Madison River Drainage Fisheries

and

Madison River Drainage Aquatic Native Species Conservation and Restoration Program

2017
Annual Report
to
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Butte
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INTERNET WEB PAGES CITED IN THIS REPORT, OR OF LOCAL INTEREST
(in alphabetical order)

Aquatic Nuisance Species Task Force.. www.anstaskforce.gov
Madison River Foundation .... www.madisonriverfoundation.org
Lower Madison River Monitoring page .... www.madisondss.com/ madison.php
Montana Fish, Wildlife, & Parks .... www.fwp.mt.gov
NorthWestern Energy .... northwesternenergy.com
Protect Your Waters.. www.protectyourwaters.net or .com

FWP personnel took all photos in this report unless otherwise credited.

FERC Articles Addressed in this Report

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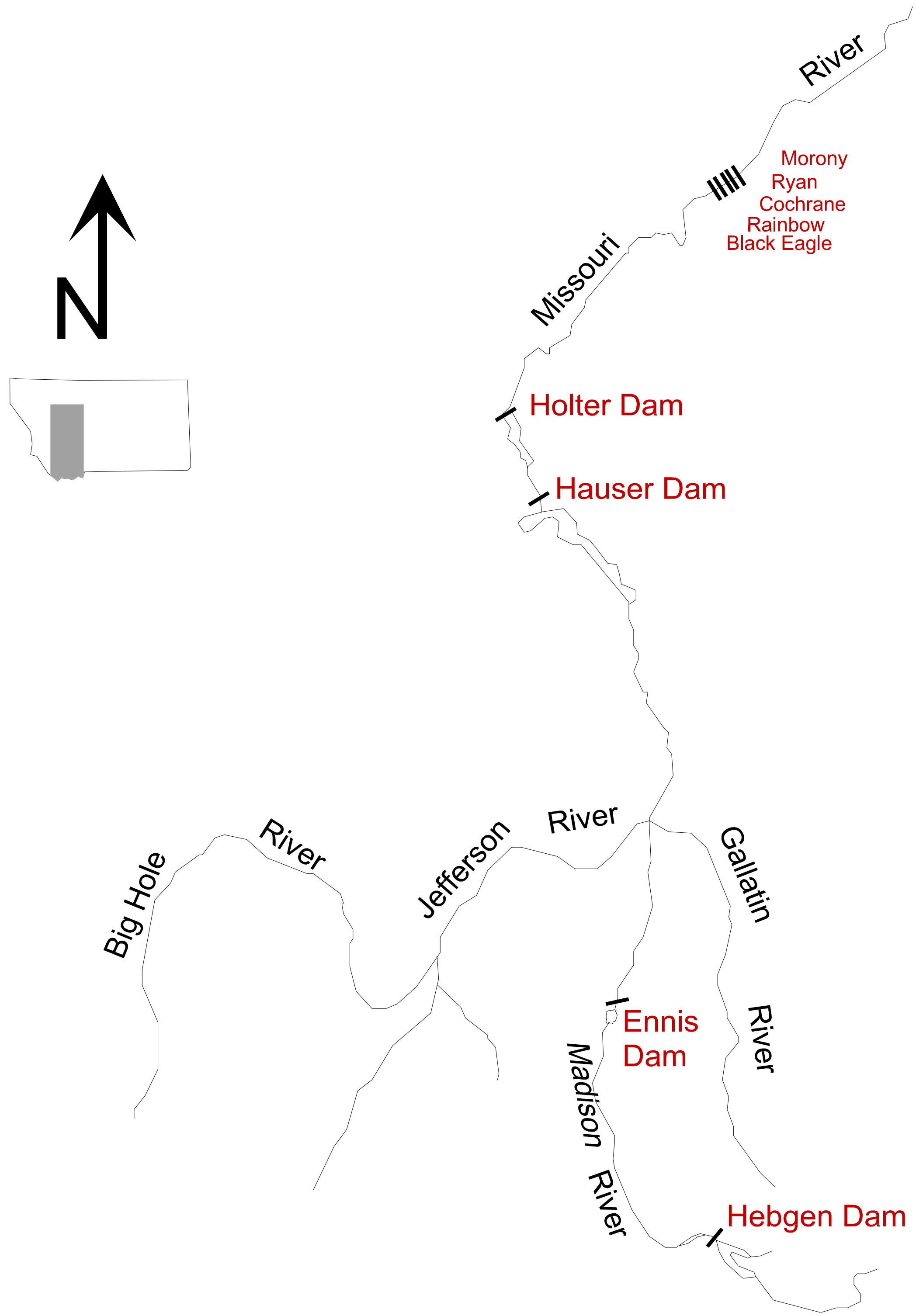


Figure 1. Map showing locations of NWE dams on the Madison and Missouri rivers (FERC Project 2188).

INTRODUCTION

Montana Fish, Wildlife, & Parks (FWP) has conducted fisheries studies in the Madison River Drainage since 1990 to address effects of hydropower operations at Hebgen and Ennis dams on fisheries. Additionally, these studies aim to assess the status of the Arctic Grayling (*Thymallus arcticus)* population of Ennis Reservoir (Byorth and Shepard 1990; Clancey 1995; Clancey 1996; Clancey 1997; Clancey 1998a; Clancey 1999; Clancey 2000; Clancey and Downing 2001; Clancey 2002; Clancey 2003; Clancey 2004; Clancey and Lohrenz 2005; Clancey 2006; Clancey 2007; Clancey 2008; Clancey and Lohrenz 2009; Clancey and Lohrenz 2010; Clancey and Lohrenz 2011; Clancey and Lohrenz 2012; Clancey and Lohrenz 2013; Clancey and Lohrenz 2014; Clancey and Lohrenz 2015; Moser and Lohrenz 2016). This work has been funded since 1990 through an agreement with the owner and operator of the dams. Initially Montana Power Company (MPC) until 1999, and then PPL Montana until November 18, 2014, when PPL Montana was purchased by NorthWestern Energy (NWE).

The original agreement between FWP and MPC was designed to anticipate relicensing requirements for MPC's hydropower system on the Madison and Missouri rivers. This includes Hebgen and Ennis dams, as well as seven dams on the Missouri River (Figure 1). NWE has maintained the direction set by MPC, and convened several committees to address fisheries, wildlife, water quality, and recreation issues related to the operation of the hydropower facilities on the Madison and Missouri rivers. These committees are composed of representatives of NWE and several agencies. Each committee has an annual budget and authority to spend NWE mitigation funds to address the requirements of NWE's Federal Energy Regulatory Commission (FERC) license for operating the Madison & Missouri dams. The Madison Fisheries Technical Advisory Committee (MadTAC) is composed of personnel from NWE, FWP, the U.S. Fish & Wildlife Service (USFWS), the U.S. Forest Service (USFS), and the U.S. Bureau of Land Management (BLM). Collectively, the nine dams on the Madison and Missouri rivers are called the 2188 Project, which refers to the FERC license number that authorizes their operation. The FERC issued NWE a license to operate the 2188 Project for 40 years (FERC 2000). The license details the terms and conditions NWE must meet during the license term; including fish, wildlife, and recreation protection, mitigation, and enhancement measures.

During the late 1990's, numerous entities developed the Memorandum of Understanding and Conservation Agreement for Westslope Cutthroat Trout in Montana (WCTA). This agreement, which was formalized in 1999 (Montana FWP 1999), identifies Conservation & Restoration Goals and Objectives for Westslope Cutthroat Trout (WCT; *Oncorhynchus clarkii lewisi)* in Montana. The Plan states "The management goal for Westslope Cutthroat Trout in Montana is to ensure the long-term, self-sustaining persistence of the subspecies within each of the five major river drainages they historically inhabited in Montana (Clark Fork, Kootenai, Flathead, upper Missouri, and Saskatchewan), and to maintain the genetic diversity and life history strategies represented by the remaining populations."

Objective 3 further states "The long-term persistence of Westslope Cutthroat Trout within their native range will be ensured by maintaining at least ten population aggregates throughout the five major river drainages in which they occur, each occupying at least 50 miles of connected habitat…" Within the Missouri River Drainage, four geographic areas are identified, including the upper Missouri, which consists of the Big Hole, Gallatin, and Madison sub-drainages.

In 2007, the WCTA was updated and combined with a similar document for Yellowstone Cutthroat Trout *(Oncorhynchus clarkii bouvieri)* (Montana FWP 2007).

Signatories to the 2007 Montana Cutthroat Trout Agreement are American Wildlands, the Blackfeet Tribal Business Council, the Confederated Salish and Kootenai Tribes, the Federation of Fly Fishers, the Greater Yellowstone Coalition (GYC), the Montana Chapter of the American Fisheries Society, the Montana Cutthroat Trout Technical Committee, the Montana Department of Environmental Quality, the Montana Department of Natural Resources and Conservation, the Montana Farm Bureau, Montana Fish, Wildlife & Parks, the Montana Stockgrowers Association, Montana Trout Unlimited, the Montana Wildlife Federation, the USDA Natural Resources Conservation Service, the Bureau of Land Management, the U.S. Fish & Wildlife Service, the Forest Service, and Yellowstone National Park. Additionally, Plum Creek Timber Company provided a letter of support for the 2007 Cutthroat Agreement, citing their 30-year agreement with the U.S. Fish & Wildlife Service to the Native Fish Habitat Conservation Plan for Plum Creek properties.

FWP initiated an effort in 1996 to conserve and restore native Westslope Cutthroat Trout in the Madison River Drainage. Fieldwork for this effort began in 1997 in tributaries of the Madison River. The agreement between FWP and NWE includes provisions to address issues regarding species of special concern.

In 2001, the Sun Ranch entered into an agreement to assist FWP with Westslope Cutthroat Trout conservation and recovery. A small hatchery facility was constructed to rear eggs for introductions and a rearing pond for the development of a Westslope Cutthroat Trout brood stock for the Madison and Missouri river drainages.

METHODS

Madison Grayling

In January 2014, FWP released an environmental assessment entitled 'Southwest Montana Arctic Grayling Reintroductions' in which FWP proposed to reintroduce Big Hole River and Red Rock Lake grayling into waters of the Madison and Big Hole drainages using eyed eggs in remote site incubators (Clancey 2014). The Decision Notice approving the proposal was issued on April 1, 2014.

The Arctic Grayling introduction program was initiated in the Madison Drainage and in other waters across southwest Montana in May 2014 (Clancey and

Lohrenz, 2015). The program is an effort to re-establish viable Arctic Grayling populations in formerly occupied waters or at sites where their populations are diminished.

In 2017, gametes were collected (Figure 2) from Arctic Grayling brood populations in Upper Twin Lake and from Green Hollow Pond on the Flying D Ranch for introductions. Fertilized eggs were transported to FWP's Yellowstone River Hatchery in Big Timber for incubation. Once the eggs incubated to the eyed-stage of development they were distributed into remote site incubators (RSIs) where incubation was completed, hatching occurred, and fry emerged (Figure 3).

Figure 2. A female Arctic Grayling from the wild brood being stripped of eggs.

Figure 3. Arctic Grayling remote site incubators at a site in the Moore’s Creek

Environmental DNA (eDNA) sampling was carried out throughout the upper Madison drainage to evaluate for the presence of Artic grayling (Figure 4). Organisms release DNA into the environment through natural biological processes, eDNA sampling is the detection of this DNA in the organisms suspected environment (Carim et al. 2016). Further explanation of eDNA sampling procedures and background are listed in Appendix G-1.

Figure 4. Collection of eDNA sample.

Fish, Wildlife and Parks personnel conducted electrofishing surveys near introduction sites in July and October 2017 to survey for introduced Arctic Grayling.

Additionally, surveys for adult Arctic Grayling were carried out on Ennis Reservoir and associated river inlets in April and May 2017.

A beach seine (Figure 5) is used to monitor index sites in Ennis Reservoir (Figure 8) for young-of-the-year Arctic Grayling and other fish species. Seining is conducted by pulling a 125 x 5 foot fine-mesh net along shallow areas of Ennis Reservoir. (Standard). index sites were seined in 2017(Appendix A

Figure 5. Beach seining in Ennis Reservoir.

Population Estimates

Electrofishing from a drift boat mounted mobile anode system (Figure 6) is the principle method used to obtain trout population estimates in the Madison River (Figure 7).

Figure 6. Mobile anode electrofishing (shocking) in the Norris section of the Madison River.

Fish captured for population estimates are weighed and measured, observed for hooking scars, marked with a fin clip, released, and allowed to redistribute throughout the reach for at least ten days. A recapture run is conducted after approximately ten-days to ensure redistribution of individuals after capture. During the recapture run, fish are observed for marks administered during the marking run, lengths are taken on marked fish, and length and weights are recorded on fish that do not exhibit a mark. The proportion of marked to un-marked fish is analyzed using a log-likelihood statistical analysis (Montana FWP 2004) to estimate trout and Mountain Whitefish populations.

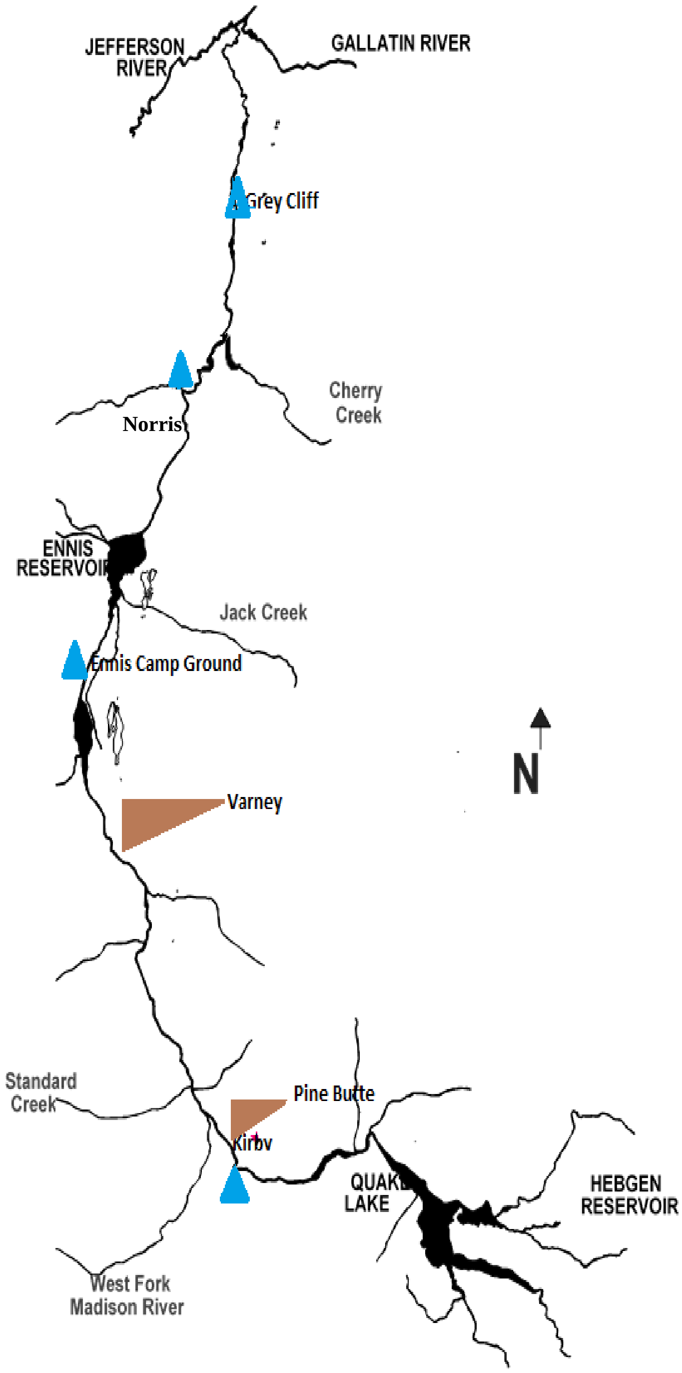


Figure 7. Locations of Montana Fish, Wildlife & Parks 2017 Madison River population estimate sections - red triangles, core sampling and redd count sections in blue.

Angler Survey

Creel/angler satisfaction surveys were carried out from March 15th to the end of November 2017 on the Upper Madison River. Surveys were conducted following a stratified random sampling study design. Three weekdays along with one weekend day were randomly selected for surveys each week. Starting location (fishing access site), sampling direction (upstream/downstream), and start time (based on sunrise/sunset) were randomly selected for each sampling day. During the peak season of May 27th to September 5th start times were randomized as morning or evening starts. Sampling days occurred in 10-hour shifts.

The survey clerk spent one-hour surveying at each site, no more or less, before moving to the next appropriate site. During travel time, spotted and reasonably accessed anglers were surveyed as well. Anglers were only interviewed if they had already been fishing for at least one hour.

Additionally, during peak season, the stretch of river between Hebgen and Quake lakes was sampled separately from the rest of the Upper Madison. A separate creel clerk conducted three total angler counts each sample day. Count days and times were also selected randomly. Creel/angler satisfaction surveys were conducted in between counts. These angler surveys were conducted under the same parameters as the surveys done on the rest of the river. Harvest has been reported by the public to be excessive in this reach of the Madison River. By collecting total angler counts as well as individual interviews, a total harvest estimate can be calculated. Results from this survey will be presented in a separate report and in the 2019 annual report to NWE.

Ennis Reservoir Gillnetting

Gillnetting of Ennis Reservoir was conducted in October 2017. Variable mesh 125-foot-long experimental gillnets are deployed overnight at predefined index sites (Figure 8). Four nets (3 floating and 1 sinking net) are fished at each site. Gillnetting on Ennis Reservoir is conducted in alternate years. Samples are sorted by net and processed systematically by species with total length and weight recorded. Additionally, a subsample of four fish from each species sampled is selected for bio-contaminate analysis (Appendix J).

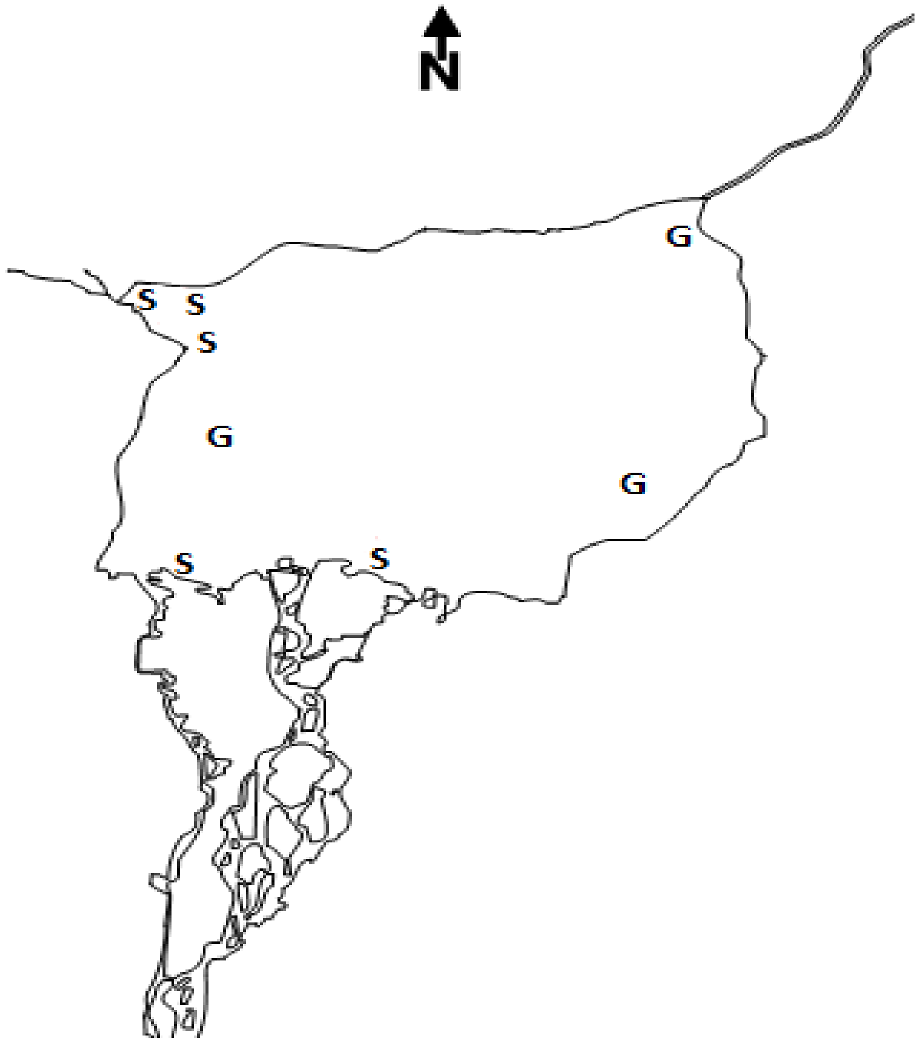


Figure 8. Locations of Ennis Reservoir 2017 beach seining (S) and gillnetting (G) sites.

River Discharge

Pulse Flows

Article 413 of the FERC license mandates NWE monitor and mitigate thermal effects in the lower river (downstream of Ennis Reservoir). In coordination with agencies, the company has developed and implemented a remote temperature monitoring system and a ‘pulsed’ flow system to mitigate high water temperatures. Real-time or near real-time meteorological and temperature monitoring is conducted to predict water temperature the following day, which determines the volume of discharge that is necessary for thermal mitigation (Appendix SS). Pulsed flows are triggered when water temperature at the Madison (Ennis) Powerhouse is 68° F or higher and the predicted air temperature at the Sloan Station (River Mile 17) near Three Forks, MT for the following day is 80° F or higher. The volume of water released in the pulse is determined by how much the water and/or air temperature exceeds the minimum thresholds (Table 1). The increase in water volume in the lower river reduces the peak water temperature that would occur at the 1,100 cubic-feet-per-second (cfs) base flow. Discharge from Ennis Dam is increased in the early morning so that the greatest volume of water is near Black’s Ford FAS and downstream during the late afternoon when daily solar radiation is greatest. The increased volume of water reduces the peak water temperature in the lower river reducing the potential for thermally induced fish kills. Discharge from Hebgen Dam typically does not fluctuate on a daily basis during pulse flows but is occasionally adjusted to increase or decrease the volume of water going into Ennis Reservoir, where daily fluctuations in the lower river are controlled.

The meteorological and temperature data monitored in the lower river may be viewed in real-time or near-real time at http://www.madisondss.com.

Table 1. Criteria for Pulse Flow. Courtesy of NorthWestern Energy 2017.

2017 Manual Protocol	Tomorrow's Predicted Maximum Air Temperature (°F) and Corresponding Pulse Flow (cfs) (Look up predicted high air temperature for the next day, at Sloan Station near Three Forks, MT)		
Today's Maximum Powerhouse Release Temperature (°F) (Look up river temperature on the Madison DSS website or the USGS McAllister gage at USGS McAllister on or after 8:30 p.m.)	Air Temp >= 75 and < 85	Air Temp >= 85 and < 95	Air Temp >= 95 and < 105
greater or equal to 68 and less than 69	1150	1150	1400
greater or equal to 69 and less than 70	1150	1400	1600
greater or equal to 70 and less than 71	1150	1600	2000
greater or equal to 71 and less than 72	1400	1600	2100
greater or equal to 72 and less than 73	1450	1800	2400
greater or equal to 73 and less than 74	1600	2100	2800
greater or equal to 74 and less than 75	1800	2600	3000
greater or equal to 75	2600	3200	3200

Flushing Flows

Article 419 of the FERC license requires that NWE develop and implement a plan to coordinate and monitor flushing flows in the Madison River downstream of Hebgen Dam. A flushing flow must be large enough to mobilize streambed materials and produce scour in some locations and deposition in other locations. This is a natural occurrence in unregulated streams and rivers, and renews spawning, rearing, and food producing areas for fish, as well as providing fresh mineral and organic soil for terrestrial vegetation and other wildlife needs.

Core Sampling and Redd Counts

High flows or flushing flows are needed for the maintenance of spawning gravels used by salmonids in the Madison River. Excessive accumulation of fine sediments in spawning gravel may smother eggs, arrest embryo development, and hamper fry emergence from the gravel.

Core sampling has been conducted at index sites on the Madison River annually as part of the flushing flow plan, Article 419. Core sampling is method of analyzing the composition of substrates from the river bed at known spawning areas. Core samples provide information on fines that can be monitored and tied to channel changing flows. Substrate samples are collected with a 12" McNeil core sampler (Figure 9). The core sampler is drilled into the substrate to a depth of 8". Substrate from within the 12"x 8" area are collected, dried, and sorted using a sieve method. Percent composition of the substrate sample according to size is then calculated.

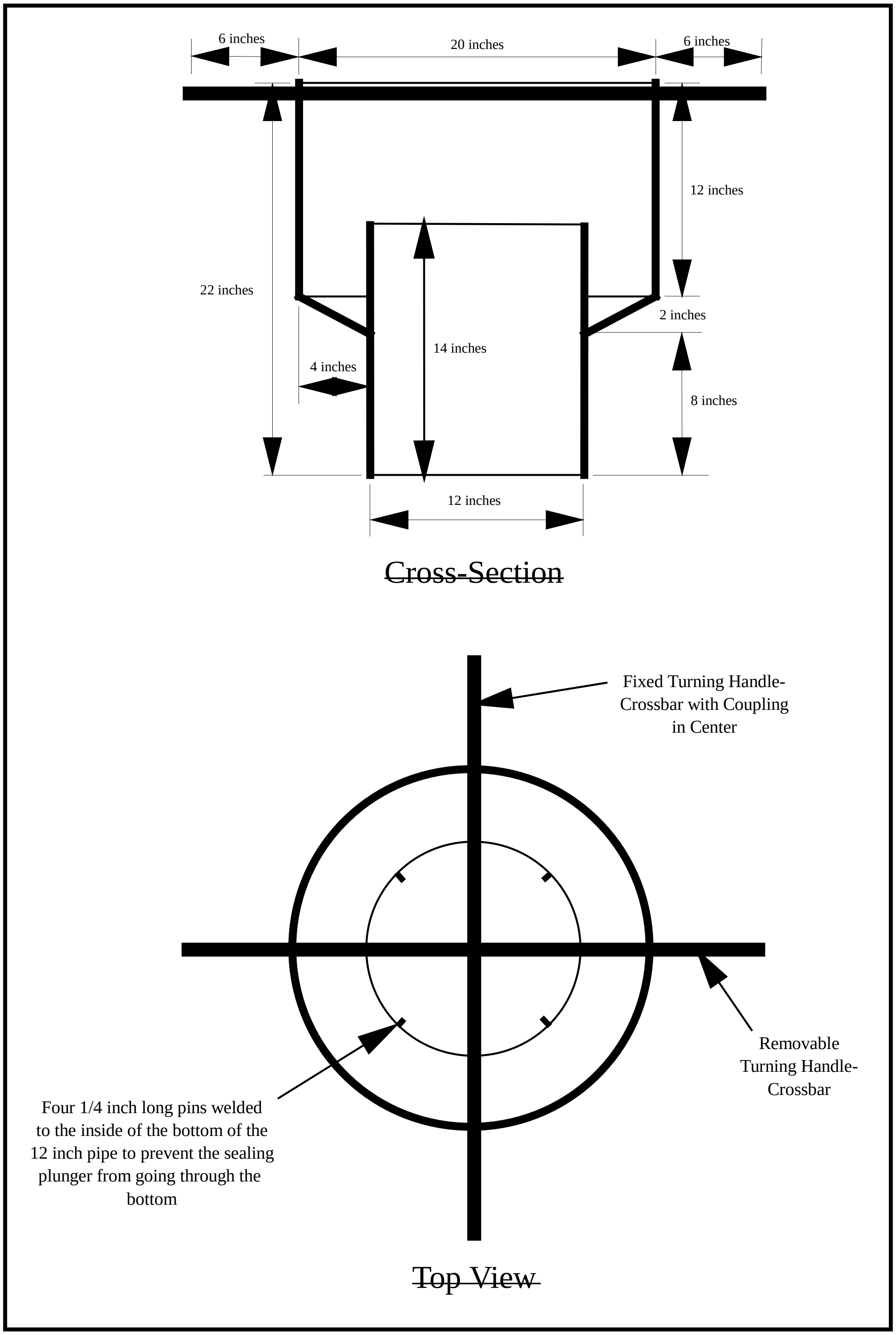


Figure 9. Schematic of 12-inch diameter substrate sampler, modeled after the original 6-inch diameter sampler developed by McNeil and Ahnell (1964).

Redd counts were initiated in 2013 to help crews identify spawning areas to focus substrate sampling. Redds are nests excavated in streambed substrate by salmonids during spawning in which fertilized eggs are deposited. Redd counts are conducted by walking and visually counting redds. Dimensions of a redd are recorded, i.e., length, width, depth. Additionally, each redd or redd complex is marked with a GPS and coordinates are recorded.

Minimum Flows

Fish, Wildlife & Parks and NWE (and NWE's predecessors Montana Power Company and PPL Montana) established an agreement in 1968 to maintain minimum instantaneous river flows at the USGS Kirby and McAllister gauges in the upper and lower river of 600 and 1,100 cfs, respectively. Minimum instream flow levels identified by FWP as being necessary to provide overwintering habitat for yearling trout and protect against summer and fall drought in low water years. These minimum flow requirements were incorporated into Article 403 of the FERC license of the 2188 Project and are required elements of operating Hebgen and Ennis dams.

Temperature Monitoring

Water temperature was recorded at 12 sites and air temperature at six sites throughout the Madison River basin from upstream of Hebgen Reservoir to the mouth of the Madison River at Headwaters State Park (Figure 10). Each of the Tidbit™ temperature loggers recorded over 43,000 temperature points in Fahrenheit from late April through early October. Air temperature recorders were placed in areas that were shaded from solar radiation 24 hours per day.

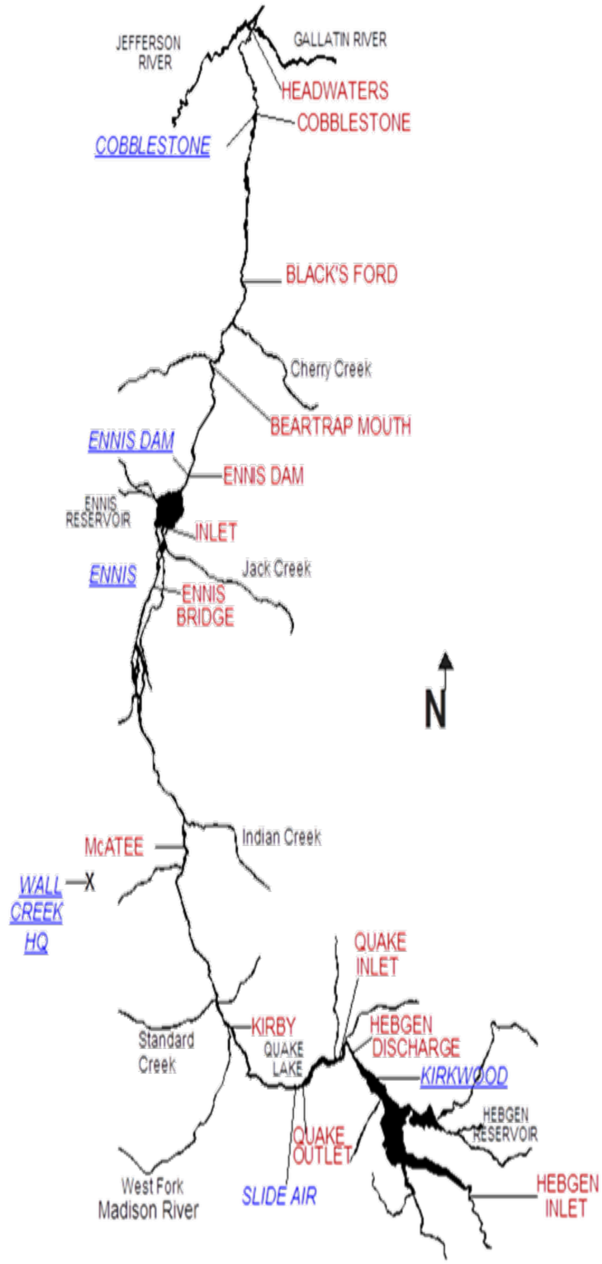


Figure 10. Locations of Montana Fish, Wildlife & Parks temperature monitoring sites. Air temperature monitoring sites are blue and underlined; water temperature monitoring sites are red.

Discharge from Hebgen Reservoir typically occurs from a depth of about 40 feet. A mechanical failure in 2011 and subsequent repair of the inlet structure, required surface discharge from 2012-2015. Discharge at depth was achieved during 2016 during spillway re-construction. Discharge from Hebgen was again switched to surface release in 2017 during refurbishment of the outlet pipe. The outlet pipe was finished in the fall of 2017. Major repairs to Hebgen Dam are complete and typical discharge has been returned to an approximately 40 feet depth.

Specific dates of surface releases are:

- 5/10/12 – 1/10/13
- 5/28/13 – 12/30/13
- 6/9/14 – 1/26/15
- 4/14/15 – 11/26/15
- 6/19/17 – 12/11/17

Aquatic Invasive Species

Highway signs announce FWP's West Yellowstone Traveler Information System (TIS) (Figure 11). The five signs are located near major highway intersections in the West Yellowstone area. The TIS notifies anglers and water recreationists of the presence of New Zealand mudsnails in the Madison River and Hebgen Reservoir and instructs them on methods of reducing the likelihood of transporting New Zealand mud snails and other AIS to other waters.

Figure 11. Roadside sign announcing the Traveler Information System near West Yellowstone, Montana.

Additional messages broadcast by the system include messages on whirling disease, zebra mussels, weed control, and TIPMont, the FWP hotline to report hunting & fishing violations. The system broadcasts at the AM frequency of 1600 KHz. Funding for the purchase, installation, and signage of the system was provided by a $9,800 grant from the Pacific States Marine Fisheries Commission as part of an effort to prevent the westward spread of zebra mussels.

Fish, Wildlife & Parks hired an Aquatic Invasive Species Coordinator in 2004 to develop and coordinate AIS control & management activities among state agencies and state and non-state entities. The AIS Coordinator is responsible for developing and coordinating Hazard Analysis and Critical Control Point (HACCP) training to State employees and other groups. The HACCP program is a method to proactively plan and implement measures to prevent the inadvertent spread of AIS during work activities.

The FWP public education campaign called "Inspect/Clean/Dry" has been around since 2010 and continues to generate public awareness of aquatic invasive species issues. This campaign uses highway billboards and posters (Appendix B) to convey the message.

In 2017, the FWP AIS field crews surveyed the Madison River (multiple sites), Hebgen and Ennis reservoirs, Cliff and Wade lakes, and the Ennis National Fish Hatchery. Water temperature, GPS coordinates, pH, weather conditions, notes on substrate, and invertebrate and macrophyte data were collected. A minimum of 400 feet is surveyed at each site. In addition, horizontal plankton tows were conducted to sample for zebra and quagga mussel veligers and invasive zooplankton.

In addition to regular biological monitoring, boat and angler inspections were conducted at FWP Region 3 Headquarters in Bozeman, MT. Thirty-two water craft were inspected. Most boaters surveyed had clean watercraft and were aware of AIS issues.

New Zealand Mudsnails have spread throughout the Madison River since first detected in 1994. NWE and FWP each maintain monitoring sites at various locations within the Madison Drainage.

Westslope Cutthroat Trout Conservation and Restoration

Efforts to conserve and restore Westslope Cutthroat Trout in the Madison Drainage center on maintaining populations that exhibit 90% to 100% genetic purity, high quality stream habitat, adequate instream flow, construction of barriers to prevent upstream migration of non-native trout species; and, where necessary, removal of competing or hybridizing non-native trout are all necessary for this native species to perpetuate. Removal of non-native species typically, but not always requires the use of the EPA registered piscicide rotenone.

Several streams that support Westslope populations were resurveyed in 2017 for potential barrier sites. Surveys were conducted to as part of efforts prioritize Westslope populations at greatest risk from hybridization with non-native Rainbow Trout in the Madison Valley.

The Beaverhead-Deerlodge and Custer-Gallatin national forests, and Yellowstone National Park are conducting projects to benefit Westslope Cutthroat Trout and/or to restore stream habitat in tributaries to the Madison River. MadTAC has provided grants to each of these federal agencies to assist their efforts.

English George and Wall Creek Barriers

Montana Fish, Wildlife & Parks management of Westslope Cutthroat Trout designates 'core populations' as those populations that exhibit 100% genetic purity, and conservation populations as those that exhibit 90-99.9% genetic purity as target populations for conservation. While conservation populations are not 100% genetically pure they warrant protection because they still maintain important genetic diversity, local adaptation, life history forms, and phenotypic variations of the species. The genetic legacy of WCT is threatened by continued hybridization with non-native trout species. Populations of WCT are considered secure by FWP when they are isolated from non-native fishes, typically by a physical fish passage barrier.

English George Creek (Figure 12) is a tributary to the Madison River south of the town of Ennis. A 4-foot barrier to upstream fish passage was constructed approximately 0.6 miles upstream of the Madison River. The barrier isolates approximately 3.4 miles of stream habitat (94.0% genetically pure Westslope Cutthroat Trout) from further introgression with Madison River Rainbow Trout.

Montana Fish, Wildlife and Parks in conjunction with the Beaverhead-Deerlodge National Forest, commissioned Morrison Maierle to do a site survey and design for a fish barrier on Wall Creek, a tributary of the Madison River, located on the B-D National Forest adjacent to the Wall Creek Game Range approximately 24 miles South of the town of Ennis (Figure 12).

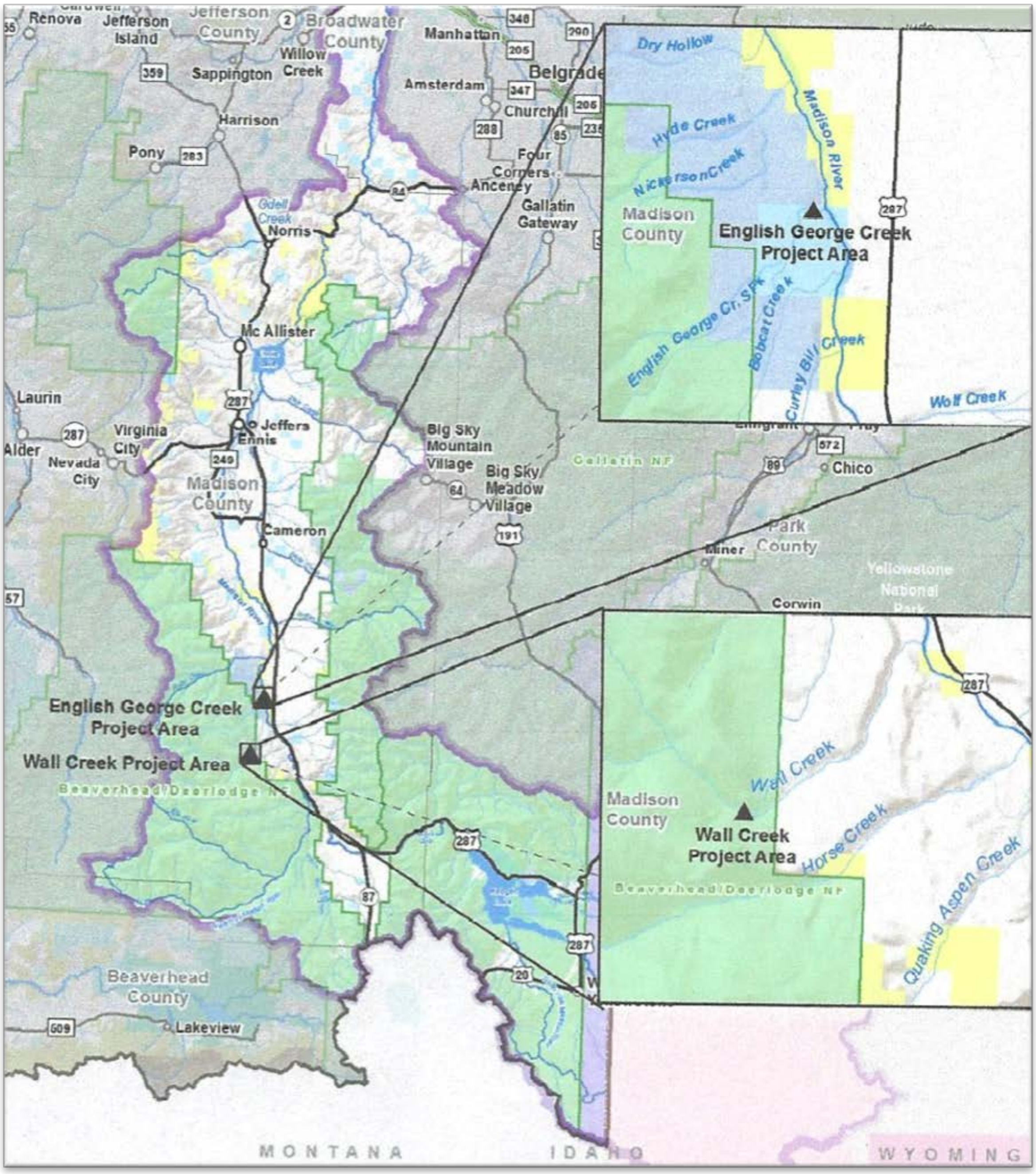


Figure 12. Map of English George barrier site and proposed Wall Creek fish barrier.

Ruby Creek Westslope Cutthroat Trout Project

Ruby Creek (Figure 13) is a tributary to the Madison River south of the town of Ennis. A 15-foot waterfall at stream mile 0.7 isolates most of the drainage from upstream movement of wild, non-native Madison River fish. Rainbow trout and Rocky Mountain Sculpin (*Cottus bondi)* were the only fish species found above the waterfall. Rainbow Trout, Brown Trout, and Sculpin are common below the waterfall. Rainbow and Brown Trout from the Madison River also seasonally utilize the lower 0.7 miles of the stream for spawning.

In December 2012, after environmental review, Rainbow Trout removal above the waterfall was initiated. A final piscicide treatment was conducted in 2013. Rigorous sampling for Rainbow Trout by electrofishing and environmental DNA sampling in the treated portion of Ruby Creek was conducted in 2015. It was determined that the treated reach of Ruby Creek was free from Rainbow Trout and introductions of Westslope Cutthroat Trout were initiated in the fall of 2015. Introductions of live fish transferred from existing Madison River populations will continue for 5 to 7 years.

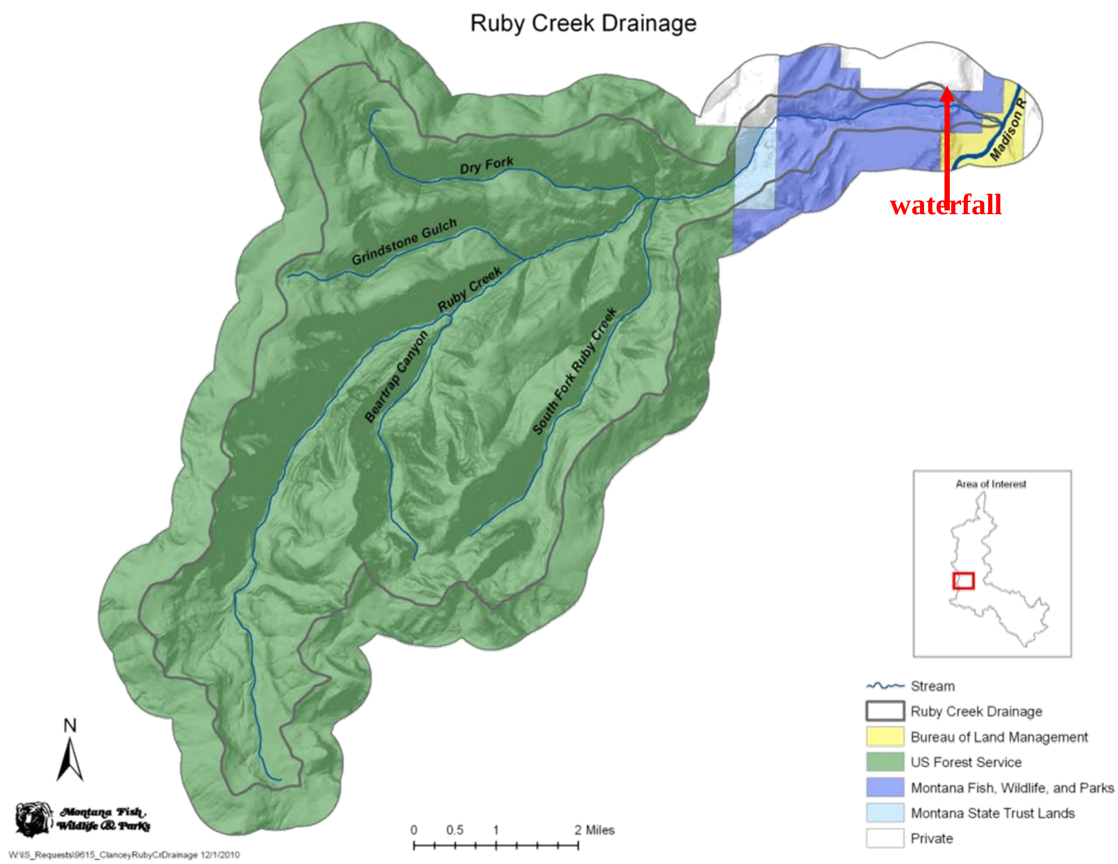


Figure 13. Ruby Creek Drainage, tributary to the Madison River.

Sun Ranch Westslope Cutthroat Trout Brood

Gametes (eggs & milt) for the Sun Ranch Westslope Cutthroat Trout program were collected from two ponds and the Sun Ranch brood stock in 2017. All fertilized eggs were transported to the Sun Ranch Hatchery for incubation and hatching (Figure 14). The MadTAC has provided funding for the Sun Ranch Program annually since 2004 (Appendix C).

Figure 14. Sun Ranch Hatchery rearing troughs.

Fish Habitat Enhancement

South Fork of Meadow Creek

A project to replace and improve irrigation and livestock watering systems in a section of the South Fork of Meadow Creek was initiated in 2011 by the Madison Watershed Coordinator with significant funding provided by MadTAC for the project. The project involved reconstruction of instream irrigation structures, fencing of approximately 3,000 feet of stream to develop a riparian pasture and control livestock access to the stream.

Additionally, in 2016 a 100-foot section of the stream was moved away from a raw cut-bank and returned to an abandoned portion of historic stream channel. Additional funding for the project was provided from the Montana Department of Natural Resources and Conservation, Montana Department of Environmental Quality, Madison Conservation District and the landowners.

Moore's Creek

A project similar to the South Fork Meadow Creek project, was implemented on Moore's Creek immediately north of the town of Ennis in 2015. The objective of the project was to improve riparian conditions through fencing and the development of off-channel livestock water sources. This project was developed and managed by the Madison Watershed Coordinator. Approximately 2,200 feet of stream was fenced to develop a riparian pasture, controlling livestock access to the stream. Funding for the project was from the Natural Resource Conservation Service, Montana Fish, Wildlife & Parks Future Fisheries Program, Madison Conservation District, the MRF, Madison-Gallatin Trout Unlimited (MGTU), the landowners and MadTAC.

Another project was implemented on Moore's Creek above Highway 191 West of Ennis in the spring of 2017. The objective of the project was to improve degraded stream, riparian, and water quality conditions that were caused by past agricultural practices. This project was developed and managed by the Madison Watershed Coordinator.

Sampling of fish abundance and species composition was conducted pre-construction by MFWP fisheries personnel to assess improvement/changes over time.

Hebgen Basin

Hebgen Reservoir Gillnetting

MFWP has conducted annual gillnetting on Hebgen Reservoir for over forty years to monitor trends in reservoir fish populations, including species assemblage, age structure, and the contribution of hatchery reared Rainbow Trout to the Hebgen fishery.

Variable mesh 125-foot-long experimental gillnets are deployed overnight at index sites on Hebgen Reservoir (Figure 15) over a three-day period during the new moon phase in late May or early June. Twenty-five nets (14 floating and 11 sinking nets) are fished during this period, with a maximum of nine nets fished per night. Samples are sorted by net and processed systematically by species with total length and weight recorded.

Figure 15. Map showing monitoring site locations of Hebgen Reservoir zooplankton and gillnetting.

Hebgen Reservoir Zooplankton Monitoring

Monthly zooplankton tows were conducted at nine established sites on Hebgen Reservoir (Figure 15) to evaluate plankton community densities and composition. Plankton samples are collected with a Wisconsin® plankton net (Figure 16) with 153-micron mesh (1 micron = 1/1,000th millimeter) towed vertically through the entire water column at one meter per second. Tows are taken preferably at locations with a minimum depth of 10 meters. Samples are rinsed and preserved in a 95% ethyl alcohol solution for enumeration. Zooplankton are identified to order Cladocera (daphnia) or Eucopepoda (copepods), and densities from each sample are calculated.

Figure 16. A Wisconsin plankton net (left) and Secchi disk (right) used to collect zooplankton and measure light penetration, respectively, in Hebgen Reservoir.

A Secchi disk (Figure 16) is used to measure light penetration (in meters) into the Hebgen Reservoir water column. Depths are taken in conjunction with zooplankton tows to establish a Trophic State Index number (TSI) to determine reservoir productivity (Carlson 1977). Secchi depths are recorded as the distance from the water surface to the point in the water column where the disk colors became indiscernible.

Wind and other environmental influences on Hebgen Reservoir are monitored at a small weather station along the reservoir shoreline on Horse Butte. These data are collected to aid in efforts to develop predictive tools for Hebgen Reservoir events, such as blue-green algae and zooplankton blooms.

RESULTS AND DISCUSSION

Madison Grayling

Introduction of Arctic Grayling in the Madison Drainage through RSIs was conducted from May 19 – June 1, 2017. Approximately 20,000 eyed eggs were incubated in the RSIs at two sites: Odell Spring Creek and Moore’s Creek. All eggs were taken from Upper Twin Lake in the Madison drainage and eyed at the Yellowstone River Trout Hatchery in Big Timber Montana. Additionally, 3,000 Arctic Grayling fry were introduced into Blaine Spring Creek on June 5, 2017. Fry were hatched out at the Yellowstone River Hatchery from eggs taken from Green Hollow pond located on the Flying D Ranch. Initial harvest of eggs obtained from Upper Twin Lake in 2017 was approximately 418,000 eggs. However, eye-up at the hatchery was approximately 50%, far lower than previous years. Water temperature strongly influenced the duration of incubation and emergence (Table 2). No young-of-the-year, juvenile or adult grayling were captured during 2017 monitoring.

Table 2. Water temperature characteristics and approximate date of last emergence at Madison Drainage Arctic Grayling RSI introduction sites, 2017. Eggs were placed into the RSIs at Odell Spring Creek and Moore's Creek on May 19.

RSI site	Average water temperature (range F)	Approximate date of last emergence
Odell Spring Creek	51.1 (49.0 – 51.3)	June 4
Moore's Creek	56.1 (54.1 – 61.4)	June 1

Environmental DNA sampling was initiated in tributaries of Arctic Grayling introductions to better evaluate RSI introductions. Twenty samples were collected in August 2017. Samples were collected at and upstream and downstream of introduction sites. Locations are listed in Appendix G-2. Results from eDNA samples came back negative for the presence of Arctic Grayling at all sample sites.

Adult Arctic Grayling surveys were conducted in Ennis Reservoir on four separate occasions from mid - April through the first week of May 2017. Surveys were conducted by electrofishing the shoreline and inlets of the Madison River on Ennis reservoir at night (Figure 17). No Arctic Grayling were sampled.

Figure 17. Night shocking for Artic Grayling in Ennis Reservoir 2017.

No juvenile Arctic Grayling were captured by beach seining in Ennis Reservoir in 2017. Six young-of-the-year Arctic Grayling have been captured since 1996 (Appendix A).

MadTAC funds are used to assist with Arctic Grayling recovery efforts in the Madison, Big Hole, Ruby, and Elk Lake drainages as mitigation for the impacts of hydropower facilities on the Madison and Missouri rivers. These funds have helped FWP implement a Candidate Conservation Agreement with Assurance (CCAA) for fluvial Arctic Grayling in the Big Hole Drainage. Landowners who sign onto the CCAA must develop and implement pro-active site-specific land management conservation measures in cooperation with agencies that will reduce or eliminate detrimental habitat conditions for the grayling. Despite the USFWS determination of 'not warranted' in September 2014, landowners and irrigators continue to enroll in the CCAA program. Over 30 landowners have enrolled over 150,000 acres, and more than 60 habitat restoration projects have been completed to date. Additionally, MadTAC funds have previously been used to assist with monitoring the development of a self-sustaining Arctic Grayling population in the upper Ruby River and developing and implementing stream-flow restoration plan for Narrows Creek, a grayling spawning tributary to Elk Lake. In 2013, MadTAC cost-share funds were granted to FWP for a project to reconnect portions of Swamp Creek to the Big Hole River, a project that was completed in 2014.

Population Estimates

Population estimates were conducted in the Pine Butte and Varney sections of the Madison in September (Figure 7). Figures 18-19 illustrate the number of Rainbow Trout per mile for several size classes in each of the two sections, and Figures 20-21 illustrate numbers of Brown Trout per mile for several size classes in each section. The population estimate for each of the size groups displayed includes all larger size groups as well. For instance, the line representing the estimated number of Pine Butte Rainbow Trout greater than 12 inches (Figure 18) includes all Rainbow Trout larger than 12 inches, not just those 12 – 14 inches.

In recent years Rainbow Trout 12 inches and larger exhibited an upward trend in the Pine Butte monitoring section (Figure18). However, numbers of Rainbow Trout show a slight decline in all size groups in the Varney section since the last sampling event in Fall 2015 (Figure 19). Rainbow trout greater than 12 inches remain towards the high end of their historic abundance in the Pine Butte section. Brown trout in the Pine Butte section remain close to historically high levels (Figures 20), while in the Varney section there was a slight increase in the numbers of fish >6 inches, while other size groups remained fairly similar to what was observed in 2015 (Figure 21). All estimates are well within historical interannual or decadal variation.

It is plausible that the surface releases since 2012 during reconstruction of the Hebgen Reservoir outlet structure have contributed to faster trout growth, especially in the Pine Butte section. Higher temperatures were closer to optimal temperature for trout growth and increased solar energy could have translated into higher net energy through the system. Water temperature monitoring sites from Hebgen Dam (Hebgen discharge) to McAtee have been monitored since 1995 and have shown their highest maximum temperatures in 2012 – 2017. It is also plausible that trout growth will slow now that repairs are completed at Hebgen Dam and cooler water will be discharged from a depth of 40 feet.

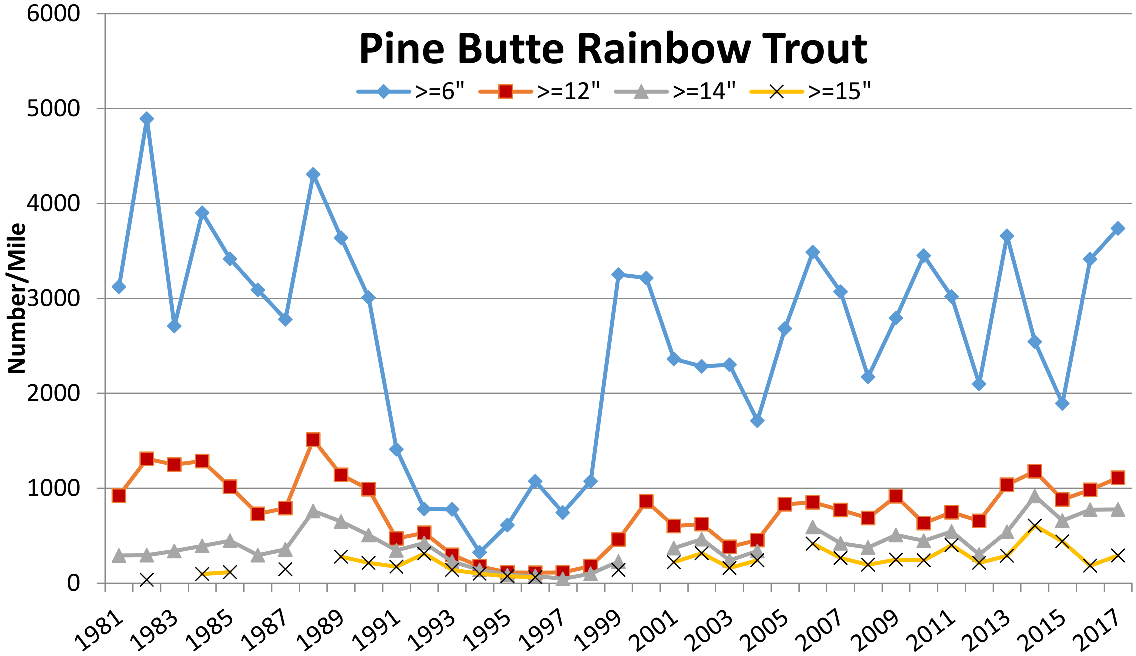


Figure 18. Figure showing the long-term trend of the Rainbow Trout population by size group in the Pine Butte section of the Madison River during fall, 1981–2017.

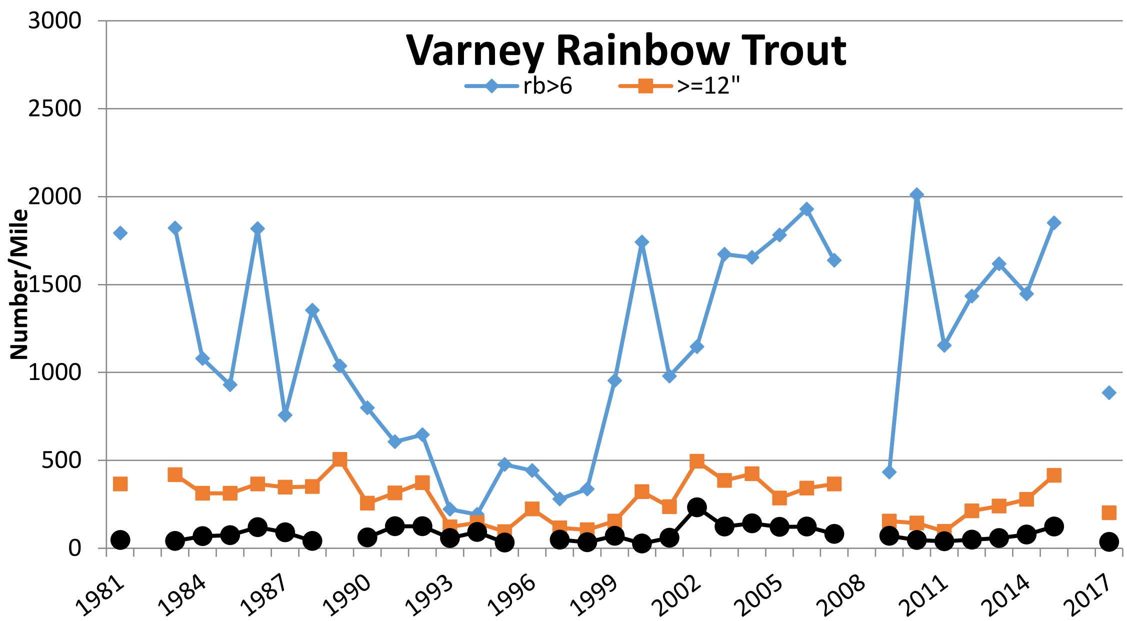


Figure 19. Figure showing the long-term trend of the Rainbow Trout population by size group in the Varney section of the Madison River during spring, 1974–2017.

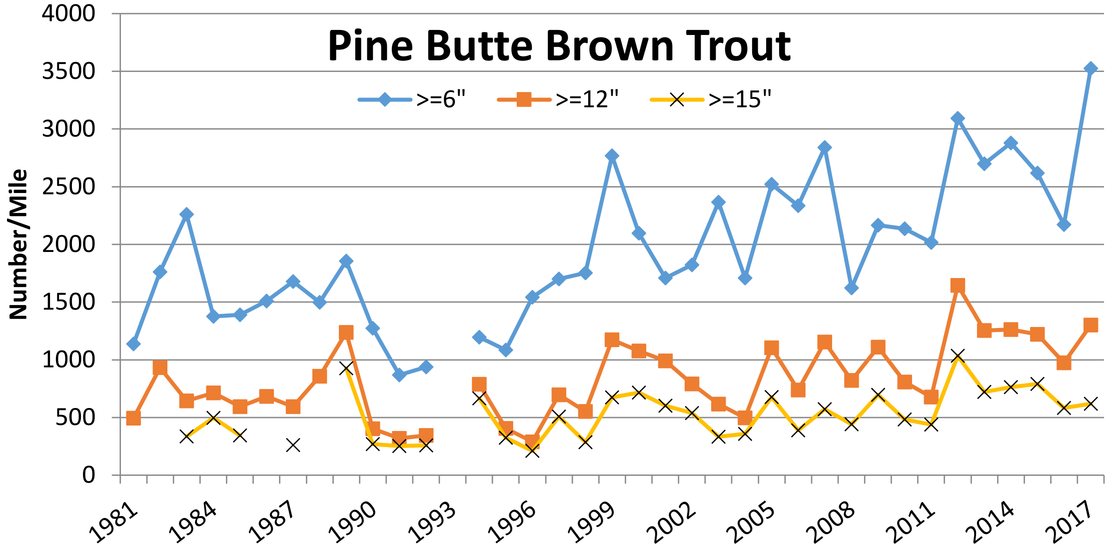


Figure 20. Figure showing the long-term trend of the Brown Trout population by size group in the Pine Butte section of the Madison River during fall, 1981–2017.

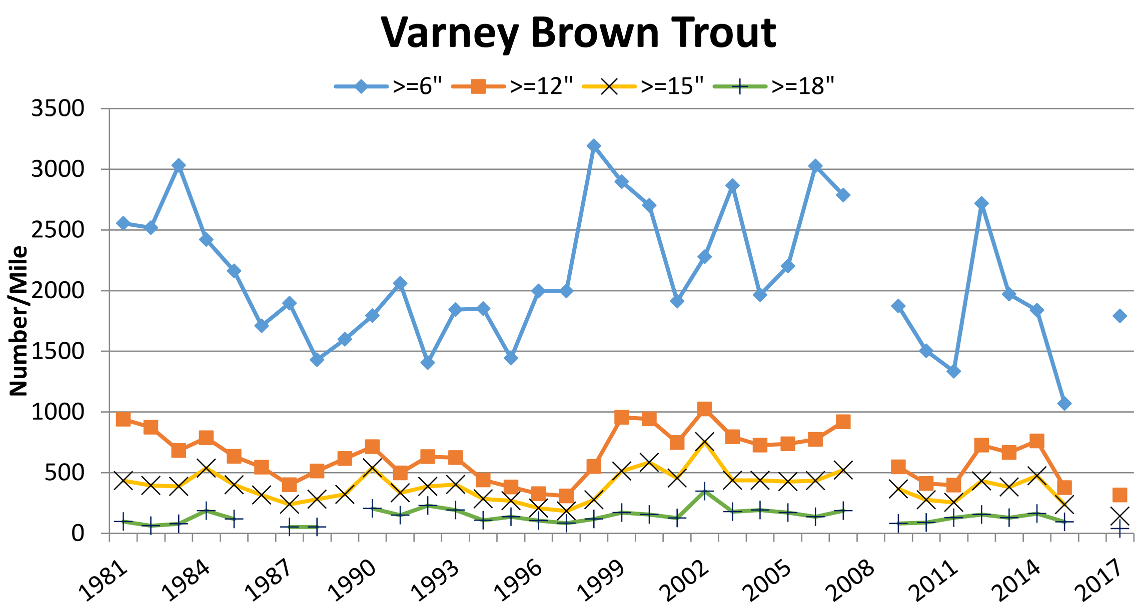


Figure 21. Figure showing long-term trend of the Brown Trout population by size group in the Varney section of the Madison River during spring, 1981–2017.

Angler Survey

Both the timing of the survey and site selection were stratified randomly. A rigorous design was necessary to accurately quantify use and attitudes across the full fishing season as well as the full fishing day.

Survey clerks on the upper Madison River conducted 1,399 surveys from March 15th-November 2017. A lower frequency of samples was collected through December to capture user data during nominally fished periods. Data are being compiled in a data base for analysis to be completed in 2018.

Ennis Reservoir Gillnetting

A total of 240 fish were captured during Ennis Reservoir gillnetting in 2017, 39% of the sample was comprised of Utah Chub, 41% White Sucker,13% Brown Trout and 7% Rainbow Trout.

The number of Rainbow Trout captured per year has varied from 6 in 1996 to 92 in 2013 (Table 3). Average length of Rainbow Trout captured has trended downward over the last decade (Figure 22) with the average length of fish captured in 2007 being 17.5" to just 11.9" in 2015 and 12.2 in 2017. While brown numbers have varied, average lengths have been relatively stable in the last decade (Figure 23). Numbers of White Sucker and Utah Chub have fluctuated widely (Figures 24 and 25). Mountain Whitefish and Longnose Sucker were absent from the 2017 sample. These two species are found intermittently during seining of Ennis Reservoir

Table 3. Number (N), average length (avg L), and average weight (avg W) and number sampled of fish species sampled in gillnetting 1995-2017.

		1995	1996	1999	2001	2003	2005	2007	2009	2011	2013	2015	2017
UC	**N**	138	44	69	135	154	221	201	96	254	37	138	95
	avg L	10.4	11.3	10.6	10.2	10.1	9.9	8.7	10.8	9.1	10.2	8.2	9.4
	avg W	0.50	0.60	0.62	0.60	0.61	0.55	0.36	0.69	0.62	0.63	0.37	0.45
WSu	**N**	99	106	84	74	70	78	78	102	146	79	210	98
	avg L	13.3	14.6	13.7	12.4	14.3	14.5	13.1	15.1	11.0	15.7	11.6	12.8
	avg W	1.00	1.30	1.38	1.10	1.46	1.59	1.05	1.75	0.96	1.92	0.85	1.02
LnSu	**N**	7	5	5	0	1	4	3	1	0	1	2	0
	avg L	9.0	16.4	13.4		7.8	14.5	13.1	16.8		7.9	13.1	
	avg W	1.30	1.70	1.15		0.16	0.36	0.60	1.92		0.24	0.93	
LL	**N**	9	16	13	40	18	32	23	20	38	41	23	30
	avg L	11.3	12.6	14.9	16.3	16.9	15.3	17.6	16.6	15.5	13.9	16.3	16.1
	avg W	0.60	0.80	1.30	1.80	1.99	1.58	2.32	1.73	2.16	1.18	1.76	1.59
Rb	**N**	0	6	11	7	16	17	14	9	16	92	55	17
	avg L		10.5	14.4	15.4	15.9	14.3	17.5	16.6	13.1	11.9	13.7	12.2
	avg W		0.40	1.48	1.50	1.58	1.37	1.60	1.80	1.12	0.82	1.10	0.79
MWF	**N**	6	19	2	0	0	0	0	0	0	3	1	0
	avg L	12.4	14.5	11.9							10.1	11.7	
	avg W	0.70	0.40	0.66							0.42	0.62	

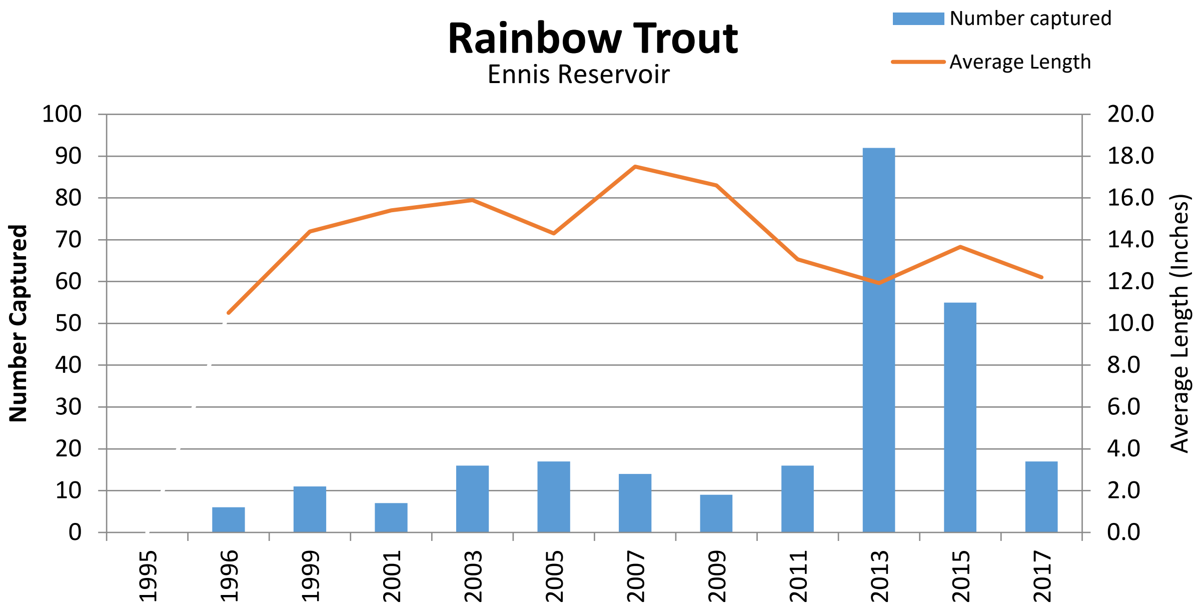


Figure 22. Ennis Reservoir Rainbow Trout gillnet catch from 2007-2017.

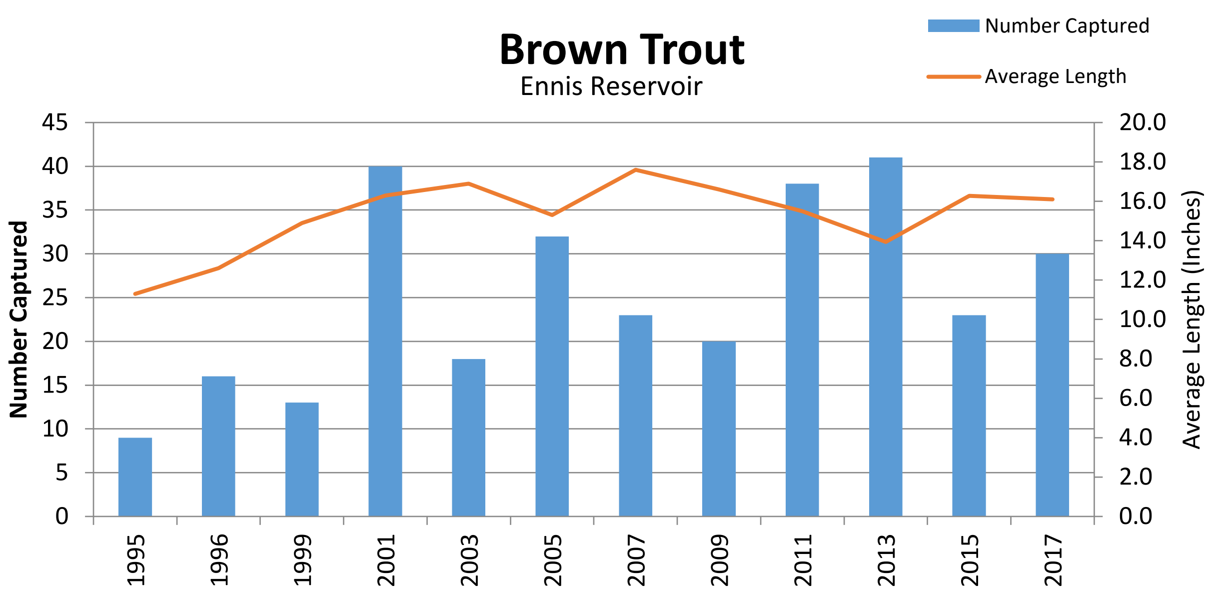


Figure 23. Ennis Reservoir Brown Trout gillnet catch from 2007-2017.

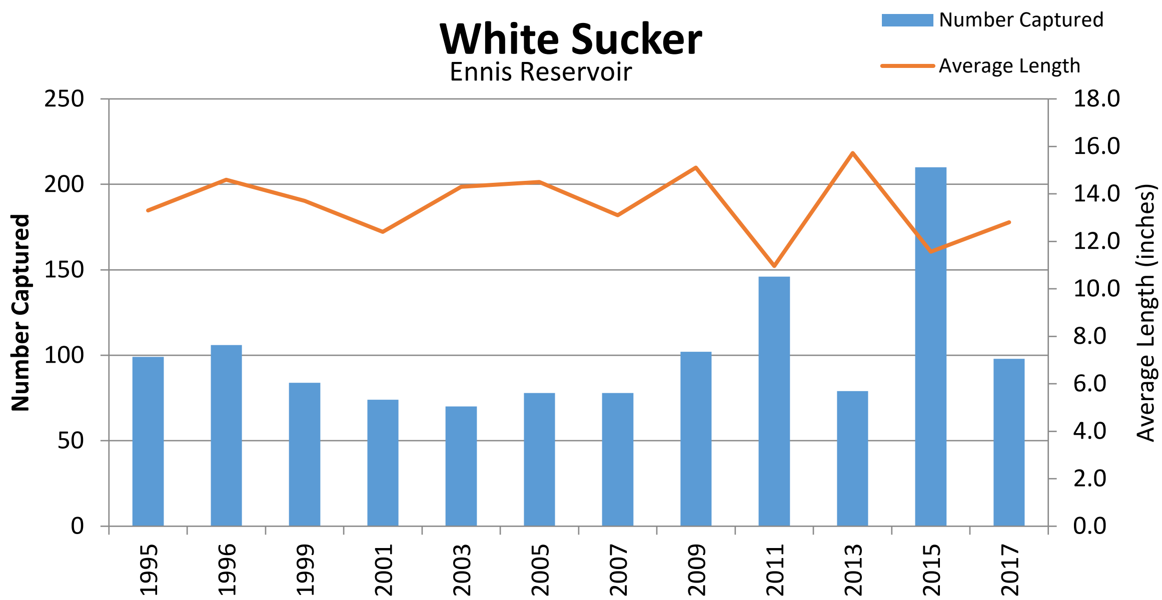


Figure 24. Ennis Reservoir White Sucker gillnet catch from 2007-2017.

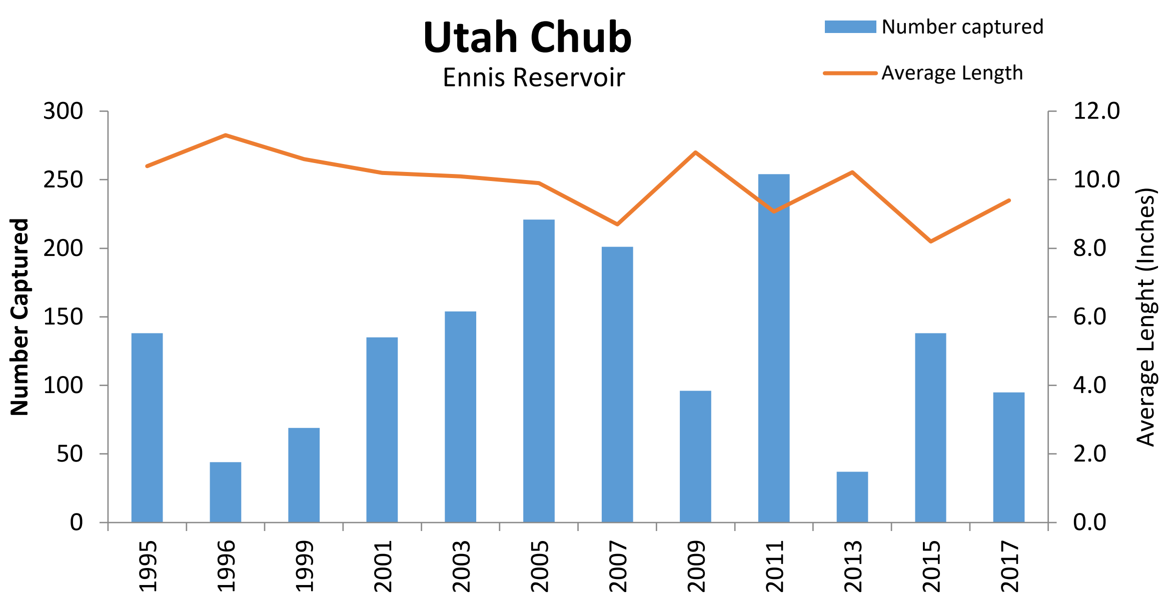


Figure 25. Ennis Reservoir Utah Chub gillnet catch from 2007-2017.

River Discharge

Pulse Flows

In 1994, predecessor, Montana Power, implemented a pulse flow system on the Madison River downstream of Ennis Reservoir in years of high water temperature to prevent thermally induced fish kills. Despite being developed as a stop-gap measure for extremely warm and dry years, pulse flows have been necessary every year from 2000 – 2007, 2009, 2010 and 2013 – 2017. Table 4, adapted from NWE data, summarizes statistics regarding pulse flows in the Madison in years pulsing was conducted.

Flushing Flows

Flushing flow releases from Hebgen Reservoir were not conducted in the Madison River in 2017 as the triggering criteria were not met.

Scour chain monitoring of bedload movement at four long-term sites showed little or no scour in 2014 when peak daily discharge ranged from approximately 3,000 cfs at Kirby to 5,000 cfs at McAllister for several days in late May. During years when flushing flows are conducted, maximum discharge at Kirby is typically 3,500 cfs to adhere to license conditions (see *Minimum Flows* section below) while flow at McAllister has been as high as 7,600 cfs. When flushing flows are conducted they are typically maintained for at least 3 days.

Core Sampling

Results from core sampling have shown conditions in upper Madison River to be relatively stable with little change in sediment deposition. Fredle index numbers remain above five for all but one site. The amount of fines <.84 mm in the lower river are continuously higher than those values observed in the upper river. Fredle index numbers have trended noticeably downward in the lower Madison. However, Rainbow Trout populations are robust in the section which might suggest that either survival to emergence has been high or the net spawn is large enough to provide normal recruitment to the population. Additionally, it is not known as to what size of substrate is being mobilized when spawning is occurring.

Table 4. Summary statistics[1/] for years in which pulse flows were conducted on the Madison River.

	Hebgen pool elevation[2/]	Feet below full pool	Feet of Hebgen draft due to pulsing	Number of days pulsing occurred	Feet of Hebgen draft to meet 1,100 cfs minimum McAllister gauge
1998	6529.62	5.25	0	Pre-pulse	5.25
2000	6531.21	3.66	0.61	29	3.05
2001	6530.53	4.34	0.05	13	4.29
2002	6530.46	4.41	0.70	18	3.71
2003	6528.59	6.28	2.68	39	3.60
2004	6532.07	2.80	0.28	12	2.52
2005	6531.52	3.35	0.30	17	3.05
2006	6530.86	4.01	1.74	15	2.27
2007	6526.05	8.82	2.12	43	6.70
2008	6524.84	10.03	0	0	10.03
2009	6533.02	1.85	0.03	8	1.82
2010	6531.50	3.37	0	3	3.37
2011	6534.04	0.83	0	0	0.83
2012	6532.00	2.87	0	0	2.87
2013	6531.07	3.80	1.70	35	2.10
2014	6532.73	2.14	0.06	42	2.08
2015	6531.97	2.90	0.48	11	2.42
2016	6530.41	4.46	1.00	26	3.46
2017	6532.62	2.25	1.66	36	0.59

[1/] As of October 1st each year [2/] Hebgen full pool is 6534.87 msl. The FERC license requires NWE to maintain Hebgen pool elevation between 6530.26 and 6534.87 from June 20 through October 1.

Minimum Flows

Minimum and maximum instream flows in various sections of the Madison River are mandated in Article 403 and in Condition No. 6 of the FERC license to NWE. Specifically, Condition 6 in its entirety states: "*During the operation of the facilities authorized by this license, the Licensee shall maintain each year a continuous minimum flow of at least 150 cfs in the Madison River below Hebgen Dam (gage no. 6-385), 600 cfs on the Madison River at Kirby Ranch (USGS gage no. 6-388), and 1,110 cfs on the Madison River at gage no. 6-410 below the Madison development. Flows at USGS gage no. 6-388 (Kirby Ranch) are limited to a maximum* *of 3,500 cfs under normal conditions excepting catastrophic conditions to minimize erosion of the Quake Lake spillway. Establish a permanent flow gauge on the Madison River at Kirby Ranch (USGS Gauge No. 6-388). Include a telephone signal at the gauge for link to Hebgen Dam operators and the Butte-based System Operation Control Center*."

Temperature Monitoring

Onset Tidbit™ temperature recorders were deployed throughout the Madison River to document air and water temperatures (Figure 10). Table 5 summarizes the data collected at each location in 2017, and Appendix E1 contains thermographs for each location. Appendix E2 contains comparisons of annual maximum temperatures at selected adjacent monitoring sites and Appendix E3 contains annual longitudinal profiles illustrating the maximum water temperature recorded at each river monitoring site since 1997. It is important to note that the maximum temperatures at each site throughout the river did not all occur on the same day in any year, and that the maximum temperature at any given site may have been attained on more than just one day in a year. Some water temperature recorders were not recovered in some years, or the data recorder malfunctioned, and the data were not recoverable, but for years where the data are available there are notable patterns:

- For all 16 years where data are available, maximum water temperature at the Hebgen Inlet site is higher than maximum water temperature at the Hebgen discharge site
- For 18 of 19 years where data are available, maximum water temperature at the Quake Inlet site is higher than maximum water temperature at the Quake outlet site
- In 2015, maximum water temperature was recorded at the Kirby and McAtee sites since monitoring was initiated at those sites in 1995. In both instances, the maximum temperature occurred in early July, before summer time air temperatures moderated.
- The Ennis Reservoir Inlet site annually exhibits the highest maximum water temperature of the 7 sites between Hebgen Dam and Ennis Reservoir
- In 19 of the 22 years where data are available, maximum water temperature at the Ennis Dam site is lower than at the Ennis Reservoir Inlet site
- Maximum water temperatures at all sites downstream of Ennis Dam typically are about 5^{o} F warmer than at Ennis Dam
- Maximum water temperature at Blacks Ford has been suppressed by pulse flows conducted to prevent thermal stress related fish kills; the last fish kill occurred in 1988.
- In 2015, maximum water temperature since monitoring was initiated in 1994 was recorded at the Kirby, Wall Creek Bridge and McAtee sites and at every monitoring site from Ennis Dam to Cobblestone. Below Ennis Dam, maximum temperatures equaled or exceeded 80^{o} F at every site except Ennis Dam. In every instance, the maximum temperature occurred in early July, before summer time air temperatures moderated.

- In 2017 Discharge out of Hebgen was from the new spillway, constructed in 2016, from June 2017 until October 2017 when discharge was switched to the refurbished outlet structure, which drafts at a depth of 40ft.

Table 5. Table showing maximum and minimum temperatures (°F) recorded at locations in the Madison River Drainage, 2017. Air and water temperature data were recorded from April 17 –September 29. Thermographs for each location are in Appendix E1.

Deployment	Site	Max	Min
Water	Hebgen	NA	NA
	Hebgen discharge	67.9	37.2
	Quake Lake inlet	71.9	36.9
	Quake Lake outlet	67.8	37.7
	Kirby Bridge	72.3	36.8
	McAtee Bridge	73.1	36.3
	Ennis Bridge	73.2	39.4
	Ennis Reservoir	75.4	39.59
	Ennis Dam	74.0	45.2
	Bear Trap Mouth	NA	NA
	Blacks Ford	78.6	43.1
	Cobblestone	81.5	43.2
	Headwaters S.P.	NA	NA
Air	Kirkwood	99.8	26.3
	Slide	84.0	31.2
	Wall Creek HQ	93.3	28.8
	Ennis	91.4	27.7
	Ennis Dam	97.9	33.5
	35 MPH Corner	95.3	30.8
	Cobblestone	104.2	25.7

Aquatic Invasive Species

The annual economic cost of invasive species management and control in the United States is estimated to be nearly $137 billion. Estimates of costs to power companies alone is 3 to 4 billion dollars annually to control invasive mussels (New York Sea Grant 1994A). The Aquatic Invasive Species Task Force estimates that 42% of the species on the Threatened or Endangered species lists are significantly affected by alien-invasive species (www.anstaskforce.gov/impacts.php).

In 1994, two invasive species were detected in the Madison Drainage – New Zealand mud snails *Potamopyrgus antipodarum* and whirling disease *Myxobolus cerebralis*. Montana has an active multi-agency AIS program coordinated through FWP (Appendix B).

FWP AIS field crews conducted sampling at numerous sites in the Madison Drainage during 2017. Samples are in the process of being analyzed a table of sites sampled in 2017 is in appendix B. Additionally, AIS crews conducted boat inspections in the Madison Drainage. All boats passed inspection, summary table of boat inspections is in appendix B.

In 2016, the presence of the PKX myxozoan *Tetracapsuloides bryosalmonae,* the parasite responsible for causing PKD (proliferative kidney disease) was detected in fish in the Madison River. Biological samples collected by FWP in August and early September of 2016 tested positive for the presence of the PKX parasite.

Sampling of waters for invasive mussels in 2016 revealed invasive mussel veligers in Tiber reservoir (confirmed) and suspect samples were found in Canyon Ferry and the Missouri River above Townsend. The Governor appointed a Mussel Incident Response Team in November 2016, to develop a management plan to contain and treat contaminated waters. For more information on Dreissinid mussels and the effect they can have on aquatic systems, see Appendix B.

AIS crews sampled numerous sites throughout southwestern Montana in the Yellowstone and throughout the Upper Missouri system, including the Madison Drainage. All were positive for the presence of NZMS. The highest density sampled was 488/m^2 in Darlington Ditch at the Cobblestone Fishing Access Site.

The Montana Aquatic Species Coordinator has developed a plan to address New Zealand mudsnails. Specifically, these actions include:

1. Listing NZMS as a Prohibited Species in Montana.
2. Assisting in development of a regional management plan for NZMS, an important portion of which will describe actions to be taken when NZMS are found in or near a hatchery.
3. Establishing statewide monitoring efforts.
4. Conducting boat inspections at popular FAS, many of which are on the Madison River. This effort assists with public education/outreach and also ensures boats are not spreading NZMS or other AIS.
5. Purchasing portable power washing systems for cleaning boats and trailers at fishing access sites.

The FWP Fisheries office in Ennis uses a power washer to clean project equipment to reduce the chance of spreading AIS through work activities.

With one exception AIS have not been found in any private, state or federal hatchery in Montana. The one hatchery that showed presence of NZMS has since been prohibited from selling fish because of additional disease concerns.

Additional information on Aquatic Invasive Species is on the web at www.anstaskforce.gov and www.protectyourwaters.net.

Westslope Cutthroat Trout Conservation and Restoration

Habitat projects and investigations conducted by the Beaverhead-Deerlodge and Custer-Gallatin national forests using MadTAC money are summarized in Appendix F.

English George and Wall Creek Barriers

A slightly hybridized Westslope Cutthroat Trout population (94% purity) occupies English George Creek. Genetic results from 2015 suggested that Rainbow Trout alleles in some samples were no longer randomly distributed suggesting that a recent immigration of Rainbow Trout into the population had occurred (Leary, 2015). To prevent further immigration of Rainbow Trout alleles into the population and having the population fall out of conservation status, a barrier was constructed in English George Creek during the summer of 2017.

A site survey was initiated in the fall of 2016 by RE Miller and Sons out of Dillon, MT, and a design and cost estimate for the project were presented to FWP in the winter of 2016 (Appendix 77). Upon approval of the design from the Madison, Gallatin Fisheries Biologist, an EA was drafted and the project put out for public comment. There were no comments in opposition to the project.

Barrier installation was initiated on July 24 and finished July 25 of 2017. The barrier structure was constructed out of full dimensional treated lumber off site and transported to installation site (Figure 26). After excavation of the barrier site the barrier was positioned and back filled (Figure 27). The stream bed directly downstream was armored with rock. The finished product resulted in a 4-foot-high structure with an 8foot long splash pad (Figure 28).

Figure 26. English George barrier being brought to installation site and being staged for placement.

Figure 27. English George barrier in place and stream channel being fortified on the downstream side of the barrier.

Figures 28. English George barrier installed view from top looking downstream and view looking upstream at the drop created.

Sun Ranch Westslope Cutthroat Trout Program

Egg take from the Sun Ranch brood stock in 2017 provided 26,328 eyed eggs. Eyed eggs from wild sources were introduced into Elkhorn Creek, in FWP Region 4, and Grayling Creek in Yellowstone National Park and the Sun Ranch Brood pond.

Appendix C lists the contributions to and production of the Sun Hatchery since 2001 as well as an annual summary for 2017 activities, and Appendix G provides a list of streams for which NWE funding has been used for genetic analyses.

Ruby Creek Westslope Cutthroat Trout Project

The Ruby Creek rotenone treatment was initially conducted on December 5, 2012, with additional treatments on April 9 and October 16, 2013 (Clancey and Lohrenz 2013, Clancey and Lohrenz 2014). Liquid rotenone and rotenone powder dough were applied to the stream and its fish bearing tributaries.

Twenty-five locations within the Ruby Creek treatment area were sampled for environmental DNA (eDNA) in 2015 prior to introducing Westslope Cutthroat Trout (WCT). One of those samples indicted a positive result for Rainbow Trout DNA, necessitating electrofishing removals throughout an approximately 1½ mile section of Ruby Creek. No Rainbow Trout were found in more than 5 hours of electrofishing over three sampling trips. The source of the rainbow DNA is unknown but may have been in fecal matter from a predator that carried it to that site. A second round of nine eDNA samples within that 1½ miles was negative for Rainbow Trout DNA.

Introductions of genetically pure aboriginal Madison WCT into Ruby Creek were initiated in late September 2015 and were continued in 2017 (Figure 29). A total of 15 WCT were introduced in 2017. Introduced fish came from McClure Creek. The low population size in McClure Creek limits the effectiveness of egg collections. Low numbers of juvenile and adult fish necessitate small transfers be spread out over 7 years to maximize genetic inclusion and prevent inbreeding depression. Similar transfers are anticipated annually through 2021.

Figure 29. Releasing genetically pure aboriginal Madison Westslope Cutthroat Trout into Ruby Creek June 2017.

Extensive ocular and backpack electrofishing surveys of Ruby Creek above the barrier were conducted in 2017 to document Westslope distribution and reproductive status throughout the treatment reach. No visible evidence of reproduction was observed. However, introduced individuals had distributed throughout the drainage from the lowest introduction site to the top of the treatment section (Figure 30).

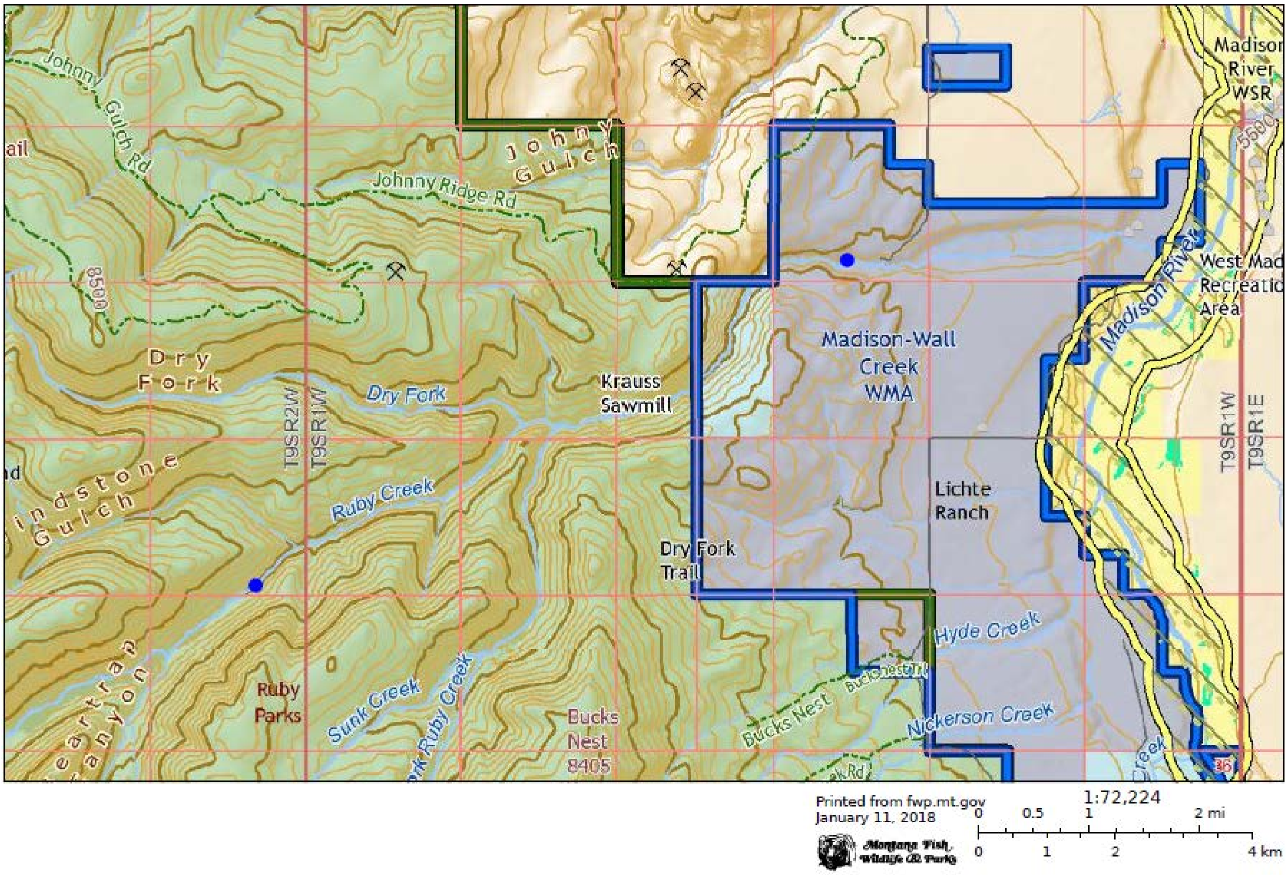


Figure 30. Blue dots represent upper and lower end of introduced Westslope Cutthroat Trout in Ruby Creek 2017.

To date, a total of 59 Westslope Cutthroat Trout have been transferred into Ruby Creek from the McClure and Last Chance populations. Thirty-nine of the original 59 were recovered in 2017. On average fish size increased from 5.0” - 10.5” (Figure 31).

Figure 31. 5.0" average size of Westslope introduced into Ruby Creek, to current 10.5" average size in Ruby Creek.

Fish Habitat Enhancement

South Fork of Meadow Creek

A project to rebuild irrigation infrastructure on a section of the South Fork of Meadow Creek was completed in 2012 to accommodate irrigation and promote rehabilitation of the riparian corridor around South Fork Meadow Creek. There were no stream channel modifications as part of this project, but the stream corridor was fenced in October 2012 creating a 30-foot zone on each side of the stream where livestock grazing and access to the stream banks are controlled. A well and two circular off-channel watering troughs were developed, and a hardened stream crossing was developed to facilitate equipment and livestock movement through the riparian corridor.

The Madison Watershed Coordinator is monitoring and photographing stream channel morphology in the project area (Figure 32). With the removal of the constant stress of livestock access along the stream banks, the channel is notably narrowing due to sediment deposition in over-widened areas, with establishment of grasses and willows that stabilize the riparian soil, development of in-channel pools, and in some areas, conversion of a sediment laden stream bottom to courser gravels and cobbles that are conducive to trout populations.

The property owners/livestock operators state that the development of the riparian pasture and off-channel watering troughs (outside of the riparian pasture) have provided benefits to their operation. Existing and developing willows along the stream corridor provide a windbreak to the livestock, even outside the fenced corridor. Remote watering has reduced issues with stranding of cattle in heavily mudded stream margins. Livestock are grazed for only a few days each year in the riparian pasture.

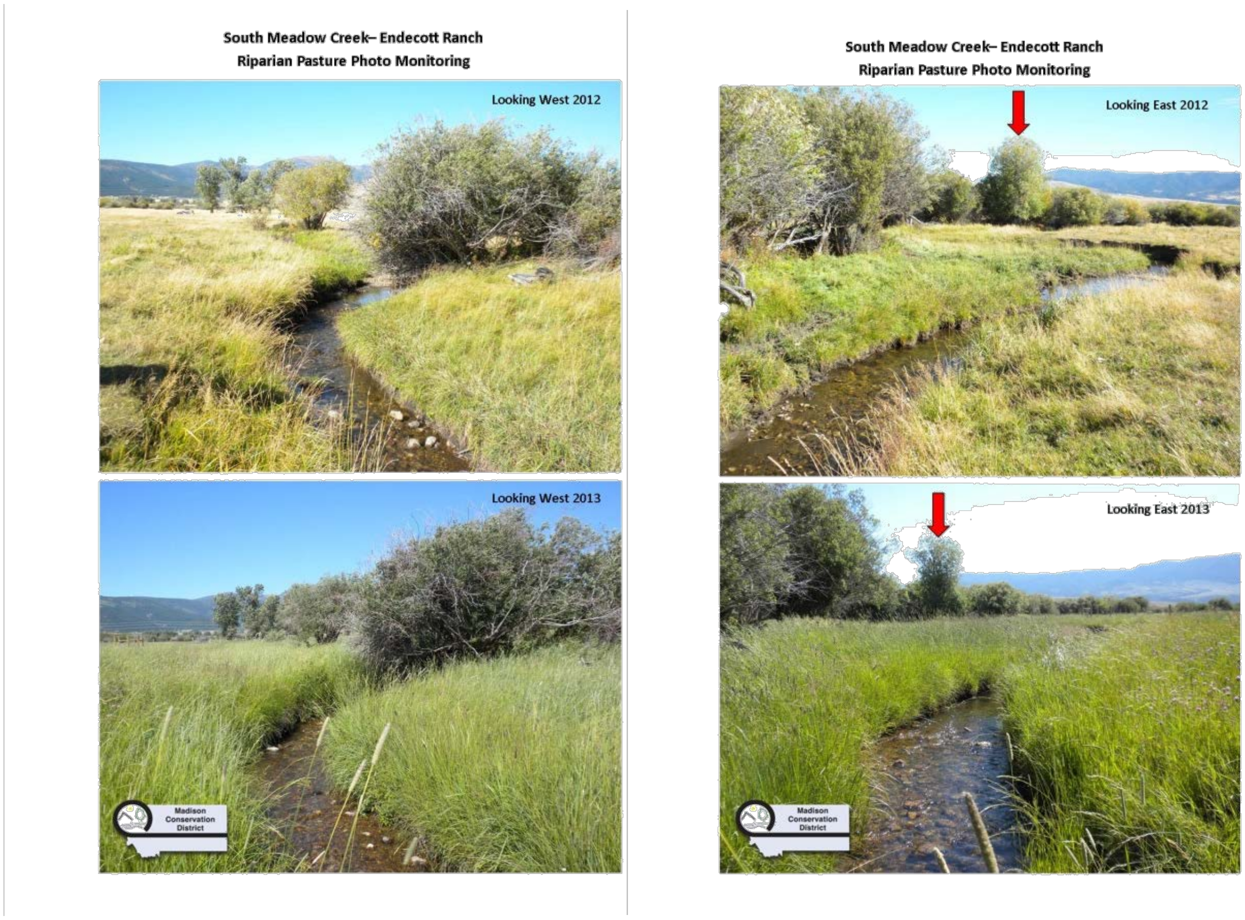


Figure 32. Photos of the Endecott section of the South Fork Meadow Creek, illustrating grass conditions before (top photos) and after (bottom photos) construction of riparian fence that controls livestock access. Photos courtesy of the Madison Conservation District.

Fish populations have been sampled in two sections of the project area since fall 2011 (Table 6). Generally, few fish are captured due to dewatering of the stream for irrigation, but 2011 was a high-water year that provided adequate stream flow for trout into the fall. Data for Brown Trout and Brook Trout in the two sections are combined to display catch-per-hour of electrofishing and average length.

Table 6. Summary statistics of electrofishing in two sections of the South Fork of Meadow Creek, 2011 – 2017.

	Brown Trout			Brook Trout		
Section and Date	Number captured	CPUE[1/] (hour)	Average length (range)	Number captured	CPUE[1/] (hour)	Average length (range)
Section 1						
9/20/11	128	127.3	4.7 (2.3 – 13.3)	21	20.9	3.7 (2.4 – 10.0)
4/13/12	11	25.0	4.8 (3.1 – 7.1)	10	22.7	5.6 (3.2 – 7.5)
9/27/12	37	82.6	4.5 (2.6 – 7.7)	9	20.1	4.6 (3.0 – 7.2)
4/29/13	4	9.4	4.9 (3.5 – 6.2)	23	54.2	6.3 (5.4 – 8.0)
4/6/14	8	14.9	5.4 (4.2 – 8.0)	36	67.1	6.1 (3.5 – 8.2)
10/10/14	18	22.9	9.2 (7.0 – 12.9)	22	28.0	6.3 (3.7 – 9.1)
4/20/15	1	1.7	9.2	24	40.3	6.2 (3.6 – 8.5)
9/29/2016	3	5	3.4 (2.9-4.0)	21	41	5.6 (3.3-6.7)
4/13/2017	13	19	7.4 (3.8-9.7)	35	50	6.1 (3.2-8.8)
10/11/2017	45	59.2	4.2 (2.6-11.1)	11	14.5	6.6 (3.4-9.3)
Section 2						
9/20/11	86	108.1	3.8 (2.8 – 9.5)	102	128.3	3.8 (2.3 – 10.1)
4/13/12	31	76.9	5.1 (2.4 – 11.2)	10	24.8	6.0 (3.3 – 7.6)
9/27/12	Not Sampled					
4/29/13	1	2.9	3.3	6	17.7	5.8 (4.8 – 6.5)
4/6/14	5	15.4	4.1 (3.2 – 5.9)	9	27.8	5,6 (4.1 – 6.5)
10/10/14	none	0.0	--	24	46.8	5.5 (3.2 – 8.3)
4/20/15	3	12.1	6.3 (3.8 -9.0)	11	44.2	5.8 (4.0-7.3)
9/29/2016	None Sampled			6	17.0	4.3 (3.3-5.8)
4/13/2017	2	2.9	6.4 (6.6-6.1)	17	28.3	6.4 (5.6-7.3)
10/11/2017	24	40	3.6 (2.6-6.8)	11	18.3	6.7 (5.6-8.5)

[1/] Catch per unit effort (hour) of electrofishing

Moore's Creek

A restoration project was conducted on a section of Moore's Creek directly north of the town of Ennis in 2015. The intent of this project is to improve water quality, fish habitat, health of the riparian area, stream channel morphology, and enhance livestock operations through construction of fencing and watering facilities.

To alleviate cattle pressure in the riparian area, a well and two circular off-channel watering troughs were developed in addition to riparian fencing. Additionally, a hardened stream crossing was developed to facilitate equipment and regulate livestock movement through the riparian corridor.

The Madison Watershed Coordinator is monitoring and photographing stream channel morphology in the project area. Changes in channel morphology will continue to be monitored for trends toward lower width/depth ratios. Montana Fish, Wildlife and Parks did not sample this project in 2017. However, it is scheduled to be revisited in 2018 to determine if the project has had any effects on fish species assemblage, size, etc.

Hebgen Basin

Hebgen Reservoir Gillnetting

A total of 2,324 fish were captured during Hebgen Reservoir gillnetting in 2017 (Table 7), 81.4% of the sample was comprised of Utah chub.

The number of Rainbow Trout captured per year has varied from 40 in 2001, to 194 in 2008 (Figure 33). Average length of Rainbow Trout captured has been higher over the last decade than in the mid-late 1990's. Additionally, the proportion of the Rainbow Trout gillnet catch under 14 inches has decreased noticeably since 2002 (Figure 34). Except in 2012 when it was in a similar proportion to 1999-2002. From 1995 to 2003, Rainbow Trout averaged 14.3 inches, while from 2004 through 2017, they averaged 16.0 inches or greater.

A micro-chemistry study to discern Hebgen Reservoir Rainbow Trout origin was concluded in 2016. Prior to 2016, numerous methods were used to assess hatchery contribution to the Hebgen Rainbow Trout population. Fin clips, tetracycline marks, fin erosion estimates, all pointed toward very low hatchery survival to adulthood. Based upon the findings of the study, that Rainbow Trout from hatcheries comprised only 13% of the Hebgen Rainbow Trout fishery, FWP ceased stocking Hebgen and adapted a wild fish management plan for the Hebgen fishery (Moser and Lohrenz 2016). Because of the potential for controversy, an EA was drafted, and public comments were requested prior to cessation of stocking.

Brown trout numbers have fluctuated widely with no consistent trend in evidence (Figure 35). The number of fish captured annually has ranged from 40 in 2001, to 326 in 1999. The number of Mountain Whitefish captured decreased significantly in 2002 but has remained relatively stable in recent years until 2017 when only 60 were sampled (Figure 36). The number captured per year has varied from 60 in 2017, to 235 in 1999. The number of Utah Chub sampled in 2017 is the highest observed since 2002 (Figure 37). The number of Utah Chub captured annually has ranged from 268 in 2008, to 2,245 in 1999. Utah Chub comprised 81.4 percent of the total Hebgen gillnet catch in 2017, an increase of approximately 20 percent from 2016 (Figure 38).

Table 7. Summary of 2017 Hebgen Reservoir gillnet catch.

Species	Number caught	Average Length (range)	Average weight (range)
Rainbow Trout	120	17.1 (7.0 - 21.0)	1.90 (0.11 – 2.23)
Brown Trout	251	20.6 (5.9 – 25.0)	2.98 (0.06 – 5.00)
Whitefish	61	17.1 (7.2 – 20.1)	2.07 (0.09 – 2.9)
Utah Chub	1,891	8.7 (5.4 – 18.2)	0.36 (0.08 – 2.06)
Eastern Brook Trout	1	10.3	0.45

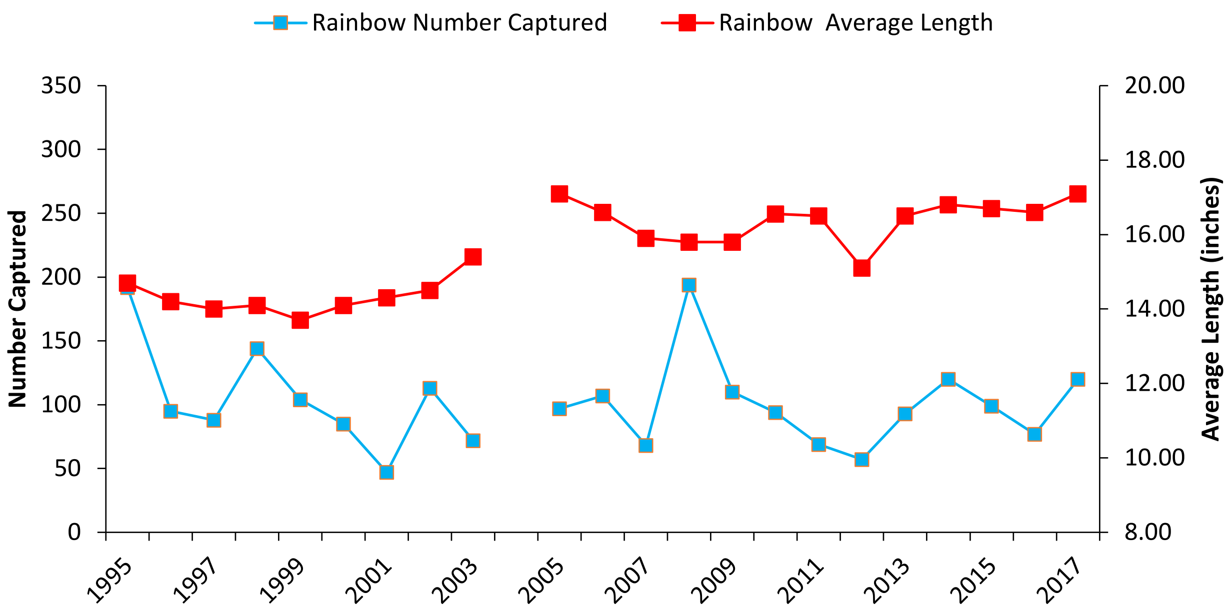


Figure 33. Figure showing Rainbow Trout average length in inches (right axis) vs. number captured (left axis) during annual Hebgen gillnetting, 1995-2017. Data from 2004 are not shown because of sampling error.

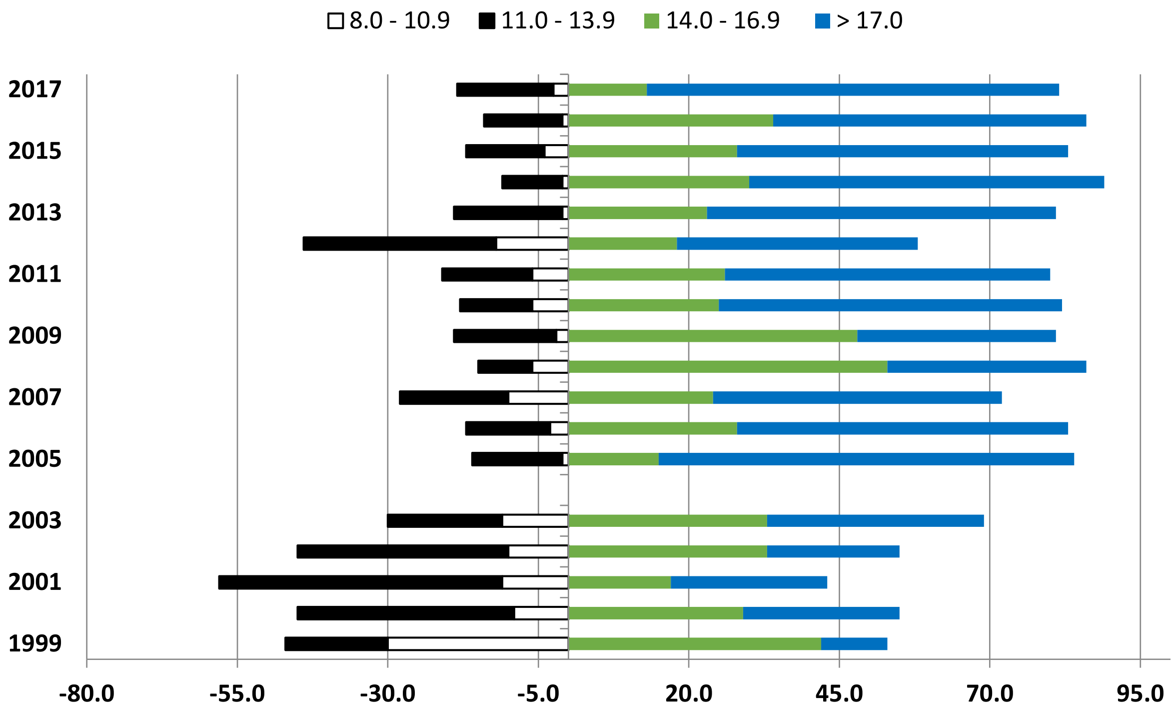


Figure 34. Figure showing percentage of Hebgen Reservoir Rainbow Trout gillnet catch under and over 14inches, 1999-2017. Data from 2004 are not shown because of sampling error.

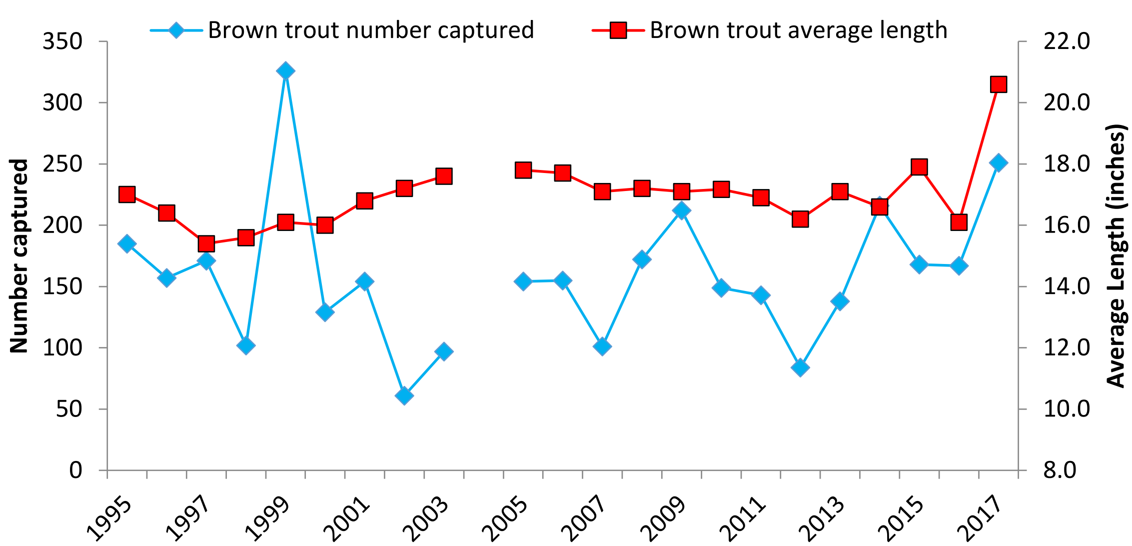


Figure 35. Figure showing Brown Trout average length in inches (right axis) vs. number captured (left axis) during annual Hebgen gillnetting, 1995-2017. Data from 2004 are not shown because of sampling error.

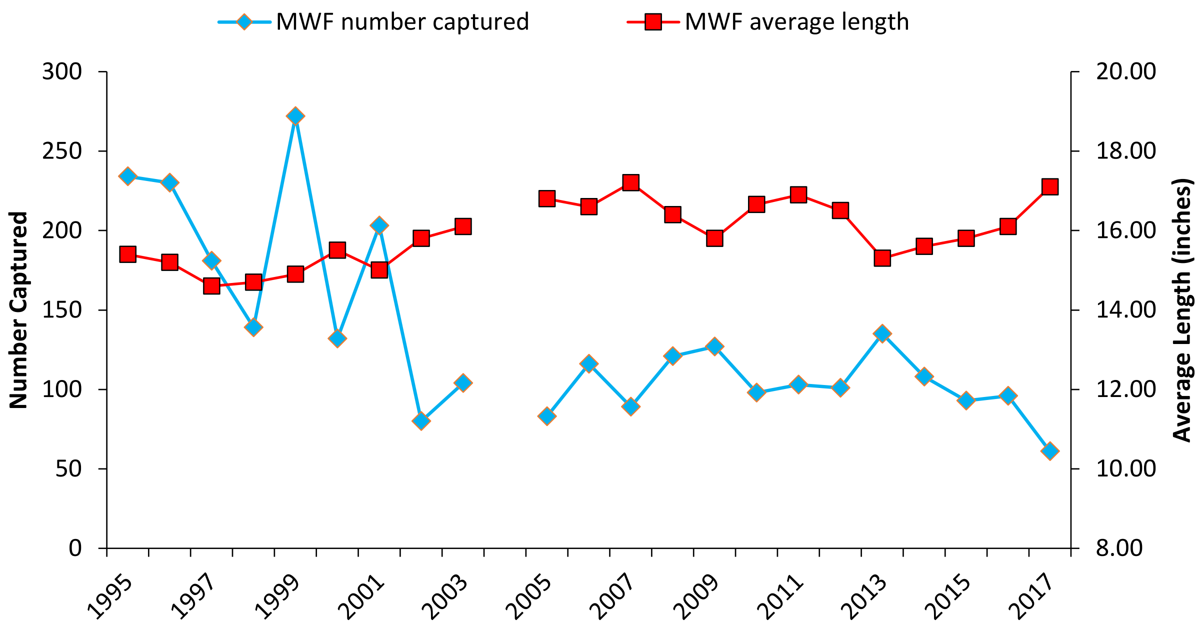


Figure 36. Figure showing Mountain Whitefish average length in inches (right axis) vs. number captured (left axis) during annual Hebgen gillnetting, 1995-2017. Data from 2004 are not shown because of sampling error.

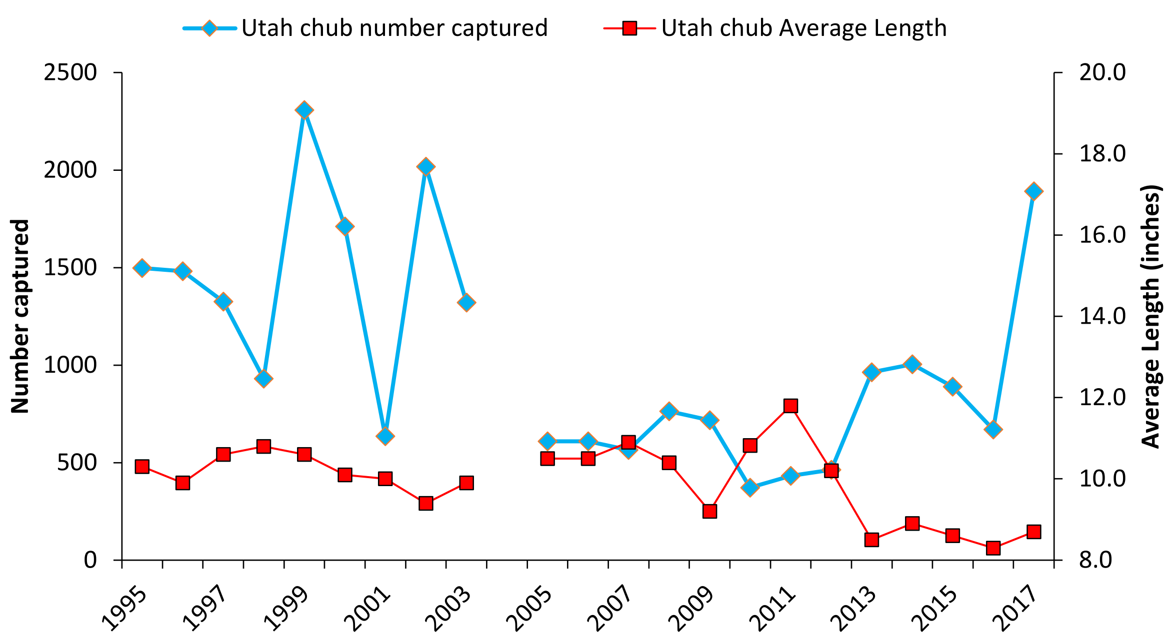


Figure 37. Figure showing Utah Chub average length in inches (right axis) vs. number captured (left axis) during annual Hebgen gillnetting, 1995-2017. Data from 2004 are not shown because of sampling error.

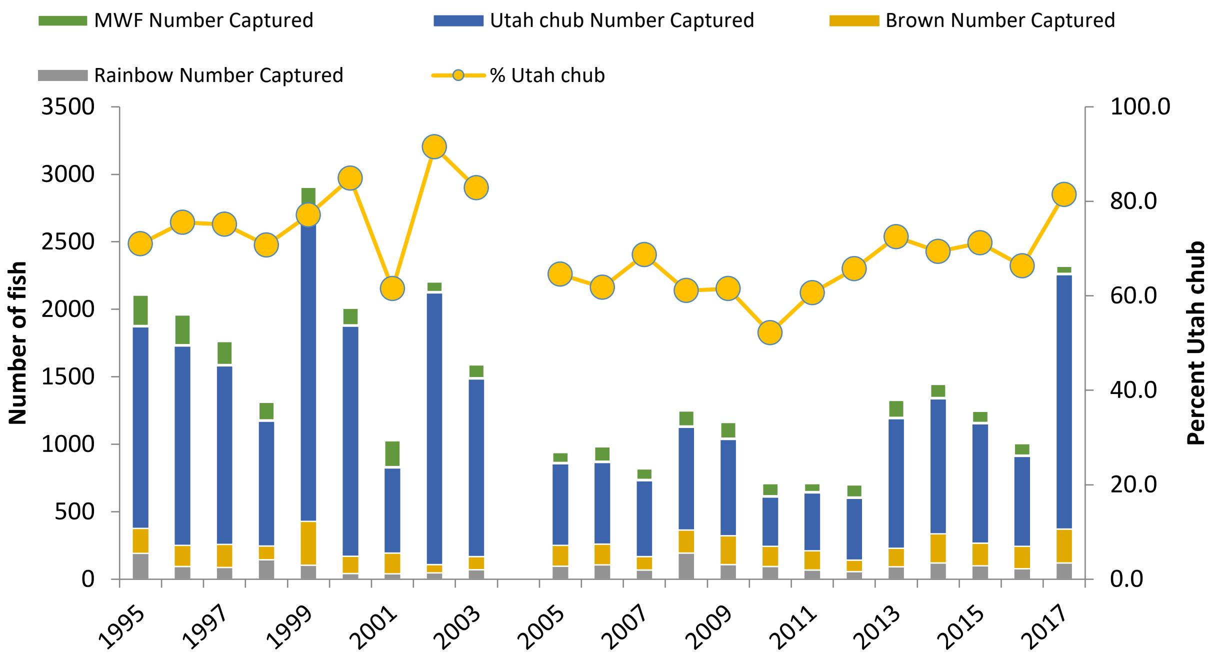


Figure 38. Figure showing species composition of Hebgen Reservoir gillnet catch, 1995 – 2017. Data from 2004 are not shown because of sampling error.

Hebgen Reservoir Zooplankton Monitoring

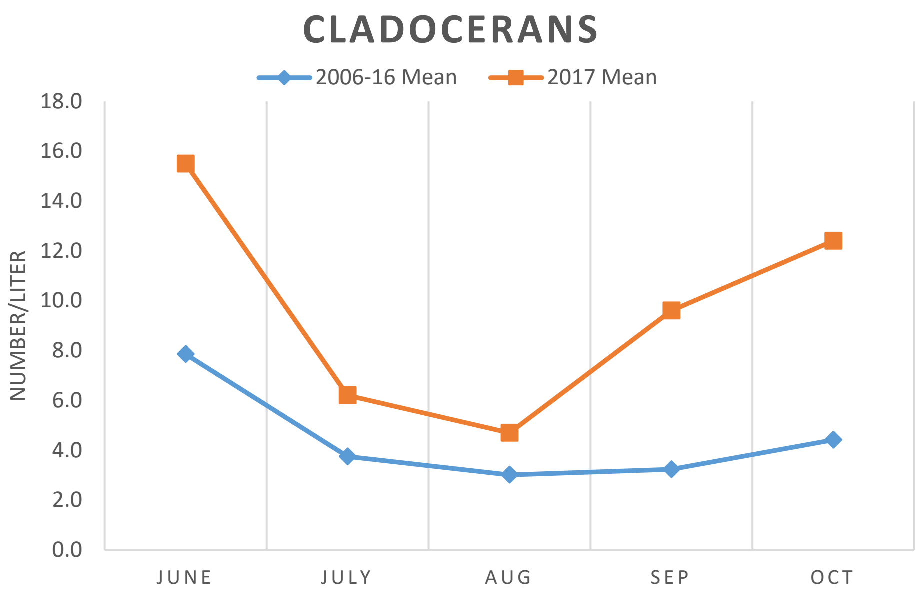
Densities (individuals/liter) of cladoceran and copepod zooplankton in Hebgen Reservoir have been monitored since 2006 (Appendix I). Annual temporal trends in abundance show peak densities occurring in late spring and early summer (Figure 39).

Studies of Utah Chub diet in several western reservoirs have shown zooplankton to be their principle food item. In Strawberry Reservoir, Utah, Johnson (1988) reported that Utah Chub shoreline feeding on zooplankton was detrimental to the survival of young-of-the-year cutthroat and Rainbow Trout. Similarly, enclosure experiments with Utah Chub and Kokanee *Oncorhynchus nerka* showed that increased densities of Utah Chub reduced zooplankton densities and negatively affected kokanee growth (Teuscher and Lueke 1996).

Applying the Trophic State Index (TSI) (Figure 40) developed by Carlson (1977), Hebgen Reservoir is classified as oligotrophic-mesotrophic with 2009 – 2017 mean TSI scores ranging from 35.6–40.3. The 2017 score was 37.4. This may partially explain the low plankton densities observed in Hebgen. Figure 38 illustrates mean cladoceran and mean copepod densities versus mean TSI score for each of the seven monitoring sites for 2009-2017.

Primary productivity in Hebgen Reservoir may be limited by climate conditions. A high elevation short-duration growing season allows for relatively few days of primary production. Hebgen Reservoir, with a full pool elevation of 6,534.87 feet, may be more characteristic of an alpine lake than of lakes at lower elevations. Johnson and Martinez (2000) found lake elevation and a shortened growing season (the number of days water surface temperature is at or exceeds 50°F) to be inversely related to lake productivity.

Additionally, wind patterns may be affecting the mixing of nutrients from tributaries entering the main body of Hebgen Reservoir. Given Hebgen Reservoirs northwest-southeast orientation this data would suggest that nutrients may be confined to the arms of the reservoir for much of the growing season. FWP and NWE incorporated an anemometer into the weather station in 2011 to measure wind direction on the reservoir rather than at nearby areas such as the West Yellowstone airport. Wind direction data (Appendix J) shows that wind patterns predominately occurred out of the southwest in 2011 and 2013, out of the northwest or west northwest in 2008 – 2009, 2012, 2015 and 2017, and from the east-southeast in 2014. This raises some interesting questions concerning nutrient cycling through the reservoir, as the productive Madison and Grayling arms of Hebgen are oriented east - west along with the less productive main body of the reservoir. Also, the narrow connection of the Grayling and Madison arms to the main body of the reservoir may be functioning as bottlenecks to limit the amount of nutrient exchange between the arms and the main reservoir.



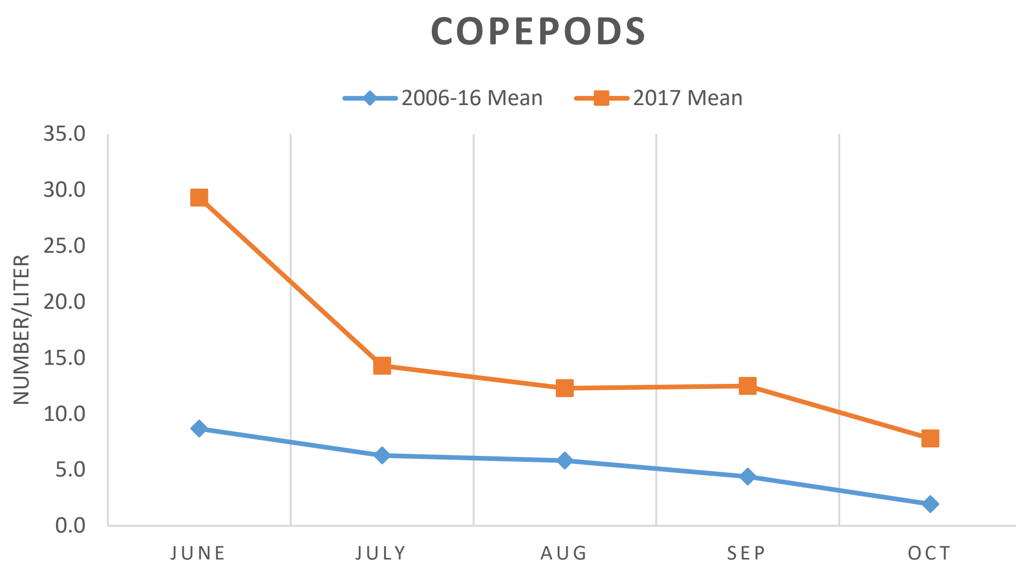


Figure 39. Figure comparing 2017 Hebgen Reservoir monthly cladoceran and copepod densities (individuals/liter) to the 2006 -16 monthly averages.

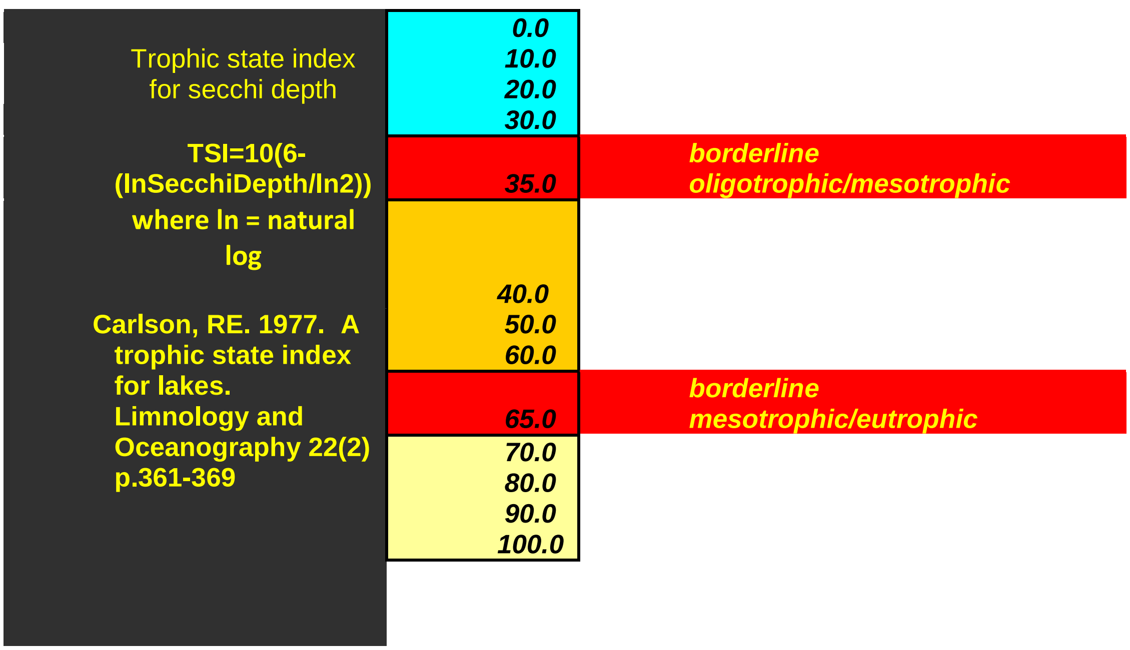
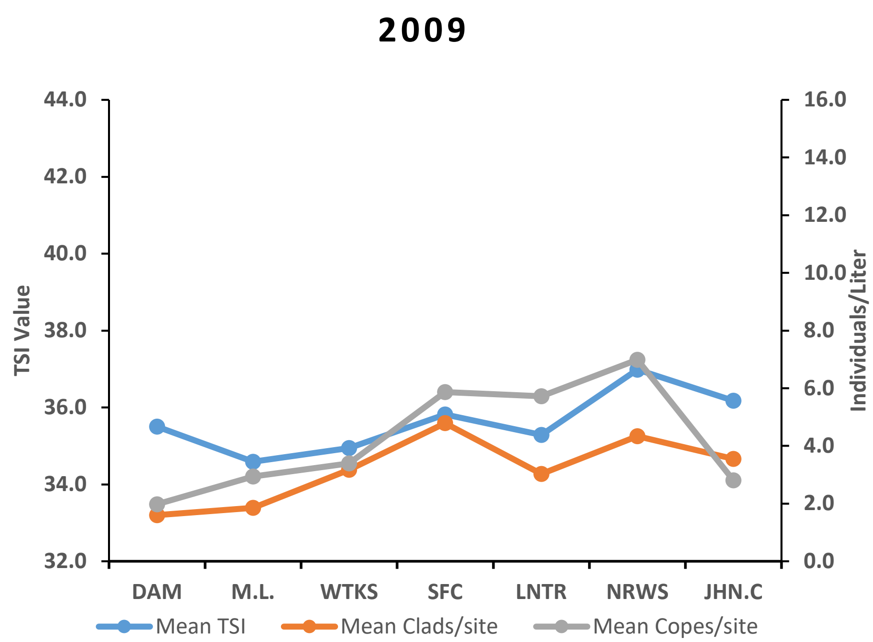
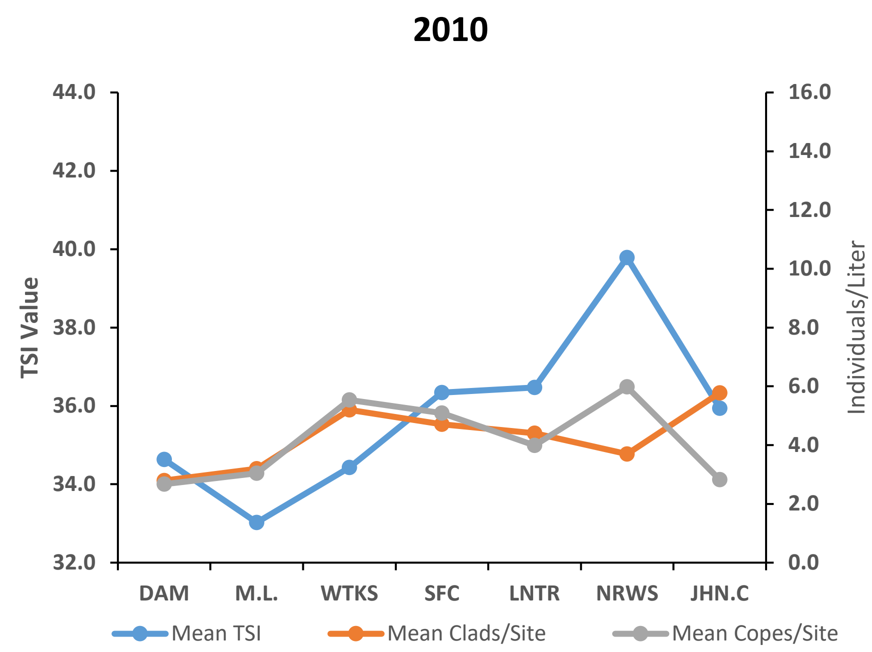
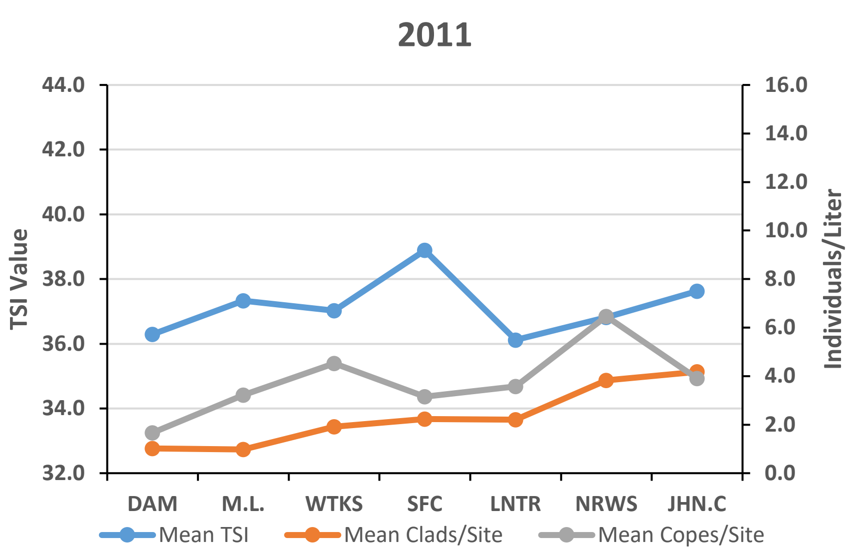
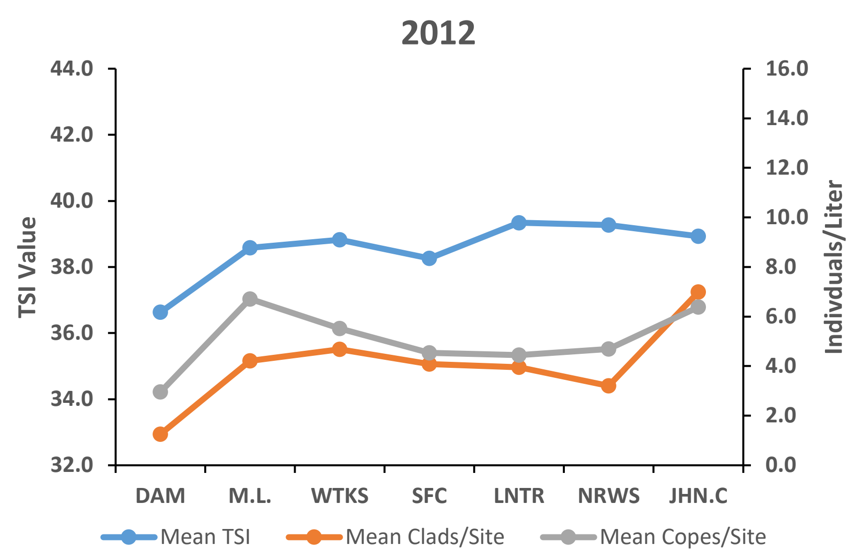


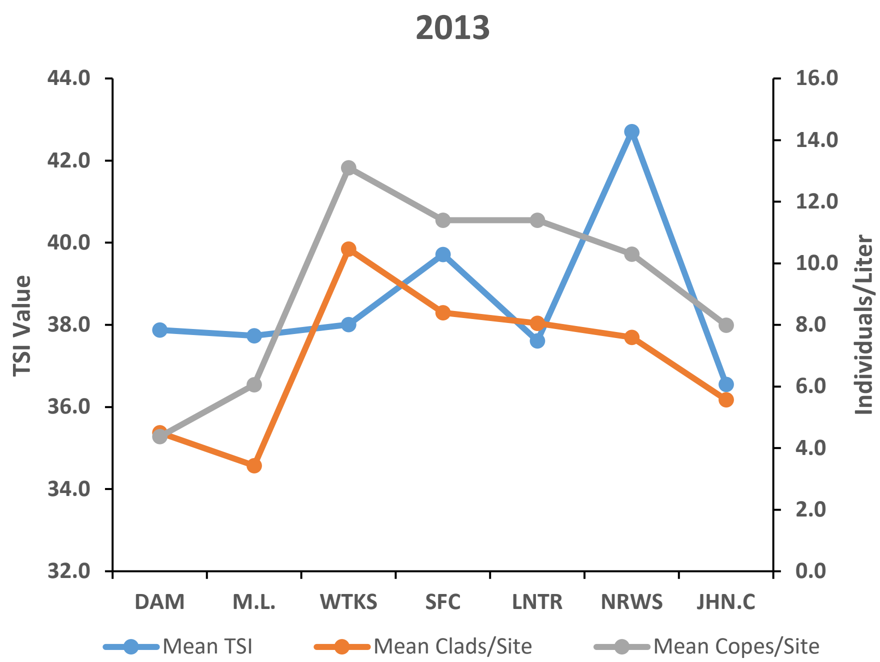
Figure 40. Figure depicting the trophic state index formula and classification for lake productivity using secchi depth measurements.

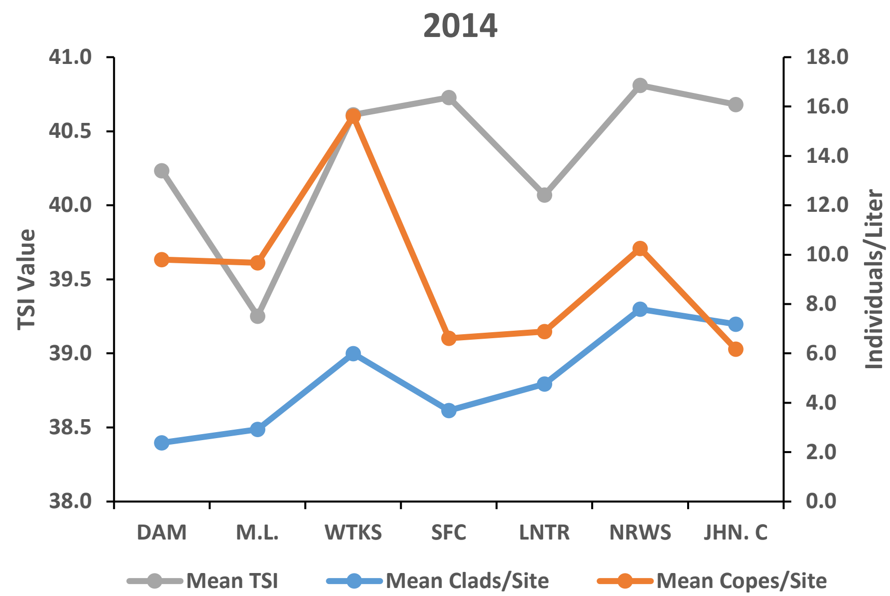

2009
TSI Value
Individuals/Liter
44.0
42.0
40.0
38.0
36.0
34.0
32.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
DAM
M.L.
WTKS
SFC
LNTR
NRWS
JHN.C
Mean TSI
Mean Clads/site
Mean Copes/site

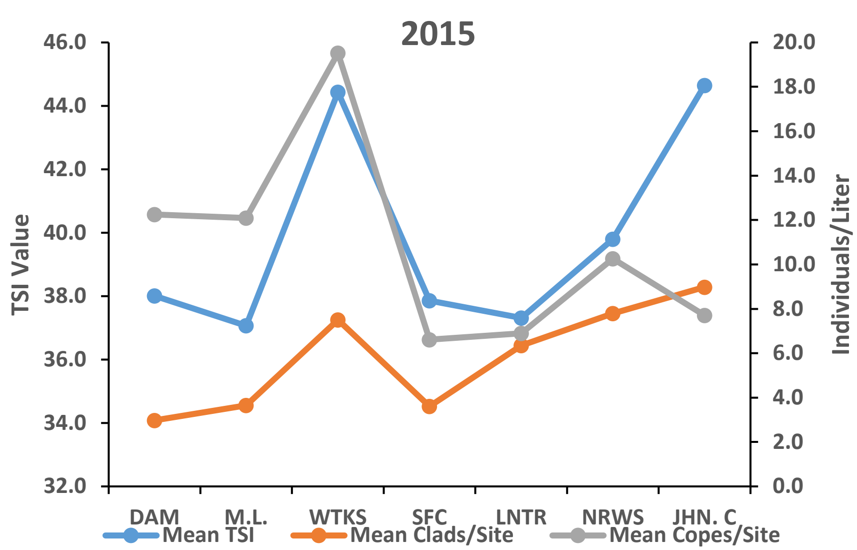

2010
TSI Value
Individuals/Liter
44.0
42.0
40.0
38.0
36.0
34.0
32.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
DAM
M.L.
WTKS
SFC
LNTR
NRWS
JHN.C
Mean TSI
Mean Clads/Site
Mean Copes/Site

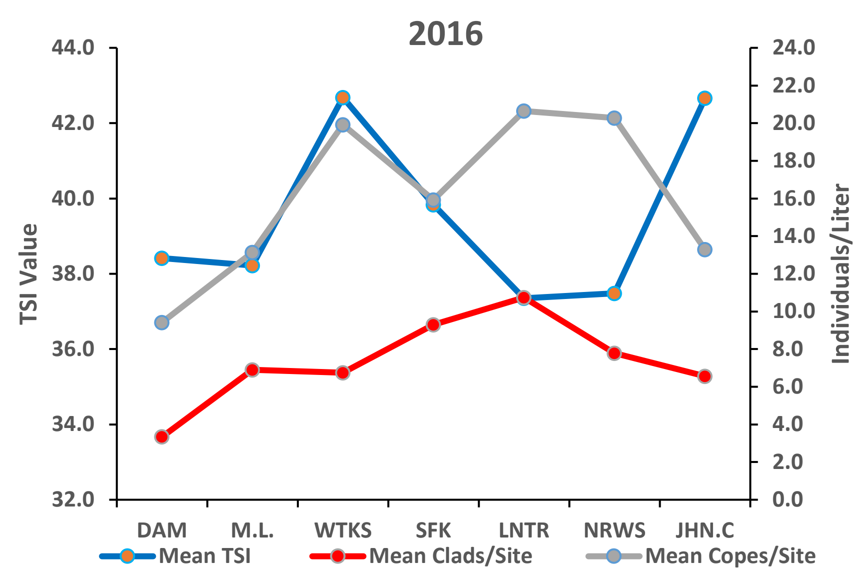

2011
TSI Value
Individuals/Liter
44.0
42.0
40.0
38.0
36.0
34.0
32.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
DAM
M.L.
WTKS
SFC
LNTR
NRWS
JHN.C
Mean TSI
Mean Clads/Site
Mean Copes/Site


2012
TSI Value
Indivduals/Liter
44.0
42.0
40.0
38.0
36.0
34.0
32.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
DAM
M.L.
WTKS
SFC
LNTR
NRWS
JHN.C
Mean TSI
Mean Clads/Site
Mean Copes/Site


2013
TSI Value
Individuals/Liter
44.0
42.0
40.0
38.0
36.0
34.0
32.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
DAM
M.L.
WTKS
SFC
LNTR
NRWS
JHN.C
Mean TSI
Mean Clads/Site
Mean Copes/Site


2014
TSI Value
Individuals/Liter
41.0
40.5
40.0
39.5
39.0
38.5
38.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
DAM
M.L.
WTKS
SFC
LNTR
NRWS
JHN. C
Mean TSI
Mean Clads/Site
Mean Copes/Site


2015
TSI Value
Individuals/Liter
46.0
44.0
42.0
40.0
38.0
36.0
34.0
32.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
DAM
M.L.
WTKS
SFC
LNTR
NRWS
JHN. C
Mean TSI
Mean Clads/Site
Mean Copes/Site


2016
TSI Value
Individuals/Liter
44.0
42.0
40.0
38.0
36.0
34.0
32.0
24.0
22.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
DAM
M.L.
WTKS
SFK
LNTR
NRWS
JHN.C
Mean TSI
Mean Clads/Site
Mean Copes/Site

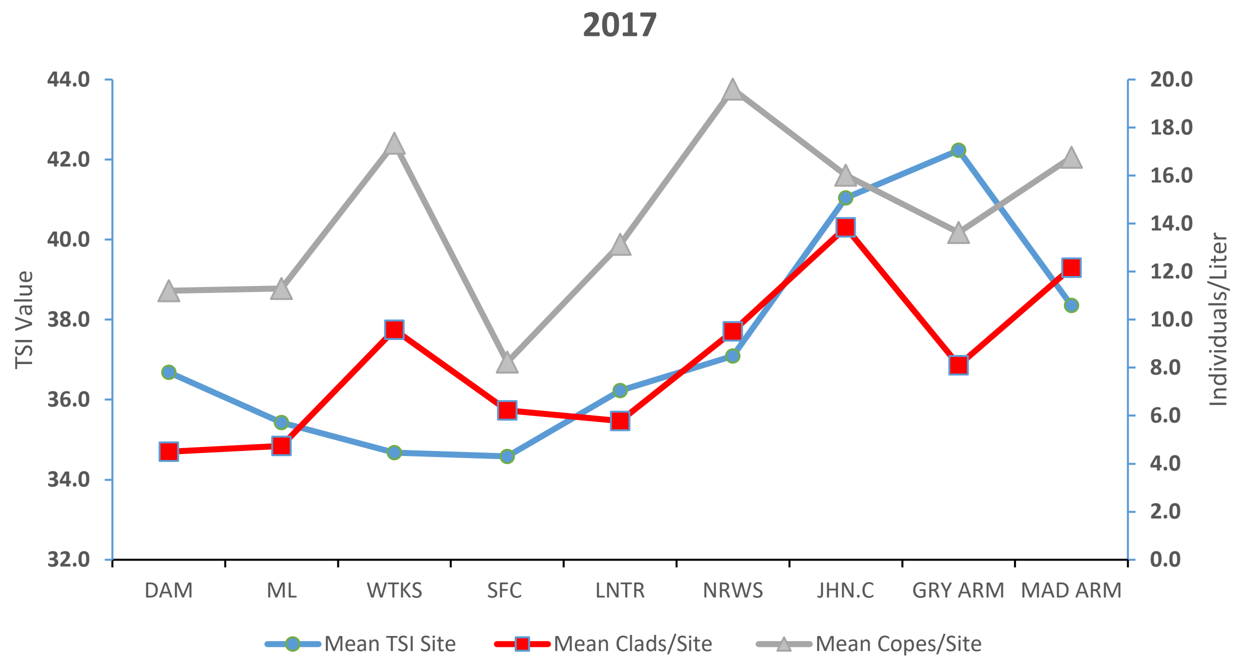


Figure 41. Hebgen Reservoir mean TSI score and mean densities of zooplankton by site, 2009 - 2017. Site names are Dam, Moonlight Bay, Watkins Creek, South Fork Cabin, Lone Tree (Horse Butte), Narrows, Johnson Creek, Grayling Arm, Madison Arm. Sites are locations are listed in Figure 15.

CONCLUSIONS AND FUTURE PLANS

Based on occasional angler reports, the Madison (Ennis) Reservoir grayling population continues to persist at low levels. The Madison population is very similar genetically to the Big Hole population which should provide a competent source for reintroductions. The Arctic Grayling introduction and monitoring effort initiated in 2014 is anticipated to continue through 2023. Introductions will be conducted for 4-5 consecutive years at selected sites, with monitoring occurring to determine the success at each site. In 2017, introductions were conducted in O'Dell Creek, Blaine Spring Creek and Moore's Creek. Additional sites will be considered as they are identified.

Westslope cutthroat trout restoration will continue to be pursued on Madison River tributaries. Construction of fish barriers is necessary to protect and, in some cases, expand remaining headwater populations of WCT. Transfer of individuals and eyed-eggs from relict population will also be necessary to prevent demographic and catastrophic extinction.

Fish population monitoring will continue annually in the Madison River. These data are necessary for setting and reviewing angling regulations, for monitoring environmental and biological impacts on the populations, and for assessing the long-term effects of fish population and water management decisions.

Monitoring of fish population responses to habitat improvement projects in the Madison Basin will continue into the future.

Aquatic Invasive Species monitoring will continue through the 2188 Biological and Biocontaminant monitoring program and through the FWP Aquatic Invasive Species Program. FWP has implemented a program and provided equipment to clean sampling gear to reduce the chance of moving AIS between waters. A study partially funded by NWE will look at in situ physiological scope of Mountain Whitefish in relation to PKX infections and water temperature. Results from this study may provide insight into what waters/conditions are conducive to fish kill of the magnitude experienced last year on the Yellowstone River.

The proportion of the Hebgen Reservoir Rainbow Trout gillnet catch larger than 14 inches has increased since 2005. The Hebgen Reservoir Rainbow Trout micro-chemistry has been finished and its results were used to make a management decision to cease stocking and manage as wild trout fishery. A creel survey of Hebgen Reservoir is planned for 2019. Trends in fish populations will be assessed yearly to inform future management.

Cladoceran and copepod zooplankton densities in Hebgen Reservoir showed diverse abundance patterns. Both cladoceran and copepod densities were highest in June. Cladoceran experienced another bloom in October when copepod densities were at their lowest. Predominant wind direction appears to affect zooplankton density in the main body of Hebgen Reservoir, likely due to its effect on nutrient mixing.

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Appendix A: Summary of Ennis Reservoir Beach Seining 1995 - 2017

AG Arctic Grayling
MWF Mountain Whitefish
LL Brown Trout
RB Rainbow Trout

Date	AG	MWF	LL	RB
7/27/95	12	177	4	0
9/1/95	23	89	4	0
6/18/96	0	6	1	2
7/22/96	0	0	0	0
8/22/96	0	0	1	0
8/20/97	1	0	3	0
10/27/97	0	5	0	0
9/4/98	0	0	0	0
9/22/99	2	34	0	0
11/2/00	0	14	3	0
8/29/01	0	0	0	0
10/2/02	1	2	4	0
10/6/03	0	2	3	1
9/28/04	1	9	96	0
9/27/05	0	11	19	5
11/5/07	0	0	0	0
9/29/08	0	0	3	1
10/1/09	0	0	139	30
10/22/09	1	5	0	0
10/6/10	0	0	1	0
10/3/11	0	4	9	5
10/9/13	0	3	1	3
10/29/14	0	1	0	0
9/30/15	0	19	1	1
10/5/2016	0	2	2	6
10/3/2017	0	0	2	2

Appendix A1: Arctic Grayling Beach Seining Locations and Catch

Species abbreviations:

AG	Arctic Grayling
MWF	Mountain Whitefish
RB	Rainbow Trout
LL	Brown Trout
WSu	White Sucker
UC	Utah Chub
LND	long nose dace

Site	AG	MWF	Note
Meadow Ck FAS rental house 10/5/2016 Fig 6 site 1	0	0	Macrophytes moderate 63ºF 3WSu 1 UC 1 LND Rb – 17.5,16.8,17.7,17.3 inches LL – 17.8 inches
Meadow Ck FAS north shore willows 10/5/2016 Fig 6 site 2	0	9	Macrophytes moderate 63ºF MWF – 3.7 inches Rb – 15.4 inches 1 LL – 3.4 inches 1 UC 3WSu
Meadow Ck FAS South shore near creek mouth 10/5/2016 Fig 6 site 3	0	0	Macrophytes sparse 64ºF 1 Rb – 1.0 inch 2 WSu 1 UC
Madison River mouth 10/5/2016 Fig 6 site 4	0	0	Macrophytes absent 58º No fish captured
Southwest shore east of Fletcher's mouth 10/5/2016 Fig 6 site 5	0	1	Macrophytes sparse 59º MWF – 3.7 inches Rb – 3.5 inches LL – 3.4 inches 1 UC 3WSu

Appendix B: AIS

The Montana Aquatic Nuisance Species Management Plan was finalized in October of 2002 and a full time Aquatic Nuisance Species (ANS) Program Coordinator was hired by Montana Fish, Wildlife and Parks in February of 2004. The emphasis of the Montana ANS Program is on coordination, education, control and prevention of spread, monitoring and detection, and rapid response. The species of emphasis are New Zealand mud snails, whirling disease, and Eurasian milfoil (all of which are established in Montana), and zebra mussels (which were documented in Tiber Reservoir in 2016). Strategies to prevent the further spread and introduction of these species are outlined below.

1. Statewide distribution survey for New Zealand Mud Snails has been completed. All state, federal and private hatcheries have been inspected for New Zealand mud snails. One private hatchery contains New Zealand mud snails, strategies have been implemented to prevent the spread of this invasive through hatchery operations. The spread of New Zealand mud snails has slowed and appears to be confined to east of the divide.

2. Zebra Mussel veliger sampling has been completed for all major reservoirs on the Missouri River, and on other high priority lakes and reservoirs. The presence of Dreissinid mussels were confirmed in Tiber reservoir and non-confirmed in Canyon Ferry and the Missouri River north of Townsend.

3. Legislation and Rulemaking: In 2005 a rule making system was developed to classify exotic wildlife (terrestrial and aquatic) as either non-controlled, controlled or prohibited. The following ANS have been since added to the prohibited list: snakehead fish (29 species), grass carp, silver carp, black carp, bighead carp, zebra mussels, rusty crayfish, nutria, African clawed frogs, North American bullfrogs, and New Zealand mud snails. Legislation was also passed during the 2005 session to provide exceptions for the possession of prohibited species, primarily for the purposes of research, in addition to providing for tougher enforcement authority including the ability to confiscate illegally possessed exotic wildlife. In May 2016, Montana implemented new AIS rules that apply to watercraft and gear Figure. SS

New AIS Rules Effective May 21, 2016

Drain plug – You must remove your drain plug and other devices that prevent water drainage before you leave the boat ramp or associated parking area, except where otherwise provided in current published fishing regulations.

Aquatic vegetation – You must remove all aquatic vegetation from your watercraft, trailer and gear before you leave the boat ramp or associated parking area.

Decontamination of infested watercraft – If AIS are found on a watercraft or the watercraft has been in a mussel infested waterway in the last 30 days, your watercraft will be decontaminated. Decontaminations include proper dry time. To ensure watercrafts are dried properly, FWP may lock your watercraft to the trailer to prevent launching, while staying in your possession. Each circumstance is unique and the amount of time your watercraft may be locked depends on the watercraft complexity, temperature and humidity. FWP staff will arrange for the watercraft to be unlocked.

4. Montana continues to actively participate in the 100^{th} Meridian angler survey program and during 2005 submitted more than 1,700 entries to the angler survey database. The angler surveys are conducted as part of the Montana boat inspection program, which was greatly expanded in 2005. Boat inspections have occurred on all major lakes, reservoirs and popular cold-water trout rivers. The first boat with zebra mussels was found in Montana in March 2005.

5. Public outreach: presentations on ANS have been made to several special interest groups including Walleyes Unlimited, Fishing Outfitters Association of Montana and Lake Associations. Additionally, several partnerships have been developed that provide additional resources for the detection and prevention of ANS. These and other resources can be found FWP website http://fwp.mt.gov/fishAndWildlife/species/ais/

6. Illegal introductions: to date over 500 illegal fish introductions have been recorded in Montana. Illegal introductions have been identified as a major source of ANS introductions into Montana waters. An aggressive public outreach campaign was launched during summer of 2005 with an increase in law enforcement to discourage the activity of “bucket biology”.

Appendix B1: Water Craft Inspections and Waters Sampled

Table B1-1. Location and number of water craft inspections conducted at the FWP Region 3 Head Quarters in 2017. Data courtesy of Craig McClane FWP AIS team member.

Vehicle State	Date	Ballasts	Water User Type	Live Fish/Bait	Waterbodies Visited/Planned	Launched in Canyon Ferry/Tiber	Risk/High Risk	Result
MT	3/31	No	Angler	NO	Missouri River:MT:Visited	No	No	PASS
MT	5/3	No	Recreationist	NO	American Falls:ID:Visited,Canyon Ferry:MT:Planning,Ennis lake:MT:Planning,Hebgan:MT:Planning	No	Yes	PASS
MT	5/16	No	Angler	NO	Smith River:CA:Visited	No	Yes	PASS
MT	5/23	No	Angler	NO	Canyon Ferry:MT:Planning	No	No	PASS
MT	6/7	Yes	Recreationist	NO	Canyon Ferry:MT:Planning	No		PASS
MT	6/9	No	Angler	NO	Ennis Lake:MT:Visited,Hyalite:MT:Visited,Castle Rock Lake:MT:Planned	No	No	PASS
MT	6/12	No	Angler	NO	Big Hole River:MT:Planning,Madison River:MT:Planning	No	No	PASS
MT	6/13	No	Angler	NO	Holter Lake:MT:Visited,Ennis Lake:MT:Planned,Koocanusa:MT:Planned	No	No	PASS
MT	6/16	No	Angler	NO		No	No	PASS

Vehicle State	Date	Ballasts	Water User Type	Live Fish/Bait	Waterbodies Visited/Planned	Launched in Canyon Ferry/Tiber	Risk/High Risk	Result
MT	6/18	No	Recreationist	NO		No		PASS
MT	6/23	No	Angler	NO	Madison River:MT:Visited,Henrys Fork:ID:Visited,Rock Creek:MT:Planned,Gallitan River:MT:Planned,Yellowston River:MT:Planned	No	No	PASS
MT	6/23	No	Angler	NO	Rock Creek:MT:Planned	No	No	PASS
MT	6/28	No	Recreationist	NO	Hyalite Lake:MT:Planned,Ennis Lake:MT:Planned,Harrison Reservoir:MT:Planned	No	No	PASS
WA	7/5	No	Recreationist	NO	Gallitan River:MT:Visited,South Fork Flathead:MT:Planned	No	No	PASS
MT	7/6	No	Angler	NO	Madison River:MT:Planned,Stillwater River:MT:Planned,Yellowstone River:MT:Planned	No	No	PASS
MT	7/12	No	Raft	NO	Madison River:MT:Visited,South Fork Flathead:MT:Planned	No	No	PASS
MT	9/3	No	Angler	NO	Madison River:MT:Visited,Big Hole River:MT:Planned,Yellowstone River:MT:Planned	No	No	PASS
MT	11/24	No	Angler	NO	Lake Havasu:AZ:Planned	Yes - Decontaminated	Yes	PASS

Vehicle State	Date	Ballasts	Water User Type	Live Fish/Bait	Waterbodies Visited/Planned	Launched in Canyon Ferry/Tiber	Risk/High Risk	Result
MT	2017-07-14	No	Recreationist	NO	Madison River - Ennis:MT:Planning,Missouri River :MT:Planning	No	No	PASS
MT	2017-07-20	No	Angler	NO	Canyon Ferry Lake - Unspecified:MT:Planning,HEBGEN LAKE - unspecified:MT:Planning,Harrison River:MT:Planning	No	No	PASS
MT	2017-07-24	No	Recreationist	NO	Harrison Pond:MT:Visited,Harrison Reservoir:MT:Planning,Noxon Reservoir - Thompson Falls:MT:Planning	No	No	PASS
KS	2017-07-26	No	Angler	NO	Highlight Reservoir - Bozeman, MT:MT:Planning,Madison River - Ennis:MT:Planning,North Platte River CASPER:WY:Visited,Yellowstone River:MT:Planning	No	No	PASS
MT	2017-07-27	No	Recreationist	NO	Ennis Lake:MT:Planning,Ennis Lake:MT:Visited,SWAN LAKE - BIGFORK:MT:Planning	No	No	PASS
WY	2017-08-07	No	Angler	NO	Flathead Lake - Bigfork:MT:Planning	No	No	PASS

Vehicle State	Date	Ballasts	Water User Type	Live Fish/Bait	Waterbodies Visited/Planned	Launched in Canyon Ferry/Tiber	Risk/High Risk	Result
SD	2017-08-07	No	Recreationist	NO	Jackson Lake:WY:Visited,Blackfoot River:MT:Planning,Snake River - WY:WY:Visited	No	No	PASS
FL	2017-08-16	No	Other	NO		No	No	PASS
MT	2017-08-23	No	Angler	NO	ASST.:WY:Planning,Hebgen Lake:MT:Planning	No	No	PASS
MT	2017-09-08	No	Angler	NO		Yes - Decontaminated	No	PASS
MT	2017-09-08	No	Recreationist	NO	Newlan Creek Reservoir:MT:Planning	No	Yes	PASS
CO	2017-09-18	No	Angler	NO	Clinton Gulch Dam Reservoir:CO:Visited		No	PASS
MT	2017-09-28	No	Angler	NO	Canyon Ferry Lake - Unspecified:MT:Planning	No	No	PASS
MT	2017-09-29	No	Hunter	NO	Canyon Ferry Lake - Unspecified:MT:Planning,Freezeout Lake:MT:Planning	No	No	PASS

Table B1-2. Sampling done by AIS crews on waters in the Madison Drainage for ANS.

Water Body	Location of Sample	Date of Sample	Purpose	Findings
Ennis Lake	Kabayoshi Ramp	6/12/2017	Presence/Absence	Larval Mayflies, Midge Larvae (unspecified), Richardson's pondweed
Ennis Lake	Ennis Lake Point Intercept Plant Sampling	6/13/2017	Presence/Absence	Coontail, Elodea species, Leafy pondweed, None, Northern watermilfoil, Richardson's pondweed, Sago pondweed, Unknown Plant, White waterbuttercup
Hebgen	Hebgen Lake Point Intercept Plant Sampling	6/14/2017	Presence/Absence	Chara spp., Coontail, Elodea species, Leafy pondweed, None, Northern watermilfoil, Richardson's pondweed, Unknown Plant
Hebgen	Lonesome Hurst Camp Ground	6/14/2017	Presence/Absence	Elodea species, Leech (unspecified), Scud (unspecified), White waterbuttercup
Hebgen	Madison Arm Resort Boat Launch	6/14/2017	Presence/Absence	Leafy pondweed, Scud (unspecified), Water Boatman
Hebgen	Hebgen Lake Point Intercept Plant Sampling	6/15/2017	Presence/Absence	Elodea species, None
Hebgen	Rainbow Point CG	6/15/2017	Presence/Absence	Crayfish (unspecified), Elodea species, Scud (unspecified), Water Boatman
Hebgen	Yellowstone Holiday Marina	6/15/2017	Presence/Absence	Larval Mayflies, Scud (unspecified)
Hebgen	Kirkwood Resort Marina	6/15/2017	Presence/Absence	Aquatic Sow Bug (unspecified), Coontail, Damselfly Larvae, Larval Mayflies, Scud (unspecified)
Madison River	Various sites	7/25/2017	Presence/Absence	Aquatic Earthworm, Ditchgrass, Flatworms, Larval Caddisflies, Larval Mayflies, Leech (unspecified), Mare's tail, Physid (unspecified), Western watermilfoil, White waterbuttercup
Madison River	Various sites	7/26/2017	Presence/Absence	Ancylid Snail, Aquatic Earthworm, Canada waterwee
Madison River	Various sites	7/26/2017	Presence/Absence	Larval Mayflies, Northern watermilfoil
Madison River	Various sites	7/26/2017	Presence/Absence	Flatworms, Larval Caddisflies, Larval Mayflies, Leafy pondweed, Physid (unspecified), Water Strider, White waterbuttercup
Madison River	Various sites	7/26/2017	Presence/Absence	Larval Caddisflies, Larval Mayflies
Ennis Lake	Ennis Lake	7/31/2017	Presence/Absence	Aquatic Earthworm, Larval Caddisflies, Leech (unspecified), Physid (unspecified), Scud (unspecified)

Water Body	Location of Sample	Date of Sample	Purpose	Findings
Ennis Lake	Ennis Lake Point Intercept Plant Sampling	7/31/2017	Presence/Absence	Chara spp., Curlyleaf pondweed, Elodea species, Leafy pondweed, None, Northern arrowhead, Northern watermilfoil, Richardson's pondweed, White waterbuttercup
Madison River	Various sites	8/14/2017	Presence/Absence	Chara spp., Flatworms, Larval Caddisflies, Larval Mayflies, Leafy pondweed, Leech (unspecified), Physid (unspecified), Western watermilfoil
Blaine Spring Creek	Ennis National Fish Hatchery	8/29/2017	Presence/Absence	Amnicola/Duskysnail, Aquatic Earthworm, Common
Ennis Lake	Ennis Lake	10/2/2017	Presence/Absence	Elodea species, Larval Mayflies, Leafy pondweed, Leech (unspecified), Physid (unspecified), Scud (unspecified), Sprites/Gyros/Rams-horns (unspecified), Unknown Plant, Water Boatman, Western watermilfoil
Hebgen Lake	Hebgen Lake	10/2/2017	Presence/Absence	Chara spp., Crayfish (unspecified), Curlyleaf pondweed, Elodea species, Larval Caddisflies, Leafy pondweed, Leech (unspecified), Northern watermilfoil, Physid (unspecified), Richardson's pondweed, Scud (unspecified), Water Boatman
Hebgen	Hebgen Lake	10/2/2017	Presence/Absence	An Aquatic Isopod, Coontail, Elodea species, Leech (unspecified), Northern watermilfoil, Richardson's pondweed, Scud (unspecified), Sprites/Gyros/Rams-horns (unspecified), Unspecified Nematode Worm
Hebgen	Madison Arm Resort Boat Launch	10/2/2017	Presence/Absence	Aquatic Earthworm, Crayfish (unspecified), Elodea species, Larval Caddisflies, Northern watermilfoil, Richardson's pondweed, Scud (unspecified), Water Boatman, Western watermilfoil
Hebgen	Kirkwood Resort Marina	10/2/2017	Presence/Absence	An Aquatic Isopod, Aquatic Earthworm, Coontail, Elodea species, Leech (unspecified), Northern watermilfoil, Richardson's pondweed, Scud (unspecified), Sprites/Gyros/Rams-horns (unspecified)

Water Body	Location of Sample	Date of Sample	Purpose	Findings
Hebgen	Yellowstone Holiday Marina	10/2/2017	Presence/Absence	An Aquatic Isopod, Canada waterweed, Coontail, Ph
Madison River	Various sites	10/2/2017	Presence/Absence	An Aquatic Isopod, Curlyleaf pondweed, Elodea species, Flatworms, Fossarias/Pondsnails/Lanxs (unspecified), Larval Caddisflies, Larval Mayflies, Larval Stoneflies, Leafy pondweed, Midge Larvae (unspecified), Northern watermilfoil, Physid (unspecified), Scud (unspecified), Sprites/Gyros/Rams-horns (unspecified), Unknown Plant, Water Boatman, Western watermilfoil, White waterbuttercup
Madison River	Various sites	10/3/2017	Presence/Absence	Larval Mayflies, Larval Stoneflies, Physid (unspecified), Sprites/Gyros/Rams-horns (unspecified), White waterbuttercup

Appendix C: Sun Ranch Hatchery, 2000 - 2017

2017 Sun Ranch WCT Recovery Program Summary

The following is a summation of the 2017 Sun Ranch hatchery operations, the number of eggs incubated, eyed, and the distribution of those eggs.

Drake & Associates personnel opened the Sun Ranch hatchery on May 3, 2017. We placed our initial trap sets in the brood pond on May 8 and spawned our first females on May 10. As in the past, we alternated sets and trapped no more than three times per week. We captured and spawned 26 females and 47 males, for a total of 23 lots, from May 10 through June 14, 2017. These pairings provided a total of 27,966 eggs.

We received our first eggs from Montana Fish, Wildlife & Parks personnel on June 21 from Granite Lake, and a second set of eggs on June 23, from the same source. These two egg takes represented 10 females and 20 males, for a total of 12 lots. The total number of eggs in these lots was 13,220.

FWP's next eggs came from Cherry & Granite Lakes on June 28, totaling 7 lots from 7 females, and 14 males. The total number of eggs was 4,875.

On July 7, the hatchery received 20 lots from FWP's Granite Lake. No numbers were given for the number of females and males comprising these lots. The total estimated number of eggs was 24,000.

Water temperature determines how long eggs incubate before hatching. This year's eggs were incubated at the hatchery well's water temperature of 44 - 51 degrees Fahrenheit until they developed eyes, which usually occurs 10 to 15 days before hatching. Once eyed, the eggs are transported to recipient streams where they are placed in remote site incubators (RSI's).

One June 7, FWP's Erik Roberts received 2,470 eggs from the Sun Ranch brood, destined for Elk Horn Creek in Region 4.

One June 21, Yellowstone National Park received 13,100 from the Sun Ranch brood which they placed in RSI's in upper Grayling Creek.

One June 30, FWP received an additional 2,000 eggs for Elk Horn Creek, and YNP received 2,000 eggs for lower Grayling Creek.

For the 2017 spawning season, the Sun Ranch hatchery incubated an estimated total of 70,061 eggs. We returned approximately 1,000 eggs to the Sun Ranch brood pond for future brood. No Granite or Cherry Lake eggs were included in the brood pond introduction.

A total of 3,307 Granite Lake eggs left the hatchery on July 14.
Cherry & Granite Lake's eggs, totaling 2,551, were shipped July 19.

Unfortunately, after shocking on July 26, no eggs from the 20 Granite Lake lots were viable. Several eggs were subjected to examination in a vinegar filled test tube. The eggs appeared to have been fertilized, but no growth occurred afterwards. We suspect the eggs may have suffered from oxygen deficiency during transport to the hatchery.

The hatchery was cleaned, disinfected, and the water turned off for the season on July 26, 2017.

Below is a table summarizing 2017 results:

2017 Sun Ranch WCT Recovery Summary

	Total Eggs	Eyed	Ave. Percent
Sun Ranch Pond 23 Lots, 26Fx47M	27,966	20,470	73
Estimated # Granite Lake 32 Lots	39,950	4,724	12
Cherry Lake 3 Lots, 3Fx6M	4,875	1,134	23

Drake & Associates 2017 Expenditures:

Income:

NorthWestern Energy		$ 10,000.00
Fish, Wildlife & Parks		$ 10,000.00
Yellowstone National Park		$ 10,000.00
	Total	$ 30,000.00

Expenses:

Personnel		$ 25,565.00
Mileage		$ 4,782.00
Misc. supplies & equipment		$ 216.52
	Total	$ 30,563.52

Year	Donor Stream	M:F spawned	# eggs produced	Recipient Water	# eggs/fry out
2001	Papoose Ck - Madison	NA	NA	Sun Brood Pond	356 fry
	MF Cabin Ck - Madison	23:12	NA		
2002	WF Wilson Ck – Gallatin	?:6	NA	Sun Brood Pond	483 fry
	MF Cabin Ck – Madison	?:3	NA		104 fry
2003	Ray Ck – Big Belt Mtns	25:9	2,420	Sun Brood Pond Bar None Pond	566 fry 560 fry
	Prickly Pear Ck – Missouri	4:1	NA	Prickly Pear Ck Eureka Ck Little Tizer Ck	28 120 52
	Hall Ck – Elkhorn Mtns	4:1	NA	Hall Ck Little Tizer Ck	20 91
2004	Cottonwood Ck – Blacktail	12:6	1,652	Sun Brood Pond	820 fry
	Muskrat Ck – Elkhorn Mtns	15:7	2,028	Bar None Pond	814 fry
	Ray Ck F x McClure Ck M (Madison)	4:8	1,410		
	Ray F x Hall M	2:1	362		
2005	Cottonwood Ck – Blacktail Ck	13:6	2,849	Sun Brood Pond Disease testing	528 fry 11 fry
	Brown’s Ck – Beaverhead	10:5	772	Sun Brood Pond	646 fry
	Sun Brood Pond	37:16	13,851	Sun Brood Pond	800 fry

				Sun Pond disease sentinels	120 fry
2005, continued	Sun Brood Pond	37:16	13,851	Euthanized to reduce hatchery load	750 fry
				Disease testing	100 fry
				Moret Pond	700 fry
				Calibration of CWT injector	5 fry
	Muskrat Ck – Elkhorn Mtns	18:9	NA	SF Crow Ck	2,262 eyed eggs

2006	Browns Ck – Beaverhead	1:1	301	Sun Brood Pond	284 fry
	Muskrat Ck – Elkhorn Mtns	16:8	2,027	Sun Brood Pond Cherry Ck - Madison	184 fry 1,750 eyed eggs
	Whites Gulch – Big Belt Mtns	3:3	982	Cherry Ck - Madison	726 eyed eggs

2007	Muskrat Ck – Elkhorn Mtns	11:22	6,533	Cherry Ck - Madison Sun Brood Pond	5,445 eyed eggs 291 fry
	Ray Ck – Big Belt Mtns	13:25	4,371	Cherry Ck - Madison Sun Brood Pond	3,467 eyed eggs 194 fry
	Whites Gulch – Big Belt Mtns	4:8	1,688	Cherry Ck – Madison Sun Brood Pond	1,015 eyed eggs 59 fry
	Sun Brood Pond	37:17	NA	Cherry Ck – Madison	2,994 eyed eggs

				Sun Brood Pond	326 fry
				High Lk – Gallatin (YNP)	1,611 eyed eggs
	Last Chance Ck – Madison (YNP)	12:8	NA	High Lk – Gallatin (YNP)	177 eyed eggs

Year	Donor Stream	M:F spawned	# eggs produced	Recipient water	# eggs/fry out
2008	Muskrat Ck – Elkhorn Mtns	28:14	NA	Cherry Ck – Madison	3,199 eyed eggs
	Ray Ck – Big Belt Mtns	23:12	NA	Cherry Ck – Madison	1,700 eyed eggs
	Whites Gulch – Big Belt Mtns	11:6	NA	Cherry Ck – Madison Sun Brood Pond	1,015 eyed eggs 117 fry
	Sun Brood Pond	28:10	NA	Cherry Ck – Madison	3,218 eyed eggs
				Sun Brood Pond	571 fry
				High Lk – Gallatin (YNP)	2,844 eyed eggs
	Last Chance Ck – Madison (YNP)	13:8	NA	High Lk – Gallatin (YNP) Sun Brood Pond	286 eyed eggs 70 fry

2009	Muskrat Ck – Elkhorn Mtns	24:12	NA	Cherry Ck – Madison Sun Brood Pond	4,134 eyed eggs 311 fry
	Whites Gulch – Big Belt Mtns	8:5	NA	Cherry Ck – Madison	630 eyed eggs
				Cherry Lk – Madison	500 fry
				Sun Brood Pond	283 fry
				Cottonwood Ck (FWP Region 4)	1,350 eyed eggs

	Ray Ck – Big Belt Mtns	20:10	NA	Cherry Ck – Madison Sun Brood Pond	1,911 eyed eggs 15 fry
	Geode Ck (YNP)	17:16	NA	High Lk - Gallatin (YNP)	838 eyed eggs
	WF Wilson Ck – Gallatin	NA	NA	Eggs destroyed - hybridized	

Year	Donor Stream	M:F spawned	# eggs produced	Recipient water	# eggs/fry out
2010	Last Chance Ck – Madison (YNP)	5:5	NA	Little Tepee Ck – Madison	443 eyed eggs
	Wally McClure Ck - Madison	10:0			
	Brays Canyon – Beaverhead	7:7	NA	Cherry Ck – Madison Sun Brood Pond	1,066 eyed eggs 123 fry
	Prickly Pear Ck – Elkhorn Mtns	8:4	NA	Eureka Ck	641 eyed eggs
	Wild Horse Ck	5:3	NA	Elkhorn Ck – Gallatin Wild Horse Ck	678 eyed eggs 76 eyed eggs
	Geode Ck (YNP)	24:18	NA	EF Specimen Ck – Gallatin	4,156 eyed eggs
	Sun Brood Pond	10:5	NA	Cherry Ck – Madison	398 eyed eggs 3,400 fry
				Sun Brood Pond	496 fry
	WF Wilson – Gallatin	1:1	NA	Eggs destroyed – male was hybrid	

2011	Sun Brood Pond	16:7	6,488	Cherry Ck – Madison Sun Brood Pond	848 fry 818 fry
	Whites Gulch – Big Belt Mtns	7:7	1,296	Cherry Lk – Madison	458 fry 498 eyed eggs

				Cottonwood Ck (FWP Region 4)	
	Muskrat Ck – Elkhorn Mtns	12:6	1,204	EF Specimen Ck - Gallatin Sun Brood pond	1,046 eyed eggs 87 fry
	Geode Ck (YNP)	16:8	1,628	EF Specimen Ck – Gallatin	1,200 eyed eggs

Year	Donor Stream	M:F spawned	# eggs produced	Recipient water	# eggs/fry out
2012	Sun Brood Pond	31:9	8,787	Cherry Ck – Madison Sun Brood Pond	3,900 fry 1,500 fry
	Sappington Ck – Big Hole	20:10	1,977	Cherry Ck – Big Hole	1,556 eyed eggs
	Bryant Ck – Big Hole	22:11	2,963		2,398 eyed eggs
	Plimpton Ck – Big Hole	16:8	840		518 eyed eggs
	Geode Ck (YNP)	39:18	4,370	EF Specimen Ck – Gallatin	3,550 eyed eggs

2013	Sun Brood Pond	38:9	15,145	Sun Brood Pond	3,000 swim-up fry
	Squaw Lake -Big Hole	20:10	9,587	Sun Brood Pond	50 swim-up fry
				Cherry Ck – Big Hole	5,280 eyed eggs
	Papoose Creek – Big Hole	3:1	365		337 eyed eggs
	Divide Creek– Big Hole	2:1	39		29 eyed eggs

	Last Chance Ck (YNP)	13:11	1,217	Goose Lakes (YNP)	702 fry
	Skelly x White creeks	16:5	1,463		700 fry
	Muskrat x Little Boulder	10:7	521		357 eyed eggs
	Muskrat - Big Hole	4:4	413	Sun Brood Pond	50 fry 311 fry destroyed
	Divide x Papoose creeks - Big Hole	2:1	1,013		50 fry 364 fry destroyed

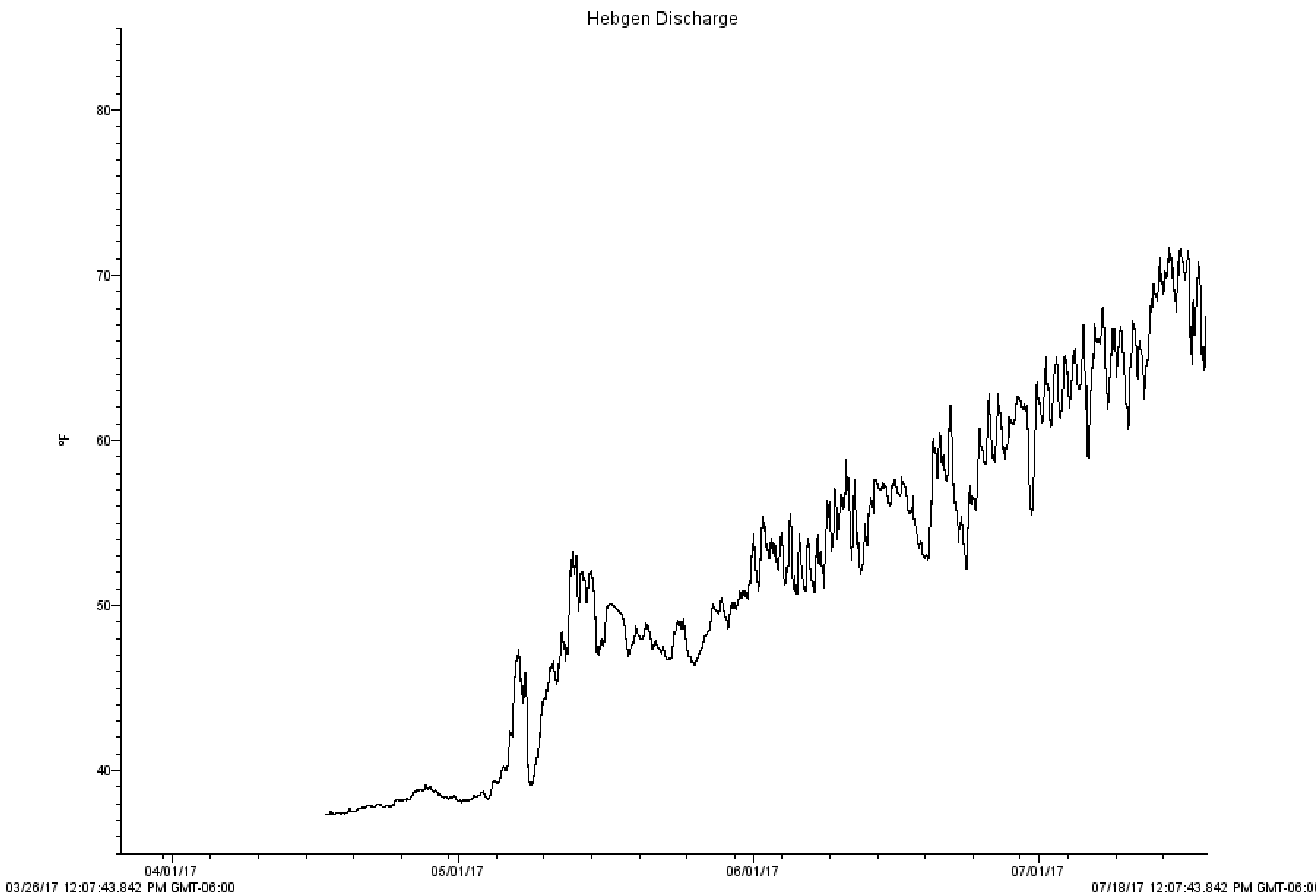
Year	Donor Stream	M:F spawned	# eggs produced	Recipient water	# eggs/fry out
2014	Sun Brood Pond	56:22	19,339	Sun Brood Pond	1,260 swim-up fry
				Elkhorn Creek - FWP R4	15,000 eyed eggs
	Threemile – Missouri River, FWP R4	20:10	5,826	Cottonwood Creek – R4	1,500 eggs
				Goose Lakes – YNP	2,000
				destroyed	2,000
	Jerry – Big Hole	18:9	764	Jerry Creek	Donor fish were slightly hybridized, so all 726 eyed eggs were re-introduced into Jerry Creek
	Bender – Big Hole	6:6	683	Cherry Creek – Big Hole	501 eggs
	Last Chance – YNP	5:3	177	NA (intended for Ruby Creek – Madison)	Only 1 viable egg, destroyed
	Whites Gulch – Big Belt Mtns	48:12	3,660	Cherry Lake – Madison	2,000 swim-up fry
2015	Sun Brood Pond	58:29	24,649	Sun Brood Pond	800 swim-up fry
				Elkhorn Creek - FWP R4	11,000 eyed eggs
				Grayling Creek- YNP	5,000 eyed eggs
				Goose Lakes – YNP	5,100 swim-up fry
	Lone Willow	16:8	4,306	Camus Lake – Big Belt Mtns	3,651 eyed eggs
				Sun Brood Pond	400 swim-up fry
	York Pond – Big Hole	12:6	4,825	York Gulch	2,782 eyed eggs
				Sun Brood Pond	200 swim-up fry
	Geode - YNP	50:25	4,977	Grayling Creek – YNP	4,977eyed eggs
	American – Big Hole	6:12	1,500	No viable eggs	

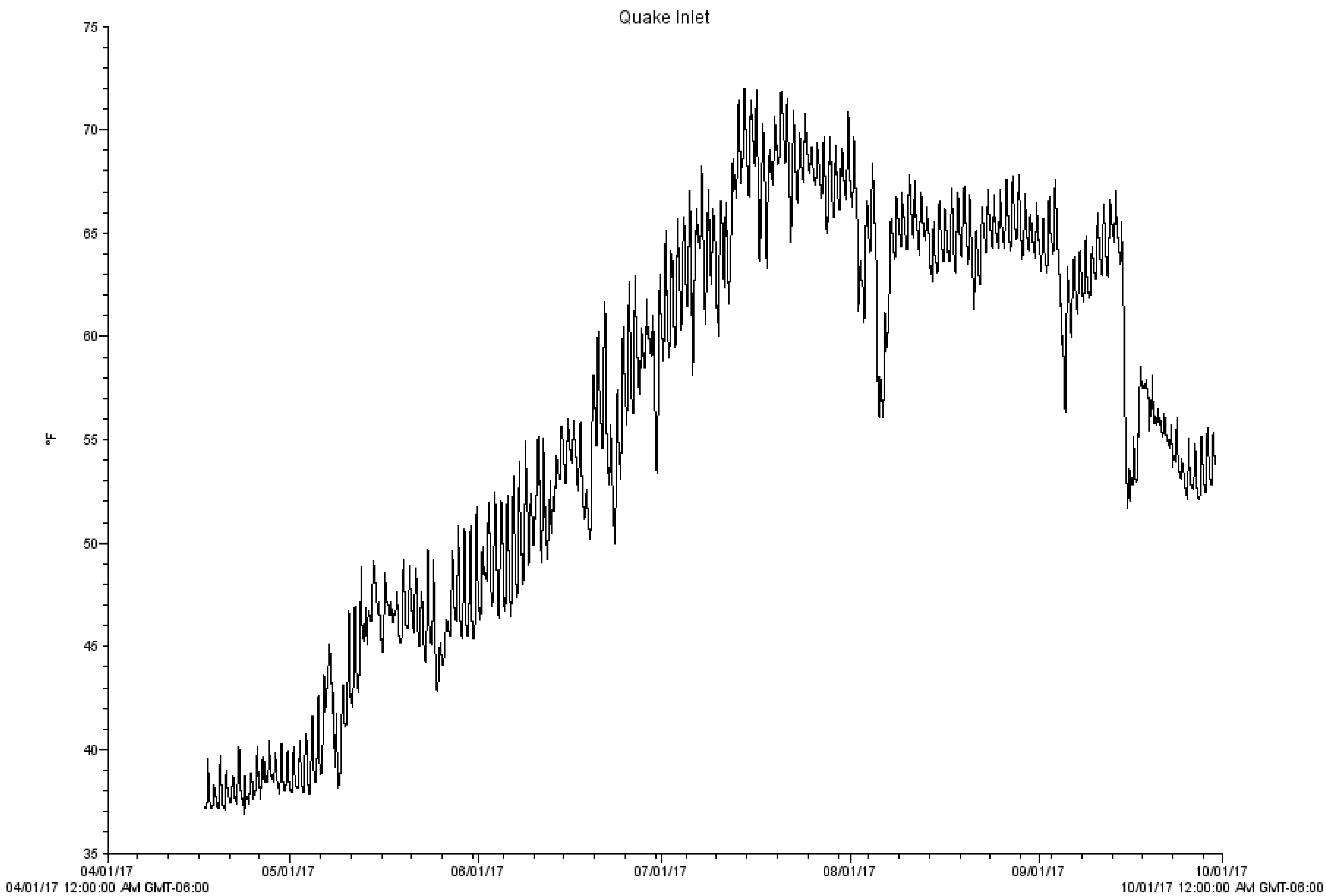
Year	Donor Stream	M:F Spawned	#Eggs Produced	Recipient Water	#eggs/fry out
	Sun Brood Pond	68:40	32,223	Sun Brood Pond	2,800
				Grayling Creek-YNP	26,800
2016	Geode Creek-YNP	17:17	1,931	Grayling Creek-YNP	1,386
	Lone Willow Creek	14:7	4,273	Lone Willow Creek	600
				Tyrell Creek	3,277
	York Pond-Big Hole	12:6	3,617	York Pond	200
				York Creek	1,252
	Granite Lake-Big Hole	47:26	18,177	No viable eggs	
	Cherry Lake-Big Hole	18:9	4,096	No viable eggs	

Year	Donor Stream	M:F Spawned	#Eggs Produced	Recipient Water	#eggs/fry out
2017	Sun Brood Pond	47:26	27,966	Sun Brood Pond	1,000
				Grayling Creek-YNP	15,100
				Elk Horn Creek	2,470
	Granite Lake-Big Hole	20:10	13,220	Granite Lake-Big Hole	
	Granite Lake-Big Hole	?	24,000	No viable eggs	
	Cherry Lake-Big Hole	6:3	4,875	Cherry Lake-Big Hole	

Appendix D: Temperature Monitoring, Madison River Sites - 2017

See Figure 10 for locations




Quake Inlet
°F
75
70
65
60
55
50
45
40
35
04/01/17
04/01/17 12:00:00 AM GMT-06:00
05/01/17
06/01/17
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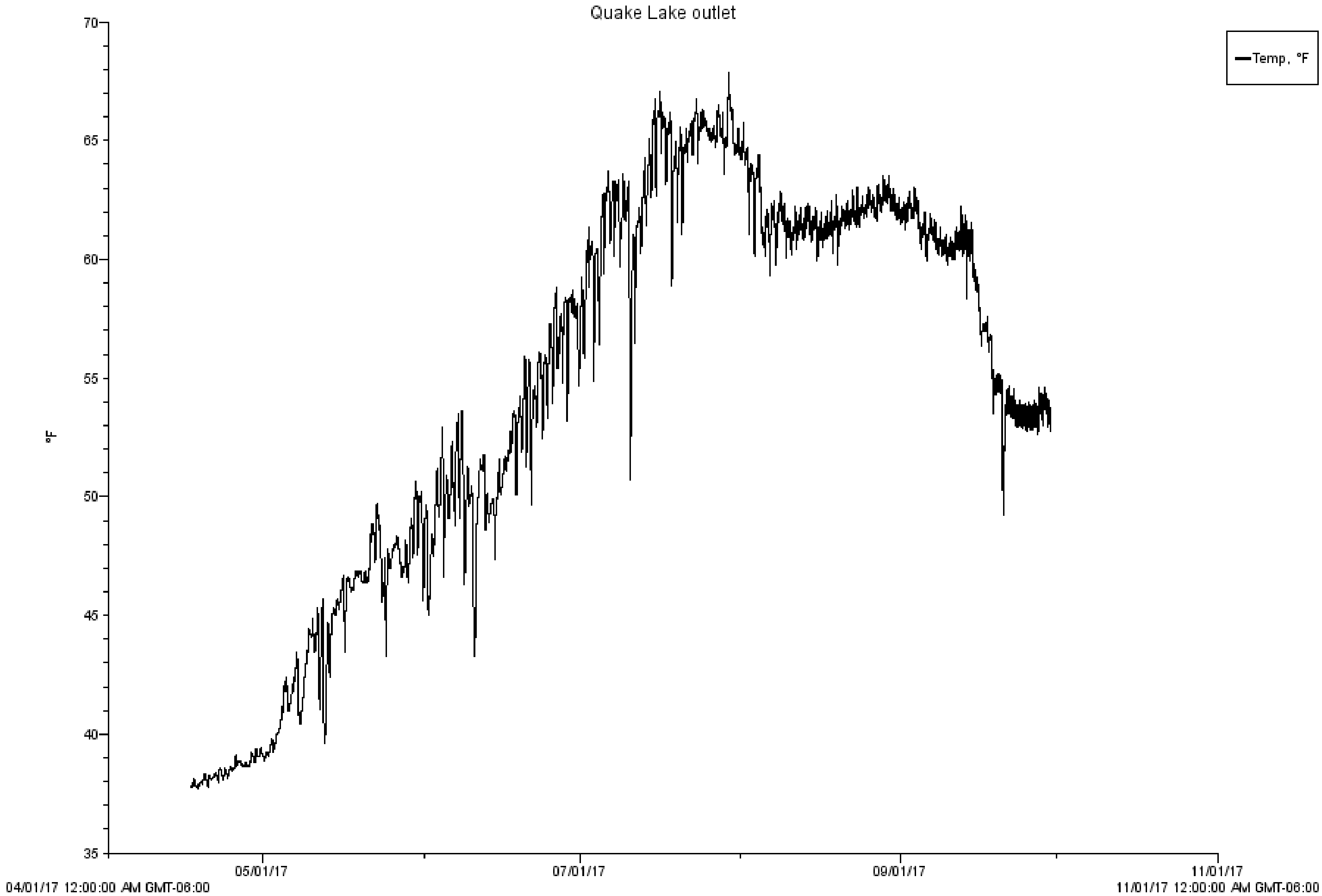
Quake Lake outlet
Temp, °F
°F
70
65
60
55
50
45
40
35
04/01/17 12:00:00 AM GMT-06:00
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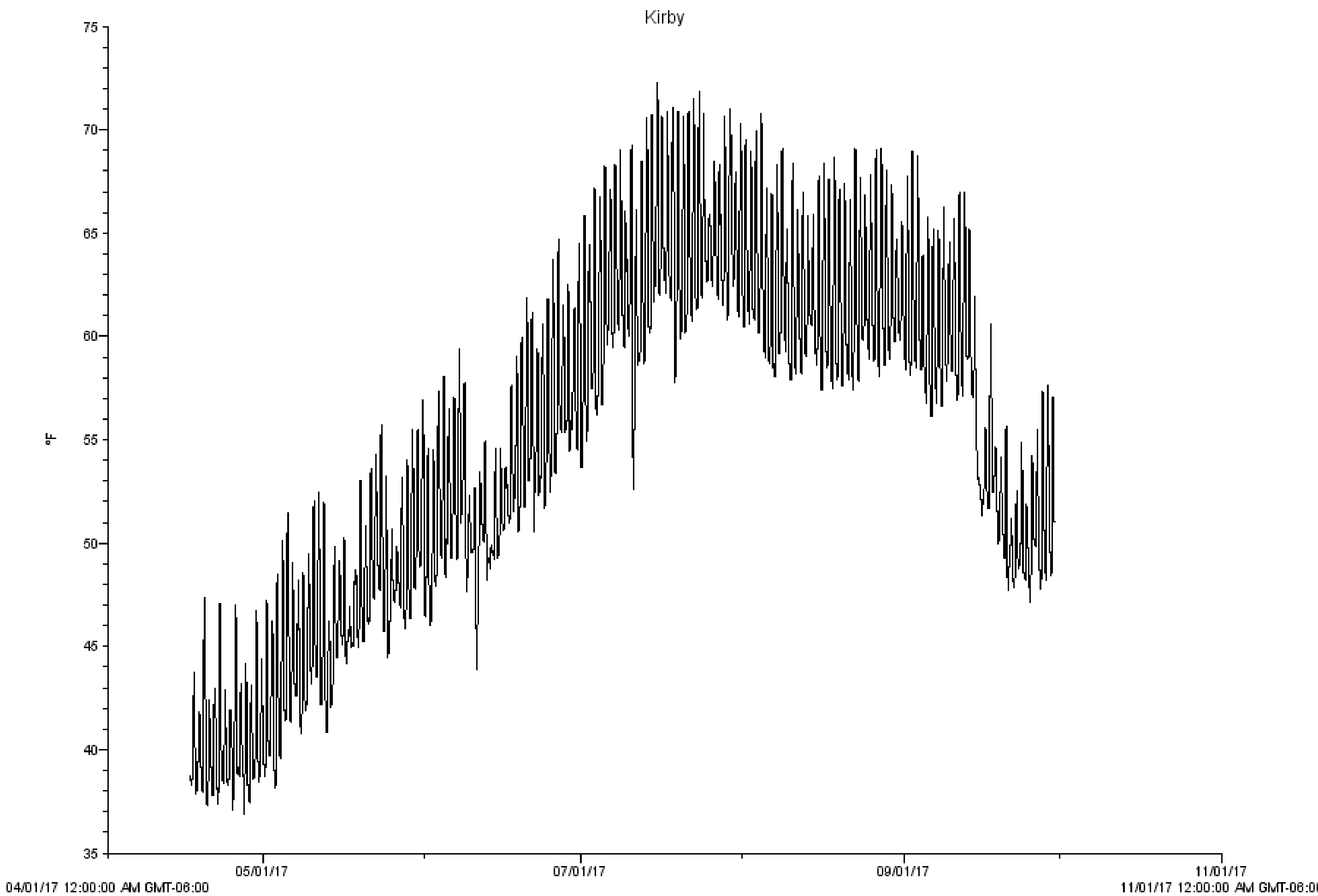
Kirby
75
70
65
60
55
50
45
40
35
°F
04/01/17 12:00:00 AM GMT-06:00
05/01/17
07/01/17
09/01/17
11/01/17
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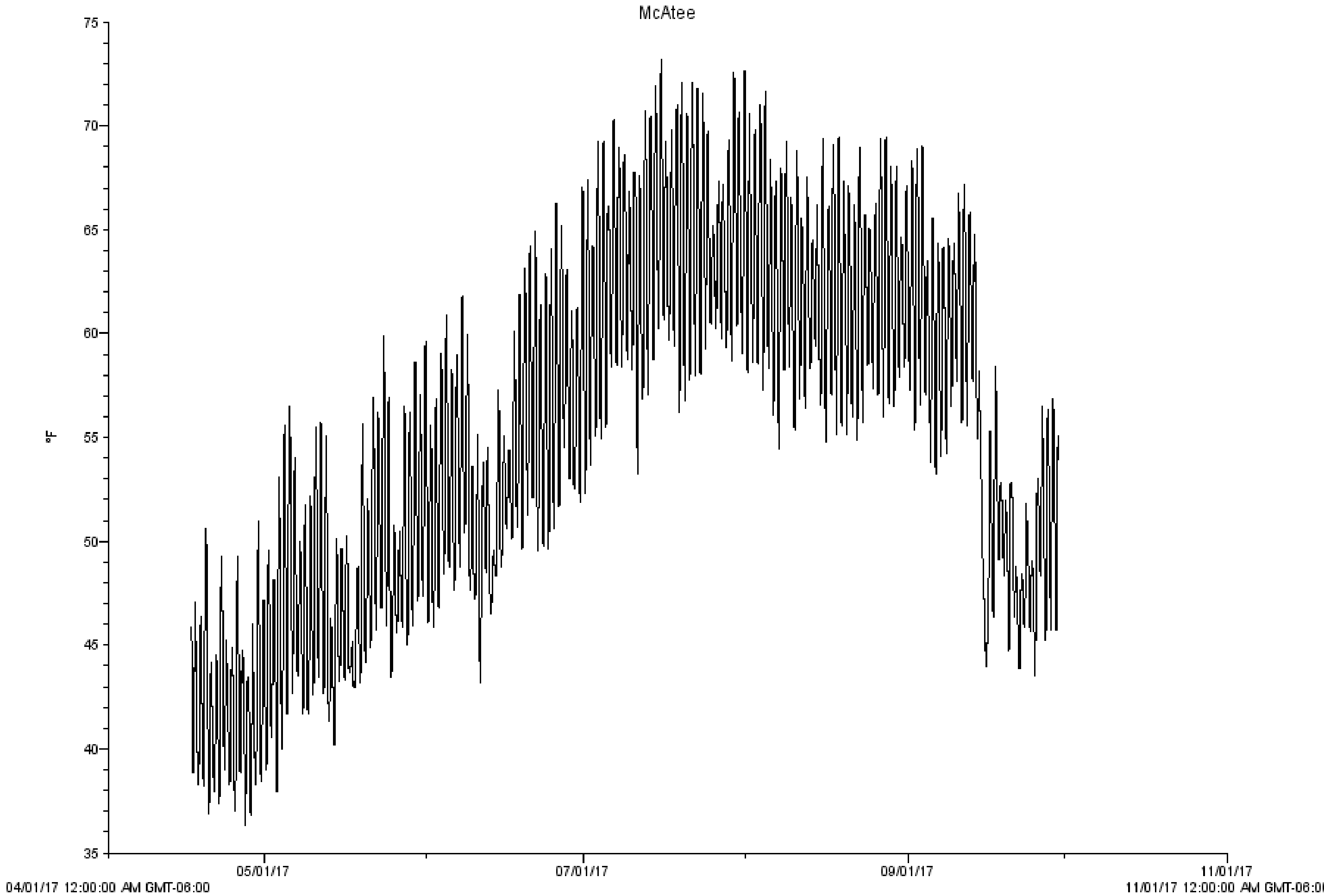
McAtee
75
70
65
60
55
50
45
40
35
°F
04/01/17 12:00:00 AM GMT-06:00
05/01/17
07/01/17
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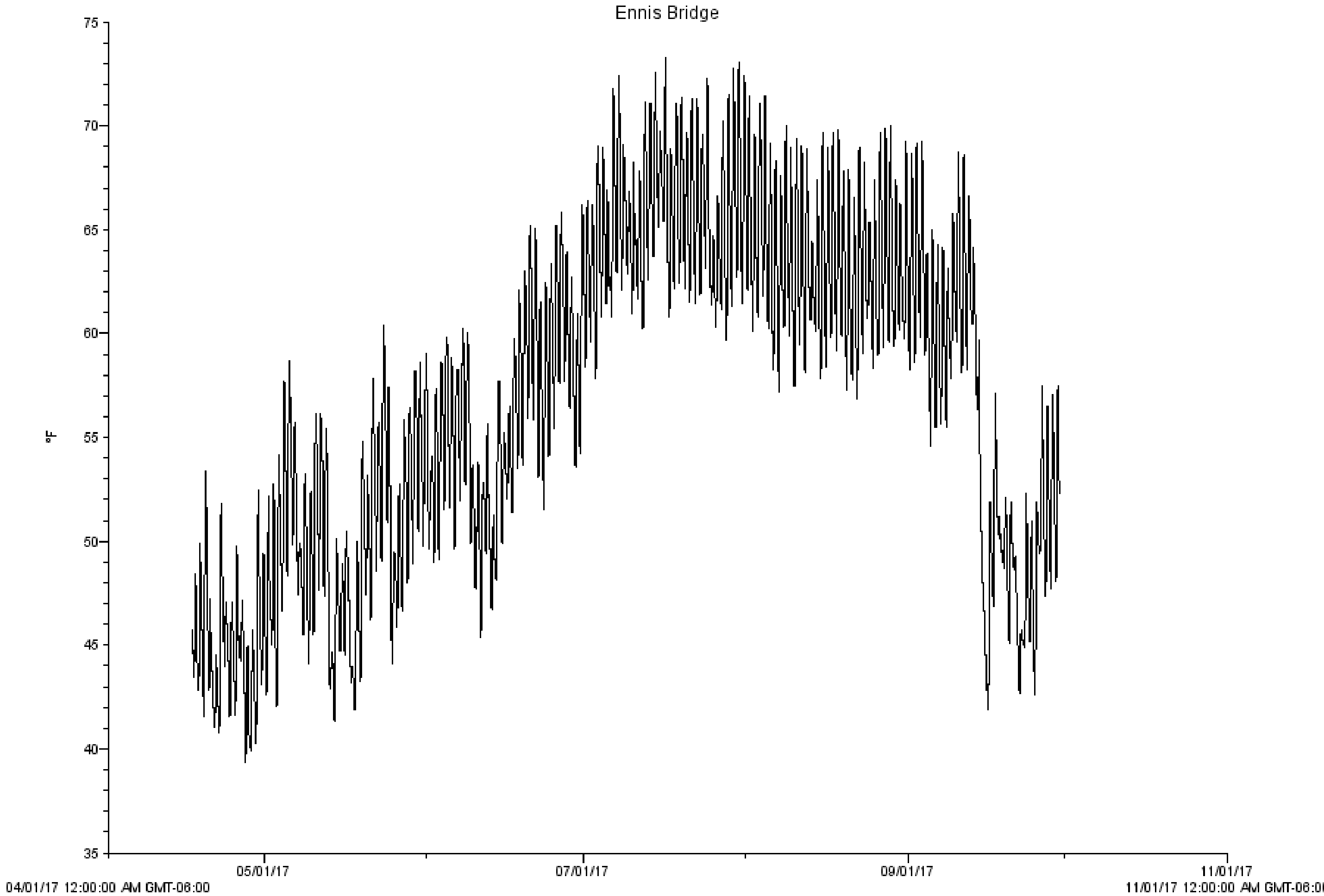
Ennis Bridge
75
70
65
60
55
50
45
40
35
°F
04/01/17 12:00:00 AM GMT-06:00
05/01/17
07/01/17
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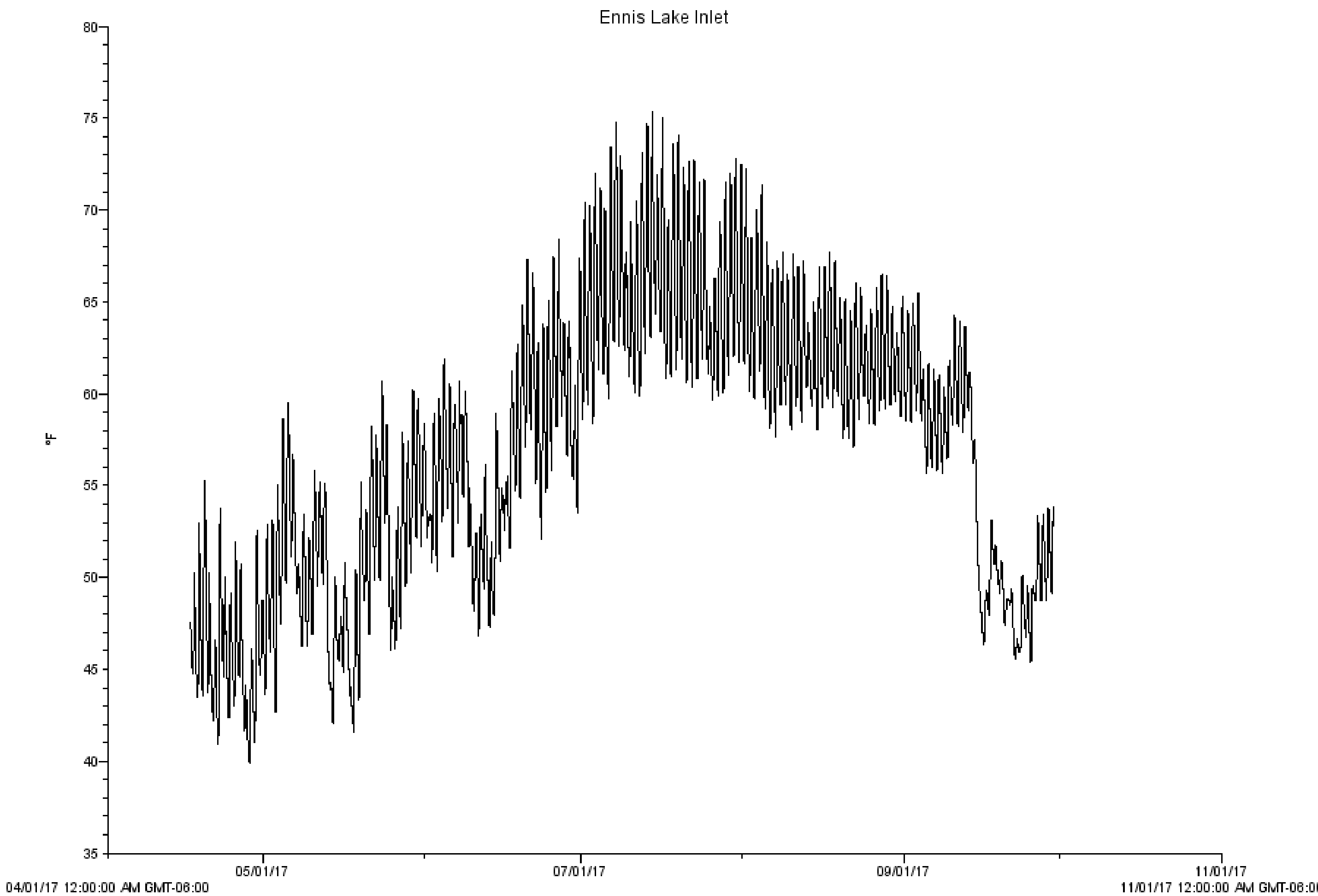
Ennis Lake Inlet
80
75
70
65
60
55
50
45
40
35
°F
04/01/17 12:00:00 AM GMT-06:00
05/01/17
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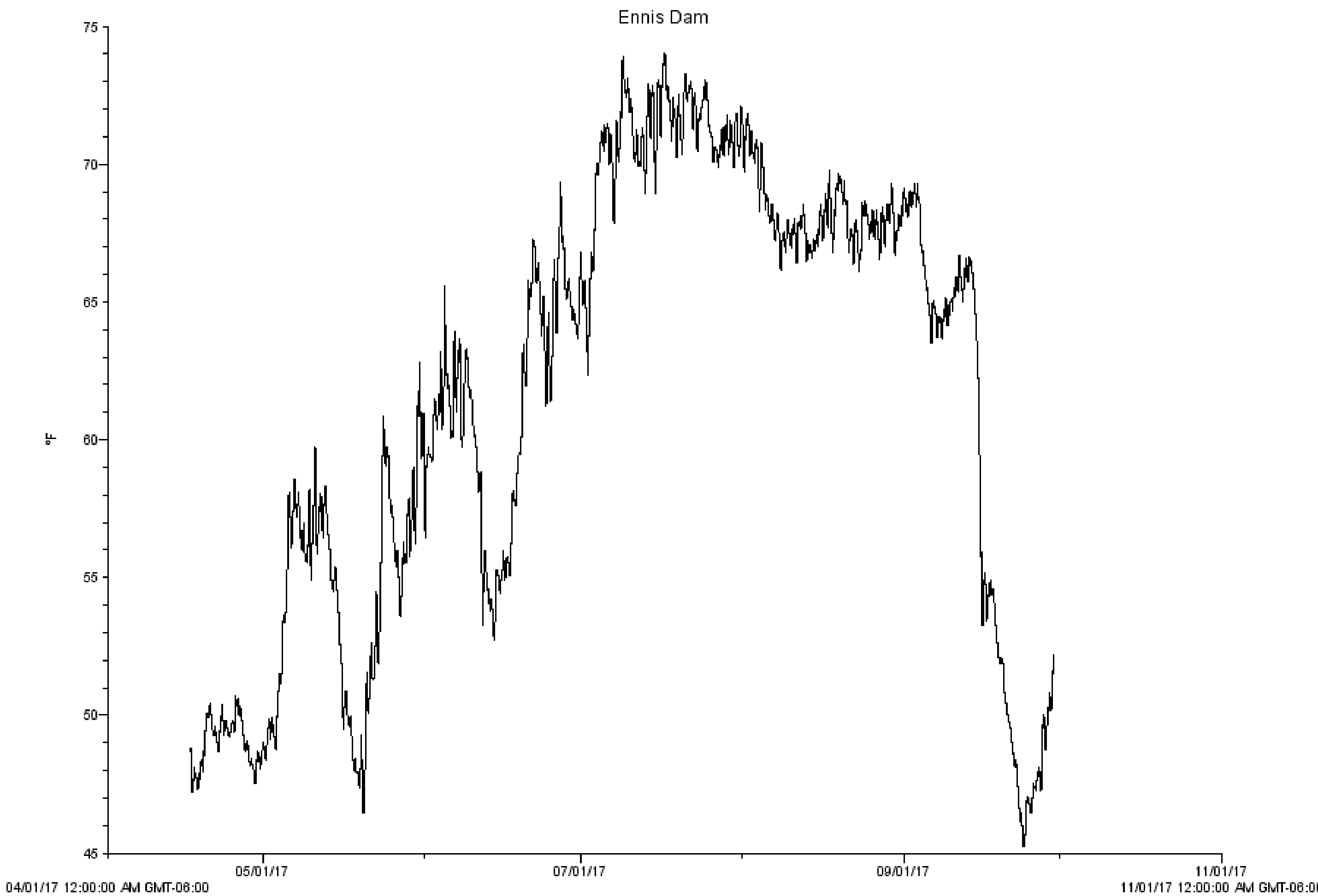

Ennis Dam
°F
75
70
65
60
55
50
45
04/01/17 12:00:00 AM GMT-06:00
05/01/17
07/01/17
09/01/17
11/01/17
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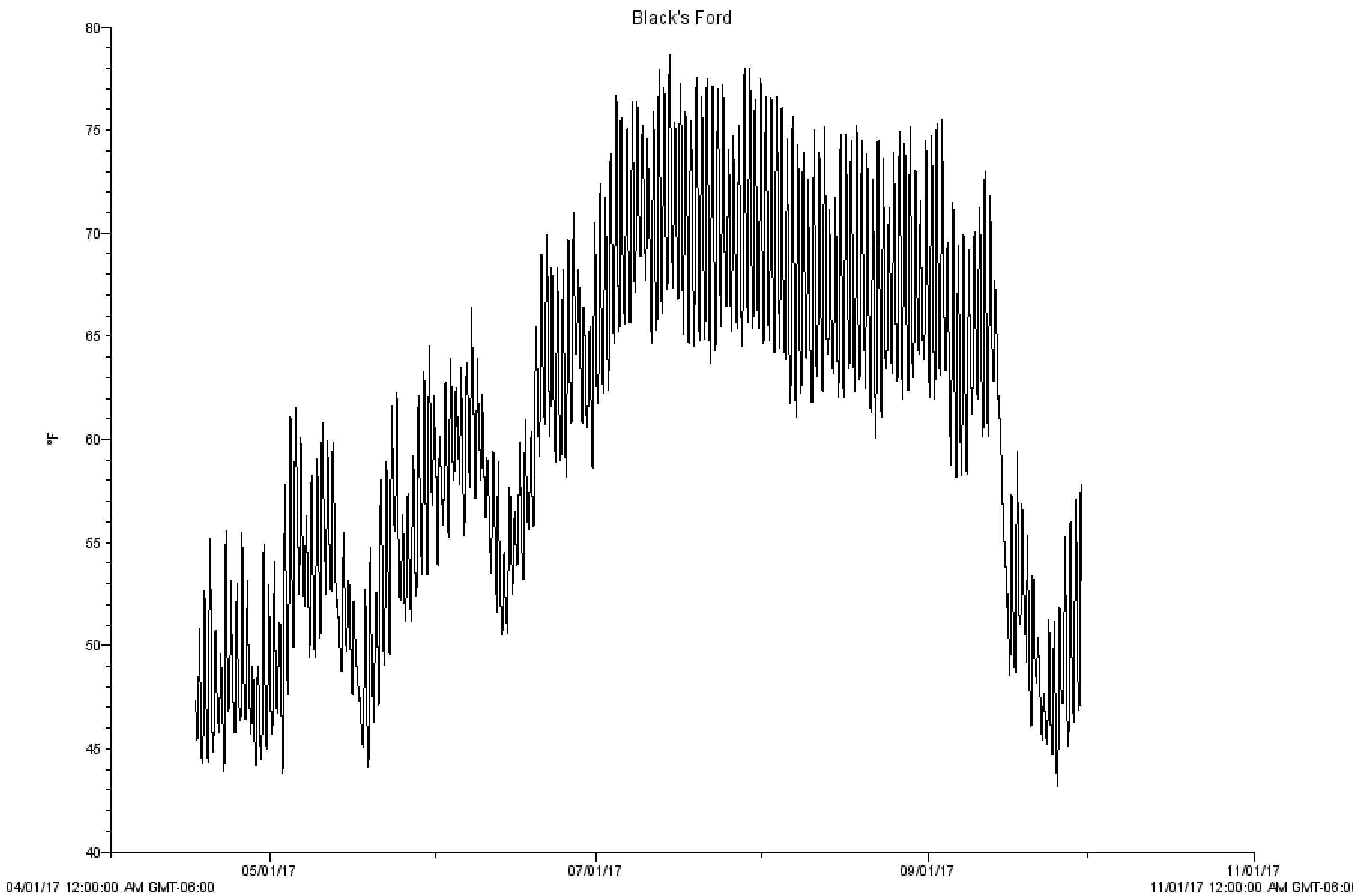
Black's Ford
°F
80
75
70
65
60
55
50
45
40
04/01/17 12:00:00 AM GMT-06:00
05/01/17
07/01/17
09/01/17
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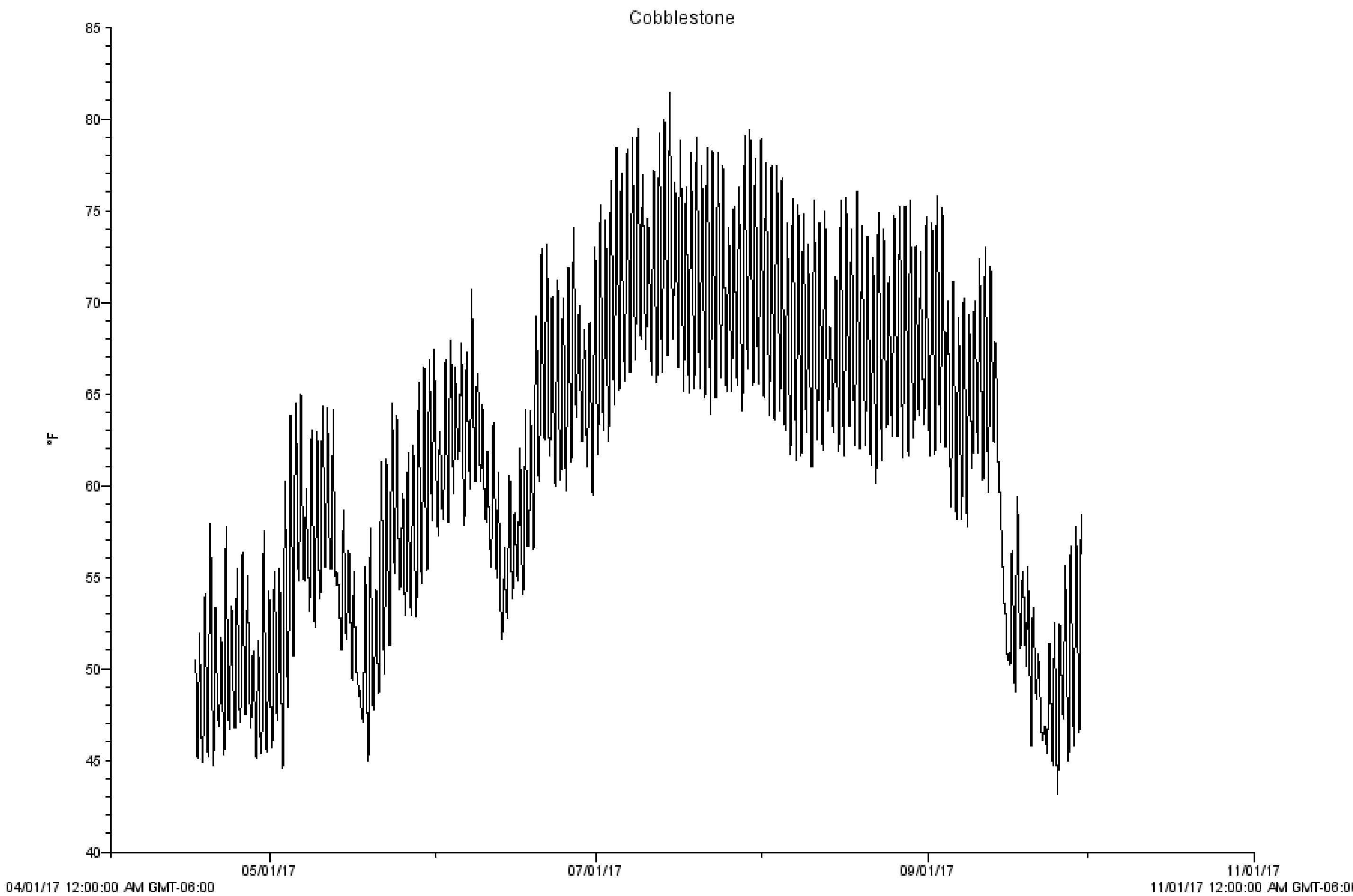
Cobblestone
°F
85
80
75
70
65
60
55
50
45
40
04/01/17 12:00:00 AM GMT-06:00
05/01/17
07/01/17
09/01/17
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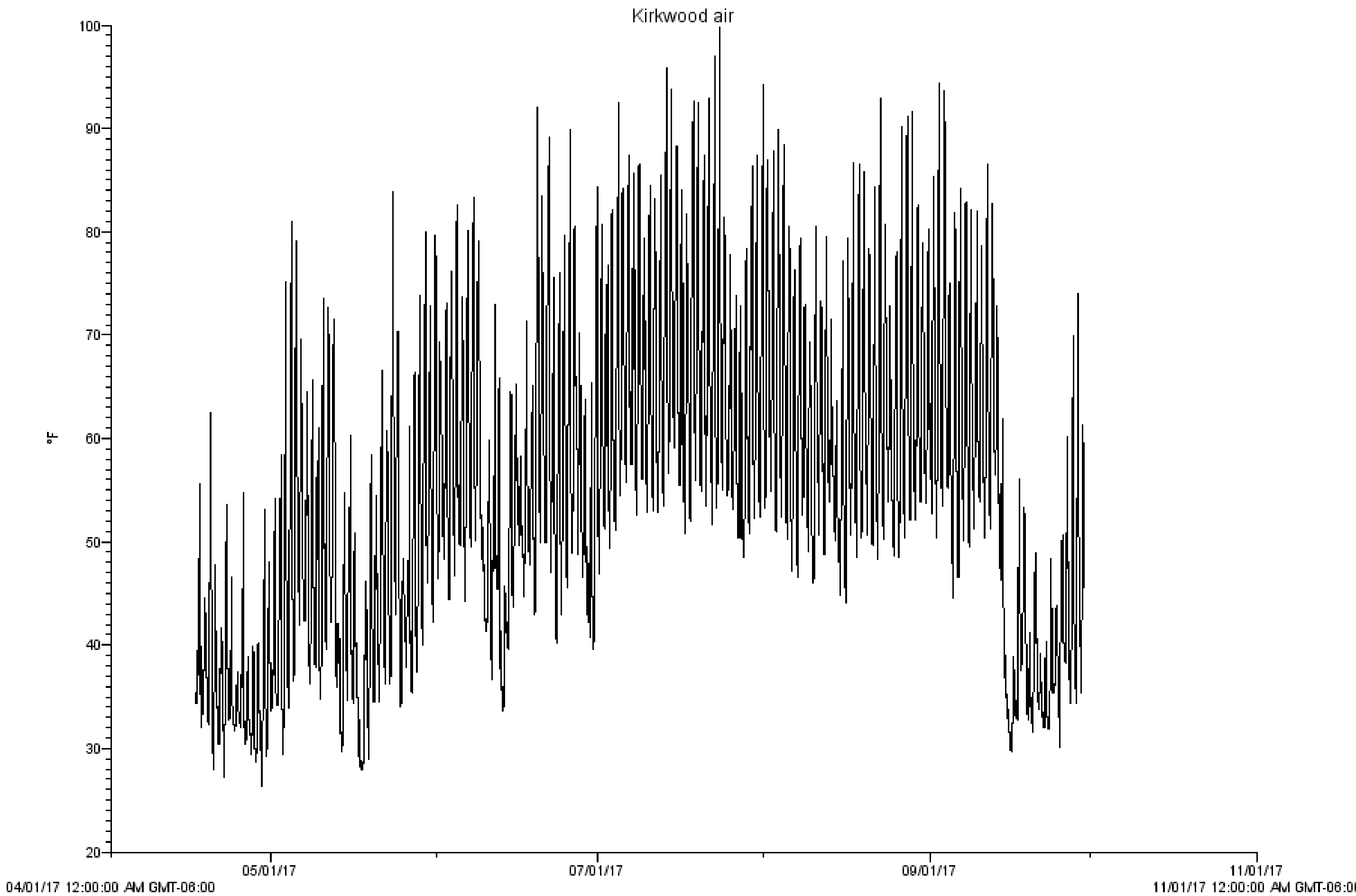
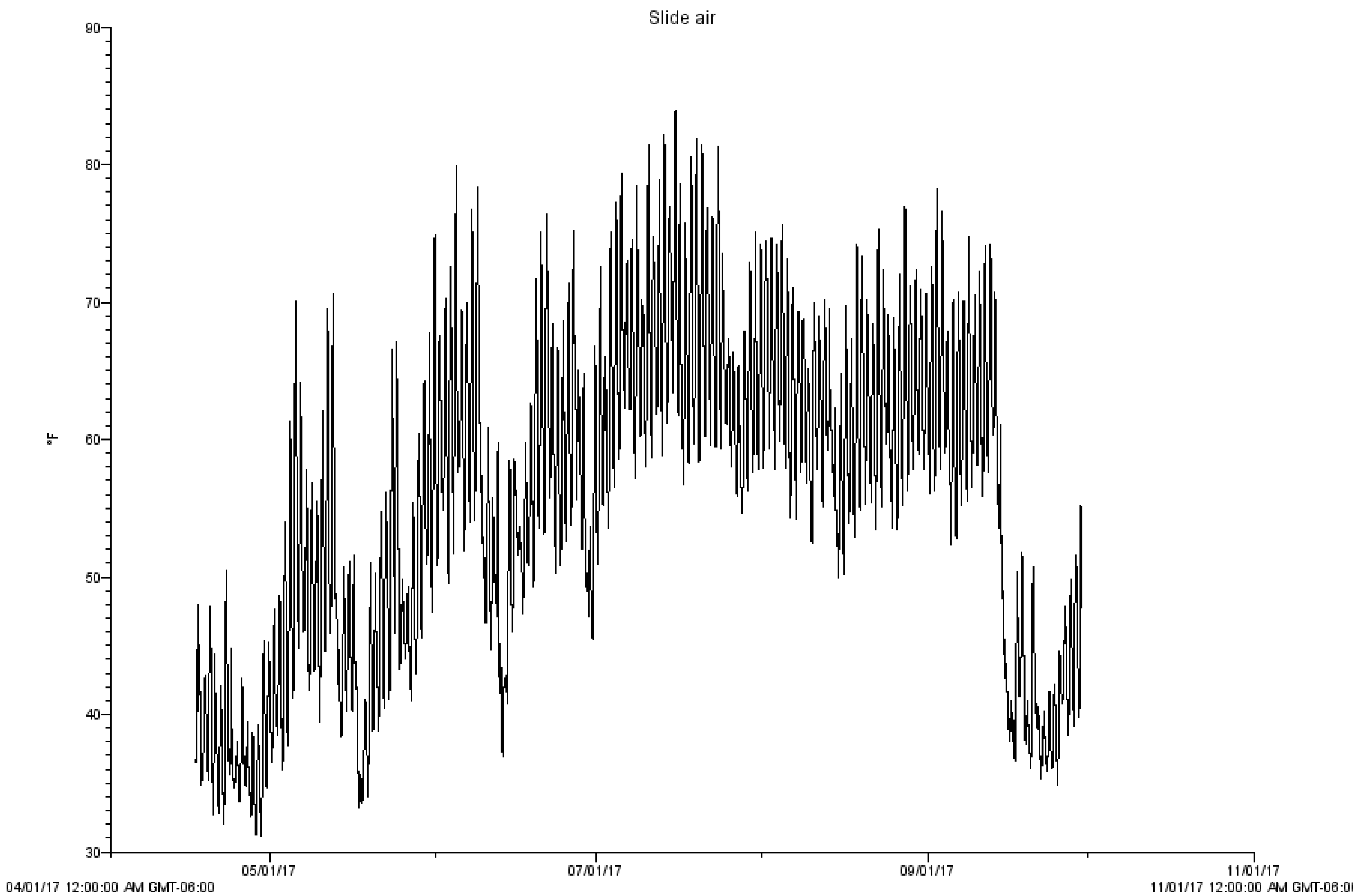

Kirkwood air
°F
100
90
80
70
60
50
40
30
20
05/01/17
07/01/17
09/01/17
11/01/17
04/01/17 12:00:00 AM GMT-06:00
11/01/17 12:00:00 AM GMT-06:00


Slide air
90
80
70
60
50
40
30
°F
04/01/17 12:00:00 AM GMT-06:00
05/01/17
07/01/17
09/01/17
11/01/17
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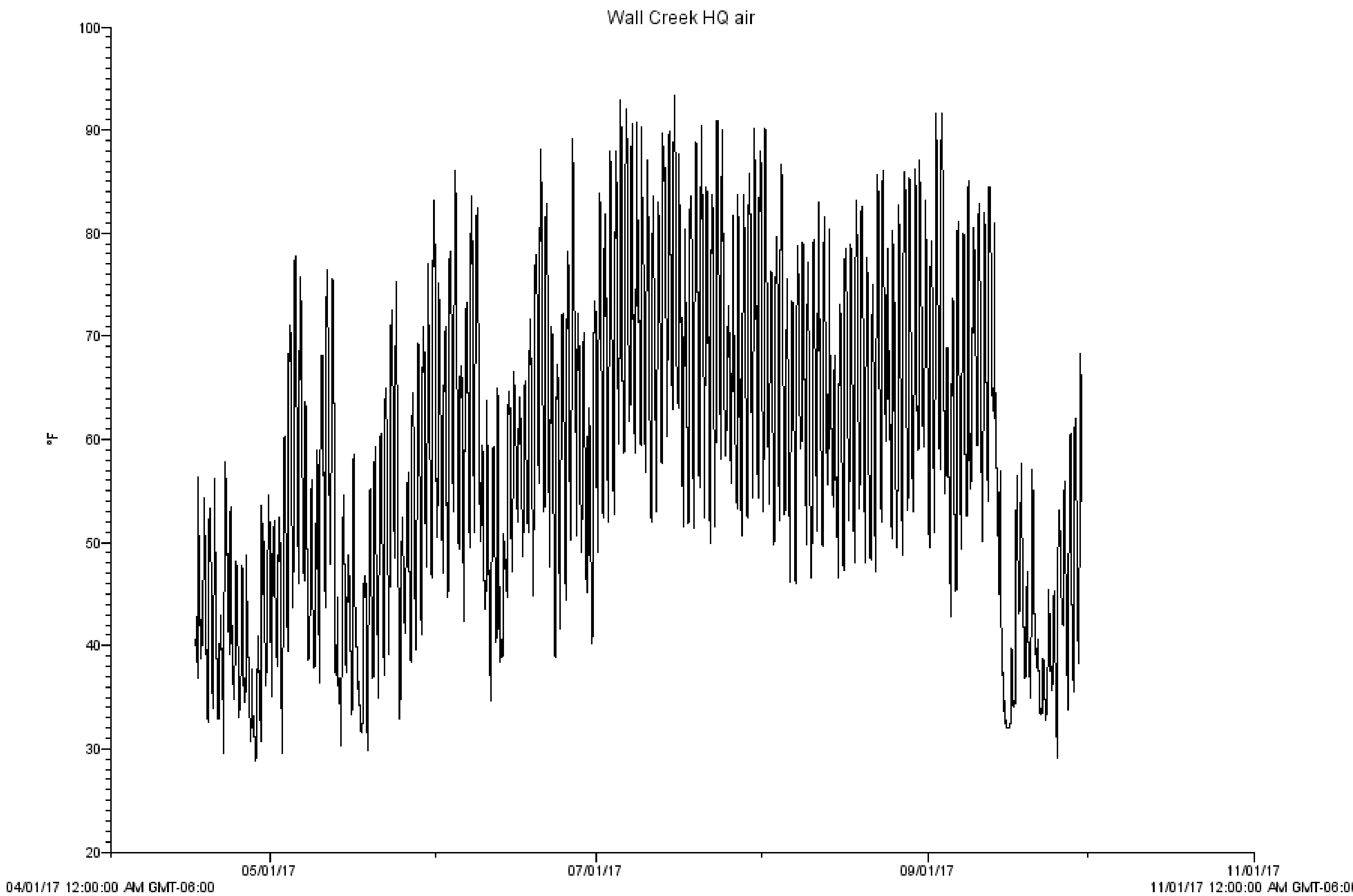

Wall Creek HQ air
100
90
80
70
60
50
40
30
20
°F
05/01/17
07/01/17
09/01/17
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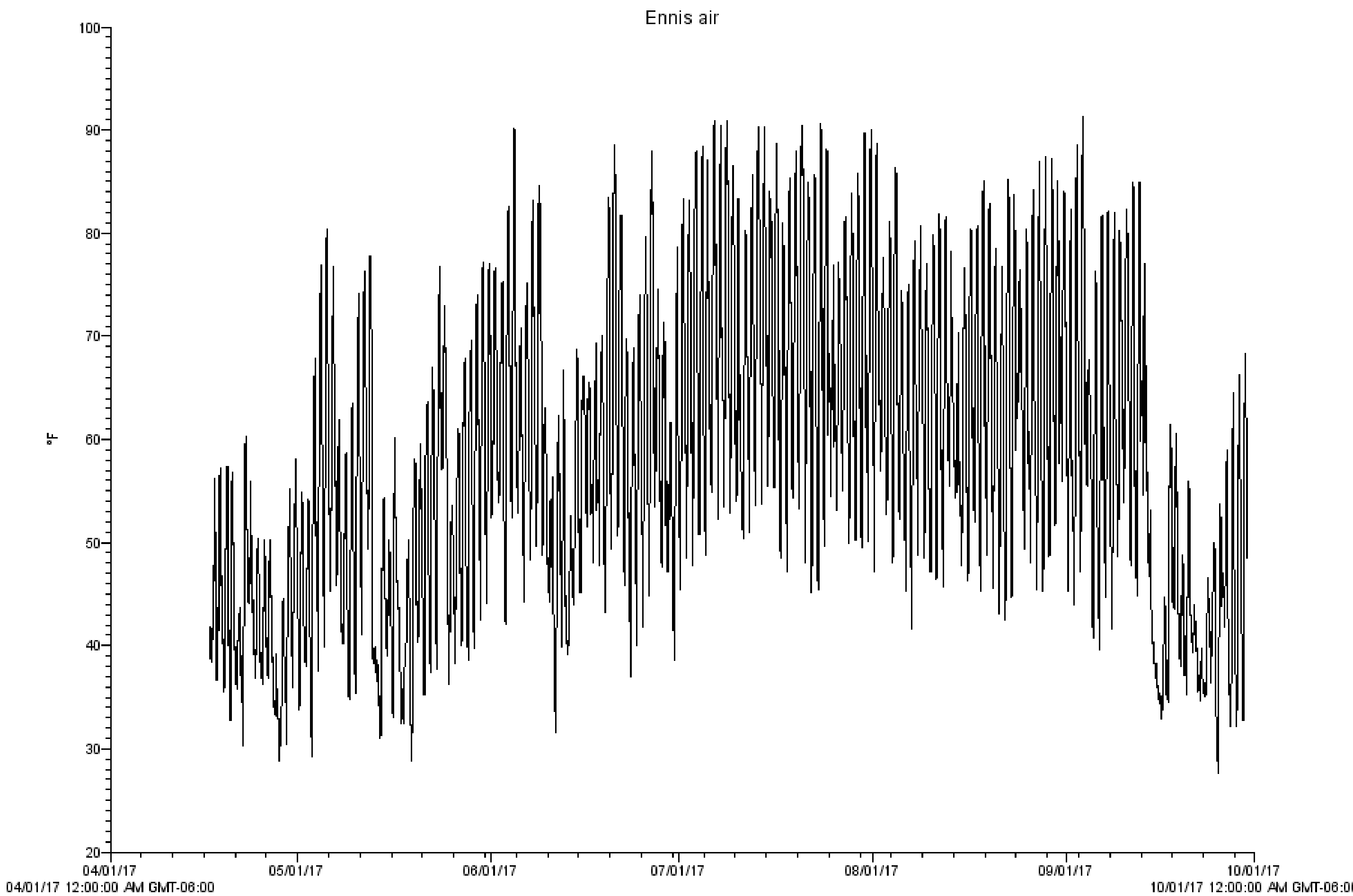
Ennis air
100
90
80
70
60
50
40
30
20
°F
04/01/17
05/01/17
06/01/17
07/01/17
08/01/17
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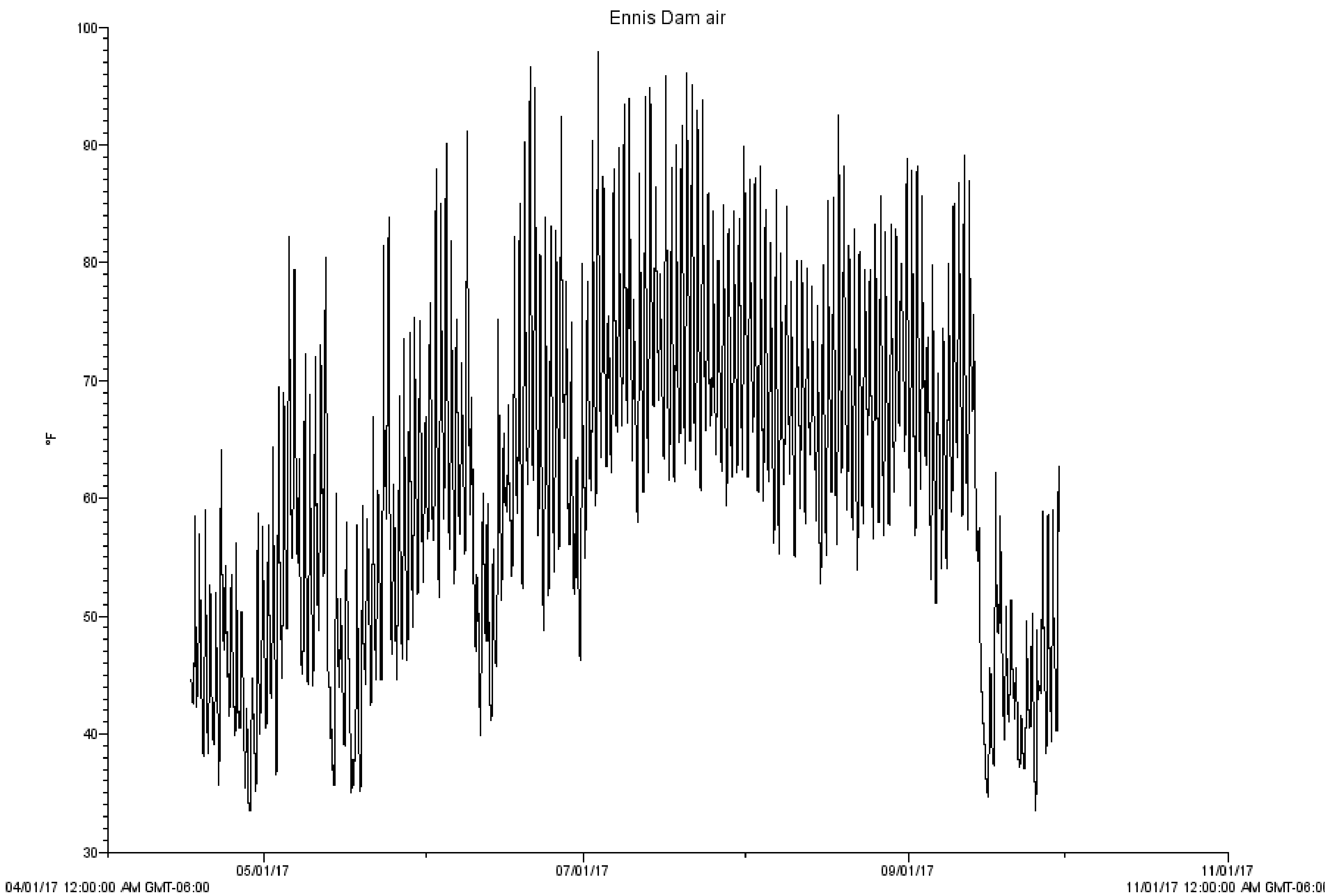
Ennis Dam air
100
90
80
70
60
50
40
30
°F
04/01/17 12:00:00 AM GMT-06:00
05/01/17
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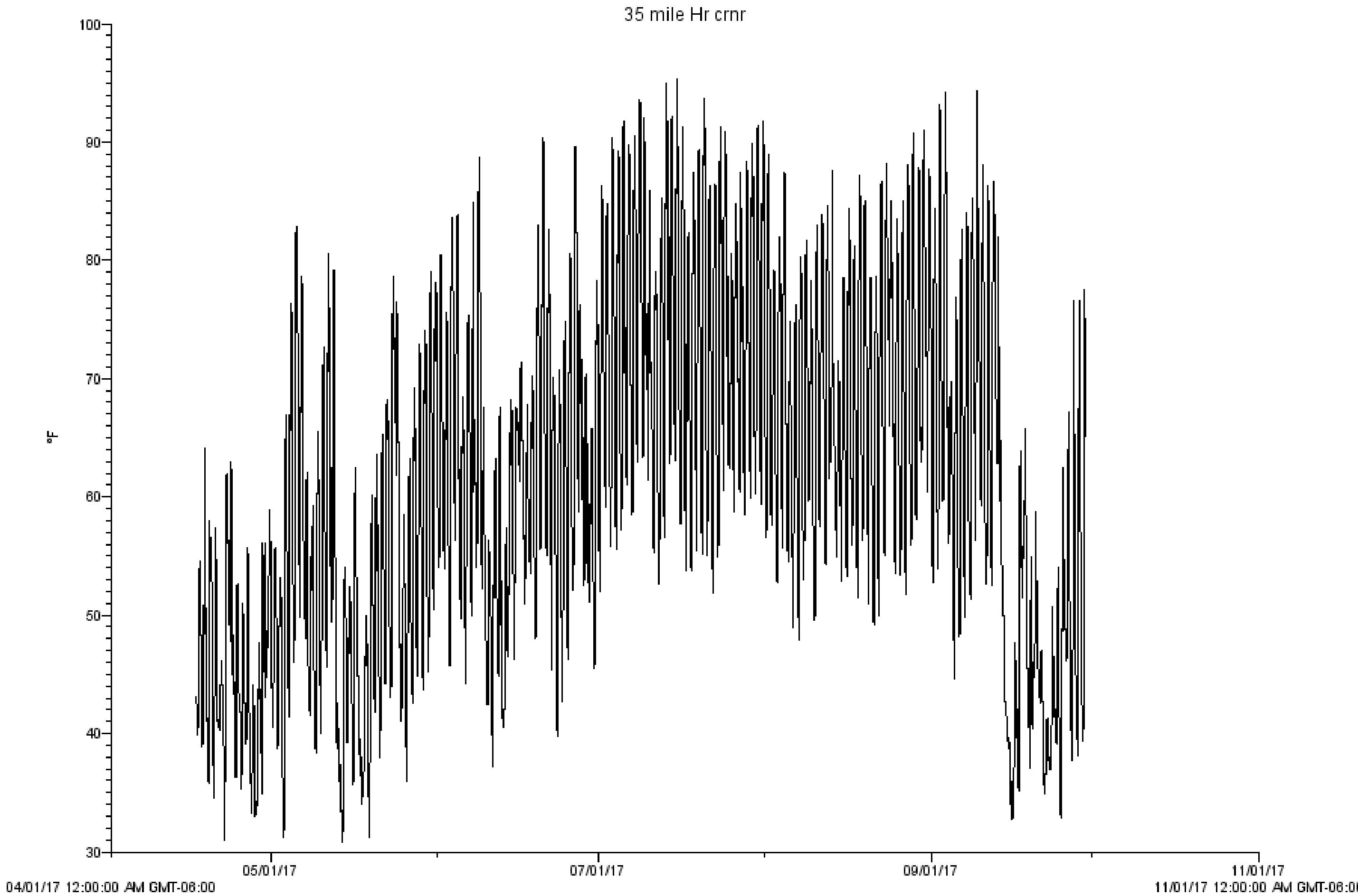
35 mile Hr crnr
°F
100
90
80
70
60
50
40
30
04/01/17 12:00:00 AM GMT-06:00
05/01/17
07/01/17
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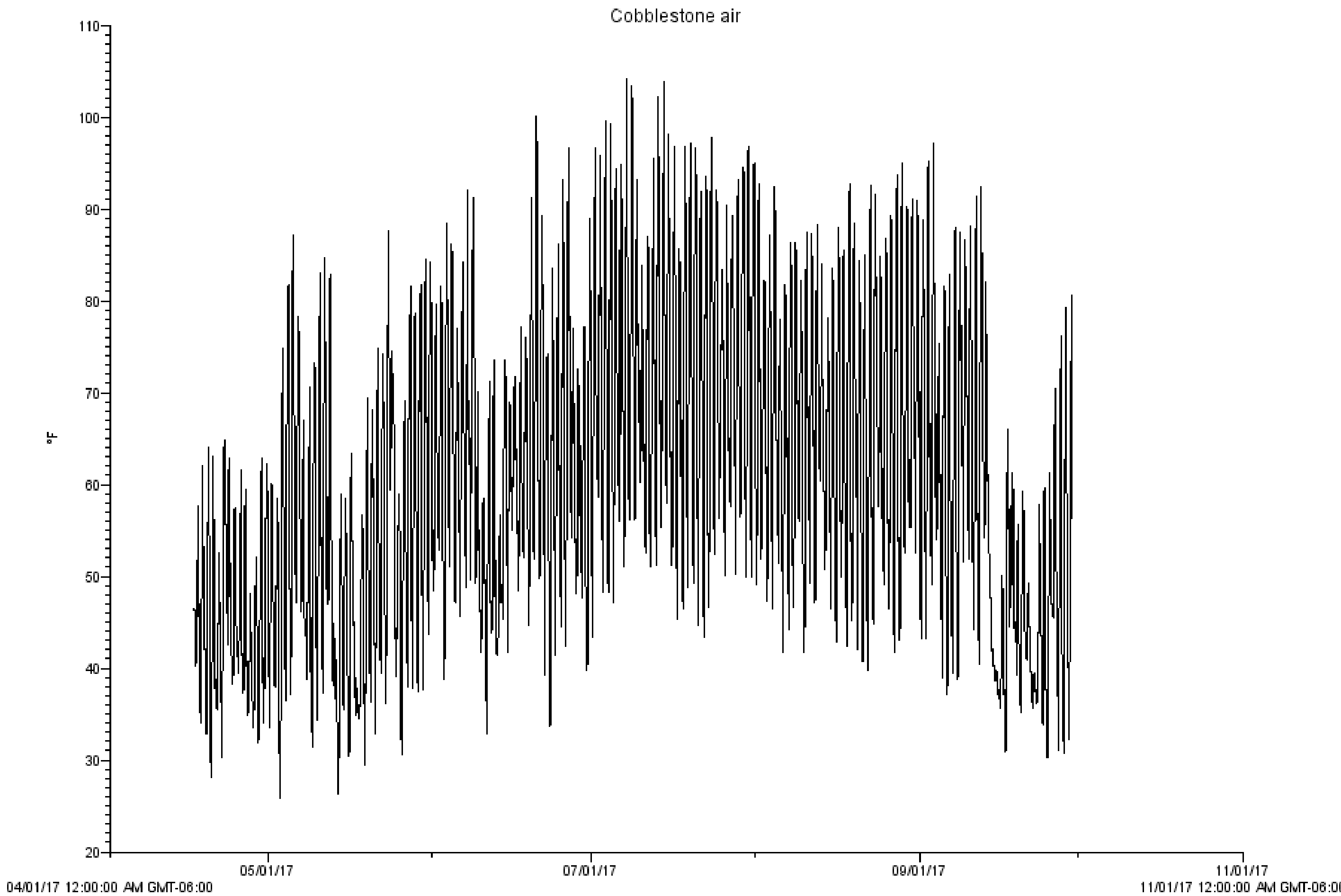

Cobblestone air
°F
110
100
90
80
70
60
50
40
30
20
04/01/17 12:00:00 AM GMT-06:00
05/01/17
07/01/17
09/01/17
11/01/17
11/01/17 12:00:00 AM GMT-06:00

Appendix D1: Maximum Temperature, Selected Sites

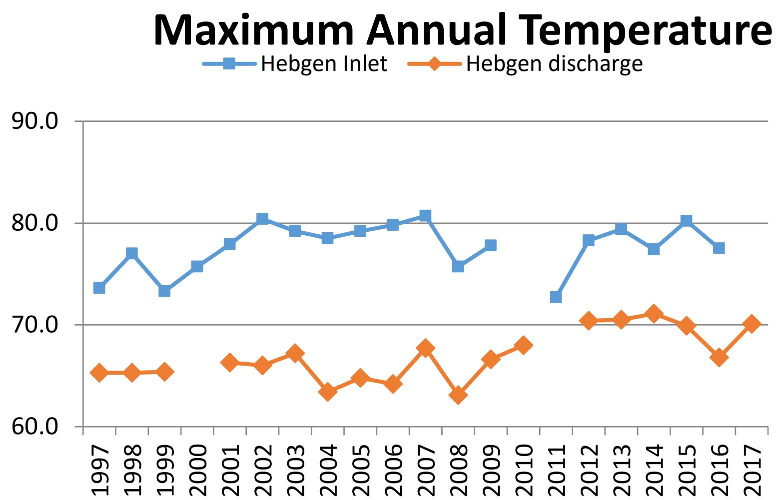
See Figure 10 for locations

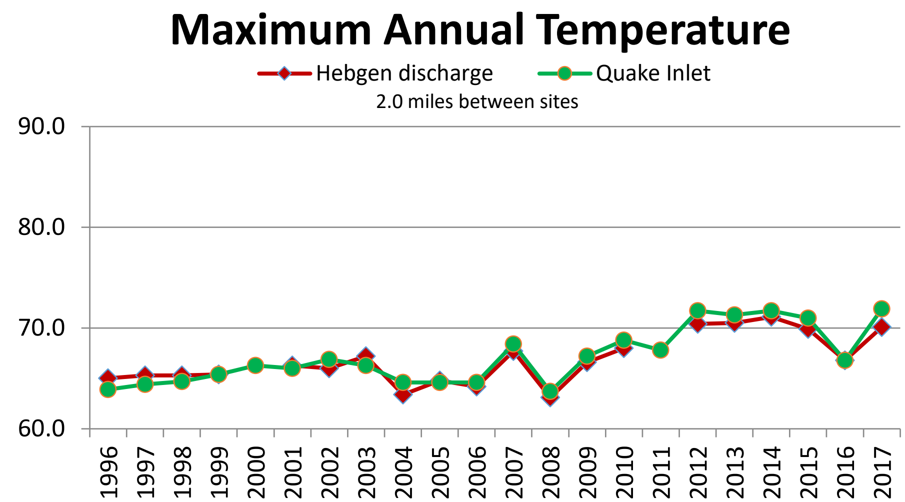
NOTES:

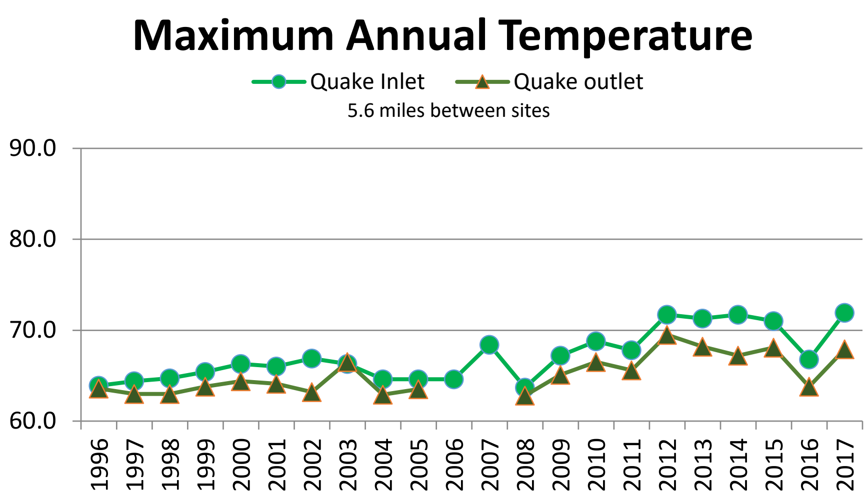
- Recorders at some locations were not recovered some years

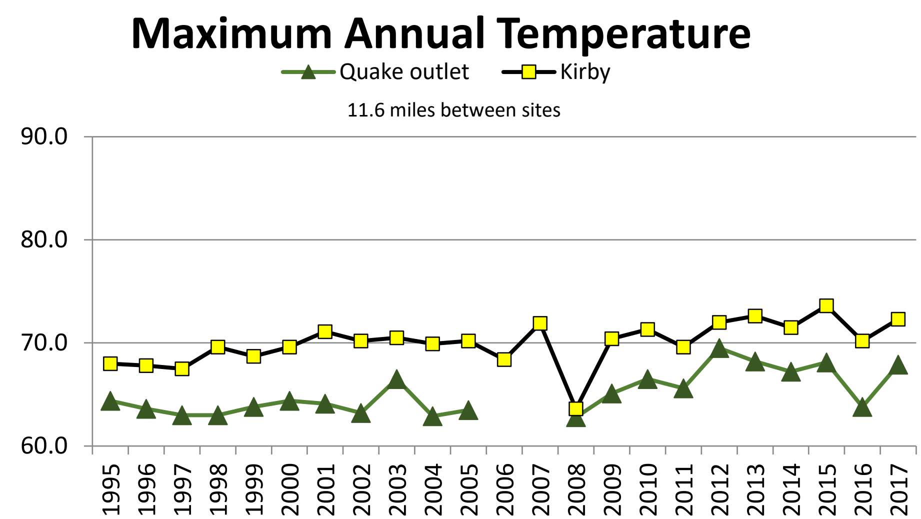
- It is important to note that the maximum temperatures at each site throughout the river did not all occur on the same day in any year, and that the maximum temperature at any given site may have been attained on more than just one day in a year

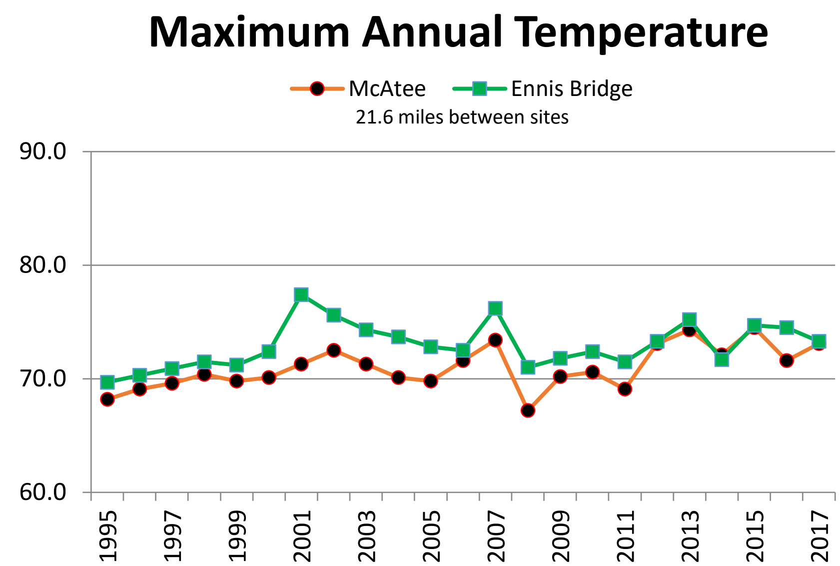
- Pulse flows were conducted out of Ennis Reservoir annually from 2000 – 2007, in 2009, and 2013 - 2017. See report pages 6 and 28


Maximum Annual Temperature
Hebgen Inlet
Hebgen discharge
90.0
80.0
70.0
60.0
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017

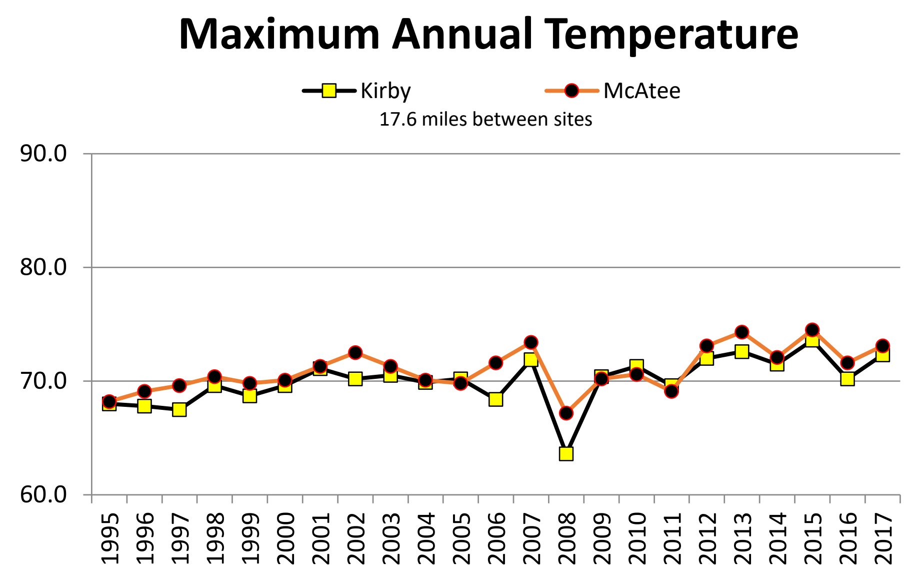

Maximum Annual Temperature
Hebgen discharge
Quake Inlet
2.0 miles between sites
90.0
80.0
70.0
60.0
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017


Maximum Annual Temperature
Quake Inlet
Quake outlet
5.6 miles between sites
90.0
80.0
70.0
60.0
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017

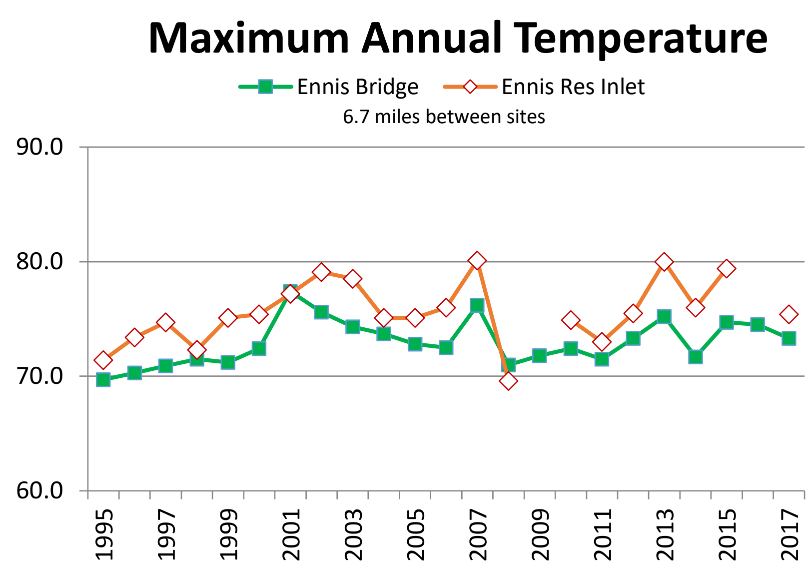

Maximum Annual Temperature
Quake outlet
Kirby
11.6 miles between sites
90.0
80.0
70.0
60.0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017



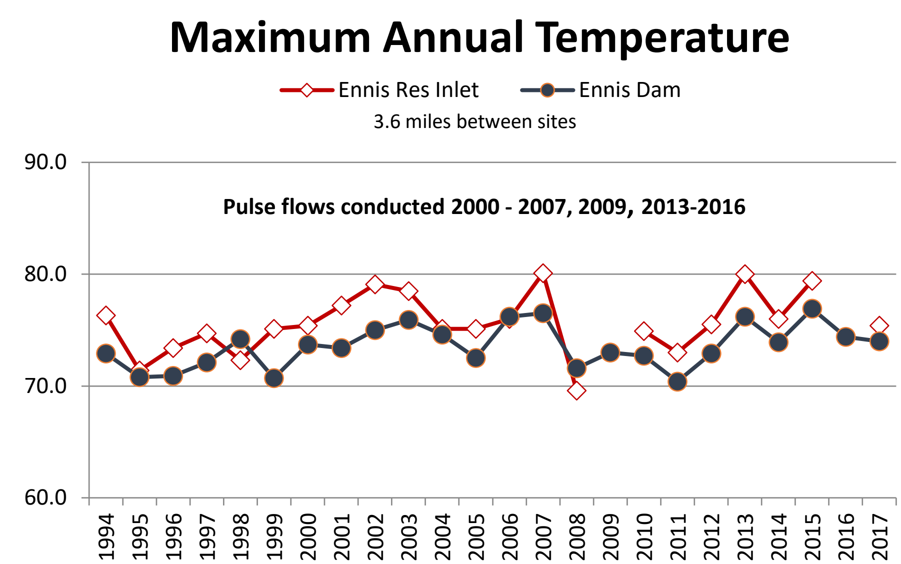
Maximum Annual Temperature
McAtee
Ennis Bridge
21.6 miles between sites
90.0
80.0
70.0
60.0
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017



Maximum Annual Temperature
Kirby
McAtee
17.6 miles between sites
90.0
80.0
70.0
60.0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017



Maximum Annual Temperature
Ennis Bridge
Ennis Res Inlet
6.7 miles between sites
90.0
80.0
70.0
60.0
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017



Maximum Annual Temperature
Ennis Res Inlet
Ennis Dam
3.6 miles between sites
Pulse flows conducted 2000 - 2007, 2009, 2013-2016
90.0
80.0
70.0
60.0
1994
1995
1996
1997
1998
1999
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2002
2003
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2005
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2007
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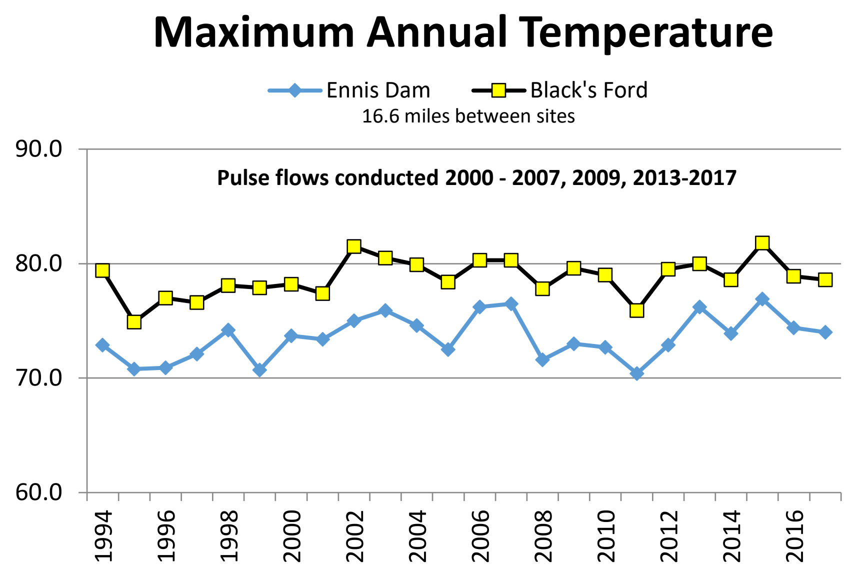
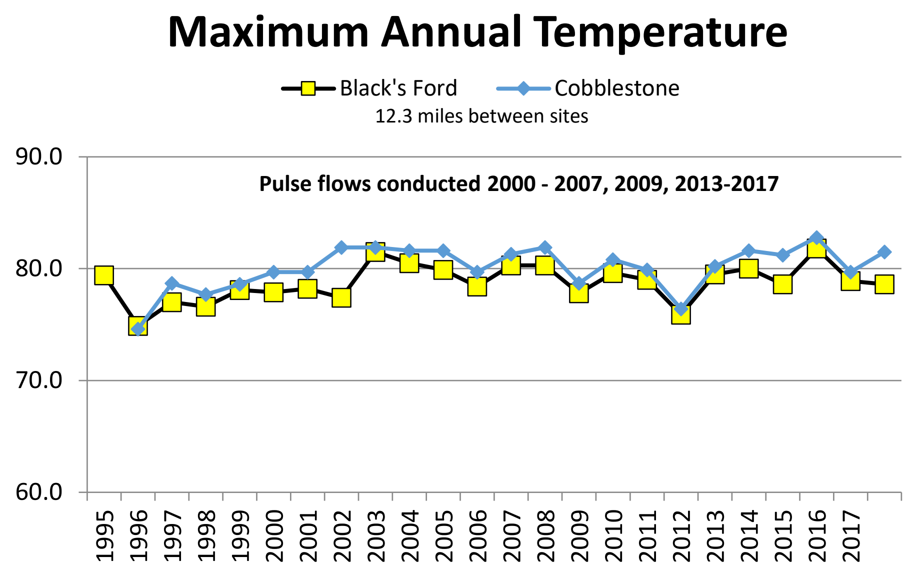
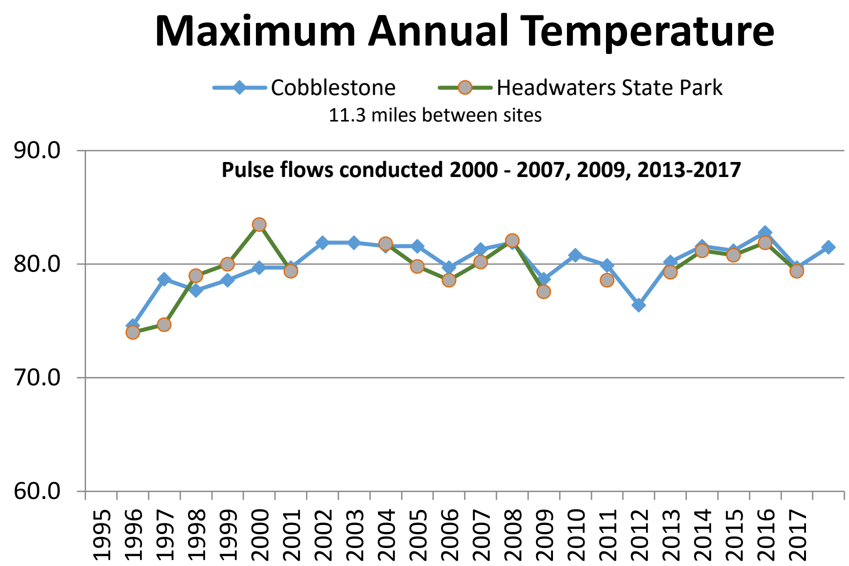
2013
2014
2015
2016
2017



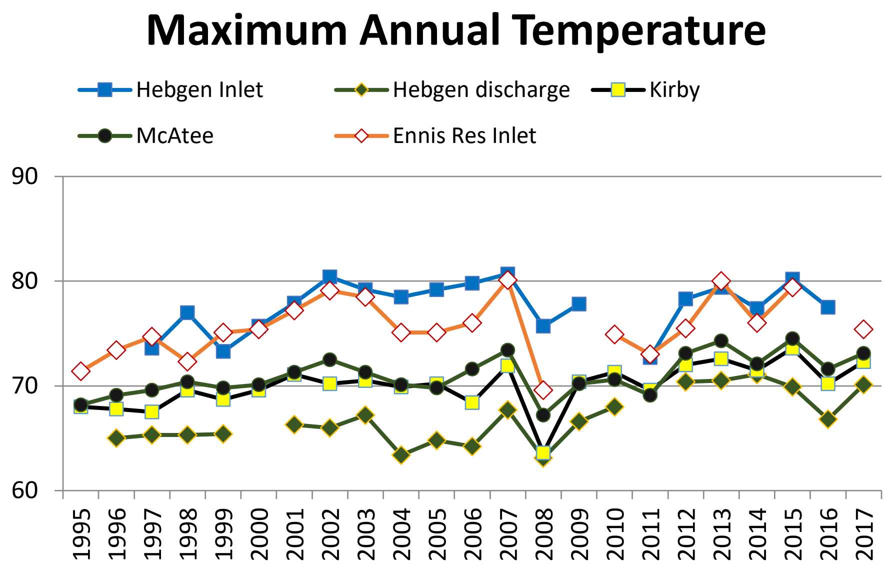
Maximum Annual Temperature
Ennis Dam
Black's Ford
16.6 miles between sites
Pulse flows conducted 2000 - 2007, 2009, 2013-2017
90.0
80.0
70.0
60.0
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

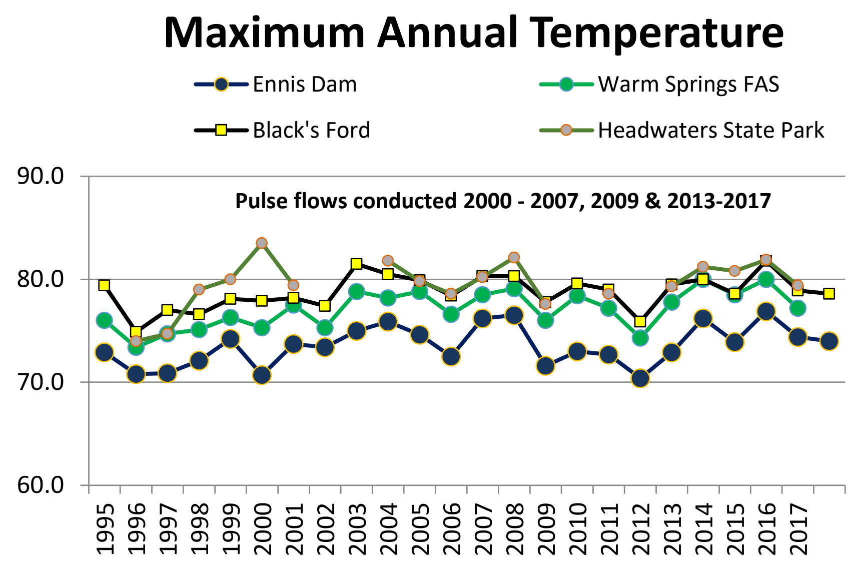


Maximum Annual Temperature
Black's Ford
Cobblestone
12.3 miles between sites
Pulse flows conducted 2000 - 2007, 2009, 2013-2017
90.0
80.0
70.0
60.0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017



Appendix Figures D-1. Longitudinal maximum temperature profiles moving downstream at Madison River monitoring sites.





Appendix Figure D-2. Maximum annual temperatures from Madison River monitoring sites (upper river sites on left, lower on right).

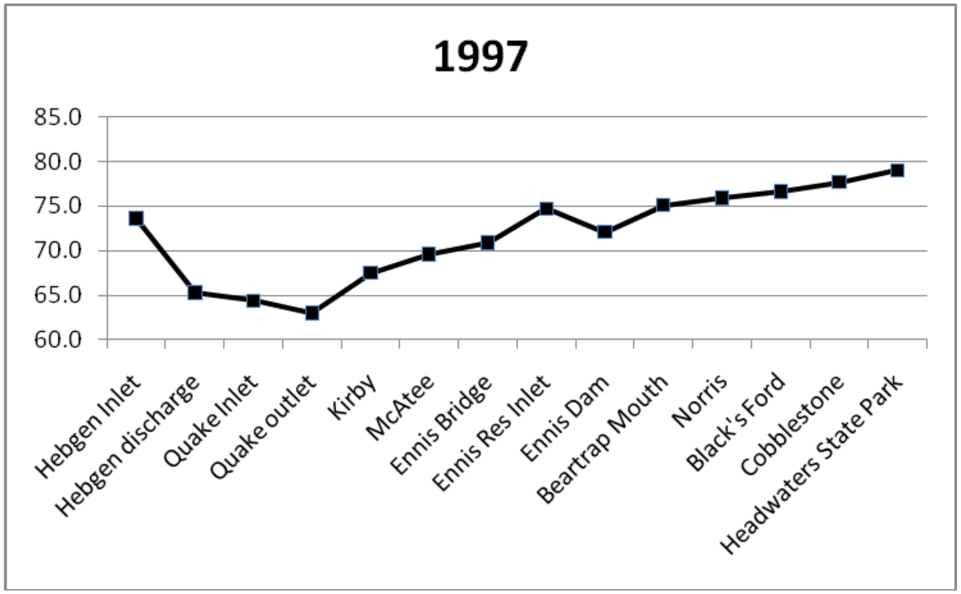
Appendix D2: Max Water Temperatures - Upstream to Downstream, 1997 - 2017

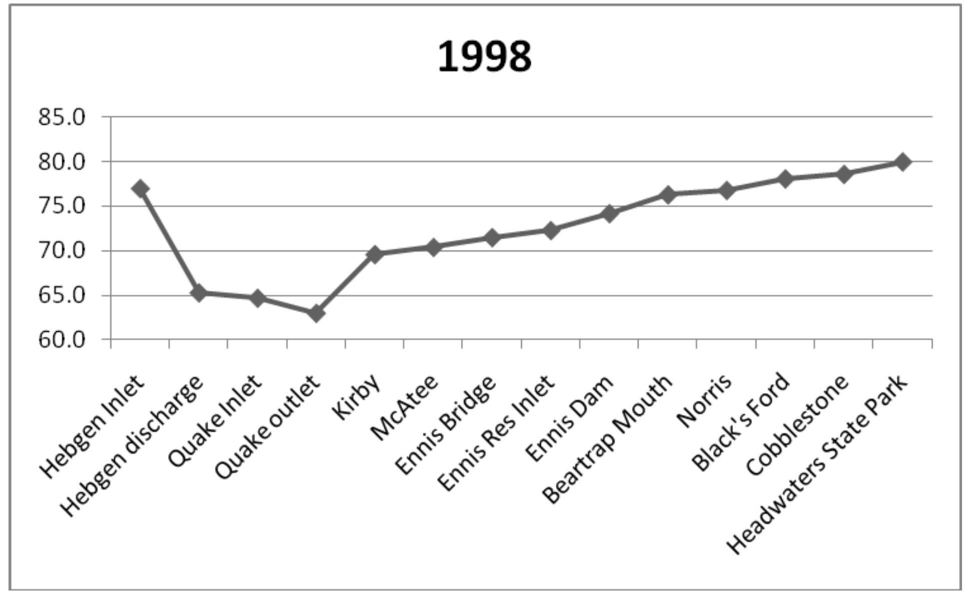
See Figure 10 for locations

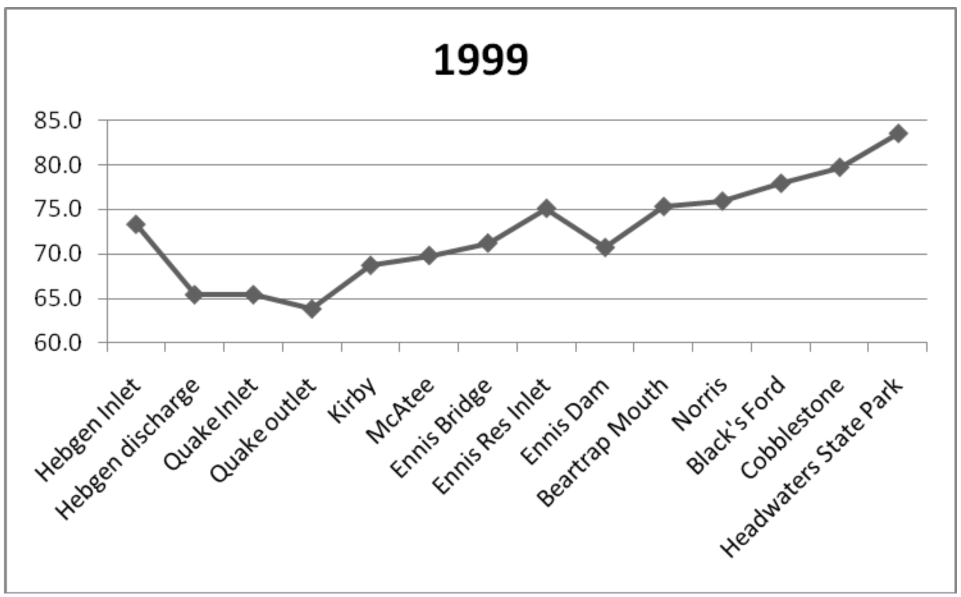
NOTES:

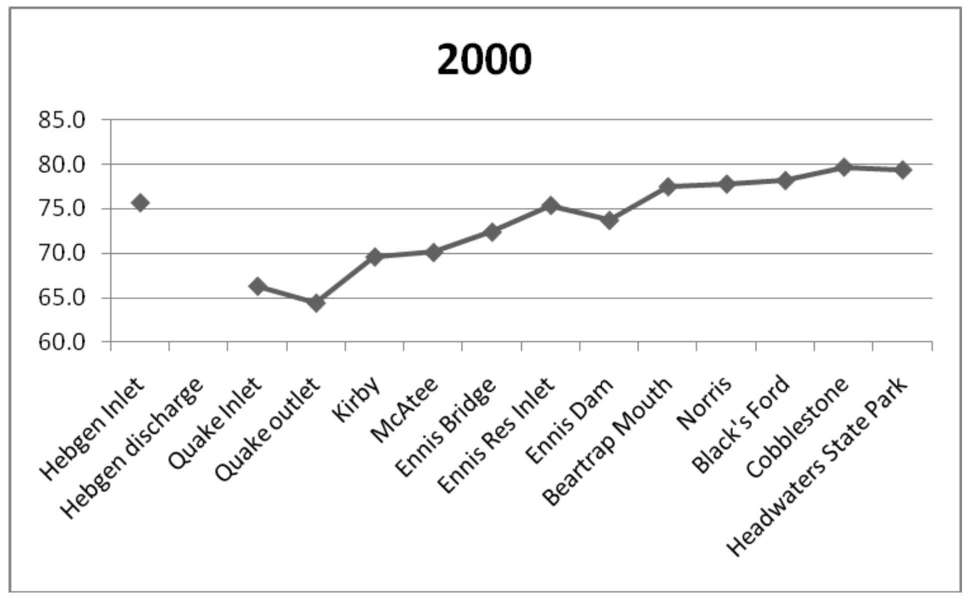
- Recorders at some locations were not recovered some years

- It is important to note that the maximum temperatures at each site throughout the river did not all occur on the same day in any year, and that the maximum temperature at any given site may have been attained on more than just one day in a year


1997
85.0
80.0
75.0
70.0
65.0
60.0
Hebgen Inlet
Hebgen discharge
Quake Inlet
Quake outlet
Kirby
McAtee
Ennis Bridge
Ennis Res Inlet
Ennis Dam
Beartrap Mouth
Norris
Black's Ford
Cobblestone
Headwaters State Park


1998
85.0
80.0
75.0
70.0
65.0
60.0
Hebgen Inlet
Hebgen discharge
Quake Inlet
Quake outlet
Kirby
McAtee
Ennis Bridge
Ennis Res Inlet
Ennis Dam
Beartrap Mouth
Norris
Black's Ford
Cobblestone
Headwaters State Park


1999
85.0
80.0
75.0
70.0
65.0
60.0
Hebgen Inlet
Hebgen discharge
Quake Inlet
Quake outlet
Kirby
McAtee
Ennis Bridge
Ennis Res Inlet
Ennis Dam
Beartrap Mouth
Norris
Black's Ford
Cobblestone
Headwaters State Park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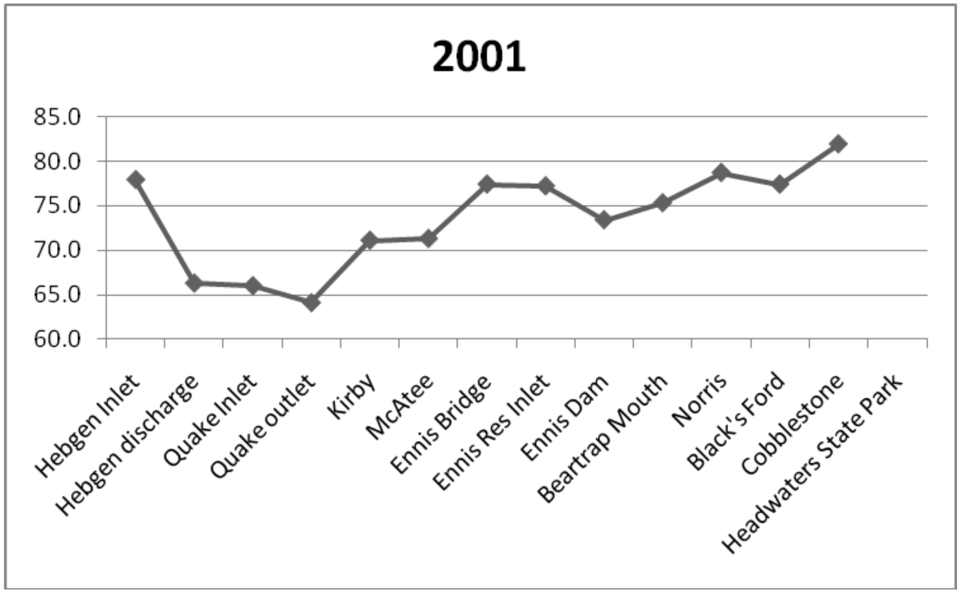
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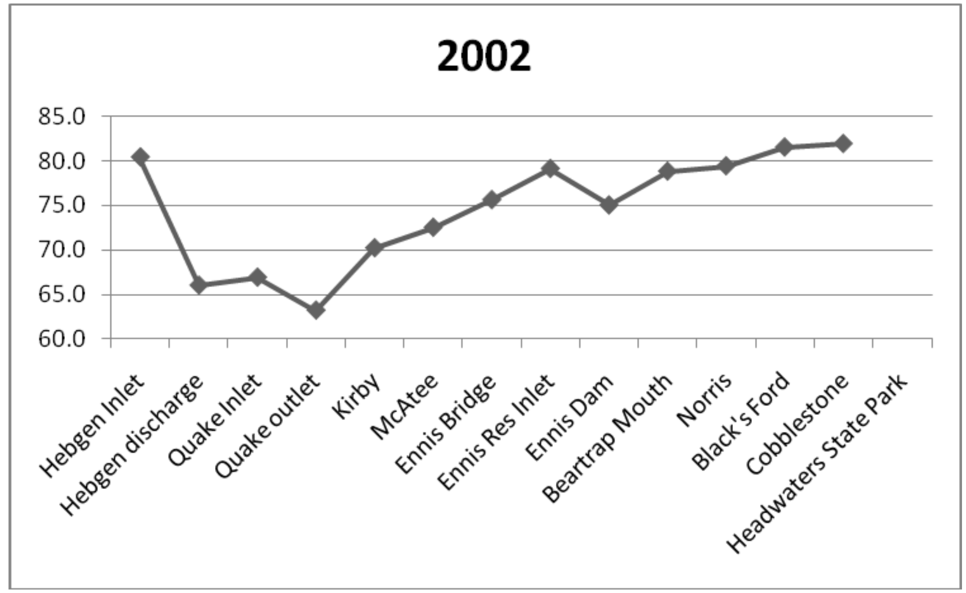
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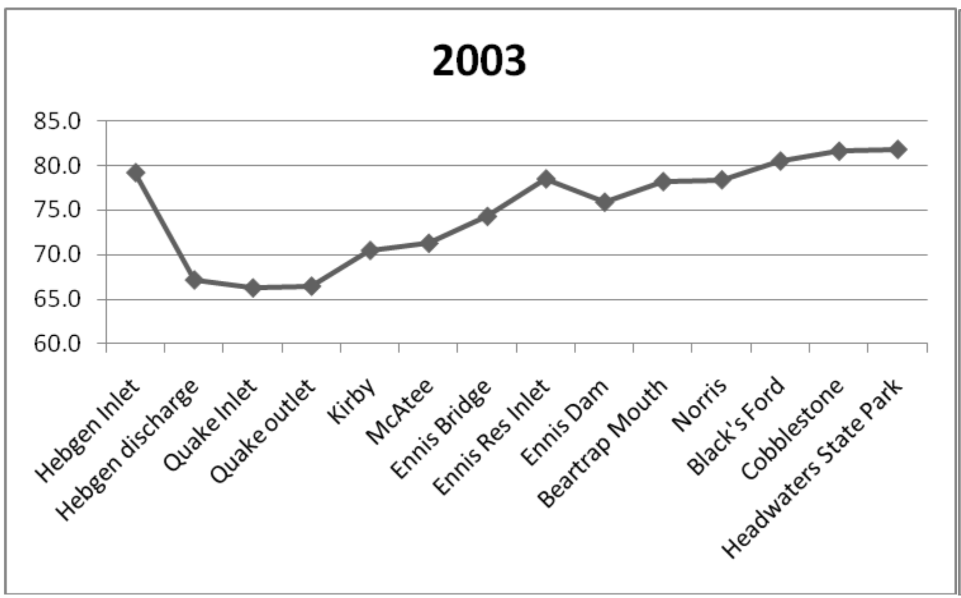
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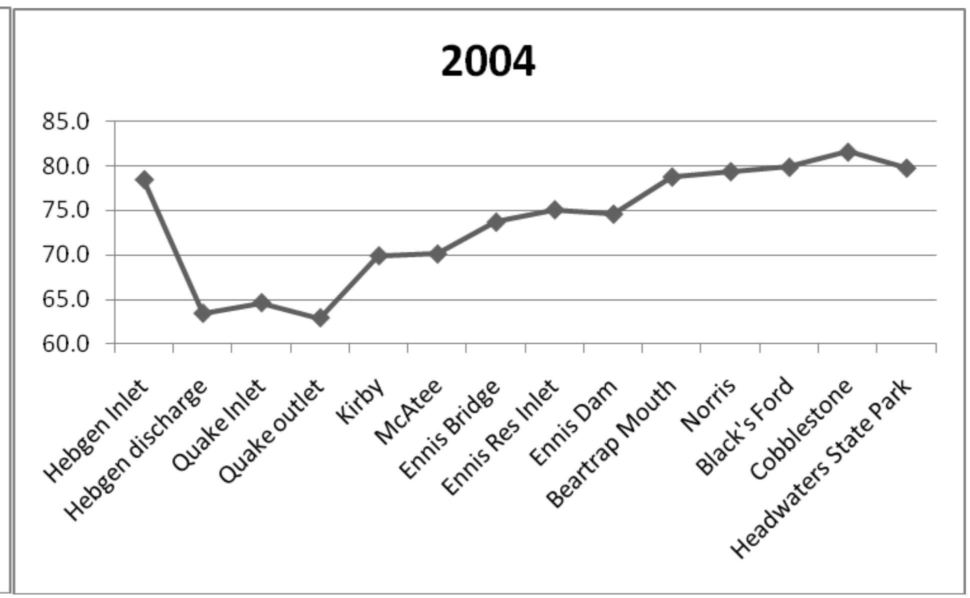
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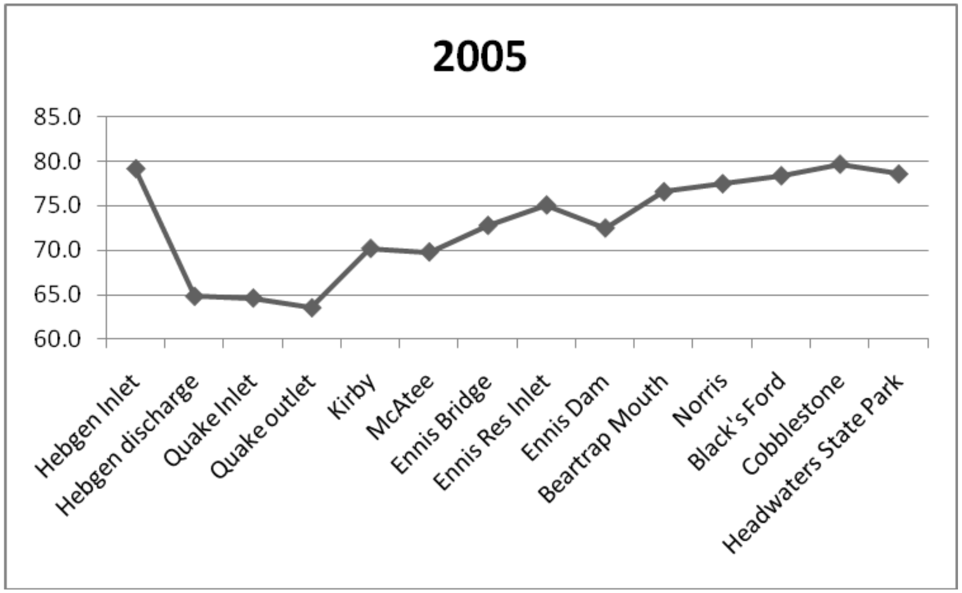
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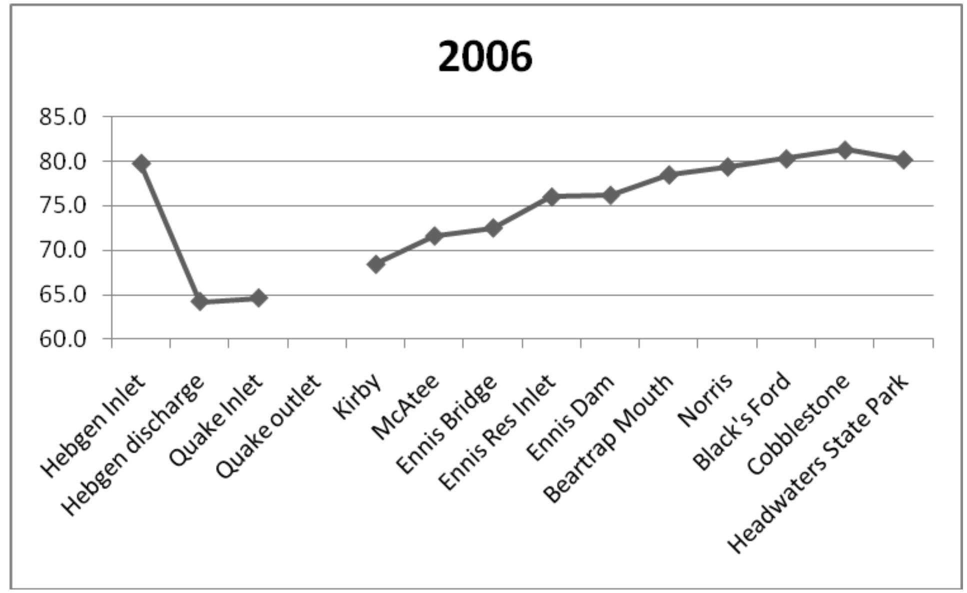
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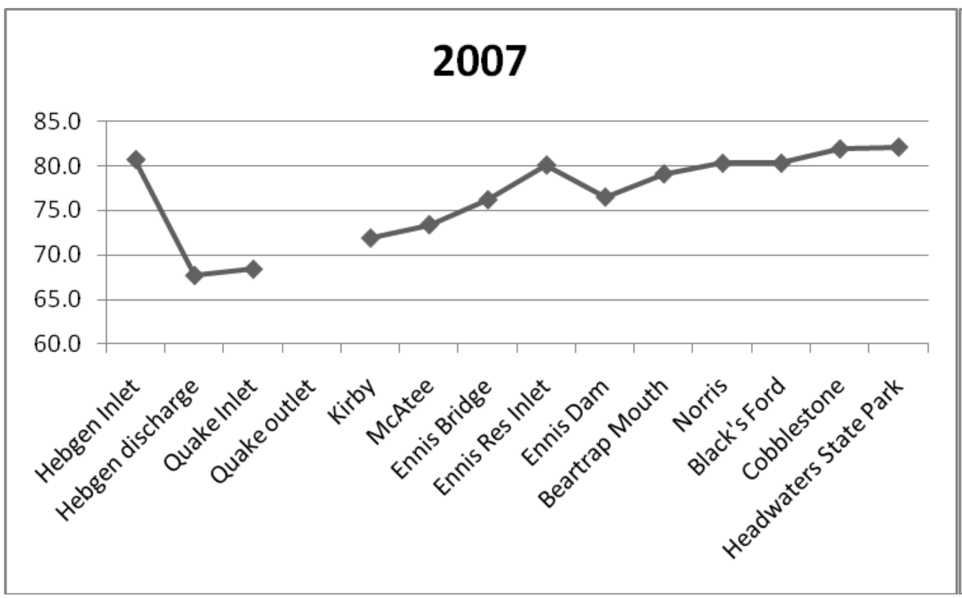
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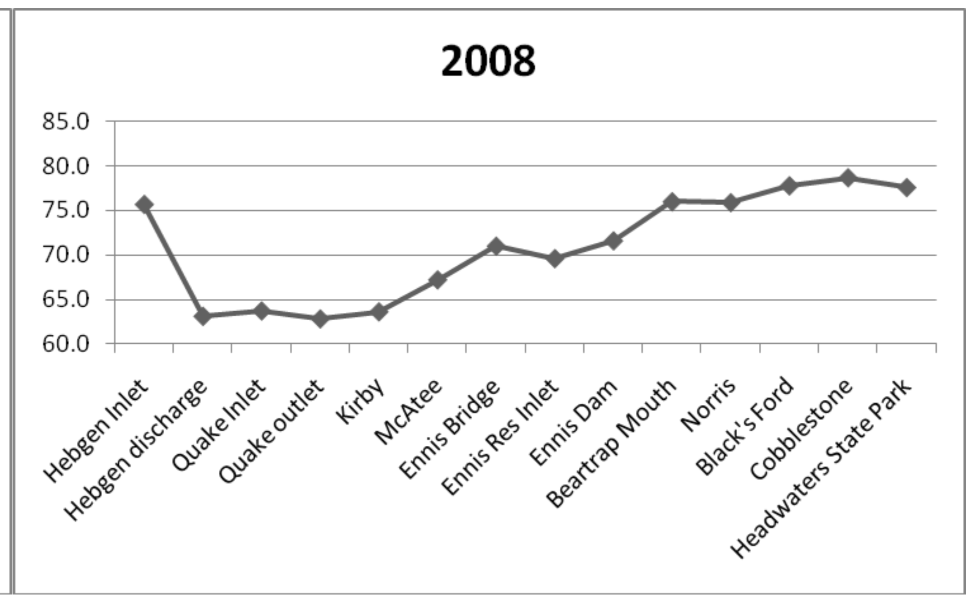
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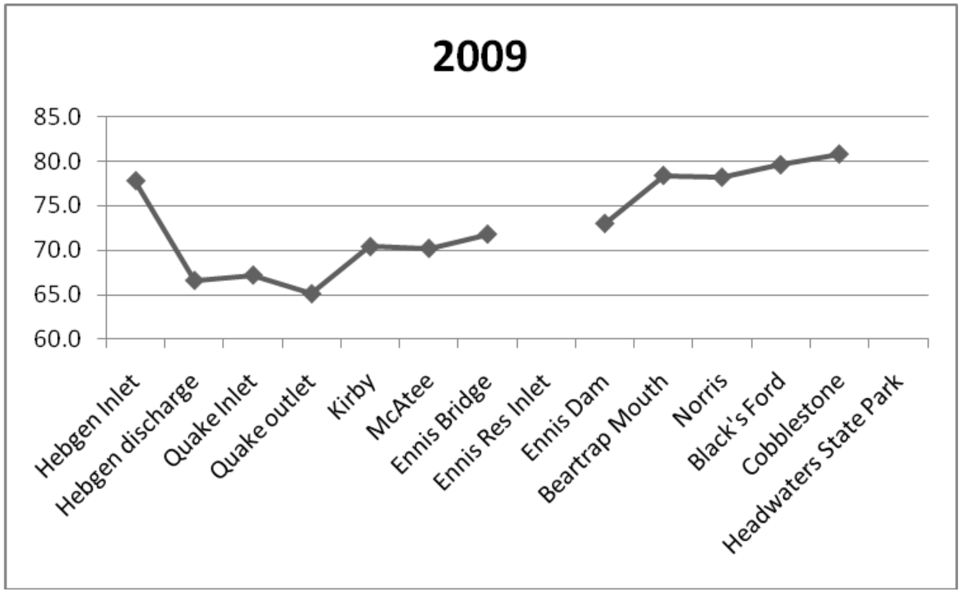
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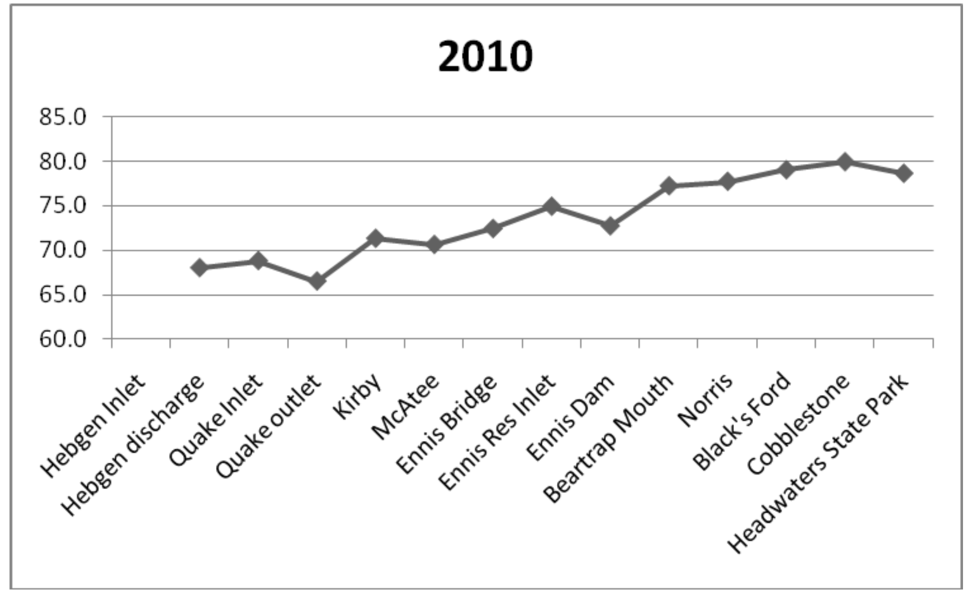
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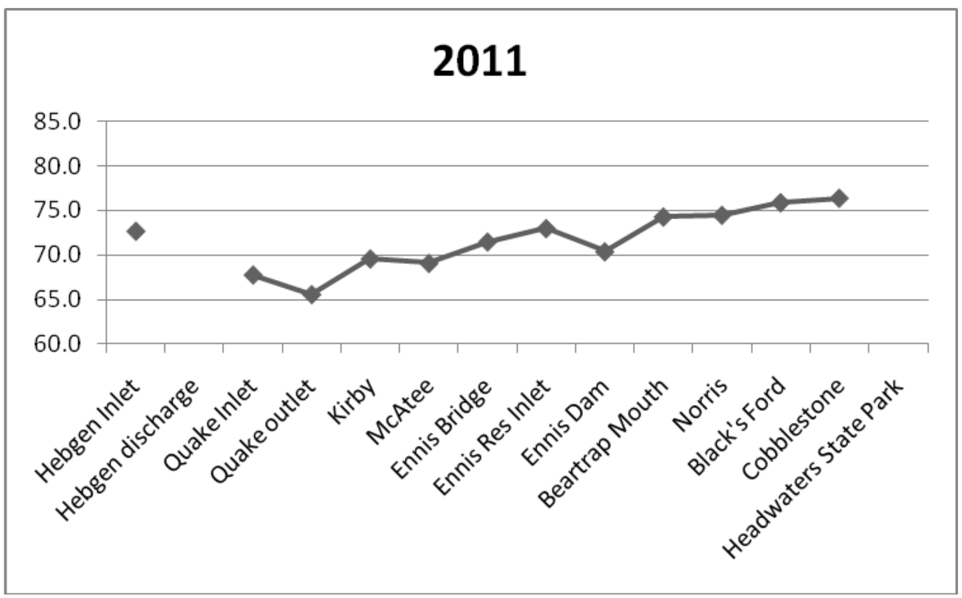
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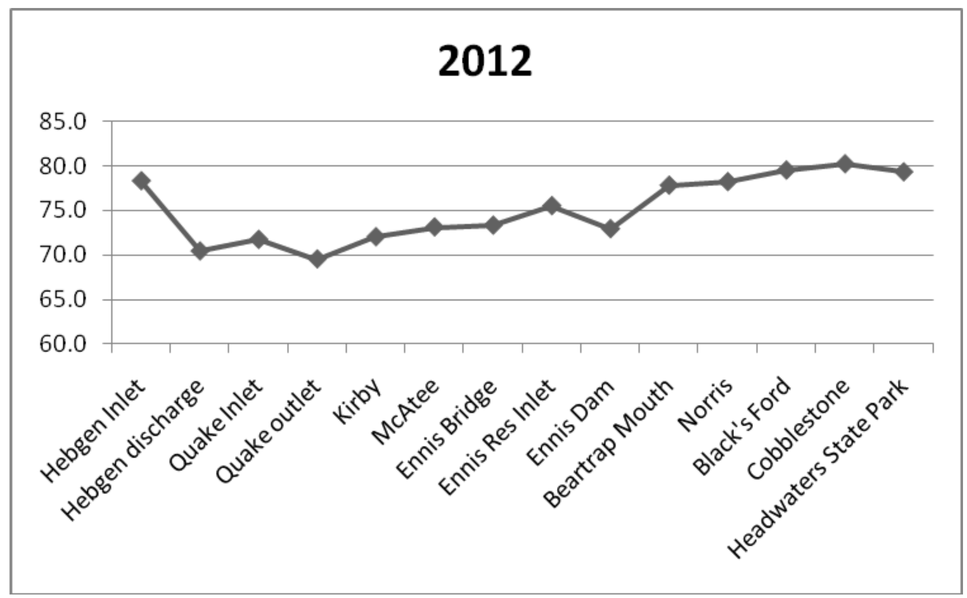
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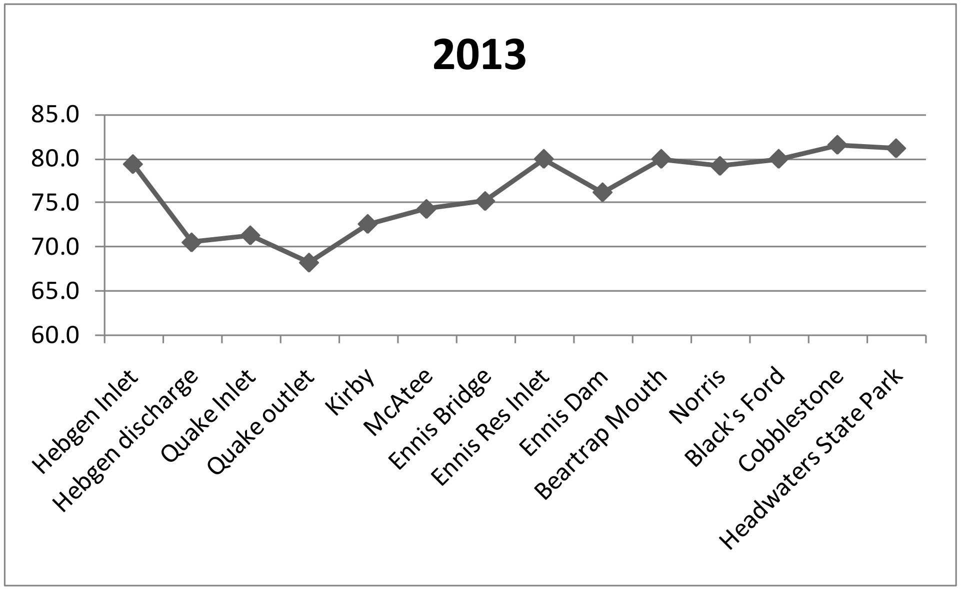
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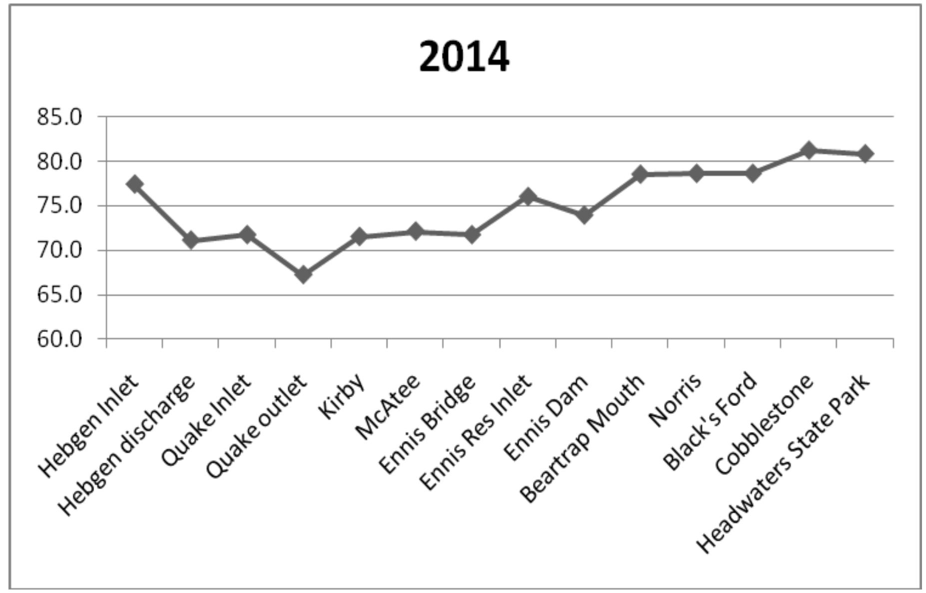
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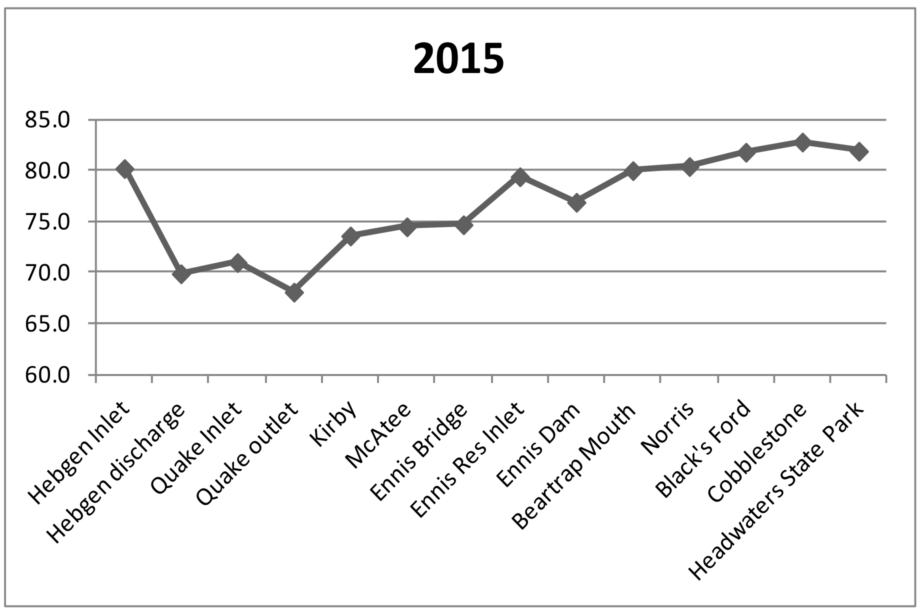
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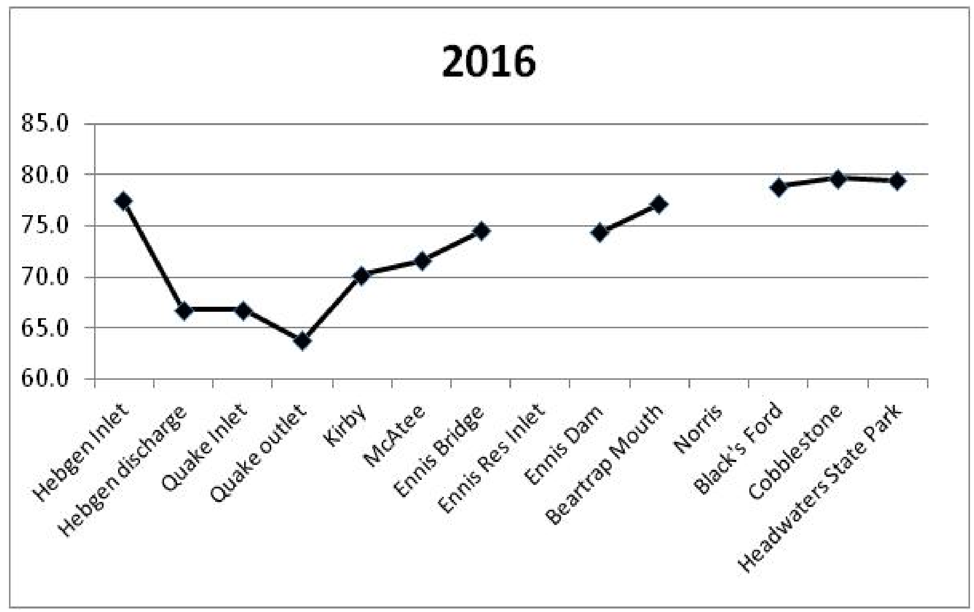
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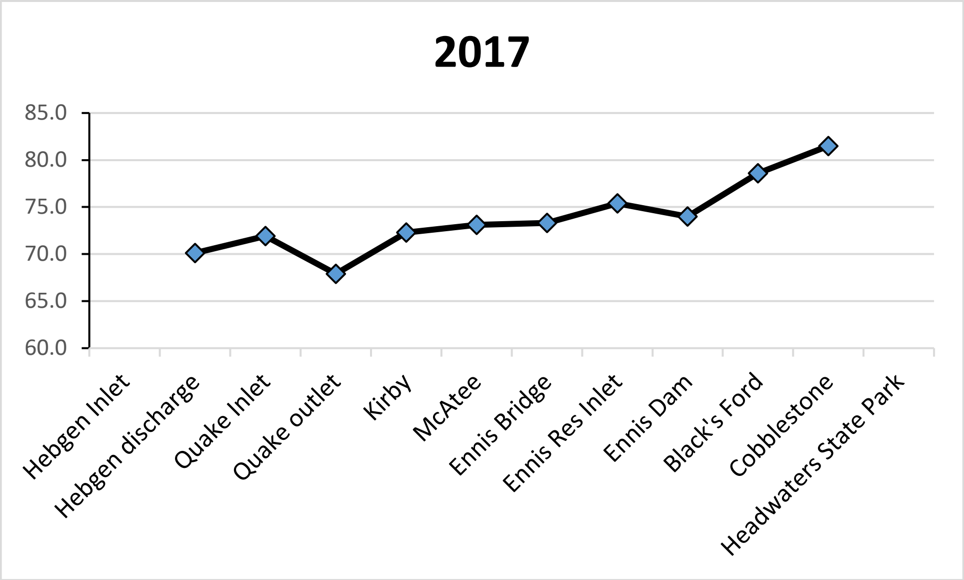


Appendix Figures D-1. Maximum Water Temperatures at Madison River Monitoring Sites 1997-2017.

Appendix E: National Forests Monitoring Reports

Which PM&E measure(s) in the Project 2188 License will this proposal enhance or support:

FERC Article	Item	Report Topic	Project
409	**(3)**	**Fish habitat Enhancement**	**Annual Water & Air Temperature Monitoring**
			Instream Water Rights
			WCT Surveys
			Rock Drill
			Beaver Creek Fish Barrier
412	**(5)**	**Species of Special Concern – Westslope Cutthroat Trout**	**Cabin Creek WCT Restoration**
			Tepee Creek WCT Restoration Planning
			Beaver Creek Fish Barrier

Report by: **Bruce Roberts**

Project Title 1: Custer Gallatin National Forest Seasonal Technicians

The Madison River Fisheries Technical Advisor Committee (TAC) approved the funding of $5,855 in 2017 to partially fund the salaries of two Custer Gallatin National Forest (CGNF) seasonal employees to help with the planning, implementation and monitoring of PM&E and other projects within the Madison River drainage. This funding equates to 40 eight-hour person days (or 320 total hours). These employees were supervised and directed by permanent Montana, Wildlife and Parks (MFWP), NorthWestern Energy (NWE), and CGNF employees depending on the task, project or location. Work was mutually agreed upon by all parties prior to the summer field season. The CGNF fish crew spent a total of 41 ten-hour days (410 hours) in 2017 completing the following work:

<u>Annual Water and Air Temperature Monitoring</u>

The CGNF fisheries program manages five long-term water and air temperature monitoring sites within Hebgen Basin: Red Canyon Creek, Cabin Creek, Watkins Creek, Little Tepee, and South Fork Madison River. These sites are in addition to those sites monitored by NWE and MFWP along the Madison River. These data are saved at the CGNF Forest Supervisor's Office in

Bozeman, Montana and are available upon request. It takes approximately 2 person days annually to travel, download, re-launch and analyze temperature data retrieved from these five continuous recording thermographs.

Instream Water Rights

The CGNF has an active program establishing instream water rights for priority fish bearing streams. The long-term goal is to establish permanent instream water rights for all streams at the Forest boundary within Hebgen Basin and across the Forest. To apply for these rights, our permanent hydrology with the assistance of our summer field crews captured flows along each of these streams at high, moderate and low discharge levels. During the summer of 2017, flows were measured along the following Hebgen Basin streams: Black Sands Spring Creek, both forks of Cream Creek, both forks of Denny Creek, Buttermilk Creek, Sheep Creek, and Red Canyon Creek. The CGNF crew spent 8 days assisting with these measurements.

Westslope Cutthroat Trout Surveys

Over the past two decades, the CGNF fish crew has been tasked with searching for new cutthroat trout populations across the Forest. Within Hebgen Basin, we are to the point of searching the extreme headwaters looking for that last Westslope Cutthroat Trout population. No new Westslope Cutthroat Trout populations were uncovered in 2017. The crew sampled the following headwater streams: unnamed tributary to Watkins Creek, E Fk Denny Creek, W Fk Denny Creek, unnamed tributary to Denny Creek, Sheep Creek, Kirkwood Creek, E Fk Trapper Creek, W Fk Trapper Creek, E Fk Cream Creek, W Fk Cream Creek, and Buttermilk Creek. The CGNF fish crew spent 18-person days surveying these streams.

Cabin Creek Westslope Cutthroat Trout Restoration

South Fork Fish Distribution

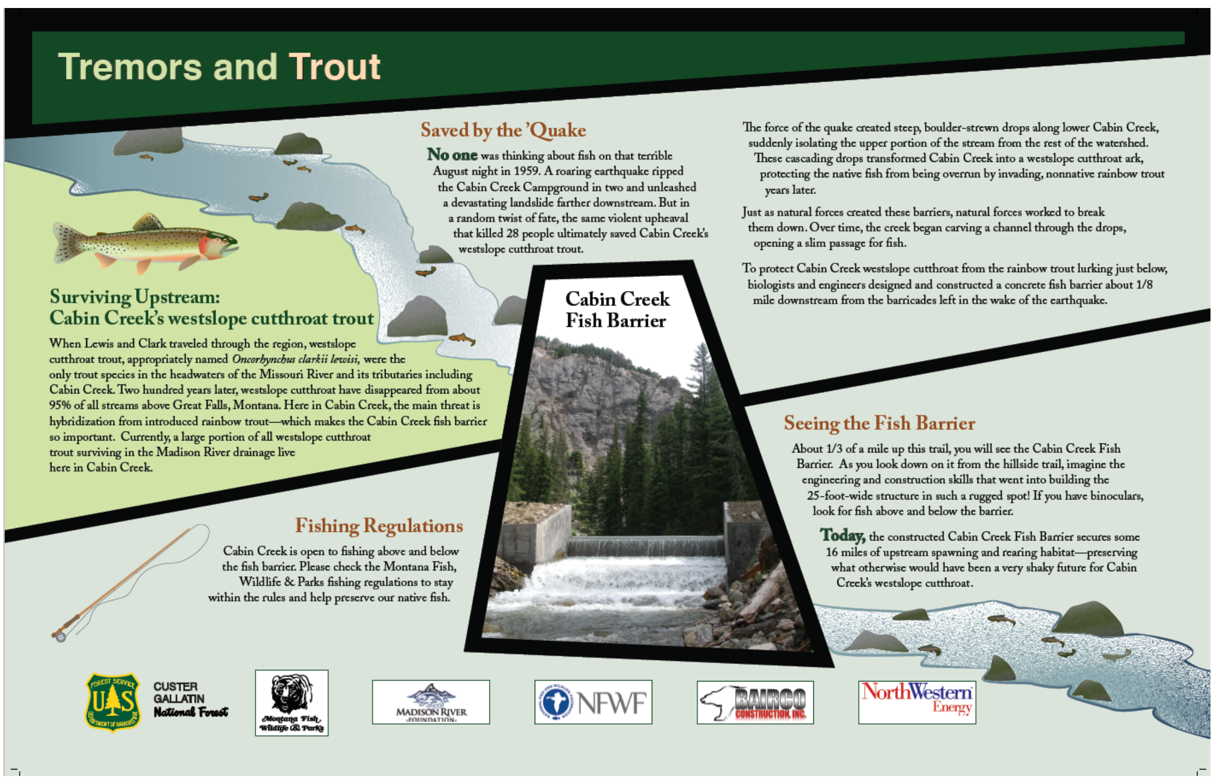
The S Fk Cabin Creek is a fishless stream located upstream from the Cabin Creek fish barrier. MFWP authorized the introduction of genetically pure WCT in to the headwaters of the S Fk Cabin Creek. The upstream barrier that kept the headwaters historically fishless has never been identified. Previous biologists thought that the barrier was the cumulative effect of several smaller cascades and LWD jams. The CGNF fish crew was tasked with electrofishing the lower half mile to determine where the upper most fish was observed to help identify the actual barrier. The upper most fish was collected approximately 20 meters upstream from the confluence with the M Fk Cabin Creek. Because of the stream remoteness requiring both ATVs and backpacking, the CGNF fish crew spent 5-person days collecting this distribution information.

Hybrid Removal

Following the construction of the Cabin Creek fish barrier, MFWP and CGNF crews started removing all trout between the newly constructed fish barrier and the natural barrier located approximately ¼ mile upstream. All collected trout including juvenile Brown Trout, Rainbow Trout, Westslope Cutthroat Trout and WCT x RBT hybrids were removed and placed downstream of the new barrier. This removal effort will continue for the next couple years until all non-native are removed from between these two barriers. The CGNF fish crew spent 2-person days collecting and moving trout between the historic and new barriers.

Interpretative Sign

The CGNF fisheries program with the assistance of the Madison River Foundation agreed to fund an interpretation panel located at the Cabin Creek trailhead explaining the purpose and need of the Cabin Creek fish barrier to the various Forest users within area. The Hebgen Lake Ranger District was receiving numerous questions about this large structure. The CGNF fish crew spent 3-person days digging holes, setting aluminum frame posts with concrete, and installing the panel. The final sign is attached below. The sign layout is consisted other previously installed interpretation signs within the Quake Lake Geologic Area.



<u>Tepee Creek Westslope Cutthroat Trout Restoration Planning</u>

MFWP and CGNF are in the process of collecting various fish and habitat data throughout the headwaters of Tepee Creek to assist with the planning of a potential Westslope Cutthroat Trout restoration project. Previously, CGNF fish crews spent several days assessing existing trout populations and distribution. In 2017, one member of the CGNF fish crew spent 1-person day assisting MFWP with the collection of additional baseline fish population data.

Project Title 2: Purchase of Combination Rock Drill / Rock Breaker

The TAC funded the purchasing of a portable combination rock drill / rock breaker for the Custer Gallatin National Forest, Beaverhead Deerlodge National Forest, and Montana Fish, Wildlife and Parks. This tool is to be used for various fish barrier and habitat enhancement projects including finishing up the Beaver Creek barrier described below. Crew members used this tool to drill approximately 40 holes for blasting. It was agreed by the TAC that the drill would be stored in Bozeman Ranger District on the Custer Gallatin National Forest but made available to the larger group for such projects.

Project Title 3: Beaver Creek Fish Barrier

The Beaver Creek fish barrier project was funded in 2014 by several partners including PPL-Montana. The original proposal requested three years of funding to complete the project. The project was initiated in October 2015 and completed in October 2017.

History

Approximately 11,000 acres burned throughout the headwaters of Beaver Creek and Cabin Creek in 2000. It appears that a post-fire debris torrent moved large woody debris and boulders in excess of 48" resulting in several tangled debris jams.

A slightly hybridized Westslope Cutthroat Trout population was discovered in 2005 by a CGNF fish crew in the headwaters of Beaver Creek drainage starting above the Potamogeton Park trailhead (FS Trails # 200 and # 202). The first genetic testing in 2005 showed that this population was less than 5% hybridized with Rainbow Trout. Subsequent testing in 2011 showed a very similar level of Rainbow Trout hybridization. It is assumed that these debris jams backed water in a way that allowed for upstream fish passage above existing barriers resulting in the hybridization.

Planning

The CGNF fish crew scoured the drainage looking for opportunities to stop this upstream invasion. The crew found three potential sites between 0.25 and 0.33 miles upstream from the trailhead. These three sites included bedrock slabs and/or chutes with substantial drops and smooth laminar flow. It is assumed that one or all of these three natural features prevented Rainbow Trout from reaching the headwaters prior to the debris torrent.

An interdisciplinary team consisting of wilderness, recreation, hydrology and fisheries specialists along with the Hebgen Lake District Ranger looked at several options to modify one of the three sites to be an upstream fish passage barrier. It was determined that the lower two sites were located partially within the Lee Metcalf Wilderness Area (Taylor-Hilgard Unit). Interestingly, the wilderness boundary description stated that the thread of the stream channel was the wilderness boundary. It was assumed that the center point or thalweg was the thread of the stream channel. The team proposed the upper site which was the only site located outside wilderness. The local fisheries biologist wrote a Decision Memo signed by the District Ranger authorizing the modification of the stream channel. A stream alteration permit (SPA 124) was obtained from MFWP to complete the instream work.

The goal of the project was to enhance the natural bedrock by removing the two debris jams located both upstream and downstream. Accomplishing this goal would achieve the following: 1) eliminate the deep resting pool located immediately downstream of the bedrock chute; 2) increase the length and height of the bedrock chute; and, 3) decrease the depth of the water by spreading out the flow from bank to bank.

Funding

The project was funded by multiple partners including PPL-Montana, Madison River Foundation, and the Custer Gallatin National Forest. NWE purchased the combination rock drill in 2017 allowing the crews to efficiently finish this project. TAC funds were used to purchase blasting supplies, wading boots, sign boards, salary, per diem and vehicle use. Salaries for permanent employees for planning and implementation were contributed by the Custer Gallatin National Forest.

One member of the CGNF fish crew spent 2 days in preparation of the larger project in 2017 conducting chainsaw work, stacking slash and signing area trails.

Implementation

The intent was to accomplish this project over a three year period between October 2015 and October 2017. Blasting was carried out between the archery and rifle big game seasons to reduce conflicts with trail users along nearby Forest Service System trails. Crews took advantage of high spring flows to help move smaller materials that were distributed from the previous fall’s blasting events.

Seasonal job appointments were extended into the fall for several recreation, trails and smoke jumper employees to implement this project.

Crews were successful at achieving our project goals and within budget.

Future work

During the various blasting events, several nearby trees became defoliated and killed. It is the goal of the Hebgen Lake Ranger District in 2018 to: 1) fall these dead trees outwards on to the adjacent hill sides to prevent future debris jams; and, 2) continue monitoring genetic purity along upper Beaver Creek and Rose Creek.

Pre-Project Photos

<u>Looking Upstream at Bedrock Chute</u>

Notice: Concentrated flow along left bank (August 2011)

<u>Looking Downstream from Bedrock Chute</u>

Notice: Size and depth of downstream resting pool and the size and complexity of downstream debris jam (August 2011).

Post-Project Photos

Surface water elevation of the downstream plunge pool prior to blasting the downstream

Notice: Resting pool eliminated and bedrock chute lengthened (August 2017)


Notice: Upstream log jam removed, and concentrated flow widened (October 2017)


Notice: Downstream debris jam partially removed and resting pool eliminated (October 2015)

Notice: Downstream debris jam removed, and resting pool eliminated (August 2017). Dead trees in the background need to fell upslope.

Project Title: **Beaverhead-Deerlodge National Forest, Madison Ranger District Seasonal Technicians and WF Madison Stream Restoration Project Report 2018**

Report by: **Darin Watschke**

The following work enhanced/supported PM&E measure(s) 408, 409, and 412 in the Project 2188 License.

Location of Projects: **Madison and Ruby River drainages**

The Madison River Fisheries Technical Advisory Committee provided $9,000 to the Madison Ranger District, Beaverhead-Deerlodge National Forest to help fund fisheries technicians for field season 2017. Two fisheries technicians were hired to conduct field work across all 7 Districts of the B-D NF. The technicians worked a total of 160 days with 102 days funded by the USFS at a cost of about $15,000. Mad TAC dollars were used to fund 58 days ($8,000) of work on Madison River drainage projects and one Ruby River project (all listed below). Additionally, about $1,000 of Mad TAC funding was utilized to purchase supplies and field gear for the technicians. All of the listed projects support one or more of the above PM&E measures.

- Upper and Lower Sureshot Lakes: *8 days*
  The fisheries technicians conducted a thorough inventory of sensitive amphibians breeding sites at Upper and Lower Sureshot Lakes and connected ponds in the North Meadow Creek drainage over two days. The remaining 2 days were dedicated to installing erosion control fabric throughout the Sureshot Lakes Ditch Repair Project area (ditch repair was in 2016) and ongoing monitoring of the function of the ditch and lake water levels.

- Greenhorn Creek WCT Conservation Project: *10 days*
  Genetically unaltered WCT were translocated into Greenhorn Creek from several donor streams in the Beaverhead River watershed in 2016 and again in 2017. These translocation efforts are the final stages of the Greenhorn WCT restoration project. Along with partners from MT FWP, Turner Enterprises, and the USFS, WCT from nearby drainages were captured, tested for genetic purity and disease, transported, and finally released back into Greenhorn Creek at various sites. The fisheries technicians spent a total of 10 days capturing, fin clipping, holding, transporting, and restocking WCT from Browns, Cottonwood and Painter creeks into the Greenhorn drainage.

- West Fork Madison Habitat Assessment: *14 days*
  The technicians evaluated habitat and fish distribution in the headwaters of the WF Madison River drainage. Part of this evaluation included a day of electrofishing a one-mile section downstream of the USFS Cabin, and a small section upstream to assess population size and distribution. The technicians also identified pool construction locations and standing large wood that would later be incorporated into pool habitats. This evaluation was a precursor to implementing the WF Madison Stream Restoration Project 2017.

- Elk River Fish Barrier Survey: *2 days*
  The technicians accompanied B-D and Gallatin NF Biologists and survey crew to conduct a site survey of the proposed fish barrier location on Elk River in the Gravelly Mountain Range.

- South Meadow Creek: *2 days*
  B-D fish techs surveyed the upper South Meadow Creek drainage to gain knowledge on the distribution of fish within the upper reaches. The upstream habitat was dominated by Brook Trout. Amphibian surveys were also conducted in wetland areas along the roadway.

- Crockett Lake/Doubtful Reservoir: *8 days*
  On four separate occasions, the fisheries technicians performed surveys for Western Toad, Columbia Spotted Frog, and Tiger Salamander presence/absence, as well as in identified breeding sites. Habitat data was also collected on these visits to identify preferred breeding habitat and timing of breeding.

- Gazelle Creek at West Fork Campground: *2 days*
  The fish technicians conducted a stream habitat evaluation and beaver dam removal at a culvert/stream crossing in the Gazelle Creek drainage.

- Duck Creek (Centennials): *4 days*
  The crew participated in a two-day demonstration and workshop with Greater Yellowstone Coordinating Committee fish biologists and hydrologists to install multiple beaver dam analog structures and to learn how to use hydraulic equipment purchased for this purpose.

- Axolotl and Grassy Lakes: *4 days*
  The technicians attended an amphibian survey training using Montana Natural Heritage Visual Encounter Surveys and a Survey 1-2-3 tablet-based program. They also conducted amphibian surveys at several lakes and wetland areas immediately after they received the training.

- Madison River: *2* days
  The technicians assisted NW Energy, MT FWP and USFS to conduct annual sampling on the mainstem Madison River. Field work included sediment core, macroinvertebrate, and periphyton sampling.

- Kidd Lake Trail: *2* days
  The technicians assessed several stream crossings and wetland condition related to proposed trail improvement regarding a mining access proposal. Field conditions and photos were used by the fish biologist to make recommendations to the Ranger.

West Fork Madison River Habitat Restoration project.
The USFS, Madison Ranger District, identified a headwater reach of the West Fork Madison River as having high restoration potential in 2016. This headwater system harbors a stable, but

isolated, conservation population of Westslope Cutthroat Trout. This area was in the Eureka Fire (2013) and was historically altered by livestock grazing. Consequently, some streambanks are eroding, there is a lack of pool habitat throughout, and high fine sediment is prominent.

The USFS received funding from NW Energy (Mad TAC) in 2017 to improve stream habitat conditions within this area. This project was postponed for one year due to complications related to Grizzly Bear Delisting and the environmental analysis and decision needed to implement this project. Project funding was retained by the USFS and project implementation and completion is anticipated in August 2018.

Appendix F: NWE Funded Westslope Cutthroat Trout Genetic Testing

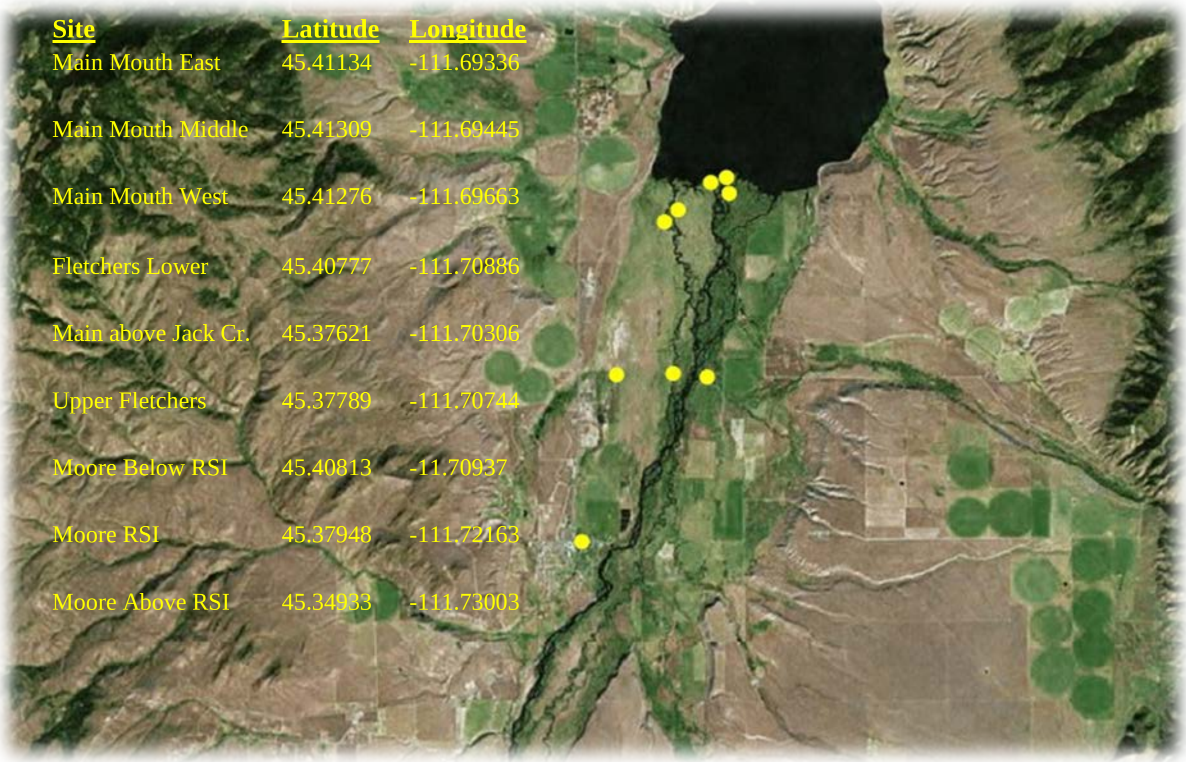
Westslope cutthroat trout populations tested for genetic status under NWE 2188 Program			
W = Westslope Cutthroat Trout; Y = Yellowstone Cutthroat Trout; R = Rainbow Trout			
Stream	Collection Date	Number of fish	Lab analysis
Horse Creek above cascade	7/29/15	30	98.0W x 2.0(R+Y) (23 of 30 100W)
Horse Creek below cascade	7/29/15	29	94.2W x 2.7R x 3.1Y
Hyde Creek	7/8/15	25	88.3Wx9.4Y x 2.3R
Wall Creek	6/4/15	25	95% W x 5% R & Y
English George Creek	6/3/15	25	94% W x 6% R & Y
SF Madison River	10/7/2014	188	133 fish≥92.3%W 55 fish<92.3%W (xR) culled
Whites Gulch	6/11-16/2014	60	100% W
Sun Ranch Brood Pond	May 2014	100	Pedigree analysis, 100% W
SF Madison River	9/17-18/13	63	47 fish>85%W 16 fish<85%W (xR) culled
Cherry Lake, Madison	Various dates 2013	53	Pedigree analysis, 100% W
Cherry Creek, Madison	various dates 2012	100	100% W
Pine Butte Creek	11/1/2012	22	97.8% W x 2.2% Y
Deadman Creek	11/1/2012	8	98.4% W x 1.6% Y
McClure Creek	10/7/2012	16	100% W
SF Madison River	8/29/2012	113	89 fish ≥ 85% W, 24 < 85% (x R) culled
Wall Creek	10/24/2011	32	95.0% W x 0.4% R x 4.6% Y
SF Madison	9/21-23/2011	242	216 @ 97.1%W x 2.9% R 26 @ various levels of intermediate; culled
SF Madison	8/3/2011	55	51 @ 97.1%W x 2.9% R 1 @ 0.8%W x 99.2%R, culled 3 @ various levels of intermediate, culled

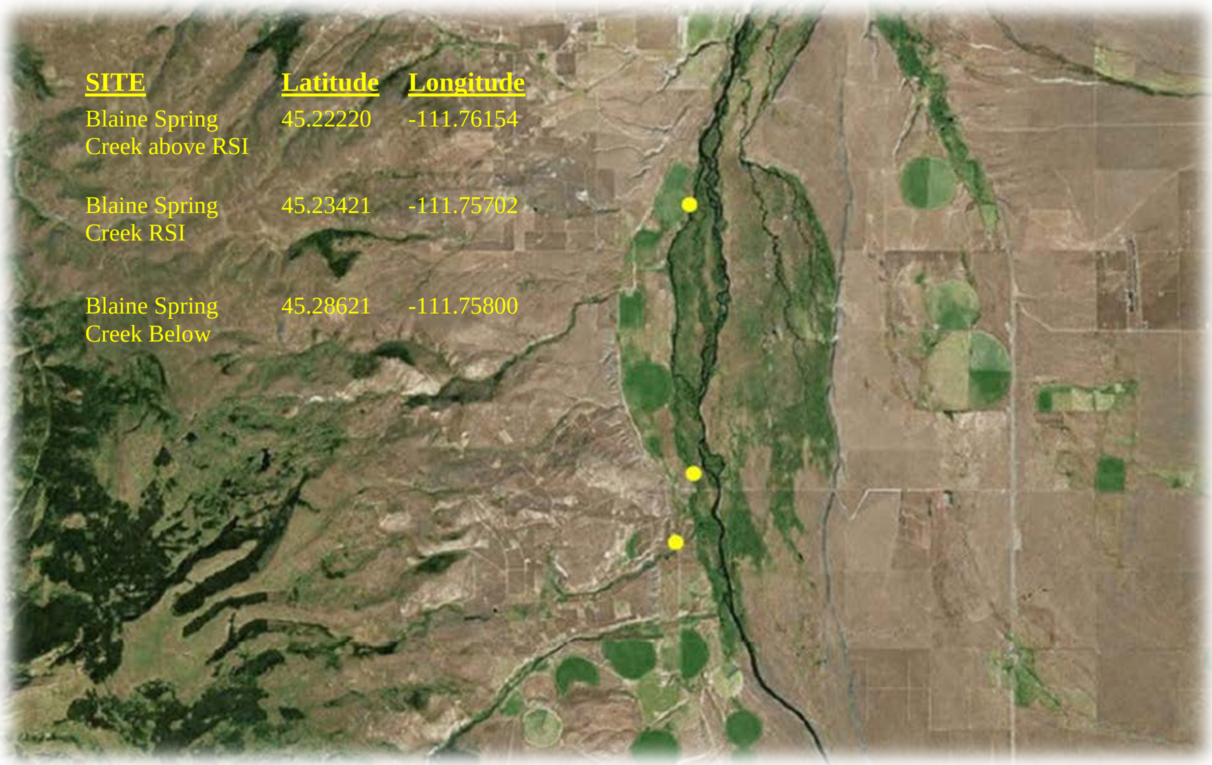
Westslope cutthroat trout populations tested for genetic status under NWE 2188 Program			
W = Westslope Cutthroat Trout; Y = Yellowstone Cutthroat Trout; R = Rainbow Trout			
Stream	Collection Date	Number of fish	Lab analysis
Soap	?	51	98% W x 2% R
McClure	6/26/2010	19	100% W
Wild Horse	6/26/2010	8	100% W
Last Chance	6/25/2010	16	100% W
WF Wilson	6/25/2010	2	1 100% W; 1 WxR
Brays Canyon	6/21/2010	26	100% W
Prickly Pear	6/1/2010	19	18@100% W 1@>99%W - 1R? allele
Cherry Lake	numerous dates 2009	50	100% W
McClure	10/7/2009	49	100% W
Brays Canyon	10/1/2009	50	100% W
Prickly Pear	10/1/2009	50	100% W
Little Tepee of Tepee of Grayling	10/1/2009	10	92.3%W x 1.9%Y x 5.8%R
Hyde	8/5/2009	25	88.5%W x 7.3%Y x 4.2%R
English George	8/4/2009	25	93.4%W x 4.3%Y x 2.3%R
SF Madison	7/16/2009	25	15 @ 97.7%W x 2.3%R 5 @ 0.8%Wx99.2%R 5 various levels of intermediate
Upper Fox	9/18/2008	18	97% W x 3% R
Tepee of Grayling	8/25/2008	8	51.5%W x 26.6%Y x 21.9%R
Wild Horse	7/17/2008	30	100% W
Last Chance	7/2/2008	21	100% W
Ray	6/19/2008	60	100% w
Muskrat	6/18/2008	52	100% W
Whites Gulch	6/11/2008	54	100% W
Halfway	9/26/2007	50	99.9% W x 0.1% R
Hall	9/20/2007	50	100% W
Ray	6/21/2007	45	100% W

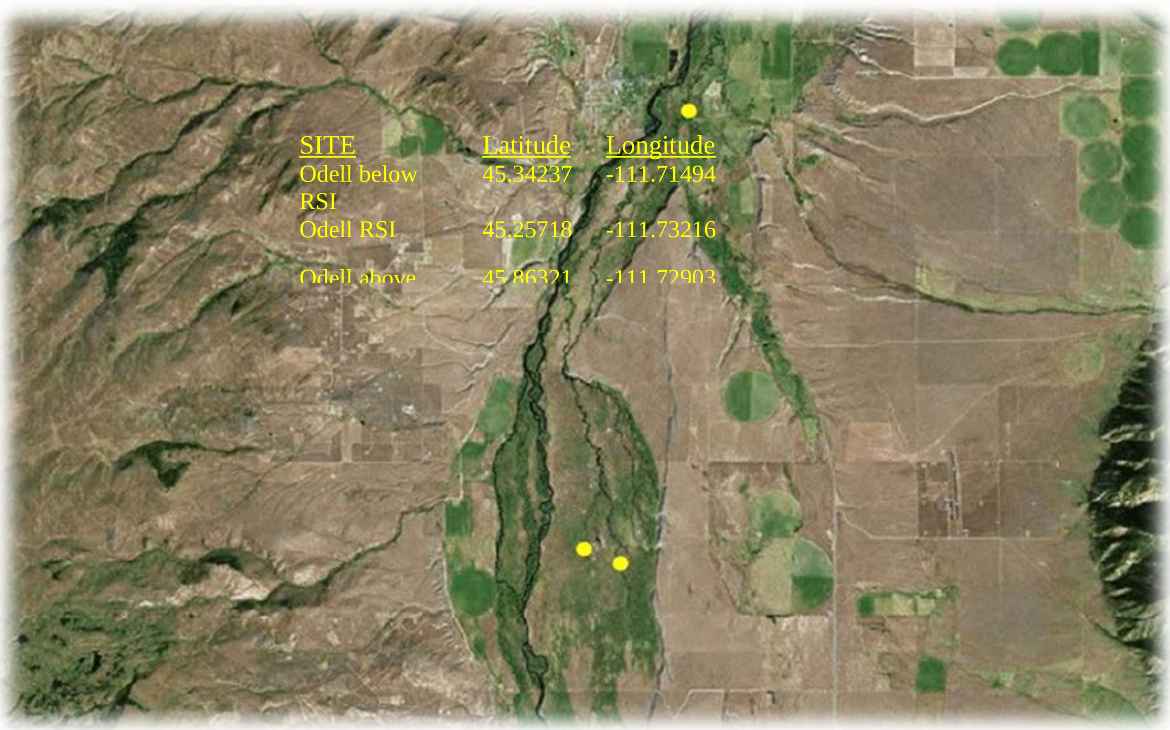
Westslope cutthroat trout populations tested for genetic status under NWE 2188 Program			
W = Westslope Cutthroat Trout; Y = Yellowstone Cutthroat Trout; R = Rainbow Trout			
Stream	Collection Date	Number of fish	Lab analysis
Muskrat	6/20/2007	38	100% W
Last Chance	6/18/2007	20	100% W
Whites Gulch	6/12/2007	24	100% W
Bear	9/19/2006	25	100% W
Bean	9/18/2006	25	100% W
Browns	6/22/2006	25	100% W
Muskrat	6/21/2006	24	100% W
Ray	6/20/2006	35	100% W
Whites Gulch	6/12/2006	31	100% W
Last Chance	6/5/2006	30	100% W
Cabin - mainstem	10/17/2005	15	97% Wx 3% R swarm
Cabin - Middle Fork	10/11/2005	8	mixture of pure W & hybrid WxR
Cabin - Middle Fork	10/11/2005	17	mixture of pure W & hybrid WxR
Whites Gulch	9/8/2005	50	100% W
Hellroaring	7/26/2005	10	27%Wx17%Yx56%R swarm
Little Elk River	7/19/2005	10	100% Y
Arasta	7/14/2005	25	87%Wx8%Rx5%Y
Browns	6/28/2005	15	100% W
Soap	6/8/2005	10	94% Wx3% R swarm
Cottonwood of Blacktail	6/1/2005	19	swarm - 1 fish had 3 Rb alleles; 18 fish no R alleles detected
Stone	2005	30	100% W
Stone	2004	50	100% W
Hall	7/9/2004	2	100% W
McClure	7/1/2004	8	100% W
Ray	7/1/2004	5	100% W
Muskrat	6/30/2004	22	100% W
Cottonwood of Blacktail	6/1/2004	33	100% W
Jones	10/30/2001	25	WxYxR; some individuals exhibited Y alleles, one exhibited R alleles
Bean	10/29/2001	54	98% W x 2% R; only 1 fish displayed R alleles
Bear	10/29/2001	53	100% W
Wall	10/19/2001	25	99% W x 1% R
NF English George	10/18/2001	9	WxRxY, too few fish to discern percentages

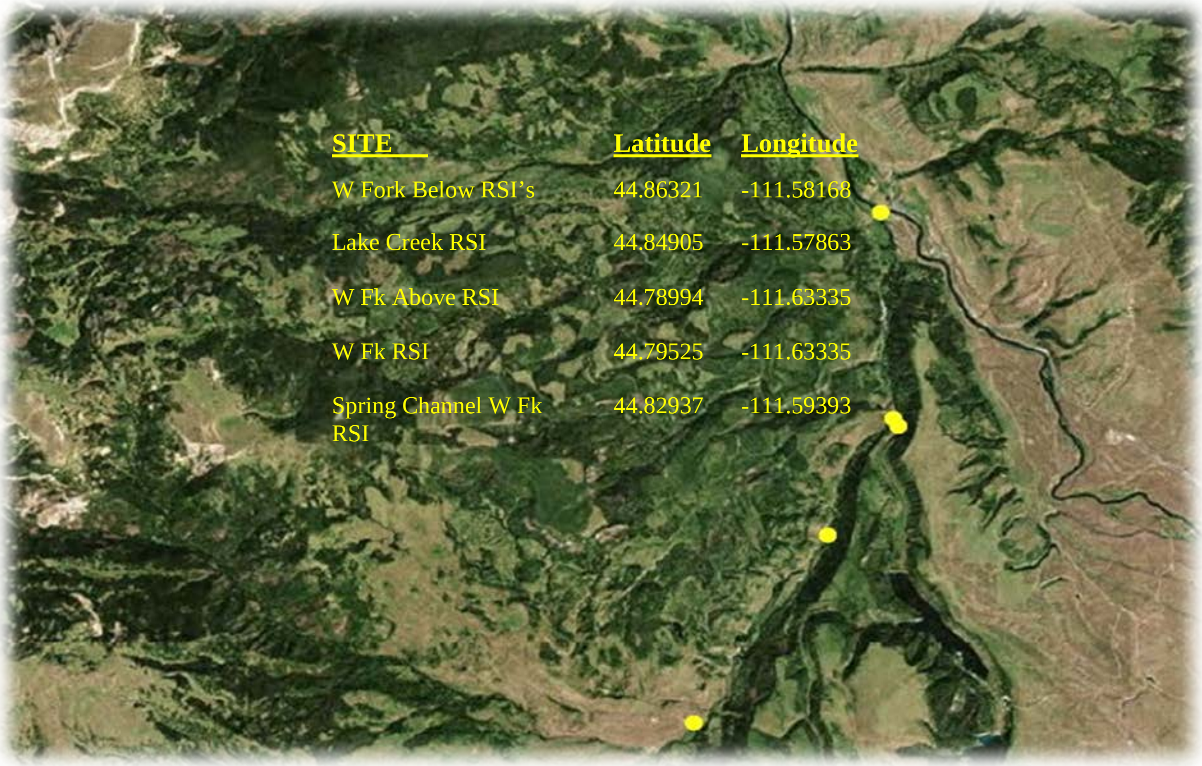
Westslope cutthroat trout populations tested for genetic status under NWE 2188 Program			
W = Westslope Cutthroat Trout; Y = Yellowstone Cutthroat Trout; R = Rainbow Trout			
Stream	Collection Date	Number of fish	Lab analysis
SF English George	10/18/2001	23	80.4%Wx19.6%Y swarm
WF Wilson	10/1/2001	48	100% W

Appendix G: Arctic Grayling eDNA Sampling Sites

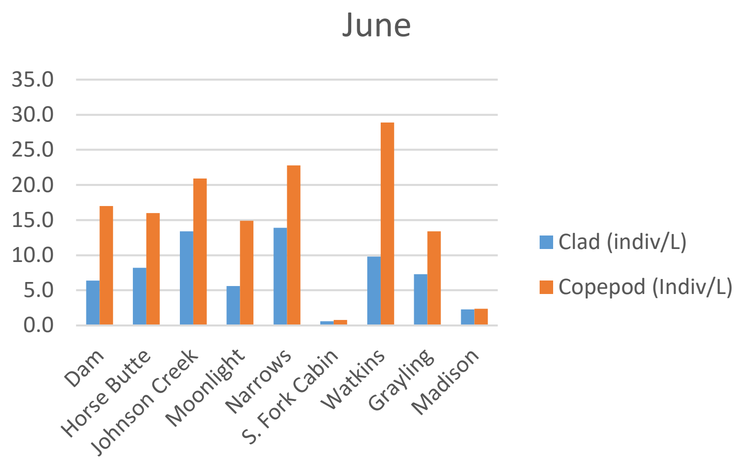


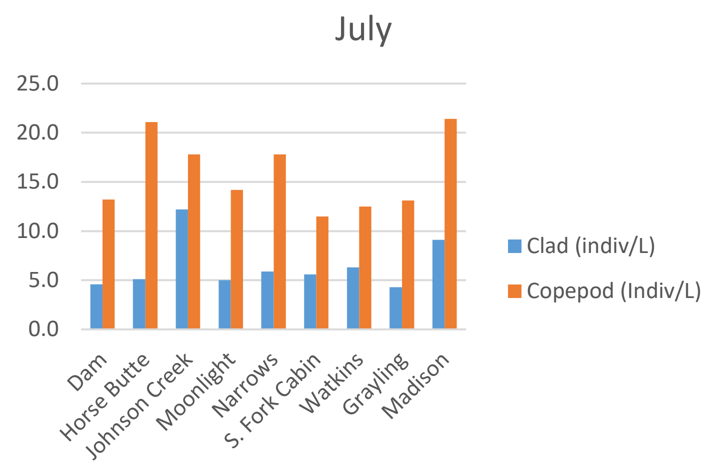

SITE
Latitude
Longitude
Blaine Spring Creek above RSI
45.22220
-111.76154
Blaine Spring Creek RSI
45.23421
-111.75702
Blaine Spring Creek Below
45.28621
-111.75800

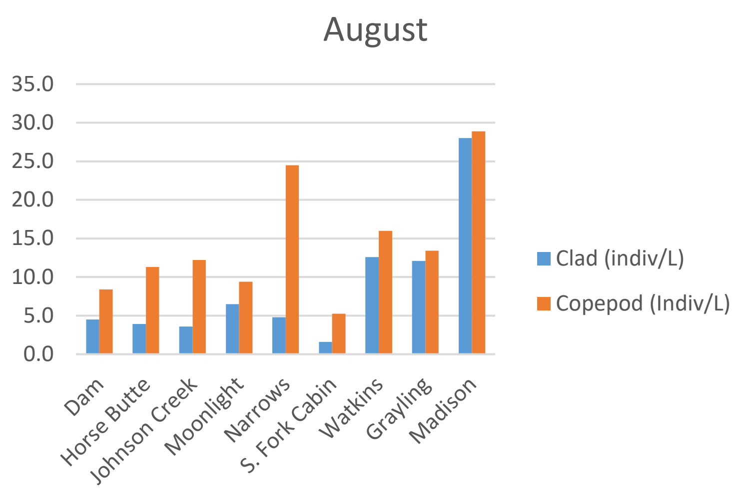

SITE
Latitude
Longitude
Odell below RSI
45.34237
-111.71494
Odell RSI
45.25718
-111.73216
Odell above
45.86321
-111.72903

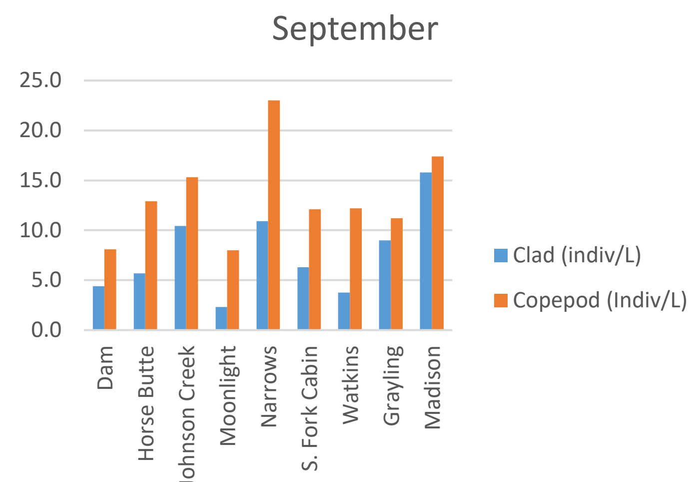

SITE
Latitude
Longitude
W Fork Below RSI's
44.86321
-111.58168
Lake Creek RSI
44.84905
-111.57863
W Fk Above RSI
44.78994
-111.63335
W Fk RSI
44.79525
-111.63335
Spring Channel W Fk RSI
44.82937
-111.59393

Appendix H: Hebgen Reservoir Zooplankton









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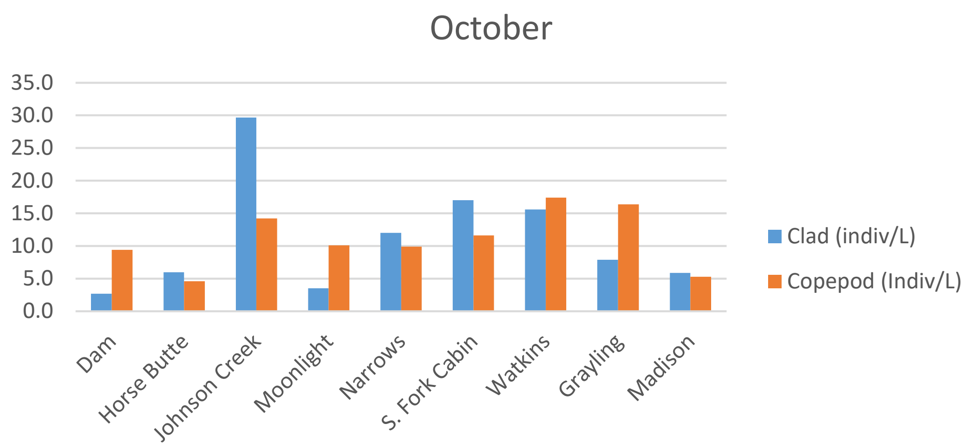

Appendix Figure H -I. Monthly cladoceran and copepod densities (#/liter) at nine sample sites, 2017

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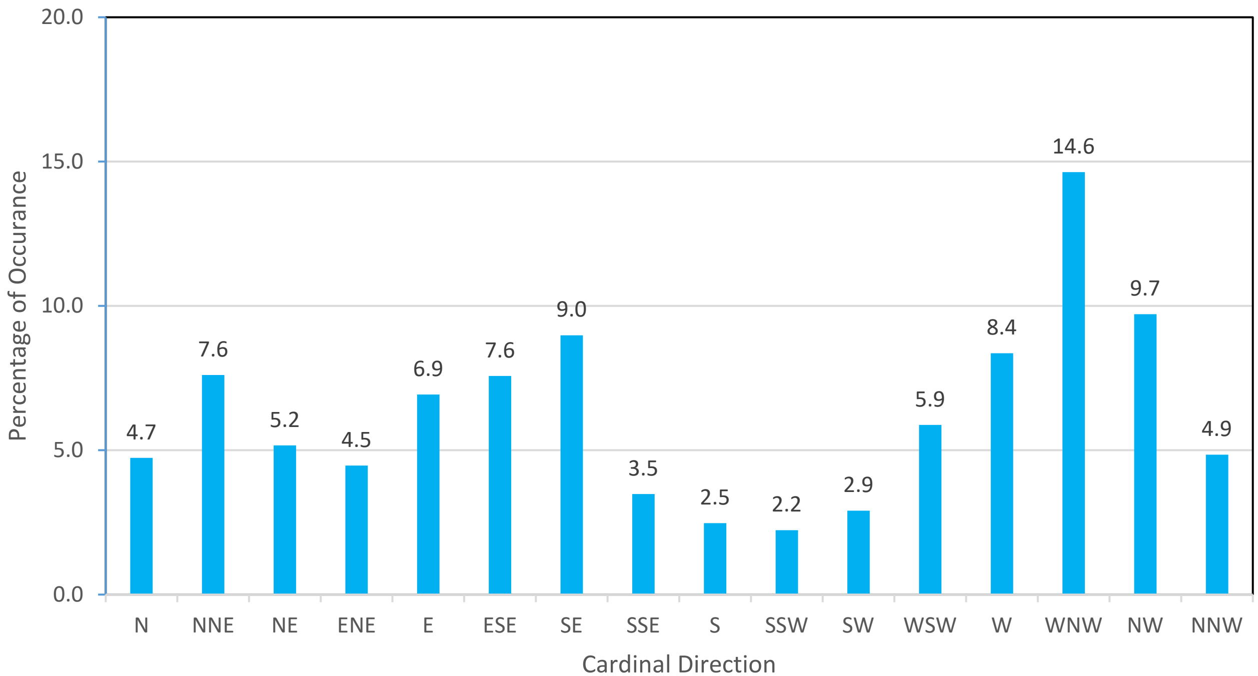
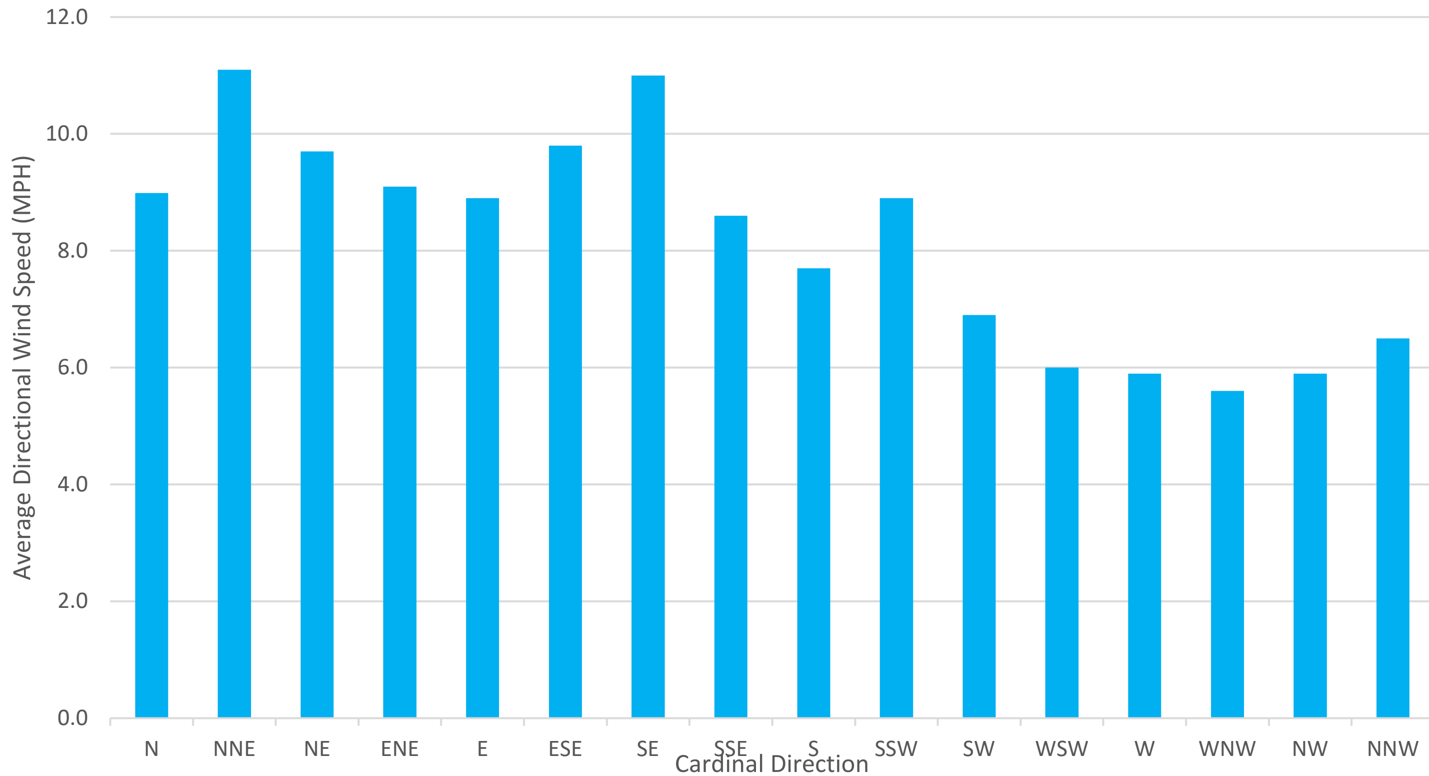
Appendix I: Hebgen Reservoir Wind Data, 2017



Appendix Figure J-2. Distribution of wind direction by percent occurrence for Hebgen Reservoir, May – October 2017



Appendix Figure J-3. Directional average wind speed (miles per hour) at Hebgen Reservoir, May – October 2017.

Appendix J: Fish Tissue Biocontaminants

Fish tissue biocontaminants were evaluated for both predator species (Rainbow Trout or Brown Trout), and bottom dwellers. Effort was made to obtain a sample of 4 individuals of similar size class (length within 25%) for analysis as filets (predators) or whole-body samples (bottom dwellers). Approximately 560 grams of tissue is required for each analysis; this requires a composite of multiple fish if size classes do not provide enough tissue from individuals. Fish were captured with experimental gill nets form Hebgen and Ennis reservoirs and analyzed for the following metals in the laboratory.

- **Aluminum**
- **Arsenic**
- **Cadmium**
- **Chromium**
- **Copper**
- **Iron**
- **Lead**
- **Manganese**
- **Mercury**
- **Nickel**
- **Strontium**
- **Selenium**
- **Zinc**

Overall, magnesium, strontium, iron, and zinc were commonly detected in fish species throughout the monitoring network. Aluminum and manganese were less frequently detected. Cadmium was not detected in any of the samples.

Mercury was detected in fish samples from Hebgen and Ennis reservoirs. The detection limit was .1 mg/kg. Lowering the mercury detection limit to 0.1 mg/kg has enabled expanded interpretation of consumption guidelines for sport fish in Montana waters by MDPHH.

Table 1. Hebgen Reservoir biocontaminant results 2017.

Biocontaminants	**Predators**		**Bottom Dwellers**
Metals	***Predator 1*** ***Brown Trout***	***Predator 2*** ***Rainbow Trout***	***Bottom Dweller 1*** ***Mountain Whitefish***
Aluminum	***34.0 mg/kg***	***13.0 mg/kg***	***128.0 mg/kg***
Arsenic	***3.9 mg/kg***	***3.4 mg/kg***	***4.0 mg/kg***
Cadmium	***ND***	***ND***	***ND***
Chromium	***1.0 mg/kg***	***0.7 mg/kg***	***6.7 mg/kg***
Copper	***23.7 mg/kg***	***2.9 mg/kg***	***28.0 mg/kg***
Iron	***74.0 mg/kg***	***43.0 mg/kg***	***210.0 mg/kg***
Lead	***0.2 mg/kg***	***0.1 mg/kg***	***0.2 mg/kg***
Manganese	***2.0 mg/kg***	***1.0 mg/kg***	***18.1 mg/kg***
Mercury	***1.2 mg/kg***	***0.5 mg/kg***	***0.39 mg/kg***
Nickel	***ND***	***ND***	***3.0 mg/kg***
Strontium	***1.6 mg/kg***	***0.7 mg/kg***	***3.2 mg/kg***
Selenium	***0.8 mg/kg***	***0.8 mg/kg***	***0.9 mg/kg***
Zinc	***34.0 mg/kg***	***21.8 mg/kg***	***40.6 mg/kg***

Table 2. Ennis Reservoir biocontaminant results 2017

Biocontaminants	**Predators**		**Bottom Dwellers**	
Metals	***Predator 1*** ***Brown Trout***	***Predator 2*** ***Rainbow Trout***	***Bottom Dweller 1*** ***Utah Chub***	***Bottom Dweller 2*** ***White sucker***
Aluminum	***8.0 mg/kg***	***19.0 mg/kg***	***78.0 mg/kg***	***137.0 mg/kg***
Arsenic	***1.0 mg/kg***	***1.4 mg/kg***	***0.9 mg/kg***	***1.3mg/kg***
Cadmium	***ND***	***ND***	***ND***	***ND***
Chromium	***ND***	***ND***	***ND***	***0.4 mg/kg***
Copper	***1.8 mg/kg***	***1.3 mg/kg***	***3.2 mg/kg***	***1.7 mg/kg***
Iron	***23.0 mg/kg***	***23.0 mg/kg***	***91.0 mg/kg***	***110.0 mg/kg***
Lead	***ND***	***ND***	***0.1 mg/kg***	***0.2 mg/kg***
Manganese	***1.2 mg/kg***	***1.5 mg/kg***	***6.6 mg/kg***	***15.2 mg/kg***
Mercury	***0.33 mg/kg***	***0.21 mg/kg***	***0.20mg/kg***	***0.16 mg/kg***
Nickel	***ND***	***ND***	***ND***	***ND***
Strontium	***3.1 mg/kg***	***3.2 mg/kg***	***15.8 mg/kg***	***29.6 mg/kg***
Selenium	***1.6 mg/kg***	***1.8 mg/kg***	***2.6 mg/kg***	***1.1 mg/kg***
Zinc	***26.5 mg/kg***	***27.3 mg/kg***	***56.3 mg/kg***	***50.1 mg/kg***