

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

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FLOWBEC upward facing sonar platform

- **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
- **Field proven:** 5 × 2-week deployments at EMEC, Orkney, UK



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)

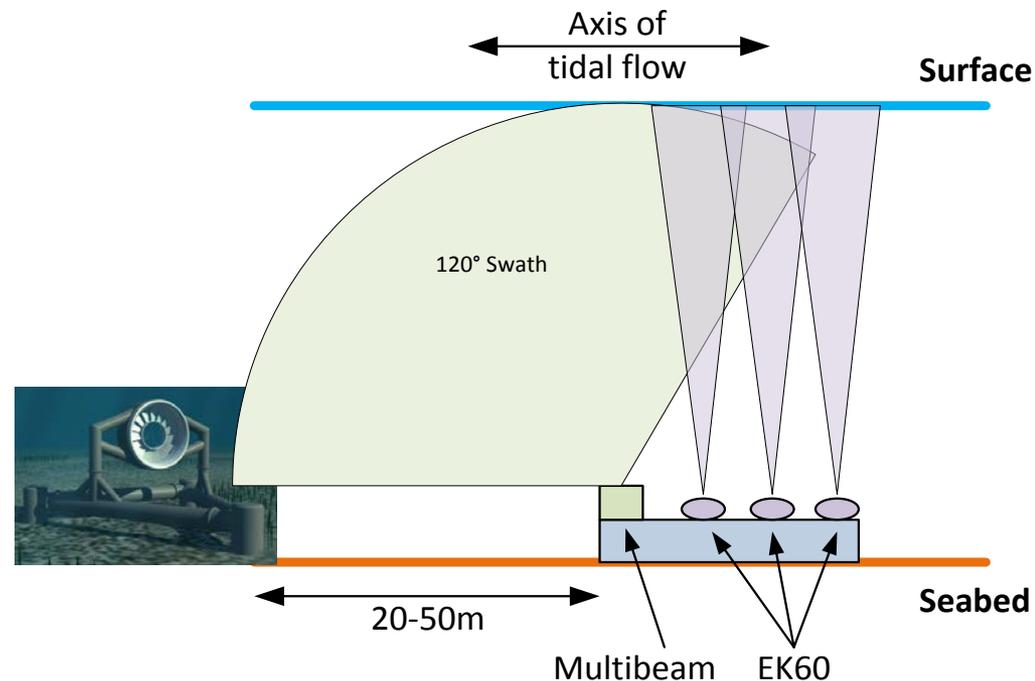
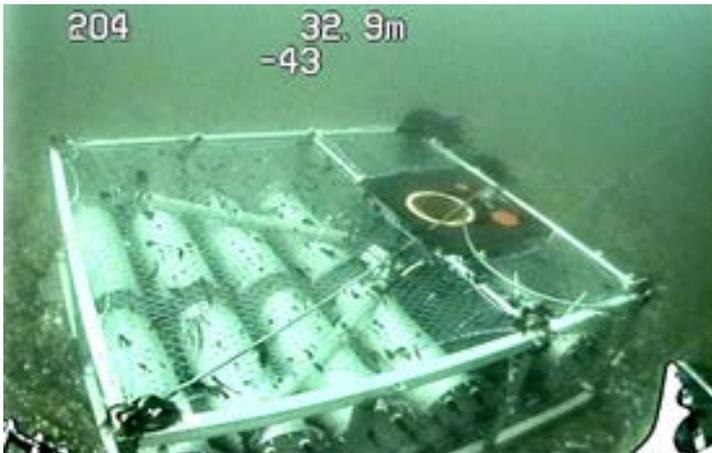
- interactions of fish, diving seabirds, marine mammals with MREDs
- target tracking, avoidance behaviour

ADV

- current, temperature, depth

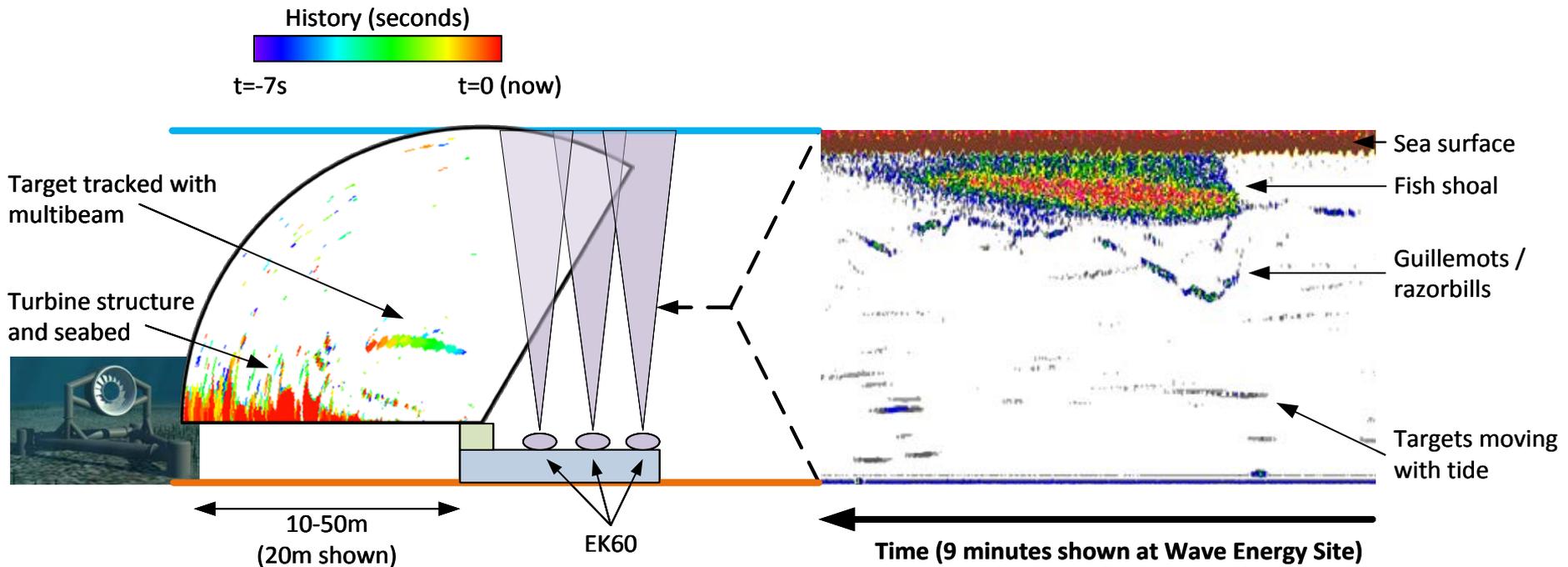
Fluorometer

- chlorophyll (phytoplankton)



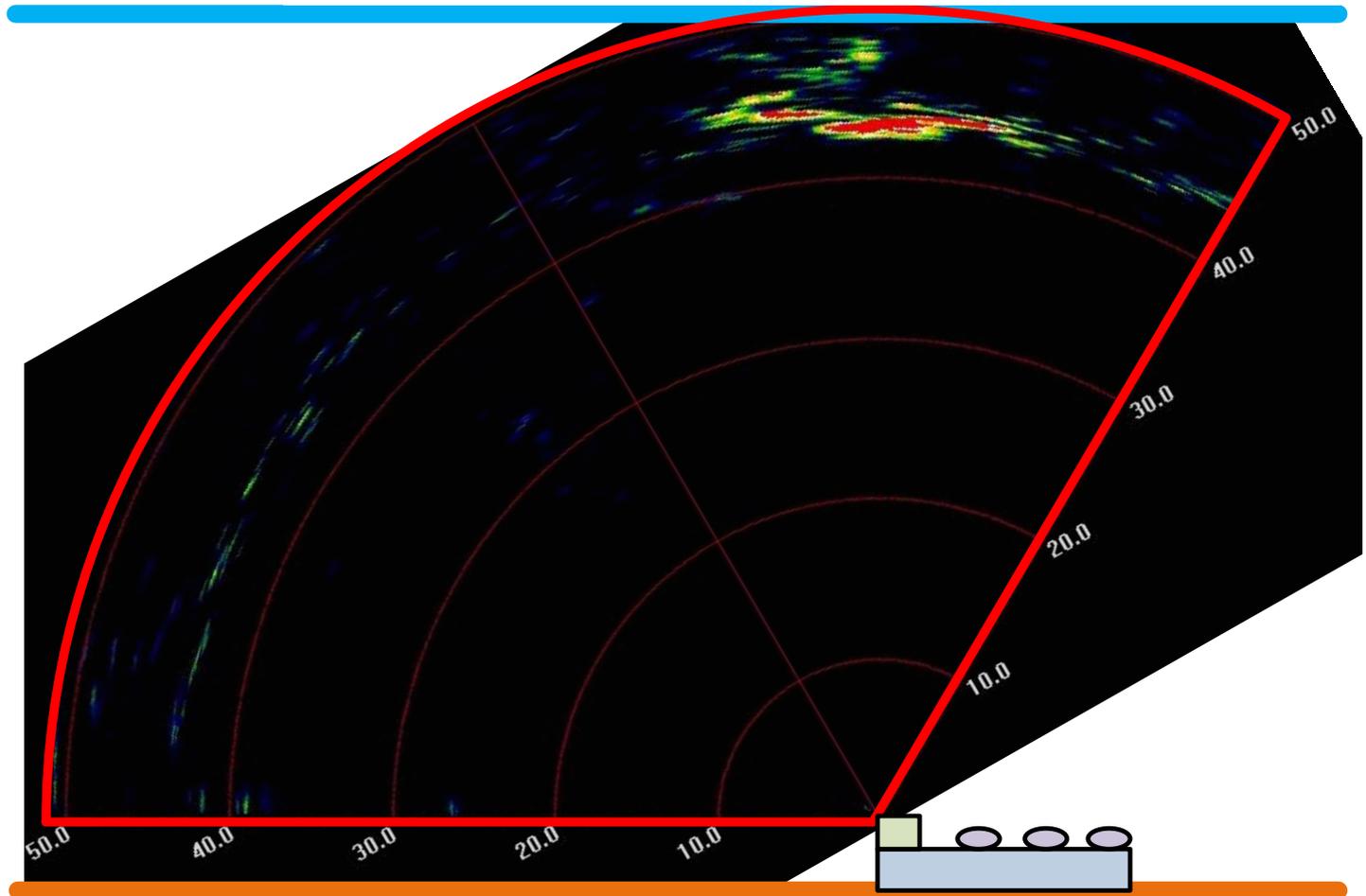
Multibeam for target tracking

EK60 for multifrequency ID

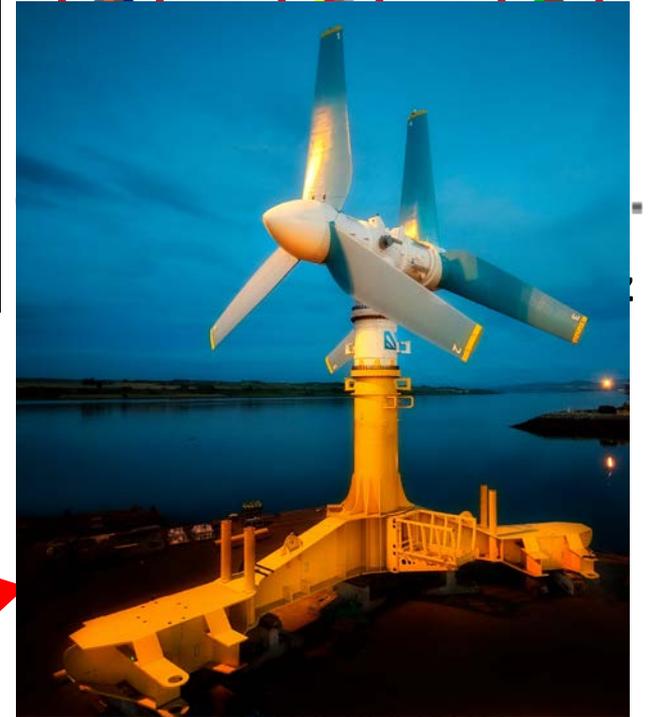
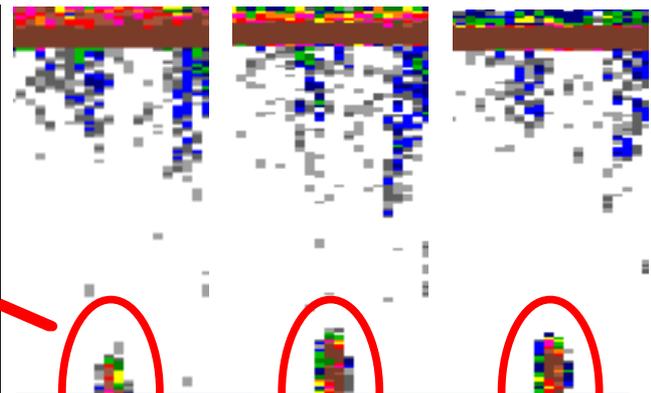
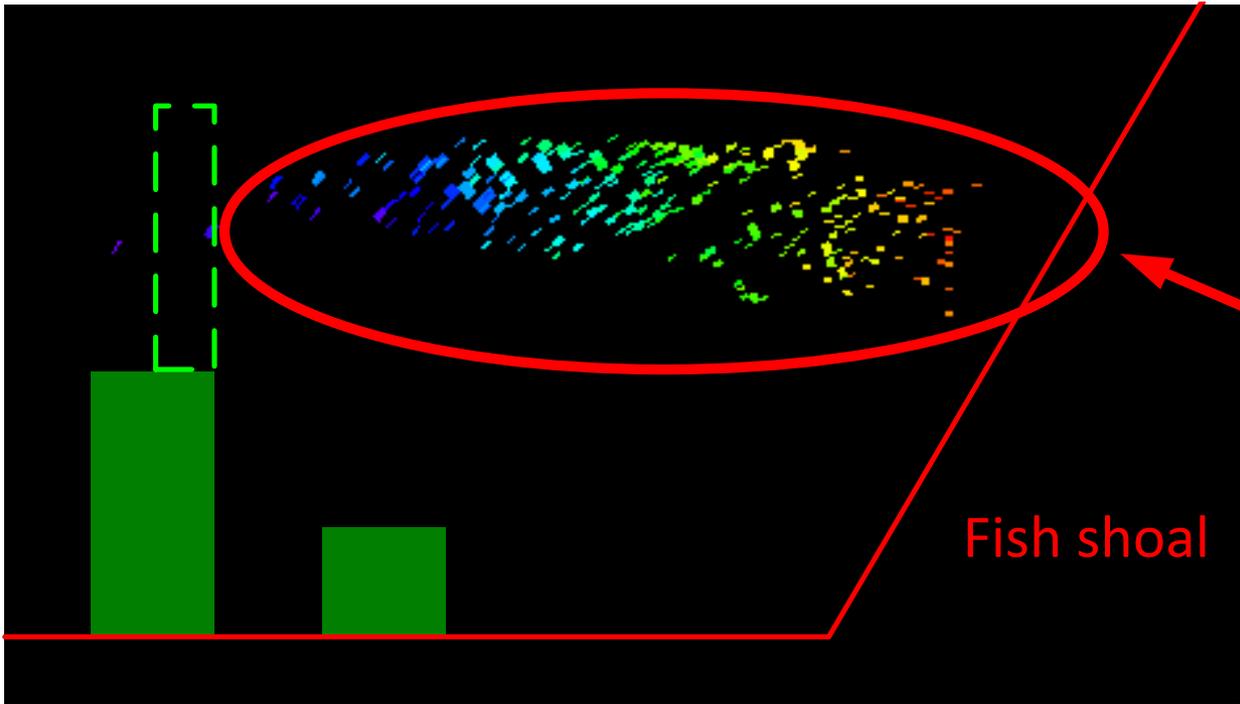


Acoustic classification ground truthed by shore observations

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



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

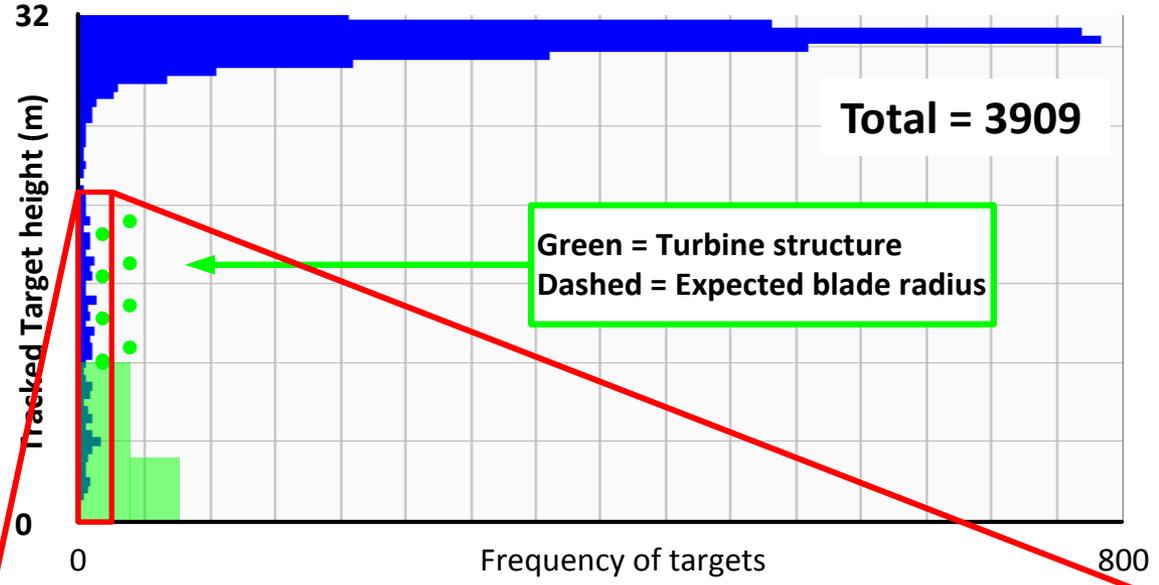


- **Target detection** using the multibeam and EK60
- **Target tracking** using the multibeam
- **Multifrequency analysis** using the EK60

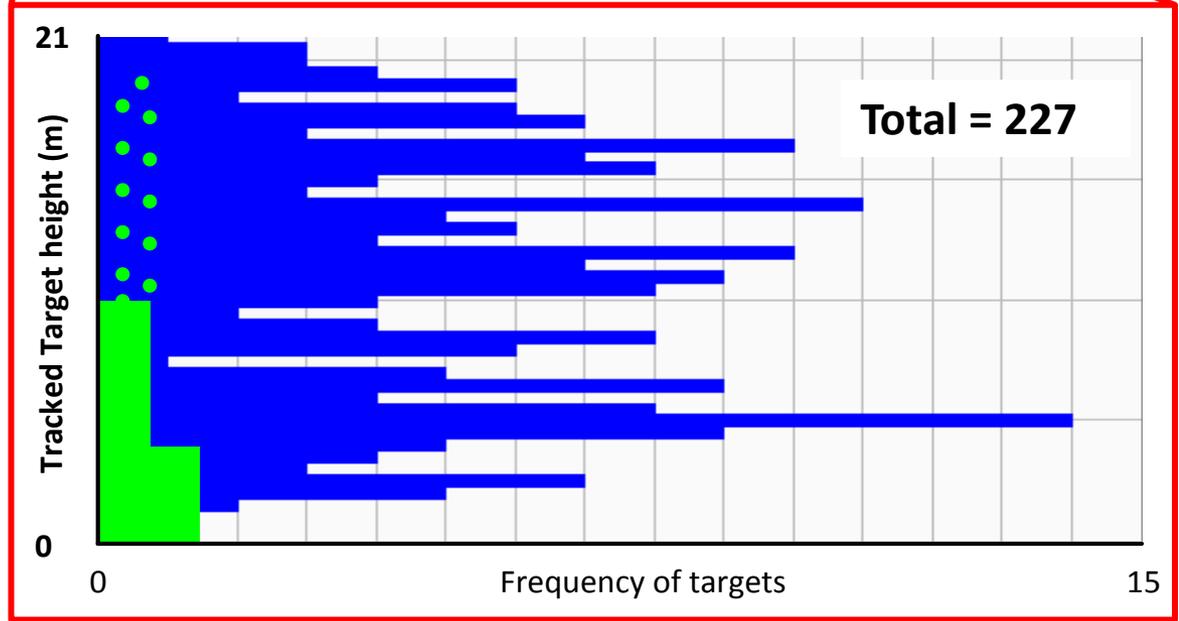
Frequency (kHz)

Target vertical distribution next to Atlantis turbine structure

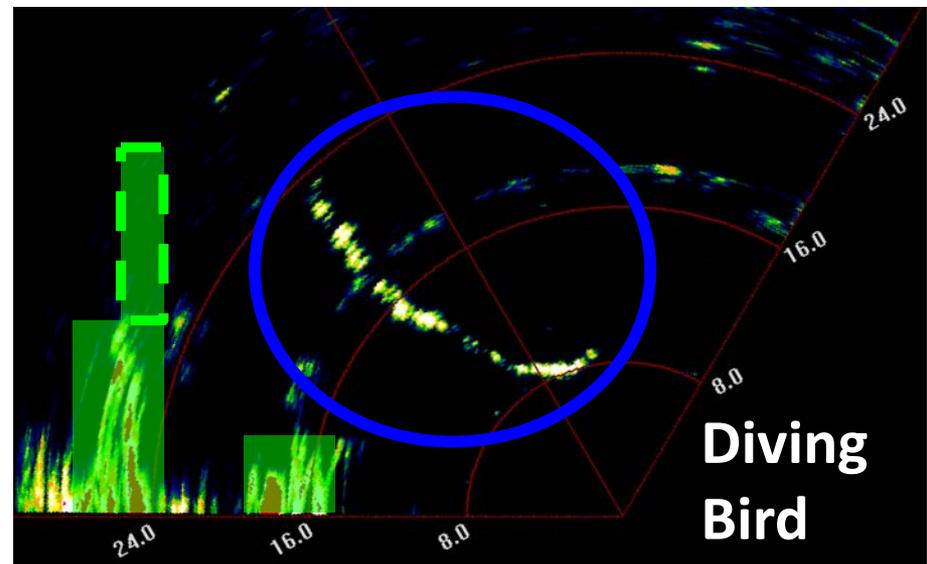
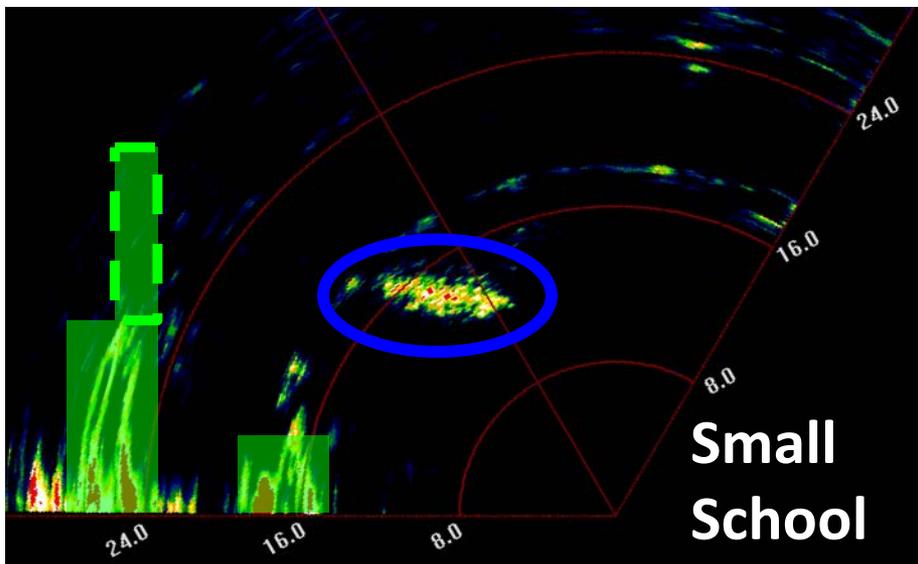
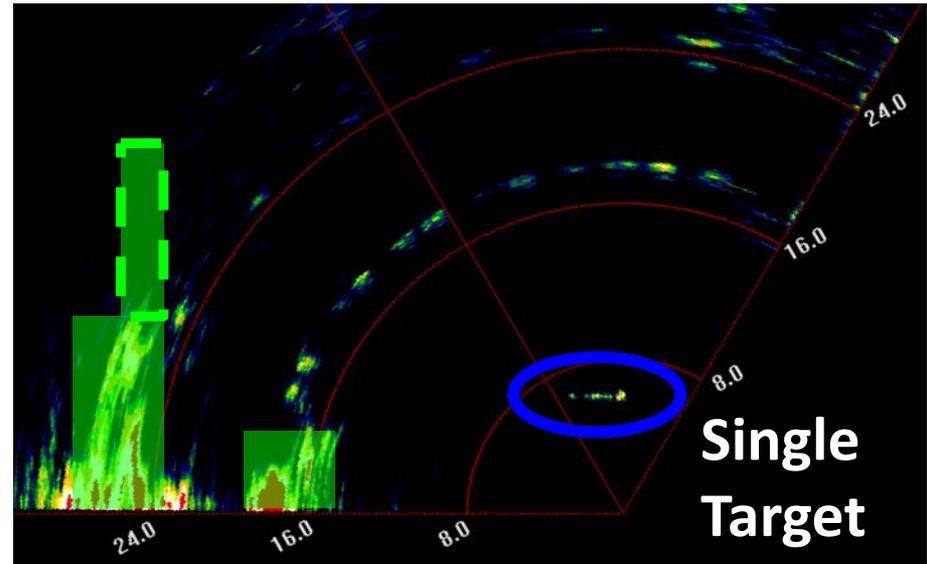
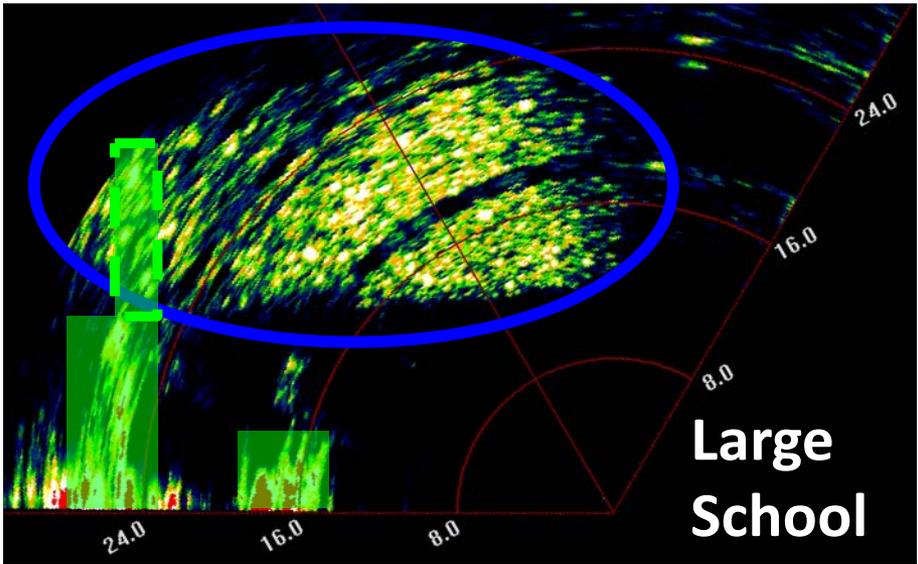
All tracked targets (mammals, birds, fish schools, individual fish) next to Atlantis turbine structure = 3909 tracks over 2 week period

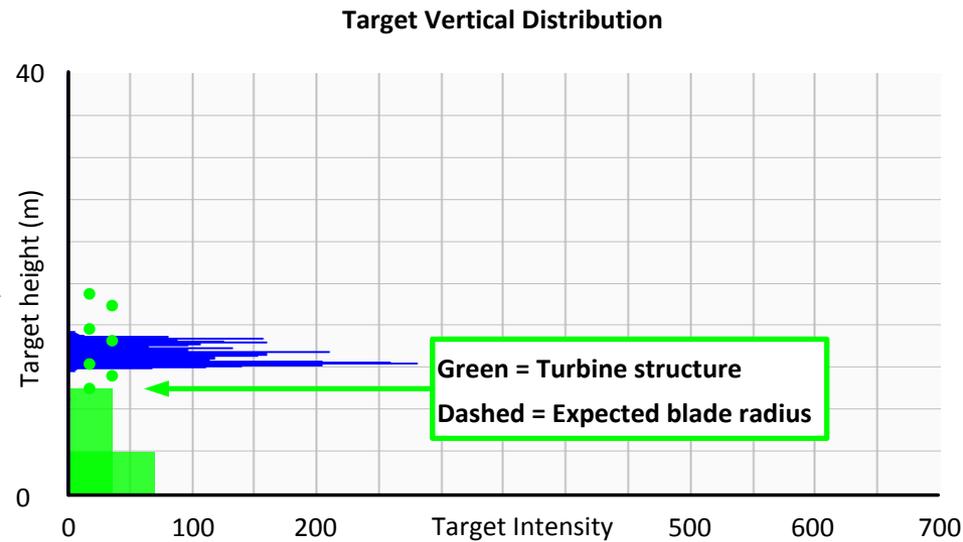
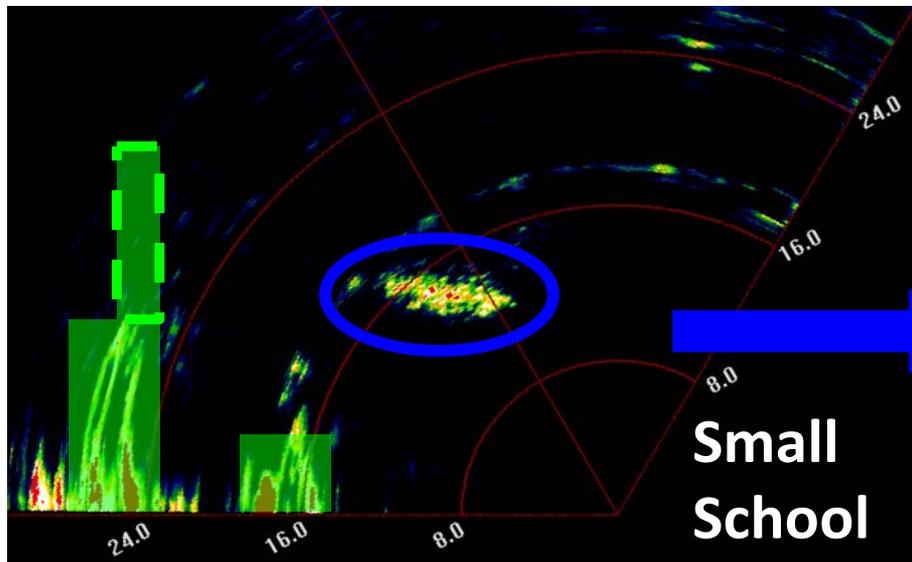
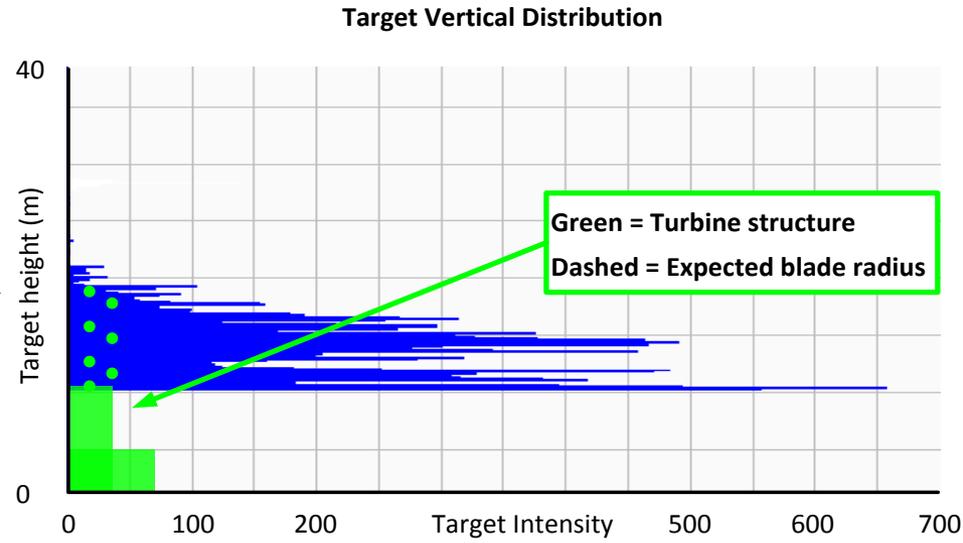
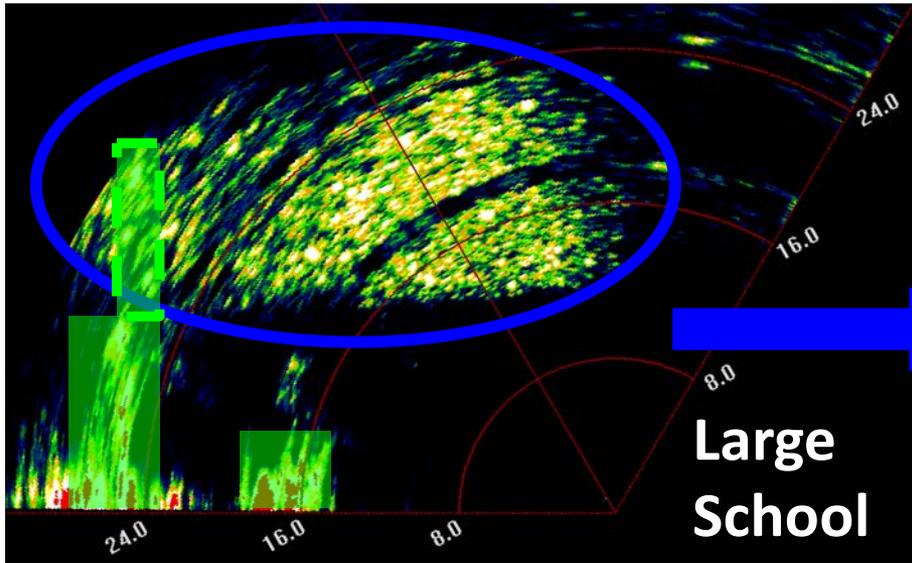


Vertical overlap with turbine height = 227 tracks over 2 week period



Target Classification





Benefits:

- High range ($\approx 50\text{m}$) and good detection
- Visibility / illumination independent
- Small data volumes (raw $\approx 6\text{GB/day}$)
- Low power (self-contained)
- Realtime processing feasible

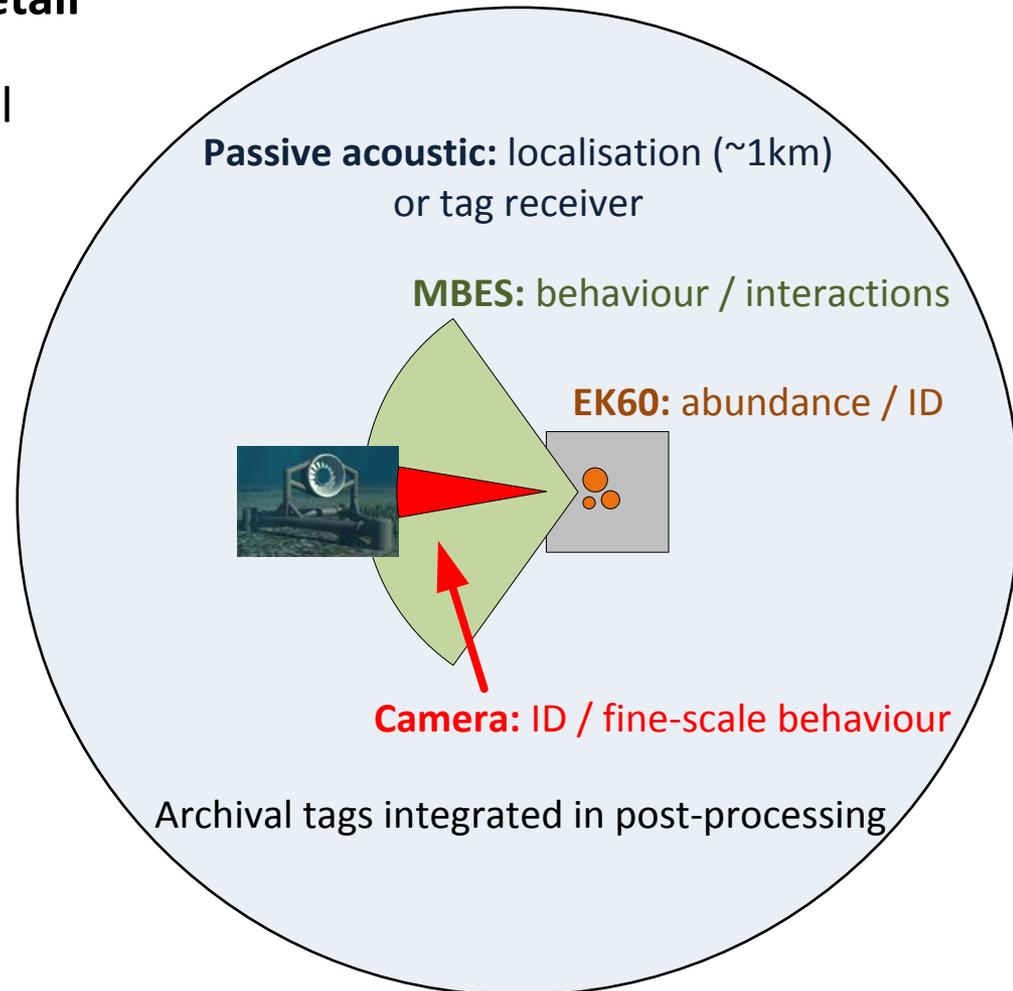
Limitations:

- Limited detail for species identification
- Observation of final ($<1\text{m}$) interaction
 - collision Y/N?
 - effect of collision?
- Any behavioural response to acoustics?

Potential solution: multi-instrument integration...

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



Investigating the ecological effects of installing and operating MREDs

- Determine 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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