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► To cite this version:

Félix Massiot-Granier, Victor Bret, Maxime Olmos, Etienne Prévost, Gerald Chaput, et al.. Meta-analysis of freshwater productivity: a contribution to the modeling of Atlantic salmon (*Salmo salar*) population dynamics at the scale of stock complexes. ICES Annual Science Conference, 2016, NA, France. hal-01453901

HAL Id: hal-01453901

<https://hal.science/hal-01453901>

Submitted on 5 Jun 2020

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Meta-analysis of freshwater productivity: a contribution to the modeling of Atlantic salmon (*Salmo salar*) population dynamics at the scale of stock complexes

F. Massiot-Granier, V. Bret, M. Olmos, E. Prévost, G. Chaput, E. Rivot

Atlantic salmon (*Salmo salar*) populations experienced substantial declines in the early 1990s, and many populations have persisted at low abundances in recent years. Even though this decrease seems to be driven by changes in marine conditions, assessing spatial (among stock units) variations of the productivity during the freshwater phase would improve our understanding of the drivers of those declines. A meta-analysis of the Atlantic salmon freshwater survival was carried out, in order to improve the modeling of the population at the scale of stock complexes. Time series of eggs-to-smolts data of 21 index rivers across the A. Salmon repartition area, together were compiled for this study. The meta-analysis was carried out through a Bayesian hierarchical model. The Beverton & Holt model was revisited through the explicit parameterization in terms of density dependent and density independent mortality rates. A partially exchangeable hierarchical model was built to incorporate covariates (such as the longitude and the latitude) to capture part of the variability among rivers. This approach offers a framework to predict the parameters of the density-dependent survival (and the associated uncertainty) for any new river for which the associated covariates latitude, longitude, wetted area and mean age of smolts are known. Outcomes of this study were used in a full age-structured life-cycle model. Accounting for density dependence in the freshwater phase changes inferences on the dynamic of the productivity over the past 40 years, increasing the intensity of the shift in 90's and the covariation of marine survival and age at maturation.

KEYWORDS:

Atlantic salmon, stock recruitment, freshwater productivity, hierarchical modeling, Meta-analysis

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