Title: Stability and variability of coastal marine habitats on decadal time scales

Supervisors: Andrew J. Davies, Gay Mitchelson-Jacob and Steve Hawkins

Project description: Long-term datasets that focus on marine communities are very rare. One particular, exploitable resource that harbours a wealth of past information is aerial photography. Usually obtained at great cost, these images capture detail that can be used to monitor physical change in coastlines and also changes in extent of biological communities (see Figure 1 and Davies et al. 2007). In this project, we will analyse images of the Irish Sea coastline (see Figure 2), which extend back from the present day to the 1940s. These images are available from the CCW and WAG archives (see letter of support for zero cost access to imagery), the Marine Institute (Irish coast; data from 1998-99 acquired), NERC, Ordnance Survey (under the Public Service Mapping Agreement) and the Department of Environment Northern Ireland.

Fig. 1: Example of aerial imagery showing shore height changes in algal canopies from Northern Ireland (Davies, 2004).

The proposed project will exploit this archive by extracting information on the coverage of intertidal and subtidal algal beds (maximum height on shore, maximum depth for subtidal and percentage cover), mussel coverage and other coastline information (coastal erosion, development etc.) throughout the Irish Sea. These observations will form the primary layer in a comprehensive meta-analysis that will include historical records of faunal abundances and a suite of environmental variables constructed from hind-cast wave exposure modelling (extending techniques developed by Davies & Johnson 2006, Burrows et al. 2008), historical temperature and rainfall records (available from the UK Meteorological Office). The aim of this project is to investigate how the major biotope defining communities of these shores have been impacted by climatic variability and anthropogenic activity over decadal time-scales (1940s to present) and how these changes create follow-on effects for the faunal communities in subsequent years. The project will contribute to more accurate predictions of how intertidal and subtidal communities respond and interact under changing climate.


Fig. 2: Region of interest.

Major hypotheses: 1) *Change in the coverage of biotope forming communities and their shore height limits will be mostly driven by cyclic variability in wave exposure*. Wind-driven wave events are strongly coupled with variability of large-scale climatic forcing such as the NAO, even small shifts in prevailing winds can result in significant change in the wave climate at certain sites (i.e. those that face in a certain direction compared to open coastline). 2) *The cover of biotope forming communities will increase, regardless of wave exposure, as a result of warmer winter temperatures resulting in enhanced invertebrate juvenile survivorship (grazing molluscs).* Temperature variability has been shown to be implicated in the survivorship of invertebrate grazers, which in-turn, affects the stability of biotope defining communities. By tracking temporal changes in cover and assessing climatic linkages, we can better understand how complex, macro-scale biotic interactions will be affected by future climate change. One significant event which can shed further light on the effects of temperature is the extreme winter of 1962/63, using multi-year imagery for particular sites; we hope to be able to assess the impact of this on biotope defining communities and the wider associated diversity.

Outputs (proposed thesis chapters): 1) Database of aerial imagery throughout the Irish Sea (georeferenced and multi-year overlaps identified) with algal canopy changes digitised for the duration of aerial imagery. 2) Hind-cast wave exposure model (probability of extreme events, daily, monthly and annual variability) for the Irish Sea extending back to 1940s (dependent on available wind data from Met Office, usually 1930-1940s). This output will also integrate observations of shoreline change into wave exposure models (i.e. construction of sea defences and structures that can disrupt wind-wave generation. 3) Past temperature and rainfall variability for the Irish Sea area (constructed from Met Office data). 4) Models of faunal species interaction with climate and macroalgal coverage.

Student training: The project is weighted heavily to the usage of geographic information systems, photogrammetric- and meta- analysis. The student will be trained in these skills and in ecological survey, which are in significant demand in industry as the usage and reliance by organisations on the analysis of spatial information increases exponentially. The student will be expected to use Davies' aerial photographic drone to conduct transects throughout North Wales.