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Title: Steelhead, turtles, and frogs: temperature dynamics of stream habitat

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Abstract:
Availability of stream habitat with suitable temperature regimes is required by many species of conservation concern. Water temperature is determined by a complex interplay of prevailing meteorology, local riparian canopy structure and solar exposure, streambed morphology, and surface and subsurface flow patterns. We developed a technique for spatial-temporal analysis of temperature regimes for San Francisquito Creek (San Francisco Peninsula, California), which comprises habitat for steelhead (*Oncorhynchus mykiss*), California red-legged frog (*Rana aurora draytonii*) and western pond turtle (*Clemmys marmorata*). Steelhead requires relatively cool conditions, whereas the frog and turtle require warmer conditions. Our approach synthesized measurements of temperature from a network of inexpensive sensors (IButton Thermochron), riparian canopy structure and solar exposure from hemispherical (fisheye) photography, stream morphology from field characterization and geographic information system (GIS) analysis, stream flow and water temperature from gauging stations, and meteorology from nearby weather stations. We employed the RTemp Model (Washington State Department of Ecology) to predict time series of water temperature in response to heat fluxes. Water temperature co-varied with air temperature, diurnally with a lag of several hours, and over longer periods. Stream reaches with high solar exposure displayed relatively high temperature variability (up to 5° C differential from baseline), whereas shaded reaches displayed only modest temperature variability (0.5-1.0° C differential). Subsurface flow through gravel beds decreased temperature (2-3° C decrease). Our approach can be applied to a broad spectrum of streams for habitat characterization, for conservation management to ensure habitat heterogeneity, and for examination of potential impacts of climate change.

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