**Fish Swimming Dynamics and Behaviour in the Vicinity of a Fish Exclusion Screen**

**Lead Supervisor Name**

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**Lead Supervisor Location/Student Home Institution**

Institution: Cardiff

School: Engineering

**Full Project Description**

The project will quantify the effectiveness of different fish screen types used in rivers to exclude fish from entering water abstraction, discharge points and bypass channels so that they can safely migrate upstream and downstream in a river system. There is a legal obligation for all river “users” (e.g. Water Companies, power stations, hydropower companies, agricultural practitioners and industrial operators) to implement fish screens on water intakes and outfalls, and it is claimed that river obstructions may be one of three dominating factors responsible for the huge decline in eel numbers across Europe. It is estimated that eel numbers across Europe have crashed to 5% of their 1980s levels and it is feared that in 30 years time, there may be no adult eels left. The decline in eel numbers has led to the Eel Regulations (2009) and also a ban for the first time ever, by the Environment Agency, on adult eel fishing in the UK. There is therefore an urgent need for an evidence-based approach to understanding how the physical attributes of a screen impact on fish swimming dynamics for different velocity conditions and how different screen types may led to entrainment, impingent and injury with consequential environmental impact. This project will quantify screen effectiveness through experiments in large scale flume facilities at Cardiff University. These experiments will examine different screen attributes and set ups under different flow velocity and turbulent shear stress scenarios. The tests will involve both detailed measurement of the flow field and the swimming or “climbing” behaviour of the fish using a range of fluid mechanics and imagery techniques. We will examine the linkages between the fish swimming trajectory and behavioural aspects to the fluid mechanics and the screen physical attributes. The student will experience a multi-disciplinary training within a project that aims to address both cutting edge science and provide quantitative evidence for a real-life problem. Training will be given through the following mechanisms: - FRESH Training - Water URI Early Career Researcher Training involving both academic and social events - Acoustic Doppler Velocimetry Techniques Training in the laboratory - Interdisciplinary research and benefit from the established links between Wilson and Cable and their wider research group and labs (Hydro-environmental Research Centre labs and CRIPES labs). - Wilson, Cable and Tyler have wide external research networks (e.g. Wilson is member of the Welsh Government’s Flood and Coastal Erosion Committee and the American Physics Society Division of Fluid Dynamics, Cable is a member of the British Society and British Ecological Society and Tyler is involved in many international networks including a panel member for the International Symposium for Fish Endocrinology). - Fisheries Management specifically understanding current practices, and finding sustainable ways of incorporating novel solutions

The student will have access to the following facilities and stakeholder engagement:

* The flume facilities and velocity measurement techniques in the hydraulic laboratory in Engineering at Cardiff University
* The large range of fish biology facilities in the CRIPES labs in Bioscience at Cardiff University
* The engagement of the Environment Agency and a fish screen manufacturer Hydrolox through progress meetings, email/telephone communication and skype calls
* Access to screening sites (subject to site owner’s permission)

**Real Life challenges this project will address**

Defra estimates that screens will cost the UK industry £85 million by 2031, with retrofitting cots of £33 million by 2020. This will also result in increased energy, carbon, infrastructure and maintenance costs.The Environment Agency (EA) has legal powers to protect European eel stock in all freshwater and estuarine waters in England and Wales (Eels Regulations 2009) so there is a legal obligation for all river “users” (e.g. Water Companies, power stations, hydropower companies, agricultural practitioners and industrial operators) to implement fish screens on intakes and outfalls. Furthermore recently the EA has invested significant funds into replacing traditional fish screen with a new type of fish screen in several river systems yet no quantitative evidence is available on how effective the new screens are over traditional screens, only anecdotal evidence exists.

**What you should know about this project**

This PhD project will examine the effectiveness of different fish exclusion screens, to enable fish to safely remain in the main river system and allow safe passage. The screens are used to stop fish entering water abstraction, discharge points and bypass channels, and deter them away from impounded waters that as well as being hazardous, severely impact on their migration cycle. A number of screens are already in use on rivers which comprise of large meshes made of metal or plastic placed across the entrance of the water abstraction inlet/outlet. Little information is known on the efficiency of these screens for different fish species, fish sizes life stages and subsequent ecological impacts in the abstracted waterbody. The main objective of this PhD will be to quantify this aspect through experiments using large scale flumes, which are physical relicas of streams, in the hydraulics laboratory at Cardiff University as well as where possible in-situ research on operating screens. The supervisory team is composed of academics from both engineering and biology backgrounds who have a track record of supervising students in this area and in this specific research area. This is a specialised area of river bioscience and there are few research centres and academics in the UK that work in this area.

**What expertise you will develop**

The student will develop expertise in Fluid Mechanics, Engineering, Experimental Design, Fisheries Management and Imagery Technology, specifically relating to flow dynamics and freshwater fish.

**Why this project is novel**

In reducing the likelihood of fish entrainment, screen gap size is thought to be an important physical property and gap size is usually related to life stage. However little is known on how gap size and whether the vertical movement of the mesh impacts on the swimming and “climbing” dynamics of juvenile fish, such as glass eel and elver, and how these behavioural aspects are impacted by different flow velocities and turbulent shear stresses which will change in response to the hydrological cycle. Furthermore, this project comprises two key components: state of the art science, namely fish swimming dynamics and kinematics using the latest fluid mechanics and imagery technologies as well as providing an evidence base for a real-life challenge that may impact future Government Agencies and other Stakeholders decisions on screen choice.

**Rest of Supervisory Team:**

**Stakeholder Organisation** Environmental Agency

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