**INTRODUCTION**

Stress on California’s salmon fisheries as a result of recent drought drives a need for effective temperature management in California’s Sacramento River. Cool temperatures downstream of Shasta Dam are required for Chinook salmon spawning and rearing. To acquire a more complete understanding of the thermal resources available to water managers, distributed temperature sensing (DTS) technology has been used at Shasta Lake in a pilot deployment from August 2015 to the present.

**BACKGROUND**

**Field Site – Shasta Lake, California**
- Shasta Dam was constructed in 1945 by United States Bureau of Reclamation (USBR) on the Sacramento River in California (Figure 1).
- Dam construction blocked access to native spawning habitat with cold water temperatures
- Warm temperatures below the dam impact salmon spawning and rearing downstream (Bartholow et al. 2001)
- Winter-run Chinook salmon are considered endangered under the Endangered Species Act (ESA; NMFS 2009).
- Central Valley Regional Water Quality Control Board adopted a late summer/fall discharge temperature objective of 13.3°C (56°F)
- Recent drought emphasizes the need for efficient temperature management to maintain endangered species populations

**Temperature Mitigations at Shasta**
- A temperature control device (TCD) was installed in 1997 to restore and sustain downstream thermal habitat for salmon spawning
- TCD enables intake of water at four depths
- Five gates exist laterally at each depth
- TCD allows for temperature management based on thermal structure of reservoir

**OBJECTIVES**
- Understand thermal resources within Shasta Lake year round for Chinook salmon spawning and rearing
- Evaluate thermal hydrodynamics of water flowing from the reservoir through dam intakes and discharging through penstocks
- Understand influence of dam operations on thermal structure and the reservoir’s cold pool storage directly upstream of the dam

**METHODS**

**Distributed Temperature Sensing Technology** (Hauser et al. 2011)
- DTS allows for high resolution temperature data along fiber optic cable
- Temperature resolution up to 0.05°C
- Laser pulses are sent down the cable with a known speed of light
- Raman backscatter, a result of molecular vibrations, is measured and used as a proxy for temperature

**PRELIMINARY DATA**

**METHODS**

**DTS Data Obtained**
- Since the deployment in August 2015, DTS has successfully captured the shift in thermal structure of the reservoir (Figure 5)
- August through September show sharp thermal stratification
- September through November show a weakening of stratification and decline of the reservoir’s thermocline
- November to December show fall mixing and loss of stratification
- Late December through March show isothermal conditions

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**REFERENCES**