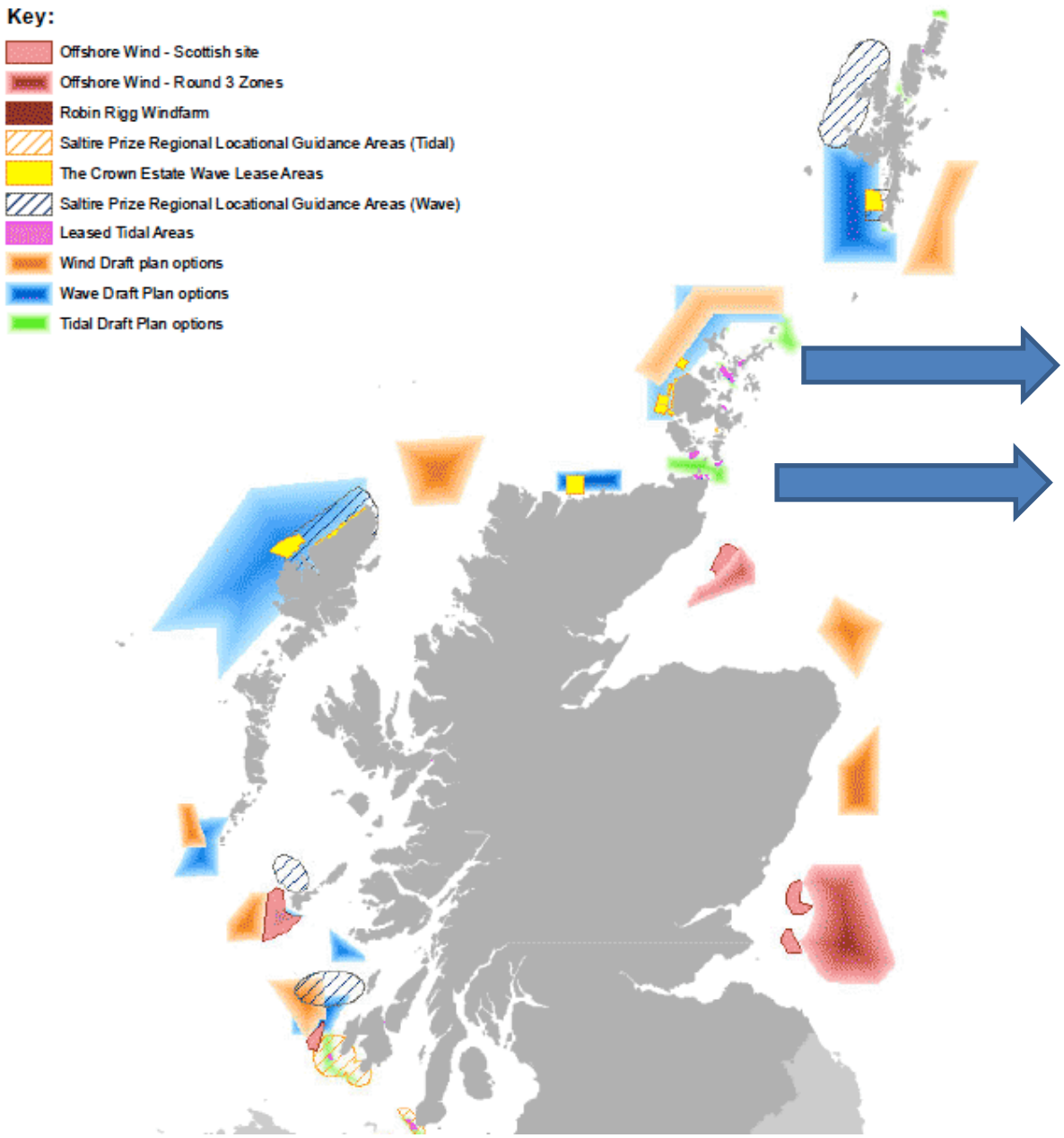

Scotland:

100% renewable by 2020

≈67.2% as of 2014

EMEC ORKNEY
The European Marine Energy Centre Ltd

MEYGEN
THE TIDE OF CHANGE IN CAITHNESS

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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

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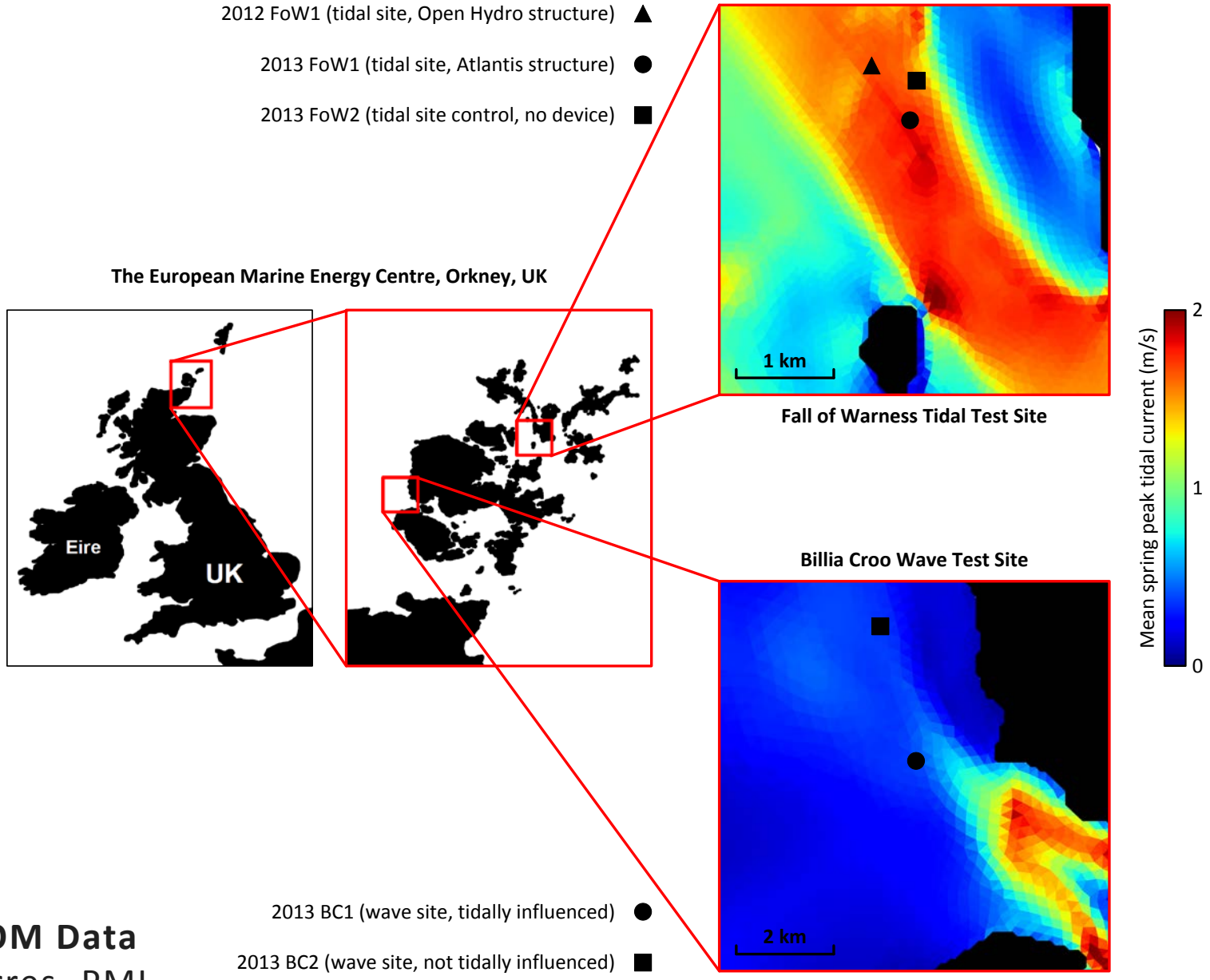

FLOWBEC FVCOM Data
Cazenave & Torres, PML

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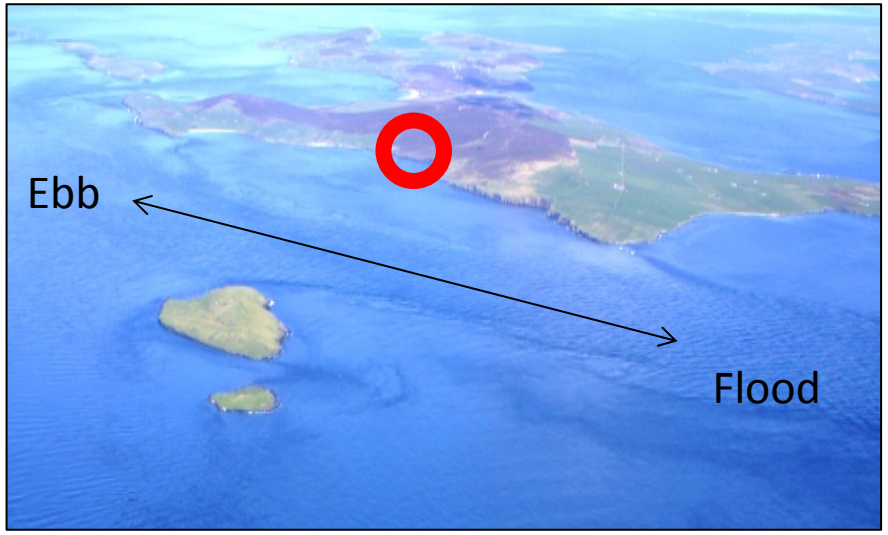
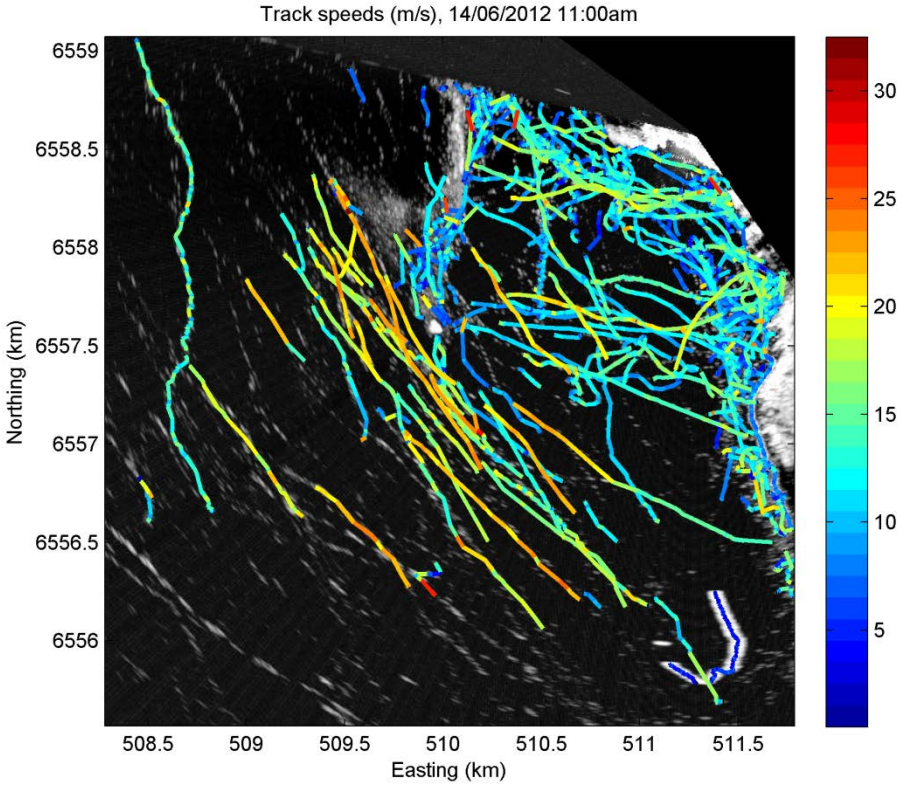
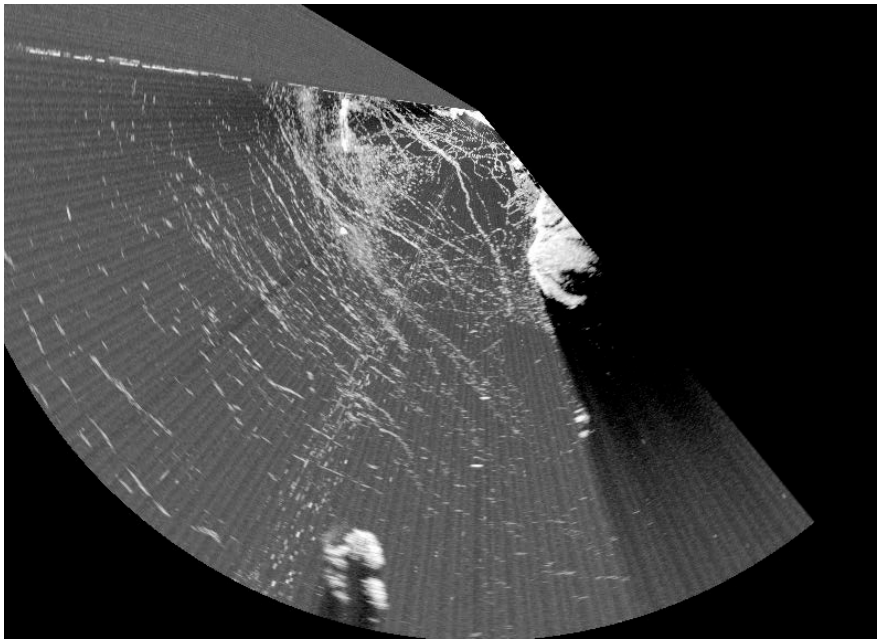
Marine X-band Radar (Bell and McCann)

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







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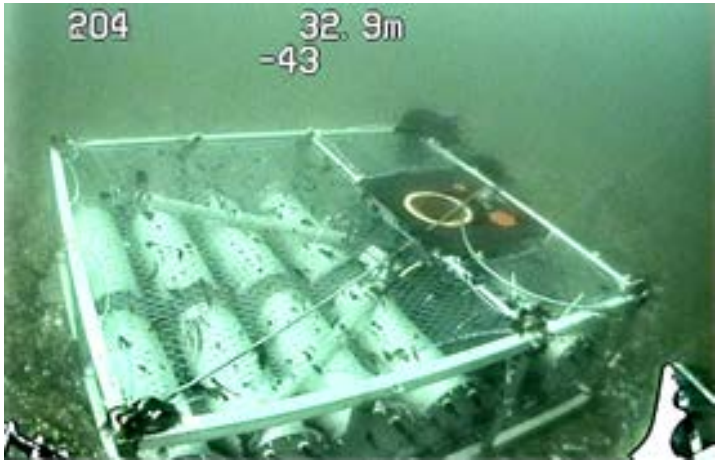
Simrad EK60 echosounder (38, 120, 200 kHz)

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

Imagenex multibeam sonar (260 kHz)

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

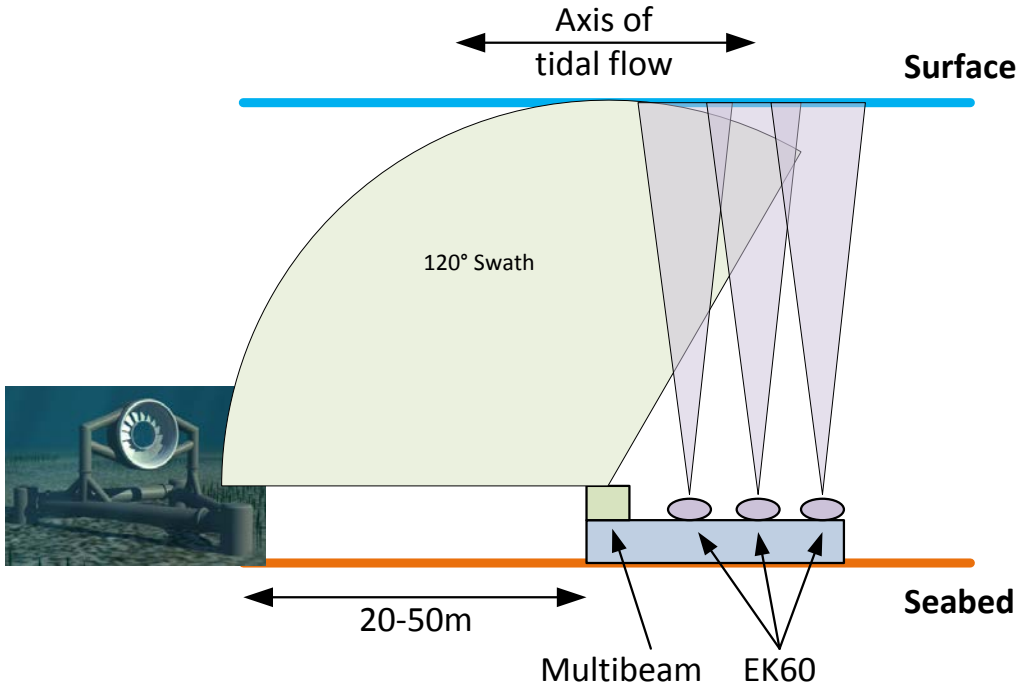


ADV

- flow, turbulence, temperature, water height

Fluorometer

- chlorophyll (phytoplankton)
- turbidity



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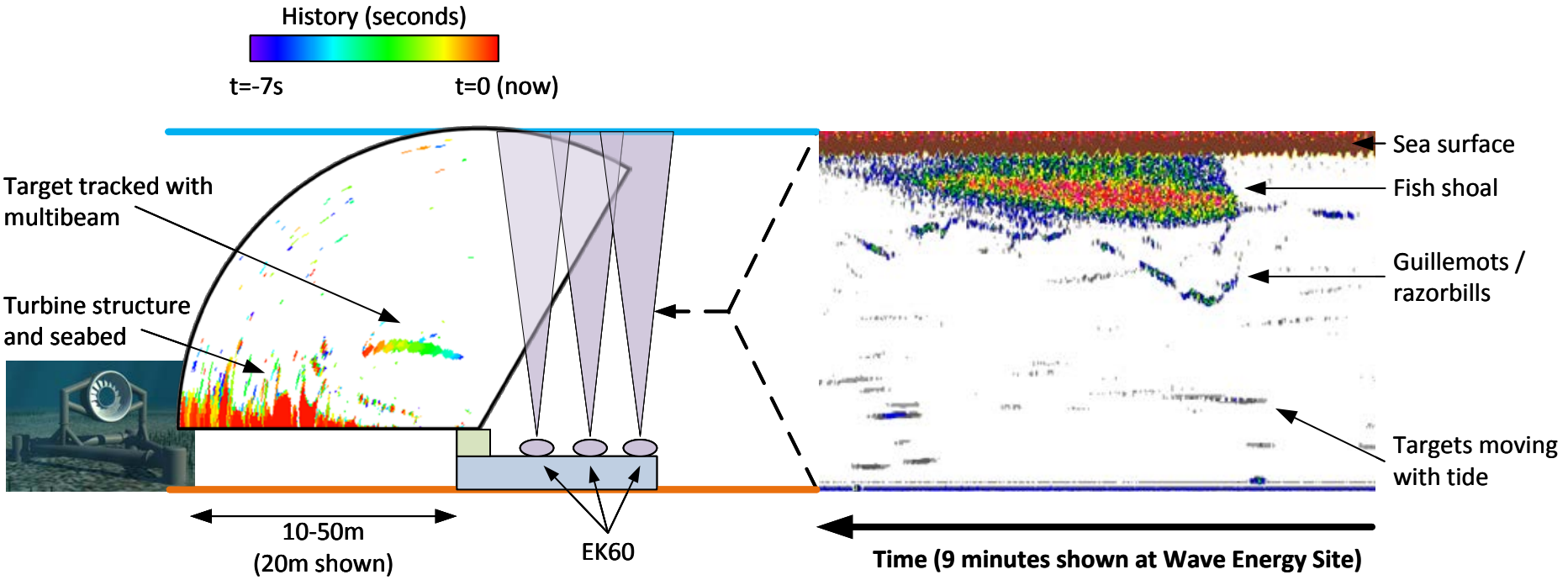
Multibeam for target tracking

EK60 for multifrequency ID



Acoustic classification ground truthed by shore observations

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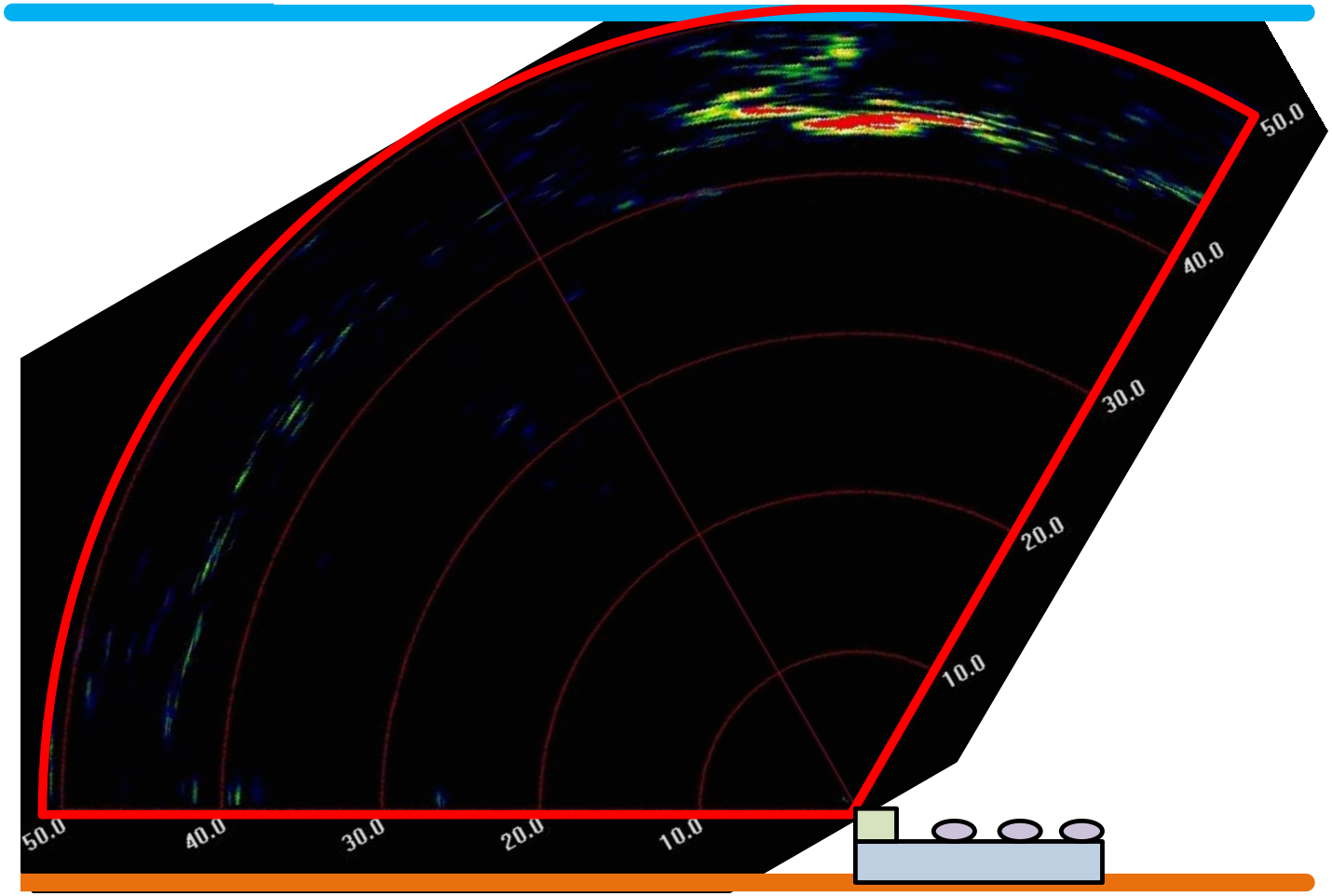
Multibeam sonar tracking of diving guillemots/razorbills feeding beneath a fish shoal at a wave energy site



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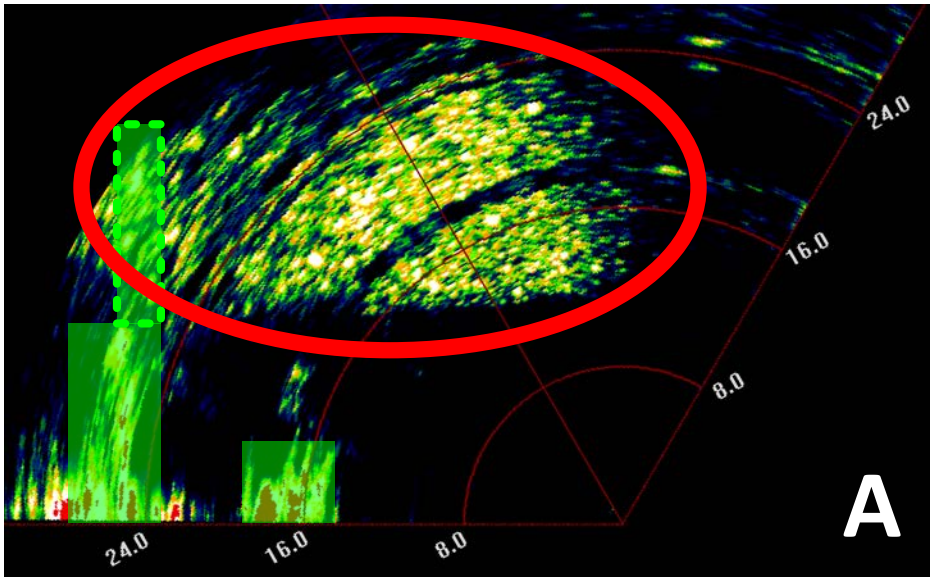
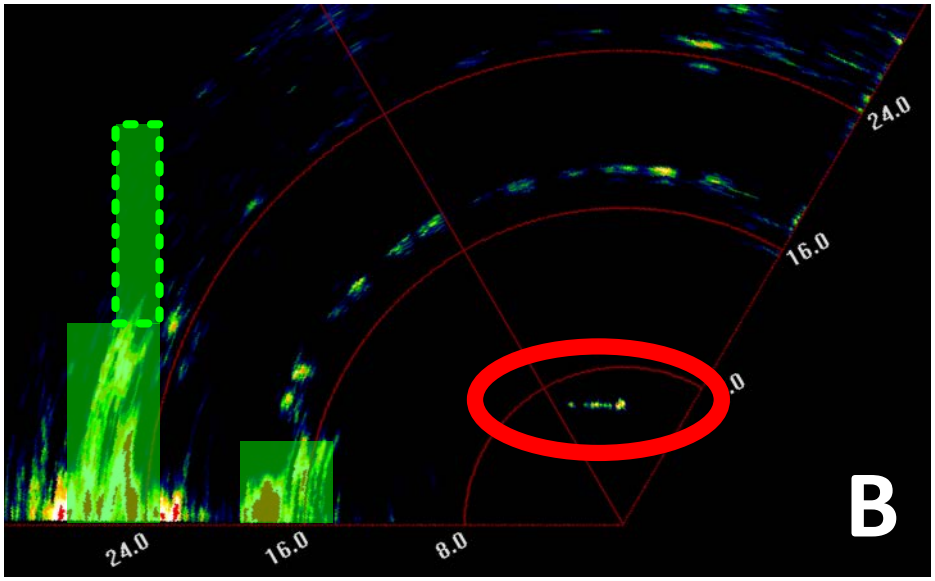
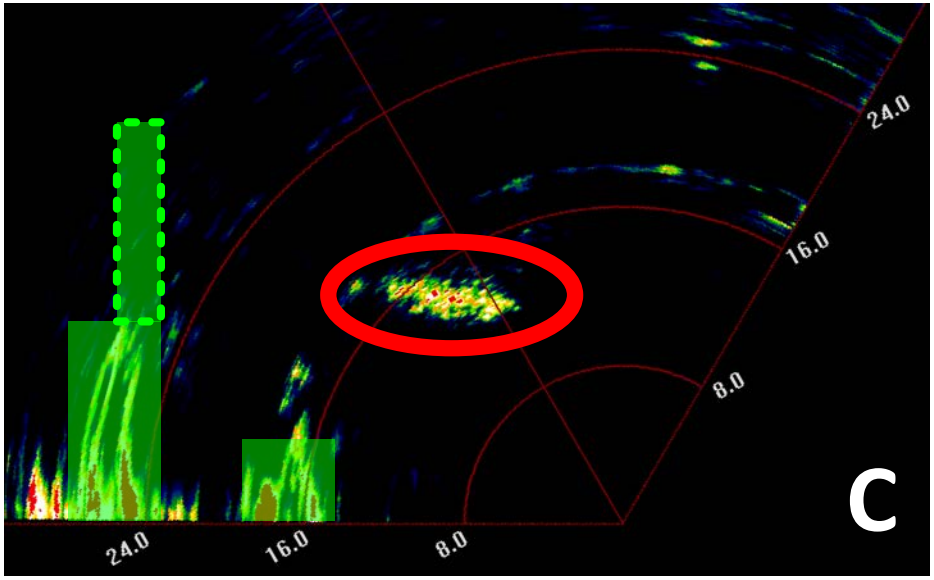
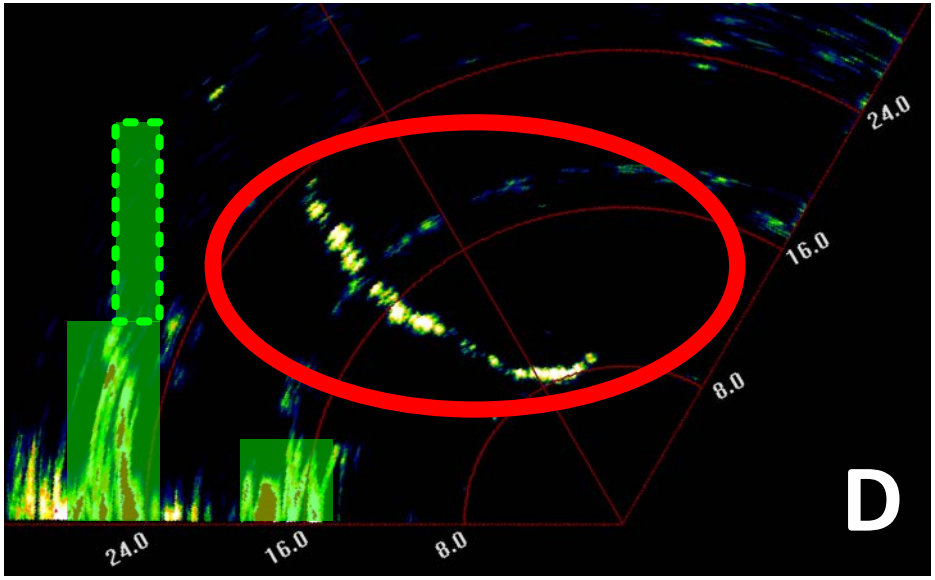
Green = Turbine structure, **Dashed** = Expected blade radius









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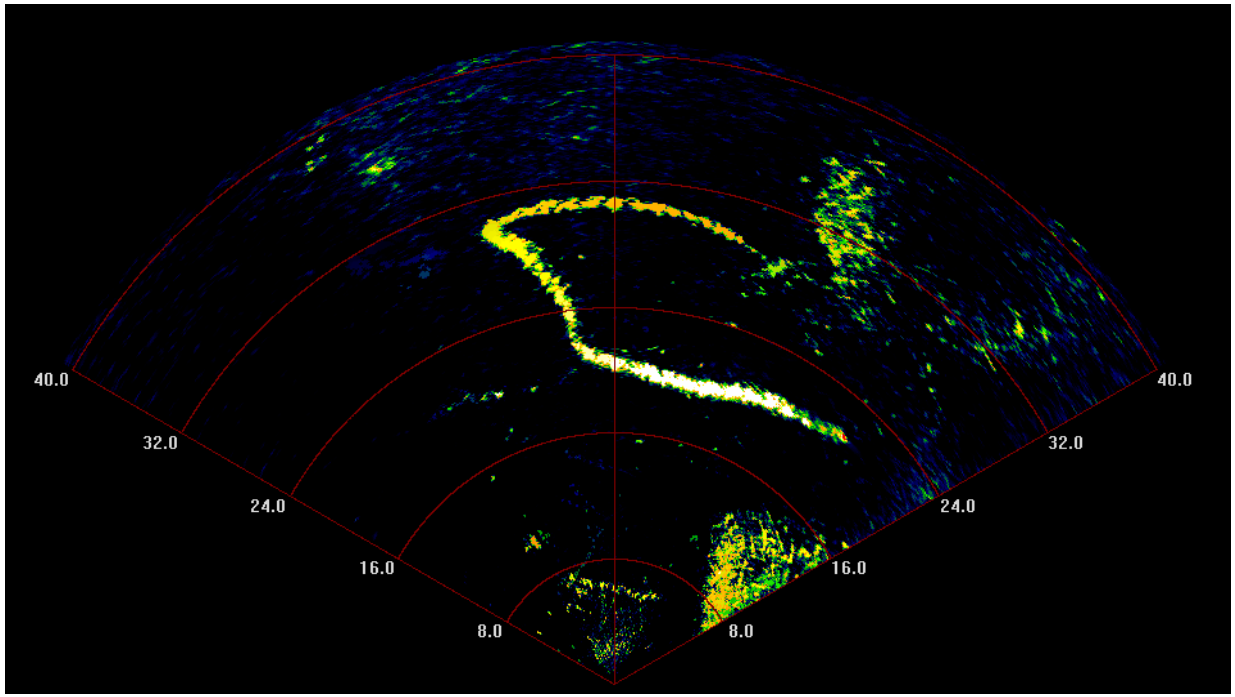
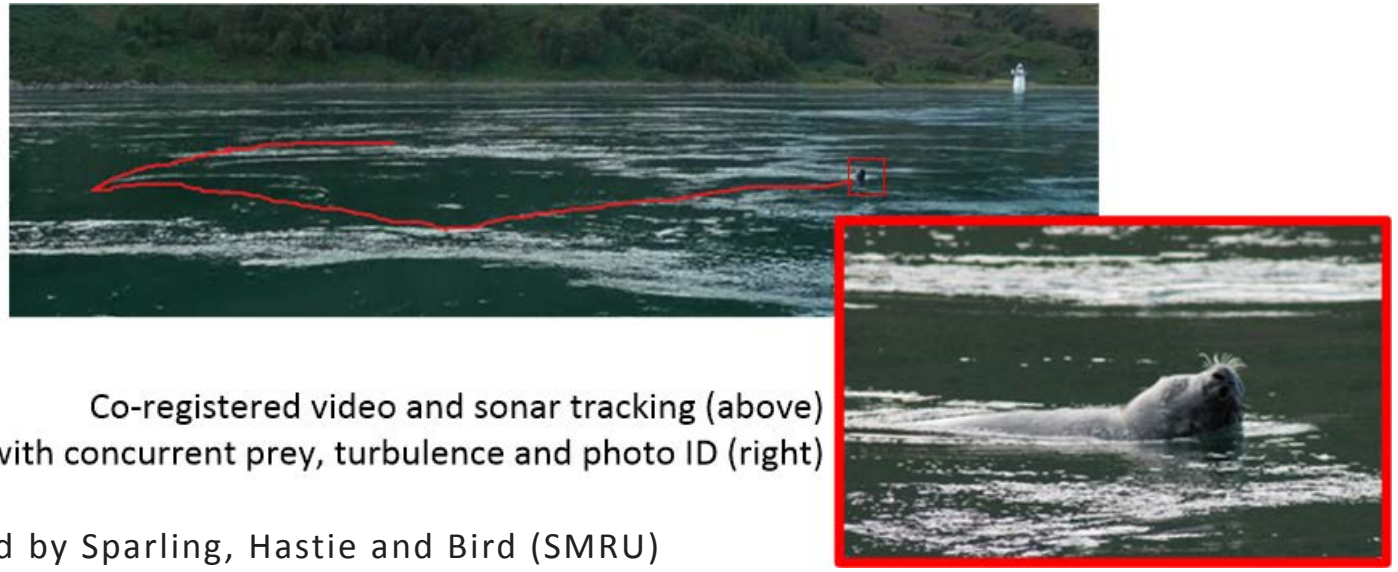


Multibeam sonar
3D seal and prey tracking
at tidal passes



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

Surveys facilitated by Sparling, Hastie and Bird (SMRU)

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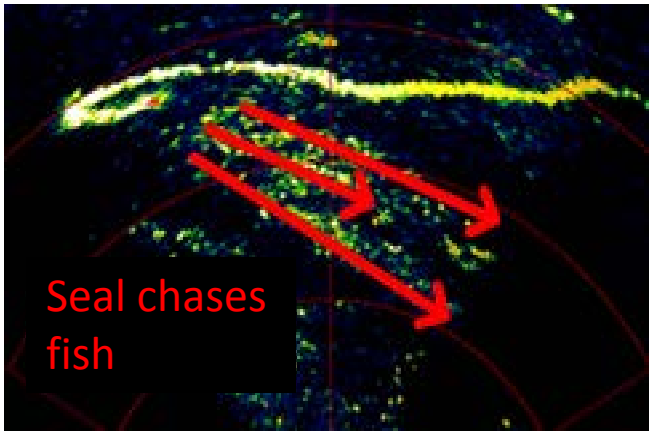
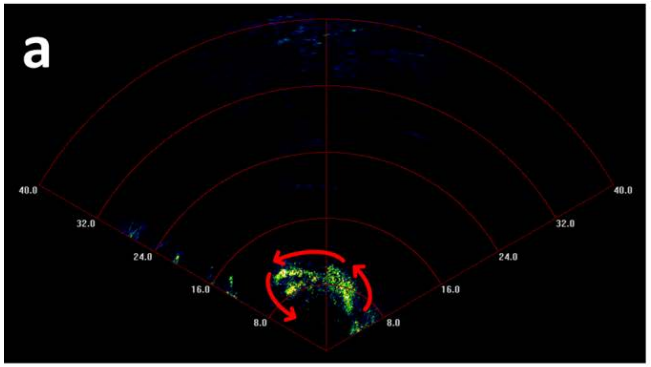
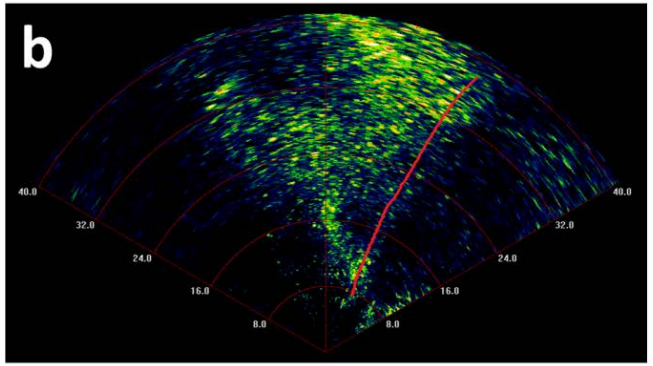
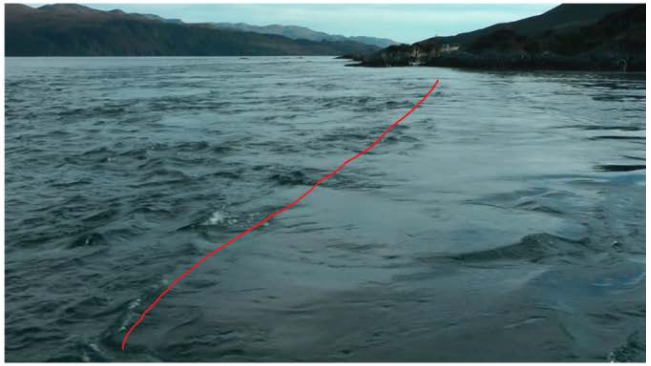


Concurrent video/sonar of predator-prey interactions







Surveys facilitated by Sparling, Hastie and Bird (SMRU)

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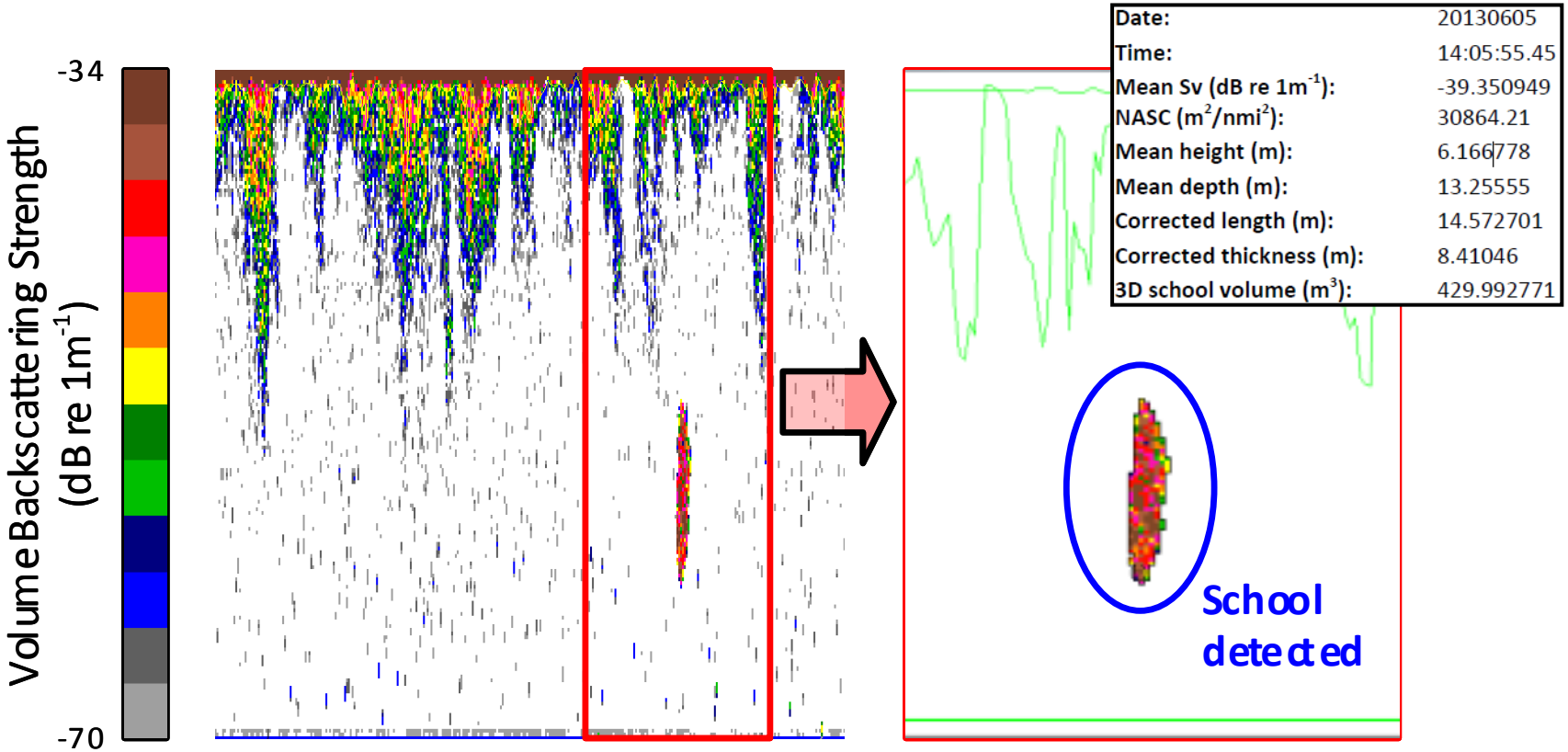
Turbulence mask and parameterisation:

- excluded from biological data, useful as a covariate

School detection:

- quantitative parameterisation of biological targets



Fraser *et al.* (2014) EIMR

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FLOWBEC target tracking

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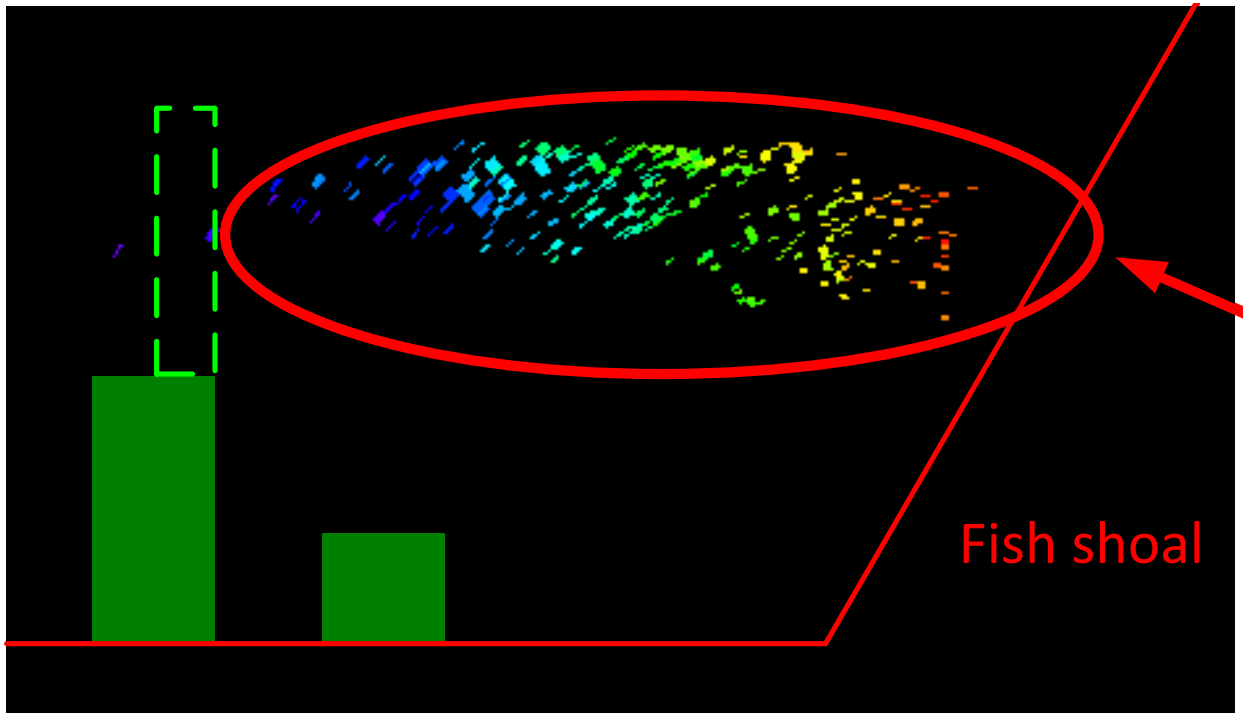
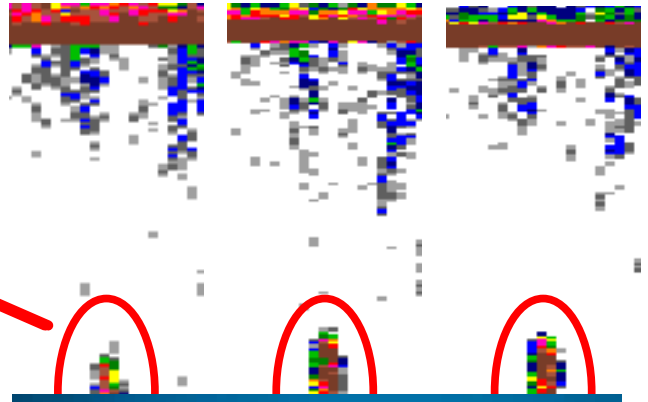
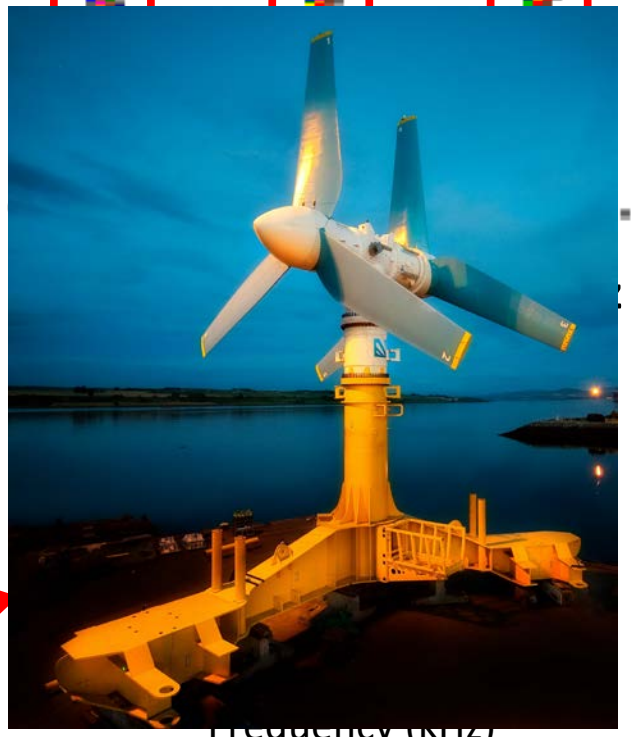
Green = Turbine structure, **Dashed** = Expected blade radius







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

Frequency (kHz)

Target vertical distribution

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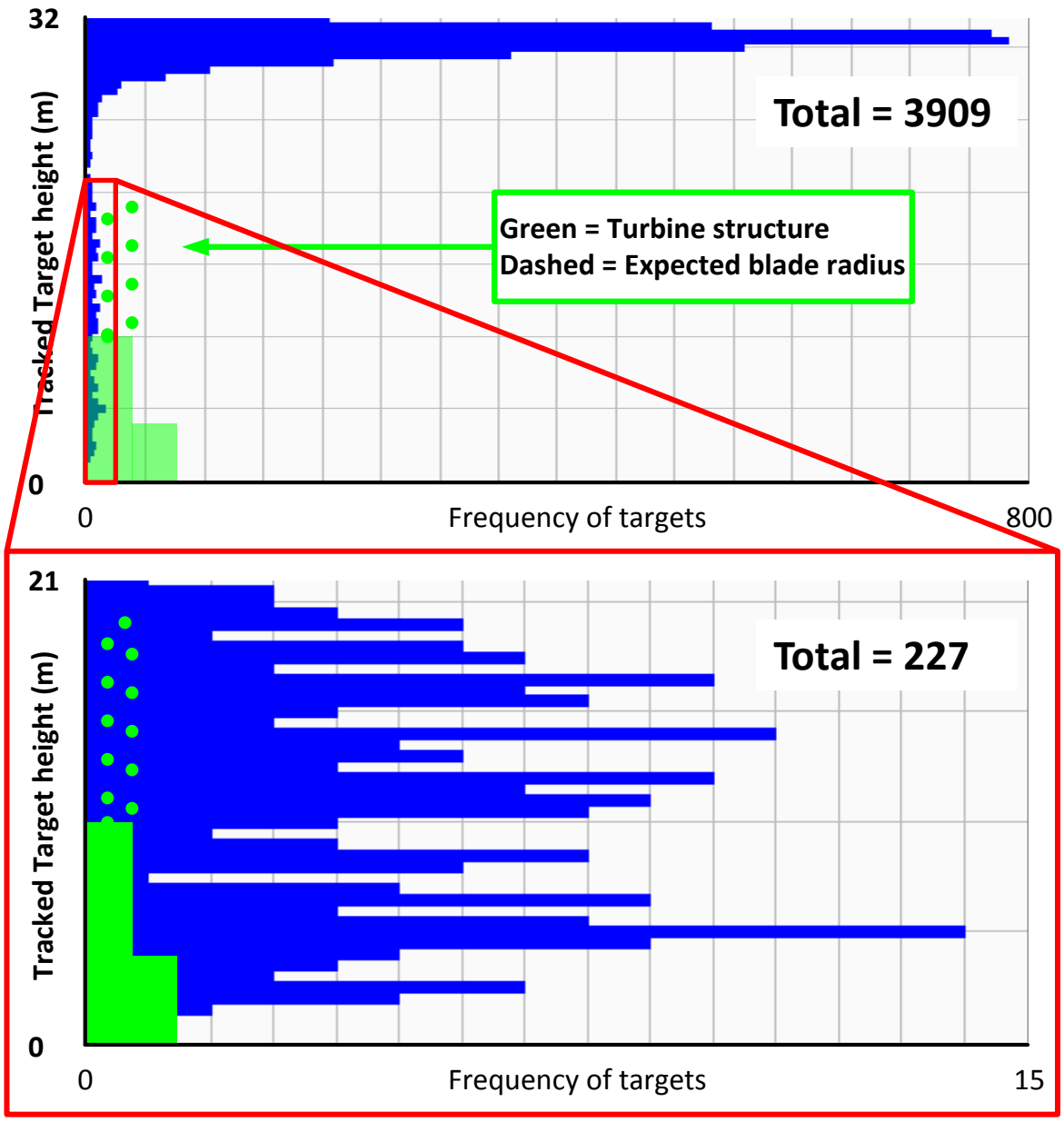
All tracked targets (mammals, birds, fish schools, individual fish) next to Atlantis turbine structure = 3909 tracks over 2 week period



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

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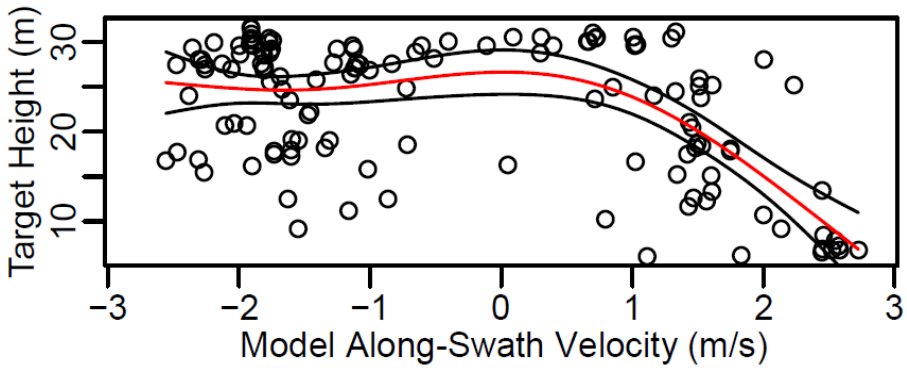
Co-registered MBES (behaviour and turbine interaction) and **EK60** (multi-frequency and turbulence metrics)

Control Site (no turbine)



Ecologically-relevant turbulence

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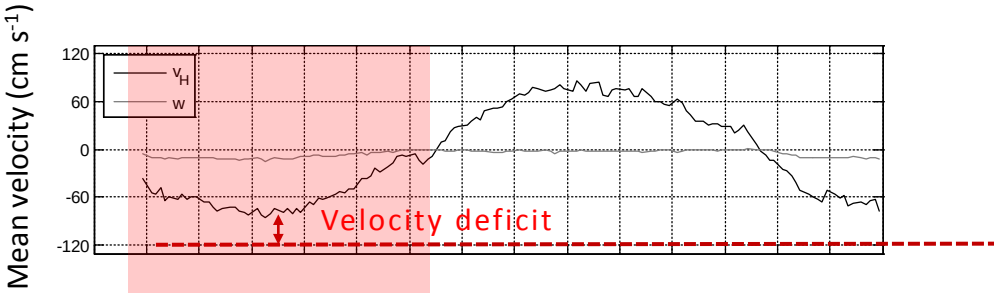
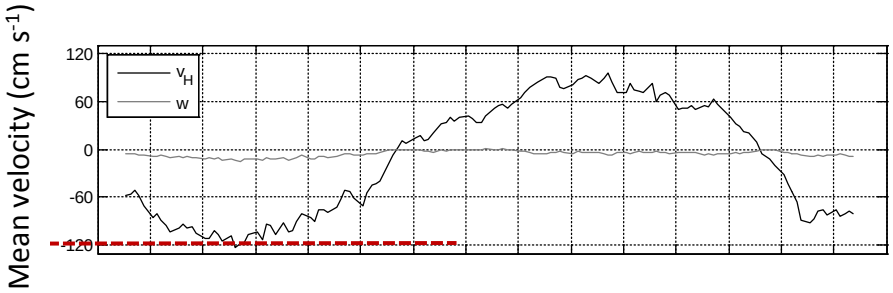
Turbine Structure



Period in turbine structure wake

Control Site (no turbine)



- Comparable hydrodynamic conditions
- Velocity *deficit* when in structure wake (ADV)
- But TKE consistently *higher* in wake, despite reduced velocity
- Suggests different flow structure (complete disruption of large natural coherent motions with more intense smaller-scale turbulence)
  - Informed by cross-correlation analysis of vertical & horizontal velocity components (ADV)

Fraser *et al.* (2014) EIMR

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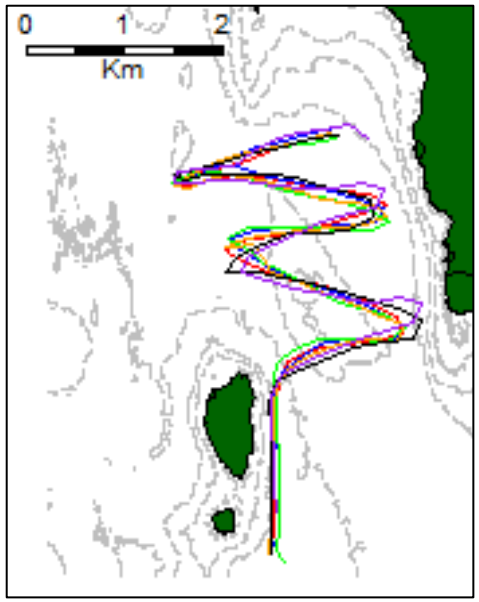
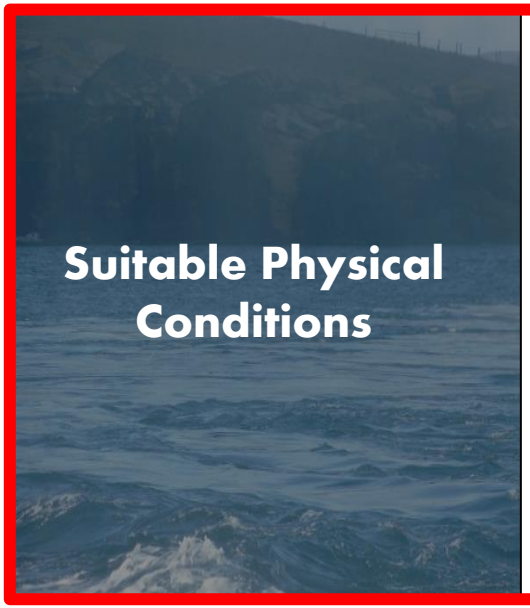
FLOWBEC frame (single point, temporal persistence)

complemented by

RESPONSE boat surveys (entire site, temporal snapshot)

Waggitt *et al.* (2014) EIMR





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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

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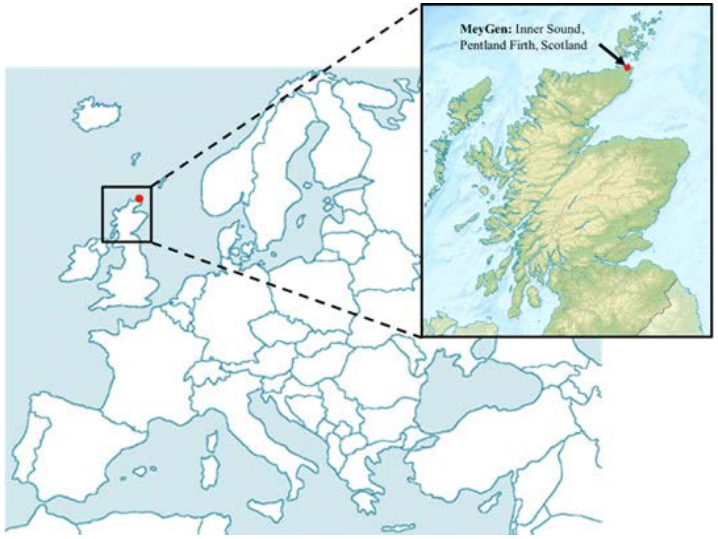
Environmental Monitoring at MeyGen (UK)

Staged consent:

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



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THE TIDE OF CHANGE IN CAITHNESS

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NERC MREKE Internship
Innovate UK KTP / MeyGen Ltd.

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