2018 Mad River Temperature Monitoring Study Summary Report

Adult Summer Steelhead Observed in Mad River During 2017 Snorkel Survey photo by Jacob Pounds

A project of Blue Lake Rancheria and Mad River Alliance with assistance and cooperation from the Humboldt Bay Municipal Water District, North Coast Regional Water Quality Control Board, and HT Harvey and Associates

Introduction

In the summer of 2018, the Blue Lake Rancheria (BLR), in partnership with Mad River Alliance (MRA), and with cooperation from Humboldt Bay Municipal Water District (HBMWD), North Coast Water Quality Control Board (NCRWQCB), and HT Harvey and Associates (HTHA), undertook a collaborative temperature monitoring project in order to better understand the water temperature dynamics in mainstem of the Mad River Watershed and selected tributaries. Data from this effort is being used to produce a temperature model for the HBMWD as a part of the 1707 instream flow dedication process.

During the warmest part of the summer (May – October) 27 HOBO thermographs were deployed between the Matthews Dam at river mile 84 and the Mad River Estuary. Nineteen of the 27 thermographs were deployed in mainstem reaches of the Mad River; 7 thermographs were deployed in tributaries (Widow White Creek, Lindsay Creek, Powers Creek, North Fork Mad River, Canon Creek, Maple Creek, and Boulder Creek). Three of these thermographs were used at air temperature references throughout the basin where different climate regimes are recognized: lower basin/coastal, middle basin/transitional, and upper basin/inland.

Watershed Overview

The Mad River watershed is located in northern California, and flows roughly 100 miles northwest from its source in the southern Klamath Mountains in southwestern Trinity County, through the Franciscan mélange of the Coast Range mountains in Humboldt County, meeting the Pacific Ocean a few miles north of Humboldt Bay. The watershed drains 497 square miles of steep, forested mountains and rolling oak-grassland hills, and is fairly narrow, averaging six miles wide through the middle-upper canyon.

The Mad River serves as the source of drinking water for 88,000 Humboldt County residents served by the Humboldt Bay Municipal Water District (HBMWD). During the low flow season, typically June through October, Mad River flows are augmented by water releases from R.W. Matthews Dam, which impounds Ruth Lake. HBMWD manages water released from Ruth Lake at R.W. Mathews Dam. These releases likely affect water temperatures downstream of the dam, but the extent and magnitude is unknown.

Mad River Status as Impaired for Sediment, Turbidity, and Temperature

In 1992, the Environmental Protection Agency (EPA) added the Mad River to Clean Water Act Section 303(d) List of Impaired Waters due to elevated sedimentation/siltation and turbidity. The North Coast Regional Water Quality Control Board (NCRWQCB) identified water temperature as an additional impairment to the watershed in 2006 (Stillwater Sciences, 2010), but a temperature TMDL is not yet scheduled (Fitzgerald, Rebecca. California State Regional Water Quality Control Board, pers. comm. 2015). Blue Lake Rancheria and all associated partners hope to fill some of the knowledge gaps regarding temperature conditions in the Mad, with this study.

Previous Temperature Monitoring

- Lewis et al. compiled a report for the Forest Science Project (FSP) in 2000, entitled: Regional Assessment of Stream Temperatures across Northern California and Their Relationship to Various Landscape-Level and Site-Specific Attributes.
- Green Diamond Resource Company (and formerly Simpson Timber Company) collected summer time water temperature data in several tributaries including: Boulder Creek between 1994 and 2007, Maple Creek between 1994 and 1999, at a number of stations in the Cañon Creek sub-basin between 1994 and 2007, and at a single station in Lindsay Creek from 1994 through 2007 (personal communication Matt House 2015)
- Dennis Halligan collected temperatures in Hall and Quarry Creek from 1995 till 1998 for the Fisheries Monitoring Program for Gravel Extraction operations on the Mad River.
- Six Rivers National Forest collected summer time continuous data from Pilot Creek from 1996-2002

Species of Interest

The Mad River watershed hosts a variety of North American wildlife, including 28 native freshwater and estuarine fish species [see table appendix A]. Of particular interest is the summer steelhead, which faces unique challenges in thermally impaired water bodies.

The Mad River is home to 3 salmonid species that are listed as threatened under the Federal Endangered Species Act (ESA): Chinook salmon (*Oncorhynchus tshawytscha*), Coho salmon *(O. kisutch),* and Steelhead trout *(O.mykiss*). The adult summer Steelhead life-form is of particular interest on the Mad River, because these fish must endure summer water temperatures. Currently the California State Department of Fish and Wildlife are considering a petition to list adult Summer Steelhead as '*endangered.'*
Other salmonids documented in Mad River include: coastal cutthroat trout (*O. clarki clarki*). Sockeye salmon *(O. nerka*), Pink salmon (*O. gorbuscha*) and Chum salmon (*O. keta*) occasionally appear, but are most likely strays from further north (Alaska, Washington, or British Columbia).

Mad River also provides critical habitat for protected estuarine fish species: longfin smelt (*Spirinchus thaleichthys),* listed as threatened under California ESA; eulachon or candle fish *(Thaleichthys xpacificus) listed ESA threatened,* and tidewater gobi *(Eucyclogobius newberryi)* listed as endangered under Federal ESA. Other species of interest include: Pacific lamprey *(Entosphenus tridentatus),* green sturgeon *(Acipenser medirostri)*, and freshwater mussels (*Anodonta californiensis,* and *A. nuttalliana*).

Water Temperature Influences on Aquatic Organisms

Water temperature plays a critically important role in the life history of most aquatic species. Fish and herpetofauna are cold-blooded organisms, so ambient water temperature is often the key factor governing their metabolism, growth rates, and in some cases, survival.

Temperature thresholds are numerical values that attempt to describe the thermal suitability of various waterways. They are estimated by various methods, and vary according to species and life history stage. In general, adult fish are less tolerant of high temperatures than juveniles. The following tables are from a 2008 California State Water Board report on the effects of temperatures on salmonids:

Table 1: Life Stage Temperature Thresholds

Life Stage	MWMT (°C)	(°F)
Adult Migration	20	68
Adult Migration plus Non-Core1 Juvenile Rearing	18	64.4
2Core Juvenile Rearing	16	60.8
Spawning, Egg Incubation, and Fry Emergence	13	55.4

1 non-Core is defined as moderate to low density salmon and trout rearing usually occurring in the mid or lower part of the basin (moderate and low not defined).
2 Core is defined as areas of high density rearing (high is not specifically defined).
Source: USEPA 2003

Table 2: Lethal Temperature Thresholds

Lethal Threshold1 (°C)			
Life Stage	**Steelhead**	**Chinook**	**Coho**
Adult Migration and Holding	24 (75.2°F)	25 (77 °F)	25 (77 °F)
Juvenile Growth and Rearing	24 (75.2°F)	25 (77 °F)	25 (77°F)
Spawning, Egg Incubation, and Fry Emergence	20 (68 °F)	20 (68 °F)	20 (68°F)

1 The lethal thresholds selected in this table are generally for chronic exposure (greater than 7 days). Although salmonids may survive brief periods at these temperatures, they are good benchmarks from the literature for lethal conditions.

A primary species of interest in the Mad River is the adult summer steelhead, the above table provides] a useful reference to assess the temperature impairment at various sites. Coho salmon *(O. kisutch)* also use the Mad and its tributaries for summer rearing, Hartwell Welsh et al. found in Mattole river tributaries, “temperature regimes in the warmest tributaries containing juvenile Coho salmon had mean weekly temperatures of 18.0°C or less.” J.R. Brett reports: “no salmonid species could tolerate temperatures exceeding 25.1 °C when exposed for one week.”

Project Goals and Objectives

The goal of the Mad River Temperature Monitoring Study is to sample water temperatures across a broad range of sites, and to gain greater insight regarding stream temperatures at as many locations as possible in the mainstem and tributaries, and produce a model with the temperature data that can inform the HBMWD as a part of the 1707 instream flow dedication process. This study is an attempt to implement a systematic approach to stream temperature monitoring in the Mad River watershed.

Key Questions include:

1. Which portions of the Mad River and its tributaries are impaired with regard to stream temperature, using EPA thresholds?
2. What effects, if any, do dam releases have on downstream temperatures?
3. How suitable is the mainstem Mad River for salmonid rearing?
4. What are some potential mechanisms for mitigating temperature impairment?
5. How can we better monitor stream temperature conditions in the Mad River?

To accomplish our goal, Blue Lake Rancheria (BLR) worked in cooperation with Mad River Alliance (MRA), North Coast Regional Water Quality Control Board (NCRWQCB), Humboldt Bay Municipal Water District (HBMWD), HT Harvey and Associates (HTHA), and in cooperation with Green Diamond Resource Company (GDRCo) for access to key deployment locations. The goal was to deploy 30 HOBO temperature loggers throughout the watershed from May-October 2018 (actual date ranges vary according to site).

Methods & Materials

The study consists of two integral parts: 1) guiding documents and 2) physical equipment to collect and process collected data. The guiding document used to guide the process is the, '*Guidelines and Standard Procedures for Continuous Water-Quality Monitors: Station Operation, Record Computation, and Data Reporting.'* From United States Geological Survey. The physical equipment consists of HOBO continuous temperature loggers, PVC tubes and galvanized pipe end caps used to create secure housings for HOBOs, and braided wire cable to secure HOBOs to their respective sampling sites; a field record book and reference photographs to give proper guidance to the deployment and retrieval sites of HOBOs and collect metadata about the deployment/retrieval sites.

Site selection was completed using land ownership and access considerations, local knowledge and satellite mapping software (GoogleEarth). Using known available access points and known holding habitats for salmonid species, a priority list of accessible sites was created. Public access is extremely limited in the stretch of Mad River between the towns of Mad River and Blue Lake, so some desired monitoring sites in the mainstem as well as tributaries were inaccessible. With available public access points, moderate coverage of the mainstem Mad River, between R.W. Matthews Dam and the estuary of Mad River was achieved. The majority of sites were located in the lower portions of the watershed. (See maps below for actual deployment sites).

Figure 1: Mad River watershed with deployment locations (Blue line demarcates river below R.W. Matthews Dam, Red line demarcates Mad River above the dam)

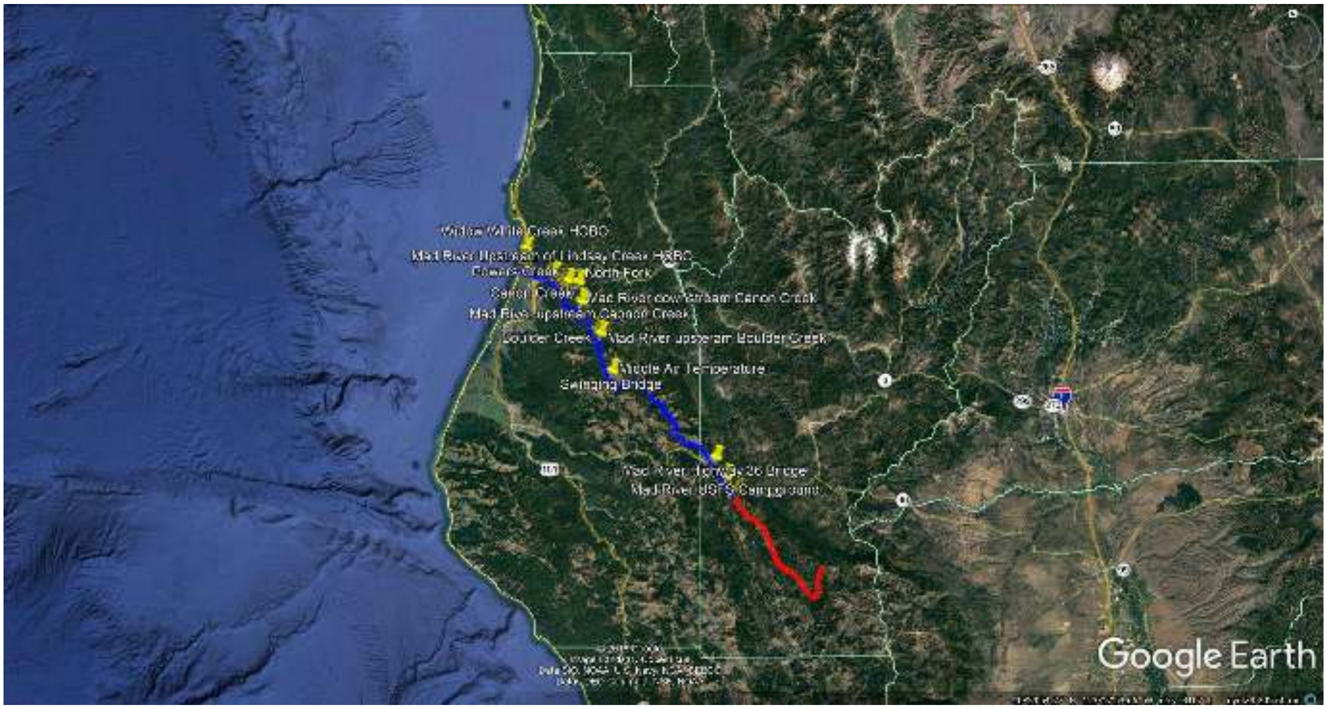


Figure 2: Mad River watershed from the Pacific Ocean to its headwaters, with deployment sites noted.

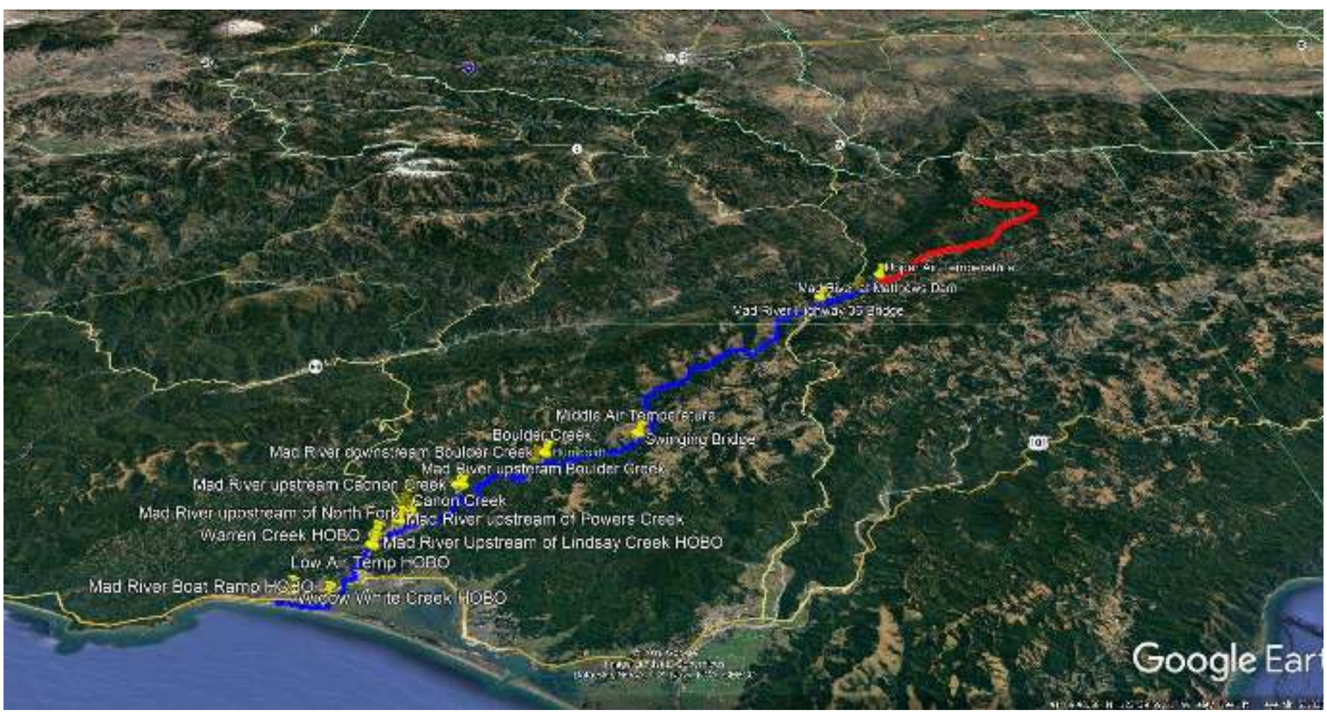


Figure 3: Lower Mad River deployment sites (coastal)

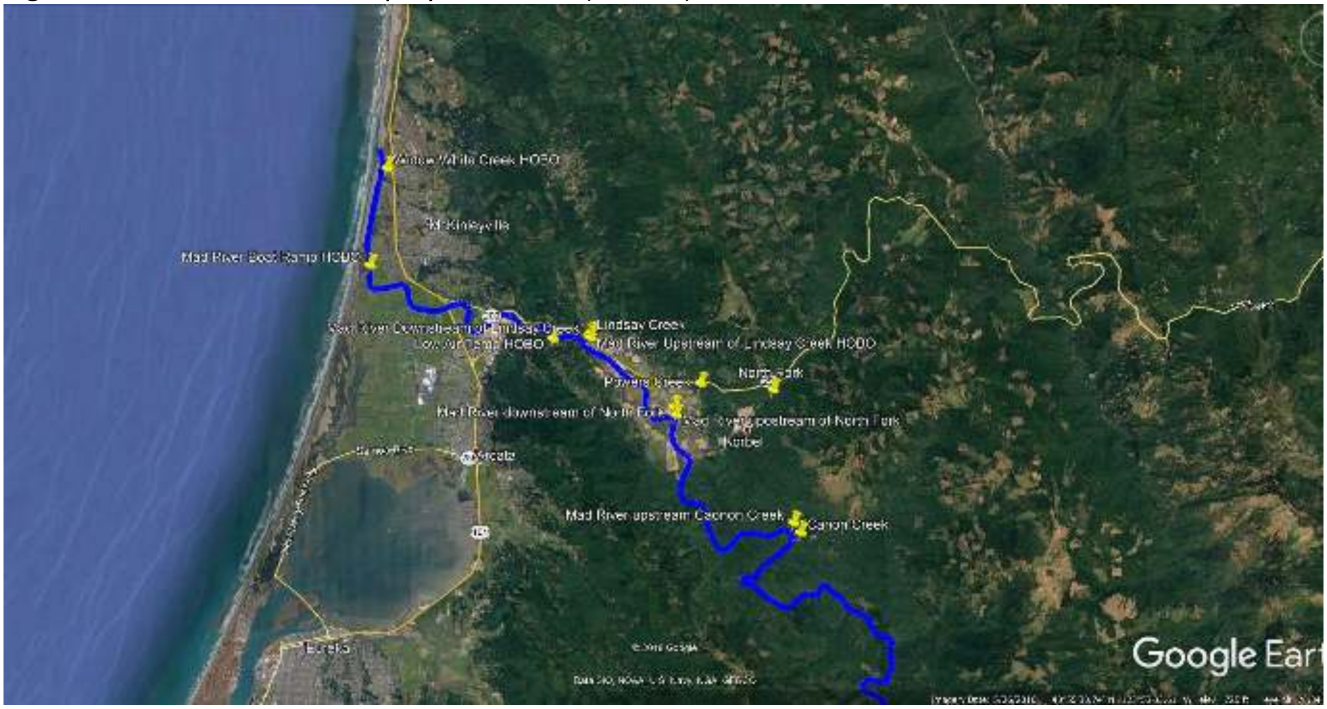
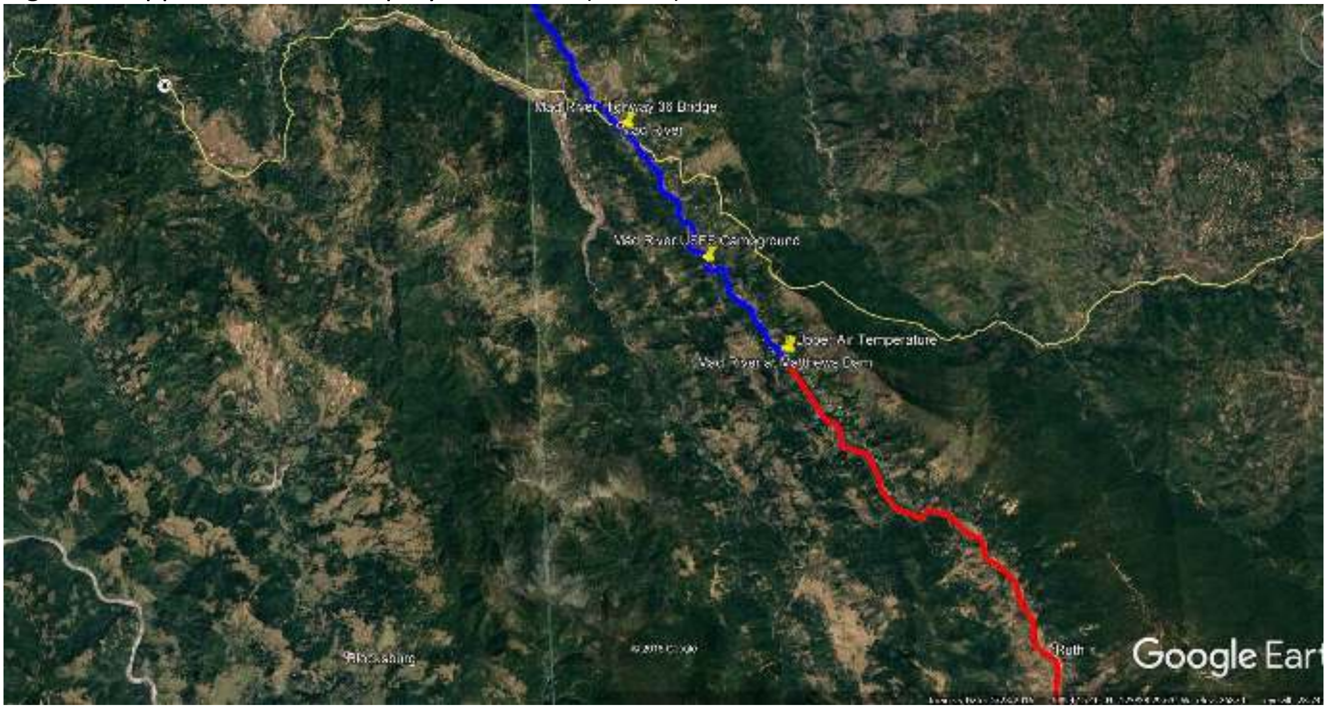


Figure 4: Middle Mad River deployment sites (transitional)

Figure 6: Upper Mad River deployment sites (inland)



Implementation

HOBO deployments occurred over the course Late May and Early Jun, 2018. This includes all sites from R.W Matthews Dam near the town of Mad River, CA to the mouth near McKinleyville, CA.

To assist in the retrieval process, detailed field notes and photographs were taken, and GPS coordinates were collected. During the deployment and retrieval periods, metadata about site conditions were also gathered. These metadata fields include:

- People deploying/retrieving HOBOs
- Physical description of site conditions
- Presence/absence of birds/wildlife/fish species/algae

25 HOBOs were successfully retrieved from October 2018. Two instruments from the initial deployment were vandalized and unrecoverable, mainstem deployment sites near Maple Creek.

Data

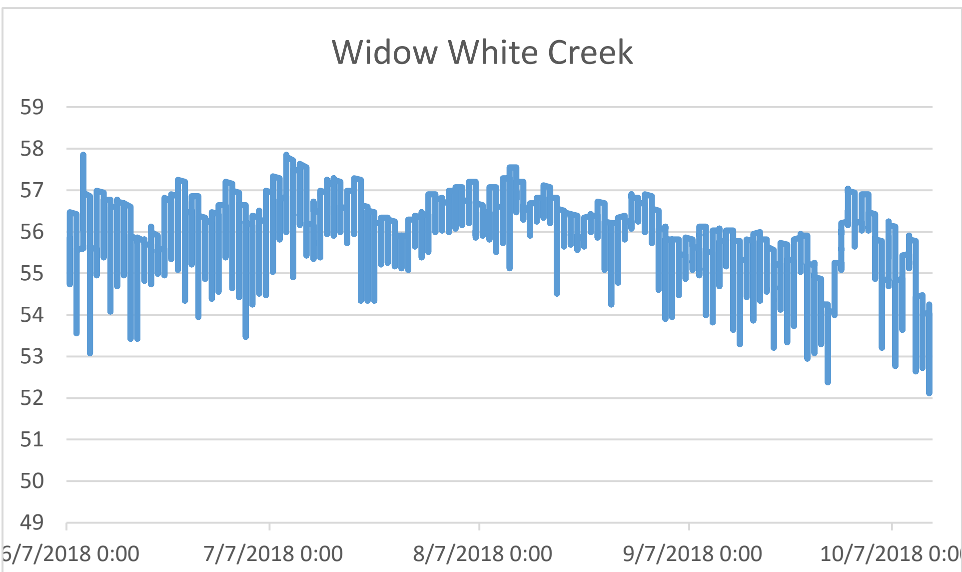
HOBO temperature loggers were set to collect temperature measurements every 30 minutes. These instruments were calibrated to manufacturer’s specifications prior to deployment. Although there are many different types and manufacturers of continuous temperature recording technology, NCRWQCB offered 27 HOBOs that had previously been used free of charge.
Data were downloaded off of each individual HOBO and processed with the proprietary HOBOware software by Onset. For each site, a visual (graph) report summary was created, and MRA provided both raw and trimmed data summaries in .csv format in Microsoft Excel spreadsheets. Plots of the raw data, grouped by geographic location and mainstem/tributary are presented in the MRA Data Summary Appendix.

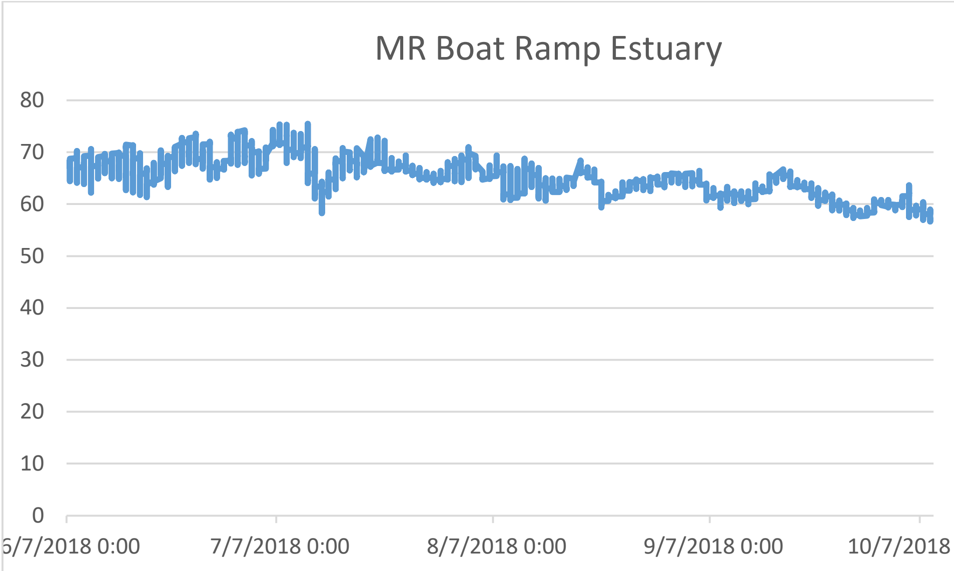
Data Analysis

Data analysis was completed by Peter Nelson of HT Harvey and Associates. The data was then used to inform a stream temperature model.

Clear differences were evident between the mainstem temperatures and the tributary temperatures (see Data Summary plots below). Tributaries showed a much smaller diurnal fluctuation, and lower overall temperature values. Diurnal fluctuations and temperatures increase as one goes inland, due to decreases in coastal influences. The same patterns apply to the mainstem, along a geographic gradient, from the estuary to the dam. Tidal influences were also evident in the lowermost mainstem sites (See Figure 2, water temperature plots). For these reasons, we broke the study reach down into three zones: coastal (estuary – Canon Creek), transitional (Canon Creek to Swinging Bridge) and inland (upstream of Swinging Bridge).

Graphical Data Summaries, in order from Downstream to Upstream:

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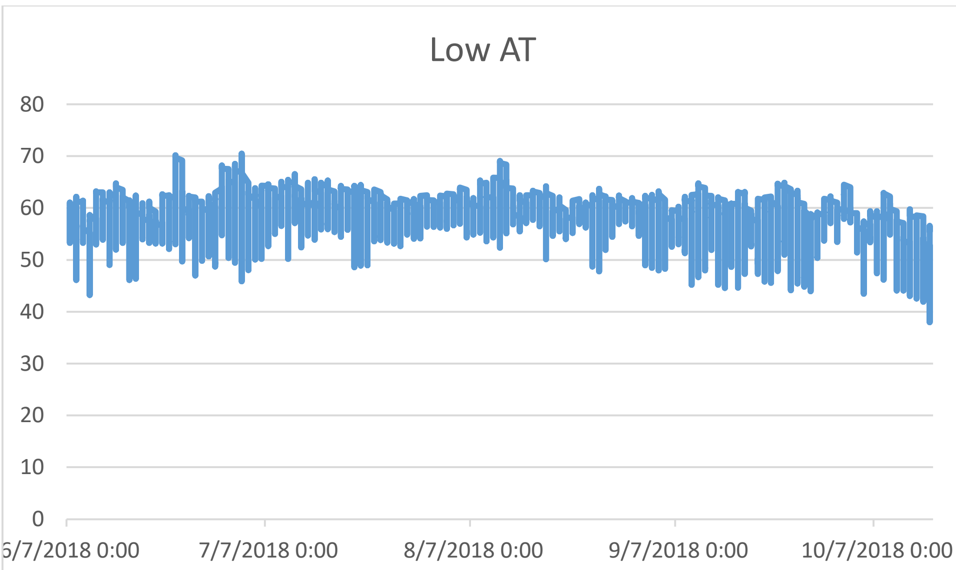
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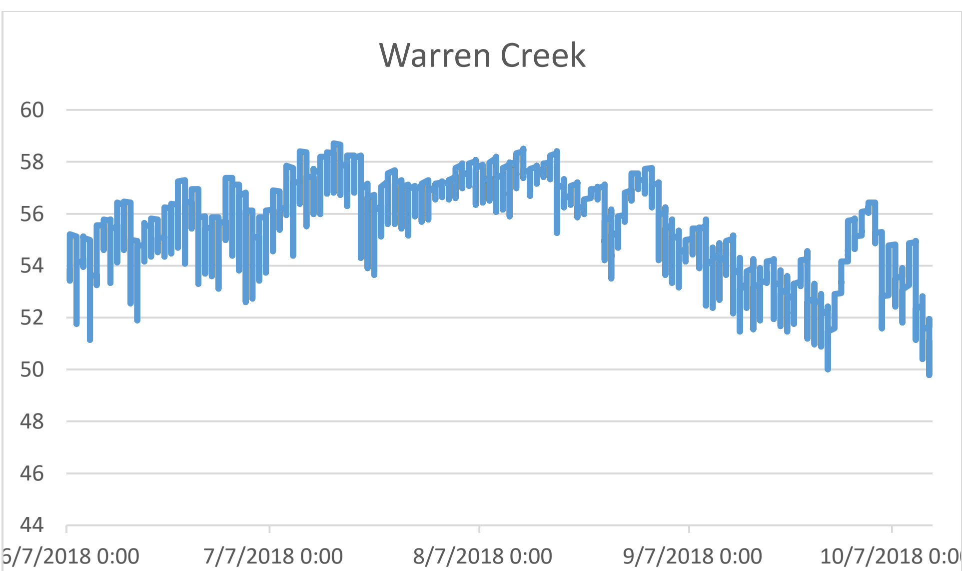
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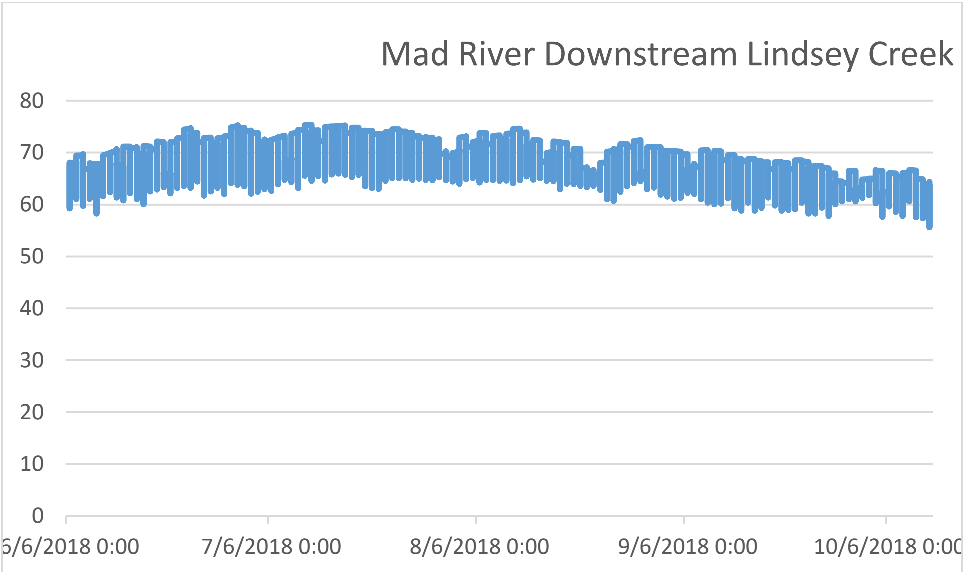
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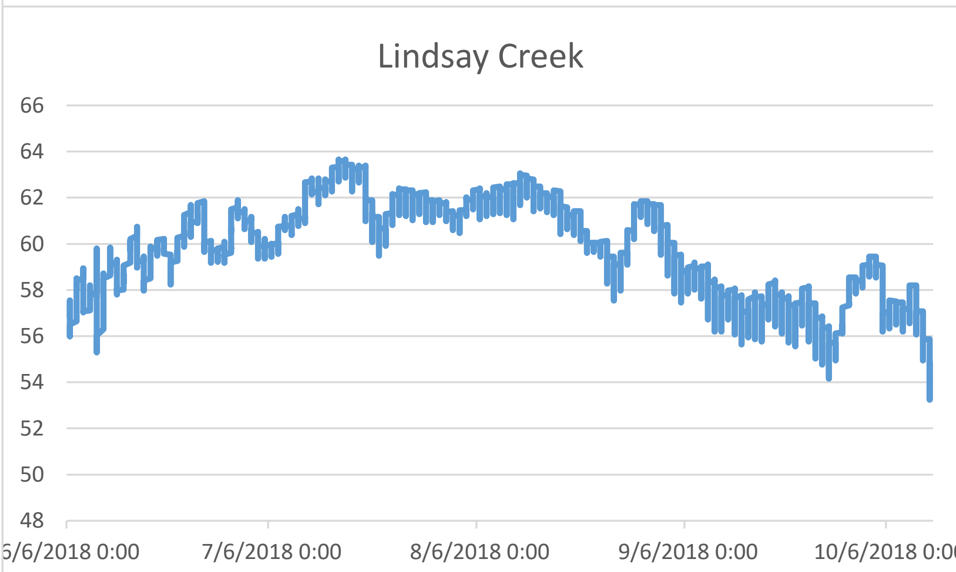
Lindsay Creek
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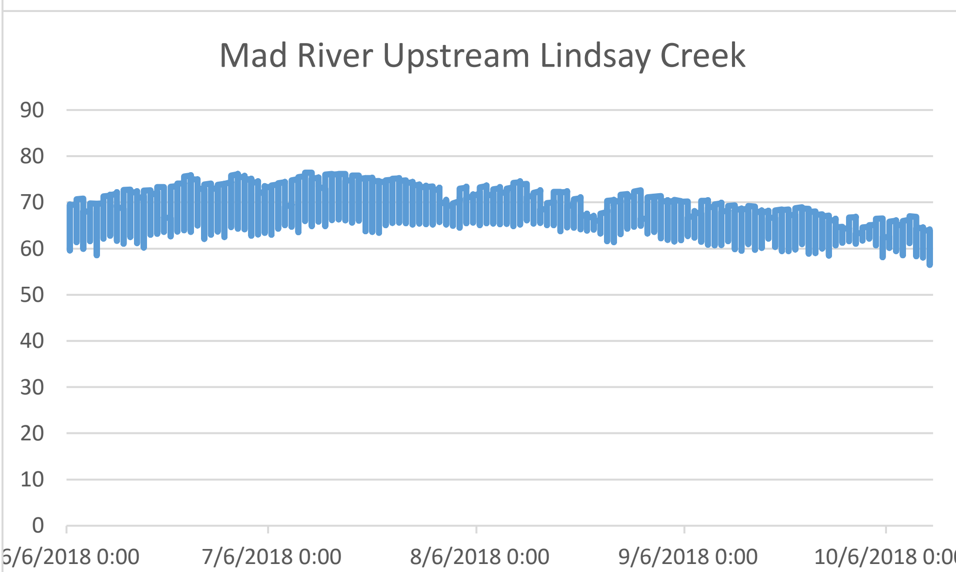
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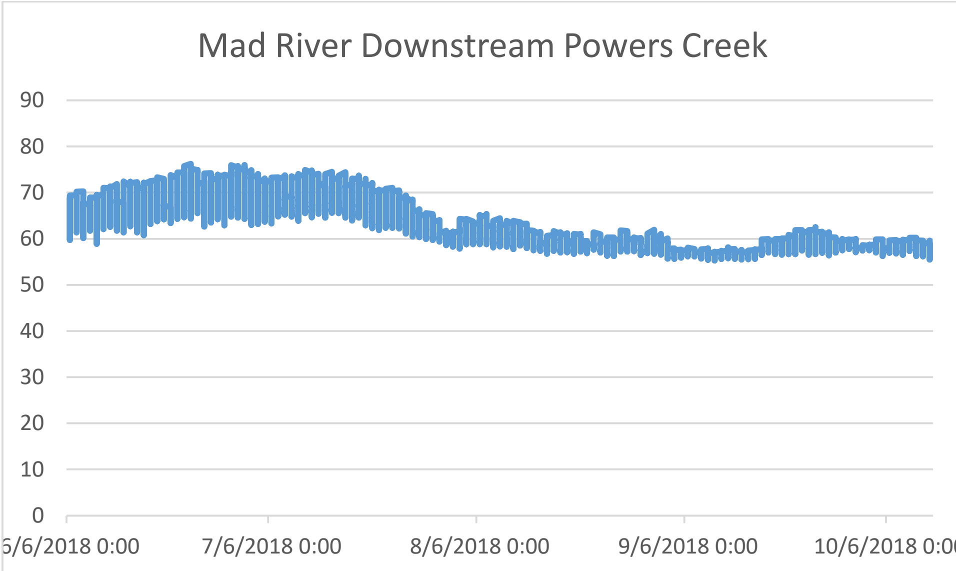
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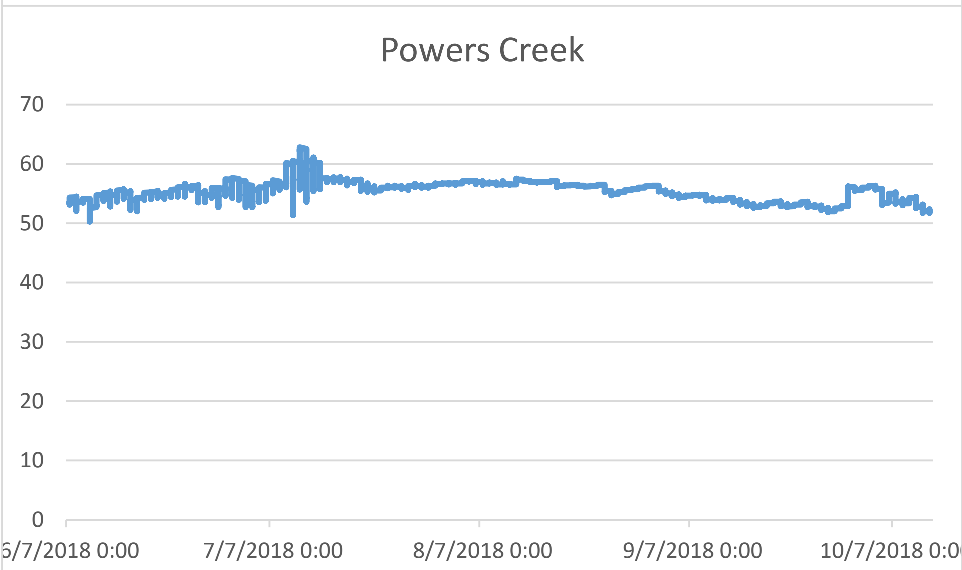
Powers Creek
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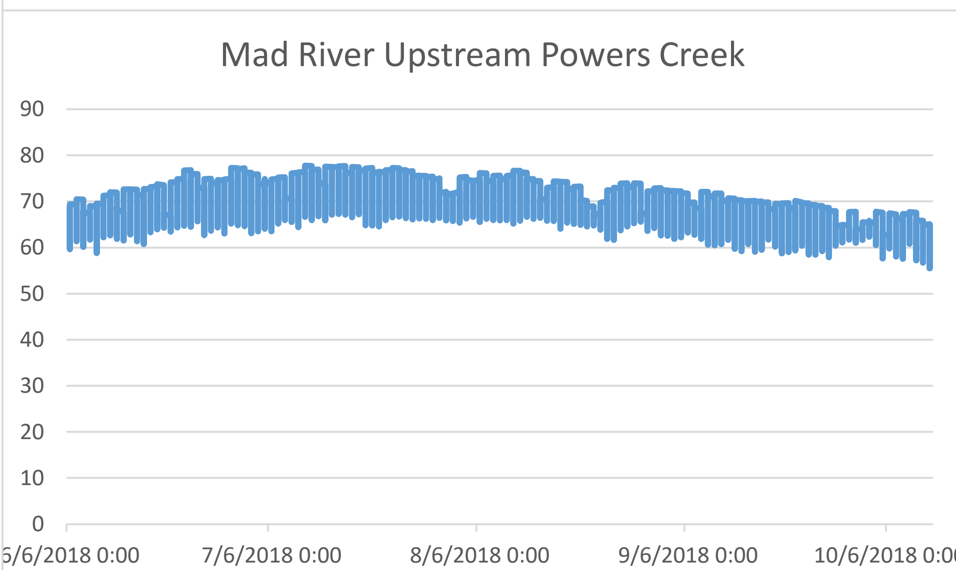
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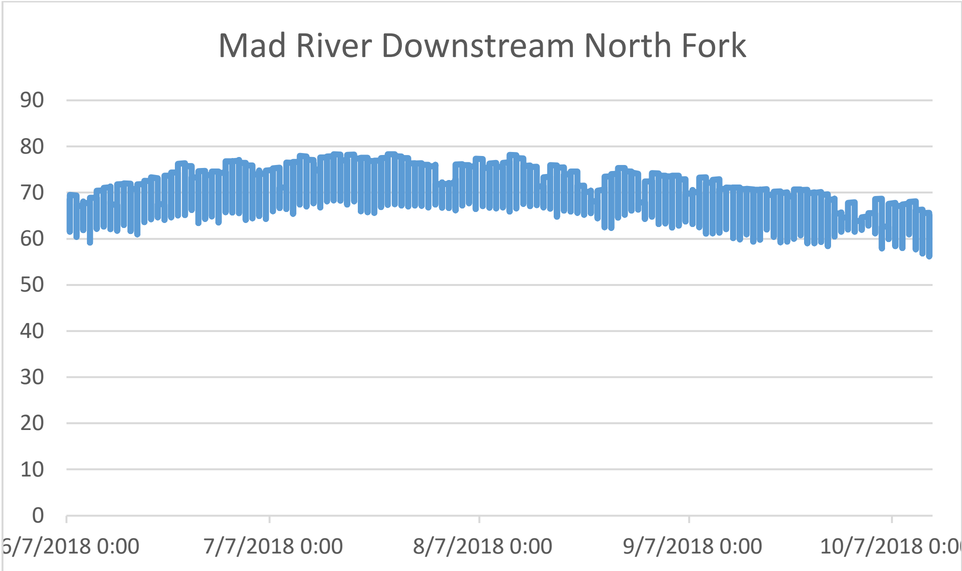
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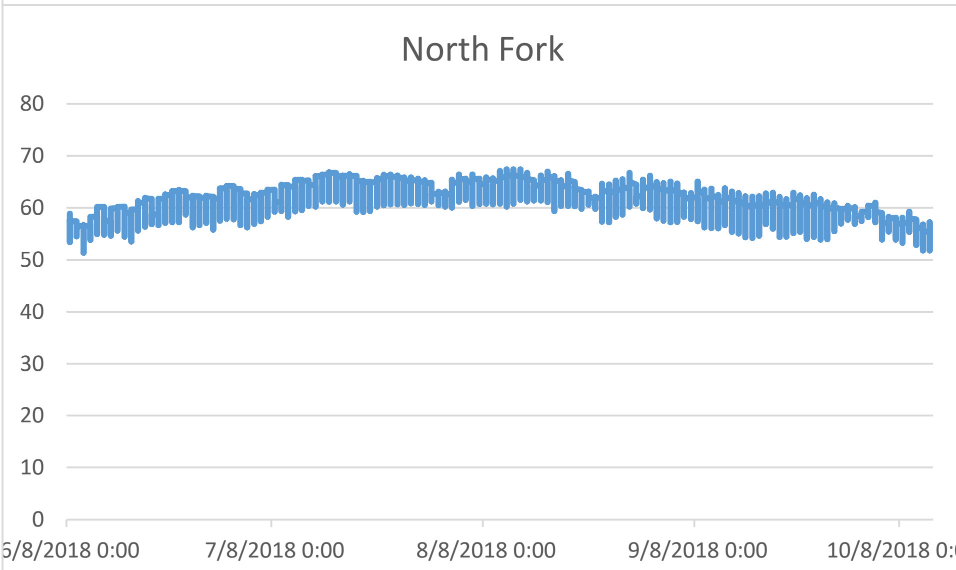
North Fork
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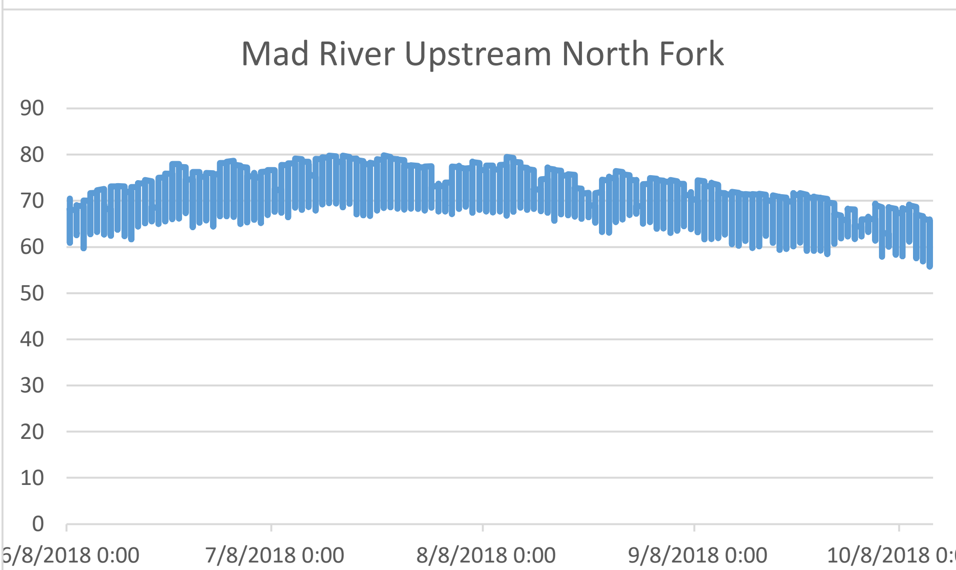
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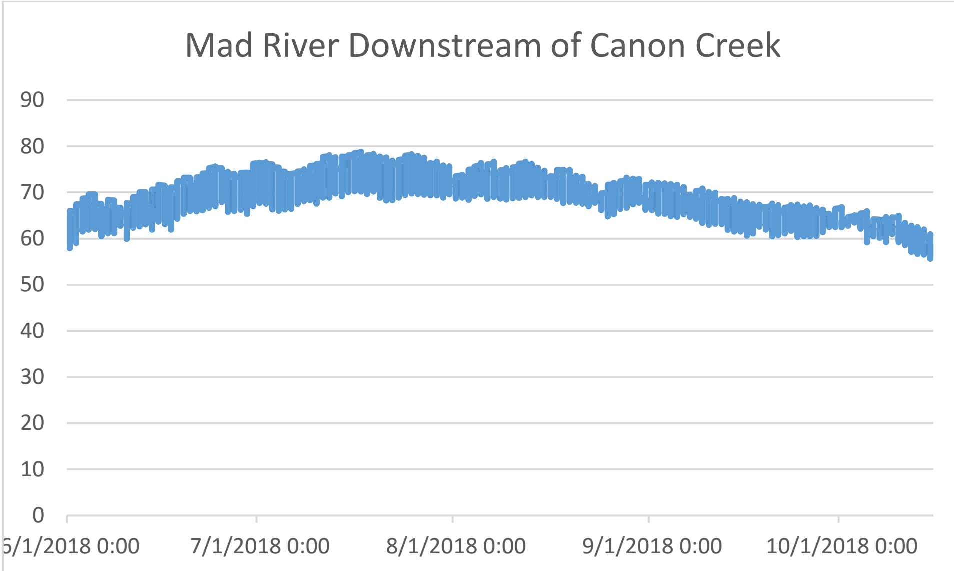
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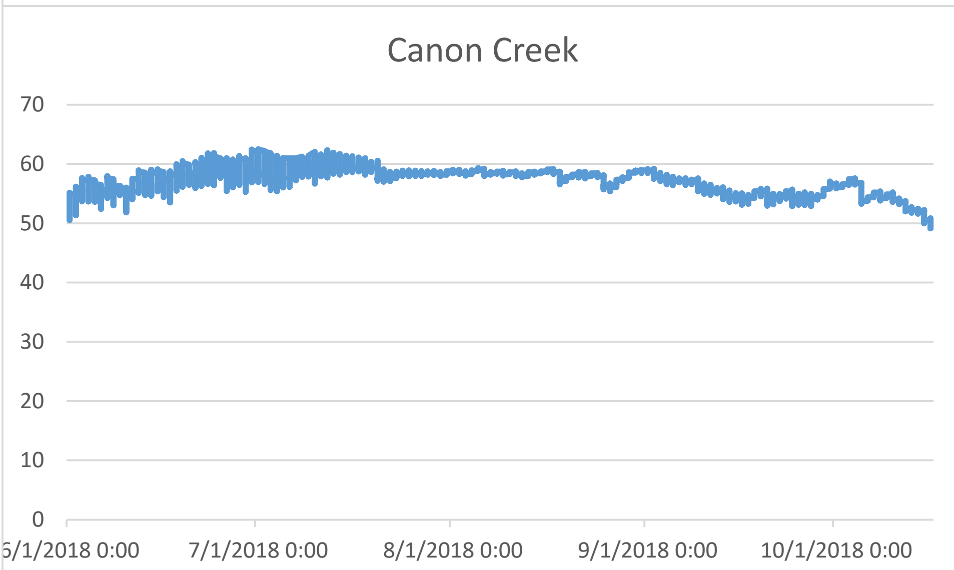
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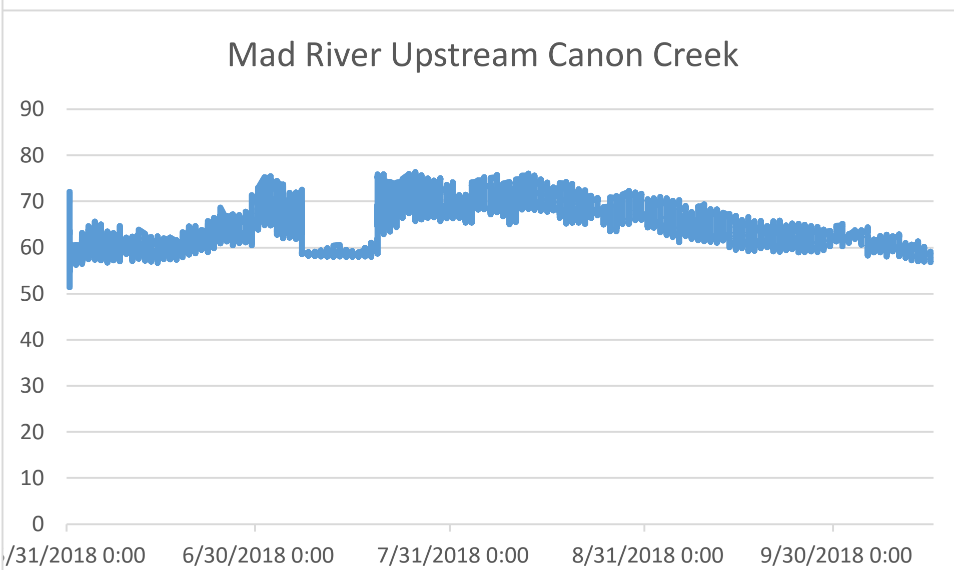
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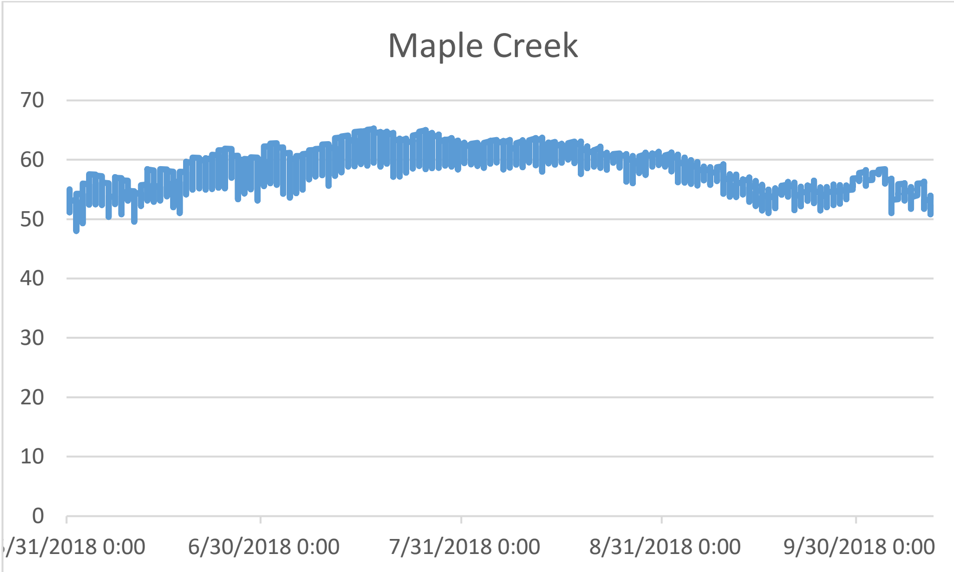
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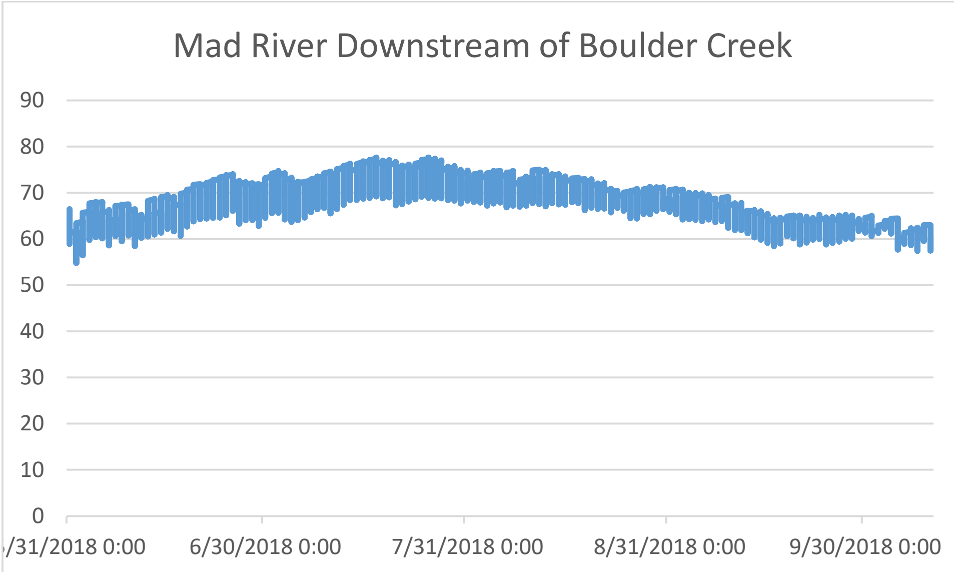
Mad River Downstream of Boulder Creek
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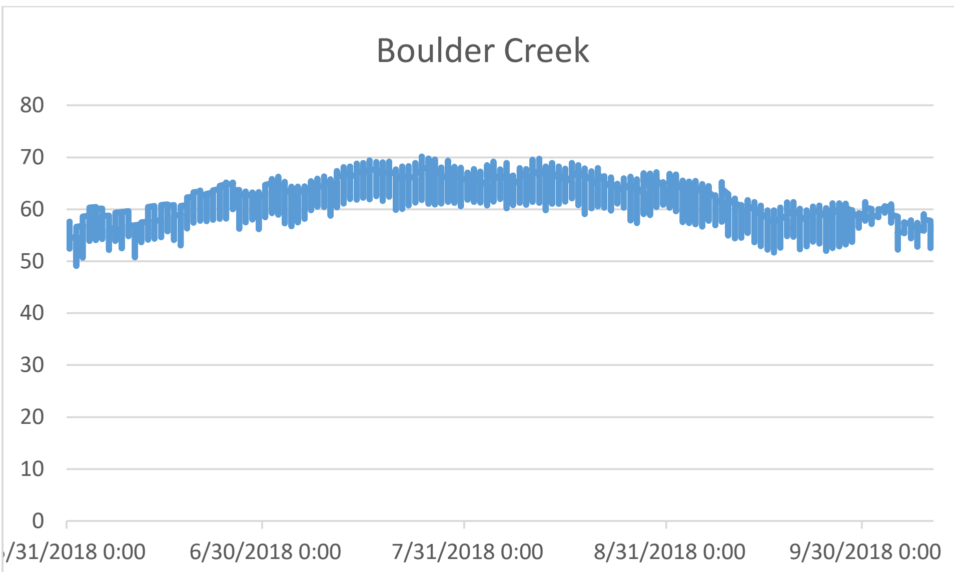
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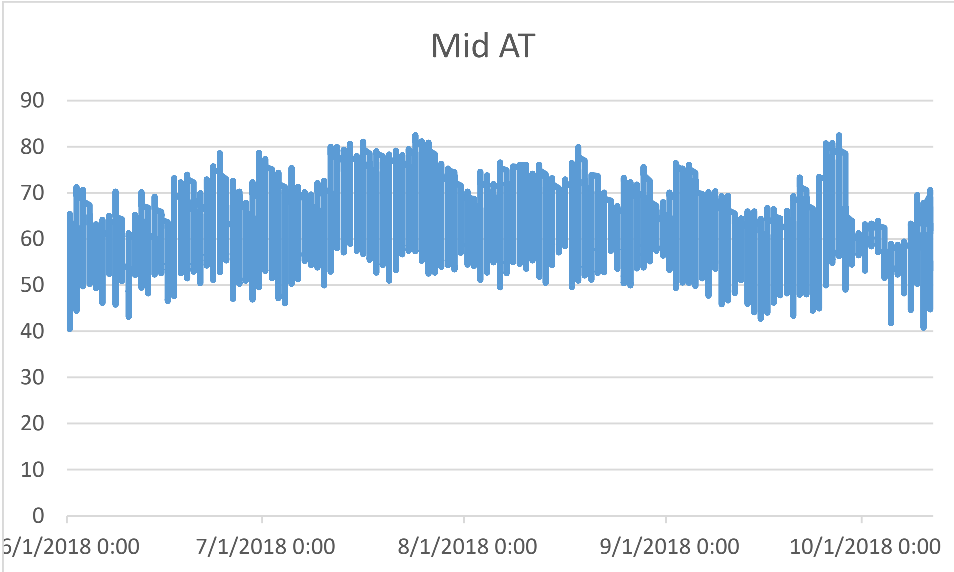
Mid AT
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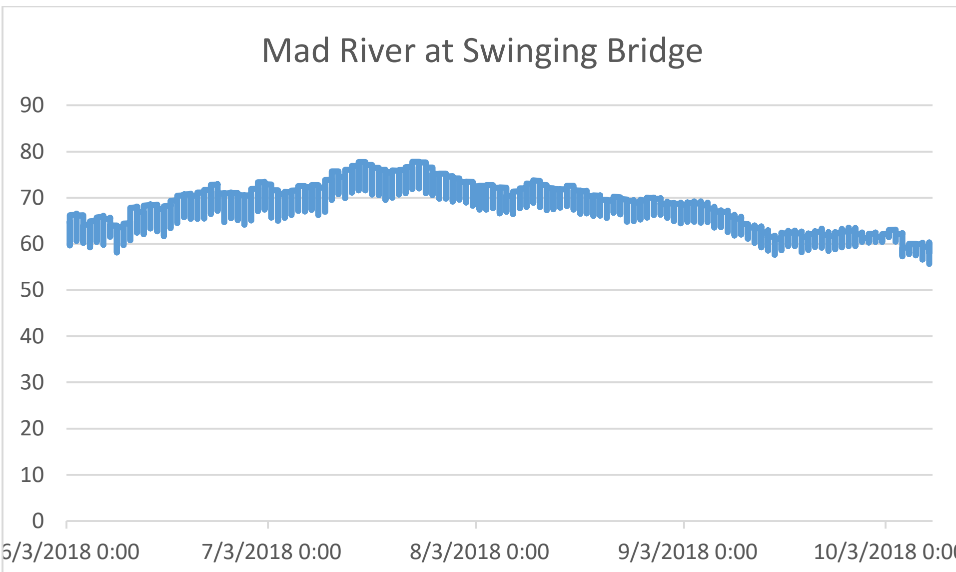
Mad River at Swinging Bridge
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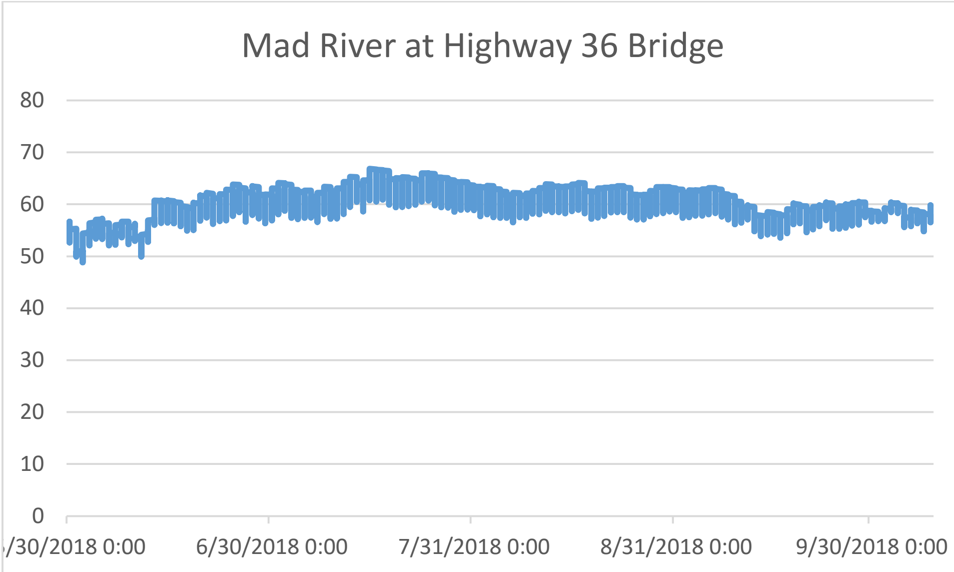
Mad River at Highway 36 Bridge
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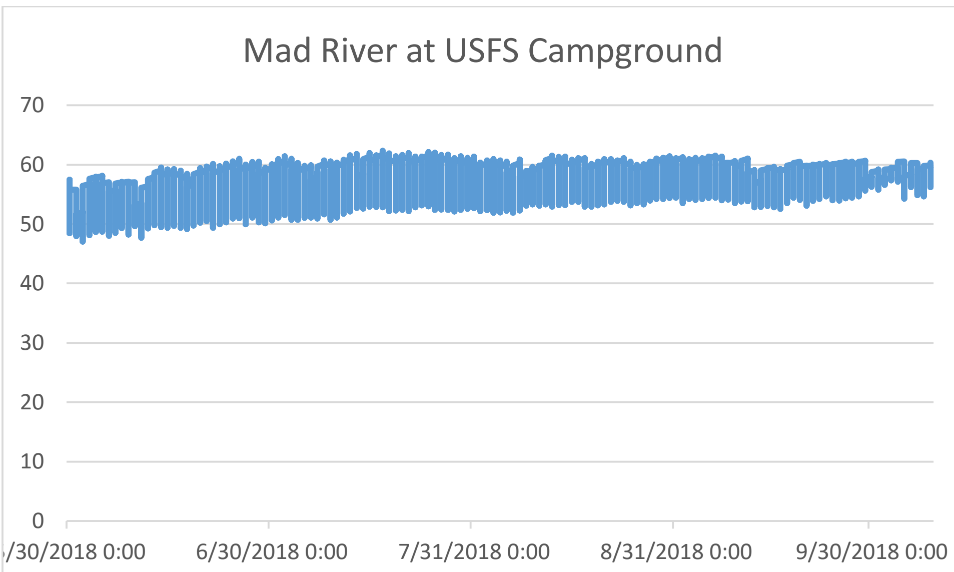
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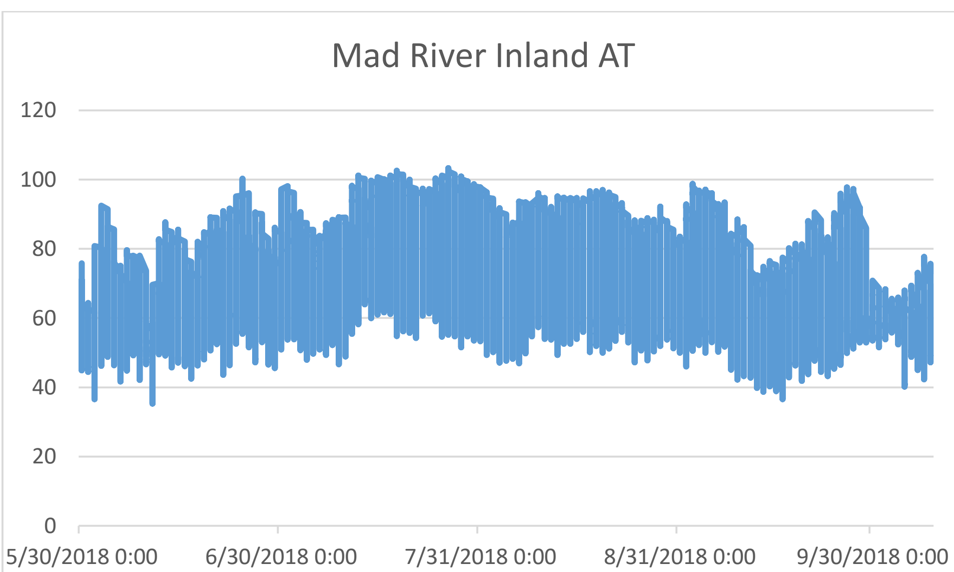
Mad River Inland AT
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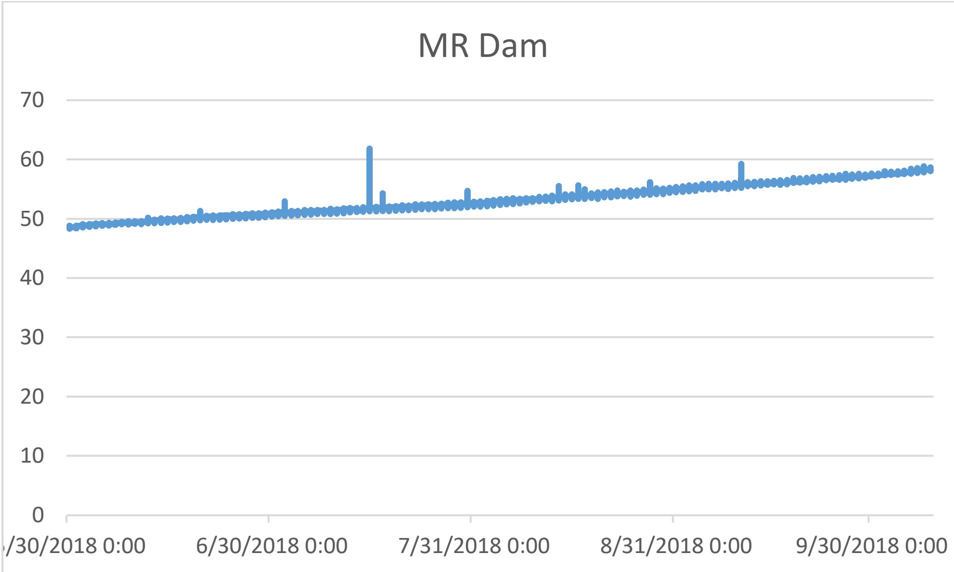
MR Dam
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Observations

Using the EPA threshold criteria for summer steelhead rearing, only tributary sites are either “adequate” or “marginal” (MWAT < 19°C). Twelve of the 18 sites are classified as “inadequate” (MWAT > 19°C).

Conclusions

Evaluation of the maximum temperature recorded during the monitoring period (Tmax) and the Mean Weekly Average Temperature (7DMAVG(A)) reveal that in some areas of the Mad River and tributaries, temperatures are reaching lethal thresholds for salmonids.

One salmonid population of particular interest is adult summer run steelhead. Summer steelhead populations are found in mainstem and tributaries of Smith River, Klamath River, Trinity River, Mad River, Eel River, and in Redwood Creek (personal communication Seth Naman NOAA fisheries 2015). Nowhere in California are summer steelhead considered abundant – the runs in many streams consist of less than 100 fish (Barnhart 1986; CDFG unpublished data), and the most recent population assessment for Mad River is 134 adults (2018 Mad river summer Steelhead Dive Report). Summer steelhead enter Mad River in late winter through early spring and must hold in suitable habitat, to survive hot summer months until they spawn the following fall or winter.

The effectiveness of this study is based on inherit design limitations including: sampling period, sampling locations and access, budget, lack of dedicated equipment (HOBOs), and Mad River being a low priority for state and federal monitoring efforts. To continue this effort more partnerships and funding sources will needed to support this temperature monitoring project in the future.

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Appendix A

Native fish species found in the Mad River and Estuary as of June 2015

Name		Status	Area Found
Coho salmon	*Oncorhynchus kisutch*	Threatened Fed.ESA	Mainstem & tributaries
Coastal cutthroat	*O. clarki clarki*		Mainstem & tributaries
Chinook salmon	*O. tshawytscha*	Threatened Fed.ESA	Mainstem & tributaries
Chum salmon	*O. keta*		Occasional stray
Pink salmon	*O. gorbuscha*		Occasional stray
Sockeye salmon	*O. nerka*		Occasional stray
Steelhead	*O. mykiss*	Threatened Fed.ESA	Mainstem & tributaries
Eulachon	*Thaleichthys pacificus*	Threatened Fed ESA	Estuary & Main & Tribs.
Tidewater gobi	*Eucyclogobius newberryi)*	Endangered Fed.ESA	Estuary
Longfin smelt	*Spirinchus thaleichthy*	Threatened CA. ESA	Estuary
Pacific lamprey	*Entosphenus tridentata*		Mainstem & tributaries
Buffalo sculpin	*Enophrys bison*		Estuary & Main & Tribs.
Coast range sculpin	*Cottus aleuticus*		Estuary & Main & Tribs.
Prickly sculpin	*Cottus asper*		Estuary & Main & Tribs.
Staghorn sculpin	*Leptocottus armatus*		Estuary & Main & Tribs.
Humboldt sucker	*C. occidentalis humboldtianus*		Mainstem & tributaries
Sacramento sucker	*Catostomas occidentalis*		Mainstem & tributaries
Three-spine stickleback	*Gasterosteous aculeatus*		Mainstem & tributaries
Starry flounder	*Platichthys stellatus*		Estuary
Night smelt	*Spirinchus starski*		Estuary
Cabezon	*Scorpaenichthys marmoratus*		Estuary
Penpoint gunnel	*Apodichthys flavidus*		Estuary
Saddelback gunnel	*Pholidae ornate*		Estuary
Pacific herring	*Culpea pallasii*		Estuary
Black rockfish	*Sebastes melanops*		Estuary
Copper rockfish	*S. caurinus*		Estuary
Bay pipefish	*Syngnathus loptorhyncus*),		Estuary
Speckled sanddab	*Citharichthys stigmaeus*		Estuary
Shiner surfperch	*Cymatogaster aggregata*		Estuary