Aquatic and Riparian Effectiveness Monitoring Program
Stream and Air Temperature Monitoring Report
November 2014

Heidi Andersen
USDA Forest Service Pacific Northwest Regional Office
Bureau of Land Management Oregon State Office

Introduction

The Aquatic and Riparian Effectiveness Monitoring Program (AREMP) began a partnership in 2011 with the US Forest Service (USFS) Pacific Northwest Regional Office, Bureau of Land Management (BLM) Oregon State Office, and US Geologic Survey (USGS) Forest Rangeland and Ecosystem Science Center to monitor year-round instream and air temperatures in watersheds throughout the Northwest Forest Plan Area in Oregon and Washington. The purpose of this ongoing partnership is to provide baseline year round air and stream temperature data to climate scientists, aquatic ecologists, fish biologists and hydrologists to help determine the sensitivity of stream temperature to climate change.

AREMP temperature data is shared with the USFS Rocky Mountain Research Station as part of the NorWeST regional stream temperature project (Isaak et al 2011). The NorWeST project gathers existing full year stream temperature data from federal government, state, tribal and private sources from across the Northwest to develop spatially explicit stream network models for climate change scenarios. Outputs from these models are available on the NorWeST website for use by biologists, hydrologists, and researchers to better understand thermal impacts on aquatic species and to help prioritize conservation efforts (http://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html).

Deployment and Downloading Methods

AREMP field crews consisting of BLM employees and interns from American Conservation Experience (ACE) and the Student Conservation Association (SCA) calibrated, deployed and downloaded instream and air temperature sensors for the last four field seasons (2011-2014). Crews placed sensors instream, directly next to the stream (stream-side) and at an upslope location 300 ft. to 700 ft. (91 m to 214 m) in elevation above the stream-side sensor. Solar radiation shields were used for instream (fig. 1) and air temperature monitoring stations (fig. 2) to minimize the impact of direct sunlight on temperature data.

Figure 1— Stream temperature sensors were housed in PVC pipes to prevent direct solar radiation. (Photo by Alanna Wong)

Figure 2— AREMP Crew Leader Alanna Wong records data while checking an air temperature sensor in a solar shield. (Photo by Drew Robison)

In 2014, hydrologists and fish biologists from local BLM, USFS and National Park Service (NPS) units assisted with checking and downloading temperature sensors. Local units download sensors in the spring and fall. The spring check ensured sensors were in place to log summer temperatures and the fall check ensured summer maximum temperatures were recorded and sensors were secured before high flows.

Temperature Sensor Locations

Temperature sensors were deployed in the Northwest Forest Plan area on USFS, BLM, and NPS Lands in Oregon and Washington (fig. 3 and table 1). In 2014, AREMP crews visited 80 watersheds to download and deploy sensors and specialists from local units visited 79 watersheds for a total of 159 watersheds (table 2). During these visits any sensors lost over the winter were replaced. Approximately 33% of the instream temperature sensors were lost over the winter due to high flows, being tampered with or destroyed by people, rusted cables, or just simply not relocated because different technicians deployed the devices. Air temperature sensors had lower loss rates; 4% for both stream-side and upslope air sensors.

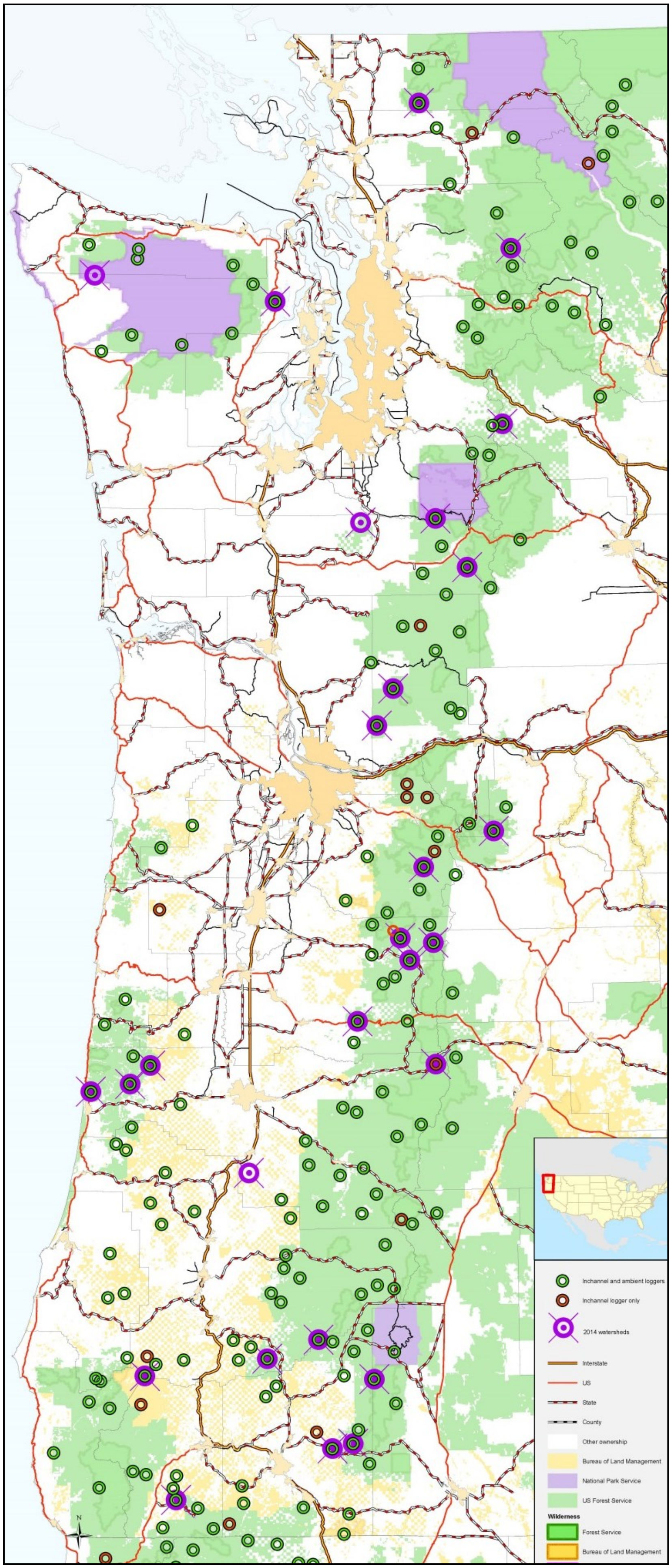


Figure 3. *Location of instream and air temperature sensors placed by Aquatic and Riparian Effectiveness Monitoring Program (AREMP) crews in the Northwest Forest Plan area of Oregon and Washington. The purple bull's eye represents watersheds surveyed for stream condition by AREMP in 2014. The green circle designates AREMP watersheds with a stream-side and upslope air sensor. The red circle depicts AREMP watersheds with an instream sensor. Current as of April 2014.*

Table 1—Number of watersheds instrumented with instream water temperature, and stream-side and upslope air temperature sensors by state as of November 2014.

	Instream (water)	Stream-side (air)	Upslope (air)
Oregon	122	115	115
Washington	60	56	54
Total	182	171	169

Table 2—Total number of watersheds visited to deploy/download instream water temperature sensors and stream-side and upslope air temperature sensors by year. Variation in number of watersheds visited per year was due to crew size. In 2014 visits increased with the assistance of specialists from local BLM, USFS and NPS units.

	Instream (water)				Stream-side (air)				Upslope (air)			
	2011	2012	2013	2014	2011	2012	2013	2014	2011	2012	2013	2014
Newly Deployed	80	44	26	4	24	73	18	0	24	66	17	0
Downloaded	0	77	49	102	0	21	72	122	0	24	74	110
Replaced	0	33	27	53	0	5	6	5	0	0	7	4
Total	80	123	102	159	24	97	96	127	24	90	98	114

Deployment Method Experiment

During the 2012 field season, we learned that the method used to secure instream sensors did not work in some stream types for year-round deployment. Approximately 30% of the 2012 instream temperature sensors checked were lost during the winter due to high flows, vandalism, or simply not relocated because different technicians deployed the devices. To minimize loss and examine additional sensor deployment techniques we partnered with Dan Isaak from the Forest Service Rocky Mountain Research Station for a small-scale experiment during the 2013 field season. In areas where sensors were lost due to flow, we tested additional sensor types and sensor deployment methods. Two different sensor attachment methods are being tested; using epoxy to attach sensors to boulders (fig. 4) and zip ties to attach sensors to large wood in the stream channel. In streams where the epoxy method is employed we are testing both Onset HOBO sensors along with Tidbits. The Tidbit sensor shields and epoxy for this experiment were provided by Dan Isaak.

Figure 4— Stream temperature sensor in a PVC solar shield epoxied to a rock. (Photo by Alanna Wong)

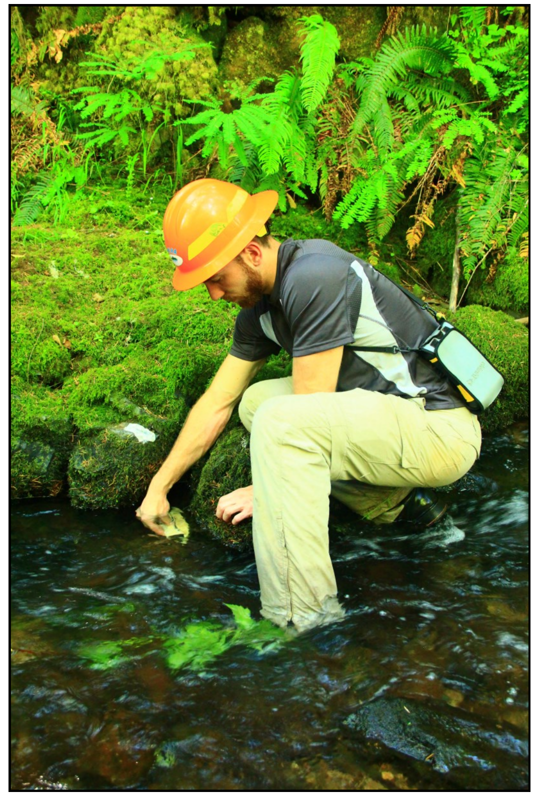
Assessment during the 2014 field season of 35 sensors attached using epoxy indicates a loss rate of approximately 20%. This loss rate is lower than the loss rate of 30% in 2012. Accordingly, we will continue to use the epoxy method to attach thermographs in watersheds where large boulders are present. We will further assess these methods into the 2015 field season. The zip tie attachment method is no longer being assessed as only one thermograph was deployed using this technique from 2013-2014.

Lessons Learned and Future Recommendations

After four seasons of temperature sensor deployments, it is clear there is a strong need for continuity in staffing for the temperature monitoring crew. Sensors are difficult to relocate due to their small size. Since our current staff consists of seasonal employees, we are lucky to have surveyors on AREMP field crews for multiple field seasons. In 2014, AREMP coordinated with local field units to help download temperature sensors to help improve staff continuity.

AREMP provided GPS coordinates for sensor locations, maps, site photographs, directions to sites, extra sensors to replace lost devices and devices to download data in the field. Data received from the local units is quality checked and uploaded to the regional USFS NRIS temperature database for use by local units and RMRS. Local units originally agreed to download data in 98 watersheds, 81% (n=79) of these watersheds were visited in the spring/summer and 42% (n=42) in the fall. One way to improve the number of visits is to provide funding to local units to visit sites on their Forest or BLM District. The advantages to having local units check these devices include:

- Consistency in staffing to find the sensors which are deployed for multiple years.
- Sensors are checked more frequently. With current funding levels sensors are only checked every 3 years by AREMP crews.
- Sensors are checked in spring and fall, ensuring summer maximum temperatures are downloaded and sensors are secured before high flows occur in the winter.
- Sensors are in place and would not have to be purchased by local units. AREMP can provide replacement sensors.



Jesse Miller (AREMP) attaches a thermograph to a rock using epoxy. (Photo by Jared Blake)

In addition to help from local units, AREMP recommends hiring a year-round term field coordinator to oversee this project. The field coordinator would be responsible for winter planning and summer field work. Additional benefits of hiring a year-round field coordinator include:

- Staff continuity to relocate sensors since the same individual will deploy and download sensors.
- The field coordinator will coordinate with local hydrologists and fish biologists to permanently take over the long term maintenance of sensors located on their units and maintain a database with contact information for local specialists that can be contacted annually to deploy, download and retrieve sensors.
- More time for logistics and planning in the off season to maximize time spent during the field season for down loading sensors rather than spending extra time in the office calibrating sensors and planning for trips.
- Improve consistency of data collection.
- More time for QAQC of data as it is collected rather than waiting until the end of the field season and having individuals who did not collect the data collate it for reporting purposes.
- A person to upload data to the NRIS stream temperature monitoring database.
- Help develop and improve data collection applications for field computers which will help prevent data entry errors by incorporating error checking as the data is collected in the field.
- Personnel available to train local units and field crews to deploy and download sensors as needed.

Literature Cited

Isaak, D.J., S.J. Wenger, E.E. Peterson, J. M. Ver Hoef, S. Hostetler, C.H. Luce, J.B. Dunham, J. Kershner, B.B. Roper, D. Nagel, D. Horan, G. Chandler, S. Parkes, and S. Wollrab. 2011. NorWeST: An interagency stream temperature database and model for the Northwest United States. U.S. Fish and Wildlife Service, Great Northern Landscape Conservation Cooperative Grant. Project website: www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html

Acknowledgements

- Brian Staab (USFS Region 6) and Louisa Evers (BLM Oregon State Office) helped procure funding for this project.
- Jason Dunham (USGS), Zachary Holden (USFS) and Eric Archer (USFS) provided technical assistance on field protocols.
- Dan Isaak (USFS – Rocky Mountain Research Station) provided technical support, and epoxy and sensors for our instream sensor attachment experiment.
- Steve Wilcox (AREMP) made the map used in this document.
- All the temperature monitoring field crew members for their hard work and advice on improving this project.

Contact Information

Heidi Andersen, Fish Biologist
Email: heidivandersen@fs.fed.us
Phone: (541) 750-7067

Please visit our website for more information on publications, presentations, reports, and summer employment.

http://www.reo.gov/monitoring/watershed-overview.shtml

Aquatic/Riparian Effectiveness Monitoring Program
AREMP

ACE intern Drew Robison uses a field computer to record site information. (Photo by Alanna Wong)

ACE intern Tommy Laird downloads a stream side air temperature sensor. (Photo by Jared Blake)