Using Fiber-Optic Distributed Temperature Sensing Technology in Crystal Springs Lake

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All data, analysis and figures are preliminary, and subject to change.

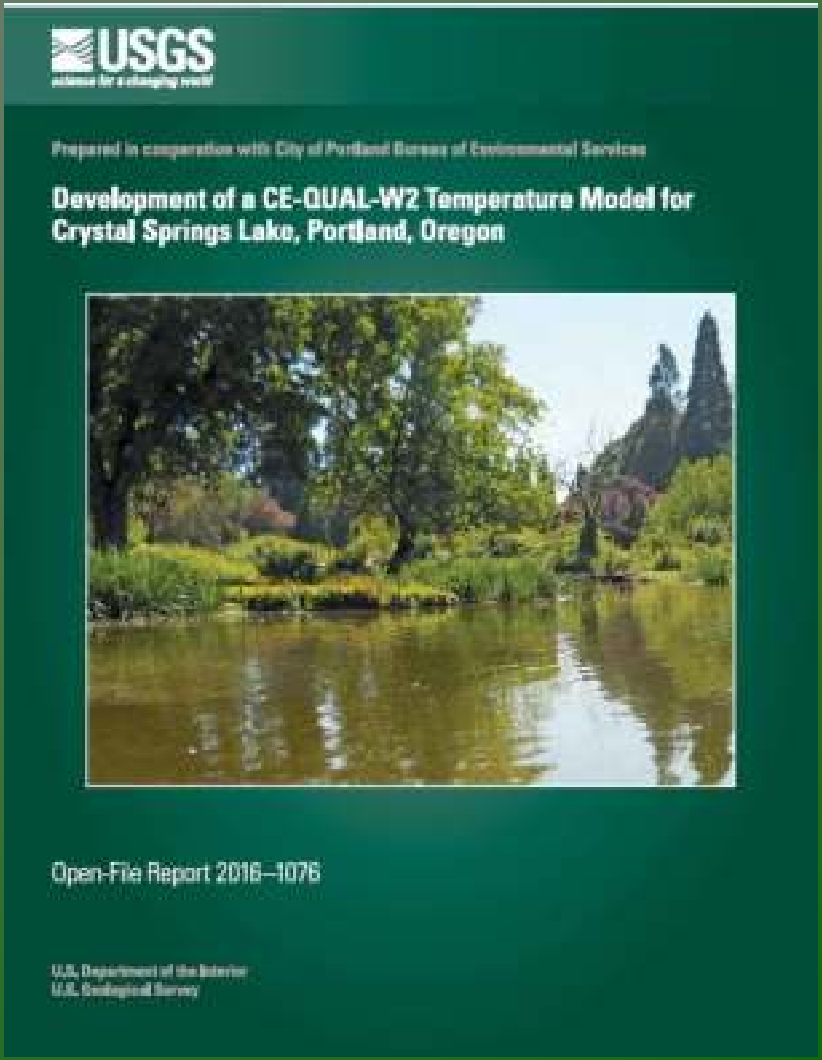
Figure 1. Map showing study sites at Crystal Springs Lake, the Golf Pond, and surrounding area, Portland, Oregon.

Background

- Study funded by Portland Bureau of Environmental Services
- Recent improvements made to Crystal Springs Creek (culvert replacements and Westmoreland Park)
- The TMDL stipulates a 7-day average of the daily maximum stream temperature (7dADM) of 64.4 °F (18.0 °C), lower during spawning season
- Crystal Springs Creek (USGS streamgage 14211542) exceeded the TMDL by an average of 3.2 °F (1.8 °C) for 42 percent of calendar years 2003–13

Report

- **Published in 2016**
- **Modeled pond temperature and levels for summer of 2014**
- ***https://pubs.er.usgs.gov/publication/ofr20161076***



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Streamflow budgeting

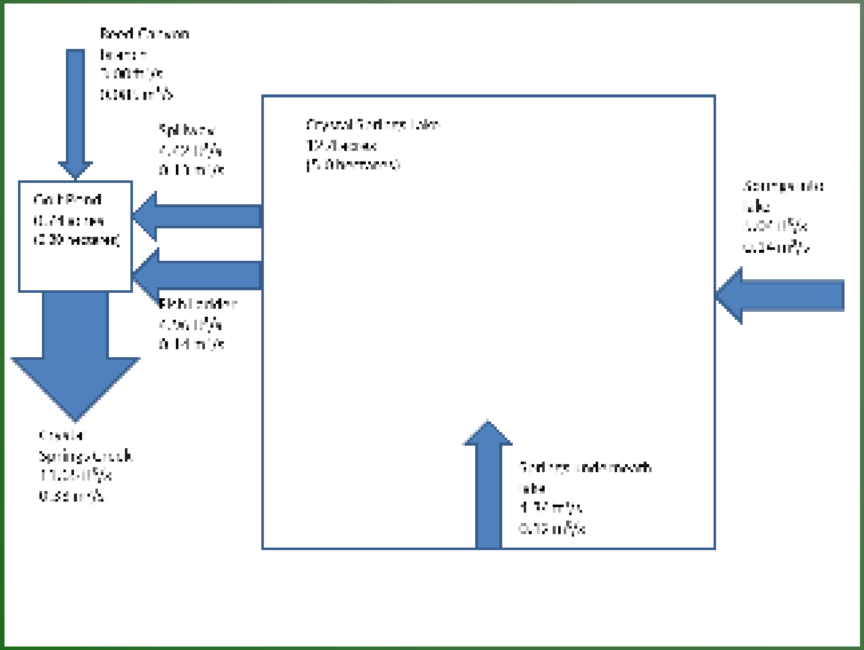

Figure 2 from: Buccola, N.L., and Stonewall, A.J., 2016, Development of a CE-QUAL-W2 temperature model for Crystal Springs Lake, Portland, Oregon: U.S. Geological Survey Open-File Report 2016–1076, 26 p., http://dx.doi.org/10.3133/ofr20161076.

- **Roughly 9.4 ft^3/s exiting the lake**
- **Roughly 5 ft^3/s entering the lake through overland springs**
- **Assume about 4.4 ft^3/s entering the lake through springs below lake surface**

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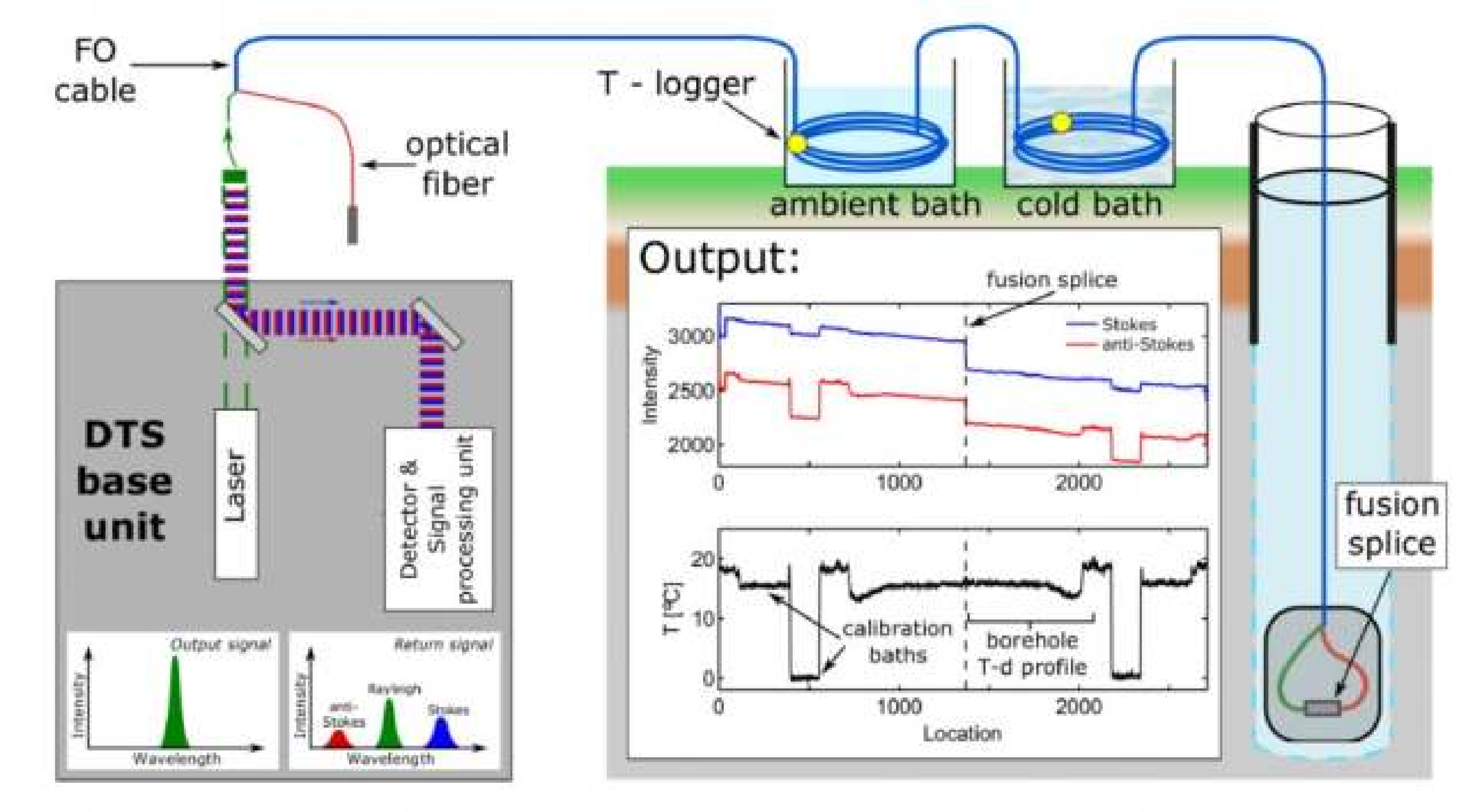
Objectives

- Proof-of-concept for using Fiber Optic Distributed Temperature Sensing (DTS)
- Ascertain potential locations of underwater springs and (or) hyporheic flow
- Compare against synoptic temperature run

Fiber Optic Distributed Temperature Sensing

- Continuous measurement over kilometers
- Variable spatial and temporal resolution
- Thermal resolution can be as accurate as 0.01 degree Celsius (depends on configuration)
- Used in previous USGS studies to:
  - Monitor hydrologic processes at larger (catchment scales)
  - Quantify interchange between surface water and groundwater, such as identifying “gaining” stream reaches

Distributed Temperature Sensing



From https://www.critex.fr/distributed-temperature-sensing-as-a-down-hole-tool-in-hydrogeology/
Oct 16, 2019

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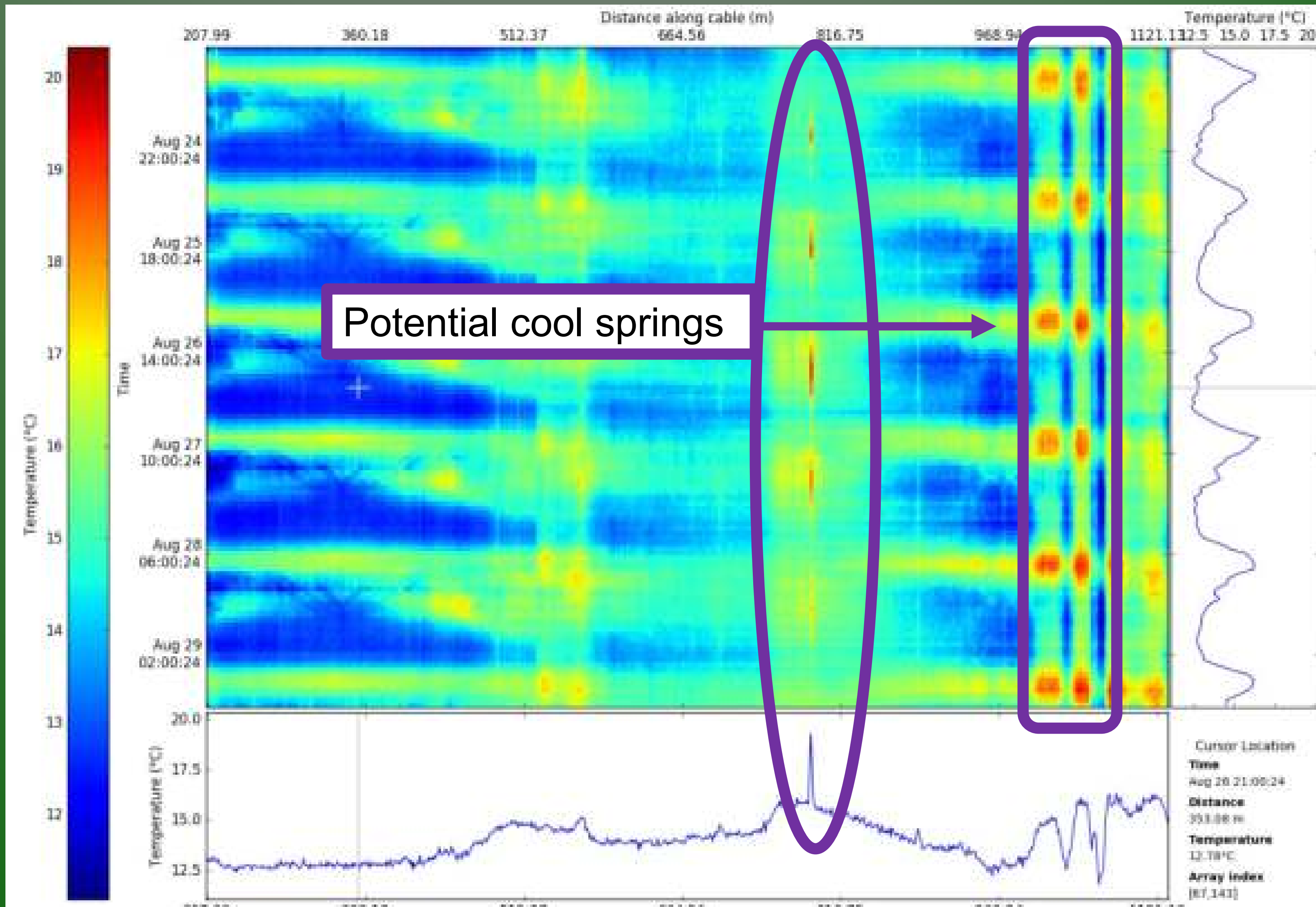
Deployment

DTS results



Distance along cable (m)
207.99
360.18
512.37
664.56
816.75
968.94
1121.13
Temperature (°C)
12.5 15.0 17.5 20.0
20
19
18
17
16
15
14
13
12
Temperature (°C)
Time
Aug 24 22:00:24
Aug 25 18:00:24
Aug 26 14:00:24
Aug 27 10:00:24
Aug 28 06:00:24
Aug 29 02:00:24
Potential cool springs
20.0
17.5
15.0
12.5
Temperature (°C)
Cursor Location
Time
Distance
Temperature
Array index

DTS Data

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Lessons Learned

- DTS a powerful tool for reconnaissance (qualitative)
- With groundtruth/calibration, DTS interpretation can be made quantitative
- DTS requires careful georeferencing, note taking, and auxiliary data
- Tools for data visualization/analysis are available (DTSGUI)

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Lessons Learned

- Bathymetry data are useful for evaluating DTS output
- Technical issue with two DTS controllers, anecdotal evidence of technology not being reliable
- Damaged or kinked FO cable can affect results
- If project were to be repeated, would include more accurate and more frequent GPS readings, and more auxiliary temperature probes.

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