HBMWD Instream Flow Dedication

Proposed Petition for Change of Use

Water Code §1707

"Elevator Pitch"

- HBMWD is diligently pursuing the full beneficial use of its water rights, under what we call the "one mill scenario" (releasing as if one pulp mill is still operating). The additional flow benefits aquatic organisms and habitat.
- Without this permit change—called a Petition for Change under Water Code section 1707—the District could be forced to reduce releases.
- The Petition for Change will also preserve the District's water rights, under California's "use it or lose it" water rights laws.

Presentation Outline

- History: Pulp Mills and Water Resource Planning
- Instream Flow Dedication Process
- HBMWD's Water Rights
- Petition for Change Narrative Summary Highlights
- Next Steps
- Questions?

HBMWD History

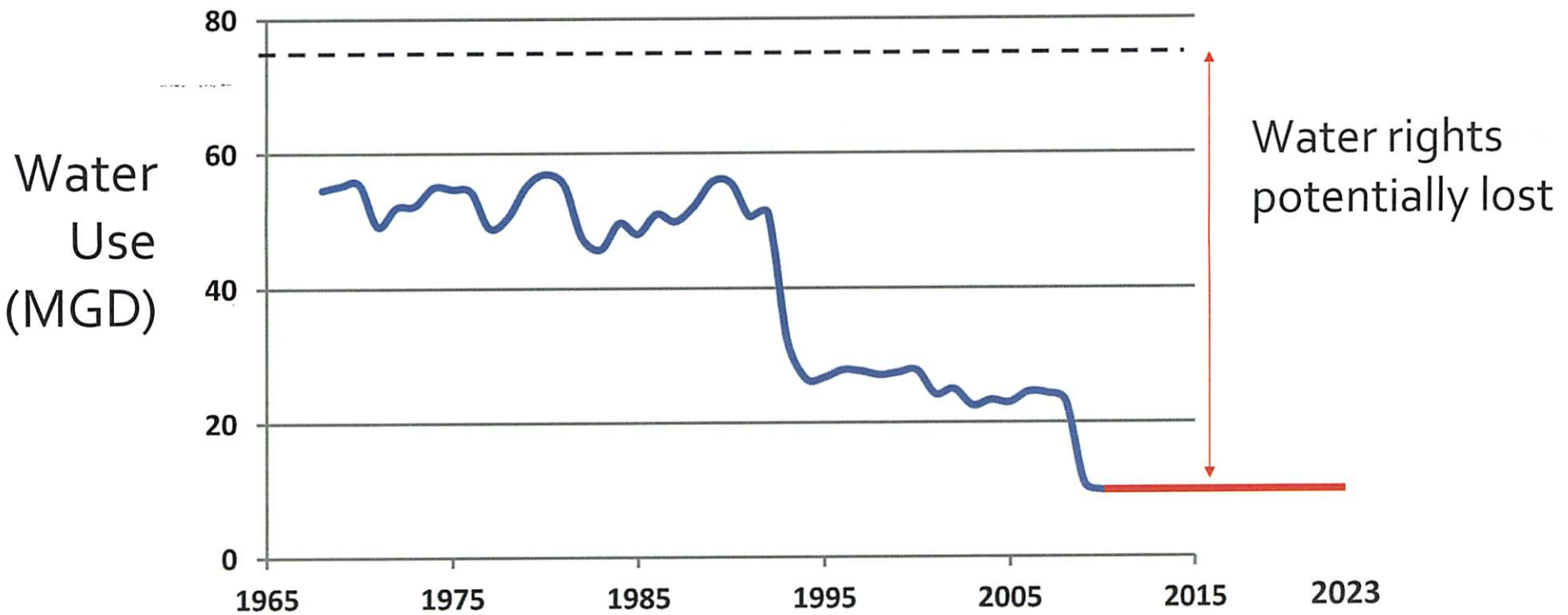
Humboldt Standard

Vol. 87—No. 133 Phone HI 2-3711 EUREKA, CALIFORNIA, TUESDAY EVENING, MAY 12, 1959 10c Per Copy 24 Pages Today

TWO PULP MILLS ANNOUNCE
THEY WILL BUY WATER HERE

May 12, 1959

HBMWD History



HBMWD Water Resource Planning

2008-2010 facilitated participatory process to develop water use ideas to maintain HBMWD water rights.

Stakeholder Advisory Committee with representatives from:

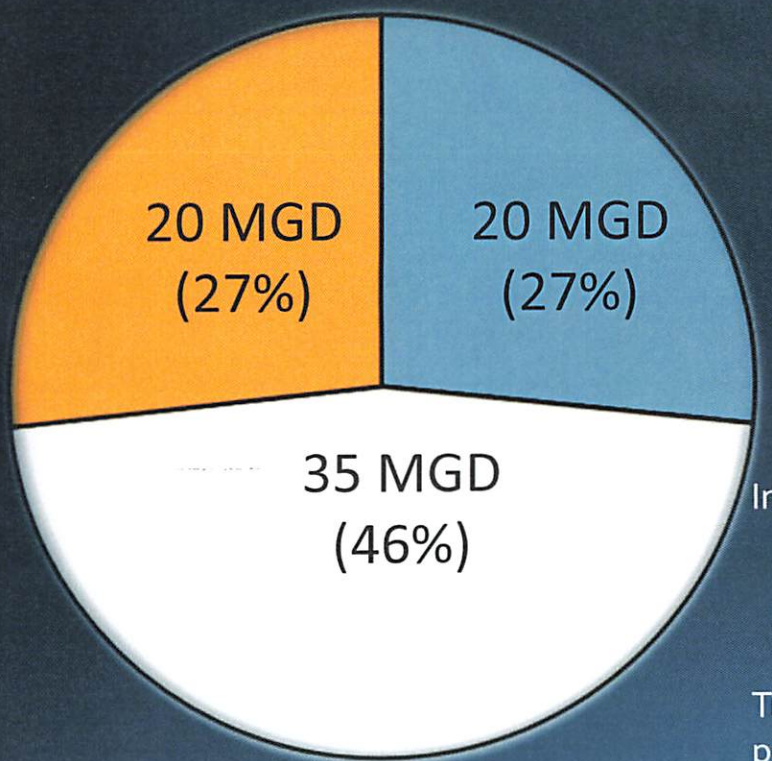
- Environmental groups (3)
- Economic development
- Blue Lake Rancheria
- Chambers of Commerce
- Real estate
- Organized labor
- Wholesale Municipal Customers (3)
- HBMWD Board (2)

HBMWD Water Resource Planning

Consensus reached on 3 water use options:

- Increase local sales of water
- Transport water to another municipality
- **Dedicate water for instream flow environmental benefits**

Water Resource Planning



Potential amount of instream flow dedication was approved by HBMWD Board of Directors, December 2016:

20mgd or 31cfs

Instream flow =

Local sales =

Transport to a public agency =

Instream Flow Dedication Process

2018

- Form Instream Flow Committee
- Awarded WCB Grant

2018-2023

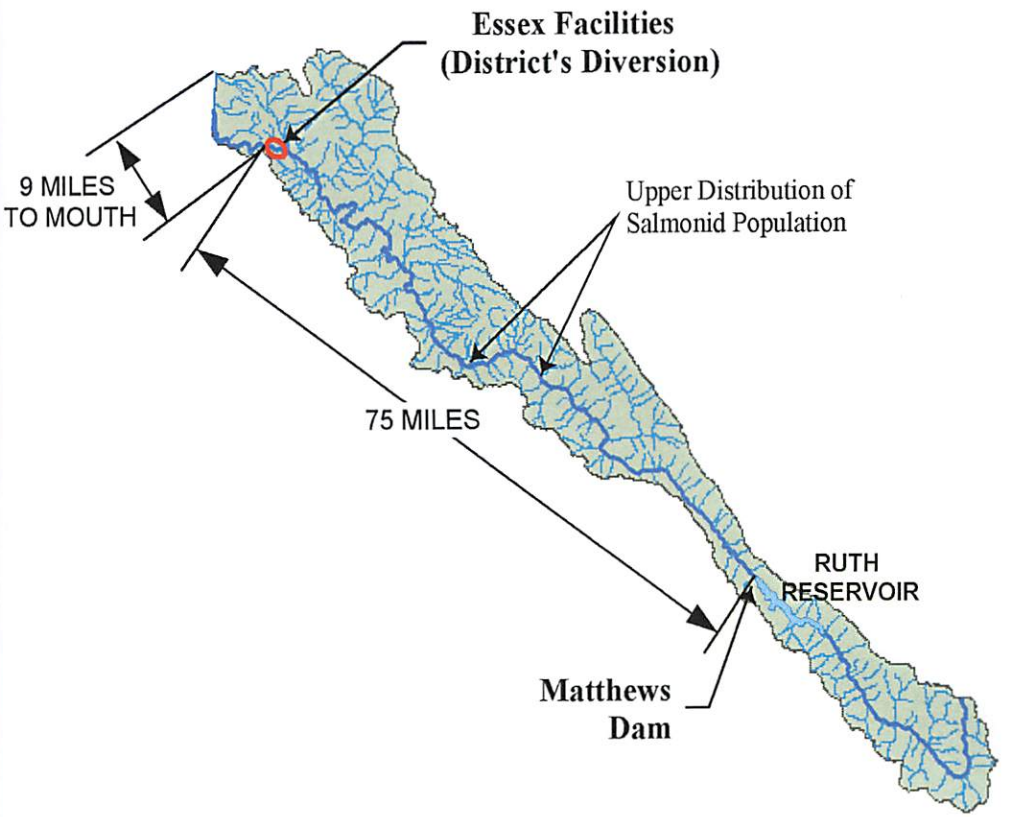
- Biological & Water Quality Studies
- Operations and Consumptive Use Studies
- Agency Outreach & Public Engagement
- Draft Project Description

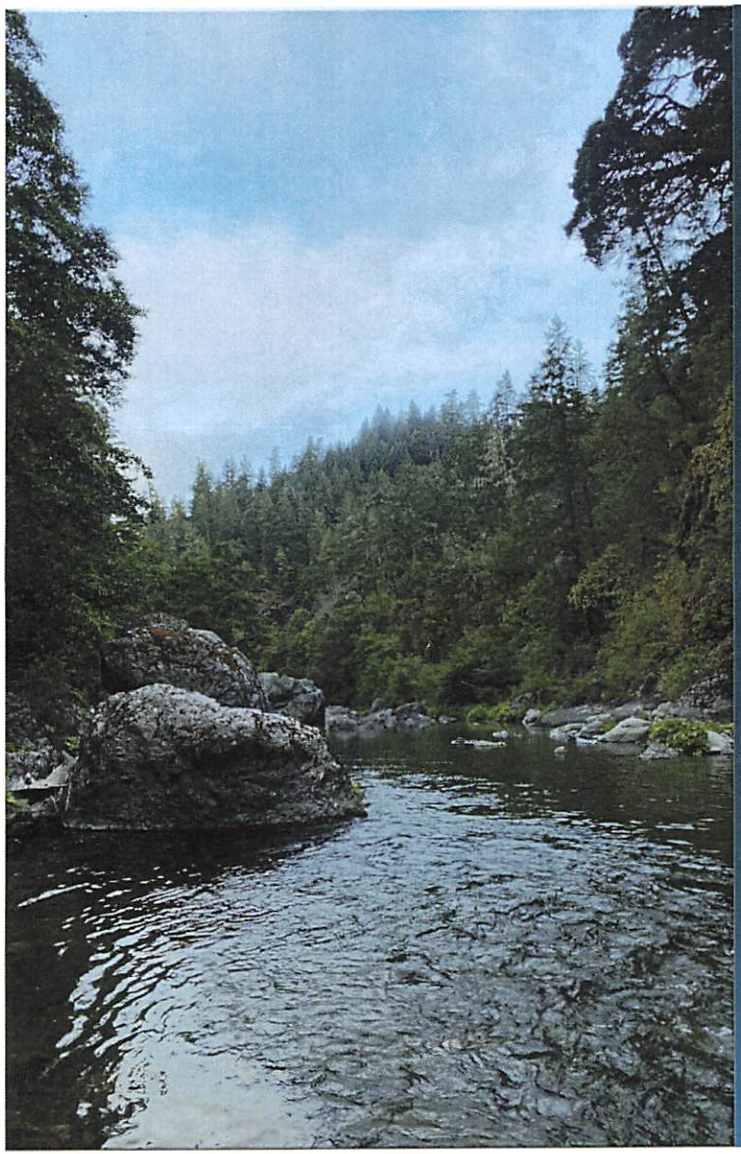
2023-

- Submit Draft Petition for Change documents
- Submit Final Petition for Change
- Approval of our Petition before 2030

Petition for Change Narrative Summary

- Description of the District's water system and current releases.
  - Since 2009, District has been operating hydro plant as if one mill continued to operate.
- The petition is a request to continue these releases by adding instream purposes of use to our water right, for preserving or enhancing fish and wildlife resources.



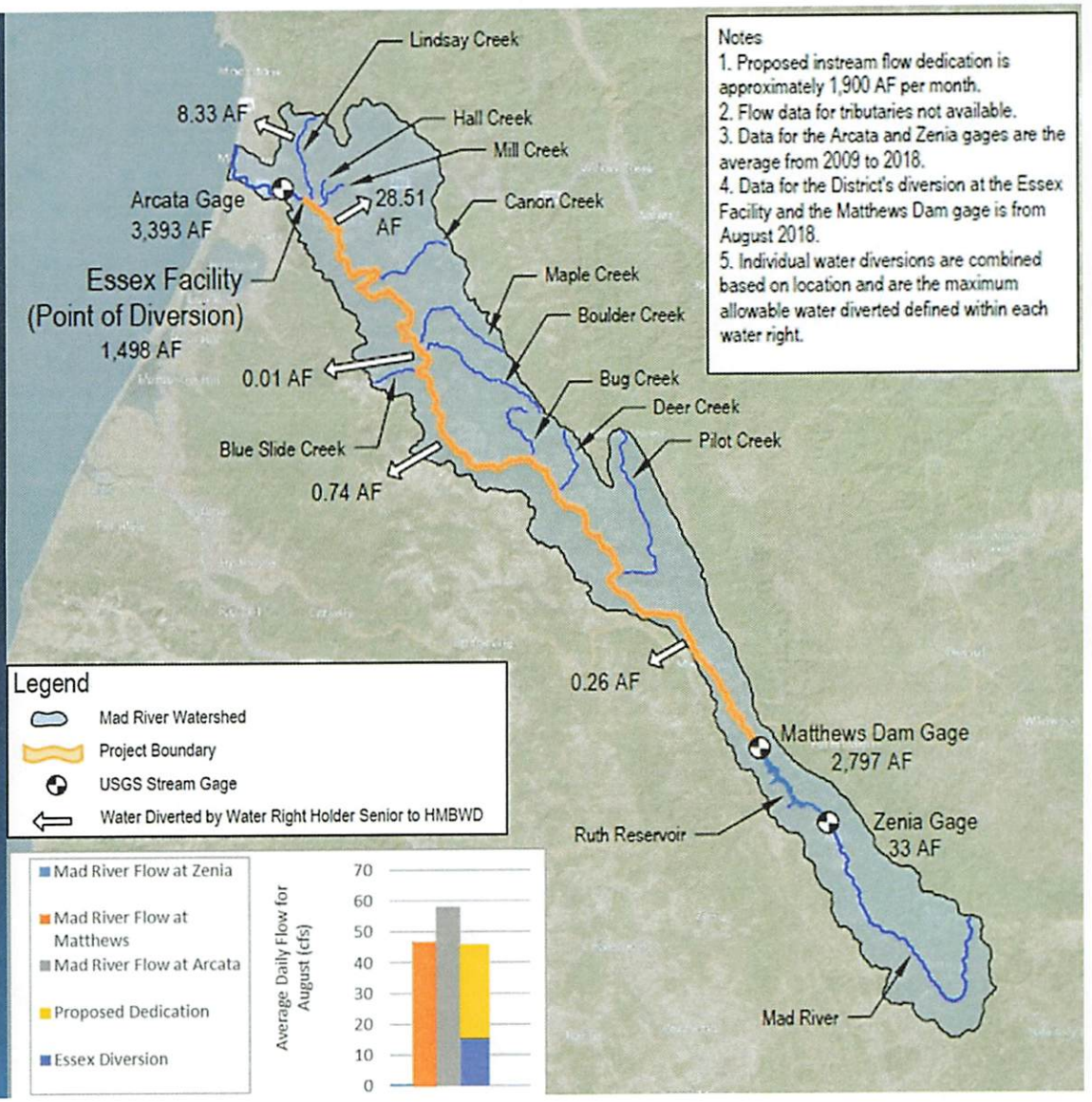


Purpose of the Project

- Improve summer rearing habitat for juvenile salmonids
- Improve spring mainstem shallow water river edge habitat for foothill yellow-legged frogs and salmonid fry
- Provide resilience for river biota to ameliorate the effects of climate change

This Map.

- Still a work in progress
- Mandatory elements:
  - Project boundary
  - All known diversions within the vicinity of the project
  - Identification of HBMWD's existing point of diversion
  - Dam & reservoir location
  - Delineation of stream habitat change petition addresses
  - Public land survey section and township lines



HBMWD Water Rights

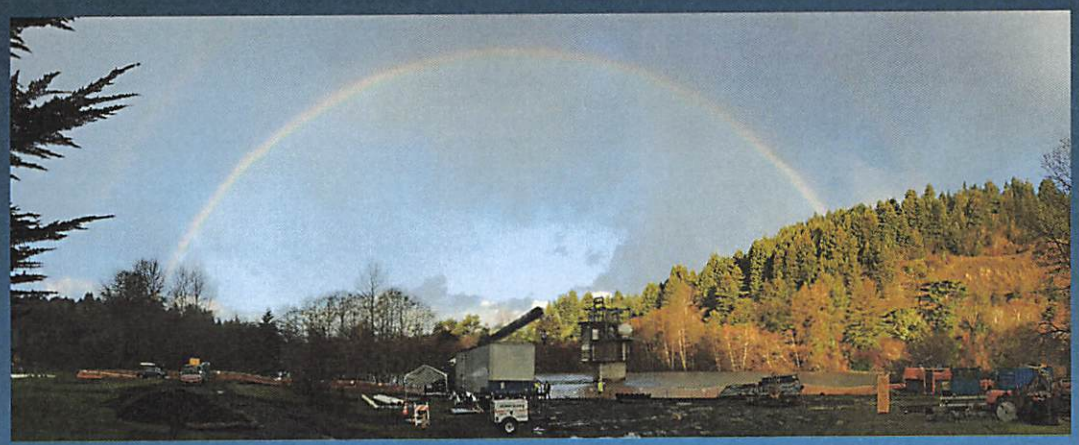
The District holds 3 post-1914 appropriative water rights.

Permit Number	Date Issued	Storage	Diversion & Use
11714	March 16, 1959, revised February 28, 2007	48,030 acre-ft from Oct 1 to Apr 30	132,030 acre-feet per year maximum combined. Direct diversion of 116 cfs year-round (11715).
11715		20,000 acre-ft from Oct 1 to Apr 30	
18347	September 25, 1981	Provides storage and diversion rates to operate the 2-MW hydroelectric generation facility at Matthews Dam.	

HBMWD Water Rights

The Essex Facility is:

- A point of re-diversion of previously stored water under Permits 11714 and 11715, and
- A point of direct diversion under Permit 11715.



Current and Proposed Operations

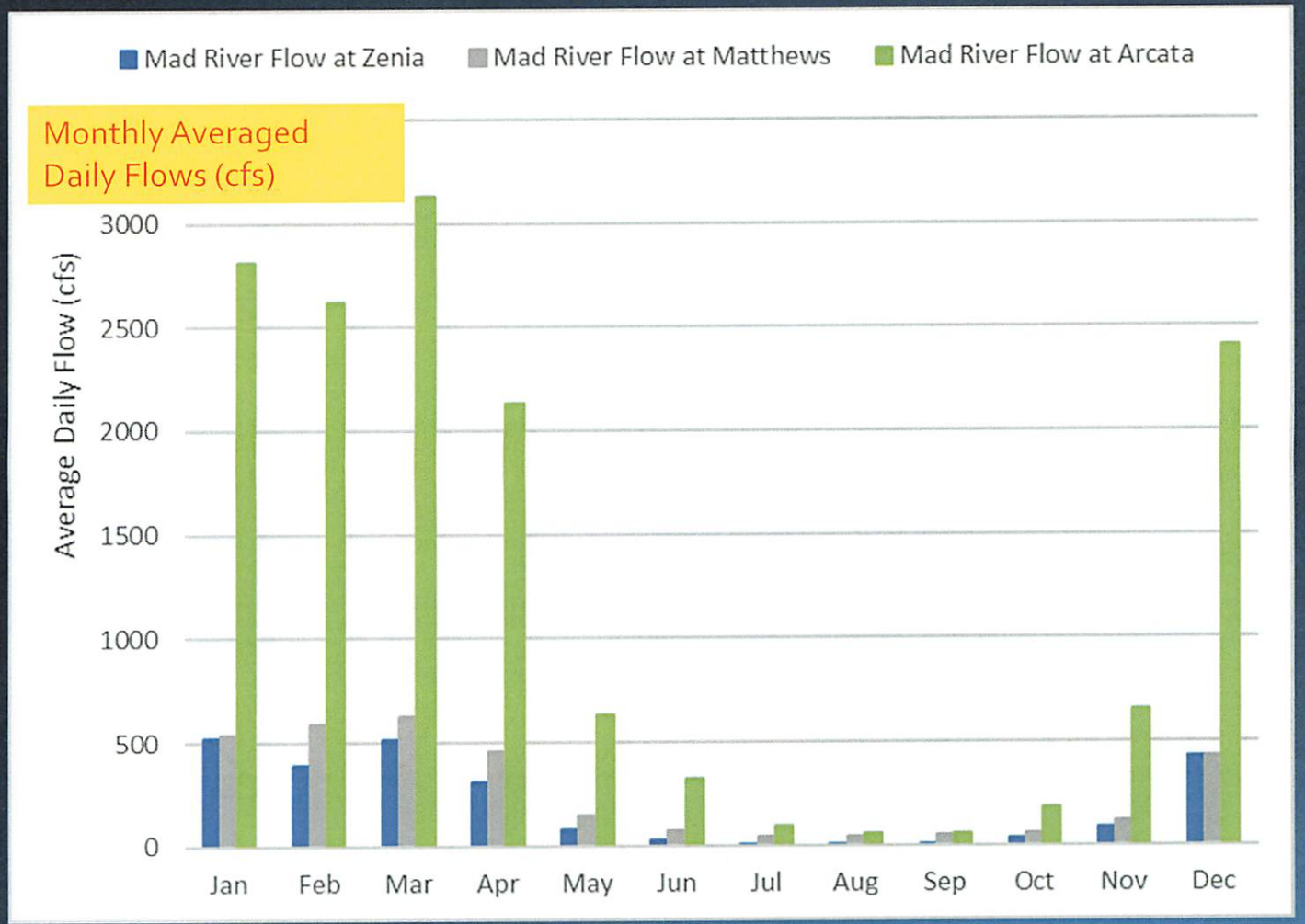
Water Rights Parameter	Current	Proposed
Amount	11714, 11715, 18347: Limited to what can be beneficially used	No changes
Rate	11714: Maximum 48,030 acr-ft per year for storage 11715: Maximum 116 cfs direct diversion and 20,000 acre-ft per year to storage 18347: Maximim 1,000 cfs direct diversion and 120,000 acre-ft per year by storage	No changes
Diversion Season	11714: Oct 1 to April 30 11715 and 18347: year-round direct diversion, Oct 1 to April 30 for storage	No changes

Current and Proposed Operations

Water Rights Parameter	Current	Proposed
Purpose of Use	11714 and 11715: Municipal use within HBMWD boundaries 18347: Power generation	**Add instream preservation or enhancement of fish and wildlife resources**
Points of Diversion	11714 and 11715: diversion to storage at Matthews Dam, rediversion at Essex Facility 18347: Ruth Reservoir	No changes
Priority	11714: July 7, 1955 11715: September 21, 1956 18347: December 9, 1980 "subject to future upstream appropriations for consumptive use"	No changes

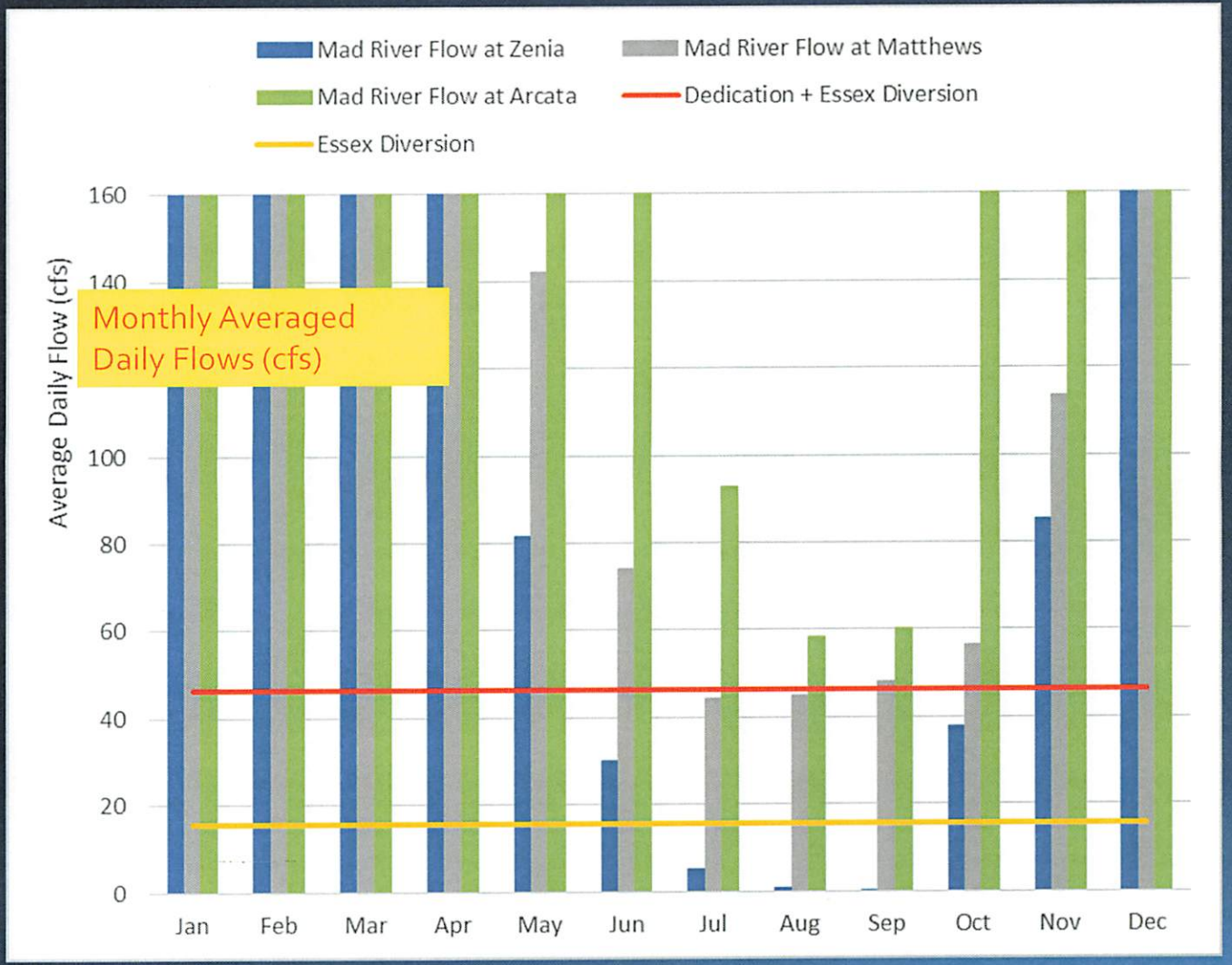
State Board must be able to make two findings:

1. Instream flow dedication will not increase the water that the District is entitled to use; and
2. Instream flow dedication will not injure other legal users of water.



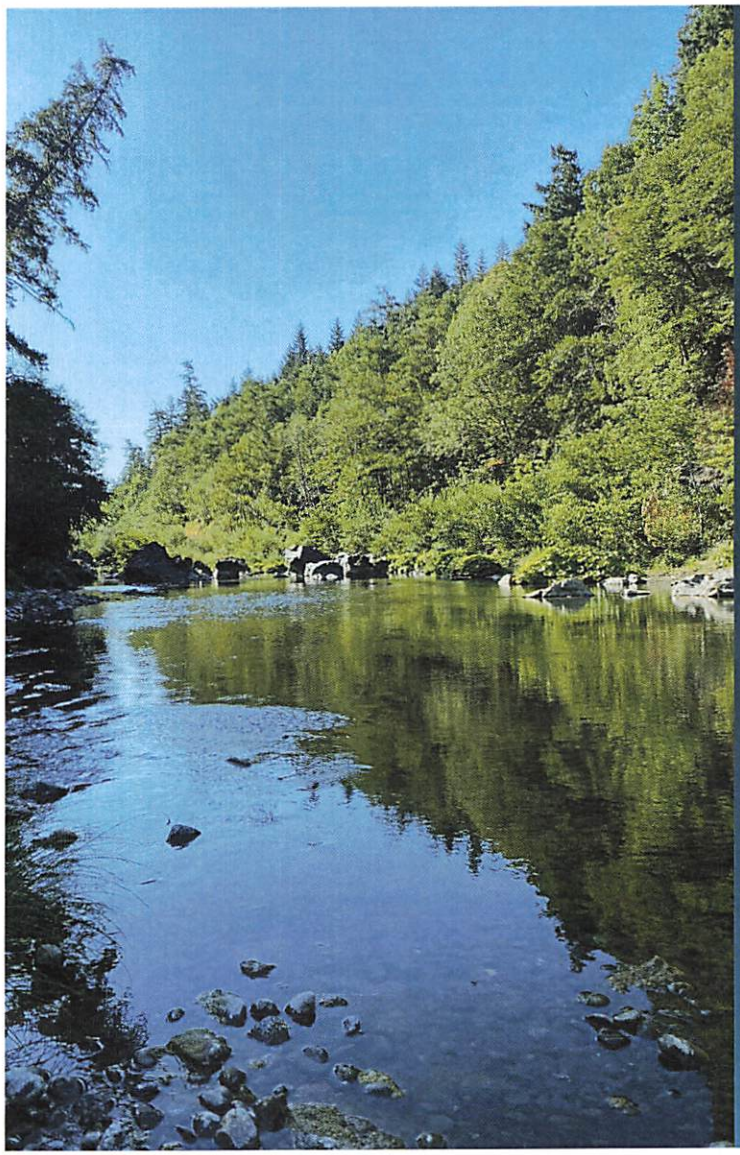
Monthly Average Daily Flows

(January 1, 2010 to July 25, 2023)



District requests the flow to be permanently dedicated is 31 cfs on a monthly average.

In the summer, red line and gray bars are approximately equal → all water is from Ruth Reservoir, has been stored and is available for instream flow purposes.



Injury Analysis

Three water user groups defined:

1. Legal water rights holders, senior and junior to the District's water rights
2. Humboldt Bay Municipal Water District
3. Cannabis cultivation operations

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Senior Water Rights Holders	0.02	0.02	0.02	0.02	0.50	0.64	0.64	0.64	0.64	0.02	0.02	0.02
HBMWD Diversions @ Essex	12.1	12.7	12.2	12.4	13.1	14.6	16.1	15.7	15.0	13.5	12.8	12.2
Total Consumptive Use	12.1	12.7	12.2	12.4	13.6	15.2	16.7	16.4	15.6	13.6	12.8	12.2
Flow at Arcata Gage	2,873	2,442	2,969	1,877	637	291	89	54	57	177	594	2,229
HCP Flow Requirements at Arcata Gage	75	75	75	75	75	75	50	40	30	50	75	75
HCP Flow Requirement Met?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Available for 31 cfs Dedication?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Monthly Average Diversion Rates for the District and Water Rights Holders Senior to the District, and Indicated Average Flow Rates (cfs)

Data from:
January 1, 2010 to
July 25, 2023

Cannabis Water Use

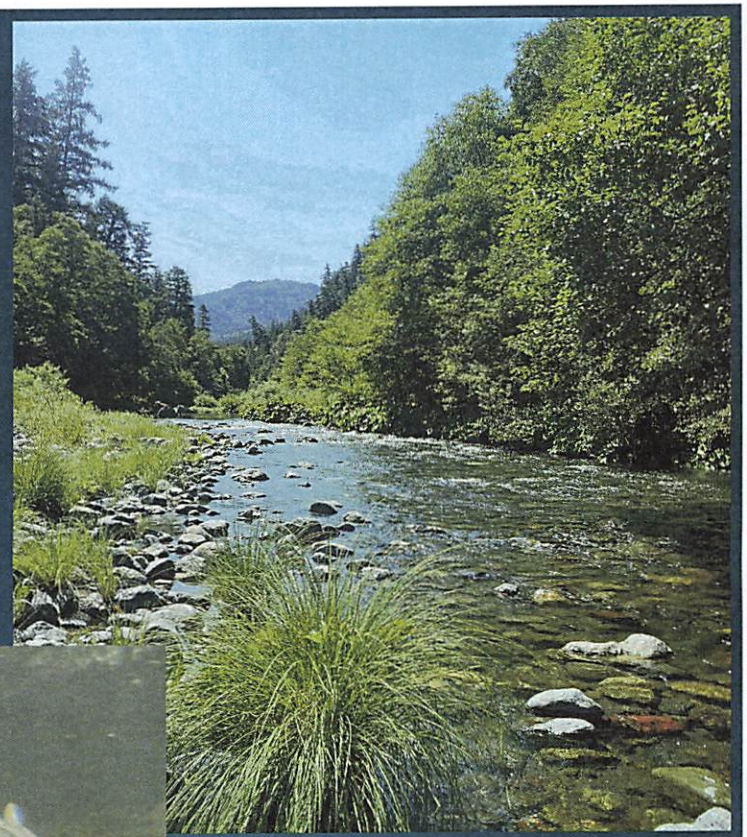
- Claimed water rights included in eWRIMS data base
- Illegal water use difficult to estimate and should decrease with increased enforcement

State Board must be able to make two findings:

- ✓ Instream flow dedication will not increase the water that the District is entitled to use, and
- ✓ Instream flow dedication will not injure other legal users of water.

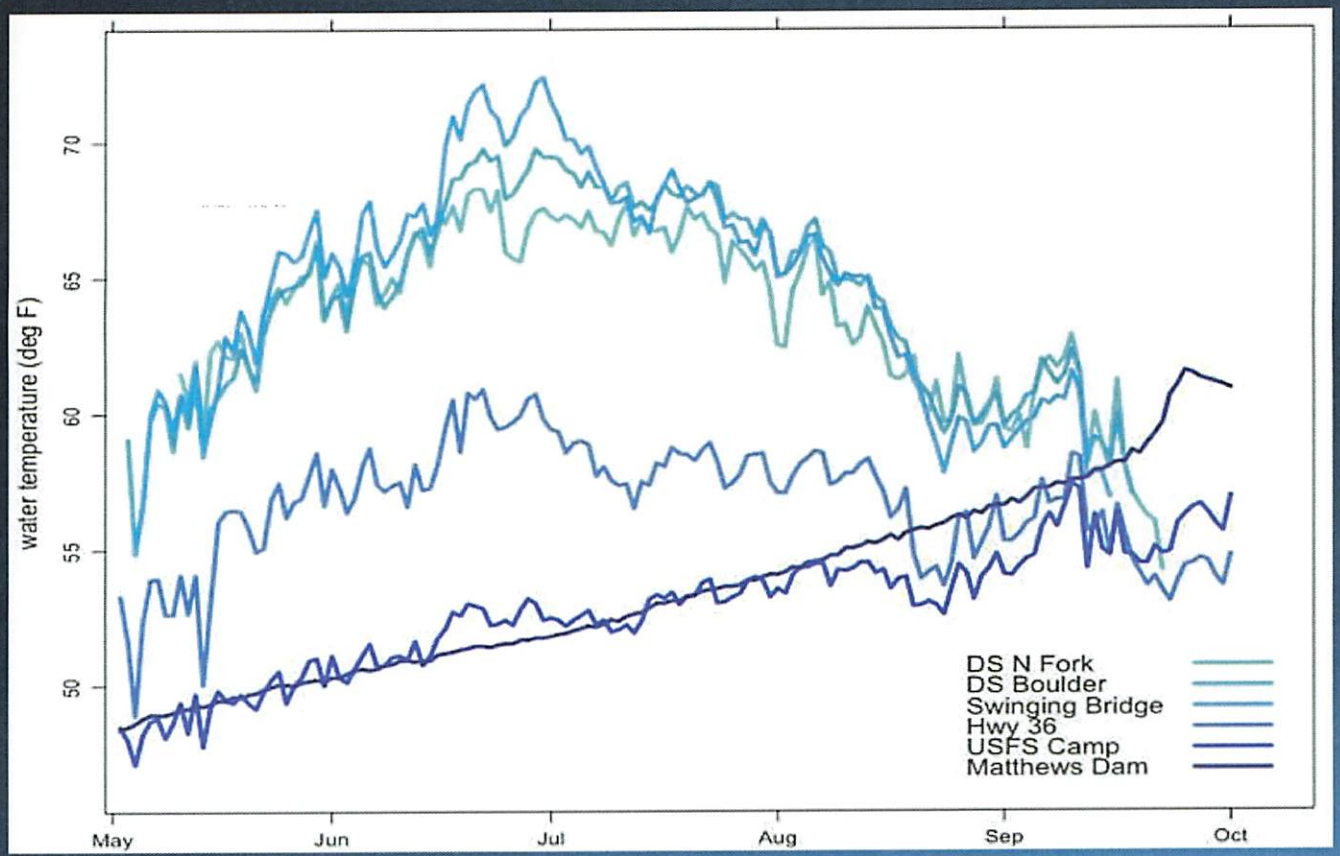
Water Quality Considerations

Water quality studies show District operations primarily benefit the first 10 miles downstream of Matthews Dam by decreasing water temperature.



Mad River Summer Steelhead photo from Jacob Pounds

Water Quality Considerations



- Middle Reach and below (Swinging Bridge down) had similar temperatures (light blue on graph)
- Daily values in Middle and Lower reaches distinctly warmer than those recorded from the Upper Reach (dark blue).
- Data collected in 2018.

Habitat Quality Considerations

Releases from Matthews Dam increase habitat in the Mad River primarily by providing higher discharge in the summer months than inflow into Ruth Reservoir. This higher discharge results in:

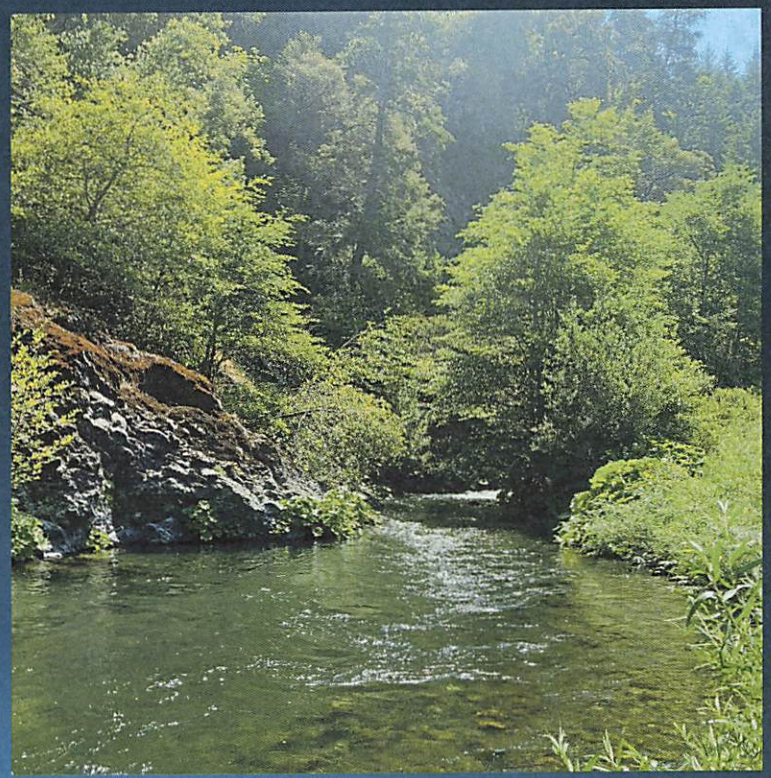
- increased holding habitat for adult summer steelhead downstream of Pilot Creek,
- improved shallow river edge water rearing habitat for juvenile salmonids in the mainstem,
- expanded habitat for egg and juvenile life stages of yellow-legged frogs, and
- resilience to climate change

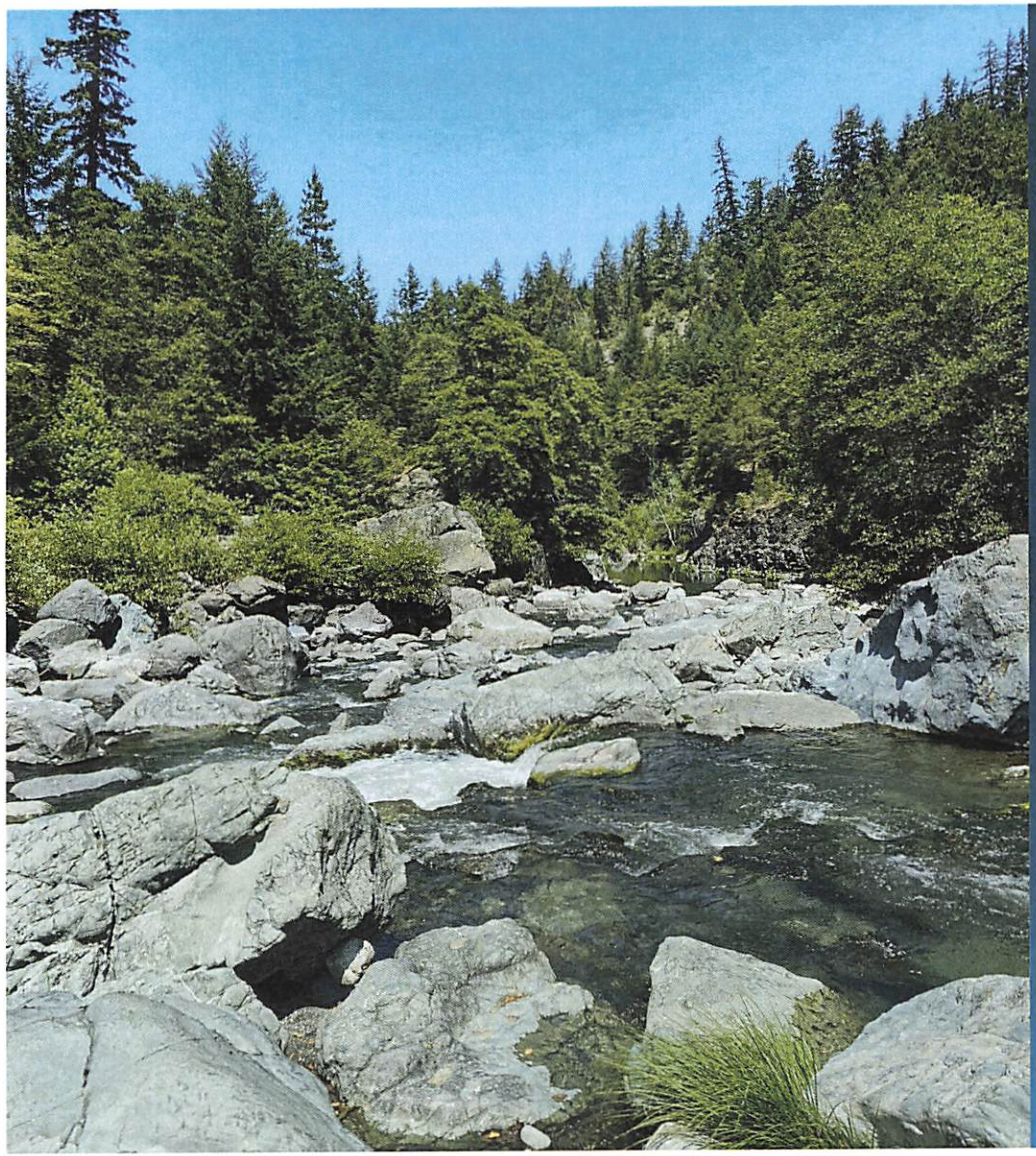
Actions and Approvals Requested of the State Water Board:

The District requests that the SWRCB process a change petition under Water Code section 1707 that would dedicate a release of approximately 31 cfs on a monthly average for the purpose of enhancing the fishery and aquatic/riparian ecosystem of the Mad River. This change would take effect upon approval by the SWRCB and would be a permanent change to the District's water rights.

Next Steps

- Submit DRAFT Petition for Change to SWRCB for comments.
- Address comments from SWRCB.
- Finalize Petition for Change with Instream Flow Committee and consultants.
- Submit finalized complete Petition for Change to SWRCB.





Questions?

Narrative Summary for Humboldt Bay Municipal Water District Petition for Change

Introduction

The Humboldt Bay Municipal Water District (HBMWD or "the District") provides water on a wholesale basis to municipal and industrial customers in the Humboldt Bay area, and on a retail basis to a few hundred retail customers. Located in Humboldt County, the District's wholesale municipal customers include the cities of: Arcata, Blue Lake and Eureka; and the Humboldt, McKinleyville, Manila and Fieldbrook-Glendale Community Services Districts. Via the wholesale relationship, the District serves a population of approximately 90,000 in the greater Humboldt Bay area, or about 2/3 of the region's population.

The District's water system is comprised of a reservoir (Matthews Dam impounding Ruth Lake), a small hydro plant at Matthews Dam, and the natural Mad River channel that runs approximately 75 miles downstream to various facilities at Essex. At the Essex Facility, the District operates five Ranney wells that supply municipal and industrial customers, a turbidity reduction facility, a disinfection system, and a surface diversion station that historically provided untreated water to two pulp mills. One mill ceased operation and water demand in 1994, and the second mill ceased operation and its water demand in 2009. Since 2009, the District has been operating the hydro plant by releasing water as if the second mill was still operating ("one mill scenario"). This has resulted in greater than natural flow during the summer within the 75 miles of river between Matthews Dam and Essex, which is permitted under the District's current water rights.

The additional water benefits aquatic organisms and habitat in and along the river corridor downstream of the dam. These releases are within the District's permitted rights and do not injure any senior water rights holders, as described below.

This Petition for Change is a request that the District be able to continue these releases by adding to its existing purposes of use for instream purposes of preserving or enhancing fish and wildlife resources. Without adding this purpose of use, the District could be required to cease releasing the additional water over and above its municipal and industrial demands (current permitted uses), which would be detrimental to aquatic organisms and habitat.

The District currently holds three post-1914 appropriative water rights on the Mad River (Appendix A). They are:

- Permit No. 11714 issued on March 16, 1959, which provides storage of 100,000 acre-feet from about October 1 to April 30, diversion methods and uses, and a fish protection release schedule.
- Permit No. 11715 issued on March 16, 1959, which provides direct diversion of 200 cfs year round and 20,000 acre-feet to storage from about October 1 to April 30, diversion methods and uses, and a fish protection release schedule. Permit No. 18347 issued on September 25, 1981, which provides diversion and storage rates for operation of the 2-MW hydroelectric generation facility at Matthews Dam.

On February 28, 2007, the State Water Board (dated February 28, 2007) approved a permit time extension from 2009 to 2029 (Appendix A). The order also reduced the amount of water subject to appropriation as follows:

- Permit 11714: Storage of 48,030 acre-feet from October 1 to April 30.
- Permit 11715: Direct diversion of 116 cfs year round and 20,000 acre-feet to storage from October 1 to April 30.
- Total annual diversion under Permits 11714 and 11715 not to exceed 132,020 acre-feet per year.

The bypass and minimum flow requirements in Permits 11714 and 11715 are incorporated into the District Habitat Conservation Plan. The bypass and minimum flow requirements in Permits 11714 and 11715 are incorporated into the District's Habitat Conservation Plan. The Habitat Conservation Plan (HCP) describes the activities conducted by the District on the Mad River and the impacts of these activities on listed fish and designated critical habitat. The National Marine Fisheries Service analyzed the HCP and in 2005 issued an incidental take permit to the District addressing the effects of the District's Mad River Operations on Northern California (NC) steelhead (*Oncorhynchus mykiss*), Southern Oregon/Northern California Coast (SONCC) coho (*O. kisutch*) salmon, and California Coastal (CC) Chinook salmon (*O. tshawytscha*) and on designated critical habitat for SONCC coho salmon under the Federal Endangered Species Act. These activities include current, ongoing activities and those activities that occur only when needed. Ongoing activities include releasing flow at Matthews Dam (including the bypass and minimum flow requirements in Permits 11714 and 11715), diverting water in the Essex Reach of the Mad River from Ranney collectors and surface diversion, operating the direct diversion facility including fish screens, dredging the forebay, and maintaining adequate water surface elevations at and flow to the Station 6 facility. As-needed activities include maintaining adequate capacity in the tailrace and spillway pools below Matthews Dam, access to and maintenance of Ranney collectors, and repair and maintenance of rock structures and revetments.

In 1981, the Federal Energy Regulatory Commission (FERC) granted Exemption No. 3430 for the 2-MW hydroelectric plant at Matthews Dam. The District has a contract to sell "as available" energy and capacity to PG&E. The District does not operate the plant as an electric "peaking" facility, nor does the District "ramp" its flow releases (i.e., dramatically change flow in a short period of time in response to power needs). Power production is incidental to the District's water supply function.

The District's water supply infrastructure is described in greater detail here (Figure 1). Near the top of the Mad River watershed, the District operates a small reservoir (Ruth Lake, storage capacity 48,000 acre-ft), Matthews Dam, and a small 2-MW hydroelectric facility. The reservoir generally fills quickly each year, usually after the first two or three major storms in the fall. After it fills, the District generally releases water through the hydroelectric facility penstock and over the ungated spillway, and flow is described as "run of the river." Water continues to flow approximately 75 miles downstream to the Essex Facility, where the District operates five Ranney wells for municipal and industrial water use and a surface water diversion for industrial water use. Downstream of the Essex Facility, water flows approximately 9 miles to the Mad River estuary and Pacific Ocean. Essex is a point of re-diversion under Permits 11714 and 11715 and a point of direct diversion under Permit 11715.

During the late spring and throughout the summer, discharge over the spillway ceases and flows in the Mad River are from tributary contributions and releases from Ruth Lake through the hydro plant. The District releases water to meet its municipal and industrial demands, minimum flow environmental requirements, and to incidentally generate electricity.

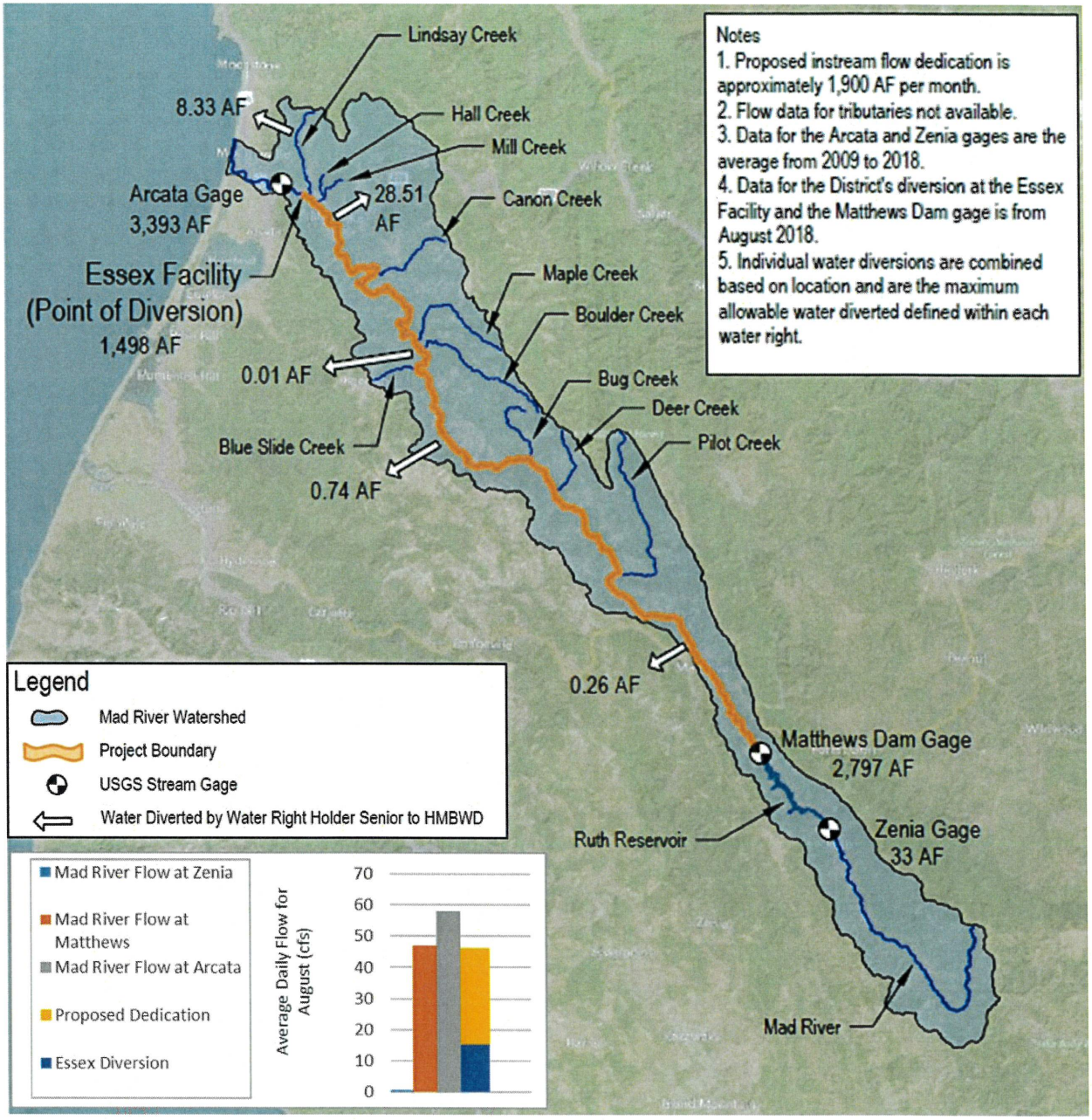


Figure 1. Water Diversions and Flow Measurements for the Proposed Dedication for the Month of August, Based on Data from January 1, 2010 to July 25, 2023. Representative Low River Flow Augmentation.

DRAFT

History of District Operations

When the District government and infrastructure were formed in the late 1950s and early 1960s, two pulp mills on the Samoa peninsula were the District's primary industrial customers, who required up to 65 million gallons per day (MGD) (100 cfs). Since 2009, both pulp mills have closed and industrial demand is negligible. New industrial users are likely to re-develop the Samoa peninsula in the future, but their water use will be a fraction (likely no more than 20%) of the former pulp mills' demands.

Revenue from industrial water sales significantly decreased when the pulp mills closed. To address both the decrease in revenue and a potential loss of water rights due to lack of use, the District organized a public engagement process starting in 2008, to understand the public's views and desires related to water use. The engagement process continues to the present, and the public's views are consistent over time. The public supports three water use options: 1) local use by existing and new municipal customers, and new industrial customers, 2) transport outside of District boundaries to a public agency, and 3) instream flow releases for environmental benefit.

Cannabis cultivation in the Mad River watershed, which falls under the jurisdiction of both Humboldt and Trinity counties, has dramatically increased and become a public concern. Numerous illegal diversions of water have been documented by enforcement agencies and the District. In one case, District staff discovered an illegal cultivation operation that was diverting water directly from Ruth Lake. Numerous investigations have documented diversions from Mad River tributaries, but Humboldt and Trinity County enforcement agencies have limited resources that must be stretched to cover the Klamath, Trinity, and Eel River watersheds in addition to the Mad River basin.

Given the public's desire for instream flow releases for environmental benefit, the continuing threat of illegal diversions from cannabis cultivation, the impacts from climate change, and the District's desire to continue environmentally beneficial releases, the District is pursuing a permanent water rights change in purpose of use under Water Code Section 1707. Given that our current permits and extension expire in 2029, we request a Long-Term Change Petition under Water Code Section 1707.

Purpose of the Project

The purpose of the Project is to:

- Improve summer rearing habitat for juvenile salmonids
- Improve spring mainstem shallow water river edge habitat for foothill yellow-legged frogs and salmonid fry
- Provide resilience for river biota to ameliorate the effects of climate change

The District's infrastructure and operations pose minimal environmental impacts compared to many large-scale dams in California. There are several reasons for this:

1. The total volume of water impounded at Ruth Lake represents a small fraction of the total runoff within the Mad River watershed because Matthews Dam is: a) located high in the watershed and b) relatively small compared to the size of the watershed and the total discharge of the watershed.
2. Ruth Lake is a fill-and-spill reservoir with an ungated spillway that generally fills early in the rainy season. This allows the river to experience the high flow winter hydrograph and associated geomorphic processes.
3. Tributaries downstream of Matthews Dam contribute significantly to the Mad River discharge.
4. Matthews Dam is upstream of a full barrier to salmon migration and a partial barrier for steelhead migration.
5. No out-of-basin transfers occur in the upper watershed, as happens on other North Coast rivers, for example, the Eel River to the Russian River or Trinity River to Sacramento River.
6. The hydroelectric facility at Matthews Dam does not operate on a power-peaking mode as do many other California dams.

Throughout the year, but particularly in the summer and early fall low flow periods, the District's flow releases substantially augment flows in the Mad River, compared to what otherwise would occur without the District's operations.

Proposed and Current Operations

Comparisons of the District's current and proposed water rights parameters are tabulated (Table 1). The District's bypass flow schedule as described in its Habitat Conservation Plan is provided in Table 2.

Table 1. Comparison of District's Current and Proposed Water Rights Parameters

Water Rights Parameter	Current	Proposed
Amount	• Permit No. 11714. Limited to what can be beneficially used • Permit No. 11715. Limited to what can be beneficially used • Permit No. 18347. Limited to what can be beneficially used	No changes proposed
Rate	• Permit No. 11714. Not to exceed 48,030 acre-ft per year to storage • Permit No. 11715. Not to exceed 116 cfs by direct diversion and 20,000 acre-ft per year to storage • Permit No. 18347. Not to exceed 1,000 cfs by direct diversion and 120,000 acre-ft per year by storage	No changes proposed

Water Rights Parameter	Current	Proposed
Season of diversion	• Permit No. 11714. From October 1 to about April 30 of the succeeding year • Permit No. 11715. Year-round for direct diversion and about October 1 of each year to April 30 of the succeeding year for storage. • Permit No. 18347. Year-round for direct diversion and October 1 of each year to April 30 of the succeeding year for storage.	No changes proposed
Authorized purposes and place of use	• Permit No. 11714. Municipal use within HBMWD boundaries according to schedule downstream of the Essex Facility[1] • Permit No. 11715. Same as 11714. • Permit No. 18347. Power generation	Add purpose of use to instream preservation or enhancement of fish and wildlife resources
Points of diversion	• Permit No. 11714. Diversion to storage at Matthews Dam; re-diversion at the Essex Facility • Permit No. 11715. Diversion to storage at Matthews Dam; direct diversion and re-diversion at the Essex Facility. • Permit No. 18347. Ruth Reservoir	No changes proposed
Priority	• Permit 11714. July 7, 1955 • Permit 11715. September 21, 1956 • Permit No. 18347. December 9, 1980 "subject to future upstream appropriations for consumptive use within the Mad River watershed"	No changes proposed
[1] See Table 2. Bypass Flows Schedule downstream of Essex Diversion.		

Table 2. Bypass Flow Schedule Downstream of the Essex Facility, Measured at the Arcata Gage.

Time Periods	Minimum Flow Downstream of Essex Diversion, cfs*
October 1 through October 15	30
October 16 through October 31	50
November 1 through June 30	75
July 1 through July 31	50
August 1 through August 31	40
September 1 through September 30	30

*Or natural flow, whichever is less. "Natural flow" is defined in the District's HCP as a calculated number based on the equation: Natural flow = (Essex diversion + flow below Essex + inflow into Ruth at Zenia) - flow release at Matthews Dam.

Instream Flow Will Not Increase the Amount of Water the District is Entitled to Use Or Injure Other Legal Users of Water

Water Code sections 1700 through 1707 govern changes to permitted water rights. Such changes must be approved by the State Water Board and "[b]efore permission to make such a change is granted the petitioner shall establish, to the satisfaction of the board, and it shall find, that the changes will not operate to the injury of any legal user of the water involved." (Wat. Code, § 1702.) Under Water Code section 1707, in order to approve a change in purpose of use for instream use the State Water Board must also find that the proposed change will not increase the amount of water the person is entitled to use.

The addition of a purpose of use for instream use to preserve or enhance fish and wildlife resources will not increase the amount of water the District is entitled to use because the water released for this purpose is within the water available for diversion under the District's existing rights. During winter months, the District will store water in Ruth Reservoir as permitted by its existing water rights. During the late spring, summer and early fall months, the District will release water from Matthews Dam within the quantities authorized under its existing permits. As reflected in Figure 2, during the months of May through October, flows as measured above Matthews Dam at Zenia (blue bars) are lower than the District's releases as measured at Matthews Dam (gray bars). In the summer months of July through September, the District's releases from Matthews Dam are a significant portion of the flow at the Arcata gage (green bars), which demonstrates that the District's releases augment flows for the benefit of the environment.

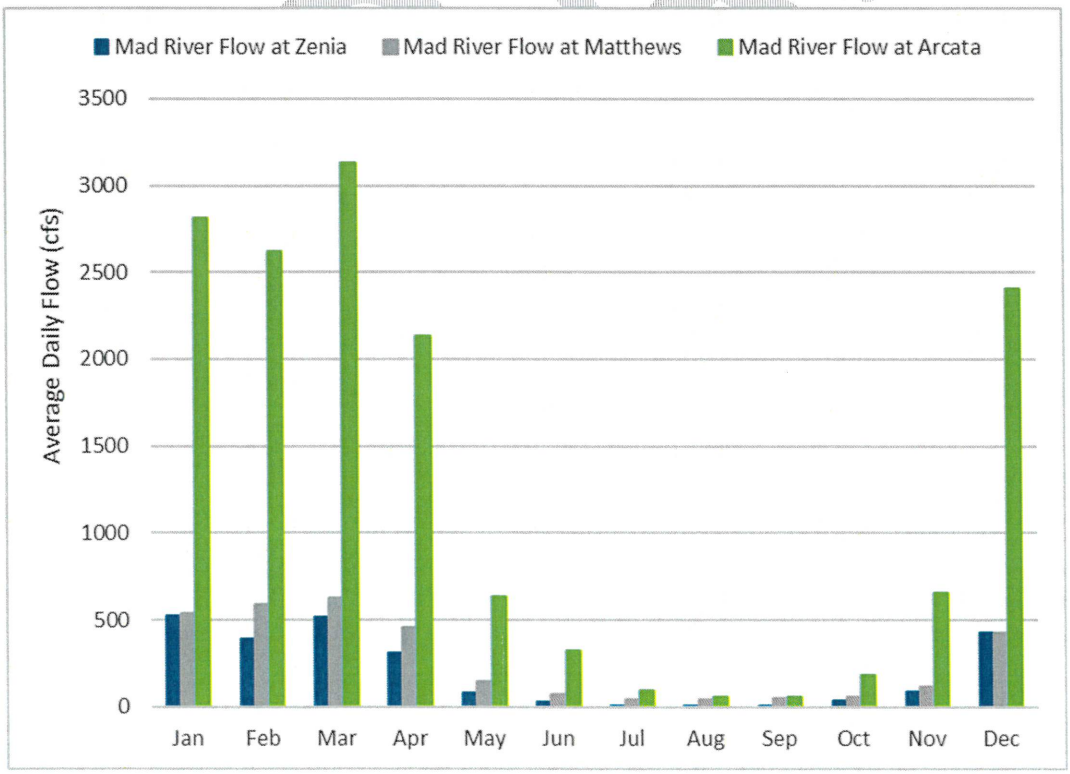


Figure 2. Mad River Average Daily Flows by Month at Indicated Locations, from January 1, 2010 to July 25, 2023.

The flow volume requested to be permanently dedicated is 1,900 AF per month (31 cfs, 20 MGD), based on monthly average daily flows. The approximate flow that the District diverts at Essex (yellow line in Figure 3) is the volume of water that would be released from Matthews Dam without the instream flow dedication. The red line indicates the sum of the water requested to be put to instream use for fish and wildlife plus the needs of the municipal and industrial users.[1] During the dry season (July through September), the red line and gray bar are approximately equal, which suggests that all of the water released by the District from Ruth Reservoir has been previously stored by the District and is available for use for instream purposes for fish and wildlife resources from Matthews Dam to the ocean.

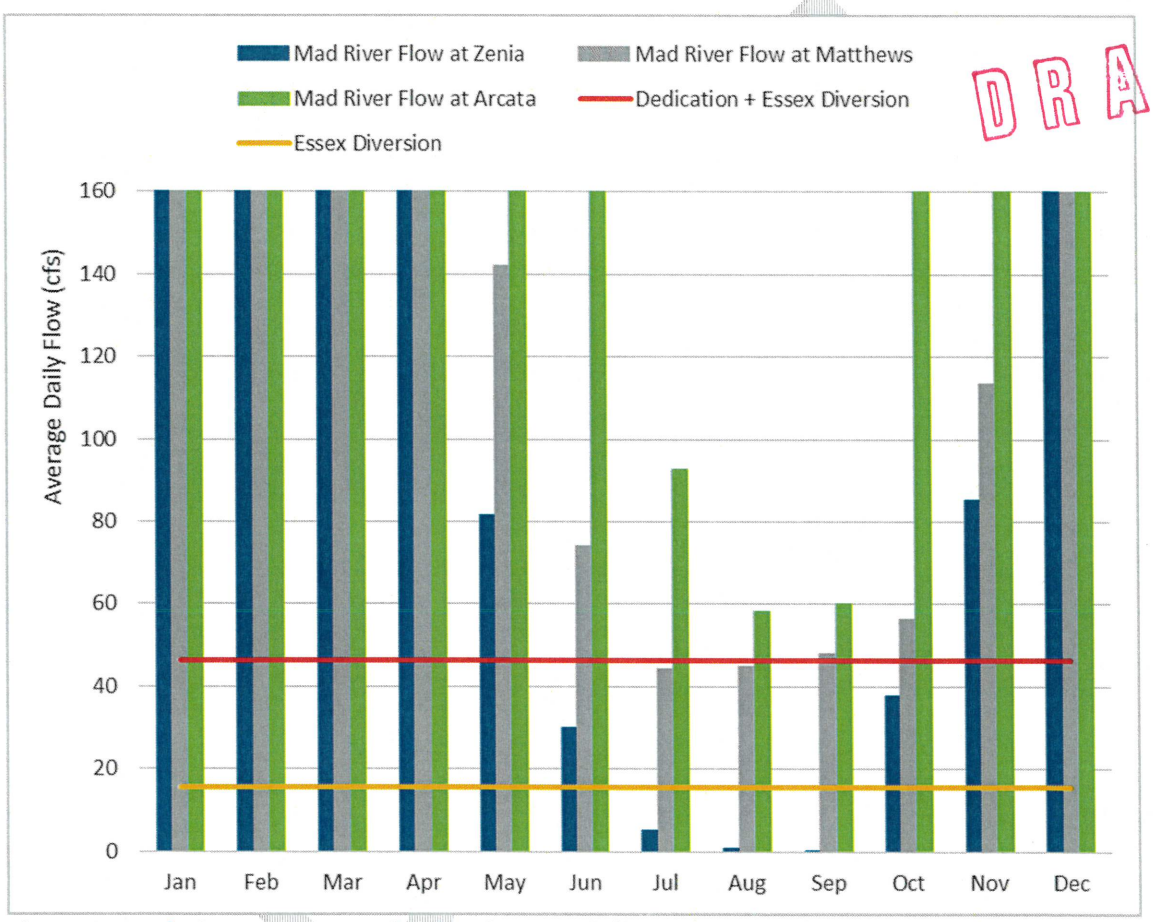


Figure 3. Mad River Average Daily Flow by Month (based on data from January 1, 2010 to July 25, 2023) at Indicated Locations with District's Diversion and Proposed Dedication.

The additional use for instream purpose would not result in injury to other legal users of water because the District's past and current operations involve the release of its stored water that is and has historically been put to consumptive use. As explained above, there is little to no natural flow available for diversion during the July through September and most of the water in the River from Matthews Dam to the ocean is comprised of the District's previously stored water. In other months, the District will release previously stored water within the limits of its water rights. In this way, the amount of water that will be dedicated to instream use will not decrease the amount of water available to other legal users of water. Dedicating the District's release of previously stored water to instream purpose will

[1] The lines reflect uniform average monthly volumes based on water available for appropriation under the District's water rights, not measured values.

maintain water levels and water quality in the River for other water users to access diversion of natural flow water that may be available for diversion under other rights.

Under current operations, during the summer and early fall months (typically July 1 to October 1), the District releases water from Ruth Lake for three reasons: 1) to run one turbine of the hydroelectric facility, 2) to supply water for diversion at the Essex Facility for municipal and industrial uses, and 3) to provide required bypass flows. Currently, industrial uses are minimal but recent interest in developments on the Samoa peninsula could increase industrial water demand again. In the District's history, its maximum consumptive water demand was 116 cfs (75 MGD) year-round from the two pulp mills (100 cfs [65 MGD]) and its municipal customers (16 cfs [10 MGD]).

Between 2010 (after the last pulp mill closed) and 2023, average daily flows during the summer at the Arcata gage have been highly variable but have been greater than 33 cfs. The District's daily average diversion at Essex during this time has been approximately 13.5 cfs with a maximum diversion of 16.1 cfs in August (Table 3). During this time, the District's Habitat Conservation Plan (HBMWD 2004) minimum flow requirements have been met. If future industrial demands increase, the District will release more water during the summer to meet the demands of the industrial and municipal customers and the minimum flow requirements, if necessary.

Under the proposed instream flow dedication, the District expects to release 31 cfs monthly average while the project is operating (e.g., releasing stored water) for instream use in addition to the 13.5 cfs monthly average diversion for consumptive use (Table 3) for combined beneficial use of 44.5 cfs monthly average, which is well within the water available and historically used by the District under its water rights. The requested additional purpose of use will not change the volume or timing of releases under these current operations. It will also not change the place of consumptive use because the District will continue to put water under Permits 11714 and 11715 to municipal use at the downstream Essex point of diversion. Similarly, the requested change will not increase the amount of water the District is entitled to use under its water rights.

Consumptive Use and Injury Analysis

Using extremely conservative assumptions, there is no injury to senior water rights users resulting from the District's proposed instream flow dedication. There is also no impact to water rights holders that are junior to the District.

To assess potential effects to other legal users, an injury/impact analysis was performed. Flow data were very limited for the 75-mile project reach (Figure 1), so a comparison of known values was used to assess injury/impact.

Values used in this analysis included measured flow rates entering and exiting Ruth Reservoir (at Zenia and Matthews Dam gages, respectively) and downstream of the Essex Facility (at the Arcata gage), maximum allowable diversion rates for legal water users, and the District's measured diversion rates. Locations of the three gages and the District's diversion are shown in Figure 1. All other points of diversion (i.e., legal water users) are combined based on proximity as indicated on Figure 1.

Water users in the Mad River watershed were listed, and data sources that characterize their water rights and usage were reviewed. Water users were categorized into these general groups:

- Legal water rights holders. Data were available through the State Water Resources Control Board Electronic Water Rights Information Management System (eWRIMS). Water right holders were identified as senior or junior to the District's water rights.

- Humboldt Bay Municipal Water District. Data were available through District records.
- Cannabis cultivation operations. In May 2014, the California Department of Fish and Wildlife used high resolution imagery to digitize cannabis cultivation sites and to estimate their water use. However, their analysis did not distinguish between legal and illegal cultivation sites. Legal cultivators who have applied for water rights are included in the eWRIMS database. In this injury/impact analysis, no attempt has been made to estimate water use of illegal cannabis operations, and we assume that illegal operations will become fewer in the future due to increased law enforcement.

Since 2010, after the last pulp mill closed, to 2023, a comparison of flows indicates that minimum summer flows at the USGS Arcata gage were always greater than the maximum demand of senior water rights holders according to eWRIMS and actual diversions by the District (Table 3), even when applying very conservative assumptions.[2] The proposed instream water dedication will support water levels and water quality between Matthews Dam and Essex while still allowing for diversion by senior right holders to the extent that is available for them to divert pursuant to their priority of right. Junior right holders will not be injured because water levels will be maintained to support diversion of any remaining water that is available for diversion pursuant to their junior priority. Therefore, no water rights holders will experience injury from the District's diversions.

[2] Actual amounts of water diverted by other water rights holders were not available so maximum diversion rates included in their water rights were used as a conservative assumption.

Table 3. Monthly average diversion rates for the District (HBMWD) and water rights holders senior to the District (based on data from January 1, 2010 to July 25, 2023) and indicated average flow rates (cfs).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Senior Water Rights Holders	0.02	0.02	0.02	0.02	0.50	0.64	0.64	0.64	0.64	0.02	0.02	0.02
HBMWD Diversions @ Essex	12.1	12.7	12.2	12.4	13.1	14.6	16.1	15.7	15.0	13.5	12.8	12.2
Total Consumptive Use	12.1	12.7	12.2	12.4	13.6	15.2	16.7	16.4	15.6	13.6	12.8	12.2
Flow at Arcata Gage	2,873	2,442	2,969	1,877	637	291	89	54	57	177	594	2,229
HCP Flow Requirements at Arcata Gage	75	75	75	75	75	75	50	40	30	50	75	75
HCP Flow Requirement Met?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Available for 31 cfs Dedication?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes:
Proposed dedication (20 MGD) = 31 cfs
HCP Flow = Flow requirements in the District's Habitat Conservation Plan (HCP). If a single month had two different minimum flows, the higher of the two is shown.
Senior Water Right Holders = The total flow rate assumed to be diverted by all water right holders that are senior to the District.
HBMWD @ Essex= Actual average flow diverted by the District at Essex
Total = The sum of Water Right Holders and HBMWD @ Essex.
Flow at Arcata Gage = Average monthly flow rate at the Arcata gage for 2010 – 2023.

Water Quality Considerations of the Petition

The North Coast Regional Water Quality Control Board has listed the Mad River as impaired for sediment, turbidity, and temperature under Section 303(d) of the California Clean Water Act, and water quality is an important consideration in the conservation of salmonids and other special-status species.

The major sources of sediment and turbidity in the Mad River are from landslides and surface erosion associated with roads, timber harvest, and other disturbance within the watershed; most of this disturbance occurs in the watershed downstream of Matthews Dam, which is approximately 76% of the basin area (Stillwater Sciences and RCAA 2010). The District's operations and release pattern will not significantly change under this Petition for Change so the proposed instream use would have no effect on sediment and turbidity in the middle and lower reaches of the Mad River, but the dam does hold back sediment immediately below the dam.

Ruth Reservoir has a seasonal effect on water temperature in the river downstream of Matthews Dam (Appendix B). During warmer months, because the intake for the discharge outlet is deep (approximately 132 feet below crest elevation), water temperatures downstream of the outlet are cool, ranging from 48.4°F in May 2018 to 61.2°F degrees in October 2018. The cool water source at the outlet affects water temperatures in the 7.5 miles downstream of Matthews Dam (at the sensor at Highway 36). However, stream temperature equilibrates with air temperature by the next downstream temperature sensor, 38.6 miles downstream from the Dam (at RM 41.6) (Figure 5). Temperature sensors from RM 41.6 to the downstream-most sensor on the mainstem at the Mad River Boat Launch (RM 3.1) are affected by ambient air temperatures, which cool closer to the coast due to the influence of the Pacific Ocean, as well as localized cooler water inputs from specific tributaries in the lower Mad River.

The main benefits of releases from Matthews Dam primarily occur in the first 10 miles of so downstream of the dam. These benefits increase habitat quality and quantity for salmonids (e.g., juvenile steelhead and resident rainbow trout) and yellow-legged frogs in spring and summer, and water quality (e.g., cooler water temperatures) in the upper reach in summer. Releases from Matthews Dam increase habitat in the Mad River primarily by providing higher discharge in the summer months than inflow into Ruth Reservoir. This higher discharge results in increased holding habitat for adult summer steelhead downstream of Pilot Creek, improved shallow river edge water rearing habitat for juvenile salmonids in the mainstem, expanded habitat for egg and juvenile life stages of yellow-legged frogs, and resilience to climate change.

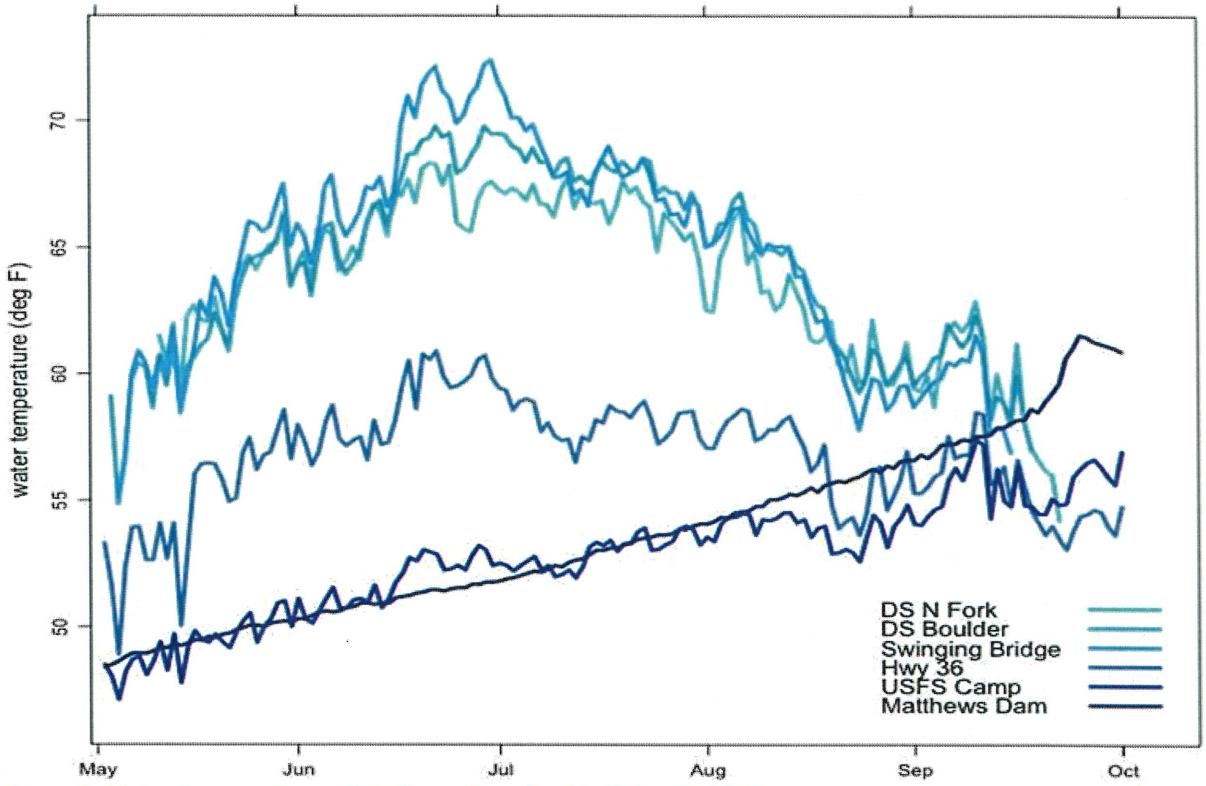


Figure 5. Water temperatures at stations along the Mad River in 2018.
Lower Reach of the Mad River (DS N Fork [RM 13.7], DS Boulder [RM 32.6]) and the Middle Reach (Swinging Bridge [RM 41.6]) had similar temperatures. Note: Here, daily values only, distinctly warmer than those recorded from the Upper Reach (Hwy 36 [RM 72.7], USFS Camp [RM 77.0], Matthews Dam [RM 80.2]). Matthews Dam=MRDam, USFS Camp=MRUSFSCamp, Hwy 36=MRHWY36, Swinging Bridge=MRSwingB, DS Boulder=MRDSBoulder, DS N Fork=MRDSNF.

The District's releases from Matthews Dam have resulted in additional instream flow in the mainstem Mad River between the dam and estuary, particularly between June and October. Without these releases, the aquatic habitat that many fish and amphibians rely on would be significantly diminished. In the upper Mad River, between Matthews Dam and Pilot Creek, District releases are the source of inflow to the mainstem and provide important shallow river edge water habitat for early life stages of steelhead and foothill yellow-legged frogs. Less of this important habitat would be available if releases from Matthews Dam were to be decreased.

Releases of bottom water from Matthews Dam (RM 80) currently results in water temperatures that are below 60°F (the preferred temperature zone for juvenile steelhead rearing during the summer and early fall months) downstream to Hwy 36 (RM 72.7). If releases were decreased, a consequence could be less habitat available with preferred temperatures because decreased volume and depth of water in the river would equilibrate more quickly with air temperature.

Over the last 60 years, the releases from Matthews Dam have resulted in higher summer and fall flows in the lower river. These higher flows have possibly allowed for the mouth of the river to remain open to the ocean year-round, which has enabled Chinook salmon, coho salmon, and steelhead to enter the river in the fall unencumbered by the presence of a barrier beach. Reduced flows could result in seasonal development of a barrier beach bar that would block upstream migration of anadromous salmonids until fall and winter runoff conditions are high enough to breach the bar. Given that Chinook salmon begin their upstream spawning migration and enter the Mad River in late August or early September, a barrier beach could delay or eventually eliminate the early part of the run.

The lower Mad River provides habitat for juvenile steelhead and coho salmon rearing during the summer months. Augmented flows increase the amount of suitable habitat for these species during the summer and fall months. Reduced flows would decrease the amount of available habitat and increase the potential for density-related effects.

Actions and Approvals Requested of the State Water Board

The District requests that the SWRCB process a change petition under Water Code section 1707 that would dedicate a release of approximately 31 cfs (as described above in Figure 3) for the purpose of enhancing the fishery and aquatic/riparian ecosystem of the Mad River. This change would take effect upon approval by the SWRCB and would be a permanent change to the District's water rights.

Key Findings In Support of 1707 Change Petition

Will the change initiate a new water right or increase the amount of water the District is entitled to use? No, the District's water right Permits 11714 and 11715 currently allow for releases of previously stored water at Matthews Dam to meet the requested 31 cfs use of water for instream purposes.
Will the change injure any legal water user? No, the proposed instream water dedication will support water levels and water quality between Matthews Dam and Essex while still allowing for diversion by right holders to the extent that was is available for them to divert pursuant to their priority of right.
Does the change petition address CEQA requirements? In progress
Will the change have any adverse effects on public trust resources? No, the requested change will improve aquatic habitat between Matthews Dam to the Essex facility.
Is the change in the public interest? Yes, the instream use will benefit fish and wildlife resources and allow for diversion of water by other users in the project area.

Project Map

A project map is included as Figure 1. This map includes:

- ✓ A delineation of the project site
- ✓ All known diversions within the vicinity of the project
- ✓ Identification of HBMWD's existing point of diversion
- ✓ Delineation of the stream habitat that the change petition intends to address

References

GHD. 2020. Water Rights Injury Analysis. Memo to Humboldt Bay Municipal Water District Reference No. 11185389. Dated February 25, 2020.

[HBMWD] Humboldt Bay Municipal Water District Habitat Conservation Plan for its Mad River Operations. Final Approved HCP - April 2004.

Stillwater Sciences and RCAA (Redwood Community Action Agency). 2010. Mad River watershed assessment. June 2010. Final report. Prepared for Redwood Community Action Agency, Eureka, California.

APPENDIX A. HBMWD Water Rights Permits

STATE OF CALIFORNIA
STATE WATER RESOURCES CONTROL BOARD

ORDER WRO - 2004 - 0038

In the Matter of Permits 11714 and 11715
Regarding Diversions by
HUMBOLDT BAY MUNICIPAL WATER DISTRICT

SOURCE: Mad River

COUNTIES: Humboldt and Trinity

ORDER APPROVING AN EXTENSION OF TIME AND PARTIAL REVOCATION OF PERMITTED WATER RIGHTS

BY THE BOARD:

1.0 BACKGROUND

Permits 11714 and 11715 were issued to the Humboldt Bay Municipal Water District (District) on March 16, 1959, pursuant to water right applications 16454 and 17291, respectively. These permits allow diversion to storage of up to 120,000 acre-feet per annum (afa), plus direct diversion of up to 200 cubic feet per second (cfs). At present, the District has developed a reservoir storage capacity of 48,030 acre-feet (af) in Ruth Lake, and has diversion capacity of 116 cfs at the community of Essex on the Mad River. These facilities and capacities constitute Phase I of the District's project. The remaining diversion and storage capacities allowed by the permits, presently undeveloped, constitute Phase II of the project.

Permits 11714 and 11715 were subsequently amended three times to add additional time to allow full development of the water allowed to be beneficially used under the two permits. These time extensions, for ten years each, were granted on April 29, 1971; July 7, 1982; and March 2, 1992. The last time extension required the District to fully develop its water rights by December 31, 2002.

On March 18, 2002, the District filed a Petition for Extension of Time (Petition) for an additional ten years to complete development of its rights. By letter of June 20, 2002, the District requested the time extension be granted for 25 years, instead of ten years.

The State Water Resources Control Board (SWRCB) provided the public notice of the Petition on July 22, 2002. No protests to the proposed action were received.

The District has recognized that Phase II will not be developed for several decades, if ever, and will require preparation of an Environmental Impact Report prior to development, as part of the petition process. Therefore, as part of its Petition for Extension of Time, the District Board of Directors also approved submittal of a request that the SWRCB revoke authorization of Phase II of its project, thus limiting the scope of the Petition to the present facilities and capacities (combined direct diversion and storage of 132,030 afa). The District submitted this request on April 30, 2004. The District also submitted substantial evidence in support of its contention that Phase I could be developed to full beneficial use within the next 25 years.

In accordance with the California Environmental Quality Act, the District, as lead agency, has completed and certified a Mitigated Negative Declaration in connection with the proposed project. The SWRCB received no comments or protests to the proposed action.

2.0 DISCUSSION

Approval of Petitions for Extension of Time is normally delegated to the Chief of the Division of Water Rights (SWRCB Resolution No. 2002—0106, section 2.6.11), except when the requested period of extension, combined with all extensions previously granted under delegated authority, exceeds 25 years (section 2.6.11(c)(2)). The District has already been granted time extensions totaling 30 years, and is requesting an additional 25-year time extension. Therefore, the SWRCB must approve any additional extension of time for these permits.

2.1 Applicable Law

Water Code section 1396 requires a permittee to prosecute project construction and beneficial use of water with due diligence, in accordance with the Water Code, the SWRCB's regulations, and the terms specified in the permit. The SWRCB may approve a request for an extension of time if the SWRCB finds that there is good cause for the extension. (Wat. Code § 1398, subd. (a).) The SWRCB's regulations allow an extension of time to be granted only on such conditions as the SWRCB determines to be in the public interest, and on a showing to the SWRCB's satisfaction that (1) due diligence has been exercised, (2) failure to comply with previous time requirements has been occasioned by obstacles which could not reasonably be avoided, and (3) satisfactory progress will be made if an extension of time is granted. (Cal. Code Regs., tit. 23, § 844.) The SWRCB generally will not accept conditions incident to the person and not to the enterprise as good cause for delay. (Ibid.) After a hearing on a petition for an extension of time, the SWRCB may revoke the permit. (Wat. Code § 1398, subd. (b); § 1410, subd. (a) – (b)(1).)

2.1.1 Due Diligence

The District completed construction of the major Phase I components of its project within four years of the issuance of the permits.

2.1.2 Obstacles

Water usage in the District has developed at a slower rate than originally anticipated, particularly following the closure of a pulp mill near Eureka that had used a substantial amount of water for processing wood pulp. While in past years, prior to 1992, the District has diverted as much as 75,000 afa, it is currently using about 30,000 afa. The pulp mill closed, and the use of water was reduced for reasons beyond the District's control. The District has taken all actions within its power to put the water to reasonable and beneficial use.

2.1.3 Satisfactory Progress

The District has identified several municipal development projects within the authorized place of use of these permits. These projects are in various stages of authorization and development. The District anticipates that these developments will be served with water from Phase I of its project. (see Wat. Code § 106.5.)

3.0 FINDINGS

1. The permittee (District) has proceeded with due diligence, and good cause has been shown for an extension of time.

2. The SWRCB has determined that the petition for an extension of time neither constitutes the initiation of a new right nor operates to the injury of any other lawful user of water.

3. The permit conditions relating to the continuing authority and water quality objectives of the SWRCB should be updated to conform to Section 780 (a & b), Title 23 of the California Code of Regulations.

4. Fish, wildlife, and plant species have been or may be listed under the federal Endangered Species Act and/or the California Endangered Species Act. A condition should be added to the permits stating that the permits do not authorize any act that results in the taking of a threatened or endangered species.

5. The SWRCB is a responsible agency pursuant to the California Environmental Quality Act (CEQA). The SWRCB has considered the environmental effects of the Petition for Change as described by the petitioner in the Mitigated Negative Declaration prepared for this project. The proposed mitigation measures will reduce any potential impacts of the continued operation of Phase I of the project to less than significant levels.

6. The SWRCB has determined that the partial revocation of the District's water rights is consistent with a reasonable expectation of future demand in the District's place of use.

ORDER

IT IS HEREBY ORDERED THAT PERMITS 11714 AND 11715 ARE AMENDED AS FOLLOWS:

1. Condition 4 of the permits shall be deleted. Condition 5 shall be amended to read:

Construction work and complete application of the water to the authorized use shall be prosecuted with reasonable diligence and completed by December 31, 2029.

(0000009)

2. The continuing authority condition shall be updated to read as follows:

Pursuant to California Water Code sections 100 and 275 and the common law public trust doctrine, all rights and privileges under this permit and under any license issued pursuant thereto, including method of diversion, method of use, and quantity of water diverted, are subject to the continuing authority of the SWRCB in accordance with law and in the interest of the public welfare to protect public trust uses and to prevent waste, unreasonable use, unreasonable method of use, or unreasonable method of diversion of said water.

The continuing authority of the SWRCB may be exercised by imposing specific requirements over and above those contained in this permit with a view to eliminating waste of water and to meeting the reasonable water requirements of permittee without unreasonable draft on the source. Permittee may be required to implement a water conservation plan, features of which may include but not necessarily be limited to: (1) reusing or reclaiming the water allocated; (2) using water reclaimed by another entity instead of all or part of the water allocated; (3) restricting diversions so as to eliminate agricultural tailwater or to reduce return flow; (4) suppressing evaporation losses from water surfaces; (5) controlling phreatophytic growth; and (6) installing, maintaining, and operating efficient water measuring devices to assure compliance with the quantity limitations of this permit and to accurately determine water use as against reasonable water requirements for the authorized project. No action will be taken pursuant to this paragraph unless the SWRCB determines, after notice to affected parties and

opportunity for hearing, that such specific requirements are physically and financially feasible and are appropriate to the particular situation.

The continuing authority of the SWRCB also may be exercised by imposing further limitations on the diversion and use of water by the permittee in order to protect public trust uses. No action will be taken pursuant to this paragraph unless the SWRCB determines, after notice to affected parties and opportunity for hearing, that such action is consistent with California Constitution article X, section 2; is consistent with the public interest; and is necessary to preserve or restore the uses protected by the public trust.

(0000012)

3. The water quality objectives condition shall be updated to read as follows:

The quantity of water diverted under this permit and under any license issued pursuant thereto is subject to modification by the SWRCB if, after notice to the permittee and an opportunity for hearing, the SWRCB finds that such modification is necessary to meet water quality objectives in water quality control plans which have been or hereafter may be established or modified pursuant to Division 7 of the Water Code. No action will be taken pursuant to this paragraph unless the SWRCB finds that: (1) adequate waste discharge requirements have been prescribed and are in effect with respect to all waste discharges which have any substantial effect upon water quality in the area involved, and (2) the water quality objectives cannot be achieved solely through the control of waste discharges.

(0000013)

4. Permits 11714 and 011715 shall be amended to include the following Endangered Species condition:

This permit does not authorize any act which results in the taking of a threatened or endangered species or any act which is now prohibited, or becomes prohibited in the future, under either the California Endangered Species Act (Fish and Game Code sections 2050 to 2097) or the federal Endangered Species Act (16 U.S.C.A. sections 1531 to 1544). If a "take" will result from any act authorized under this water right, the permittee shall obtain authorization for an incidental take prior to construction or operation of the project.

Permittee shall be responsible for meeting all requirements of the applicable Endangered Species Act for the project authorized under this permit.

(0000014)

5. Paragraph 1 of Permit 11714 is deleted in its entirety, and the following term is substituted:

The amount of water to be appropriated shall be limited to the amount that can be beneficially used and shall not exceed 48,030 afa by storage, to be collected from October 1 of each year to April 30 of the succeeding year. The maximum amount per annum to be stored under this permit and Permit 11715 shall not exceed 48,030 afa. The total annual diversion and use allowed under this permit and Permit 11715 shall not exceed 132,030 afa.

(0000005)

6. Term 1 of Permit 11715 is deleted in its entirety, and the following term is substituted:

The amount of water to be appropriated shall be limited to the amount that can be beneficially used and shall not exceed 116 cfs by direct diversion, year-round, and 20,000 afa by storage, to be collected from October 1 of each year to April 30 of the succeeding year. The maximum amount to be appropriated by direct diversion under this permit shall not exceed 84,000 afa. The maximum amount per annum to be stored under this permit and Permit 11714 shall not exceed 48,030 afa. The total annual diversion and use allowed under this permit and Permit 11714 shall not exceed 132,030 afa.

(0000005)

7. All other conditions of Permits 11714 and 11715 are still applicable.

CERTIFICATION

The undersigned Clerk to the Board does hereby certify that the foregoing is a full, true, and correct copy of an order duly and regularly adopted at a meeting of the State Water Resources Control Board held on August 26, 2004.

AYE: Peter S. Silva
Richard Katz
Gary M. Carlton

NO: None.

ABSENT: Arthur G. Baggett, Jr.
Nancy H. Sutley

ABSTAIN: None.

Debbie Irvin
Clerk to the Board

PERMIT No. 11714

This is to certify that the application of which the foregoing is a true and correct copy has been considered and approved by the State Water Rights Board SUBJECT TO VESTED RIGHTS and the following limitations and conditions:

1. The amount of water to appropriated shall be limited to the amount which can be beneficially used and shall not exceed 100,000 acre-feet per annum by storage to be collected from about October 1 of each year to about April 30 of the succeeding year.

2. The maximum amounts herein stated may be reduced in the license if investigation so warrants.

3. Actual construction work shall begin on or before December 1, 1960, and shall thereafter be prosecuted with reasonable diligence, and if not so commenced and prosecuted, this permit may be revoked.

4. Said construction work shall be completed on or before July 1, 1967.

5. Complete application of the water to the proposed use shall be made on or before July 1, 1970.

6. Progress reports shall be filed promptly by permittee on forms which will be provided annually by the State Water Rights Board until license is issued.

7. All rights and privileges under this permit including method of diversion, method of use, and quantity of water diverted are subject to the continuing authority of the State Water Rights Board in accordance with law and in the interest of the public welfare to prevent waste, unreasonable use, unreasonable method of use or unreasonable method of diversion of said water.

8. For the protection, propagation and preservation of fish life permittee shall:

a. At all times by-pass or release minimum flow of five cubic feet per second into the natural stream bed of

Mad River immediately below Ruth Dam.

b. During the periods herein specified, by-pass or release into the natural stream bed of Mad River immediately below Essex Diversion Dam the following minimum flows or the natural flow of Mad River as regulated by diversions now in existence, whichever is less:

October 1 through October 15	30 cfs
October 16 through October 31	50 cfs
November 1 through June 30	75 cfs
July 1 through July 31	50 cfs
August 1 through August 31	40 cfs
September 1 through September 30	30 cfs

9. This permit is subject to the Memorandum of Understanding between Humboldt Bay Municipal Water District and County of Trinity, drafted on January 28, 1959, and duly approved by both agencies and on file with the State Water Rights Board.

This permit is issued and permittee takes it subject to the following provisions of the Water Code:

Section 1390. A permit shall be effective for such time as the water actually appropriated under it is used for a useful and beneficial purpose in conformity with this division (of the Water Code), but no longer.

Section 1391. Every permit shall include the enumeration of conditions therein which in substance shall include all of the provisions of this article and the statement that any appropriator of water to whom a permi s issued takes it subject to the conditions therein expressed.

Section 1392. Every permittee, if he accepts a permit, does so under the conditions precedent that no value whatsoever in excess of the actual amount paid to the State therefor shall at any time be assigned to or claimed for any permit granted or issued under the provisions of this division (of the Water Code), or for any rights granted or acquired under the provisions of this division (of the Water Code), in respect to the regulation by any competent public authority of the services or the price of the services to be rendered by any permittee or by the holder of any rights granted or acquired under the provisions of this division (of the Water Code) or in respect to any valuation for purposes of sale to or purchase, whether through condemnation proceedings or otherwise, by the State or any city, city and county, municipal water district, irrigation district, lighting district, or any political subdivision of the State, of the rights and property of any permittee, or the possessor of any rights granted, issued, or acquired under the provisions of this division (of the Water Code).

Dated: MAR 1 6 1959

STATE WATER RIGHTS BOARD

L. K. Hill

L. K. Hill
Executive Officer

80666 7-58 15M ① SPO

STATE OF CALIFORNIA – RESOURCES AGENCY
STATE WATER RESOURCES CONTROL BOARD
DIVISION OF WATER RIGHTS
77 Cadillac Drive, Sacramento, CA 95825
(916) 924-2478

EDMUND G. BROWN JR., *Governor*

RECEIVED SEP 28 1981

IN REPLY REFER
TO: 333:DEM:26657

SEPTEMBER 25 1981

Humboldt Bay Municipal Water District
c/o Arthur Bolli, General Manager
P. O. Box 95
Eureka, CA 95501

APPLICATION 26657 PERMIT 18347

YOUR WATER RIGHT PERMIT IS ENCLOSED. THE BOARD REQUIRES THAT YOU SUBMIT ANNUAL REPORTS SHOWING THE PROGRESS YOU HAVE MADE IN THE CONSTRUCTION OF YOUR PROJECT OR, IF CONSTRUCTED, THE USE MADE UNDER YOUR PERMIT WHICH WOULD QUALIFY FOR LICENSING PURPOSES. WE WILL MAIL THE FORMS TO YOU WHEN THE REPORTS ARE DUE.

PLEASE NOTE THAT, WITH RESPECT TO OTHER RIGHTS ATTACHING TO THIS SOURCE, THE PRIORITY OF THIS RIGHT COMMENCES WITH THE DATE OF THE APPLICATION. THEREFORE, IN TIME OF WATER SHORTAGE, THOSE WITH RIGHTS SENIOR TO YOURS CAN TAKE THEIR WATER FIRST. ADDITIONAL LIMITATIONS ON THE DIVERSION OF WATER ARE SPECIFIED BY THE TERMS OF THIS PERMIT. YOU SHOULD READ THE TERMS AND CONDITIONS CAREFULLY SO THAT YOU ARE FAMILIAR WITH YOUR RESPONSIBILITIES AS AN APPROPRIATOR OF WATER UNDER THIS ENTITLEMENT.

AFTER THE PROJECT HAS BEEN COMPLETED, AN INSPECTION WILL BE MADE TO DETERMINE THE AMOUNT OF WATER WHICH HAS BEEN PLACED TO BENEFICIAL USE WITHIN THE TERMS OF THE PERMIT. A LICENSE WILL THEN BE ISSUED CONFIRMING A RIGHT TO THAT AMOUNT OF WATER.

PLEASE INFORM US OF ANY CHANGE IN ADDRESS OR OWNERSHIP.

D. W. SABISTON
PROGRAM MANAGER
HEARING SECTION

ENCLOSURE

WR 14a (8/80)

STATE OF CALIFORNIA
THE RESOURCES AGENCY
STATE WATER RESOURCES CONTROL BOARD
DIVISION OF WATER RIGHTS

PERMIT FOR DIVERSION AND USE OF WATER

PERMIT 18347

Application 26657 of Humboldt Bay Municipal Water District

P. O. Box 95, Eureka, California 95501

filed on December 9, 1980, has been approved by the State Water Resources Control Board SUBJECT TO VESTED RIGHTS and to the limitations and conditions of this Permit.

Permittee is hereby authorized to divert and use water as follows:

1. Source: Mad River

Tributary to: Pacific Ocean

2. Location of point of diversion:	40-acre subdivision of public land survey or projection thereof	Section	Township	Range	Base and Meridan
Ruth Reservoir South 18°East 3,194 feet from W1/4 corner of Section 18, T1S, R7E	NW1/4 of NW1/4	19	1S	7E	H

County of Trinity

3. Purpose of use:	4. Place of use:	Section	Township	Range	Base and Meridan	Acres
Power	NW1/4	19	1S	7E	H	

The place of use is shown on map filed with the State Water Resources Control Board.

5. The water appropriated shall be limited to the quantity which can be beneficially used and shall not exceed 1,000 cubic feet per second by direct diversion to be diverted from January 1 to December 31 of each year and 120,000 acre-feet per annum by storage to be collected from October 1 of each year to April 30 of the succeeding year.

6. The amount authorized for appropriation may be reduced in the license if investigation warrants.

7. Construction work shall be completed on or before December 1, 1984.

8. Complete application of the water to the proposed use shall be made on or before December 1, 1985.

9. Progress reports shall be submitted promptly by permittee when requested by the State Water Resources Control Board until license is issued.

10. Permittee shall allow representatives of the State Water Resources Control Board and other parties as may be authorized from time to time by said Board, reasonable access to project works to determine compliance with the terms of this permit.

11. Pursuant to California Water Code Sections 100 and 275, all rights and privileges under this permit and under any license issued pursuant thereto, including method of diversion, method of use, and quantity of water diverted, are subject to the continuing authority of the State Water Resources Control Board in accordance with law and in the interest of the public welfare to prevent waste, unreasonable use, unreasonable methods of use, or unreasonable method of diversion of said water.

The continuing authority of the Board may be exercised by imposing specific requirements over and above those contained in this permit with a view to minimizing waste of water and to meeting the reasonable water requirements of permittee without unreasonable draft on the source. Permittee may be required to implement such programs as (1) reusing or reclaiming the water allocated; (2) using water reclaimed by another entity instead of all or part of the water allocated; (3) restricting diversions so as to eliminate agricultural tailwater or to reduce return flow; (4) suppressing evaporation losses from water surfaces; (5) controlling phreatophytic growth; and (6) installing, maintaining, and operating efficient water measuring devices to assure compliance with the quantity limitations of this permit and to determine accurately water use as against reasonable water requirements for the authorized project. No action will be taken pursuant to this paragraph unless the Board determines, after notice to affected parties and opportunity for hearing, that such specific requirements are physically and financially feasible and are appropriate to the particular situation.

12. The quantity of water diverted under this permit and under any license issued pursuant thereto is subject to modification by the State Water Resources Control Board if, after notice to the permittee and an opportunity for hearing, the Board finds that such modification is necessary to meet water quality objectives in water quality control plans which have been or hereafter may be established or modified pursuant to Division 7 of the Water Code. No action will be taken pursuant to this paragraph unless the Board finds that (1) adequate waste discharge requirements have been prescribed and are in effect with respect to all waste discharges which have any substantial effect upon water quality in the area involved, and (2) the water quality objectives cannot be achieved solely through the control of waste discharges.

13. This permit is issued subject to future upstream appropriations for consumptive use within the Mad River Watershed.

***This permit is issued and permittee takes it* subject to the following provisions of the Water Code:**

Section 1390. A permit shall be effective for such time as the water actually appropriated under it is used for a useful and beneficial purpose in conformity with this division (of the Water Code), but no longer.

Section 1391. Every permit shall include the enumeration of conditions therein which in substance shall include all of the provisions of this article and the statement that any appropriator of water to whom a permit is issued takes it subject to the conditions therein expressed.

Section 1392. Every permittee, if he accepts a permit, does so under the conditions precedent that no value whatsoever in excess of the actual amount paid to the State therefor shall at any time be assigned to or claimed for any permit granted or issued under the provisions of this division (of the Water Code), or for any rights granted or acquired under the provisions of this division (of the Water Code), in respect to the regulation by any competent public authority of the services or the price of the services to be rendered by any permittee or by the holder of any rights granted or acquired under the provisions of this division (of the Water Code) or in respect to any valuation for purposes of sale to or purchase, whether through condemnation proceedings or otherwise, by the State or any city, city and county, municipal water district, irrigation district, lighting district, or any political subdivision of the State, of the rights and property of any permittee, or the possessor of any rights granted, issued, or acquired under the provisions of this division (of the Water Code).

Dated: SEPTEMBER 25 1981

STATE WATER RESOURCES CONTROL BOARD

Raymond Walsh

Chief, Division of Water Rights

APPLICANT MUST NOT FILL IN BLANKS BELOW

PERMIT No. 11715

This is to certify that the application of which the foregoing is a true and correct copy has been considered and approved by the State Water Rights Board SUBJECT TO VESTED RIGHTS and the following limitations and conditions:

1. The amount of water appropriated shall be limited to the amount which can be beneficially used and shall not exceed 200 cubic feet per second by direct diversion, year-round, and 20,000 acre-feet per annum by storage to be collected from about October 1 of each year to about April 30 of the succeeding year.

2. The maximum amounts herein stated may be reduced in the licenses if investigation so warrants.

3. Actual construction work shall begin on or before December 1, 1960, and shall thereafter be prosecuted with reasonable diligence, and if not so commenced and prosecuted, this permit may be revoked.

4. Said construction work shall be completed on or before July 1, 1967.

5. Complete application of the water to the proposed use shall be made on or before July 1, 1970.

6. Progress reports shall be filed promptly by permittee on forms which will be provided annually by the State Water Rights Board until license is issued.

7. All rights and privileges under this permit including method of diversion, method of use, and quantity of water diverted are subject to the continuing authority of the State Water Rights Board in accordance with law and in the interest of the public welfare to prevent waste, unreasonable use, unreasonable method of use or unreasonable method of diversion of said water.

8. For the protection, propagation and preservation of fish life permittee shall:

a. At all times by-pass or release minimum flow of five cubic feet per second into the natural stream bed of Mad River immediately below Ruth Dam.

b. During the periods herein specified, by-pass or release into the natural stream bed of Mad River immediately below Essex Diversion Dam the following minimum flows or the natural flow of Mad River as regulated by diversions now in existence, whichever is less:

October 1 through October 15	30 cfs
October 16 through October 31	50 cfs
November 1 through June 30	75 cfs
July 1 through July 31	50 cfs
August 1 through August 31	40 cfs
September 1 through September 30	30 cfs

9. This permit is subject to the Memorandum of Understanding between Humboldt Bay Municipal Water District and County of Trinity, drafted on January 28, 1959, and duly approved by both agencies and on file with the State Water Rights Board.

water.

This permit is issued and permittee takes it subject to the following provisions of the Water Code:

Section 1390. A permit shall be effective for such time as the water actually appropriated under it is used for a useful and beneficial purpose in conformity with this division (of the Water Code), but no longer.

Section 1391. Every permit shall include the enumeration of conditions therein which in substance shall include all of the provisions of this article and the statement that any appropriator of water to whom a permit is issued takes it subject to the conditions therein expressed.

Section 1392. Every permittee, if he accepts a permit, does so under the conditions precedent that no value whatsoever in excess of the actual amount paid to the State therefor shall at any time be assigned to or claimed for any permit granted or issued under the provisions of this division (of the Water Code), or for any rights granted or acquired under the provisions of this division (of the Water Code), in respect to the regulation by any competent public authority of the services or the price of the services to be rendered by any permittee or by the holder of any rights granted or acquired under the provisions of this division (of the Water Code) or in respect to any valuation for purposes of sale to or purchase, whether through condemnation proceedings or otherwise, by the State or any city, city and county, municipal water district, irrigation district, lighting district, or any political subdivision of the State, of the rights and property of any permittee, or the possessor of any rights granted, issued, or acquired under the provisions of this division (of the Water Code).

Dated: MAR 16 1959

STATE WATER RIGHTS BOARD

L. K. Hill

L. K. Hill
Executive Officer

80606 7-58 15M ① SPO

APPENDIX B. Temperature and DO Modeling Report

APPENDIX B. Temperature and DO Modeling Report

1.1 Introduction

The North Coast Regional Water Quality Control Board has listed the Mad River as impaired for sediment, turbidity, and temperature under Section 303(d) of the California Clean Water Act, and water quality is a critically important factor with regard to the conservation of salmonids and other special-status species. This project would dedicate instream flows to the Mad River for environmental benefit purposes. However, stream flow enhancement has the potential to affect the quality of the water downstream from the point of discharge, but is anticipated to benefit fish and wildlife. The District and its partners monitored water temperature, air temperature, turbidity, and discharge between May 1 and October 31, 2018, to analyze the relationships among these factors. The goal of the 2018 monitoring was to determine whether the instream flow dedication could improve water quality over existing conditions, which may be a limiting factor for salmonids and other special-status species in the Mad River.

1.2 Methods and Results

1.2.1 Sources of Information

Water and air temperature data on the Mad River were collected by the Mad River Alliance (MRA) from May 1 to September 26, 2018, using Onset HOBO temperature loggers. The deployment locations for the temperature loggers were selected on the basis of: (1) accessibility; (2) capability to provide an accurate representation of ambient creek/river temperatures; (3) avoidance of known springs and seeps; and (4) ability to conceal the data loggers to reduce vandalism and ensure instrument and data recovery (Pounds pers. comm. 2019). Mainstem water temperature data were recorded every 30 minutes at 17 sites, but unfortunately three of the mainstem HOBO temperature loggers were lost or stolen. Tributary water temperature data were collected at 8 sites (Table 14, Figure 8). H. T. Harvey & Associates examined the data set and determined that some of the temperature data were collected prior to the HOBO logger being deployed; these data were subsequently cropped. We also removed temperature data from the Mad River upstream of Cañon Creek (MRUSCanon) between July 7 at 7:00 p.m. and July 19 at 6:30 a.m. because there was a 10°F decrease in recorded temperatures that was not observed at neighboring sites. Additional water temperature data from the Ruth Lake Marina (at surface) and the Matthews Dam tailrace, as well as turbidity, rainfall and discharge data at the dam (tailrace), were provided by the District for May 1 to October 31, 2018. Stream gage data from the U.S. Geological Survey were checked against the District data but were not included in the analyses.

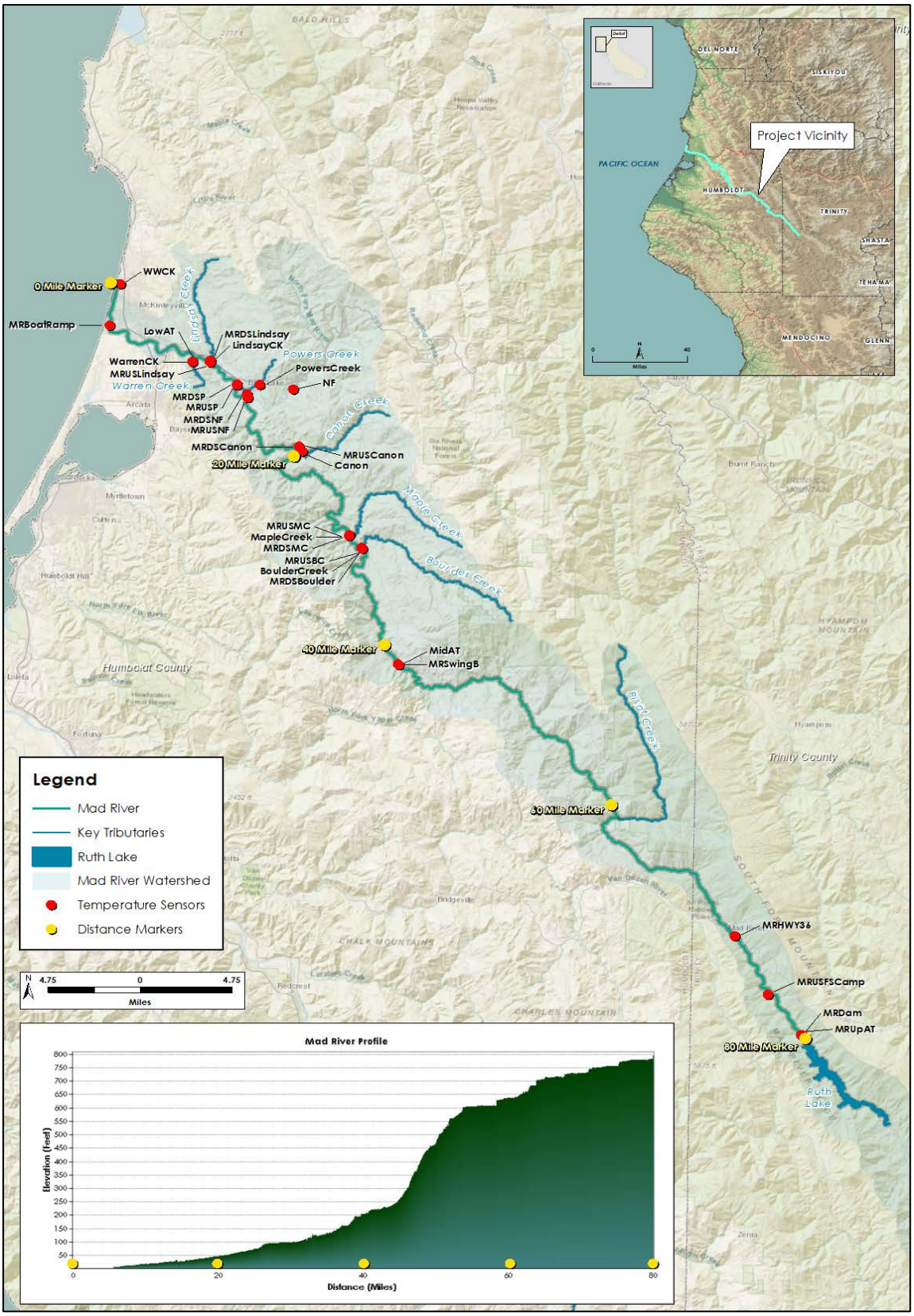


Figure 1. Temperature Monitoring Sites, Tributaries, and Elevation Profile for the Mad River, Humboldt County, California

Table 1. Water and Air Temperature Monitoring Sites on the Mad River

RM	ID	Reach	Category	Name	Lat	Lon
0.7	WWCK	E	TR	Widow White Creek	40.9623443	-124.1203722
3.1	MRBoatRamp	E	MS	Mad River Boat Ramp	40.92896818	-124.1297681
9.5	LowAT	LR	AT	Lower Mad River Air Temp	40.90131994	-124.0469784
9.5	WarrenCK	LR	TR	Warren Creek	40.90138535	-124.0471489
10.3	MRDSLindsay	LR	MS	Mad River downstream of Lindsay Creek	40.90174272	-124.0304291
10.3	LindsayCK	LR	TR	Lindsay Creek	40.90277703	-124.0296433
10.4	MRUSLindsay	LR	MS	Mad River upstream of Lindsay Creek	40.90116693	-124.0297067
12.4	MRDSP	LR	MS	Mad River downstream of Powers Creek	40.88395270	-124.0028767
12.4	PowersCreek	LR	TR	Powers Creek	40.88407803	-123.9802949
12.4	MRUSP	LR	MS	Mad River upstream of Powers Creek	40.88339983	-124.0028903
13.7	MRDSNF	LR	MS	Mad River downstream of North Fork	40.87623962	-123.9926627
13.7	NF	LR	TR	North Fork Mad River	40.88102512	-123.9473143
13.9	MRUSNF	LR	MS	Mad River upstream of North Fork	40.87343792	-123.9919857
19.6	MRDSCanon	LR	MS	Mad River downstream of Cañon Creek	40.83528060	-123.9403968
19.6	Canon	LR	TR	Cañon Creek	40.83136258	-123.9370303
19.6	MRUSCanon	LR	MS	Mad River upstream of Cañon Creek	40.83477073	-123.9401075
31.2	MRDSMC*	LR	MS	Mad River downstream of Maple Creek	40.76495528	-123.8887041
31.3	MapleCreek	LR	TR	Maple Creek	40.76459488	-123.8886667
31.3	MRUSMC*	LR	MS	Mad River upstream of Maple Creek	40.76446717	-123.8891854
32.6	MRDSBoulder	MR	MS	Mad River downstream of Boulder Creek	40.75471003	-123.8765421
32.6	BoulderCreek	MR	TR	Boulder Creek	40.75523691	-123.8763601
32.6	MRUSBC*	MR	MS	Mad River upstream of Boulder Creek	40.75435072	-123.8755169
41.6	MidAT	MR	AT	Middle Mad River Air Temperature	40.66226768	-123.8381917
41.6	MRSwingB	MR	MS	Mad River at Swinging Bridge	40.66176464	-123.8372687
72.7	MRHWY36	UR	MS	Mad River at Highway 36 Bridge	40.44925597	-123.5023560

RM	ID	Reach	Category	Name	Lat	Lon
77.0	MRUSFSCamp	UR	MS	Mad River at USFS Campground	40.40264200	-123.4688680
80.2	MRUpAT	UR	AT	Upper Mad River Air Temperature	40.37083274	-123.4347936
80.2	MRDam	UR	MS	Mad River at Matthews Dam	40.37068642	-123.4359363

RM is river mile, ID is the site code, and Reach identifies each site as estuarine (E), lower reach (LR), middle reach (MR), or upper reach (UR). Name provides the site name with some location information. Lat stands for latitude; Lon for longitude. Category is either mainstem (MS), tributary (TR), or air temperature (AT).

* HOBO lost or stolen from this site; no data recovered.

The time series from the MRA 2018 temperature monitoring data are depicted collectively in Figure 9.

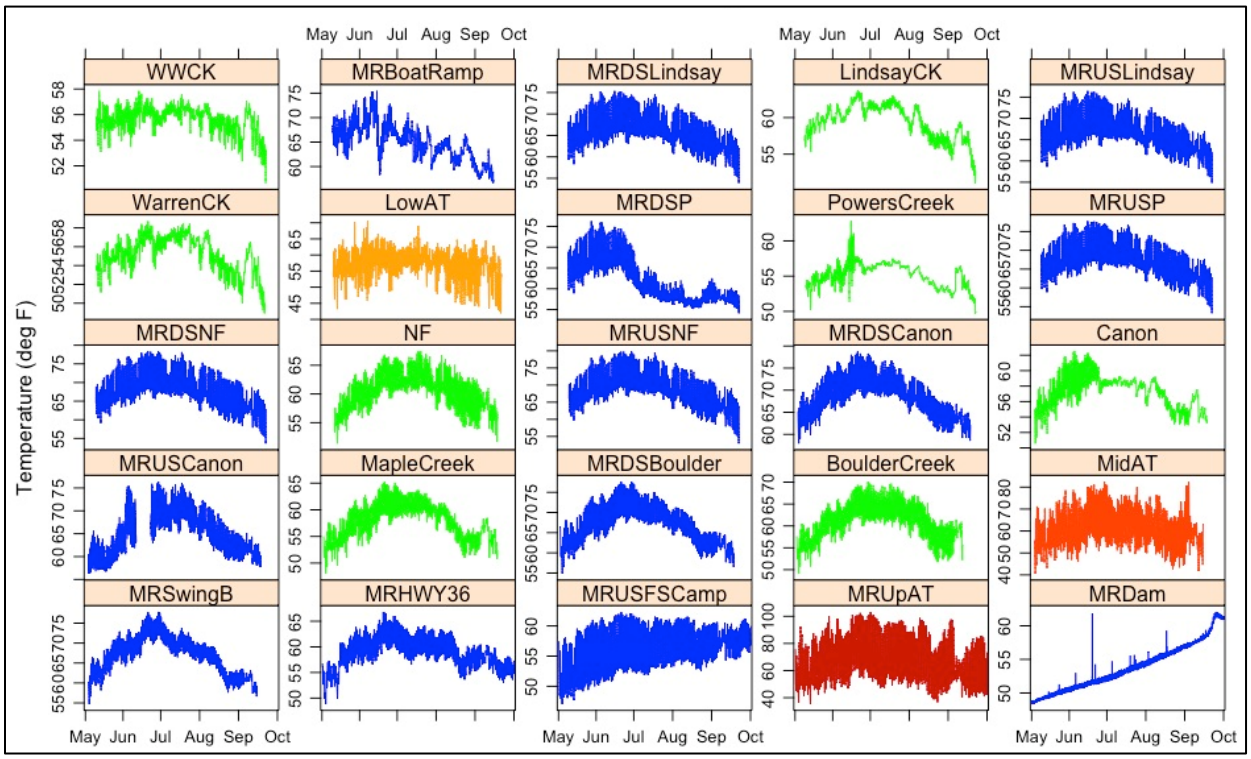


Figure 2. Mad River Water and Air Temperatures (May 1–September 26, 2018), Recorded Using HOBO Temperature Loggers at Multiple Mainstem (Blue), Tributary (Green), and Air Temperature (Orange-Red) Sites

1.2.2 Analytical Approach

We used graphical analyses, permutation distribution clustering (pdc), multiple regression with ARIMA[1] errors, and cross correlation functions (CCF) to explore the potential relationship between: (1) water temperatures at the point of discharge at Matthews Dam and downstream; (2) water temperatures from tributaries and the

[1] Auto Regressive Integrated Moving Average

mainstem downstream from the tributary confluence; (3) air temperatures and local or downstream mainstem water temperatures; and (4) dam discharge rates and downstream water temperatures. We had originally intended to use the Multiple Regression Stream Temperature Model[2] (MRSTM) developed by the U.S. Forest Service (USFS), but determined that this approach required data that we were unable to acquire, particularly discharge time series from tributaries. Instead, we retained the basis for the analysis used by the MRSTM (i.e., multiple regression) and employed additional statistical methods to refine this approach (Fellman et al. 2015). The MRSTM was not capable of implementing the ARIMA error terms associated with non-stationary time series data, such as what was collected during the 2018 monitoring on Mad River. Time series manipulation, analyses, and modelling were performed using R (R Core Team 2019), particularly the astsa (Stoffer 2019), lattice (Sarker 2008), lubridate (Grolemund and Wickham 2011), pdc (Brandmaier 2015), tseries (Trapletti and Hornik 2019), and zoo packages (Zeileis and Grothendieck 2005).

Mad River mainstem water temperatures and the associated water quality may be affected by or correlated with multiple factors. The factors that we evaluated were: (1) the temperature of upstream sites; (2) the temperature of tributaries to the Mad River; (3) local air temperature; and (4) the temperature and volume of water released at Matthews Dam. The volume of water contributed by tributaries also has the potential to affect water quality in the mainstem. Because we lacked flow data from these tributaries, we could not analyze the influence of tributary discharge on mainstem temperature. Similarly, while the range of discharge volumes observed in the mainstem during the monitoring period ranged from 41 to 227 cubic feet per second (cfs), the highest releases were limited to relatively short intervals in June and early July, which restricted our ability to model the effects of lower or higher discharge rates from Matthews Dam on downstream water temperature.

Maximum Weekly Average Temperature (MWAT) and Maximum Weekly Maximum Temperature (MWMT) were calculated from the HOBO temperature logger data. MWAT is the average daily temperature for the warmest 7-day period, and MWMT is the 7-day average of the daily maximum temperatures. These indices are useful to compare with temperature thresholds developed for different salmonid species and their life stages to assess the potential for chronic temperature effects (Stillwater Sciences 2010, Carter 2008).

1.2.2.1 Graphical Analyses and Permutation Distribution Clustering

The MRA 2018 temperature monitoring data time series (Figure 9) show a broad range of water and air temperatures between May 1 and September 26, 2018. Water temperatures ranged from the mid-40s to the mid-70s (°F) in both the mainstem Mad River and the tributaries. The corresponding air temperatures varied from 35 to 103°F (Figures 9 and 10). Both air and water time series displayed a strong diel component (i.e., 24-hour period), with a more limited range observed at lower elevation sites compared to their counterparts at higher elevations and closer to Matthews Dam. Most of these time series had the same general structure whereby average temperatures peaked around the end of June and gradually declined, with the lowest mean temperatures occurring near the end of the study period. The time series that did not exhibit this pattern were the two mainstem sites at the highest elevations: Mad River at USFS Campground (MRUSFSCamp) and Mad

[2] https://www.fs.fed.us/rm/boise/AWAE/projects/stream_temp/multregression_model.shtml

River at Matthews Dam (MRDam). Both of these sites showed a steady increase in average water temperature over the course of the 2018 monitoring period. MRUSFSCamp displayed the greatest diel temperature fluctuations, and MRDam exhibited the lowest diel temperature fluctuations. The two sites are 3.2 river miles (RMs) apart (2.8 miles straight-line distance) (Table 14). The mainstem site lowest in elevation, the Mad River Boat Ramp (MRBoatRamp), displayed the smallest diel fluctuations, probably due to its estuarine setting and the influences of ocean water temperatures and cooler coastal air temperatures.

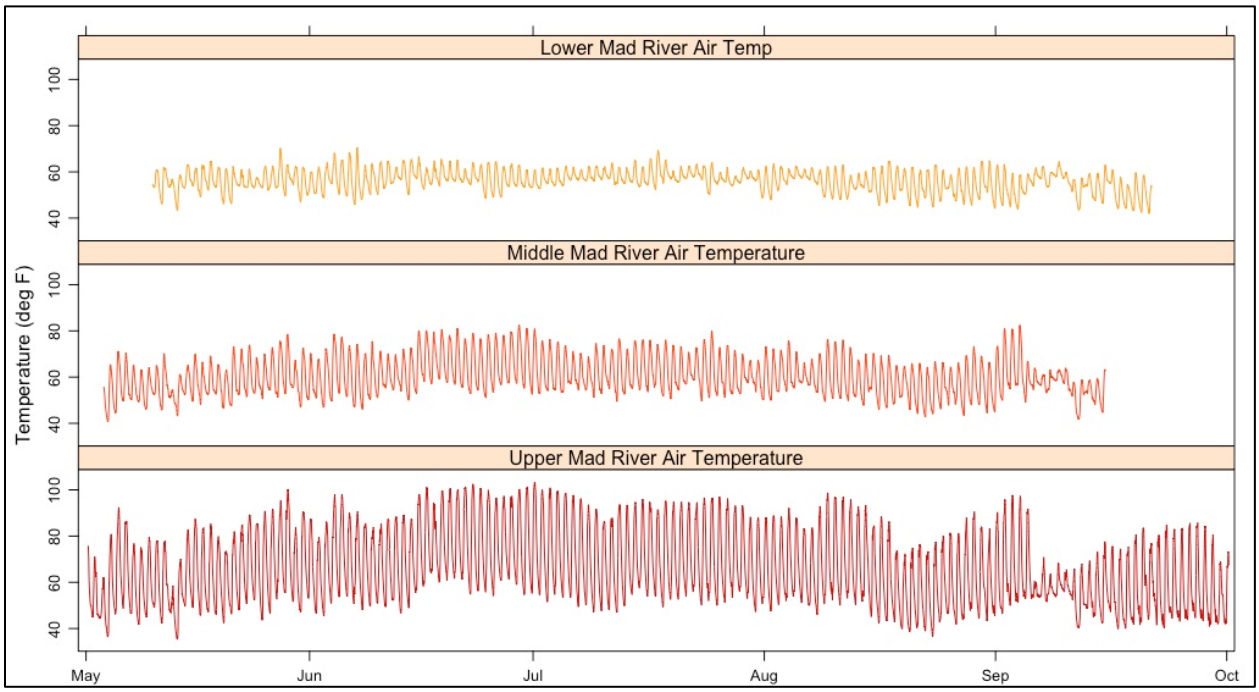


Figure 3. Air Temperatures along the Mad River (May 1–September 26, 2018), Recorded Using HOBO Temperature Loggers

Based on the general pattern of mainstem water temperatures over the 2018 monitoring period, it appeared that temperature in the upper reaches was predictive of temperature further downstream; however, both tributaries and local air temperature also affected mainstem water temperature. Tributary effects were most apparent when we compared the mainstem temperatures upstream and downstream of each confluence. Paired site data were collected for four tributaries in the lower reach of the Mad River: Lindsay Creek, Powers Creek, North Fork Mad River, and Cañon Creek. Temperature loggers were deployed in each of these tributaries upstream of their confluences with the mainstem, and in the mainstem immediately (less than 30 feet) upstream and downstream of each confluence. We also evaluated the tributary effect of Boulder Creek, except that the upstream mainstem temperature logger was lost or stolen. Therefore, we used time series data from the next site upstream at Swinging Bridge (MRSwingB), 9.0 RMs above the Boulder Creek confluence (Table 14, Figure 8). We generated time series of the temperature differentials for each of the five tributaries (Figure 11). Not all tributaries affected mainstem temperatures; the effects of Lindsay Creek, North Fork Mad River, and Boulder Creek were essentially undetectable in the mainstem. However, Powers Creek and, to a lesser extent, Cañon Creek affected (locally reduced) the mainstem temperature. During July and August, Powers Creek reduced the

water temperature in the Mad River by more than 10°F; the maximum difference was 15.0°F on August 13, 2018; Powers Creek typically is subsurface at its confluence with the Mad River during this time of year, contributing cool water via a seep to the mainstem.

The diel water and air temperature fluctuations demonstrated that changing levels of solar heat energy directly affect both measurements, but the differences in heat capacity between water and air are also evident from the time series data. The fluctuations in diel air temperatures spanned wider ranges than the fluctuations for diel water temperatures. Seasonal changes in temperature suggested that multiple factors determine mainstem water conditions—the air temperature time series showed a similar initial climb and gradual decline observed in most water temperature time series, but the pattern was comparatively muted, which was indicative that local solar heat energy (evidenced by the air temperature time series) was only one of multiple contributing factors.

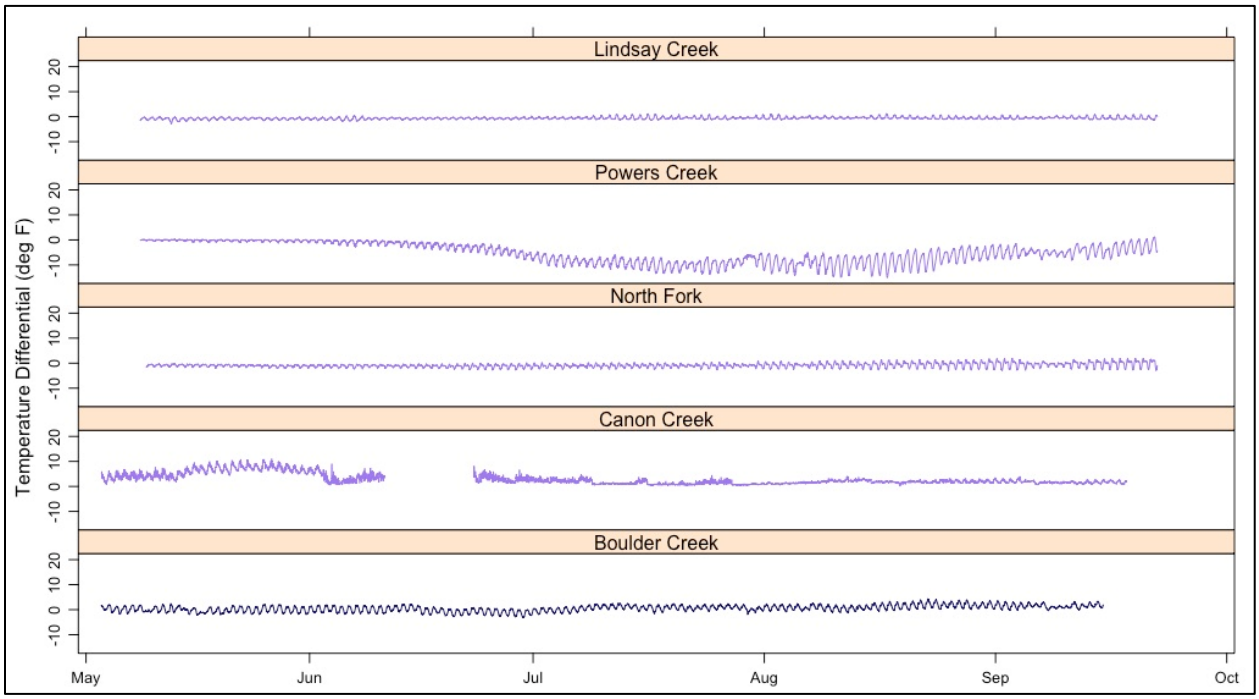


Figure 4. Mad River Mainstem Temperature Differences Measured Upstream and Downstream of Selected Tributaries (May 1–September 26, 2018)

Similar temperature time series are indicative of similar environmental conditions, connectivity between sites, or both (Brown 1969, Johnson 2004, Ferencz and Cardenas 2017). We used permutation distribution clustering (pdc) analysis to examine the similarities among time series. This analysis is a complexity-based clustering method developed specifically for time series, and uses the permutation distribution of those series to compare their differences.

Clustering generally provides a means to distinguish hierarchical, meaningful subgroups within a population of data sets (Altman and Krzywinski 2017, Caruso et al. 2018). If conditions at downstream sites closely resemble upstream sites, we would expect time series from adjoining sites to exhibit only minor differences and to have

a relatively close association in the resulting tree structure (Figure 12). In fact, the pdc results of comparisons among Mad River water temperature time series identified incremental but informative differences among the monitoring sites and suggested that sites tended to become progressively less similar as the downstream distance from the highest elevation sites increased, with some exceptions (Figure 12).

The pdc analysis generated two well-defined groups (note the 'height' of the legs separating these groups in Figure 12). The smaller group (MRDam, MRBoatRamp, MRUSCanon, and Mad River downstream of Powers Creek [MRDSP]) was composed of somewhat dissimilar time series, and the larger group contained well-ordered series that ranged from the blue sites high in the river system to the green sites closer to the river mouth. The primary findings of the pdc analysis were that: (1) while not exact, the pattern was very close to that of the sequential order of the sites and strongly supported the hypothesis that, the closer a site may be to an upstream site, the more similar the diel and seasonal patterns of water temperature; and (2) the smaller group was striking because it included the time series for the highest (MRDam) and lowest (MRBoatRamp) elevation sites. The MRDam time series was substantially different from the others, with a steady, seasonal climb in temperatures that displayed two kinds of anomalies: periodic spikes in water temperature and an unusual increase near the end of the 2018 monitoring period (roughly September 14–26). Two of the higher mainstem sites (MRUSFSCamp and Mad River at Highway 36 Bridge [MRHWY36]) were the only additional sites monitored during the September 14–26 period, and exhibited subtler versions of the increase, but the pdc analysis strongly suggested that water temperatures immediately below Matthews Dam had essentially no predictive value for downstream sites. We suggest that the other three sites clustered with MRDam because they each had a distinctive pattern; the rest of the sites displayed similar patterns. MRBoatRamp was the mainstem site closest to the river mouth and was strongly estuarine. The temperatures at this site were affected by tidal action, the presence of ocean water, and coastal air temperatures. As noted in the methods discussion, MRUSCanon had a period of anomalous temperature data between July 7 and July 19 that was excluded from the analysis after consulting the MRA; that gap in the time series sets this site apart. MRDSP was unusual because the previously strong diel fluctuations in water temperature were abruptly and severely muted, beginning on July 30, 2018.

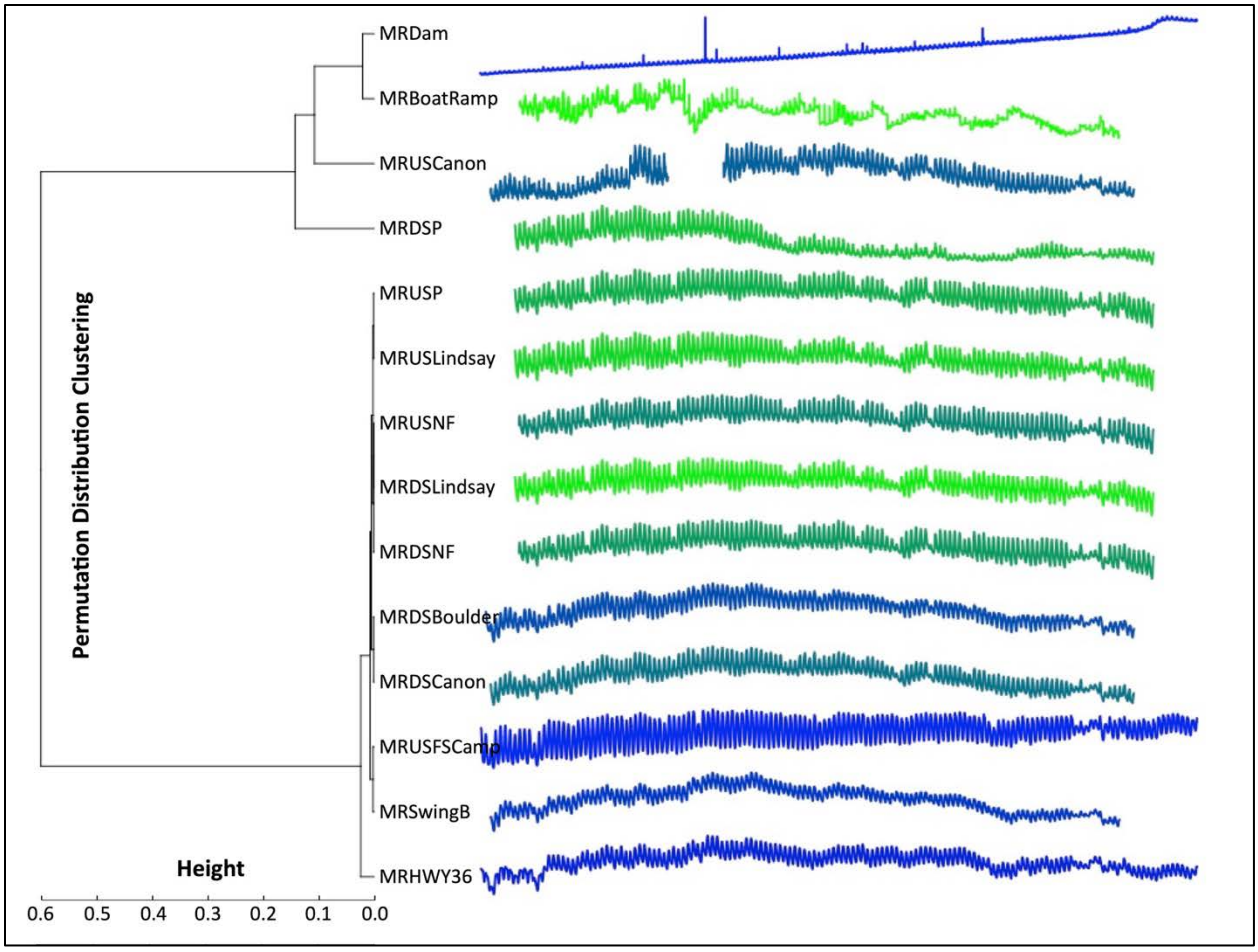


Figure 5. Permutation Distribution Clustering (PDC) of Mad River Mainstem Temperature Time Series (May 1–September 26, 2018) Showing their Relative Similarity
Note: Colors range from blue to light green, with the bluest colors from the highest elevation sites

1.2.2.2 Cross Correlation Functions

To further explore the potential effects of upstream sites on lower portions of the river and determine the predictive power of these observations, we used CCF to relate pairs of temperature time series. We tested the Matthews Dam (MRDam) time series against three downstream sites (Figure 13). Because of the apparently unusual series presented by the Matthews Dam data, we also used the MRUSFSCamp time series as the standard, but no pairs evolve concurrently, probably due to non-stationarity of the time series, and the sum of all autocorrelation functions (acf) for each analysis approaches 0 (Figure 13). We anticipated that the lag would correlate with the site separation in RMs, but no such relationship was detected.

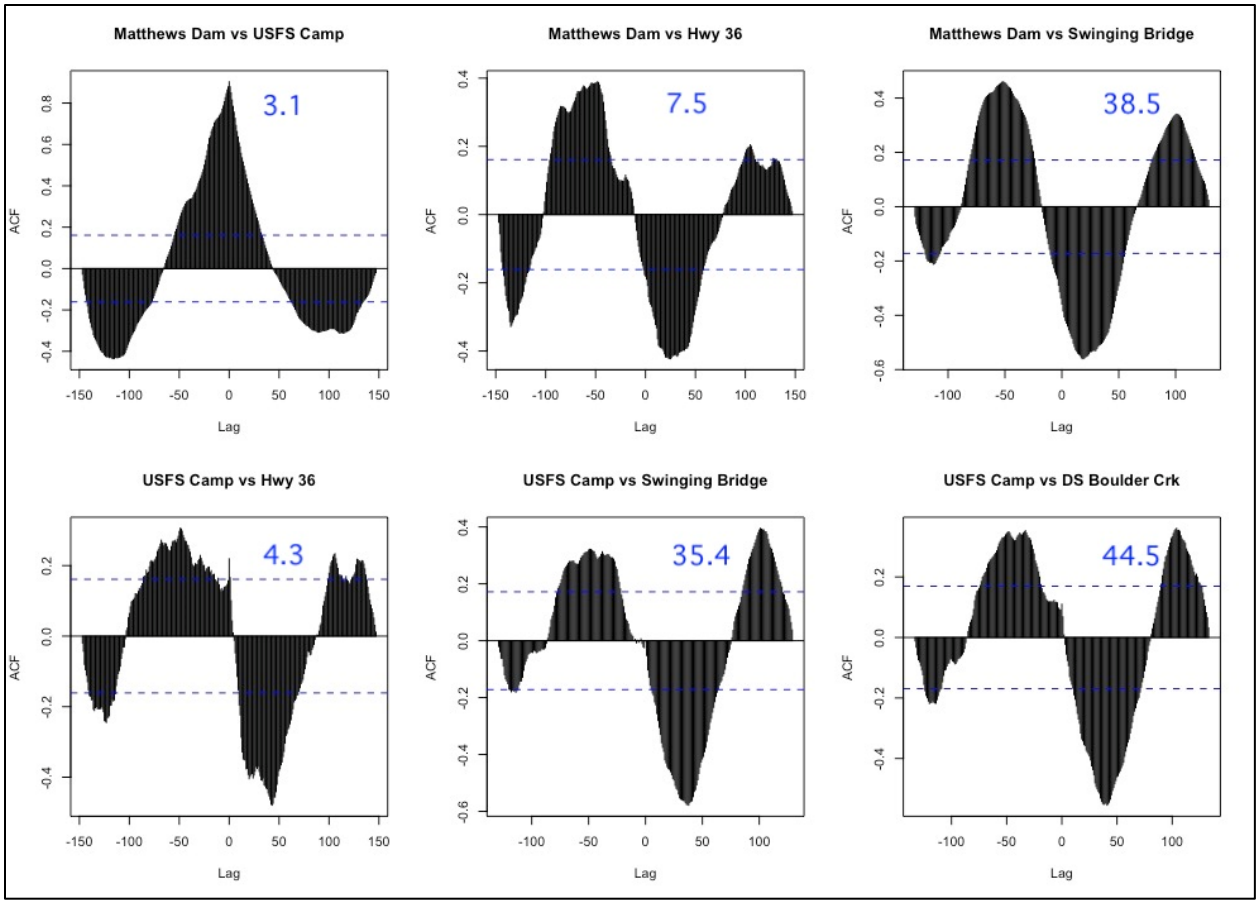


Figure 6. Autocorrelation and Lag in Upstream-Downstream Pairs of Time Series
Note: River miles separating pairs of sites are shown in blue. ACF= autocorrelation function, USFS Camp=MRUSFSCamp, Matthews Dam=MRDam, Hwy 36=MRHWY36, Swinging Bridge=MRSwingB, DS Boulder Crk=MRDSBoulder.

1.2.2.3 Modeling

We initially used lagged linear regression to model the relationship between mainstem water temperatures and multiple explanatory variables. This approach was selected based on published estimates of delayed events in comparable river systems; however, this approach was unsuccessful, leading to the use of CCF (discussed above). The CCF results suggested that hysteresis (e.g., lag) was probably not a strong factor, and led to the switch to a standard linear regression approach. Modeling efforts were focused on mainstem water temperatures in the middle and upper reaches of the Mad River, where water quality issues appeared to be most critical. We selected MRSwingB for the middle reach and MRHWY36 for the upper reach. The explanatory variables used in the initial models were middle and upper air temperatures (noon only); water temperatures from the MRDam site (3:00 p.m. only), the dam tailrace, and Ruth Lake; and the dam discharge rates supplied by the District. We chose a single temperature value from each day available to avoid the potential confounding effects of diel fluctuations and selected the time of day when these values were likely to be near their maximum.

The regression models with temperatures in the middle reach (MRSwingB) and upper reach (MRHWY36) as the dependent variables were not able to resolve the changing seasonal conditions (peaking summer air temperatures) and the steady increase in the dam discharge temperatures, despite the application of ARIMA errors. The progression of temperature profiles that were identified with the permutation distribution clustering (Figure 12) appeared to be a result of the reduction in the influence of dam discharge temperatures as the downstream distance increased, as well as the increased influence of ambient air temperature and other environmental factors. Mainstem water temperatures in the upper reach at MRUSFSCamp, which was 3.2 RMs below Matthews Dam, were strongly affected by the temperature of the discharged water and, to a lesser extent, by local air temperatures; these relationships were successfully modeled (Table 15). Even this close to Matthews Dam, however, retention of discharge volume in the models was never strongly supported, and therefore it is not possible to evaluate the effects of change in discharge on water temperature with the model given the available data.

Table 2. Multiple Linear Regression with ARIMA Errors, Relating Mad River Mainstem Water Temperatures at the MRUSFSCamp Site in the Upper Reach to Temperatures at Matthews Dam and Air Temperatures Recorded at the Upper Reach

Residuals				
Min	**1Q**	**Median**	**3Q**	**Max**
-1.00693	-0.20120	-0.03405	0.19353	1.28234
Coefficients				
	Estimate	**Std. Error**	**t value**	**Pr(>|t|)**
(Intercept)	6.172110	0.776089	7.953	4.88e-13 ***
MRDam	0.443359	0.024024	18.455	< 2e-16 ***
Tailrace	0.295129	0.030162	9.785	< 2e-16 ***
UpAir	0.130033	0.006452	20.153	< 2e-16 ***
Model Fit				
Residual standard error	0.399 on 144 degrees of freedom*			
Multiple R-squared	0.9693	Adjusted R-squared	0.9686	
F-statistic	1513 on 3 and 144 DF	p-value	< 2.2e-16	

Significance codes: 0 '***'; 0.001 '**'; 0.01 '*'; 0.05 '.' 0.1 ' ' 1

*36 observations deleted due to missingness

Model: USFS ~ MRDam + tailrace + UpAir

Because of the importance of discharge levels to the management of this river system, we ran multiple models again using data from June 1 to October 31 only, when dam release was entirely controlled by the District (e.g., no spill was occurring) and showed the greatest variance. Because of the comparatively extended period during late summer and early fall when dam releases were low and fairly constant, we anticipated that the greater variability in discharge volume and a quasi-monotonic increase in mean air temperature during this period would permit detection of a discharge volume effect, but the results were essentially the same: ambient air

temperature and the temperature of the discharged water were far more important to the model outcome than discharge rates in determining mainstem water temperature (Figure 14).

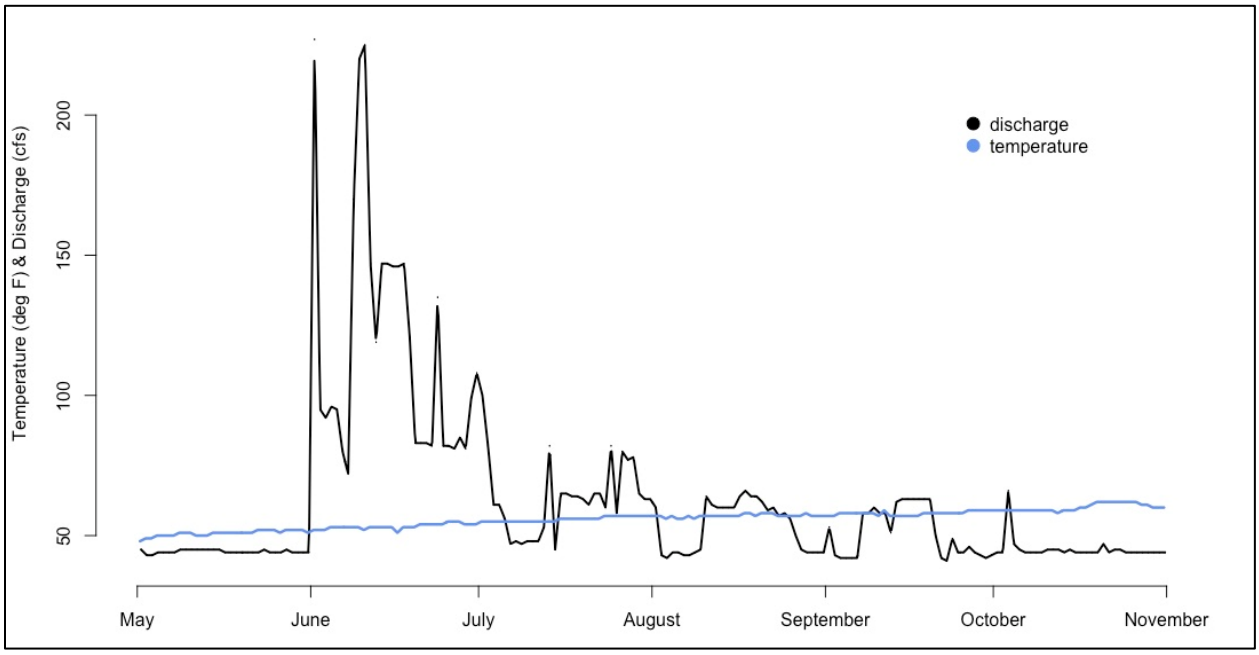


Figure 7. Time Series (June 1–October 31, 2018) of Matthews Dam Discharge Rates (Black) and Water Temperature at the Tailrace (Blue) (Daily Values)

The warmest water temperature recorded during the 2018 monitoring was 76.4°F at MRUSCanon in the lower reach on June 27. The coolest water temperature recorded during the 2018 monitoring was 47.1°F at MRUSFSCamp in the upper reach on May 4. Effects on mainstem water temperatures attributable to discharge temperatures diminished with distance downstream from Matthews Dam (Figure 15); these are discernable at MRHWY36 (7.5 RMs below the dam), but are no longer detectable under the conditions observed at MRSwingB (RM 41.6). Thus, the upper reach is influenced by discharge water temperatures, but not the middle or lower reaches. Figure 15, which includes representative sites from the lower (Mad River downstream of North Fork [MRDSNF], Mad River downstream of Boulder Creek [MRDSBoulder]), middle (MRSwingB), and upper (MRHWY36, MRUSFSCamp) reaches, clearly illustrates these results.

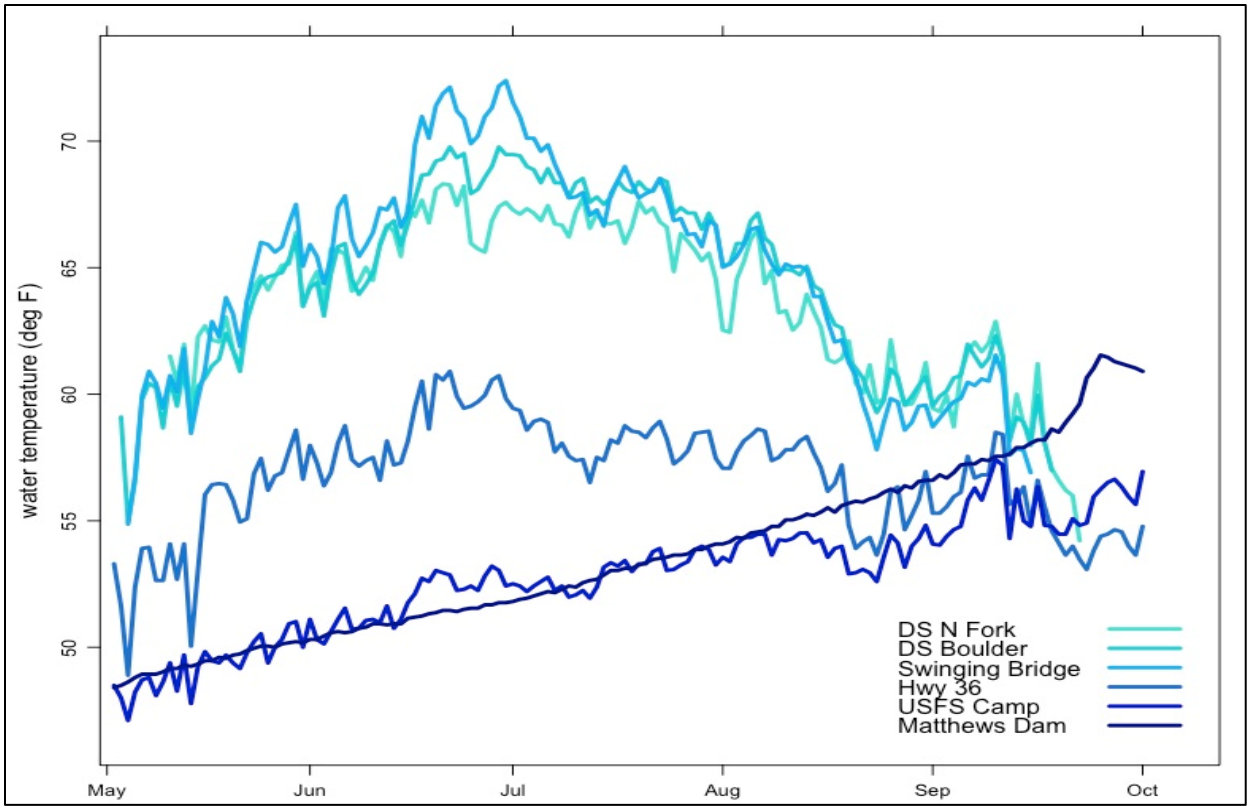


Figure 8. Lower Reach of the Mad River (DS N Fork, DS Boulder) and the Middle Reach (Swinging Bridge RM 41.6) in 2018 had Similar Temperatures
Note: Here, daily values only, distinctly warmer than those recorded from the Upper Reach (Hwy 36, USFS Camp, Matthews Dam). Matthews Dam=MRDam, USFS Camp=MRUSFSCamp, Hwy 36=MRHWY36, Swinging Bridge=MRSwingB, DS Boulder=MRDSBoulder, DS N Fork=MRDSNF.

1.2.2.4 Temperature Indices

Tributaries to the lower Mad River (e.g., Widow White, Warren, Lindsay, and Powers Creeks) had MWAT and MWMT values that were consistently lower than the mainstem Mad River and contributed cooler water to the mainstem, as evidenced by slightly lower MWAT and MWMT values upstream and downstream of Warren, Lindsay, and Powers Creeks (Table 15). MWAT and MWMT temperatures in the mainstem were coolest downstream of Matthews Dam, and warmest in the middle and upper reaches (Table 15). Additional years of water and air temperature recordings were obtained from MRA and the MWAT and MWMT indices were calculated, and are provided as an addendum to this report (Addendum A).

Table 3. Water Temperature Indices (Maximum Weekly Average Temperature [MWAT], Maximum Weekly Maximum Temperature [MWMT] in Degrees Celsius) at Monitoring Sites on the Mad River

RM	ID	Reach	Category	Name	MWAT	MWMT
0.7	WWCK	E	TR	Widow White Creek	13.6	14.1
3.1	MRBoatRamp	E	MS	Mad River Boat Ramp	21.2	23.1

RM	ID	Reach	Category	Name	MWAT	MWMT
9.5	WarrenCK	LR	TR	Warren Creek	14.2	14.6
10.3	MRDSLindsay	LR	MS	Mad River downstream of Lindsay Creek	20.8	23.9
10.3	LindsayCK	LR	TR	Lindsay Creek	17.1	17.4
10.4	MRUSLindsay	LR	MS	Mad River upstream of Lindsay Creek	21.2	24.5
12.4	MRDSP	LR	MS	Mad River downstream of Powers Creek	20.4	23.8
12.4	PowersCreek	LR	TR	Powers Creek	14.2	15.9
12.4	MRUSP	LR	MS	Mad River upstream of Powers Creek	21.7	25.3
13.7	MRDSNF	LR	MS	Mad River downstream of North Fork	22.1	25.5
13.7	NF	LR	TR	North Fork Mad River	17.4	19.3
13.9	MRUSNF	LR	MS	Mad River upstream of North Fork	22.8	26.3
19.6	MRDSCanon	LR	MS	Mad River downstream of Cañon Creek	22.9	25.6
19.6	Canon	LR	TR	Cañon Creek	15.2	16.5
19.6	MRUSCanon	LR	MS	Mad River upstream of Cañon Creek	21.6	24.0
31.2	MRDSMC*	LR	MS	Mad River downstream of Maple Creek	NA	NA
31.3	MapleCreek	LR	TR	Maple Creek	16.4	18.2
31.3	MRUSMC*	LR	MS	Mad River upstream of Maple Creek	NA	NA
32.6	MRDSBoulder	MR	MS	Mad River downstream of Boulder Creek	22.8	24.9
32.6	BoulderCreek	MR	TR	Boulder Creek	18.4	20.5
32.6	MRUSBC*	MR	MS	Mad River upstream of Boulder Creek	NA	NA
41.6	MRSwingB	MR	MS	Mad River at Swinging Bridge	23.3	24.9
72.7	MRHWY36	UR	MS	Mad River at Highway 36 Bridge	17.1	18.9
77.0	MRUSFSCamp	UR	MS	Mad River at USFS Campground	14.7	16.5
80.2	MRDam	UR	MS	Mad River at Matthews Dam	16.3	16.5

RM is river mile, ID is the site code, and Reach identifies each site as estuarine (E), lower reach (LR), middle reach (MR), or upper reach (UR). Name provides the site name with some location information. NA= not applicable. Note: Conversion from degrees Celsius to Fahrenheit is F = (Cx9/5) +32

* HOBO temperature logger lost or stolen from this site; no data recovered.

1.2.2.5 Turbidity and Other Factors

The Mad River was added to the California Clean Water Act Section 3030(d) impaired water list in 1992, partially due to elevated turbidity levels (Stillwater Sciences 2010). Turbidity, a measure of water opacity due to suspended solids, is an important factor in water quality assessments, and has demonstrable effects on salmonid ecology (Fellman et al. 2015, McElroy et al. 2018). The Mad River Watershed Assessment (MRWA) report (Stillwater Sciences 2010) noted that "mainstem sites showed a downstream increase in turbidity...with the highest values measured at Mad River near Arcata." The MRWA also reported that tributaries in the middle and lower reaches of the Mad River are the principal contributors to elevated mainstem turbidity levels and that the "Ruth Lake Reservoir reduces peak turbidity downstream of the dam but prolongs the event by slowly releasing turbid water" (Stillwater Sciences 2010). Data available for our report was limited to 2018 District measurements of Mad River turbidity at the dam tailrace. Turbidity at the tailrace ranged from a maximum of 13.84 nephelometric turbidity units (NTU) (May 1) to a minimum of 1.35 NTU (October 21) during the 2018 monitoring period (Figure 16). Turbidity increased in the fall in response to the first fall rain event (Figure 17).

The multiple linear regression analysis suggested that temperature at the dam tailrace is negatively correlated with turbidity at the same location (not a causative relationship); discharge fit the model reasonably well (adjusted R^2=0.54) but the relationship is weak (Table 16, Figure 17).

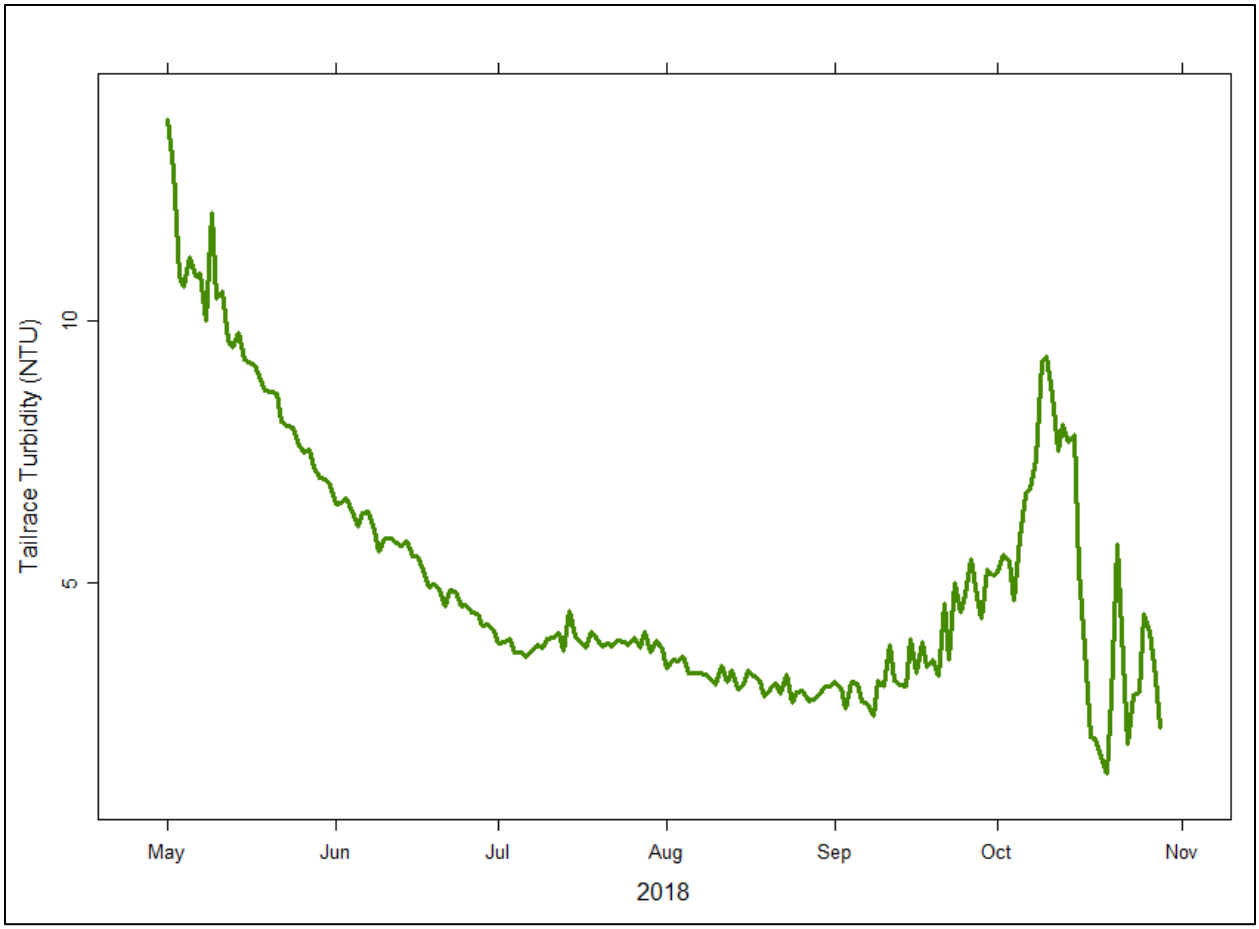


Figure 9. Turbidity Measurements at Matthews Dam (Daily Values)

Table 4. Linear Regression Model Output Relating Turbidity to Water Temperature and Discharge at the Matthews Dam Tailrace

Residuals				
Min	**1Q**	**Median**	**3Q**	**Max**
-2.4654	-1.0940	-0.6566	0.4176	5.8590
Coefficients:				
	Estimate	**Std. Error**	**t value**	**Pr(>|t|)**
(Intercept)	21.911302	3.103333	7.061	3.43e-11 ***
temperature	-0.333805	0.051566	-6.473	8.73e-10 ***
discharge	0.028703	0.005098	5.630	6.77e-08 ***
Model Fit				
Residual standard error	1.662 on 181 degrees of freedom			
Multiple R-squared	0.5495	Adjusted R-squared	0.5445	
F-statistic	110.4 on 2 and 181 DF	p-value	< 2.2e-16	

Significance codes: 0 '***'; 0.001 '**'; 0.01 '*'; 0.05 '.' 0.1 ' ' 1

Model: turbidity ~ temperature + discharge

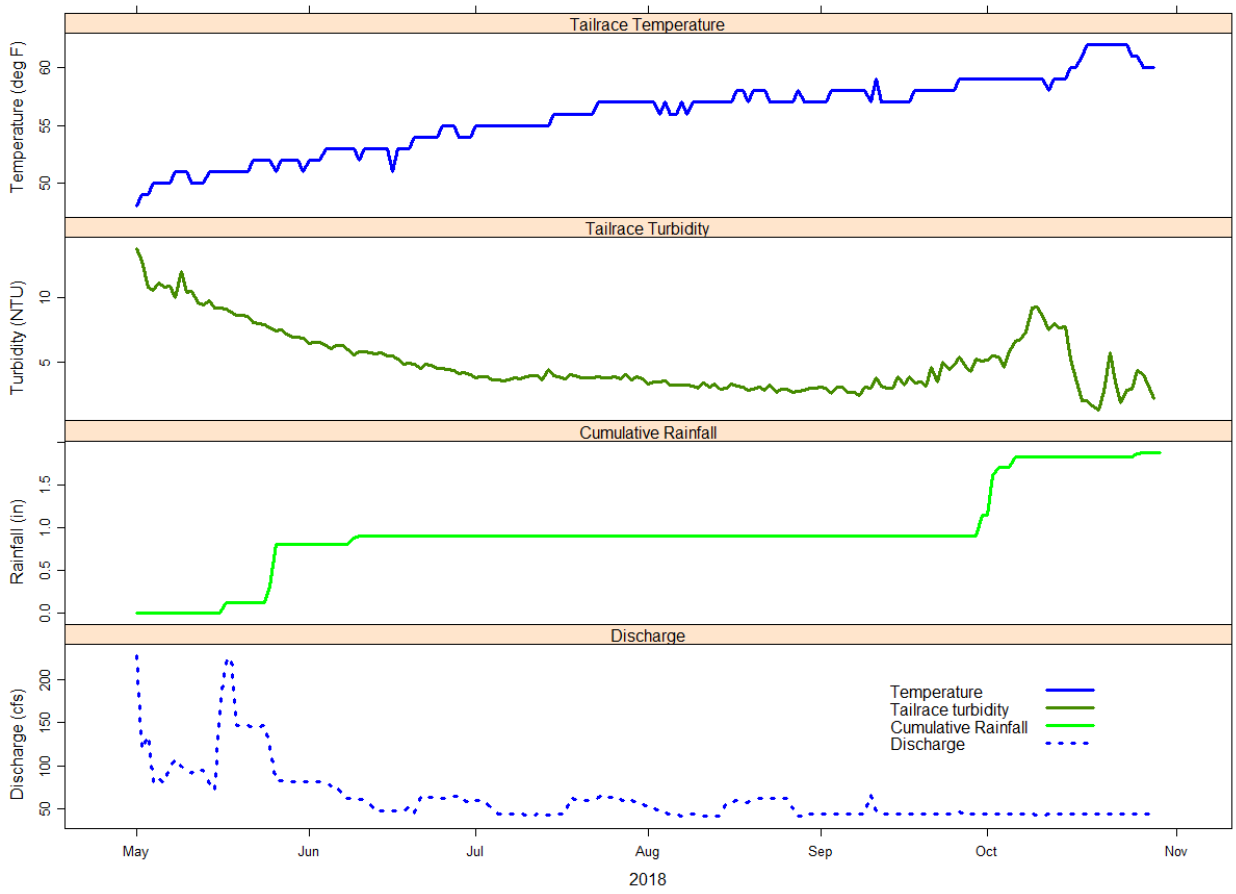


Figure 10. Temperature, Turbidity, Rainfall and Discharge Volume at Matthews Dam (Daily Values)

1.3 Discussion

Summer temperatures in the mainstem Mad River, especially downstream of the upper reach, continued to remain at levels considered "stressful" for salmonids, based on temperature thresholds developed for specific life stages (Stillwater Sciences 2010, Carter 2008). Summer high temperatures can limit distribution and growth of rearing juvenile coho salmon and steelhead (Carter 2008). MWMT values considered limiting for rearing juvenile coho salmon are generally 18.1 or greater, and MWAT values above 16.8 may preclude juvenile coho salmon from rearing in streams (Carter 2008). Many of the tributaries to the lower Mad River had MWAT and MWMT levels below those considered stressful or limiting, and their cooler water contributions to the mainstem Mad River may provide relief (e.g., locally decreased temperatures) for juveniles rearing in the mainstem. MWAT values for rearing juvenile steelhead are considered to be stressful above 19 (i.e., higher than for coho salmon), as are MWMT values above 24 (Carter 2008). The mainstem temperatures were warmer than

these thresholds for steelhead in the middle and lower reaches but suitable in the upper reach, likely due to the cooling contribution of discharge from Matthews Dam even though summer air temperatures were highest in the upper watershed.

For the 2018 monitoring period, it appeared that temperature effects attributable to dam discharges did not extend far downstream, but did exert an influence at least 7.5 RMs downstream to MRHWY36 (Figure 8). The greatest change in the temperature profiles was observed in the river segment between temperature loggers at RMs 41.6 and 72.7: in this river segment, the channel gradient is the steepest (Figure 1) and a series of boulder falls occurs on the mainstem between Bug Creek and Deer Creek (RMs 50–53) that blocks upstream access for anadromous salmon and in many years, for most steelhead (Stillwater Sciences 2010). However, groundwater and hyporheic influences in the mainstem Mad River may affect local water temperatures (Pounds pers. comm. 2019), which may be important for summer steelhead that hold over the summer. Future efforts to monitor water temperatures should include sites in this difficult-to-access area[3] between RMs 41.6 and 72.7: this portion of the Mad River includes particularly important habitat where summer steelhead hold (RMs 41.6–48.8) (Pounds pers. comm. 2019, Naman et al. 2014).

Foothill yellow-legged frog oviposition typically begins in the beginning of May and continues to mid-June when stream temperatures are at least 50°F. In 2018, mainstem water temperatures were generally above 50°F after May 1: colder temperatures were only recorded once at the MRUSFSCamp in early May, and none were detected downstream of that site. Upstream of the MRUSFSCamp site, temperatures never fell below 50°F after mid-June. Therefore, discharge temperatures have the potential to shift suitable early-season reproductive conditions for the foothill yellow-legged frog to later in spring, based on the 2018 monitoring data and our modeling results, in the 3–4 RMs below Matthews Dam.

[3] Access is difficult due to the terrain and private land holdings.

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Addendum A. Summary Analysis of Mad River Alliance Temperature Data

A collaborative temperature monitoring project led by the Mad River Alliance (MRA) was initiated in 2014 to sample water temperatures throughout the Mad River Watershed and its tributaries, with most recent data available from 2021. Water temperature was collected with HOBO thermographs deployed annually between the Matthews Dam and Mad River Estuary. Annual sampling typically focused on the summer season low flow period when air and water temperatures reach their maximum. Deployments generally occurred in May, June, or July and retrievals in September or October before the first fall rains increase flow. The exact locations of deployment varied based on access and resource availability, and not all HOBOs deployed were successfully retrieved, but there were multiple sites that were routinely monitored. Collaborators include Green Diamond Resources, Blue Lake Rancheria, Six Rivers National Forest, Humboldt Bay Municipal Water District (HBMWD), North Coast Regional Water Quality Board (NCRWQCB), and in 2018, H. T. Harvey & Associates.

We analyzed time-series water temperature data collected annually between 2014 and 2021 from seven, consistently sampled stations at certain river locations. Temperature data from 2016 was excluded from analyses because the sensor data were deemed unreliable. The HOBO thermographs recorded ambient temperatures every 30-minutes during the period of deployment, and their time-series data were used to calculate the Maximum Weekly Average Temperature (MWAT) and Maximum Weekly Maximum Temperature (MWMT) from each year of deployment (Table 1, Figure 1). The MWAT represents the average daily rolling mean for the warmest 7-day period, and the MWMT represents the rolling maximum daily temperature over a 7-day period. These indices, outlined in Table 1 and graphically depicted in Figure 1, are often used to evaluate the potential for high summer temperatures to affect special status aquatic species (Stillwater Sciences 2010[4], Carter 2008[5]). HOBO thermographs also collected time-series air temperature data at three sites throughout the Mad River (upstream, middle stream, and downstream). The maximum air temperature detected and its associated date, and monthly averages were determined (Table 2 and 3).

While no statistical analyses were used to assess how temperatures change throughout the season of deployment or based on geographic location, there are clear trends in the data that may have implications for the survival and distribution of anadromous, special status species. Air temperature is consistently higher inland (at upstream sites) compared to the coastline (Figure 2), and generally cools off starting in September. These air temperatures influence the MWAT and MWMT metrics (Table 1; Figure 1). For example, peak water temperatures track periods with warmer air, which tend to occur in July and August, and the lowest water

[4] Stillwater Sciences. 2010. Mad River Watershed Assessment. In Association with Redwood Community Action Agency, and Natural Resources Management Corp, Eureka, California.
[5] Carter, K. 2008. Effects of Temperature, Dissolved Oxygen/Total Dissolved Gas, Ammonia and pH on Salmonids: Implications for California's North Coast TMDLs. California Regional Water Quality Control Board, North Coast Region. January.

temperatures occur at more coastal (downstream) sites, where air temperature is lower compared to more inland (upstream) sites. Temperatures at the Matthews Dam discharge are typically colder than downstream inland locations (Figure 1).

The indices derived from water and air temperature time-series data provide an overview of summer temperature conditions in the Mad River for different years, and can be reviewed in conjunction with the annual Mad River Temperature Monitoring Summary Reports, which provide the annual time series data at other locations in the basin as well, and the Water Quality Report, which contains an in depth depiction of the 2018 time series data and various analyses of water temperature from 22 sites within the mainstem of the Mad River and its tributaries.

Table 1. Water Temperature Indices (Maximum Weekly Average Temperature [MWAT], Maximum Weekly Maximum Temperature [MWMT] in °C at Sites Consistently Sampled.

Year	Matthews Dam (RM 80.2)		USFS Camp (RM 77.0)		Highway 36 Bridge (RM 72.7)		Swinging Bridge (RM 41.6)		Down Stream Powers Creek (RM 12.4)		Boat Ramp (RM 3.1)	
	MWAT	MWMT	MWAT	MWMT	MWAT	MWMT	MWAT	MWMT	MWAT	MWMT	MWAT	MWMT
2014	14.4	16.2	NA	NA	22.4	25.2	22.9	24.6	NA	NA	19	20.5
2015	NA	NA	19.3	28.3	19.2	28.1	23.6	25.4	NA	NA	21.0	21.9
2017	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2018	16.3	16.5	14.7	16.5	17.1	18.9	23.3	24.9	20.4	23.8	21.2	23.1
2019	15.7	15.9	16.3	18.2	18.2	19.7	22.1	23.3	23.3	25.6	22.5	23.7
2020	15.1	15.2	NA	NA	19.7	21.4	23.0	24.5	21.4	24.9	NA	NA
2021	20.7	22.6	NA	NA	19.7	22.4	23.5	25.4	NA	NA	20.8	22.6

The 6-selected were consistently sampled throughout the project duration, from upstream (Matthews Dam) to downstream (Boat Ramp). RM indicates the river mile mark. NA=not applicable. No data from 2016 or 2017 were analyzed.

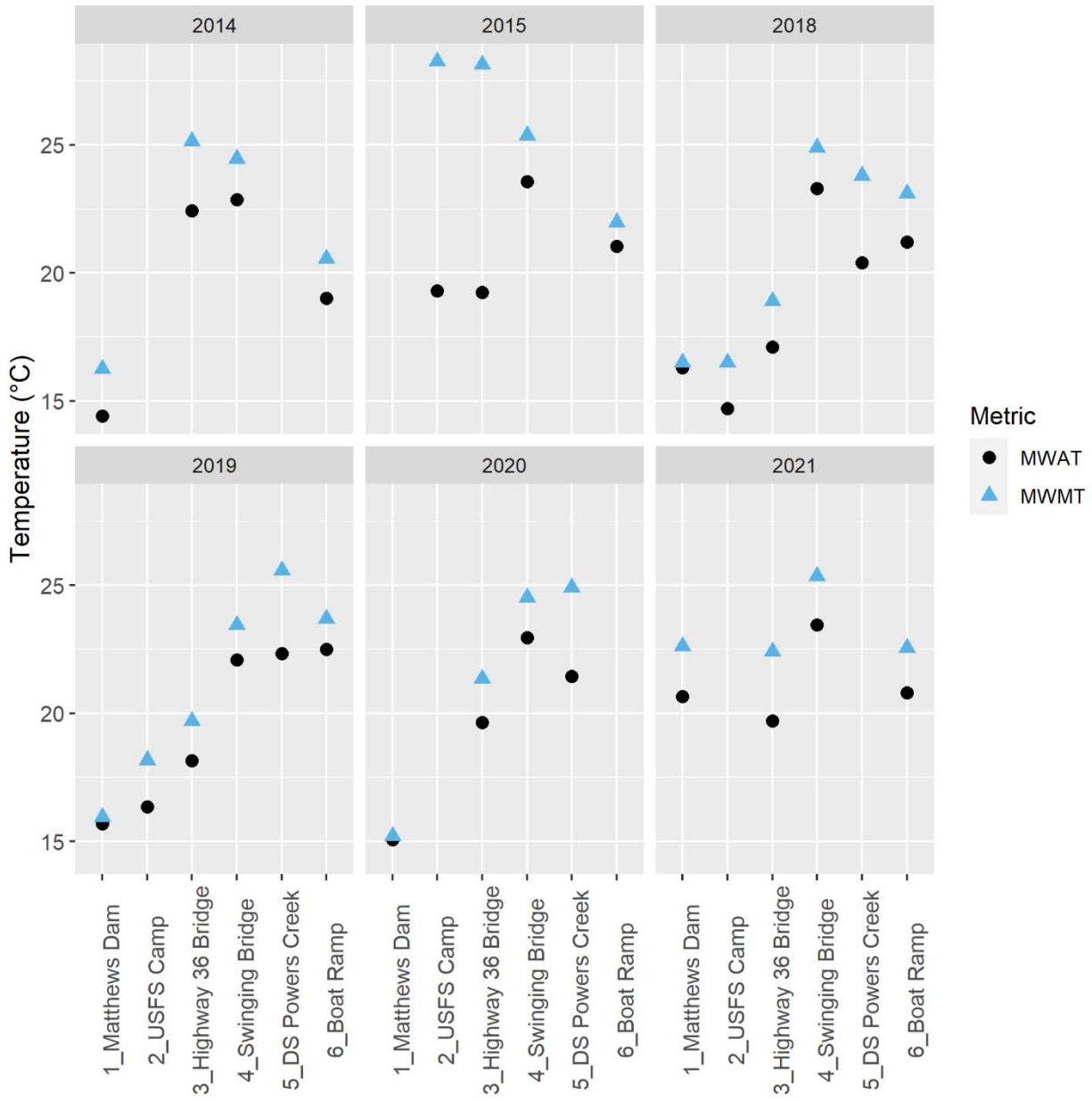

Figure 1. Maximum Weekly Average Temperature (MWAT) and Maximum Weekly Maximum Temperature (MWAT) in °C.

Stations (x-axis) are labeled from upstream to downstream. MWATs are the black dots and MWMTs are the blue triangles. No data from 2016 or 2017 were analyzed. The location of these stations can be referenced in Figure 8 of the Water Quality Report.

Table 2. Annual Maximum Air Temperature Indices in °C.

Year	Upper	Middle	Lower
2015	37.9 (10/14)	32.9 (7/29)	31.9 (6/9)
2018	39.6 (7/26)	32.5 (10/14)	25.2 (10/16)
2019	39.8 (8/27)	31.0 (8/27)	21.4 (8/21)
2020	42.8 (9/1 ; 9/7)	33.3 (9/7)	22.2 (8/15)
2021	40.5 (8/15)	NA	33.8 (7/7)

Air temperatures were measured in °C at the upper, middle, and lower reaches along the Mad River. Values in () next to temperatures are the date (M/DD) that the maximum temperature was detected. NA=no temperature sensors deployed. No data from 2016 or 2017 were analyzed.

Table 3. Monthly Average Air Temperatures in °C.

Month	2015			2018			2019			2020			2021		
	Up	**Mid**	**Low**	**Up**	**Mid**	**Low**	**Up**	**Mid**	**Low**	**Up**	**Mid**	**Low**	**Up**	**Mid**	**Low**
June	18.0	18.1	13.4	18.0	14.7	13.8	NA	NA	NA	14.9	14.3	14.4	NA	NA	NA
July	19.0	19.2	14.8	23.7	17.9	14.2	21.3	18.0	15.7	16.3	14.4	13.8	23.7	NA	18.7
Aug.	18.0	18.3	14.9	NA	16.7	14.5	21.6	18.4	15.9	17.9	16.0	15.2	21.9	NA	16.2
Sept.	15.5	15.8	13.0	NA	14.7	12.5	16.6	15.6	14.5	15.7	15.5	14.8	18.6	NA	14.7
Oct.	16.9	16.9	16.6	NA	15.6	14.9	9.9	10.0	8.2	11.6	14.7	13.4	15.2	NA	15.5

Air temperatures in °C were measured at the upper (Up), middle (Mid), and Lower (Low) reaches along the Mad River. NA=no temperature sensors deployed. No data from 2016 or 2017 were analyzed.

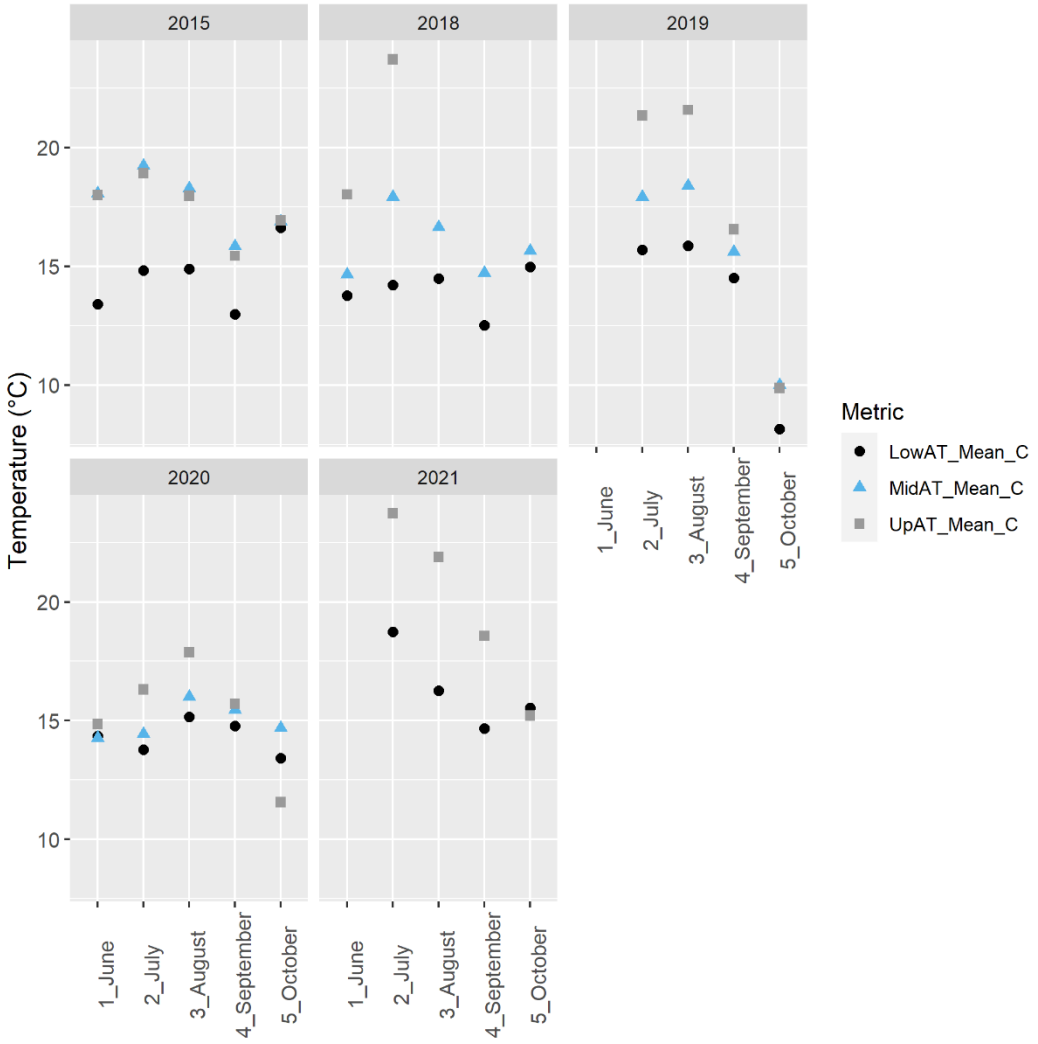

Figure 1. Monthly Average Air Temperatures in °C.
Monthly average air temperatures (AT) in °C measured at the upper (UpAT_Mean_°C; grey square), middle (MidAT_Mean_°C; blue triangle), and Lower (LowAT_Mean_°C; black dot) reaches along the Mad River. The location of these stations can be referenced in Figure 8 of the Water Quality Report.