USING DISTRIBUTED TEMPERATURE SENSING TO UNDERSTAND TEMPERATURE DYNAMICS AT SHASTA LAKE, CALIFORNIA

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The drought in the western United States has emphasized the need to manage water efficiently for multiple purposes, including the provision of adequate thermal habitat for endangered fish. In California, management of discharges from Shasta Dam is one of the tools to store cold water in the reservoir for release at times that are critical for salmon spawning and rearing. To better understand the temperature patterns upstream of the dam, a team from the University of Nevada Reno in collaboration with NOAA Fisheries has been using distributed temperature sensing (DTS) to monitor water temperature with depth in the reservoir. DTS measures the backscattered Raman photons along a standard telecommunication optical fiber. Raman backscatter can be related to the temperature of the fiber at the point of scattering, and therefore near-continuous profiles of temperatures can be obtained along any fiber (Selker et al. 2006; Tyler et al. 2009). Typical integration times of 60 seconds can provide temperature resolution of less than 0.05°C (Hausner et al. 2011). The technology has been used for many different applications including examining Antarctic ice shelf stability (Kobs et al. 2014), describing convective mixing at Devil's Hole in Death Valley National Park (Hausner et al. 2012), and monitoring heat generation in salt-gradient solar ponds (Suarez et al. 2014). In the pilot application at Shasta Lake, deployment of the DTS required careful consideration of secure deployment in close proximity to hydropower intakes with water levels that can fluctuate as much as 100 feet. The fiber optic cable is ~3/8" diameter, and has an outer shield of braided stainless steel. The breaking strength of the cable is ~ 1,000 lbs. The DTS detector was housed inside the dam, and the cable was routed through the dam and down the west side of the temperature control device (TCD) that allows selective withdrawal from the reservoir. Transmission of data from the TCD for the pilot deployment is via a cell modem. The sensing cable drops ~400 feet down through the reservoir in front of the dam. The pilot deployment successfully captured the decline of the reservoir thermocline as water levels dropped in the fall and the development of isothermal conditions in late November. Future work involves using the DTS data to understand reservoir dynamics as release operations change to enable predictive modeling of reservoir operations.