

# ***Strategies for benthic habitat mapping of Marine Protected Areas***

## **Supervisors with affiliations**

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## **Project background**

Recent benthic habitat investigations have taken advantage of habitat suitability models commonly used in terrestrial ecology. These methods allow users to test the contribution of multiple environmental variables against the occurrence of species and determine which factors contribute most to their distribution. This is only possible because of the improved quality and coverage of environmental variables available for marine systems which until recently were prohibitively expensive to acquire (Brown *et al.*, 2011; McBreen *et al.*, 2011).

The diverse benthic habitats of western Scotland have previously only been studied by broad-scale mapping (>50m). This study aims to refine these earlier attempts by developing a number of detailed, high-resolution (5m) predictive habitat maps. The wider benefit of this study would be a 'toolbox' of methodologies useful for the management of Marine Protected Areas. Potentially the Firth of Lorn presents wide diversity of biotopes from rocky reef substrate to mixed sand and mud environments. The approach taken by this project would enable the assessment of species occurrence, and in particular, commercial fisheries to be much more refined.

The student will develop novel algorithmic approaches to combine new very high resolution acoustic bathymetric data with emerging high resolution hydrodynamic model output (FVCOM) to generate predictive habitat maps at unprecedented spatial resolutions for sensitive habitats. The project will use the Firth of Lorn, which includes a large Special Area of Conservation for rocky reefs) as the development site, and will compare algorithm performance with Northern Irish inshore coastal areas. The ultimate goal is to develop standardised approaches which can be applied in other sensitive inshore coastal environments.

This work builds on existing predictive habitat mapping in the Firth of Lorn conducted by SNH (Report: 387 The Highland and Hebrides & Orkney marine environment: A GIS Source) (SNH, 2006), and fits to NERC's Biodiversity RP priorities of harnessing biodiversity for the sustainability of ecosystems and beneficial services and for the sustainable use of natural resources. The original habitat mapping was at moderate spatial resolution (1 km) whereas the new project will have access to new high resolution bathymetric data (1 m) which has been collected under the INIS-HYDRO project (part of the NERC MAREMAP program). Habitats such as rocky reefs are naturally patchy and fragmented and it is acknowledged that 1 km resolution is inadequate for understanding and monitoring impacts on these sensitive habitats.

The project has the support of Scottish Natural Heritage who are collaborating on an initial pilot study on-going at SAMS. Of specific interest to many stakeholders is the occurrence of commercial species (e.g. scallops) as this affects areas likely to be impacted by commercial fisheries. As well as theoretical work, the project will deliver practical outputs in terms of refined habitat maps for use in the future management of Marine Protected Areas.

## Key research questions

Can different approaches of seabed survey (vessel-based multibeam, autonomous underwater vehicle & video and grab sampling) and data manipulation (GIS and modelling) be rationalised into a specific methodology for habitat mapping for monitoring for Marine Protected Areas?

## Methodology

*Bathymetric and Backscatter data:* The Firth of Lorn provides an ideal study area for this proposal as a 553km<sup>2</sup> MBES survey has been collected by SAMS during the summer & autumn of 2012 ([www.inishydro.eu](http://www.inishydro.eu)). This data will form the main basis of the study and the availability of a large archive of faunal data will provide a means of testing both predictive habitat suitability modelling (HSM) techniques and highlight any potential impact on resident benthic fauna. MBES bathymetric and backscatter data collected at UKHO order 1a provides a cell size of 5 m<sup>2</sup> and vertical resolution <10 cm. Using *ArcGIS 10* derivative layers will be generated from acoustic data to inform the HSM. *Hydrodynamic & habitat modeling:* The project will also take advantage of a new high- resolution 3D hydrodynamic model of the Firth of Lorn developed at SAMS (FVCOM) to provide bed stress and bottom current values. *Seabed sampling & video observations:* Grab sample stations will be selected to fill any gaps in the archival data held at SAMS (additional funding to support this fieldwork is available from SAMS NERC MAREMAP allocation). On non-rocky areas, grab sampling will be conducted and fauna identified to the lowest taxonomic level using stereo microscopy equipment at SAMS. In addition to existing video, new observations using drop-down video and AUV will be collected in the Firth of Lorn to complement the seabed sampling. All equipment required is in place at SAMS.

*Habitat suitability modelling:* The student will probably use a machine-learning method of predicting species distributions across suitable habitat from point samples of presence based upon physical variables applied to the model. To enable habitat map creation, predictions for the highest contributing species from clustered assemblages will be combined using the 'rank' tool in *ArcGIS 10* to create assemblage maps.

This work would provide valuable information to inform the management of any future network of Marine Protected Areas.

This project meets these challenges by providing:

1. A hydrodynamic model that provides information for predictive habitat model the study takes advantage of new and existing data. New methods of analysis will probabilistically link physical conditions within the Firth of Lorn to the distribution of resident fauna.
2. The use of models to integrate physical and biological data, demonstrating which environmental variables have the greatest effect on the distribution of fauna. Combining the predicted distributions of multiple fauna will help predict the effect of physical variables on biodiversity of the Firth of Lorn.
3. Utilising SAMS Firth of Lorn hydrodynamic model to enable the simulation of alternative hydrodynamic regimes resulting from the introduction of structures such as hydro-electric turbines. These results can then be used to predict any impact on faunal distributions by highlighting areas that will exceed faunal tolerances as determined from the previous results. This is of significance to commercial fisherman, chartered fishing and diving vessels and seafood restaurants around Western Scotland whose incomes rely on a healthy and productive marine environment.

## Training

A comprehensive training programme will be provided comprising both specialist scientific training and generic transferable and professional skills. In addition GIS training, hydrographic data processing and some training on collected vessel-based and AUV data will be provided.

### **Requirements**

Candidates must have a degree qualification in marine biology, marine geology or an oceanographic science. Ideally some experience with GIS (Arc) and bathymetric data.

### **Further reading or any references referred to in the proposal**

**Brown, C.J.**, Smith, C.J., Lawton, P. and Anderson, J.T. 2011. Benthic habitat mapping: A review of progress towards improved understanding of the spatial ecology of the seafloor using acoustic techniques. *Estuarine, Coastal and Shelf Science*

**McBreen, F.**, Askew, N., Cameron, A., Connor, D., Ellwood, H., Carter, A., (2011), UK SeaMap 2010 Predictive mapping of seabed habitats in UK waters, JNCC Report 446, ISBN 0963 8091.

**Scottish Natural Heritage.** 2006. Firth of Lorn Special Area of Conservation Advice under Regulation 33(2) of The Conservation (Natural Habitats, &c.) Regulations 1994 (as amended).