Managing street tree canopy and composition to reduce urban air and runoff temperatures in Portland, Oregon

Authors: Lauren A. Burns, Kevan B. Moffett

Affiliation: School of the Environment, Washington State University, Vancouver, WA

Mass fish die offs attributed to elevated summer stream temperatures are occurring in greater frequency in the Pacific Northwest. As climate change progresses and poses a threat to native ecosystems, there exists a need to explore additional methods to mitigate thermal degradation of streams and rivers. Urban areas have been identified as contributing heat sources to downstream surface waters and have the potential to increase stream temperatures and degrade cold-water habitats which are of ecological, economic, and social significance in this region. Predicted climate change effects of decreasing streamflows and rising in-stream water temperatures combined with the added anthropogenic effects of the urban heat island effect and warm stormwater runoff may further imperil residing threatened and endangered species that rely on this habitat. To aid cities in adapting to changing climate while protecting local species of concern managing urban tree canopy, especially canopy overhanging paved streets, may be one strategy to help cool cities, manage runoff, and reduce runoff temperatures. While urban forestry benefits have been widely researched, including knowledge of street trees' benefits for reducing runoff volumes, little data exist on the interrelationship between urban forests and runoff temperatures. Much of the existing information on urban temperatures and urban heat islands is at the coarse scale of satellite pixels 10's of meters across; lot and street-level relations of canopy to urban temperatures remain less well understood as yet.

We tested the importance of the amount and type of street tree cover in relation to local air and runoff temperatures. We measured water and weather variables (air, pavement, and runoff temperatures, runoff volumes, precipitation, and solar radiation), in addition to tree metrics (deciduous or evergreen type, height, and canopy cover fraction) for 12 street blocks in inner Portland, Oregon. The sites spanned low vs. high street tree canopy cover for both deciduous and evergreen dominated tree types (3 streets for each of the 4 combinations) of high-density residential neighborhoods. Preliminary results suggest that both dominant tree type and amount of canopy are significant factors related to urban runoff temperature and air temperature in summer and early fall. Model results suggest a strong relationship between street pavement surface and air temperatures (R^2=0.87). For both air and runoff temperatures, results suggest significant differences in the means between the main effects (i.e., tree type and canopy cover) on the dependent temperature, and notable interaction effects (i.e. tree type x canopy cover). On average, air and runoff temperatures were 0.3 degrees Celsius cooler at sites dominated by evergreen coniferous street trees compared to deciduous-treed sites, and runoff temperatures from sites with high street tree canopy cover were on average up to 0.4 degrees Celsius cooler than runoff from low canopy cover sites. This trend was also observed for air temperature, though to a lesser extent, with high canopy cover sites 0.2 degrees Celsius cooler on average than low canopy cover sites. Continued study will fit the field data into a numerical model suitable for predicting benefits of different street tree planting decisions for mitigating high-temperature urban runoff in Portland and beyond. This work may help better inform city managers and planners of their options for reducing sources of urban heating and protecting already stressed aquatic ecosystems by better managing the existing urban forest resource.