

<b>PROJECT DETAILS</b>
<b>Project Title</b>
Predicting the implications of changes in migration phenology for the conservation of Atlantic salmon
<b>Project Summary</b>
<p>Migrations between different habitats are key events in the lives of many organisms and especially for anadromous fishes[1]. The long distance movements by anadromous salmonid fishes are usually triggered by predictable seasonal changes in their environment, especially for juveniles descending the river to sea as ‘smolts’[2]. The timing of smolt migration aims to coincide their arrival in the marine environment when conditions are optimal for survival and growth, and thus should maximise fitness[1,2].</p> <p>The Atlantic salmon (<i>Salmo salar</i>) is an ecological and economically important species whose distribution is declining across its range[3]. Evidence increasingly suggests that, for individuals, their condition (e.g. body size) and seaward migration timing - their ‘migration phenology’ - are important determinants of their subsequent marine growth and survival[4]. Seaward migration timing and condition, however, appear to have been changing in recent years due to environmental changes, including climate change (especially warming)[5]. For example, smolt migration now occurs 2.5 days earlier per decade and the average smolt body length has decreased by 0.5cm p.a.[6]. This could be important as studies suggest marine survival substantially increases as smolt size increases[4,6]. It has thus been recently hypothesised that long-term salmon population declines are a function of changes in their migration phenology that adversely impact their early marine growth and survival[4,6].</p> <p>The studentship will thus test the hypothesis that contemporary population declines in anadromous salmonids are a function of changes in their migration phenology. Initial models to test this will be developed using individual data collected from <i>S. salar</i> in the River Frome, Dorset, and then extended spatially, temporally and structurally to include populations with different age structures from other rivers in Britain and Northern France. They will be simplified to derive parsimonious management recommendations to maximise fitness. Correspondingly, objectives (O) are to: (O1) quantify any general impact of smolt condition (including length, weight and condition) on marine survival (age- and stage-specific survival); (O2) test the importance of smolt condition on marine survival versus alternative factors; (O3) explore the mechanisms driving impacts of smolt condition on marine survival; and (O4) use results of (O1) to (O3) to generalise findings to other species and identify management mitigation tools.</p> <p>O1 to O3 are developed using long-term data from the River Frome, Dorset. New data collected within the studentship (2018-2020) add to long-term data (2004-2017) during which over 80,000 juvenile <i>S. salar</i> have been measured and tagged. Data from fixed tag recording stations and recapture events have generated individual smolt migration data and their complete life histories (i.e. immature juvenile to adult spawner). These data will be used in novel population models to test the relationships between migration phenology, marine growth and survival, and adult run size. The models will then be extended to other populations in Britain and Northern France. Results are then used in O4 to develop optimal management strategies in the <i>S. salar</i> freshwater life phase, particularly in relation to minimising the impacts of warming on their migration phenology.</p> <p>References: [1]Willson, M.F. and Halupka, K.C., 1995. Anadromous fish as keystone species in vertebrate communities. <i>Conservation Biology</i>, 9, pp.489-497.[2]Byrne, C.J. et al. 2003. Temporal and environmental influences on the variation in Atlantic salmon smolt migration in the Burrishoole system 1970–2000. <i>Journal of Fish Biology</i>, 63, pp.1552-1564. [3]Wolter, C., 2015. Historic catches, abundance, and decline of Atlantic salmon <i>Salmo salar</i>. <i>Aquatic sciences</i>, 77, pp.367-380.[4]Gregory, S.D. et al. 2017. Patterns on a parr: Drivers of long-term salmon parr length in UK and French rivers depend on geographical scale. <i>Freshwater Biology</i>, 62, pp.1117-1129. [5]Parry, E.S. et al. 2017. The effects of flow on Atlantic salmon (<i>Salmo salar</i>) redd distribution in a UK chalk stream between 1980 and 2015. <i>Ecology of Freshwater Fish</i>, 27, pp.128-137. [6] Gregory, S.D., Armstrong, J. and Britton J.R. In Press. Is bigger really better? Towards improved models for testing how Atlantic salmon <i>Salmo salar</i> smolt size</p>

impacts marine survival. Journal of Fish Biology

### **Academic Impact**

This research will substantially strengthen the empirical evidence base for management to mitigate the impacts of climate change on salmonid populations in Northern Europe. This is also of global interest, given the importance of salmonid fishes in many other regions, including North America. Where the results indicate a relationship between warming, smolt phenology and population decline, then these fit the remit of journals such as Global Change Biology, Where the results indicate a causal relationship between habitat management actions and an increased probability of smolts surviving to adulthood, then these data could be of interest to journals such as Journal of Applied Ecology and Canadian Journal of Fisheries and Aquatic Sciences. The PhD student will further this academic impact by presenting results at international conferences (e.g., the NoWPaS Salmonid Research Network) and will integrate into the research community at BU and the match funder, including in their 'SAMARCH' European Inter-regional project. They will also be encouraged to join and be active within relevant societies (e.g. the British Ecological Society, BES).

### **Societal Impact**

Anadromous salmonid fish communities in Europe have declined by 70% since the 1970s. This is despite these fishes being strong ecological status indicators in the EU Water and Marine Directives and having strong legislative protections. The ultimate aim of this research is to therefore, in conjunction with wider research being completed by the match funder, including in their European inter-regional project 'SAMARCH' that helps support this studentship, create and disseminate new knowledge that will improve the survival of salmonid fishes at all their life-stages, and across fresh- and transitional and coastal waters. This knowledge will then enable salmon conservation limits (CL) and quotas (QU) to be based on more robust science and assist the development of adaptive management plans to mitigate impacts of environmental changes. Meeting this aim will then deliver a range of societal benefits, including sustaining recreational salmonid angling in Europe that is currently worth €1.2 billion p.a. but is declining year-on-year. By working with SAMARCH international researchers, this research will thus help sustain European salmonid populations via more effective management. In doing so, it will help the delivery of considerable socio-economic benefits, including via increased economic values of fisheries, increased angler participation leading to enhanced human well-being, and increased existence values.

### **Training Opportunities**

Research ethics: the student will complete training in Animal Procedures Modules 1-3 and so obtain their Home Office personal license to enable their collection of field data using tagged fish and develop advanced competencies in contemporary ecological methods, including fish tagging and tracking.

Statistical modelling: The research objectives involve developing statistical models using large datasets composed of biometric data from many individually tagged fish. A training programme will be established for the student to develop a range of competencies in this area, with an emphasis on Bayesian techniques. This will be completed via the supervisory team and match funder, plus participation in workshops and training within the Department, including relevant Level 7 units. Thus, a combination of formal (e.g. training courses) and informal (via supervisors) training will be used, with an emphasis on using R as the software of choice.

Professional skills: competencies will be developed in literature review, presentation skills (via presentations at weekly research meetings), scientific writing and research ethics. These will be gained through bespoke training and experience, and attendance of relevant Doctoral College training events.

Field skills: The student will also work collaboratively with the match-funder and their French partners (Agrocampus Ouest and the French National Institute for Agricultural Research) in SAMARCH (European Inter-regional funded project, 2017 to 2022). They will gain substantial field experience by working on four 'Index' salmon rivers, three in Northern France, and the River Frome, Dorset, within their completion of Research objectives 1 to 3.

### **SUPERVISORY TEAM**

<b>First Supervisor</b>	Robert Britton
<b>Additional Supervisors</b>	Stephen Gregory (external), Philipa Gillingham
<b>Recent publications by supervisors relevant to this project</b>	<p>Gregory SD, Armstrong J &amp; Britton JR In Press. Is bigger really better? Towards improved models for testing how Atlantic salmon <i>Salmo salar</i> smolt size impacts marine survival. <i>Journal of Fish Biology</i></p> <p>Ruiz Navarro A, Gillingham P &amp; Britton JR 2016. Shifts in the climate space of temperate cyprinid fishes due to climate change are coupled with altered body sizes and growth rates. <i>Global Change Biology</i> 22, 3221-3232</p> <p>Basic T, Britton JR 2016. Characterising the trophic niches of stocked and resident cyprinid fishes: consistency in partitioning over time, space and body sizes. <i>Ecology and Evolution</i> 6, 5093–5104</p> <p>Guo Z, Andreou D., Britton JR 2016 Using research and management of invasive <i>Petromyzon marinus</i> in the Great Lakes to inform conservation and monitoring in threatened European populations. <i>Reviews in Fisheries Science and Aquaculture</i> 25, 84-99.</p> <p>Ruiz Navarro A, Gillingham PK, Britton JR 2016 Predicting shifts in the climate space of freshwater fishes in Great Britain due to climate change. <i>Biological Conservation</i> 203, 33-42</p> <p>Thomas, C. D., Gillingham PK et al. 2012 Protected areas facilitate species' range expansions. <i>PNAS</i> 109, 14063–14068</p>

<b>INFORMAL ENQUIRIES</b>
To discuss this opportunity further, please contact Robert Britton via email: <a href="mailto:rbritton@bournemouth.ac.uk">rbritton@bournemouth.ac.uk</a>
<b>ELIGIBILITY CRITERIA</b>
<p>The PhD 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:</p> <ul style="list-style-type: none"> <li>• outstanding academic potential as measured by either a 1st class honours degree or a Master's degree with distinction or equivalent Grade Point Average (GPA)</li> <li>• an IELTS (Academic) score of 6.5 minimum (with a minimum 6.0 in each component) for candidates for whom English is not their first language</li> </ul> <p>In addition to satisfying minimum entry criteria, BU will look closely at the qualities, skills and background of each candidate and what they can bring to their chosen research project in order to ensure successful completion.</p> <p>Applicants will be asked to submit an online application form and a proposal (c. 1500 words) outlining their understanding of the project for which they are applying, the approach they would envisage taking and what qualities they will bring to the research community.</p> <p>Please note:</p> <ul style="list-style-type: none"> <li>• Current BU Doctoral students are not eligible to apply for a Studentship</li> <li>• Current MRes/MPhil students can apply, subject to satisfactory completion of their Research Degree prior to being able to take up the award</li> <li>• PhD Studentships cannot be used to support BU staff to complete doctoral programmes</li> </ul> <p><b>Additional Eligibility</b></p> <p>It is expected that applicants have some knowledge of the ecology of Atlantic salmon (or similar fish species) and it is desirable that applicants have knowledge of statistical modelling techniques.</p>

## HOW TO APPLY

Please complete the online application form by **25<sup>th</sup> March 2018**. Further information on the application process can be found at: [www.bournemouth.ac.uk/studentships](http://www.bournemouth.ac.uk/studentships)