**DOCTORAL POSITION**

From *September 2021* to *September 2024*

**Investigating environmental determinants of life-history strategies in a wild population of Atlantic salmon (*Salmo salar*).**

**Thesis abstract:**

To better understand and anticipate the response of organisms to climate change, it is mandatory to investigate the eco-evolutionary processes which govern the populations and foster their adaptation. More particularly we need to unveil how environmental factors and constraints (e.g. evolutionary trade-offs) influence the expression of life history traits and in turn the evolution of life history strategies. However, the study of eco-evolutionary processes and life history evolution in natural populations is challenging because of the difficulty to isolate particular ecological and evolutionary effect, to take into account confounding effects of other factors and variation of the environment conditions. Moreover, the data collected are often partial or even biased by the observation process itself.

This project aims to assess eco-evolutionary processes (life history decisions, evolutionary trade-offs) and the influence of environmental factors (e.g. water temperature and flow) in a wild population of Atlantic salmon to better understand its potential response to climate change. More precisely, the objectives of the thesis will be to (1) develop a statistical modeling framework which integrates life history decisions and evolutionary trade-offs while explicitly represent the processes that generate our observation, (2) explore the potential changes of life history traits (e.g. growth, survival, life history decisions) over time and (3) investigate the influence of environmental factors on life histories.

The candidate will beneficiate from a long-term monitoring program of a wild Atlantic salmon population in the Scorff river (Morbihan, France). The dataset is based on an ongoing capture-mark-recapture program conducted by ORE-DiaPFC[1] (Environmental Research Observatory for Diadromous fish) and including more than 30,000 individuals tagged over 15 years. Environmental factors (e.g. water temperature and flow) are also available and recorded on a daily basis.

**Tasks and methodology:**

*1 ) Explicit modelling of proximate mechanisms for revealing life-history trade-offs in natura*
For analyzing such empirical data, we will develop a hierarchical Bayesian model explicitly considering the proximate mechanisms responsible for both life history variations and trade-offs at the individual level (i.e. the dynamic process) and the partial observation of individuals (i.e. observation process) (e.g. Buoro *et al.* 2010, 2012). We will focus on the sexual maturation process, winter survival and seaward migration decision of Atlantic salmon juveniles, to emphasize potential trade-offs between them.

[1] https://www6.inrae.fr/diapfc/Dispositifs/Observatoires-in-natura/Scorff

*2) Investigating the impacts of extreme climatic events in summer and winter on individual characteristics and life histories.*
Using this modeling framework, we will first investigate how low-flow conditions in summer affect individuals' size and further life history decisions (e.g. maturation and migration). Second, we will evaluate how harsh winter conditions (high flow/low water temperature) affect winter survival and/or individuals' growth. Finally, we will explore how growth conditions in winter and water flow in spring control the phenology of seaward migration.

**Key words:** life history strategies, evolution, capture-mark-recapture, Atlantic salmon

**Funding:** E2S UPPA project from the university of "Pau et des Pays de l'Adour" UPPA

**Working conditions:** Office and few days of fieldwork per year.

**Hosting laboratory:**

The student will be hosted at ECOBIOP, a joint research unit of University of Pau and Pays de l'Adour (UPPA) and INRAE, that undertakes research on the ecology and behavior of diadromous fish to better understand adaptation of aquatic organisms to environmental perturbations. The applicant will be registered at the Doctoral School « Sciences Exactes & leurs applications » (ED211) of the UPPA.

**Localisation address:** Saint-Pée s/ Nivelle, France

**Laboratory expertise:**

*ECOBIOP* has a special focus on human induced perturbations, in particular climate change, fragmentation, fishing and contamination, and has an internationally recognized expertise on diadromous fishes, i.e. salmon, trout, shad, lamprey and eel. Ecobiop is also characterized by a strong experience in biostatistics and modelling approaches such as hierarchical Bayesian modelling and individual-centered demogenetic modelling.

**Thesis Director:**

The project will be supervised by Dr. Mathieu BUORO and Dr. Etienne PREVOST from ECOBIOP, and Pr. Stephanie CARLSON from UC Berkeley.

**Starting Date:** The position will start in September 2021.
**Duration:** 3 years
**Gross salary:** 1 870 € / month (which includes extra gratification for teaching duties – 32h per year)

**Mission - Main activities:**

The candidate will conduct mainly office work: data-base extraction and analysis, Bayesian modeling, article redaction. But the applicant will also contribute to the fieldwork in the Scorff river to collect new data (1-3 weeks/year). The candidate will also be required to teach at UPPA (Anglet[2]).

[2] https://www.univ-pau.fr/en/campus-tour/anglet.html

**Scientific framework Purpose(s)**

**Expected results**

First, the candidate is expected to develop a mechanistic and statical modeling framework allowing to separate the observation process (i.e. non exhaustive capture of individuals) from the dynamic process (eco-evolutionary process) using state-space approach (e.g. Buoro et al. 2010, 2012).

Second, the candidate will use this model to explore changes of life histories over time (15 years) and emphasize the potential effects of extreme climatic events on life history decisions.

The candidate must publish at least 2 articles on these topics.

**Research collaborations**

The PhD project will be part of the International Associated Laboratory *MacLife,* bringing together INRAE, UPPA, University of California-Berkeley and the University of Basque Country-Bilbao, to investigate the response of aquatic ecosystems and living biota to Climate Change and Extreme Climate Events. Pr. Stephanie CARLSON from UC Berkeley will be involved in the supervision of the project and at least one international mobility will be organized at UC Berkeley.

**Applicant‘s profile:**

The ideal candidate has a master degree in ecology and evolution, with strong knowledge in evolutionary ecology and population dynamics. He/She is passionate for scientific research, rigorous and highly motivated. He/She has demonstrable skills in scientific scripting language like R. A previous experience in capture-recapture analysis and Bayesian analysis would be a plus. The candidate must have a good English level and the capacity to work autonomously.

**Application - Evaluation criteria:**

Application file assessment: Selection committee

Candidates will first be selected based on their application file. Those selected after this first step, will then be interviewed. Application files will be evaluated based on the following criteria:

- Grades and ranking during your Master degree, steadiness in your academic background
- English language proficiency
- Candidate’s ability to present her/his work and results

Work experience similar to an internship in a laboratory – or likewise; previously achieved research work (reports, publications).

**Application will include:** *(in a single pdf file)*

- CV
- Cover letter
- Master degree grade transcripts and ranking
- Reference letter

- Contact details of at least two people, from you work environment, who can be contacted for further reference

Application must be send to the following email address with the title “Doctoral application”: mathieu.buoro@inrae.fr

For more details, please visit our websites: http://e2s-uppa.eu/en/index.html and www.ecobiop.com

**Application deadline:** May 14th 2021

**References:**

Buoro M., Prévost E. and O. Gimenez, 2012. Digging through model complexity: using hierarchical models to uncover evolutionary processes in the wild. *Journal of Evolutionary Biology*, 25(10): 2077–2090. Link

Buoro M., Prévost E. and O. Gimenez, 2010. Investigating Evolutionary Trade-Offs in Wild Populations of Atlantic Salmon (*Salmo Salar*): Incorporating Detection Probabilities and Individual Heterogeneity. *Evolution*, 64(9):2629-42. Link

Hwan, J. L., Fernández-Chacón, A., Buoro, M., Carlson, S. M. (2017). Dry season survival of juvenile salmonids in an intermittent coastal stream. Canadian Journal of Fisheries and Aquatic Sciences, online first. DOI : 10.1139/cjfas-2017-0026