MASTS Small Grants (2013 Round, access to 'cutting edge' knowledge and techniques: microsatellite analyses)

Final Report

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Grant received in support of PhD Project:
Vulnerability of *Modiolus modiolus* reefs to climate change: from mechanisms to management

Project overview:
This PhD project took an eco-physiological approach to investigate the limits of environmental stress tolerance in *Modiolus modiolus* (horse mussel) reefs via comparison of stress response of populations from varying latitudes under controlled aquarium-based future climate conditions. Data arising from investigations provides preliminary information on the climate envelope of the species under current and future climate conditions. Additional microsatellite genetic analyses (supported by this grant) of *Modiolus* populations determined genetic structure and connectivity of populations and also provided foundational information for any population-based differences in stress response and plasticity/acclimatory ability that were observed. The project facilitated collaboration between academic and government partners from fisheries and conservation departments across the Irish Sea and northwards throughout the distribution range of biogenic horse mussel reefs. Results will contribute to a robust evidence base to inform ecosystem based management and marine spatial planning and to underpin sustainable fisheries and marine renewable energy developments against the back drop of environmental change.

Relevance to MASTS:
This project was carried out at a MASTS partner institute, Heriot-Watt University. The project was aligned with the MASTS research theme: *Biodiversity, Function and Services* and the Scottish Government's Strategic Research Theme (2011-2016), *Environmental Change (Local Responses to Global Change), Theme 1 - Scotland's environmental assets, biodiversity and ecosystem services are identified and valued to inform decision making*. It is also contributed to MASTS goals: "to enhance scientific excellence in marine research through communication, collaboration and co-ordination within the Scottish marine research community", "to support a healthier environment as a result of better informed policies to manage human activity based on the best available scientific knowledge (BASK)", and "to provide experience and training to the next generation of marine researchers and opinion makers through the MASTS graduate school and related bespoke events". Outcomes of the work also contribute to fundamental knowledge of *M. modiolus* habitats and inform national governments and organisations particularly in light of current marine management developments across the UK and Europe.

Summary of work funded by grant:
The MASTS Small Grants (2013) application was made to support the following project objective:

-Complete preliminary microsatellite genetic analyses of *M. modiolus* population to examine genetic diversity and connectivity of *M. modiolus* populations across the species distribution.

Funds were obtained to carry out preliminary microsatellite screening of *M. modiolus* populations from across the species UK range including those as far south as the Lleyn Peninsula, Wales, and as far north as Shetland Islands, Scotland.

Results:

Results of this work validated the use of a number of new microsatellite markers for *M. modiolus*. Figure 1 provides example of results from screening of a northern population (Karlsruhe, Orkney Islands).

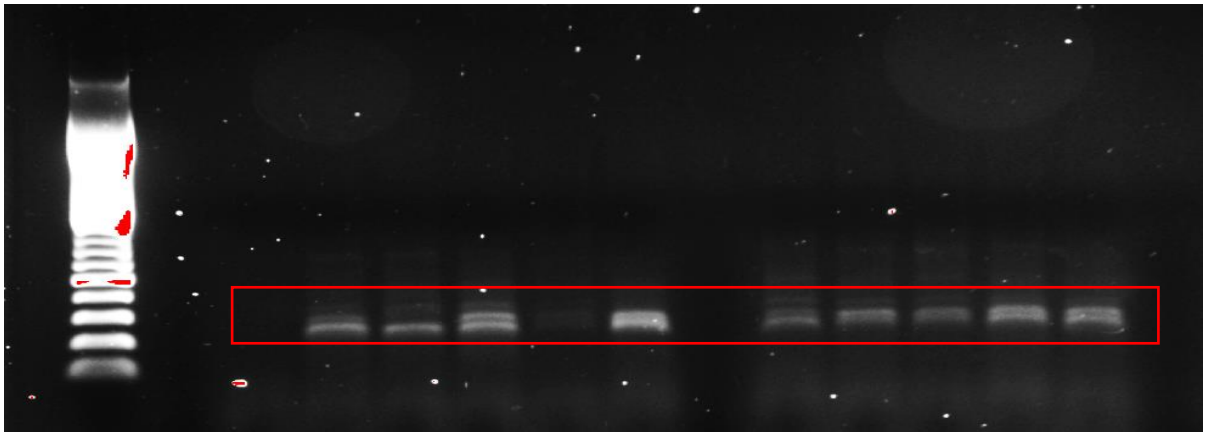

Figure 1. Gel electrophoresis confirmation of PCR amplification of microsatellite marker for Karlsruhe, Orkney Islands. Double bands at end of well lanes (indicated by red box) indicate successful amplification of target alleles (Source: Mackenzie, 2017).

Results from this preliminary screening provided important foundational information on the use of microsatellite markers for determining genetic structure of *M. modiolus* populations. This introductory investigation greatly contributed to later connectivity work including an in-depth examination of population connectivity/structure across Scottish *M. modiolus* populations (via collaboration with Scottish Natural Heritage). The latter investigation found low to moderate levels of genetic differentiation (i.e. moderate to high levels of connectivity) across Scottish *M. modiolus* populations.

Future work:

Future work will continue to examine the genetic connectivity and diversity of additional *M. modiolus* reef sites across the European and pan-Atlantic range (including populations in Norway, the Faroes, Iceland and Atlantic Canada) of the species to improve understanding of the nature of the *M. modiolus* network. Results will also feed into larval dispersal modelling for Scottish *M. modiolus* populations, currently in progress, and thus contribute to a greater understanding of the role of MPA sites in acting as larval sink or source populations.

Outputs arising from work:

This work contributed to successful PhD completion and defence by the applicant (Mackenzie, 2017). Additionally, all genetic connectivity and dispersal modelling results will be combined to provide a comprehensive overview of *M. modiolus* population connectivity. Results will then be submitted for peer-reviewed publication (in prep).

Reference:

Mackenzie, CL. (2017) Vulnerability of *Modiolus modiolus* reefs to climate change: from mechanisms to management. Dissertation, Heriot-Watt University, Edinburgh.