



Wave Energy Extraction off Orkney: Methodologies for Rocky Shore Monitoring

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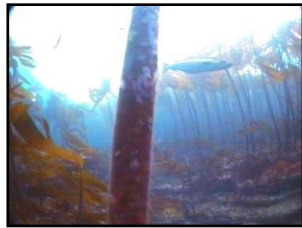
Work Stream 10: Ecological Consequences of Tidal and Wave Energy Conversion

The UK government has set the objective of delivering at least 15% of electricity from renewable sources by 2020. In 2003 the European Marine Energy Centre was established in Stromness to test wave and tidal energy extraction devices in the resource-rich waters around Orkney. Subsequently, in March 2010, the Crown Estate announced leasing agreements with several developers and energy providers for deployment of marine energy devices, predominantly within Orkney waters and the Pentland Firth. This large-scale expansion finds Orkney at the fore-front of the marine renewable energy sector.

While exposure to wave energy plays a dominant role in both shaping the landscape and determining the ecological community, little is known of the potential consequences of commercial scale removal of wave energy. We describe the development of an extensive long-term monitoring programme in Orkney to assess the potential ecological impacts of altering wave energy exposure on rocky shores. Methodologies are intended to establish pre-development background conditions and to monitor impacts of wave energy extraction by examining multiple indicators including:

- Sublittoral environments using video and still imagery;
- Cliff-base biological characteristics in areas never previously surveyed;
- Littoral species identified as potential sentinels of changes following energy extraction and climatic change.

Sublittoral Transects off Vestra Field – The proposed region of subsea cable convergence - from an extensive area containing leasing sites for several wave energy device deployments – has been surveyed by underwater video. Images have been captured in 5 metre depth intervals (to a maximum of 50 metres) and in areas of transition between major biological zones. This characterisation is being merged with bathymetric data provided by the Crown Estate and will be used in conjunction with numerical hydrodynamic models to predict ecological responses to energy extraction.



Depth 11m: dense *Laminaria hyperborea* forest provides a biodiversity-rich habitat including important breeding and hunting grounds for gadoid fish.



Depth 21m: sparser *L. hyperborea* park provides valuable habitat for epiphytic algae and diverse fauna.

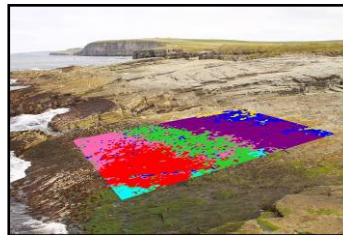
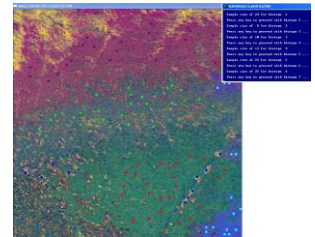


Depth 30m: the aphotic zone is dominated by animals, in particular echinoderms and sponges; a thin veneer of fine sediment overlies parts of the rocky bottom.



Depth 46m: fine sediment creates an important habitat for infaunal species; tidal-flow induces formation of ripples and bedforms.

Cliff Surveys - Detailed description and identification of biotopes along the West Mainland shores of Orkney, including cliff bases and skerries, can be used to identify areas of potential environmental sensitivity. Much of this coastline has never previously been surveyed, owing to difficulties of access, and we have now completed the first comprehensive survey of littoral assemblages of the entire west coast of Orkney.



In the fixed view-point image (top left) the area for analysis is selected. Following transformation into a 'bird's-eye view', principal component analysis of red, blue and green components produces the image above which has been populated with supervised classification samples of several 'biotopes'.

Software developed 'in-house' assigns each grid square to one of these 'biotopes' and the image back-transformed onto the original (above). This can allow rapid quantification of large areas with difficult access and, for planar surfaces, at oblique angles.

Sentinel Species Monitoring – Detecting wider ecological trends on rocky shores is possible through observation of individual and population changes. Four littoral species have been short-listed for consideration on the wave exposed West Mainland of Orkney: *Chthamalus stellatus*, *Fucus distichus anceps*, *Gibbula umbilicalis*, and *Patella ulysiponensis*. The use of multiple indicators should allow responses to wave energy extraction to be detected alongside a background of changes due to other systemic forcing agents such as climate change. An example of one part of this programme is described below.

Barnacle Image Processing - In collaboration with VisionLab at Heriot Watt University, we are investigating the feasibility of using species-specific differences in shell shape to inform image recognition software. In particular, the shape of the operculum and the intersection of the tergal and scutal plates along the longitudinal axis may prove to be effective markers for the software to differentiate. VisionLab are employing a Viola-Jones classifier to produce a rejection cascade capable of recognising barnacles. Future refinement of software training and the use of rotation invariant detectors should produce a reliable and rapid means of analysing imagery.

