

## **BEATRICE OFFSHORE WIND FARM SMOLT TRACKING STUDY**

Beatrice Offshore Windfarm Limited (BOWL) with The Scottish Centre for Ecology and the Natural Environment (SCENE) are proposing to complete a two-part study to satisfy the requirements of BOWL's S36 consent condition 31 (to participate in the monitoring requirements as laid out in the Scottish Atlantic Salmon, Sea Trout and European Eel Monitoring Strategy so far as they apply at a local level (the Moray Firth)) and condition 27a5 (Project Environmental Monitoring Programme (PEMP) (Diadromous fish)).

This study will commence in spring 2016 and will utilise acoustic telemetry to track the seaward migration of Atlantic salmon smolts from the River Conon through the Cromarty Firth and into the Moray Firth. The study is designed to improve the understanding of the speed, mortality and marine migration behaviour of the high conservation and economic value Atlantic salmon at the smolt stage.

The aims of the study are as follows:

To quantify:

- 1) The rate of natural migration and the natural mortality rate of salmon smolts in riverine habitats of the lower River Conon;
- 2) The speed and route of estuarine passage and the natural mortality rate of smolts in the Cromarty Firth;
- 3) The direction and speed of passage of smolts in the marine environment of the Moray Firth; and
- 4) The coastal features influencing the direction and speed of passage of smolts in the marine environment (for example current speed and direction, coastal bathymetry and coastal topography).

In addition to the above aims this two-part study will also develop and test new study methodologies and provide proof of concept for these to be applied further elsewhere. This will specifically provide data to enable improved design of future studies of coastal migration by fish.

Further intended outputs of this study include:

- Validation of the potential for active tracking of fish released into the marine environment as a methodology for determining coastal habitat use;
- Testing the validity of using near-shore coastal vectors as a proxy for marine migration pathways; a method for generating very high resolution temporal and spatial data (compared with the current alternatives - using fixed position receivers);
- The need for high spatio-temporal resolution data to determine potential environmental drivers (tide, currents, wind speed & direction, etc) of

fish movement speed and direction for subsequent modelling of smolt migration; and

- Improved understanding of environmental drivers of migration parameters allow the potential for spatial modelling of smolt migration based on local environmental conditions.

## **Acoustic Telemetry**

Acoustic telemetry is a relatively new technology which enables the tracking of tagged fish in freshwater and marine environments. Acoustic tags emit a sound signal at a fixed frequency and for some types of tag they also carrying a unique identification code defined by the sound pulse pattern. The presence of a fish carrying a coded tag and its identity can be determined by acoustic receivers, each comprising a hydrophone and a data logger, placed strategically in an array across the site of interest. Alternatively, it is possible to actively track fish with a mobile hydrophone to detect either the frequency of the tag or its code.

SCENE has used this technology successfully in several previous studies to monitor the emigration of Atlantic salmon smolts (and other fish) from rivers and estuaries to the sea.

## **Methodology**

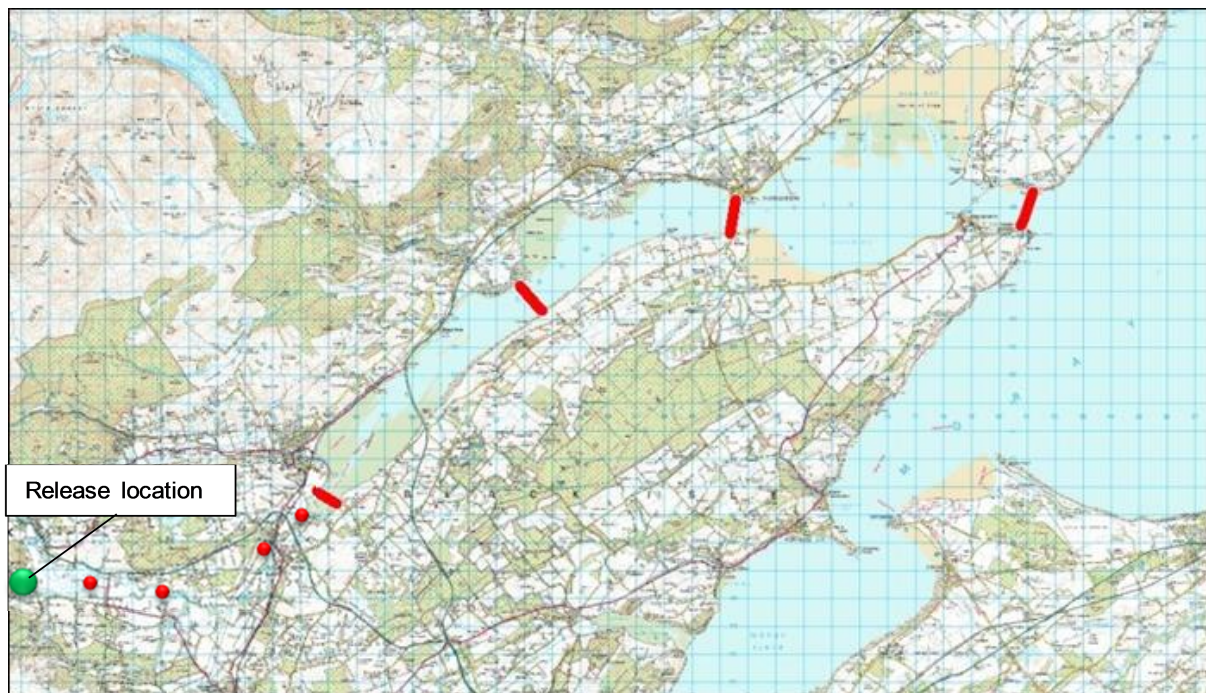
Outlined below is the design of a two-part study to address the above aims, including an indicative acoustic array layout for the study area.

### **Part 1 - Tracking wild fish through river and firth habitats**

120 salmon smolts will be tagged during their natural migration period in April and May 2016 from the River Conon. Fish will be collected using a fixed trap (a Wolf trap) on the River Bran (a tributary of the Conon) at Achanalt. Smolts will be tagged throughout the entire period of the smolt run with fish sizes being representative of the population as a whole as determined by historical records. The aim is to tag fish exceeding 135mm in Length so as to remove any possible effect of tag size on the fish itself. Smolts will be tagged, under Home Office licence, with 7 mm coded acoustic tags (Vemco V7-2L 69kHz or Thelma biotel 7.33mm 69kHz, repeat cycle 20s) with a battery life of ca 100 days and returned to the river immediately downstream of the Torr Achilty power station on the lower River Conon. Trap capture and release of downstream migrating smolts has been conducted by the Cromarty District Salmon Fishery Board for a number of years; this activity has resulted in high rates of survivorship of translocated smolts, determined by more than 15 years of PIT (passive integrated transponder) tagging.

In part 1 of the study, smolt migration will be tracked using a series of fixed receivers in the River Conon. Receivers will also be placed strategically to monitor tagged smolts as they enter the transitional tidal zone, the estuary and the main body of the Cromarty Firth. In the estuary and firth receivers will be placed in an array.

To ensure complete detection of all possible routes to the open sea, receivers will be placed at 50m and 150m from each shoreline. The shore is an acoustically noisy environment and requires greater receiver coverage to ensure 100% detection of tagged individuals in these areas. Away from the shore, receivers will be spaced at 500m intervals. This assumes a 250m detection range from each individual receiver. Previous work suggests detection ranges in such locations should be in excess of 400m, however extensive range testing and the use of fixed sentinel tags will form an important component of this study and these data will inform receiver placement.



**Figure 1: Proposed acoustic receiver deployment in the part 1 study (red dots). Acoustic receiver arrays appear marked as a red line**

Although array placement sites are yet to be confirmed with the Cromarty Firth Port Authority, it is envisaged that the array will comprise:

- The estuary mouth (the Sutors 1.2 km), - 6 receivers
- Invergordon to Newhall point (1.2 km) – 6 receivers
- Balconia Point to Castlecraig (1.2 km) – 6 receivers
- Tighnahinch (800 m) – 4 receivers
- Tagging site to head of the tide – 4 receivers

The total requirement of receivers required across all arrays is 26. This design seeks to achieve 100% detection of emigrating smolts under all conditions. This will be tested by a period of significant range testing prior to the smolt release and the use of constant monitoring sentinel tags. A transect line of Vemco VR2Tx receivers will be deployed prior to the main migration period within zones identified for placement of the receiver study array. These receivers will be deployed at increasing increments of distance from one other. Sentinel tags, built into these receivers, will

be set to transmit at a constant rate for a period of around 1 month to enable detection probability to be calculated. This is derived from the strength of the signal received from the sentinel tag over a variety of environmental conditions experienced within the firth.

Data on detection probability derived from this range testing will inform the exact location of receiver arrays and receiver distance placements. Receiver sentinel tags will be programmed to send signals for the duration of the study period (including the smolt migration period) allowing for continuous measures of range to be made throughout the study and thus to determine detection probability at any given time.

A suitably experienced external contractor will be engaged to deploy and retrieve receivers in the Cromarty Firth.

Further to the passive tracking element, active tracking of naturally dispersing smolts within the Cromarty Firth will be undertaken to determine possible predation of migrating smolts. Movement of a tag which has been predated upon is significantly different to that of a naturally migrating fish thus enabling smolts that have become prey to marine predators to be detected. Manual tracking within the firth, between the fixed arrays, will supplement data in determining the ultimate fate of tagged fish.

## **Part 2 – Active tracking in the Moray Firth**

In this part of the study, smolts will be tracked as they migrate into the marine environment of the Moray Firth, beyond the mouth of the Cromarty Firth, using a manual tracking system operated from a small boat. Two groups of smolts will be tracked:

- a) Naturally dispersing tagged smolts – that is those fish from part 1 of this study that successfully migrate to, and pass through the Sutors and enter the coastal zone; and
- b) Directly released smolts – fish released at the mouth of the Cromarty Firth.

### *Naturally Dispersing Smolts*

Tracking of naturally dispersing tagged smolts will be attempted by 2 methods:

- i) Smolts that are detected incidentally during the continuous tracking of directly released smolts, described below; and
- ii) By searching directly for naturally dispersing smolts from the boat using a pre-defined sweep search pattern. The spacing of the sweep pattern will be determined by range trials early in the study. The timing of coastal searches will be defined by knowledge of the likely arrival of smolts at downstream receivers and the speed of travel. The geographic coverage of the sweep will be determined partly by weather but will concentrate initially on near-shore detection. For safety reasons no tracking will be conducted after dark.

## *Directly Released Smolts*

Tracking of smolts released directly to the marine environment will be achieved by tagging five smolts acquired directly from trapping in the River Conon. Frequency coded V7 acoustic tags will be used which are more rapidly detected using mobile detection equipment. The tagged smolts will be held overnight in a small floating, semi-rigid construction cage (ca 2x2x2M) moored in the estuary to allow recovery from tagging. The cage will then be towed through the Cromarty Firth over 5 hours to a location near the mouth of the Firth where it will be moored overnight to allow for an acclimation period. The fish will be released on an ebbing tide at the Sutors at first light (e.g. on 1<sup>st</sup> May sunrise is at 04.28; sunset at 20.02 UT; nautical twilight begins at 02:34 and ends at 21.57 UT), during a suitable weather window, and will be actively tracked for up to 20 hours (during daylight hours).

Tracking will be conducted by experienced and appropriately trained staff operating from up to two vessels and following known identified fish from the release site (and simultaneously acquiring detections of naturally dispersing smolts). Tracking vessels will determine the range of tracked fish by sonic signal strength; to avoid displacing fish unnaturally vessels will not approach closer when the signal strength exceeds 80 dB. In addition to smolt position and vector of travel the survey vessels will also collect local environmental data on: wind direction, wave height, water salinity and temperature. Additional data on tide height, current direction and speed will be generated from Admiralty charts and combined with other publicly available information sources to provide a description of the physical conditions during the tracking exercise.

This study will be very intensive but of short duration and will provide high spatio-temporal resolution smolt position during migration.

Six batches of 5 fish in 6 replicates of the above protocol will be released to the coastal zone across the period of the smolt run (April to May). Thus 30 fish (in addition to those tagged in part 1) will comprise this component part of the work. As this technique has not been attempted previously, an initial trial will be used to inform and adjust the methodology to maximise the quality of data obtained. The protocol elements that could be modified are:

- the location of the release site - this will depend upon other marine users but will be either immediately inside or immediately outside “the Sutors”.
- the number of fish released in each batch – this will be informed by smolt grouping behaviour and their speed of travel.
- the time over which each fish (or fish group) is tracked – this will be limited by the number of hours of light available but on the 1<sup>st</sup> May the time available for tracking is approximately 19.5 hours.

## **Study reporting**

On completion of the field work, and once the tracking data and associated environmental data has been thoroughly analysed, SCENE on behalf of BOWL will complete a study report setting out the equipment, methods, results and interpretation of these results. The report will be issued to Marine Scotland for final approval. The information will not only satisfy the specific consent conditions for Beatrice Offshore Wind Farm, but will be used to produce peer reviewed scientific papers.