

# Turbulence, Trophic Interactions, and Sustainable Energy Extraction

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## BACKGROUND

- The role of turbulence in high energy sites is largely unknown, yet is critical for device design and in predicting environmental impacts
- This interdisciplinary project utilises an innovative range of acoustic instruments and, drawing on expertise from ecology and engineering, will provide new information on the physical properties and ecological significance of turbulent flows in highly energetic environments
- This study will lead to a better understanding of the scale and significance of the impacts of marine energy extraction

Data	Type	Deployments	Resolution
Seabed EK60	Multifrequency backscatter	5 x 2 week	0.76m / 1s
Mobile EK60	Multifrequency backscatter	103 transects	0.76m / 1s
ADCP	Velocity and ping strength	1 month	1m / 1s
MBES	Multibeam backscatter	5 x 2 week	0.08m / 0.14s
ADV	Velocity	5 x 2 week	-

Table 1. Primary data summary. Deployments indicate amount of data and resolution given in along beam spatial/temporal

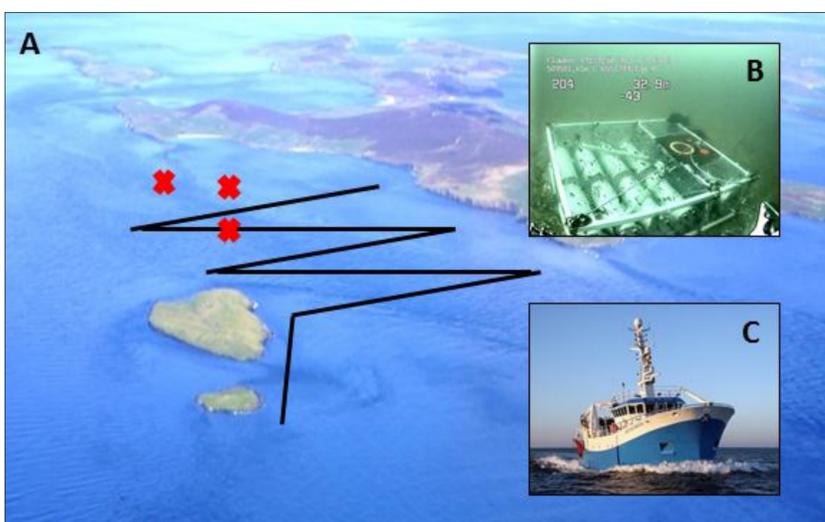


Figure 1. Study site and methods. Red crosses show platform deployments, black lines indicate vessel transects

## APPROACH

- We employ spatially overlapping and concurrent data types (Table 1) from a variety of instruments deployed at EMEC test sites (Figure 1A) in Orkney, UK
- Complemented by stationary FLOWBEC platform (Figure 1B) deployments of acoustic instruments on seabed near test turbines
- Velocity information provided by adjacent Acoustic Doppler Current Profiler (ADCP) deployment
- Spatially overlapping data from moving vessel (Figure 1C) and host of supporting data types including meteorological, marine X-band radar, and FVCOM model data

## OBSERVATIONS

- Preliminary analysis has involved the investigation of variations in mean volume backscatter (Figure 2A) throughout the water column revealing a complex picture of turbulent generation from different sources and biological interaction with turbulent structures of different scales
- Broad trends with a relative frequency agreement correspond with physical variations such as wind and tide direction (Figures 2B, 2C) whereas clear spikes with differential frequency response correspond to brief but clear school features (Figure 3)
- Power spectral density (PSD) as a function of period (Figure 4) reveals periodicities and dominant processes at work in backscatter signal, clearly highlights a strong dependence on peak ebb and flood tides with a spike at about 6.19 hours

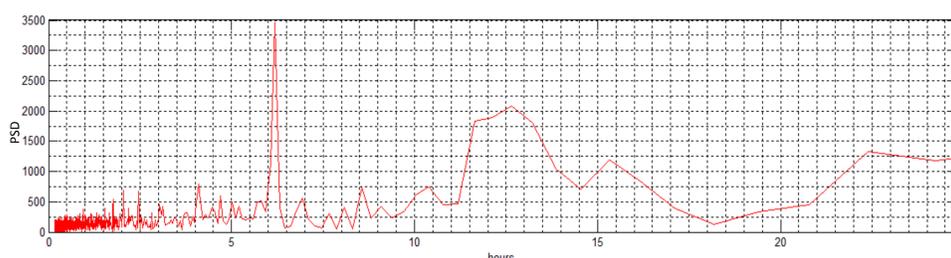


Figure 4. Power spectral density of backscatter variation (Figure 2A) expressed in terms of period

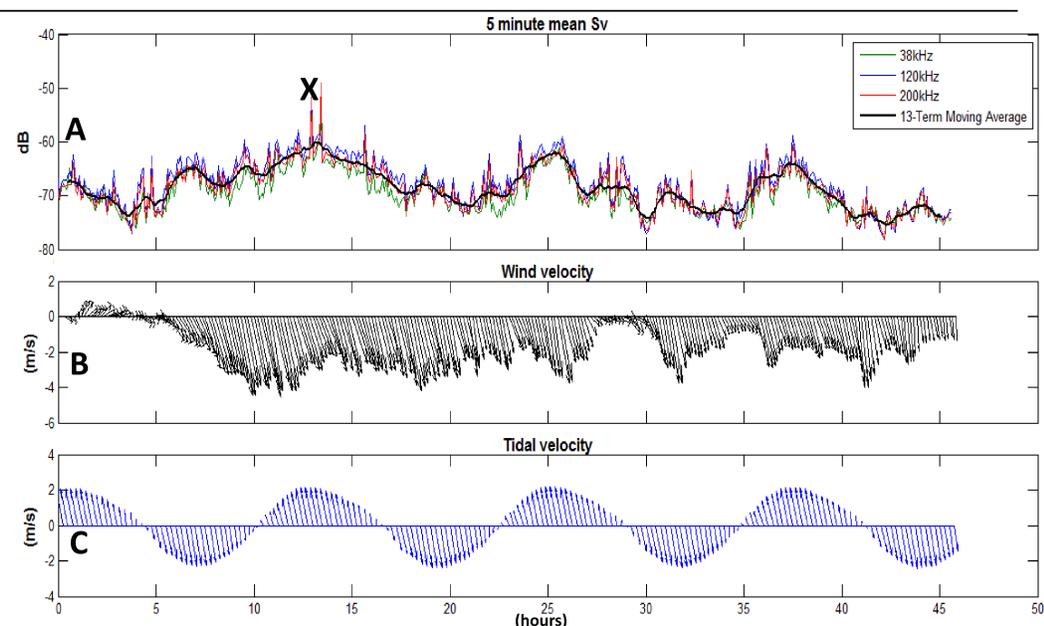


Figure 2. Multifrequency mean backscatter variations and supporting data. Section shows almost 2 days of data from 00:54 on 07/06/2013 with x-axis given in hours.

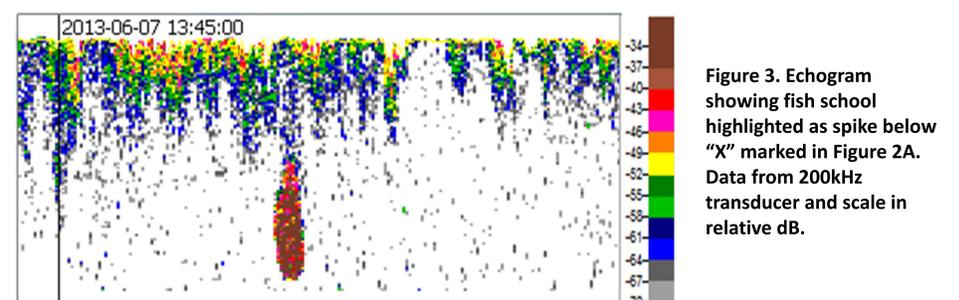


Figure 3. Echogram showing fish school highlighted as spike below "X" marked in Figure 2A. Data from 200kHz transducer and scale in relative dB.

## ACKNOWLEDGEMENTS

This project is funded by the University of Aberdeen's Energy and Food Security theme. Fieldwork is funded by Natural Environment Research Council and Defra grants (NE/J004308/1, NE/J004200/1 and NE/J004332/1) and supported by Marine Scotland and Scottish Natural Heritage. Thanks to Eric Armstrong, Chris Hall, Paul Bell, Mike Stewart, Ricardo Torres, Christina Bristow, Philippe Blondel, Jennifer Norris, Pierre Cazenave, and Mathew Finn.

## WHAT'S NEXT

- This study will lead to increases in both the physical and ecological understanding of turbulent environments and the behaviour, trophic interactions, and foraging habitats of important species
- The novel approach taken here will provide vital new information needed to develop our understanding of the highly complex effects that marine energy extraction will have on the hydrodynamics of these sites
- Resulting scale and significance of ecological implications will be assessed and mitigation measures outlined



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