Predicting the impact of water temperature increase on cold water fish that may be induced by climate change

AMANO Kunihiko (Dr.(Eng.)), Head
MOCHIZUKI Takafumi, Researcher

Environment Department, River Environment Division

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1. Introduction

It is predicted that global warming will be accompanied by climate change, but it is difficult to quantitatively evaluate its impacts on river ecosystems. This research hypothesized that global warming will increase river water temperature to study its impact on the fish species inhabiting rivers.

2. Evaluation of water temperature dependency of fish species

Data representing river water quality and the national survey for river and riparian ecosystems were analyzed for 109 Class A river systems in Japan. The frequency distribution of river water temperature values at locations confirmed to be habitats of 5 common fish species and 6 stenothermal cold water fish species were obtained, then compared with the frequency distribution of all measured river water temperatures nationwide, to analyze water temperature dependency of these fish species. We have used 24-year period data for river water temperature analysis.

The frequency distributions of water temperature measured at confirmed locations of 5 common fish species were almost identical to the frequency distribution of all data, but the measured water temperatures at locations where yamame trout or other cold water fish were confirmed were biased towards low temperature and the frequency it exceeded 25C° was particularly low (Fig. 1). When the mean annual maximum temperature was obtained and analyzed, at

confirmed, the temperature never exceeded 26C°, and it can be concluded that the surrounding water temperature is the limit for the habitation of cold water fish [1].

3. Sensitivity analysis of water temperature increase and summary

Figure 2 shows the estimated mean annual maximum water temperature distribution based on the results of the nationwide water quality survey of public water bodies. The mean annual maximum water temperature is below 26C° in and north of Tohoku , and in regions to the west, it is partially distributed in Shinshu or in mountainous regions.

If we assume the mean annual maximum water temperature increases by 1C° nationwide, focusing on the change of the area with temperature below 26C° where cold water fish will be able to live, their habitable range which equals about 9% of the national land will be lost, with possible negative impact on the habitats of cold water fish such as cherry salmon that are widely distributed in western Japan [1].   And if the maximum temperature rises by 5 C°, the area of the national land where rivers in which cold water fish can live are distributed will fall to about 5%, so they will
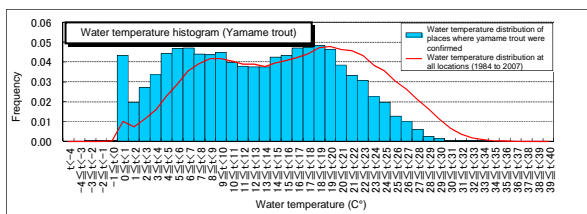

Figure 1.Water Temperature Frequency Distribution at Locations Where the Cold Water Fish, Yamame Trout, were Confirmed (Blue) and Water Temperature Distribution in Rivers Nationwide (Red)

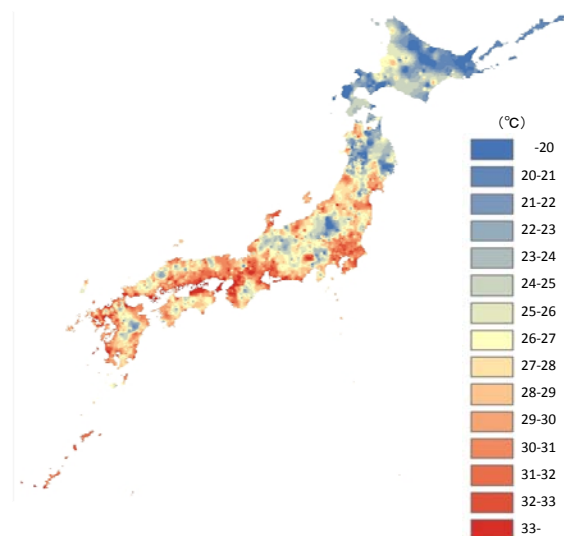locations where cherry salmon or yamame trout were

Figure 2. Nationwide Distribution of Estimated Mean Annual Maximum Water Temperature

no longer exist anywhere in Honshu, making it very difficult for cold water fish to survive.

[Reference]
1) Amano, K. and T. Mochizuki: An assessment of the dependency of fish and aquatic invertebrates on water quality using the national survey for river and riparian environment, Advances in River Engineering, JSCE, Vol.17, 2011.