Post-Doctoral position

Investigating the drivers of Atlantic salmon populations decline across the North Atlantic basin

We are seeking an enthusiastic and motivated researcher in quantitative ecology to join our group for a 18-months (possible extension to 2 years) full-time post-doctoral fellow starting early-mid 2020, based at the ESE Ecology and Ecosystem Health research unit (Rennes, France).

The post-doctoral fellow will be in charge of developing and evaluating Atlantic salmon (*salmo salar*) population models to investigate the drivers and mechanisms of spatial and temporal variability in life histories and population dynamics.

The research will be developed in an attractive collaborative scientific environment in the context of two funded research projects: The EU funded SAMARCH Project (see ref below), and the SalmoGlob project (see ref. below). It is also closely connected to ICES Working Group on North Atlantic Salmon ICES WGNAS and projects under the International Year of Salmon program.

Context

Understanding the response of populations to global changes, in terms of demography and adaptive capacity, is critical to support ecosystem-based management. Some major challenges are i) to separate out the effect of genetic inheritance and environmental phenotypic plasticity on variation in life histories, and *ii*) to partition the effects of global drivers that likely impact and synchronize the dynamics of multiple populations simultaneously, from the effects of drivers acting locally. Separating out the ecological processes and their interactions acting at different spatial scales to drive population dynamics is particularly challenging in the case of anadromous fishes, which can interact with a multitude of single and/or synergistic factors at different points in time and space during their life cycle. Life cycle models built in a hierarchical statistical (bayesian or frequentist) modelling approach are essential tools for integrating multiple sources of data and information to assess the effects of multiple factors that interact in a hierarchy of scales.

The postdoctoral research fellow will address these issues using the Atlantic salmon (*Salmo salar*) as a case study. A. salmon is one of the most emblematic fish in the Atlantic Ocean. The species reproduces in rivers distributed across the eastern (Europe) and western (North America) regions of the North Atlantic. A. salmon populations from North America and Europe have undergone a widespread decline in abundance over the last four decades (ICES, 2019; Olmos et al., 2019). The broad scale pattern of decline suggests that major ecosystem changes in the North Atlantic Ocean are the main driver of these declines (Olmos et al., 2019; Olmos et al. in press). However, the drivers and mechanisms involved at various spatial and temporal scales remain largely unclear.

Project

The project aims to develop A. salmon population dynamic models to investigate the drivers and mechanisms of spatial and temporal variability in life histories and population dynamics at the North Atlantic basin scale. The general approach will consist in building and evaluating hierarchical statistical population models based on population data (abundance, age structure, catches …) and environmental variables (Sea Surface Temperature, SST; Primary Production, PP; …) available over the entire North Atlantic basin. The project will build on the hierarchical Bayesian life cycle modeling framework developed by Olmos et al. (2019) and Olmos et al. (in press). This age- and stage-structured population model quantifies the spatial synchrony in the population dynamics and life history strategies of several

large groups of populations from North America and Europe over more than 40 years. First results show strong synchronicity in the temporal variation of the survival rates of salmon at sea and in the proportion of fish maturing after one year spent at sea across the North Atlantic basin. Results also show that temporal variations of the marine survival are correlated to the SST (negative correlation) and net PP indices (positive correlation) in foraging areas shared by salmon of multiple origin during their marine sojourn.

The project offers different research opportunities, some of which are listed below (but any other fresh and creative ideas are welcome!):

i) Refining the representation of the variability in life histories to better understand the drivers and mechanisms of demographics and population dynamics. The existing framework considers a simplified portfolio of A. salmon life histories, and does not consider any covariation between life history traits. In particular, only fish that spent one or two sea winter at sea before maturing are considered, although greater variability in life histories exists (more than two years spent at sea, repeat spawners), particularly in North American and northern European populations. Because sex-specific transition thresholds are highly suspected in this species, developing the the demographic model to represent sex-specific life histories is also a critical step to improve understanding of the spatio-temporal variability in life histories. Last, an exciting development would be to explore the intricate relationships between marine survival and maturation schedule, which are both suspected to be related to growth at sea.

ii) Testing hypotheses on the influence of environmental drivers to explain temporal variations in life history traits. The analysis developed in Olmos et al. (in press) only considers the influence of SST and PP on marine survival and did not include the analysis of salmon populations from northern Europe. Extending the approach (population dynamics and correlation with environmental variables) by including other covariates (e.g. better proxies of trophic resources, etc …) and populations from northern Europe would allow extending the gradient of environmental variation and may contribute to an even better understanding of the response of A. salmon populations to large scale ecosystem changes.

iii) An issue critical to our understanding of the drivers of the variability in life histories is to separate out the effect of phenotypic plasticity from those of genotypic heritability. The existing model implicitly attributes 100% of the life histories variability to phenotypic plasticity. However, some critical life history traits, such as the maturation age are known to be highly heritable. Following ideas like the ones developed in DeFilippo et al. (2019), a challenge in this project would be to develop a statistical modelling approach to separate out effect of environmentally driven phenotypic plasticity from those of heritability in the mean age at maturation, and quantify their relative contribution to population dynamics.

From a methodological perspective, models will be built in a statistical integrated population modeling approach (Bayesian or Maximum Likelihood). A challenge is to develop efficient programming (compare softwares, algorithms, parameterizations …) to ensure models can deliver results in a reasonable amount of time, so has modelling improvement can be transferred to experts for routine stock assessment in the context of the ICES/CIEM Working Group on North Atlantic Salmon.

References

SalmoGlob project - https://www6.rennes.inra.fr/ese_eng/RESEARCH/UMR-ESE-project/(idproj)/112/(idlang)/uk

SAMARCH project - https://samarch.org/

DeFilippo, L. B., Schindler, D. E., Ohlberger, J., Schaberg, K. L., Foster, M. B., Ruhl, D., & Punt, A. E. (2019). Recruitment variation disrupts the stability of alternative life histories in an exploited salmon population. *Evolutionary Applications*, *12*(2), 214-229. https://doi.org/10.1111/eva.12709

ICES WGNAS. (2019). *Working Group on North Atlantic Salmon (WGNAS). ICES Scientific Reports. 1:16. 368 pp.* https://doi.org/10.17895/ices.pub.4978

Olmos, M., Massiot-Granier, F., Prévost, E., Chaput, G., Bradbury, I. R., Nevoux, M., & Rivot, E. (2019). Evidence for spatial coherence in time trends of marine life history traits of Atlantic salmon in the North Atlantic. *Fish and Fisheries*, *20*(2), 322-342. https://doi.org/10.1111/faf.12345

Olmos, M., Payne, M.R., Nevoux, M., Prévost, E., Chaput, G., Du Pontavice, H., Guitton, J., Sheehan, T., Mills, K., and Rivot, E. *in press*. Spatial synchrony in the response of a long range migratory species (Salmo salar) to climate change in the North Atlantic Ocean. Global Change Biology. https://doi.org/10.1111/gcb.14913

Location and collaborations

The successful applicant will work directly with Etienne Rivot, in collaboration with Marie Nevoux in a stimulating research group based in the Research Unit ESE Ecology and Ecosystem Health (Rennes, France).The team and local collaborators offers a challenging and creative working environment. It uses a broad range of modelling techniques ranging from populations to ecosystem levels, with expertise in statistical inference from hierarchical models, Bayesian statistics, and connection between demographics, population dynamics and ecosystems.

The postdoc researcher will also have opportunities to develop collaborations with the research community of the EU-funded SAMARCH project (Stephen Gregory, GWCT, UK; https://samarch.org/). We also plan some connections with Etienne Prévost and Mathieu Buoro, (INRA, ST Pée sur Nivelle, France), Maxime Olmos (NOAA NWFS, Seattle, USA), Jan Ohlberger (UW SAFS, Seattle, USA), and the group of Kathy Mills (GMRI, USA).

There will also be strong connections with the ICES Working Group on North Atlantic Salmon that provides most population data and uses the modelling framework to assess and forecast the status of Atlantic salmon populations in the North Atlantic basin. The researcher will be invited to contribute to the annual meeting of the ICES WGNAS in 2021 (+ 2022 as an option).

Requirements

We are looking for candidate with (i) a doctoral degree in quantitative ecology and/or fisheries sciences or a related field, (ii) experience with demographic models, population dynamics modelling, (iii) an experience in life history theory and Bayesian modelling would be an advantage ; (iv) and the ability to work well both collaboratively and independently and to publish articles in well ranked international scientific journals is considered as a prerequisite.

Duration, appointment and salary

This is a 18-months (possible extension to 2 years) full time position, starting date is flexible between early and mid 2020.

The fixed term contract provides a net salary ~ 2100 euros per month + welfare schemes.

Contacts to apply

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Closing date for application: 28 February 2020

Application preferentially by email, enclosing CV + motivation + References letters (max 3)