Geophysical Research Abstracts
Vol. 19, EGU2017-16745, 2017
EGU General Assembly 2017

How climate change will affect sessile stages of brown trout (Salmo trutta) in mountain streams of the Iberian Peninsula

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Streamflow and temperature regimes are determinant for the availability of suitable physical habitat for instream biological communities. Iberian brown trout (Salmo trutta) populations live in a climatic border in which summer water scarcity and raising temperatures will compromise their viability throughout the current century. Due to their impaired mobility, sessile stages of trout life cycle (i.e. eggs and larvae) are among the most sensitive organisms to environmental changing conditions.

At a given spawning redd, thermal habitat is limited by the length of the period at which suitable temperatures occur. At the same time, suitable physical habitat is limited by the instream flow regime during spawning and incubation of eggs and larvae. Temperature and flow do also interact, thus producing synergistic effects on both physical and thermal habitats.

This study is aimed at quantitatively predicting thermal and physical habitat loss for the sessile stages of brown trout life cycle due to clime change, in mountain streams at the rear edge of the species natural distribution using high-resolution spatial-temporal simulations of the thermal and physical habitat. Two streams of Central Spain have been studied (Cega and Lozoya streams). Daily temperature and flow data from ad hoc downscaled IPCC (RCP4.5 and RCP8.5) predictions were used as input variables. Physical habitat changes were simulated from previously predicted stream flow data by means of hydraulic simulation tools (River2D). By taking into account the thermal tolerance limits and the proportion of lost physical habitat, limiting factors for the reproduction of brown trout in the study area were determined.

The general increase of mean temperatures shortens the duration of the early developmental stages. This reduction of the sessile period is rather similar in both RCP4.5 and RCP8.5 scenarios by 2050. Differences between both scenarios become greater by 2099. The duration of sessile developmental is reduced in 12 days (-10%) according to scenario RCP4.5 and as much as 30 days (-25%) according to RCP8.5 in the Cega stream. Reduction of this sessile period in the Lozoya stream ranges between 14 days (-12%) in RCP4.5 and 35 (-29%) in RCP8.5.

However, this acceleration of the development is not sufficient to compensate the much greater reduction of the thermal window in which mean water temperature remain below 10°C (considered a critical threshold). In the Cega stream, suitable thermal window reduction will range between 21% (RCP4.5) and 49% (RCP8.5) by 2099. In contrast, the Lozoya stream will lose much less time of suitable temperatures by 2099: 3% and 21%, according to RCP4.5 and RCP8.5, respectively.

Although habitat reductions will be significant during the spawning season, the most important problems for trout population viability seem to be related to the reduction of the available time window for embryos and larvae to complete their development. Besides, due to the differential sensitivity of instream thermal habitat to a general increase in air temperature, it is highly recommendable to address locally adapted mitigation programs to avoid a general retraction of the current native range of this species.