

## The impact of flicker or pulsating shadow effect, caused by wind turbines, on Atlantic salmon

### Research questions to be answered through this project:

Flicker, or pulsating shadow effect, caused by rotating turbine blades is an issue which, it is suggested, may have an impact on the behaviour, survival and productivity of Atlantic salmon. The magnitude of any impact is likely to be influenced both spatially and temporally through the course of a day, depending on the position of the sun (and height), the orientation of the turbine (as determined by wind speed and direction) and cloud cover. The position of fish within the river, including each fish's line of sight relative to factors such as bank height/slope, river planform, complexity of in-stream cover, surface water turbulence/reflection, presence and extent of riparian vegetation may also be important. This project asks the contractor to review the existing national and international literature to answer four questions using the literature available:

1. What are the potential biological and ecological impacts/responses of flicker (pulsating shadow effect) on Atlantic salmon at an individual level at each life stage (fry, parr, smolt and adult) within a river system?
2. Do Atlantic salmon acclimate to repeated disturbance and may that increase susceptibility to other pressures, such as predation risk? (*\*It may be helpful to consider literature on the impact of pulsating light and predator exposure experiments*)
3. Can the impact of flicker be extrapolated to the whole Atlantic salmon population of an affected river?
4. Are there ways in which this issue can be successfully mitigated by developers and fishery managers?

### Background

Onshore windfarms have become a common sight within the Scottish countryside and may impact freshwater environments and the fish that they support in a number of ways. These include changes to water quality caused during construction and drainage, or damage to vulnerable freshwater habitats (such as gravels used by fish for spawning) during stream and river crossings. The issue of flicker or pulsating shadow effects is a potential impact which has not been investigated with regard to the placement of onshore wind turbines but has been raised in respect to its potential impact in offshore installations. New turbines and the installation of larger turbines during the repowering of established sites, may have the potential to impact Atlantic salmon. A species which is already undergoing significant declines throughout its natural range, and a feature within Special Areas of Conservation (SACs), may be adversely impacted by shadow flicker. This literature review will inform regulators and others as to whether this is an issue, whether it is not, or whether more targeted research is needed. It cuts across a range of policy areas, including renewable energy, climate change and conservation of features within designated sites and wider fisheries management.

**Knowledge gap** *The key knowledge gap is an understanding of the biological and ecological impact of flicker shadow on Atlantic salmon in river and stream environments. Exploring whether the inferred potential impact is supported by actual evidence. Following this project, if evidence is limited, recommendations for future collaborative research projects will be necessary.*

**Previous relevant studies** include:

There are no existing programmes of research into this issue within the UK or elsewhere, therefore a review of published and grey literature and expert opinion will be necessary.

**Relevant policy goals, statutory commitments, and policy decisions** include:

This project can have implications for a range of policy areas. These include renewable energy and tackling climate change. It also has potentially significant implications for managing interactions between turbine placement (proximity to a river, size and density) and the maintenance of conservation of features within designated sites, as well as wider fisheries management.

Statutory obligations to protect Atlantic salmon in SACs (Habitats Directive), to maintain freshwater biodiversity (Water Framework Directive), to manage Atlantic salmon (various statutory commitments delivered by MSS, DSFBs etc). Atlantic salmon are also protected under Appendix III of the Bern Convention, are listed as a UPBAP Priority species (Spring stock component), and its status is monitored by NASCO, ICES and OSPAR. The Scottish Government have been tasked with the delivery of a Wild Salmon Strategy by March 2021 under the current Programme for Government.

**Anticipated impacts** of this project are as follows:

- **Overall:**

If it can be firmly demonstrated within the existing literature that wind turbine flicker has a biological impact on Atlantic salmon production within rivers, then the magnitude of that impact on existing Atlantic salmon populations should be investigated to determine the actual scale of the issue. The outcome of this work will inform future approaches to the position and siting of wind turbines adjacent to Atlantic salmon rivers.

- **Project outputs.**

- To inform planning or other regulatory responses in Scotland to proposals relating to the placement of wind turbines in areas close to rivers which contain Atlantic salmon.

- **Primary beneficiaries**

Planning, advisory and regulatory authorities. Fishery managers, including District Salmon Fishery Boards.

- Expected **improvements for policy, people, and the environment** include:

Depending on the output of the review – better, evidence-based, responses to planning authorities, developers and regulators with regard to wind farm planning applications. Better regulation will have benefits for sites designated for nature conservation, the wider countryside. This may benefit the public and those who manage, and benefit from, the presence of Atlantic salmon.

**Project scope**

**1. Objectives**

The overall aim of this project is to review the available literature relating to the impact of flicker shadow on freshwater fish, and Atlantic salmon in particular. This may, depending on the evidence presented, inform policy in relation to the placement of wind turbines in areas adjacent to rivers.

- Review the current literature on ‘flicker effects’ on freshwater fish with a particular focus on Atlantic salmon;
- Use examples from the literature to provide insights into the actual biological impact that these may have on Atlantic salmon in rivers; and
- Suggest ways in which this issue, should it be shown to be significant, can be mitigated or used to inform turbine placement near rivers.

**2) Outputs required:**

- a) A report of max. 20-30 pages (and no more than 12,000 words) (excluding appendices) that addresses all the outputs described in the preceding sections.
- b) An executive summary (2 pages).
- c) A plain English summary of aims and results (1 page) – for dissemination purposes.
- d) Policy brief/statement

**3) Projected timeline:**

1 <sup>st</sup> July 2021	Project initiation/start-up
30 <sup>th</sup> July 2021	Draft report
13 <sup>th</sup> August 2021	Final report

**Maximum funding available (incl. VAT): £6,500**