Evaluating the impact of substrate temperature on thermal habitat suitability and ecological restoration in shallow urban rivers

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Abstract

Managing river temperature in highly urbanized stream systems is critical for maintaining aquatic ecosystems and associated beneficial uses. Elevated river temperatures arise from warm surface inflows from impervious areas, channelization, the absence of riparian forests, and the lack of groundwater-surface water interactions. In the current work, we utilize a mechanistic river temperature model, i-Tree Cool River, to evaluate the cooling impacts of alternative ecological restoration scenarios: a) shading effects of tree planting in riparian areas and b) alternative streambed materials. The model was calibrated and validated on a 4.2 km reach of the Compton Creek in the Los Angeles (LA) River watershed, California, for low and high flow periods. The Arroyo Chub and Stickleback were considered the target species for analyzing thermal habitat suitability. River temperature simulations showed that like the ambient air temperature. The thermal response of the river in high flow periods was a function of upstream river temperature , where in low flow periods river water temperature was most affected by the tested restoration scenarios. Tree planting in the riparian corridor decreased the median thermal metrics: Max Weekly Max, Max Weekly Average, and Min Weekly Min Temperatures by an average of 3 (13%) to 20.4 , 19.7 , and 17.8 , respectively. Using limecrete as an alternative bed material to the current concrete bottom decreased the median thermal metrics by an average of 0.9 (4%) to 22.7 , 22 , and 19 , respectively. Combining the two scenarios decreased the river temperature metrics by an average of 4 (18%) to 18.2 . Besides riparian vegetation, altering bed material is an impactful option in case of groundwater contamination and if channelized urban corridors lack the substrate to support vegetation. The use of ecological restoration scenarios resulted in summertime temperatures were within the documented spawning temperature thresholds and therefore temperature would not be a limiting factor in the potential reintroduction of the Arroyo Chub and Stickleback to Compton Creek. This tributary could be considered as a potential refuge and improved fish habitat in the LA basin during low flow periods.

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Abstract: Managing river temperature in highly urbanized stream systems is critical for maintaining aquatic ecosystems and associated beneficial uses. Elevated river temperatures arise from warm surface inflows from impervious areas, channelization, the absence of riparian forests, and the lack of groundwater-surface water interactions. In the current work, we utilize a mechanistic river temperature model, i-Tree Cool River, to evaluate the cooling impacts of alternative ecological restoration scenarios: a) shading effects of tree planting in riparian areas and b) alternative streambed materials. The model was calibrated and validated on a 4.2 km reach of the Compton Creek in the Los Angeles (LA) River watershed, California, for low and high flow periods. The Arroyo Chub and Stickleback were considered the target species for analyzing thermal habitat suitability. River temperature simulations showed that like the ambient air temperature. The thermal response of the river in high flow periods was a function of upstream river temperature, where in low flow periods river water temperature was most affected by the tested restoration scenarios. Tree planting in the riparian corridor decreased the median thermal metrics: Max Weekly Max, Max Weekly Average, and Min Weekly Min Temperatures by an average of 3 °C (13%) to 20.4 °C, 19.7 °C, and 17.8 °C, respectively. Using limecrete as an alternative bed material to the current concrete bottom decreased the median thermal metrics by an average of 0.9 °C (4%) to 22.7 °C, 22 °C, and 19 °C, respectively. Combining the two scenarios decreased the river temperature metrics by an average of 4 °C (18%) to 18.2 °C. Besides riparian vegetation, altering bed material is an impactful option in case of groundwater contamination and if channelized urban corridors lack the substrate to support vegetation. The use of ecological restoration scenarios resulted in summertime temperatures were within the documented spawning temperature thresholds and therefore temperature would not be a limiting factor in the potential reintroduction of the Arroyo Chub and Stickleback to Compton Creek. This tributary could be considered as a potential refuge and improved fish habitat in the LA basin during low flow periods.

We assessed impacts of the substrate on thermal habitat suitability in urban rivers

We used an updated mechanistic temperature model coupled with a hydraulic model

Arroyo Chub and Stickleback were considered for ecological restoration of study site

The best ecological restoration scenario decreased average river temperatures by 18%

Alternative bed material could be used in cases riparian shade option is challenging