The Pentland Salmon Initiative: A new research partnership exploring the potential interactions between migratory fish and marine renewables

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INTRODUCTION

Atlantic salmon (*Salmo salar*) are iconic and economically important fish, but their migratory behaviour during passage through Scottish coastal seas is not well understood. This means that there are unanswered questions about the potential for interactions between migrating salmon and marine renewables. Will migrating fish encounter renewable energy devices as they pass through areas where development is planned, and what will be the outcome of these encounters?

In order to explore these questions, the Pentland Salmon Initiative aims to engage organisations with interests or experience relevant to marine renewables and salmon migration, and we welcome opportunities for collaboration with new partners. Our initial focus is the Pentland Firth: a potential bottleneck for migrating salmon and a key site for the developing marine energy sector.

THEME 1: Modeling salmon migration in Scottish Seas

Models are central to any attempt to understand salmon migration. This includes particle tracking models (PTMs), which simulate trajectories of individual organisms within hydrodynamic models. ERI researchers have completed a report for The Crown Estate on the applications of PTMs for salmon migration. We aim to develop the PTM approach to estimate the rate at which migrating salmon may encounter renewable energy arrays.
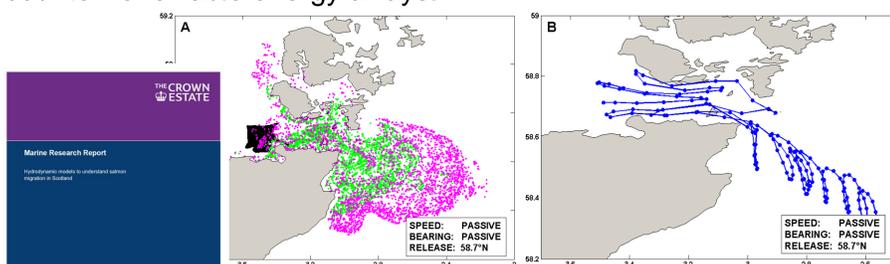

Figure 1. Outputs from a PTM for the Pentland Firth. **A)** Particle positions 72 and 143 hrs after release (pink and green dots respectively). **B)** Example trajectory of one individual particle in the model

http://www.thecrownestate.co.uk/energy-infrastructure/research/energy-research/reports/

THEME 3: Exploring effects on migrating salmon

Migrating salmon may be affected by noise generated by the marine renewables industry – both from construction activities and device operation. Salmon can detect and respond to low frequency sounds (Fig. 4), and may even use these as navigational cues.

The Pentland Salmon Initiative is gathering expertise on the auditory system of salmon, fish behaviour, and underwater acoustics. We aim to conduct a series of experiments to investigate natural 'soundscapes' and to assess potential effects of anthropogenic sound on wild salmon.
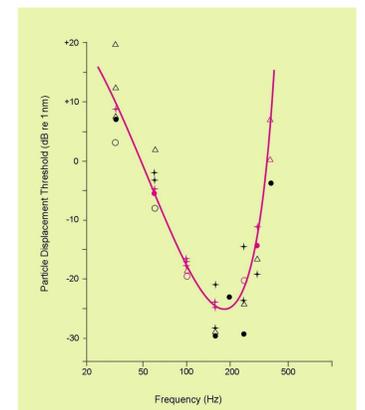
Figure 4. Hearing sensitivity curve (audiogram) for the Atlantic salmon obtained from behavioural conditioning experiments under free-field conditions in the sea. Salmon are sensitive to particle motion rather than sound pressure and here the hearing thresholds are presented in terms of particle displacement.

THEME 2: Salmon migration data

Models must be validated using data concerning coastal hydrodynamics and fish behaviour. Building on existing knowledge, we aim to bring together fishery stakeholders, experienced researchers, technology firms and renewable energy developers to develop tagging and tracking approaches for salmon moving through energetic coastal waters.

Working with Marine Scotland Science, we have collated data from salmon tagging studies conducted in Scotland (Fig. 2). These data will be used to inform analyses of salmon movements around the Scottish coast, including via a simple individual-based 'cellular' model (Fig. 3).
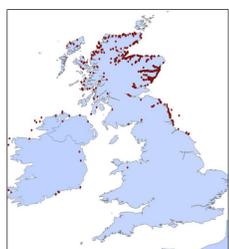
Figure 2. Historical tagging data; each point is a salmon recapture location.
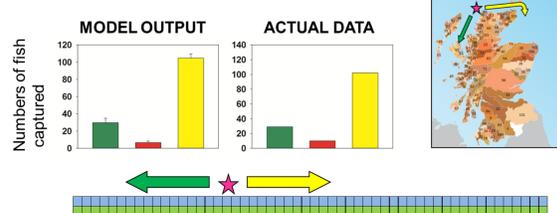
Figure 3. Example output from a simple individual-based model of salmon movements around Scotland, compared with real data from a tagging study

THEME 4: Monitoring salmon populations in northern rivers

In September 2013, Caithness District Salmon Fishery Board, working with ERI, North Highland College UHI and The Crown Estate, carried out an electric fishing survey of 22 sites in the 6 major river systems of Caithness (Fig. 5). Salmon fry and parr were at high abundance throughout. These survey data form an important baseline dataset for the status of salmon populations in Caithness, enabling future monitoring. Furthermore, this method could be rolled out on a larger scale. Other monitoring approaches can be developed in collaboration with stakeholder groups.

Figure 5. Electric fishing on the Wick (left) and Thurso (right) rivers.