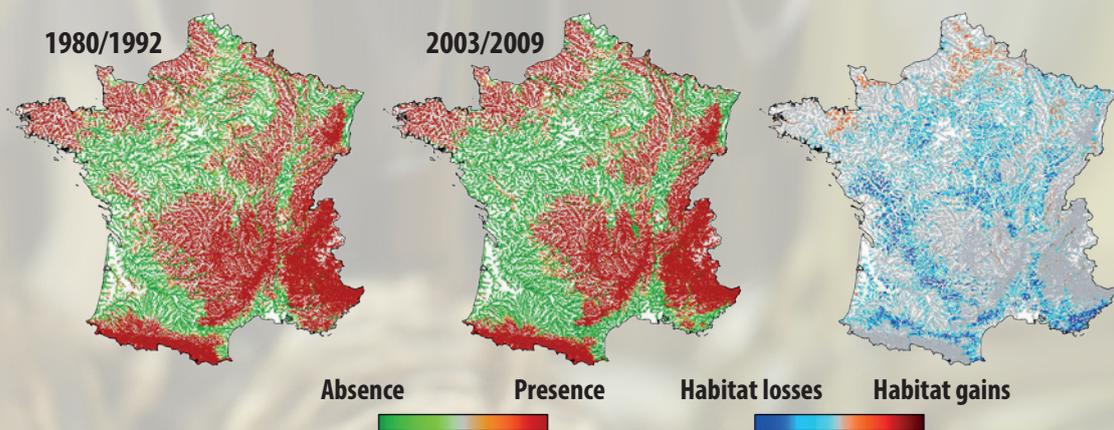


Do stream fish track climate change ? Assessing distribution shifts in recent decades

Understanding the ability of species to shift their distribution ranges in response to climate change is crucial for conservation biologists and resources managers. Although freshwater ecosystems include some of the most imperilled fauna worldwide, such range shifts have been poorly documented in streams and rivers and have never been compared to the current velocity of climate change. Based on national monitoring data, we examined the distributional changes of 32 stream fish species in France and quantified potential time lags in species responses, providing a unique opportunity to analyze range shifts over recent decades of warming in freshwater environments. A multi-faceted approach, based on several range measures along spatial gradients, allowed us to quantify range shifts of numerous species across the whole hydrographic network between an initial period (1980–1992) and a contemporary one (2003–2009), and to contrast them to the rates of isotherm shift in elevation and stream distance. Our results highlight systematic species shifts towards higher elevation and upstream, with mean shifts in range centre of 13.7 m

decade⁻¹ and 0.6 km decade⁻¹, respectively. Fish species displayed dispersal-driven expansions along the altitudinal gradient at their upper range limit (61.5 m decade⁻¹), while substantial range contractions at the lower limit (6.3 km decade⁻¹) were documented for most species along the upstream–downstream gradient. Despite being consistent with the geographic variation in climate change velocities, these patterns reveal that the majority of stream fish have not shifted at a pace sufficient to track changing climate, in particular at their range centre where range shifts lag far behind expectation. Our study provides evidence that stream fish are currently responding to recent climate warming at a greater rate than many terrestrial organisms, although not as much as needed to cope with future climate modifications.



Changes in distribution area of the trout (*Salmo trutta*) between two periods. The difference between these two maps highlights habitat changes (right map).

