Madison River Drainage Fisheries

and

Madison River Drainage Westslope Cutthroat Trout Conservation and Restoration Program

2012
Annual Report
to
PPL Montana
Environmental Division
Butte
www.pplmontana.com

by

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Montana Fish, Wildlife, & Parks
Ennis
May 2013

Montana Fish, Wildlife & Parks
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
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

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

An electronic version of this and other FWP reports are available at http://fwp.mt.gov/fishAndWildlife/fishAndWildlifeLibrarySearch.html

FERC Articles addressed in this report

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EXECUTIVE SUMMARY

Beach seining for juvenile Arctic grayling and mountain whitefish was not conducted in Ennis Reservoir in 2012. Long-term population trends are displayed for rainbow and brown trout in three river sections. Water temperature was monitored at 15 sites and air temperature at 7 sites within the Madison Drainage. Darlinton Ditch spring creek, several sites in Hebgen and Ennis reservoirs and numerous Madison River Fishing Access Sites were sampled for New Zealand mud snails and selected other aquatic nuisance species by FWP ANS staff in 2012. No New Zealand mud snails, Eurasian Watermilfoil or juvenile or adult Zebra or Quagga mussels were detected in the river or reservoirs, though NZMS were found in high abundance in Darlinton Ditch. Fisheries monitoring was conducted on Jack, Watkins and the South Fork of Meadow creeks and the South Fork of the Madison River as part of stream channel restoration and habitat improvement projects. The Sun Ranch hatchery was used to incubate westslope cutthroat trout eggs for introduction into three streams, including one in Yellowstone National Park, and into the Sun brood pond. Introduction of genetically pure westslope cutthroat trout continued in the Cherry Creek Drainage in 2012. No non-native fish were observed or captured during widespread electrofishing throughout the Cherry Creek Project area in 2012. Monitoring of the Cherry Creek fish population below the project area where rotenone caused an unintended fish kill in 2010 showed significant recovery of trout numbers, with both rainbow and brown trout larger than 14 inches becoming more abundant. Ruby Creek, a tributary to the Madison River, received its initial rotenone treatment 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 decreased for the fourth consecutive year, though 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. A GPS downloadable bathymetric map of Quake Lake is available through the FWP on-line Fishing Guide.

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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). 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 westslope cutthroat trout in Montana is to ensure the long-term, self-sustaining persistence of the subspecies within each of the five major river drainages they historically inhabited in Montana (Clark Fork, Kootenai, Flathead, upper Missouri, and Saskatchewan), and to maintain the genetic diversity and life history strategies represented by the remaining populations." 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

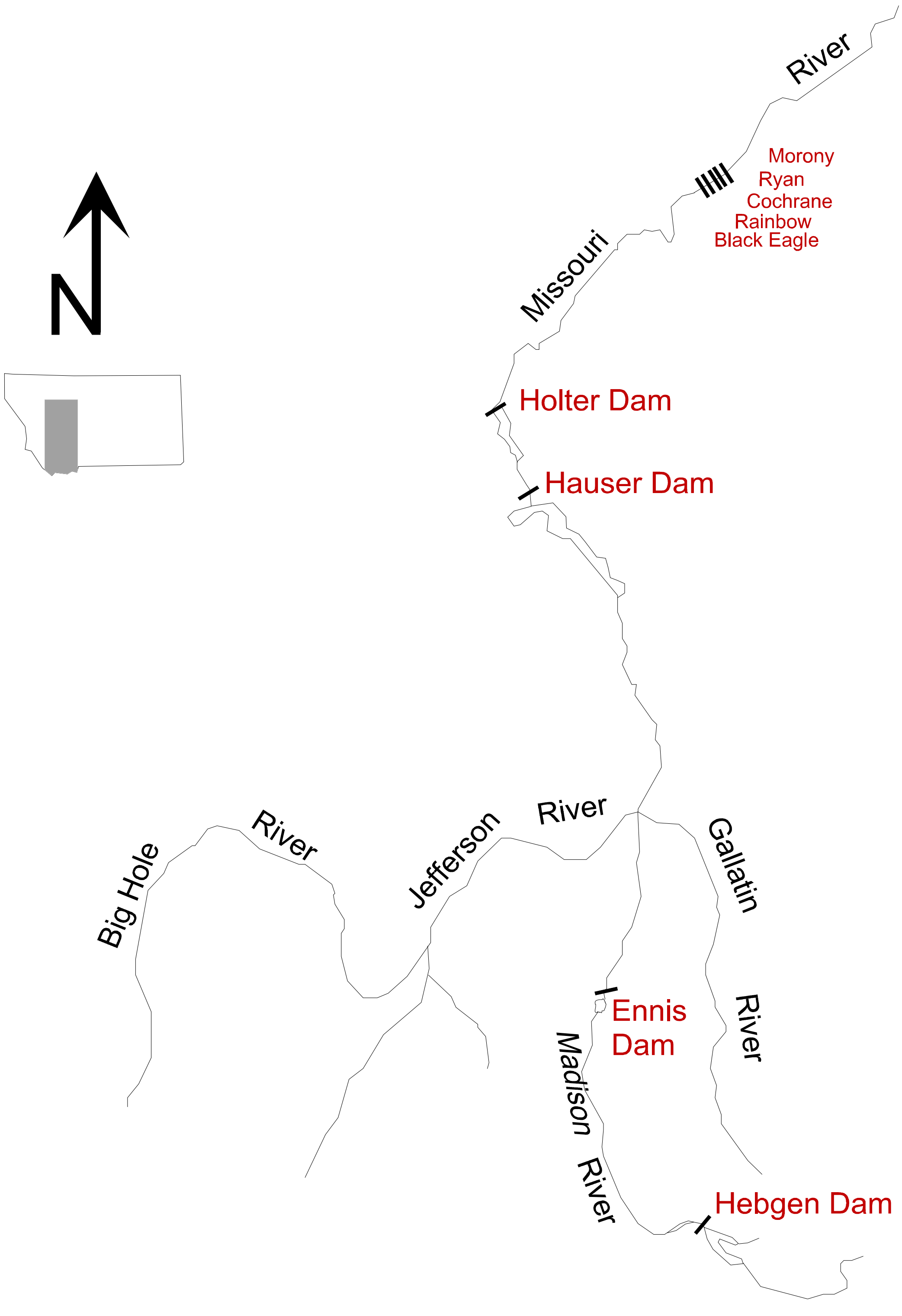


Figure 1. Map showing locations of PPL Montana dams on the Madison and Missouri rivers (FERC Project 2188).

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.

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 westslope cutthroat trout in the Madison River drainage. Fieldwork for this effort began in 1997 in tributaries of the Madison River. The agreement between FWP and 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 it will provide an opportunity to meet or fulfill WCTA objectives 3, 4, & 5. FWP determined in 1997 that introducing westslope cutthroat to Cherry Creek is 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 outlines 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 successfully initiated in 2003.

In 2001, the Sun Ranch entered into an agreement to assist FWP with westslope cutthroat trout conservation and recovery. The ranch built a small hatchery facility and a rearing pond to facilitate development of a westslope cutthroat trout broodstock for the Madison and Missouri river drainages, and provided personnel to assist with fieldwork and conduct hatchery operations.

METHODS

Madison Grayling

Beach seining in Ennis Reservoir for juvenile Arctic grayling and whitefish will be conducted in alternate years, therefore was not conducted in 2012.

Population Estimates

Electrofishing from a driftboat mounted mobile anode system (Figure 2) is the principle method used to capture Madison River trout for population estimates in several sections of the Madison River (Figure 3).

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

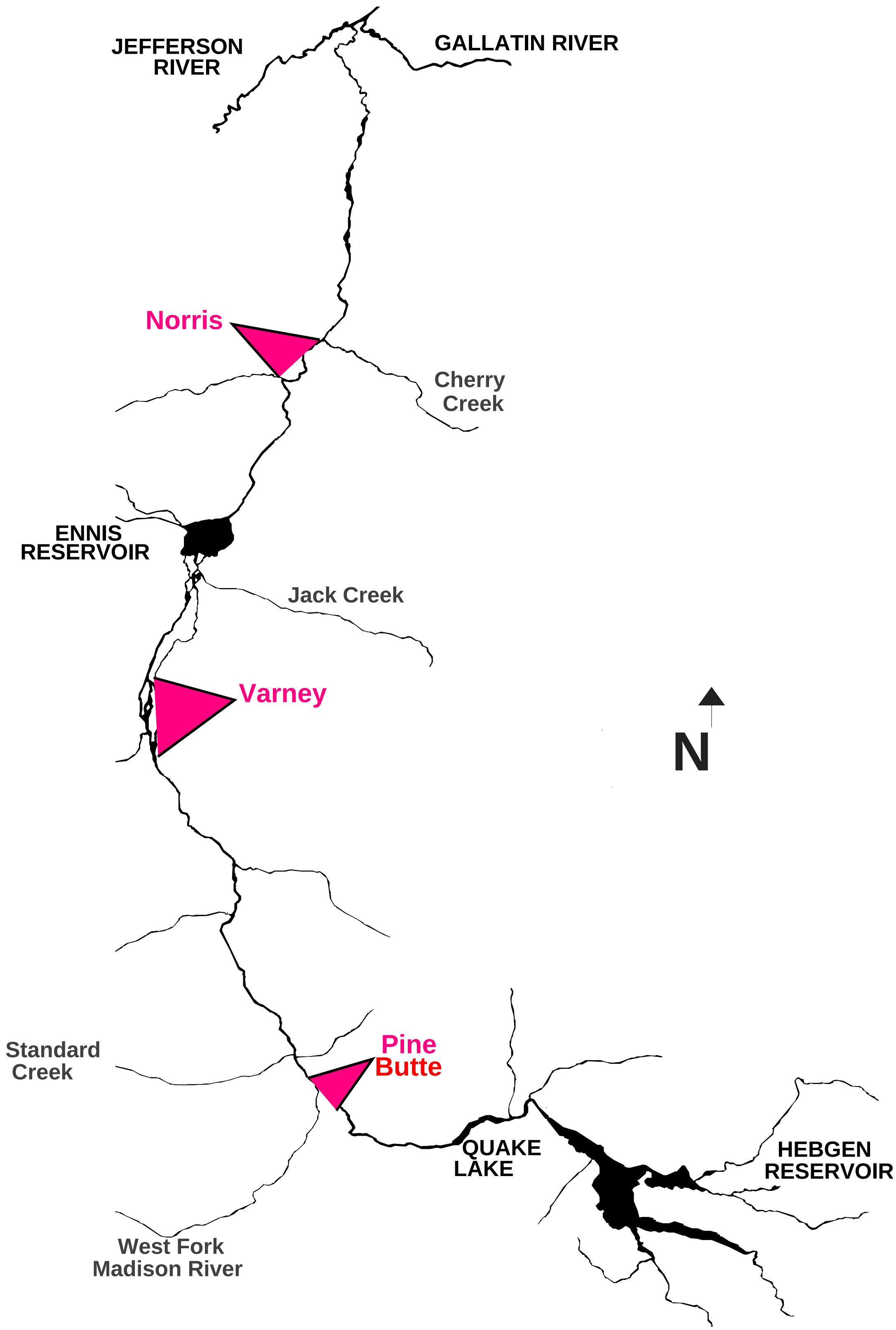


Figure 3. Locations of Montana Fish, Wildlife, & Parks 2012 Madison River population estimate sections.

River Discharge

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 will occur. 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.

MadTAC and FWP entered into an agreement with the U.S. Geological Survey to evaluate the erosive potential of the Quake Lake Dam to determine if the 3,500 cfs maximum limit was still necessary, or if it could be exceeded during flushing flow operations to increase river discharge below Ennis Reservoir to enhance sediment transport in the lower river.

Minimum Flows

Fish, Wildlife & Parks and PPL Montana (and PPL Montana's predecessor Montana Power Company) have an agreement established in 1968 to maintain minimum instantaneous river flows at the USGS Kirby and McAllister gauges in the upper and lower river of 600 and 1100 cfs, respectively. These instream flow levels were determined by FWP to provide favorable overwinter habitat for yearling trout, and also protect against summer and fall drought in low water years. These minimum flows were incorporated into Article 403 of the FERC license for the 2188 Project and are required elements of operating Hebgen and Ennis dams.

Table 1. Pulse flow trigger criteria.

	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	

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 4). 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™ 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.

Aquatic Nuisance Species

Highway signs announce FWP's West Yellowstone Traveler Information System (TIS) (Figure 5). 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 in the Madison River and Hebgen Reservoir, and instructs them on methods of reducing the likelihood of transporting New Zealand mud snails and other ANS to other waters.

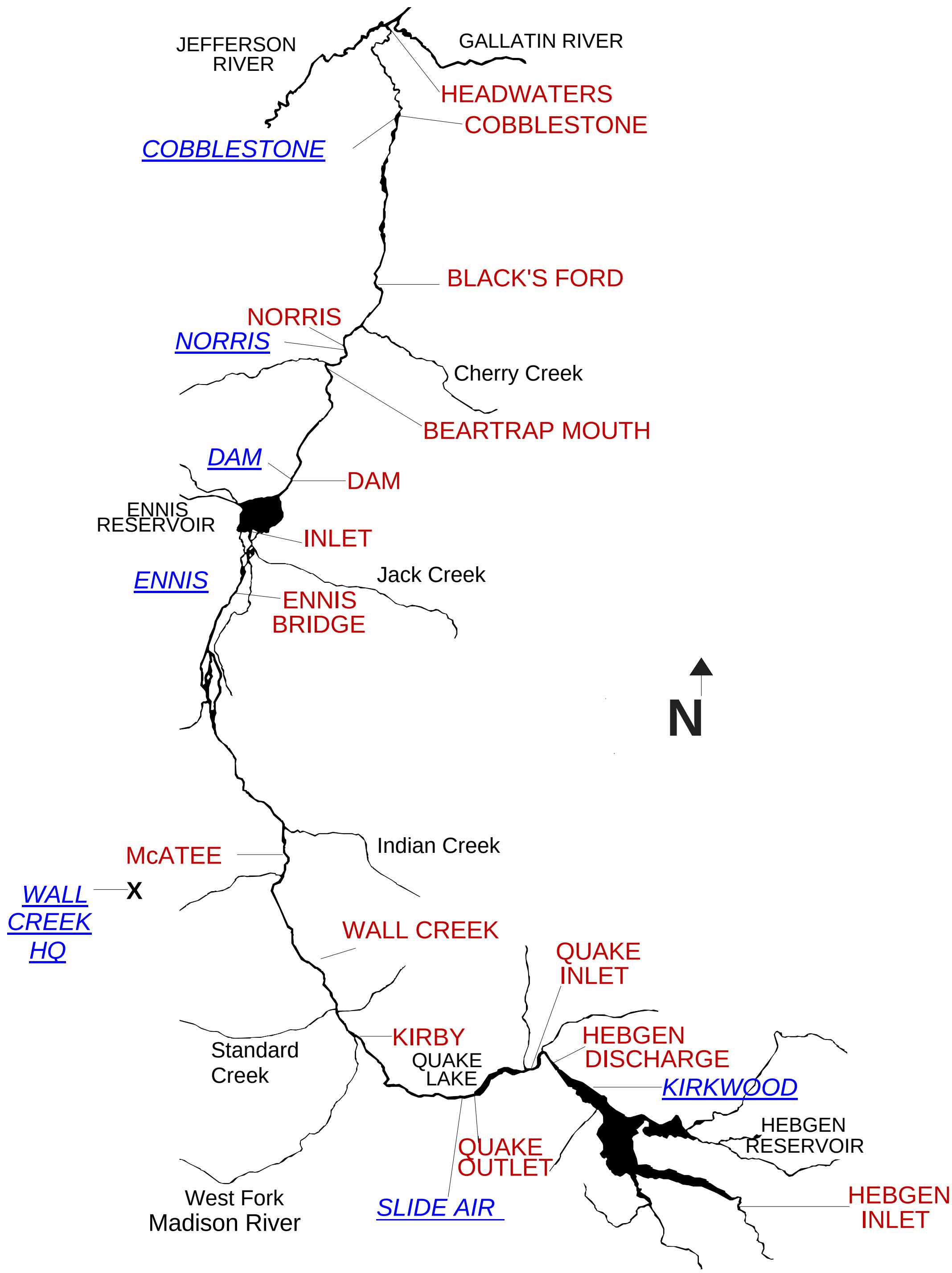


Figure 4. Locations of Montana Fish, Wildlife & Parks temperature monitoring sites. Air temperature monitoring sites are blue; water temperature monitoring sites are red. A river site near Wall Creek was added in 2010.

Figure 5. Roadside sign announcing the Traveler Information System near West Yellowstone, Montana.

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

Fish, Wildlife & Parks hired an Aquatic Nuisance Species Coordinator in 2004. The position is responsible for developing and coordinating ANS control & management activities among state agencies as well as between state and non-state entities. The ANS 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 ANS during work activities.

In 2010, FWP initiated a public education campaign called “Inspect/Clean/Dry”. This campaign uses highway billboards (Figure 6) and vehicle tailgate wraps and posters (Appendix A) to create public awareness of aquatic nuisance species issues.

In 2012, the FWP ANS field crews surveyed the Madison River at ten fishing access sites as well as the Darlinton Ditch foot bridge area at Cobblestone FAS. Water temperature, GPS coordinates, pH, weather conditions, horizontal plankton tow, notes on substrate, and invertebrate and macrophyte surveys were collected. A minimum of 400 feet is surveyed at each site. In addition to visual surveys for AIS, horizontal plankton tows were conducted to sample for Zebra and Quagga mussel veligers and invasive zooplankton. Similar surveys were conducted at five sites in Hebgen Reservoir and at three sites in Ennis Reservoir. All surveys occurred in June through August and on multiple dates at some locations.

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. At Hebgen Reservoir 60 vessels were inspected, 410 on the Madison River and 130 at Ennis Reservoir. The majority of boaters had clean watercraft and were aware of AIS issues and none of the angling boats were using live bait.

In 2009 the FWP ANS 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

Figure 6. Inspect/Clean/Dry billboard.

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.

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 westslope cutthroat trout in the Madison Drainage center on maintaining 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 westslope cutthroat trout and/or to restore stream habitat in tributaries to the Madison River. MadTAC has provided grants to each of these federal agencies to assist their efforts.

Sun Ranch Westslope Cutthroat Trout Brood

Gametes (eggs & milt) for the Sun Ranch Westslope Cutthroat Trout program were collected from four streams and the Sun Ranch brood stock in 2012. All fertilized eggs were transported to the Sun Ranch

Hatchery for incubation and hatching (Figure 7). A portion of the resulting fry from one stream and the Sun brood were introduced to the Sun Ranch Brood Pond (Figure 8) to contribute to the Sun Ranch brood development. Fry from the Sun Ranch Pond broodstock were used for introductions in Cherry Creek. The MadTAC has provided funding for the Sun Ranch Program annually since 2004.

Occasionally, when project personnel are unavailable to do so, USFWS personnel from the Ennis National Fish Hatchery care-take the eggs or fry at the Sun Ranch Hatchery. Generally, this requires few days each year, but is an important contribution to the program.

<u>Cherry Creek Native Fish Introduction Project</u>

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 9) 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 and Yellowstone cutthroat trout *Oncorhynchus clarki bouvieri* (YCT; Figure 10). 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 westslope cutthroat trout introductions continued in 2012.

Figure 7. Sun Ranch Hatchery rearing troughs.

Figure 8. Sun Ranch Brood Pond.

Figure 9. Cherry Creek waterfall located at stream mile 8.0. This falls is the downstream extent of the Cherry Creek project area.

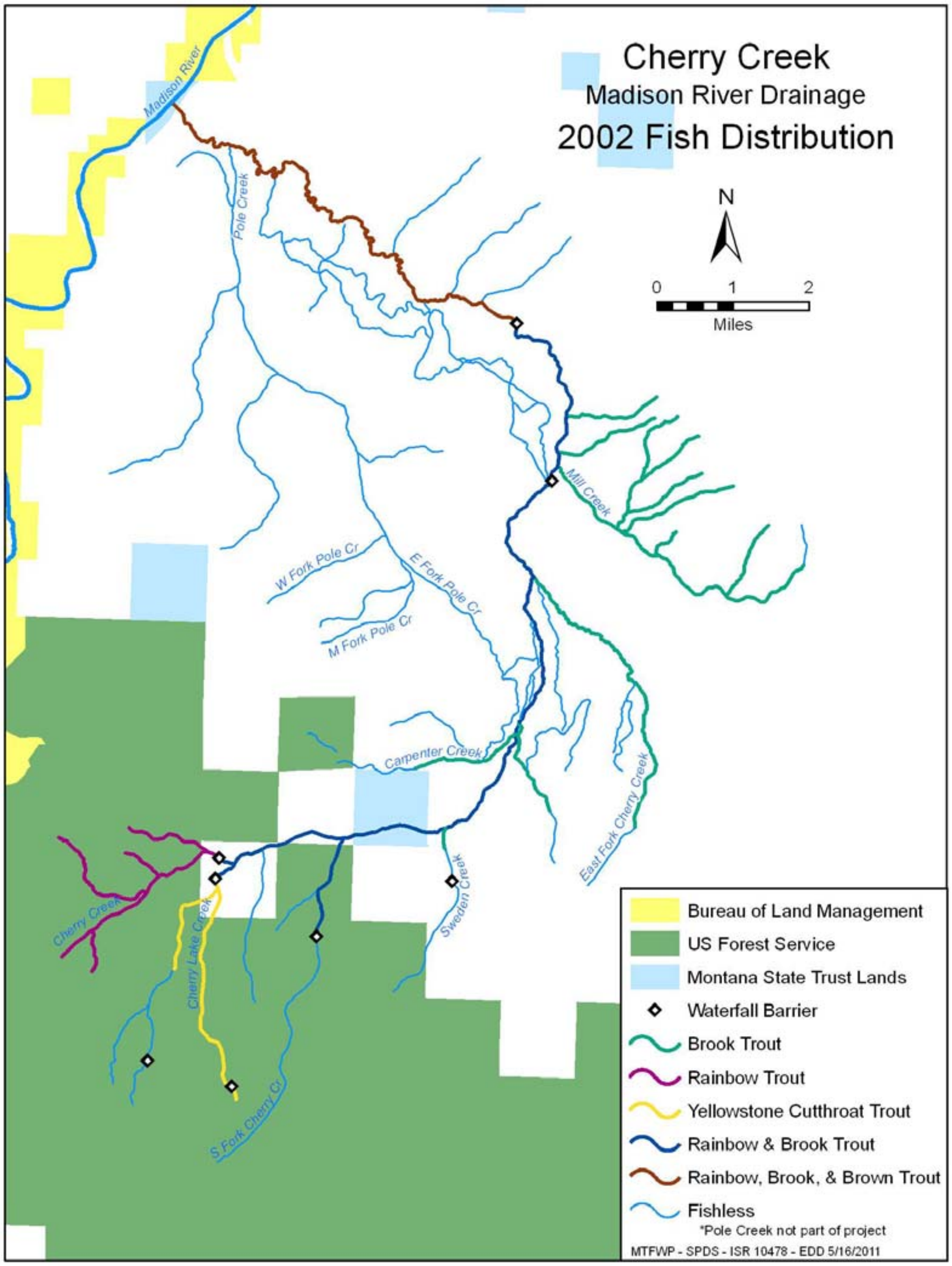


Figure 10. Map of the Cherry Creek Drainage showing the 2002 non-native fish distribution.

In 2012, young-of-the-year westslope cutthroat from the Sun Ranch brood were stocked into Phase 4 of the project area. From 2006 – 2010, westslope cutthroat trout eyed eggs from wild donor populations, the Sun Ranch brood, and the Washoe Park Hatchery were placed in remote streamside incubators (RSIs; Figure 11), 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

Figure 11. Remote streamside incubator (round bucket) and capture bucket (square bucket) in Cherry Creek.

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.

Ruby Creek Westslope Cutthroat Trout Project

Ruby Creek (Figure 12) is a tributary to the Madison River south of the town of Ennis. A 15-foot waterfall (Figure 13) at stream mile 0.7 isolates most of the drainage from Madison River fish. Rainbow trout and Rocky Mountain (mottled) sculpin are the only fish species above the waterfall, while rainbow and brown trout 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 Westslope Cutthroat Trout 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.

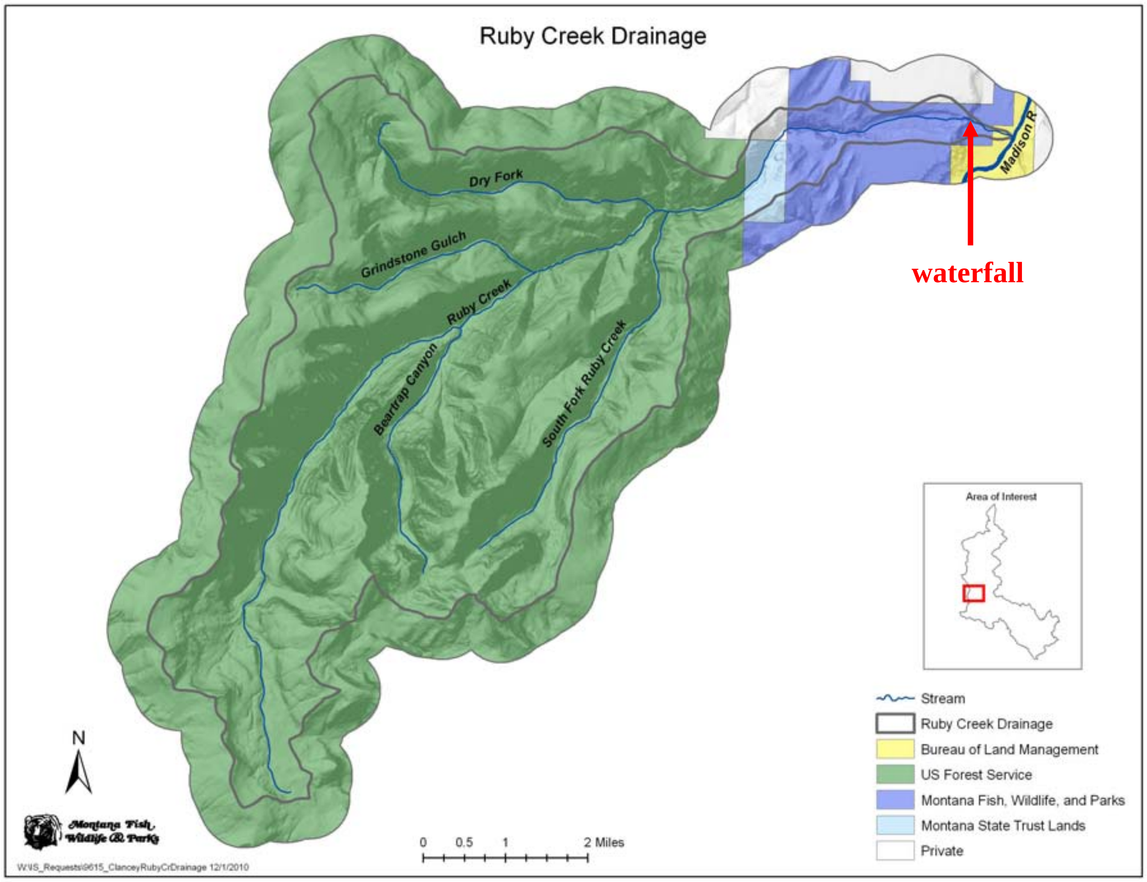


Figure 12. Ruby Creek Drainage, tributary to the Madison River.

Figure 13. 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.

Fish distribution was determined by electrofishing on several occasions over the previous two years. 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.

Fish were captured on-site for use as sentinels during the treatment and neutralization. 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 and brown trout were used as sentinel fish through the neutralization zone, where flow-through time was 34 minutes. Here, sentinels were posted 10, 15, 20 and 30 minutes below the neutralization station.

Dry rotenone powder was mixed with sand and gelatin for application during the bioassay and treatment.

Fish Habitat Enhancement

<u>Madison River</u>

Article 409 of the FERC Order for the 2188 Project states that PPL Montana shall develop a plan to fund stream habitat enhancement and restoration activities. Item 1 of Article 409 focuses on the river between McAtee and Varney bridges, a distance of approximately 13 river miles, calling for providing holding water for large fish.

<u>Jack Creek</u>

Jack Creek is a tributary to the Madison River approximately two miles upstream of Ennis Reservoir. The MadTAC has contributed funding for habitat enhancement projects on Jack Creek and one of its tributaries, McKee Spring Creek. FWP established two fish monitoring sections on Jack Creek to evaluate the effects of the habitat improvements. The Madison Valley Ranch section serves as a control where no habitat improvement is occurring. In Fall 2010 the Jack Creek Ranch section was converted from a straightened and channelized section to a sinuous channel with pools, point bars, and other fish habitat improvements. Electrofishing was conducted in April 2008 and April 2010 to establish a pre-project fisheries baseline for comparison with the post project fish population. Post-project fisheries monitoring has been conducted in April 2011 and 2012.

<u>South Fork of Meadow Creek</u>

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 will be 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 and its tributaries are shown in Figure 14.

<u>Hebgen Reservoir Gillnetting</u>

Gillnetting has been conducted annually on Hebgen Reservoir by FWP for over thirty 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 15) over a three-day period during the new moon phase in late May or early June. Twenty-five nets (14 floating and 11 sinking nets) 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.

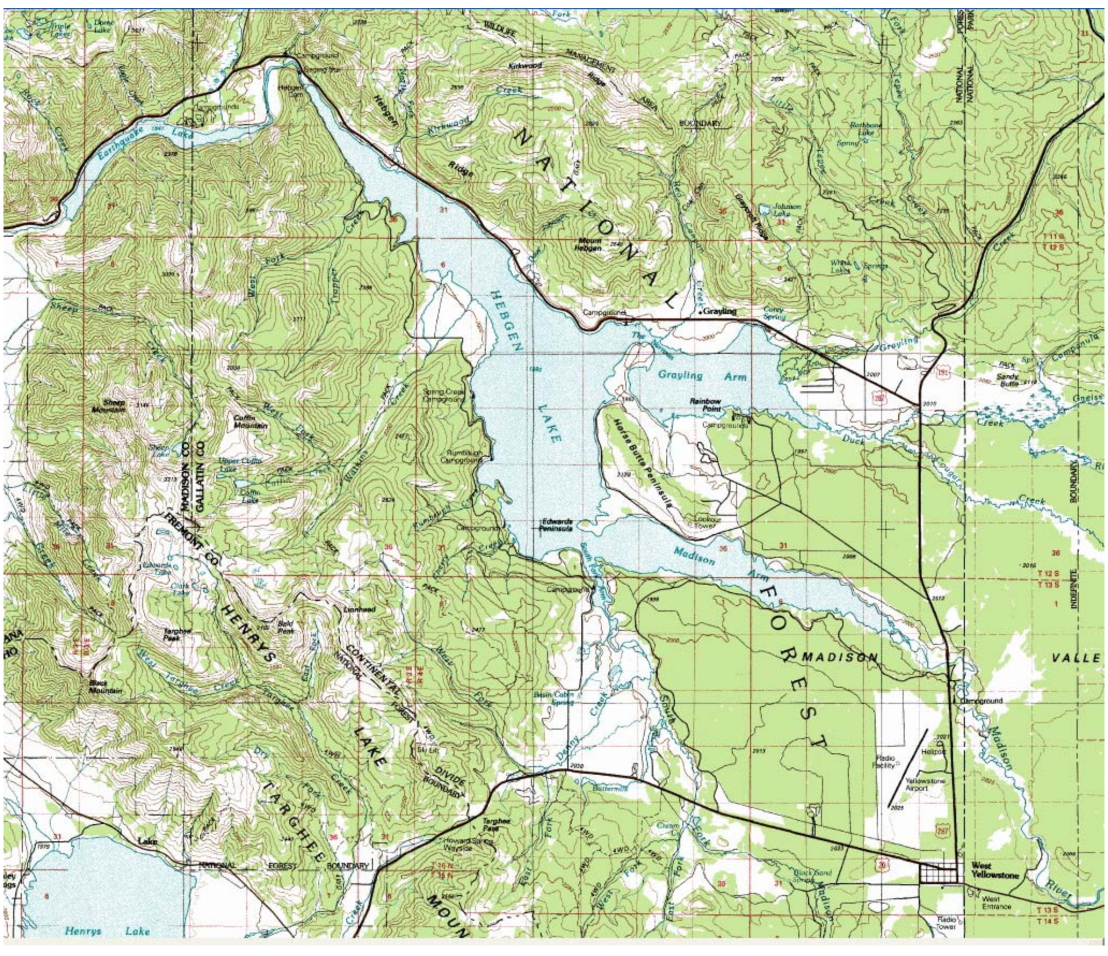


Figure 14. Map of Hebgen Reservoir and surrounding area.

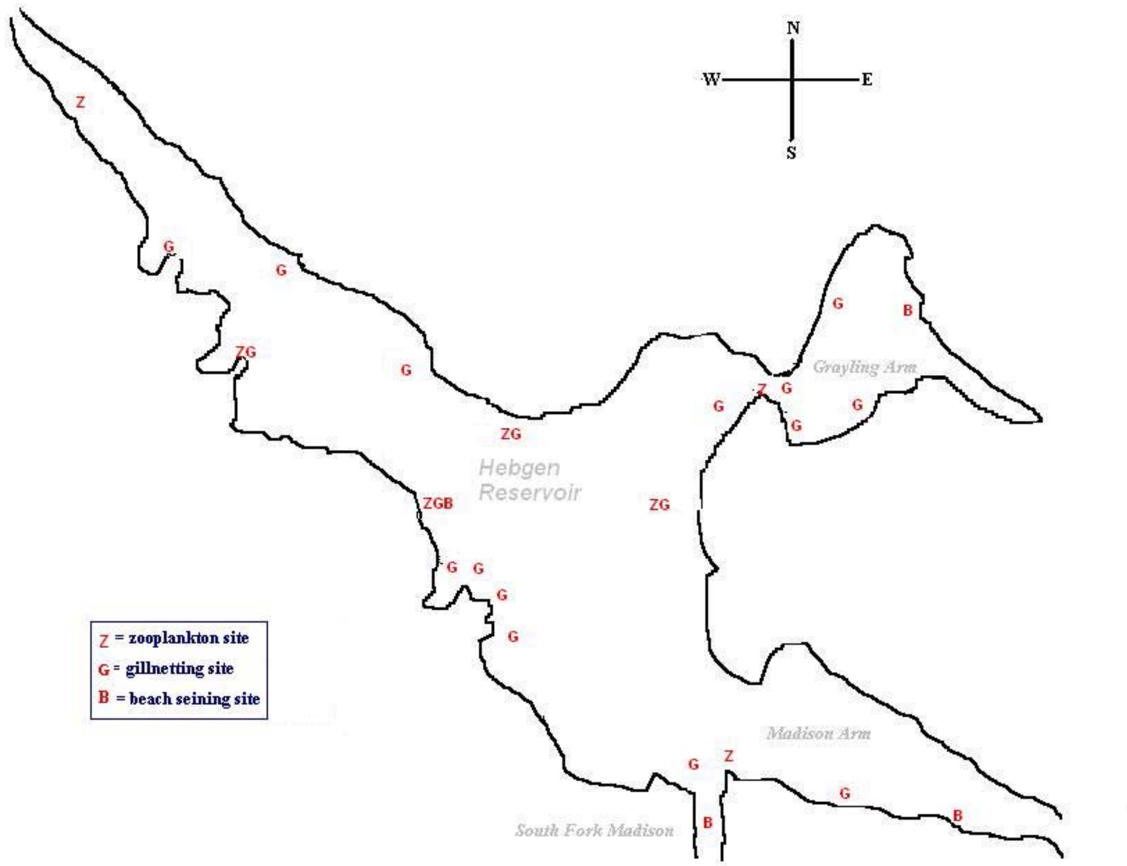


Figure 15. Map showing monitoring site locations of Hebgen Reservoir zooplankton, gillnetting, and beach seining.

<u>Hebgen Reservoir Tributary Habitat Improvement Monitoring</u>

South Fork Madison Large Woody Debris Project

FWP personnel conducted fish population monitoring for changes in fish assemblages and abundance in Phase I of a large woody debris habitat enhancement project implemented in 2006 by the Gallatin National Forest. Monitoring was conducted using mobile anode electrofishing equipment. Fish captured were identified to species, enumerated and measured for total length.

Watkins Creek Large Woody Debris Project

Watkins Creek is a tributary to Hebgen Reservoir's west side. Use of Watkins Creek for spawning by reservoir rainbow trout has been limited. In 2010, in an effort to increase the quantity and quality of spawning habitat and recruitment of rainbow trout to Hebgen, the Gallatin National Forest conducted a project to add large woody debris to a quarter mile section of Watkins Creek to promote the trapping and sorting of spawning gravels (Appendix B). FWP 2188 project personnel are monitoring the fish population response to the project. Three fisheries monitoring sites were established – one within the project reach and control reaches upstream and downstream to evaluate the effectiveness of the habitat enhancement project on fish assemblage, relative abundance and spawning use by Hebgen rainbow trout. Monitoring within the reaches was conducted with a Smith-Root backpack electrofisher model 12-B POW. Fish captured were enumerated by species and measured for total length. Additionally, total electrofishing time for each section was used to calculate a catch per unit effort (CPUE) estimate index of abundance..

Hebgen Basin Juvenile Fish Sampling

South Fork Madison River

A rotary screw trap (Figure 16) was operated from June 7 to July 12 in the South Fork Madison River to evaluate yearling and young-of-the-year rainbow trout emigration to Hebgen Reservoir. When operational the trap fished for a period of no less than a 24-hours. Captured fish were enumerated, identified to species and a total length was recorded for fish greater than one inch. These fish were fin clipped (Figure 17) and released 150 to 200 yards upstream of the trap to determine trap efficiency. Trap efficiency was calculated from the number of marked fish recaptured during a trapping event to the number of marked fish released upstream in the previous trapping event. Weekly yield estimates were calculated by dividing the number of unmarked fish by the duration of trap operation and dividing again by calculated trap efficiencies.

Figure 16. Rotary screw trap used sample juvenile fish on the South Fork Madison River.

Figure 17. Rainbow trout exhibiting unique fin clip used to determine trap efficiency and black tail a characteristic of whirling disease.

Hebgen Reservoir Shoreline Juvenile Fish Sampling

Beach seining (Figure 18) 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, 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 19). 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 enumerated. At each site all young-of-the-year trout, whitefish, and up to 30 Utah chub are measured. All remaining chubs are enumerated.

Figure 18. Beach seining.

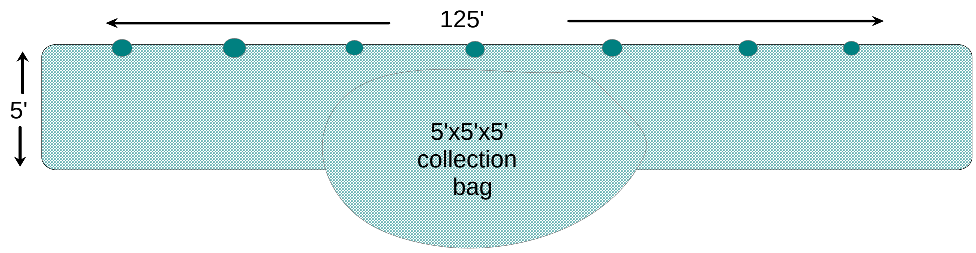


Figure 19. Depiction of a beach seine.

Hebgen Reservoir Zooplankton Monitoring

Monthly zooplankton tows were conducted at seven established sites on Hebgen Reservoir to evaluate plankton community densities and composition (Figure 15). Plankton were collected with a Wisconsin plankton net (Figure 20) 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.

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 20) 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 20. 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

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 as a Threatened species 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.

MadTAC funds are used to assist with Arctic grayling recovery efforts in the Big Hole, Ruby, and Elk Lake drainages. 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 land management conservation measures in cooperation with agencies that will reduce or eliminate detrimental habitat conditions for the grayling. Despite the USFWS ruling that listing grayling is 'warranted but precluded', landowners and irrigators continue to enroll in the program. Currently 33 landowners have enrolled 150,481 acres, with an additional 6,542 acres of State land enrolled. Additionally, MadTAC funds have 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.

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 3). 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 22) includes all rainbow trout larger than 12 inches, not just those 12 – 14 inches.

Figures 21 - 23 illustrate the number of rainbow trout per mile for several size classes in each of the three sections, and Figures 24 - 26 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 27) compare favorably with population levels in other sections of the Madison River (Figures 21-26). The preponderance of holding sites among the boulder and cobble substrate allows for a greater density of fish than in other river sections. Whirling disease did not have a severe population impact on trout in the Bypass and Norris sections downstream of Ennis Reservoir, presumably due to the different temperature regime than that of the river upstream of Ennis Reservoir.

River Discharge

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 have not been necessary since except for two days in 2009, requiring 0.03 feet of draft in Hebgen Reservoir. Table 2, adapted from PPL Montana data, summarizes statistics regarding pulse flows in the Madison in years pulsing was conducted.

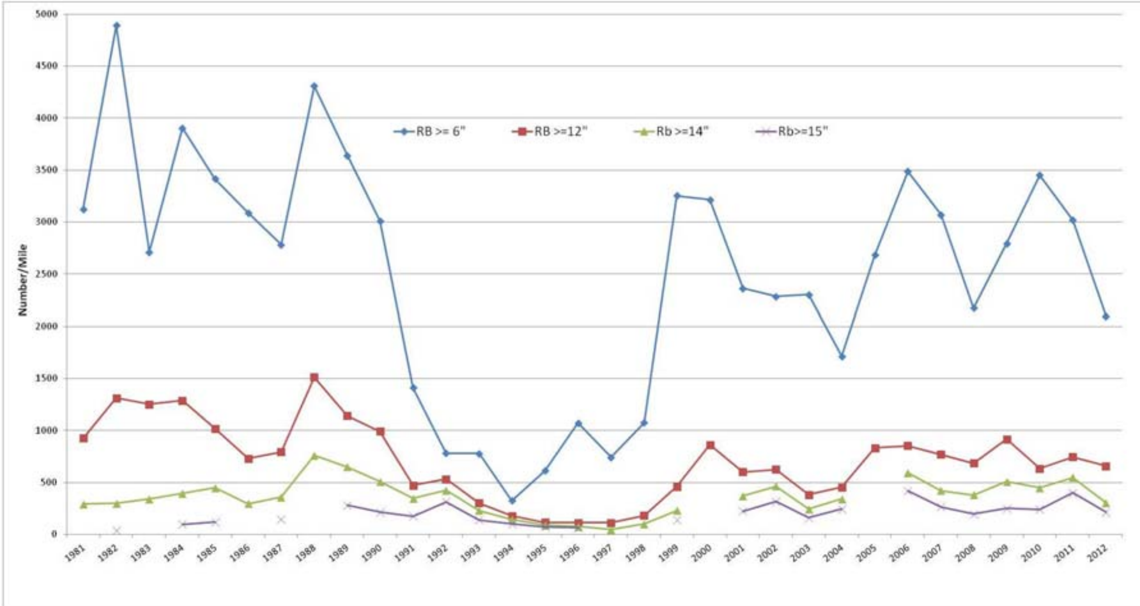


Figure 21. Figure showing the long-term trend of the rainbow trout population by size group in the Pine Butte section of the Madison River during fall, 1981–2012.

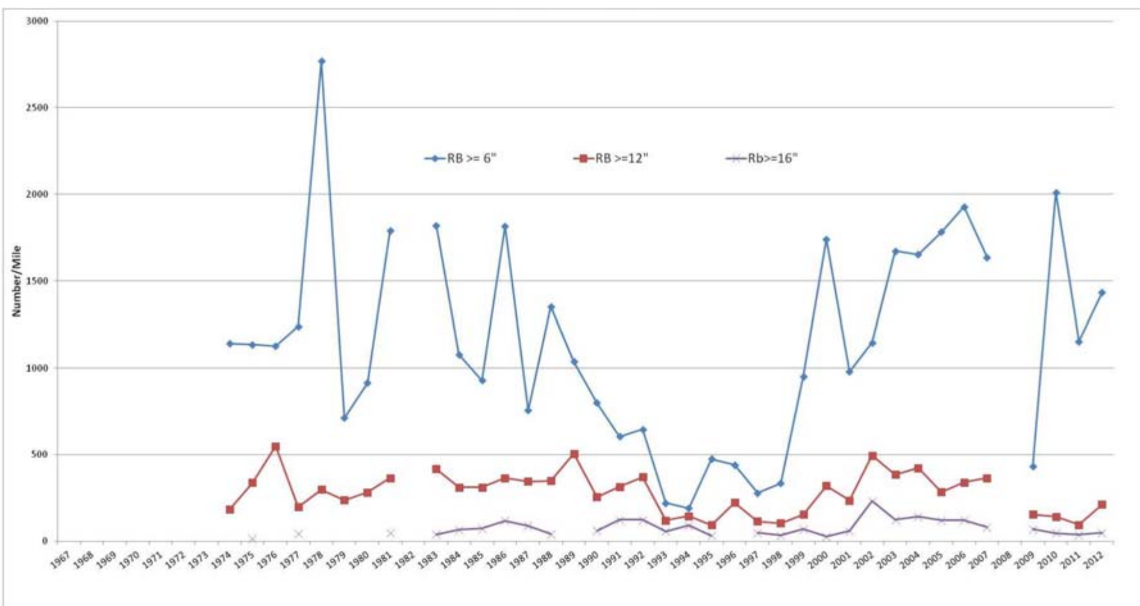


Figure 22. Figure showing the long-term trend of the rainbow trout population by size group in the Varney section of the Madison River during fall, 1967–2012.

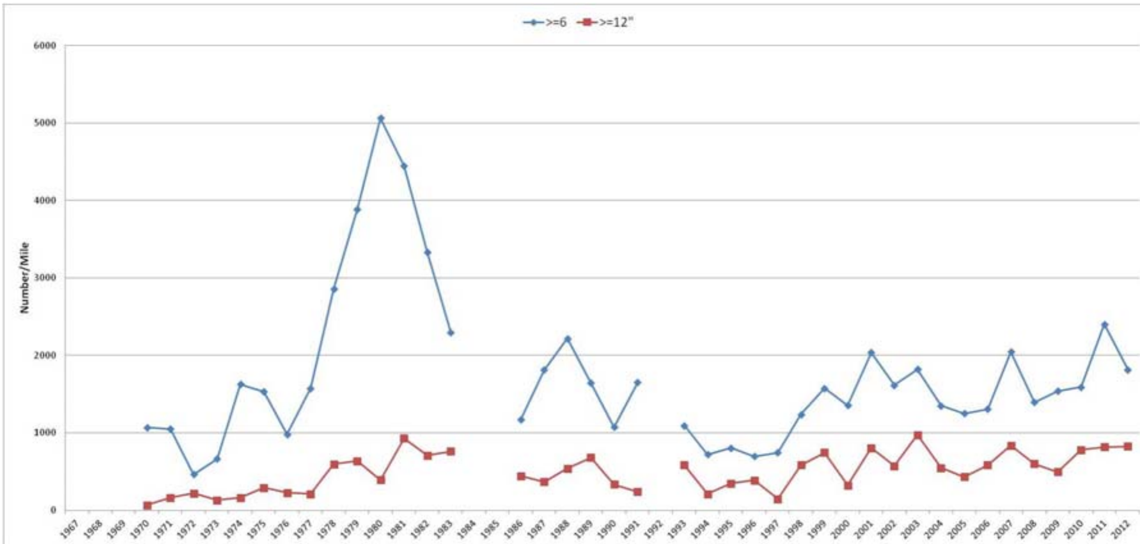


Figure 23. Figure showing the long-term trend of the rainbow trout population by size group in the Norris section of the Madison River during spring, 1967–2012.

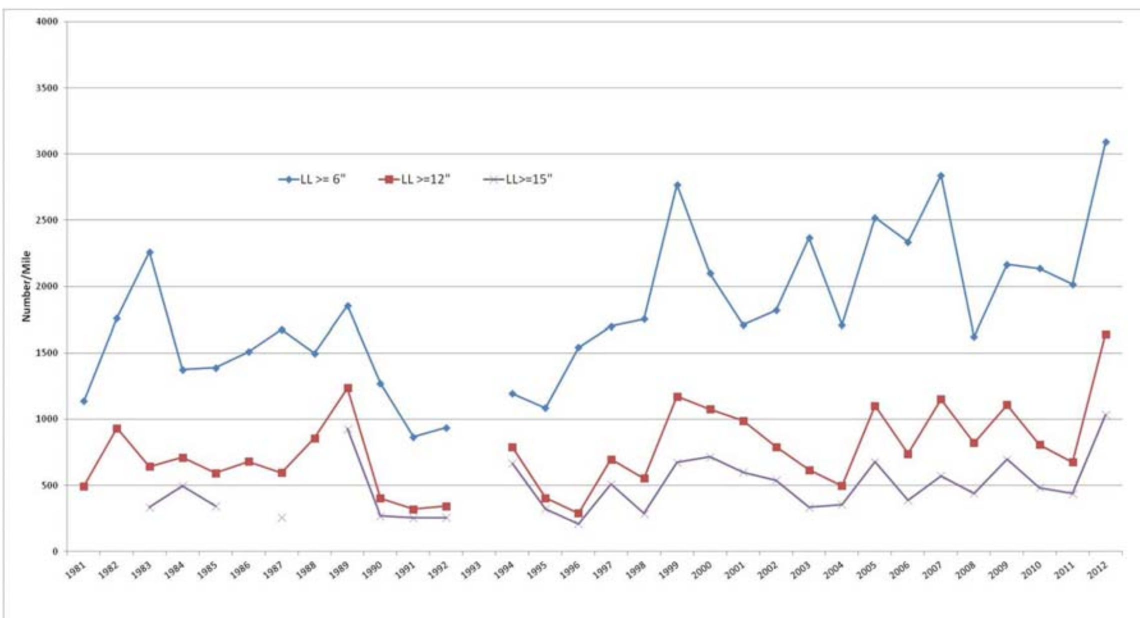


Figure 24. Figure showing the long-term trend of the brown trout population by size group in the Pine Butte section of the Madison River during fall, 1981–2012.

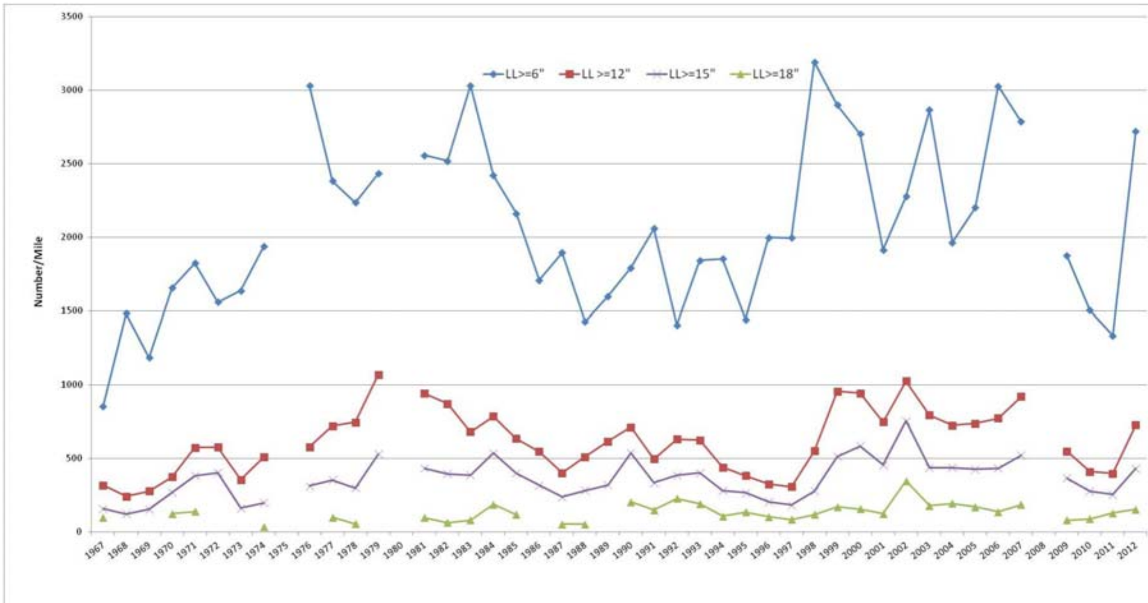


Figure 25. Figure showing the long-term trend of the brown trout population by size group in the Varney section of the Madison River during fall, 1967–2012.

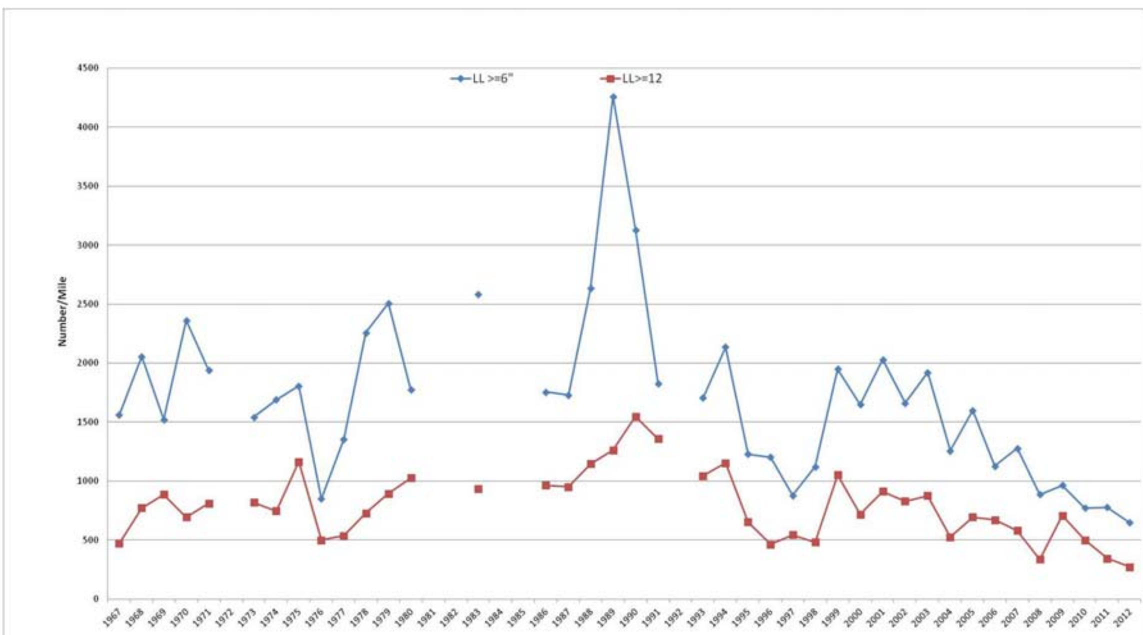


Figure 26. Figure showing long-term trend of the brown trout population by size group in the Norris section of the Madison River during spring, 1967–2012.

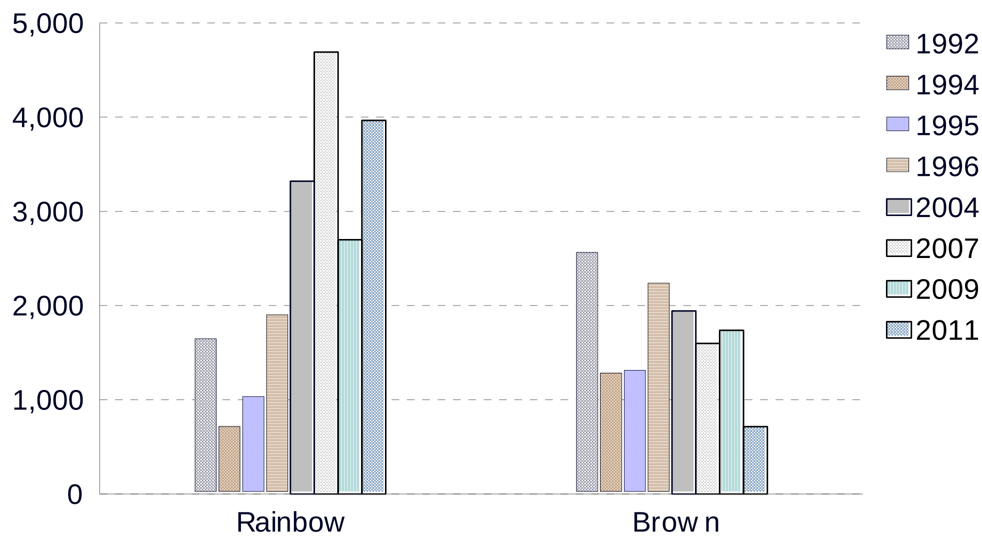


Figure 27. Population estimates (number/mile) of rainbow and brown trout in the Bypass section of the Madison River, spring estimates. PPL Montana personnel conducted the 1992 estimate.

Table 2. 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
2000	6531.21	3.66	0.61	29
2001	6530.53	4.34	0.05	13
2002	6530.46	4.41	0.70	18
2003	6528.59	6.28	2.68	39
2004	6532.07	2.80	0.28	12
2005	6531.52	3.35	0.30	17
2006	6530.86	4.01	1.74	15
2007	6526.05	8.82	2.12	43
2009	6533.02	1.85	0.03	2

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

Flushing Flows

Due to the extreme and prolonged natural runoff, flushing flow releases from Hebgen Reservoir were not necessary in the Madison River in 2011.

Minimum Flows

Minimum and maximum instream flows in various sections of the Madison River are mandated in Article 403 and in Condition No. 6 of the FERC license to PPL Montana. Specifically, Condition 6 in its entirety states: "*During the operation of the facilities authorized by this license, the Licensee shall maintain each year a continuous minimum flow of at least 150 cfs in the Madison River below Hebgen*

Dam (gage no. 6-385), 600 cfs on the Madison River at Kirby Ranch (USGS gage no. 6-388), and 1,110 cfs on the Madison River at gage no. 6-410 below the Madison development. Flows at USGS gage no. 6-388 (Kirby Ranch) are limited to a maximum of 3,500 cfs under normal conditions excepting catastrophic conditions to minimize erosion of the Quake Lake spillway.

Establish a permanent flow gauge on the Madison River at Kirby Ranch (USGS Gauge No. 6-388). Include a telephone signal at the gauge for link to Hebgen Dam operators and the Butte-based System Operation Control Center."

Temperature Monitoring

Onset Tidbit™ temperature recorders were deployed throughout the Madison River to document air and water temperatures (Figure 4). Table 3 summarizes the data collected at each location in 2012, and Appendix C1 contains thermographs for each location. Appendix C2 contains comparisons of annual maximum temperatures at selected adjacent monitoring sites and Appendix C3 contains annual longitudinal profiles illustrating the maximum water temperature recorded at each river monitoring site for the past 15 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 14 of 15 years where data are available, maximum water temperature at the Quake Inlet site is higher than maximum water temperature at the Quake outlet site
- The Ennis Reservoir Inlet site annually exhibits the highest maximum water temperature of the 7 sites between Hebgen Dam and Ennis Reservoir
- In 14 of the 16 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.

Table 3. Table showing maximum and minimum temperatures (°F) recorded at selected locations in the Madison River Drainage, 2012. Air and water temperature data were recorded from April 23 – October 5 (43,456 data points each recorder). Thermographs for each location are in Appendix C.

	Site	Max	Min
Water	Hebgen inlet	78.3	45.3
	Hebgen discharge	70.4	38.1
	Quake Lake inlet	71.7	31.4
	Quake Lake outlet	69.5	38.0
	Kirby Bridge	72.0	37.6
	Wall Ck Bridge		
	McAtee Bridge	73.1	37.2
	Ennis Bridge	73.3	39.6
	Ennis Reservoir Inlet	75.5	39.8
	Ennis Dam	72.9	43.5
	Bear Trap Mouth	77.8	44.1
	Norris	78.2	44.1
	Blacks Ford	79.5	42.9
	Cobblestone	80.2	44.1
	Headwaters S.P. (Madison mouth)	79.3	45.5
Air	Kirkwood	99.8	22.9
	Slide	89.7	23.6
	Wall Creek HQ	93.5	25.6
	Ennis	94.0[1/]	28.6
	Ennis Dam	90.8	30.7
	Norris	100.8[2/]	36.4
	Cobblestone	92.1	28.2

[1/] Maximum temperature recorded at Ennis air was 105.4, but the recorder had been exposed to full sun with a reflective metal background on numerous occasions during the monitoring period. According to National Weather Service, the max air temp in Ennis was 94°F on August 28.
[2/] Maximum temperature recorded at Norris air was 144.6 recorded on June 26 during the Beartrap 2 wildfire. The highest temperature recorded outside the period of the Beartrap 2 fire is shown here.

Aquatic Nuisance 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 *Potamopyrgus antipodarum* and whirling disease *Myxobolus cerebralis*. Montana has an active multi-agency ANS program coordinated through FWP (Appendix A).

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 ANS field crews found no Zebra or Quagga mussel veligers or adults, or Eurasian Watermilfoil in samples collected from Madison Drainage sites in 2012.

New Zealand Mudsnails

AIS sampling at Madison Drainage locations revealed NZMS density at the footbridge area of Darlinton Ditch at Cobblestone FAS to be 1,800 per square meter, but samples were negative at all other sites sampled. As NZMS have previously been documented throughout much of the Madison Drainage, it is unlikely that NZMS are truly absent from these sites, but more likely are at undetectably low levels.

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 ANS.
5. Purchasing portable power washing systems for cleaning boats and trailers at fishing access sites.

The FWP Fisheries office in Ennis uses a power washer to clean project equipment to reduce the chance of spreading ANS 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 Nuisance 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 B.

Sun Ranch Westslope Cutthroat Trout Program

Nine female and 31 male Sun Ranch Brood fish were spawned in 2012, providing 6,288 eyed eggs. Recipient waters were Cherry Creek (3,900 fry) and the Sun Brood Pond (1,500 fry).

Over 10,000 eggs from donor stream wild populations were incubated at the Sun Hatchery in 2012. Eyed eggs or fry from wild sources were introduced into Cherry Creek and Cherry Lake, the East Fork of Specimen Creek Drainage in YNP, Cherry Creek in the Big Hole River Drainage, and the Sun Ranch brood pond.

Appendix D lists the contributions to and production of the Sun Hatchery since 2001 as well as an annual summary for 2012 activities, and Appendix E provides a list of streams for which PPL Montana funding has been used to test genetic purity.

Cherry Creek Native Fish Introduction Project

No eyed eggs were introduced into the Cherry Creek Project area in 2012, but almost 4,000 Sun Ranch brood fry were introduced into Phase 4 of the project area (Figure 28). The Sun Ranch brood was developed from several wild donor populations.

In 2012, 3,000 triploid WCT fry were introduced into Cherry Creek. These fry are uniquely marked from other planted WCT so their growth & distribution can be determined when captured by electrofishing during routine monitoring efforts and compared to diploid wild WCT.

Personnel from FWP, Montana State University, 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 in phases 1, 3 and 4 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 has been documented by the WCT introduced as eggs in 2006 – 2008 as evidenced by young-of-the-year WCT captured by electrofishing in 2010-2012. Figure 29 shows an adult WCT captured in Cherry Creek that was introduced as a fertilized egg.

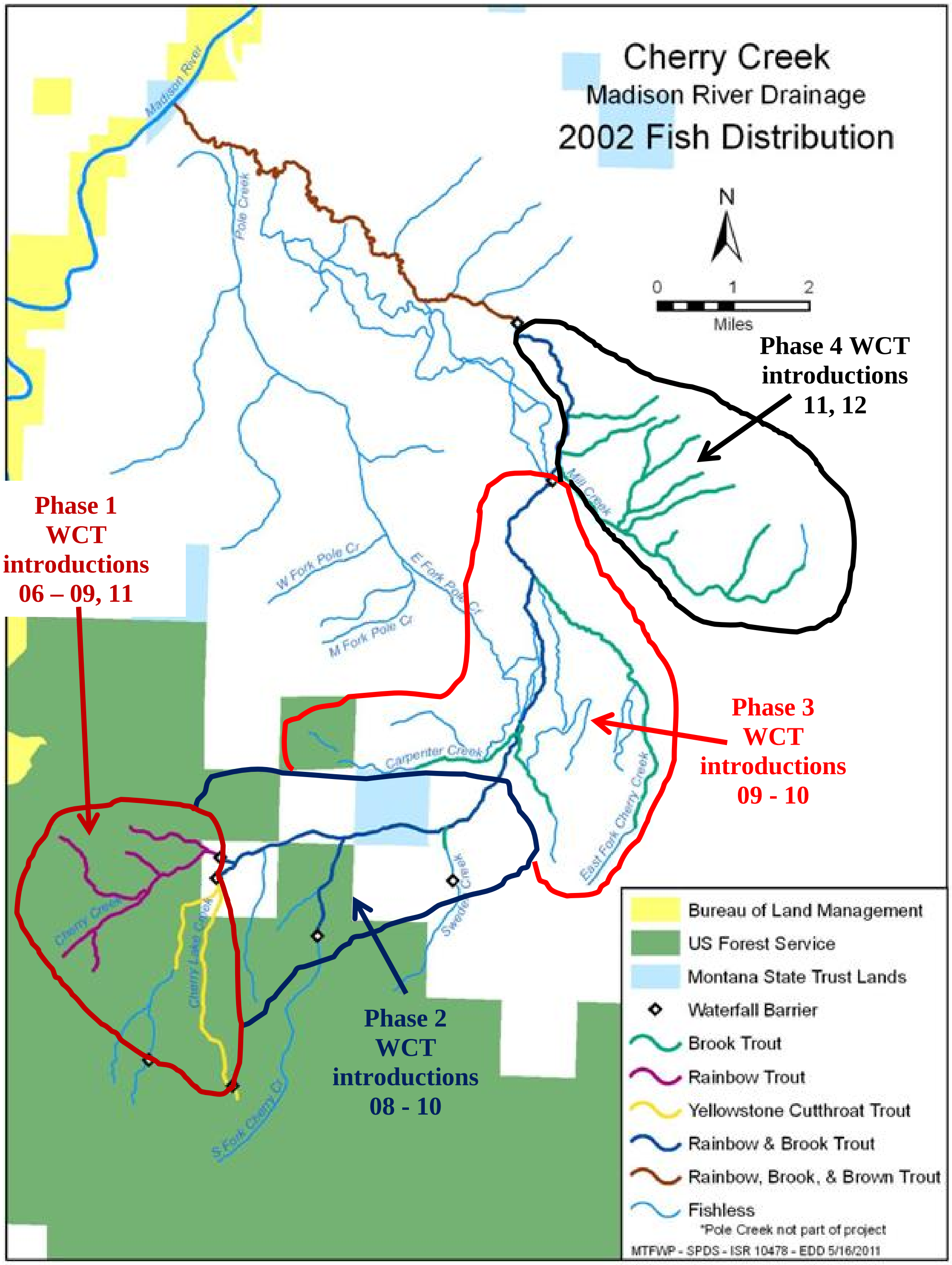
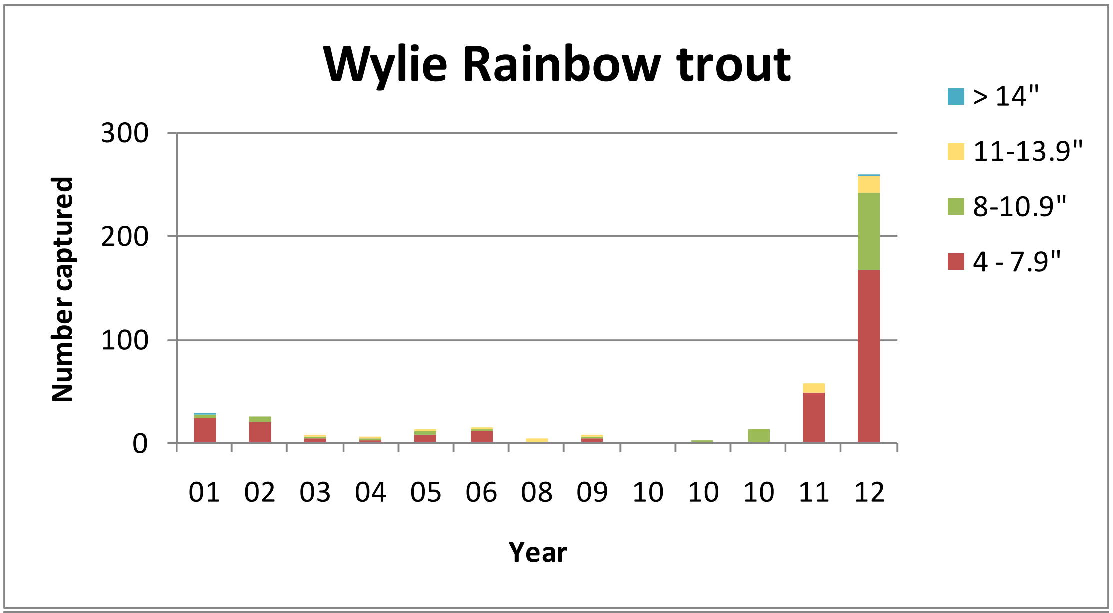


Figure 28. Phases 1 - 4 of the Cherry Creek Native Fish Introduction Project where wild westslope cutthroat trout were introduced in 2006 - 2012 following eradication of non-native Yellowstone cutthroat, rainbow, and brook trout in 2003 – 2010.

Figure 29. An 11.3 inch westslope cutthroat trout captured in Cherry Creek Phase 2 in 2010. This fish was introduced into Cherry Creek as a fertilized egg. FWP photo by Lee Nelson.

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.

Monitoring of the trout population in lower Cherry Creek where rotenone ran farther than expected on August 4, 2010, causing a significant fish kill, documents recovery of that population. A nearly complete kill of trout occurred in the Wylie section (stream mile 5.6 – 6.0), while there was no discernible mortality in the Electric Gate section (stream mile 2.7 – 3.0). Sampling has been conducted up to several times annually to monitor the recovery of the non-native trout population in the Wylie section of lower Cherry Creek (Figure 30). In addition to the rainbow and brown trout collected, significant numbers of whitefish, westslope cutthroat trout and brook trout were observed (Table 4).



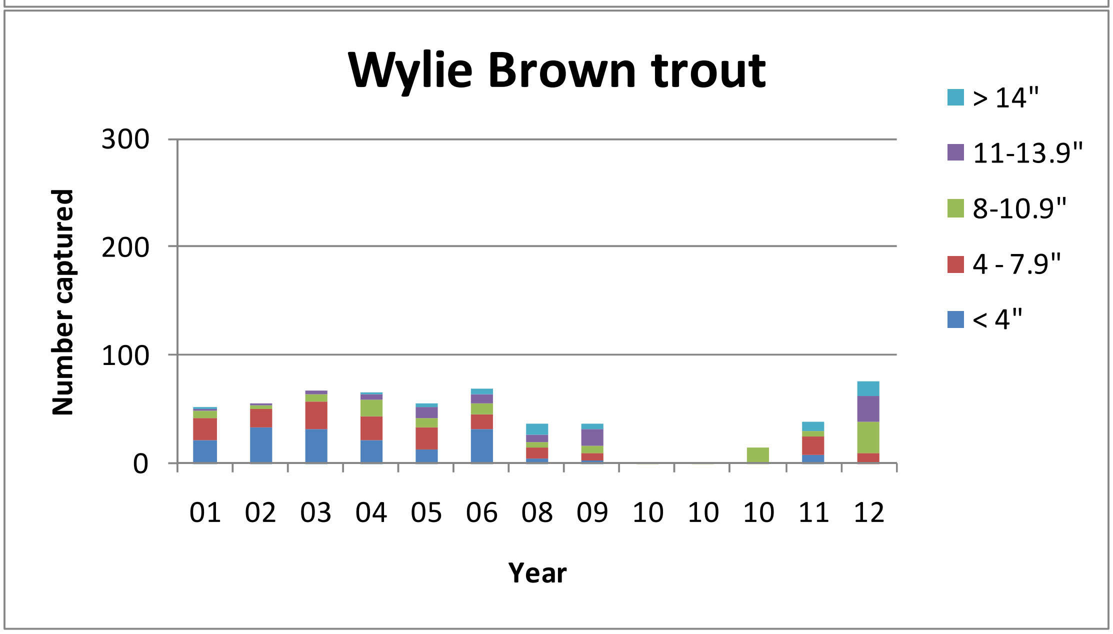


Figure 30. Characteristics of late Summer/Autumn rainbow and brown trout populations in the Wylie section of lower Cherry Creek (stream mile 5.6 -6.0), 2010 – 2012. Sampling occurred in 2010 on August 11 and 27, and October 27. In 2011, fish were measured only as less than or greater than 10 inches. 2001 – 2009 data collected by Turner Enterprises, Inc. in an adjacent section of Cherry Creek (stream mile 5.1 – 5.6) under an FWP collectors permit.

Table 4. Statistics of trout captured in 2011 and 2012 in the 2000-foot long Wylie section of Cherry Creek two years after a nearly complete unintentional rotenone kill on August 4, 2010. All species except westslope cutthroat were present prior to the fish kill.

	Number captured		Average length		Length range	
	2011	2012	2011	2012	2011	2012
Rainbow	75	260	7.7	7.8	5.0-14.2	5.1-15.5
Brown	31	75	8.4	11.0	5.2-22.4	7.3-18.1
Brook	5	49	9.3	9.1	6.8-10.6	6.5-12.8
Whitefish	3	61	7.3	8.3	5.8-8.3	5.0-16.9
Westslope cutthroat	5	20	11.3	12.2	10.7-11.8	8.4-14.0

Ruby Creek Westslope Cutthroat Trout Project

The Ruby Creek rotenone treatment was conducted on December 5, 2012. Appropriate quantities of rotenone powder, sand, gelatin and water were mixed to make dough that was wrapped in burlap for application to the stream (Figure 31).

Figure 31. Burlap-wrapped rotenone mix in a Ruby Creek spring. Photo by Dan Frazer, MFWP.

The bioassay 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 succumbed, while no sentinel sculpins over 1 hour below that point succumbed. Based on this information, rotenone dough was applied to Ruby Creek at a concentration of ½ ppm 1 ½ hours below the bioassay application point, and a two hour application of ½ ppm Prenfish liquid rotenone was conducted 2 ½ and 4 hours below the bioassay point.

Sentinel trout throughout the treatment area all succumbed to the treatment, while no sentinel sculpins succumbed other than those noted in the bioassay.

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.

Neutralization was initiated 11:30 a.m. on December 5 and was terminated at 8:00 a.m. on December 6. Table 5 summarizes the rate of potassium permanganate application and the residual level 30 minutes downstream. Sentinel fish were placed at locations immediately upstream of the neutralization station and at 10, 15, 20 and 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. In this instance, the replacement sentinel fish survived for 5 ½ hours prior to terminating neutralization.

Table 5. Rate of potassium permanganate applied to Ruby Creek and the range of residual concentration 30 minutes downstream during the noted time period, December 2012.

Date	Time of day (hour)	Application rate (ppm)	Residual at 30 minutes (ppm)
12/5/12	11:30 a	2.7	0.86
	12:18 p - 7:00 p	2.7	1.00 – 1.43
	7:00 p – 12:00 a	1.6	0.88 – 0.92
12/6/12	12:00 a – 8:00 a	1.1	0.71 – 0.76

Sentinel trout immediately upstream of the neutralization station were alive and vigorous at 8:30 p.m., but suffered complete mortality by 9:45 p.m. Replacement sentinel fish were deployed at 2:30 a.m. December 6 and survived until released at 8:00 a.m.

Sentinel trout 30 minutes downstream of the station showed no signs of rotenone stress throughout the project and were released at 9:45 a.m. December 6. At the sentinel fish sites 10, 15 and 20 minutes below the station, sentinel trout smaller than 4 inches succumbed, but those larger survived. There was no evidence of sculpin mortality at or below the neutralization station.

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

Madison River

Article 409 of the FERC Project 2188 license requires PPL Montana and partner agencies to explore the possibility of creating holding water for large trout between McAtee and Varney bridges. Few options exist for creating this scenario, and the cost of implementation is beyond the ability of the Madison Fisheries program. Several local fishing outfitters have asked for information regarding options previously explored by PPL Montana and FWP.

The most feasible method of increasing large trout holding water between McAtee and Varney bridges is the placement of boulders and/or boulder clusters, such as those that occur naturally in the river between Hebgen Dam and McAtee Bridge and below Ennis Dam in the Beartrap Canyon.

Free standing boulders are not readily available close to this 13-mile section of the river, so would have to be purchased or found at other locations and transported to the site. For this analysis a minimum of 30 boulders per mile is used with no consideration for how or where the boulders are placed – in clusters or singly; near the bank or mid-channel. Also, no attempt has been made to determine the cost of locating the 390 boulders or the cost to transport them to a staging area along the river.

Generally, for a boulder to create a holding water affect in the river it must have dimensions of approximately 3' x 4' x 4'. According to USGS geologist Karl Kellogg (pers. comm. 2013) who has worked in the Madison, "*Most of the boulders in the Madison River are either Belt Group quartzite (second generation from voluminous conglomerates in the region) or Cretaceous granite. In either case, the density is about 2.7 g/cc, which I calculate would be about 168 lbs/cubic foot or 76 kg/ cubic foot.*" His calculations are correct. At 168 lbs per cubic foot, a 3'x 4'x 4' boulder weighs 8,064 lbs.

There are no methods to easily place a 4 ton boulder in the river. Potential methods are helicopter, front end loader and a cable logging system (skyline). The front end loader and skyline methods are dismissed because of the long distance of river involved and the access that would be necessary along that distance for each of those methods. Additionally, any heavy equipment that would access the river to place the boulders would cause significant riparian and in-stream habitat damage due to the number of times it would need to enter and exit the river. Other concerns include the potential of an oil or fuel leak.

To lift and transport a 4 ton boulder, a Chinook helicopter would be necessary. The closest known commercial location that could provide the necessary machine is Columbia Helicopters in Portland Oregon. In response to FWP's inquiry, Columbia Helicopters responded, "*At 5000' msl the 107- II would lift about 8500# maximum if it's cold out (0^o C) and the end of the fuel cycle. If they are 7500-8500# they would fly ok. It would probably be about $60,000 mobe and $6,500 per hour at this time with a 3 hour minimum per day. Any more weight than that, you would need the 234 Chinook which would fly up to about 23,000# at that altitude and temperature. The 234 could be made available after fire season Nov 1; it is the only one we have left in N America. To get it and support equipment* *over there would cost around $100,000 and it goes for $12,500 per hour at this time, with a three hour minimum per day*. *On both machines it would depend on where we mobe from to determine a cost. We are reviewing our hourly rates for 2013 at this time. How would you be rigging the boulders*?"

Assumptions for this analysis are:

- to minimize helicopter time, each boulder is harnessed (rigged) and ready for immediate lift and transport
- a 10-minute average round trip to place each boulder
- 390 boulders (30 per mile for 13 miles)

Applying these assumptions shows that a minimum of 65 hours of actual helicopter flight time is necessary to place all the boulders over the 13-mile section of river. Assuming the Chinook 107-II could do the work at $6,500 per hour, the cost just to place the boulders is $422,500, plus the mobilization ("*mobe*") costs of $60,000. If the Chinook 234 were necessary, which, based on the air temperature and fuel capacity limitations they cite, is the more likely case, those costs would increase to $812,500 and $100,000, respectively.

The 'habitat enhancement' value of such a project is questionable. Creating holding water for large fish will serve to concentrate those fish for easier targeting by anglers, but it will do little to increase the fish population or improve habitat. Annual habitat variability, such as river discharge, and other factors have far greater influence on annual fish production than would the placement of boulders to create large fish holding water.

<u>Jack Creek</u>

Reconstruction of the Jack Creek channel was completed in 2010. By increasing sinuosity, designers increased channel length from approximately 1,290 linear feet to 1,518 linear feet, a nearly 18 percent increase. Additionally, fish habitat features and riparian vegetation were incorporated into the channel reconstruction.

Fisheries monitoring was conducted in the Jack Creek Ranch section April 2008 and 2010 prior to channel reconstruction, and in 2011 and 2012 after channel reconstruction (Figure 32). Additionally, the fish population in a nearby unaltered reach of stream (Madison Valley Ranch section) was monitored as a control. Fish population monitoring in these two reaches will continue periodically for several years as the newly constructed channel matures.

A rainbow trout spawning run was documented in Jack Creek during the 2008 fish monitoring. Subsequent work with this spawning run has shown that these fish migrate as far as 8 miles up Jack Creek to spawn. It is unknown how long this spawning run has been occurring. It may have developed as a result of the apparent localization of rainbow trout spawning suggested by the results of the 2010 rainbow trout radio telemetry study (Clancey and Lohrenz, 2012).

<u>South Fork of Meadow Creek</u>

Design and bid awarding to rebuild irrigation infrastructure, including in-stream weirs and headgates, were completed in 2011 with construction scheduled to begin in 2012. There will be no stream channel modifications as part of this project, but the stream corridor will be fenced creating a 30-foot zone on each side of the stream where livestock grazing is prevented. 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.

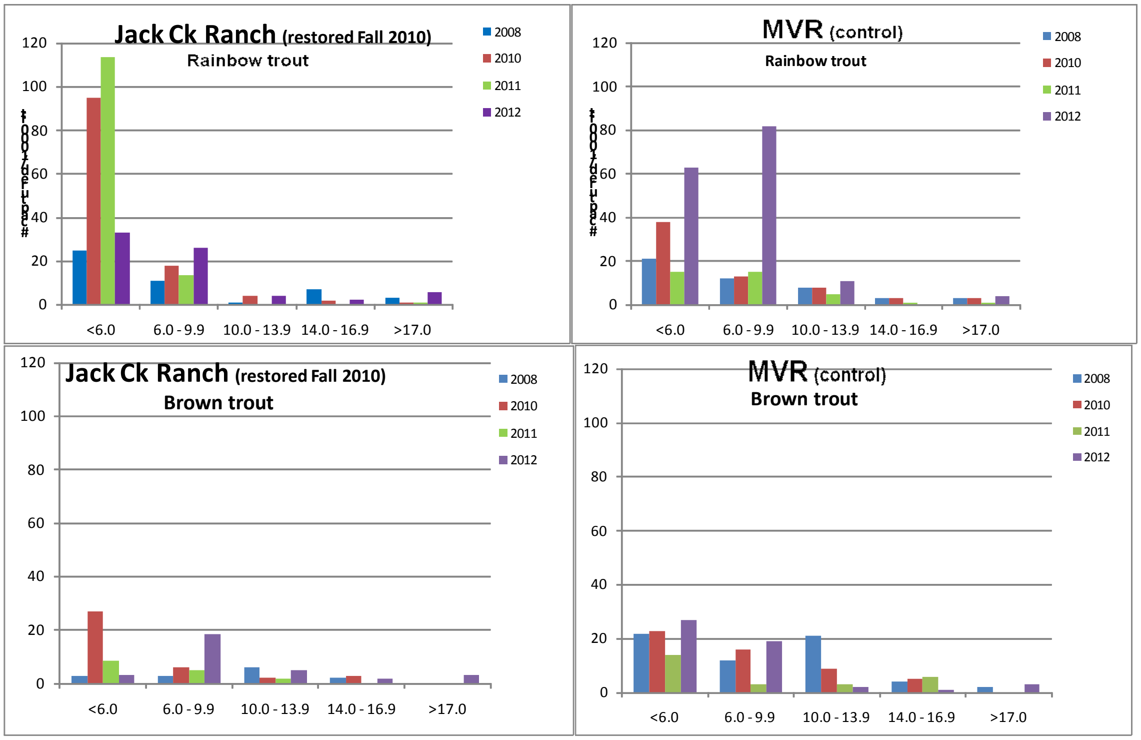


Figure 32. Number of rainbow (top charts) and brown (bottom charts) trout by size class in April in two sections of Jack Creek. Channel reconstruction of the Jack Creek Ranch section occurred in the Fall, 2010.

Fish populations were sampled in two sections of the project area in 2011 (Figure 33). Sampling in Section 1 in 2012 captured only 37 brown trout and 9 brook trout, all less than 8 inches, as stream flows were extremely low in the project area. Sampling was not conducted is Section 2 in 2012. Stream channel morphology will be monitored and photographed prior to fence construction and also for several years after fence construction to document changes that occur.

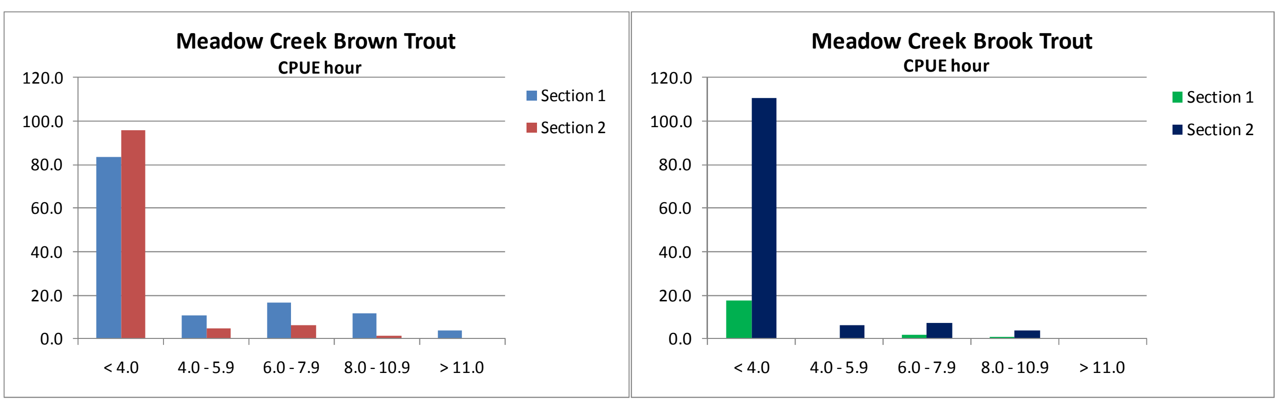


Figure 33. Catch-per-unit-effort (hour) of electrofishing for brown and brook trout in two sections of the South Fork of Meadow Creek, September 2011. Sampling in Section 1 in 2012 captured only 37 brown trout and 9 brook trout, all less than 8 inches, as stream flows were extremely low in the project area. Sampling was not conducted in Section 2 in 2012.

Hebgen Basin

Hebgen Reservoir Gillnetting

A total of 738 fish were captured during Hebgen Reservoir gillnetting in 2011 (Table 6), over half of them were Utah chub *Gila atreria*.

Table 6. Summary of 2012 Hebgen Reservoir gillnet catch.

Species	Number caught	Average Length (range)	Average weight (range)
Rainbow trout	57	15.1 (8.4-19.7)	1.40 (0.27-2.50)
Brown trout	84	16.2 (6.4-22.8)	1.63 (0.08-4.27)
Whitefish	101	16.5 (6.7-21.6)	1.95 (0.11-3.89)
Utah Chub	463	10.2 (5.2-15.9)	0.60 (0.06-1.84)

The number of rainbow trout captured by gillnetting has decreased for three consecutive years since the peak number captured (Figure 34). The number of rainbows captured per year has varied from 40 in 2001 to 194 in 2008.

Average length of rainbow trout captured has been higher over the last decade than in the mid-late 1990's. Additionally, the proportion of the rainbow trout gillnet catch under 14 inches has decreased noticeably since 2003 (Figure 35), except in 2012 when it was in a similar proportion to 1999-2003.

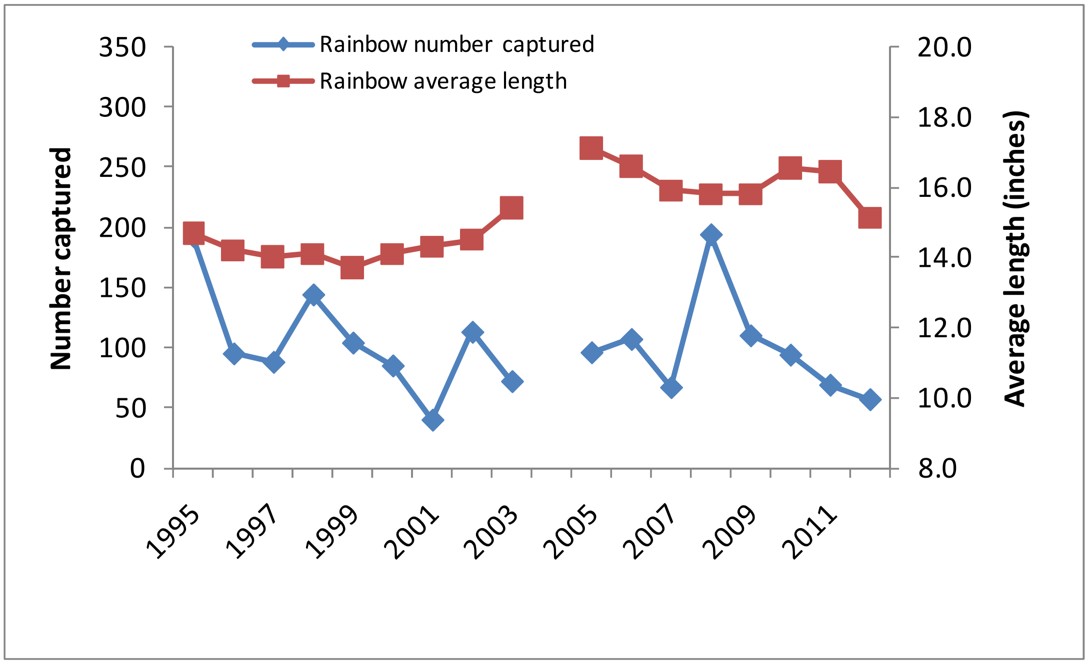


Figure 34. Figure showing rainbow trout average length in inches (right axis) vs. number captured (left axis) during annual Hebgen gillnetting, 1995-2012. Data from 2004 are not shown because of sampling error.

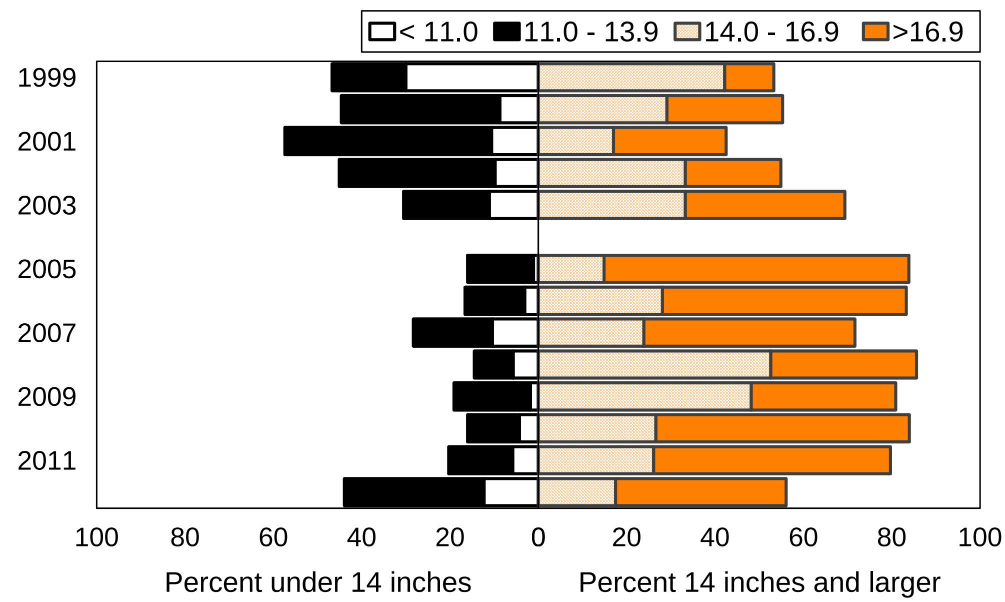


Figure 35. Figure showing percentage of Hebgen Reservoir rainbow trout gillnet catch under and over 14 inches, 1999-2012. Data from 2004 are not shown because of sampling error.

Vertebrae from 19 rainbow trout were examined for tetracycline marks, none were positive. A positive tet-mark would indicate a fish of hatchery origin. Also, none of the 19 fish examined showed external signs characteristic of hatchery-origin fish, such as dorsal fin erosion or abnormally developed paired fins.

Brown trout numbers have fluctuated widely with no consistent trend evident for more than a few consecutive years (Figure 36). 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 37). 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 since. Average length has shown no consistent trend since 1995 (Figure 38). The number of Utah chub captured annually has ranged from 268 in 2008 to 2,245 in 1999.

Utah chub comprised nearly 80 percent of the total Hebgen gillnet catch in 1995-2003 but have averaged slightly less than 60 percent since (Figure 39).

Hebgen Reservoir Tributary Habitat Improvement Monitoring

South Fork Madison Large Woody Debris Project

Relative abundance of rainbow and brown trout has decreased significantly in two sections of the South Fork Madison River that underwent a large woody debris habitat improvement projects in 2005 and 2006 (Figure 40; Clancey & Lohrenz 2006). The goal of the projects was to enhance spawning and

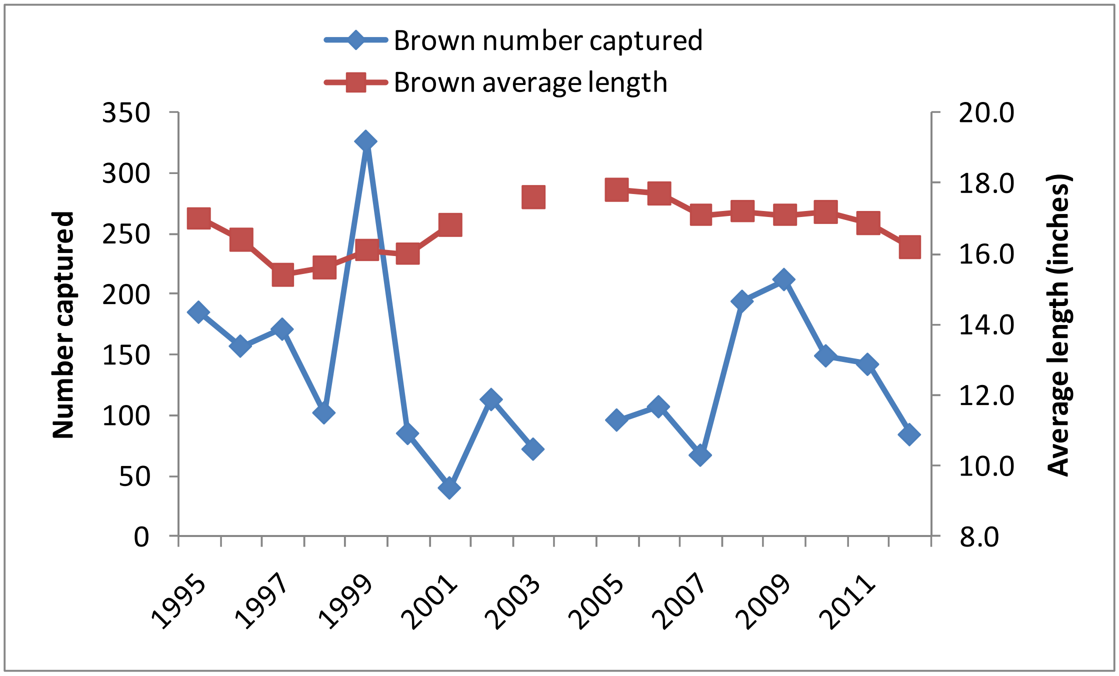


Figure 36. Figure showing brown trout average length in inches (right axis) vs. number captured (left axis) during annual Hebgen gillnetting, 1995-2012. Data from 2004 are not shown because of sampling error.

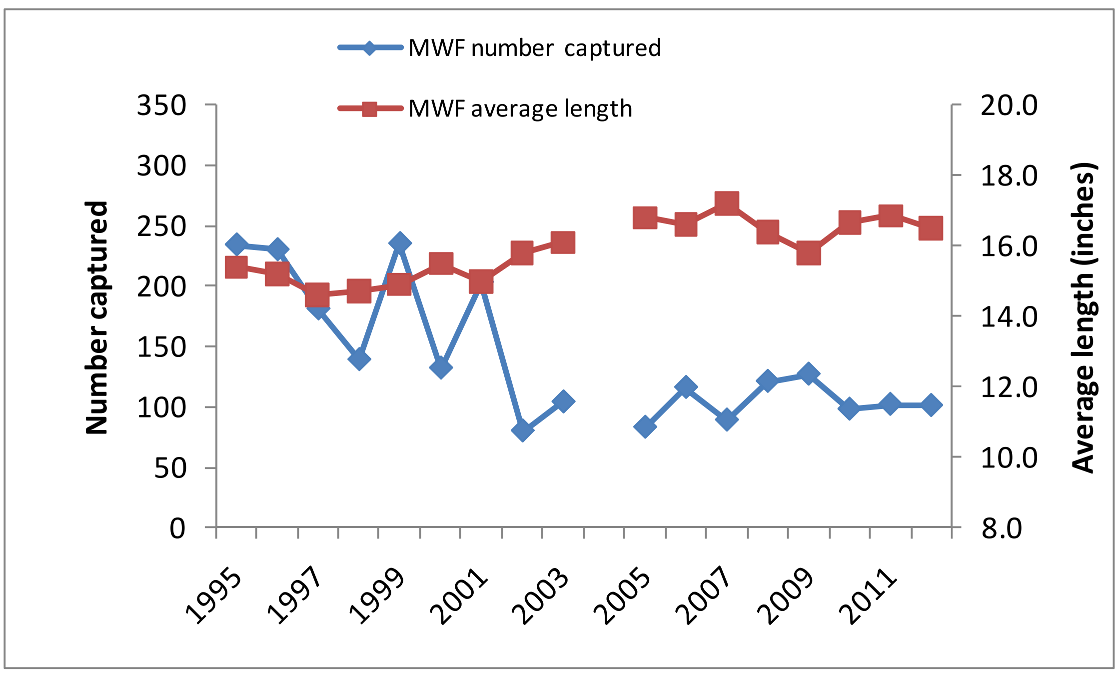


Figure 37. Figure showing mountain whitefish average length in inches (right axis) vs. number captured (left axis) during annual Hebgen gillnetting, 1995-2012. Data from 2004 are not shown because of sampling error.

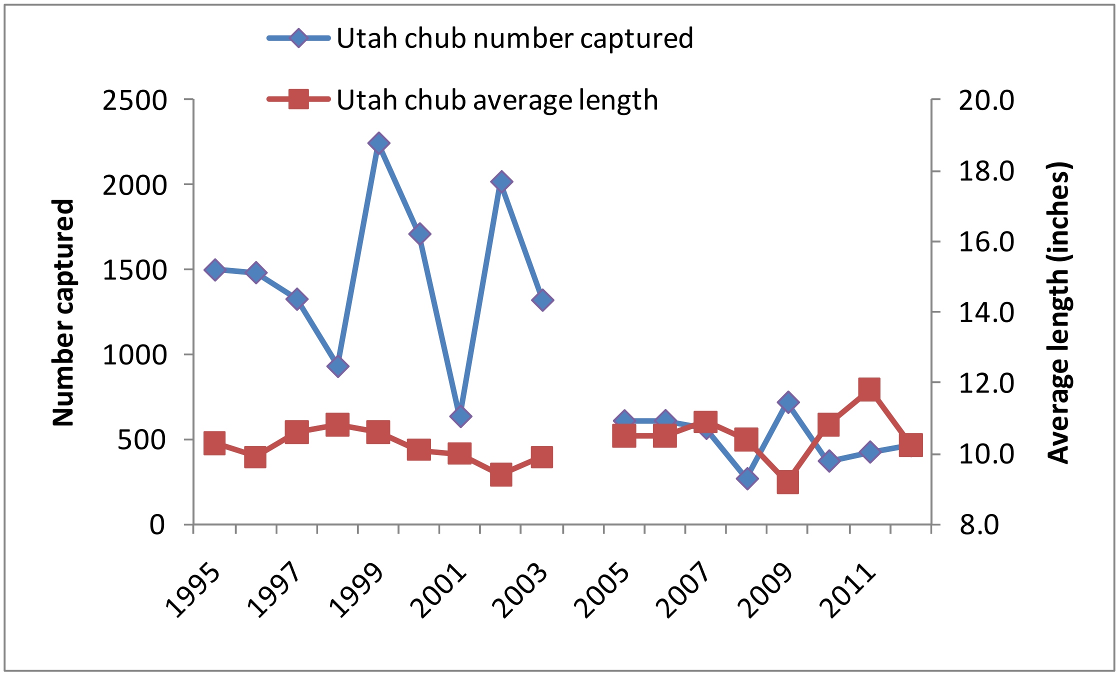


Figure 38. Figure showing Utah chub average length in inches (right axis) vs. number captured (left axis) during annual Hebgen gillnetting, 1995-2012. Data from 2004 are not shown because of sampling error.

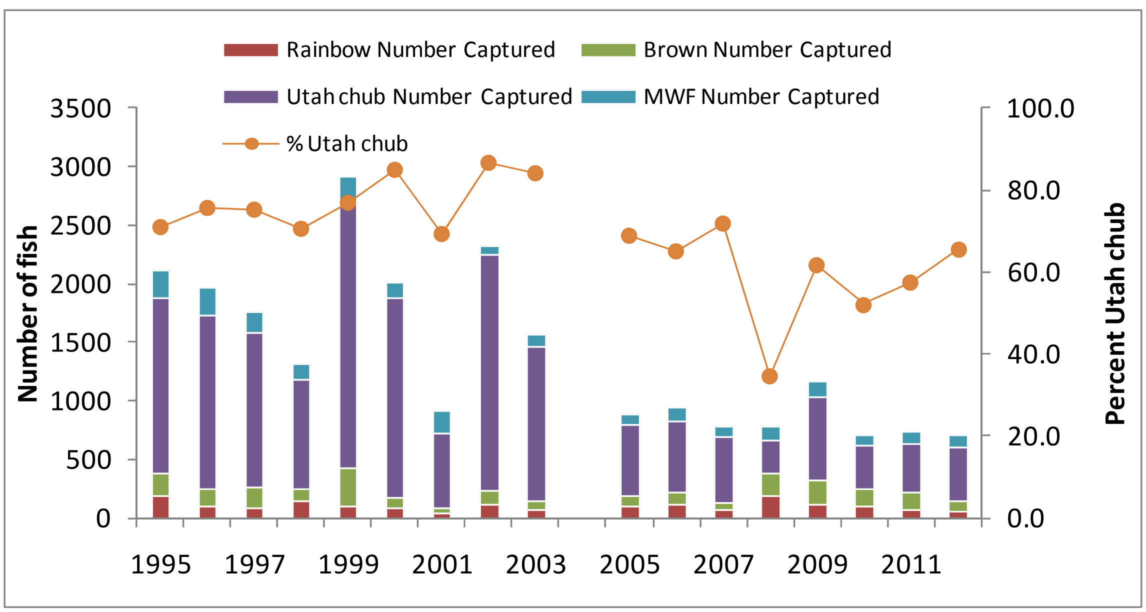


Figure 39. Figure showing species composition of Hebgen Reservoir gillnet catch, 1995 – 2012. Data from 2004 are not shown because of sampling error.

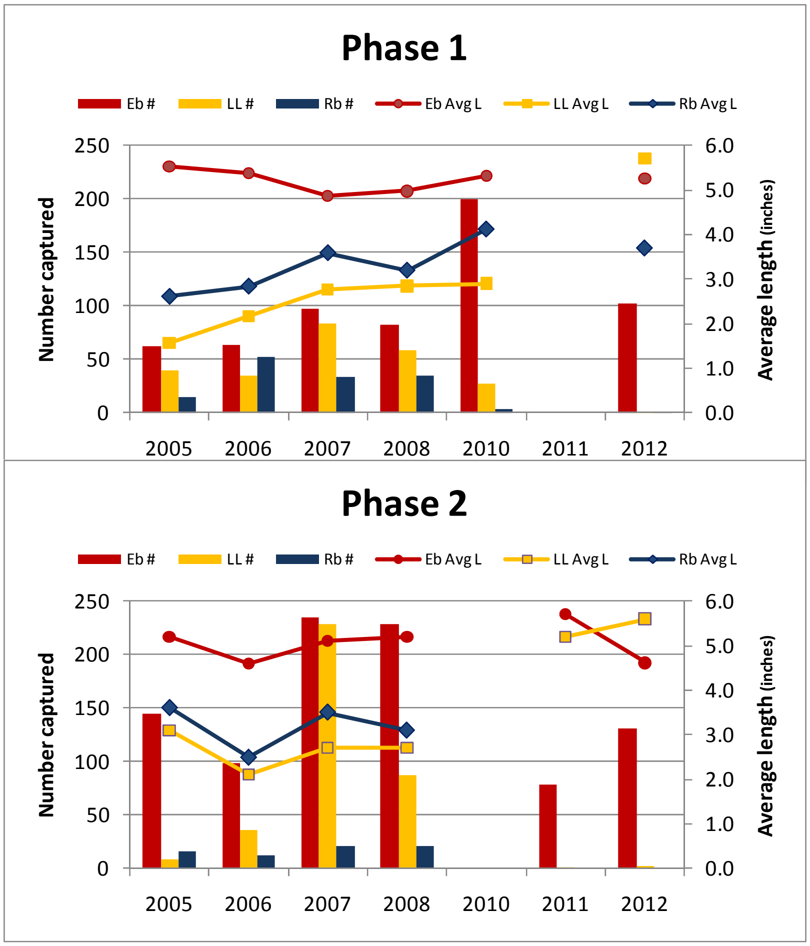


Figure 40. Figure showing the relative abundance and average size of rainbow (Rb), brown (LL) and brook (Eb) trout in two sections of the South Fork Madison River following a large woody debris habitat improvement project in 2005.

rearing habitat for rainbow trout. Only one rainbow trout and three brown trout were captured by electrofishing in the two sections. The initial response of the species assemblage in Phase 2 after project completion in 2006 was positive, with 229 brown and 21 rainbow trout sampled in 2007 compared to 8 brown and 12 rainbow trout sampled in 2005 prior to project implementation.

While the goal of the project was to enhance spawning and rearing habitat for rainbow trout, it likely increased inter-specific competition for habitat and forage. Investigations of westslope cutthroat and eastern brook trout interactions in Montana streams indicate that the rate of displacement of westslope cutthroat trout through brook trout invasion are likely related to stream habitat conditions such as pool abundance and woody debris (Shepard 2004). Brook trout prefer habitats that contain wood debris, and the carrying capacity of adult brook trout in streams is influenced by the presence of cover supplied by submerged brush and logs, undercut banks, large rocks, and overhanging vegetation (Flebbe and Dollof 1995; Saunders and Smith 1965; Elwood and Waters 1969; O'Connor and Power 1976).

The lower number of fish observed in Phase 2 in 2011 is likely a function of high flows during a prolonged spring runoff which caused several of the debris jams constructed in 2006 to be displaced downstream or deposited on the stream banks (Figure 41). Only six of the original 24 structures

Figure 41. Photo of large woody debris in Phase 2 of the South Fork Madison River deposited on the stream bank by high flows during spring runoff 2011.

constructed were remaining in the project reach after 2011 runoff. This reduction in available habitat likely influenced fish movement from the reach to areas with greater habitat availability.

Watkins Creek

Results of fish population surveys of the Watkins Creek large woody debris (LWD) project in 2010-12 are shown in Table 7, and a Gallatin National Forest habitat report is in Appendix B. GNF personnel will repeat the habitat surveys in 2013.

Rainbow trout, rainbow x Yellowstone cutthroat trout hybrids and Rocky Mountain (mottled) sculpin were the only fish species sampled in the Watkins Creek project area and control sites. Catch-per-unit-effort (hour) and average length of trout during post-runoff sampling are shown in Figure 42. Capture efficiencies in August 2011 were likely affected by higher than average stream discharge, however the LWD project section exhibits a lower catch in all years relative to the two control sections. Average size of fish in the LWD section appears to have increased since project implementation.

Hebgen Basin Juvenile Fish Sampling

South Fork Madison River

A total of 223 young-of-the-year rainbow trout were captured in the rotary screw trap in 2012 (Table 8). Peak emigration in 2012 occurred on July 12, the final day of trap operation, when 94 young-of-the-year were captured. In previous years peak emigration of young-of-the-year rainbow trout has consistently occurred in late June through the second week of July. Peak emigration of young-of-the-

Table 7. Summary of electrofishing monitoring conducted for Watkins Creek LWD project, 2010 -12. Snow and ice cover prevented sampling of the upstream control site on 5/28/10 and 7/18/11.

Section	Sample Date	Number of Salmonids Captured	Electrofishing effort (seconds)	Catch-per-Unit-Effort (fish/hour)
Upstream Control	7/21/10	7	1060	24
	8/31/11	15	1695	32
	8/23/12	46	1456	114
LWD Project Section	5/28/10	17	2372	26
	7/21/10	5	1018	18
	7/18/11	3	0833	13
	8/31/11	11	1626	24
	8/23/12	30	1283	84
Downstream Control	5/28/10	47	1993	85
	7/21/10	33	2366	50
	7/18/11	7	1060	25
	8/31/11	28	1864	54
	8/23/12	31	1186	94

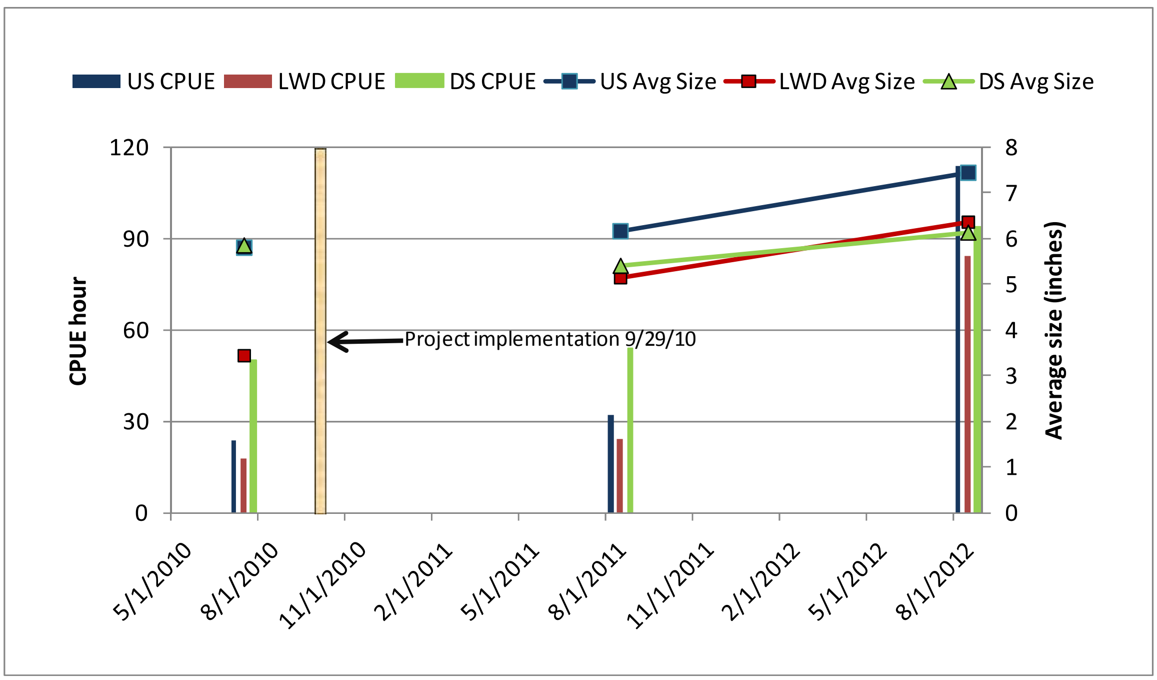


Figure 42. Catch-per-unit-effort (hour) and average size of trout in the large woody debris (LWD) habitat improvement section and the upstream (US) and downstream (DS) control sections of Watkins Creek, 2010-2012.

Table 8. Number of captured and estimated out-migrant yearling rainbow trout and number of captured young-of-the-year rainbow trout, South Fork Madison River, 2004 – 2012.

	Yearlings		
Year	Captured	Estimated	Y-O-Y
2004	455	1,481	11,027
2005	1,162	2,942	18,306
2009	402	608	256
2010	247	543	2,226
2012	95	378	223

year rainbows may not have been sampled in 2012 as the trap was inactivated July 12 due to other work obligations.

Ninety-five yearling rainbow trout were captured in 2012, but trapping was initiated later than in previous years, so the number of yearling rainbow trout is probably underestimated. In past years peak emigration of yearling rainbow trout occurred late April through May (Clancey and Lohrenz 2004; Sestrich and Lohrenz 2006; Clancey and Lohrenz 2009). A list of all fish captured at South Fork Madison rotary screw trap in 2012 is listed in Table 9.

The observed reduction in young-of-the-year rainbow trout in the South Fork may be attributable to whirling disease (Clancey and Lohrenz 2012). Significant reduction in young-of-the-year rainbow trout survival can occur when infection grades are 3.0 or greater; with 99% mortality observed within 30 days in laboratory trials and 97% mortality observed within one year in the field (Vincent 2004; Sipher and Bergersen 2001).

Table 9. Summary of fish species captured at the South Fork Madison rotary screw trap, 2012.

	Number Captured	Mean Length (inches)
Brown trout yearlings	365	3.6
Brown trout Y-O-Y	417	NA
Rainbow trout yearlings	95	3.5
Rainbow trout Y-O-Y	223	NA
Brook trout yearlings	1	3.6
Sculpin	10	NA

Beach Seining

Beach seining has been conducted intermittently to monitor juvenile fish numbers in Hebgen Reservoir. Figure 43 illustrates total catch at three index sites for 2007, 2008, 2011 and 2012.

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 peak spawning of Utah chub in Hebgen occurred mid June to early July in shallow near-shore zones often with submergent or emergent

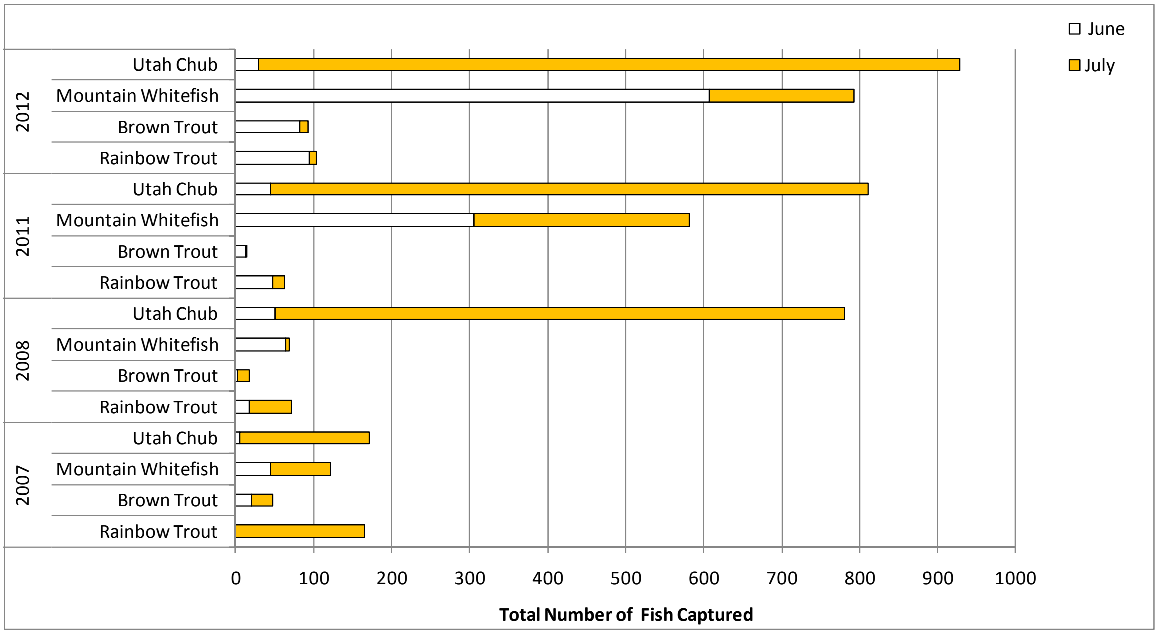


Figure 43. Beach seining catch of juvenile Hebgen Reservoir fish, June and July, 2008, 2009, 2011 and 2012.

vegetation and inundated terrestrial vegetation. The low number of young-of-the-year Utah chub observed in July 2007 and conversely the relatively high number observed in 2008 and 2011 may be related to reservoir elevation and how it affects the availability of spawning habitat utilized by Utah chub (Figure 44). Reservoir elevation decreased by 1.32 feet from June to July 2007. 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 F). Annual temporal trends in abundance show peak densities occurring in late spring and early summer (Figure 45).

Body size of both cladoceran and copepods increased as densities declined. This has been observed in zooplankton populations in several temperate lakes. 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 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 (Hall and Threlkeld 1976).

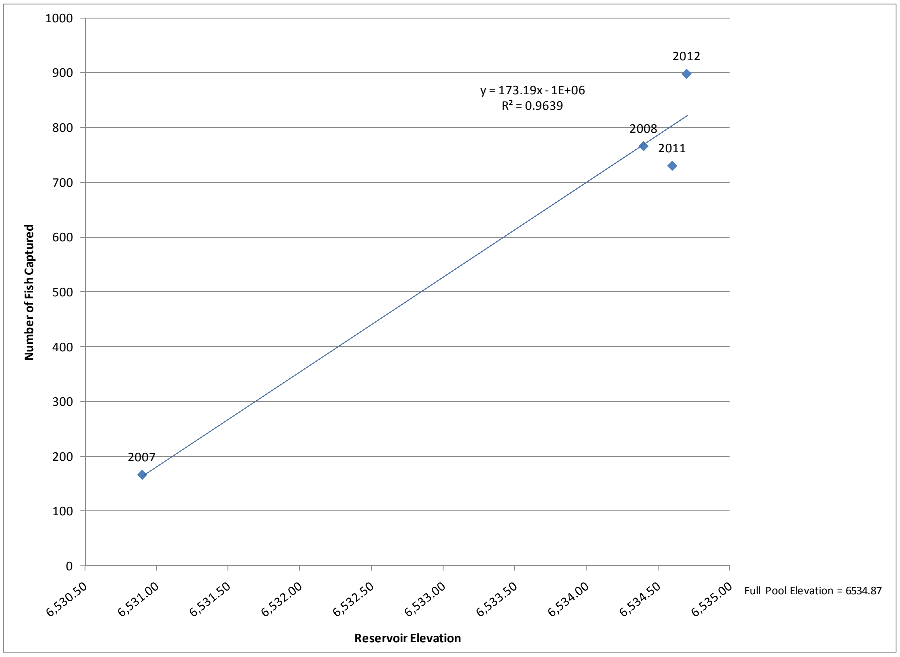
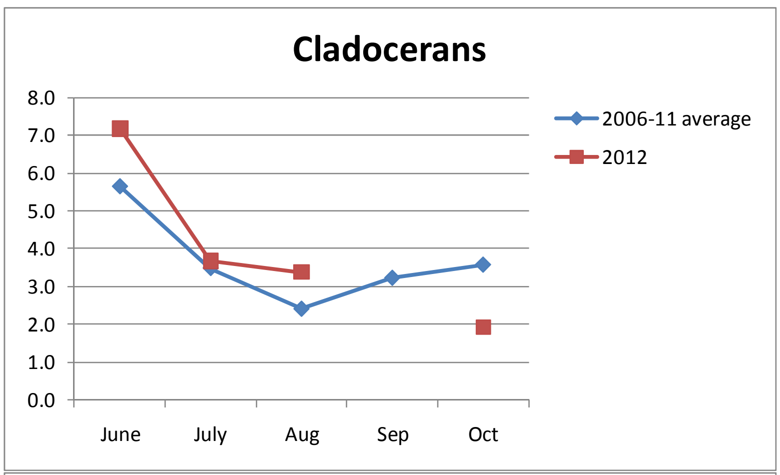


Figure 44. Number of young-of-the-year Utah chub collected during July seining of index sites versus reservoir elevation 2007, 2008, 2011 and 2012.



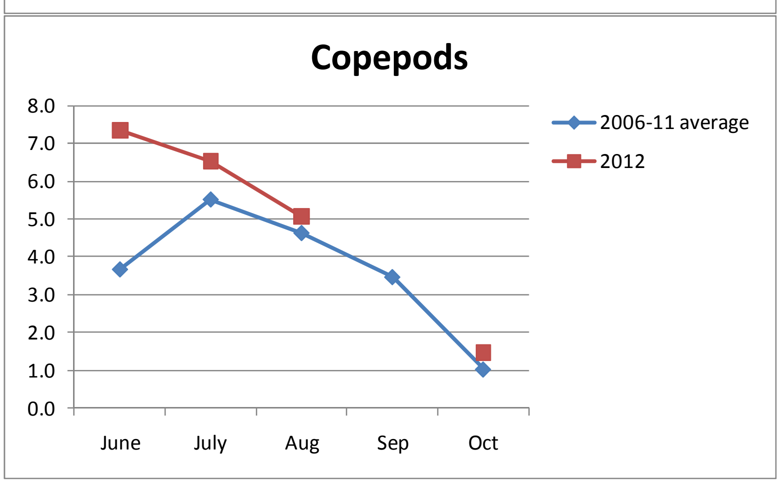


Figure 45. Figure comparing 2012 Hebgen Reservoir monthly cladoceran and copepod densities (individuals/liter) to the 2006 -11 monthly averages.

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 46) developed by Carlson (1977), Hebgen Reservoir is classified as oligotrophic-mesotrophic with mean TSI scores of 35.6, 35.8, 37.2 and 39.9 in 2009 – 2012, respectively. This may partially explain the low plankton densities observed in Hebgen. Figure 47 illustrates mean cladoceran and mean copepod densities versus mean TSI score for each of the seven monitoring sites for 2009-2012.

Primary productivity in Hebgen Reservoir may be limited by climate conditions. A high elevation short-duration growing season allows for relatively few days of primary production. Hebgen Reservoir, with a full pool elevation of 6,534.87 feet, may be more characteristic of an alpine lake than of lakes at lower elevations. Johnson and Martinez (2000) found lake elevation and a shortened growing season (the number of days water surface temperature is at or exceeds 50°F) to be inversely related to lake productivity. 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 48). 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.

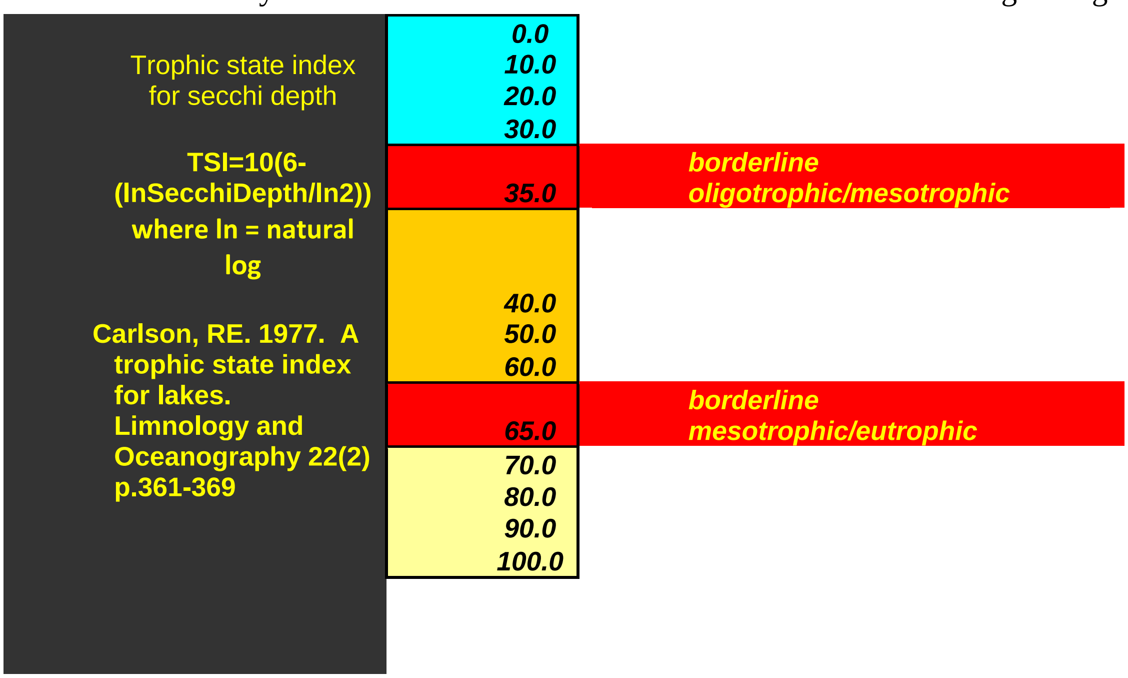


Figure 46. Figure depicting the trophic state index formula and classification for lake productivity using secchi depth measurements.

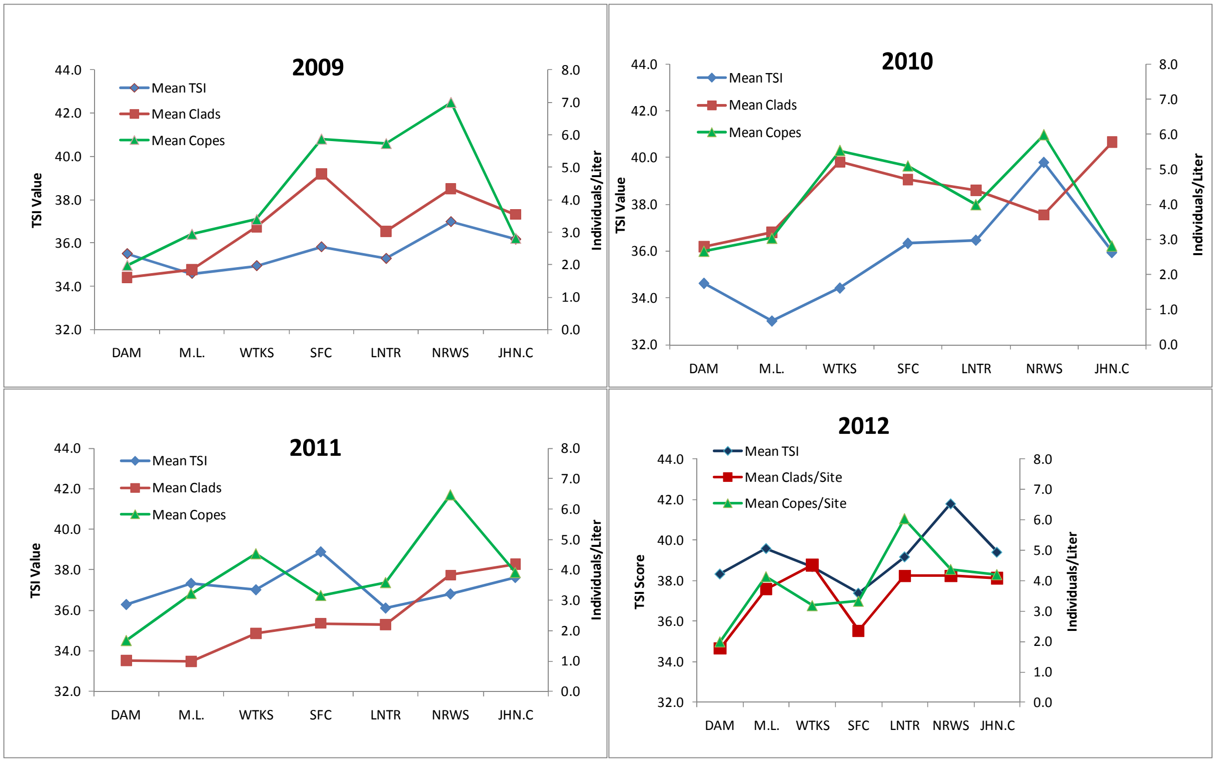
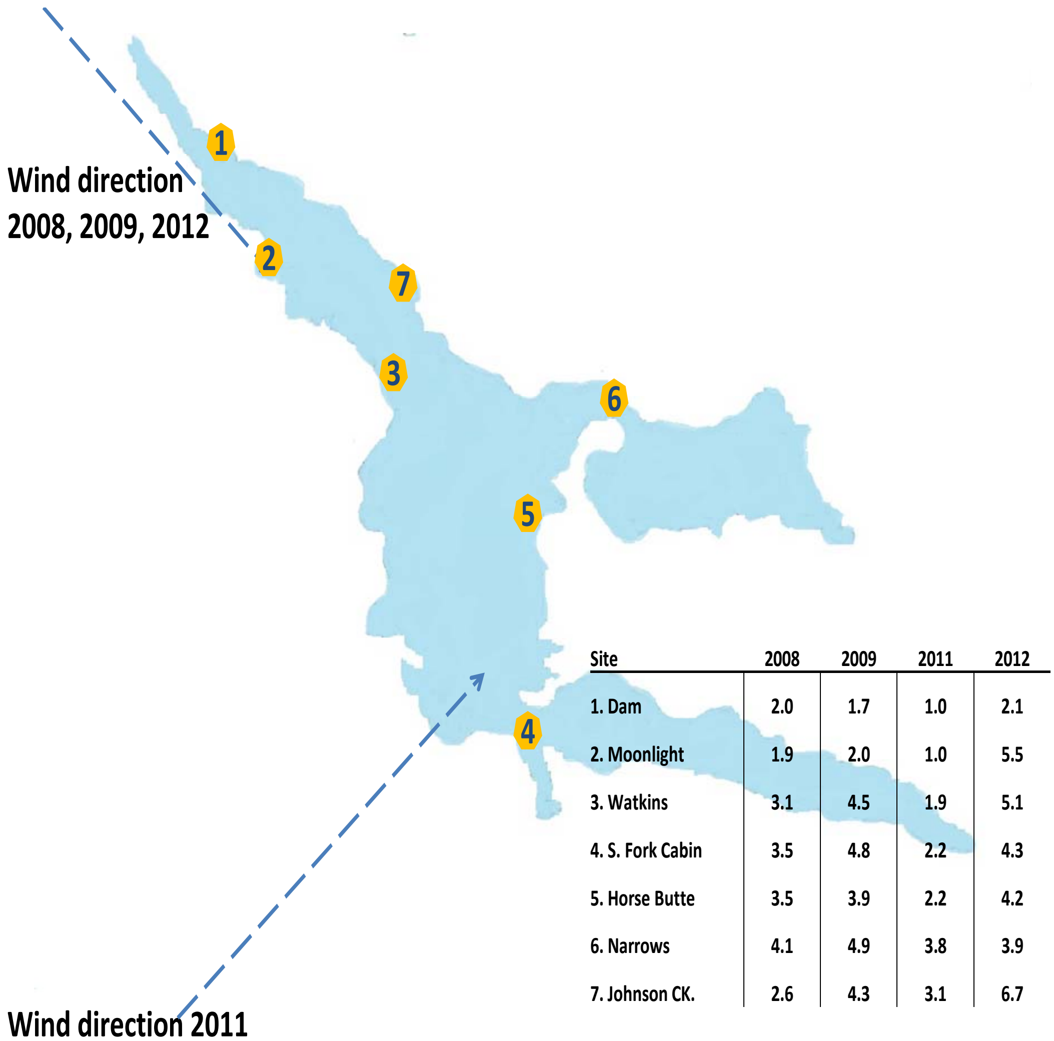


Figure 47. Hebgen Reservoir mean TSI score and mean densities of zooplankton by site, 2009 - 2012. Site names are Dam, Moonlight Bay, Watkins Creek, South Fork Cabin, Lone Tree (Horse Butte), Narrows, and Johnson Creek. Sites are listed in a counterclockwise fashion from the dam (Figure 17).



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

Figure 48. Prevailing wind direction and mean zooplankton densities per site for 2008, 2009, 2011 and 2012.

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 G) shows that wind patterns predominately occurred out of the southwest in 2011, 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), may be influenced by the frequency of wind events and wind speed (Figure 49). June experienced the greatest number of wind occurrences, had the highest average wind speed and the highest densities of zooplankton followed by July, and August respectively. The other three monitoring sites have some geographical feature that limits wind disturbance, and they exhibited the least amount of fluctuation in zooplankton densities over the summer and fall.

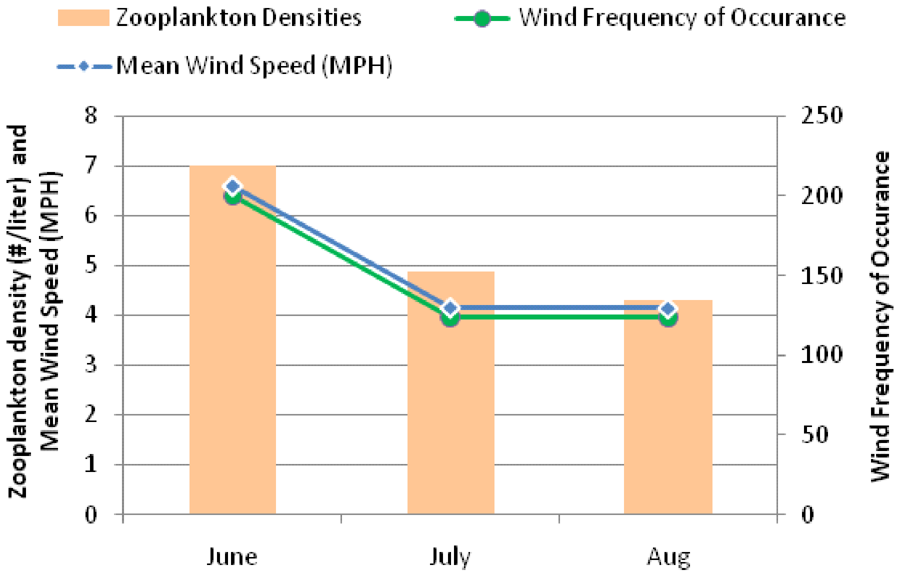


Figure 49. Chart showing mean wind speed in miles per hour (MPH), wind frequency of occurrence (number of occurrences/month) and mean zooplankton densities (number/liter) by month at the Dam, Watkins, Johnson and Horse Butte monitoring sites in the main body of Hebgen Reservoir.

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.

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 the fish response to habitat improvement projects on Jack, Watkins and the South Fork of Meadow Creek will continue into the future.

Aquatic Invasive Species monitoring will continue through the 2188 Biological and Biocontaminant monitoring program and through the FWP Aquatic Nuisance Species Program.

FWP has implemented a program and provided equipment to clean sampling gear to reduce the chance of moving ANS among waters.

In 2012, WCT from the Sun Ranch Brood provided fry for the Cherry Creek project and introduction back into the Sun Ranch Brood. Additionally, fertilized eggs from four wild donor populations were reared in the Sun Ranch Hatchery and introduced into two recipient streams as eyed eggs or fry.

Introductions of WCT continued in Phase 4 of Cherry Creek in 2012. WCT in Cherry Lake will be sampled for genetic diversity in 2013 to determine if additional stockings are necessary. If genetic diversity in Cherry Lake is found to be adequate, there will be no more WCT stocking in the Cherry Creek Drainage. Wide population spread monitoring was conducted throughout the project area in 2012 and is expected to continue for several more years.

The proportion of the Hebgen Reservoir rainbow trout gillnet catch larger than 14 inches has increased since 2003.

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.

LITERATURE CITED

Bramblett, R.G. 1998. Environmental Assessment. Madison River Drainage Westslope Cutthroat Trout Conservation and Restoration Program: Cherry Creek Native Fish Introduction. Prepared for Montana Fish, Wildlife, & Parks, April 15, 1998. 70 pages.

Byorth, P. and B. Shepard. 1990. Ennis Reservoir/Madison River Fisheries Investigations. Montana Fish, Wildlife, & Parks Final Report to Montana Power Company. 90 pages.

Carlson, R.E. 1977. A Trophic State Index for Lakes. Limnology and Oceanography 22(2): 361-369.

Clancey, P. 1995. Madison River/Ennis Reservoir Fisheries. 1994 Annual Report to Montana Power Company, Environmental Division, Butte, from Montana Fish, Wildlife, & Parks, Ennis. May 1995.

Clancey, P. 1996. Madison River/Ennis Reservoir Fisheries. 1995 Annual Report to Montana Power Company, Environmental Division, Butte, from Montana Fish, Wildlife, & Parks, Ennis. February 1996.

Clancey, P. 1997. Madison River/Ennis Reservoir Fisheries. 1996 Annual Report to Montana Power Company, Environmental Division, Butte, from Montana Fish, Wildlife, & Parks, Ennis. March 1997.

Clancey, P. 1998a. Madison River/Ennis Reservoir Fisheries. 1997 Annual Report to Montana Power Company, Environmental Division, Butte, from Montana Fish, Wildlife, & Parks, Ennis. June 1998.

Clancey, P. 1998b. Decision Notice: Cherry Creek Native Fish Introduction Project. Region 3, July 6, 1998. 30 pages.

Clancey, P. 1999. Madison River/Ennis Reservoir Fisheries and Madison River Drainage Westslope Cutthroat Trout Conservation and Restoration Program. 1998 Annual Report to Montana Power Company, Environmental Division, Butte, and Turner Enterprises, Inc., Gallatin Gateway, from Montana Fish, Wildlife, & Parks, Ennis. April 1999.

Clancey, P. 2000. Madison River/Ennis Reservoir Fisheries and Madison River Drainage Westslope Cutthroat Trout Conservation and Restoration Program. 1999 Annual Report to PPL Montana (formerly Montana Power Company), Environmental Division, Butte, and Turner Enterprises, Inc., Gallatin Gateway, from Montana Fish, Wildlife, & Parks, Ennis. April 2000.

Clancey, P. and D. Downing. 2001. Madison River/Ennis Reservoir Fisheries and Madison River Drainage Westslope Cutthroat Trout Conservation and Restoration Program. 2000 Annual Report to PPL Montana, Environmental Division, Butte, and Turner Enterprises, Inc., Bozeman, from Montana Fish, Wildlife, & Parks, Ennis. April 2001.

Clancey, P. 2002. Madison River/Ennis Reservoir Fisheries and Madison River Drainage Westslope Cutthroat Trout Conservation and Restoration Program. 2001 Annual Report to PPL Montana, Environmental Division, Butte, and Turner Enterprises, Inc., Bozeman, from Montana Fish, Wildlife, & Parks, Ennis. June 2002.

Clancey, P. 2003. Madison River/Ennis Reservoir Fisheries and Madison River Drainage Westslope Cutthroat Trout Conservation and Restoration Program. 2002 Annual Report to PPL Montana, Environmental Division, Butte, and Turner Enterprises, Inc., Bozeman, from Montana Fish, Wildlife, & Parks, Ennis. March 2003.

Clancey, P. 2004. Madison River/Ennis Reservoir Fisheries and Madison River Drainage Westslope Cutthroat Trout Conservation and Restoration Program. 2003 Annual Report to PPL Montana, Environmental Division, Butte, and Turner Enterprises, Inc., Bozeman, from Montana Fish, Wildlife, & Parks, Ennis. May 2004.

Clancey, P. and T. Lohrenz. 2005. Madison River/Ennis Reservoir Fisheries and Madison River Drainage Westslope Cutthroat Trout Conservation and Restoration Program. 2004 Annual Report to PPL Montana, Environmental Division, Butte, and Turner Enterprises, Inc., Bozeman, from Montana Fish, Wildlife, & Parks, Ennis. April 2005.

Clancey, P. 2006. Madison River/Ennis Reservoir Fisheries and Madison River Drainage Westslope Cutthroat Trout Conservation and Restoration Program. 2005 Annual Report to PPL Montana, Environmental Division, Butte, and Turner Enterprises, Inc., Bozeman, from Montana Fish, Wildlife, & Parks, Ennis. June 2006.

Clancey, P. 2007. Madison River/Ennis Reservoir Fisheries and Madison River Drainage Westslope Cutthroat Trout Conservation and Restoration Program. 2006 Annual Report to PPL Montana, Environmental Division, Butte, and Turner Enterprises, Inc., Bozeman, from Montana Fish, Wildlife, & Parks, Ennis. June 2007.

Clancey, P. 2008. Madison River/Ennis Reservoir Fisheries and Madison River Drainage Westslope Cutthroat Trout Conservation and Restoration Program. 2007 Annual Report to PPL Montana, Environmental Division, Butte, and Turner Enterprises, Inc., Bozeman, from Montana Fish, Wildlife, & Parks, Ennis. July 2008.

Clancey, P. and T. Lohrenz. 2009. Madison River/Ennis Reservoir Fisheries and Madison River Drainage Westslope Cutthroat Trout Conservation and Restoration Program. 2008 Annual Report to PPL Montana, Environmental Division, Butte, and Turner Enterprises, Inc., Bozeman, from Montana Fish, Wildlife, & Parks, Ennis. August 2009.

Clancey, P. and T. Lohrenz. 2010. Madison River/Ennis Reservoir Fisheries and Madison River Drainage Westslope Cutthroat Trout Conservation and Restoration Program. 2009 Annual Report to PPL Montana, Environmental Division, Butte, and Turner Enterprises, Inc., Bozeman, from Montana Fish, Wildlife, & Parks, Ennis. June 2010.

Clancey, P. and T. Lohrenz. 2011. Madison River/Ennis Reservoir Fisheries and Madison River Drainage Westslope Cutthroat Trout Conservation and Restoration Program. 2010 Annual Report to PPL Montana, Environmental Division, Butte, and Turner Enterprises, Inc., Bozeman, from Montana Fish, Wildlife, & Parks, Ennis. May 2011.

Clancey, P. and T. Lohrenz. 2012. Madison River/Ennis Reservoir Fisheries and Madison River Drainage Westslope Cutthroat Trout Conservation and Restoration Program. 2010 Annual Report to PPL Montana, Environmental Division, Butte, and Turner Enterprises, Inc., Bozeman, from Montana Fish, Wildlife, & Parks, Ennis. May 2012.

Clancey, P. 2012. Environmental Assessment for the Reintroduction of Native Westslope Cutthroat Trout in Ruby Creek by Removal of Non-native Rainbow Trout with Electrofishing and Rotenone, 43 pages. Montana Fish, Wildlife, & Parks, Ennis. May 2012.

Elwood J.W. and T.F. Waters. 1969. Effects of floods on food consumption and production rates of a stream brook trout population. Trans. Am. Fish. Soc. 2**:** 253-262.

Federal Energy Regulatory Commission. 2000. Order Issuing New License, Project No. 2188-030. Issued September 27, 2000.

Flebbe, P. A., and C. A. Dolloff. 1995. Trout use of woody debris and habitat in Appalachian wilderness streams of North Carolina. North American Journal of Fisheries Management 15:579–590.

Graham, R.J. 1955. Biology of the Utah chub in Hebgen Lake, Montana. Master's thesis. Montana State University.

Hall, D.J. and S.T. Threlkeld. 1976. The size –efficiency hypothesis and the size structure of zooplankton communities. Annual Review of Ecological Systems. 7:177-208. www.annualreviews.org/aronline.

Johnson, B. and P. Martinez. 2000. Trophic economics of lake trout management in reservoirs of differing productivity. North American Journal of Fisheries Management. 20: 127-143.

Johnson, J. 1988. Environmental assessment of plans to restore Strawberry Reservoir fishery. Utah Division of Wildlife Resources No 87-14. Salt Lake City, Utah.

Montana Fish, Wildlife, & Parks. 1999. Memorandum of Understanding and Conservation Agreement for Westslope Cutthroat Trout in Montana. May 1999.

Montana Fish, Wildlife, & Parks. 2004. FA+. Montana Fish, Wildlife, & Parks, Information Services Unit, Bozeman.

Montana Fish, Wildlife, & Parks. 2007. Memorandum of Understanding and Conservation Agreement for Westslope Cutthroat Trout and Yellowstone Cutthroat Trout in Montana. July 2007.

O'Connor, J. F, and G. Power. 1976. Production by brook trout *(Salvelinus fontinalis)* in four streams in the Matamek watershed, Quebec. Journal of the Fisheries Research Board of Canada 33:6-18.

Pimentel, D., R. Zuniga, and D. Morrison. 2005. Update on the environmental and economic costs associated with alien-species in the United States. Ecological Economics, 2005 (Vol. 52) (No. 3) 273-288.

Saunders, J. W., and M. W. Smith. 1965. Changes in a stream population of trout associated with increased silt. Journal of the Fisheries Research Board of Canada 22:395–404.

Sestrich, C. and T. Lohrenz. 2006. Hebgen Basin Interagency Fisheries Working Group 2005 Accomplishment Report to PPL Montana. July 2006. 69 pages.

Shepard, B.B. 2004. Factors that may be influencing nonnative brook trout invasion and their displacement of native westslope cutthroat trout in three adjacent southwestern Montana streams. North American Journal of Fisheries Management 24: 1088-1100.

Sipher, C. R. and E. P. Bergersen. 2001. The effects of whirling disease on growth and survival of Snake River cutthroat and Colorado River rainbow trout fingerlings. 7th Annual Whirling Diseases Symposium abstracts. Whirling Disease Foundation, Bozeman MT, and Utah Division of Wildlife Resources, Logan, UT.

Sloat, M.R., B.B. Shepard, and P. Clancey. 2000. Survey of tributaries to the Madison River from Hebgen Dam to Ennis, Montana with an emphasis on distribution and status of westslope cutthroat trout. Report to Montana Fish, Wildlife, & Parks, Helena, Montana. 165 pages.

Teuscher D. and C. Luecke. 1996. Competition between kokanees and Utah chub in Flaming Gorge Reservoir, Utah-Wyoming. Transactions of the American Fisheries Society. 125:505-511.

Vincent, R.E. 2004. Personal Communiction.

Appendix A

The Montana Aquatic Nuisance Species Management Plan was finalized in October of 2002 and a full time Aquatic Nuisance Species (ANS) Program Coordinator was hired by Montana Fish, Wildlife and Parks in February of 2004. The emphasis of the Montana ANS Program is on coordination, education, control and prevention of spread, monitoring and detection, and rapid response. The species of emphasis are New Zealand mud snails, whirling disease, and Eurasian milfoil (all of which are established in Montana), and zebra mussels (which 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 ANS have been since added to the prohibited list: snakehead fish (29 species), grass carp, silver carp, black carp, bighead carp, zebra mussels, rusty crayfish, nutria, African clawed frogs, North American bullfrogs, and New Zealand mud snails. Legislation was also passed during the 2005 session to provide exceptions for the possession of prohibited species, primarily for the purposes of research, in addition to providing for tougher enforcement authority including the ability to confiscate illegally possessed exotic wildlife.

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 ANS 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 ANS, and a half day training was provided on ANS 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 ANS have been made to several special interest groups including Walleyes Unlimited, Fishing Outfitters Association of Montana and Lake Associations. ANS 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 ANS introductions into Montana waters. An aggressive public outreach campaign was launched during summer of 2005 with an increase in law enforcement to discourage the activity of “bucket biology”.

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:

INSPECT.
CLEAN.
DRY.

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 Agriculture

Montana Fish, Wildlife & Parks

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

STOP AQUATIC HITCHHIKERS!

Appendix B

Monitoring Reports

Gallatin National Forest Hebgen Ranger District: Watkins Creek 2011

Gallatin and Beaverhead-Deerlodge NF Seasonal Technician Funding, 2011 (omitted from Clancey & Lohrenz 2012)

2012: 1) Gallatin NF Seasonal Technician Funding; 2) Beaver Creek Barrier Investigation; and, 3) Cabin Creek Barrier Investigation

Beaverhead-Deerlodge NF Seasonal Technician Funding 2012

Project Title: **Watkins Creek Large Woody Debris Placement (December 2008 Proposal, September 2010 Implementation)**

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

408-3 Fish habitat enhancement both in main stem and tributary streams, including enhancement for all life stages of fishes.

Report by: **Bruce Roberts**

Location of Proposed Project: **Watkins Creek**

INTRODUCTION

Watkins Creek is presently a lightly used spawning tributary to Hebgen Lake for various reasons including: low late-season stream flows, partial barrier culvert across FS Road # 167 (East Denny Creek Road), and high sediment levels (Watschke, 2006). The Forest Service is in the process of replacing the existing culvert along the East Denny Creek Road with a bridge. Montana Trout Unlimited has discussed leasing water rights options along lower Watkins Creek to improve late-season stream flows. Together, it is anticipated that Watkins Creek will soon harbor a larger adfluvial run of spawning rainbow and brown trout.

Approximately two miles upstream of Hebgen Lake is a quarter mile reach of stream mostly devoid of instream Large Woody Debris (LWD) (Pictures 1, 2, and 3). Very few high quality pools exist within this reach; streambed is dominated by larger non-suitable spawning substrate; and, unvegetated stream banks beneath this dense stand are eroding. This healthy dense stand of spruce shows little sign of increased naturally occurring LWD recruitment in the near future. The Forest Service proposed to drop 40-50 spruce trees into Watkins Creek at 15-20 sites to meet intended objectives. The primary objective was to increase recruitment of wild juvenile trout both in Watkins Creek and Hebgen Lake by sorting and trapping spawning gravels. Secondary objectives were to increase: 1) trapping of fine sediments; 2) creation of high quality scour and dammed pools; and, 3) sunlight penetration to the valley floor increasing herbaceous and deciduous vegetation plants.

Funding for this project was approved at the December 2008 MADTAC meeting. Issues that arose as a result of the project being planned within the Lionshead Inventoried Roadless Area (IRA) caused the project to be delayed by one field season.

METHODS

A Forest Service saw crew directionally fell approximately 60 spruce and lodgepole trees (primarily spruce) along the main channel and adjacent high water side channel to artificially increase LWD recruitment. It was attempted to space these LWD jams every 7 to10 bankful widths. The project was implemented on September 29, 2010. The project was laid out by Scott Barndt (Gallatin National Forest fish program manager), Bruce Roberts (Gallatin National Forest west zone fisheries biologist), and Jim Hanson (Gallatin National Forest fire engine foreman and lead chain saw trainer/certifier). The two project biologists picked the sites and chain saw operator helped identify which trees he could safely drop to meet project objectives. The intent was to mimic naturally occurring LWD jams located immediately upstream. Two or three smaller trees were identified to be dropped first at a specific location followed by a much larger tree that would pin down or anchor everything together. Trees were cut far enough away from the highwater mark to maintain channel stability and to insure cut logs were adequately entangled with standing trees to prevent downstream movement of downed LWD.

Trees were not jockeyed around into position using come-a-longs, pulleys, or other mechanical devices; where they landed is where they stayed.

To monitor project success, Montana Fish, Wildlife and Parks conducted a pre-population survey during the summer of 2010. The Forest Service measured habitat attributes such as residual pool depth along the thalweg and estimated the amount of spawning substrate immediately upstream and/or downstream of each structure or LWD jam. Measuring residual pool depth would determine how much scouring actually took place associated with each structure. Spawning substrate estimates would determine how spawning substrate was sorted and trapped. These data will be remeasured post-project to evaluate the effectiveness of the treatment after a couple highwater events. Maximum depth (m) and tail crest depth (m) measurements used to calculate residual pool depth were measured along the thalweg in areas where the crew felt these depths would occur after subsequent highwater events.

RESULTS

A total of 19 LWD jams were created using 60 trees ranging in size from 6” to 24” diameter breast height Seventeen LWD jams were created along the main-channel of Watkins Creek (Pictures 4 and 5) and two along a high water side-channel adjacent to Watkins Creek. Only four of the seventeen main-channel sites had existing spawning substrate within the area either immediately upstream and/or downstream. One of the four sites with existing spawning substrate was an existing LWD jam that we added additional pieces to so the scour and gravel sorting and trapping had previously occurred.

Table 1. Habitat attributes measured at 17 main channel sites previous to any high water events.

Treatment No.	Treatment Location	Maximum Depth (m)	Tail Crest Depth (m)	Residual Pool Depth (m)	Spawning Substrate (m^2)	
					Above	Below
1 (top)	Main	0.45/[a]	0.23	0.22	0.0	4.0
2	Main	0.25	0.25	0.00	0.0	0.0
3	Main	0.25	0.20	0.05	0.0	0.0
4	Main	0.26	0.25	0.01	0.0	0.0
5	Side					
6	Main	0.35	0.20	0.15	0.0	0.0
7	Side					
8	Main	0.40	0.28	0.12	36.5	0.0
9	Main	0.31	0.23	0.08	0.0	0.0
10	Main	0.26	0.20	0.06	0.0	9.0
11	Main	0.23	0.24	-0.01	0.0	0.0
12	Main	0.21	0.25	-0.04	0.0	0.0
13	Main	0.20	0.21	-0.01	0.0	0.0
14	Main	0.19	0.16	0.03	0.0	0.0
15	Main	0.25	0.15	0.10	5.0	1.5
16	Main	0.30	0.31	-0.01	0.0	0.0
17	Main	0.26	0.24	0.02	0.0	0.0
18	Main	0.30	0.25	0.05	0.0	0.0
19 (bottom)	Main	0.14	0.15	-0.01	0.0	0.0

/[a] = Treatment Site 1 was an existing LWD jam that was augmented with additional LWD pieces, so scouring and substrate accumulation had previously occurred.

Pictures 1 and 2 – Pre-LWD recruitment condition along the proposed treatment reach of Watkins Creek.

Pictures 3 and 4 – Pre- and Post-treatment looking upstream at Site 18 along Watkins Creek.

Picture 5 – Post-treatment looking upstream at Site 19 along Watkins Creek.

Project Title: **Gallatin and Beaverhead-Deerlodge NF Seasonal Technician Funding (Dec. 2010 Proposal)**

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

FERC Article	Item	Report Topic	Project	Page Number
408	**(1)**	**Hebgen Lake gillnetting**		**1**
	(7)	**Enhance upper river tributary spawning**	**Watkins Cr LWD Placement**	**1**
409	**(3)**	**Fish habitat enhancement**	**Watkins Cr LWD Placement**	**1**
412	**(5)**	**Species of Special Concern – Westslope Cutthroat Trout**	**S Fk Madison R**	**3**
			Beaver and Rose Creeks	**5**
			Gravel Pit Pond	**6**
Unknown			**Kid's Fishing Derby**	**7**

Report by: **Bruce Roberts**

Location of Proposed Project: **Hebgen Basin**

The Madison River Fisheries Technical Advisory Committee provided $5,000 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 32 ten-hour days working on Hebgen Basin projects listed above. This 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 up and down the Madison River.

Hebgen Lake Annual Gillnetting Survey

The Gallatin National Forest fisheries crew assisted MFWP crews with their annual spring gillnet sampling of Hebgen Lake. Data and results of this project will be presented to the Madison River Fisheries Technical Advisory Committee in MFWP 2011 annual report.

Watkins Creek Large Woody Debris Placement Monitoring

The Gallatin National Forest received funding in December 2008 from the Madison River Fisheries Technical Advisory Committee to place large woody debris (LWD) along a 0.25 mile reach of Watkins Creek to improve both rearing and spawning habitat for resident and adfluvial Hebgen Lake trout. The project was not implemented until September 2010. The Gallatin National Forest fisheries crew was used to determine if the goals of the project were achieved. Post-project monitoring will continue for three to five more years.

Residual pool depth and spawning habitat abundance were the habitat attributes selected to be monitored. Residual pool depth is equal to the maximum pool depth of a scour pool minus the pool tail crest depth. Residual pool depth can also be described as the depth of a stagnant pool if a stream stops flowing. Measurements to calculate residual pool depth can be taken independent of discharge. In 2010 just after project implementation, the Gallatin National Forest fisheries crew took depth measurements associated with each

LWD structure where they thought the maximum pool depth and pool tail crest depth would develop the following year after a high water. The crew measured the deepest area of the stream channel directly under each LWD cluster and deepest area of the stream channel downstream of each structure where they thought the pool tail crest depth would form. The differences between these two measurements are displayed in the attached graph as maroon colored bars (pre-) (Figure 1). The post-runoff residual pool depths are displayed as blue colored bars (post-). The difference between the pre- and post- residual pool depths is what was scoured out during high flow.

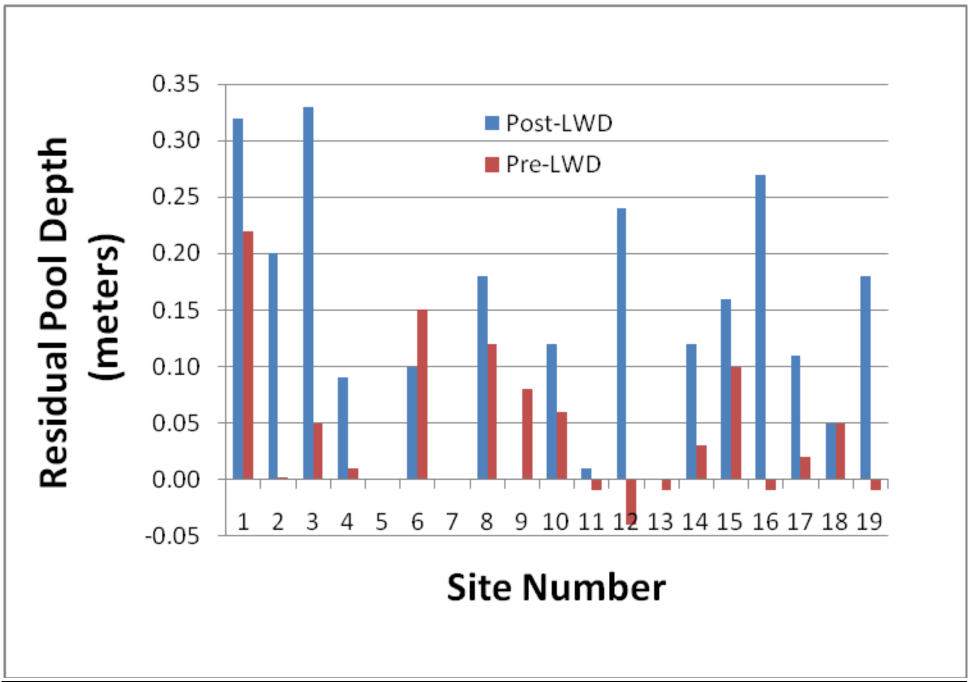


Figure 1. Residual pool depth (m) associated with seventeen LWD structures placed along the mainstream of Watkins Creek during the fall of 2010. The difference between the pre- (red) and post- (blue) bars is the amount of under scour associated with each structure that occurred after one high water event. Sites 5 and 7 were structures that were placed along a dry side channel and were not monitored.

Sample of one of the 17 LWD structures during spring runoff placed along Watkins Creek.

The following notes were made after one spring run-off event:

- No downstream movement of any of the placed LWD pieces or clusters was observed.

- Two of the 19 LWD structures displayed in the graph are located in a dry high water side channel. No pre- and post- measurements were collected at these two sites (Site Numbers 5 and 7).

- Substantial scour (> 0.10 m) occurred immediately underneath eight of the 17 main channel LWD structures.

- Ten of the 17 main channel structures exhibited upstream pooling (or damming of water) with maximum depths ranging between 0.27 to 0.90 meters.

- Dammed pools acted as tremendous sediment traps causing sediment to be deposited within the stream channel as well as across the floodplain creating new banks.

- Two of the 17 main channel structures showed no discernable sign of under scouring (Site Number 9 and 13). This was most likely was a result of the structures being placed too close together. Pooled or dammed water from the downstream structure inundated upstream structures causing reduced water velocity and scour. Residual pool depth measurements were not collected at those two sites.

- With the exception of one site, all observed scouring was associated with the channel bed whether than adjacent streambanks. The one short reach of scoured streambank was associated with one of the two sites located along the dry high water side channel.

- Three of the 17 main channel structures straddled the streambanks resulting in little scouring or damming action (Site Numbers 6, 11, and 18).

- There was a 21 m^2 reduction (56 m^2 to 35 m^2) in the amount of spawning substrate associated with the 17 main channel structures. The majority of the reduction occurred at one site where existing spawning substrate was covered by fine sediment deposition. New pockets of spawning substrate tended to be small and associated with the newly formed pool tails.

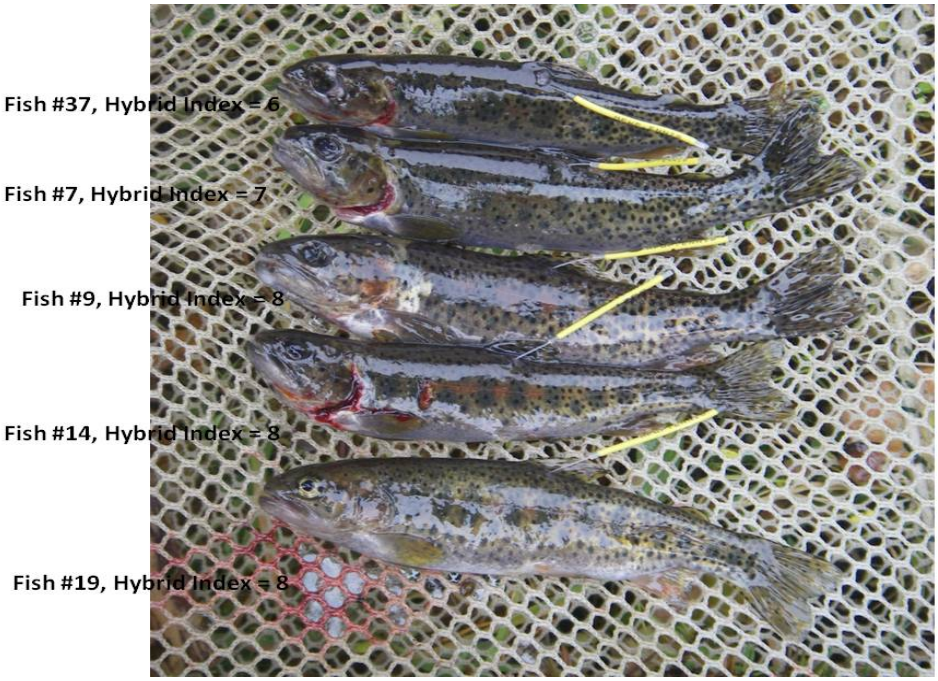
South Fork Madison River Westslope Cutthroat Trout Restoration

The headwater of the South Fork of Madison River is inhabited by an isolated population of slightly hybridized westslope cutthroat trout. Each year, approximately six to seven miles of the South Fork naturally dewaters which provides some level of protection to this population from downstream non-natives. It is not known how or when but non-native rainbow trout occasionally invade this headwater population. This occurred again sometime between 2007 and 2009.

Madison River Fisheries Technical Advisory Committee funded the construction of a downstream barrier to prevent non-native invasion. A four foot high step was blasted into a bedrock shelf in 2008 just above Mosquito Gulch. The effectiveness of this barrier is presently being monitored. It is not known if the recent invasion occurred before or after the construction of this barrier.

Montana Fish, Wildlife and Parks and the Gallatin National Forest fisheries crews embarked on a project to remove significantly hybridized westslope cutthroat trout scattered throughout this population. MFWP fish geneticists, Robb Leary, determined that if the genetic makeup of this population did not substantially change between 2009 and August 2011 that we would still be able to place tested individuals into one of three genetic classes of westslope cutthroat trout (WCT) hybrids: 1) WCT that were > 97% genetically pure (the original fish); 2) fish that were primarily rainbow trout; and, 3) intermediate fish or F1 hybrids. In August 2011, crews took 50 tissue samples from this population. It was determined that the genetic makeup of the population had not changed between 2009 and 2011.

September 2011, crews electrofished approximately 1.5 miles of occupied habitat. Tissue samples were taken from all collected fish. All fish were uniquely tagged with either a Floy tag or VI Tag and held in live cages. Tissue samples were rushed to the University of Montana Salmon and Trout Genetics lab for testing. Between the August 2011 and September 2011 samples, nearly 300 individuals were genetically tested. Twenty hybrids with a hybrid index of five or greater were removed from the population. 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. See attached photos below of removed hybridized westslope cutthroat trout. Funding for the seasonal employee salary, purchase of tags, and genetic testing at the University of Montana were provided by the Madison River Fisheries Technical Advisory Committee.



A sample of hybridized westslope cutthroat trout (along with their assigned Hybrid Index) that were removed from the headwaters of the South Fork of Madison River in September 2011.

<u>Beaver Creek and Rose Creek Westslope Cutthroat Trout Drainage-wide Inventory</u>

Slightly hybridized westslope cutthroat trout were first discovered in Rose Creek in 2005, a tributary to upper Beaver Creek. Beaver Creek is a tributary to the Madison River located between Hebgen Dam and Earthquake Lake. These fish were determined to be 97% westslope cutthroat trout hybridized with rainbow trout. The Gallatin National Forest fisheries crew re-surveyed the Rose Creek drainage in 2011 along the upper reaches

Beaver Creek to determine current genetic makeup and distribution. Genetic tissue samples were collected and submitted to the University of Montana Salmon and Trout genetics lab for analysis. Based on visually external characteristics, the crew believes the genetic makeup of westslope cutthroat trout in these two streams is predominately that of westslope cutthroat trout. They felt there were no barriers separating fish between upper Beaver Creek and Rose Creek. The crew spent time looking downstream of the confluence of Rose Creek looking for potential barriers which would impede the upstream migration of rainbow trout. Two such partial barriers were identified approximately 0.5 miles below the confluence of Rose Creek. See attached picture below. If the pending genetic results from both Rose Creek and upper Beaver Creek show similar genetic purities, it would be proposed that one of the two bedrock shelves be modified with explosives to create a four to five foot high jump that would act as a complete barrier.

One of two bedrock shelves located along upper Beaver Creek that are thought to be partially responsible for preventing the invasion of rainbow trout in to upper Beaver Creek and Rose Creek.

Gravel Pit Pond Oxygen and Depth Profile Surveys

The Sun Ranch westslope cutthroat trout hatchery program is an extremely valuable resource assisting fisheries biologists (MFWP, Park Service, private, etc.) to restore westslope cutthroat trout throughout the upper Missouri River drainage. The brood stock at this facility is made up of several upper Missouri River drainage populations. The Sun Ranch pond is currently the only location where upper Missouri River brood stock is being held. The need to spread this brood stock has been discussed at several westslope cutthroat trout conservation meetings. The Hebgen Lake Ranger District has offered up the recently closed Gravel Pit Pond located near Hebgen Lake to meet this need. Joint fisheries crews from Montana Fish, Wildlife and Parks and the Gallatin National Forest are in the process of assessing the suitability of this pond. A bathometric map was created of this 7-acre pond with the maximum depth of 17 feet at full pool elevation. Oxygen and water temperature measurements were collected in early September. Oxygen and water temperature measurements will be assessed in February during peak snow pack.

Montana Fish, Wildlife and Parks and Gallatin National Forest fisheries crews working together to assess oxygen and water temperature conditions in the Gravel Pit Pond located near the intersection of Highways 287 and 191.

West Yellowstone Kid's Fishing Derby

Montana Fish, Wildlife and Parks, Gallatin National Forest, PPL-Montana, and local angling stores sponsor the West Yellowstone kid's fishing derby each June. The derby is held at Koelzer Pond located eight miles north of West Yellowstone, Montana. Adjacent private land owners allow eligible kids to fish both Koelzer Pond and Duck Creek one day a year. Although the fishing was slow and the number of anglers was down in 2011, everyone enjoyed the beautiful weather and barbequed hot dogs. Funds from the Madison River Fisheries Technical Advisory Committee helped fund seasonal employees who gathered prizes, prepared equipment, and help young anglers.

A proud grandpa and his six year old grandson fishing Duck Creek just below Koelzer Pond.

Project Title: 1) **Gallatin NF Seasonal Technician Funding; 2) Beaver Creek Barrier Investigation; and, 3) Cabin Creek Barrier Investigation.**

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**
412	**(5)**	**Species of Special Concern – Westslope Cutthroat Trout**	**Little Tepee Creek**	**1**
			Wally McClure Creek	**1**
			South Fork Madison River	**2**
			Beaver Creek	**2**
			Ruby Creek	**3**
			Beaver Creek	**3**
			Cabin creek	**3**

Report by: **Bruce Roberts**

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

The Madison River Fisheries Technical Advisory Committee (TAC) provided $5,038 ($10,076 including the Beaverhead-Deerlodge National Forest) 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 28 ten-hour days working on Hebgen Basin and upper Madison River fisheries projects. This 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 up and down the Madison River. Not all projects that were originally coordinated and agreed upon were implemented because of ever changing schedules and higher priorities: Tepee Creek population estimates, Watkins Creek LWD monitoring, Hebgen Lake gillnetting and Kid's Fishing Day.

Annual Water and Air Temperature Monitoring

The Gallatin National Forest fisheries and hydrology programs have four additional long-term water temperature monitoring sites located in Hebgen Basin which are not monitored by PPL-MT or MFWP (Red Canyon Creek, Cabin Creek, Watkins Creek and South Fork Madison River). In conjunction with all four sites, air temperature is also being monitored. These data sets are presently being storing at the Gallatin National Forest, Supervisor's Office and are available upon request.

Little Tepee Creek Westslope Cutthroat Trout Population Monitoring

Genetically pure westslope cutthroat trout (WCT) from Last Chance Creek within Yellowstone National Park and Wally McClure Creek were introduced into upper Little Tepee Creek in 2010 and 2011. In 2010, fertilized eggs from these two streams were introduced using streamside incubators (RSI's). In 2011, adult and juvenile WCT that fell downstream of the Wally McClure Creek fish barrier were individually genetically tested and moved to Little Tepee Creek. Fisheries crews from MFWP and GNF surveyed a large portion of upper Little Tepee Creek to document success of these introductions. No age-1 fish from the 2010 introduction were collected. Nine adults from the 2011 introduction were collected. The sampling occurred too early to document spawning success from the adults that were introduced in 2011. Nine additional adults from Wally McClure Creek were introduced in to Little Tepee Creek in 2012.

Wally McClure Creek Adult Westslope Cutthroat Trout Collection

Ever since the fish barrier was constructed along lower Wally McClure Creek, a small number of adult and juvenile westslope cutthroat trout move downstream each year and cannot get back upstream. This was expected when this barrier was constructed. Each year, these fish are collected and individually genetically tested and moved to Little Tepee Creek, if determined to be pure. In 2012, fisheries crews from MFWP and GNF collected and tested 16 WCT. All were determined to be genetically pure. Seven of the 16 were dead upon the crew returning, and the remaining nine were transferred to Little Tepee Creek.

South Fork Madison River Westslope Cutthroat Trout Restoration

The headwater of the South Fork of Madison River is inhabited by an isolated population of slightly hybridized westslope cutthroat trout. Each year, approximately six to seven miles of the South Fork naturally dewaters which provides some level of protection to this population from downstream non-natives. It is not known how or when but non-native rainbow trout occasionally invade this headwater population. This occurred again sometime between 2007 and 2009.

Madison River Fisheries TAC funded the construction of a downstream barrier to prevent non-native invasion. A four foot high step was blasted into a bedrock shelf in 2008 just above Mosquito Gulch. The effectiveness of this barrier is presently being monitored. It is not known if the recent invasion occurred before or after the construction of this barrier.

MFWP and GNF fisheries crews embarked on a project in 2011 to remove significantly hybridized westslope cutthroat trout scattered throughout this population. MFWP fish geneticists, Robb Leary, determined that if the genetic makeup of this population did not substantially change between 2009 and August 2011 that we would be able to categorize tested individuals into one of three genetic classes of westslope cutthroat trout (WCT) hybrids: 1) WCT that were > 97% genetically pure (the original fish); 2) fish that were primarily rainbow trout; and, 3) intermediate fish or F1 hybrids. In August 2011, crews took 50 tissue samples from this population. It was determined that the genetic makeup of the population had not changed between 2009 and 2011.

In September 2012, fishery crews electrofished the same 1.5 miles of occupied habitat for the second year in a row. Fish that retained their Floy tag from 2011 removal treatment or fish that were obviously clipped in 2011 were not re-sampled in 2011. Tissue samples were taken from all previously non-clipped or non-tagged WCT or WCT x RBT hybrids. All new fish were uniquely tagged with a Floy tangle disc and held in live cages for eight to ten days. Tissue samples were rushed to the University of Montana Salmon and Trout Genetics lab for analysis. In 2012, 83 additional WCT or WCT x RBT hybrids were genetically tested. Twenty-four were determined to be significantly hybridized and were slated to be removed. One of these 24 escaped the live cage before being removed from the population. A second escaped the hands of the individual that was culling these hybrids. It is assumed both these fish still obtain their uniquely numbered tag and will be looked for in 2013 if the treatment is repeated.

During both the 2011 and 2012 hybrid removal treatments, no young-of-the-year (YOY, normally 30-40 mm) and no age-1 (normally 80-110 mm) fish have been collected. A thermograph was placed along this upper reach of the South Fork Madison River to determine if temperature is playing a role in why we are not seeing any YOY or age-1 WCT. The smallest fish that have been collected to date are slightly larger than 120 mm.

This makes one wonder if we are missing some piece of spawning and rearing habitat elsewhere in the drainage. GNF fisheries crew spent three days conducting walk through and electrofishing surveys throughout the upper drainage including Black Bear Canyon and Dry Canyon. What they found was that most stream channels in the upper South Fork drainage were dry with the exception of one. This one was later electrofished and determined to also be fishless.

Beaver Creek Fish Population Survey

Pat Clancey (MFWP) and Bruce Roberts (GNF) have been exploring the option of blasting an upstream fish migration barrier along Beaver Creek downstream of Rose Creek to protect the existing headwater population of slightly hybridized westslope cutthroat trout. To adequately design the barrier to ensure no upstream passage, one first needs to know the size the fish would be trying to negotiate the barrier. GNF fisheries crew electrofished Beaver Creek downstream of two bedrock shelves that could potentially be made into a permanent barrier. The largest fish collected downstream of these two sites was 266 mm (or 10.5 inches). Two redds from the previous spring were also observed downstream of the lower bedrock shelf. These redds were assumed to have been constructed by much larger fish than were collected later in the summer. It is assumed that these redds were constructed by larger Beaver Creek, Madison River or Quake Lake fish.

Ruby Creek Westslope Cutthroat Trout Restoration

Ruby Creek is a tributary to Madison River draining the eastside of the Gravelly Mountains south of Ennis, Montana. MFWP proposed to remove non-native trout from this drainage in order to re-stock with genetically pure westslope cutthroat trout. The results of this project will be reported by Pat Clancey and Travis Lohrenz (MFWP) in their annual report to the Madison River Fisheries TAC. The GNF fisheries crew assisted both Pat and Travis (MFWP) and Darin Watschke (Beaverhead-Deerlodge National Forest) with the salvage of over 2,000 rainbow trout from the drainage in August 2012. They were both laid off in December 2012 before Ruby Creek was treated with rotenone.

Beaver Creek Barrier Investigation

A 2011, two bedrock shelves were identified along Beaver Creek which could be blasted to create an upstream migration barrier to trout. The Madison River Fisheries TAC hired a private blasting expert for one day to review both sites to determine if it was both possible and feasible to create a barrier at either site by blasting. Christopher Hyle of Orica Mountain West, Butte, Montana, toured both sites on September 26, 2012. Christopher Hyle was hired by PPL-MT in the past to blast the South Fork Madison River barrier. He felt that a barrier could be created at both sites but the lower of the two would be the easiest and least expensive. He also determined that the fractured nature of the bedrock would pose no problems during blasting. The upper site is located entirely outside the boundary of the Lee Metcalf Wilderness (Taylor Hilgard Unit). The wilderness boundary is the center of the stream at the lower site so half the barrier would be located inside the wilderness boundary and half would be located outside. This will require much more coordination which our wilderness community if we decide to move forward at this location. The genetics of the westslope cutthroat trout have not changed significantly between 2005 and 2011, so it was determined to shelve this project for a couple more years until we can coordinate on the issue of wilderness character.

Cabin Creek Barrier Investigation

Over the past five years, three potential barrier locations have been identified along lower Cabin Creek. A barrier has been deemed necessary by area fish biologists to prevent future rainbow trout invasion into the headwaters of this large drainage. An upstream migration barrier would protect between 20 and 25 miles of presently occupied WCT habitat. The Madison River Fisheries TAC hired a private contracting expert for one day to review all three sites to determine if it is both possible and feasible to build at each of these sites. Devin Baer, Baerco Construction, Lovell, Wyoming, toured all three sites on October 15, 2012. Baerco Construction has constructed two very difficult barriers in very remote locations with difficult terrain features including the Crooked Creek barrier in the Pryor Mountains, Montana. Each of the three sites had their own plus and minus, but it was determined that the middle site was by far the best location. With this information, the GNF plans to move forward with the design and fund raisings for this out-year project. The Madison River Fisheries TAC agreed that this project should be its highest priority for funding in December 2013. Proposals to help co-fund this project are being planned for Bring-Back-The-Natives (National Fish and Wildlife Foundation), Western Native Trout Initiative (WNTI) and Future Fisheries.

Project Title: Beaverhead-Deerlodge NF Seasonal Technician Funding 2012 (Dec. 2011 Proposal)

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

FERC Article	Item	Report Topic	Project
412	**(5)**	**Species of Special Concern – Westslope Cutthroat Trout**	**Ruby Creek WCT Restoration**
			Greenhorn Creek WCT Restoration
			Ruby River WCT Genetics

Submitted by: **Darin Watschke**

Location of Proposed Project: **Madison River Drainage**

The Madison River Fisheries Technical Advisory Committee provided $5,038 to the Beaverhead-Deerlodge National Forest fisheries program to assist with hiring a fisheries technician for field season 2012. However, the Madison Ranger District was not able to hire an aquatics technician in 2012 due to hiring constraints (no new hires were permitted outside of the Fire Organization and all noncompetitive rehire aquatics seasonals accepted summer positions outside of the Forest Service). Therefore, the funding was utilized to fund fire, range, and wildlife seasonals to assist with project specific aquatics work in the Madison and Ruby River drainages. The individuals spent a total of 20 ten-hour days working on Westslope cutthroat trout restoration and genetic analysis projects listed below. About $2,000 of the TAC funding was not utilized and will be added to the 2013 seasonal tech funding to expand aquatics field investigations in the Madison River drainage in 2013.

Ruby Creek Westslope Cutthroat Trout Restoration

Ruby Creek is a tributary to Madison River draining the eastside of the Gravelly Mountains south of Ennis, Montana. MFWP proposed to remove non-native trout from this drainage in order to re-stock with genetically pure westslope cutthroat trout. The results of this project will be reported by Pat Clancey and Travis Lohrenz (MFWP) in their annual report to the Madison River Fisheries TAC. MRD seasonal crews assisted with the salvage of over 2,000 rainbow trout from the drainage in August 2012.

Greenhorn Creek Westslope Cutthroat Trout Restoration

Greenhorn Creek is a tributary to the Ruby River draining the west side of the Greenhorn Mountains south of Alder, Montana. MFWP, USFS, BLM and Turner Enterprise have been physically removing non-native trout from this drainage (2006-2012) and recently (2102) constructed a fish passage barrier on state DNRC lands in the lower drainage, in an effort to restore genetically pure WCT throughout 17 miles of the upper drainage. MFWP proposes to chemically remove all nonnative trout species from the upper Greenhorn drainage in late summer 2013. MRD seasonal crews assisted with brook trout removals, fish distribution surveys, and flow measurements in the Greenhorn drainage in August 2012. Once established, the Greenhorn WCT population may be used as a genetic brood source for establishing WCT populations throughout the Ruby River and, possibly the Madison River drainages.

Ruby River Westslope Cutthroat Trout Genetic Analysis

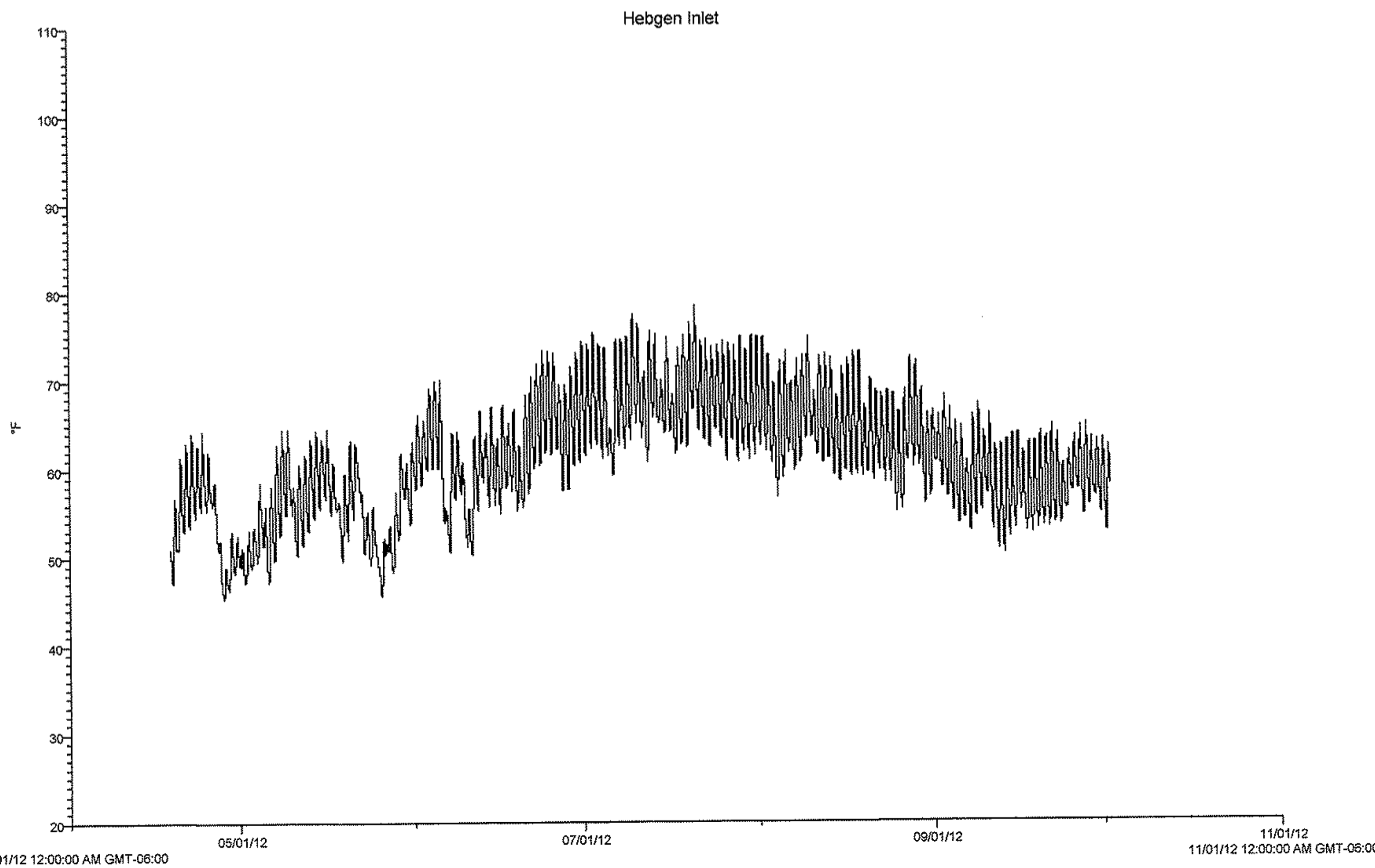
Less than 200 genetically unaltered WCT are estimated to inhabit a small tributary (Dark Hollow) to Greenhorn Creek in the Ruby River drainage. Therefore, MFWP proposes to potentially augment this population (once chemical treatment is complete), with WCT gametes from a second unaltered, aboriginal population in the Ruby River drainage. Remaining genetically unaltered WCT populations in the Ruby River drainage were investigated in 2012 to assess population size and to update genetic information. Fin clips were harvested from three populations on USFS in 2012 and sent to Missoula for genetic analysis. MRD seasonal crews assisted with electrofishing efforts in all three drainages. These streams included Coal, Bivens, and Geyser creeks. Once established, the Greenhorn WCT population may be used as a genetic brood source for establishing WCT populations throughout the Ruby River and, possibly the Madison River drainages.

Appendix C1

Temperature recordings from Madison River monitoring sites
2012
See Figure 4 for locations

NOTES:

- Maximum temperature at Ennis air was 105.4, but the recorder had been exposed to full sun with a reflective metal background for a period of time. According to National Weather Service, the max air temp in Ennis was 94^{o}F on August 28.
- Maximum temperature at Norris air was 144.6 recorded on June 26 during the Beartrap 2 wildfire. The highest temperature recorded outside the period of the Beartrap 2 fire is shown here.



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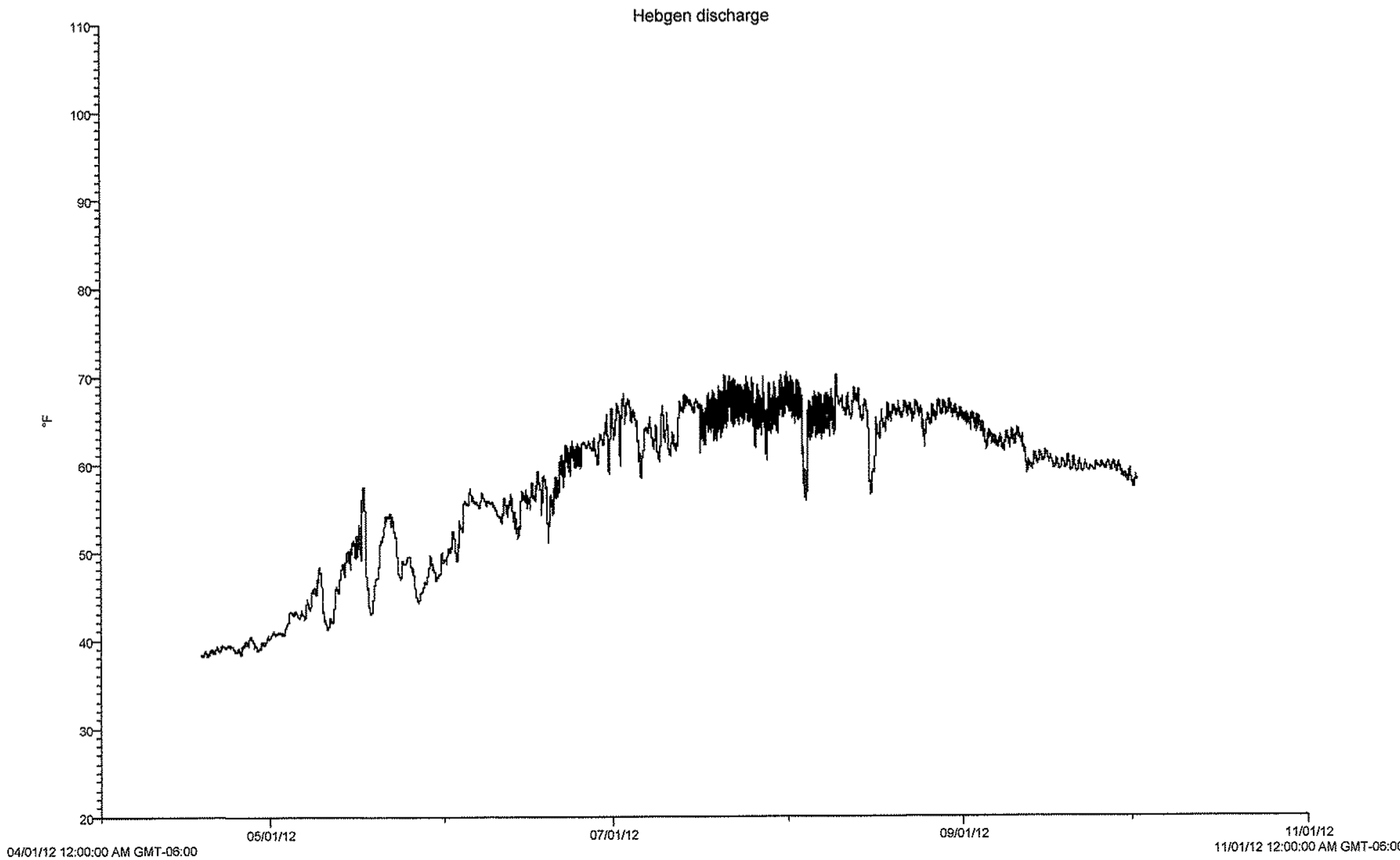
Hebgen discharge
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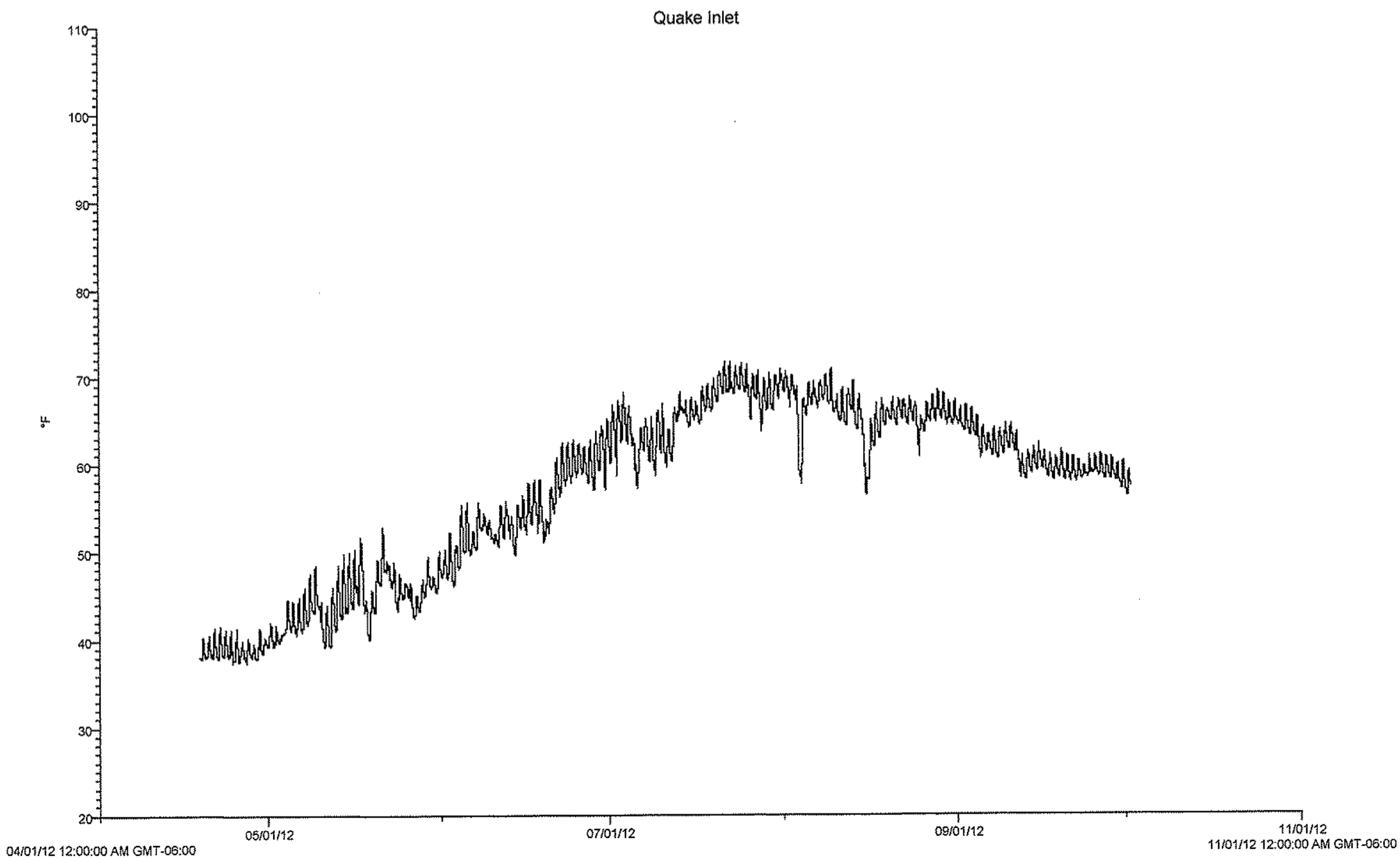

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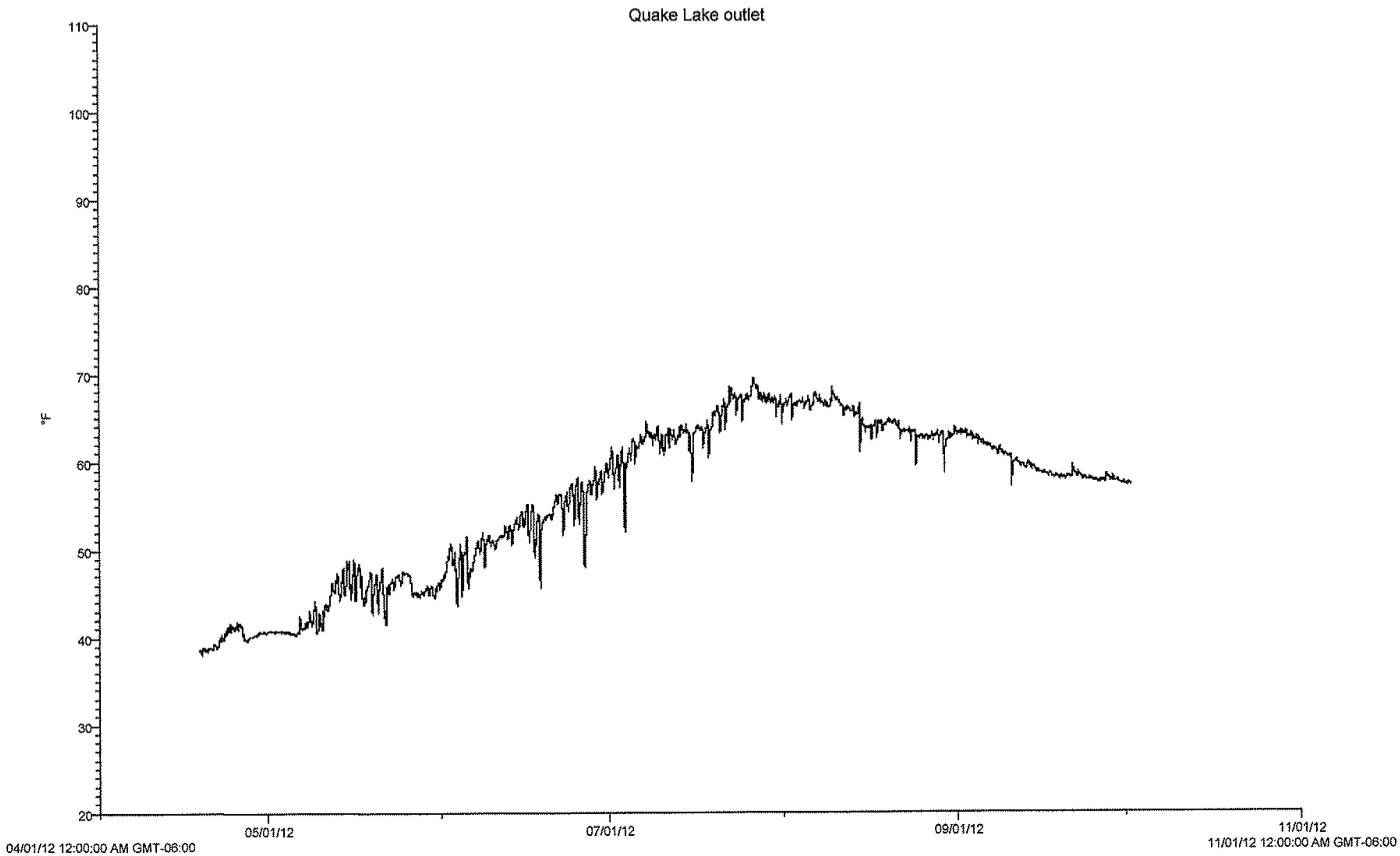
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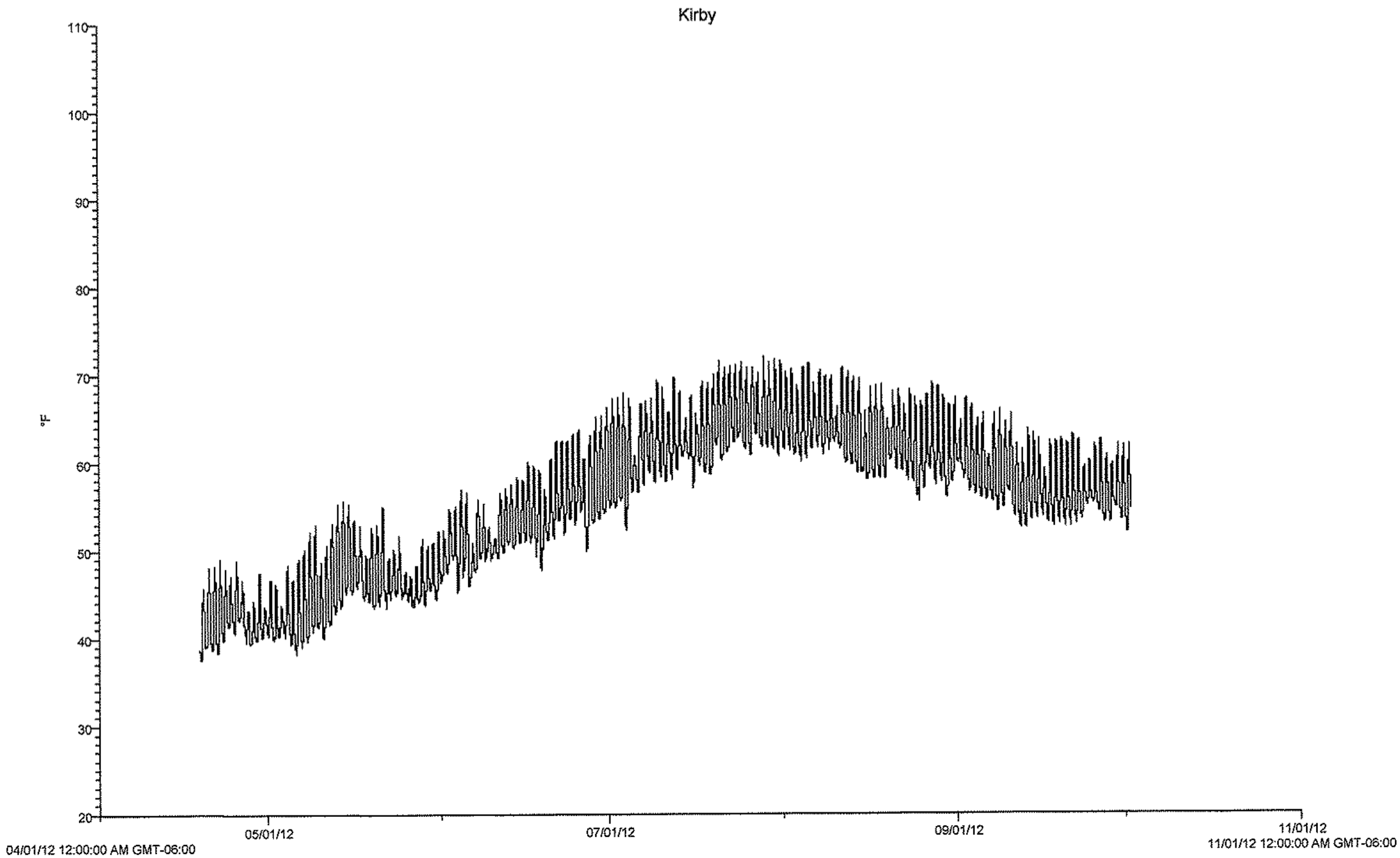

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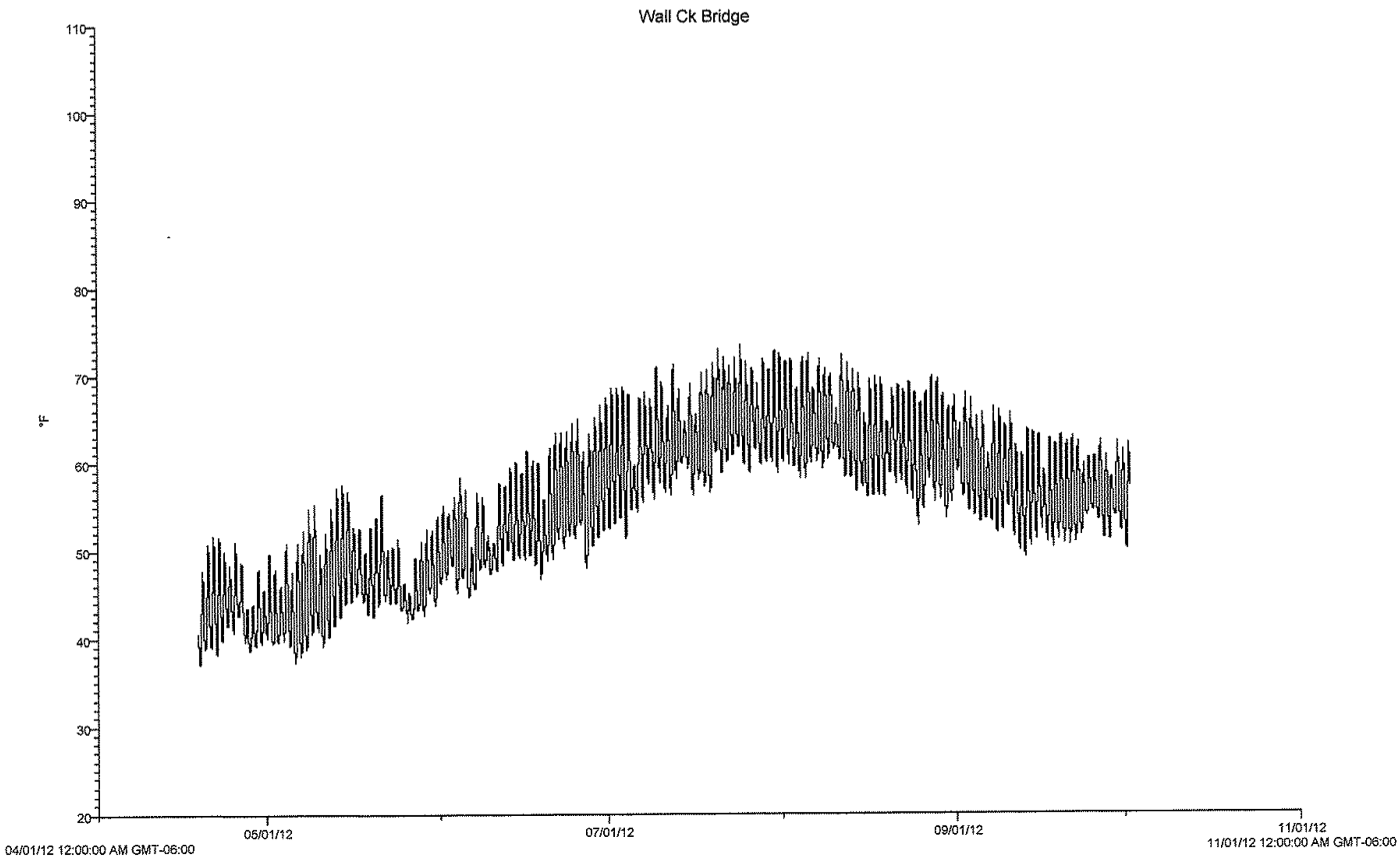
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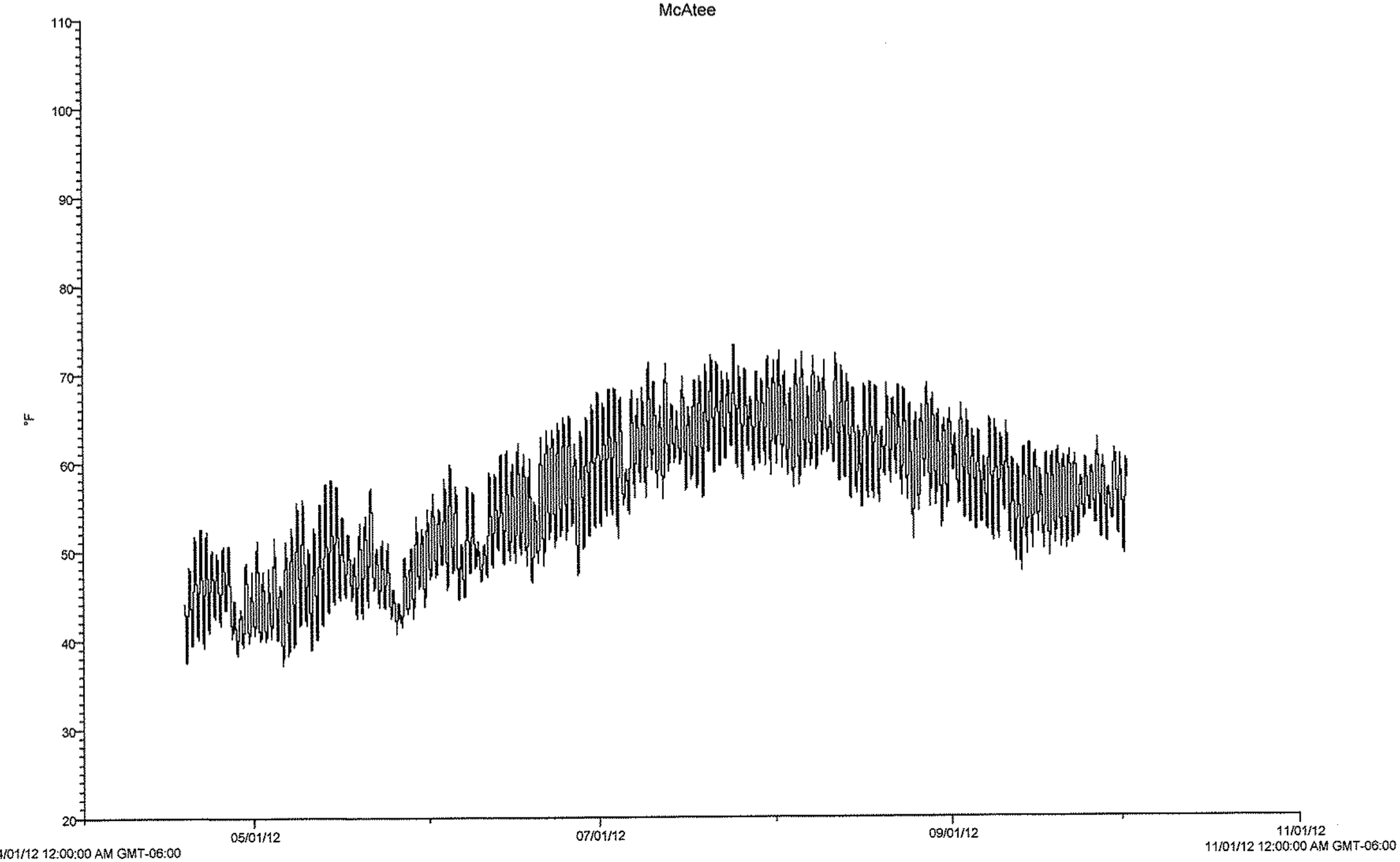
McAtee



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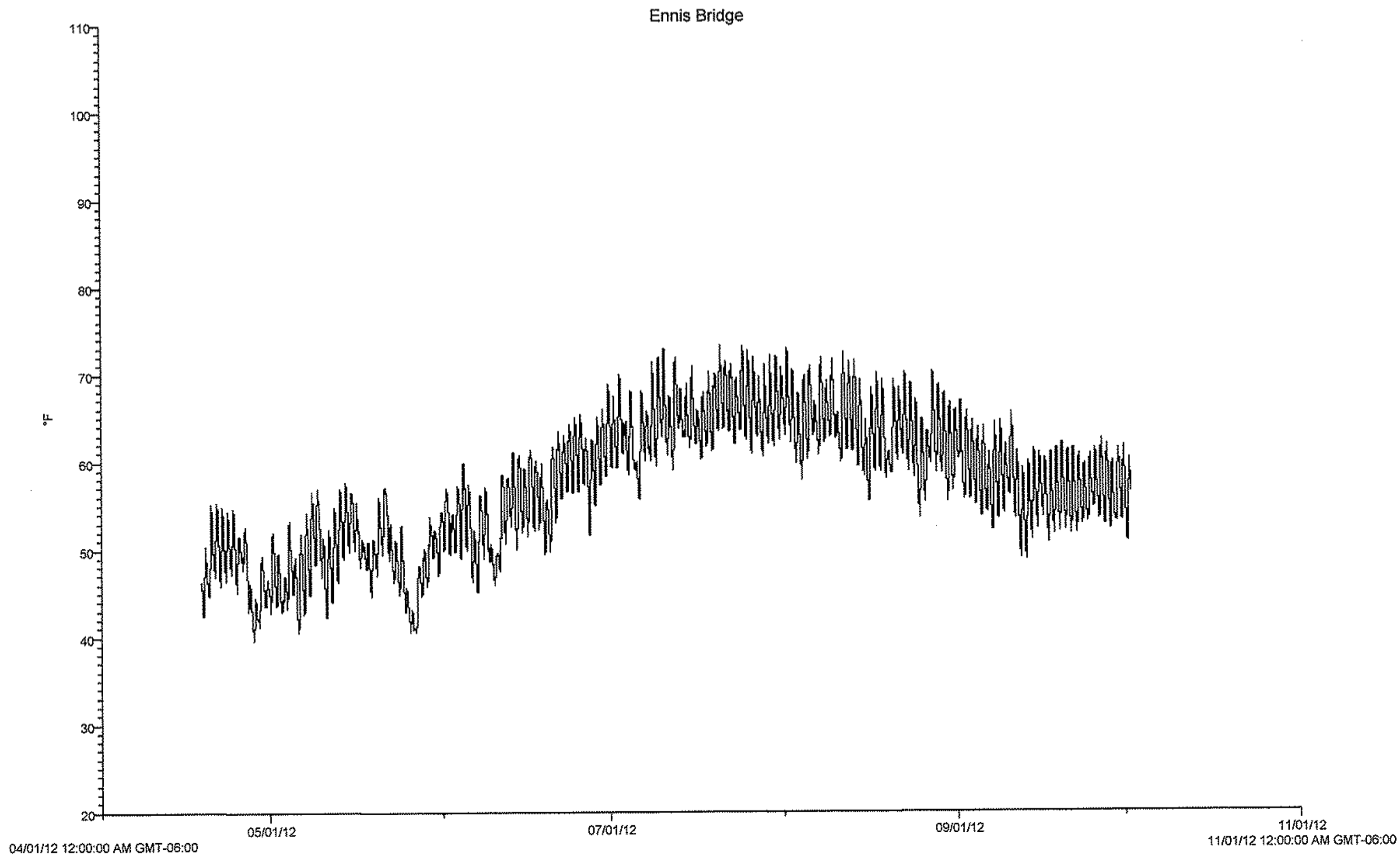

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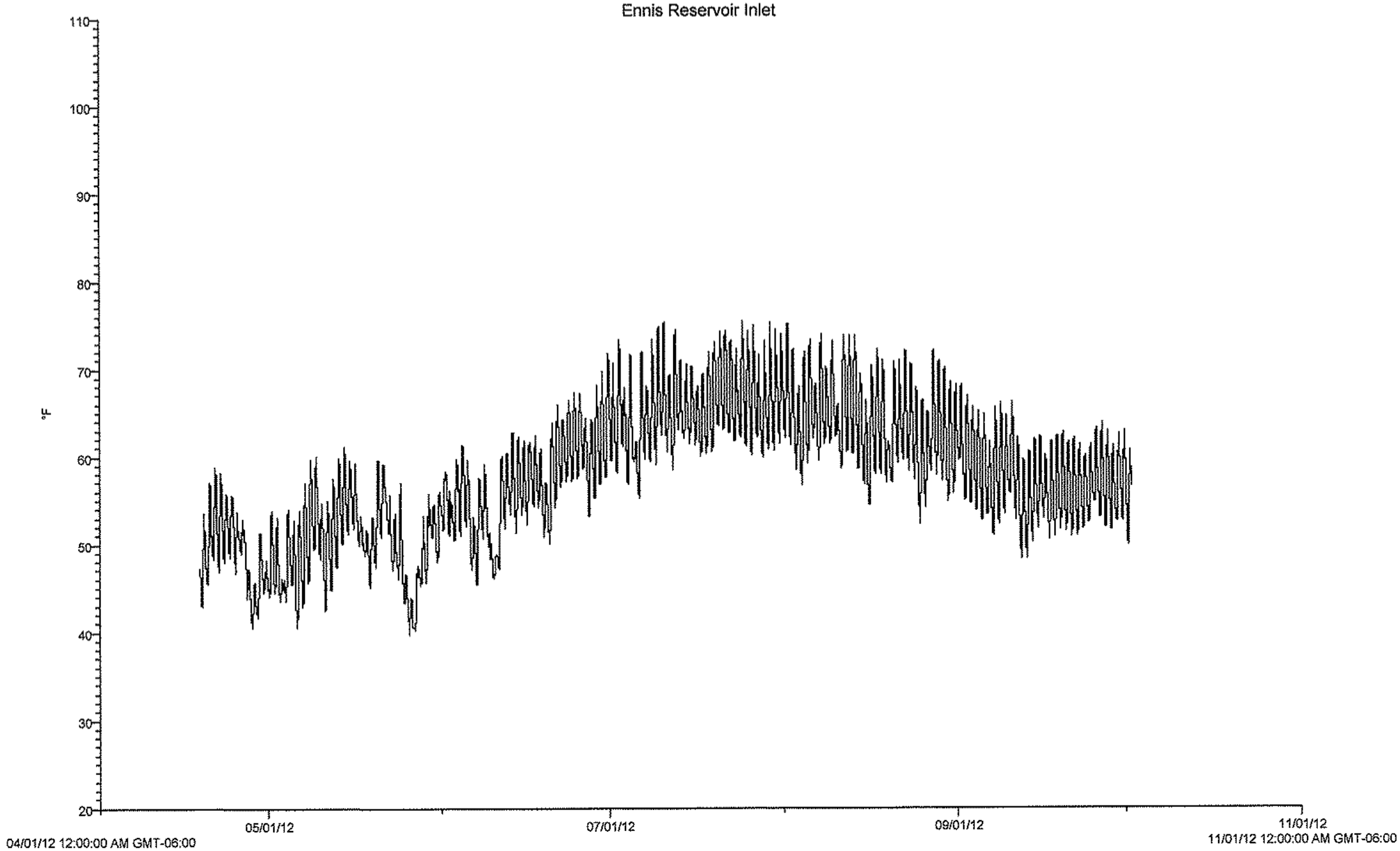
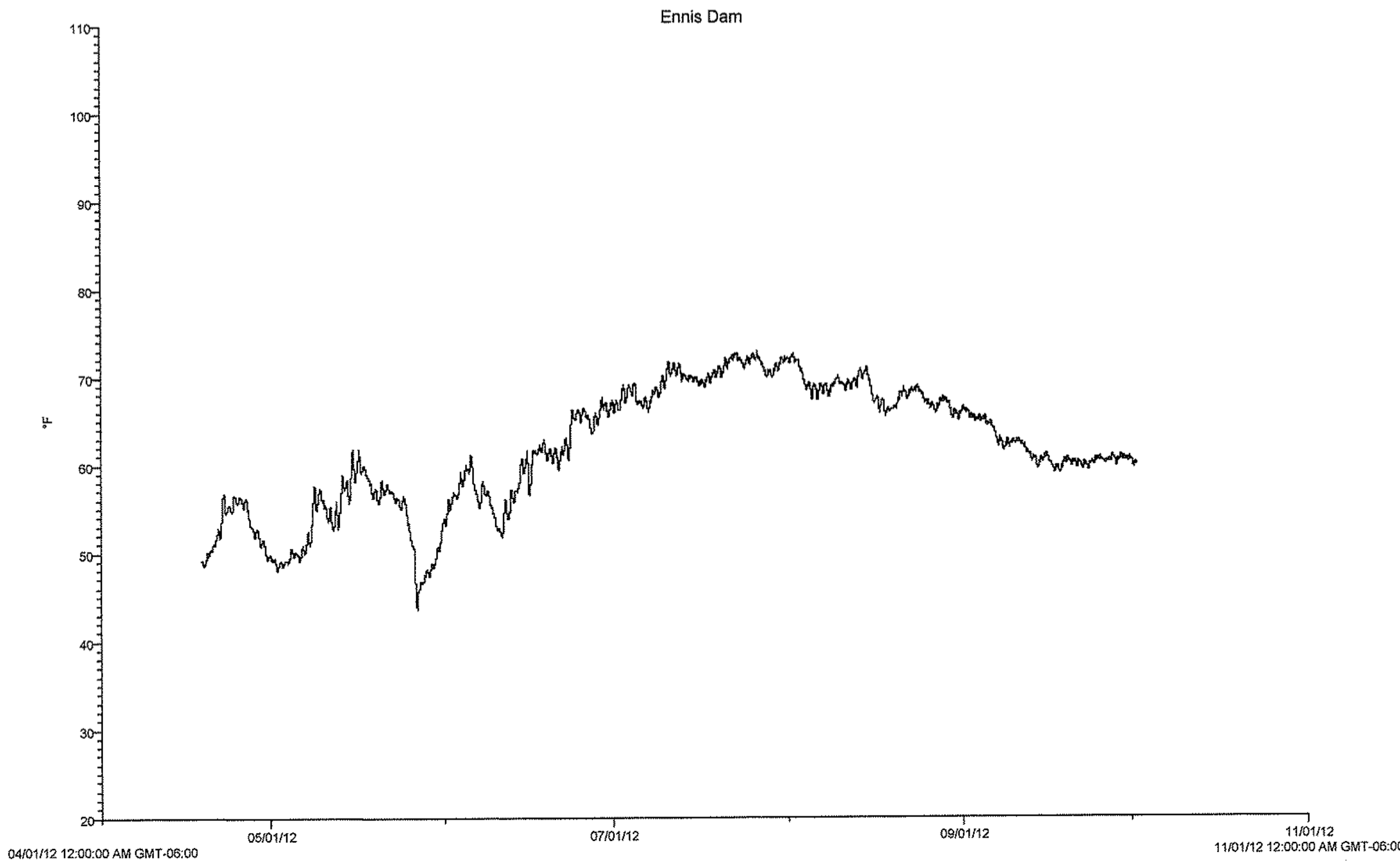
Ennis Reservoir Inlet





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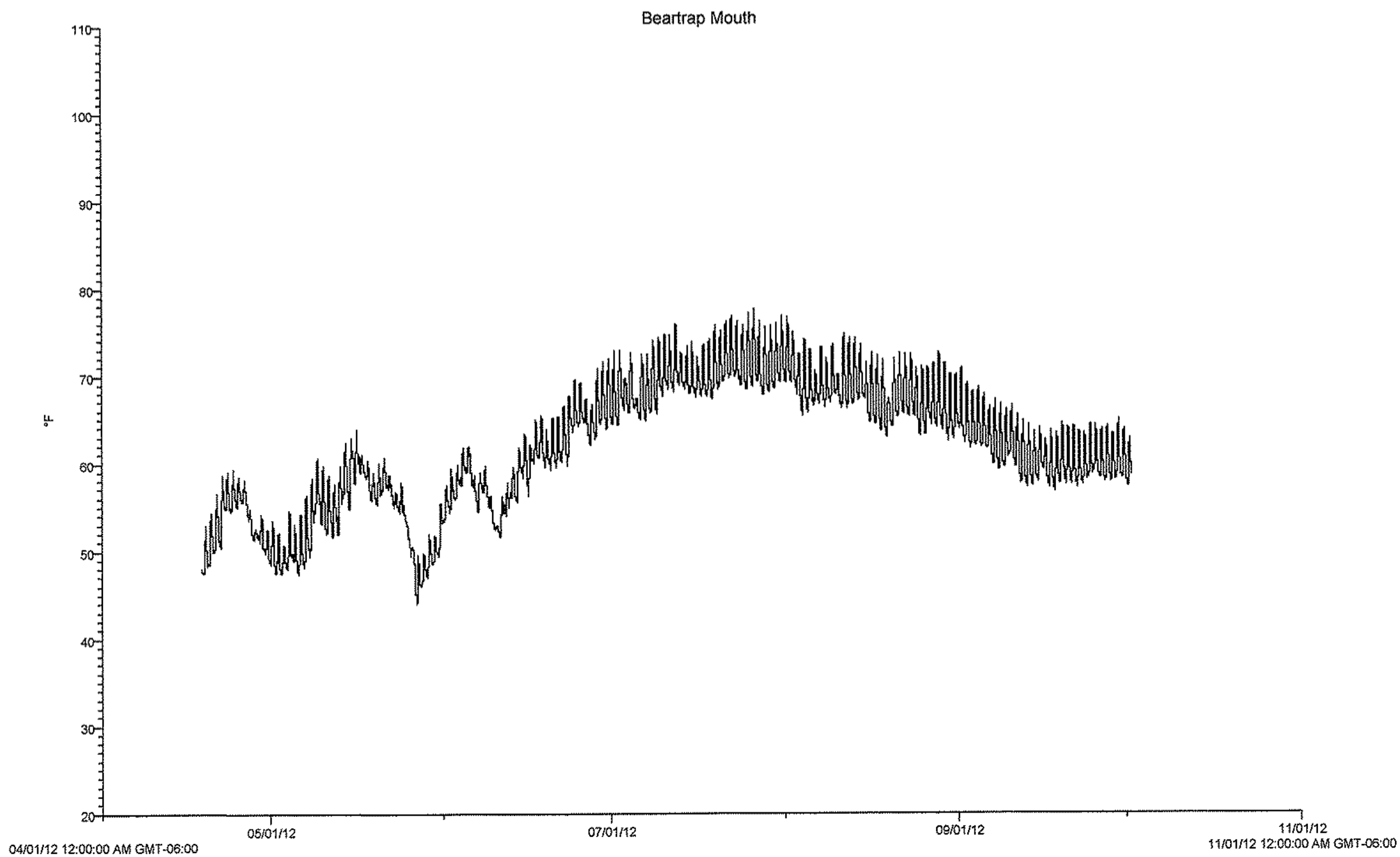

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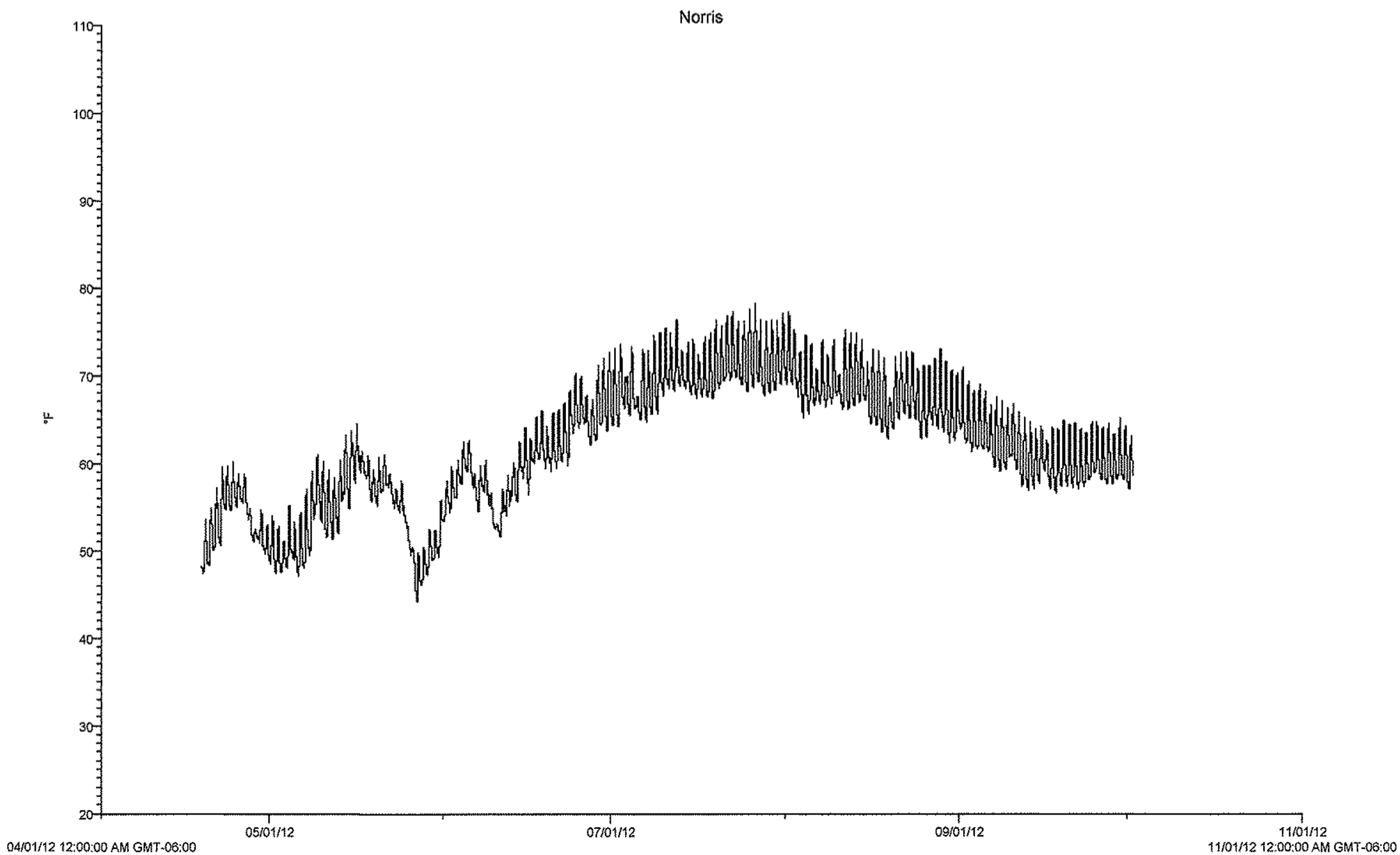

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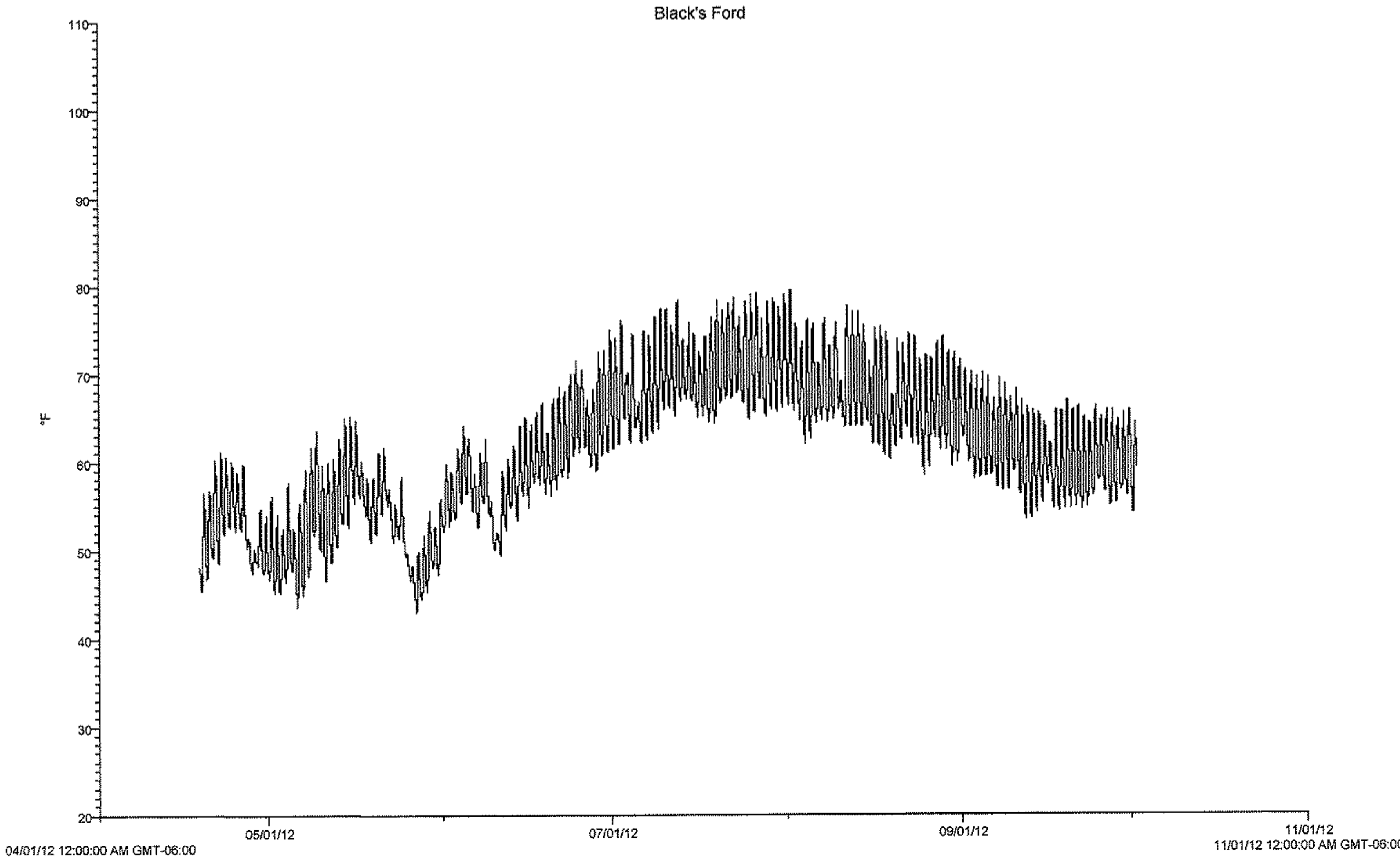
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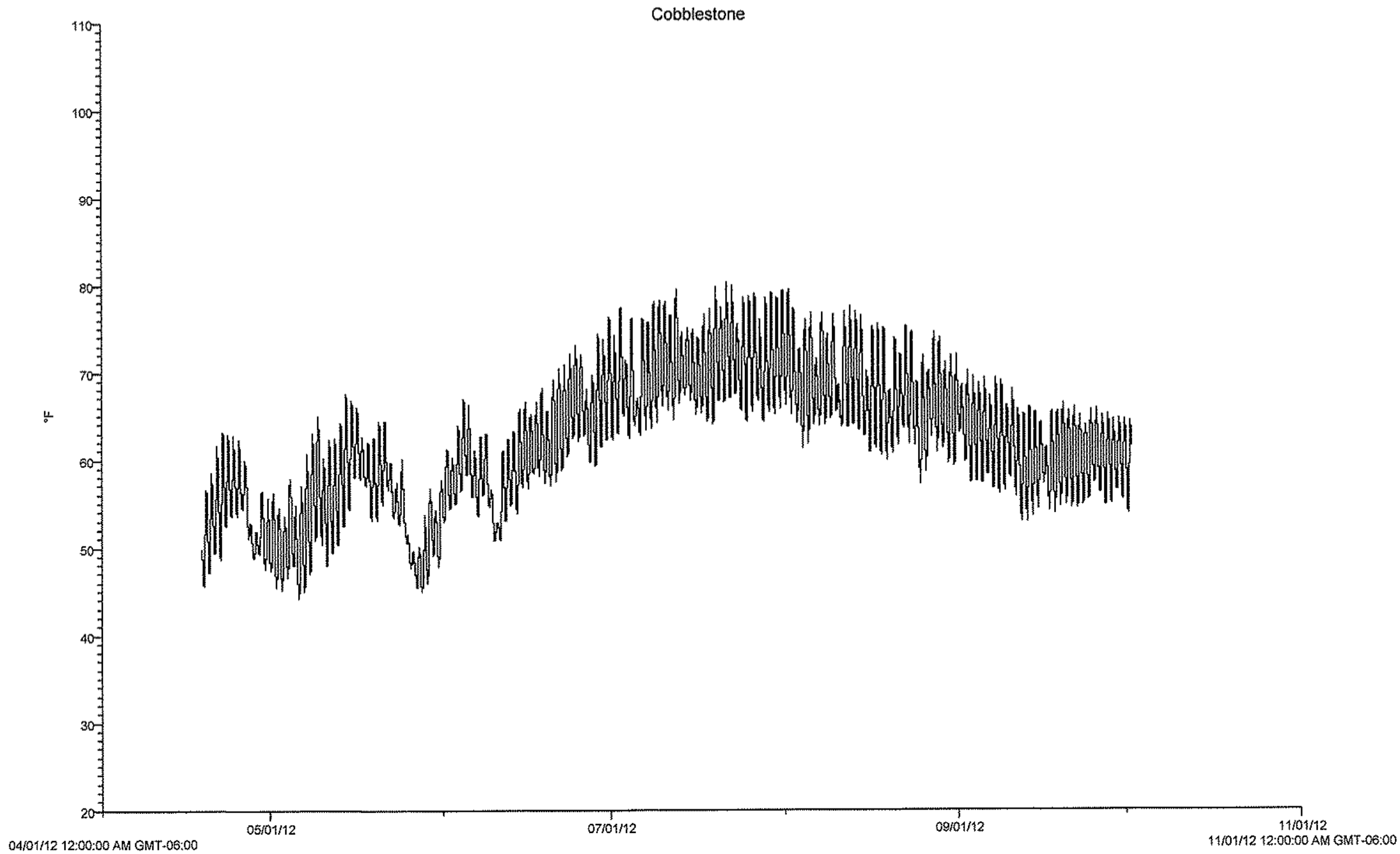

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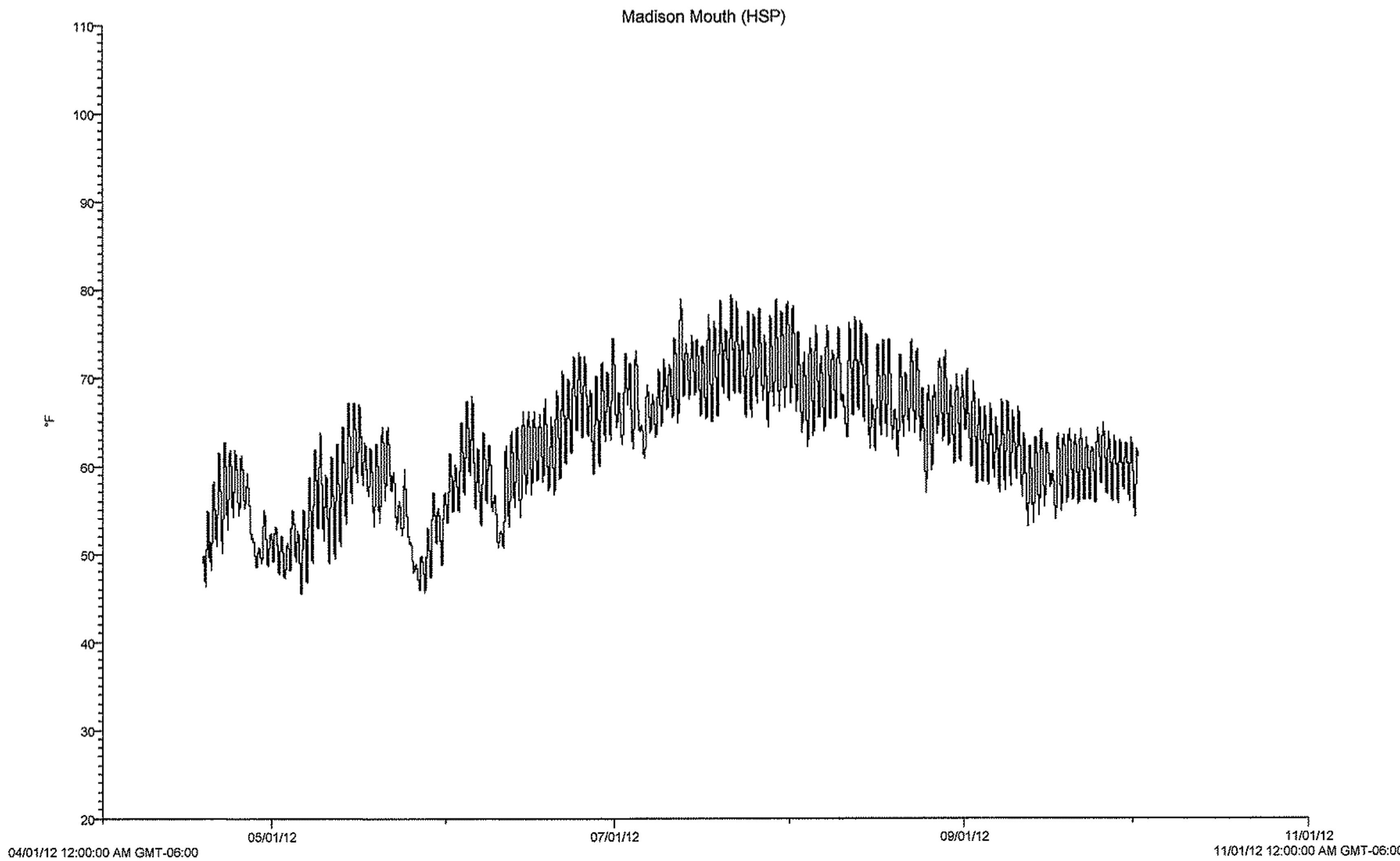

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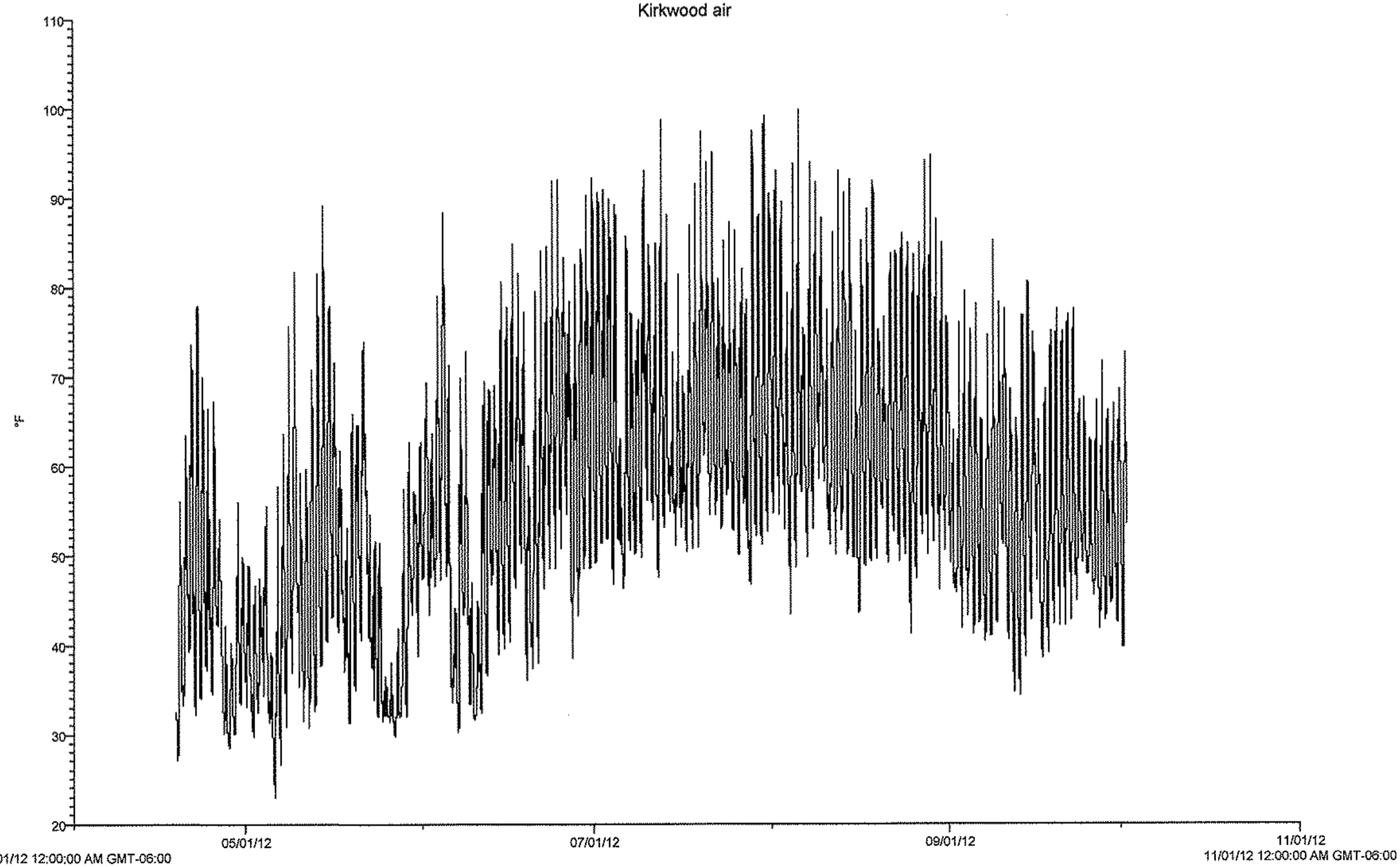

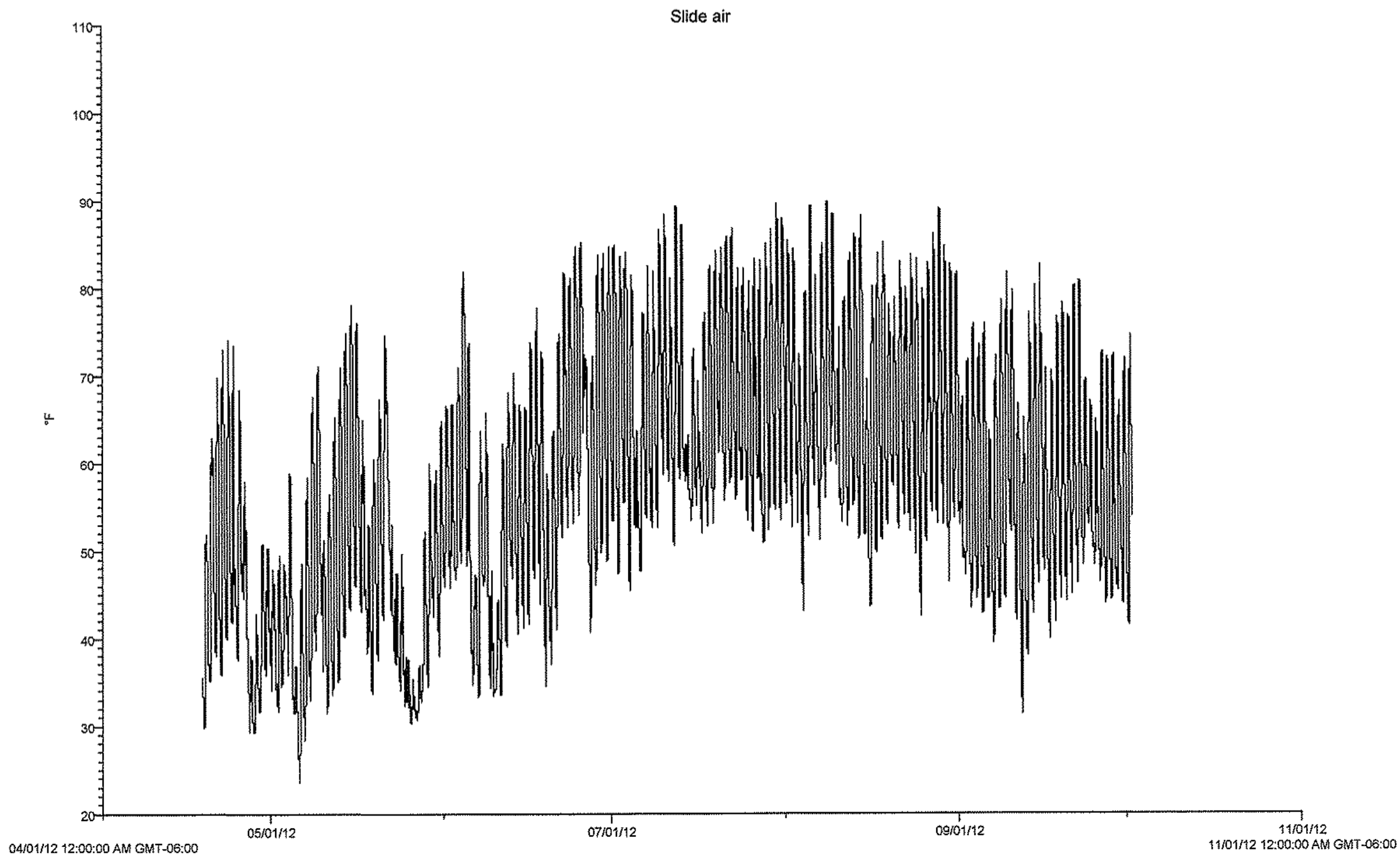

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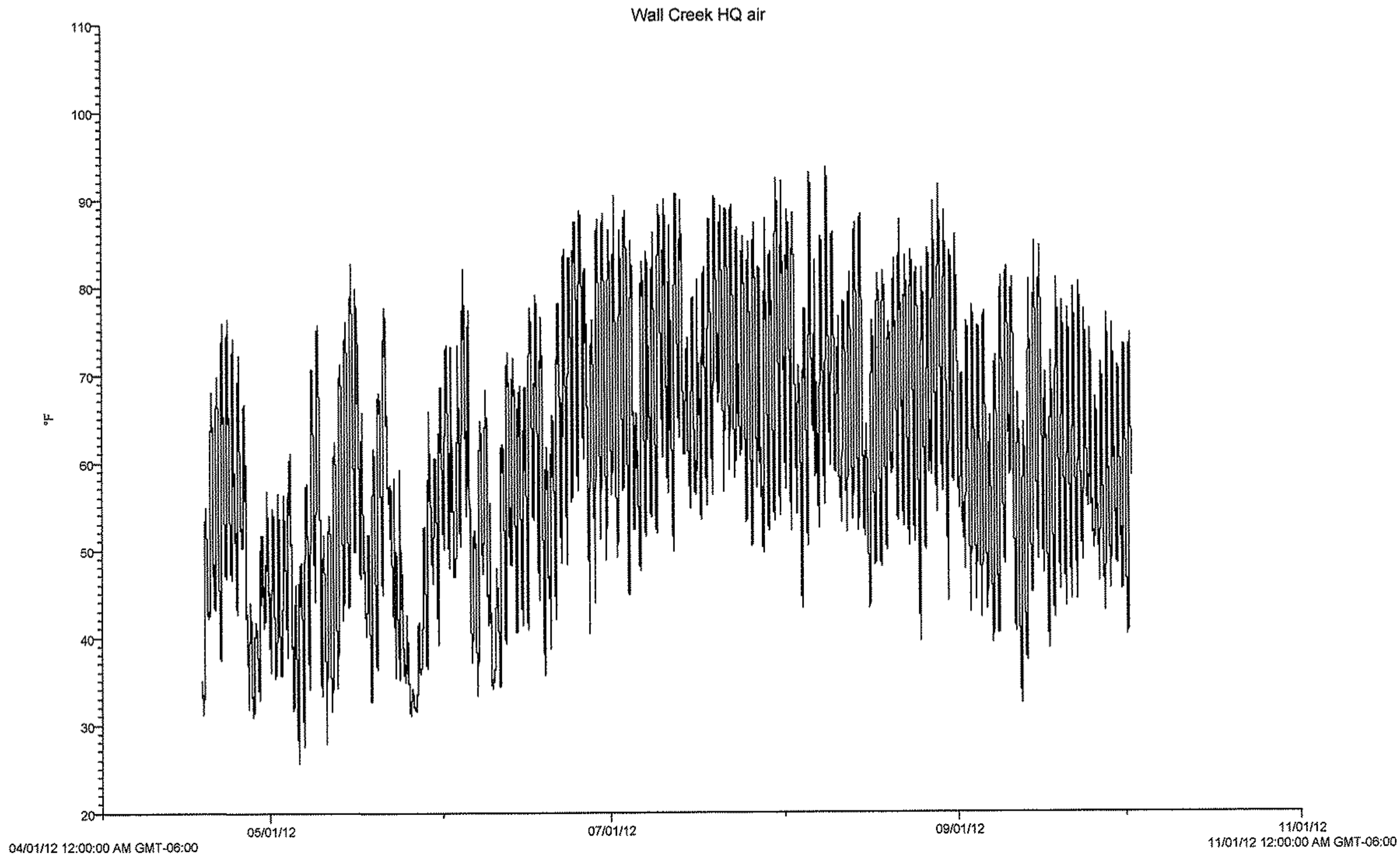
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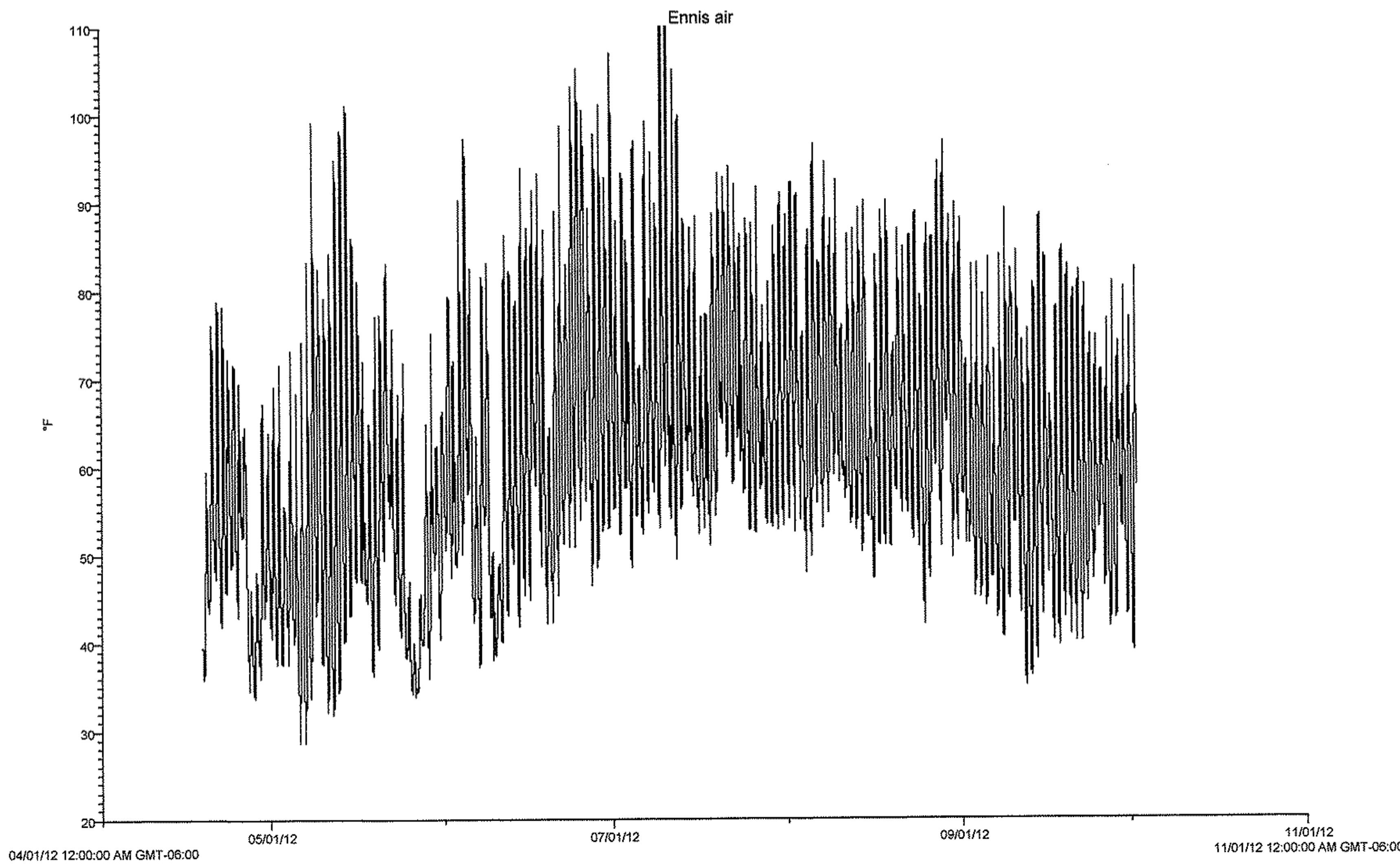
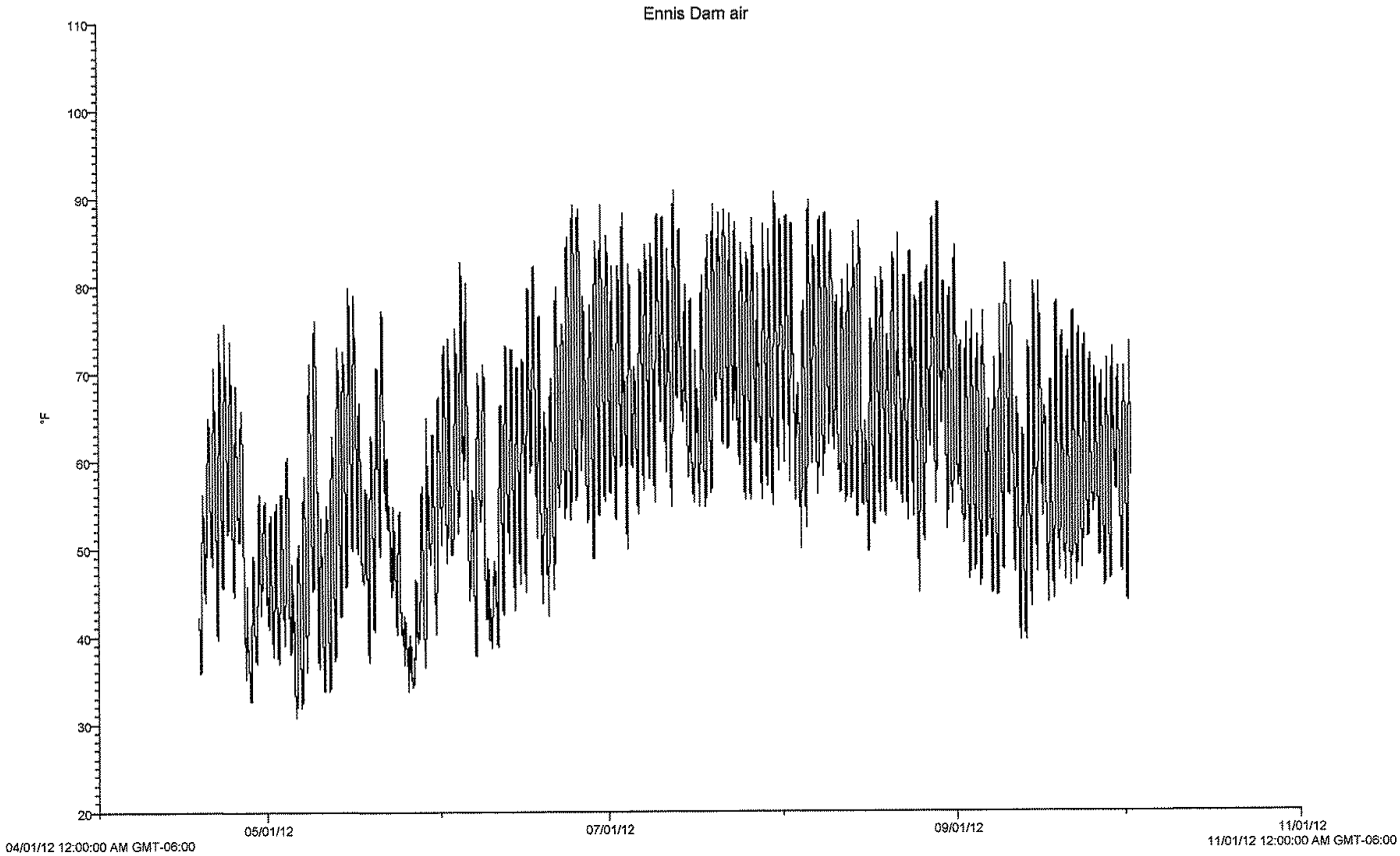


Maximum temperature at Ennis air was 105.4, but the recorder had been exposed to full sun with a reflective metal background on numerous occasions during the monitoring period. According to National Weather Service, the max air temp in Ennis was 94°F on August 28.



Ennis Dam air
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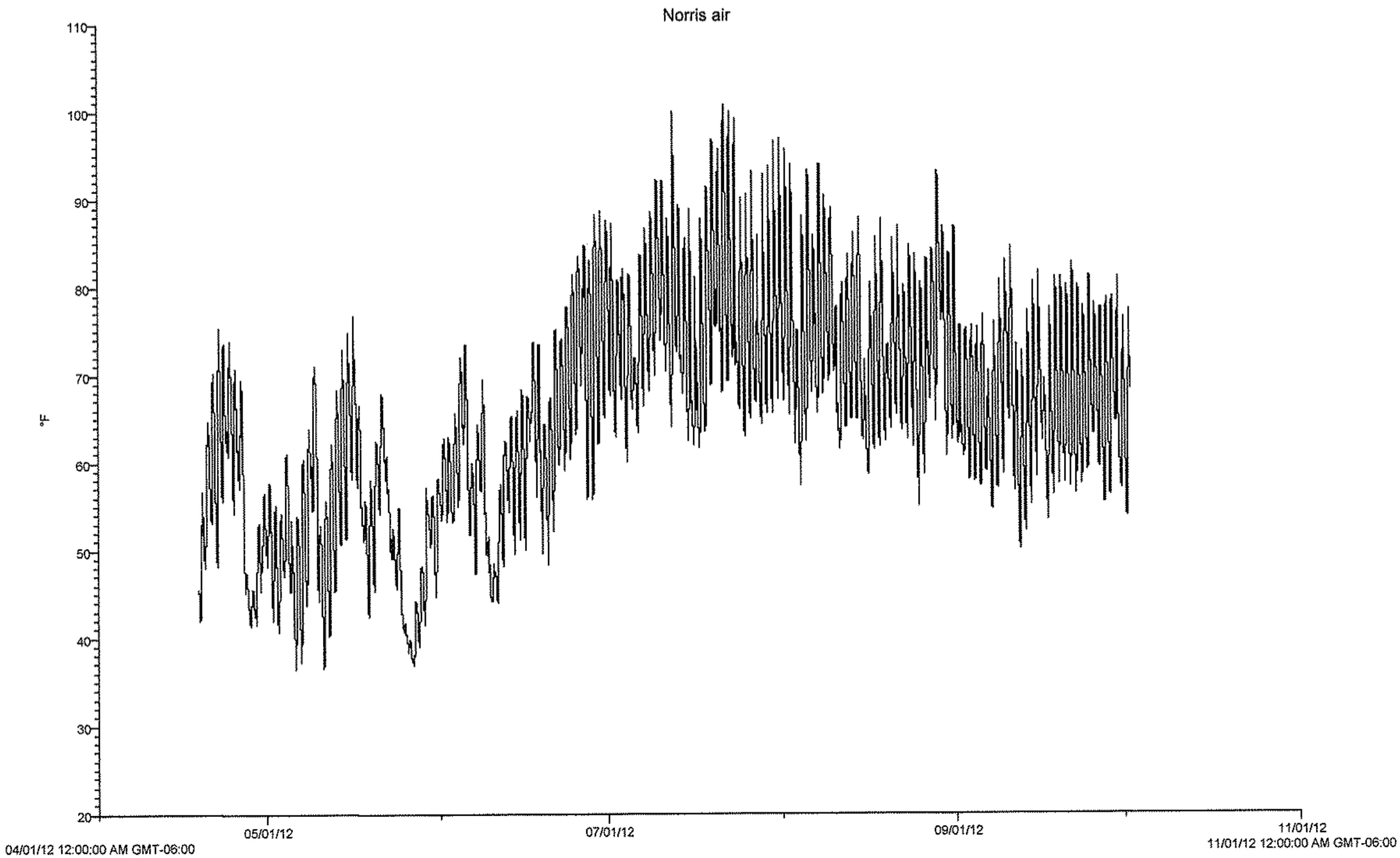

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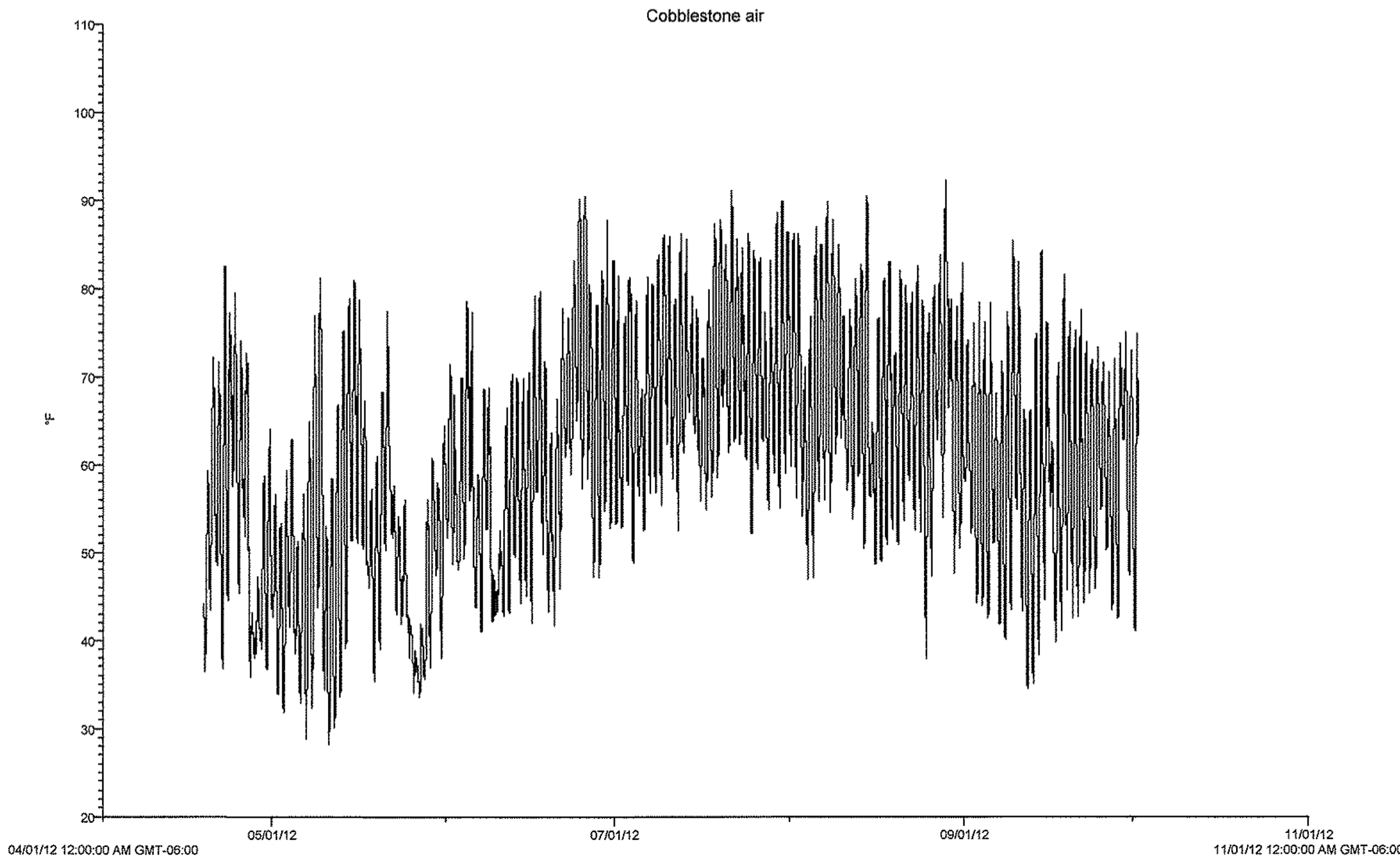
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Appendix C2

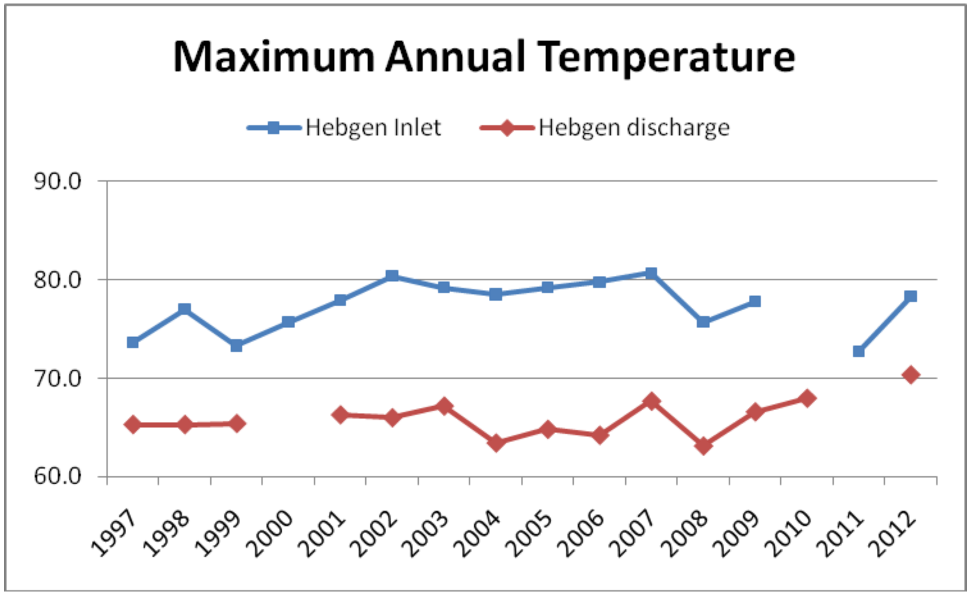
Comparison of maximum annual water temperatures at selected Madison River monitoring sites
1994/1995/1996 - 2012
See Figure 4 for locations

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. See report pages 6 and 23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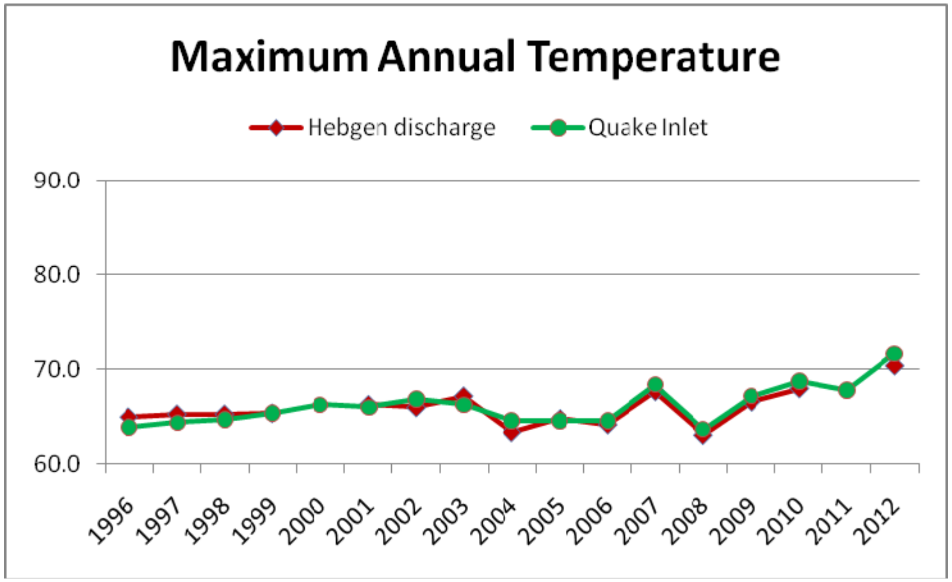
Hebgen discharge
90.0
80.0
70.0
60.0
1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012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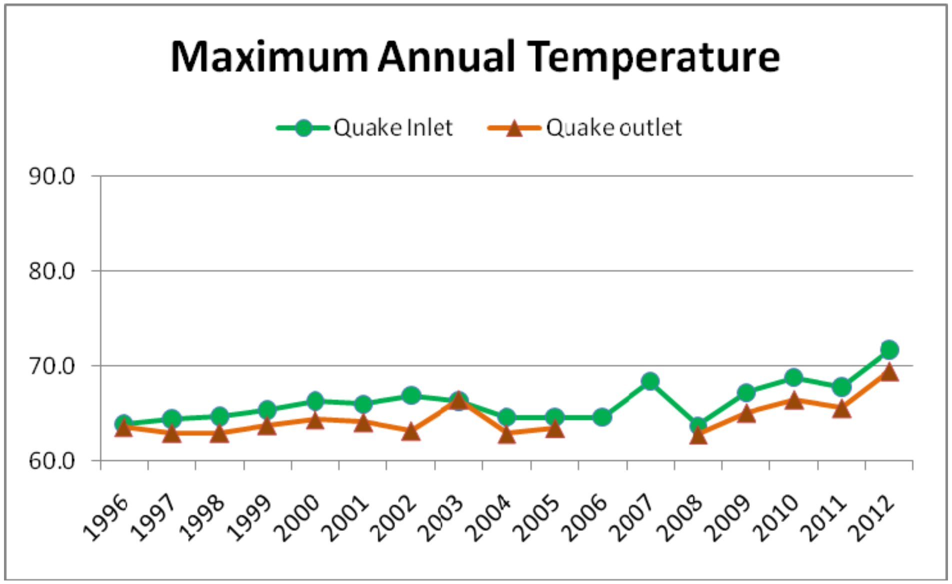
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Quake outlet
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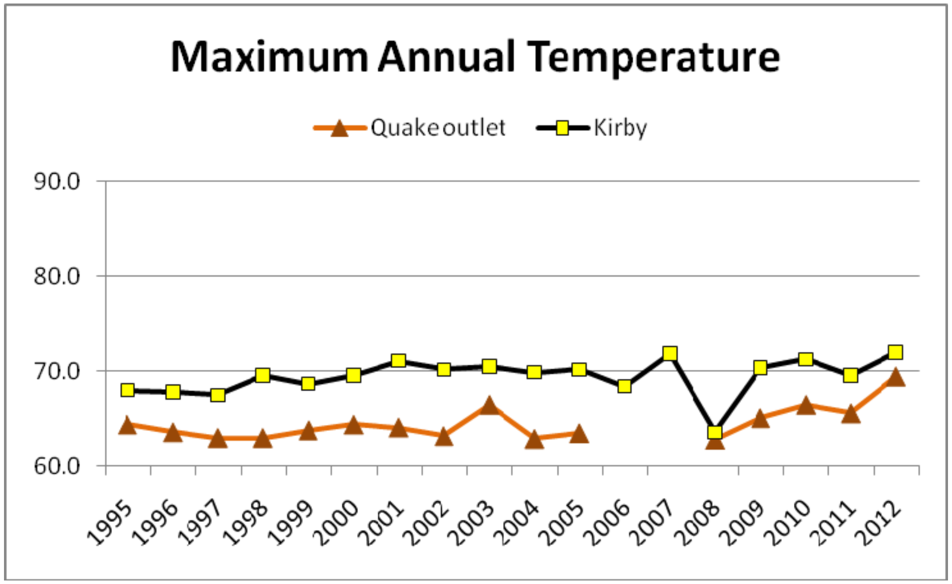
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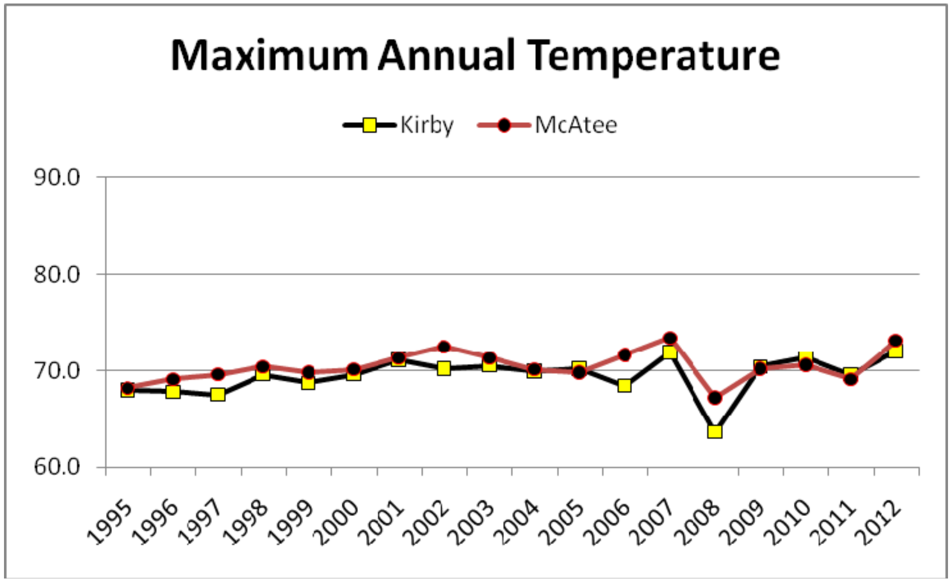

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McAtee
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60.0
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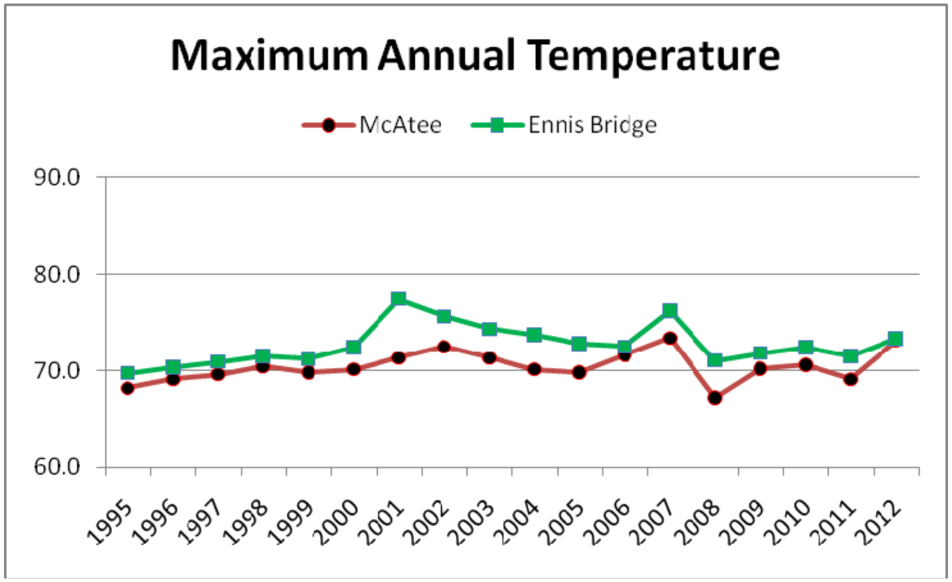

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Ennis Bridge
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70.0
60.0
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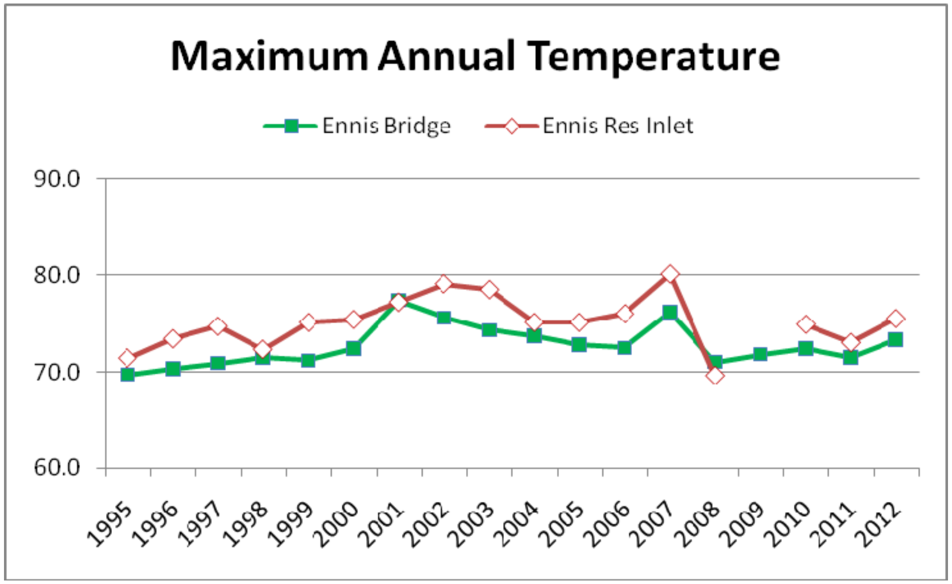

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Ennis Res Inlet
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70.0
60.0
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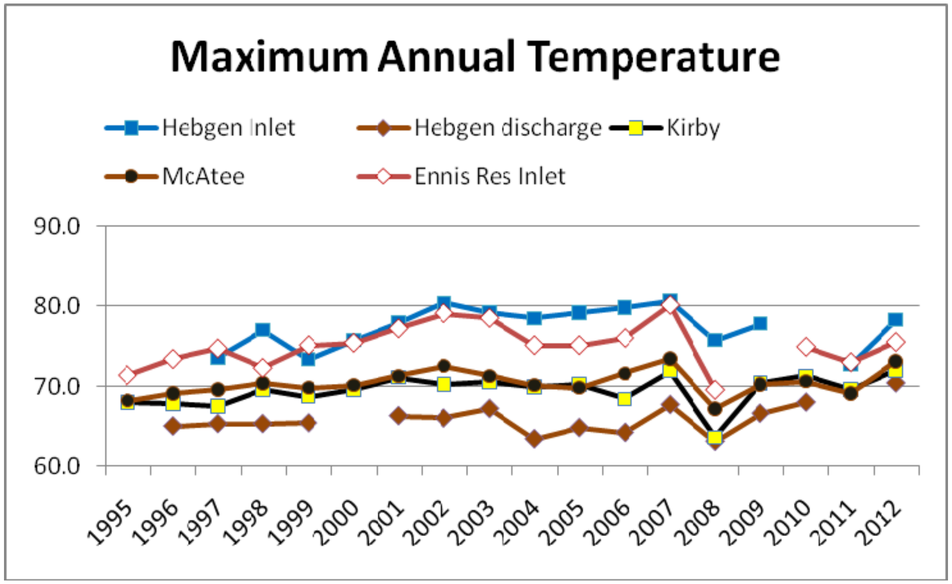

Maximum Annual Temperature
Hebgen Inlet
Hebgen discharge
Kirby
McAtee
Ennis Res Inlet
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70.0
60.0
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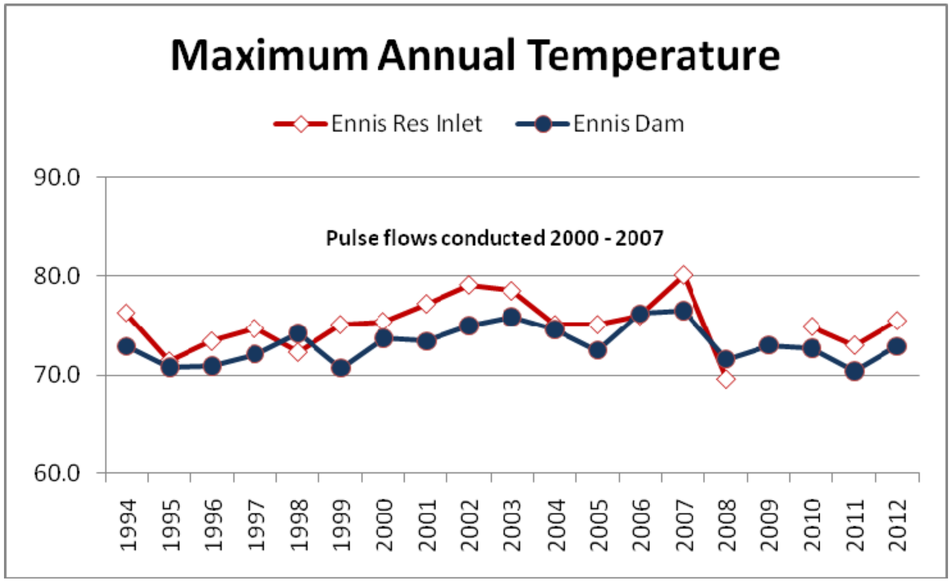
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Ennis Res Inlet
Ennis Dam
Pulse flows conducted 2000 - 2007
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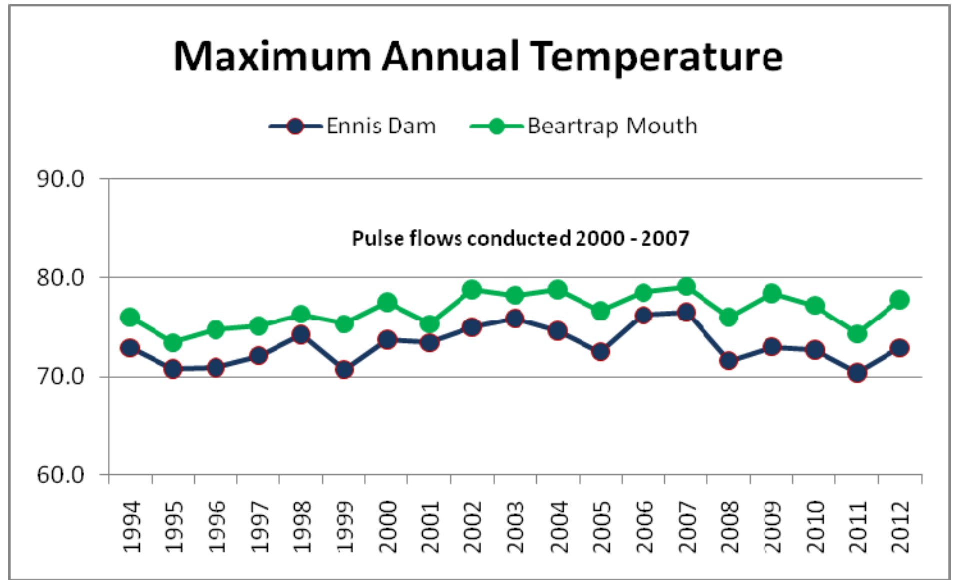
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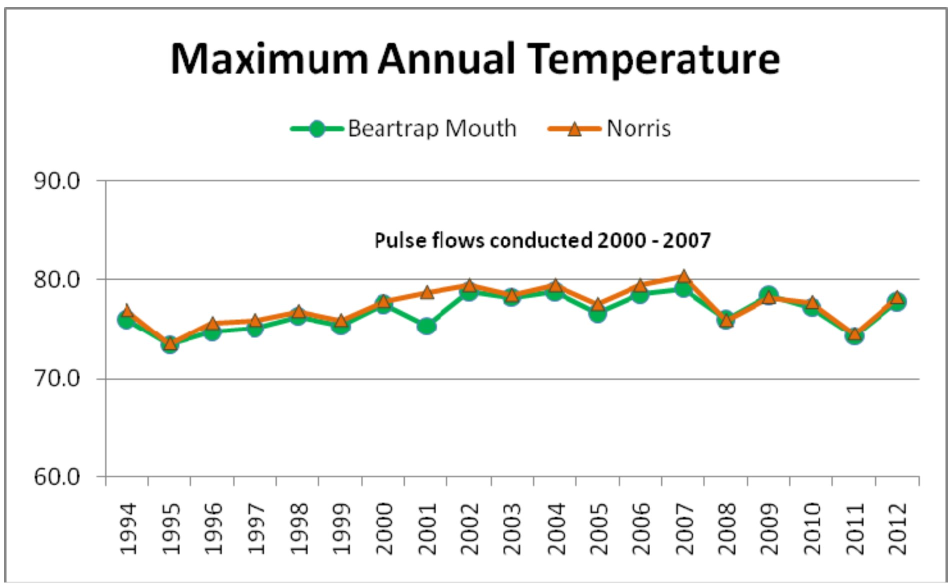
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Beartrap Mouth
Norris
Pulse flows conducted 2000 - 2007
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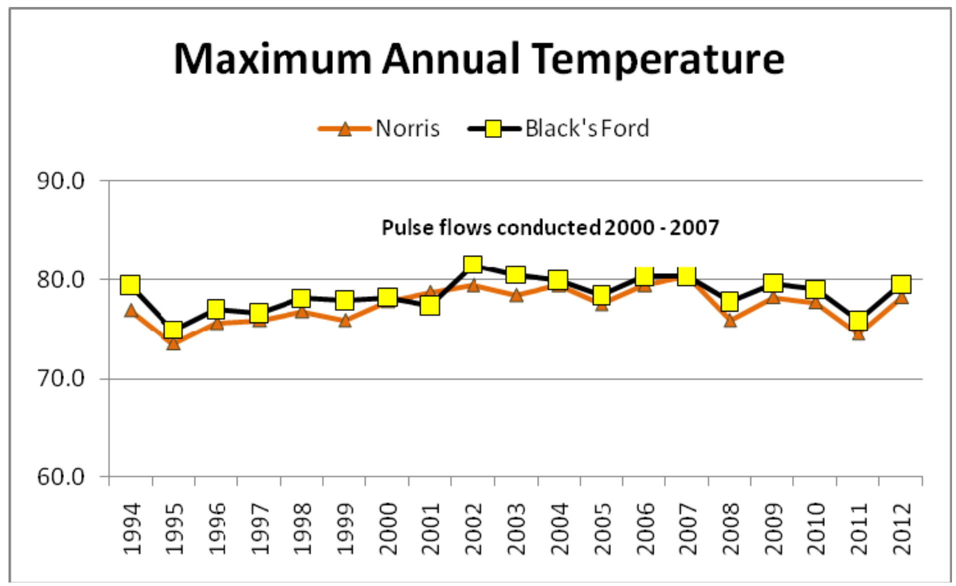
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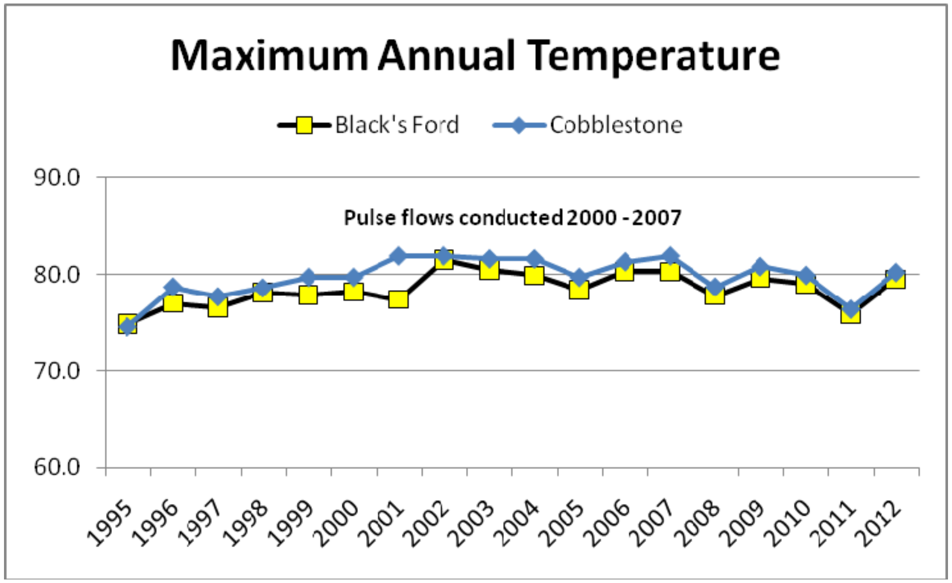
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Black's Ford
Cobblestone
Pulse flows conducted 2000 - 2007
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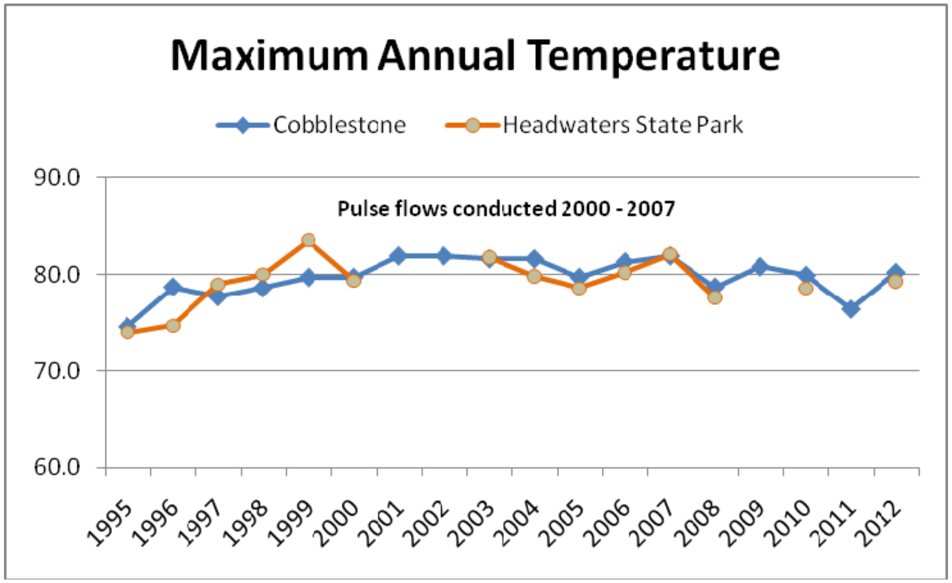
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Cobblestone
Headwaters State Park
Pulse flows conducted 2000 - 2007
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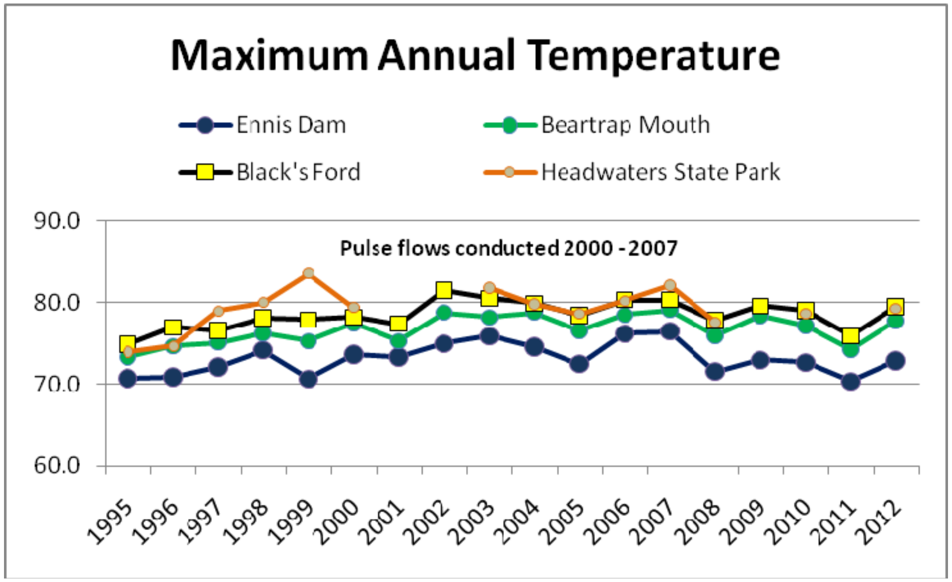
Maximum Annual Temperature
Ennis Dam
Beartrap Mouth
Black's Ford
Headwaters State Park
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90.0
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70.0
60.0
1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012

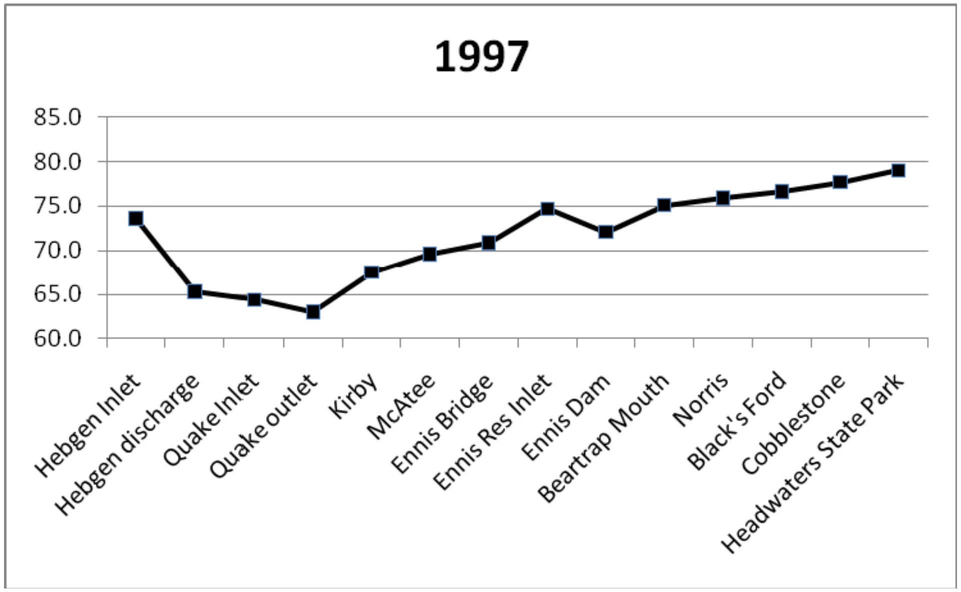
Appendix C3

Maximum annual water temperatures recorded at Madison River monitoring sites
1997 - 2012
See Figure 4 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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Quake Inlet
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Norris
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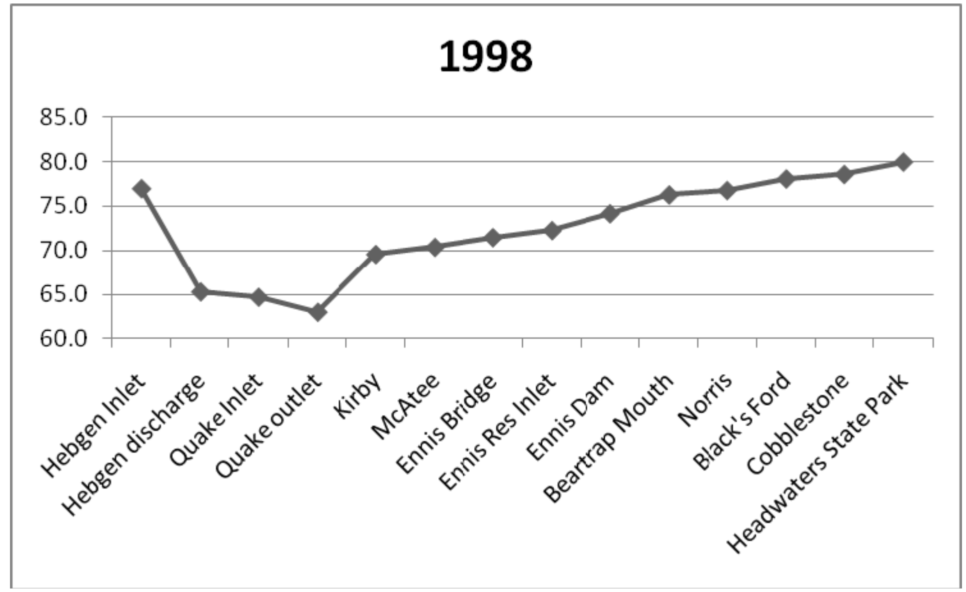
Cobblestone
Headwaters State Park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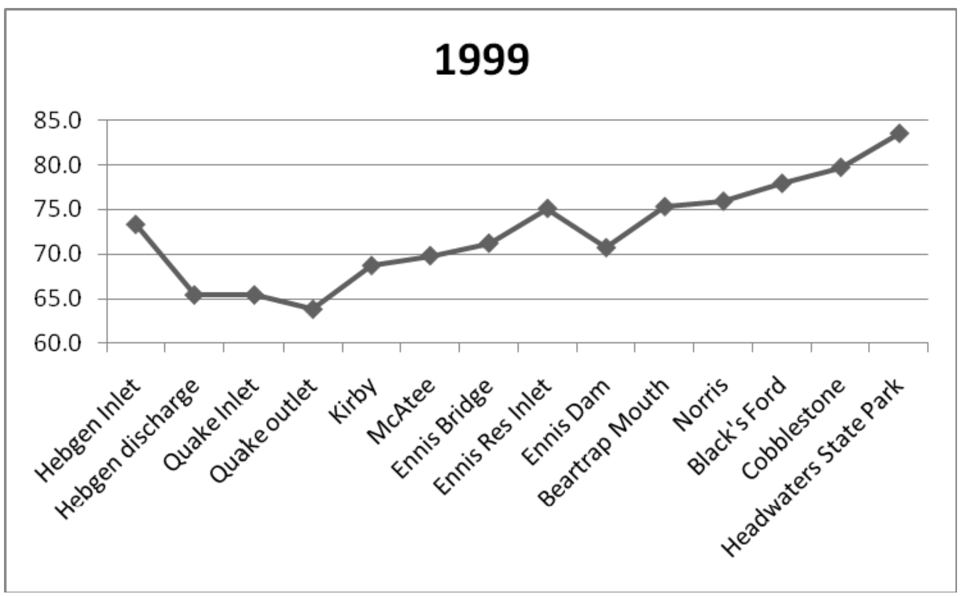
Norris
Black's Ford
Cobblestone
Headwaters State Park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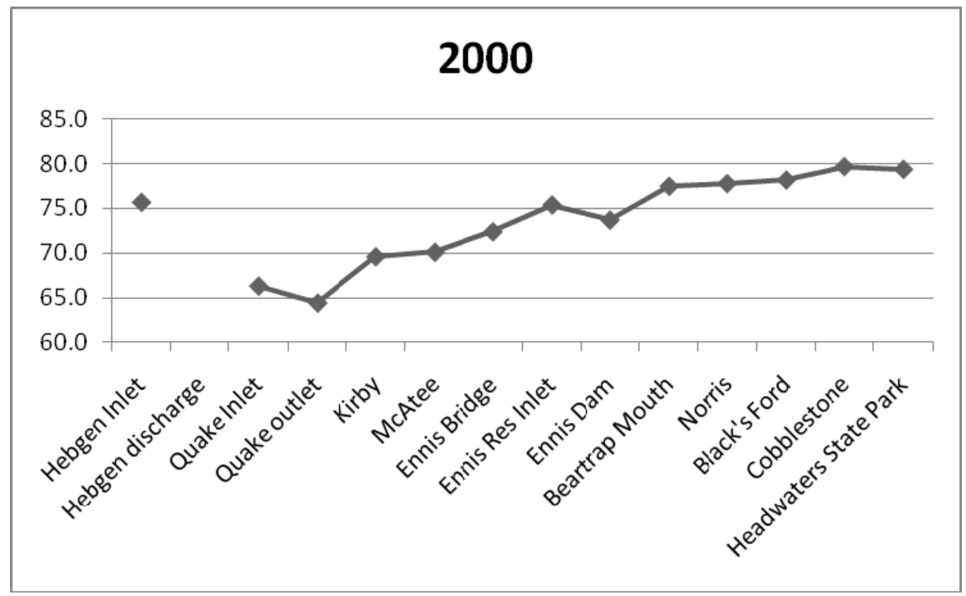
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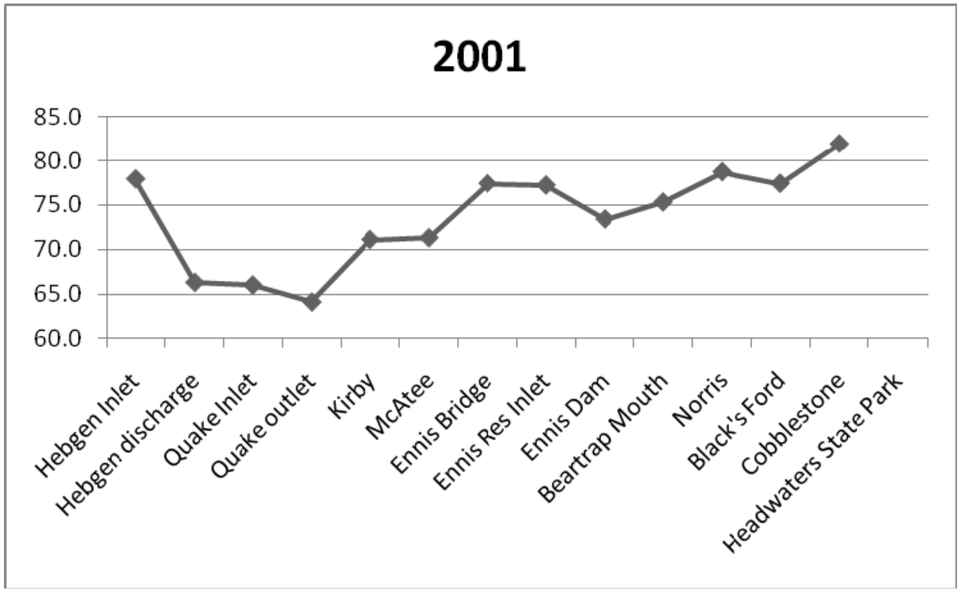
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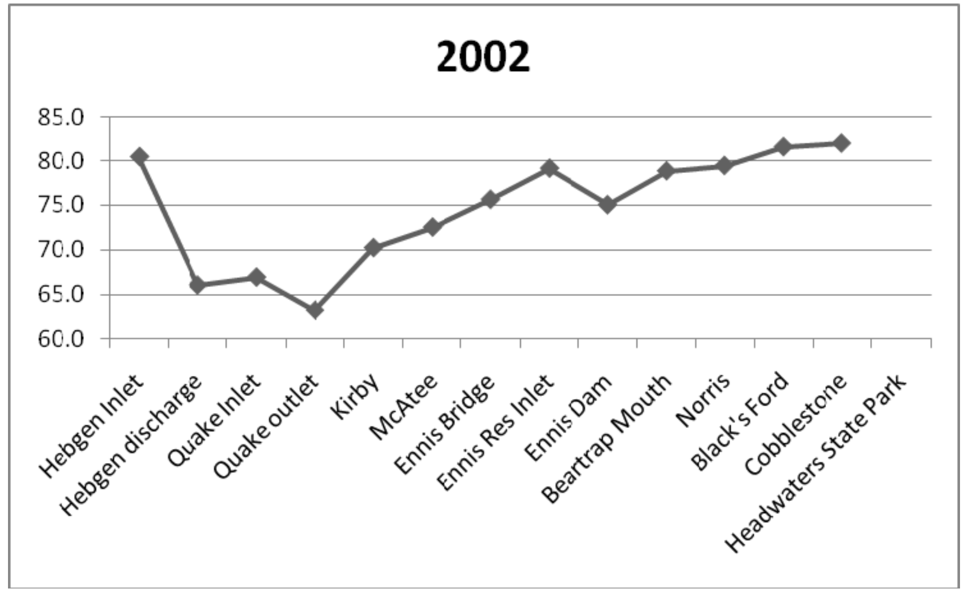
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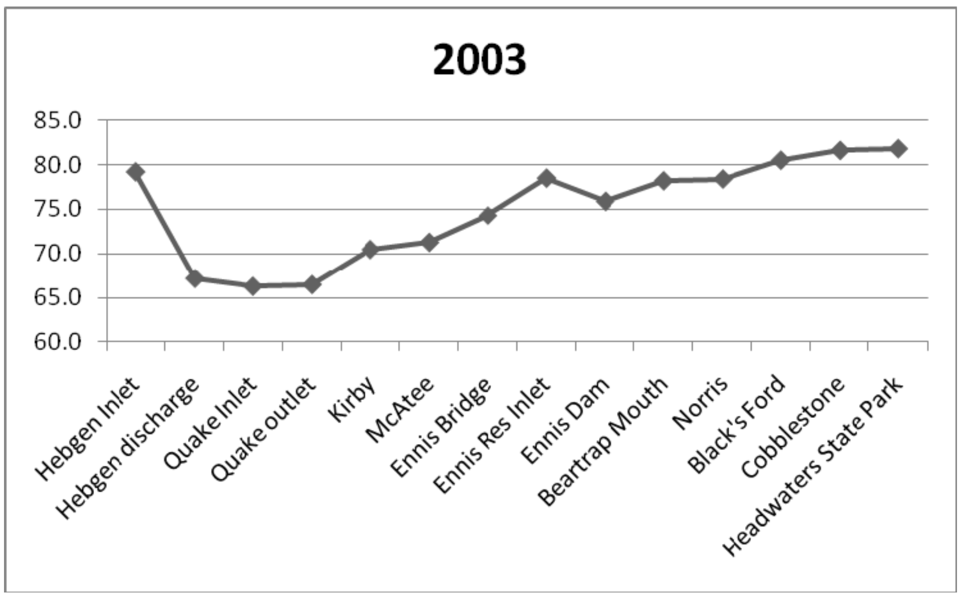
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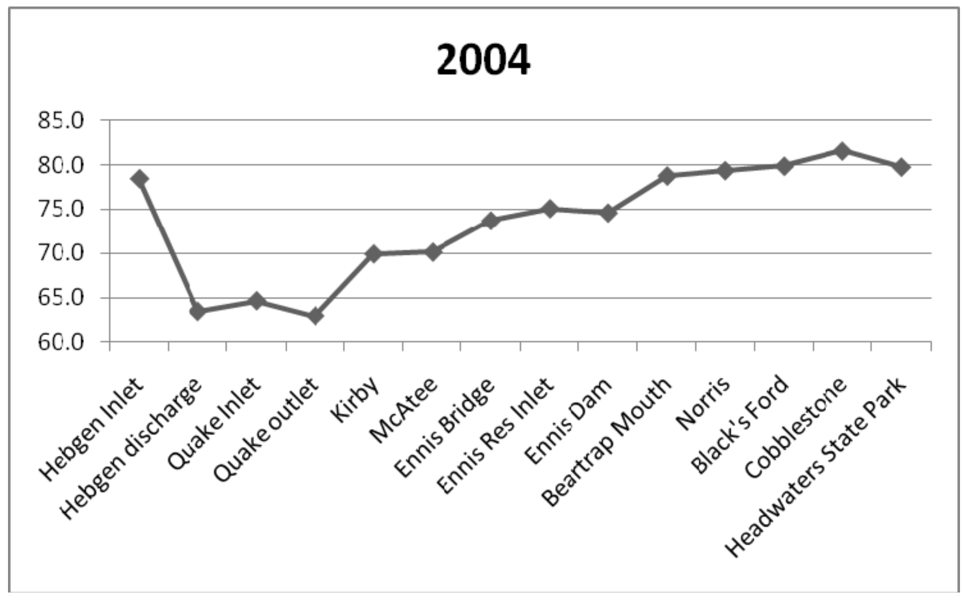
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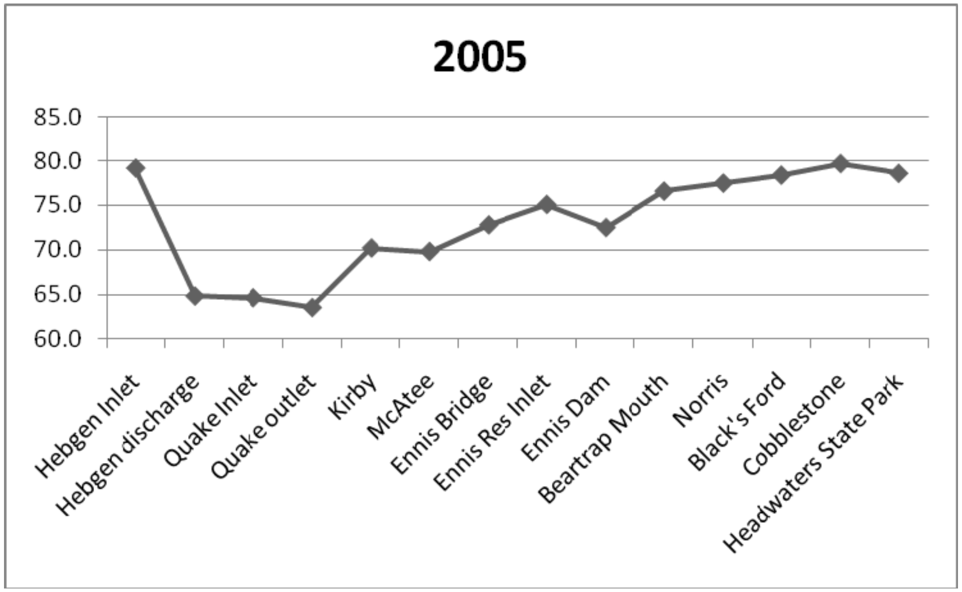
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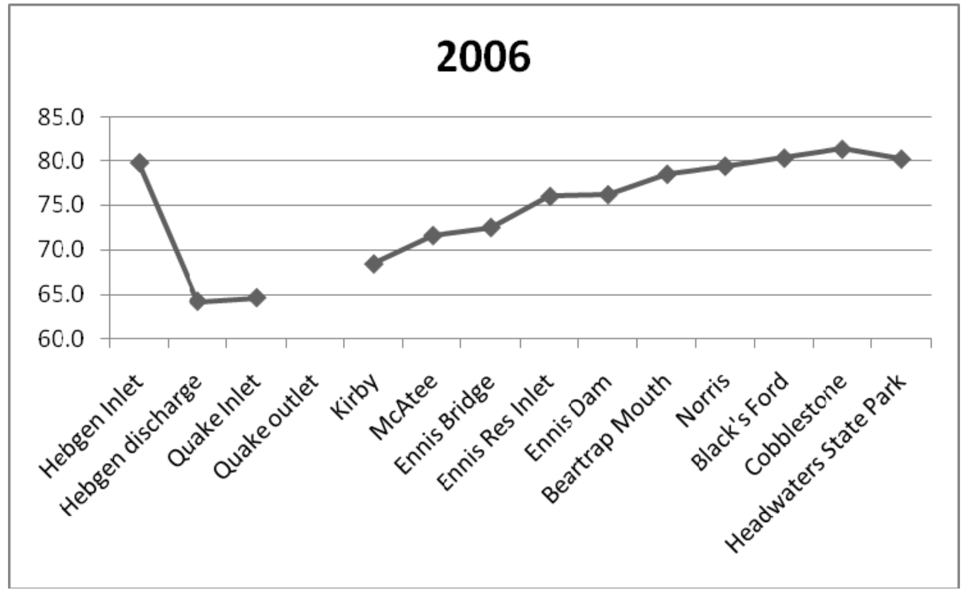
Headwaters State Park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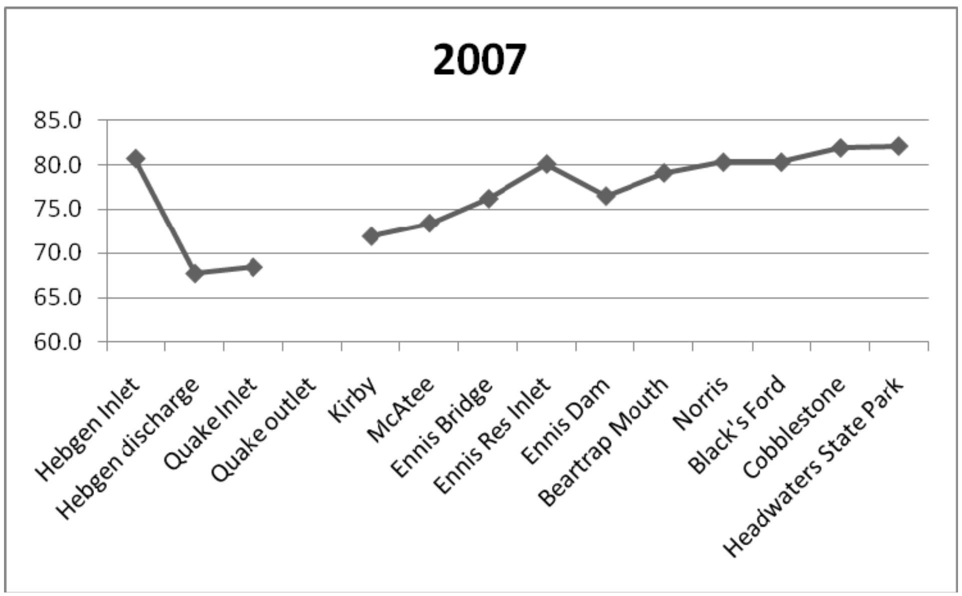
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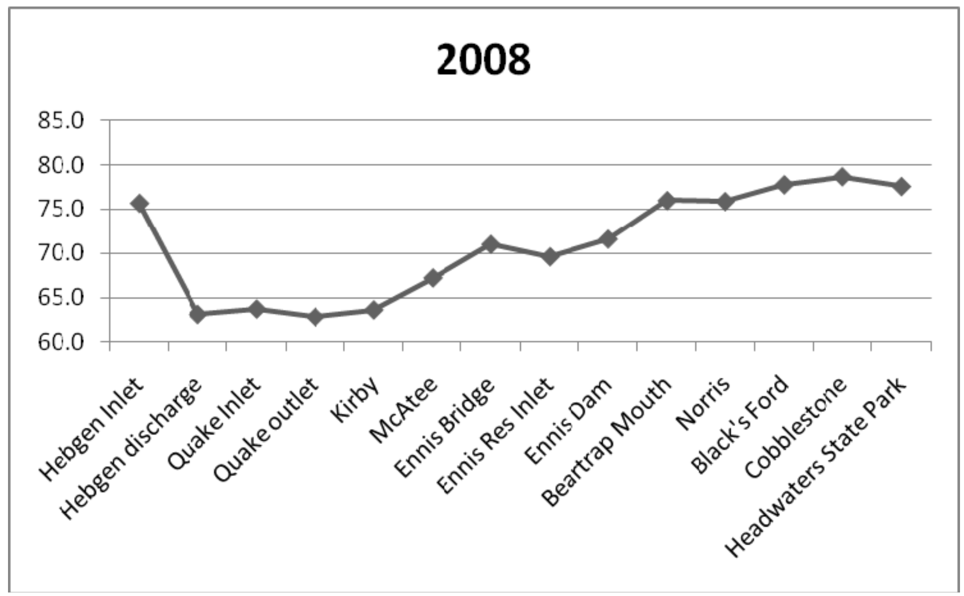
Headwaters State Park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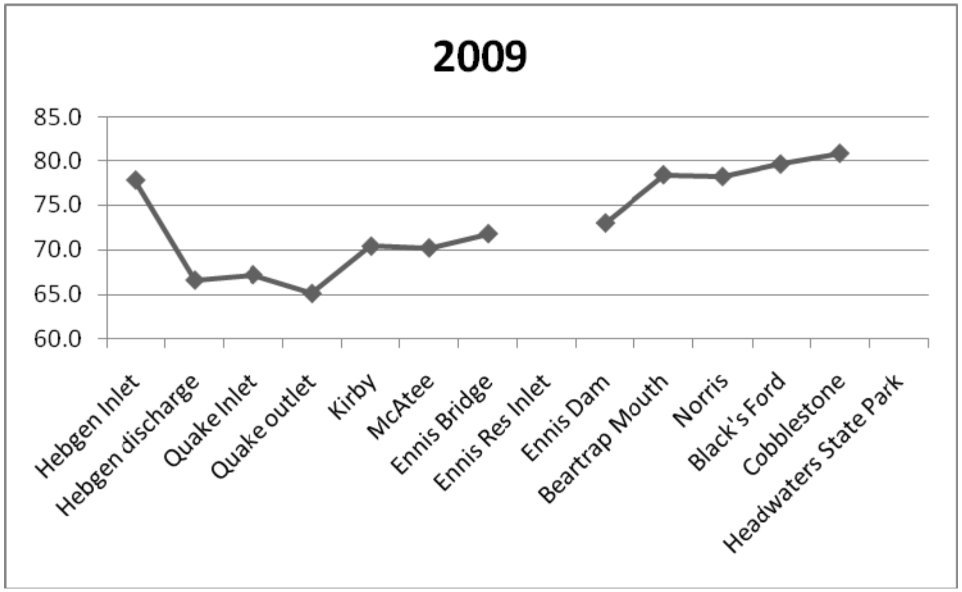
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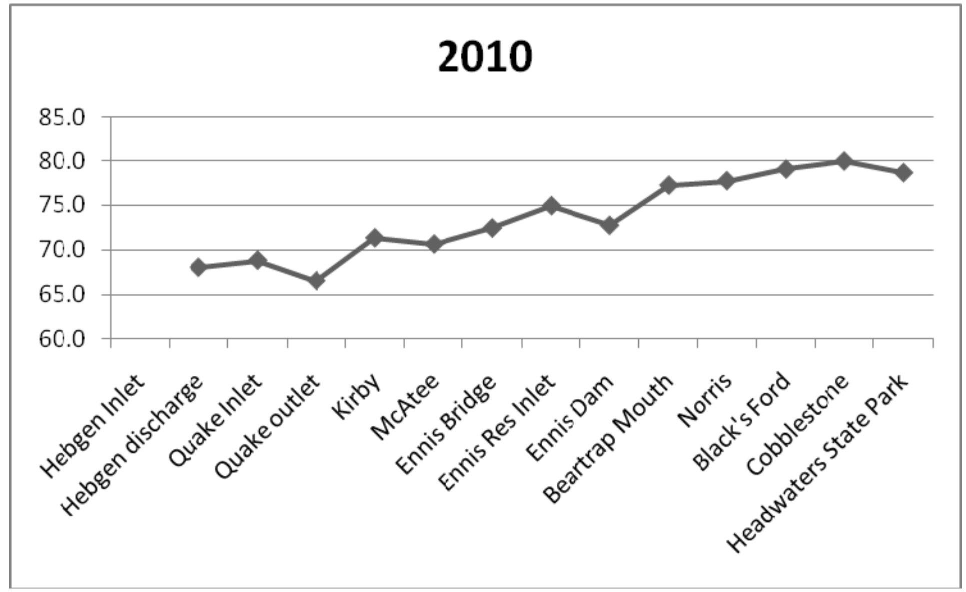
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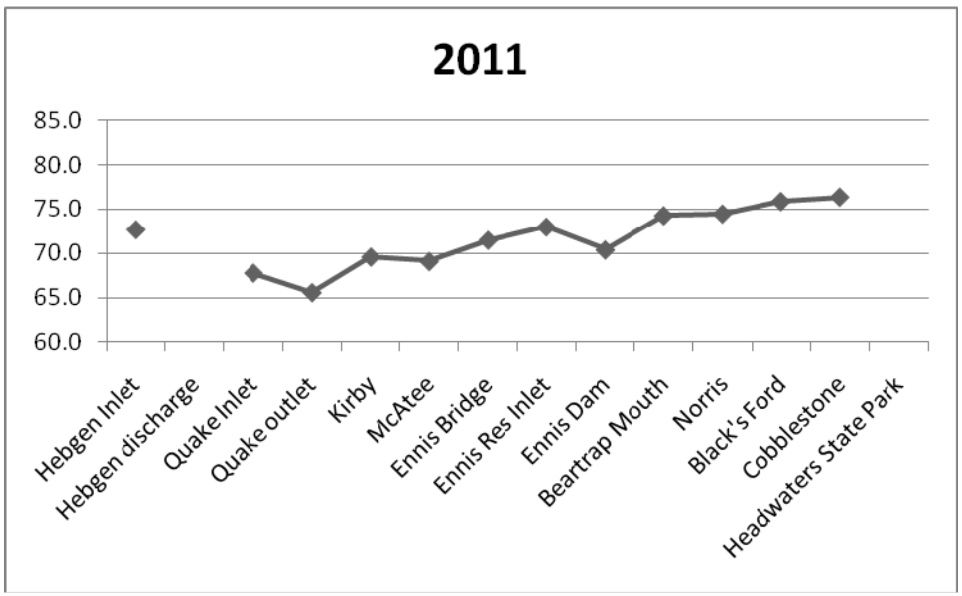
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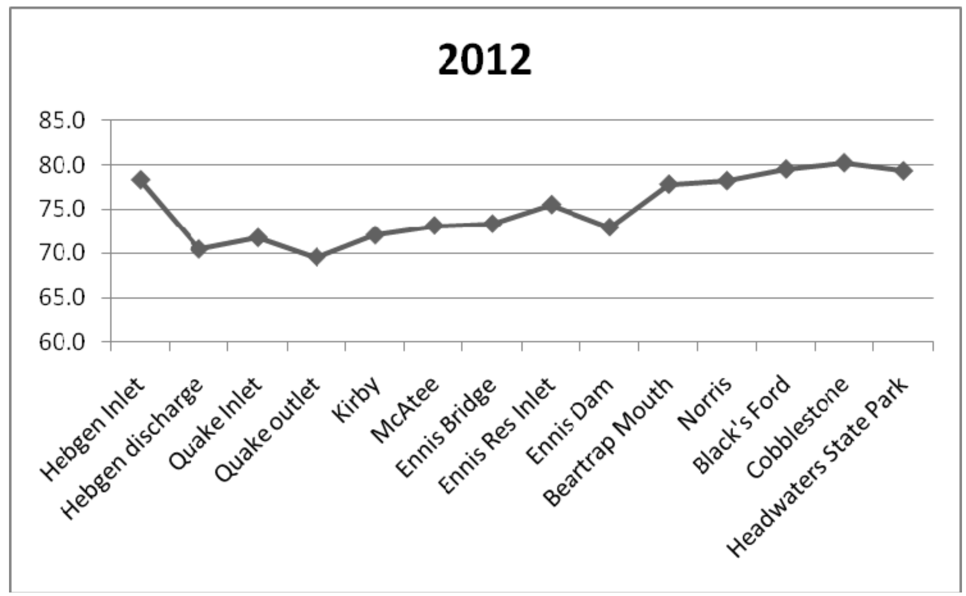
Cobblestone
Headwaters State Park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McAtee
Ennis Bridge
Ennis Res Inlet
Ennis Dam
Beartrap Mouth
Norris
Black's Ford
Cobblestone
Headwaters State Park

Appendix D

Sun Ranch Hatchery Contributions and Production
2001 – 2012

Drake & Associates 2012 Summary Report

Year	Donor Stream	M:F spawned	# eggs produced	Recipient Water	# eggs/fry out
2001	Papoose Ck - Madison	NA		Sun Pond	356 fry total
	MF Cabin Ck - Madison	23:12		Sun Pond	
2002	WF Wilson Ck - Gallatin	?:6		Sun brood pond	483 fry
	MF Cabin Ck - Madison	?:3		Sun brood pond	104 fry
2003	Ray Ck - Big Belts	25:9	2,420	Sun brood pond	566 fry
				Bar None Pond	560 fry
	Prickly Pear Ck - Missouri	4:1	NA	Prickly Pear	28
				Eureka Ck	120
				Little Tizer	52
	Hall Ck - Elkhorns	4:1	NA	Hall	20
				Little Tizer	91
2004	Cottonwood Ck - Blacktail	12:6	1,652	Sun brood pond	820 fry
	Muskrat Ck - Elkhorns	15:7	2,028	Bar None Pond	814 fry
	Ray F x McClure M (Madison)	4:8	1,410		
	Ray F x Hall M	2:1	362		
2005	Cottonwood Ck - Blacktail	13:6	2,849	Sun brood pond	528 fry
				disease testing	11 fry
	Browns 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
				disease testing	100 fry
				euthanized to reduce hatchery load	750 fry
				Moret Pond	700 fry
				calibration of CWT injector	5 fry
	Muskrat Ck - Elkhorns	18:9	NA	SF Crow Ck	2262 eyed eggs
2006	Browns Ck	1:1	301	Sun brood pond	284 fry
	Muskrat Ck - Elkhorns	16:8	2,027	Sun brood pond	184 fry
				Cherry Ck	1750 eyed eggs
	Whites Gulch - Big Belt Mtns	3:3	982	Cherry Ck	726 eyed eggs

Year	Donor Stream	M:F spawned	# eggs produced	Recipient Water	# eggs/fry out
2007	Muskrat Ck - Elkhorns	11:22	6,533	Cherry Ck	5445 eyed eggs
				Sun brood pond	291 fry
	Ray Ck - Big Belt Mtns	13:25	4,371	Cherry Ck	3467 eyed eggs
				Sun brood pond	194 fry
	Whites Gulch - Big Belt Mtns	4:8	1,688	Cherry Ck	1015 eyed eggs
				Sun brood pond	59 fry
	Sun brood pond	37:17	NA	Cherry Ck	2994 eyed eggs
				Sun brood pond	326 fry
				High Lake (YNP)	1611 eyed eggs
	Last Chance Ck - Madison (YNP)	12:8	NA	High Lake YNP	177 eyed eggs
2008	Muskrat Ck - Elkhorns	28:14	NA	Cherry Ck	3199 eyed eggs
	Ray Ck - Big Belt Mtns	23:12	NA	Cherry Ck	1700 eyed eggs
	Whites Gulch - Big Belt Mtns	11:6	NA	Cherry Ck	1015 eyed eggs
				Sun brood pond	117 fry
	Sun brood pond	28:10	NA	Cherry Ck	3218 eyed eggs
				Sun brood pond	571 fry
				High Lake (YNP)	2844 eyed eggs
	Last Chance Ck - Madison (YNP)	13:8	NA	High Lake (YNP)	286 eyed eggs
				Sun brood pond	70 fry
2009	Muskrat Ck - Elkhorns	24:12	NA	Cherry Ck	4134 eyed eggs
				Sun brood pond	311 fry
	Whites Gulch - Big Belt Mtns	8:5	NA	Cherry Ck	630 eyed eggs
				Cherry Lake	500 fry
				Sun Pond	283 fry
				Cottonwood Ck (R4)	1350 eyed eggs
	Ray Ck - Big Belt Mtns	20:10	NA	Cherry Ck	1911 eyed eggs
				Sun brood pond	15 fry
	Geode Ck (YNP)	17:16	NA	High Lake 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 - Yellowstone NP	5:5	NA	Little Tepee - Hebgen basin	443 eyed eggs
	Wally McClure - Hebgen trib	10:0	NA	Little Tepee - Hebgen basin	
	Brays Canyon	7:7	NA	Cherry Creek	1066 eyed eggs
				Sun brood pond	123 fry
	Prickly Pear - Elkhorm Mtns	8:4	NA	Eureka Creek - Elkhorn Mtns	641 eyed eggs
	Wild Horse	5:3	NA	Elkhorn - Gallatin	678 eyed eggs
				Wild Horse	76 eyed eggs
	Geode Creek - YNP	24:18	NA	EF Specimen Creek	4156 eyed eggs
	Sun brood pond	10:5	NA	Cherry Creek	398 eyed eggs 3400 fry
				Sun brood pond	496 fry
	WF Wilson	1:1	NA	eggs discarded - male was hybrid	
2011	Sun brood pond	16:7	6,488	Sun brood pond	818 fry
				Cherry Creek	848 fry
	Whites Gulch - Big Belt Mtns	7:7	1,296	Cherry Lake	458 fry
				Cottonwood Ck FWP R4	498 eyed eggs
	Muskrat Ck - Elkhorns	12:6	1,204	Sun brood pond	87 fry
				EF Specimen Creek	1046 eyed eggs
	Geode Creek (YNP)	16:8	1,628	EF Specimen Creek	1200 eyed eggs

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

2012 Sun Ranch WCT Recovery Program Summary

The Sun Ranch hatchery was opened, cleaned, and readied to accept pure westslope cutthroat trout (WCT) eggs on May 16, 2012. We initially ran our well for a week to ensure that we flushed all iron and other settled metals that could be detrimental to incubating eggs.

The first eggs were delivered by a Yellowstone National Park fisheries biologist on May 25. Those eggs were taken from Geode Creek in YNP. The total seasonal egg take from the Park was 4370.

Drake & Associates personnel trapped and spawned nine females and thirty one males from the Sun Ranch westslope cutthroat brood pond, beginning on May 18. These pairings resulted in 16 lots, and provided 8787 eggs. Protocol dictates that we use a minimum of two males for every viable lot of eggs.

Unlike past years when we trapped continuously in the brood pond, and checked traps every other day, this year we tried an alternate approach. We placed traps in three locations in the pond, but only "fished" with those traps two or three times a week. This approach resulted in catching close to two hundred fish, as compared to 40 to 50 in previous years.

The hatchery began receiving wild source eggs from MT Fish, Wildlife & Parks (FWP) employees on June 15. Three creeks from the Big Hole River basin, Sappington, Bryant, and Plimpton, yielded a total of 5,780 eggs throughout June and July.

Water temperature determines how long eggs incubate before hatching. The eggs taken in May and early June were incubated at our well's water temperature of 46 degrees Fahrenheit. Eggs delivered to the hatchery in late June and July were placed in warmer water, 50 – 54 degrees.

This temperature variation allows us to manipulate egg development ensuring a more uniform redistribution of the eggs into their respective recipient streams. We have two custom designed in-line heaters built exclusively for our recovery efforts allowing us the luxury of varying the temperature between incubators.

The eggs were incubated at the hatchery until they developed eyes. This typically occurs approximately 10 to 15 days before the egg hatches. Once eyed, the eggs were transported to recipient streams where they were placed in remote site incubators (RSI's). YNP eggs were placed in the inlet tributary to High Lake. The wild eggs taken by FWP, were introduced to Cherry Creek, in the Big Hole River drainage.

Drake & Associates personnel met FWP staff at various locations -- Ennis, MT, Three Forks, MT, and Twin Bridges, MT, to deliver wild eyed eggs for RSI dissemination.

Approximately 6500 eggs were reared to fry stage in hatchery tanks for stocking into both the Sun Ranch brood pond, and Cherry Creek in the Madison River drainage. 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.

On August 24, a total of approximately 1500 fry were introduced to the Sun Ranch brood pond. These fry represent an equal percentage of Sun Ranch brood lots and those from wild sources. This approach provides a broad genetic WCT representation and a source for genetically pure eggs for future recovery efforts.

On August 28, slightly less than 4,000 fry were stocked in Cherry Creek, in the Madison River drainage. These fish averaged between 2.5 to 3 inches long, and were distributed in several sites of the lower reaches of the creek, above the water falls.

The hatchery was cleaned, disinfected, and the water turned off for the season on September 4, 2012.

Below is a table summarizing this year's hatchery results:

2012 Sun Ranch Hatchery Results

	Total Eggs	Eyed	Ave. Percent
YNP Geode Crk. 19 Lots, 18F 39M	4370	3550	81
Sun Ranch pond 16 Lots, 9F 31M	8787	6288	72
Sappington Crk. 10 Lots, 10F 20M	1977	1556	79
Bryant Crk. 11 Lots, 11F 22M	2963	2398	80
Plimpton Crk. 8 Lots, 8F 16M	840	518	62

Appendix E

PPL Montana funded Westslope Cutthroat Trout genetic testing results

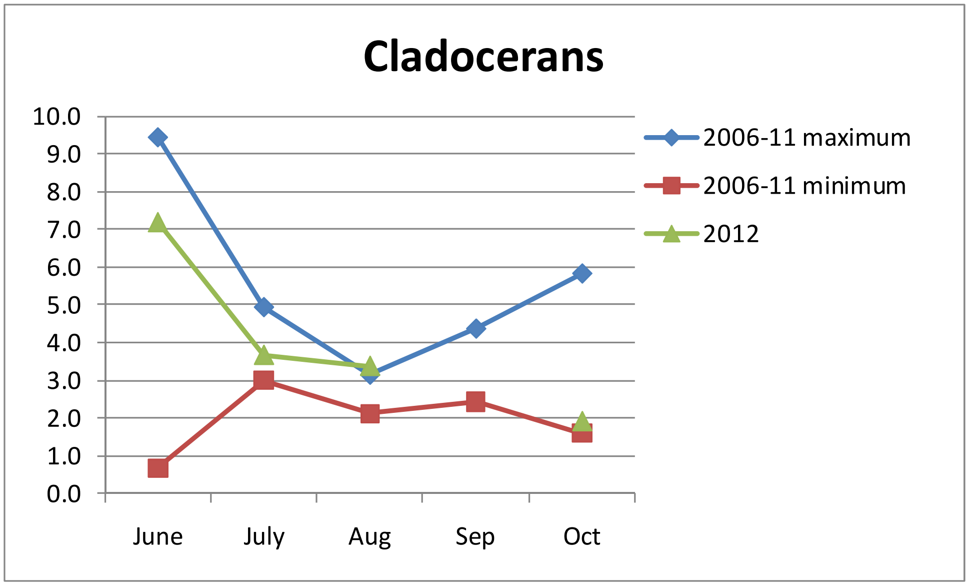
Westslope cutthroat populations tested for genetic status under PPL Montana 2188 Program

W = westslope cutthroat trout; Y = Yellowstone cutthroat trout; R = rainbow trout

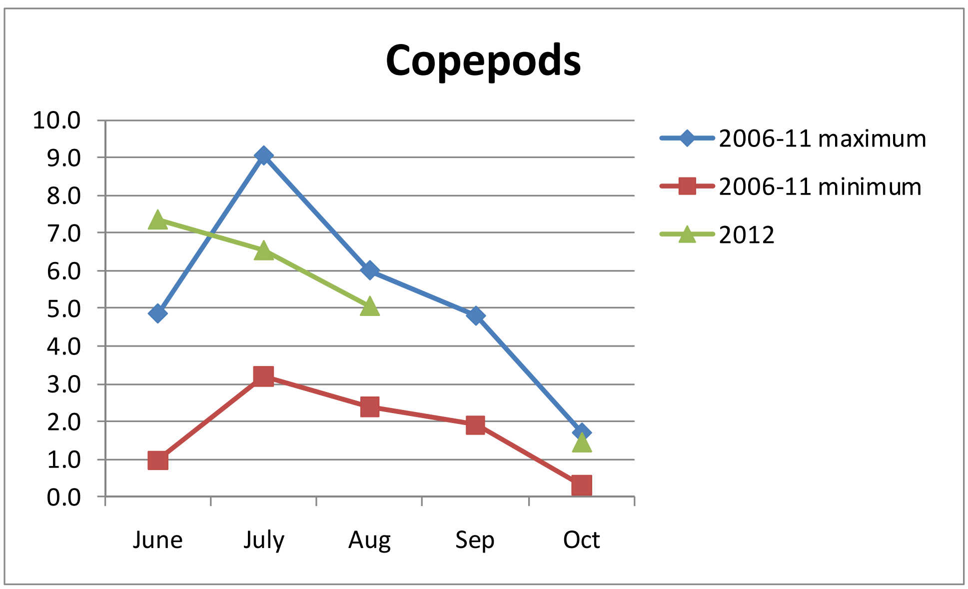
Stream	Collection date	Number of fish	lab analysis
Pine Butte Creek	11/1/2012	23	not available
Deadman Creek	11/1/2012	9	not available
McClure Creek	10/7/2012	16	100% W
SF Madison River	8/29/2012	113	89 fish ≥ 85% WCT, 24 < 85% (x Rb)
Wall Creek	10/24/2011	32	95%WCT, 0.4% Rb, 4.6% YCT
SF Madison	9/21-23/2011	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	

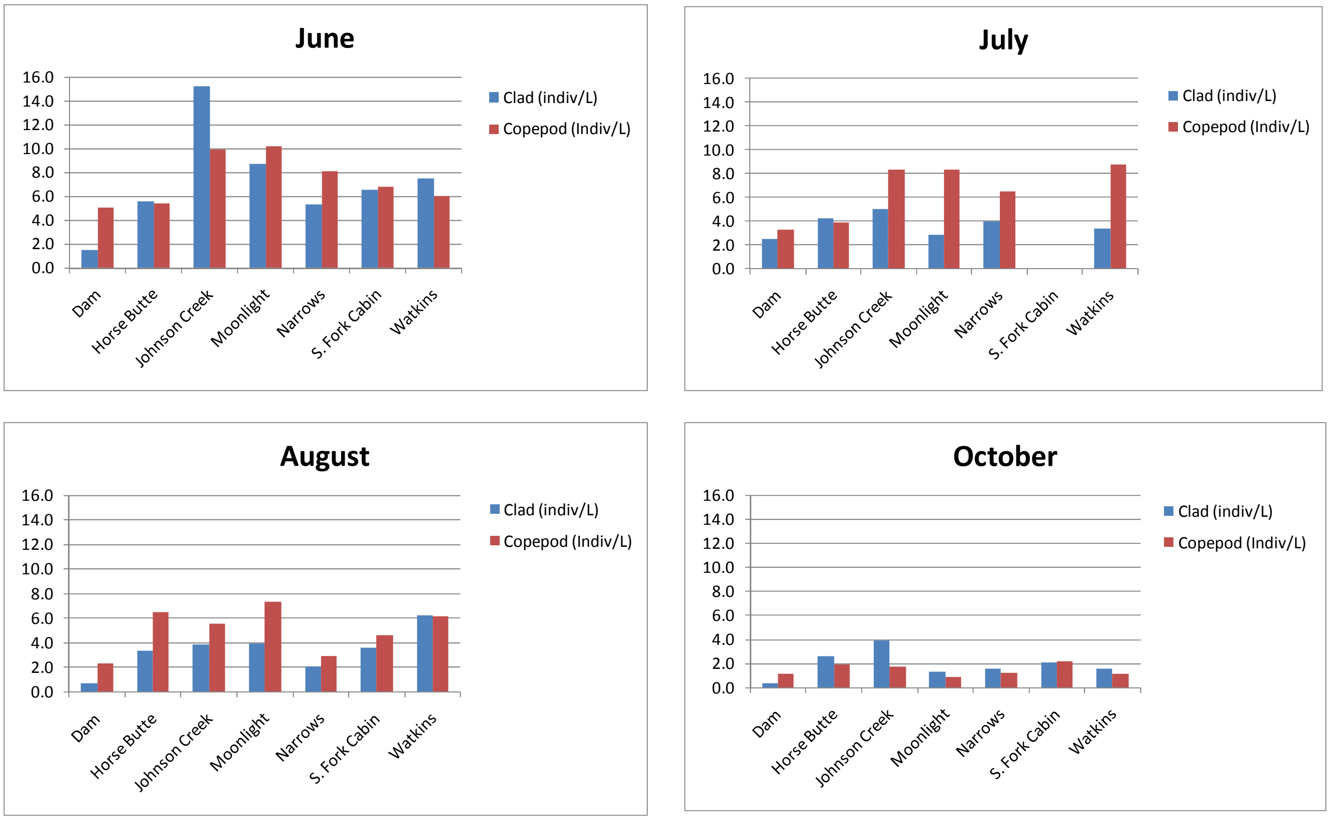
Appendix F



Appendix Figure I -1. Monthly maximum and minimum cladoceran average densities vs 2012 monthly average densities at seven sample sites.



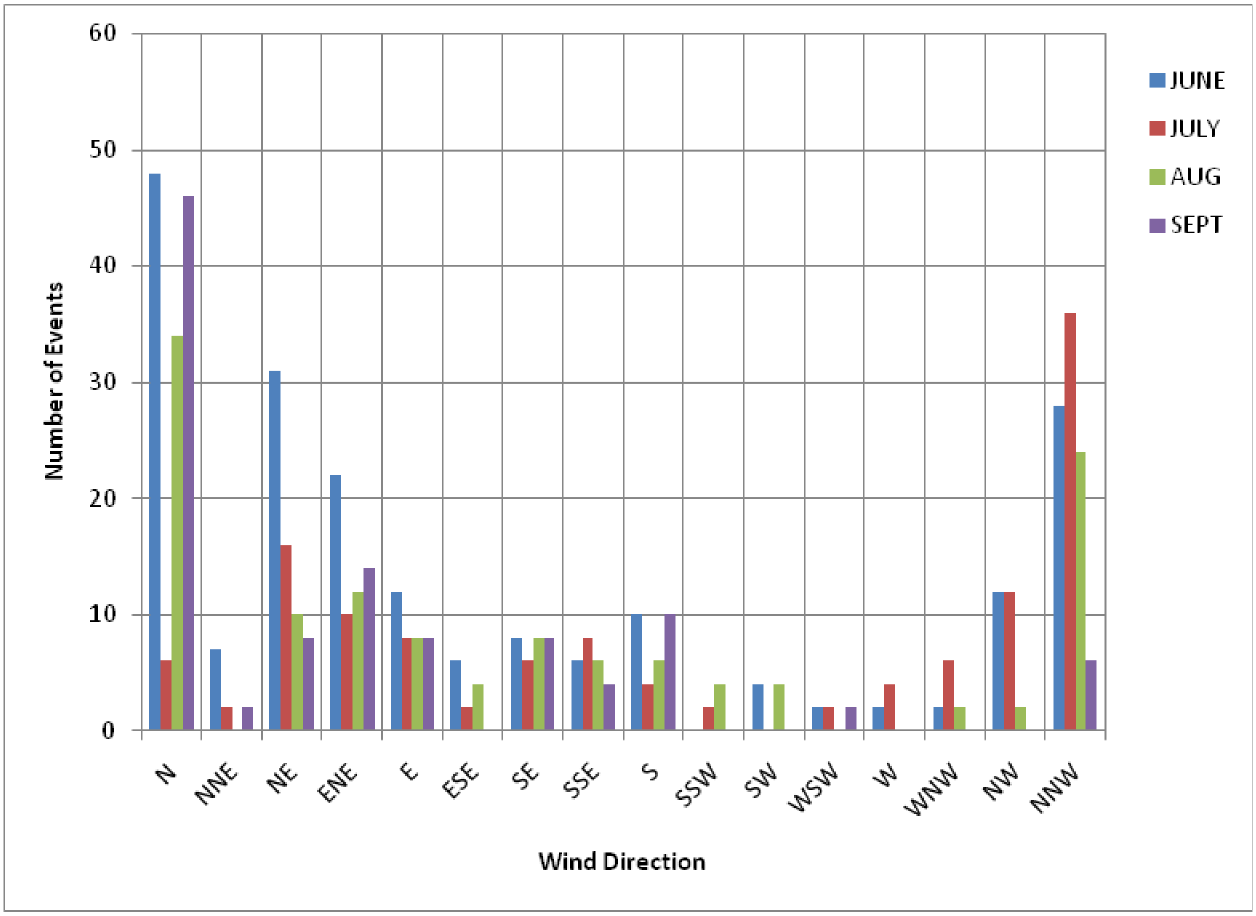
Appendix Figure I -2. Monthly maximum and minimum copepod average densities (#/liter) vs 2012 monthly average densities at seven sample sites.



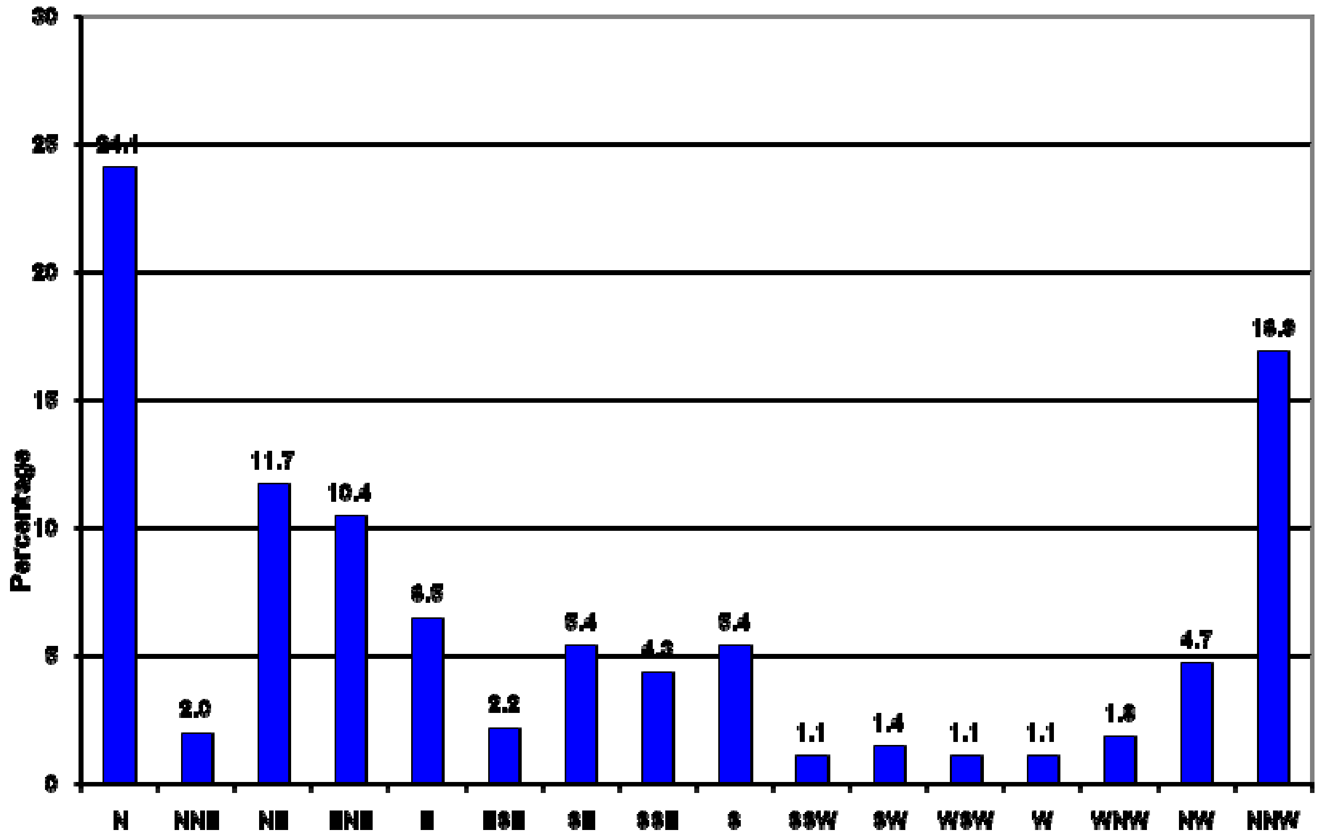
Appendix Figure I -3. Monthly cladoceran and copepod densities (#/liter) at seven sample sites, 2012.

Appendix G

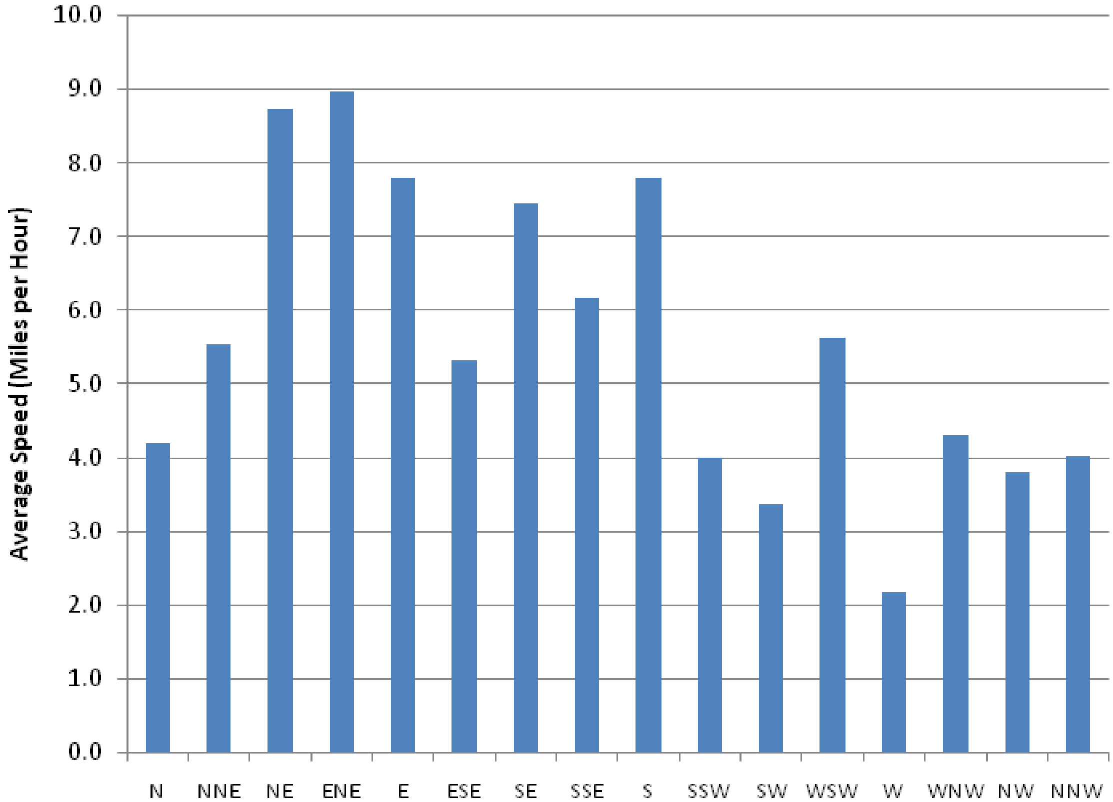
Hebgen Reservoir wind data, 2012



Appendix Figure G-1. Number of wind events by direction for Hebgen Reservoir, June - September, 2012.



Appendix Figure G-2. Distribution of wind direction by percent occurrence for Hebgen Reservoir, June – September, 2012.



Appendix Figure G-3. Directional average wind speed (miles per hour) at Hebgen Reservoir, June – September, 2012.