BU STUDENTSHIPS 2020

PROJECT DESCRIPTION

PROJECT DETAILS

PROJECT TITLE

Measuring the migratory and ecological responses of a threatened anadromous fish to river reconnection: Twaite shad *Alosa fallax* in the River Severn

PROJECT SUMMARY

Rationale

Habitat fragmentation is a major source of biodiversity loss in freshwaters, with rivers around the world fragmented by dams and weirs that create impoundments. These impoundments restrict river longitudinal connectivity, inhibit fish migrations across ecosystem boundaries (marine-freshwater), prevent lifecycle completion, modify gene-flow and impact population sustainability.

Restoring longitudinal connectivity can be achieved via 'fish-passes' on the impoundments, but these only favour movements of salmonid fishes. Increasingly, impoundment removal is used as the holistic alternative. There have, however, been few attempts to quantify its conservation and ecological outcomes for non-salmonid migratory fishes, despite these species facing unprecedented European population declines, such as in European shads *Alosa* spp. and sea lamprey *Petromyzon marinus*.

Most British rivers suffer substantial longitudinal disconnection. This includes the River Severn and its tributaries (e.g. River Teme), where major impoundments have been present in their lower reaches for over 150 years, despite their *Alosa* spp. populations of European importance. These migratory species cannot access their historical spawning grounds. Instead, they share spawning areas downstream of the final impoundment. The result is high competition for spawning sites, reduced reproduction success, increased hybridisation between *Alosa* spp. Correspondingly, weir removals and new fish-pass engineering in the lower Severn and Teme have started to re-connect these fishes with over 250 km of lost habitat through a multi-partner project. This re-connection scheme enables testing of the response of these migratory fishes to this restoration schemes, requiring the generation of knowledge on their migratory behaviours, spatial and temporal habitat utilisation, and the influence of their over-wintering behaviours on their subsequent spawning migrations. Baseline data (prior to full river reconnection) on these aspects have been developed by this PhD's supervisory team, with this PhD designed to measure the responses of the fish to reconnection over the next three years.

Aim and objectives

The proposed research will thus evaluate changes in *Alosa* spp. migratory behaviours and spawning distributions in the River Severn between 2018 and 2023. In 2021/22, the Severn will be fully open to migrating adults of this threatened anadromous fish for the first time in over 150 years following completion of the weir modifications and fish passes. The research will test *Alosa* spp. migration behaviours before and after river reconnection using contemporary telemetry, genetic and ecological methods through completion of the following objectives: (O1) assess *Alosa* migration distances and movements, and spatial spawning distributions, before (2018-2020) and after (2021-2023) reconnection; (O2) assess *Alosa* movements and behaviours in and around the newly constructed fish passes and the modified weirs; and (O3) quantify changes in *Alosa* migration ecology resulting from reconnection in the context of, for example, spawning site fidelity (spawning periods) and marine habitat use (non-spawning periods).

Methods

There are two primary methods of data collection in the PhD:

- Bio-telemetry: completion of the objectives is strongly reliant on the application of biotelemetry technology, using acoustic and/ or passive integrated transponder (PIT) tags in tracking movements of *Alosa* spp. through the river (acoustic telemetry) and through fish passes (PIT tags). The innovative use of acoustic tags enables tagged fish to be tracked over a three year period, covering three spawning seasons, thus

are critical to O3 (*Alosa fallax*, the main species in the river, is iteroparous). It is probable that relatively low numbers of fish are acoustic tagged but relatively large numbers will be PIT tagged.
- Molecular methods: Aspects of the research will be reliant on the application of contemporary molecular methods such as environmental-DNA and identification of species from DNA extracted from fish tissues and eggs. These methods are applied in O1 to determine changes in the spatial extent of river utilisation by all *Alosa* during the study period (i.e. not just tagged fish), as well as providing data on genetic differences between individuals (e.g. their extent of hybridisation) for use in O2 and O3.
It is likely that these methods will be used in a complementary manner throughout the research.

Outcomes
Given the increased use of river restoration schemes globally, especially in relation to reconnecting rivers for migratory species, then this innovative research is very timely, as it will contribute strongly to this applied area by revealing how the behaviour of a migratory species reacts to new migration opportunities, and how this changes their spatial and temporal utilisation of freshwaters.

ACADEMIC IMPACT

The research will substantially strengthen current knowledge of how migratory, non-salmonid fishes respond to reversals of anthropogenic disturbances, particularly their population responses and associated ecological consequences to the re-connection of rivers that enables their access to site spawning sites for the first time for over 150 years. In particular, academic impact is achieved through the PhD providing novel insights into how populations will respond to decreased resource competition (e.g. exploitation of new spawning areas in *Alosa* spp. resulting in altered patterns of spawning distributions). Thus, outputs each objective will be appropriate for publishing in a range of scientific journals, from relatively specialist freshwater and conservation journals (e.g. *Freshwater Biology, Aquatic Conservation, Biological Conservation* to broader scale, generalist journals (*Ecology*, *Journal of Animal Ecology*). There are also options for the outreach of this academic impact to be strengthened via using all of the outputs in policy-based journals. Allied to this, the PhD student will also present their work at relevant international symposia and to contribute to the BU and sector wide research communities.

SOCIETAL IMPACT

The regulation of rivers for flood prevention is becoming a major societal issue in the UK, given the major socio-economic consequences of flood events in recent winters (e.g. 2019/20). Despite best-practice and policy guidance from regulators such as the Environment Agency, pressure continues to build for greater regulation of flows through hard-engineering solutions. However, these are likely to have substantial ecological and conservation consequences, with potential for extirpations of migratory species of European importance due to habitat fragmentation. The opposite approach of allowing rivers to increasingly adopt natural flows and characteristics, with less severe land-use practises in the upper catchment and greater connectivity in the lower reaches, is seen as a viable alternative by some regulators, with the additional benefit of enabling more sustainability in the populations of threatened migratory species. This argument between hard- and soft-engineering solutions is thus critical for society and biodiversity. This PhD is ideally placed to strongly inform this debate, highlighting the potential conservation and ecological benefits that can accrue from soft-engineering solutions. Thus, there is the potential for considerable societal benefit to be achieved in the PhD, especially through working with the match-funder and their regulatory partners to seek sustainable solutions.

DEVELOPMENT OPPORTUNITIES

The PhD provides substantial training opportunities, including:

- Bio-telemetry: the research will be heavily reliant on the application of biotelemetry technology, using acoustic and/ or passive integrated transponder (PIT) tags in tracking movements of *Alosa* spp. through the river (acoustic telemetry) and through fish passes (PIT tags). Training on all aspects of tagging, including implantation, will be provided.

- Molecular methods: Aspects of the research will be reliant on the application of contemporary molecular methods such as environmental-DNA and identification of species from DNA extracted from fish tissues and eggs. Training will be delivered throughout the PhD on this through a combination of formal off-

campus training and informal laboratory training from the supervisory team. This will also include training in field sample collection and preservation to ensure samples are not ruined prior to analysis.

- Research skills: training will be provided via formal and informal approaches on research skills including literature review, writing scientific publications and presentation skills.

- The student will be supported in completed the Animal Procedures Modules 1-4 and so obtain their Home Office personal license for all tagging procedures on live fish.

SUPERVISORY TEAM	
First Supervisor	Robert Britton
Additional Supervisors	Demetra Andreou, Jonathan Bolland
Recent publications by supervisors relevant to this project	Davies, P., **Britton, J.R., Bolland J.D**. et al. (2020) Novel insights into the marine phase and river fidelity of anadromous twaite shad *Alosa fallax* in the UK and Ireland. *Aquatic Conservation: Marine & Freshwater Ecosystems* Nolan, E.T., Gutmann Roberts, C. and **Britton, J.R**. (2019). Predicting the contributions of novel marine prey resources from angling and anadromy to the diet of a freshwater apex predator. *Freshwater Biology, 64(8)*, 1542-1554. Antognazza, C.M., **Britton, J.R**., **Andreou, D**. et al. (2019). Environmental DNA as a non-invasive sampling tool to detect the spawning distribution of European anadromous shads (Alosa spp.). *Aquatic Conservation: Marine and Freshwater Ecosystems*, *29*(1), pp.148-152. Radinger, J., **Britton, J.R.,** Carlson, S. M., Magurran, A. E., Alcaraz-Hernández, J. D., Almodóvar, A., . . . García-Berthou, E. (2019). Effective monitoring of freshwater fish. *Fish and Fisheries*, *20*(4), 729-747. **Bolland, J.D**., Wright, R.M. et al. 2019. Direct and indirect impacts of pumping station operation on downstream migration of critically endangered European eel. *Fisheries Management and Ecology*, *26*(1), pp.76-85. **Bolland, J.D., Britton, J.R**. et al. (2019). Refinement of acoustic-tagging protocol for twaite shad Alosa fallax (Lacépède), a species sensitive to handling and sedation. *Fisheries Research*, *212*, pp.183-187.

INFORMAL ENQUIRIES
Please contact Robert Britton (rbritton@bournemouth.ac.uk) or Demetra Andreou (dandreou@bournemouth.ac.uk) for informal enquiries.
ELIGIBILITY CRITERIA
The BU PhD and MRes Studentships are open to UK, EU and International students. Candidates for a PhD Studentship should demonstrate outstanding qualities and be motivated to complete a PhD in 4 years and must demonstrate: • outstanding academic potential as measured normally by either a 1st class honours degree (or equivalent Grade Point Average (GPA) or a Master's degree with distinction or equivalent

- an IELTS (Academic) score of 6.5 minimum (with a minimum 6.0 in each component, or equivalent) for candidates for whom English is not their first language and this must be evidenced at point of application.

ADDITIONAL ELIGIBILITY CRITERIA

Experience in fish telemetry, aquatic ecology and/ or ecological fieldwork is highly desirable.

HOW TO APPLY

Please complete the online application form by 12th July 2020.

Further information on the application process can be found at: www.bournemouth.ac.uk/studentships

It is anticipated that the PhD will commence in January 2021.