MASTS Small Grant Scheme – Final Report

Andrew Want, Heriot-Watt University

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Underpinning the development of indicator species in high-energy environments

Background:

The rocky coast of West Mainland, Orkney is characterised by spectacular, sheer cliffs exposed to extreme wave energy. In March 2010, the Crown Estate announced the leasing of several sites along this coast to developers and energy providers hoping to exploit this energy-rich resource. The ecological consequences of commercial scale removal of wave energy, however, are not well understood (Frid *et al*., 2012). As part of a detailed, 'pre-development' monitoring programme we have identified several potential 'indicator' species which may serve as important sentinels for long-term change in the marine environment – in this case, following changes in wave energy - as well as other long-term forcing agents such as climatic change. An extensive list of rocky shore species has been identified and recommended for monitoring of several important environmental variables including energy exposure as part of the Marine Strategy Framework Directive (Burrows *et al*., 2014). Included within the list of rocky shore indicator species are several fucoids.

Fucoids are the major macroalgal component of the midshore throughout the North Atlantic, playing an important role in the intertidal biological community by providing canopy cover and as a food source for grazers. With increasing wave energy there is a transition to more exposure-tolerant fucoid species, typically associated with morphological adaptations suited to mitigate extreme hydrodynamic forces on the shore. These plants may play a critical role in our understanding of this environment following the deployment of wave-energy extracting devices.

Rationale:

As part of ongoing research funded by the UK Centre for Marine Energy Research, we are studying several species associated with the high-energy intertidal zone around Orkney which may be particularly sensitivity to changes in exposure. Among these species are the high-energy variant fucoids: *Fucus vesiculosus* f. *linearis*, *F. spiralis* f. *nanus*, and *F. distichus* subsp. *anceps*. The latter species in particular has been selected by our team as a potential indicator of wave energy and considerable research has already been completed. In Orkney, it is located on only the most exposed westward dipping platforms in areas typically devoid of other fucoids. Beyond Orkney, in the British Isles, *F. distichus* subsp. *anceps* is recorded sporadically on a few isolated rocky shores exposed to the open Atlantic.

While this species is more widespread on colder shores farther north, the British Isles populations appear to form a fringe of outlying southern populations. Most of these populations are isolated from one other by considerable distances, in one case in excess of 300 km. The phenology of *F. distichus* subsp. *anceps* is not well understood; the distribution and settlement behaviour of their propagules is unknown. Is there

movement of genes from one discrete rocky outcrop to another distant isolate? Perhaps each population is a relict left over from periods of glaciation when this species may have become far more dominant on British shores? Or perhaps, additional as yet undiscovered populations may provide connectivity?

In the summer of 2015, I had the opportunity to participate in an SNH-funded field project to characterise the biological community of sea caves on several isolated islands off the north and west coasts of Scotland, including North Rona and the St Kilda archipelago. This provided the opportunity to collect samples of *F. distichus* subsp. *anceps* and *F. spiralis* f. *nanus* for genetic analysis. Together with existing material from Orkney and Lewis, these samples are providing data from geographically isolated specimens of unknown genetic connectivity.

Main Objectives:

- To complement ongoing ecological field research on potentially important indicator species with important genetic information;
- Assess the level of genetic diversity within and between geographically isolated populations of high-energy variant fucoids;
- Assess the level of population differentiation using Analysis of Molecular Variance;
- Assess the vulnerability of isolated populations to environmental disturbances by helping to understand whether or not repopulation might be expected in the event of population loss.

Summary of work funded by MASTS:

In late-October, 2016, desiccated samples of high-energy variant fucoids were taken to the Centro de Ciences do Mar at the University of the Algarve in Portugal. For the next two weeks, I worked on these samples under the guidance of Dr. Joao Neiva and Cristina Paulino within the laboratory of Dr. Ester Serrao. In total, DNA was extracted from 96 individual fucoids, mostly *F. distichus anceps*. Genetic material from samples were amplified and analysed against a series of microsatellite primers, previously identified by the group. MASTS small grant funding was applied to provide necessary reagents used and sequencing charges for the samples. While at the university, I delivered a seminar explaining my work and thanking MASTS for their critical support.

Left: loading an electrophoresis gel with genetic samples extracted from isolated populations of Scottish seaweed.

Relevance to MASTS:

This project is closely aligned with the MASTS theme of Marine Biodiversity, Function and Services and with the Marine Energy research forum hosted by MASTS. These studies will provide a better understanding of the suitability of high-energy fucoids as sentinels for monitoring changes in the littoral shore and to provide valuable information regarding vulnerability of these organisms to environmental change.

Planned Output/Deliverables:

- Peer-reviewed paper on genetic connectivity of high-energy variant fucoids in the North Atlantic – informing the suitability of these species as indicators for climatic change or wave energy extraction studies;
- Contribution of data from Scottish samples in a collaborative paper with the University of the Algarve on genetic diversity within *F. distichus*;
- Peer-reviewed paper on the long–term changes in distribution of *F. distichus* subsp. *anceps*;
- Submission of results to the GenBank data repository.

References cited:

Burrows, M.T., Mieszkowska, N. & Hawkins, S.J. (2014). Marine Strategy Framework Directive Indicators for UK rocky Shores Part 1: Defining and validating the indicators JNCC Report: No. **522**, SAMS/MBA/NOCS for JNCC, JNCC Peterborough.

Frid, C., Andogeni, E., Depestele, J., Judd, A., Rihan, D., Rogers, S.I. & Kenchington, E. (2012). The environmental interactions of tidal and wave energy generation devices. *Environmental Impact Assessment Review*, **32**: 133-139.