

# Identifying wild vs stocking components in fish recruitment despite the absence of identification data: an application to Atlantic salmon 0+ juveniles.

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## Abstract:

Over the last decades, exploited fish population have been declining significantly due to environmental changes, overexploitation and human activities. This has been reflected in the decline or collapse of numerous stocks. Alongside with fisheries regulations and habitat restoration, stock enhancement is a recurrent management tool used to inverse these trends. These enhancement programs are costly so measuring their impact is key although they are often poorly monitored.

During the course of an enhancement programme, stocking intensity may have been varied, intentionally or not, according to spatio-temporal units, wild production fluctuates in space and time too. The objective of this study is to propose an approach which takes advantage of these spatio-temporal variations of stocking vs wild recruitment for estimating their relative contribution from abundance data when no identification of the wild and stocked fish are available. We use Bayesian hierarchical modelling as a template for taking into account the spatio-temporal structure, while explicitly acknowledging that the abundance data issue from a mixture of fish of wild and hatchery origins. We illustrate our approach by means of a case study on 0+ juvenile of Atlantic salmon (*Salmo salar*) densities in the Allier catchment, France.

Not unlike similar stock enhancement projects in salmonids, the Allier stocking program lacks identification data for monitoring the fish that are released in the catchment separately from their wild counterparts. However, abundance data are available at the 0+ juvenile stage in early fall. A Bayesian hierarchical model was developed for estimating 0+ juvenile densities at two spatial scales over the 37 years of the study period, while assessing the relative contribution of wild reproduction, stocked eggs and stocked 0+ juvenile to the total 0+ juvenile production was evaluated.