Impacts potentiels du changement climatique sur les populations et les communautés de poissons dans le milieu continental

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The objective of this talk is to present results from two national projects funded by the Ministry of Ecology and Sustainable Development and The French Institute for Biodiversity. Two approaches have been used.

The first, at the national level, aims at modelling the present distribution of fish species and at simulating the modification of these distributions under several scenarios of global warming. Models developed with national fisheries data (French Fishing Council) are generalized on a simplified hydrographical network of 8 440 river segments averaging 7.7 km in length, integrating estimations of modelling parameters (slope, drainage area, altitude, flow regime, and interpolated monthly mean values of present and predicted air temperatures). Species probability of occurrence was predicted for each segment to illustrate current and projected modifications of species distribution under climate change scenarios. Results show substantial decrease in the distribution of cryophilous species in general, but also differences between species: Trout is maintained in steep high-altitude refuges whereas bullhead becomes restricted to headwater streams in cooler parts of northern France for the most part. Predicted species habitat loss and fragmentation is quantified regionally.

Several complementary approaches were applied to an isolated, fragmented population of Bullhead in the Bez river basin (275 km²), a close-to-natural watershed in the Diois mountains (S.E. France). Bullhead populations have been quantified annually by age group since 2002 throughout the 33 km drainage network, in a way that the dynamics of the whole population can be assessed and the dynamics of subpopulations compared between tributaries. Sites were equipped with temperature recorders.
Biodemographic studies show substantial contrasts in life history traits (life expectancy and age at maturity; reproductive effort) in relation to temperature. Variability of feeding resources was related to environmental factors (temperature, sedimentology) and bullhead **niche breadth and feeding strategies** were linked to predator age, predator population density, and to resource availability. **Genotypic diversity** was also analysed, showing the lowest diversity in disconnected upstream reaches of the Bez network, and lower diversity of the Bez population in comparison to two external populations, confirming the isolated nature of the population and upstream subpopulations.
Two **experimental studies of physiological responses** to thermal regimes spanning the range of predicted warming were applied (1) to populations from 2 Bez tributaries, and (2) to a population, with or without feeding stress. Main results are that reproductive effort peaks around 9°C and then decreases rapidly, that physiological responses differ between populations, but feeding stress had no effect.
Lastly, a **spatially distributed matrix population model** integrating passive larva dispersal and active juvenile dispersal in relation to survival and fecundity was developed. The model was calibrated to fit fragment-level metapopulation dynamics between obstacles in the Bez network, and can now be linked to secondary models of stress impact to simulate population level responses to global change.

Finally, the consequences of global warming on river management, in relation to the implementation of the Water Framework directive will be discussed.

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