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

FLOWBEC upward facing sonar platform

History (seconds)

t=-7s

Turbine structure and seabed

Target tracked with multibeam

Sea surface

Fish shoal

Guillemots / razorbills

Targets moving with tide

10-50m (20m shown)

Time (9 minutes shown at Wave Energy Site)

Acoustic classification ground truthed by shore observations
Multibeam tracking of diving guillemots/razorbills feeding beneath a fish shoal at a wave energy site
Fish shoal

FLOWBEC target tracking

Green = Turbine structure, Dashed = Expected blade radius

• 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
Target Classification

- **Large School**
- **Single Target**
- **Small School**
- **Diving Bird**
Vertical distribution (collision risk) of target classes

- **Large School**
- **Small School**

**Target Vertical Distribution**
- Green = Turbine structure
- Dashed = Expected blade radius
FLOWBEC upward facing sonar platform

**Benefits:**

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

**Limitations:**

- Limited detail for species identification
- Observation of final (<1m) 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

Multi-instrument integration

- Passive acoustic: localisation (~1km) or tag receiver
- MBES: behaviour / interactions
- EK60: abundance / ID
- Camera: ID / fine-scale behaviour

Archival tags integrated in post-processing
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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