Madison River Drainage Fisheries

and

Madison River Drainage Westslope Cutthroat Trout Conservation and Restoration Program

2013

Annual Report
to
PPL Montana
Environmental Division
Butte
www.pplmontana.com

by

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Montana Fish, Wildlife, & Parks
Ennis
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www.fwp.mt.gov

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
Madison Conservation District & Watershed Coordinator …http://www.madisoncd.org/
Lower Madison River Monitoring page …. www.madisondss.com/ppl-madison.php
Montana Fish, Wildlife, & Parks……..www.fwp.mt.gov
PPL Montana……...www.pplmontana.com
Protect Your Waters……www.protectyourwaters.net or .com
Quake Lake bathymetric map…….
http://fwp.mt.gov/fishing/guide/waterbodyDetail.html?llid=1113877448522

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FERC Articles addressed in this report

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EXECUTIVE SUMMARY

Beach seining for juvenile Arctic grayling and mountain whitefish was conducted in Ennis Reservoir in 2013, but none of either species were captured. Long-term population trends are displayed for rainbow and brown trout in three river sections. Ennis Reservoir gillnetting was conducted. Water temperature was monitored at 15 sites and air temperature at 7 sites within the Madison Drainage. Darlington Ditch Spring Creek, sites in Hebgen and Ennis reservoirs and Quake Lake, O'Dell Creek and numerous Madison River Fishing Access Sites were sampled for New Zealand mud snails and selected other aquatic invasive species by FWP Aquatic Invasive Species staff in 2013. No new invasive species were detected, though NZMS were found in high abundance in Darlington Ditch Spring Creek and low abundance in O'Dell Creek. The Sun Ranch hatchery was used to incubate westslope cutthroat trout eggs from nine donor populations for introduction into one stream, into two lakes in Yellowstone National Park and into the Sun brood pond. There were no westslope cutthroat trout introductions in Cherry Creek in 2013. No non-native fish were observed or captured during widespread electrofishing throughout the Cherry Creek Project area in 2013. Westslope cutthroat have been documented to be pioneering significant distances into tributaries where they were not introduced as eggs or as fry. Ruby Creek, a tributary to the Madison River, received two rotenone treatments to remove non-native trout for eventual introduction of genetically pure westslope cutthroat trout. The number of rainbow trout captured during annual Hebgen Reservoir gillnetting increased from 2012 and average length remained high. The proportion of rainbow trout over 14 inches in the Hebgen gillnet catch has increased noticeably since 2005. Zooplankton density in Hebgen Reservoir was monitored.

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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, and 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). This work has been funded through an agreement with the owner and operator of the dams, initially Montana Power Company (MPC), now PPL Montana. The original agreement between FWP and MPC was designed to anticipate relicensing requirements for MPC's hydropower system on the Madison and Missouri rivers, which includes Hebgen and Ennis dams, as well as seven dams on the Missouri River (Figure 1). PPL Montana 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 PPL Montana and several agencies. Each committee has an annual budget and authority to spend PPL Montana mitigation funds to address the requirements of PPL Montana's Federal Energy Regulatory Commission (FERC) license for operating the Madison & Missouri dams. The Madison Fisheries Technical Advisory Committee (MadTAC) is composed of personnel of PPL Montana, 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 PPL Montana a license to operate the 2188 Project for 40 years (FERC 2000). The license details the terms and conditions PPL Montana 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 clarki lewisi* in Montana. The Plan states "The management goal for WCT 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." Objectives are:

1. Protect all genetically pure WCT populations
2. Protect introgressed (less than 10% introgressed) populations
3. Ensure the long-term persistence of WCT within their native range
4. Providing technical information, administrative assistance, and financial resources to assure compliance with listed objectives and encourage conservation of WCT
5. Design and implement an effective monitoring program by the year 2002 to document persistence and demonstrate progress towards goal

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 subdrainages.

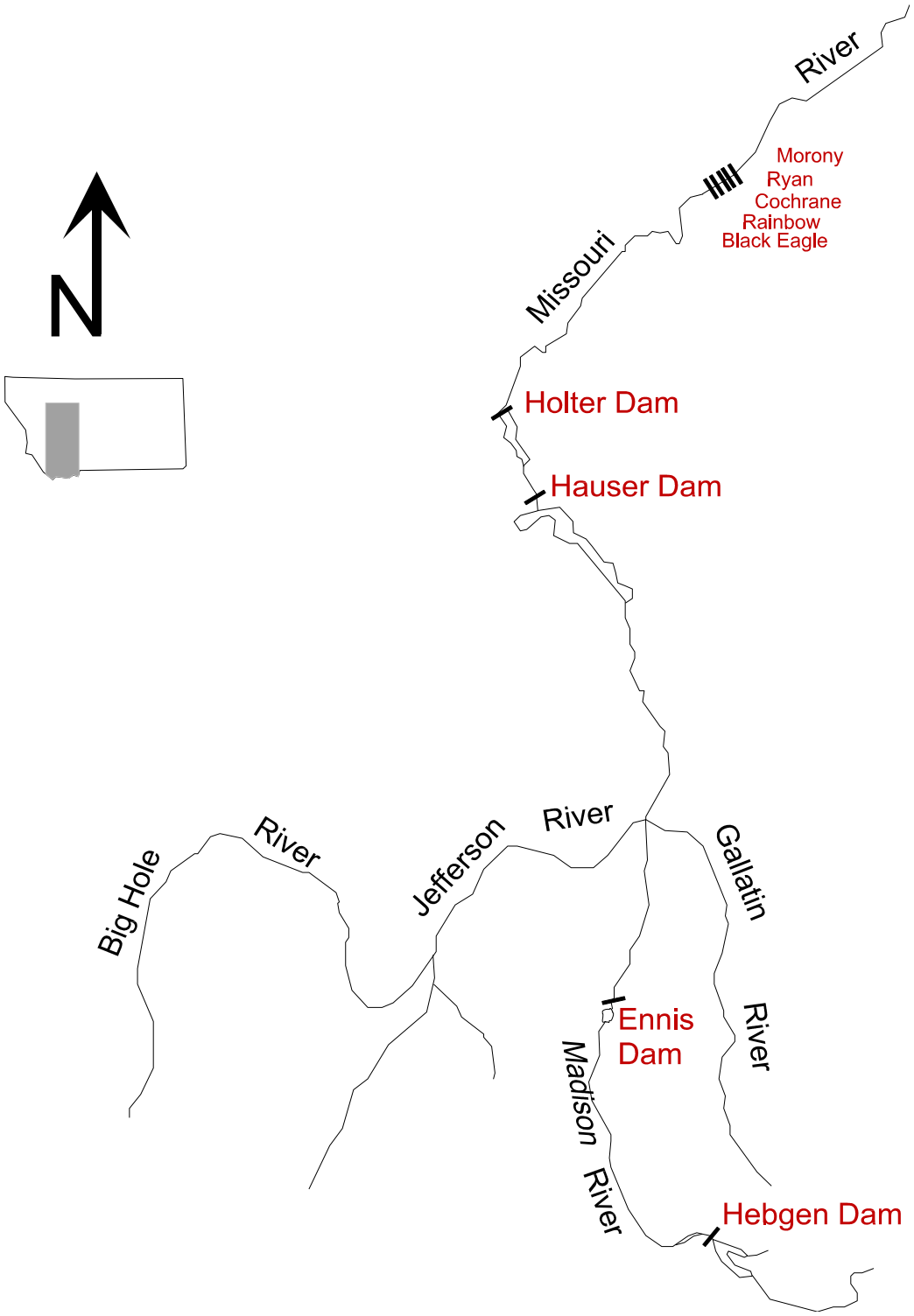

Figure 1. Map showing locations of PPL Montana dams on the Madison and Missouri rivers (FERC Project 2188).

In 2007, the WCTA was updated and combined with a similar document for Yellowstone Cutthroat Trout *Oncorhynchus clarki 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, 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.

Late in 1996, FWP initiated an effort is to conserve and restore the native WCT in the Madison River drainage. Fieldwork for this effort began in 1997 in tributaries of the Madison River. The agreement between FWP and PPL Montana includes provisions to address issues regarding species of special concern.

In recognition of the severity of the situation faced by the westslope cutthroat trout, and in keeping with the philosophy of promoting native species on their properties, Turner Enterprises, Incorporated (TEI) offered access to the Cherry Creek drainage on the Flying D Ranch to assess its suitability for introducing westslope cutthroat. Cherry Creek, a tributary to the Madison River, was identified as an opportune location to introduce genetically pure WCT, and provided an opportunity to meet or fulfill WCTA objectives 3, 4, & 5. FWP determined in 1997 that introducing westslope cutthroat to Cherry Creek was feasible, but would require the removal of all non-native trout presently in that portion of the drainage (Bramblett 1998, Clancey 1998b). FWP, TEI, and the Gallatin National Forest (GNF) subsequently entered into an agreement to pursue this effort. The agreement outlined the roles and responsibilities of each party, including the GNF, which manages the public land at the upper end of the Cherry Creek drainage. Administrative and legal challenges to the Cherry Creek Project delayed its implementation from 1999 - 2002. The project was initiated in 2003.

In 2001, the Sun Ranch entered into an agreement to assist FWP with WCT conservation and recovery. The ranch built a small hatchery facility to rear eggs for introductions and a rearing pond to facilitate development of a WCT broodstock for the Madison and Missouri river drainages.

METHODS

Madison Grayling

A beach seine (Figures 2 & 3) is used to monitor index sites in Ennis Reservoir (Figure 4) 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 in the reservoir. Standard index sites were seined in 2013.

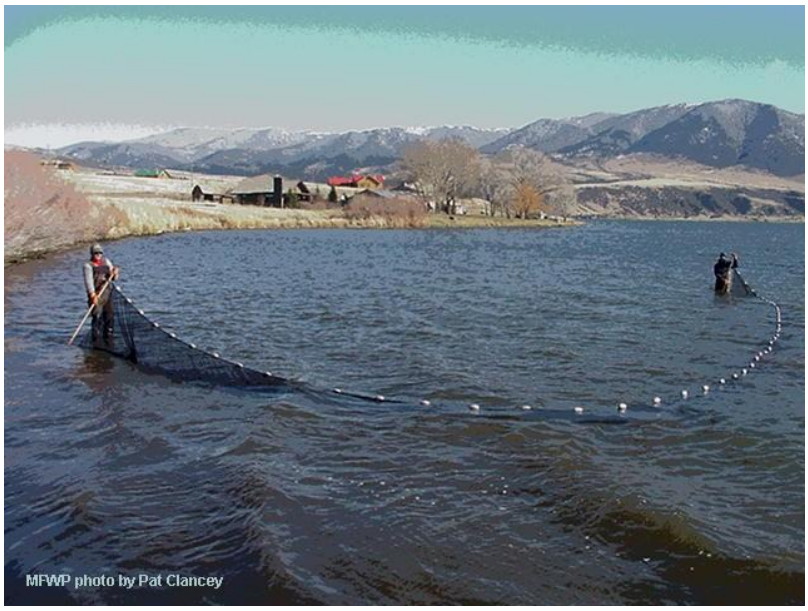

Figure 2. Beach seining in Ennis Reservoir.

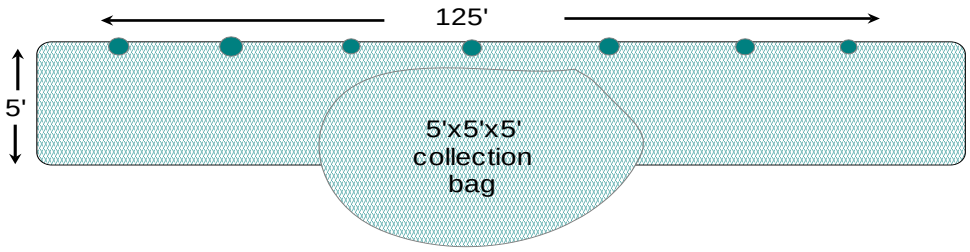

Figure 3. Depiction of a beach seine.

Population Estimates

Electrofishing from a driftboat mounted mobile anode system (Figure 5) is the principle method used to capture Madison River trout for population estimates in several sections of the Madison River (Figure 6).

Fish captured for population estimates are weighed and measured, marked with a fin clip, and released. A log-likelihood statistical analysis (Montana FWP 2004) is used to estimate trout populations.

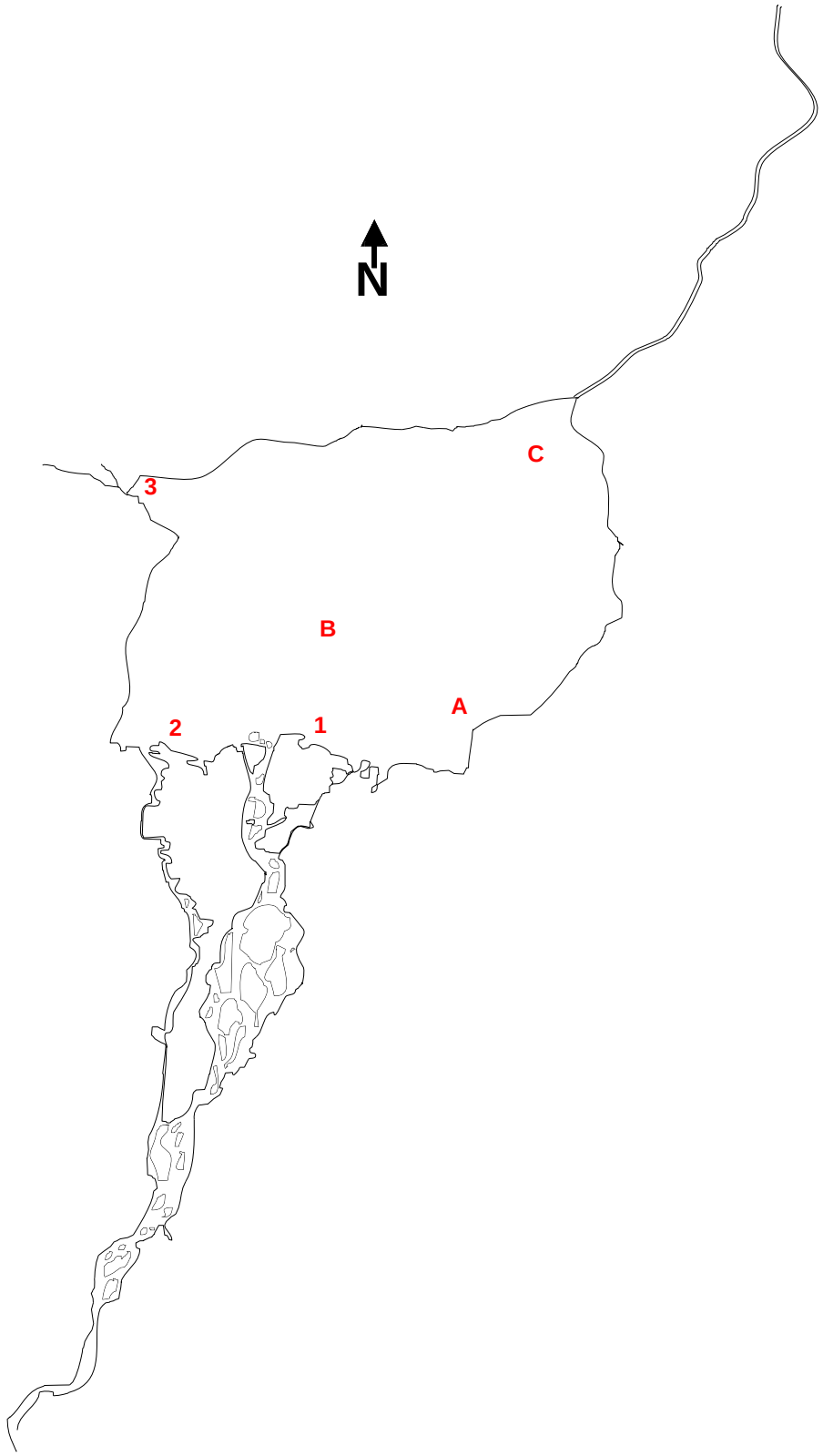

Figure 4. Locations of Ennis Reservoir 2013 beach seining (numbers) and gillnetting (letters) sites. The beach seining numbers correspond to locations described in Appendix A.

Figure 5. Mobile anode electrofishing (shocking) in the Norris section of the Madison River.

Ennis Reservoir Gillnetting

Gillnetting was conducted in Ennis Reservoir in early October, 2013. Experimental nets, composed of five 25-foot panels of progressively larger mesh (¾", 1", 1 ¼", 1 ¾" 2") were set at four locations and left to fish overnight (Figure 4). Floating nets were used at the shallow south end of the reservoir, and one floating and one sinking net was used at the deeper north end. Because the south end of the reservoir is so shallow, floating nets are capable of sampling nearly the entire water column. At the deeper north end, a floating net and a sinking net were required to sample pelagic and benthic areas, respectively. Captured fish were removed from the nets, separated by species, measured, weighed, enumerated, and released if alive.

River Discharge

Minimum Flows

In the 1960's, FWP data suggested that instream flow levels of 600 and 1,100 cfs at the USGS Kirby and McAllister gauges in the upper and lower river, respectively, would provide favorable overwinter habitat for yearling trout, and also protect against summer and fall drought in low water years (Vincent, pers. comm.). In 1968, Montana Power Company (PPL Montana's predecessor) informally committed to make every effort to maintain these minimum instantaneous river flows, and was able to adhere to them on all but a few occasions. These minimum flows were incorporated into Article 403 of the September 27, 2000, FERC license for the 2188 Project and are required elements of operating Hebgen and Ennis dams.

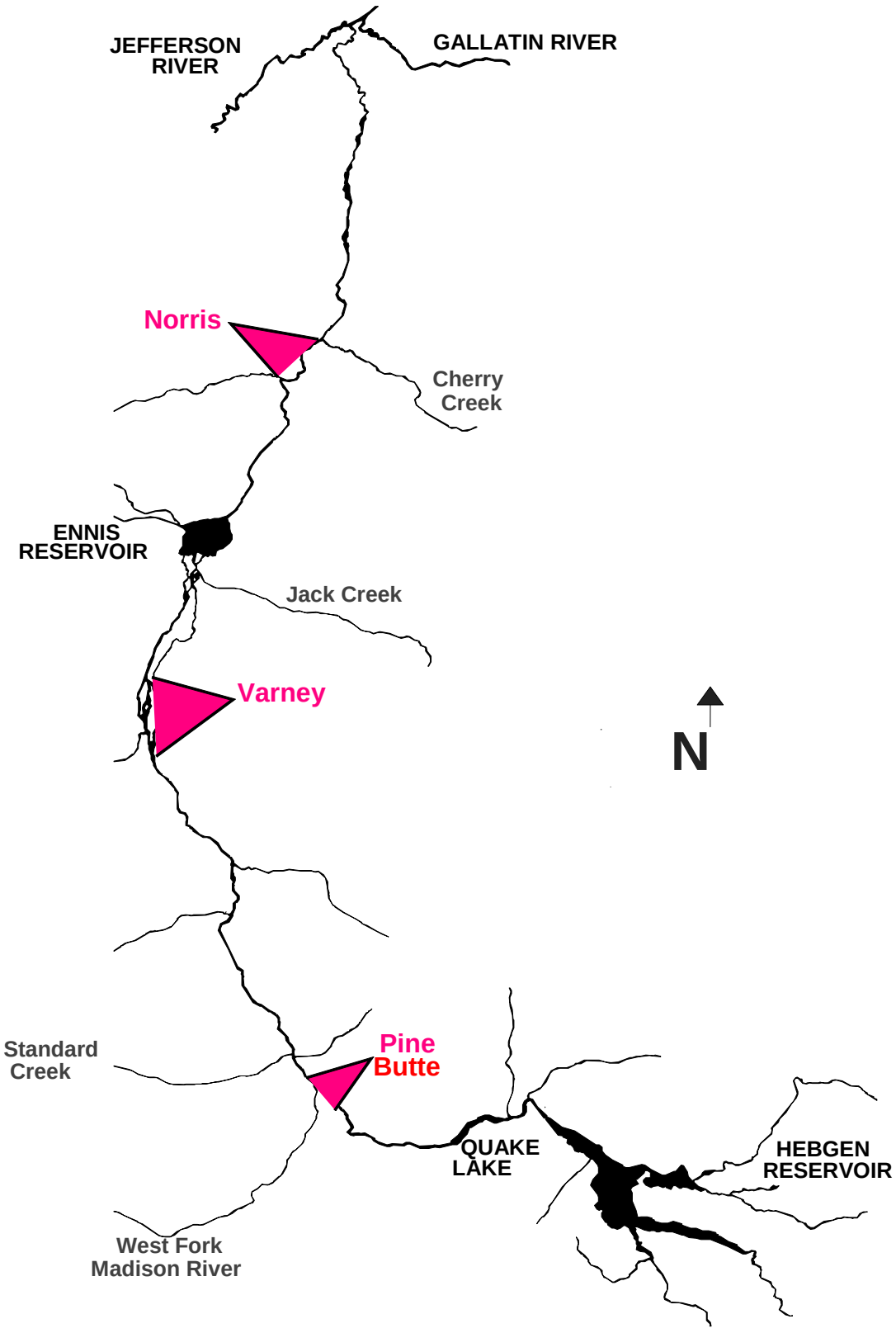

Figure 6. Locations of Montana Fish, Wildlife, & Parks 2013 Madison River population estimate sections.

Pulse Flows

Article 413 of the FERC license mandates PPL Montana to 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 to prevent water temperatures from exceeding 80^{o}F at Black's Ford. Pulsed flows are triggered when water temperature at the Madison (Ennis) Powerhouse is 68^{o} F or higher and forecast air temperature at Three Forks for the following day is 80^{o} 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 in the area of Black's Ford 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 or eliminating 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/ppl-river.cfg/ppl-madison.php.

Flushing Flows

Article 419 of the FERC license requires the company to develop and implement a plan to coordinate and monitor flushing flows in the Madison River downstream of Hebgen Dam. A flushing flow is a flood stage of runoff that mobilizes streambed materials, resulting in 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.

Temperature Monitoring

Water temperature was recorded at 15 sites and air temperature at seven sites throughout the Madison River Basin from upstream of Hebgen Reservoir to the mouth of the Madison River at Headwaters State Park (Figure 7). Beginning in 2010, a water temperature recorder was deployed in the river between the Kirby and McAtee sites at a station named 'Wall Creek' to provide data related to the on-going surface discharge out of Hebgen Reservoir during reconstruction of the control structure. Each of the Tidbit^{TM} 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 24 hours per day.

Table 1. Pulse flow trigger criteria

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	Water temperature at Madison (Ennis) Powerhouse	Tomorrow's Maximum Forecast Air Temperature at Three Forks Pulse Flow Rate (McAllister Discharge)		
No Pulsing Required	Less than 68°F	No action		
Pulsing Contingent on Weather Forecast	≥ 68°, < 70°	< 80° No action	≥ 80° 1400 cfs	
Pulsing Required, Volume Contingent of Weather Forecast > 90°F	≥ 70°, < 72°	< 90° 1400 cfs	≥ 90°, < 95° 1600 cfs	≥ 95° 2100 cfs
Pulsing Required, Volume Contingent of Weather Forecast > 85°F	≥ 72°, < 73°	< 85° 1400 cfs	≥ 85°, < 90° 1600 cfs	≥ 90° 2100 cfs
Pulsing Required, Volume Contingent of Weather Forecast > 85°F	≥ 73°	< 85° 1800 cfs	≥ 85° 2400 cfs	

Aquatic Invasive Species

Highway signs announce FWP's West Yellowstone Traveler Information System (TIS) (Figure 8). The five signs are located near major highway intersections in the West Yellowstone area, notifying drivers entering and leaving the area of the TIS system. The TIS notifies anglers and water recreationists of the presence of New Zealand mud snails *Potamopyrgus antipodarum* in the Madison River and Hebgen Reservoir, and instructs them on methods of reducing the likelihood of transporting this and other AIS to other waters.

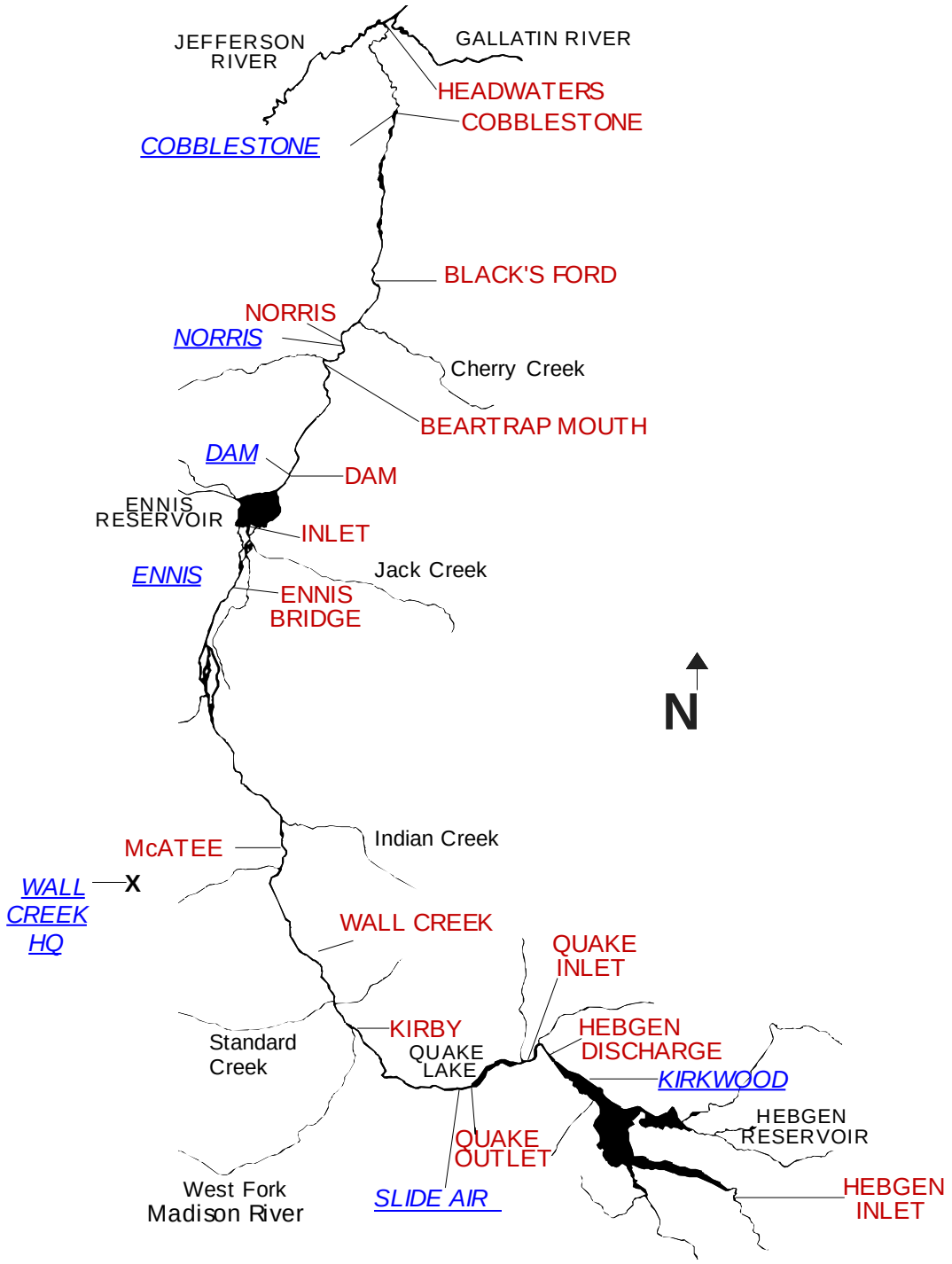

Figure 7. Locations of Montana Fish, Wildlife & Parks temperature monitoring sites. Air temperature monitoring sites are blue; water temperature monitoring sites are red. A river site near Wall Creek was added in 2010.

Figure 8. Roadside sign announcing the Traveler Information System near West Yellowstone, Montana.

Additional messages broadcast by the system include messages on whirling disease *Myxobolus cerebralis*, zebra mussels *Dreissena polymorpha*, 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. The position is responsible for developing and coordinating AIS control & management activities among state agencies as well as between 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.

In 2010, FWP initiated a public education campaign called "Inspect/Clean/Dry". This campaign uses highway billboards (Figure 9) and vehicle tailgate wraps and posters (Appendix B) to create public awareness of aquatic invasive species issues.

In 2013, the FWP AIS field crews surveyed the Madison River at nine fishing access sites as well as the Darlington Ditch Spring Creek (Darlington Ditch) at Cobblestone FAS, O'Dell Creek near Valley Garden FAS, Hebgen and Ennis reservoirs and Quake Lake. Water temperature, GPS coordinates, pH, weather conditions, samples for zebra mussel, quagga mussel *Dreissena rostriformis bugensis* and Asian clam *Corbicula fluminea* veligers, notes on substrate, and invertebrate and macrophyte surveys were collected. A minimum of 400 feet of stream is surveyed at each site.

In addition to regular biological monitoring, angler/boater surveys were conducted throughout the drainage to inspect watercraft and angling gear for AIS and to educate the public on AIS issues. AIS crews spent 60 days in the Madison River Drainage between Rainbow Point at Hebgen Reservoir and Blacks Ford FAS along the lower river, including 4 days at Wade Lake.

In 2009 the FWP AIS program conducted monitoring of dissolved calcium concentration in state waters to evaluate risk of zebra and quagga mussel establishment. The calcium level of a water body is a critical characteristic for zebra and quagga mussel establishment. These mussel species do not survive when there is a low calcium concentration in the water, since calcium is an essential element in the composition of the bivalve shell. Calcium concentrations of 15 mg/liter or less are thought to limit the distribution of zebra and quagga mussels. Survival of the larvae and size of an established adult population are both thought to increase with increasing levels of calcium.

Figure 9. Inspect/Clean/Dry billboard.

New Zealand Mud Snails

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

Westslope Cutthroat Trout Conservation and Restoration

Efforts to conserve and restore genetically pure and conservation populations of WCT in the Madison Drainage center on maintaining or restoring genetically pure or nearly genetically pure populations, high quality stream habitat, adequate instream flow, and, where necessary, removal of competing or hybridizing non-native trout. Stream habitat surveys were conducted throughout much of the Madison Drainage from 1997 – 1999 (Clancey 1998a, Sloat et al. 2000). Backpack electrofishing was used to survey fish species. Removal of non-native species will typically require use of the EPA registered piscicides (fish-pesticides) rotenone or antimycin.

The Beaverhead-Deerlodge and Gallatin National Forests and Yellowstone National Park are conducting projects to benefit WCT 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.

Sun Ranch Westslope Cutthroat Trout Brood

Gametes (eggs & milt) for the Sun Ranch WCT program were collected from nine streams in 2013. All fertilized eggs were transported to the Sun Ranch Hatchery for incubation and hatching (Figure 10). Portions of the resulting fry from one stream and from the Sun Ranch Brood were introduced to the Sun Ranch Brood Pond (Figure 11). The MadTAC has provided funding for the Sun Ranch Program annually since 2004.

Figure 10. Sun Ranch Hatchery rearing troughs.

Figure 11. Sun Ranch Brood Pond.

Cherry Creek Native Fish Introduction Project

The Cherry Creek Native Fish Introduction Project was initiated in 2003. The project area is comprised of over 60 miles of stream habitat and the 7-acre, 105 acre-foot Cherry Lake, and includes all of the Cherry Creek Drainage upstream of a 25-foot waterfall (Figure 12) approximately 8 miles upstream of the Madison River confluence. The only fish species present in the project area in 2003 were brook trout *Salvelinus fontinalis*, rainbow trout *Oncorhynchus mykiss* and Yellowstone cutthroat trout (YCT; Figure 13). The large size of the project area required that the project be completed in phases. Each phase was treated with fish toxicants for at least two consecutive years. Chemical treatments to eradicate non-native fish were completed in 2010, and WCT introductions continued through 2012.

In 2013, no fish were introduced into the Cherry Creek project area. From 2006 – 2010, WCT eyed eggs from wild donor populations, the Sun Ranch brood, and the Washoe Park Hatchery were placed in remote site incubators (RSIs; Figure 14), hatched, and fry swam out of the RSIs into the stream. The RSIs are plumbed to allow stream water to flow into the bottom of the bucket, percolate up through an artificial substrate where the eggs are placed, and out the RSI near the top of the bucket. When ready to enter the stream, fry follow the water out the hole near the top of the bucket. A capture bucket was placed on the outflow of the RSI to capture and enumerate departing fry to allow estimation of survival in each RSI.

Figure 12. Cherry Creek waterfall located at stream mile 8.0. This falls is the downstream extent of the Cherry Creek project area.

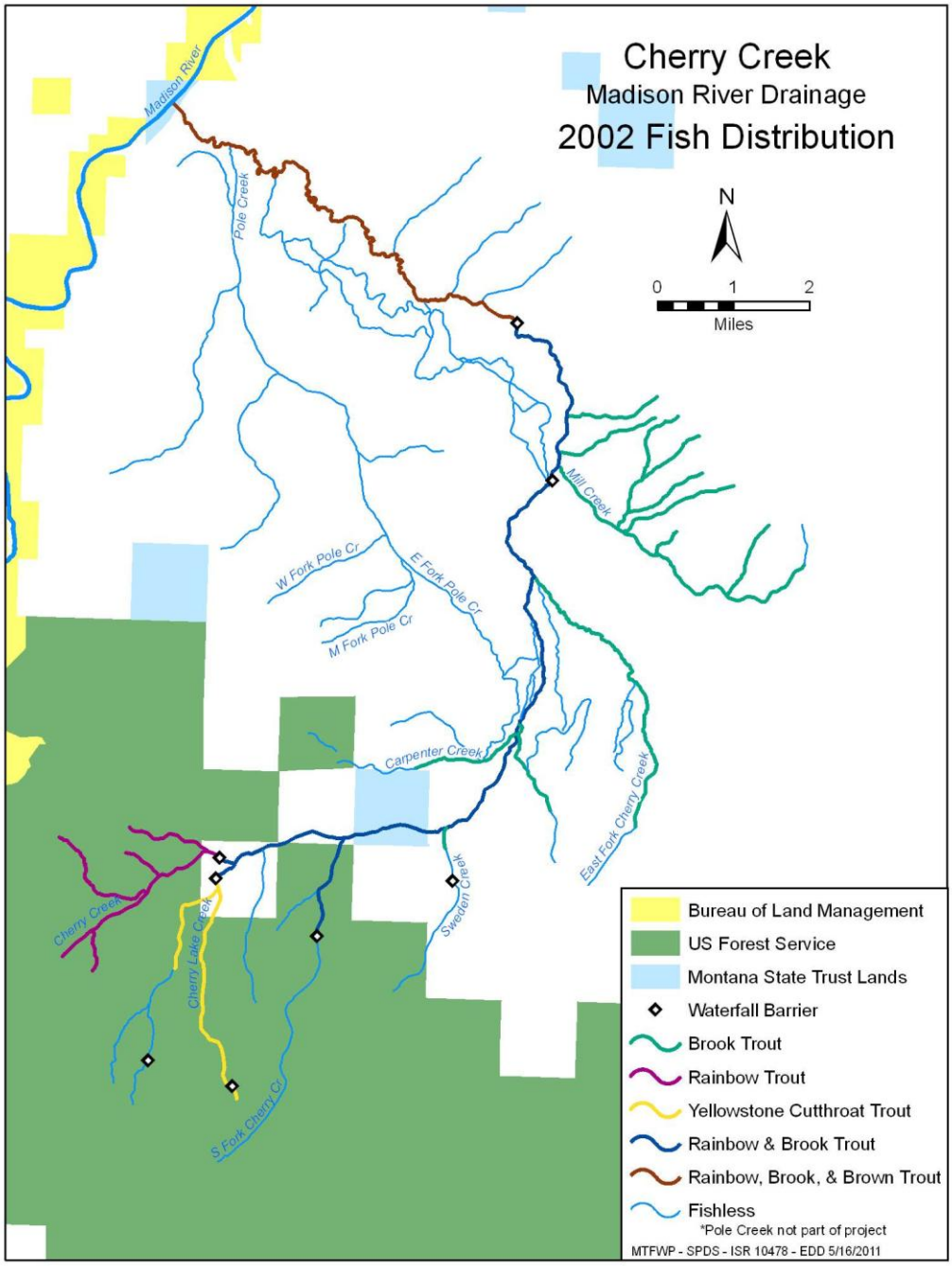

Figure 13. Map of the Cherry Creek Drainage showing the 2002 non-native fish distribution.

Figure 14. Remote streamside incubator (round bucket) and capture bucket (square bucket) in Cherry Creek.

Ruby Creek Westslope Cutthroat Trout Project

Ruby Creek (Figure 15) is a tributary to the Madison River south of the town of Ennis. A 15-foot waterfall (Figure 16) at stream mile 0.7 isolates most of the drainage from Madison River fish. Rainbow trout and Rocky Mountain (mottled) sculpin *Cottus bairdi* are the only fish species above the waterfall, while rainbow trout, brown trout *Salmo trutta* and sculpin are common below the waterfall. Brown trout are known to use the lower 0.7 miles of the stream for spawning.

In 2012 FWP produced an Environmental Assessment (EA) entitled "Reintroduction of Native WCT in Ruby Creek by Removal of Non-native Rainbow Trout with Electrofishing and Rotenone" (Clancey 2012). Written comments were received from five parties and verbal comment from one party during the 30 day EA review period that ended June 16, 2012. All commenting parties supported the proposed project or felt it to be a workable project as proposed. Letters were received from the Madison River Foundation and the Greater Yellowstone Coalition, emails were received from three individuals and verbal comment from the adjacent landowner. The Madison River Foundation and the Greater Yellowstone Coalition offered volunteer help for the pre-treatment fish salvage and stream monitoring during the rotenone treatment.

Fish distribution was determined by electrofishing on several occasions in 2011 and 2012. On all sample dates fish were found only in mainstem Ruby Creek up to approximately stream mile 7 ½ and in the lower ¾ mile of the South Fork of Ruby Creek. The named tributaries of Beartrap Creek, Grindstone Gulch and Dry Gulch were dry on all sample dates, and the mainstem was dry from approximately mile 7 ½ to mile 10. Though streamflow is perennial upstream of mile 10, no fish were ever sampled there.

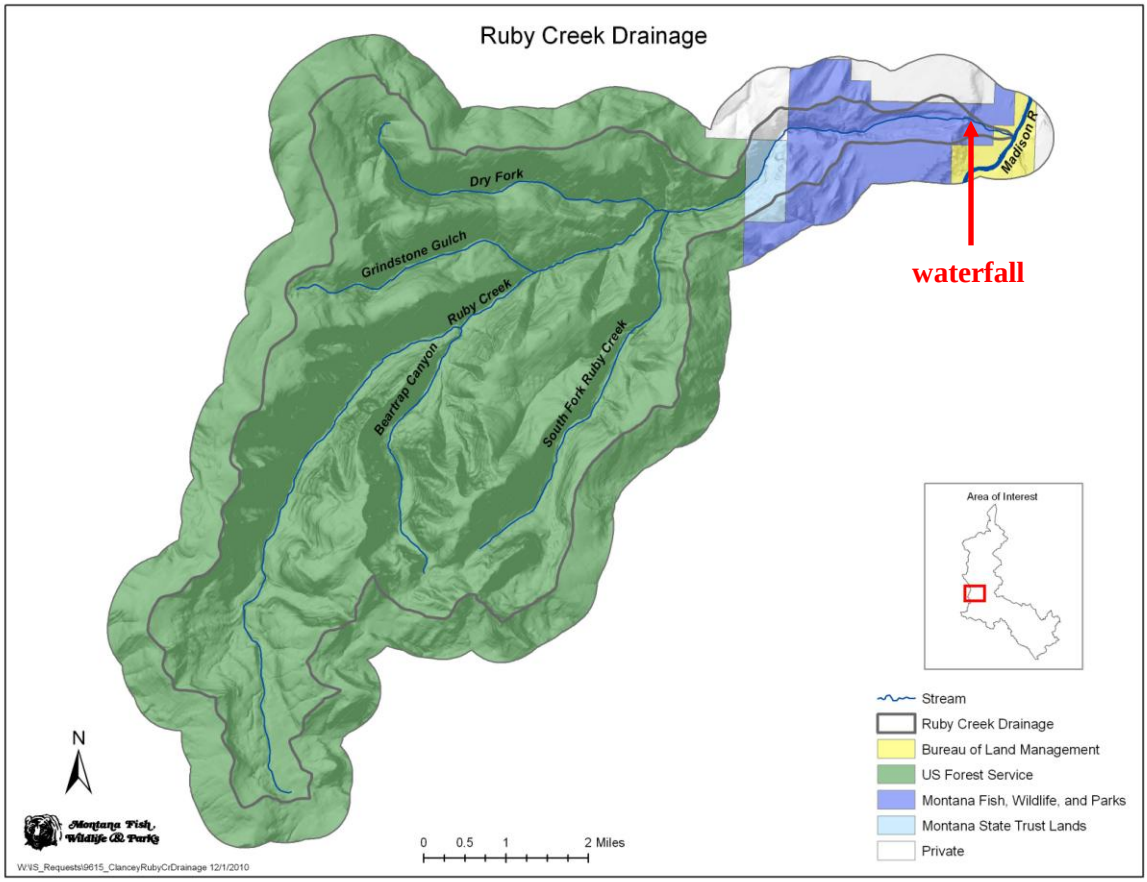

Figure 15. Ruby Creek Drainage, tributary to the Madison River.

Figure 16. Ruby Creek waterfall at stream mile 0.7. This waterfall is a barrier to upstream fish movement and will serve to isolate the reintroduced WCT population from non-native fish.

During the bioassay and initial treatment in December 2012, five rainbow trout and five sculpins were placed in flow-through buckets every ½ hour of stream flow time throughout the treatment area. Dye testing showed flow-through time of the treatment area to be 5 ¾ hours. Rainbow trout and brown trout were used as sentinel fish through the neutralization zone, where flow-through time was 34 minutes.

Treatments were conducted on April 9 and October 16, 2013. Liquid rotenone and/or dry rotenone powder mixed with sand and gelatin was used during the 2013 treatments.

Fish Habitat Enhancement

South Fork of Meadow Creek

A project to replace an aged irrigation system in a section of the South Fork of Meadow Creek was initiated in 2011 by the Madison Watershed Coordinator. Upon completion the project will include reconstruction of instream irrigation weirs, headgates, and irrigation water delivery systems to improve efficiency. The new instream diversions were initially designed to facilitate fish movement through them, and water delivery will be via pipeline rather than open ditch. Approximately 3,000 feet of stream was fenced as part of the project to prevent livestock encroachment within 30 feet on either side of the stream. Funding for the project is from the Montana Department of Natural Resources and Conservation, Montana Department of Environmental Quality, Madison Conservation District, PPL Montana Madison Fisheries Technical Advisory Committee, and the landowners.

Hebgen Basin

Hebgen Reservoir Gillnetting

Gillnetting has been conducted annually on Hebgen Reservoir (Figure 17) by FWP 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 were deployed overnight at index sites on Hebgen Reservoir (Figure 18) 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) were fished during this period, with a maximum of nine nets fished per night.

Samples were sorted by net and processed systematically by species with total length and weight recorded. Rainbow trout were also visually examined for physical anomalies seen in hatchery-reared stocks, and for external and internal tags applied to wild juvenile and adult rainbow trout at tributary traps in previous years. Vertebrae were extracted from rainbow trout specimens and examined for the presence of tetracycline marks, a biological stain that appears in ossified structures. Tetracycline can be added to hatchery pellets to put a mark in the vertebrae, creating a positive identification feature for hatchery raised fish.

In 2013, FWP initiated a program to use micro-chemistry techniques to identify spawning origins of Hebgen Reservoir rainbow trout. Through this program, which is in its early stage of development, water samples are collected from known and suspected rainbow trout spawning tributaries and ratios of specific chemical elements in those waters are analyzed. An otolith (middle ear bone) is then collected from rainbow trout, typically from fish harvested by anglers. The otolith is prepared for analyses by precisely sanding it to expose the focus (center). Laser technology is then used to analyze the elemental

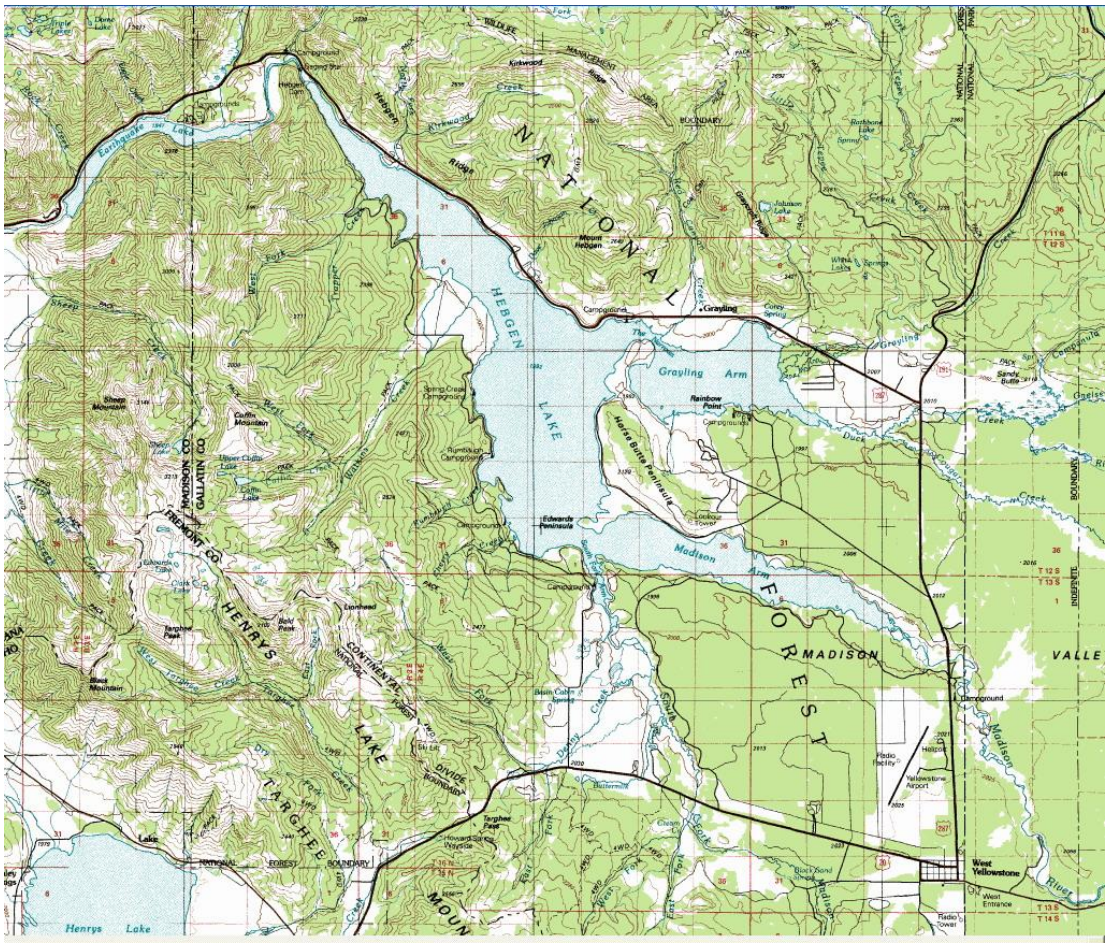

Figure 17. Map of Hebgen Reservoir and surrounding area.

chemical composition of the otolith focus to determine which water source the fish was in at birth and shortly thereafter.

Hebgen Reservoir Shoreline Juvenile Fish Sampling

Beach seining (Figure 2) was conducted at several sites on Hebgen Reservoir to monitor overlap of juvenile habitat use among young-of-the-year rainbow trout, brown trout, mountain whitefish *Prosopium williamsoni*, and Utah chub *Gila atraria*. Samples were collected using a 125'x 5' x ¼" inch mesh seine with a 5'x 5' x 5' collection bag (Figure 3). The float and lead lines of the seine are tied to long dowels and pulled through the water by two people, then pulled onto shore where fish are separated from debris and counted. At each site all young-of-the-year trout, whitefish, and up to 30 Utah chub are measured. All remaining chubs are counted.

Hebgen Reservoir Zooplankton Monitoring

Monthly zooplankton tows were conducted at seven established sites on Hebgen Reservoir (Figure 18) to evaluate plankton community densities and composition. Plankton were collected with a Wisconsin plankton net (Figure 19) with 153 micron mesh (1 micron = 1/1,000,000th meter) towed vertically through the entire water column at one meter per second. Tows were taken at locations with a minimum depth of 10 meters. Samples were rinsed and preserved in a 95% ethyl alcohol solution for enumeration.

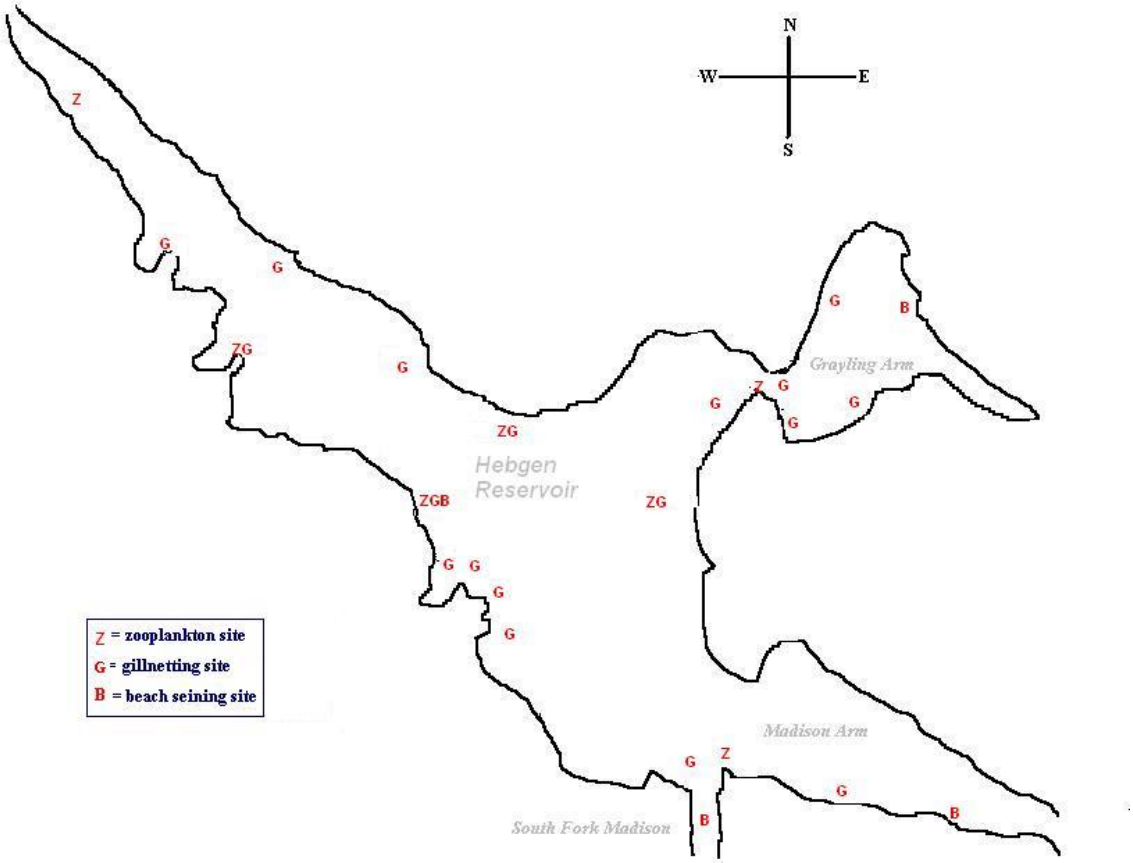

Figure 18. Map showing monitoring site locations of Hebgen Reservoir zooplankton, gillnetting, and beach seining.

Zooplankton were identified to order Cladocera (daphnia) or Eucopepoda (copepods), and densities from each sample were calculated. Carapace length was measured on six individuals of each Cladocera and Eucopopoda from each aliquot. Length adjustments were made to convert from micrometers to millimeters, and individual lengths were recorded in millimeters. Mean length was calculated for each sample and each site to determine if spatial and temporal variation existed.

A Secchi disk (Figure 19) was used to measure light penetration (in meters) into the Hebgen Reservoir water column. Depths were taken in conjunction with zooplankton tows to establish a Trophic State Index number (TSI) to determine reservoir productivity (Carlson 1977). Secchi depths were 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 development of blue-green algae blooms and zooplankton distribution relative to trout stocking.

Figure 19. A Wisconsin plankton net (left) and Secchi disk (right) used to collect zooplankton and measure light penetration, respectively, in Hebgen Reservoir.

RESULTS AND DISCUSSION

Madison Grayling

No juvenile Arctic grayling were captured by beach seining in Ennis Reservoir in 2013. Only six young-of-the-year Arctic grayling have been captured since 1996 (Appendix A).

In April 2007, the USFWS determined that fluvial Arctic grayling in the Big Hole River did not qualify as a Distinct Population Segment (DPS), and therefore were not warranted for listing under the Endangered Species Act (ESA). This decision was challenged in court. As part of a settlement agreement the USFWS agreed to re-evaluate the status of Arctic grayling in the Missouri River Basin.

In May 2009, the USFWS concluded that all life forms (fluvial and adfluvial) of Arctic grayling in the upper Missouri River Basin were genetically and geographically distinct from other Arctic grayling populations, therefore qualified for designation as a DPS and warranted for listing; however, listing of the Upper Missouri River Arctic grayling DPS under the ESA was precluded due to higher priority species. The Madison River population of Arctic grayling is included in the 2009 DPS designation, therefore may be listed under ESA if the DPS's listing priority is elevated. As part of settlement for a lawsuit associated with many species tenure on the Candidate Species List, the USFWS has agreed to reevaluate the status of Arctic grayling in the Upper Missouri DPS, beginning in October 2013. By September 2014 the USFWS will issue a proposed listing rule for Arctic grayling or will remove Arctic grayling from the Candidate Species List if listing is not warranted. A final rule is expected by September 2015.

MadTAC funds have been used to assist with Arctic grayling recovery efforts in the Big Hole River, Ruby River and Elk Lake as mitigation for potential impacts of PPL Montana hydropower operations on the Madison Arctic grayling population, and due to the possibility that the Big Hole population may someday

be used to attempt reintroductions into the Madison Drainage where a vestigial Arctic grayling population resides. These funds have helped FWP develop 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 conservation measures in cooperation with agencies that will reduce or eliminate detrimental habitat conditions for the grayling. Currently 33 landowners have enrolled 150,481 acres, with an additional 6,542 acres of State land enrolled. 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 MFWP for a project to reconnect portions of Swamp Creek to the Big Hole River and to re-establish Arctic grayling in Elk Lake (Appendix C).

Population Estimates

Population estimates were conducted in the Norris section of the Madison River in March and in the Pine Butte and Varney sections in September (Figure 6). A new charting format was adopted in 2011, developed by FWP Regional Fish staff (Vaughn pers comm.). Each chart displays the estimated number of fish 6 inches and larger, and also illustrates additional size groups. The population 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 12 inches and larger (Figure 20) includes all rainbow trout larger than 12 inches, not just those 12 – 14 inches.

Figures 20 - 22 illustrate the number of rainbow trout per mile for several size classes in each of the three sections, and Figures 23 - 25 illustrate numbers of six inch and larger brown trout per mile in each of the sections.

Rainbow and brown trout population levels in the Bypass (Figure 26) compare favorably with population levels in other sections of the Madison River. The preponderance of holding sites among the boulder and cobble substrate allows for a greater density of fish than in other river sections.

Ennis Reservoir Gillnetting

Table 2 summarizes the 2013 Ennis Reservoir gillnet data. Unlike most previous years when Utah chub were the most abundant species captured, in 2013 they were the least abundant species except for mountain whitefish, and made up only 15 percent of the total catch (Appendix D). In previous years they have comprised from 26 to 66 percent of the total catch. Rainbow trout were the most abundant species captured in 2013. Until 2013, no whitefish had been captured in Ennis Reservoir gillnetting since 1999. In 1995, 1996 and 1999 a total of 6, 19 and 2 whitefish were captured, respectively. Average length ranging between 11.9 and 14.5 inches.

Charts illustrating the number captured, average length and species composition from 1995 - 2013 are in Appendix D.

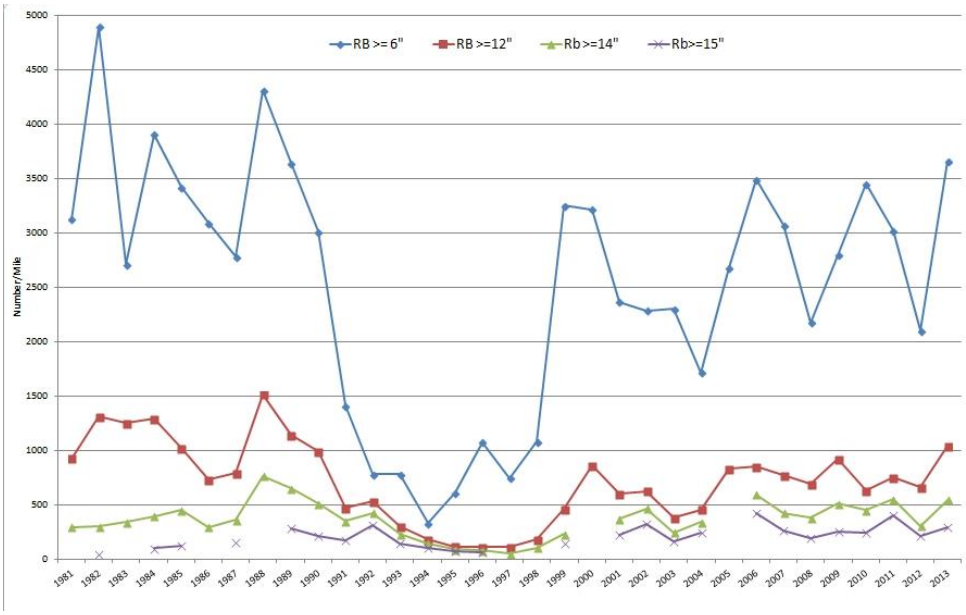

Figure 20. Figure showing the long-term trend of the rainbow trout population by size group in the Pine Butte section of the Madison River during fall, 1981–2013.

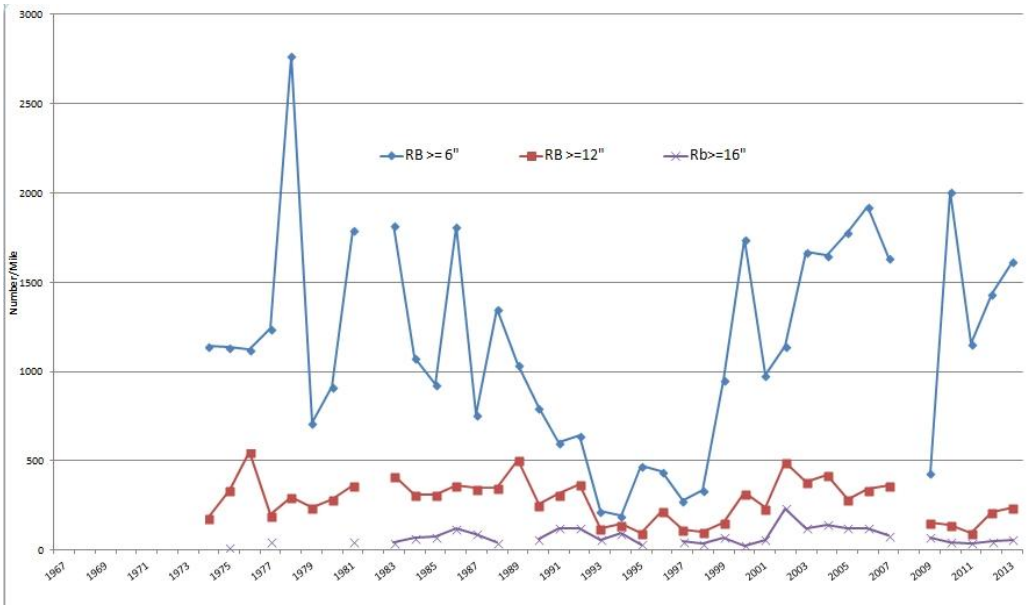

Figure 21. Figure showing the long-term trend of the rainbow trout population by size group in the Varney section of the Madison River during fall, 1967–2013.

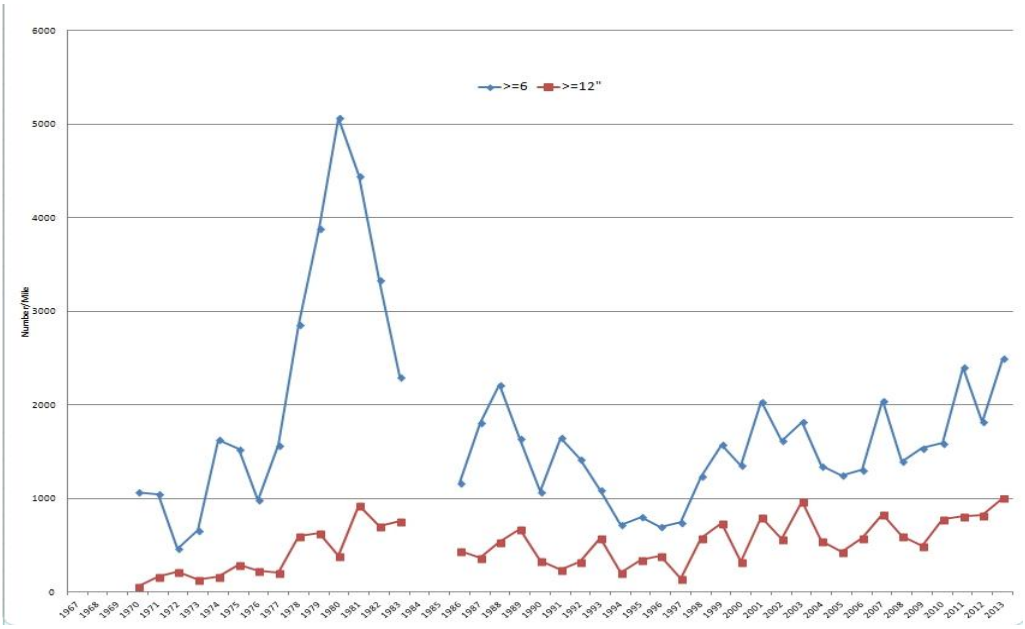

Figure 22. Figure showing the long-term trend of the rainbow trout population by size group in the Norris section of the Madison River during spring, 1967–2013.

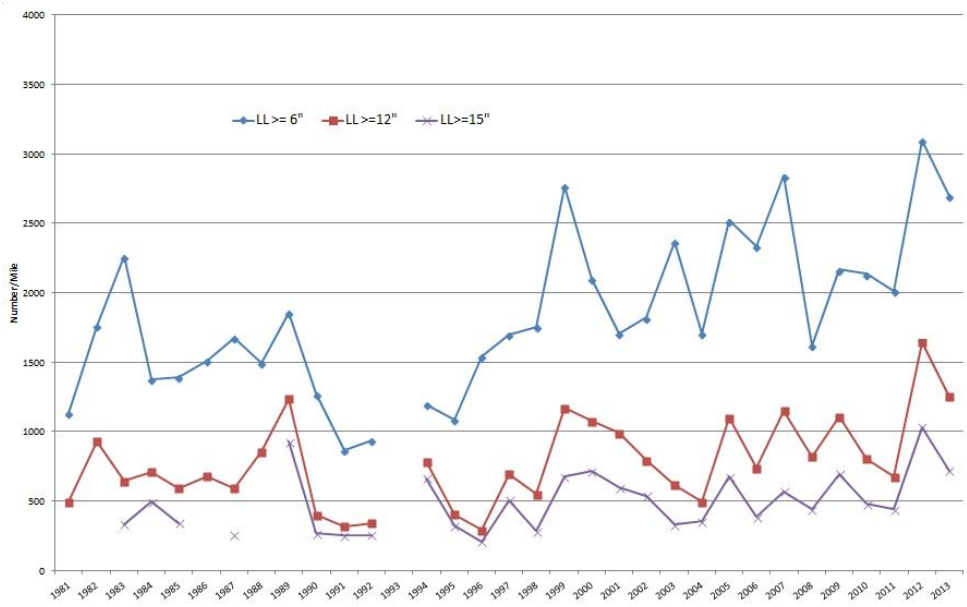

Figure 23. Figure showing the long-term trend of the brown trout population by size group in the Pine Butte section of the Madison River during fall, 1981–2013.

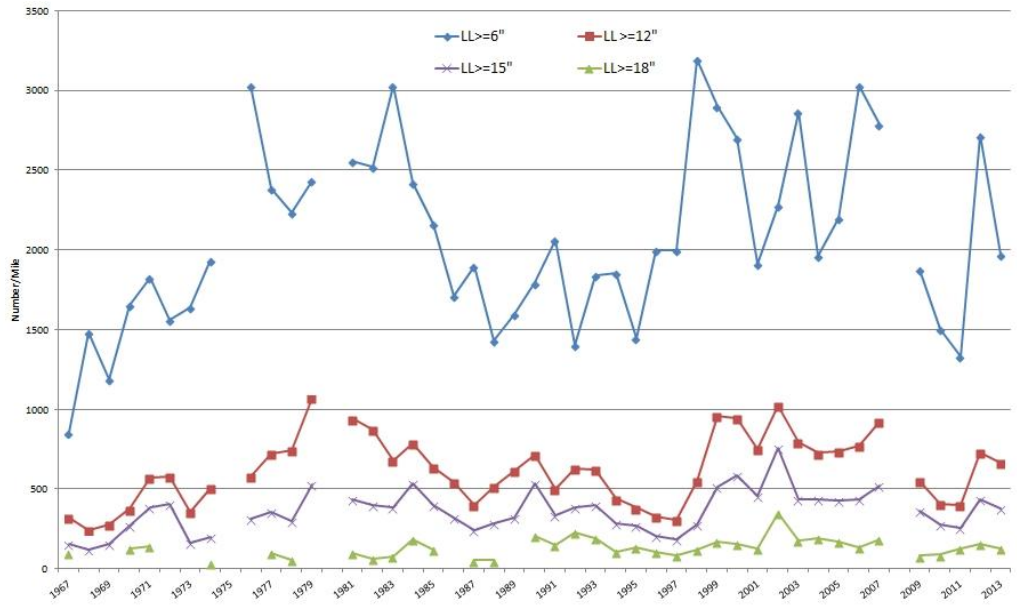

Figure 24. Figure showing the long-term trend of the brown trout population by size group in the Varney section of the Madison River during fall, 1967–2013.

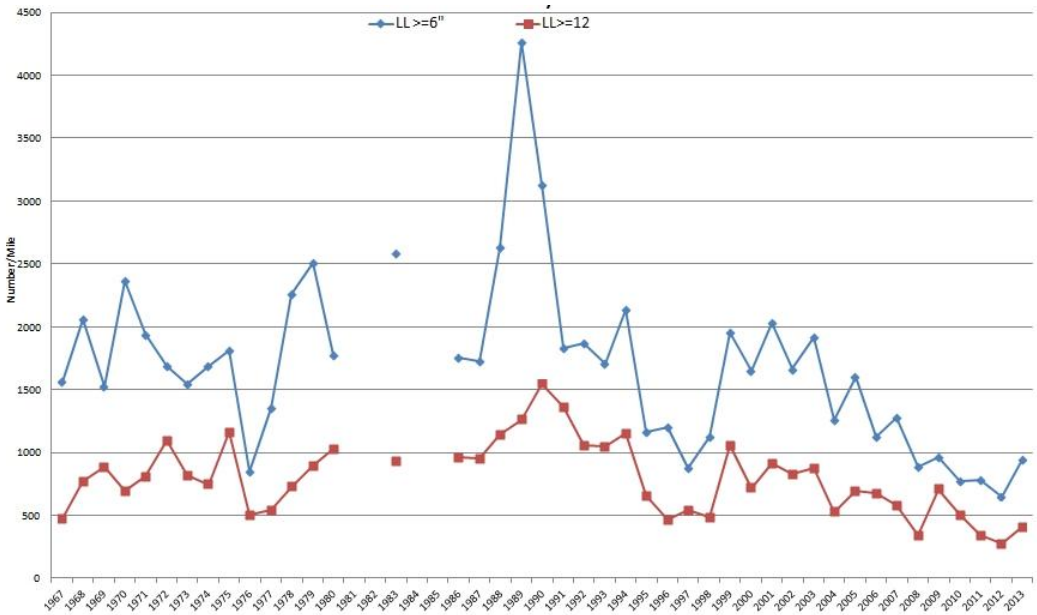

Figure 25. Figure showing long-term trend of the brown trout population by size group in the Norris section of the Madison River during spring, 1967–2013.

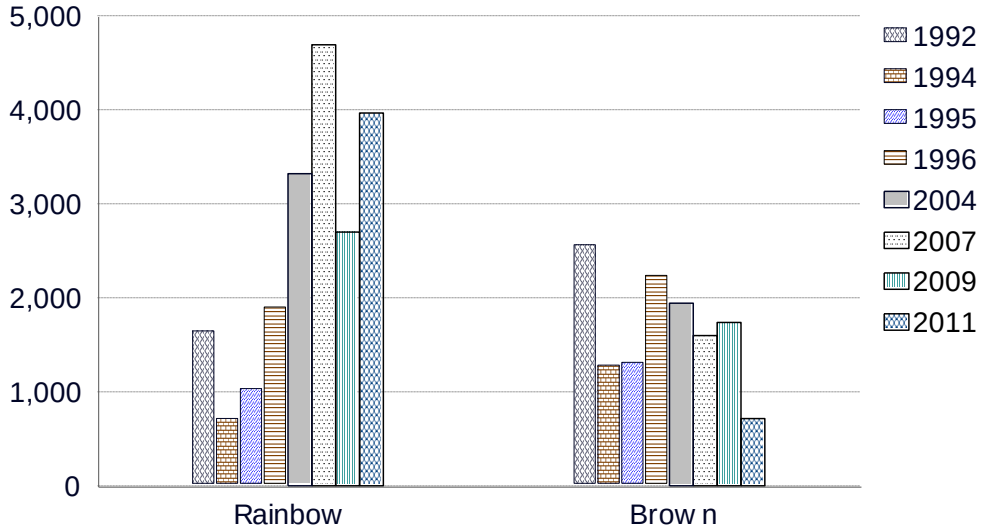

Figure 26. Population estimates (number/mile) of rainbow trout and brown trout in the Bypass section of the Madison River, spring estimates. PPL Montana personnel conducted the 1992 estimate.

Table 2. Summary of October 9 – 10, 2013, gillnet catch in Ennis Reservoir. Length is in inches, weight is in pounds.

	UC[1]	WSu	Rb	LL	MWF
Avg.length	10.2	15.7	11.9	13.9	10.1
Avg.weight	0.63	1.92	0.82	1.18	0.42
Number sampled	37	79	92	41	3

[1] UC = Utah Chub; WSu = White Sucker; Rb = rainbow trout; LL = brown trout; MWF = mountain whitefish

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River Discharge

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 September 27, 2000, FERC license to PPL Montana. Condition No. 6 succinctly states the elements of Article 403. At the time the FERC license conditions were being developed prior to the license being issued, all entities, including MPC and FWP, supported the elements of Article 403, and requested that the Forest Service include these conditions within their authority to mandate conditions in the FERC license. The minimum flows at the Kirby and McAllister gauges were in place through an agreement between MPC and FWP prior to the FERC license.

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."

Pulse Flows

In 1994 PPL Montana 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 were necessary every year from 2000 – 2007, but since then have been necessary only in 2009 and 2013. Table 3, adapted from PPL Montana 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 2013 as the triggering criteria were not met.

Temperature Monitoring

Onset Tidbit™ temperature recorders were deployed throughout the Madison River to document air and water temperatures (Figure 7). Table 4 summarizes the data collected at each location in 2013, 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 for the past 17 years, 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 14 years data are available, maximum water temperature at the Hebgen Inlet site is higher than maximum water temperature at the Hebgen discharge site
- For 15 of 16 years where data are available, maximum water temperature at the Quake Inlet site is higher than maximum water temperature at the Quake outlet site
- Hebgen Reservoir and Quake Lake decrease the maximum water temperature, but that affect appears to be attenuated by the time the water reaches the Kirby site. The Kirby and McAtee sites exhibit very similar maximum water temperatures
- The Ennis Reservoir Inlet site annually exhibits the highest maximum water temperature of the 7 sites between Hebgen Dam and Ennis Reservoir
- In 16 of the 19 years where data are available, maximum water temperature at the Ennis Dam site is lower than at the Ennis Reservoir Inlet site

Table 3. Summary statistics for years in which pulse flows were conducted on the Madison River.

Year	Hebgen October 1 pool elevation[1/]	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
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
2009	6533.02	1.85	0.03	2	1.82
2013	6531.07	3.80	1.70	42	2.10

[1/] Hebgen full pool elevation is 6534.87 feet mean sea level. The FERC license requires PPL Montana to maintain Hebgen pool elevation between 6530.26 and 6534.87 from June 20 through October 1.

- Maximum water temperature at Blacks Ford has been suppressed by pulse flows when necessary to prevent thermal stress related fish kills, the last of which occurred in 1988.
- Maximum water temperatures at all sites downstream of Ennis Dam typically are at least 5^{o} F warmer than at Ennis Dam

Aquatic Invasive Species

The annual economic cost of invasive species management and control in the United States is estimated to be nearly $120 billion (Pimentel et al 2005). The Aquatic Nuisance 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 and whirling disease. Montana has an active multi-agency AIS program coordinated through FWP (Appendix B).

Within FWP Region 3 dissolved calcium levels measured in 2009 varied from 11mg/l at the Big Hole River Fish Trap FAS to 62 mg/l at Clark Canyon Reservoir. The sole site sampled in the Madison Drainage was Ennis Reservoir, which showed a calcium concentration between 20 – 24 mg/l. Calcium concentrations of 15 mg/liter or less are thought to limit the distribution of zebra/ and quagga mussels.

FWP AIS field crews found no Zebra or Quagga mussel or Asian clam veligers or adults, or Eurasian watermilfoil *Myriophyllum spicatum* in samples collected at Madison Drainage sites in 2013.

Table 4. Table showing maximum and minimum temperatures (^{o}F) recorded at selected locations in the Madison River Drainage, 2013. Air and water temperature data were recorded from April 24 – October 6 (43,456 data points each recorder). Thermographs for each location are in Appendix E.

	Site	Max	Min
Water	Hebgen inlet	79.4	42.9
	Hebgen discharge	70.5	37.1
	Quake Lake inlet	71.3	36.4
	Quake Lake outlet	68.2	37.2
	Kirby Bridge	72.6	35.5
	Wall Ck Bridge	73.8	33.9
	McAtee Bridge	74.3	34.3
	Ennis Bridge	75.2	37.5
	Ennis Reservoir Inlet	80.0	36.3
	Ennis Dam	76.2	39.7
	Bear Trap Mouth	80.0	38.4
	Norris	79.2	38.6
	Blacks Ford	80.0	36.9
	Cobblestone	81.6	36.7
	Headwaters S.P. (Madison mouth)	81.2	38.7
Air	Kirkwood	86.8	18.5
	Slide	92.7	20.7
	Wall Creek HQ	92.4	19.8
	Ennis	96.1	17.9
	Ennis Dam	90.3	26.7
	Norris	93.9	32.7
	Cobblestone	101.1	23.2

New Zealand Mudsnails

AIS sampling at Madison Drainage locations revealed the greatest density of NZMS to be 3,573 per square meter at the footbridge area of Darlington Ditch at Cobblestone FAS. Two of 3 sites sampled in O'Dell Creek were positive at densities of 80 and 21 per square meter.

The Montana Aquatic Species Coordinator has developed a plan to address New Zealand mud snails. 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 undertaken 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 for cleaning project equipment to reduce the chance of spreading AIS through work activities.

NZMS have not been found in any state or federal hatcheries in Montana. Strategies have been implemented to prevent the spread of NZMS from the sole private hatchery in which they were discovered in the state. The spread of NZMS has slowed and appears to be confined in Montana to east of the Continental Divide.

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 Gallatin national forests are summarized in Appendix F.

Sun Ranch Westslope Cutthroat Trout Program

Egg take from nine donor streams incubated at the Sun Hatchery in 2013 provided 9,052 eyed eggs. Eyed eggs or fry from wild sources were introduced into Cherry Creek (Big Hole Drainage), Goose Lakes in Yellowstone National Park and the Sun Ranch Brood pond.

Nine female and 38 male Sun Ranch Brood fish were spawned in 2013, providing 14,980 eyed eggs. The sole recipient water of these fish was the Sun Ranch Brood Pond (3,000 fry).

Appendix G lists the contributions to and production of the Sun Hatchery since 2001 as well as an annual summary for 2013 activities, and Appendix H provides a list of streams for which PPL Montana funding has been used for genetic analyses.

Cherry Creek Native Fish Introduction Project

Introductions of eyed eggs and WCT fry were conducted in the Cherry Creek Project area between 2006 and 2012 (Figure 27).

Personnel from FWP, the Wildlife Conservation Society, Gallatin National Forest, and Turner Enterprises are conducting monitoring activities throughout the project area to assess survival, growth and distribution of the various donor populations that have been used to establish the Cherry Creek WCT population. Pending available funding, genetic samples from the developing population will be analyzed as the WCT population establishes and stabilizes to ascertain the proportion from each donor source relative to the proportion of eggs introduced. WCT have been documented to be pioneering up some tributaries, primarily as yearlings, where they were not introduced either as eyed eggs or fry, and two anglers have reported catching WCT in the Madison River near the mouth of Cherry Creek, including photo documentation. Spawning by WCT introduced as eggs in 2006 – 2009 has been documented as evidenced by young-of-the-year WCT captured by electrofishing in 2010-2013 in phases where no introductions occurred in 2010-2013. Figure 28 shows an adult WCT captured in Cherry Creek that was introduced as a fertilized egg.

No piscicides have been applied in the project area since 2010 as no non-native fish have been found in the project area during annual surveys.

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. Liquid rotenone and/or rotenone powder dough was applied to the stream and its fish bearing tributaries.

A bioassay conducted prior to the December 5, 2012 treatment showed that sentinel trout within 1 ½ hours of the rotenone dough application point died within 1 ½ hours of initial exposure to 1 part-per-million (ppm) rotenone, but trout 2 hours below the application point were still alive 4 hours after initial exposure. Two or three of five sentinel sculpins ½ and 1 hour below the bioassay application point died, while no sentinel sculpins over 1 hour below that point died. Rotenone application sites and rotenone concentrations were based off of the bioassay results.

Sentinel trout throughout the entire treatment area were killed by the treatment, while no sentinel sculpins died other than those noted in the bioassay.

During all treatments, neutralization of the rotenone with potassium permanganate was conducted immediately below the waterfall at stream mile 0.7. Typically, up to 30 minutes of contact time between rotenone and potassium permanganate is necessary to fully neutralize the rotenone. A sufficient quantity of potassium permanganate must be applied to the stream to accomplish three things – overcome the biological demand in the stream, neutralize the rotenone and provide a surplus after 30 minutes of contact time to illustrate that the other two demands are being met.

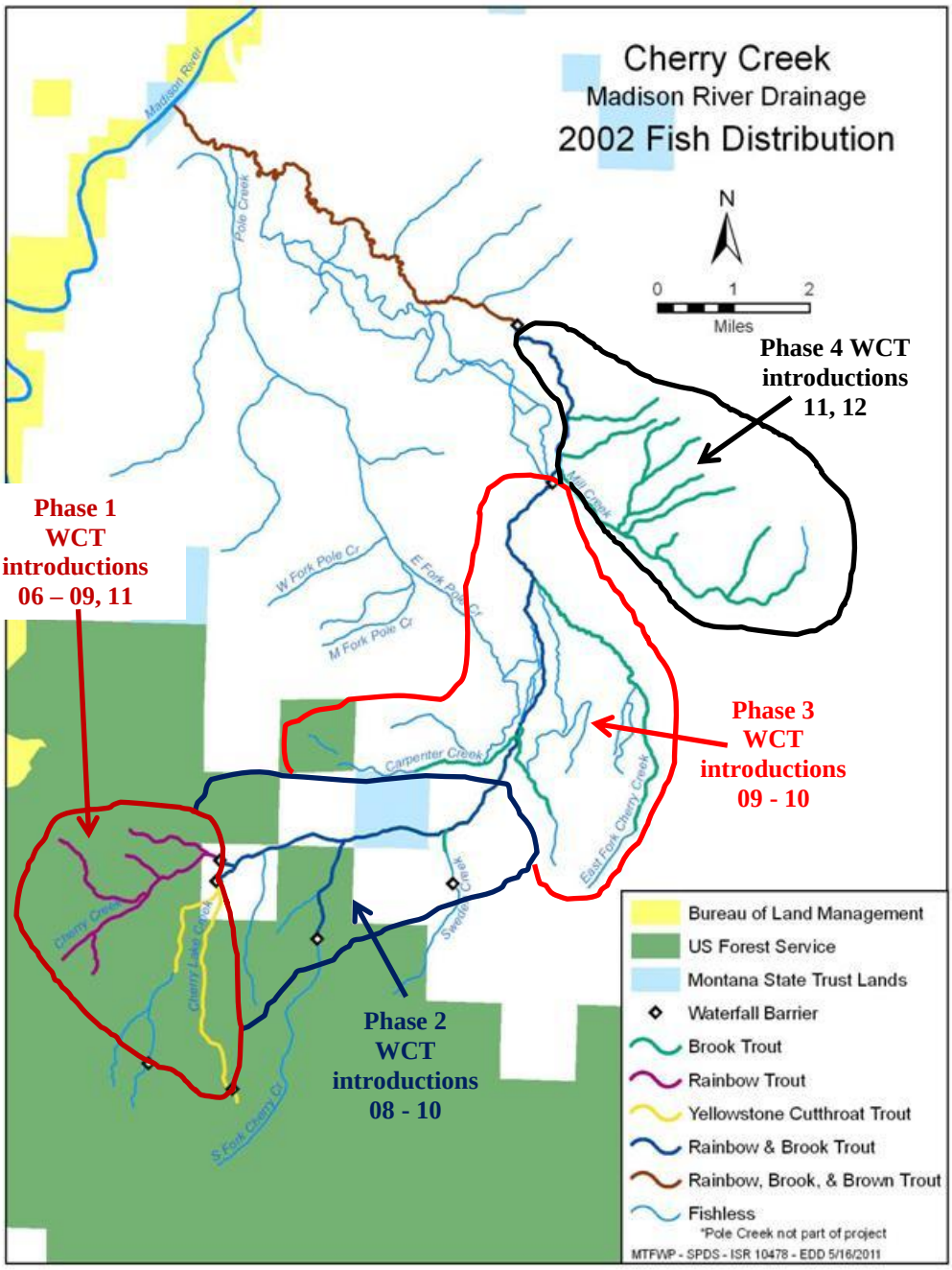


Figure 27. Phases 1 - 4 of the Cherry Creek Native Fish Introduction Project where wild WCT were introduced in 2006 - 2012 following eradication of non-native Yellowstone cutthroat, rainbow, and brook trout in 2003 – 2010.

Figure 28. An 11.3 inch WCT captured in Cherry Creek Phase 2 in 2010. This fish was introduced into Cherry Creek as a fertilized egg. FWP photo by Lee Nelson.

Sentinel fish were placed at locations immediately upstream of the neutralization station and at selected locations up to 30 minutes stream-flow time below the station. To conduct a thorough treatment, sentinel fish immediately upstream of the neutralization station must succumb to the rotenone, but FWP policy requires that neutralization must continue until their replacements survive for 4 hours. These criteria were met during all treatments. During the April and October treatments, replacement sentinels survived 5 hours and 19 hours, respectively, before neutralization was terminated. Additionally, sentinel fish 30 minutes below the neutralizations site survived, indicating complete neutralization of the rotenone prior to entering the Madison River.

Water temperatures throughout the treatment and neutralization zones ranged from $40^{o} – 46^{o}$ F due to spring inflow near the upper end of the treatment area, and thus there was no ice on the stream.

Fish Habitat Enhancement

South Fork of Meadow Creek

Design and bid awarding to rebuild irrigation infrastructure, including in-stream weirs and headgates, were completed in 2011 with construction initiated in 2012. 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 is prevented. The Madison Watershed Coordinator is monitoring and photographing stream channel morphology and other parameters prior to and following fence construction to document any changes that occur (Figure 29). The original design of the instream weir structures was modified out of concern that they would not pool adequate water to feed the irrigation ditches.

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 needs, though 2011 was a good water year, which resulted in adequate instream flow.

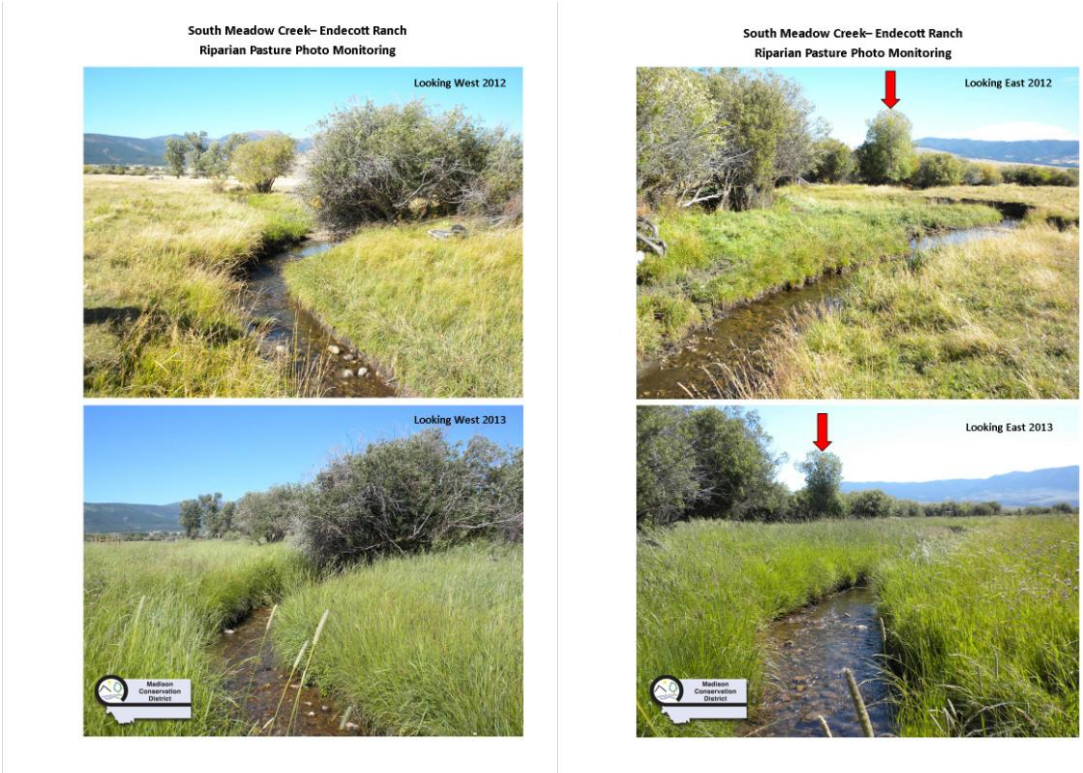


Figure 29. Photos of the Endecott section of the South Fork Meadow Creek, illustrating grass conditions before (top photos) and after (bottom photos) construction of riparian fence that restrict livestock access. Photos courtesy of the Madison Conservation District.

Table 6. Summary statistics of electrofishing in two sections of the South Fork of Meadow Creek, 2011 – 2013.

	Brown trout		Brook trout	
Section and Date	Number captured	Average length (range)	Number captured	Average length (range)
Section 1				
9/20/11	128	4.7 (2.3 – 13.3)	21	3.7 (2.4 – 10.0)
4/13/12	11	4.8 (3.1 – 7.1)	10	5.6 (3.2 – 7.5)
9/27/12	37	4.5 (2.6 – 7.7)	9	4.6 (3.0 – 7.2)
4/29/13	4	4.9 (3.5 – 6.2)	23	6.3 (5.4 – 8.0)
Section 2				
9/20/11	86	3.8 (2.8 – 9.5)	102	3.8 (2.3 – 10.1)
4/13/12	31	5.1 (2.4 – 11.2)	10	6.0 (3.3 – 7.6)
9/27/12	Not Sampled			
4/29/13	1	3.3	6	5.8 (4.8 – 6.5)

Hebgen Basin

Hebgen Reservoir Gillnetting

A total of 1,329 fish were captured during Hebgen Reservoir gillnetting in 2013 (Table 7), over 70% were Utah chub *Gila atreria*.

Table 7. Summary of 2013 Hebgen Reservoir gillnet catch.

Species	Number caught	Average Length (range)	Average weight (range)
Rainbow trout	93	16.5 (9.5 – 20.8)	1.73 (0.34 – 2.92)
Brown trout	138	17.1 (6.4 – 23.6)	1.90 (0.10 – 49.0)
Whitefish	135	15.3 (6.5 – 20.6)	1.68 (0.10 – 3.47)
Utah Chub	963	8.5 (5.3 – 14.7)	0.37 (0.06 – 1.73)

The number of rainbow trout captured by gillnetting in 2013 rebounded from 2012 (Figure 30). The number of rainbows captured per year has varied from 40 in 2001 to 194 in 2008. The average length of rainbow and brown trout and whitefish has increased since 2003, but it is most noticeable among rainbow trout.

Additionally, the proportion of the rainbow trout gillnet catch under 14 inches has decreased noticeably since 2002 (Figure 31), except in 2012 when it was in a similar proportion to 1999-2002.

Water chemistry analyses are nearly complete for the Hebgen Reservoir rainbow trout spawning origin study (Appendix I), and nearly 300 otoliths have been collected. Technical issues at the out-of-state laboratory have suspended the analyses, but it is expected to resume in 2014.

Brown trout numbers have fluctuated widely with no consistent trend evident for more than a few consecutive years (Figure 32). 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 (Figure 33). The number captured per year has varied from 80 in 2002 to 235 in 1999. Average length has shown a generally upward trend.

The number of Utah chub captured decreased significantly in 2005 and has remained low until 2013. Average length has shown no consistent trend since 1995 (Figure 34). The number of Utah chub captured annually has ranged from 268 in 2008 to 2,245 in 1999.

Utah chub comprised 77% of the total Hebgen gillnet catch between 1995-2003, but have averaged 61% since (Figure 35).

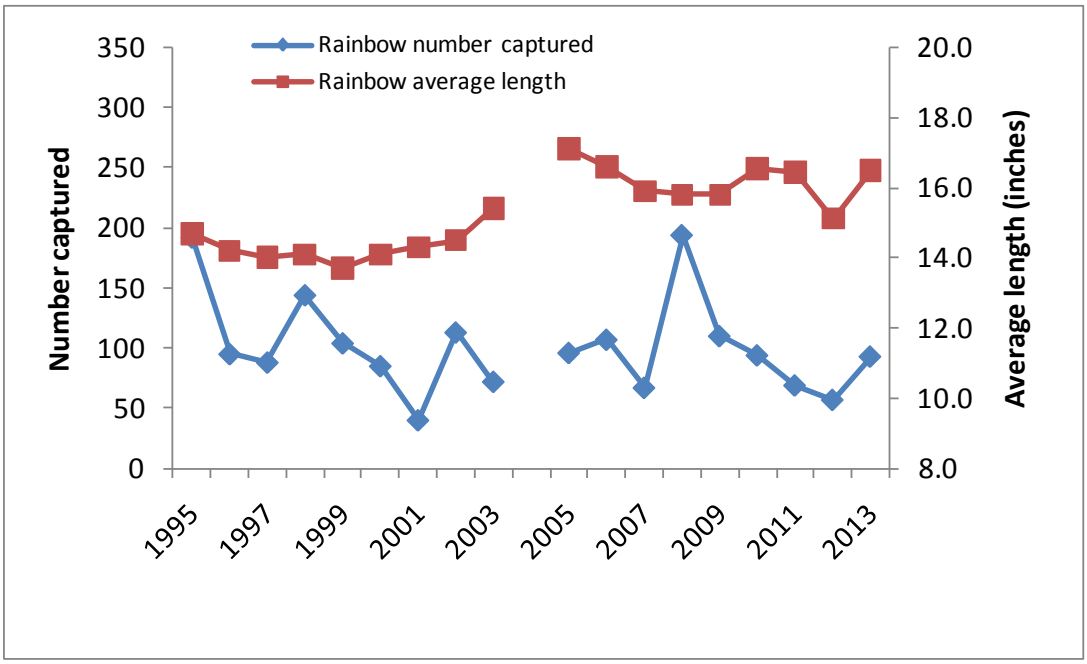


Figure 30. Figure showing rainbow trout average length in inches (right axis) vs. number captured (left axis) during annual Hebgen gillnetting, 1995-2013. Data from 2004 are not shown because of sampling error.

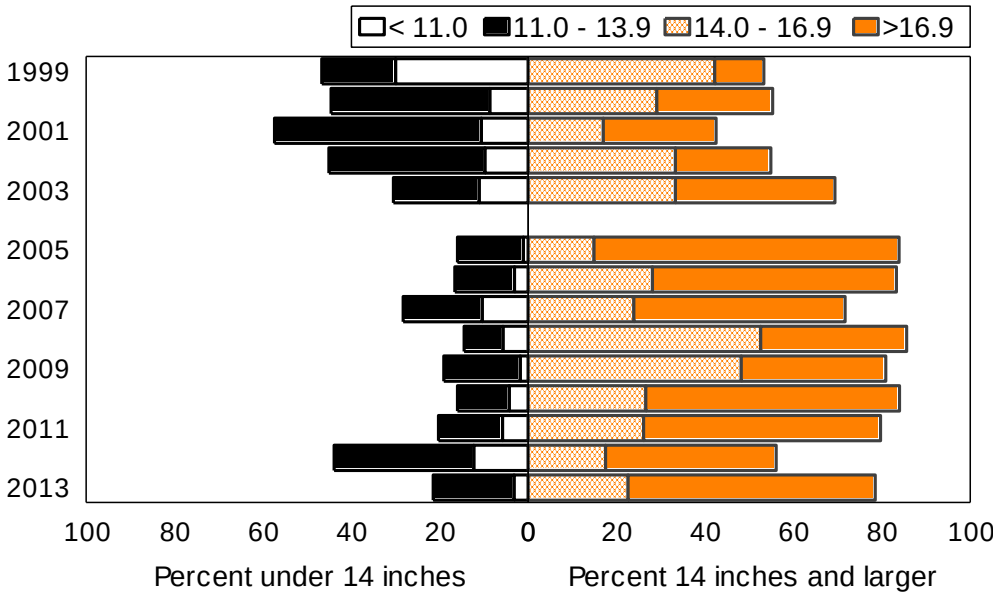


Figure 31. Figure showing percentage of Hebgen Reservoir rainbow trout gillnet catch under and over 14 inches, 1999-2013. Data from 2004 are not shown because of sampling error.

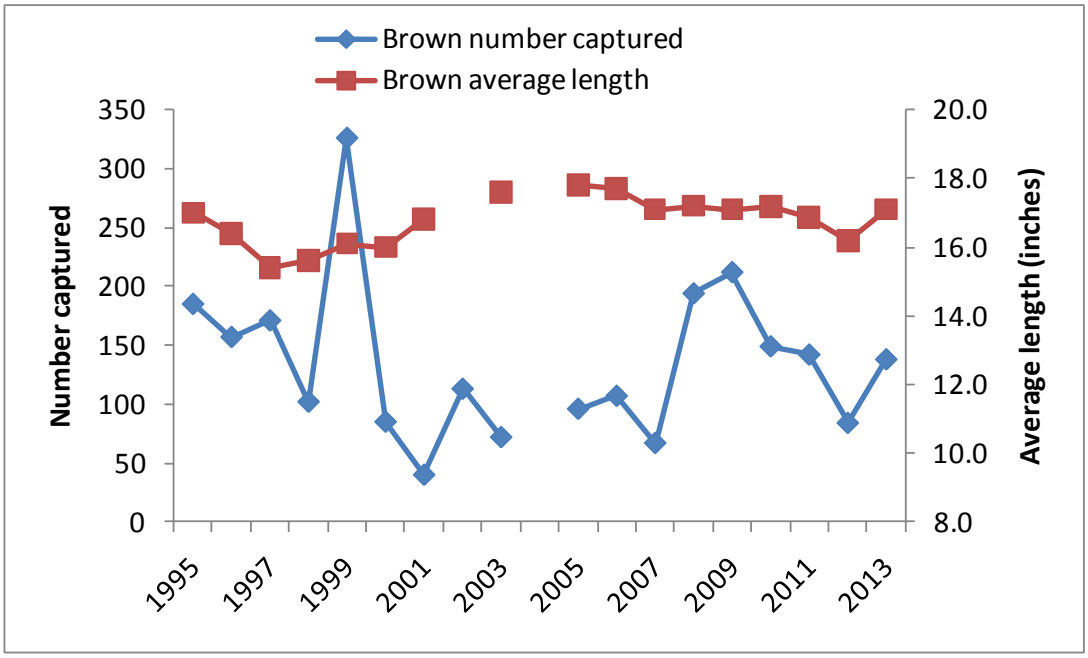


Figure 32. Figure showing brown trout average length in inches (right axis) vs. number captured (left axis) during annual Hebgen gillnetting, 1995-2013. Data from 2004 are not shown because of sampling error.

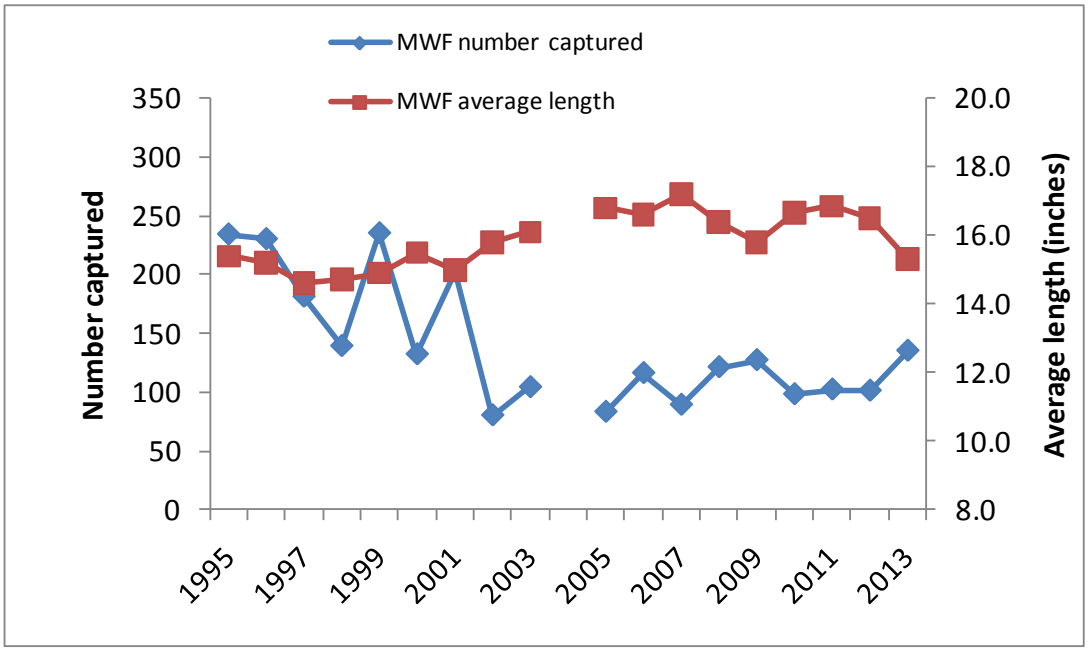


Figure 33. Figure showing mountain whitefish average length in inches (right axis) vs. number captured (left axis) during annual Hebgen gillnetting, 1995-2013. Data from 2004 are not shown because of sampling error.

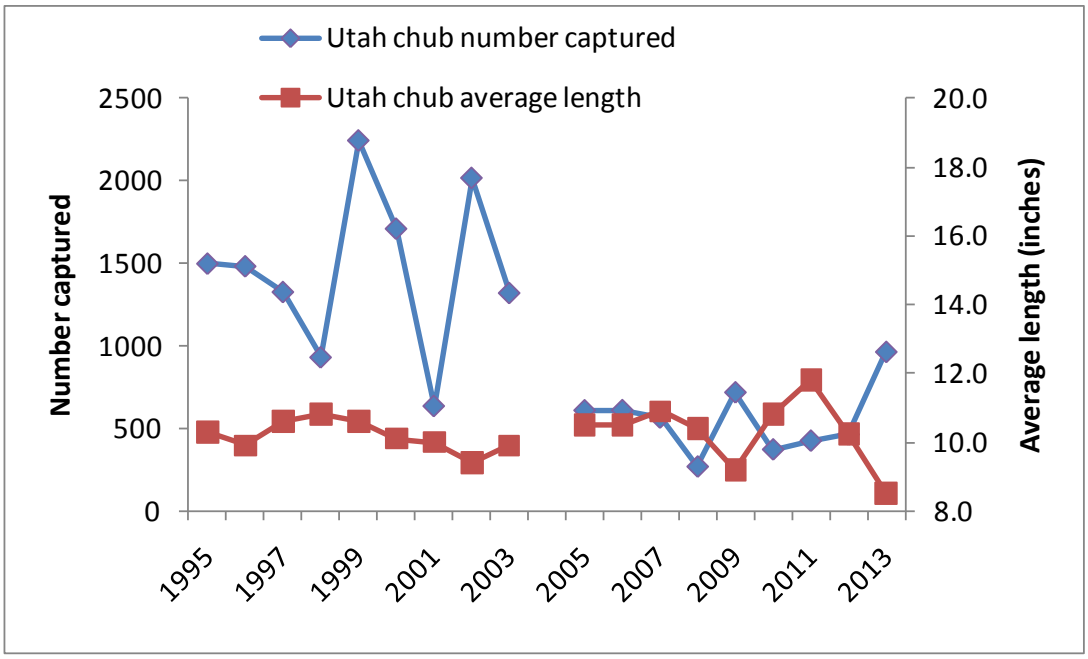


Figure 34. Figure showing Utah chub average length in inches (right axis) vs. number captured (left axis) during annual Hebgen gillnetting, 1995-2013. Data from 2004 are not shown because of sampling error.

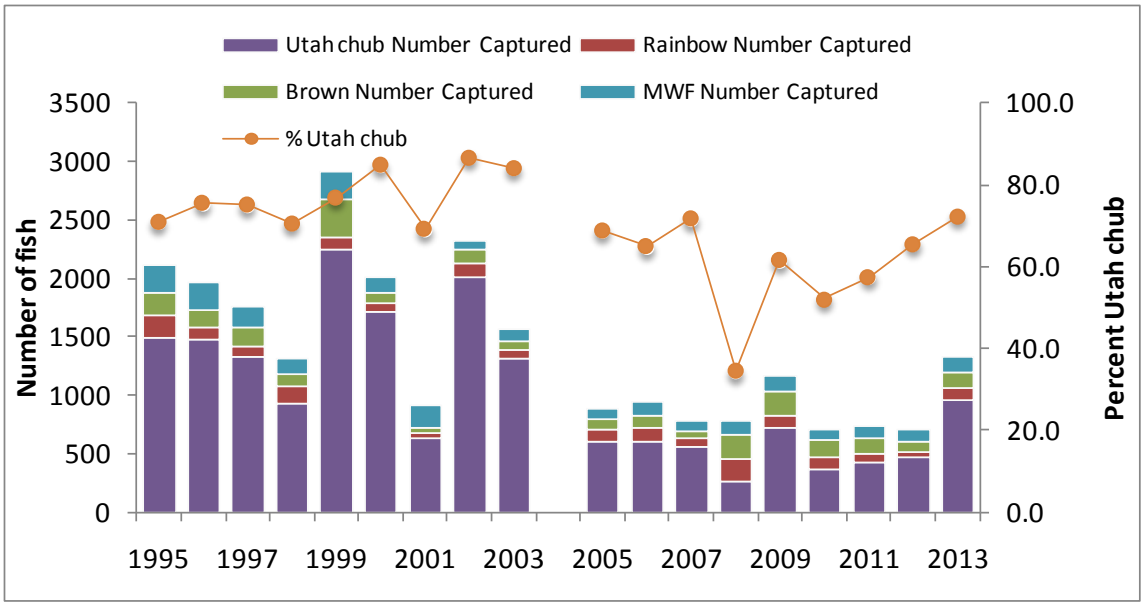


Figure 35. Figure showing species composition of Hebgen Reservoir gillnet catch, 1995 – 2013. Data from 2004 are not shown because of sampling error.

Hebgen Basin Juvenile Fish Sampling

Beach Seining

Beach seining has been conducted intermittently to monitor juvenile fish numbers in Hebgen Reservoir. Figure 36 illustrates total catch at three index sites for 2007, 2008 and 2011 - 2013.

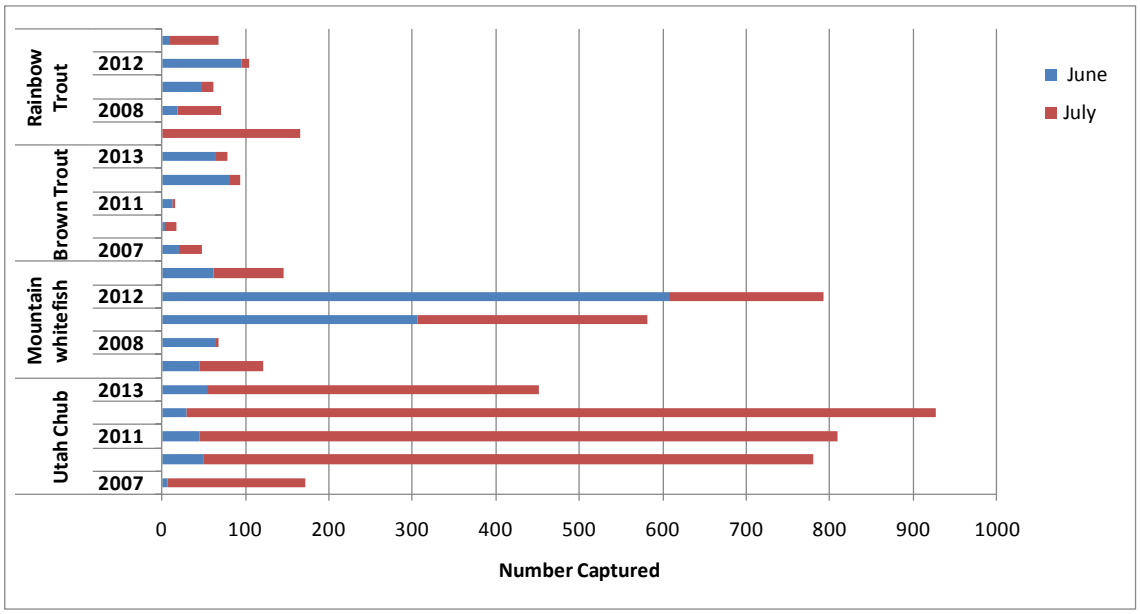


Figure 36. Beach seining catch of juvenile Hebgen Reservoir fish, June and July, 2007, 2008, 2011 - 2013.

Numbers of juvenile chubs have consistently been low in June and shown dramatic increases in July, which may be a function of their size. Graham (1955) found that peak spawning of Utah chub in Hebgen occurred mid June to early July in shallow near-shore zones often with submergent or emergent vegetation and inundated terrestrial vegetation. The number of young-of-the-year Utah chub captured by beach seining appears to be closely related to reservoir elevation, which affects the availability of spawning habitat utilized by Utah chub (Figure 37). Teuscher and Lueke (1996) suggest vegetation as a key component to successful Utah chub spawning. Differences observed in the number of young-of-the-year Utah chub throughout the years may be a function of reservoir elevation on Utah chub access to inundated shoreline vegetation.

Hebgen Reservoir Zooplankton Monitoring

Densities (individuals/liter) of cladoceran and copepod zooplankton in Hebgen Reservoir have been monitored since 2006 (Appendix J). Annual temporal trends in abundance show peak densities occurring in late spring and early summer (Figure 38).

Body size of both cladoceran and copepods increased as densities declined. A similar trend has been observed in zooplankton populations in several temperate lakes (Hall and Threlkeld 1976). The warming of the reservoir in early spring typically triggers a phytoplankton bloom promoting quick growth of the zooplankton community. However, size selective predation on larger cladocerans by fish reduces their abundance and predation shifts to copepods. Reduced predation on the remaining

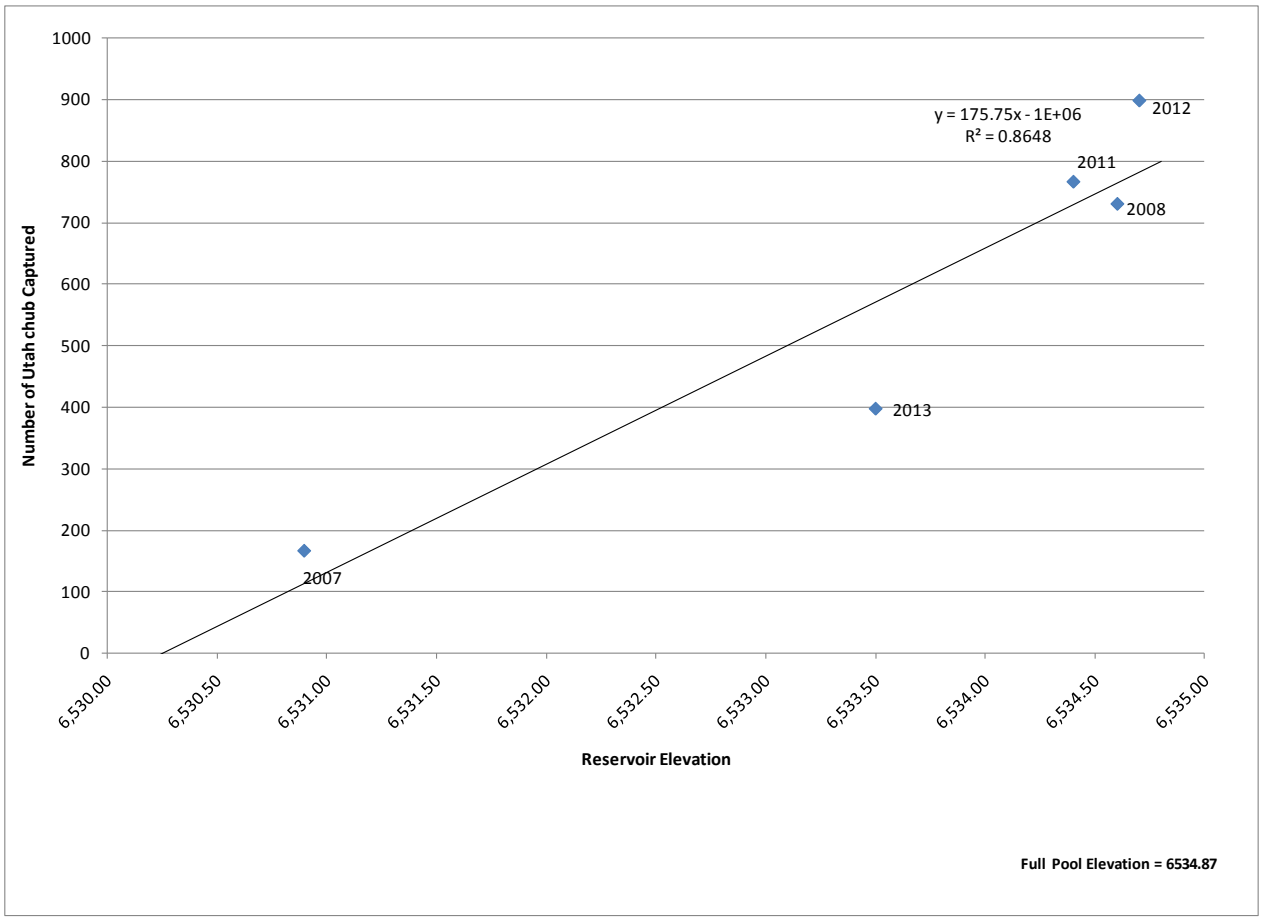


Figure 37. Number of young-of-the-year Utah chub collected during July seining of index sites versus reservoir elevation 2007, 2008, 2011 - 2013.

cladoceran community could account for the increase in body size seen in the cladoceran community through summer until densities are such that another predation shift occurs.

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 39) developed by Carlson (1977), Hebgen Reservoir is classified as oligotrophic-mesotrophic with 2009 – 2012 mean TSI scores ranging between 35.6 – 39.9. The 2013 score was 38.6. This may partially explain the low plankton densities observed in Hebgen. Figure 40 illustrates mean cladoceran and mean copepod densities versus mean TSI score for each of the seven monitoring sites for 2009-2013.

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

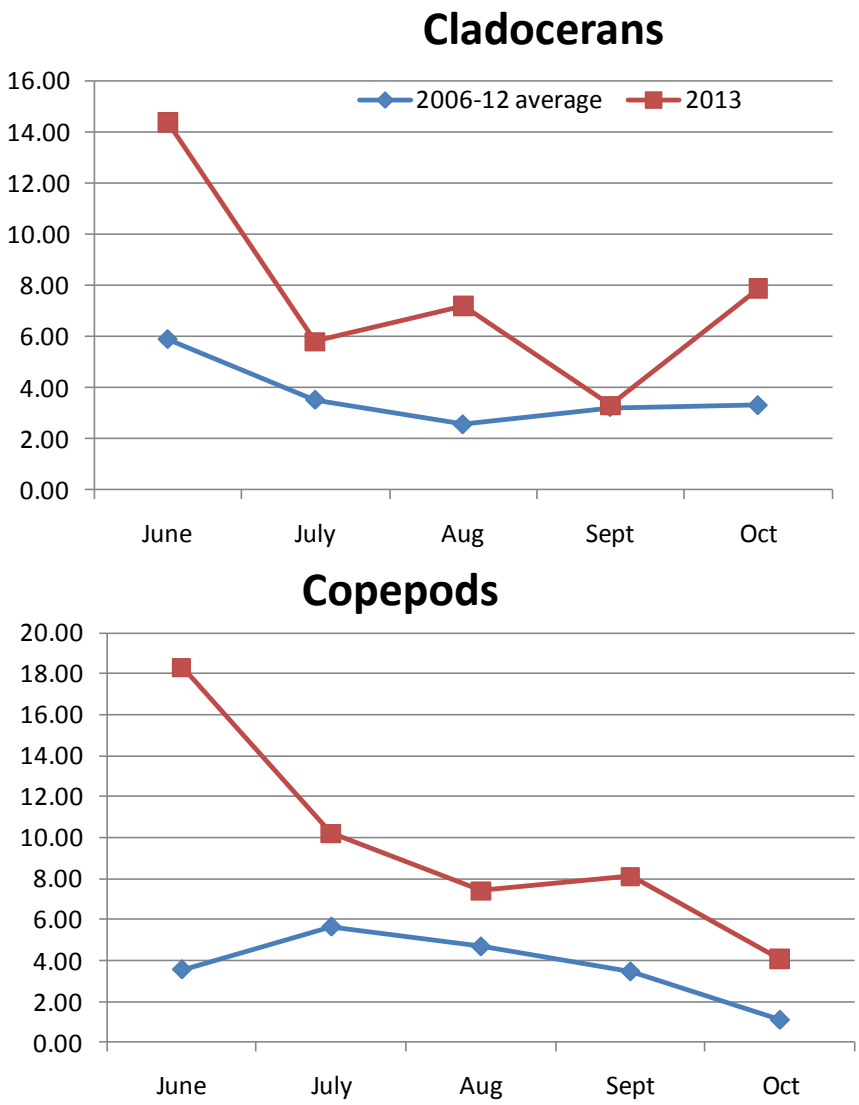


Figure 38. Figure comparing 2013 Hebgen Reservoir monthly cladoceran and copepod densities (individuals/liter) to the 2006 -12 monthly averages.

season (the number of days water surface temperature is at or exceeds 50°F) to be inversely related to lake productivity. Mean daily surface water temperatures for Hebgen over the last five years equaled or exceeded 50° F an average of 130 days. In 2007, surface temperatures equaled or exceeded 50° F for 152 days, extending the growing season by almost a month, which may have contributed to the increase in cladoceran densities observed. Additionally, wind patterns may be inhibiting the mixing of nutrients from tributaries entering Hebgen with the main body of the reservoir. For the months of June through October, 2007-2009, at the West Yellowstone airport, wind direction was predominately out of the northwest (Figure 41). 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.

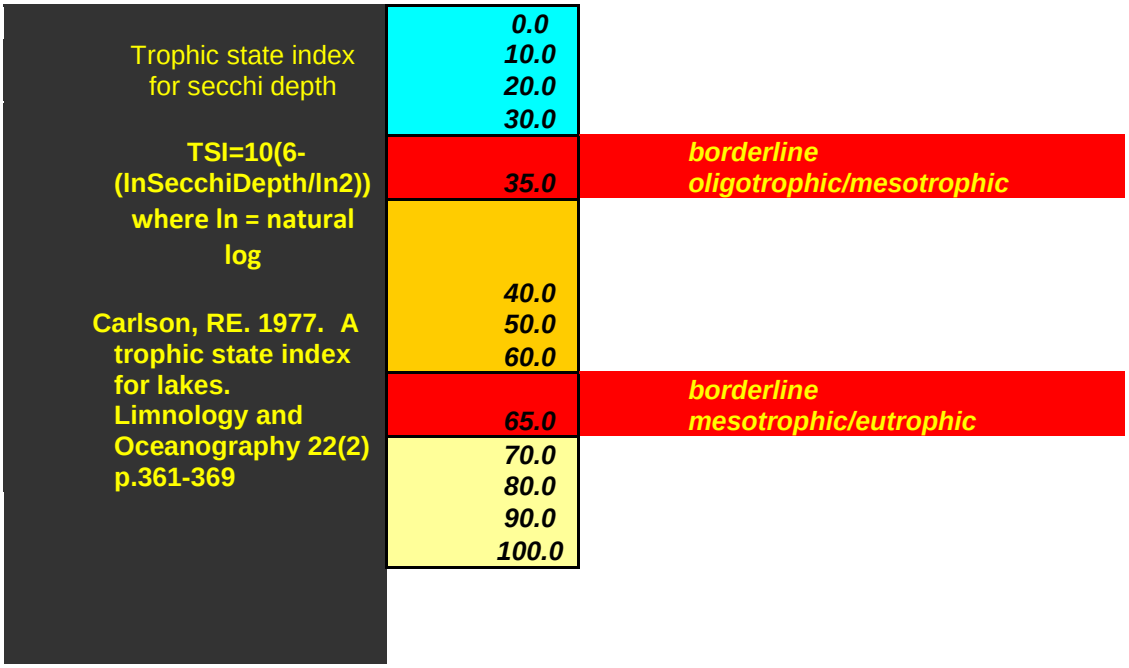


Figure 39. Figure depicting the trophic state index formula and classification for lake productivity using secchi depth measurements.

FWP and PPL Montana 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 K) shows that wind patterns predominately occurred out of the southwest in 2011 and 2013, but out of the northwest in 2007 – 2009 and 2012. 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. Additionally, connectivity of the arms to the main body of the reservoir is narrow which may be functioning as a bottleneck limiting the amount of nutrient exchange between the arms and the main reservoir.

Zooplankton densities at monitoring sites in the main body of the reservoir (Dam, Watkins, Johnson and Horse Butte sites) were examined to assess the influence of wind on them (Figure 42). In 2013, contrary to 2012, June experienced the least number of wind occurrences and had a mean wind speed similar to all other months. However, as in 2012, June exhibited the highest densities of zooplankton. To date, no trend between zooplankton density and wind characteristics is apparent.

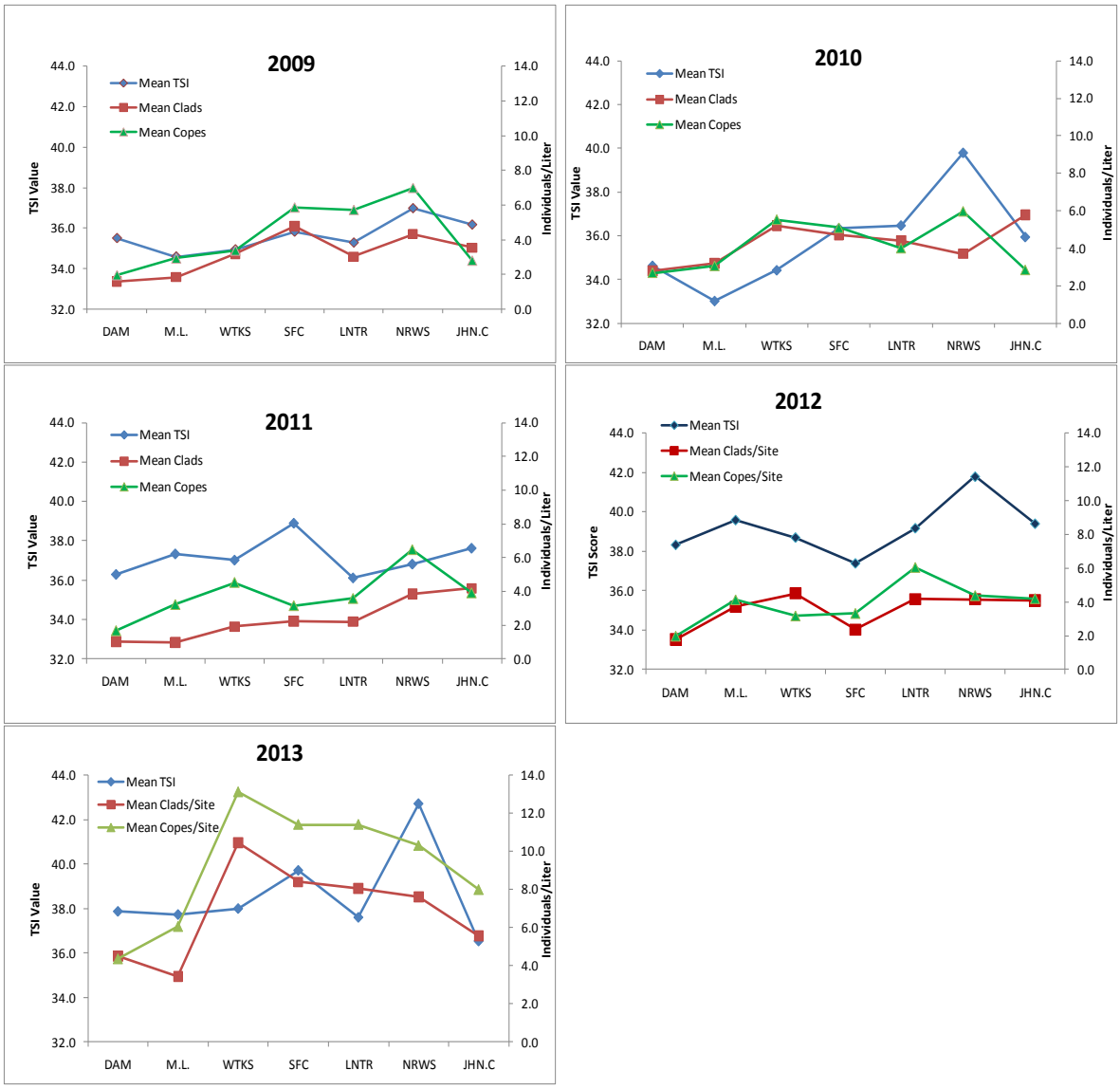
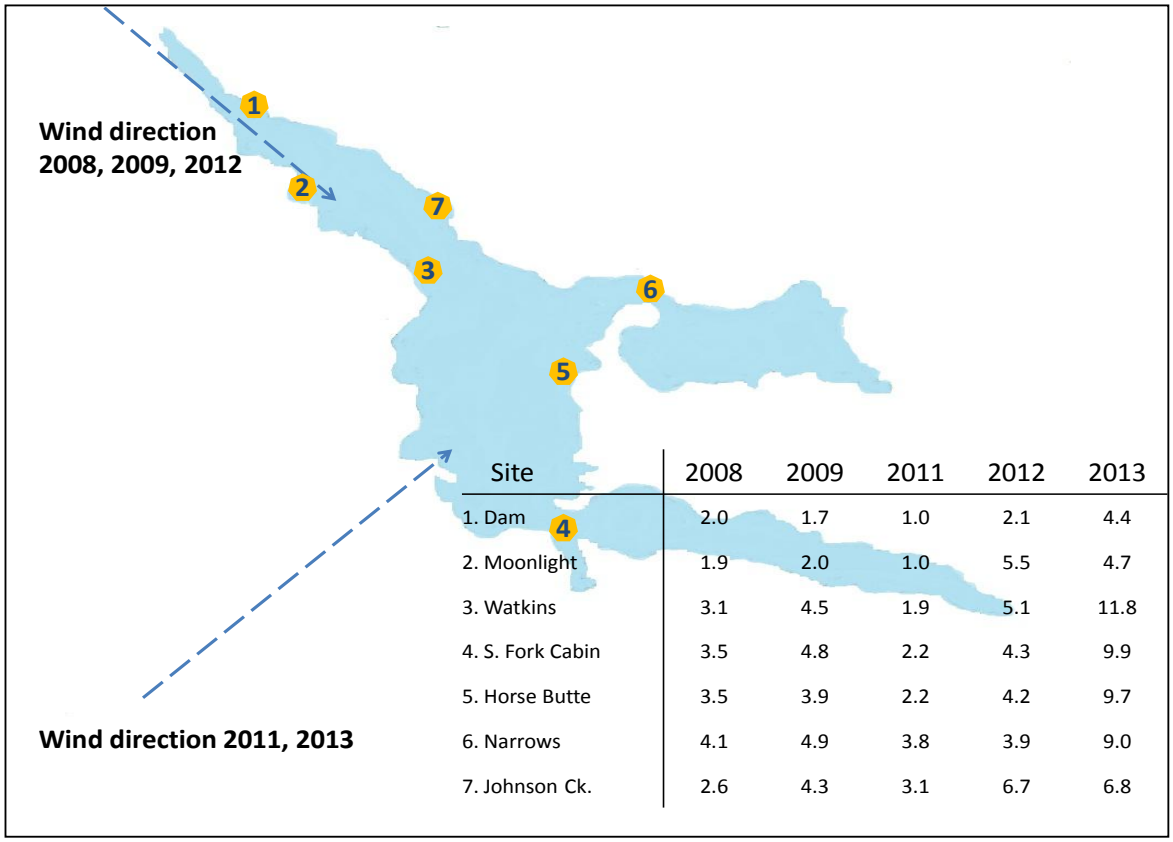


Figure 40. Hebgen Reservoir mean TSI score and mean densities of zooplankton by site, 2009 - 2013. Site names are Dam, Moonlight Bay, Watkins Creek, South Fork Cabin, Lone Tree (Horse Butte), Narrows, and Johnson Creek. Sites are listed in a counterclockwise fashion from the dam (Figure 18).



Site	2008	2009	2011	2012	2013
1. Dam	2.0	1.7	1.0	2.1	4.4
2. Moonlight	1.9	2.0	1.0	5.5	4.7
3. Watkins	3.1	4.5	1.9	5.1	11.8
4. S. Fork Cabin	3.5	4.8	2.2	4.3	9.9
5. Horse Butte	3.5	3.9	2.2	4.2	9.7
6. Narrows	4.1	4.9	3.8	3.9	9.0
7. Johnson Ck.	2.6	4.3	3.1	6.7	6.8

Figure 41. Prevailing wind direction and mean zooplankton densities per site for 2008, 2009, and 2011 - 2013.

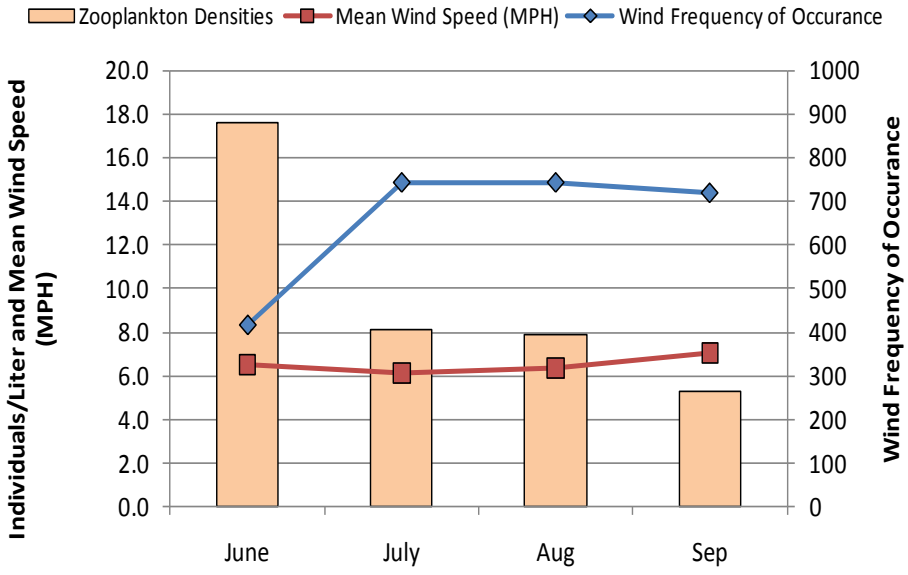


Figure 42. Chart showing mean wind speed in miles per hour (MPH), wind frequency of occurrence (number of occurrences/month) and mean zooplankton densities (number/liter) by month, 2013, at the Dam, Watkins, Johnson and Horse Butte monitoring sites in the main body of Hebgen Reservoir.

CONCLUSIONS AND FUTURE PLANS

The Madison (Ennis) Reservoir grayling population continues to persist at low levels. While the Madison population is very similar genetically to the Big Hole population, it exhibits an adfluvial life history pattern versus the fluvial behavior of the Big Hole River population. In 2014, FWP will produce and environmental assessment to hatch Big Hole River derived Arctic grayling into the Madison River using RSIs.

Fish population monitoring will continue annually in the Madison River. These data are necessary for setting and reviewing angling regulations, and to monitor environmental and biological impacts on the populations.

Monitoring of fish population response 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 among waters.

In 2013, the Sun Ranch Hatchery was used to incubate eggs and provide WCT eyed eggs and/or fry for Cherry Creek (Big Hole Drainage), Goose Lakes in Yellowstone National Park and introduction back into the Sun Ranch Brood. Additionally, fry from the Sun Ranch Brood and some donor populations were introduced into the Sun Brood Pond.

No introductions of WCT occurred in Cherry Creek in 2013. WCT in Cherry Lake were sampled for genetic diversity and it was determined that at least one more stocking would be beneficial, though not necessary, to more fully replicate the genome of the donor population. Widespread population and genetic monitoring has been conducted annually throughout the project area since 2007. WCT are dispersing throughout the project area and into Cherry Creek below the project area and into the Madison River. Yearling WCT have been found pioneering significant distances up tributaries in which no direct introductions occurred. Genetic diversity is broad, with all donating populations represented.

The proportion of the Hebgen Reservoir rainbow trout gillnet catch larger than 14 inches has increased since 2003. The Hebgen Reservoir rainbow trout micro-chemistry study will continue in 2014.

Cladoceran and copepod zooplankton densities in Hebgen Reservoir showed diverse abundance patterns. Cladoceran density tends to be at its highest in June while copepod density peaks in July, though in 2013 both were highest in June. There is no apparent influence of wind on zooplankton density as measured by monthly sampling.

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Appendix A1

Summary of Ennis Reservoir beach seining 1995 - 2013

Species abbreviations:

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

Appendix A2

Description of 2013 young-of-the-year Arctic grayling beach seining locations in Ennis Reservoir, and catch at each site. See Figure 4 for site locations.

Species abbreviations:

AG Arctic grayling
MWF mountain whitefish
Rb rainbow trout
LL brown trout
WSu white sucker

Site	AG	MWF	Note
Vicinity of Madison River mouth 10/9/13 Figure 4 Site 1	0	1	Sparse macrophytes, 4.0" MWF, no other fish
Vicinity of Fletchers Channel mouth 10/9/13 Figure 4 Site 2	0	0	Sparse macrophytes 1 Rb 3.0", 13 y-o-y WSu
Meadow Ck FAS North shore & west shore willows 10/9/13 Figure 4 site 3	0	2	Macrophytes sparse to dense 3.4" & 9.2" MWF 2 Rb 3.3" & 4.0" 1 LL 6.4" 3 y-o-y WSU

Appendix B

The Montana Aquatic Invasive Species Management Plan was finalized in October of 2002 and a full time Aquatic Invasive Species (AIS) Program Coordinator was hired by Montana Fish, Wildlife and Parks in February of 2004. The emphasis of the Montana AIS 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 is yet to be documented in the state). 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. To date no zebra mussels have been found within the state.

3. Legislation and Rule making: In 2005 a rule making system was developed to classify exotic wildlife (terrestrial and aquatic) as either non controlled, controlled or prohibited. The following AIS 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.

4. Montana continues to actively participate in the 100th 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. Training: a one day workshop was provided during the Annual Meeting of the Montana Chapter of the American Fisheries Society on AIS identification, 2 day HACCP workshops have been provided for Montana hatchery personnel and field workers, a half day training was provided for Montana Firefighters on the prevention of spread of AIS, and a half day training was provided on AIS identification and prevention of spread as part of fish health training for fisheries and hatchery personnel within FWS Region 6.

6. Public outreach: presentations on AIS have been made to several special interest groups including Walleyes Unlimited, Fishing Outfitters Association of Montana and Lake Associations. AIS informational booths were present at five Montana outdoor shows: Billings, Bozeman, Great Falls, Missoula and Kalispell. Informational packets have been developed and are being distributed for private pond owners to encourage responsible pond ownership.

7. Illegal introductions: to date over 500 illegal fish introductions have been recorded in Montana. Illegal introductions have been identified as a major source of AIS 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".

INSPECT. CLEAN. DRY.

With just **three easy steps**, you can do your part to help stop the spread of aquatic invasive species like plants, mussels and whirling disease:

1. INSPECT.

After leaving a lake or stream, inspect your boat, engine, trailer, anchor, waders, and other fishing and boating gear for mud, water, and vegetation that could carry aquatic invasive species.

2. CLEAN.

Completely remove all mud, water, and vegetation you find. Boaters should use a pressurized power sprayer, found at most do-it-yourself car washes. The hot water helps kill organisms and the pressure removes mud and vegetation. No need to use soap or chemicals.

3. DRY.

Aquatic invaders can survive only in water and wet areas. By draining and drying your boat and fishing equipment thoroughly, you will kill most invasive species. The longer you keep your boat, trailer, waders, and other equipment outside in the hot sun between fishing trips, the better.

A message brought to you in partnership by
Montana Fish, Wildlife & Parks and the Montana Department of Agriculture

Montana Department of Agriculture

Montana Fish, Wildlife & Parks

MAKE THE CALL: Report violations anonymously to 1-800-TIP-MONT

STOP AQUATIC HITCHHIKERS!

Appendix C

Arctic grayling mitigation project reports

- Swamp Creek Siphon
- Elk Lake/Narrows Creek flow restoration and Arctic grayling eyed egg introduction

SWAMP CREEK SIPHON

PROJECT UPDATE
January 1, 2014

Purpose

This project will install a siphon to transport canal water underneath Swamp Creek, which will improve instream flows six miles downstream of the canal and provide fish passage to access 12 stream miles upstream of the canal. The siphon will be designed for the capacity of the water rights. A design was completed in 2012 for this project by Pioneer Technical Services Inc. Overland flow from irrigation, precipitation or flooding will be diverted into Swamp Creek through an overflow weir. The siphon will be a High Density Polyethylene (HDPE) Pipe (63" x 150 linear feet) and canal banks will be heightened upstream to accommodate water backed up at the siphon. A trash rack will be installed on the upstream end of the siphon to prevent large debris from entering the siphon. The water user also has a water right in Swamp Creek that is diverted into the canal and used downstream. A pin and plank diversion and screwgate will be installed upstream of the siphon in Swamp Creek to divert water from Swamp Creek into the canal. A denil type fish ladder and a measuring device will be installed in the diversion. The new diversion will allow the water right holders the ability to control and measure diverted flow for irrigation and instream flow conservation. The project is part of the landowner's site-specific plan (SSP) for the Big Hole Arctic Grayling Candidate Conservation Agreement with Assurances program. US Fish and Wildlife Service (FWS) and Montana Fish, Wildlife & Parks (FWP) will hire a contractor, complete oversight and administration for this project and the development and implementation of the SSP.

Scope of Work

- Install a 63' x 150 feet siphon
- Install Trash Rack
- Insatll Canal over flow
- Insatll Pin and plank Diversion in Swamp Creek
- Insatll Denil Fish Ladder in Swamp Creek Pin and plank diversion
- Insatll measuring device in Swamp Creek diversion

Table 1. Swamp Creek Siphon Project Schedule

Task	Schedule	Status
Pre-Project Montoring	April 2012-August 2014	On-Going
DNRC Renewable Resource Grant and Loan Program	June 2013	Secured
FWP -Future Fisheries Improvement Program	June 1, 2012	Secured
Design	June 22, 2012	Completed
Montana PPL Grant via AGRP	December 2012	Secured
MEPA	September-October 2012	Completed

Permitting	March-June 2013	Completed
Archeology Review	Spring/summer 2013	Completed
Landowner\Wateruser Agreements	Fall 2013	Completed
USFWS Fish Passage Initiative Grant	Submitted for 2014	Submitted
Secure Additional Funding	Fall 2013/Winter 2014	On-Going
Construction Procurement	June-July 2014	If Funding is Secured
Construction	August-November 2014	If Funding is Secured

Table 2. Swamp Creek Siphon Construction Budget

Item #	**Task**	**Cost Estimate**
1	Mobilization/Demobilization	$ 20, 478
2	Site Cleaning and Preparation	$ 5,843
3	Water Management	$ 14,692
4	Siphon Diversion/Headgate Structures	$120,208
5	Pipe-Siphon	$ 93,672
6	Riprap	$ 3,904
7	Erosion Control Fabric (Type B)	$ 4,188
8	Erosion Control Fabric (12" Coir Log)	$ 2,000
9	Regrading Plan	$ 22,822
10	Parshall Flume	$ 6,405
11	Reclamation and Revegetation	$ 8,496
12	**Construction Subtotal**	**$302,708**
13	**Construction Contingency**	**$ 30,271**
	Construction Total	**$ 332,979**
14	**Contingency Oversight**	**$ 20,000**
15	**Beaverhead Conservation District Admin for RRGL Grant**	**$10,000**
	PROJECT TOTAL	**$ 362,979**

Table 3. Swamp Creek Siphon Funding as of January 1, 2014

Source	**Amount**	**Status**
DNRC Renewable Resource Grant and Loan Program	$100,000	Secured
FWP-Future Fisheries Improvement Program	$30,000	Secured
Arctic Grayling Recovery	$20,000	Secured

Program/Montana PPL		
Big Hole River Foundation	$2,500	Secured
USFWS Fish Passage Initiative Grant	100,000	Submitted for 2014 funding
USFWS Partners for Fish & Wildlife Program	*	
Montana Fish, Wildlife & Parks - State Wildlife Grants	*	
Total Secured	**152,500**	
Total Needed	**210,479**	
Construction Total	**362,979**	

*USFWS Partners for Fish and Wildlife Program and FWP State Wildlife Grants will most likely commit funding to the Swamp Siphon Project but the commitment depends on the amount of funding secured in other grants and the availability of funding annually allocated to these programs.

Fisheries Management, Dillon Field Office, 730 ½ N. Montana, Dillon, MT 59725.
Phone: (406) 683-9310 Fax: (406) 683-4126 email: mattjaeger@mt.gov

This memo provides an update for Montana PPL regarding a project they contributed funding towards. The project in question restored flows and habitat to a channel (Spring Creek) that is tributary to Elk Lake for the purpose of creating conditions that support successful Arctic grayling reproduction. This project piped flows past a losing reach of Narrows Creek, routed flows to a perennial spring adjacent to Elk Lake, and created spawning habitat in that channel in Fall 2011 (Figure 1, 2). Flow may also be routed into the Narrows Creek channel below the losing reach as deemed appropriate. Over 60 Elk Lake westslope cutthroat trout moved into and built about 30 redds in the new spawning channel each year in 2012 and 2013 (Figure 2). Montana Arctic grayling of Centennial Valley origin were restored to Elk Lake beginning in 2010 (Table 1) and have been documented in the lake but haven't yet been documented using the spawning channel; however, relatively few fish were sexually mature and able to spawn prior to this year. Restoration of Arctic grayling primarily occurred through use of remote site incubators that were fed by the aforementioned re-routed Narrows Creek water (Figure 2).

Figure 1. Project area.

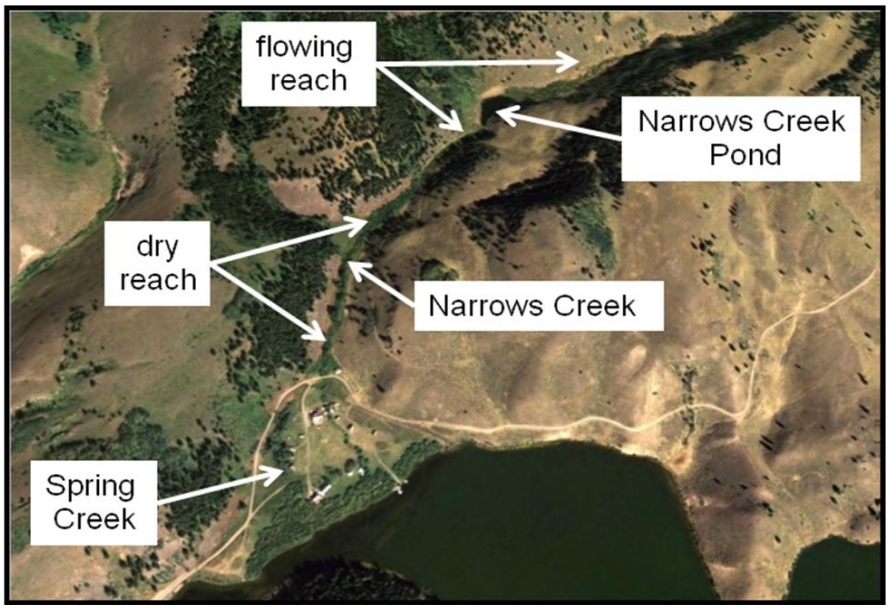


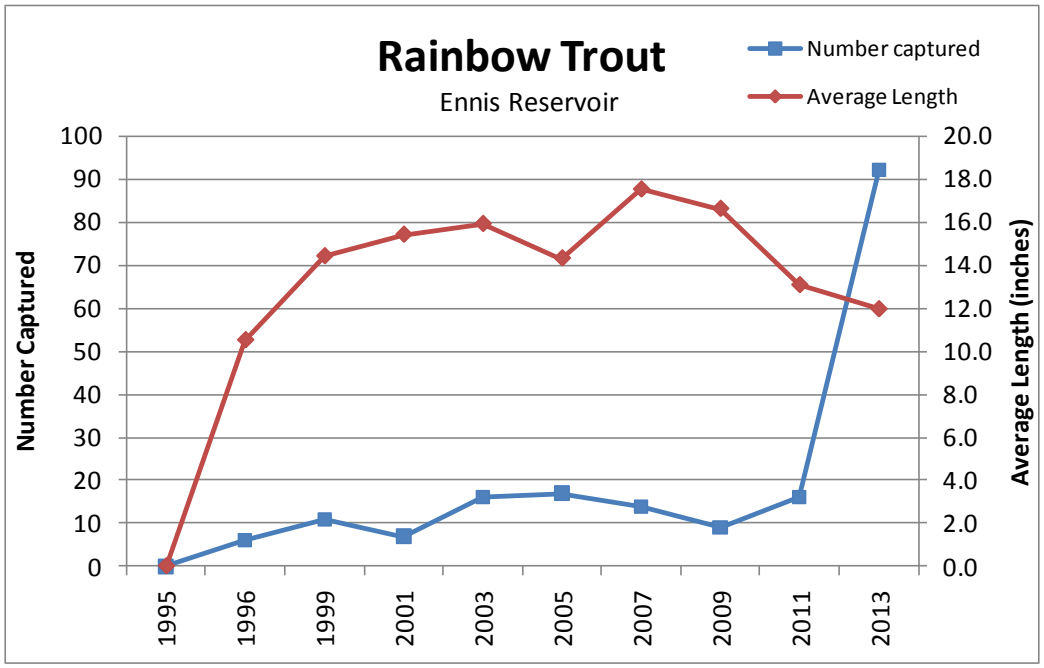
Figure 2. Pictures of (clockwise from top left) Spring Creek before habitat work and flow augmentation, Spring creek following habitat work and flow augmentation, westslope cutthroat trout spawning in Spring Creek, Arctic grayling remote site incubators in Spring Creek.

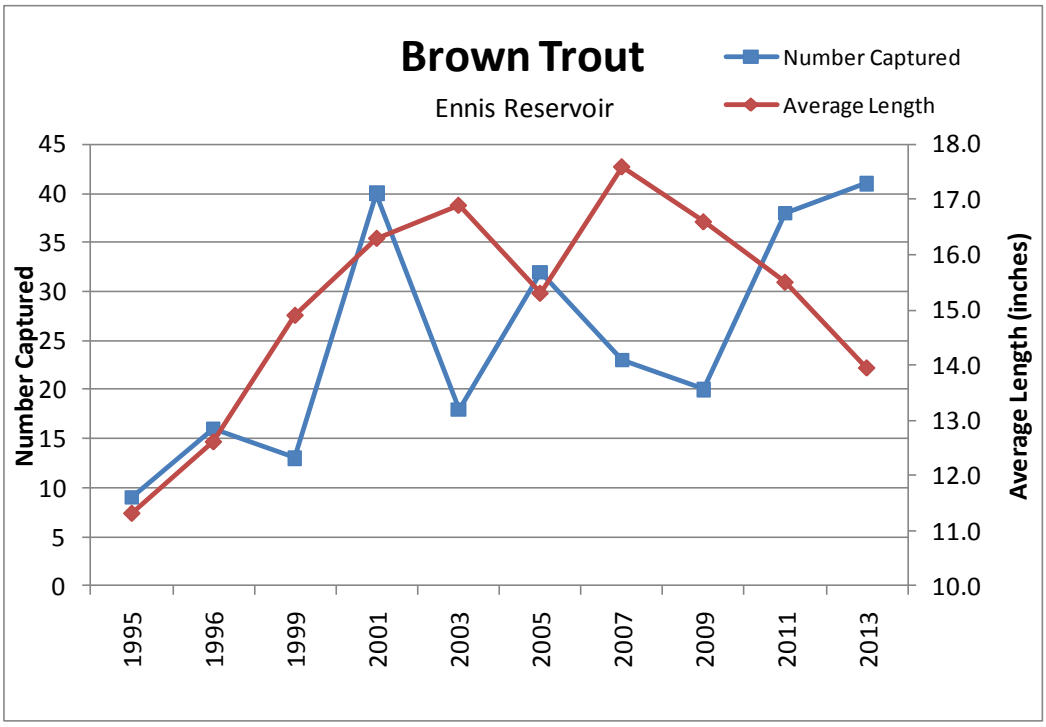
Table 1. Propagation summary for Arctic grayling in Elk Lake.

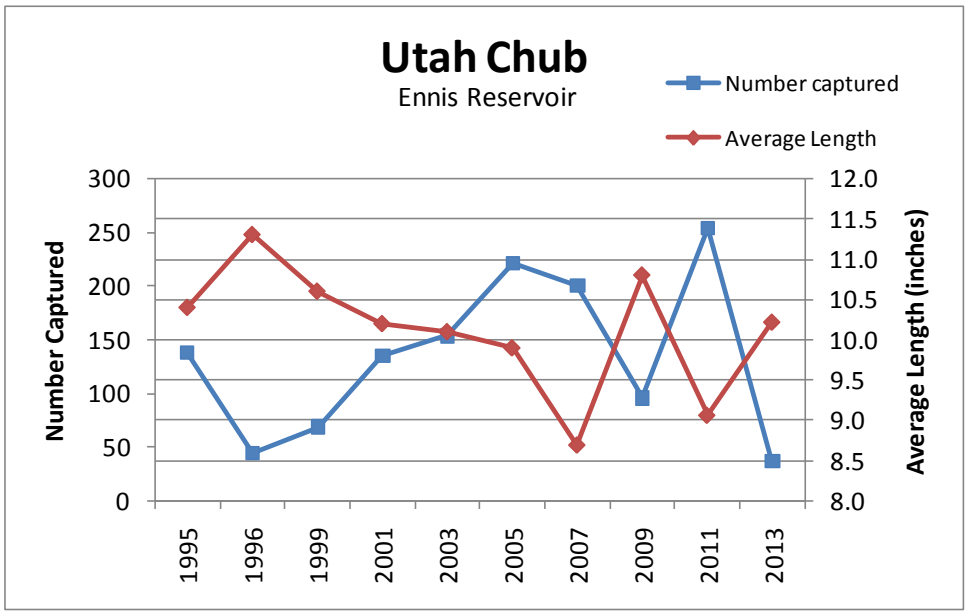
Year	♀	♂	Propagation	Location	Family lot resolution	Eggs	Swim up fry	Success
2010	22	60	hatchery	Rose Creek	No	123,000	7,000*	5.7%*
2011	25	21	RSI	Spring Creek	Yes	139,700	51,300	36.7%
2012	39	27	hatchery/RSI	Spring Creek	No	128,000	94,743	74.1%
2013	34	34	RSI	Spring Creek	No	86,377	37,285	36.8%

Appendix D

Ennis Reservoir Gillnet Trend
1995 – 2013






Utah Chub
Ennis Reservoir
Number captured
Average Length
Number Captured
Average Length (inches)
300
250
200
150
100
50
0
12.0
11.5
11.0
10.5
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9.5
9.0
8.5
8.0
1995
1996
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2001
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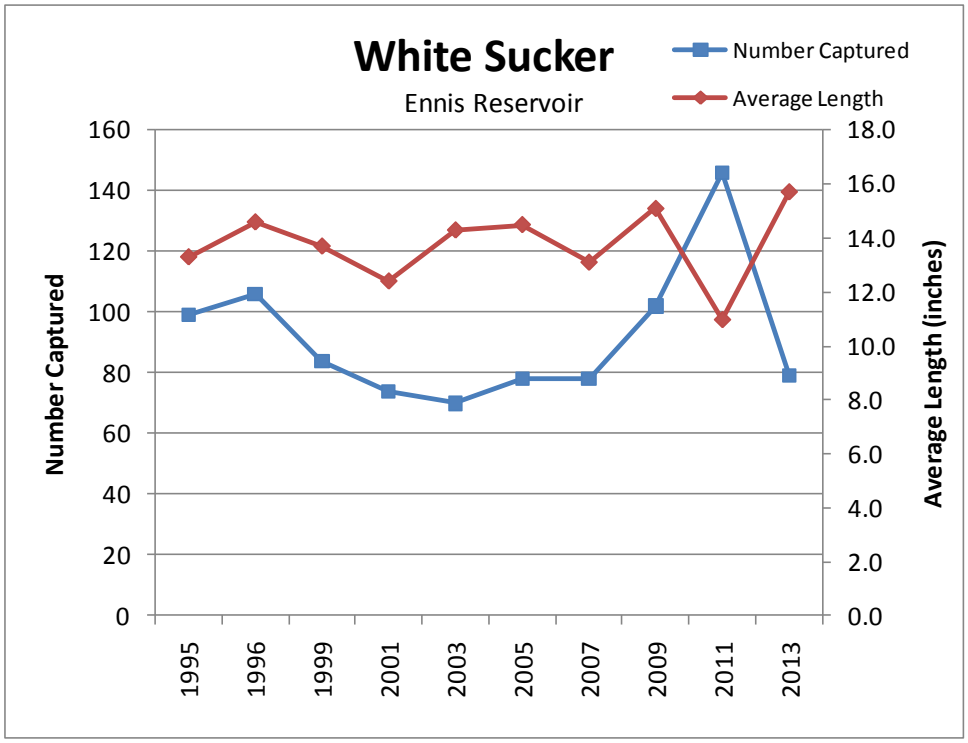
2005
2007
2009
2011
2013


White Sucker
Ennis Reservoir
Number Captured
Average Length
Number Captured
Average Length (inches)
160
140
120
100
80
60
40
20
0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
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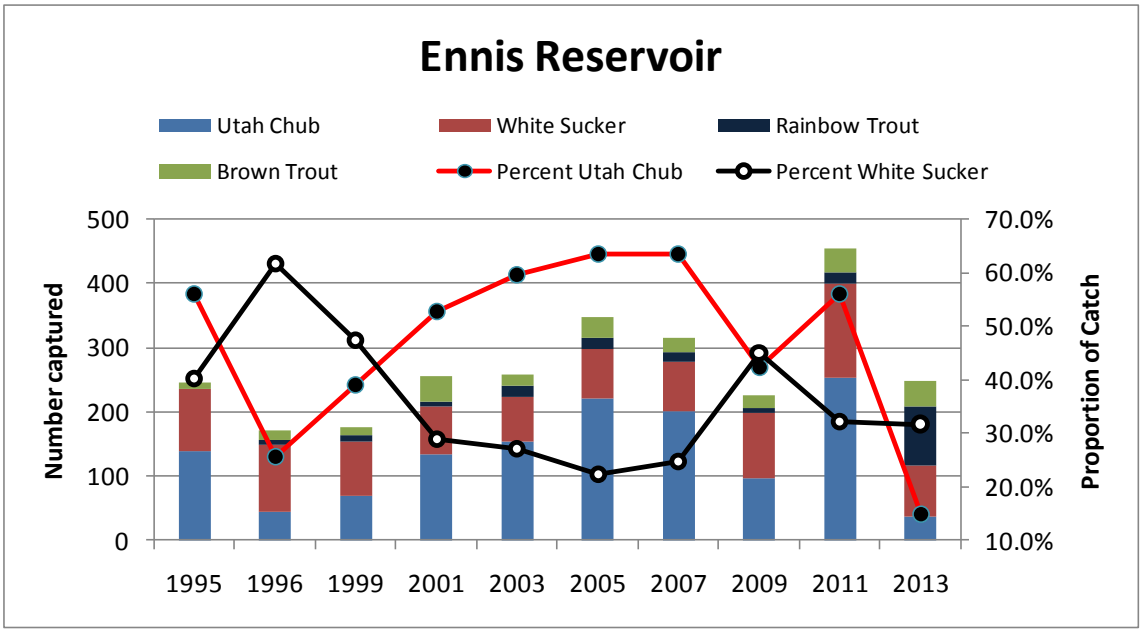
Ennis Reservoir
Utah Chub
White Sucker
Rainbow Trout
Brown Trout
Percent Utah Chub
Percent White Sucker
Number captured
Proportion of Catch
500
400
300
200
100
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70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
1995
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2007
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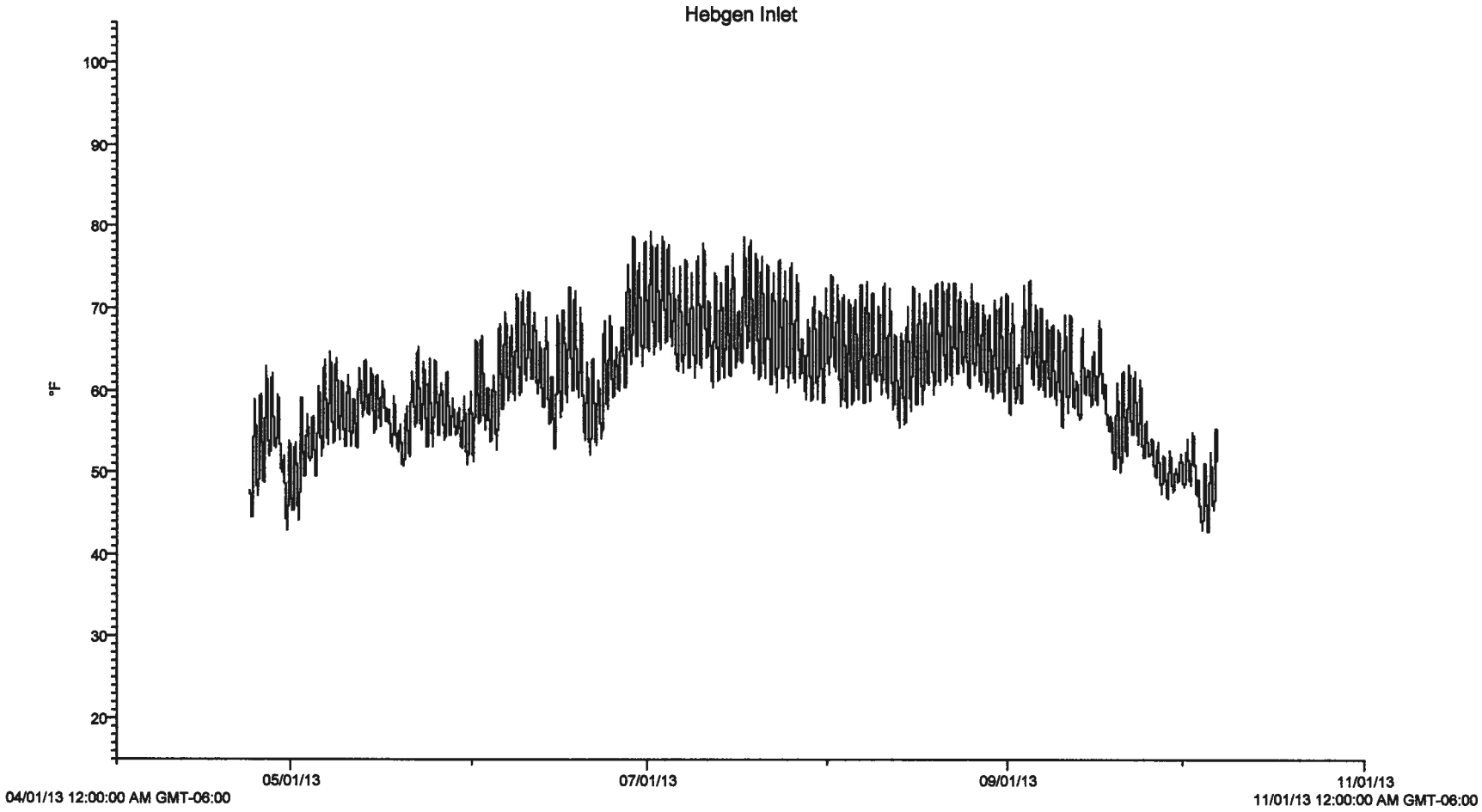
Appendix E1

Temperature recordings from Madison River monitoring sites
2013
See Figure 7 for locations


Hebgen Inlet
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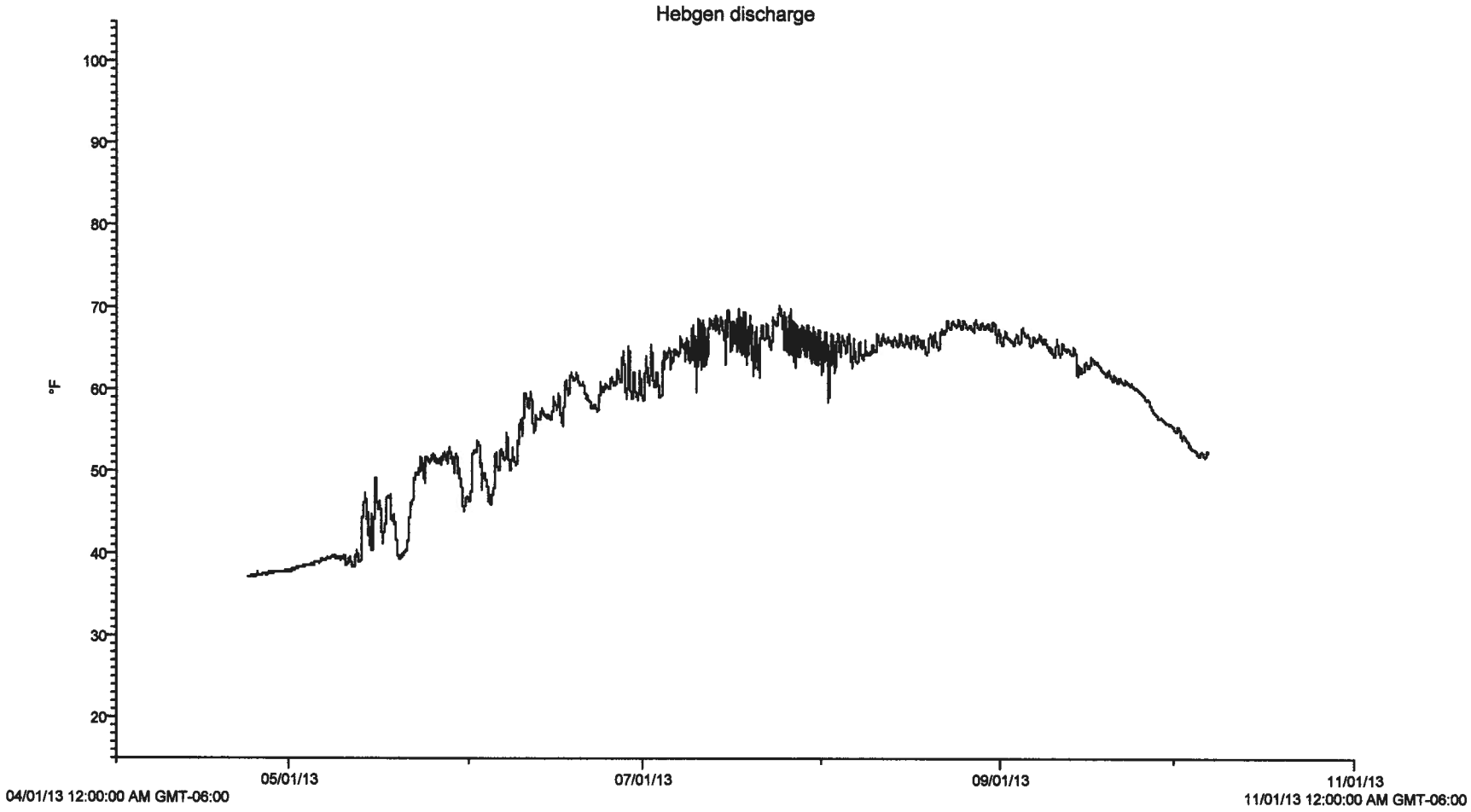
Hebgen discharge
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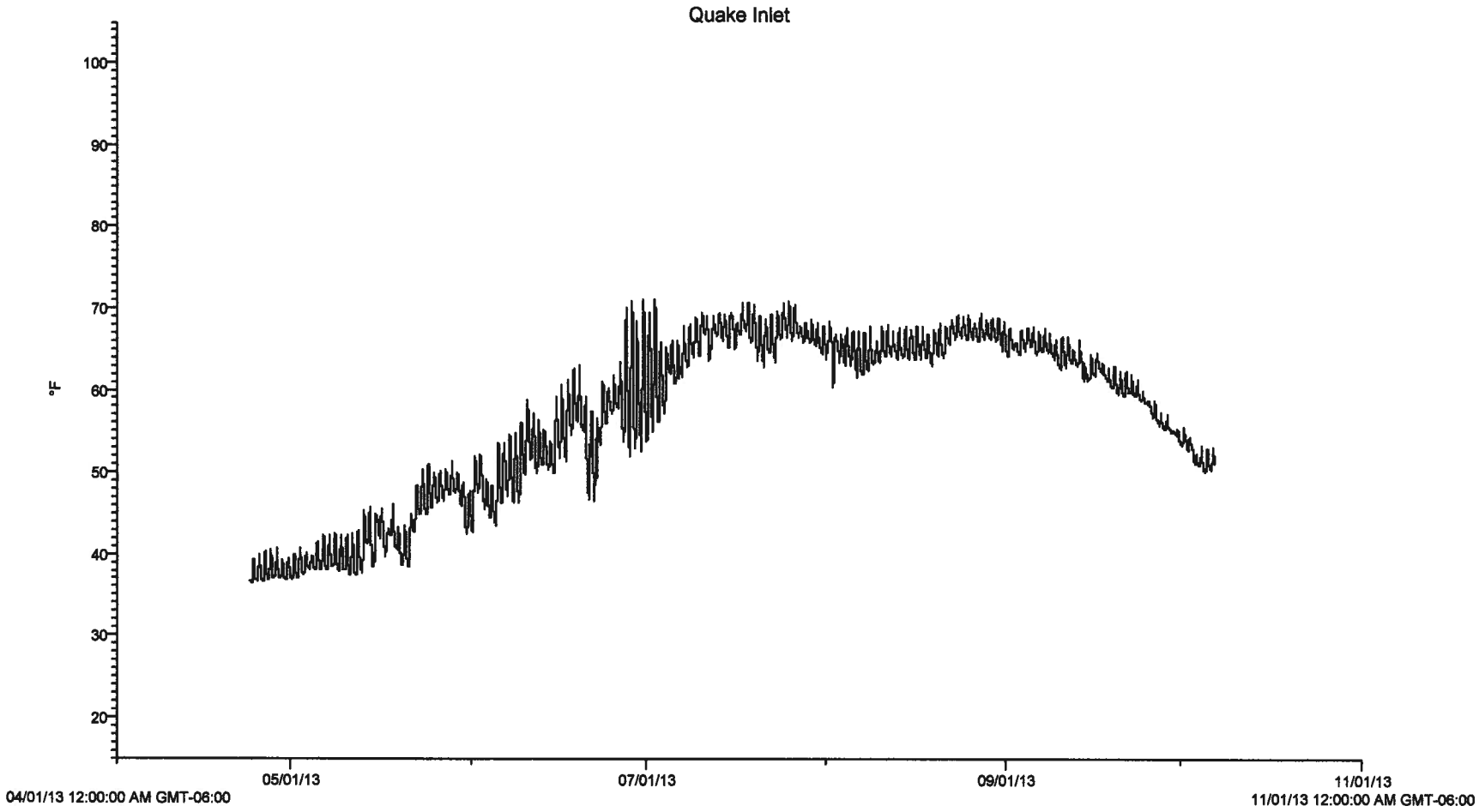
Quake Inlet
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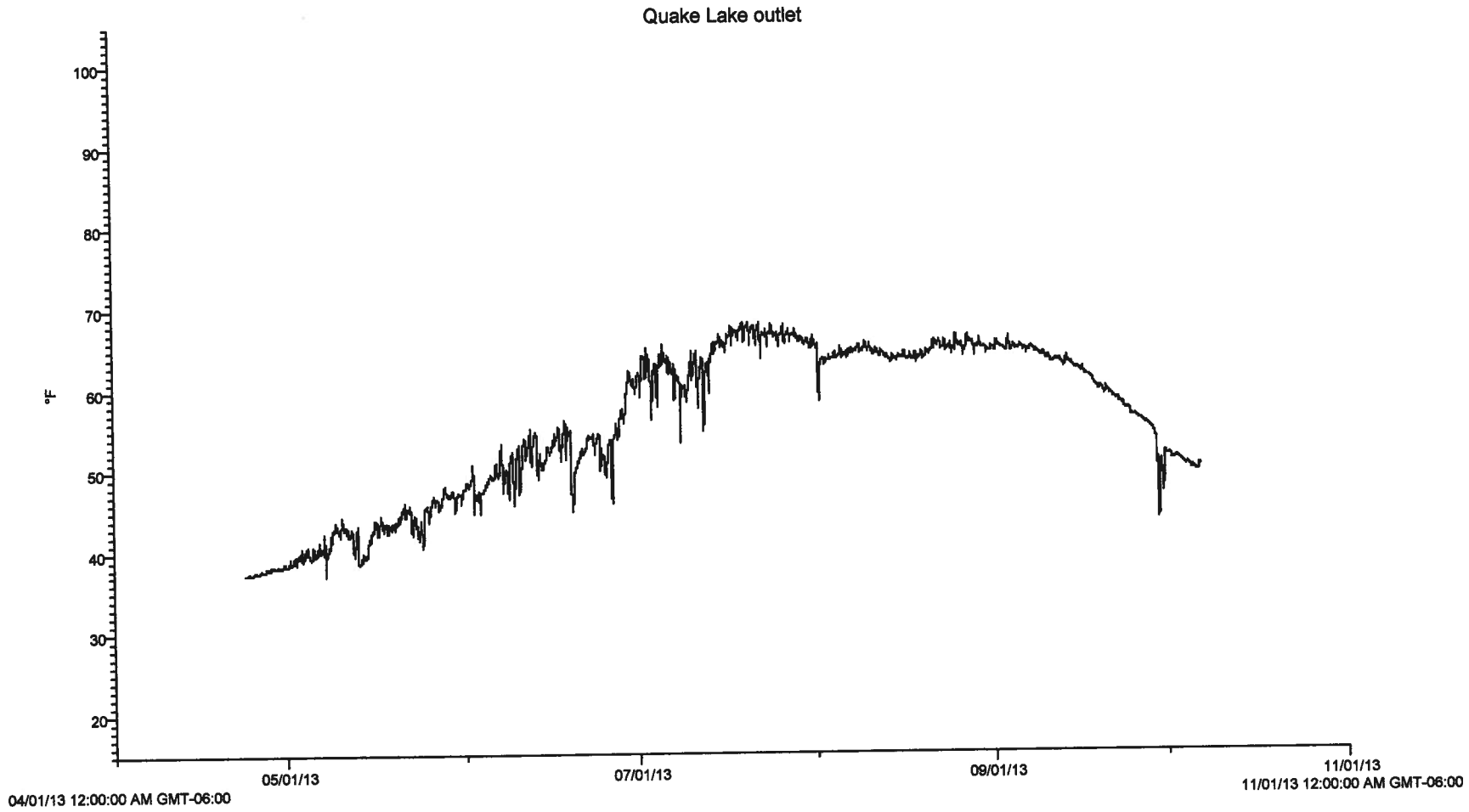
Quake Lake outlet
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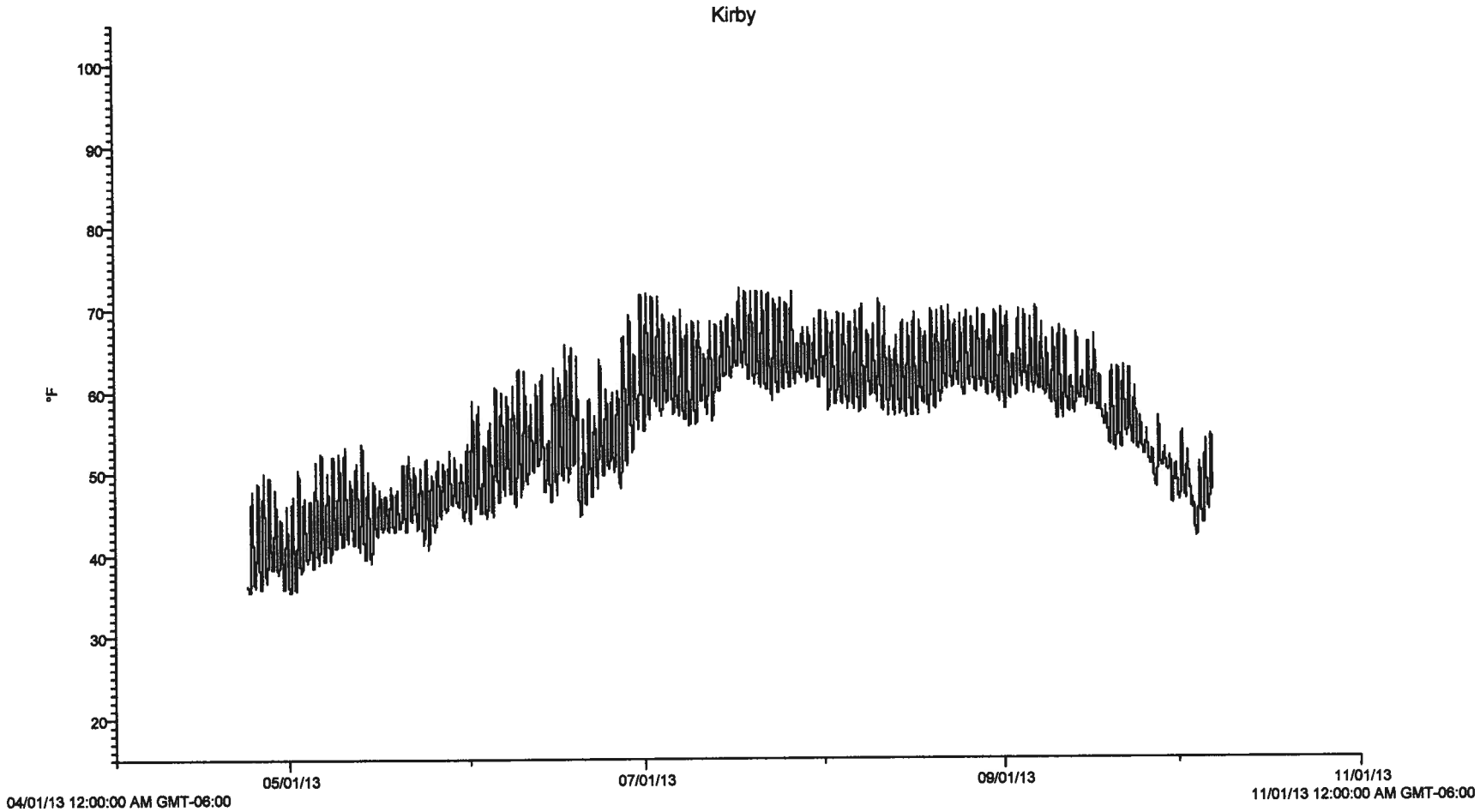
Kirby
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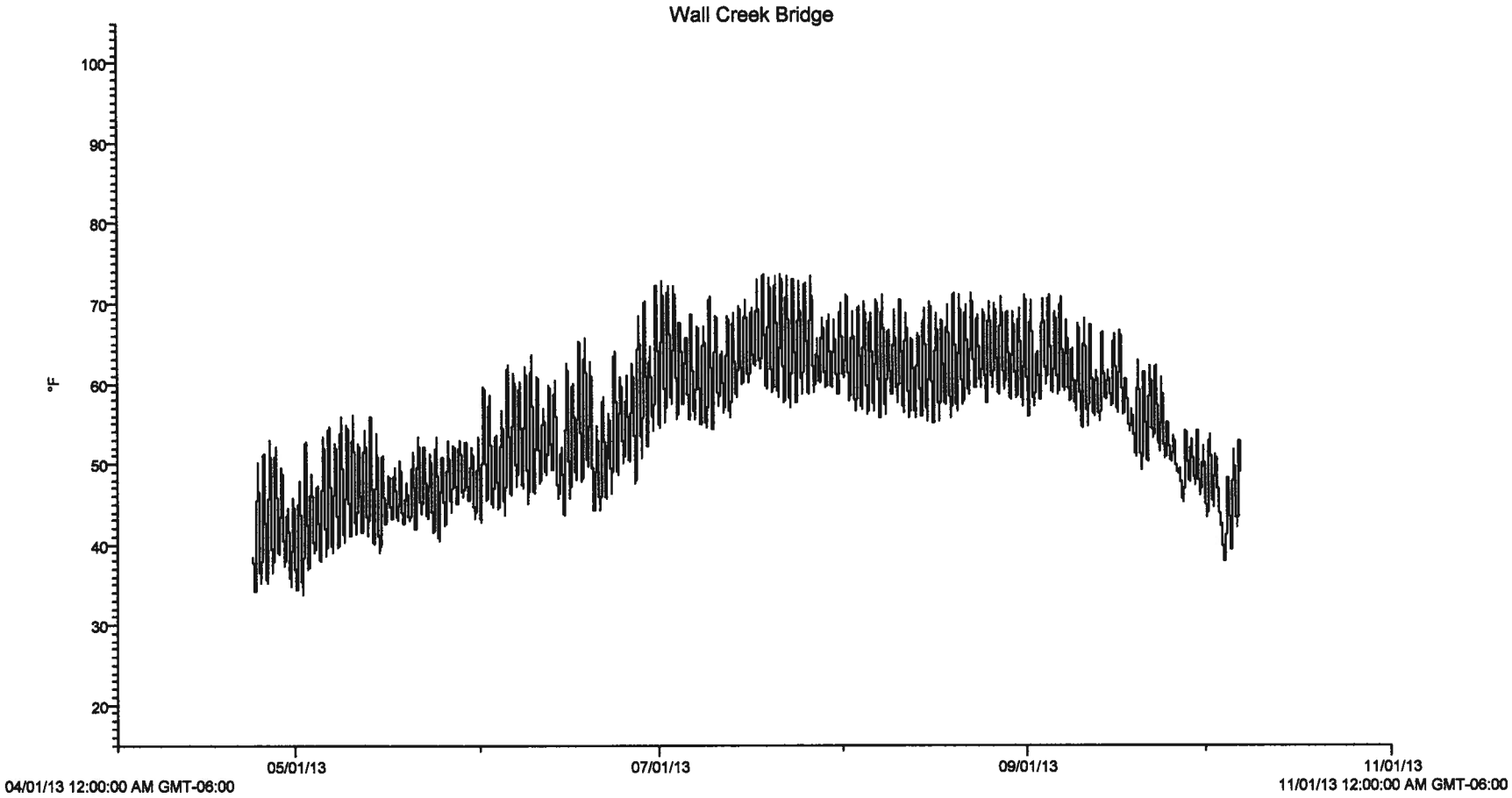
Wall Creek Bridge
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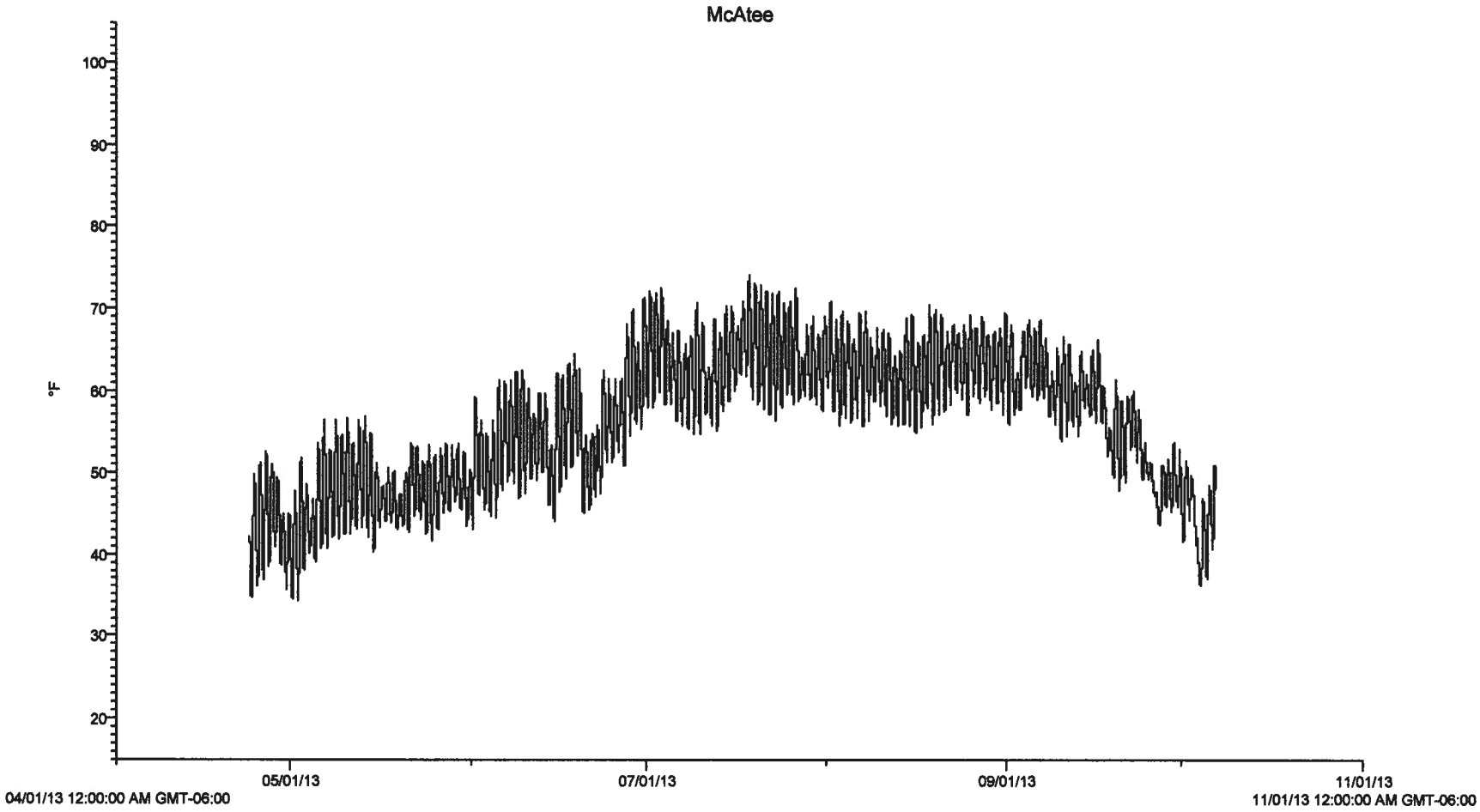
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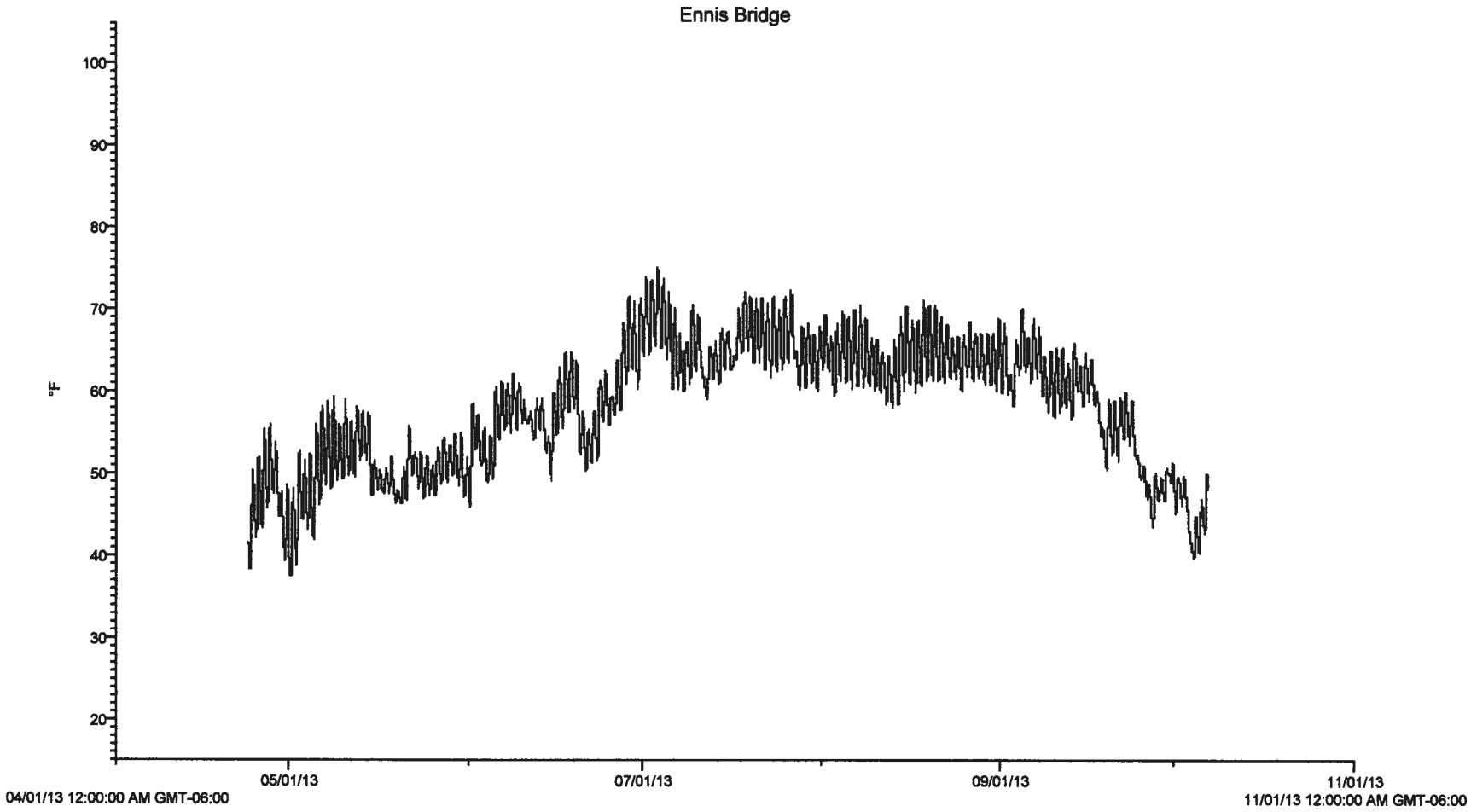
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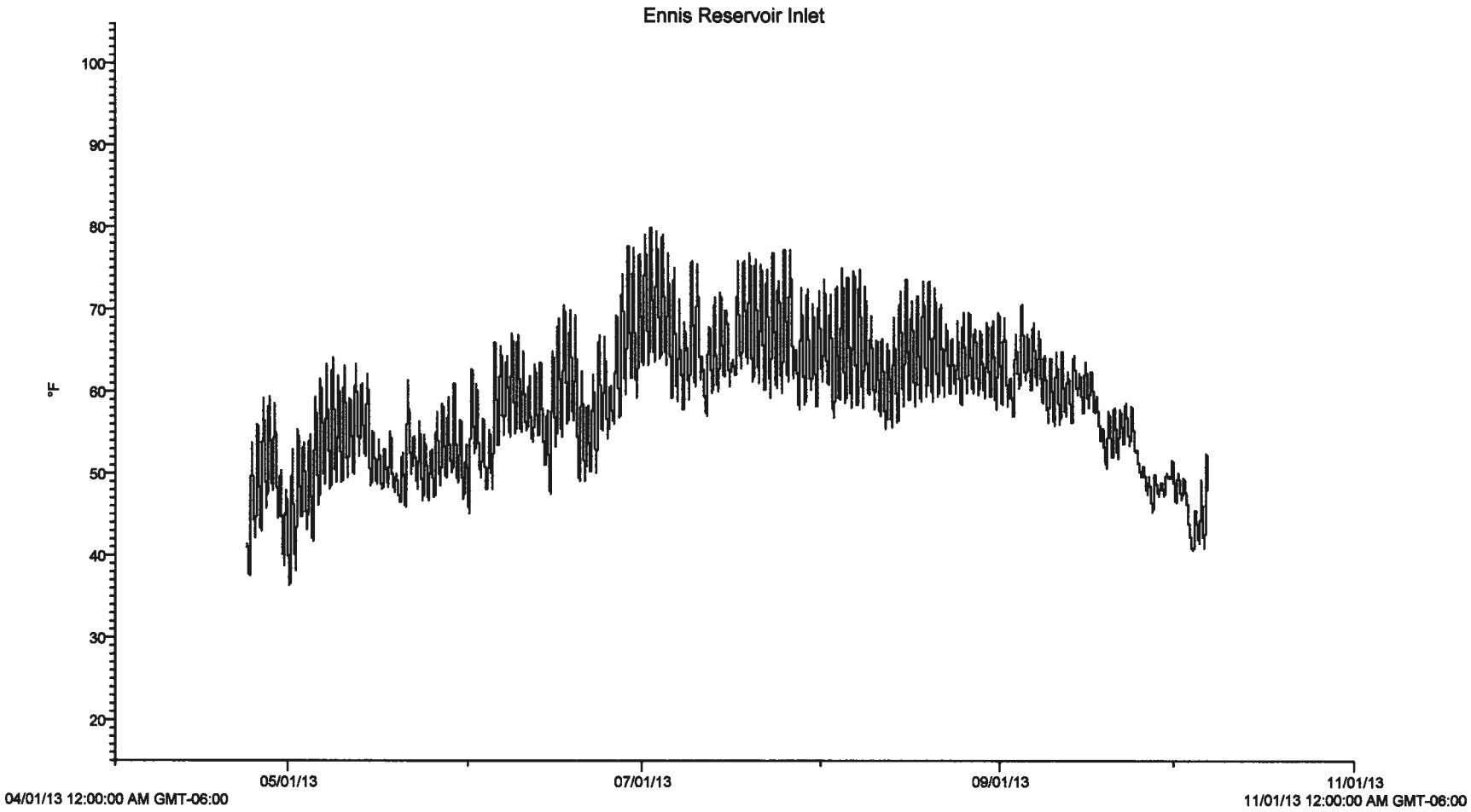
Ennis Reservoir Inlet
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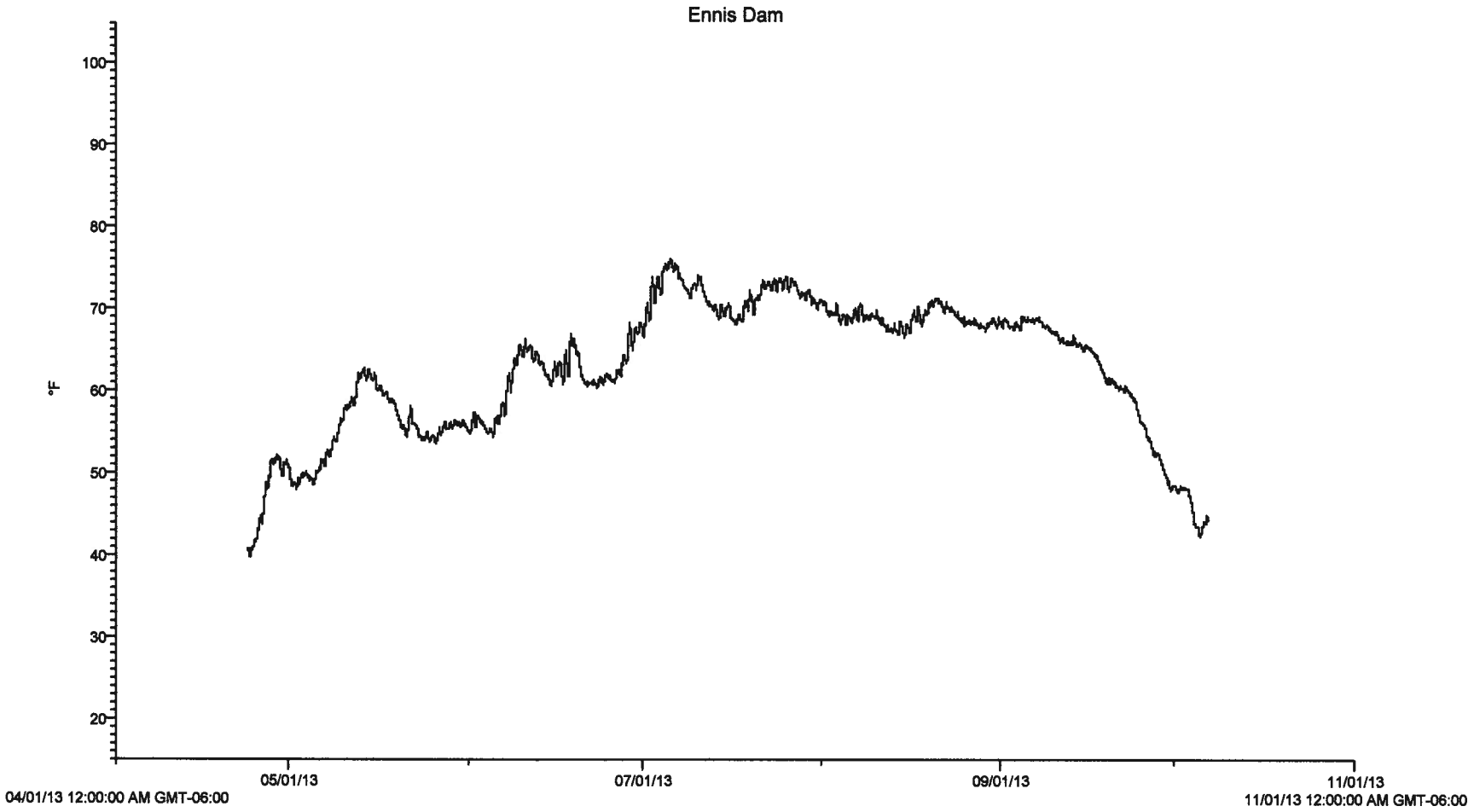
Ennis Dam
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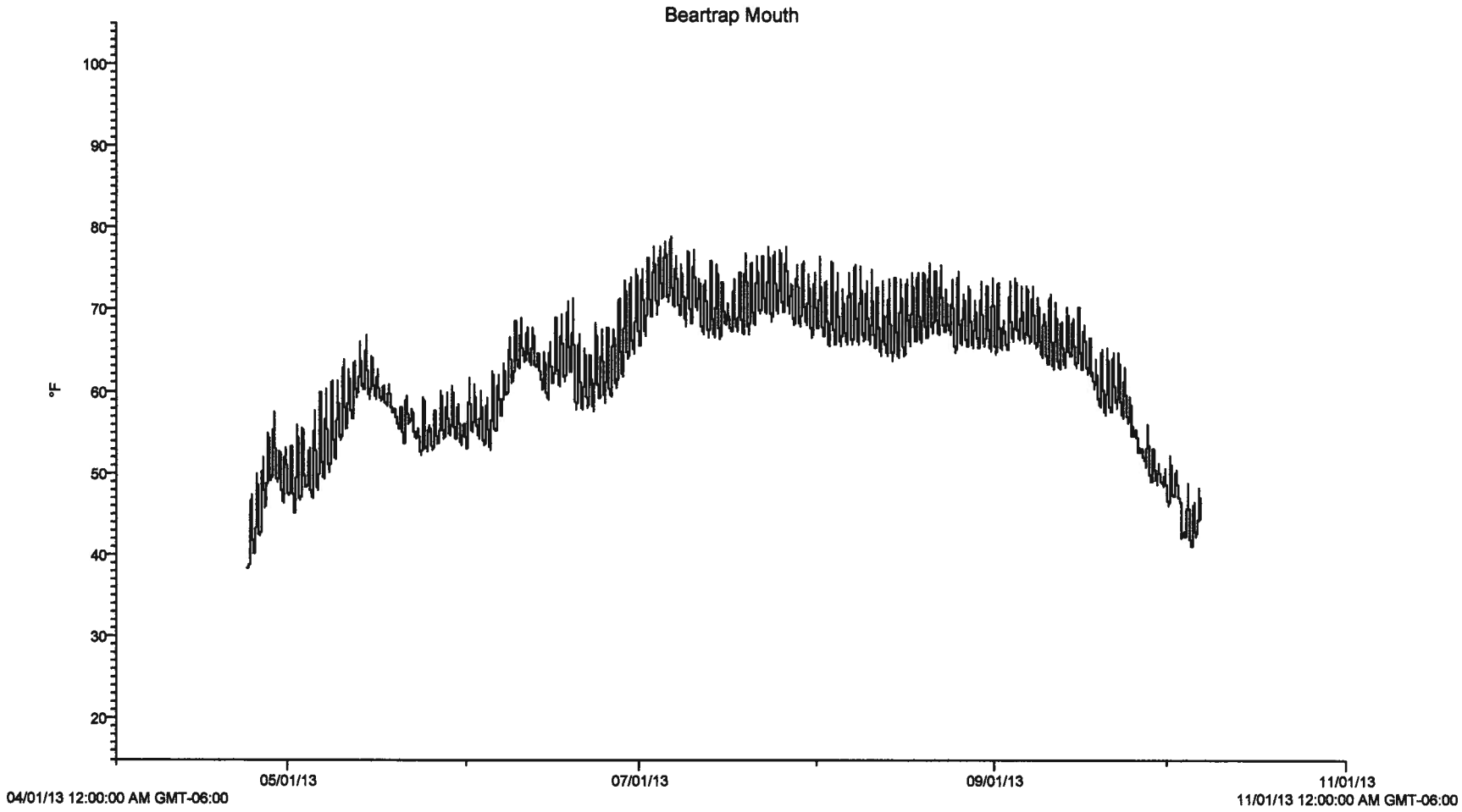
Beartrap Mouth
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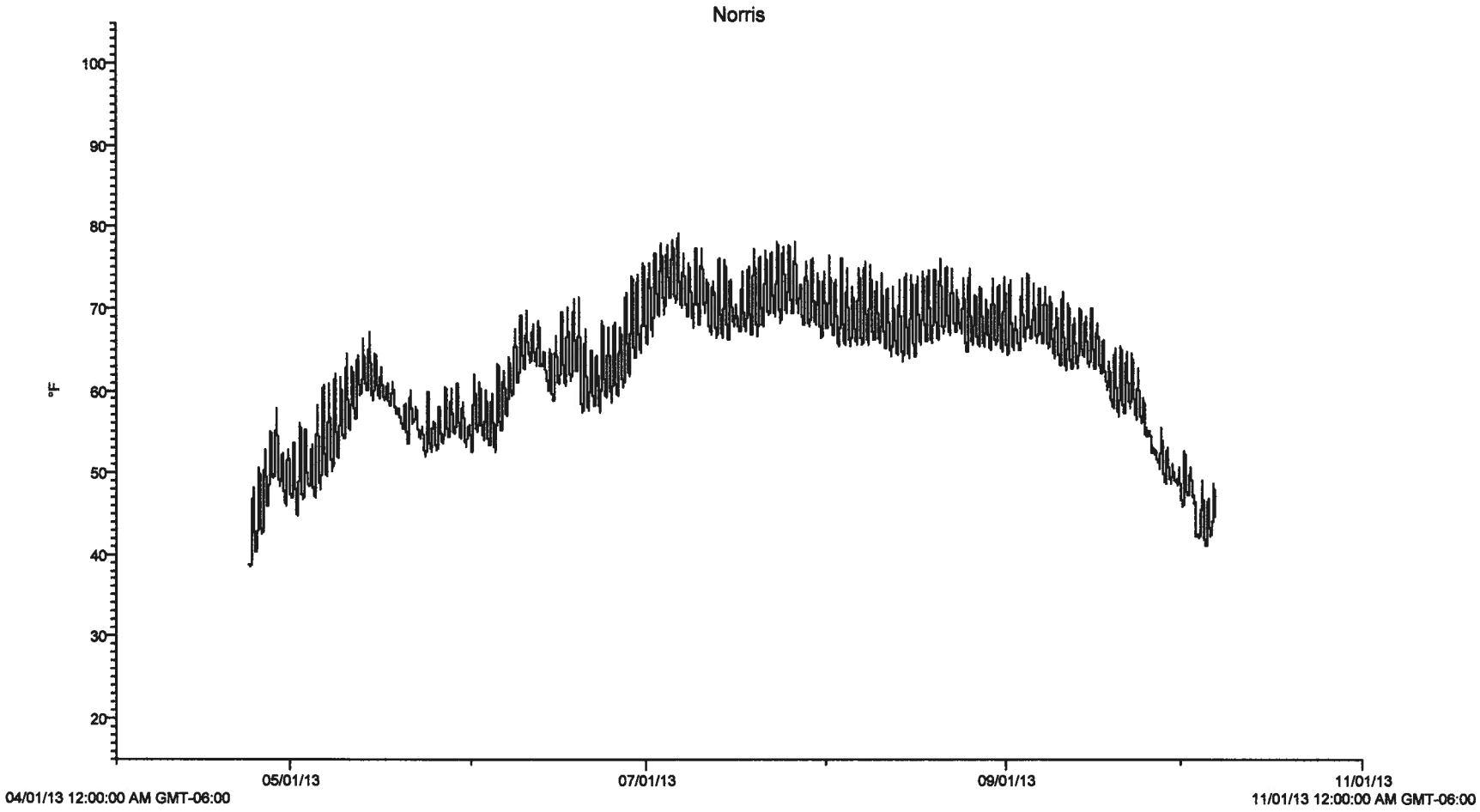
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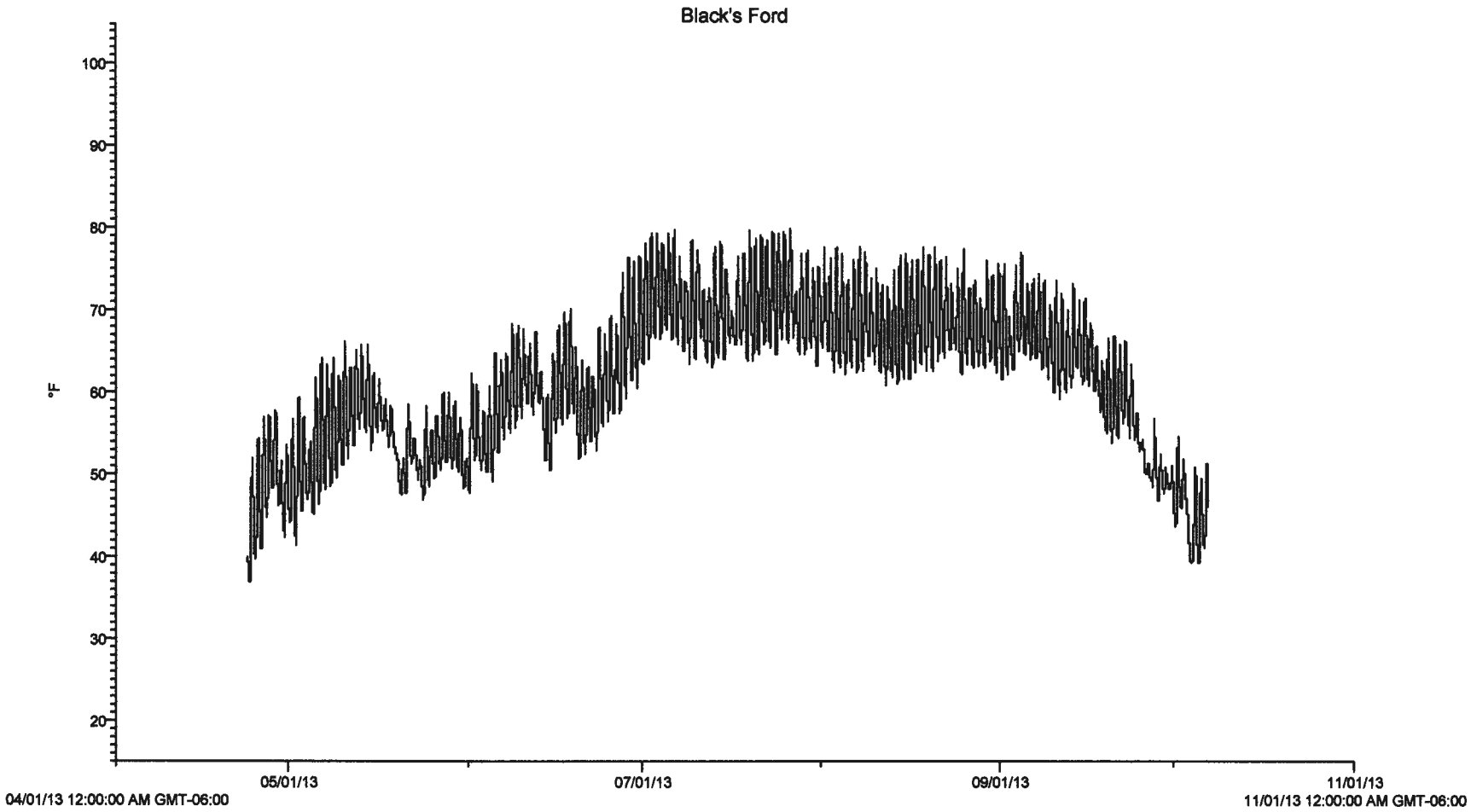
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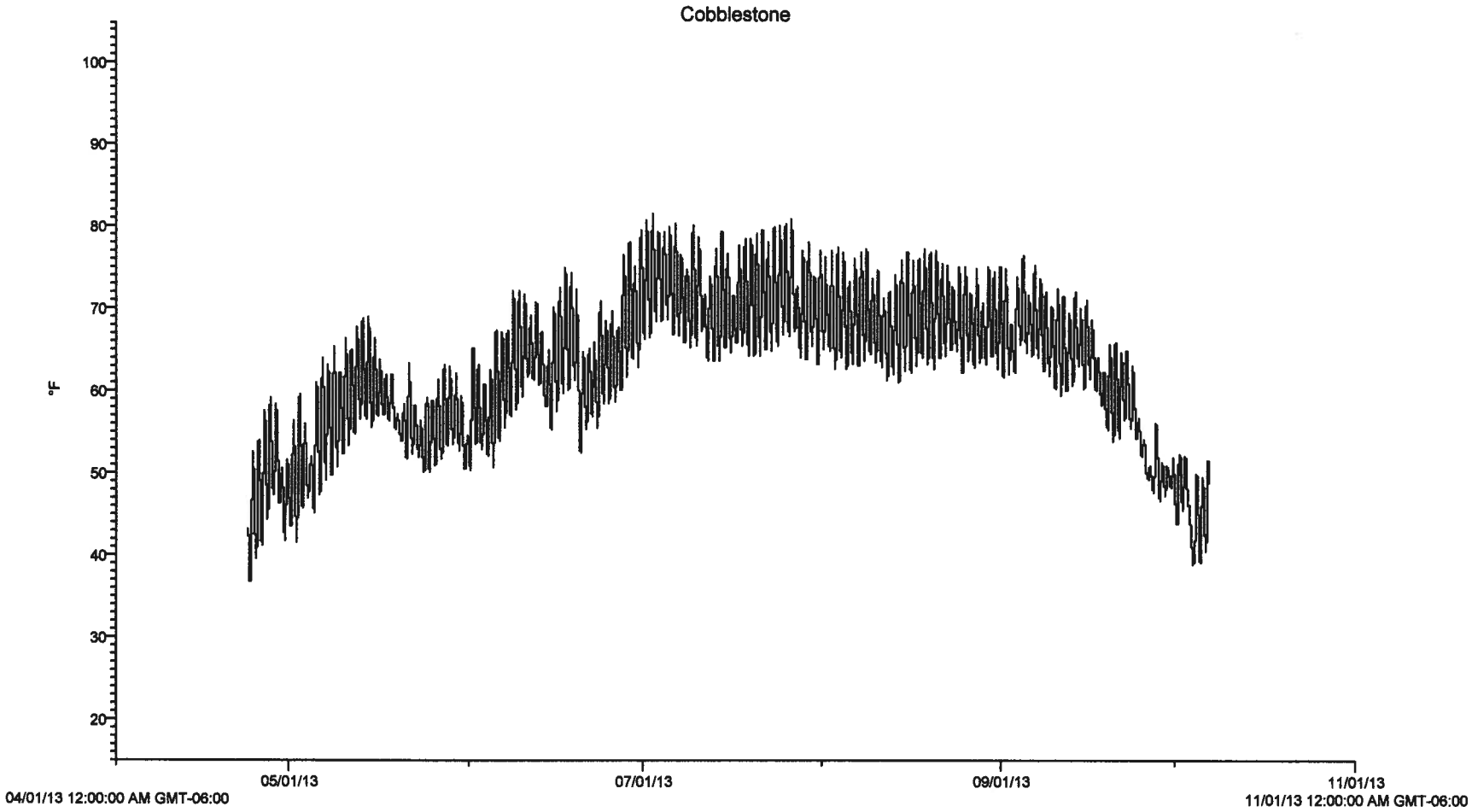
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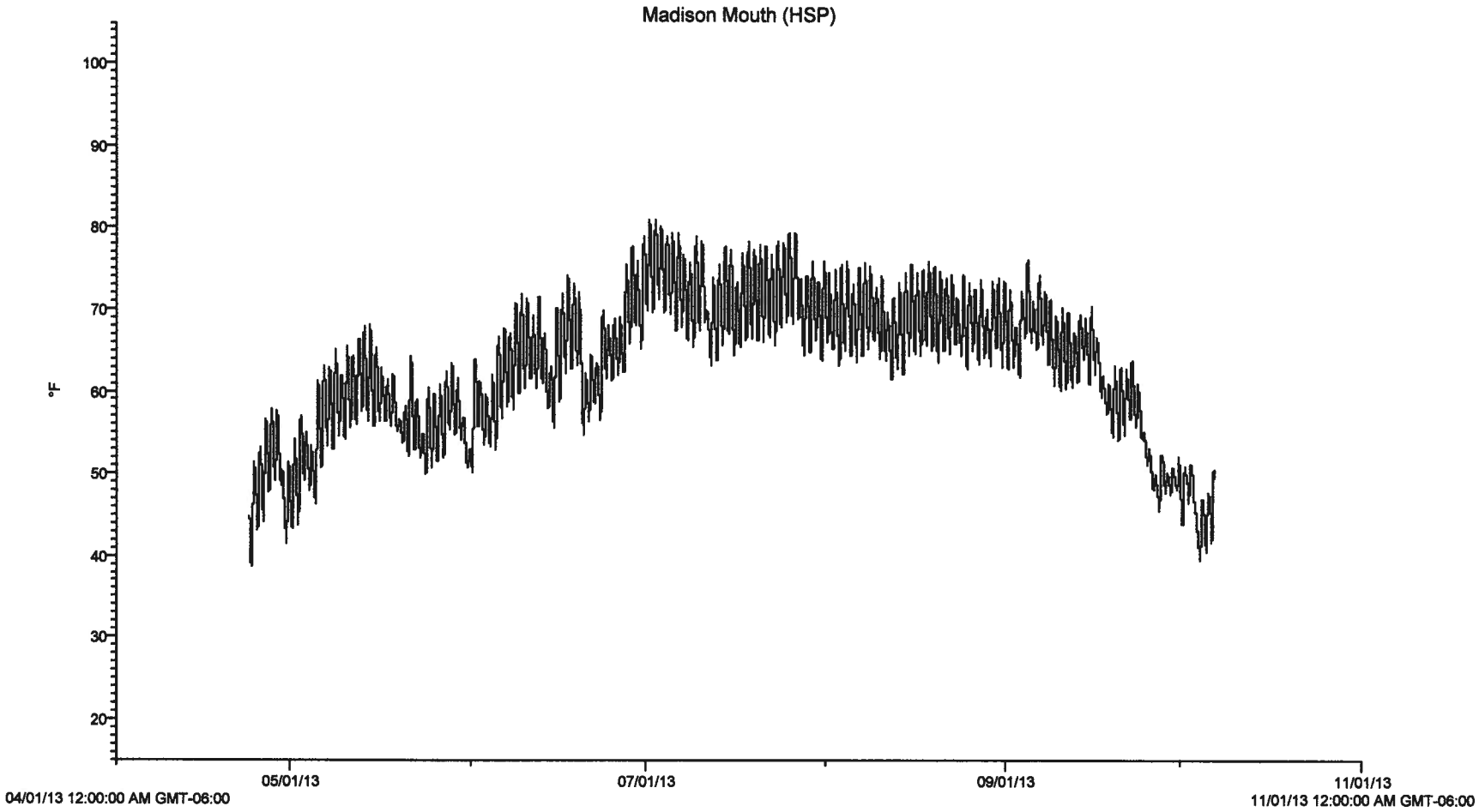
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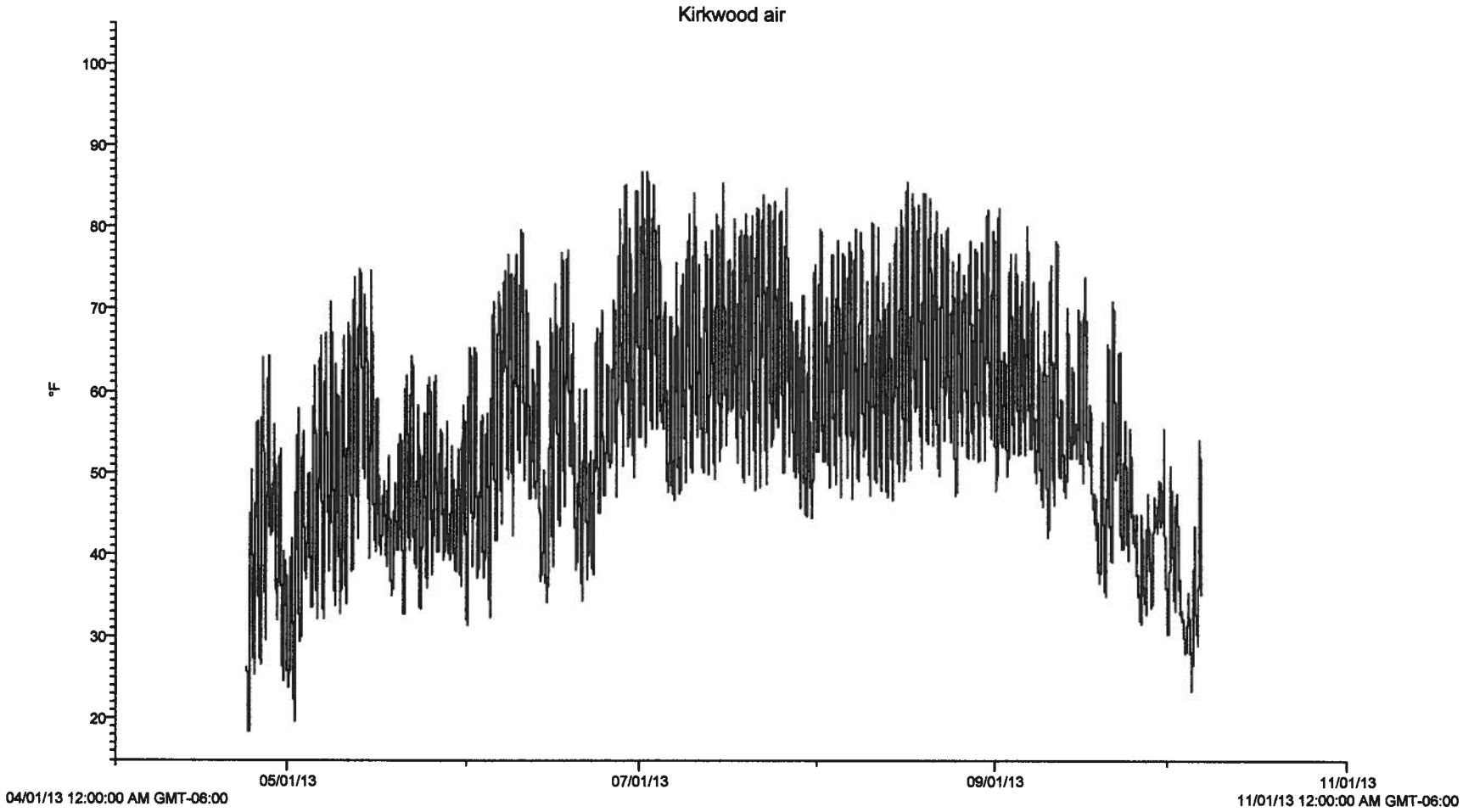
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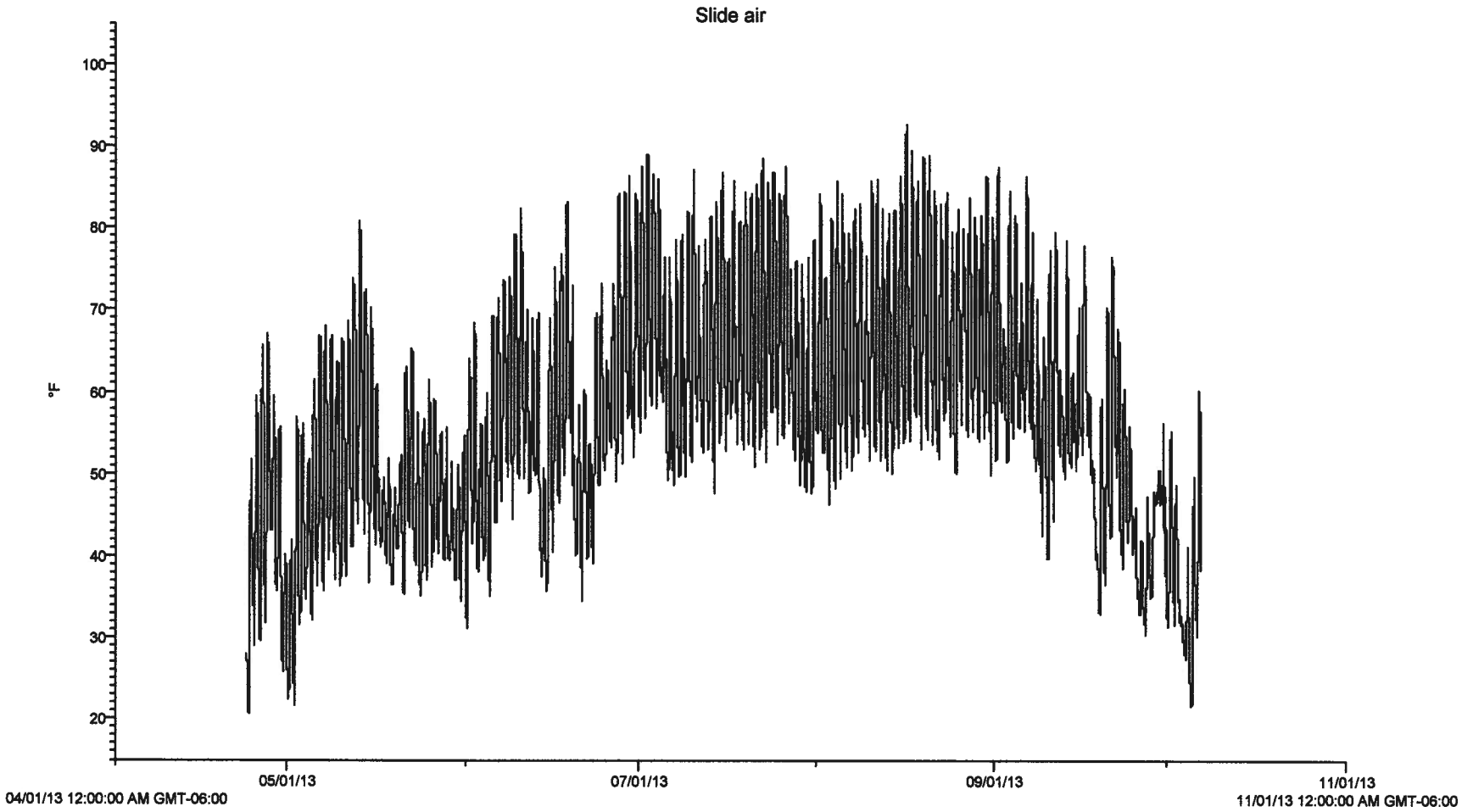
Slide air
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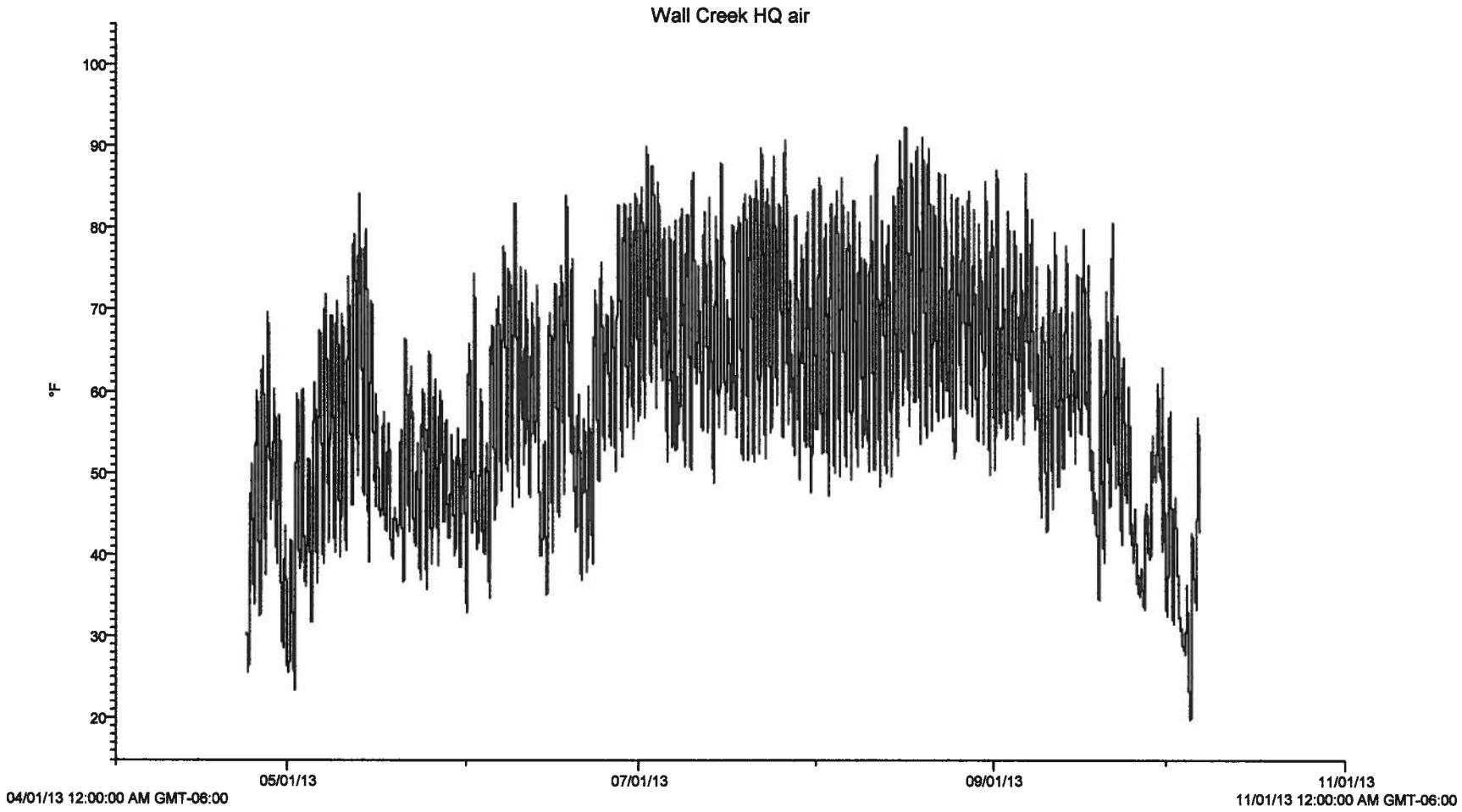
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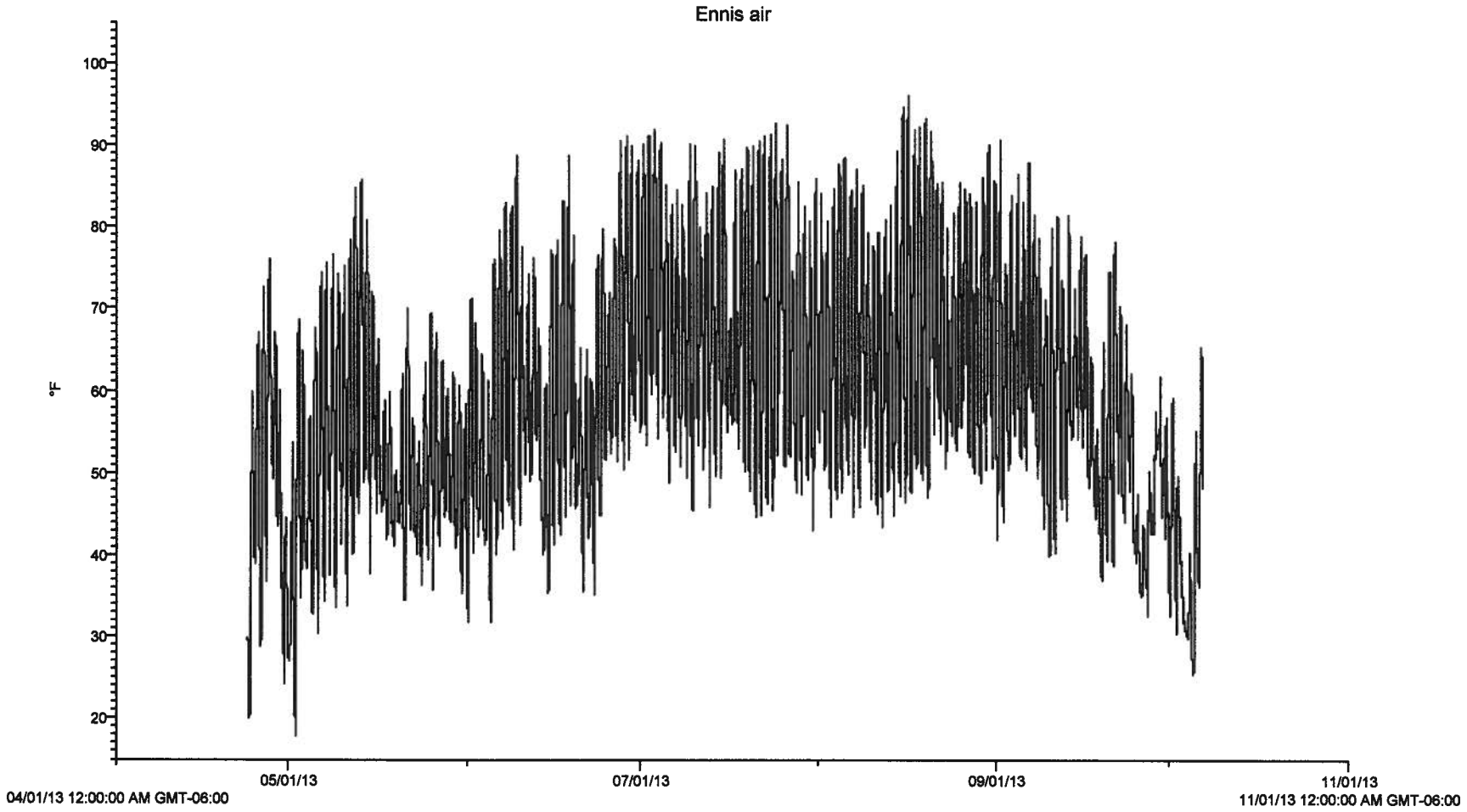
Ennis air
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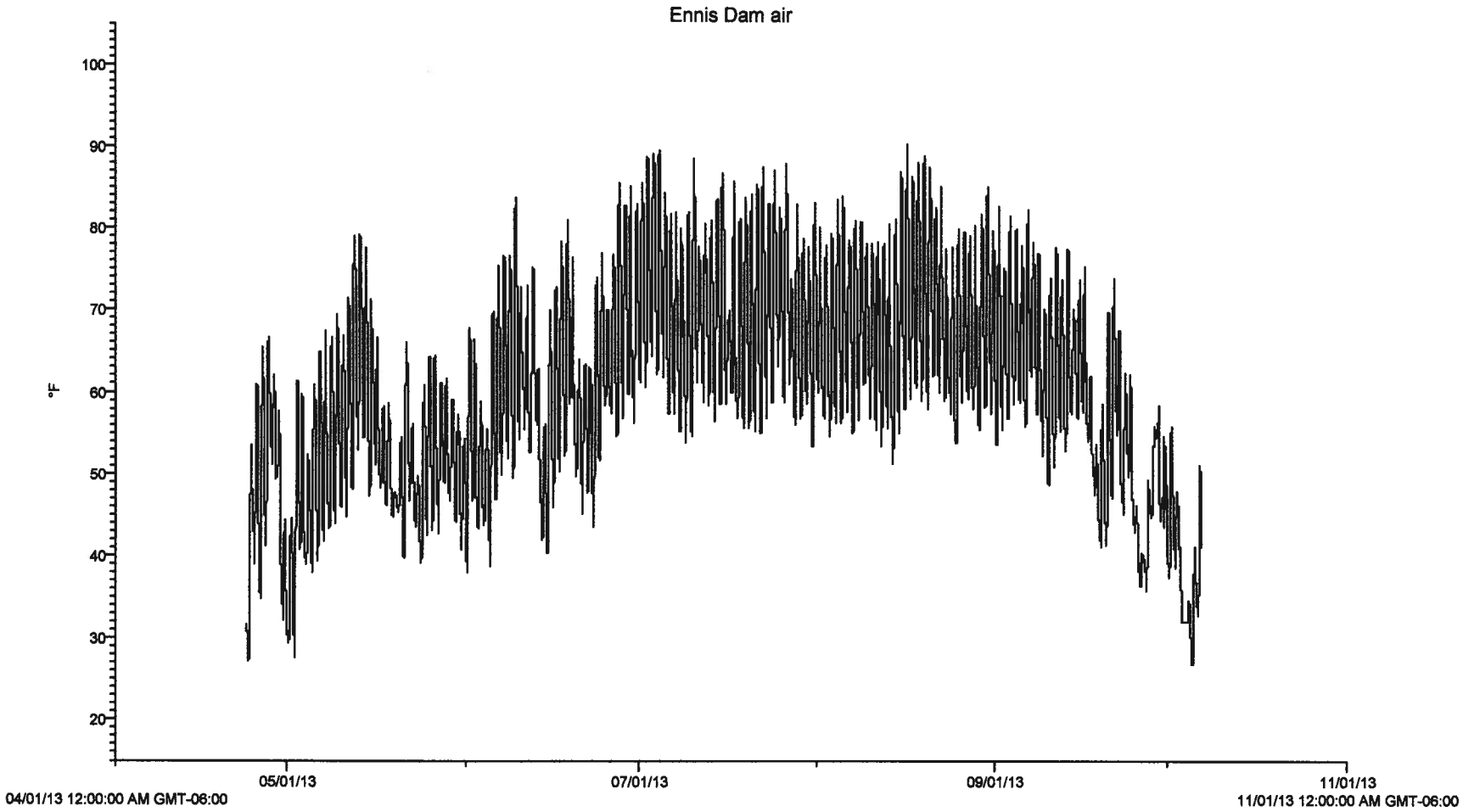
Ennis Dam air
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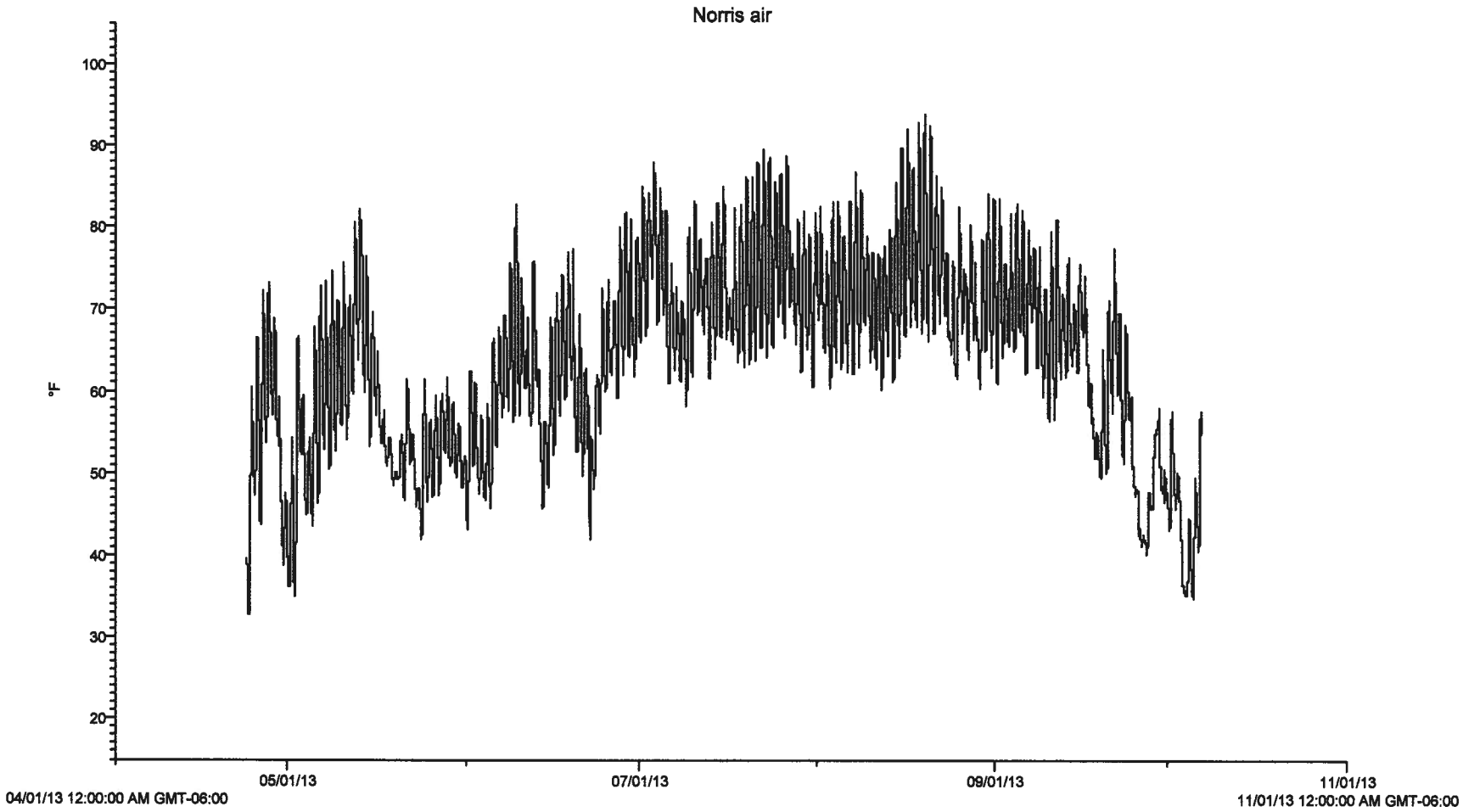
Norris air
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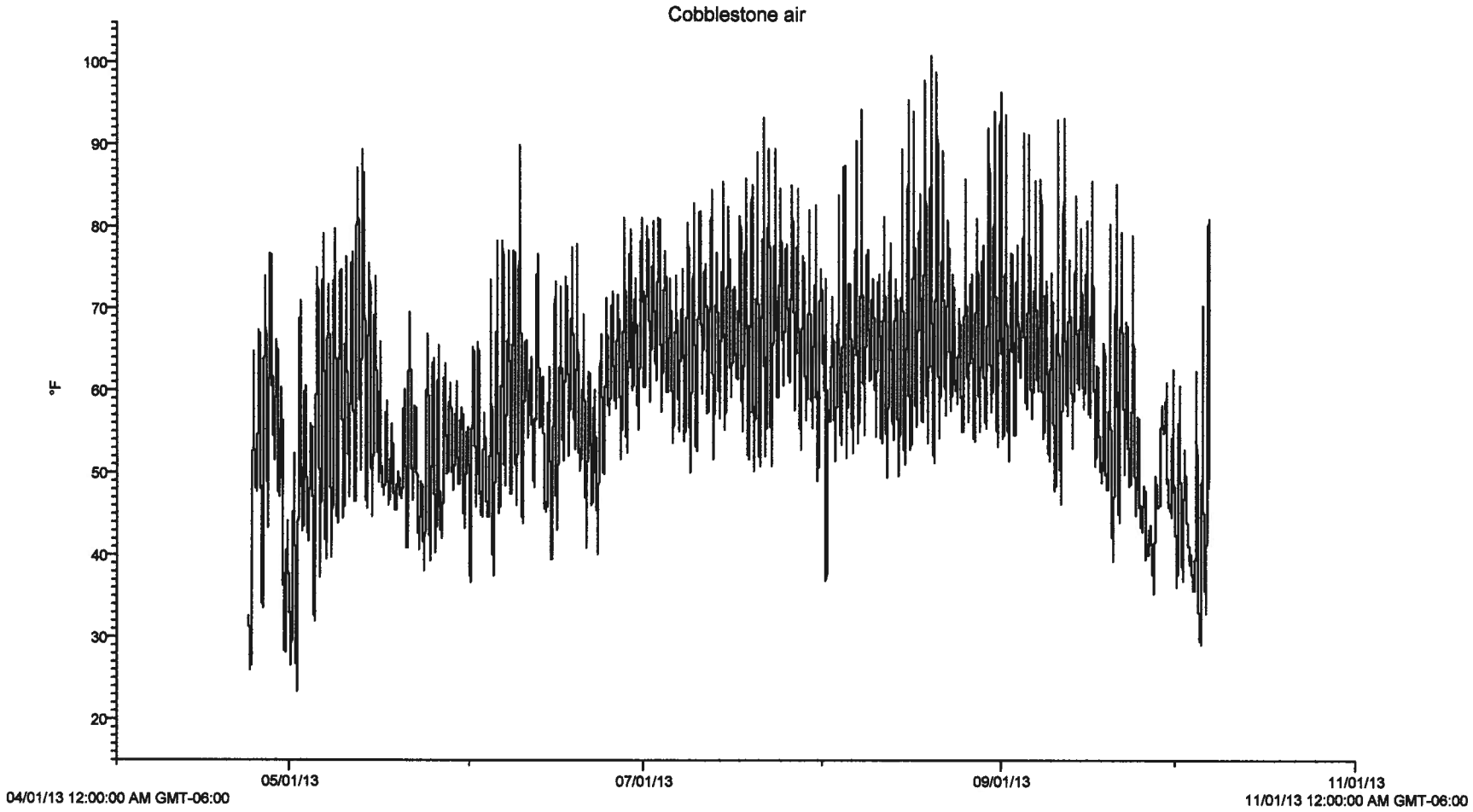
Cobblestone air
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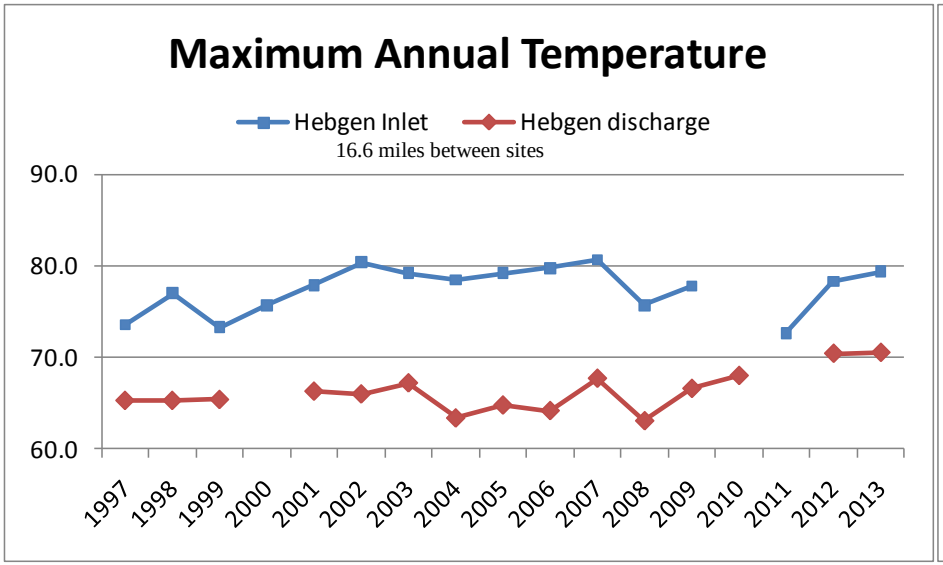
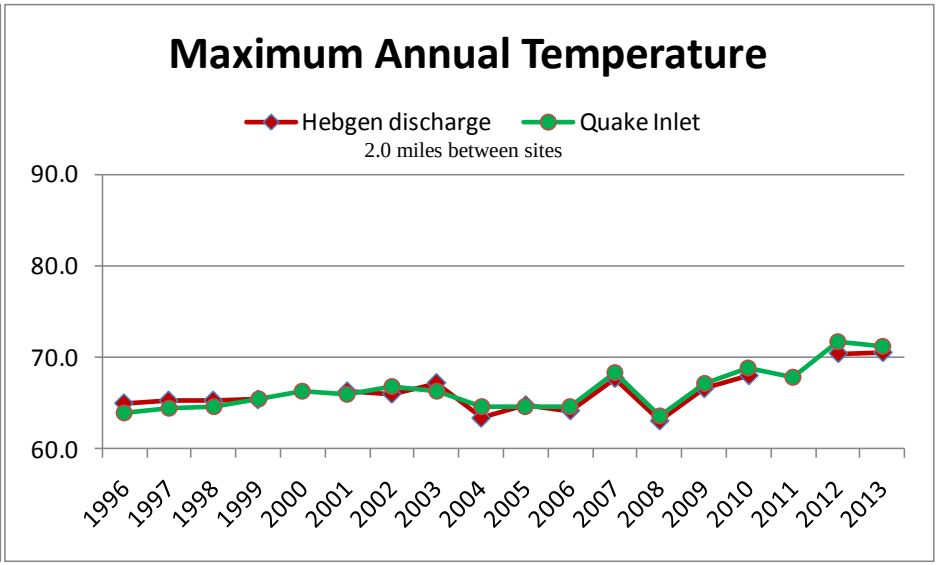
Appendix E2

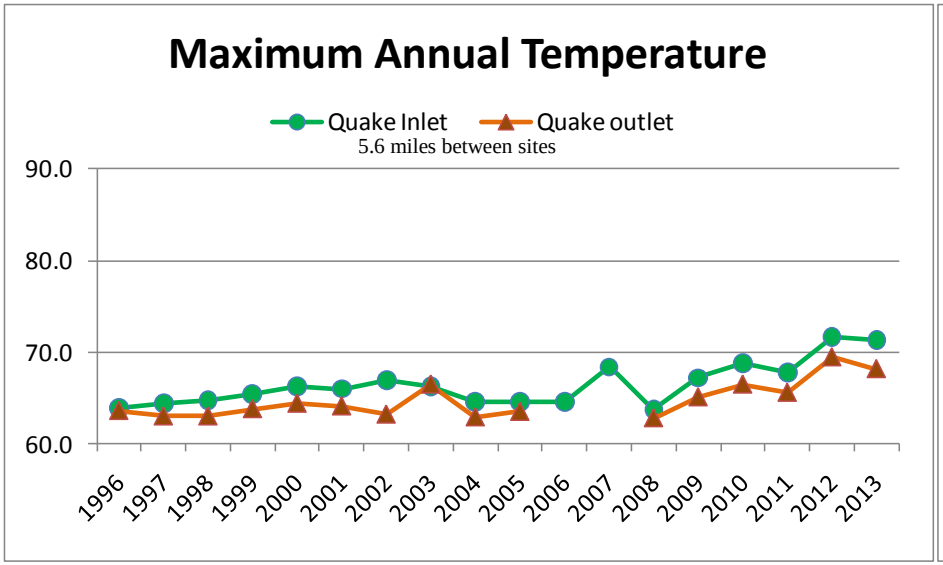
Comparison of maximum annual water temperatures at selected Madison River monitoring sites
1994/1995/1996 - 2013
See Figure 7 for locations

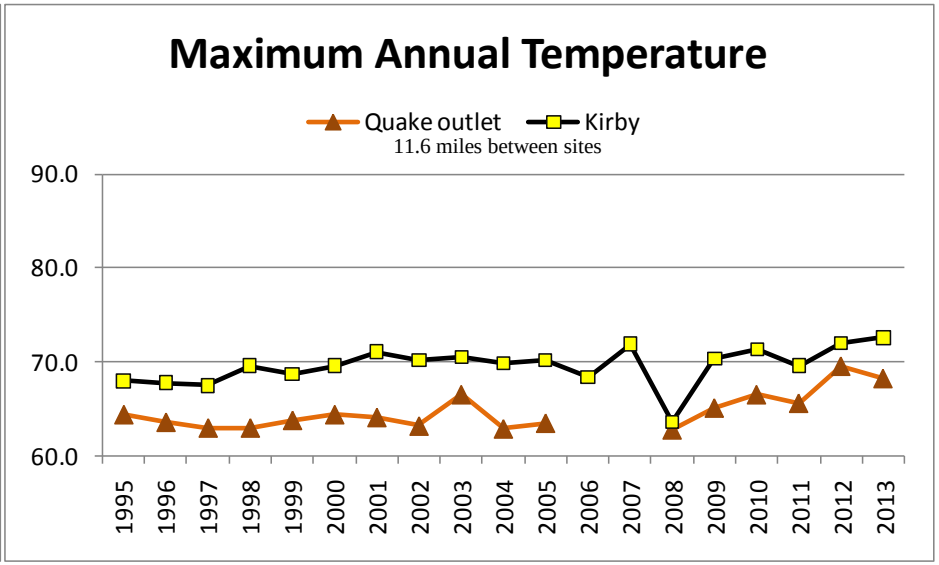
NOTES:

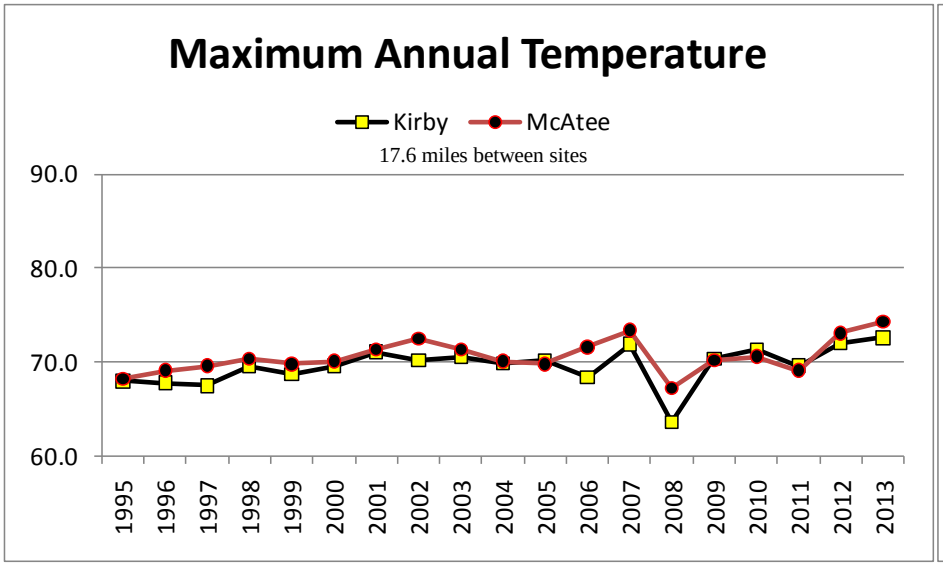
- Recorders at some locations were not recovered some years
- It is important to note that the maximum temperatures at each site throughout the river did not all occur on the same day in any year, and that the maximum temperature at any given site may have been attained on more than just one day in a year
- Pulse flows were conducted out of Ennis Reservoir annually from 2000 – 2007, 2009 and 2013. See report pages 8 and 27
- For all 14 years data are available, maximum water temperature at the Hebgen Inlet site is higher than maximum water temperature at the Hebgen discharge site
- For 15 of 16 years where data are available, maximum water temperature at the Quake Inlet site is higher than maximum water temperature at the Quake outlet site
- Hebgen Reservoir and Quake Lake decrease the maximum water temperature, but that affect appears to be attenuated by the time the water reaches the Kirby site. The Kirby and McAtee sites exhibit very similar maximum water temperatures
- The Ennis Reservoir Inlet site annually exhibits the highest maximum water temperature of the 7 sites between Hebgen Dam and Ennis Reservoir
- In 16 of the 19 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 at least 5^{o} F warmer than at Ennis Dam
- Maximum water temperature at Blacks Ford has been suppressed by pulse flows when necessary to prevent thermal stress related fish kills, the last of which occurred in 1988.

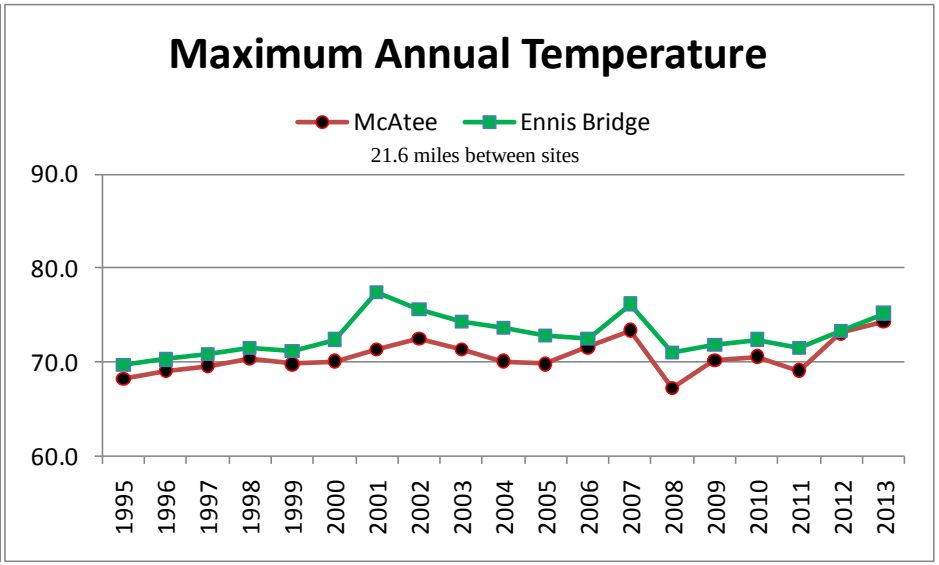

Maximum Annual Temperature
Hebgen Inlet
Hebgen discharge
16.6 miles between sites
90.0
80.0
70.0
60.0
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013

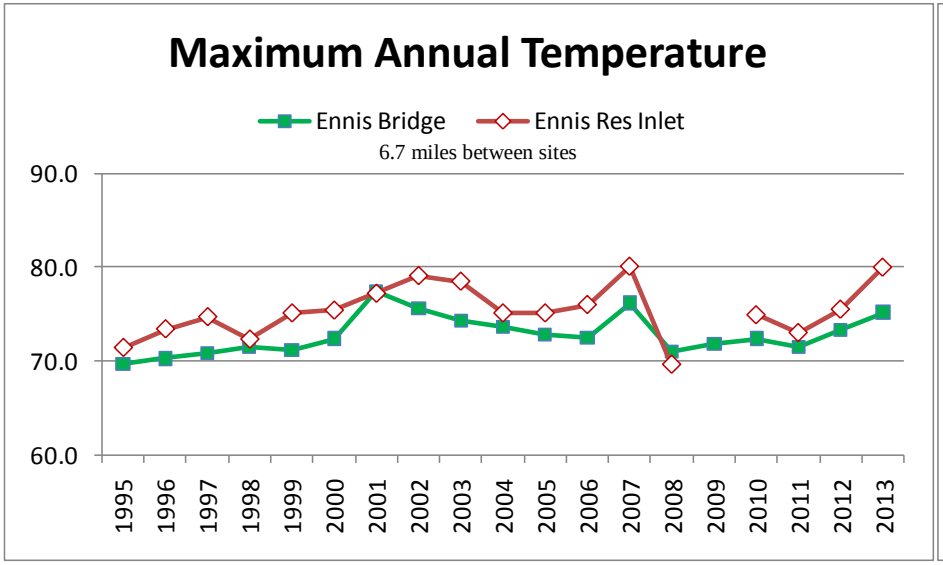

Maximum Annual Temperature
Hebgen discharge
Quake Inlet
2.0 miles between sites
90.0
80.0
70.0
60.0
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013

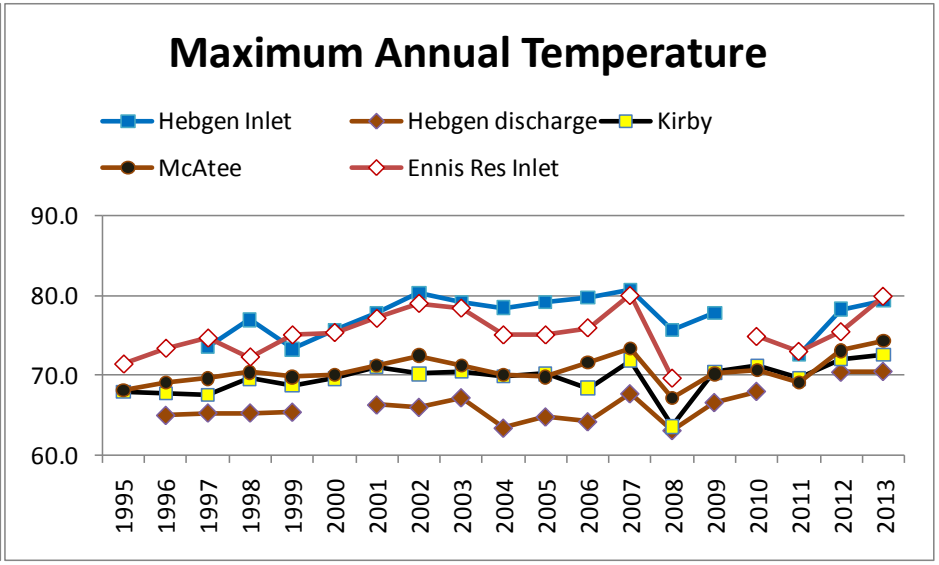

Maximum Annual Temperature
Quake Inlet
Quake outlet
5.6 miles between sites
90.0
80.0
70.0
60.0
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013

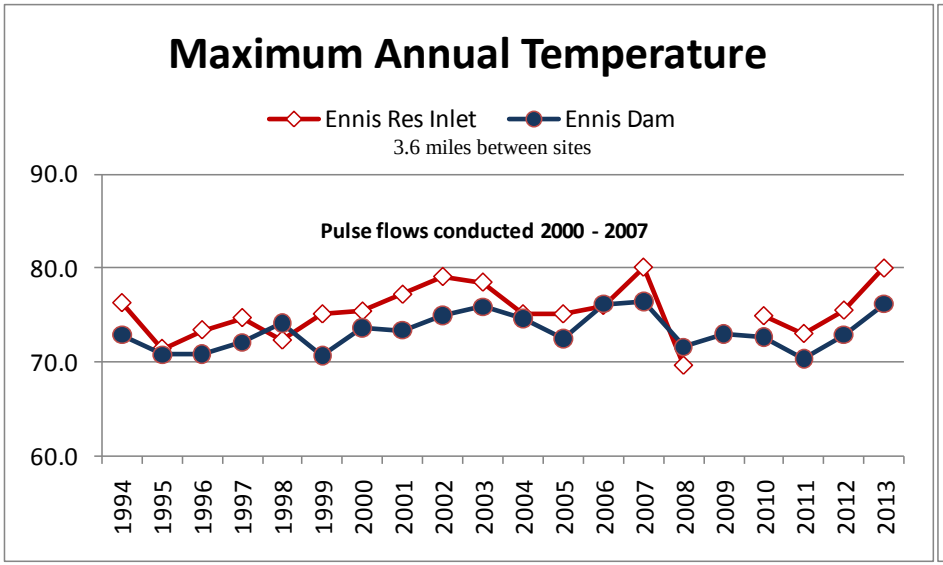

Maximum Annual Temperature
Quake outlet
Kirby
11.6 miles between sites
90.0
80.0
70.0
60.0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013

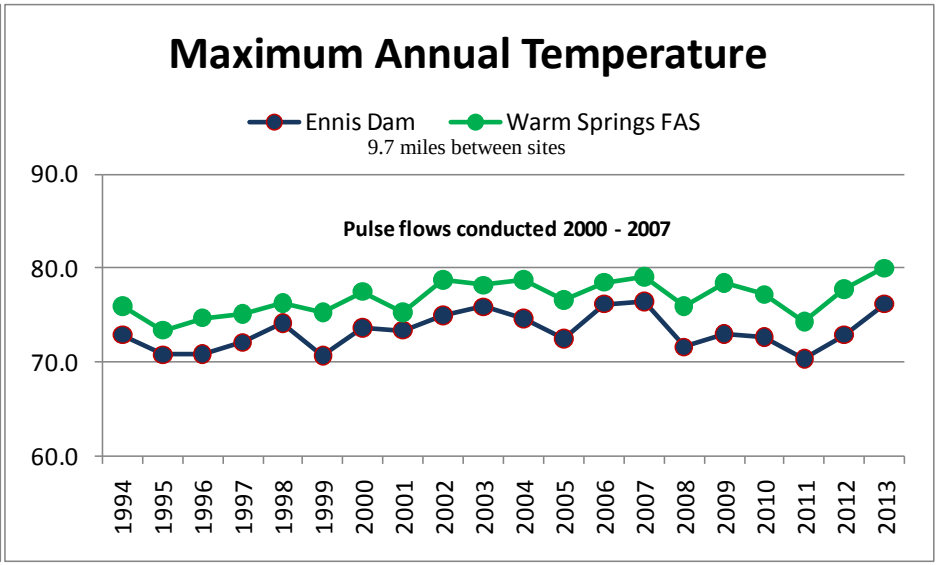

Maximum Annual Temperature
Kirby
McAtee
17.6 miles between sites
90.0
80.0
70.0
60.0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013

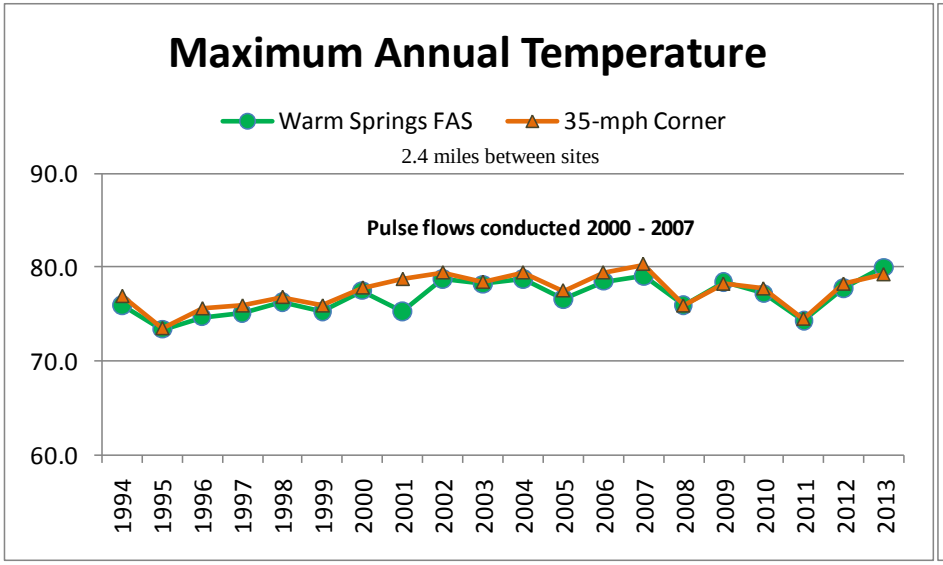

Maximum Annual Temperature
McAtee
Ennis Bridge
21.6 miles between sites
90.0
80.0
70.0
60.0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013

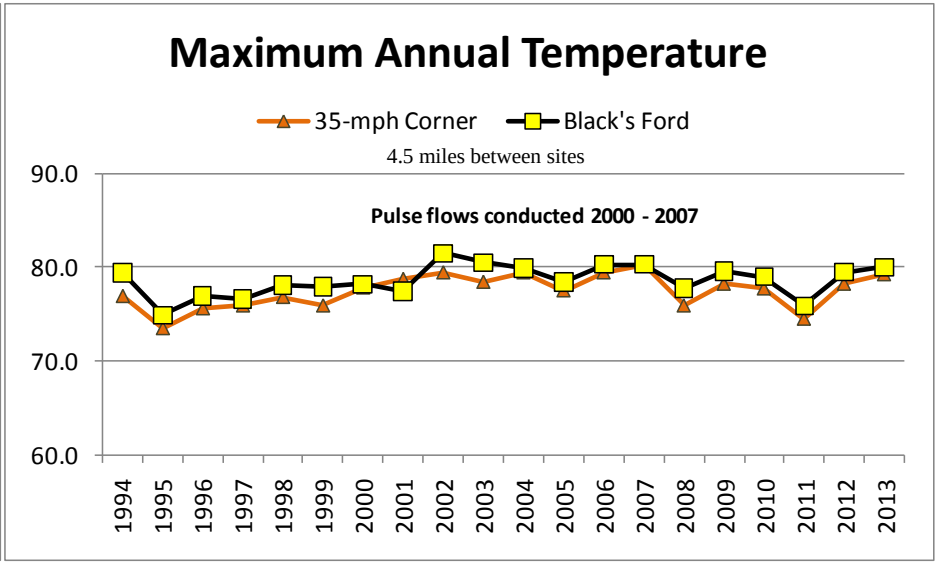

Maximum Annual Temperature
Ennis Bridge
Ennis Res Inlet
6.7 miles between sites
90.0
80.0
70.0
60.0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013

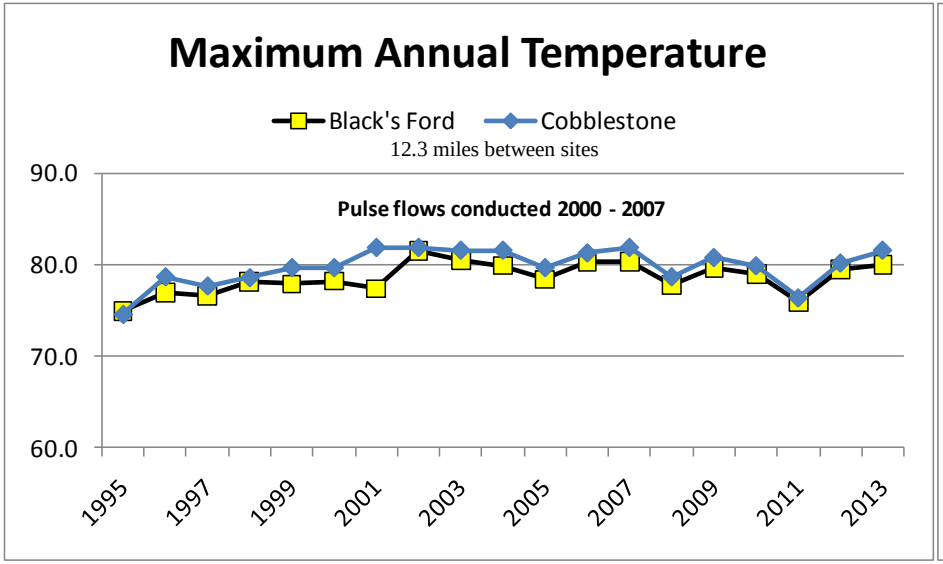

Maximum Annual Temperature
Hebgen Inlet
Hebgen discharge
Kirby
McAtee
Ennis Res Inlet
90.0
80.0
70.0
60.0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013

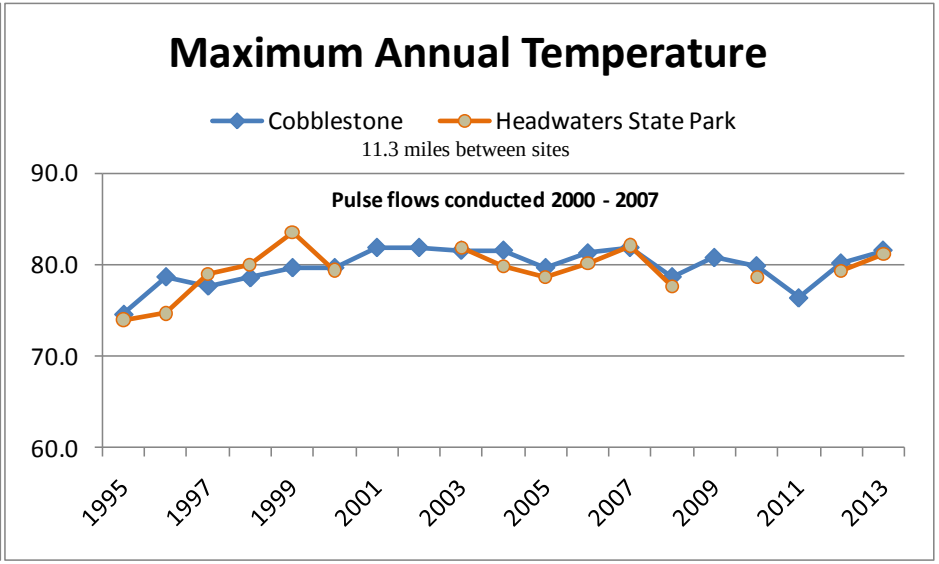

Maximum Annual Temperature
Ennis Res Inlet
Ennis Dam
3.6 miles between sites
Pulse flows conducted 2000 - 2007
90.0
80.0
70.0
60.0
1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013

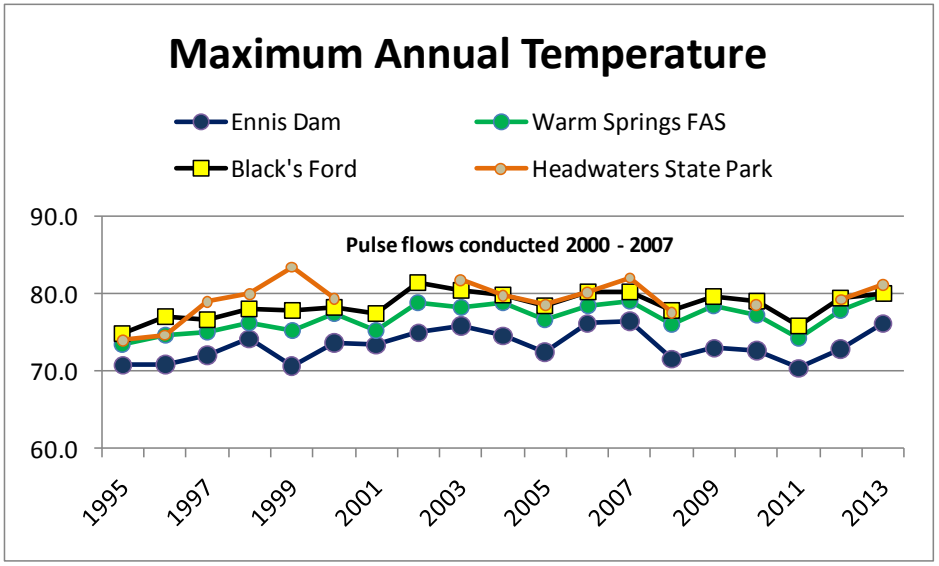

Maximum Annual Temperature
Ennis Dam
Warm Springs FAS
9.7 miles between sites
Pulse flows conducted 2000 - 2007
90.0
80.0
70.0
60.0
1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013


Maximum Annual Temperature
Warm Springs FAS
35-mph Corner
2.4 miles between sites
Pulse flows conducted 2000 - 2007
90.0
80.0
70.0
60.0
1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013


Maximum Annual Temperature
35-mph Corner
Black's Ford
4.5 miles between sites
Pulse flows conducted 2000 - 2007
90.0
80.0
70.0
60.0
1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013

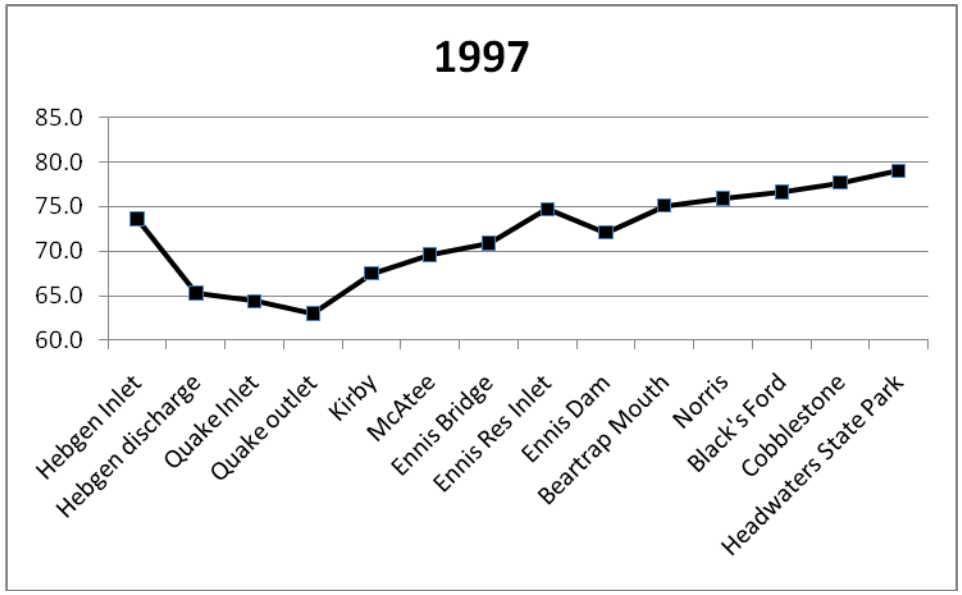

Maximum Annual Temperature
Black's Ford
Cobblestone
12.3 miles between sites
Pulse flows conducted 2000 - 2007
90.0
80.0
70.0
60.0
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013

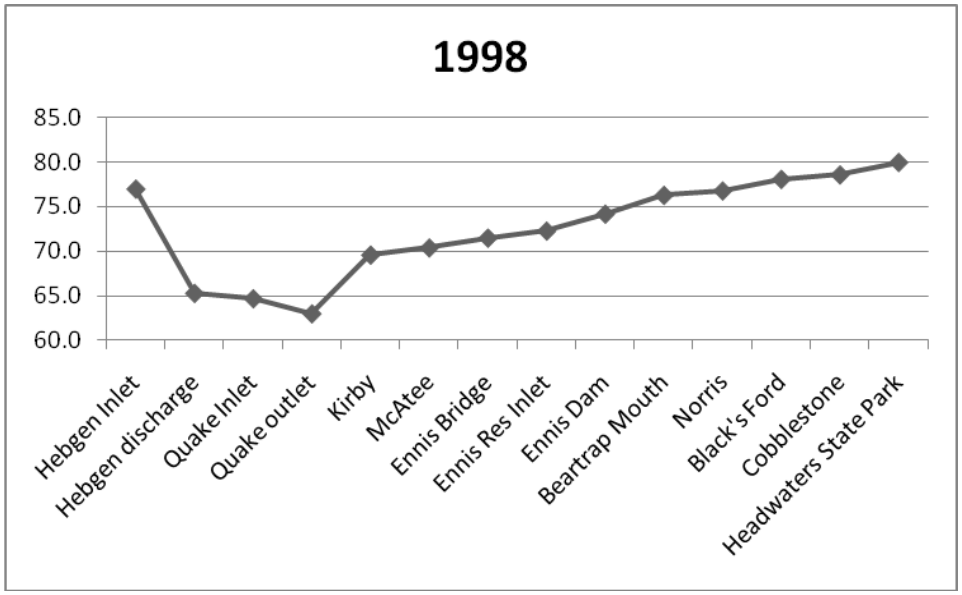

Maximum Annual Temperature
Cobblestone
Headwaters State Park
11.3 miles between sites
Pulse flows conducted 2000 - 2007
90.0
80.0
70.0
60.0
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013

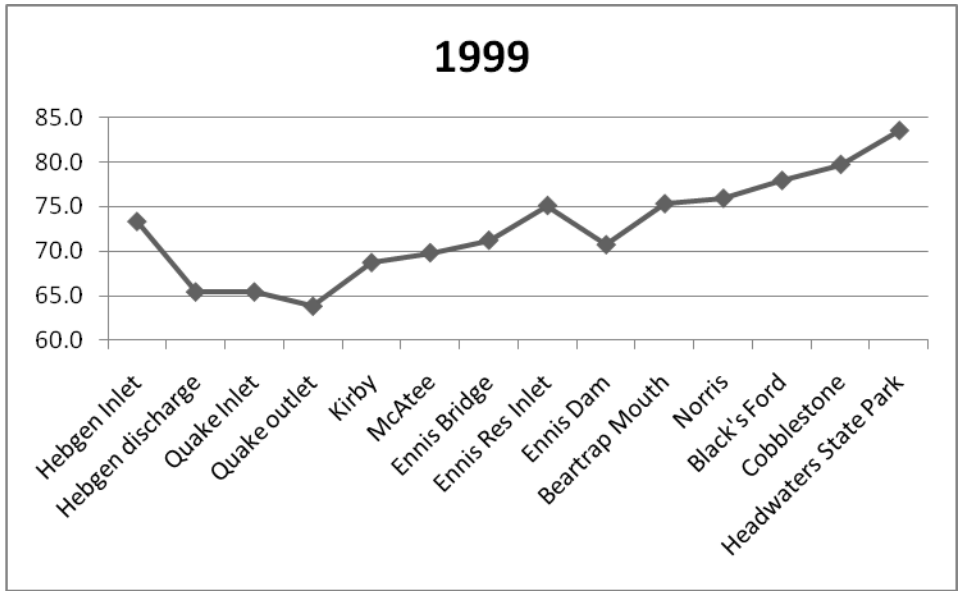

Maximum Annual Temperature
Ennis Dam
Warm Springs FAS
Black's Ford
Headwaters State Park
Pulse flows conducted 2000 - 2007
90.0
80.0
70.0
60.0
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013

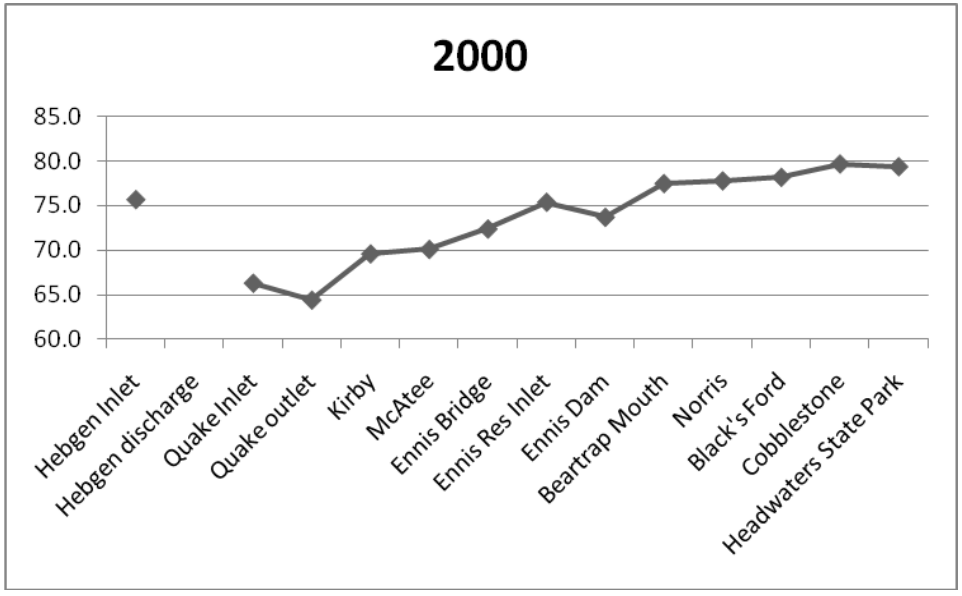
Appendix E3

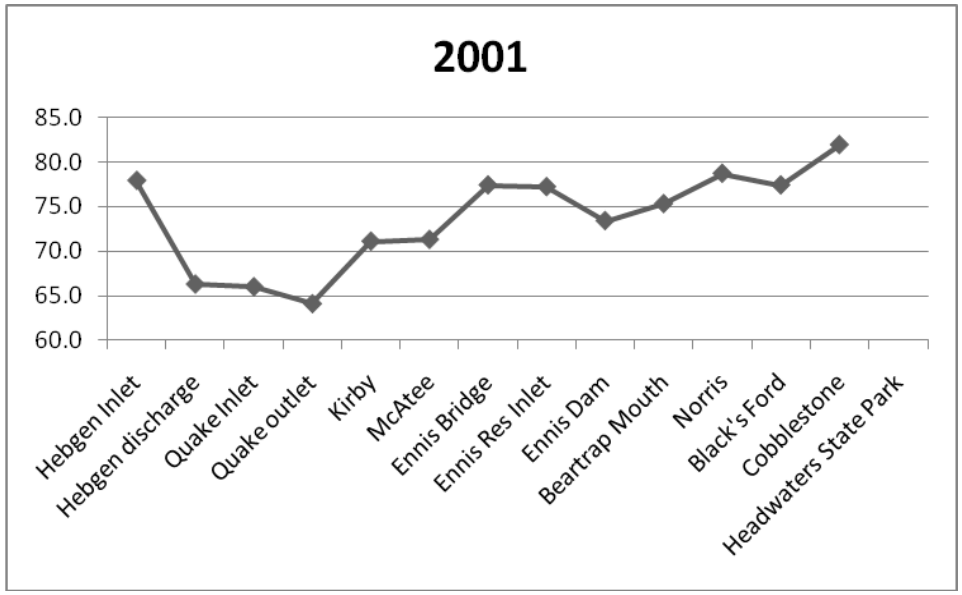
Longitudinal profiles illustrating the maximum water temperature recorded at each site, 1997 - 2013
See Figure 7 for locations

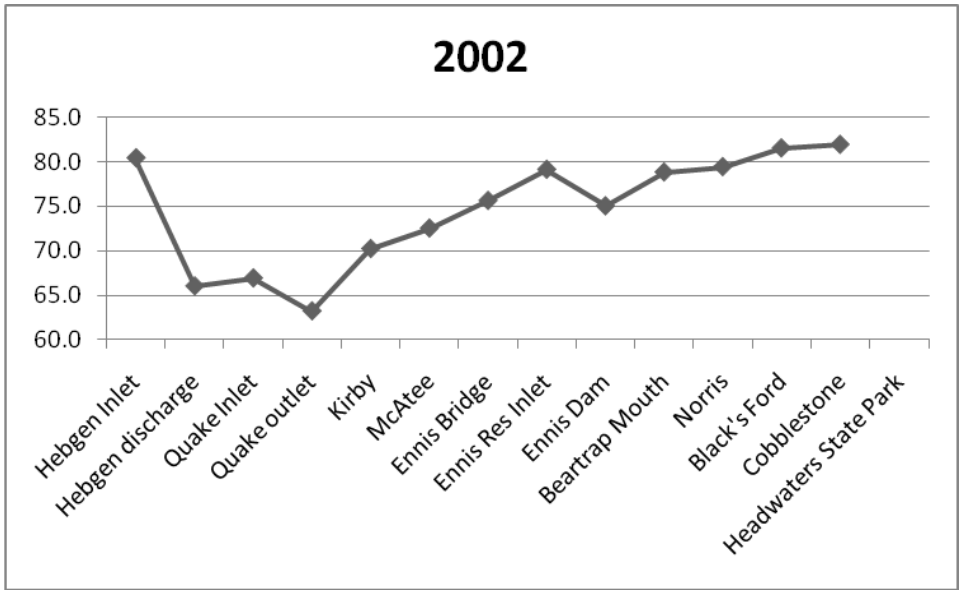

1997
85.0
80.0
75.0
70.0
65.0
60.0
Hebgen Inlet
Hebgen discharge
Quake Inlet
Quake outlet
Kirby
McAtee
Ennis Bridge
Ennis Res Inlet
Ennis Dam
Beartrap Mouth
Norris
Black's Ford
Cobblestone
Headwaters State Park

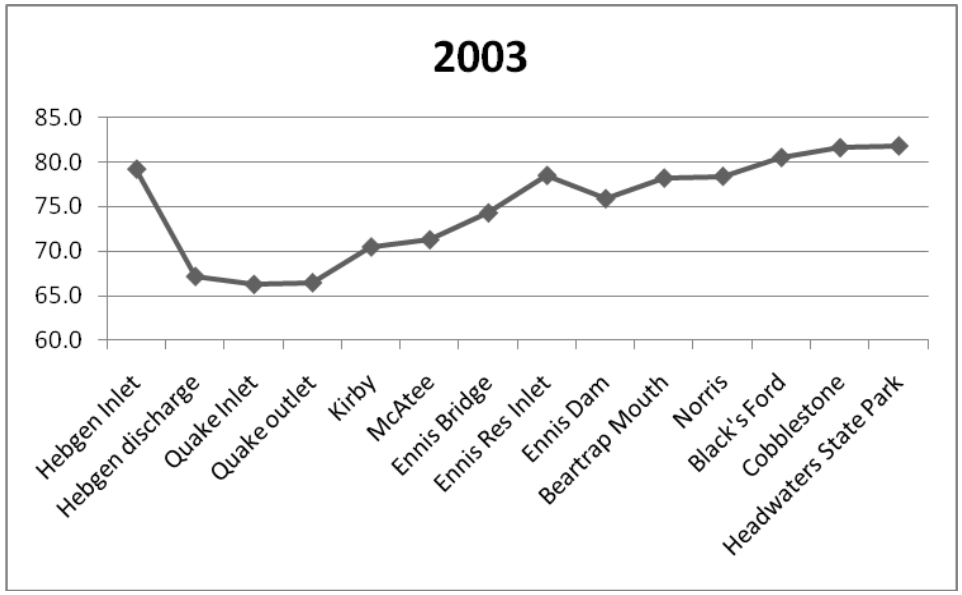

1998
85.0
80.0
75.0
70.0
65.0
60.0
Hebgen Inlet
Hebgen discharge
Quake Inlet
Quake outlet
Kirby
McAtee
Ennis Bridge
Ennis Res Inlet
Ennis Dam
Beartrap Mouth
Norris
Black's Ford
Cobblestone
Headwaters State Park

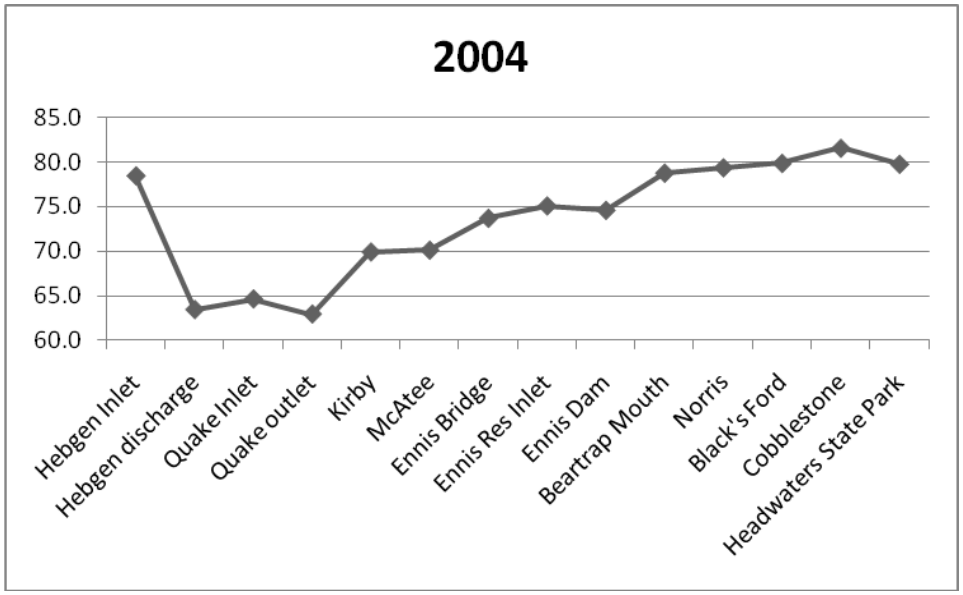

1999
85.0
80.0
75.0
70.0
65.0
60.0
Hebgen Inlet
Hebgen discharge
Quake Inlet
Quake outlet
Kirby
McAtee
Ennis Bridge
Ennis Res Inlet
Ennis Dam
Beartrap Mouth
Norris
Black's Ford
Cobblestone
Headwaters State Park

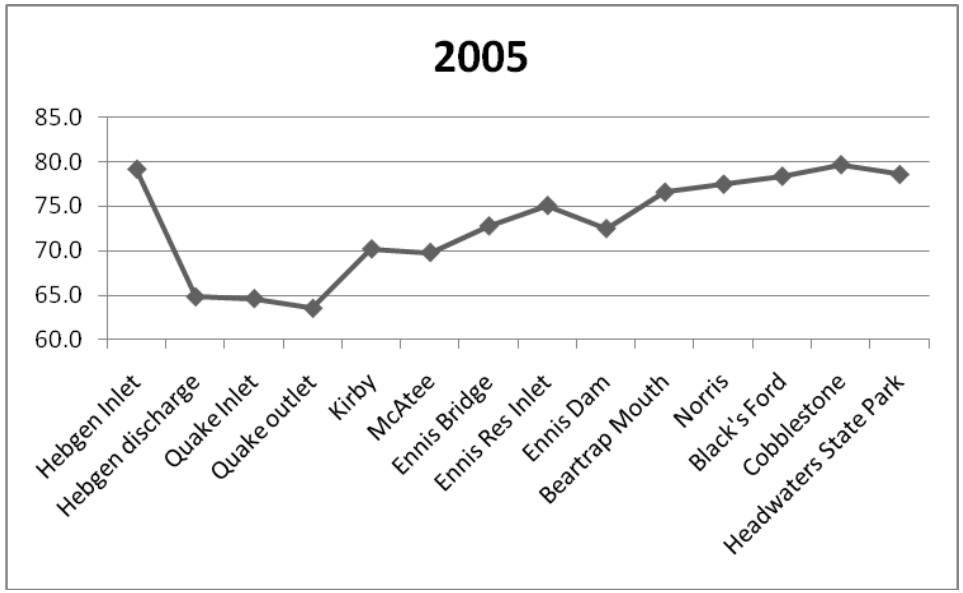

2000
85.0
80.0
75.0
70.0
65.0
60.0
Hebgen Inlet
Hebgen discharge
Quake Inlet
Quake outlet
Kirby
McAtee
Ennis Bridge
Ennis Res Inlet
Ennis Dam
Beartrap Mouth
Norris
Black's Ford
Cobblestone
Headwaters State Park

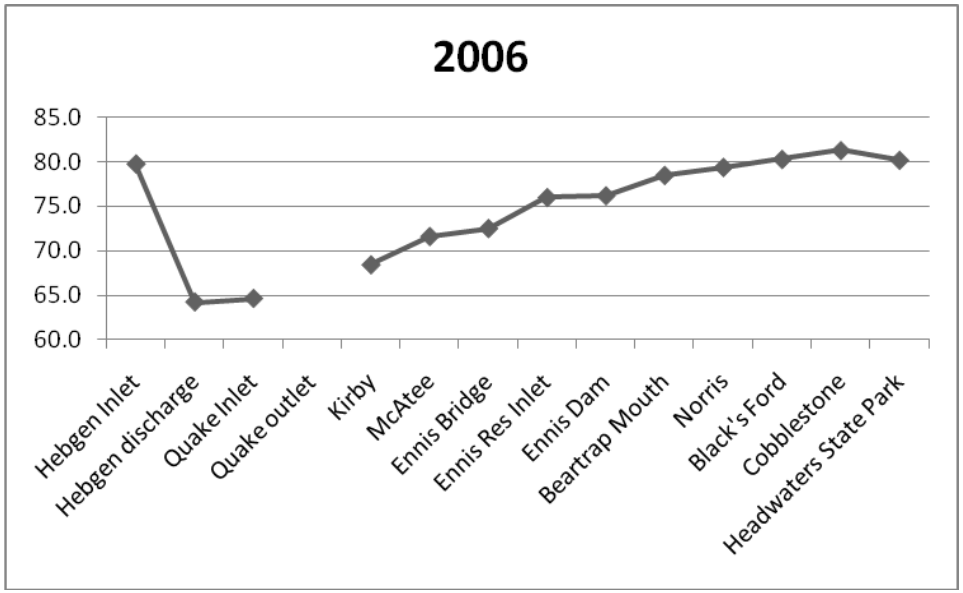

2001
85.0
80.0
75.0
70.0
65.0
60.0
Hebgen Inlet
Hebgen discharge
Quake Inlet
Quake outlet
Kirby
McAtee
Ennis Bridge
Ennis Res Inlet
Ennis Dam
Beartrap Mouth
Norris
Black's Ford
Cobblestone
Headwaters State Park


2002
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


2003
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


2004
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


2005
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


2006
85.0
80.0
75.0
70.0
65.0
60.0
Hebgen Inlet
Hebgen discharge
Quake Inlet
Quake outlet
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McAtee
Ennis Bridge
Ennis Res Inlet
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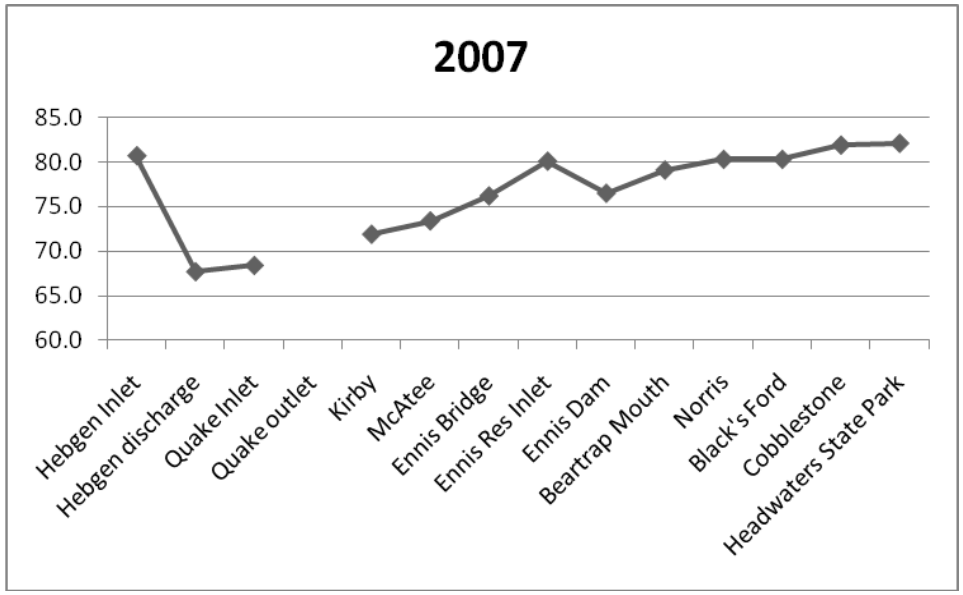
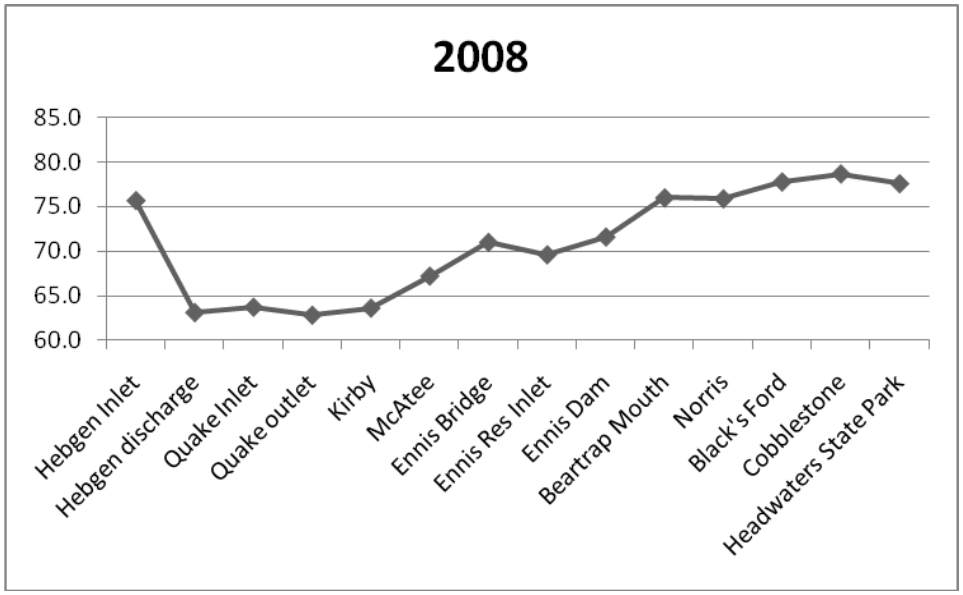
Beartrap Mouth
Norris
Black's Ford
Cobblestone
Headwaters State Park


2007
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


2008
85.0
80.0
75.0
70.0
65.0
60.0
Hebgen Inlet
Hebgen discharge
Quake Inlet
Quake outlet
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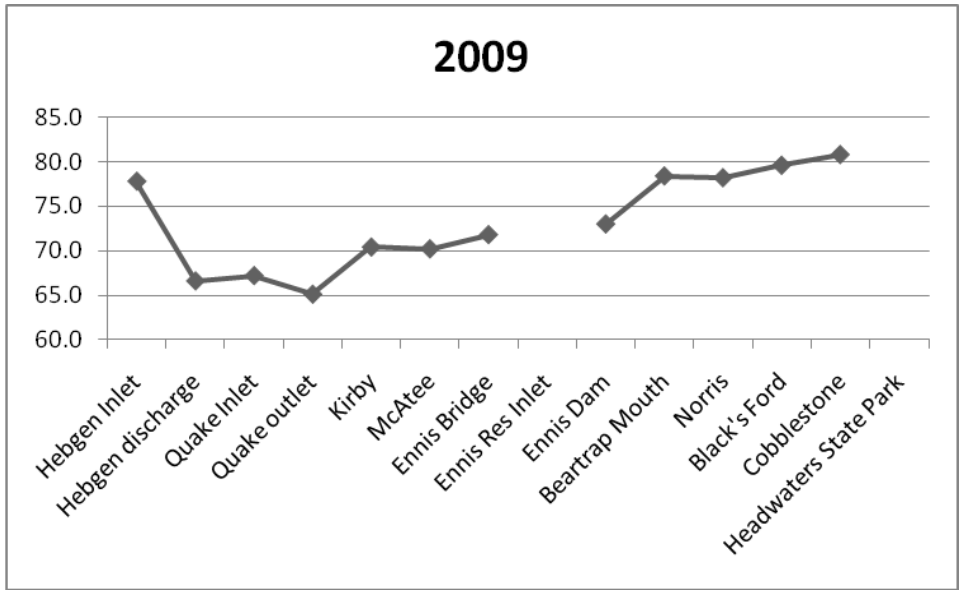
McAtee
Ennis Bridge
Ennis Res Inlet
Ennis Dam
Beartrap Mouth
Norris
Black's Ford
Cobblestone
Headwaters State Park


2009
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80.0
75.0
70.0
65.0
60.0
Hebgen Inlet
Hebgen discharge
Quake Inlet
Quake outlet
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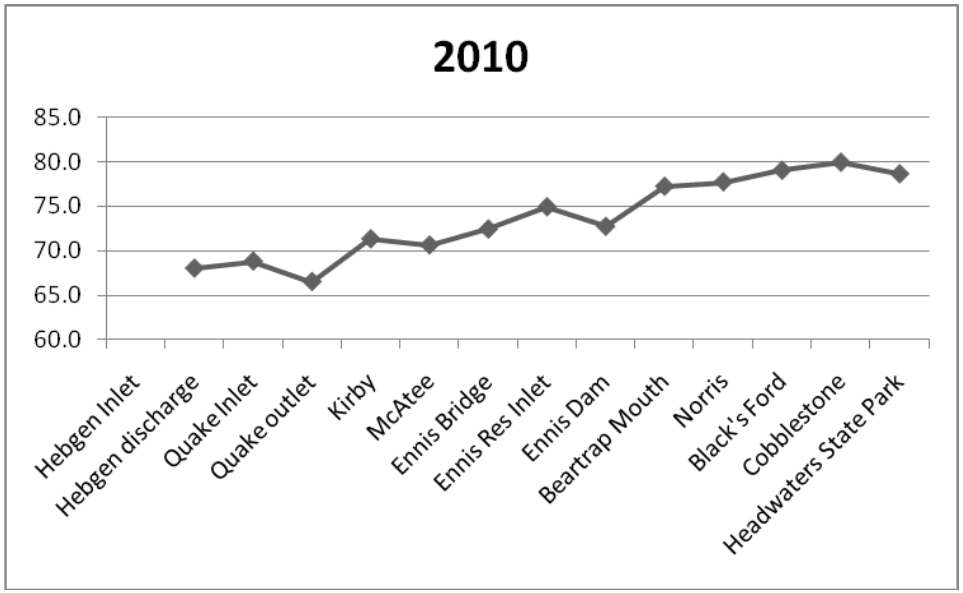
McAtee
Ennis Bridge
Ennis Res Inlet
Ennis Dam
Beartrap Mouth
Norris
Black's Ford
Cobblestone
Headwaters State Park


2010
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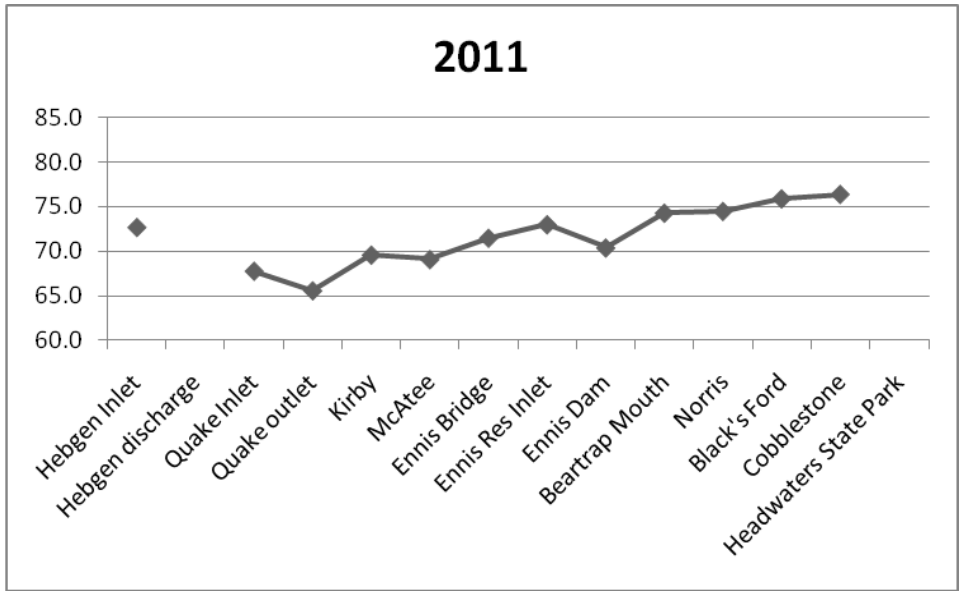
75.0
70.0
65.0
60.0
Hebgen Inlet
Hebgen discharge
Quake Inlet
Quake outlet
Kirby
McAtee
Ennis Bridge
Ennis Res Inlet
Ennis Dam
Beartrap Mouth
Norris
Black's Ford
Cobblestone
Headwaters State Park


2011
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Hebgen Inlet
Hebgen discharge
Quake Inlet
Quake outlet
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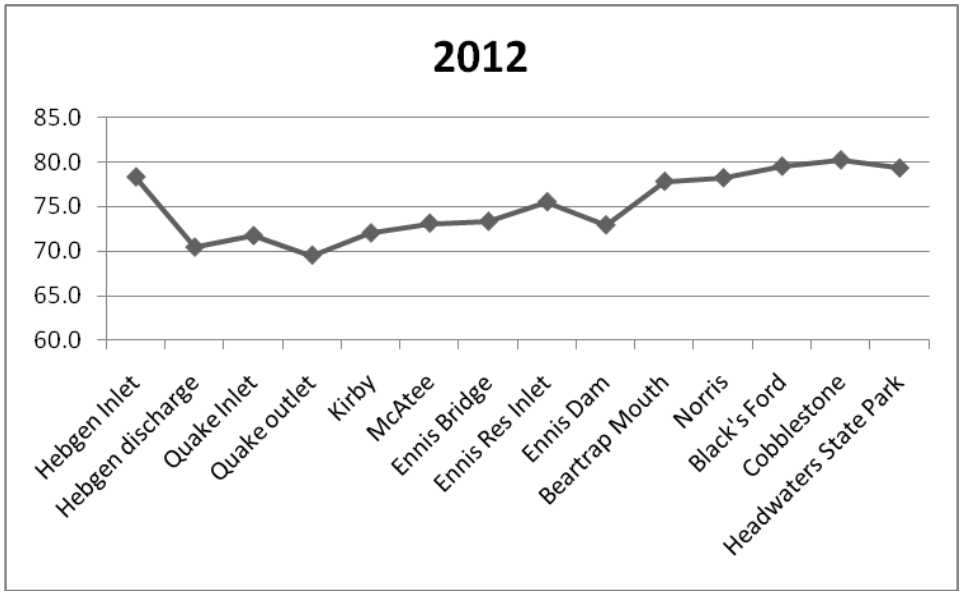
McAtee
Ennis Bridge
Ennis Res Inlet
Ennis Dam
Beartrap Mouth
Norris
Black's Ford
Cobblestone
Headwaters State Park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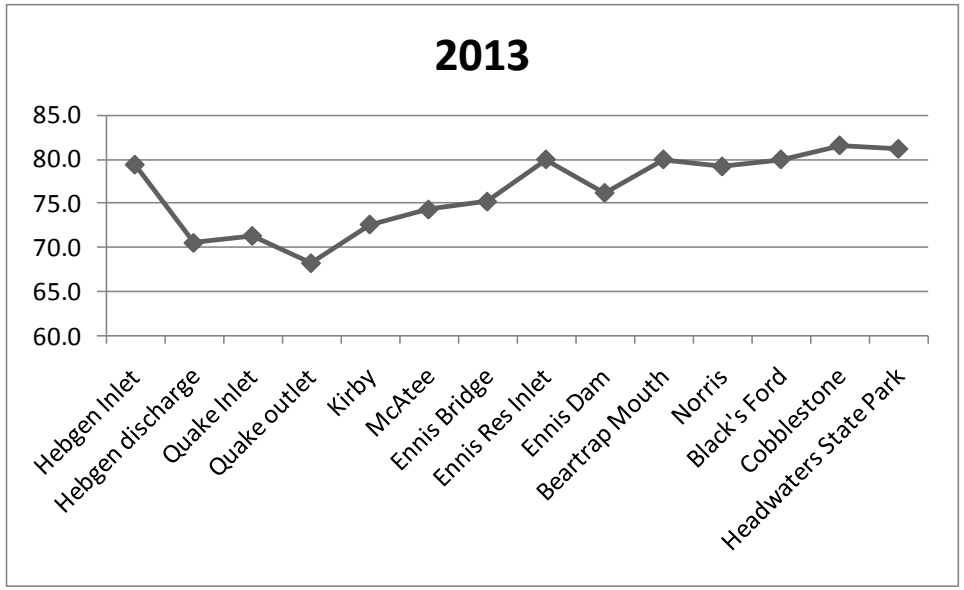
60.0
Hebgen Inlet
Hebgen discharge
Quake Inlet
Quake outlet
Kirby
McAtee
Ennis Bridge
Ennis Res Inlet
Ennis Dam
Beartrap Mouth
Norris
Black's Ford
Cobblestone
Headwaters State Park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75.0
70.0
65.0
60.0
Hebgen Inlet
Hebgen discharge
Quake Inlet
Quake outlet
Kirby
McAtee
Ennis Bridge
Ennis Res Inlet
Ennis Dam
Beartrap Mouth
Norris
Black's Ford
Cobblestone
Headwaters State Park

Appendix F

Project Title: 1) **Gallatin NF Seasonal Technician Funding**

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

FERC Article	Item	Report Topic	Project	Page Number
409	**(3)**	**Fish habitat Enhancement**	**Annual Water Temperature Monitoring**	**1**
			Watkins Creek	**2**
412	**(5)**	**Species of Special Concern – Westslope Cutthroat Trout**	**South Fork Madison River**	**1**
			Ruby Creek	**2**
			Cabin Creek	**2**

Report by: **Bruce Roberts**

Location of Proposed Project: **Hebgen Basin and Madison River**

The Madison River Fisheries Technical Advisory Committee (TAC) provided $5,038 to the Gallatin National Forest fisheries program to assist with the hiring of a two-person seasonal fisheries crew. The crew spent a total of 35 ten-hour days working within Madison River drainage on Fisheries and Wildlife TAC funded projects. The proceeding table shows how each project relates to the FERC Articles listed in PPL-Montana's FERC 2188 license to own and operate Hebgen Dam and others facilities along the Madison River. Not all projects that were originally coordinated and agreed upon by TAC members were implemented because of ever changing schedules and higher priorities.

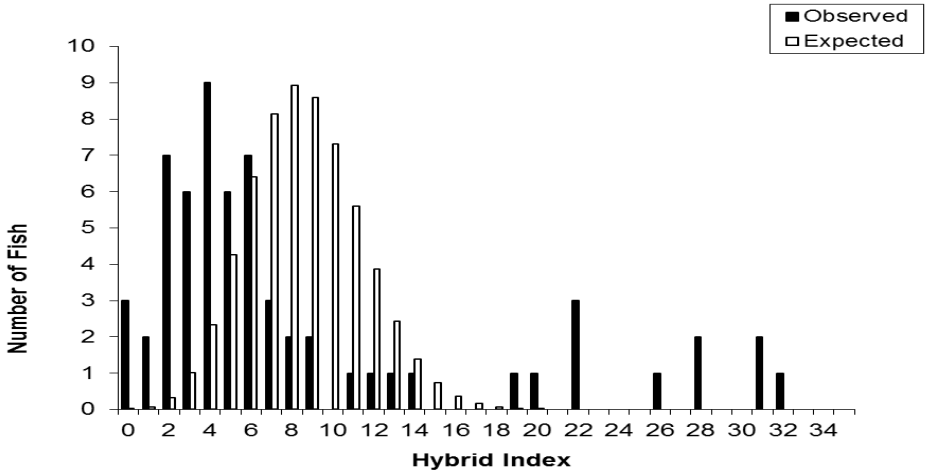
Annual Water and Air Temperature Monitoring

The Gallatin National Forest fisheries/hydrology programs have five long-term water temperature monitoring sites located in Hebgen Basin additional to those locations monitored by PPL-MT and MFWP (Red Canyon Creek, Cabin Creek, Watkins Creek, Little Tepee, and South Fork Madison River). These data sets are stored at the Gallatin National Forest Supervisor's Office and are available upon request.

South Fork Madison River Westslope Cutthroat Trout Restoration

Montana Fish, Wildlife and Parks and the Gallatin National Forest fisheries crews embarked on a three year project to remove substantially hybridized westslope cutthroat trout scattered throughout this isolated headwater population. Tandem crews electrofished approximately 1.5 miles of occupied habitat. Tissue samples were taken from all new fish that were not either clipped or tagged in the previous two years. Sixty-one new fish were collected in 2013, uniquely tagged and held in live cages. Tissue samples were rushed to the University of Montana Salmon and Trout Genetics lab for testing. Fifteen substantially hybridized WCT with a hybrid index of ten or greater were removed from the population in 2013. According to Robb Leary, personal communications, the genetic makeup of the remaining population would be similar to that prior to the most recent rainbow trout invasion within the last decade. This year's removal was the last in a series of three subsequent removals. In all, 59 substantially hybridized WCT x RBT were removed in 2011 - 2013. The plan is to periodically monitoring the genetic purity of this population.

Figure 1. Distribution of assigned hybrid indices of 61 newly collected westslope cutthroat trout (WCT) or WCT x rainbow trout hybrids genetically tested in September 2013 along the headwaters of the South Fork Madison River.



Ruby Creek Westslope Cutthroat Trout Restoration

Gallatin National Forest fisheries crews worked jointly with Montana Fish, Wildlife and Parks on a project within the middle Madison River drainage to remove rainbow trout from Ruby Creek as a pre-curser project to re-introduce genetically pure westslope cutthroat trout from Wally McClure Creek. The accomplishments of this project are reported within the body of this Montana Fish, Wildlife and Parks report.

Cabin Creek Barrier Investigation

Gallatin National Forest fisheries crews worked jointly with Montana Fish, Wildlife and Parks to retest the westslope cutthroat trout genetics immediately upstream from the proposed Cabin Creek fish barrier project.

Gallatin National Forest completed the following work in advance of approving the Cabin Creek fish barrier project using Forest Service appropriated funds. An interdisciplinary team of resource specialists reviewed the proposed barrier location. For safety, visuals and wild and scenic river eligibility reasons, the proposed location was moved downstream approximately ¼ mile. The new location was resurveyed to assist with design work. The Gallatin National Forest submitted seven separate funding proposals to PPL-MT (2012 and 2013), National Fish and Wildlife Foundation (Bring Back the Natives), Future Fisheries (MFWP), Western Native Trout Initiative (USFWS), Gallatin County Resource Advisory Committee (RAC), and the Madison River Foundation to fund this expensive project. The estimated engineering cost of the barrier is $397,604. So far, $305,000 partner donations have been promised with another $75,000 pending waiting on the USFWS' final 2014 budget. The Gallatin National Forest has contributed an estimated $35,000 for associated activities leading up to this project including surveys, planning, design, and contracting type work. The Gallatin National Forest is presently working on finishing up an authorizing decision document, final engineering plans, and necessary

multi-party financial agreements. Upon the anticipated completion of this work in early-April, the project will be submitted to contracting for solicitation, bid, and award with construction anticipated in low-water 2014.

Watkins Creek Large Woody Debris Recruitment Project

This project was funded by the Madison River Fisheries TAC in 2008 and completed in 2010.
Watkins Creek within the project area lacked instream large woody debris (LWD) which has resulted in eroding stream banks and simplified instream habitat including few pools and limited spawning habitat. Live mixed diameter spruce trees from within the adjacent riparian area were directionally fell to the desired locations to create jams or clusters of two or more interlocking LWD pieces every eight to ten bankfull widths. The project emulates naturally occurring large woody debris jams located immediately upstream of the proposed treatment reach. The project was designed to help scour pools and trap accumulations of gravel sized particles used by spawning trout. In 2013, our GNF fisheries crew re-measured certain habitat attributes to determine if project goals were being achieved. The followings graphs were presently in previous year reports. This year's monitoring data were added to these previously published graphs.

Nineteen large woody debris clusters were placed along a quarter mile reach of Watkins Creek. None of the 19 clusters exhibited any downstream movement since they were installed. Three of the 19 clusters straddled the streambanks after the first high water event resulting in no scour and/or damming action (Figure 2; site numbers 6, 11, and 18). Subsequently, cluster 11 has dropped in to the stream channel causing substantial under scour (0.32 m). Two of the 19 LWD clusters were installed along a dry high water side channel. No habitat attribute data were collected at these two sites (site numbers 5 and 7). Substantial scour (> 0.10 m) occurred immediately underneath eight of the 19 LWD clusters within the first high water event. Ten of the 19 clusters exhibited upstream pooling with maximum depths ranging from 0.30 to 0.95 meters (Figure 3). These dam pools also acted as tremendous sediment traps with unmeasurable tons of fine sediment being deposited across the floodplain creating new banks.

The Watkins Creek large woody debris project was a complete success in terms of meeting our desired goal of slowing water velocity, creating a diversity of pool and riffle habitat, and reducing bank erosion. This project did result in substantial sorting of bedload materials, but not the desired effect we expected or hoped for. There was an unanticipated reduction in the amount of spawning trout substrate (m^2) within the project reach (Figure 4). The damming action from each of the LWD clusters did result in a tremendous amount of floodplain storage of fine sediment which was not expected. There is no way to measure the tonnage of fine sediment trapped and stored.

Figure 2. Residual pool depth (Maximum pool depth minus pool tail crest depth (m)) associated with 19 installed LWD clusters along Watkins Creek.

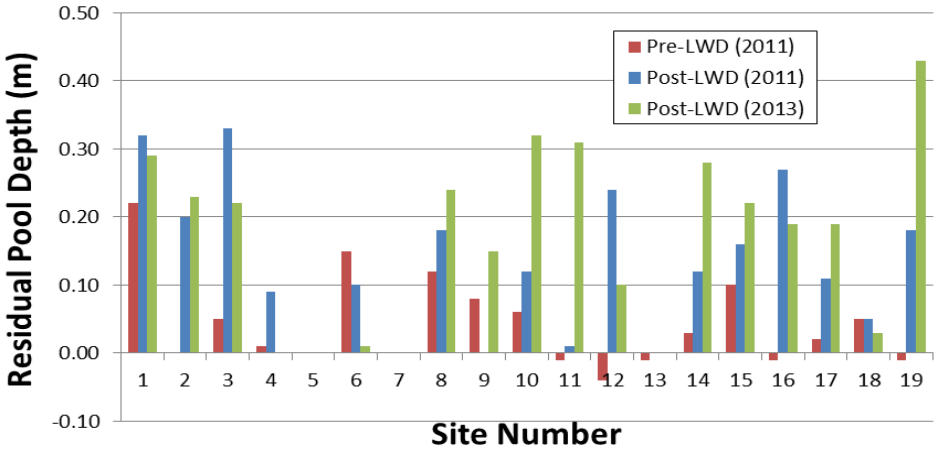


Figure 3. Maximum depth (m) of upstream dam pools associated with 19 installed LWD clusters along Watkins Creek.

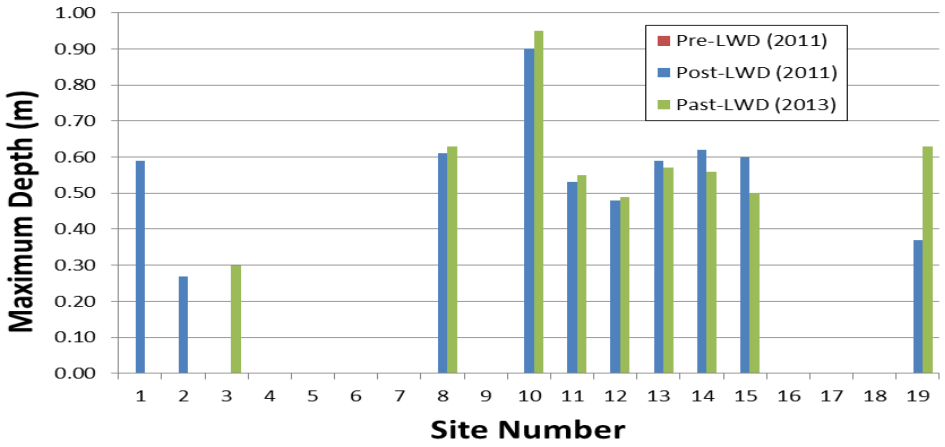
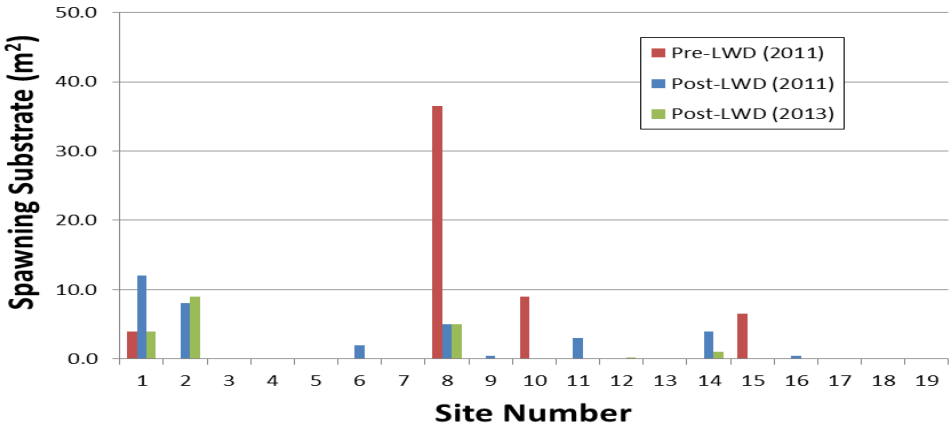


Figure 4. Spawning substrate (m^2) associated with 19 installed LWD clusters along Watkins Creek.



Appendix G

Sun Ranch Hatchery Contributions and Production
2001 – 2013

Drake & Associates 2013 Summary Report

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 Cottonwood Ck (FWP Region 4)	458 fry 498 eyed eggs
	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 - Boulder x Little Boulder	10:7	521		357 eyed eggs
	Muskrat - Boulder	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

2013 Sun Ranch Westslope Cutthroat Trout Recovery Program Summary

The following is a summation of the 2013 Sun Ranch hatchery operations, the number of eggs incubated, and the distribution of those eggs. Also included is the dissemination of eggs raised to fry stage in the hatchery.

Drake & Associates personnel began opening the Sun Ranch hatchery on May 6, 2013, by flushing the well and hatchery piping. The hatchery was completely cleaned and readied to accept WCT eggs by May 13. We placed our initial trap sets in the brood pond on May 15, and spawned the first fish on May 20.

Alternating our trapping to no more than three days a week, we captured and spawned nine females and 38 males between May 20 and June 5. These pairings resulted in 19 lots for a total of 15,145 eggs.

We received our first eggs from Montana Fish, Wildlife & Parks on June 12, and the first contributions from Yellowstone National Park on June 21.

YNP's contributions totaled 11 lots from Last Chance Creek, with the sum of 1,271 eggs from eleven females and thirteen males.

FWP supplied eggs from: Squaw Lake (Big Hole drainage), Muskrat Creek, Papoose Creek, Divide Creek, and from cross drainage fertilization between Skelly/Whites Creeks, and Muskrat/Little Boulder Creeks. The total number of eggs received from FWP personnel was 14,187.

Water temperature determines how long eggs incubate before hatching. This season's eggs were incubated at the hatchery well's water temperature of 44 - 48 degrees Fahrenheit until they developed eyes, which typically occurs 10 to 15 days before the egg hatches.

Once eyed, the eggs are transported to recipient streams where they are placed in remote site incubators (RSI's).

Three thousand brood pond eggs were placed in RSI's and introduced into the brood pond as soon as the fry began to swim up. We chose to double the number stocked in previous years because of the fry's small size and vulnerability to predation by aquatic invertebrates, amphibians and larger fish.

FWP's Squaw Lake eggs were also shipped from the hatchery on July 10. These eggs were placed in RSI's on Cherry Creek, (Big Hole). Additionally, 50 eggs from Squaw Lake were stocked in the Sun Rn. brood pond. The remaining eggs for Cherry Creek were shipped from the hatchery two weeks later.

Table 1, lists the total contributions to Cherry Creek from the various donor sources.

Table 1

Source	#'s incubated	Eye-up %	#'s to Cherry C.
Squaw Lake	9,587	61	5,280
Papoose Crk.	365	92	337
Divide Crk.	39	74	29
			Total: 5646

Last Chance Creek eggs were slated to leave the hatchery for placement into tributaries of Goose Lake in YNP on July 16. Goose Lake is in the Firehole River basin, Madison River drainage. However, while placing the

RSI's Park biologist discovered that water temperatures in those tributaries were too warm to incubate eggs, so YNP asked Drake & Associates to raise the eggs destined for Goose Lake to fry stage.

In addition to the 702 eggs from Last Chance, 1,157 eggs from Skelly/Whites, as well as 521 eggs from Muskrat/Little Boulder were destined for Goose Lake.

Due to confusion between the field reporting sheets and the hatchery data sheets, 413 Muskrat eggs, and 364 Divide/Papoose eggs were raised together to fry stage, but almost all were ultimately destroyed, when Park personnel decided not to introduce eggs from a Big Hole drainage source into Goose Lake. Approximately 100 fry from this group were placed in the Sun Rn. brood pond.

Approximately 2,800 eggs were reared to fry stage in hatchery tanks for stocking into Goose Lake. Rearing fry is extremely time consuming, and delicate. The inability to switch to natural feed, genetic abnormalities, predation, and stress all result in natural attrition. In the weeks before stocking, there was very high mortality in the Skelly/Whites eggs, reducing their numbers to approximately 700 fry.

On August 29, Drake & Associates personnel, with the assistance of Ennis National Fish Hatchery and YNP biologists, stocked 1,714 fry into Goose Lake, (628 from Last Chance, 1086 from Skelly/Whites & Muskrat/Lt. Boulder).

The hatchery was cleaned, disinfected, and the water turned off for the season on September 4, 2013.

Below is a table summarizing this year's results:

2013 Sun Ranch WCT Recovery Summary

	Total Eggs	Eyed	Ave. Percent
Sun Rn. Pond 19 Lots, 9F 38M	15,145	14,840	98
Muskrat Crk. 4 Lots, 4F 4M	413	311	75
Squaw Lake 10 Lots, 10F 20M	9,587	5,828	61
Papoose Creek 1 Lot, 1F 3M	365	337	92
Divide/Papoose 1 Lot, 1F 2M	1,013	364	36
Divide Creek 1 Lot, 1F 2M	39	29	74
Last Chance Creek 11 Lots, 11F 13M	1,217	702	58
Skelly/Whites 11 Lots, 5F 16M	1,463	1,157	79

Muskrat/Lt.Boulder	521	327	62
7 Lots, 7F 10M			

Appendix H

PPL Montana funded Westslope Cutthroat Trout genetic testing results

WCT populations tested for genetic status under PPL Montana 2188 Program			
W = westslope cutthroat trout; Y = Yellowstone cutthroat trout; R = rainbow trout			
Stream	Collection Date	Number of fish	Lab analysis
SF Madison River	9/17-18/13	63	15 of 63 individuals exceeded hybrid index, removed from population
Cherry Lake, Madison	Various dates 2013	53	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% WCT, 24 < 85% (x Rb)
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
SF Madison	8/3/2011	55	51 @ 97.1%W x 2.9% R 1 @ 0.8%W x 99.2%R 3 @ various levels of intermediate
Soap Ck	?	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 Ck of Grayling Ck	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
Muskrat	6/20/2007	38	100% W
Last Chance	6/18/2007	20	100% W
Whites Gulch	6/12/2007	24	100% W
Bear Ck	9/19/2006	25	100% W
Bean Ck	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 Ck - mainstem	10/17/2005	15	97% Wx 3% R swarm
Cabin Ck - Middle Fork	10/11/2005	8	mixture of pure W & hybrid WxR
Cabin Ck - Middle Fork	10/11/2005	17	mixture of pure W & hybrid WxR
Whites Gulch	9/8/2005	50	100% W
Hellroaring Ck	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 Ck	6/8/2005	10	94% Wx3% R swarm
Cottonwood Ck - 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 Ck - Blacktail	6/1/2004	33	100% W
Jones Ck	10/30/2001	25	WxYxR; some individuals exhibited Y alleles, one exhibited R alleles
Bean Ck	10/29/2001	54	98% W x 2% R; only 1 fish displayed R alleles
Bear Ck	10/29/2001	53	100% W
Wall Ck	10/19/2001	25	99% W x 1% R
NF English George	10/18/2001	9	WxRxY, too few fish to discern percentages
SF English George Ck	10/18/2001	23	80.4%Wx19.6%Y swarm
WF Wilson	10/1/2001	48	100% W

Appendix I

Hebgen Reservoir Rainbow Trout Micro-chemistry Study

For the last decade, Montana Fish, Wildlife & Parks has used various mark-recapture techniques in an effort to discern the contribution of hatchery reared and wild rainbow trout to the Hebgen Reservoir rainbow trout population. Results have been inconclusive and offered no clear picture of the contribution of wild vs. hatchery return to the population or the creel.

In 2013, an otolith microchemistry study was initiated to assess the proportion of stocked rainbow trout and wild rainbow trout in the Hebgen Reservoir fishery. An otolith is a middle ear bone often used in age studies of salmonid species (Figure 1). Otolith microchemistry analysis has proven to be a reliable technique for discerning natal origin and migration patterns of trout. The elemental chemical ratios in the waters a fish resides in are captured in the otolith as it grows, thus allowing the determination of where that fish lived over the course of its life.

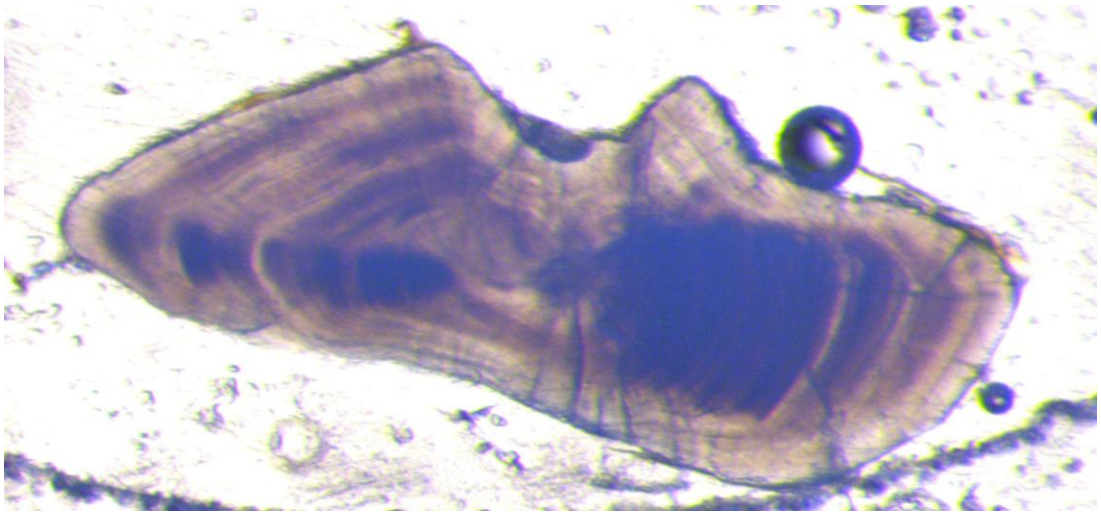


Figure 1. Picture of a salmonid otolith mounted on a petrographic slide for microchemistry analysis-Photo Courtesy of Mike Duncan Montana Fisheries Cooperative Unit.

Water sampling.—Runoff and base flow water samples were collected from the Blue Water state hatchery, Hebgen Lake, and its tributaries by Montana FWP personnel (Figure 1). Fifty-mL water samples were collected from each location using ultra-clean vials, filtered with 0.45-µm sterile filters, and preserved with 0.5 mL of NO_3. Water samples were shipped to Oregon State University where elemental (Ca, Sr, Ba, Mn, and Zn) and isotopic (^{87}Sr and ^{86}Sr) concentrations were measured with a plasma-mass spectrometer.

Fish collection.— 300 rainbow trout (100 from three different age classes) were collected from Hebgen Lake by Montana FWP personnel using gillnets, night electrofishing and through angler interactions. An additional 20 rainbow trout of the approximate age when normally stocked into Hebgen were collected from Blue Water state hatchery.

Otoliths will be extracted from captured fish, cleaned, sanded or sectioned to expose the otolith core, and mounted to petrographic slide for microchemistry analysis.

The pertinent elements and isotopes identified by the water sample analysis will be analyzed for each otolith. Analytical transects for each otolith will be completed from the core (natal area) to the edge (time of collection). Analysis of the otolith transects will help identify the natal origin and movement patterns for each fish that was collected.

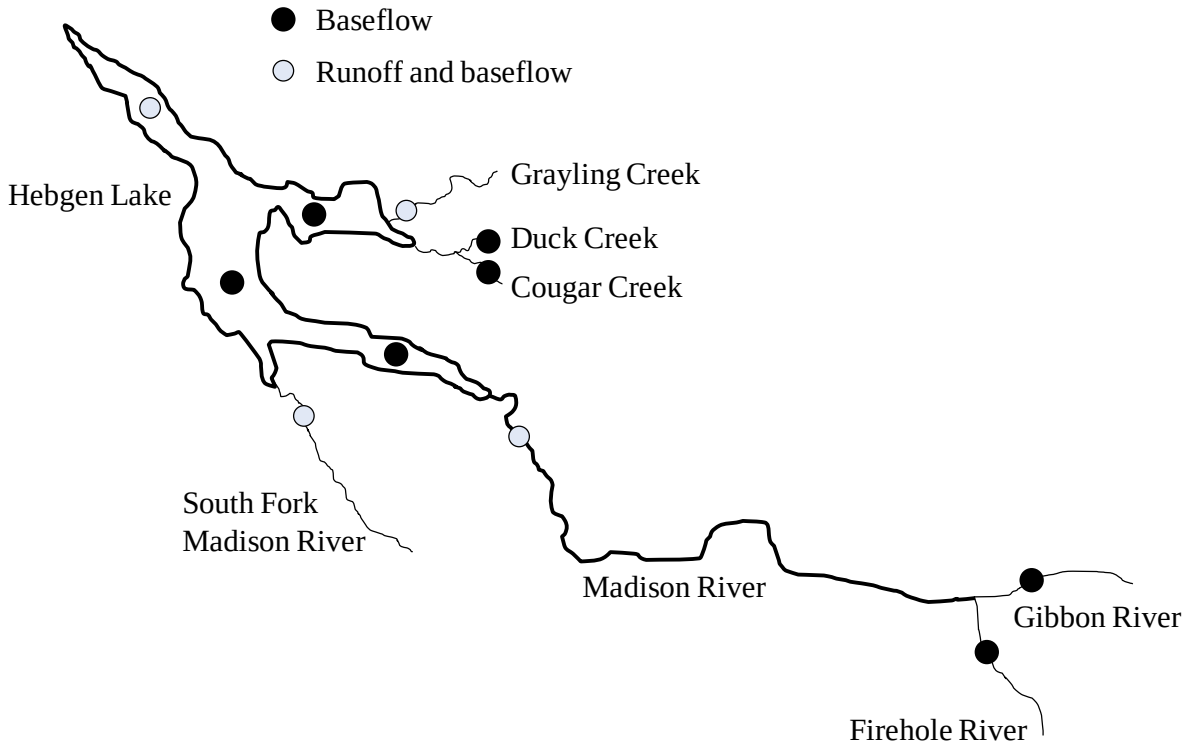
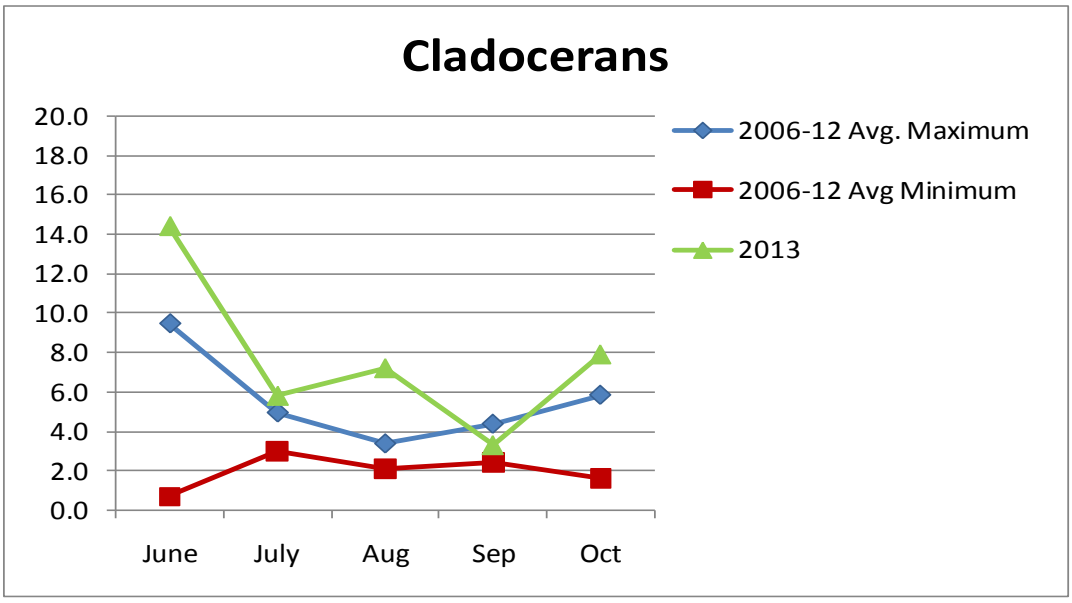


Figure 1. **Upper Madison River Basin. Dots indicate water sample locations.**

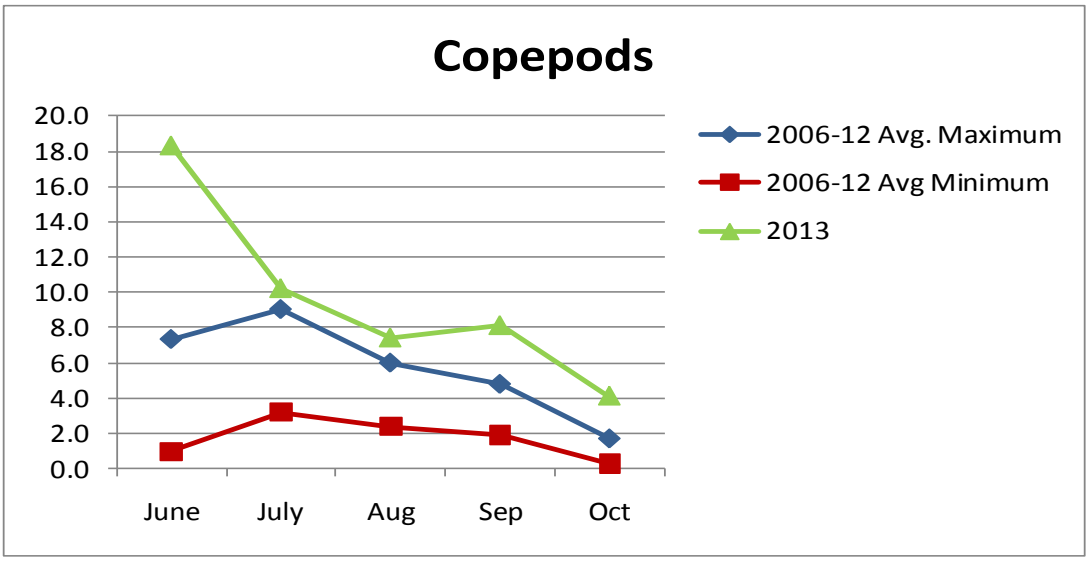
Results-

Completion of the water analysis indicate that the proportions in elemental concentrations are significant between water sources to be able to discern fish of wild or hatchery origin. Preliminary analysis of ratios between tributaries suggest that differentiation between natal streams will be possible. . If the study holds to schedule, collection of otoliths from a wide size and age range of rainbow trout will be completed in 2014, followed by elemental analysis of the otoliths. . If the study holds to schedule, analysis of otoliths from rainbow trout will be completed in 2014.

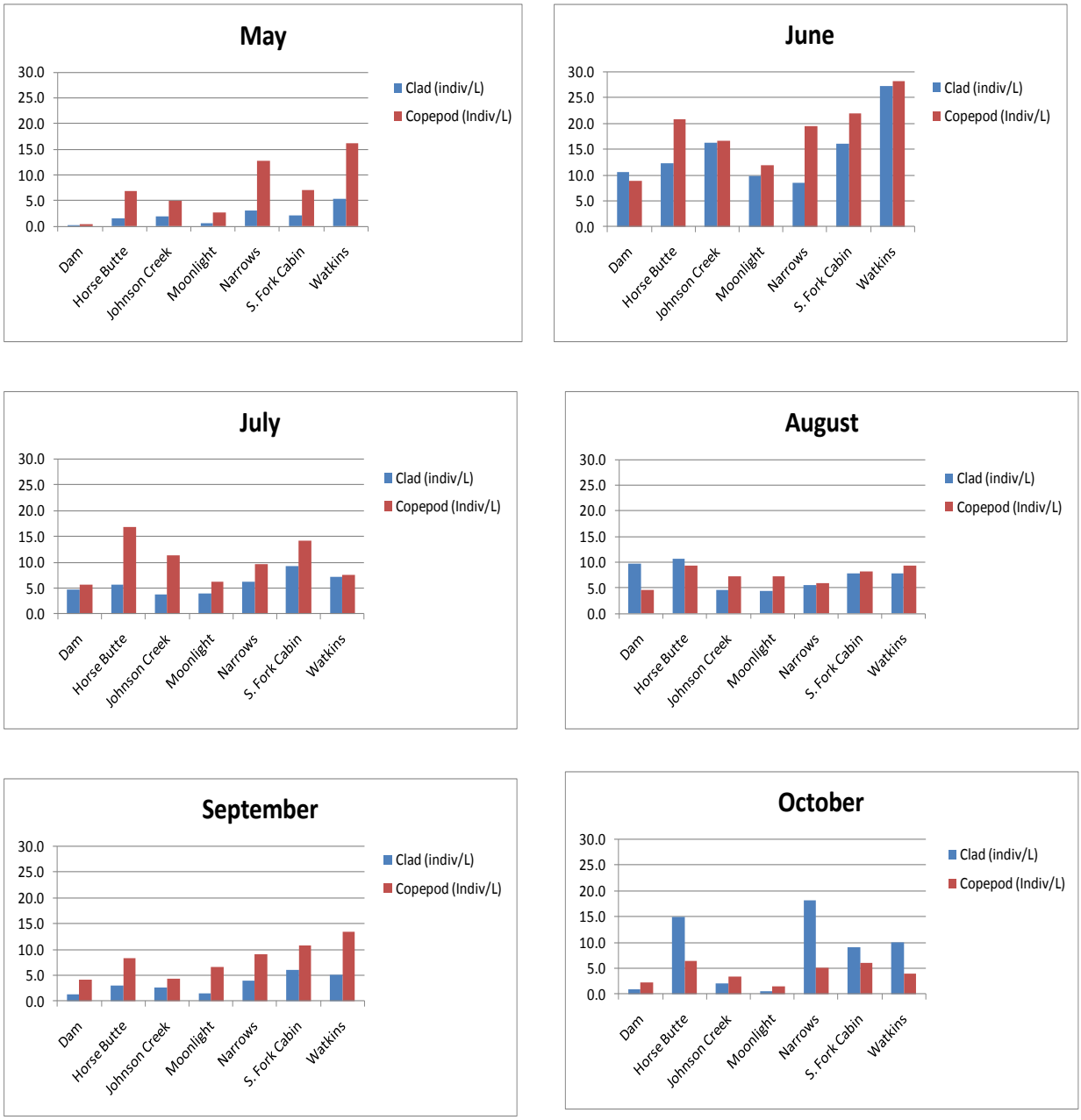
Appendix J



Appendix Figure J -1. Monthly average maximum and minimum cladoceran densities (#/liter) vs 2013 monthly average densities at seven sample sites.



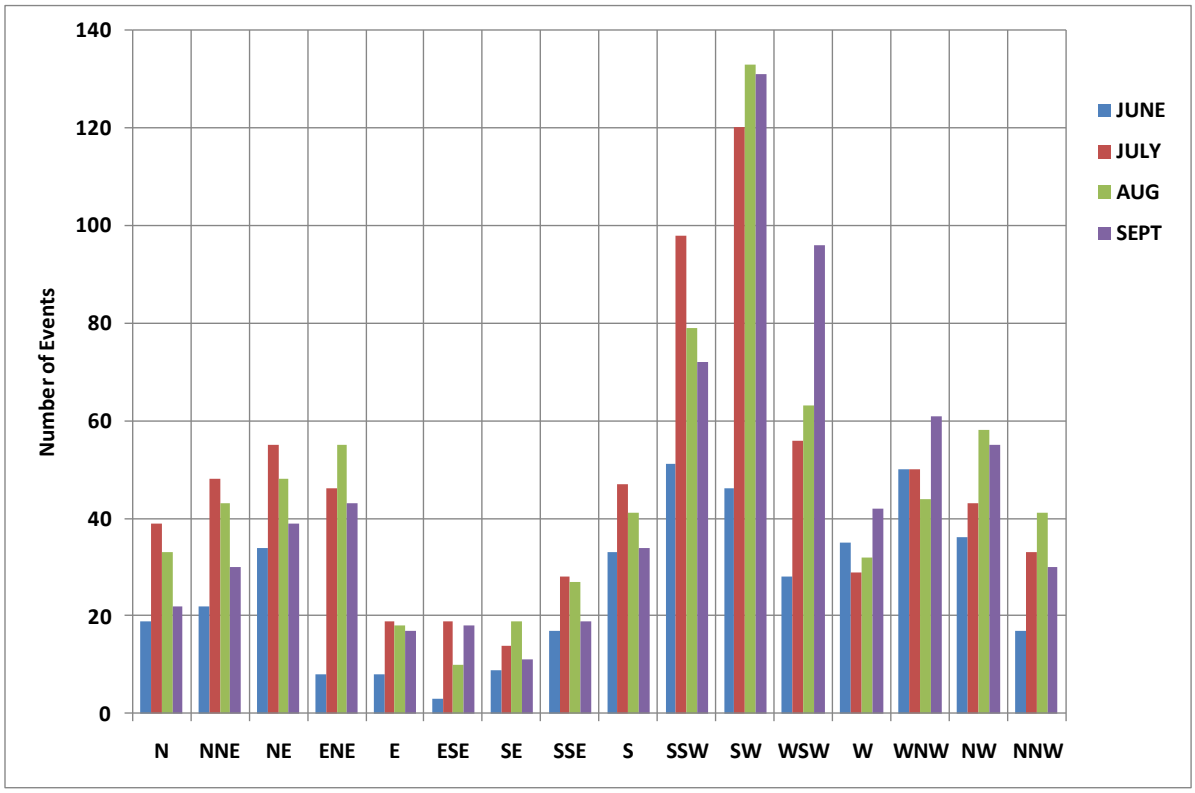
Appendix Figure J -2. Monthly average maximum and minimum copepod densities (#/liter) vs 2013 monthly average densities at seven sample sites.



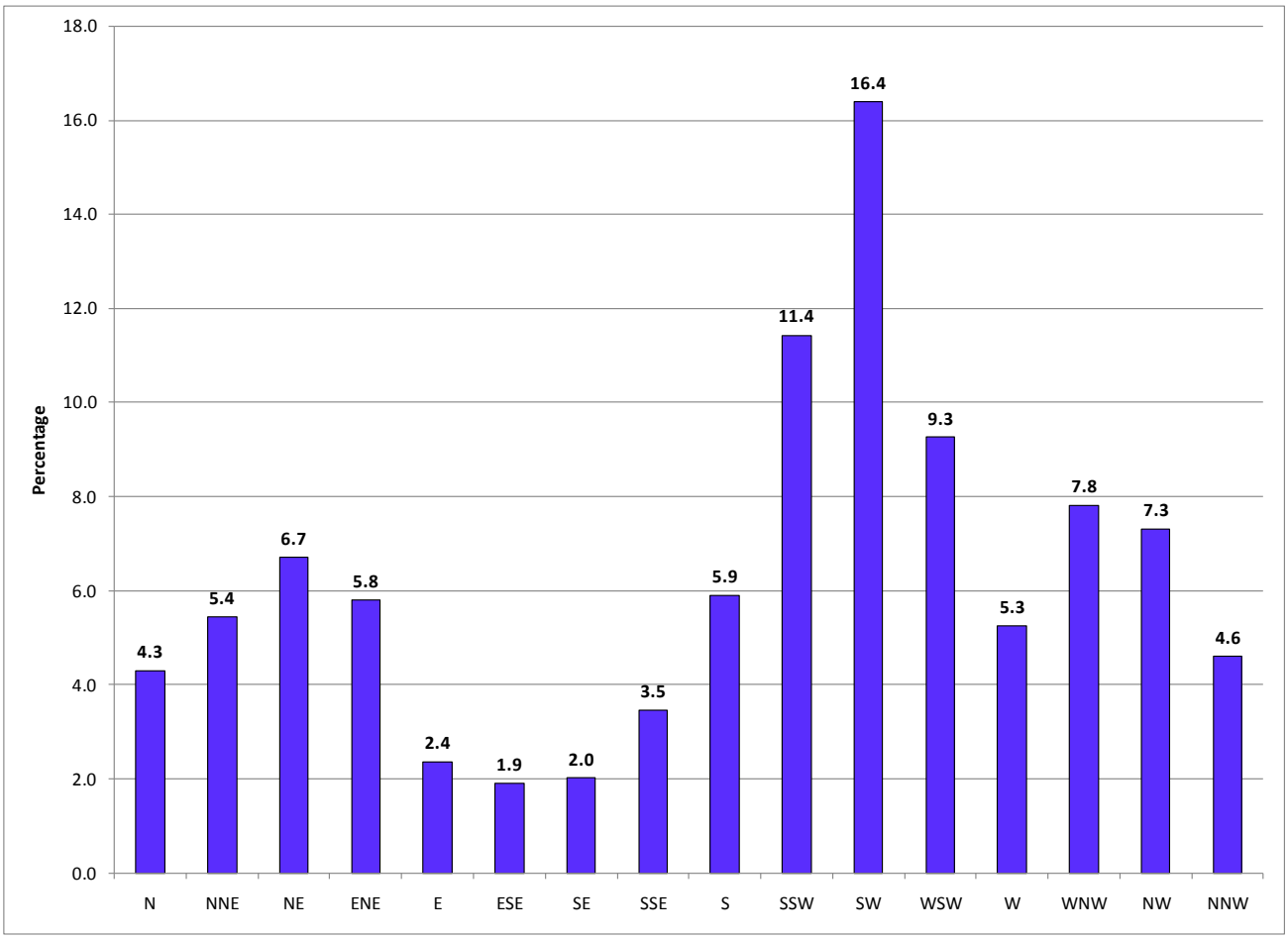
Appendix Figure J -3. Monthly cladoceran and copepod densities (#/liter) at seven sample sites, 2013.

Appendix K

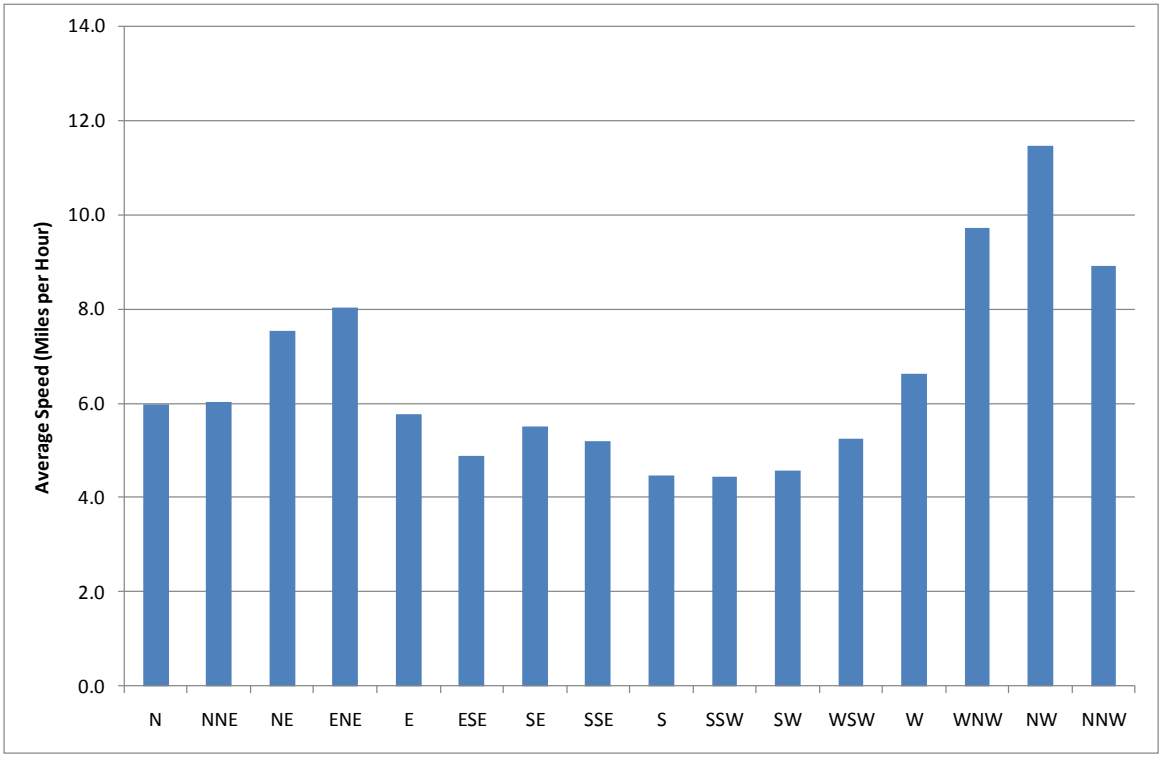
Hebgen Reservoir wind data, 2013



Appendix Figure K-1. Number of wind events by direction for Hebgen Reservoir, June - September, 2013.



Appendix Figure K-2. Distribution of wind direction by percent occurrence for Hebgen Reservoir, June – September, 2013.



Appendix Figure K-3. Directional average wind speed (miles per hour) at Hebgen Reservoir, June – September, 2013.