Proceedings of the 2nd International Conference on Environmental Interactions of Marine Renewable Energy Technologies (EIMR2014), 28 April – 02 May 2014, Stornoway, Isle of Lewis, Outer Hebrides, Scotland. *www.eimr.org*

EIMR2014-326

Salmon in Scottish coastal waters: recent advancements in knowledge in relation to their interactions with marine renewable energy installations.

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ABSTRACT

There are concerns about interactions between Marine Renewable Energy (MRE) and migratory fish, in particular Atlantic salmon. Marine Scotland Science (MSS) is attempting to gain information in key areas. Firstly it is necessary to obtain information about which populations of salmon occupy which coastal areas. To this end MSS has been undertaken a programme of genetic characterisation of regional variation in salmon, based on Single Nucleotide Polymorphisms, in order to assign fish intercepted at sea to their likely region of origin. In addition to obtaining geographical distribution of migrating salmon, information about the depths at which they are swimming in coastal waters is vital in the assessment of potential impact of MRE devices. In May-June 2013 MSS fitted pop-up satellite tags to adult salmon caught on the north coast, recording water depth and temperature at regular intervals, and providing a single geographic location following detachment.

INTRODUCTION

Atlantic salmon, *Salmo salar*, a species in decline across much of its range, is valued highly both economically and in terms of conservation, and may potentially be impacted by the proposed rapid expansion in the extraction of marine renewable energy (MRE) in Scotland. The likelihood of salmon coming into contact with proposed MRE developments is uncertain because of the lack of data on swimming behaviour and depth use of salmon in Scottish coastal waters. There is a similar lack of knowledge about the geographical distribution and movements of salmon, and about which stocks of salmon may be impacted by particular developments. Information on the use of coastal waters by homing Atlantic salmon is therefore urgently required to inform the sustainable development of marine renewable energy [1]. We present here the first information on salmon swimming depths in Scottish coastal waters.

METHODOLOGY

Fifty Atlantic salmon were captured in bag nets at Armadale on the north coast of Scotland. Fish in good condition and > 70cm in length were fitted with pop-up satellite tags (PSATs [2]), attached just posterior to the dorsal fin. Tags were programmed to record depth and temperature information at approximately 60s intervals. After pop-up, these tags communicate their location and the information they have recorded via the ARGOS satellite.

Genetic assignment techniques using Single Nucleotide Polymorphic (SNP) genetic markers were used to identify the region of origin of the salmon tagged in the study. Such methods use genotype likelihoods to draw inferences about where individuals were or were not born, potentially allowing fish to be assigned back to their natal regions and thus helping to explain migratory patterns in these fish. Fish from sites on rivers across Scotland were screened using a large panel of SNP markers. Regional assignment groups were defined and a targeted set of SNPS are under development to allow assignment of fish to, firstly,

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Scotland and, secondly, to the assignment regions identified within Scotland.

OBSERVATIONS

Genetic analysis has identified four large scale assignment regions within Scotland comprising the North and West, the Kyle of Sutherland, the East and the South of Scotland respectively (Figure 1). Work is progressing both on adding more rivers to this 'genetic baseline' and hence potentially increasing the resolution for possible assignments, and subsequently to this on assigning fish from the tagging programme to the regions identified.

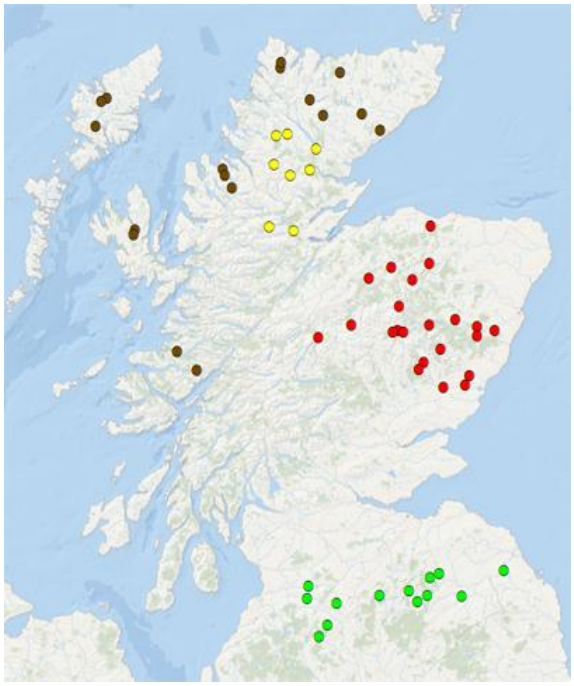

Figure 1. The assignment regions identified within Scotland. Brown – North & West, yellow – Kyle of Sutherland, red – East, green – South.

Approximately 90% of the PSATs reported to the ARGOS network, providing depth and temperature data and pop-up locations. These latter indicated that salmon had extended across a wide swathe of the north Scotland coastal zone, swimming in all possible directions. Individuals differed in their patterns of depth use. An example of the temperature and depth data obtained for one salmon is shown (Figure 2). Over the course of seven days, this individual moved westwards into warmer seas. This fish was predominantly surface orientated, but undertook repeated dives, in this case to around 70m, approximately equivalent to the maximum depths in the region in which the fish was swimming.

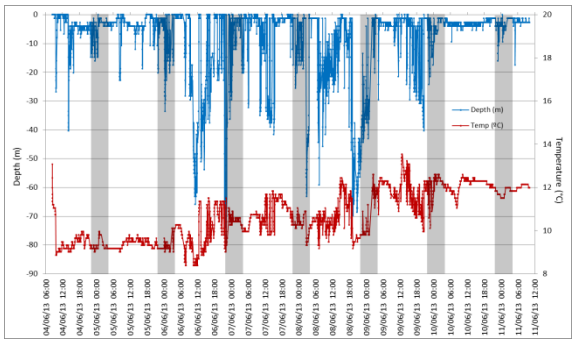

Figure 2. Example of a depth and temperature track of a returning salmon released at Armadale.

CONCLUSIONS

Knowledge relevant to the assessment of the potential impact of MRE development has been advanced on several counts. An initial characterisation of regional variation in SNP sequences of salmon has been created to enable assignment of salmon caught at sea to large-scale regions of origin with further work refining this process ongoing. Successful deployment of satellite tags on salmon for the first time in UK waters has revealed patterns of depth use in adult salmon which yield insight into their potential for collision risk with MRE devices. Together, these preliminary data have already helped to understand better the migration routes and depths of salmon around Scotland and will thus allow more detailed modelling of the interactions of salmon with MRE developments. Information on avoidance behaviour will then be required to assess impact.

ACKNOWLEDGEMENTS

We thank James Mackay and his crew for catching salmon, Julian Maclean for preparatory work and Jason Henry for field assistance.

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