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Simulating the thermal impact of substrate temperature on 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. In this work, we updated and utilized a mechanistic river temperature model, i-Tree Cool River, to evaluate the cooling impacts of two ecological restoration scenarios: (1) an alternative streambed material limecrete and (2) shading effects of tree planting in riparian areas. The i-Tree Cool River model was modified to account for diurnal fluctuations of streambed temperature, which is relevant in shallow urban streams where lack of natural shading combined with low heat capacity of the water column can make diurnal fluctuations relatively extreme. The model was calibrated and validated on a 4.2 km reach of Compton Creek in the Los Angeles River watershed, California. Two native fish, arroyo chub (*Gila orcuttii*) and unarmored threespine stickleback (*Gasterosteus aculeatus williamsoni*), were considered the target species for assessing thermal habitat suitability. Key findings include: (1) model performance was improved when accounting for diurnal fluctuations in bed temperature (R^2 increased from 0.43 to 0.68); and (2) substrate rehabilitation and tree planting can potentially reduce summertime temperatures to within the documented spawning temperature thresholds for the focal fish species. Using limecrete as an alternative material for the concrete bottom decreased the median river temperature metrics: maximum weekly maximum, maximum weekly average, and minimum weekly minimum temperatures by an average of 3 °C (13%) to 20.4 °C, 19.7 °C, and 17.8 °C, respectively. Tree planting in the riparian corridor decreased the average river temperature 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. Therefore, water temperature would not be a limiting factor in potential reintroduction of the focal fish species to Compton Creek if restoration were implemented. Implications of this work could be used by urban forest and water managers for restoring thermally polluted rivers in other urban areas.