Barrett abstract:

Vertical heterogeneity in lakes and estuaries can present cold-adapted fishes with a temperature-oxygen squeeze, such that the epilimnion is stressfully warm and the cooler hypolimnion is hypoxic, thereby restricting fishes to the metalimnion. In temperate floodplain rivers, patches of lentic habitat (e.g., alcoves), have the potential to provide thermal refuge for cold-water fishes during summer, but little is known about whether these smaller habitat features present fish with temperature-oxygen squeezes. In this study, we measured temperature and oxygen profiles in six cold-water alcoves on the Willamette River floodplain (Oregon, USA) to characterize potential trade-offs in temperature and oxygen for a cold-water fish, coastal cutthroat trout (*Oncorhynchus clarkii clarkii*). We used synergistic methods (a subdermal thermocouple, surgically implanted iButtons, and external temperature transmitting radio tags) to monitor fish body temperatures at different temporal scales and compare them to temperature-depth profiles to evaluate how fish responded to these trade-offs. The cold-water alcoves displayed a linear relationship between dissolved oxygen and temperature, where cooler temperatures came at the expense of reduced oxygen. Fish were often located in the metalimnion and within 0.25m of the estimated thermocline, where intermediate values of temperature and oxygen occurred. The span of depths selected by these fish represents less than 20% of the available vertical habitat in these alcoves. These results demonstrate that refuges formed by cool hyporheic upwelling can generate a temperature-oxygen squeeze that results in only a subset of the refuge habitat feature being used by fish. Oxygen constraints on thermal refuge use may be a blind spot for climate adaptation planning of cold-water fishes, because dissolved oxygen data are limited compared to water temperature and many cool refuges are fed by subsurface flows, which are potentially hypoxic.