Madison River Drainage Fisheries

and

Madison River Drainage Westslope Cutthroat Trout Conservation and Restoration Program

2010
Annual Report
to
PPL Montana
Environmental Division
Butte
www.pplmontana.com

and

Turner Enterprises, Inc.
Bozeman

by

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Montana Fish, Wildlife, & Parks
Ennis
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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
Blue Ribbon Flies ....www.blueribbonflies.com
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
New Zealand Mudsnail in the Western USA........
www.esg.montana.edu/aim/mollusca/nzms
PPL Montana..www.pplmontana.com
Protect Your Waters...................................www.protectyourwaters.net <u>or</u> .com
Whirling Disease Foundation.........................www.whirling-disease.org

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/wildthings/fishAndWildlifeLibrarySearch.html

FERC Articles addressed in this report

FERC Article	item	report topic	page number Methods	page number Results
403	NA	River Discharge	7	38
408	(1)	Hebgen gillnetting, disease monitoring - Effect of project operations on fish populations	25	50
	(3)	Reservoir drawdown effects on fish populations	25	50
	(5)	Population Estimates – project operations effects	6	33
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EXECUTIVE SUMMARY

Two adult Arctic grayling were captured during electrofishing in the Channels section of the Madison River immediately upstream of Ennis Reservoir in April 2010. No young-of-the-year Arctic grayling or whitefish were captured during Ennis Reservoir beach seining in October 2010. Other species captured at index sites were Rocky Mountain (mottled) sculpin, and juvenile brown trout, Utah chub, and long-nose dace. Some beach seining index sites were inaccessible due to a rock slide that damaged Madison (Ennis) Dam. The rock slide caused PPL Montana to draw the reservoir down approximately five feet for damage inspection. Following inspection the reservoir was refilled to the normal winter elevation of two feet below full pool. The reservoir was at winter elevation when beach seining was conducted. Fish distribution may have been altered by this water level manipulation. Numbers of rainbow trout over six inches increased in all three river electrofishing sections from 2009 levels, most notably in the Varney section where they had suffered a severe decrease from 2007 – 2009. Numbers of brown trout showed little change to a slight decrease in all three sections. Water temperature was monitored at 15 sites and air temperature at 7 sites within the Madison Drainage. Six Madison River Fishing Access Sites were sampled for New Zealand mud snails and selected other aquatic nuisance species by FWP ANS staff in 2010. No New Zealand mud snails, Eurasian Watermilfoil or juvenile or adult Zebra or Quagga mussels were detected. Sentinel fish from hatchery rainbow trout stock are still severely infected by whirling disease when placed in cages the river, but the wild rainbow trout population has rebounded to approximately 60 percent of its pre-whirling disease level. Fisheries monitoring was conducted on Jack, O'Dell and Watkins creeks and the South Fork of the Madison River as part of stream channel restoration and habitat improvement projects. Spawning season movements of 27 radio implanted rainbow trout are reported. The Sun Ranch hatchery was used to incubate westslope cutthroat trout eggs for introduction into five streams in southwestern Montana. All planned non-native fish removals for the Cherry Creek Native Fish Introduction Project were completed in 2010 with a treatment of a portion of Phase 3 and all of Phase 4. Rotenone carried several miles beyond its anticipated decay point on one day, resulting in mortality of non-target fish downstream of the project area. Westslope cutthroat trout eyed egg introductions were continued in Phase 2 and Phase 3. The number of rainbow trout captured during annual Hebgen Reservoir gillnetting decreased from 2009 while average length increased. The proportion of rainbow trout over 14 inches in the Hebgen gillnet catch has increased noticeably since 2005. Juvenile trout emigration trapping from Hebgen Reservoir tributaries was conducted. Zooplankton density in Hebgen Reservoir was monitored.

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INTRODUCTION

Montana Fish, Wildlife, & Parks (FWP) has conducted fisheries studies in the Madison River Drainage since 1990 to address effects of hydropower operations at Hebgen and Ennis dams on fisheries, and to assess the status of the Arctic grayling *Thymallus arcticus* population of Ennis Reservoir (Byorth and Shepard 1990, Clancey 1995, Clancey 1996, Clancey 1997, Clancey 1998a, Clancey 1999, Clancey 2000, Clancey and Downing 2001, Clancey 2002, Clancey 2003, Clancey 2004, Clancey and Lohrenz 2005, Clancey 2006, Clancey 2007, Clancey 2008, Clancey and Lohrenz 2009, Clancey and Lohrenz 2010). 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 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). Each entity has equal authority in decision making within the TAC. 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

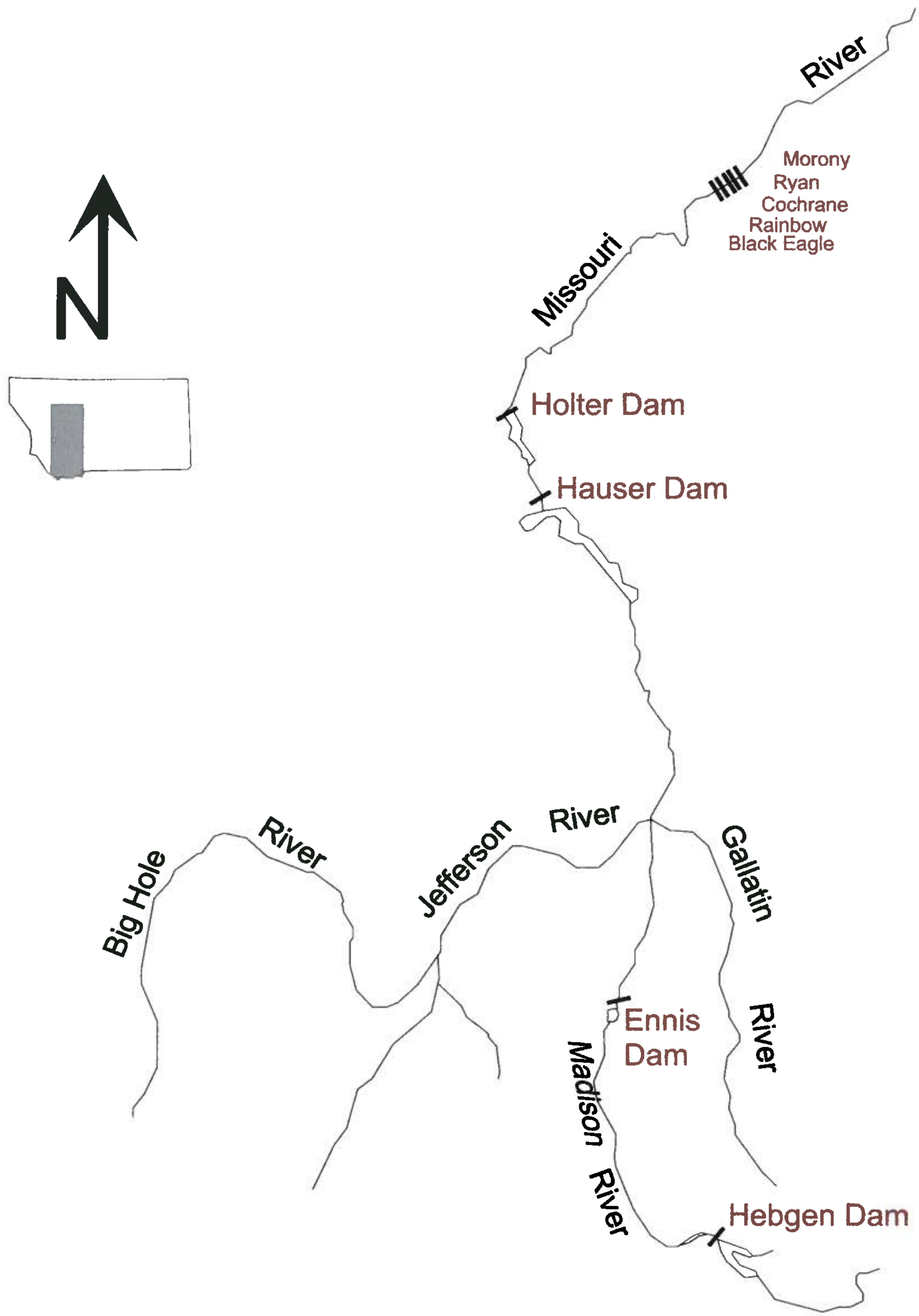


Figure 1. Map showing locations of PPL Montana dams on the Madison and Missouri rivers (FERC Project 2188).

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

A beach seine (Figures 2 & 3) is used to monitor index sites in Ennis Reservoir (Figure 4) for young-of-the-year grayling and other fish species. Seining is conducted by pulling a 125 x 5 foot fine-mesh net along shallow areas in the reservoir.

Figure 2. Beach seining in Ennis Reservoir.

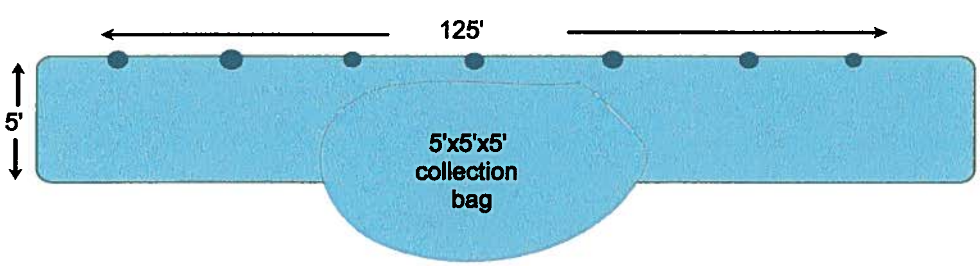


Figure 3. Depiction of a beach seine.

Figure 4. Locations of Ennis Reservoir 2010 beach seining sites. The numbers correspond to locations described in Appendix B2.

Mobile anode electrofishing surveys (Figure 5) were conducted in the Channels section of the Madison River (Figure 6) in April to assess the status of the Madison Arctic grayling spawning population. Up to three mobile anode drift boats were operated simultaneously throughout the braided river channels on sample days.

The MadTAC provided $15,000 to Big Hole River Arctic grayling recovery efforts in 2010.

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

Population Estimates

Electrofishing from a driftboat mounted mobile anode system (Figure 5) is the principle method used to capture Madison River trout for population estimates in several sections of the Madison River (Figure 6). Fish captured for population estimates are weighed and measured, marked with a fin clip, and released. A log-likelihood statistical analysis (Montana FWP 2004) is used to estimate trout populations.

Aging of Madison fish was ceased in 2000 due to the significant time requirement necessary to continue that activity, though it was continued in the Norris and Pine Butte sections through 2001 and 2003, respectively, to provide information for specific research or management activities.

Rainbow Trout Radio Telemetry

In September 2009, 35 Madison River rainbow trout *Oncorhynchus mykiss* were implanted with radio transmitters to compare spawning season movements to a similar study conducted in 1999 (Downing et al. 2002) that included identification of rainbow trout spawning

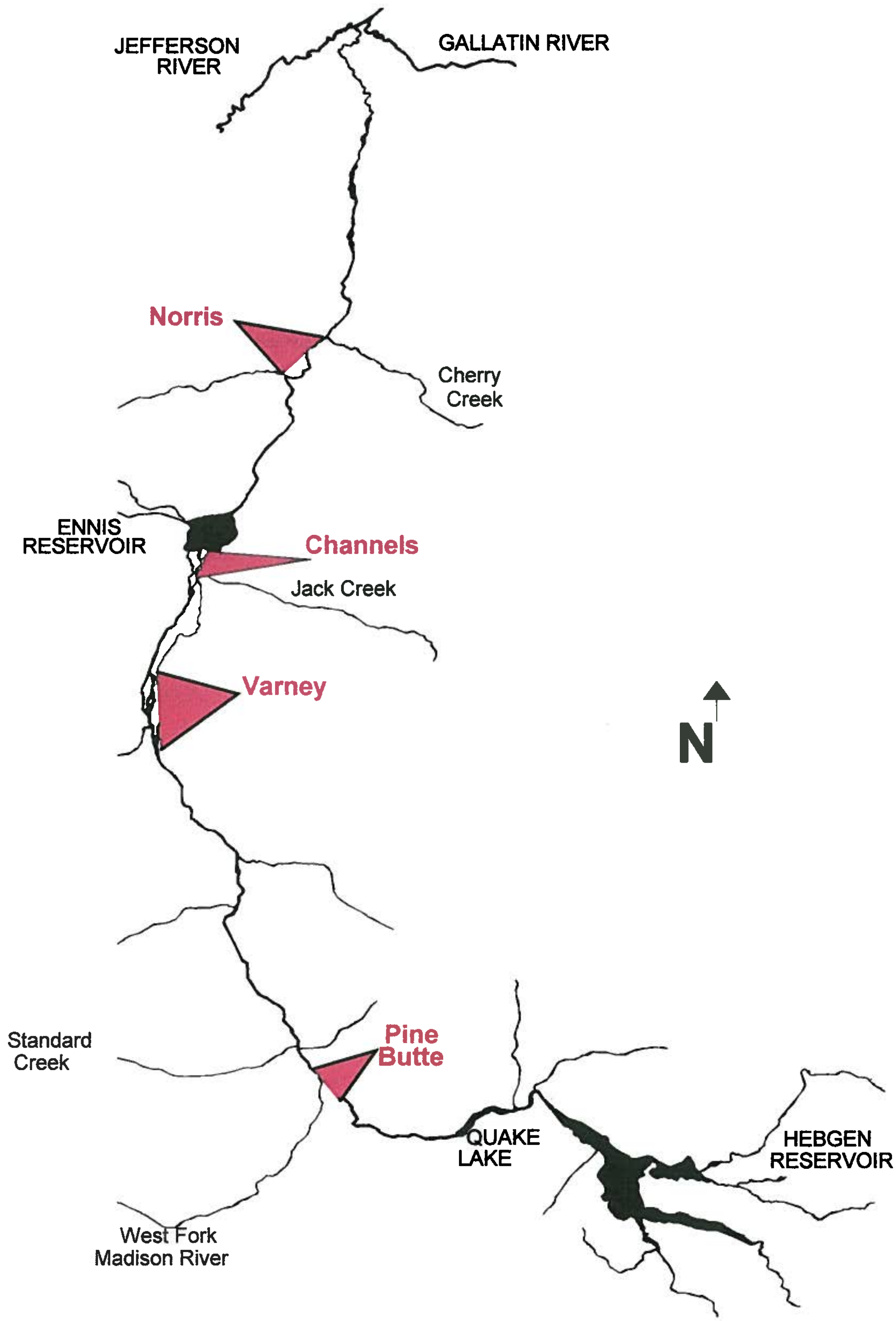


Figure 6. Locations of Montana Fish, Wildlife, & Parks 2010 Madison River population estimate sections.

sites in the Madison River upstream of Ennis Reservoir. The transmitters are designed to be on 13 hours each day, with a rated battery life of two years. Transmitters were implanted in fish captured during routine Fall electrofishing in the Pine Butte, Snoball and Varney sections. Additionally, rainbow trout between Burnt Tree and Ennis FAS were captured in Fall 2009 for implantation. Relocations are conducted from a fixed wing aircraft, from a raft, or from roads along the river. Aerial surveys occur more frequently during the rainbow trout spawning season in April – June and less frequently at other times of year.

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° F or higher and forecast air temperature at Three Forks for the following day is 80° F or higher. The volume of water released in the pulse is determined by how much the water and/or air temperature exceeds the minimum thresholds (Table 1). The increase in water volume in the lower river reduces the peak water temperature that would occur at the 1,100 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.

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°	≥ 80°	
		No action	1400 cfs	
Pulsing Required, Volume Contingent of Weather Forecast > 90°F	≥ 70°, < 72°	< 90°	≥ 90°, < 95°	≥ 95°
		1400 cfs	1600 cfs	2100 cfs
Pulsing Required, Volume Contingent of Weather Forecast > 85°F	≥ 72°, < 73°	< 85°	≥ 85°, < 90°	≥ 90°
		1400 cfs	1600 cfs	2100 cfs
Pulsing Required, Volume Contingent of Weather Forecast > 85°F	≥ 73°	< 85°	≥ 85°	
		1800 cfs	2400 cfs	

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.

Temperature Monitoring

Water temperature was recorded at 15 sites and air temperature at seven sites throughout the Madison River Basin from upstream of Hebgen Reservoir to the mouth of the Madison River at

Headwaters State Park (Figure 7). A water temperature recorder was deployed between the Kirby and McAtee sites in 2010 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 8). The five signs are located near major highway intersections in the West Yellowstone area, notifying drivers entering and leaving the area of the TIS system. The TIS notifies anglers and water recreationists of the presence of New Zealand mud snails 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. 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 9) and vehicle tailgate wraps and posters (Appendix E) to create public awareness of aquatic nuisance species issues.

In May 2010, FWP ANS field crews surveyed six fishing access sites on the Madison River. Temperature, GPS coordinates, pH, weather conditions, horizontal plankton tow, notes on substrate, and invertebrate and macrophyte surveys were collected. A minimum of 200 feet is surveyed at each site. Horizontal plankton tows were conducted to sample for Zebra and Quagga mussel veligers.

In addition to regular biological monitoring, angler/boater surveys were conducted on the Madison River to educate the public on AIS issues. In 2010, check stations were located at Warm Springs FAS from June 15th-18th and at Lyons Bridge FAS from August 20th-21st and September 2nd-5th. As part of the angler/boater check stations, additional plankton samples were collected. Samples were collected at Warm Springs and Blacks Ford FAS on July 16th-18th, at Lyons Bridge FAS on August 22nd, and at Windy Point, Varney Bridge and Burnt Tree Hole on September 5th.

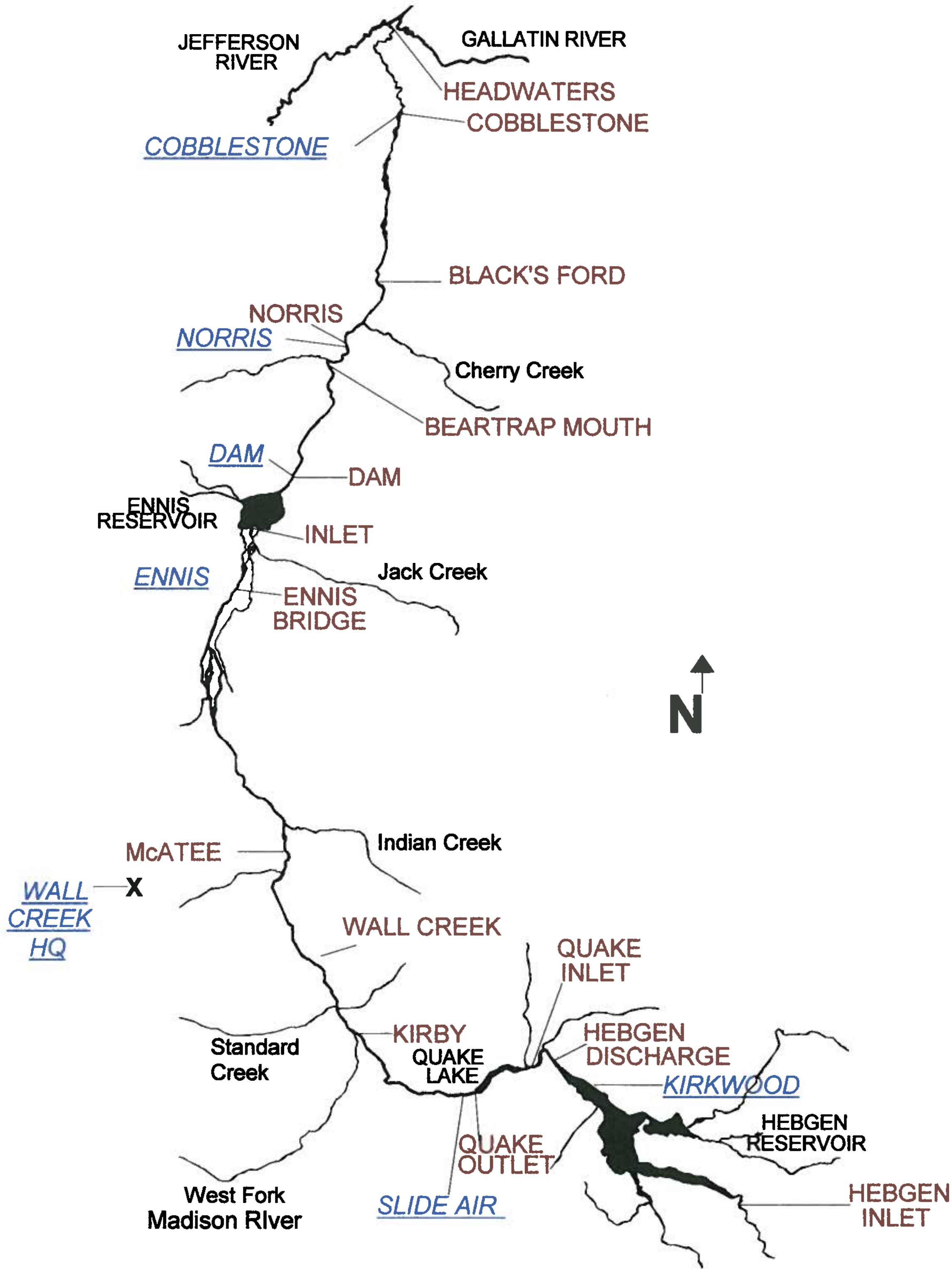


Figure 7. Locations of Montana Fish, Wildlife, & Parks temperature monitoring sites. Air temperature monitoring sites are blue; water temperature monitoring sites are red. A river site near Wall Creek was added in 2010.

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

Figure 9. Inspect/Clean/Dry billboard.

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 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.

Whirling Disease

Whirling disease monitoring has been conducted in the Madison River since 1996 by using sentinel cage techniques. Each cage holds 50 young-of-the-year rainbow trout for 10 days. At the end of the 10 day period, fish are transferred to whirling disease free water in a laboratory where they are held until they are 90 days old, at which time they are euthanized and sent to the Washington Animal Disease Diagnostic Lab (WADDL) for analyses. Juvenile rainbow trout used in the studies are not offspring of Madison River fish, but are from the same captive stock used since studies began in 1996. This stock has been used continuously over the years to allow comparison over time and among various rivers.

In 2010, twelve sites in the Madison below Hebgen were monitored for whirling disease infection rates. Two cages were simultaneously deployed at each site to measure risk at the upper and lower ends of each site.

Dave Kumlien, Executive Director of the Whirling Disease Foundation, presents two articles regarding whirling disease on the Blue Ribbon Flies webpage. These articles summarize some of the advances that have been made by whirling disease researchers and additional information that is needed. To view these and other articles, go to www.blueribbonflies.com, click on Journal, then on Articles and Essays.

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 Madison District of the U.S. Forest Service and Yellowstone National Park are conducting projects to benefit westslope cutthroat trout and/or to restore stream habitat in tributaries to the Madison River. Grant money from the PPL Montana relicensing agreement was granted to each of those 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 six streams and the Sun Ranch brood stock in 2010. All fertilized eggs were transported to the Sun Ranch Hatchery for incubation and hatching (Figure 10). A portion of the resulting fry from one stream and the Sun brood were introduced to the Sun Ranch Brood Pond (Figure 11) to contribute to the Sun Ranch brood development. The contributing stream was a new population not previously represented in the brood. Eggs and fry from the Sun Ranch Pond broodstock were used for introductions in Cherry Creek and stocked into the pond to maintain the Sun Ranch brood.

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.

Cherry Creek Native Fish Introduction Project

The Cherry Creek Native Fish Introduction Project was initiated in 2003. The project area is comprised of over 60 miles of stream habitat and the 7-acre, 105 acre-foot Cherry Lake, and includes all of the Cherry Creek Drainage upstream of a 25-foot waterfall (Figure 12) approximately 8 miles upstream of the Madison River confluence. The only fish species present in the project area in 2003 were brook trout *Salvelinus fontinalis*, rainbow trout, and Yellowstone cutthroat trout *Oncorhynchus clarki bouvieri* (YCT; Figure 13). The large size of the project area required that the project be completed in phases. Each phase was treated with fish toxicants for at least two consecutive years. In 2010 all of Phase 4 was treated twice. Additionally, the mainstem portion of the Phase 3 was treated to remove fish that leapt the barrier during Spring runoff when water rose high enough to run overland between the two barriers separating Phases 3 and 4 (Figure 14) and caused erosion around one side of one of the barriers.

Preparatory fieldwork consisted of determining stream flow time, placing application station markers, posting sentinel fish, setting up the detoxification station, and some electrofishing to assess thoroughness of the previous year's treatments.

Fintrol became unavailable for use at Cherry Creek in 2007 due to a production problem, so a rotenone product called CFT Legumine™ (CFT) was used beginning that year. Bioassays were conducted in the East Fork Cherry Creek in July 2007 to determine the effective exposure time of the CFT (Table 2). Based on bioassay results, CFT label instructions, and results of the 2007 treatment, CFT was applied to the stream during the 2008 treatment at no more than 1.0 part-per-million (ppm) for four hours. Treatments were initiated on August 4.

Figure 10. Sun Ranch Hatchery rearing troughs.

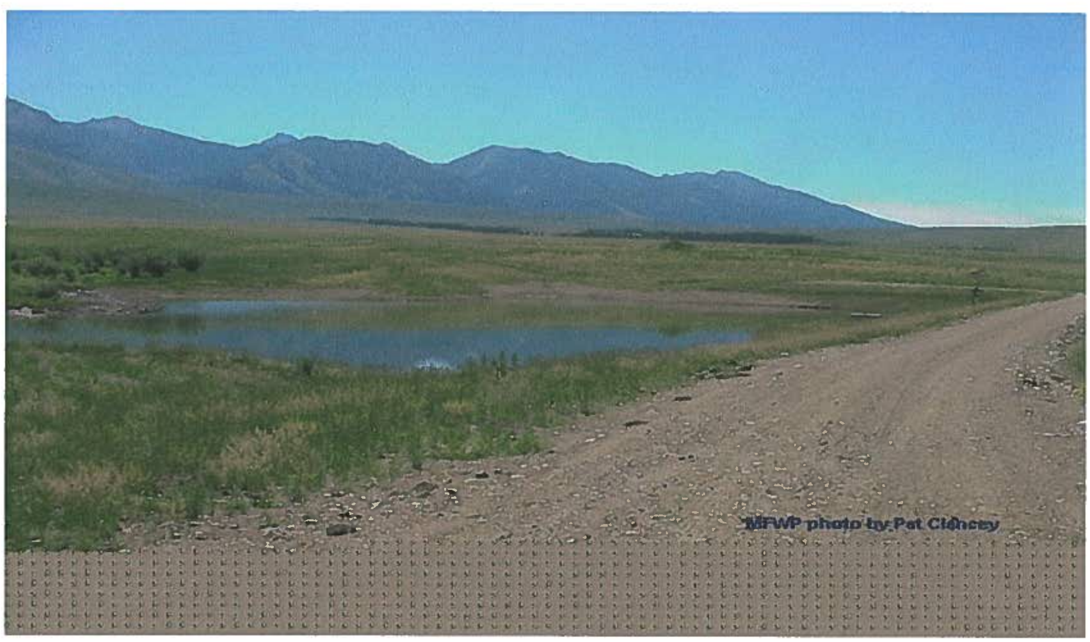


Figure 11. Sun Ranch Brood Pond.

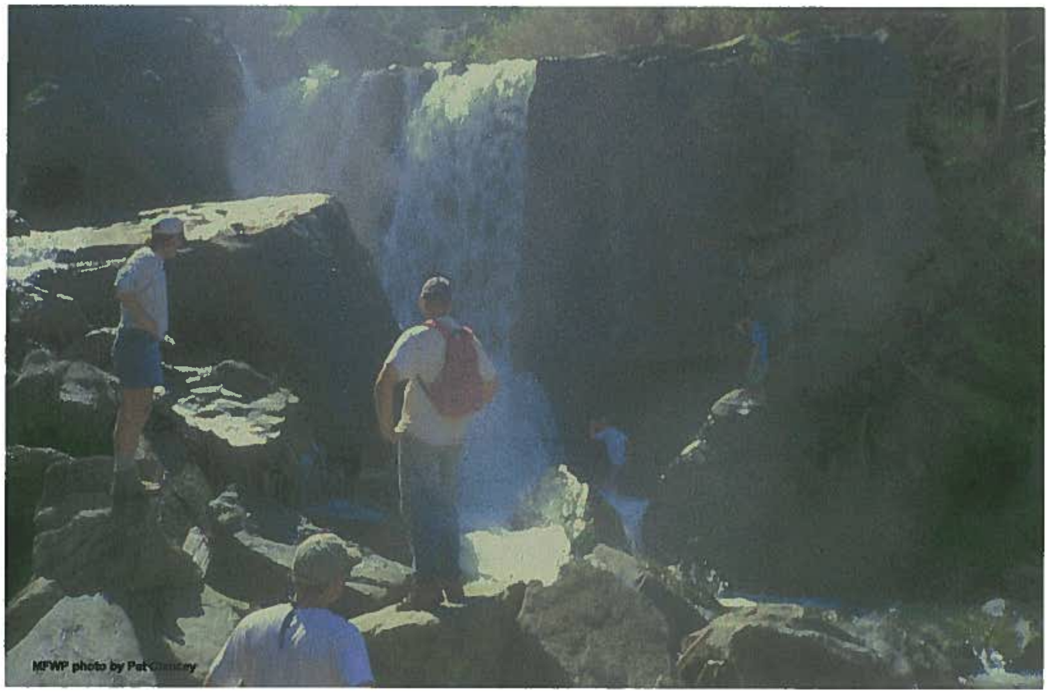


Figure 12. Cherry Creek waterfall located at stream mile 8.0. This falls is the downstream extent of the Cherry Creek project area.

Stream discharge was measured following standard USGS protocols, and a staff gauge was temporarily placed to determine if discharge changed appreciably during or prior to treating a given section of stream. Discharge was measured in a stream section the evening prior to treatment of that section, which allowed calculation and preparation of the piscicide that night or the next morning.

Stream treatments were made using trickle application systems (Figure 15). The system consists of a 3½ gallon plastic bucket & lid, garden hose, a gate valve, and a commercially available automatic dog watering bowl. A plastic elbow is fixed to a hole drilled in the bottom of the bucket, a short section of garden hose and the gate valve are clamped to the elbow (Figure 16), and a longer section of garden hose attach the assembly to the dog watering bowl. The bucket is partially filled with filtered stream water, the CFT is added, and the bucket is topped off with filtered stream water and stirred with a wooden dowel. At a predetermined time the gate valve is opened allowing the mixture to flow into the bowl, where it then trickles into the stream through a small hole drilled in the bottom of the bowl (Figure 17). Typically, one bucket empties in 3½ - 4 hours. Applications of CFT are designed using a 4-hour application period. In previous years, antimycin applications were designed using a 7-hour application period, but rotenone acts on the fish more quickly than antimycin, so the treatment period is shortened.

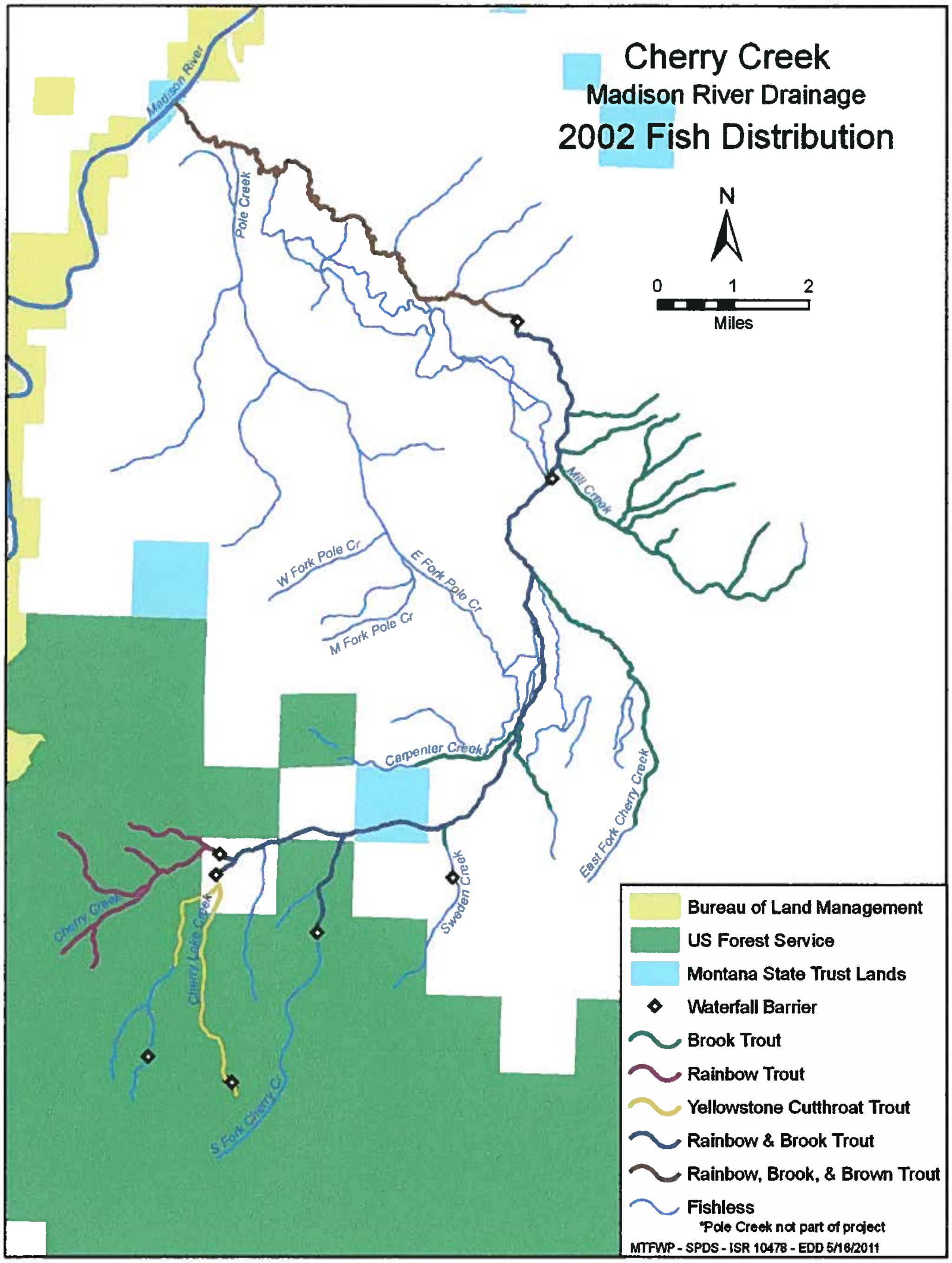


Figure 13. Map of the Cherry Creek Drainage showing the 2002 non-native fish distribution.

Figure 14. Two barriers, indicated by arrows, separating Cherry Creek phases 3 and 4 during Spring runoff 2010. At the height of runoff and prior to sandbagging, water flowed overland between the two barriers. A retired irrigation ditch is adjacent to the road. Turner Enterprises photo.

Stations were placed at selected points along the stream and started at predetermined times to coordinate application of the mixture with other stations along the stream. Backpack sprayers were used each day to treat off-channel water and larger pools.

Table 2. CFT Legumine™ rotenone bioassay results of in the East Fork of Cherry Creek designed to determine effective exposure time, July 2007. Run time of the application station was 7 hours 52 minutes. CFT application was initiated at 09:33.

Sentinel fish station[1/]	Time of initial exposure	Time of 100% mortality	Hours of exposure til 100% mortality
30	10:03	10:50	0:47
60	10:33	12:55	2:22
90	11:03	12:55	1:52
120	11:33	14:00	2:27
150	12:03	14:55	2:52
180	12:33	16:15	3:42[2/]
210	13:03	16:15	2:48
240	13:33	NA[3/]	

[1/] Minutes of stream flow time downstream of CFT application station
[2/] 2 fish dead, 1 nearly dead at 1455 hrs (2:22 hours of exposure)
[3/] 100% mortality of sentinel fish was confirmed the following morning at 11:45

Westslope cutthroat eggs from three wild donor streams, the Sun Ranch brood, and the Washoe Park Hatchery were reared to the eyed stage then placed in remote streamside incubators (RSI; Figure 18) in the Cherry Lake fork of Phase 1 and in Phase 2. Eggs completed incubation in the RSI, hatched, and fry swam out of the RSI into the stream. The RSI is plumbed to allow stream water to flow into the bottom of the bucket, percolate up through an artificial substrate where the eggs are placed, and out the RSI near the top of the bucket. When ready to enter the stream, fry follow the water out the hole near the top of the bucket.

A capture bucket was placed on the outflow of the RSI to capture and enumerate departing fry to allow estimation of survival in the RSI.

Figure 15. Trickle system and sentinel fish bag on Cherry Lake Creek. The sentinel fish bag is upstream of the CFT application point to monitor the effectiveness of the station upstream of the one shown here.

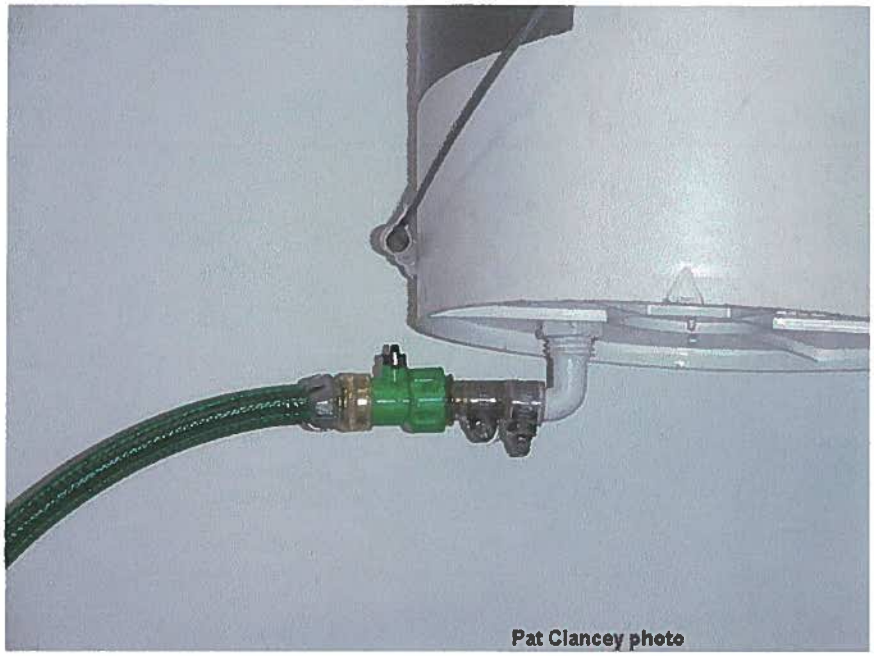


Figure 16. Elbow & gate valve assembly.

Figure 17. Close-up view of the dog watering bowl trickling CFT/streamwater mixture into the stream during the Cherry Creek Project.

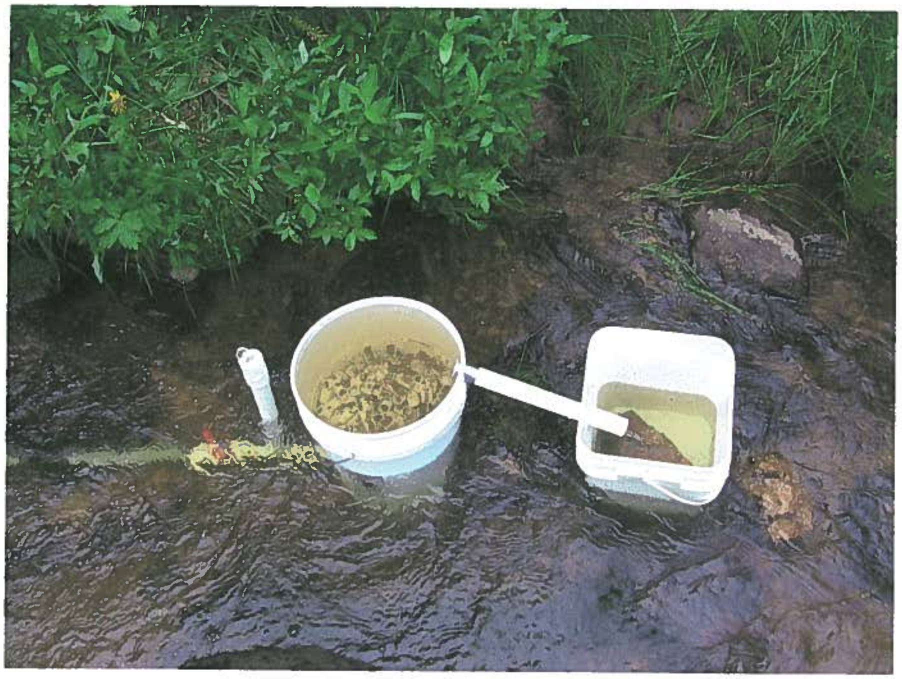


Figure 18. Remote streamside incubator (round bucket) and capture bucket (square bucket) in Cherry Creek.

Fish Habitat Enhancement

Smith Lake

Smith Lake Dam on Lake Creek, a tributary to the West Fork of the Madison River, is a four foot high cobble and earthen dam believed to have been constructed in the 1920s. The purpose of the structure was to divert water for operation of a sluice box and water wheel pump (Figure 19) to pump water 500 vertical feet to an offsite livestock water trough. Brown trout *Salmo trutta* migrate up Lake Creek for spawning, but in some years, fish passage around the dam is blocked by tarps that are used to reduce leakage through the dam and the bypass channel. Several alternative methods were explored to provide stockwater and reduce or eliminate the need for the water wheel pump.

Figure 19. Photograph showing the water wheel at Smith Lake Dam on Lake Creek. FWP photo by Travis Lohrenz.

O'Dell Creek

O'Dell Creek is a spring creek that originates south of Ennis, flowing north approximately 12 miles to its confluence with the mainstem Madison River. In 1955 a ditch was excavated to intercept groundwater flow and portions of O'Dell Creek were channelized to dewater a wetland complex. These projects were intended to maximize available rangeland for cattle and simplify irrigation. In 2005, DJP Consulting and the Granger Ranches received funding from MadTAC, PPL Montana's Wildlife Technical Advisory Committee and other sources to restore stream form and function to portions of O'Dell Creek and associated wetlands on Granger Ranch property (Table 3, Figure 20). Backfilling of the East Ditch resulted in groundwater resuming its original flow pattern into the wetland and also resulted in increased streamflow and improved water temperature regime in other stream channels.

Fisheries monitoring is conducted at six sites in the project area (Figure 21). Five surplus radio transmitters were implanted in brown and rainbow trout in the O'Dell Old Middle section in 2010 to ascertain fish movement. Upstream and downstream fish traps were constructed in O'Dell Creek approximately 10 stream miles below the restored stream segments to investigate fish movement in O'Dell Creek. The traps were operated September 24 through November 5.

Table 3. Summary of stream restoration actions at O'Dell Creek on the O'Dell and Longhorn ranches, 2005 - 2010.

Fish Monitoring Site	Result of Stream Channel Modification
O'Dell (East) Ditch	Backfilled - 2005
O'Dell Spring North	Increase in stream discharge, no physical modifications
Old Middle	Historic channel reconnected and reconstructed - 2006
O'Dell West	Stream channel narrowed & meandered, increased stream discharge, improved water temperature regime - 2008
Above Falls	Stream channel narrowed & meandered, increased stream discharge, improved water temperature regime - 2009
Below Falls	Stream channel narrowed & meandered, increased stream discharge, improved water temperature regime - 2010
Longhorn Ranch	Ditch backfilled, stream channel narrowed & meandered - 2007

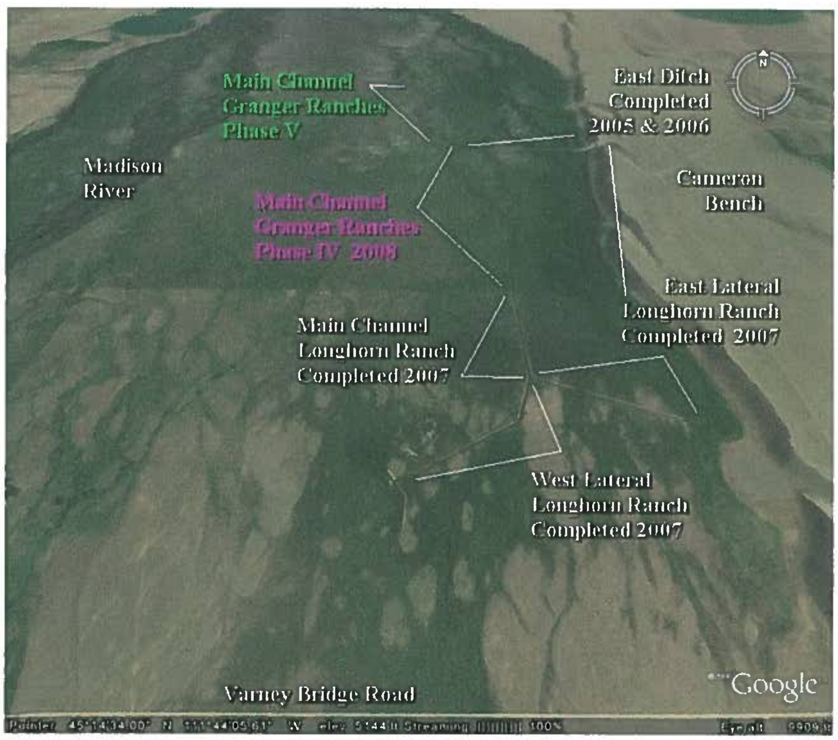


Figure 20. Photograph showing location and chronology of stream improvement activities on O'Dell Creek, Granger and Longhorn ranches, from Peters 2009.

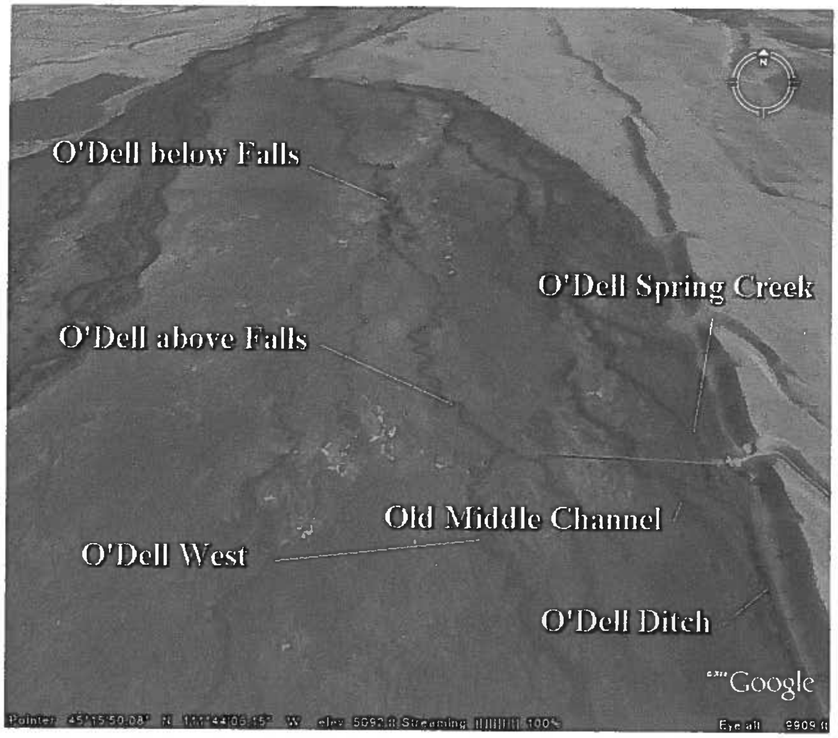


Figure 21. Photograph depicting approximate locations of FWP fish sampling sites on O'Dell Creek, from Peters 2009.

Jack Creek

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. The Jack Creek Ranch section is being 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. Habitat improvement construction was conducted in 2010.

Hebgen Basin

Hebgen Reservoir and its tributaries are shown in Figure 22.

Hebgen Reservoir Gillnetting

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 23) 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.

Hebgen Reservoir Tributary Habitat Improvement Monitoring

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. Its course is north easterly from Coffin Lakes. Use of Watkins Creek for spawning by reservoir rainbow trout is limited. 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 F). 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.

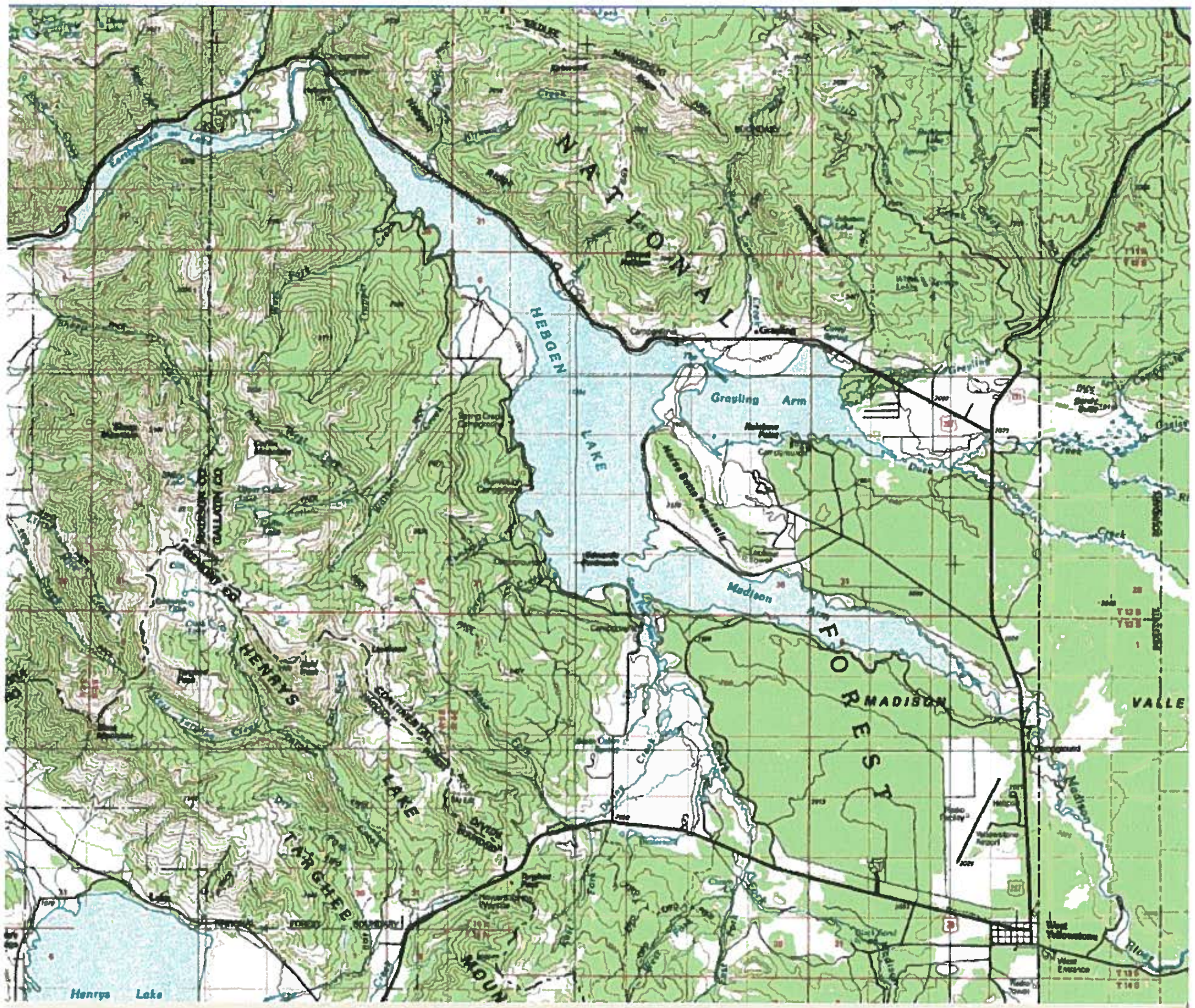


Figure 22. Map of Hebgen Reservoir and surrounding area.

Hebgen Basin Whirling Disease Monitoring

Whirling disease sentinel fish cages containing young-of-the-year rainbow trout were deployed at two South Fork Madison locations for a 10-day exposure from May 15 – 25. Sentinel fish were reared in isolation tanks for an additional 80 days at the FWP Whirling Disease Laboratory in Pony, Montana. At the conclusion of the 90-day period fish were sacrificed and sent to the Washington Animal Disease Diagnostic Lab (WADDL) at Washington State University where they underwent histological examination to rate the severity of the infection using the MacConnell-Baldwin scale (Appendix A). The MacConnell-Baldwin scale grades infection from 0-5 with 0 being no infection and 5 being severe infection.

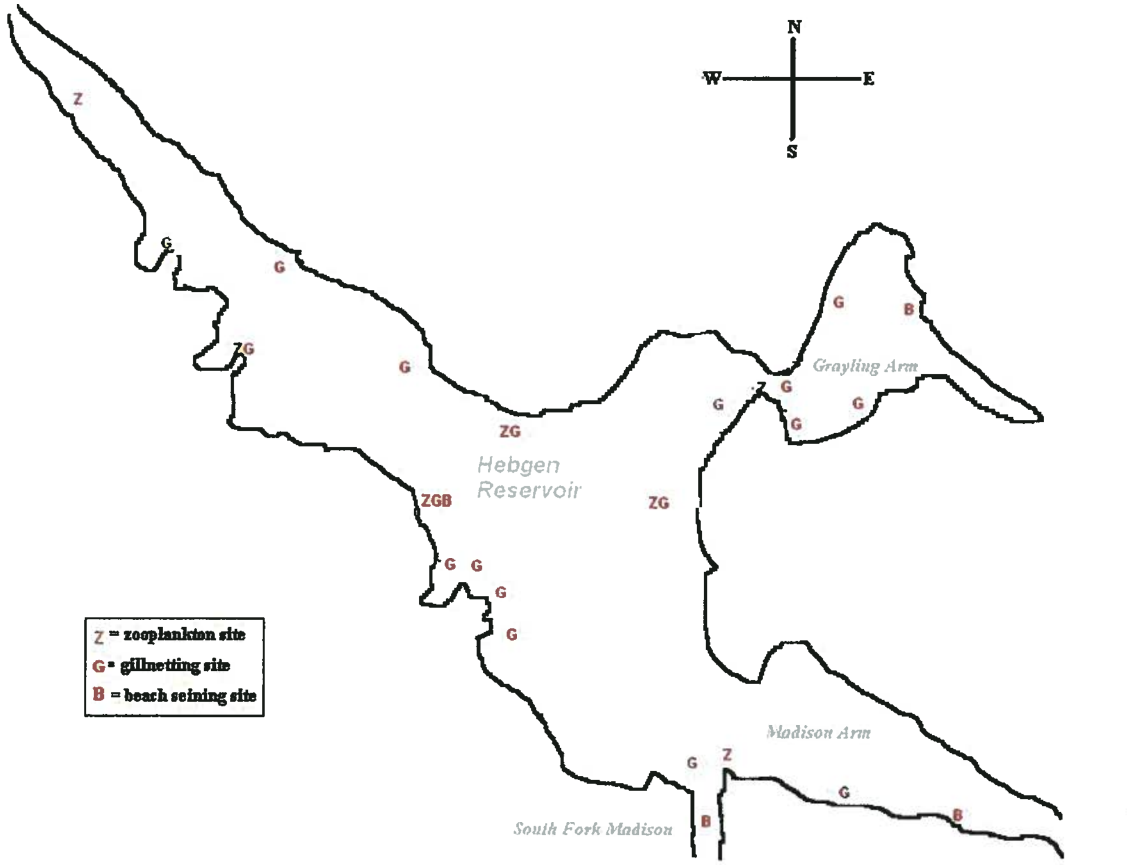


Figure 23. Map showing monitoring site locations of Hebgen Reservoir zooplankton, gillnetting, and beach seining.

Hebgen Basin Juvenile Fish Sampling

Rotary screw traps (Figure 24) were operated at Duck Creek and the South Fork Madison River in 2010 to evaluate juvenile rainbow trout escapement and to investigate production of juvenile rainbow trout in the presence of whirling disease in the South Fork Madison River.

Figure 24. Rotary screw trap used to sample juvenile fish on Duck Creek and the South Fork Madison River.

Captured fish were enumerated, identified to species and measured (total length). Fish with a total length greater than one inch were fin clipped (Figure 25) and released 150 to 200 yards upstream of the trap to estimate trap efficiency. Trap efficiency was calculated from the proportion of marked fish to unmarked fish captured during a trapping event. The total number of emigrants was estimated by dividing the number of unmarked fish captured by trap efficiency.

Figure 25. Tiger trout (brown trout x brook trout hybrid) with a lower caudal fin clip (red oval) administered to discern between recaptured and new fish during rotary screw trap efficiency trials.

Hebgen Basin Tributary Spawner Trapping

Hebgen tributaries were not trapped for spawning adults in 2010.

Hebgen Reservoir Shoreline Juvenile Fish Sampling

Beach seining was not conducted at Hebgen index sites (Figure 23) in 2010.

Hebgen Reservoir Zooplankton Monitoring

Monthly zooplankton tows were conducted at seven established sites on Hebgen Reservoir to evaluate plankton community densities and composition (Figure 23). Plankton were collected with a Wisconsin plankton net 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 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) for determination of 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.

RESULTS AND DISCUSSION

Madison Grayling

No young-of-the-year Arctic grayling were captured during beach seining in Ennis Reservoir in 2010 (Appendix B). A major rock slide on August 28 destroyed several control gates on Madison Dam (Figure 26), causing uncontrolled discharge over the dam and requiring a reservoir drawdown to inspect damage to the dam. Reservoir elevation dropped to nearly five feet below full pool, but had recovered three feet by early October when seining was conducted. Despite this recovered reservoir pool, some routine seining sites could not be accessed even at two feet below full pool. Normal reservoir elevation in October is full pool (4841 feet mean sea level (msl). Note - U.S. Geological Survey 1:24000 quad maps show Ennis Reservoir elevation of 4815 msl, but actual elevation is 4841 msl).

Two adult Arctic grayling were captured during electrofishing in April 2010 with 45 worker-days of effort. A 16.6 inch male was captured on April 9, and a 15.6-inch female was captured on April 23.

Arctic grayling require loose, recently scoured gravels and cobbles to broadcast their eggs over during spawning each spring (Byorth and Shepard 1990). Generally, normal spring runoff creates these conditions, but it is possible that winter and spring ice scour creates similar conditions. The duration and severity of the Madison River ice gorge (Figure 27) may affect the spawning success of the Ennis Reservoir 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 and comprised a significant segment of the global Arctic grayling population, 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.

Madison grayling exhibit adfluvial behavior. They reside in Ennis Reservoir all year except when they enter the Channels area of the Madison River in April to spawn, though periodically FWP receives reports of grayling in the Madison River as far as 30 miles upstream of Ennis Reservoir into the Fall.

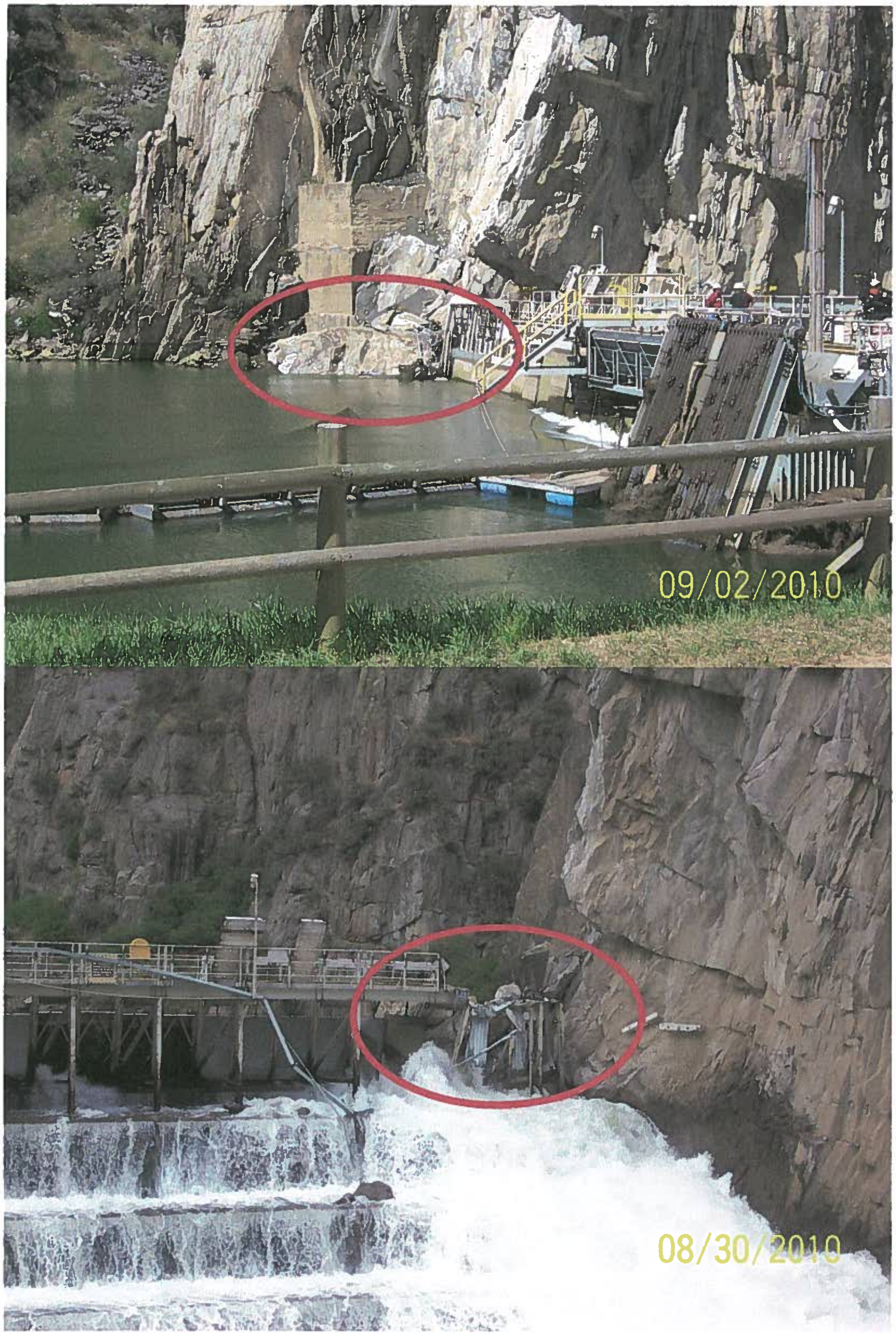


Figure 26. Photos of Madison (Ennis) Dam August 28, 2010, boulder impact. Photos by Brent Mabbott, PPL Montana.

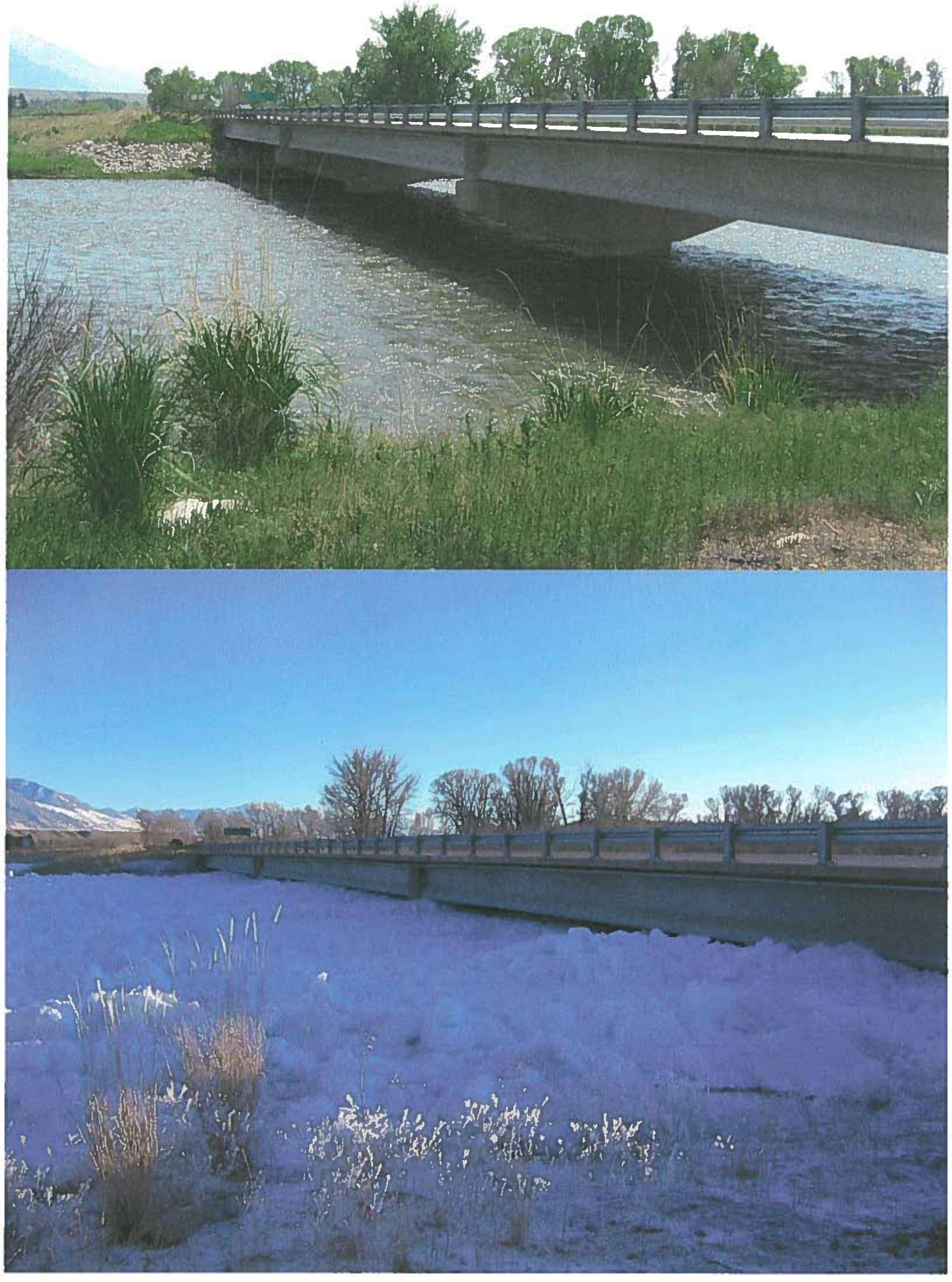


Figure 27. Photos illustrating ice-fee (top) and ice-gorged (bottom) conditions of the Madison River at the U.S. Highway 287 Bridge at Ennis.

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 158,242 acres, with an additional 5,390 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 6).

Figures 28 - 30 illustrate population levels of six inch and larger rainbow trout per mile. The rainbow population in Pine Butte and Varney exhibited increases from 2009. The significant increase in the Varney section is due to a strong yearling cohort (Appendix C1). In the Norris section rainbows increased slightly over the 2009 level.

Figures 31 - 33 illustrate numbers of six inch and larger brown trout. Brown trout populations decreased in all three sections compared to 2009, and in Norris are at the lowest level seen in the past 16 years.

In 2005, FWP Regional Management personnel began reporting population numbers greater than six inches rather than using fish length to designate fish as yearling or two year old & older. Appendix C1 contains charts illustrating fish numbers as yearling and two year old & older fish per mile as reported in previous years of this report (Clancey 1995 – 2010). Appendix C2 contains historic total population levels of two year old & older rainbow and brown trout (+ 80% C.I.) for each section.

Rainbow Trout Radio Telemetry

Five fixed wing aircraft flights, two river floats, and four on-the-ground surveys were conducted from March through July 2010 to relocate rainbow trout implanted with transmitters in September and October 2009.

Figure 34 illustrates documented rainbow trout movement greater than 0.2 miles of 27 Madison River mainstem spawning radio tagged rainbow trout March through July 2010 versus 13 mainstem spawning radio tagged rainbows the same months in 1999. Four of the 2010 rainbows exhibited initial upstream movements of 7.4, 9.1, 12.0 and 31.7 miles, then descended downstream for respective net movements of 5.4, -1.7, -11.5 and 3.7 miles. These fish are designated in Figure 34.

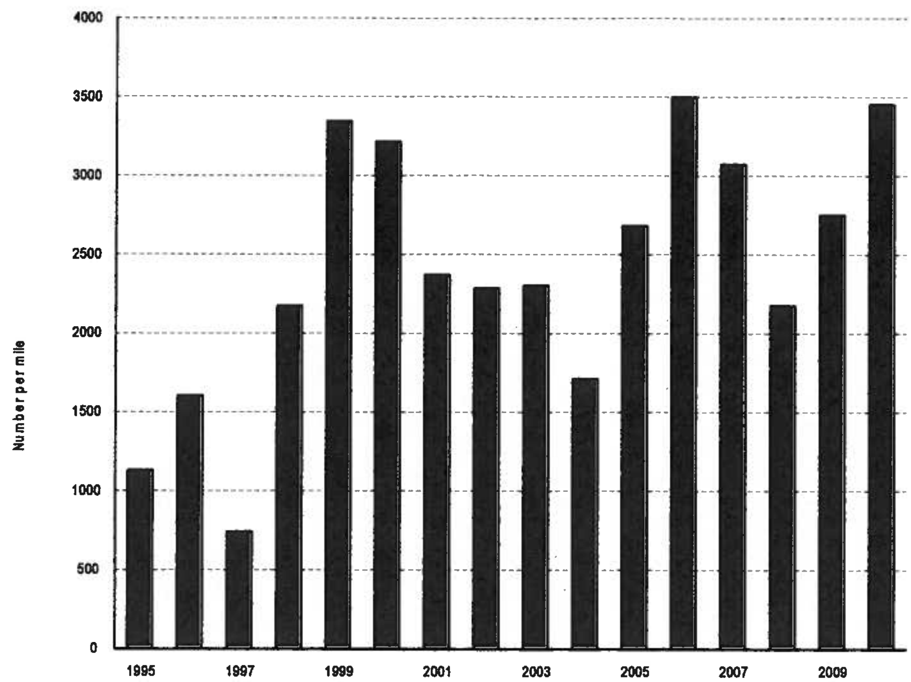


Figure 28. Figure showing the estimated number of rainbow trout (≥ 6") in the Pine Butte section of the Madison River during fall, 1995–2010.

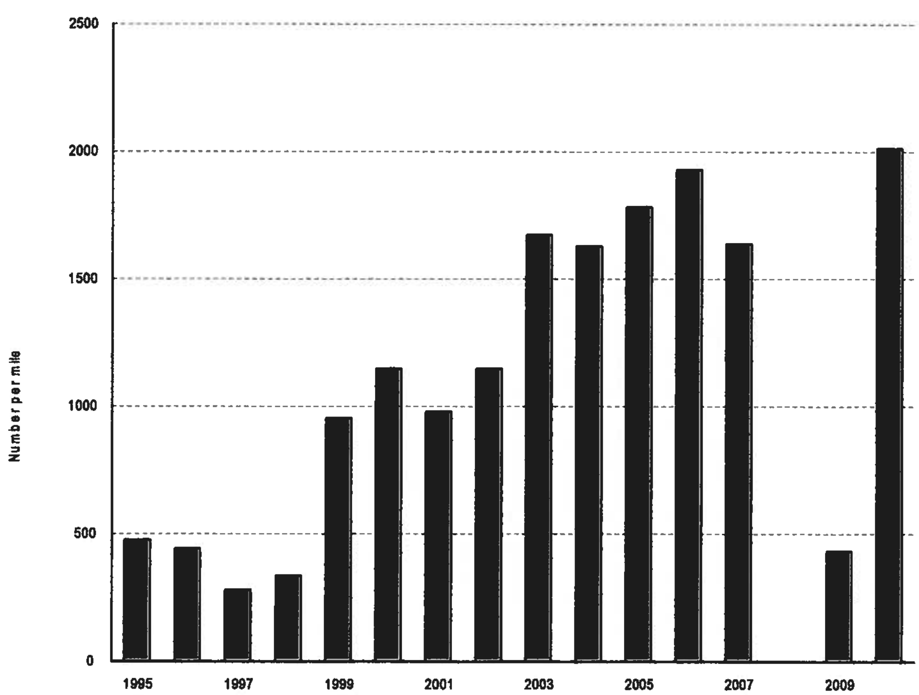


Figure 29. Figure showing the estimated number of rainbow trout (≥ 6") in the Varney section of the Madison River during fall, 1995–2010.

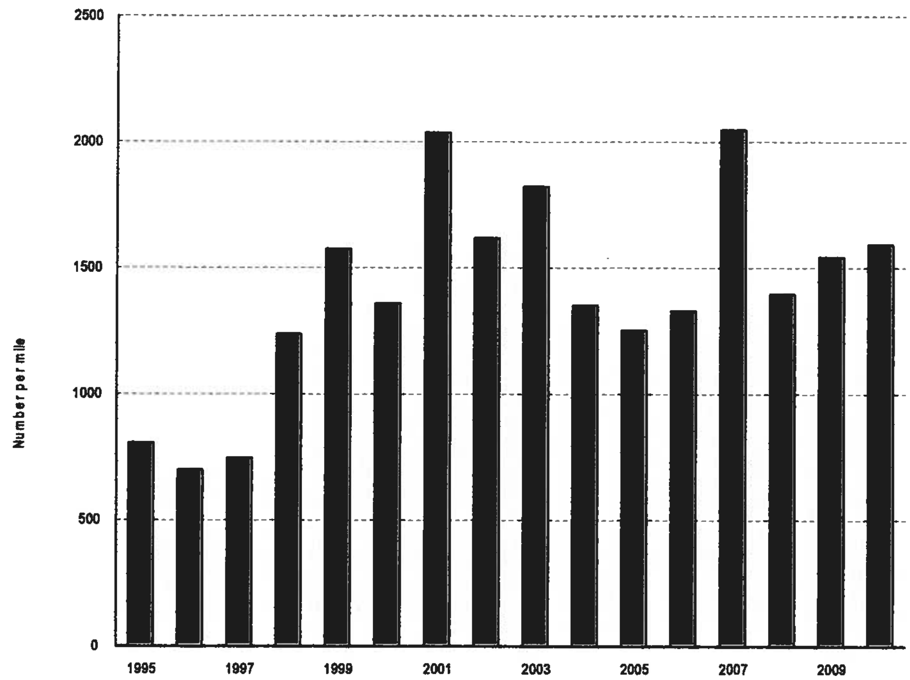


Figure 30. Figure showing the estimated number of rainbow trout (≥ 6") in the Norris section of the Madison River during spring, 1995–2010.

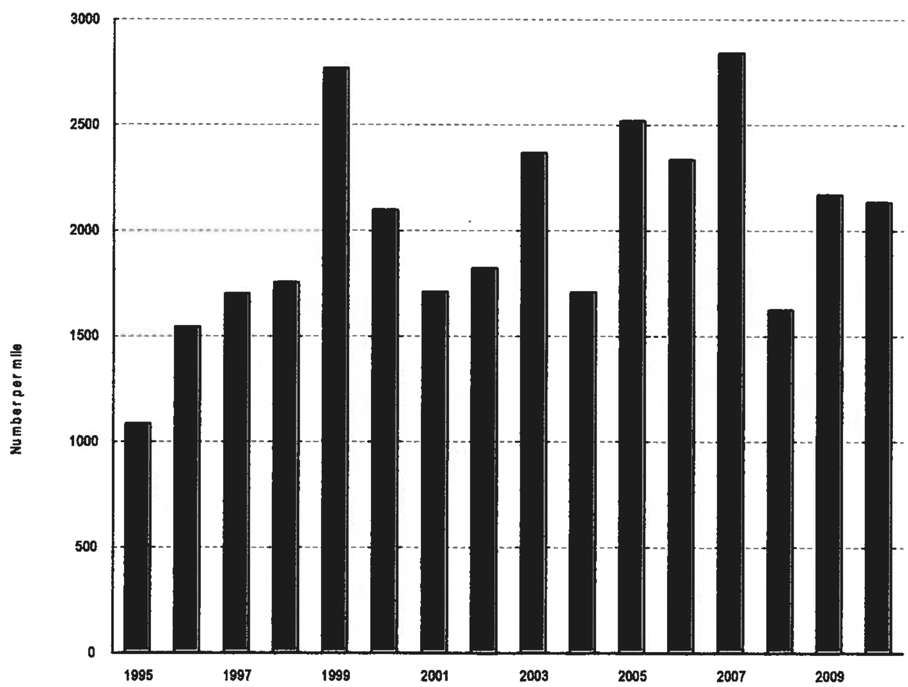


Figure 31. Figure showing the estimated number of brown trout (≥ 6") in the Pine Butte section of the Madison River during fall, 1995–2010.

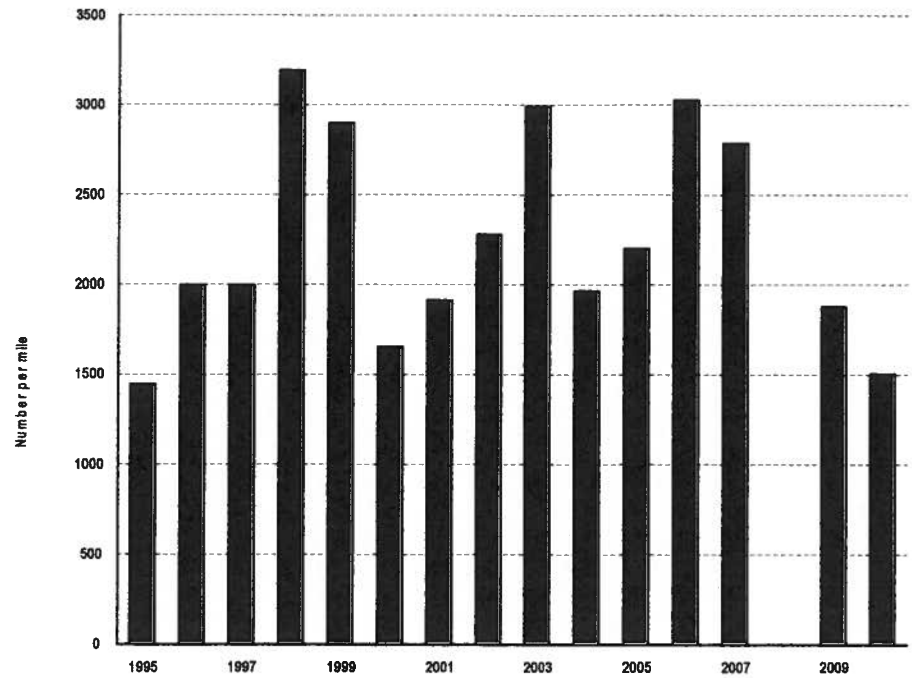


Figure 32. Figure showing the estimated number of brown trout (≥ 6") in the Varney section of the Madison River during fall, 1995–2010.

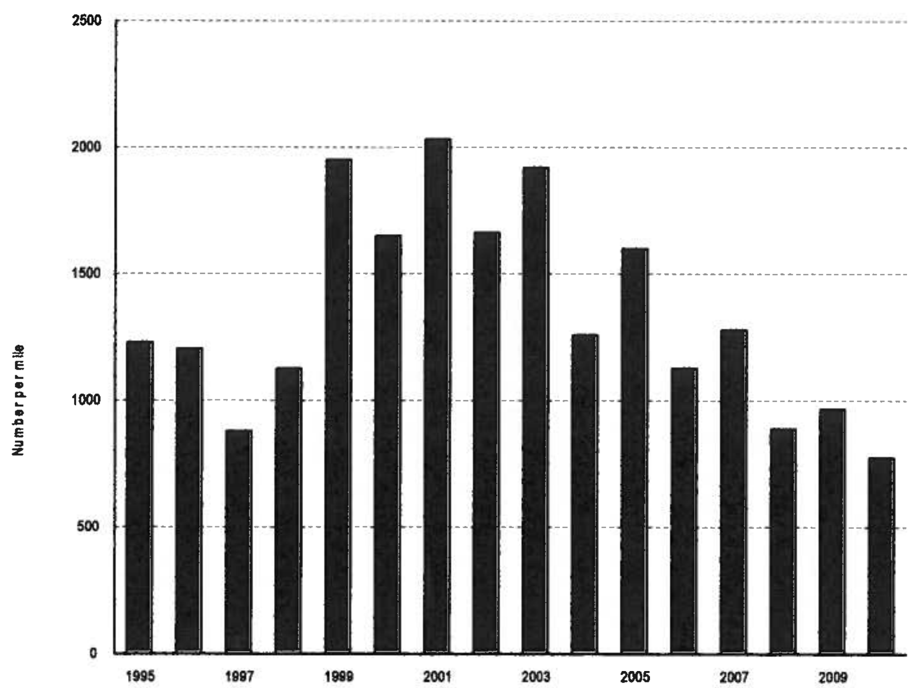


Figure 33. Figure showing the estimated number of brown trout (≥ 6") in the Norris section of the Madison River during spring, 1995–2010.

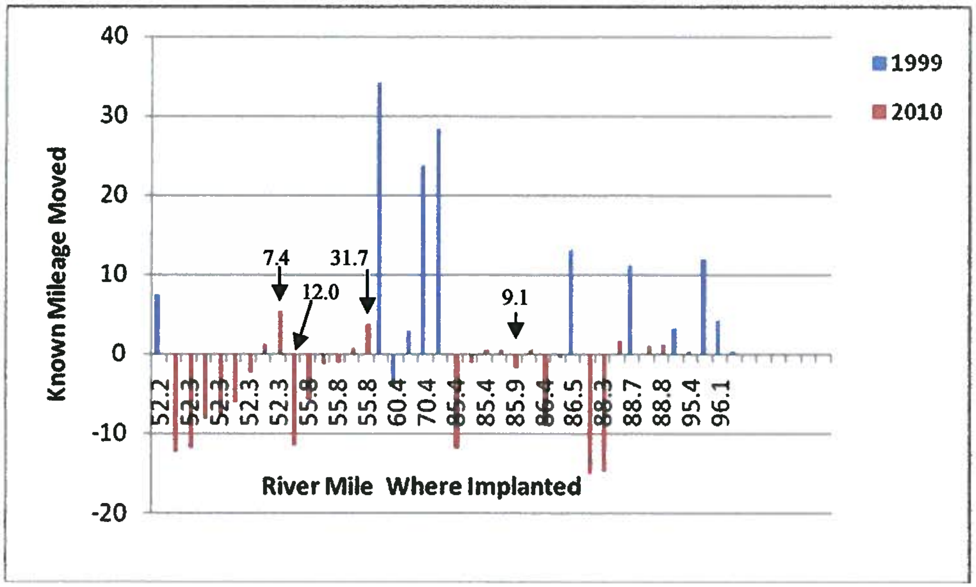


Figure 34. Known mileage moved from tagging location by radio tagged rainbow trout March through July, 1999 vs. 2010. Negative values indicate downstream movements, positive values indicate upstream movement. Fish that initially moved upstream then descended are designated with an arrow and the upstream mileage moved.

From March through July 1999, Downing (2000) documented rainbow trout spawning in the Madison River between river mile 45.3 (south shore of Ennis Reservoir) and river mile 109.1 (Hebgen Dam). He found that 17 of his radio implanted rainbow trout spawned in the mainstem river during that period, 13 upstream of Lyons Bridge (river mile 88.3). One of those ascended above Quake Lake to the vicinity of Cabin Creek. Nine of the 13 were captured, implanted and released upstream of Lyons Bridge. The other four moved upstream from locations 2.5 (near Moose Ck) – 34.2 (near Varney Bridge) miles below Lyons Bridge. He documented four other implanted rainbow trout spawning in the mainstem within 0 – 7.4 miles of their release locations near Moose Creek, 1 ½ miles upstream of McAtee Bridge, just below Varney Bridge, and ½ mile upstream of 8-Mile Fishing Access Site. He also documented four fish that moved into tributaries to spawn. Two of those fish made significant upstream movements from their September 1998 capture and release site just below Varney Bridge into Gazelle and Freezeout creeks in the West Fork Madison drainage, movements of 31.1 and 40.3 miles, respectively. One moved 5.8 miles downstream from its capture and release site, then ascended Squaw Creek 2.6 miles to spawn. The fourth rainbow moved 1 mile downstream then ascended 6 miles up the West Fork Madison to spawn. Downing (2000) found only one of the 17 mainstem river spawning radio implanted rainbow trout showed downstream movement of more than one mile during the 1999 spawning season (March – July), six showed movements of less than one mile either up or downstream, and 10 showed upstream movements of more than one mile (Figure 34).

None of the rainbow trout involved in the 2010 monitoring effort were documented to have ascended higher than river mile 95.0. The one fish that did ascend to river mile 95 was captured and implanted in September 2009 at river mile 85.9. This fish ultimately exhibited a net downstream movement of 1.7 miles (Figure 34).

The telemetry study will continue through 2011.

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. Pulse flows were not necessary in 2008 or 2009. Table 4, adapted from PPL Montana data, summarizes statistics regarding pulse flows in the Madison in years pulsing was conducted.

Table 4. 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	2.8	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

[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

Flushing flows were not conducted in the Madison River in 2010.

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 7). Table 5 summarizes the data collected at each location in 2010. Appendix D contains thermographs for each location.

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 E).

Within FWP Region 3 dissolved calcium levels 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, New Zealand Mud snails, or Eurasian Watermilfoil in samples collected from Madison River sites in 2010.

A total of 167 watercraft were inspected by the FWP ANS crew. Most water users were from Montana, but there were also boaters from California, Missouri, Texas, Pennsylvania, Idaho, Minnesota, Utah and Washington. Of the 167 watercraft inspected, 14 % were recreationists, 40 % were guides with clients, and 46 % were unguided anglers.

Table 5. Table showing maximum and minimum temperatures (°F) recorded at selected locations in the Madison River Drainage, 2010. Air and water temperature data were recorded from April 20 –October 2 (43,456 data points). Thermographs for each location are in Appendix D.

	Site	Max	Min
Water	Hebgen inlet[1/]	NA	NA
	Hebgen discharge	68.0	37.2
	Quake Lake inlet	68.8	34.9
	Quake Lake outlet	66.5	37.8
	Kirby Bridge	71.3	34.7
	Wall Ck Bridge	71.4	33.1
	McAtee Bridge	70.6	32.9
	Ennis Bridge	72.4	33.8
	Ennis Reservoir Inlet	74.9	33.3
	Ennis Dam	72.7	41.7
	Bear Trap Mouth	77.2	38.0
	Norris	77.7	37.8
	Blacks Ford	79.0	34.3
	Cobblestone	79.9	34.8
	Headwaters S.P. (Madison mouth)	78.6	37.5
Air	Kirkwood	87.0	15.7
	Slide	87.3	17.7
	Wall Creek HQ	92.3	21.1
	Ennis[2/]	93.8	21.4
	Ennis Dam	89.5	24.1
	Norris	88.8	31.5
	Cobblestone	91.4	22.7

[1/] Recorder at Hebgen Inlet was not recovered.

[2/] Maximum temperature at Ennis air was 123.2, but the recorder had been moved by an unknown party from its shaded position to a point in the full sun. The maximum temp outside that period is listed in this table.

New Zealand Mud snails

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

1) Listing New Zealand mud snails as a Prohibited species in Montana.
2) Assisting in development of a regional management plan for New Zealand mud snails, an important portion of which will describe actions to be undertaken when New Zealand mud snails 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 New Zealand mud snails 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. Strategies have been implemented to prevent the spread of NZMS from the sole private hatchery in which they were discovered. The spread of New Zealand mud snails 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, and for New Zealand mud snails specifically, is available at www.esg.montana.edu/aim/mollusca/nzms.

Whirling Disease

Caged young-of-the-year rainbow trout in the Madison River continue to exhibit high infection rates & severity (Table 6) and still exceed the infection rate & severity level postulated by researchers to reduce rainbow trout population numbers. For rainbow trout, average histology scores above 2.5 are associated with high mortality of young-of-the-year and significant decreases in population.

The juvenile rainbow trout used in the sentinel cage studies are not offspring of Madison River rainbow trout, but are from the captive stock that has been used in sentinel cages since studies began in 1996. The high infection rate exhibited by this captive stock shows that whirling disease remains at high levels in the Madison, but offspring of Madison River rainbow trout appear to be developing a resistance to whirling disease as evidenced by rainbow trout population estimates in the upper river (Figures 28-30). In 1998, and again in 2004, eggs were collected from spawning rainbow trout near the Slide Inn below Quake Lake and the resulting fry exposed to a controlled number of TAMs in the Wild Trout Laboratory in Bozeman. Fry produced from the 2004 spawners exhibited a lower proportion of fish in the highly infective categories compared to those from 1998 spawners (Figure 35). In Figure 35, the average histology score of the 1998 test fish is 4.13, while that of the 2004 test fish is 2.42.

Table 6. Sentinel rainbow trout whirling disease infection rates, Madison River, May 14/15 - 24/25, 2010, unless otherwise noted.

Site	Average infection score		Percent of fish infected	
	Upper cage	Lower cage	Upper Cage	Lower cage
Madison River mainstem				
Slide Inn	0.36	0.56	27	37
Green Island (Fly Fishers Club @ Big Bend)	2.21	2.38	94	97
Pine Butte	3.11	4.26	100	100
Eagles Nest	3.50	3.54	100	100
Kirby	3.64	3.23	100	100
West Fork	4.38	4.26	100	100
Lyons	4.46	4.81	96	100
Sun West	4.07	4.85	100	100
Palisades	4.18	3.91	100	100
Varney	4.32	4.74	96	100
Madison River tributaries				
$3 Spring Ck	0	0	0	0
Papoose Ck	0	0	0	0
Wolf Ck May 15-25	0	--	0	--
Jun 30 – Jul 10	0	0	0	0
Ruby Ck May 15-25	--	0.12	--	4
Jun 30 – Jul 10	0	0	0	0
Blaine Spr Ck	0.05	3.10	4	97

Information on whirling disease, including numerous links, is available online at www.whirling-disease.org.

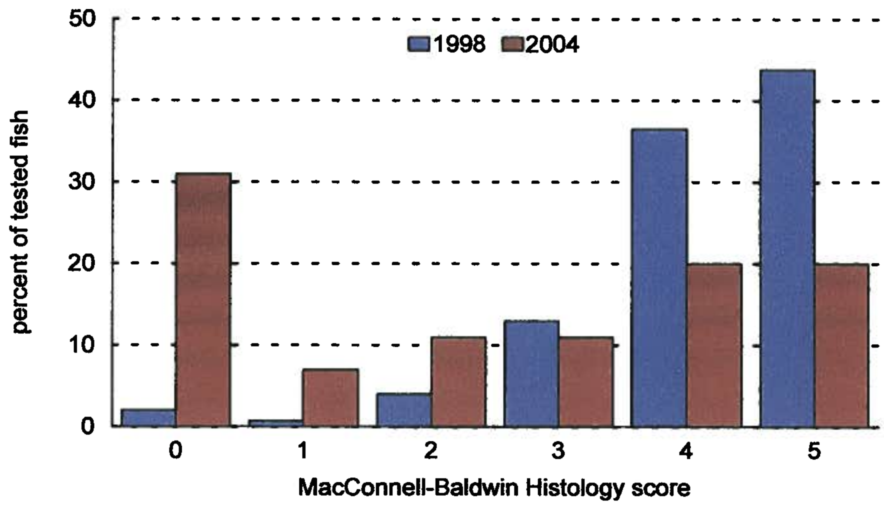


Figure 35. Figure showing the percentage of young-of-the-year Madison River rainbow trout within MacConnell-Baldwin histology ratings in 1998 and 2004. See Appendix A for MacConnell-Baldwin definitions.

Westslope Cutthroat Trout Conservation and Restoration

Habitat projects conducted by the Madison Ranger District of the Beaverhead-Deerlodge National Forest are summarized in Appendix F.

Sun Ranch Westslope Cutthroat Trout Program

Ten male and five female Sun Ranch Brood fish were spawned in 2010, providing 4,933 eyed eggs. Recipient waters were Cherry Creek (398 eyed eggs & 3400 fry) and the Sun Brood Pond (496 fry).

Over 7,500 eggs from donor stream wild populations were incubated at the Sun Hatchery in 2010. Eyed eggs or fry were introduced into Cherry Creek, Cherry Lake, the East Fork of Specimen Creek Drainage in YNP, Little Tepee Creek in the Hebgen Basin, Elkhorn Creek in the Gallatin drainage, and into Eureka Creek in the Elkhorn Mountains. Fry from one wild donor stream and the Sun Brood were introduced into the brood pond.

Appendix G lists the contributions to and production of the Sun Hatchery since 2001, and Appendix H provides a list of streams for which PPL Montana funding has been used to test genetic purity.

Cherry Creek Native Fish Introduction Project

In 2010, 1,066 eyed eggs from one wild donor stream, 398 Sun brood eggs, and 154 eyed eggs from the Washoe Park Hatchery were placed in RSIs in Phases 2 and 3 (Figure 36), resulting in 1,083 fry. Wild eggs were reared to the eyed stage at the Sun Ranch Hatchery then placed in RSI's (Figure 16). Wild fry were hatched and reared at the Sun Hatchery prior to transport to Cherry creek and lake for stocking. Pending available funding, genetic samples will be collected from the developing population as the WCT population establishes and stabilizes to ascertain the proportion from each donor source relative to the proportion of eggs introduced. Figure 37 shows an adult WCT captured in Cherry Creek that was introduced as a fertilized egg.

In addition to the wild fry releases, approximately 400 triploid fry from the Washoe Park Hatchery were stocked into Phase 3. The eggs of these triploid fry were pressure treated during development to cause them to have three sets of chromosomes rather than the usual two sets, which renders them sterile. Success of the triploid treatment was confirmed through blood tests. These fish were marked so they can be differentiated from wild fish throughout their life. This is the first introduction of triploid westslope cutthroat trout in Montana, so results of this introduction will provide information toward the potential of using sterile westslope cutthroats for fish management purposes. Additional triploid introductions are planned in Cherry Creek for 2011 and possibly beyond.

Personnel from FWP, Montana State University, Gallatin National Forest, and Turner Enterprises spent approximately 200 worker-days conducting preparatory and support activities and chemical treatments in 2010. A total of 22.4 gallons of CFT rotenone were required to complete treatments in 2010, all in Cherry Creek and tributaries (Table 7). Unless non-native fish are found in the project area during surveys, eradication efforts have been completed in Cherry Creek. Additional wild westslope cutthroat introductions are planned for Cherry Lake in 2011 and 2013, and Cherry Creek Phase 4 in 2011 and 2012.

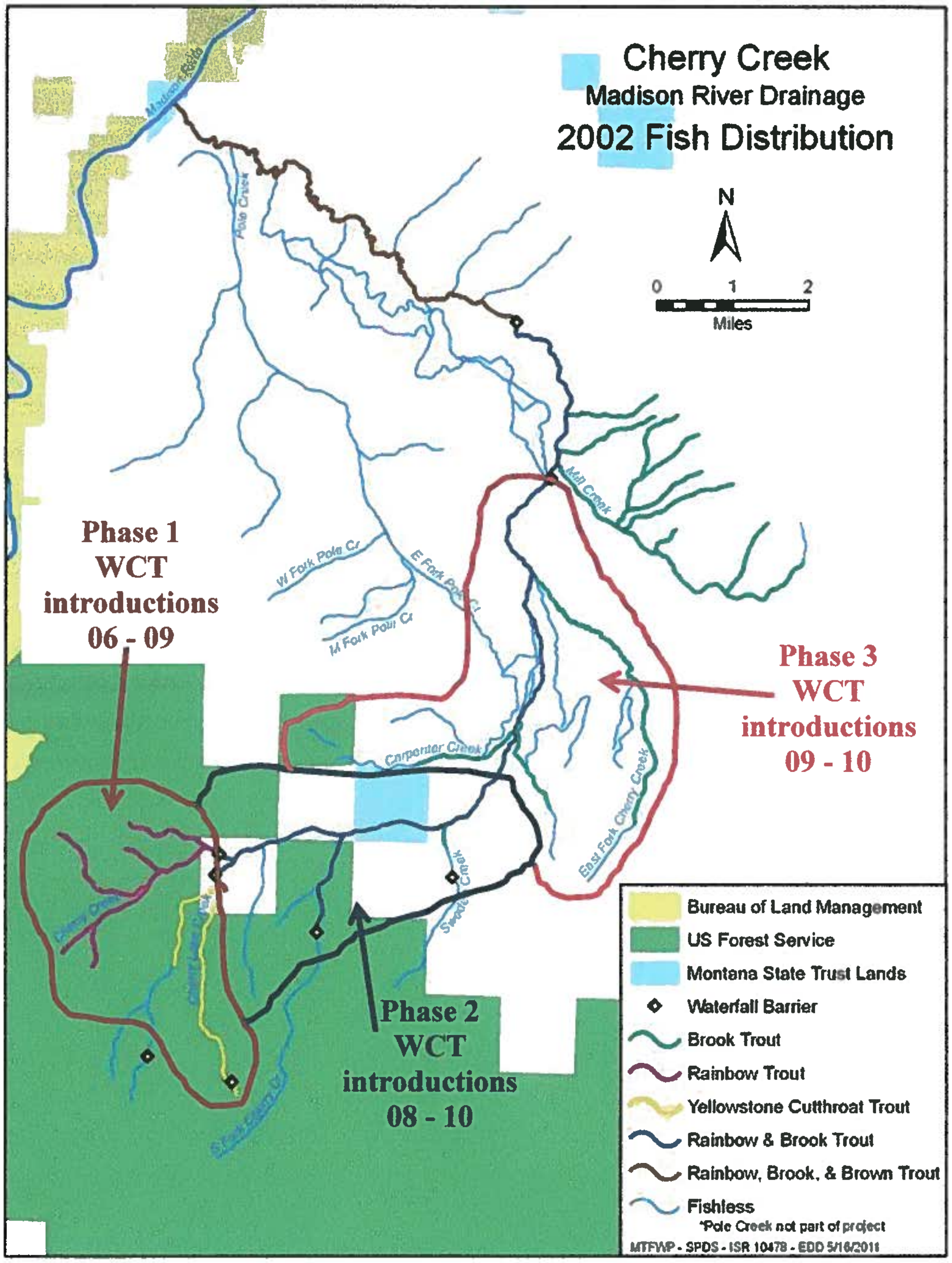


Figure 36. Phases 1 - 3 of the Cherry Creek Native Fish Introduction Project where westslope cutthroat trout were introduced in 2006 through 2010 following eradication of non-native Yellowstone cutthroat, rainbow, and brook trout in 2003 – '10.

Figure 37. 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.

Table 7. Schedule of Cherry Creek piscicide treatments, the number of stream miles treated, number of worker days, and quantity of piscicide used, 2003 – 10.

Year	Phase	miles treated	# worker-days	piscicide quantity
2003	1	11	284	4.9 gallons Antimycin
2004	1	11	240	6.4 gallons Antimycin; 1.0 gallon rotenone
2005	2	8	220	7.0 gallons antimycin 1.0 gallons rotenone lqd 1 lb rotenone pwdr
2006	2	8	256	5.9 gallons Antimycin
2007	2, 3	4, 23	264	9.0 gallons rotenone
2008	3	23	158	14.6 gallons rotenone 2 lbs rotenone pwdr
2009	3	5	16	5.7 gallons rotenone 0.5 lbs. Rotenone pwdr
2010	3, 4	5, 12	200	22.4 gallons rotenone

Fish Habitat Enhancement

Smith Lake

The aged stock water delivery system on Lake Creek has been deactivated in favor of a more efficient system that eliminated the need to manipulate streamflow at Smith Lake Dam. Plans were developed and grants acquired, including from MadTAC, to drill a well and develop a delivery system that delivers water to the stock tanks that are 500 vertical feet above the stream. This eliminates the need to seal the dam and bypass with tarps, allowing brown trout and other fish to freely pass the dam for spawning and other needs. The well was completed in 2009, and the pipeline to the stock tanks was completed in 2010.

O'Dell Creek

Stream channel restoration was conducted in O'Dell Creek as part of a wetland restoration effort initiated in 2005 (Table 3), including physical channel modifications and increasing aquatic habitat complexity. FWP conducts monitoring to determine the response of the fish community to these changes.

Brown trout are the predominant gamefish species inhabiting O'Dell Creek in the restoration area. Rainbow trout, Rocky Mountain sculpin *Cottus bairdi* and longnose dace *Rhinichthys cataractae* are also present. Rainbow trout are generally too sparse to conduct population estimates.

Figures 38 - 41 illustrate the population characteristics of brown trout in various O'Dell sections since 2005.

Radio transmittered trout in O'Dell Creek exhibited only localized movements after implanting occurred in early May. There were no indications of long migrations downstream to the Madison River. Transmitter batteries expired around the end of August due to the age of the transmitters when deployed.

Only one adult brown trout was captured in the O'Dell fish trap during its operation September 24 through November 5. It measured 17.5 inches and was captured in the upstream trap on October 27. Additionally, two whitefish *Prosopium williamsoni*, three rainbow trout, and six brown trout were captured during trap operation, all less than 6 inches.

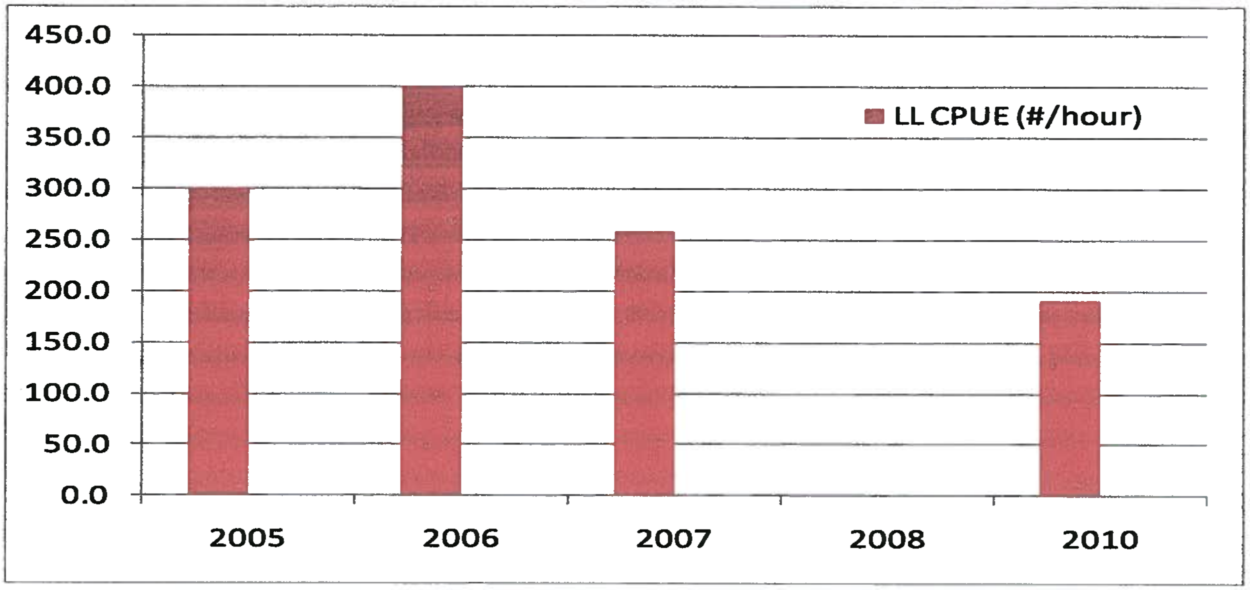


Figure 38. Figure showing catch-per-unit-effort of brown trout in O'Dell Spring section, O'Dell Creek Ranch. Stream channel restoration has not been conducted in O'Dell Spring.

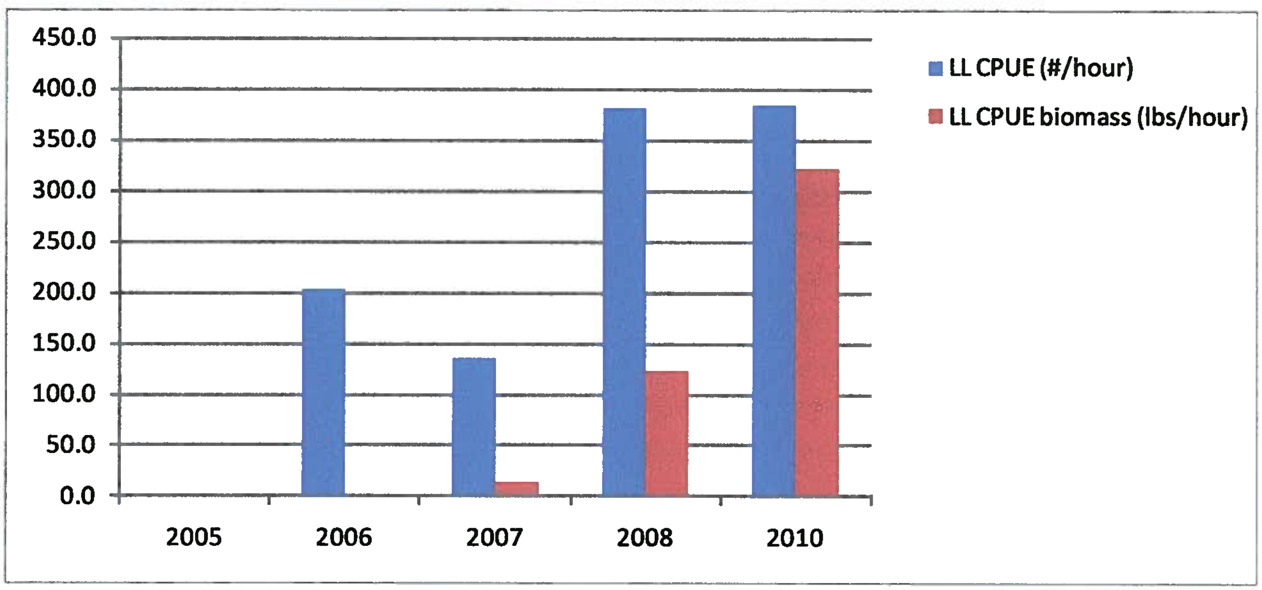


Figure 39. Figure showing catch-per-unit-effort of brown trout in the Old Middle Channel section, O'Dell Creek Ranch. Stream channel restoration occurred in 2006.

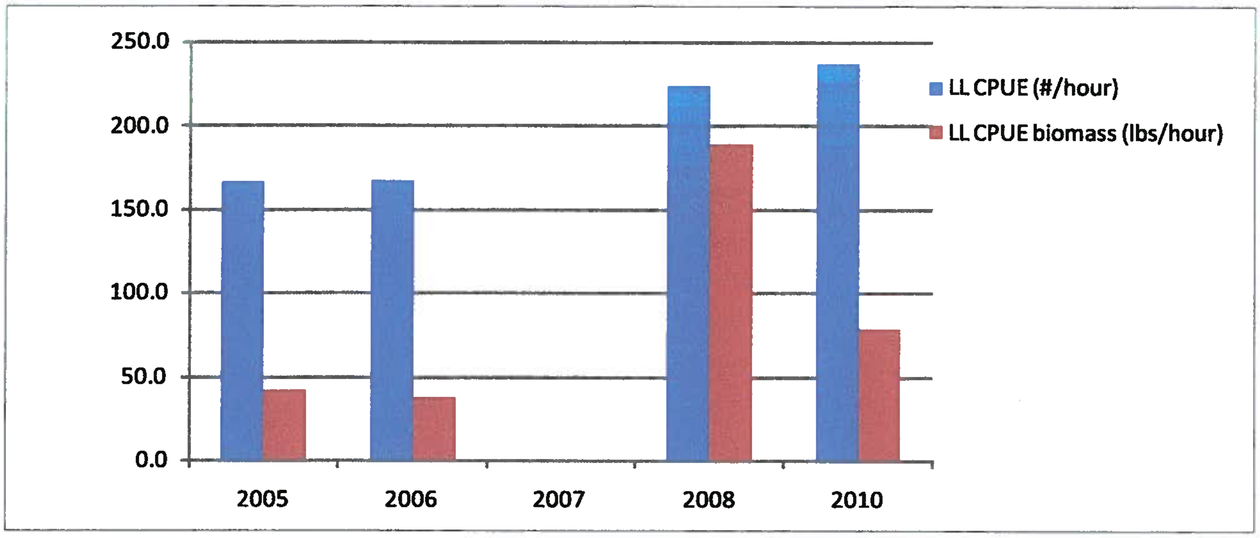


Figure 40. Figure showing catch-per-unit-effort of brown trout in the Above Falls section, O'Dell Creek Ranch. Stream channel restoration occurred in 2009.

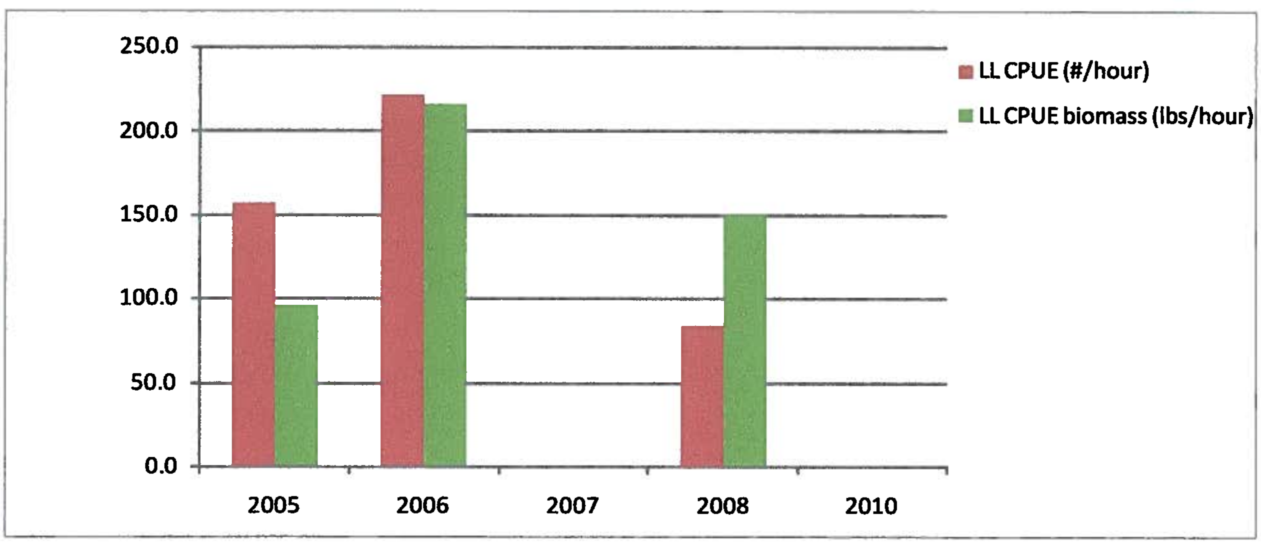


Figure 41. Figure showing catch-per-unit-effort of brown trout in the Below Falls section, O'Dell Creek Ranch. Stream channel restoration occurred in 2010, so no fisheries monitoring was conducted that year.

Jack Creek

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, nearly an 18 percent increase. Additionally, fish habitat features and riparian vegetation were incorporated into the channel reconstruction.

Fisheries monitoring was conducted in April 2008 and April 2010 and 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 (Figure 34). Monitoring of this spawning run will continue in an effort to discern additional population characteristics.

Hebgen Basin

Hebgen Reservoir Gillnetting

A total of 713 fish were captured during Hebgen Reservoir gillnetting in 2010 (Table 8), over half of them were Utah chub *Gila atreria.*

Table 8. Summary of 2010 Hebgen Reservoir gillnet catch.

Species	Number caught	Average Length (range)	Average weight (range)
Rainbow trout	94	16.6 (9.8-19.8)	1.69 (0.34-2.78)
Brown trout	149	17.2 (11.3-22.5)	1.74 (0.54-3.58)
Whitefish	98	16.7 (8.1-20.3)	1.85 (0.26-3.16)
Utah Chub	372	10.8 (5.8-14.7)	0.68 (0.07-1.59)

The number of rainbow trout captured by gillnetting in 2010 decreased from 2009, but the trend over the past seven years is increasing, and in 2008 and 2009 the number captured returned to the level seen in the mid - late 1990's (Figure 42). The number of rainbows captured per year has varied from 47 in 2001 to 194 in 2008. No rainbow trout tagged in tributaries with coded-wire or Floy™ tags were captured during gillnetting in 2010.

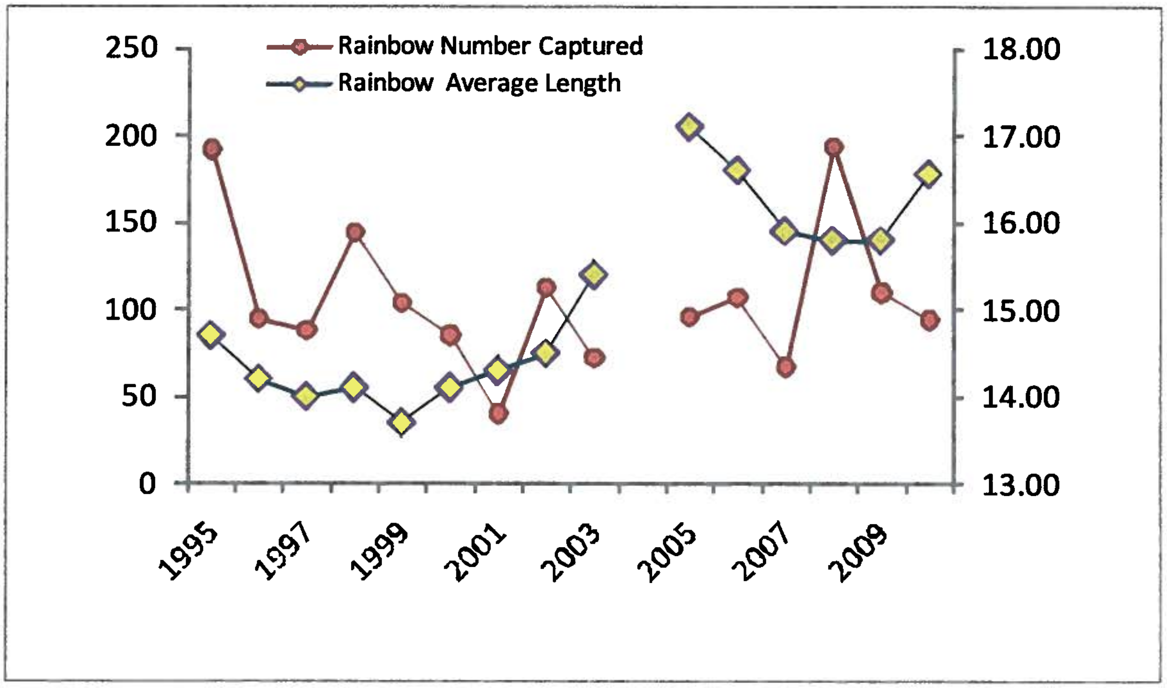


Figure 42. Figure showing rainbow trout average length in inches (right) vs. number captured (left) during annual Hebgen gillnetting, 1995-2010. Data from 2004 are not shown because of sampling error.

Average length of rainbow trout captured has been higher in the 2000's 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 43).

Six of 56 (10.7%) rainbow trout vertebrae examined were positive for tetracycline marks, indicating fish of hatchery origin. One of the six marked fish also exhibited dorsal fin erosion. Dorsal fin erosion is often associated with hatchery produced trout. Applying the 10.7% tetracycline ratio to the total number of rainbow captured (94) ten rainbow trout can be assigned to hatchery origin. Over 300,000 rainbow trout were stocked in Hebgen Reservoir in 2008 compared to an annual average of 90,800 in 2005-2007. This may account for the increase in hatchery contribution observed in the 2010 gillnetting sample, as three fish that exhibited tetracycline marks were less than 14 inches in total length.

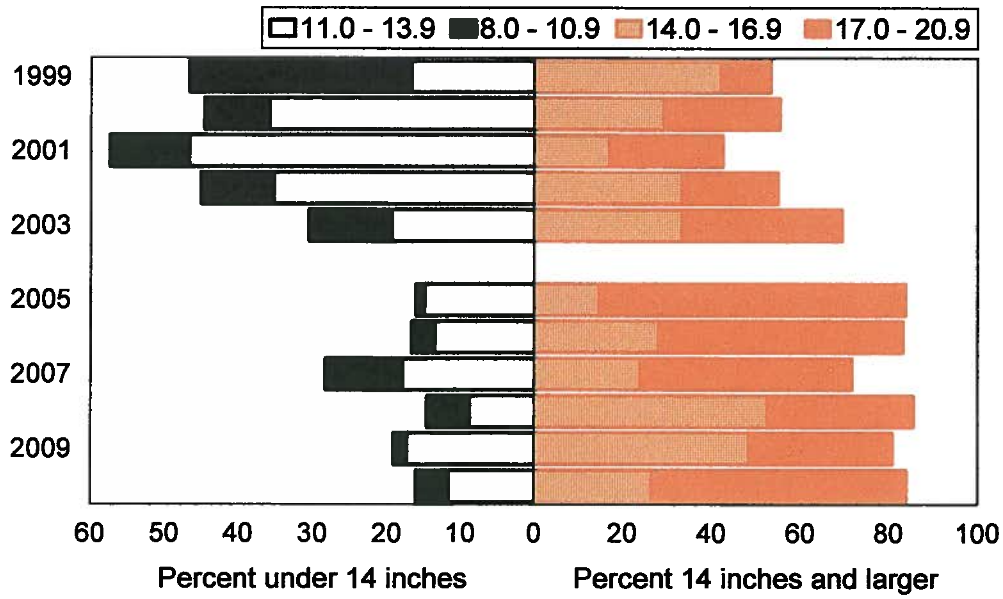


Figure 43. Figure showing percentage of Hebgen Reservoir rainbow trout gillnet catch under and over 14 inches, 1999-2010. Data from 2004 are not shown because of sampling error.

Brown trout numbers have fluctuated widely with no consistent trend evident for more than a few consecutive years (Figure 44). The number of fish captured annually has ranged from 61 in 2002 to 326 in 1999. Three brown trout tagged with yellow Floy™ tags during the fall of 2008 at the Madison weir were captured during 2010 gillnetting.

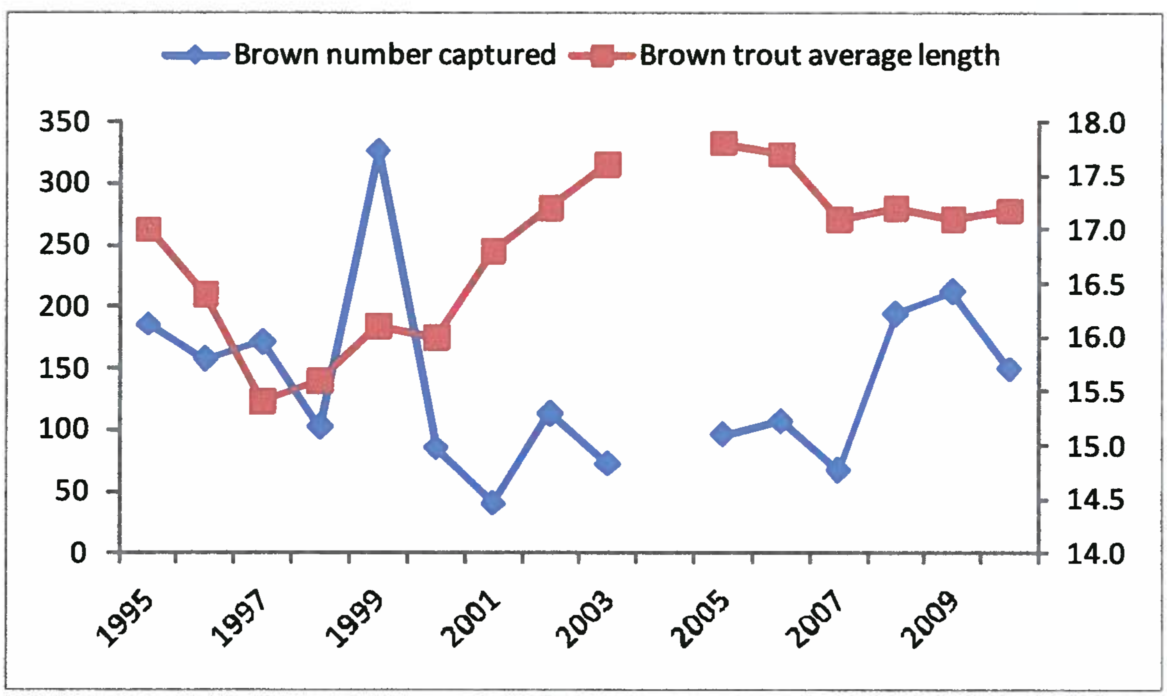


Figure 44. Figure showing brown trout average length in inches (right) vs. number captured (left) during annual Hebgen gillnetting, 1995-2010. Data from 2004 are not shown because of sampling error.

The number of whitefish captured decreased significantly in 2002, but has remained relatively stable in recent years (Figure 45). The number captured per year has varied from 83 in 2005 to 272 in 1999. Average length has shown a generally upward trend.

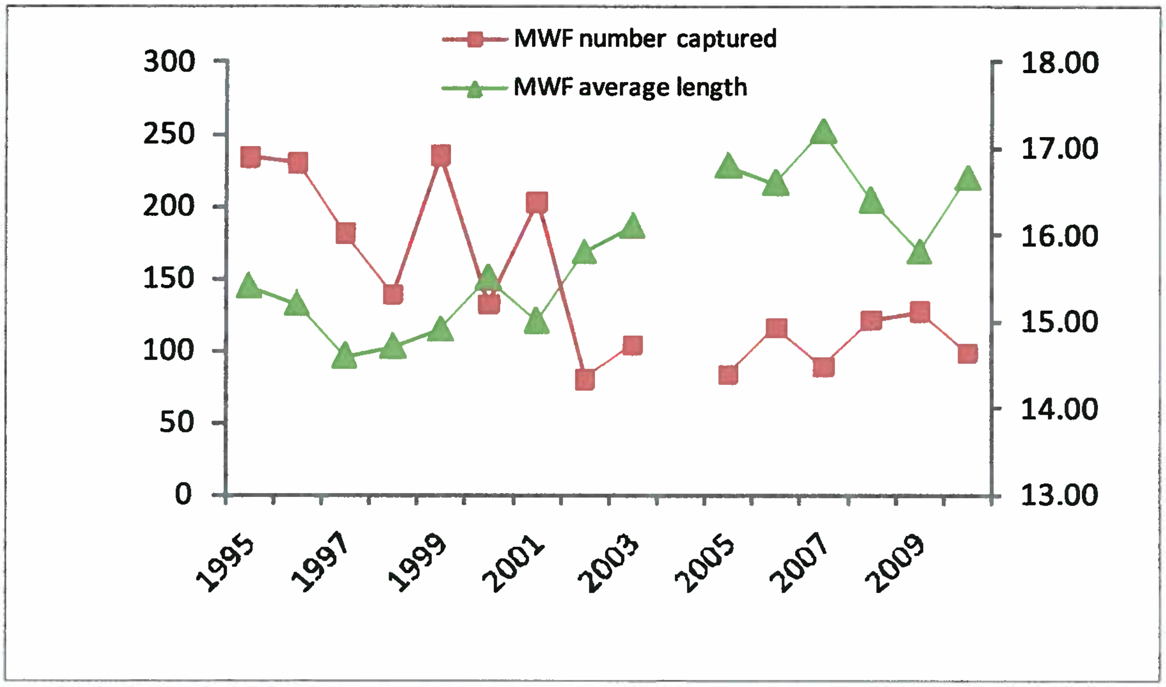


Figure 45. Figure showing mountain whitefish average length in inches (right) vs. number captured (left) during annual Hebgen gillnetting, 1995-2010. Data from 2004 are not shown because of sampling error.

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 46). The number of Utah chub captured annually has ranged from 230 in 2010 to 2,308 in 1999.

Utah chub comprised 90.9 percent of the total Hebgen gillnet catch in 2002, but have averaged 60 percent over the past five years (Figure 47). Although Utah chub still comprise the majority of the gillnet catch numbers are at their lowest since monitoring was initiated.

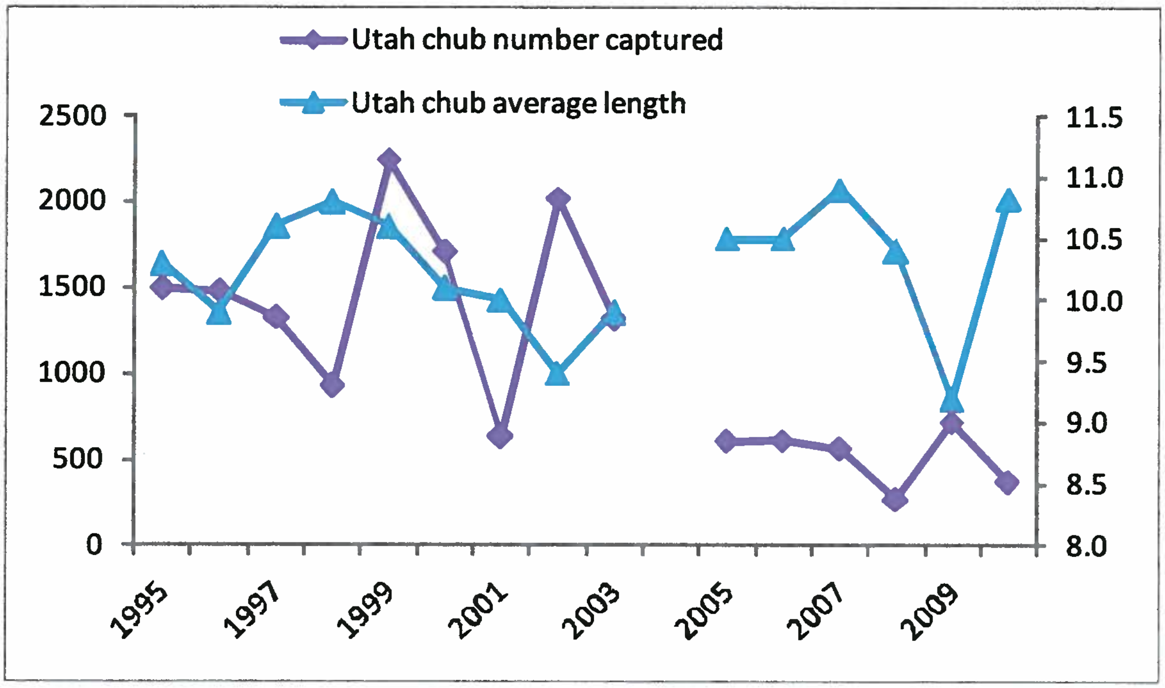


Figure 46. Figure showing Utah chub average length in inches (right) vs. number captured (left) during annual Hebgen gillnetting, 1995-2010. Data from 2004 are not shown because of sampling error.

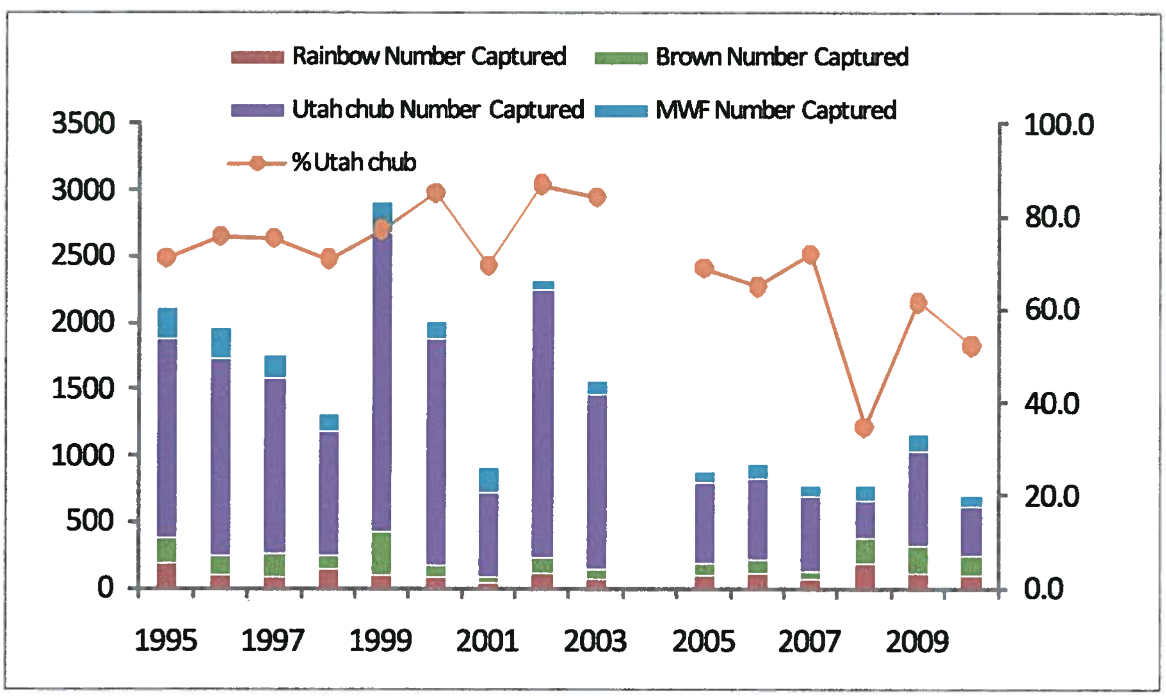


Figure 47. Figure showing species composition of Hebgen Reservoir gillnet catch, 1995 – 2010. Data from 2004 are not shown because of sampling error.

Hebgen Reservoir Tributary Habitat Improvement Monitoring

South Fork Madison Large Woody Debris Project

Relative abundance of brook trout increased significantly in 2010 in a section of the South Fork Madison River that underwent a large woody debris habitat improvement project in 2005, with a corresponding decrease in relative abundance of both rainbow and brown trout (Figure 48). The goal of the project was to enhance spawning and rearing habitat for rainbow trout. Predation pressure on young-of-the-year rainbow and brown trout by brook trout has likely increased as the brook trout population has increased. The project will continue to be monitored biannually to further document changes.

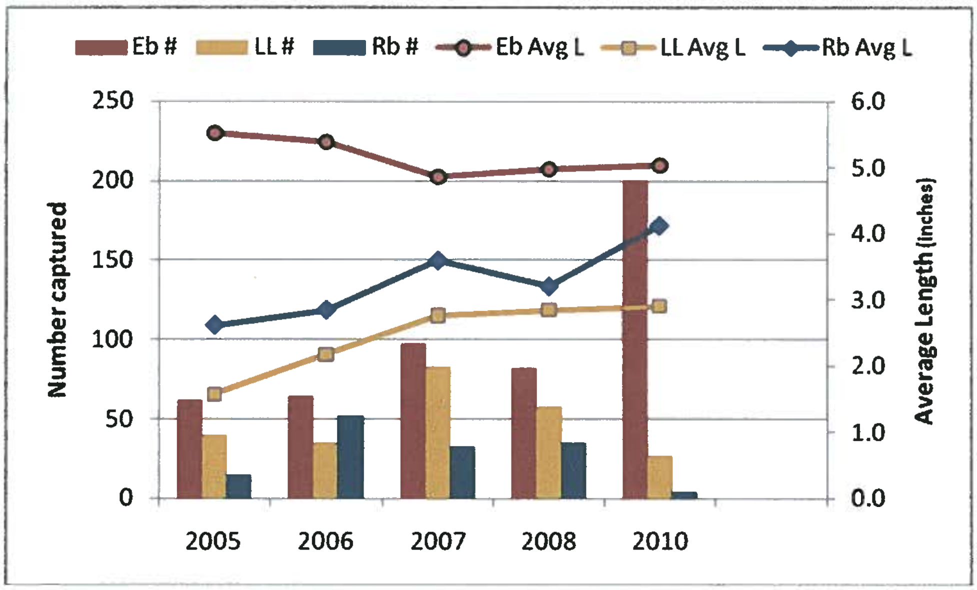


Figure 48. Figure showing the relative abundance and average size of rainbow (Rb), brown (LL) and brook (Eb) trout in a section of the South Fork Madison River following a large woody debris habitat improvement project in 2005.

Watkins Creek

FWP personnel conducted two fish population surveys prior to implementation of a large woody debris project in Watkins Creek in 2010 (Table 9; Appendix F). Only the project and downstream control reach were sampled during the as first sampling event on May 28th as ice cover made the upstream control inaccessible. A second survey of all monitoring reaches was conducted on July 21st.

Table 9. Summary of electrofishing monitoring conducted in Watkins Creek prior to LWD project implementation.

Section	Sample Date	Number of Salmonids Captured	Effort (seconds)	Catch-per-Unit-Effort (fish/hour)
Upstream Control	7/21/10	7	1060	24
Project Section	5/28/10	17	1018	60
	7/21/10	7	2372	11
Downstream Control	5/28/10	47	1193	142
	7/21/10	33	2366	50

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. The downstream control reach yielded slightly higher numbers of salmonids in May than in July. This variance is likely due to fish holding in winter habitat i.e. deep pools and being less dispersed through the reach. Additionally, water temperatures were 12 degrees cooler, making fish more susceptible to capture.

Hebgen Basin Juvenile Fish Sampling

In 2005, upstream fish passage through the Duck Creek culvert on US Highway 191 was improved by constructing a boulder cascade at the outlet. Prior to construction, adult fish were delayed and possibly prevented from passing at this culvert due to the vertical height of the culvert outlet above the streambed. Juvenile fish trapping results show a subsequent increase in outmigrant juvenile brown trout in 2006 and 2007, and an increase in outmigrant juvenile whitefish in 2006. In 2009 and 2010, rotary screw trap capture of juveniles of both species declined to pre-construction levels (Figure 50).

Rotary screw trap catches of juvenile fish in Duck Creek and the South Fork of the Madison River show two different life histories of rainbow trout. Significantly more rainbow trout yearlings emigrated from Duck Creek than did young-of-the-year, while the opposite was true of the South Fork of the Madison River (Table 10).

Higher spring flows in recent years have reduced the efficiency of the rotary screw traps, but it appears that Duck Creek is now providing more rainbow trout to Hebgen Reservoir than is the South Fork of the Madison (Table 11).

Duck Creek

Rainbow trout emigration from Duck Creek peaked in mid-May while brown trout emigration peaked 2-3 weeks earlier in late April (Figure 49).

Table 10. Numbers of young-of-the-year and juvenile trout, and numbers of other fish species captured in the Duck Creek and South Fork Madison rotary screw traps, 2010.

	Duck Creek		S.F. Madison	
Species	Yearling	Y-O-Y	Yearling	Y-O-Y
Rainbow trout	587	102	227	2,226
Brown trout	148	1,153	1,776	16,459
Brook trout	35	2	1	0
Whitefish	0	0	0	0
Longnose dace	45	0	0	0
Mottled sculpin	177	0	12	13
Utah chub	18	0	0	0

Table 11. Actual and estimated number of captured yearling & older rainbow trout in the Duck Creek and South Fork Madison River rotary screw traps, and actual number captured of young-of-the-year rainbow trout for the South Fork Madison, 2004 – 2010.

	Duck		SF Madison		
Year	actual	estimated	actual	estimated	y-o-y
2004	1,070	4,313	455	1,481	11,027
2005	1,338	3,552	1,162	2,942	18,306
2006	656	3,561	---	---	---
2007	317	4,467	---	---	---
2009	683	2,421	402	608	256
2010	587	12,489	227	2,270	2,226

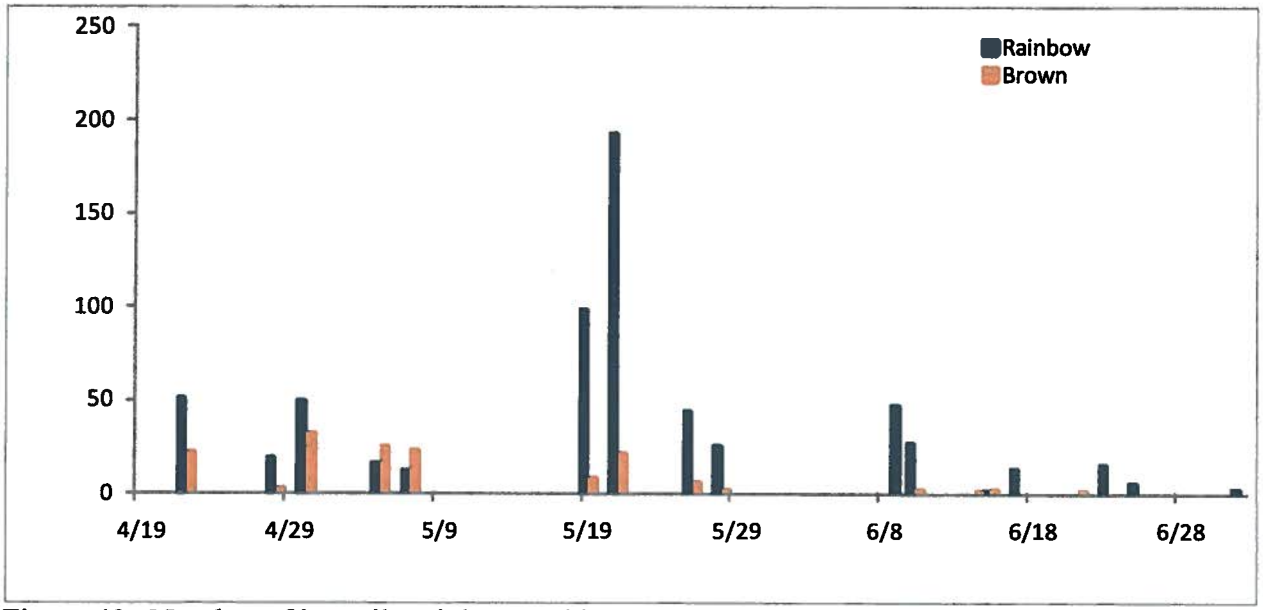


Figure 49. Number of juvenile rainbow and brown trout captured by date in Duck Creek rotary screw trap, 2010.

South Fork Madison

Emigration timing of yearling rainbow and brown trout from the South Fork Madison rotary screw trap is shown in Figure 51. While the annual production of yearling rainbow emigrants is consistent with previous years, the number of young-of-the-year rainbow emigrants has decreased significantly. Only 2,226 young-of-the-year rainbow trout were captured in 2010 compared to 18,306 in 2005 and 11,027 in 2004 (Table 11). Additionally, the number of young-of-the-year whitefish decreased from 54 and 37 in 2004 and 2005 respectively, to 4 in 2009 and 1 in 2010. Brown trout emigration was peaking when trapping began in late April 2010.

Studies of lake versus tributary rearing Bonneville Cutthroat trout *Oncorhynchus clarki utah* in Strawberry Reservoir, Utah (Knight et al 1999) and rainbow trout in Lake Alexandria, New Zealand (Hayes 1995) show the recruitment of young-of-the-year migrants to the lake or reservoir populations is significantly less than that of fish that rear in natal streams until at least age 1 before emigrating. Factors that may be limiting the recruitment of young-of-the-year migrant rainbow trout are susceptibility to predation, habitat and forage availability due to reservoir storage conditions, and competition with other fishes. Availability of littoral cover can greatly increase juvenile fish survival by reducing the probability of an encounter with a predator. Additionally, both intra and interspecific competition for forage and other resources is amplified when habitat availability is condensed (Walls et al. 1990). A study of brown trout in Lake Eucumbene, New South Wales, New Zealand showed higher lake levels to be positively linked to year class survival (Tilzey 1999). By rearing in the natal stream for 2-3 years, Duck Creek juveniles likely experience less forage and habitat competition and posses greater predator avoidance and forage capabilities when they enter the reservoir than do the South Fork Madison young-of-the-year emigrants.

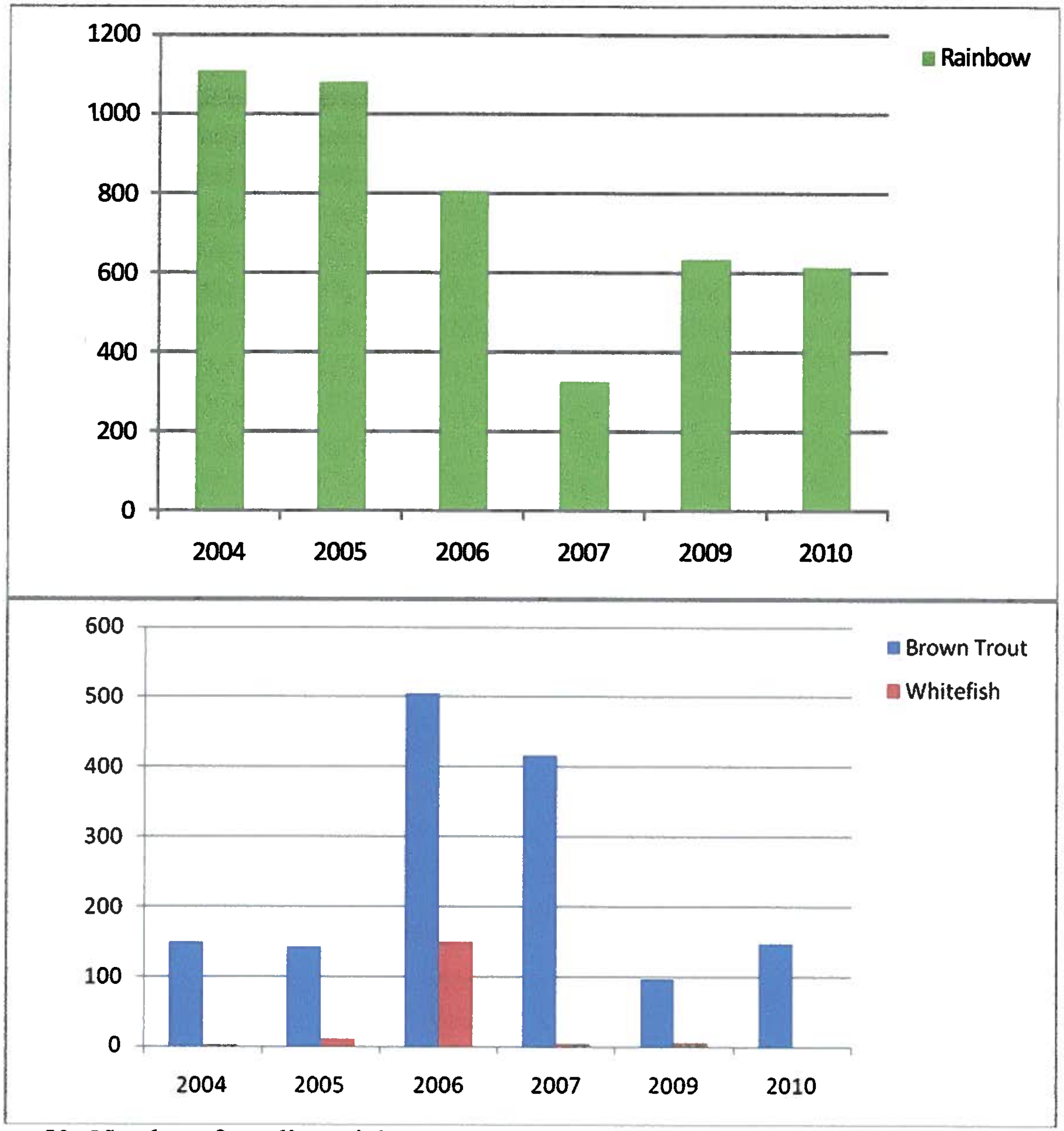


Figure 50. Number of yearling rainbow trout (top) and brown trout and whitefish (bottom) captured in the Duck Creek rotary screw trap, 2004 – 2010.

Hebgen Basin Disease Monitoring

Whirling Disease

Laboratory analyses of 2010 South Fork Madison whirling disease samples shows infection scores at two sites to be 0.61 and 1.09, both lower than seen in several previous years. Monitoring in previous years indicates a moderate to high infection on the MacConnell-Baldwin scale (Appendix A) in the South Fork Madison but little or no infection in other Hebgen tributaries (Table 12). Some rainbow trout spawners ascending Duck Creek in previous years exhibit external characteristics of whirling disease.

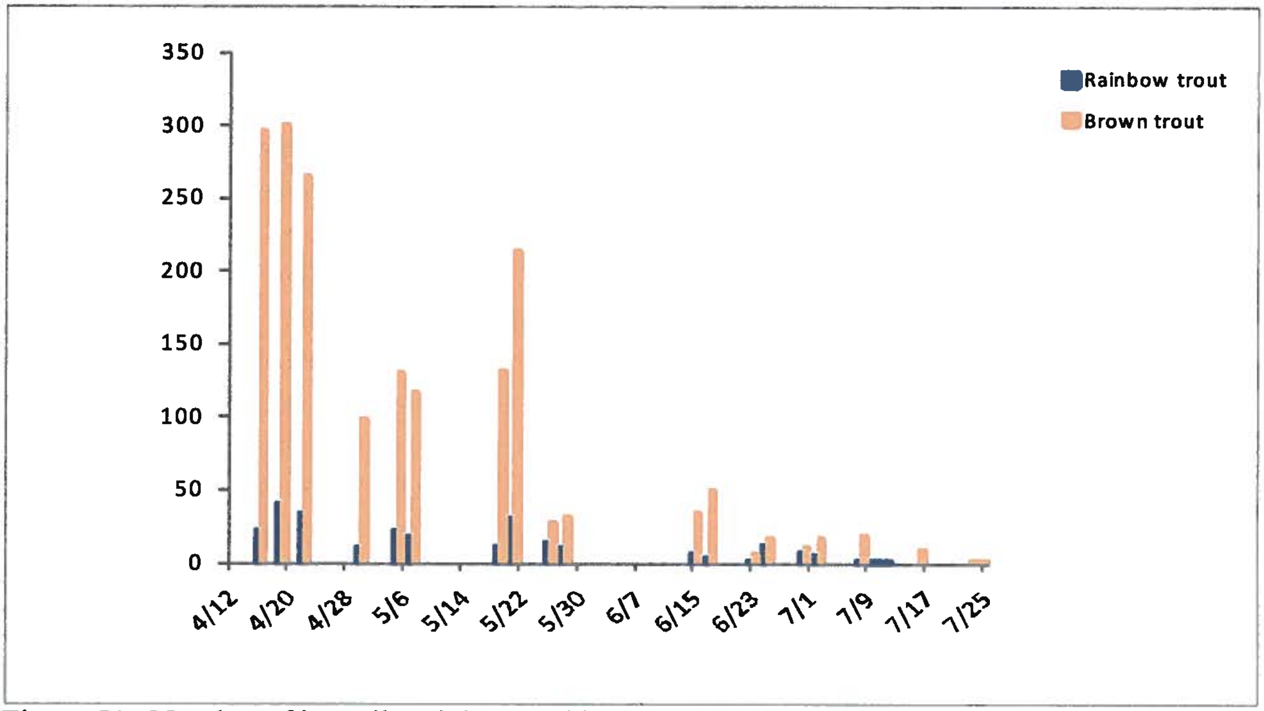


Figure 51. Number of juvenile rainbow and brown trout captured by date in South Fork Madison rotary screw trap, 2010.

Figure 52. Blacktail on a caudal fin clipped yearling rainbow trout from the South Fork Madison rotary screw trap.

Table 12. Whirling disease scores for tributaries of Hebgen Reservoir, 2007 - 2010. Sentinel fish from 2009 were inadvertently destroyed prior to completion of the required 90 incubation period, therefore test results are unavailable for 2009.

Year	Site	Test Period	WD score
2007	South Fork	May 10 – 20	4.29
		May 20 -30	4.66
		May 30 – Jun 9	3.96
		Jun 9 -19	3.67
		Jun 19 - 29	2.52
	Black Sands Spring	May 10 – 20	0.02
		May 20 -30	0
		May 30 – Jun 9	0
		Jun 9 -19	0
		Jun 19 - 29	0
	Duck Ck	May 10 – 20	0.12
		May 20 -30	0
		May 30 – Jun 9	0.08
		Jun 9 -19	0.06
		Jun 19 - 29	0
2008	South Fork	Jun 18 – 28	3.30
		Jun 28 – Jul 8	2.46
	Duck Ck	Jun 18 – 28	0
		Jun 28 – Jul 8	0
	Cougar Ck	Jun 18 – 28	0
		Jun 28 – Jul 8	0
	Grayling Ck	Jun 18 – 28	0
		Jun 28 – Jul 8	0
2010	South Fork	May 16 – 26	1.09 (Highway 20) 0.62 (1/4 mile above Highway)

The observed reduction in young-of-the-year rainbow trout and whitefish in the South Fork may be attributable to whirling disease. 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 (Sipher and Bergersen 2001). Sentinel Whirling disease infection rates and severity

Hebgen Reservoir Zooplankton Monitoring

Densities (individuals/liter) of cladoceran and copepod zooplankton in Hebgen Reservoir have been monitored since 2006. Annual temporal trends in abundance show peak densities occurring in late spring and early summer (Figures 53 & 54).

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).

Utah chub comprise the majority of the fish biomass in Hebgen Reservoir (Figure 47) and may be influencing zooplankton densities through predation. Cladoceran densities in Hebgen also appear to be inversely related to the ratio of adult Utah chub/brown trout (Figure 55).

Studies of Utah chub diet in several western reservoirs have shown zooplankton to be the principle food item for Utah chubs. 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).

With mean TSI of 35.6 and 35.8 in 2009 and 2010 respectively, Hebgen Reservoir is classified as a borderline oligotrophic-mesotrophic lake according to the Trophic State Index developed by Carlson (1977) (Figure 56). This may explain the low densities of plankton observed in monthly plankton tows. Hebgen Reservoir plankton densities relate positively with TSI score (Figure 57).

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 58). Given Hebgen Reservoirs northwest-southeast orientation this data would suggest that nutrients may be confined to the arms of the reservoir for much of the growing season.

FWP is working with PPL Montana to upgrade the anemometer of the weather station to include wind direction for the 2011 season to explore this relationship further.

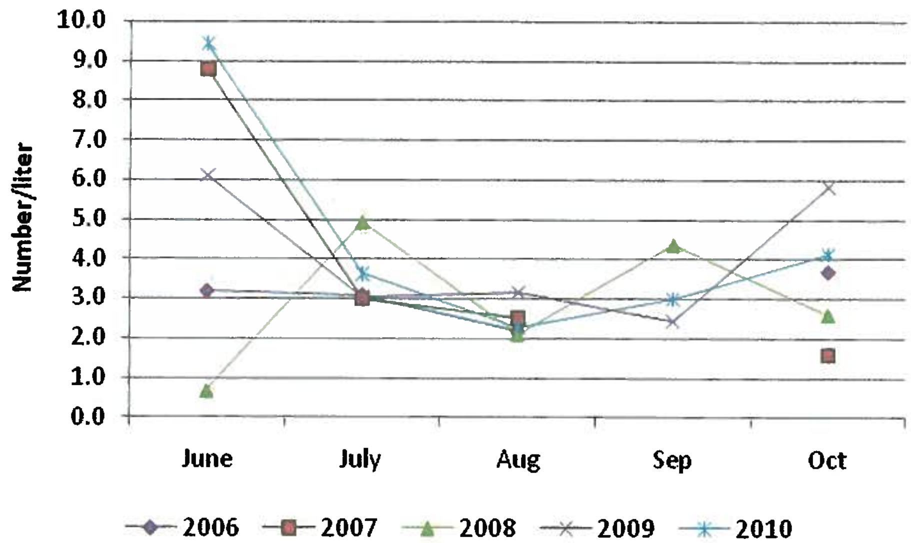


Figure 53. Figure showing cladoceran densities (individuals/liter) sampled in Hebgen Reservoir by month, 2006-2010.

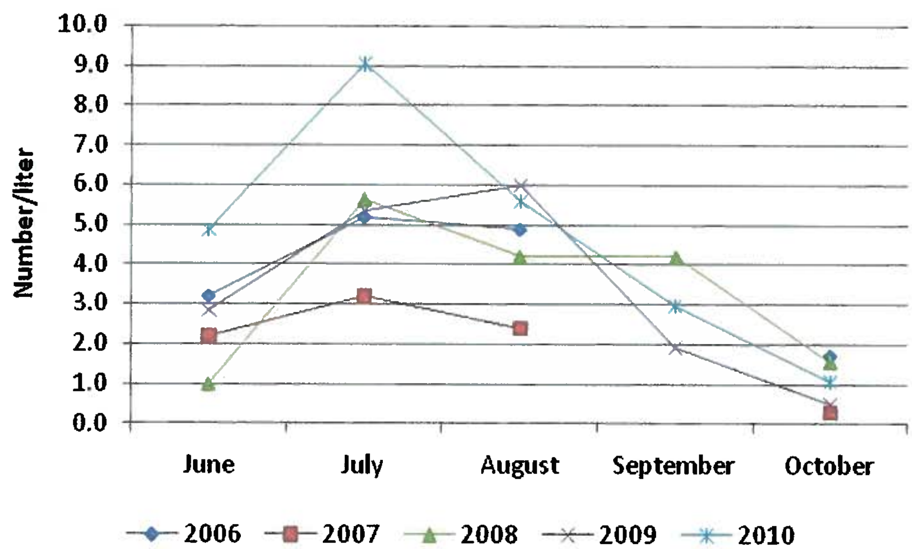


Figure 54. Figure showing copepod densities (individuals/liter) sampled in Hebgen Reservoir by month, 2006-2010.

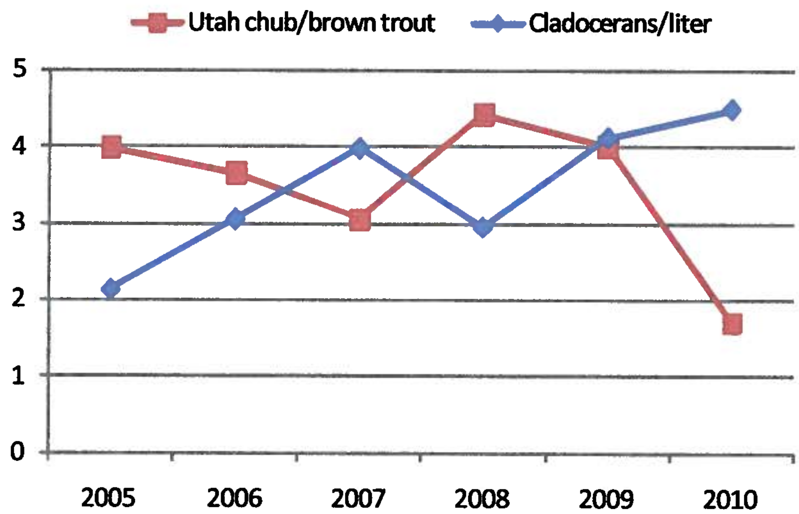


Figure 55. Number of Utah chub per brown trout (calculated from annual spring gillnetting) and annual mean cladoceran density in Hebgen Reservoir, 2005 - 2010.

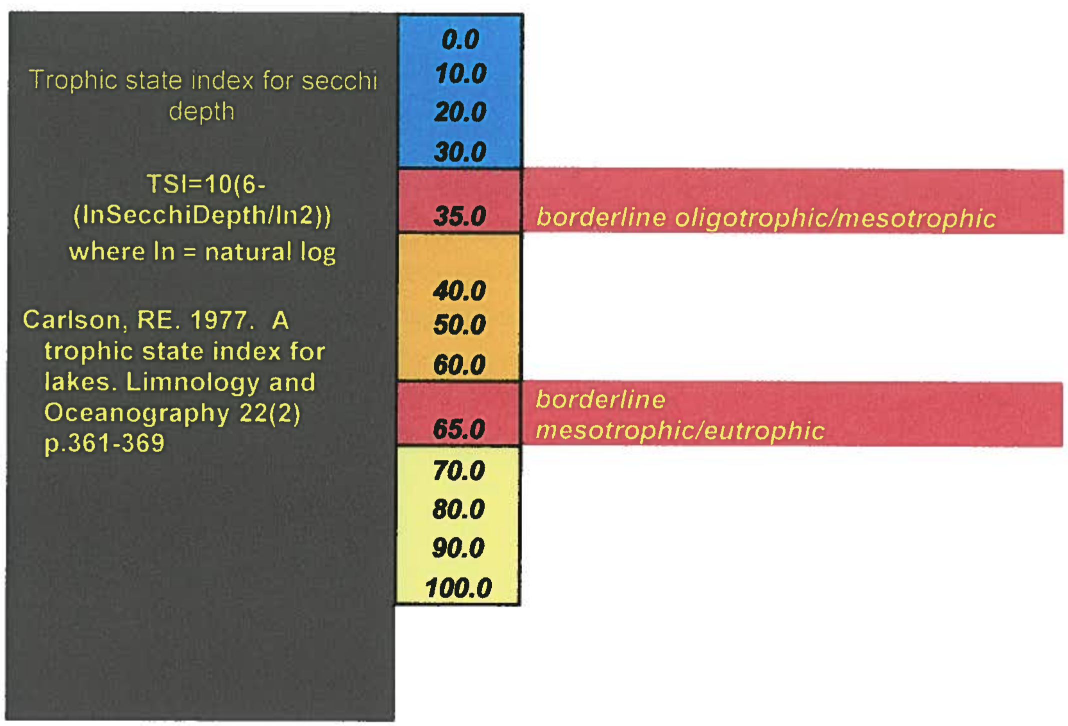


Figure 56. Figure depicting the trophic state index formula and classification for lake productivity using secchi depth measurements.

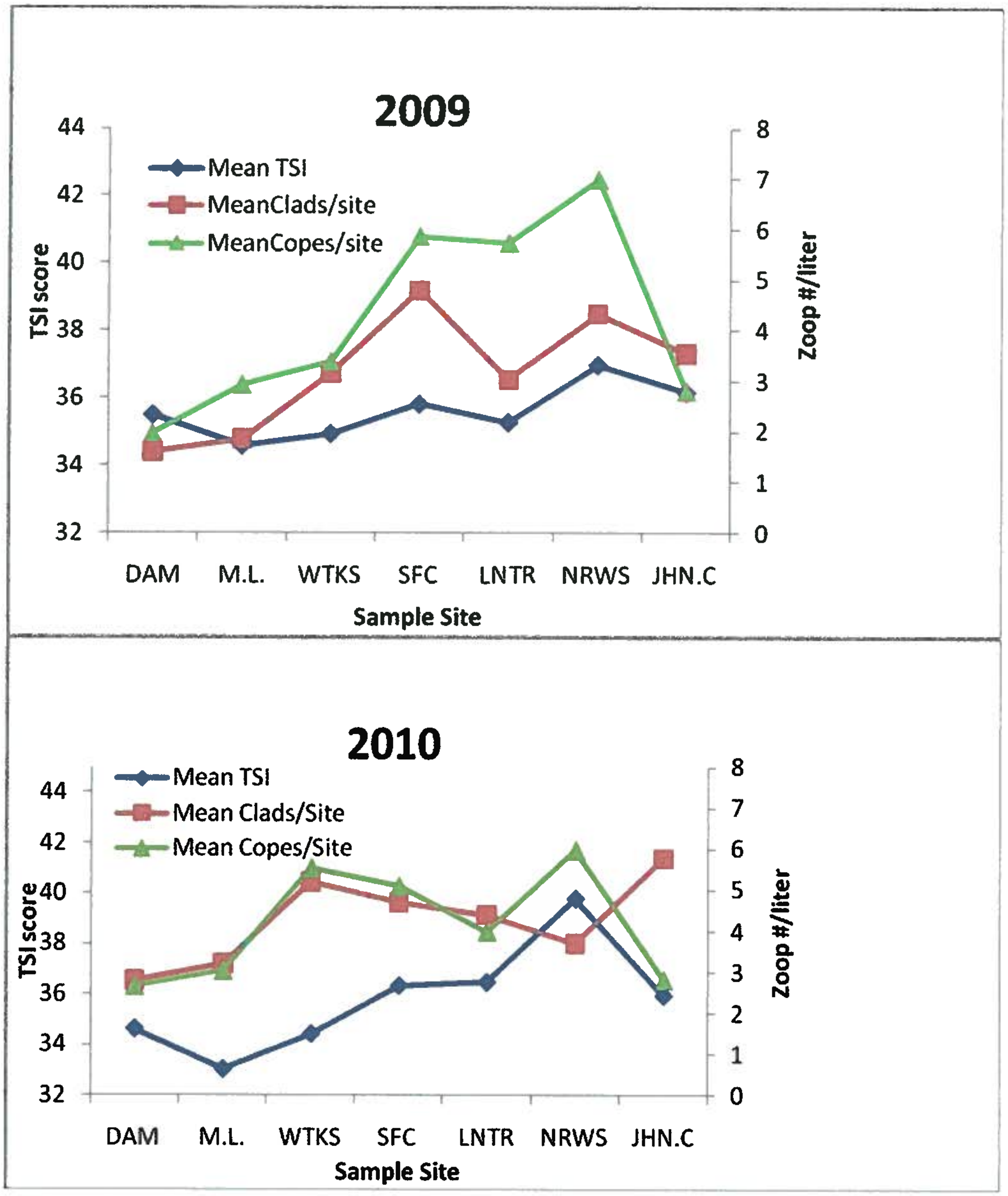
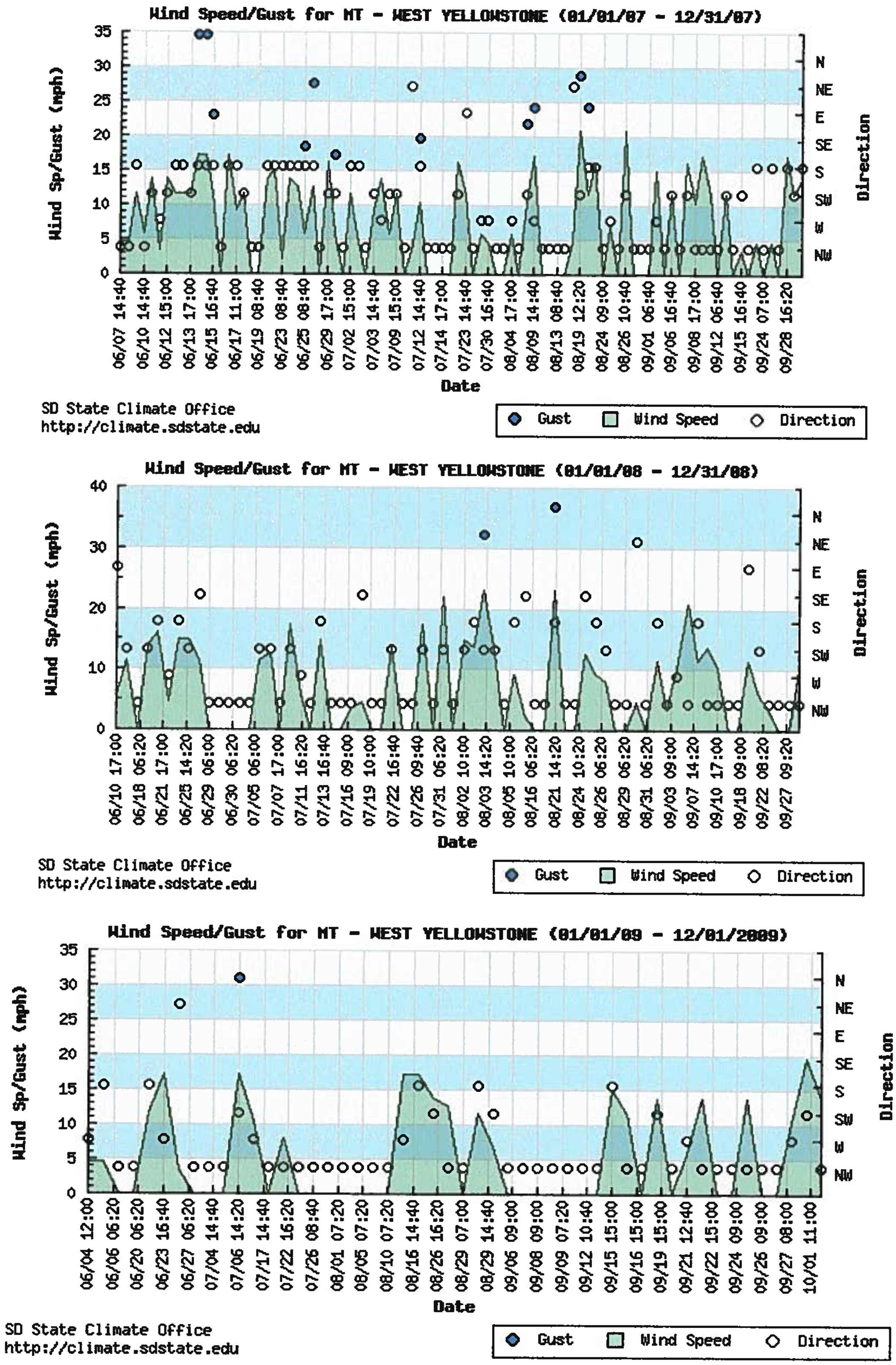


Figure 57. Hebgen Reservoir mean TSI score and densities of zooplankton by site, 2009 and 2010. Site names are Dam, Moonlight Bay, Watkins Creek, South Fork Cabin, Lone Tree (Horse Butte), Narrows, and Johnson Creek. Sites are listed in a counterclockwise fashion from the dam (Figure 21).



Figures 58. Wind gust, speed and direction data recorded at the West Yellowstone airport, June through September, 2007 (top), 2008 (middle), and 2009 (bottom). Data are from South Dakota State University Climate Office. Data for 2010 are not yet available.

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.

New Zealand Mudsnail populations will continue to be monitored through the 2188 Biological and Biocontaminant monitoring program and through the FWP Aquatic Nuisance Species Program.

Rainbow trout captive stock used in sentinel cage studies in the Madison River have continued to show high infection rates and severity. In laboratory studies, progeny of Madison River rainbow trout exhibited lower infection severity to whirling diseasewhen compared to hatchery stock rainbow trout.

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

In 2010, WCT from the Sun Ranch Brood provided eggs and fry for the Cherry Creek project and introduction back into the Sun Ranch Brood. Additionally, fertilized eggs from six wild donor populations were reared in the Sun Ranch Hatchery and introduced into recipient streams as eyed eggs or fry, and resulting fry from one of those wild donor populations was also introduced into the Sun Ranch Brood.

In 2010, eradication of nonnative trout was completed for the Cherry Creek Native Fish Introduction Project and introductions of WCT continued in Phase 3 and Cherry Lake. Introductions will continue in 2011 and beyond, and monitoring will document the development of the WCT population.

Activation of the well and delivery system allows permanent removal of tarps and a portion of a hand-built rock dam in Lake Creek, providing year-round passage for spawning brown trout and other aquatic species. Installation of the waterline from the well drilled in 2009 to stock tanks was completed in 2010.

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

The South Fork of the Madison River, where juvenile rainbow trout emigrate to the reservoir as young-of-the-year, is the only tributary of Hebgen Reservoir to show high whirling disease infection of sentinel fish. Sentinel rainbow trout in Duck Creek and Black Sand Springs have exhibited infection rates less than 0.20 in previous years, and in most cases showed no infection.

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.

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Appendix A

The MacConnell-Baldwin whirling disease grade-of-severity scale and definitions.

Grade 0: No abnormalities noted. *Myxobolus cerebralis* is not seen.

Grade 1: Small, discrete focus or foci of cartilage degeneration. No or few associated leukocytes.

Grade 2: Single, locally extensive focus or several smaller foci of cartilage degeneration and necrosis. Inflammation is localized, few to moderate numbers of leukocytes infiltrate or border lytic cartilage.

Grade 3: Multiple foci (usually 3 –4[1/]) of cartilage degeneration and necrosis. Moderate number of leukocytes are associated with lytic cartilage. Inflammatory cells extend minimally into surrounding tissue.

Grade 4: Multifocal (usually 4 or more sites[1/]) to coalescing areas of cartilage necrosis. Moderate to large numbers of leukocytes border and/or infiltrate lytic cartilage. Locally extensive leukocyte infiltrates extend into surrounding tissue.

Grade 5: Multifocal (usually 6 or more[1/]) to coalescing areas of cartilage necrosis. Moderate to large numbers of leukocytes border and/or infiltrate necrotic cartilage. The inflammatory response is extensive and leukocytes infiltrate deeply into surrounding tissue. This classification is characterized by loss of normal architecture and is reserved for the most severely infected fish.

[1/] lesion numbers typical for head, not whole body sections.

Appendix B1

Summary of Ennis Reservoir beach seining 1995 - 2010

Species abbreviations:

AG Arctic grayling
MWF mountain whitefish
LL brown trout
Rb rainbow trout

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

Appendix B2

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

Species abbreviations:

AG	Arctic grayling
MWF	mountain whitefish
Rb	rainbow trout
LL	brown trout
WSu	white sucker
UC	Utah chub
LND	long-nose dace
Sc	Rocky Mountain (mottled) sculpin

Site	AG	MWF	Note
Southeast shore west of Bailey's mouth 10/6/10 Fig 4 site 1	0	0	Small pockets of macrophytes 16 juvenile UC One 3-inch LL
Southeast shore west of Bailey's mouth 10/6/10 Fig 4 site 2	0	0	Small pockets of macrophytes 10 juvenile UC 1 mottled Sc
Meadow Ck FAS North shore & west shore willows 10/6/10 Fig 4 site 3	0	0	Few macrophytes Dozens of y-o-y UC 1 LND Several Sc

Appendix C1

Historic population estimates of aged rainbow and brown trout per mile in the Pine Butte, Varney, and Norris sections of the Madison River

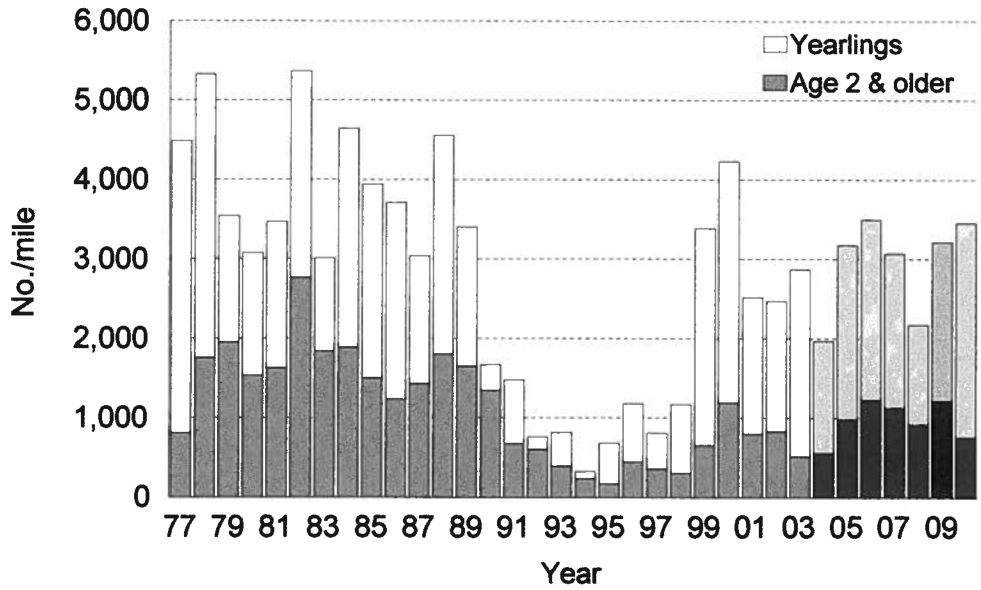


Figure C1 - 1. Figure showing fall rainbow trout population estimates in the Pine Butte section of the Madison River, 1977-2010. Estimates for 2004 - 2010 are not aged.

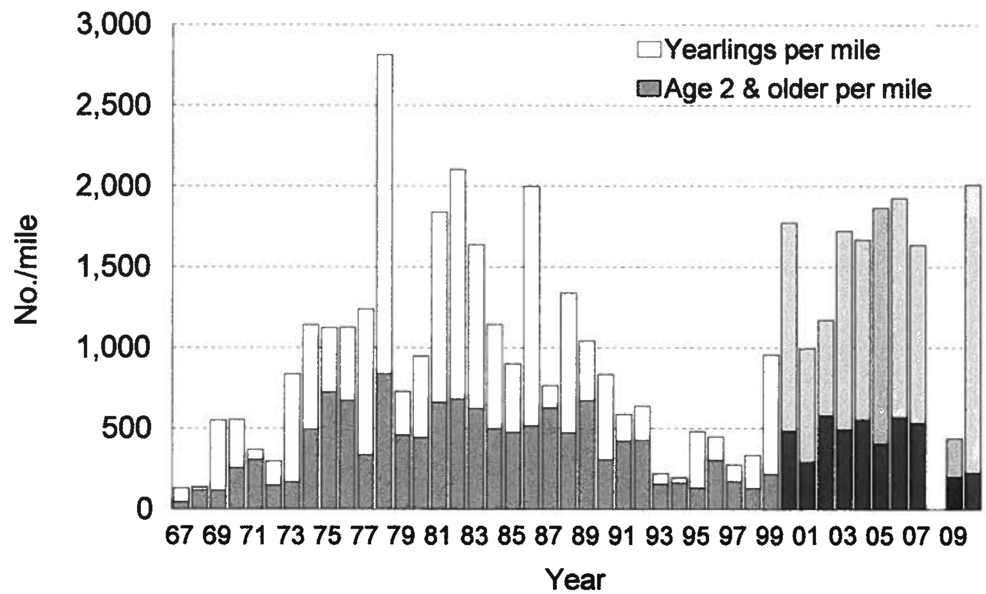


Figure C1 – 2. Figure showing fall rainbow trout population estimates in the Varney section of the Madison River, 1967-2010. Estimates for 2000 - 2010 are not aged. Estimates were not conducted in Varney in 2008.

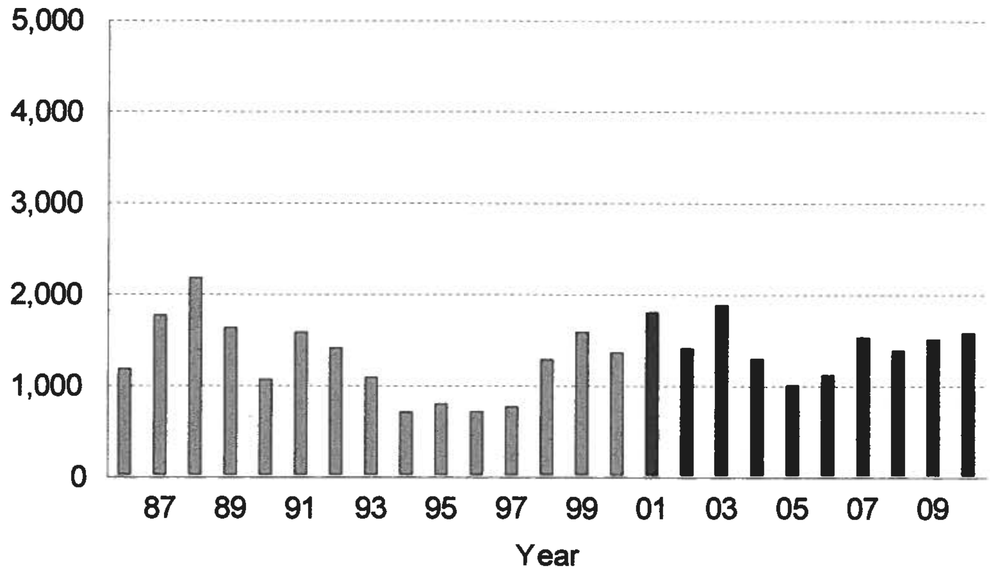


Figure C1 – 3. Figure showing spring rainbow trout population (two-year old & older) estimates in the Norris section of the Madison River, 1986-2010. Estimates for 2001 - 2010 are not aged.

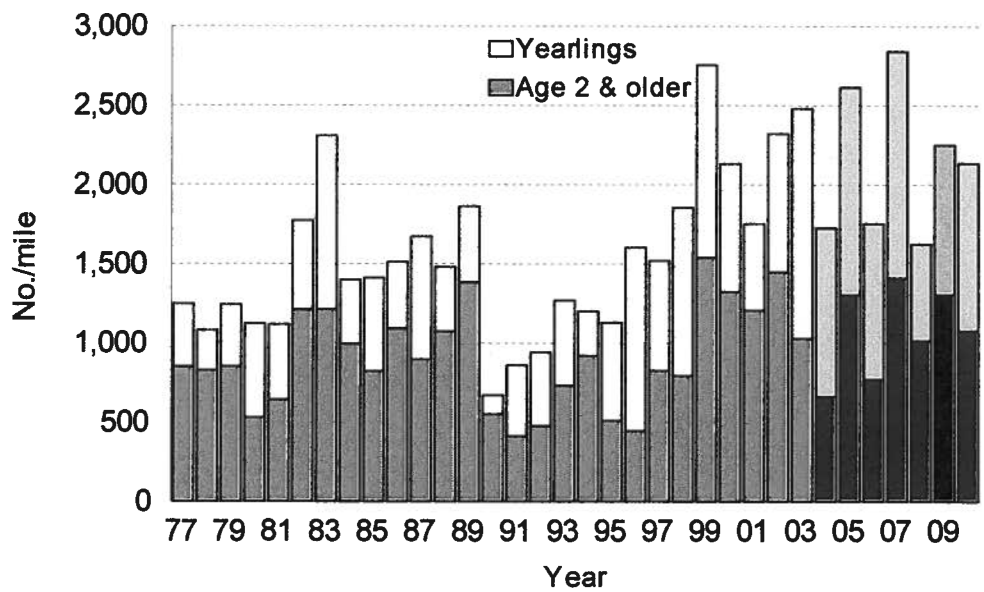


Figure C1 - 4. Figure showing fall brown trout population estimates in the Pine Butte section of the Madison River, 1977-2010. Estimates for 2004 - 2010 are not aged.

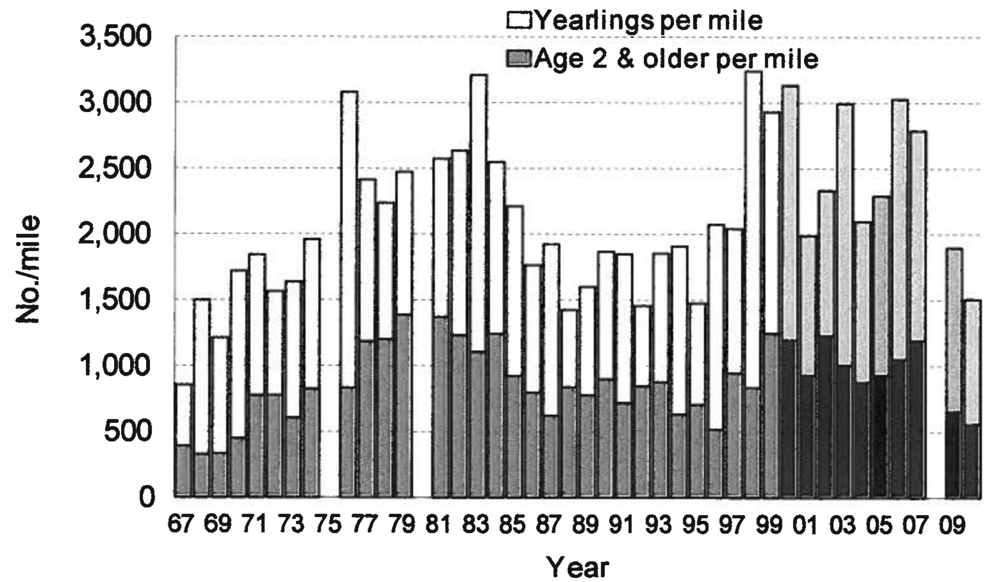


Figure C1 - 5. Figure showing fall brown trout population estimates in the Varney section of the Madison River, 1967-2010. Estimates for 2000 - 2010 are not aged. Estimates were not conducted in Varney in 2008.

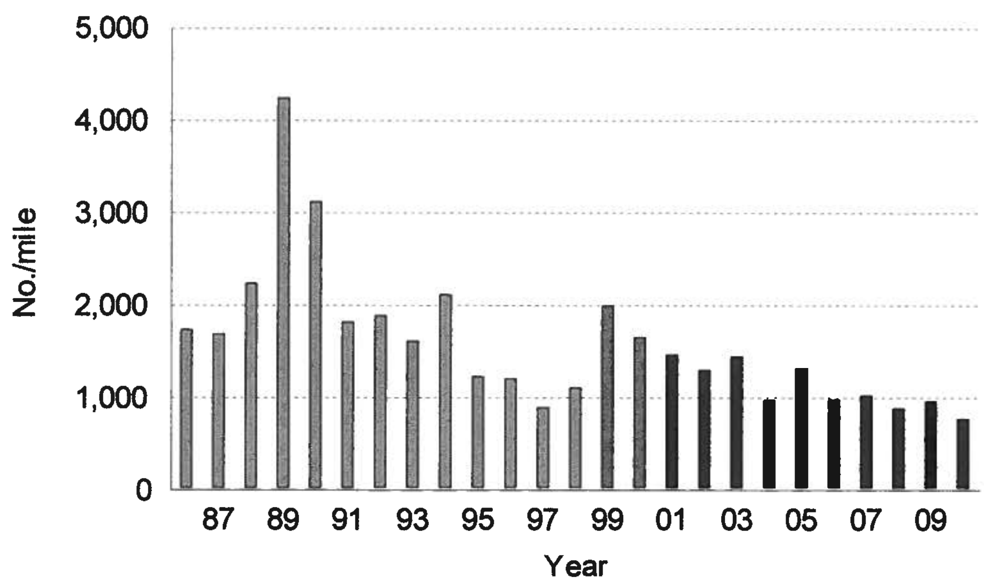


Figure C1 – 6. Figure showing spring brown trout population (two-year old & older) estimates in the Norris section of the Madison River, 1986-2010. Estimates for 2001 - 2010 are not aged.

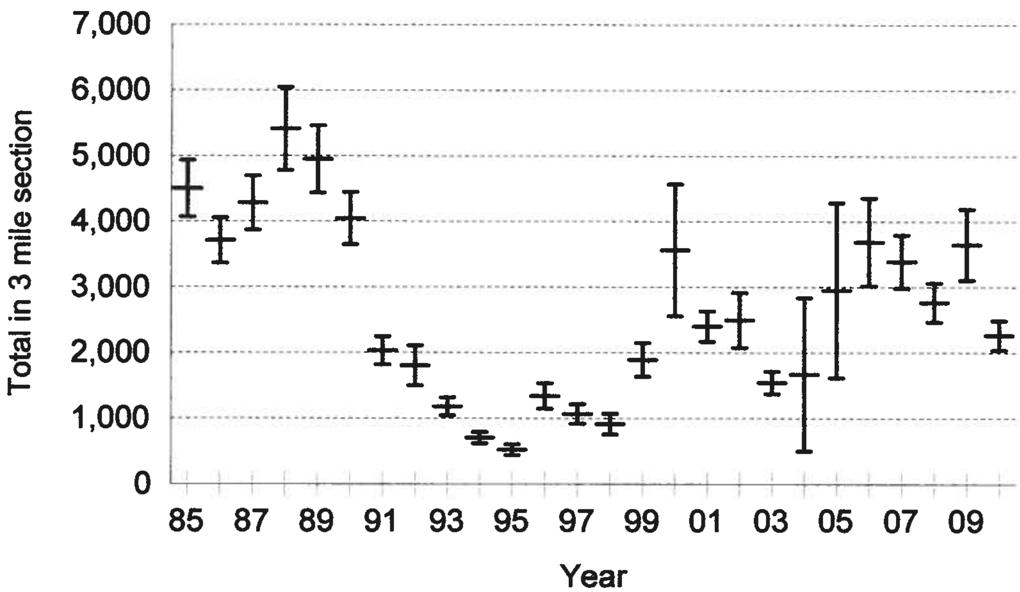
Appendix C2

Population estimates (total number in section± 80 percent Confidence Intervals)
of age 2 & older rainbow and brown trout in the Madison River
See Figure 5 for section locations

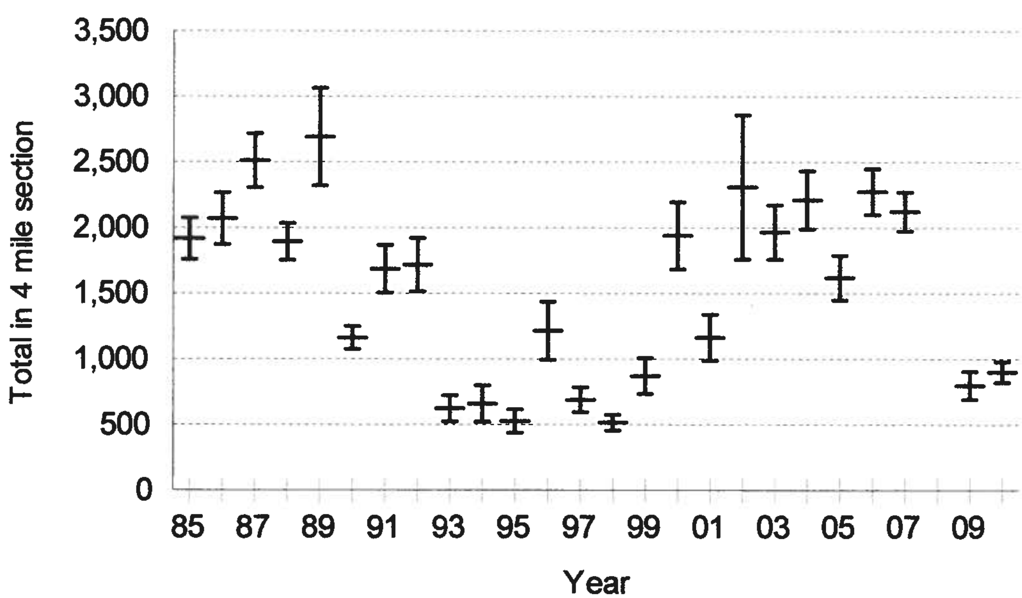
<u>section lengths</u>

Pine Butte – 3 miles
Varney – 4 miles
Norris – 4 miles

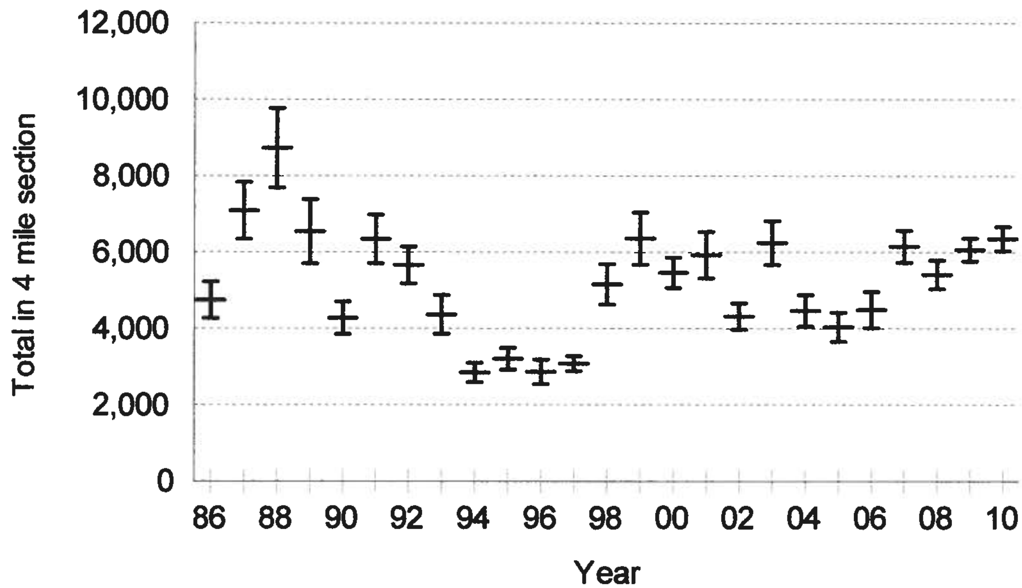
Pine Butte
Rainbow Trout
Age 2 & older



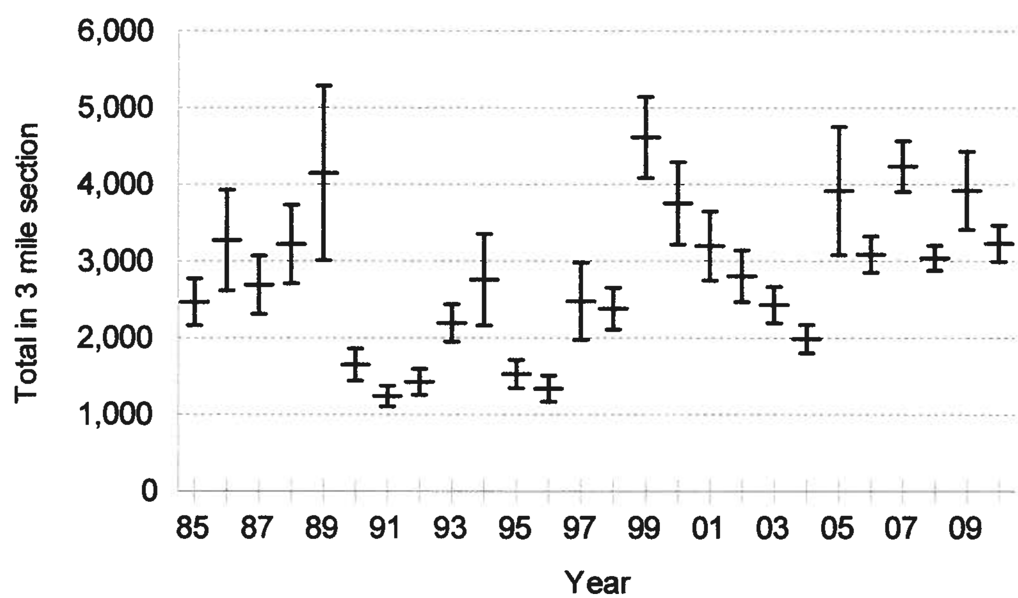
Varney
Rainbow Trout
Age 2 & older



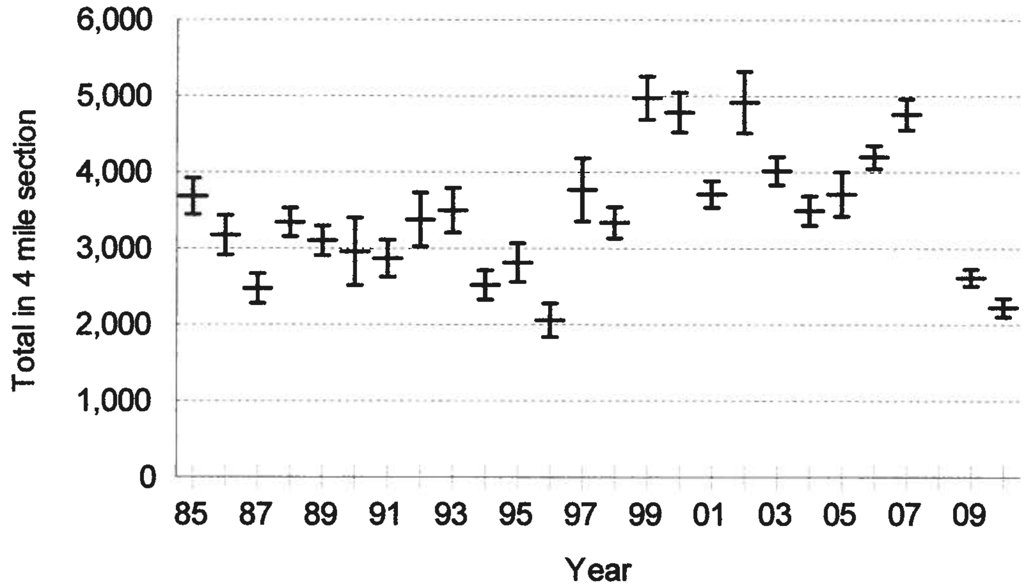
Norris
Rainbow Trout
Age 2 & older



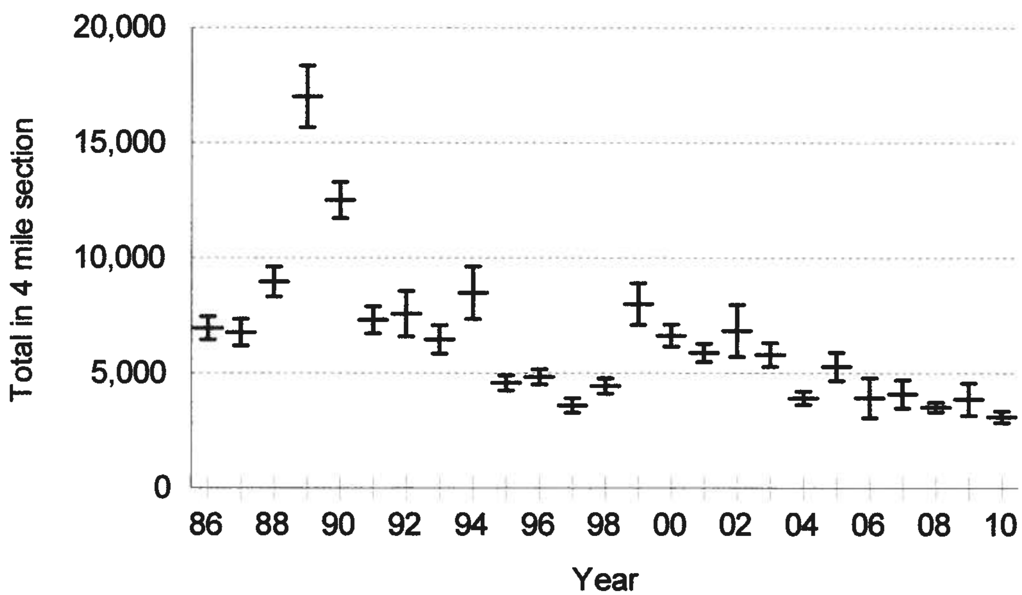
Pine Butte
Brown Trout
Age 2 & older



Varney
Brown Trout
Age 2 & older



Norris
Brown Trout
Age 2 & older

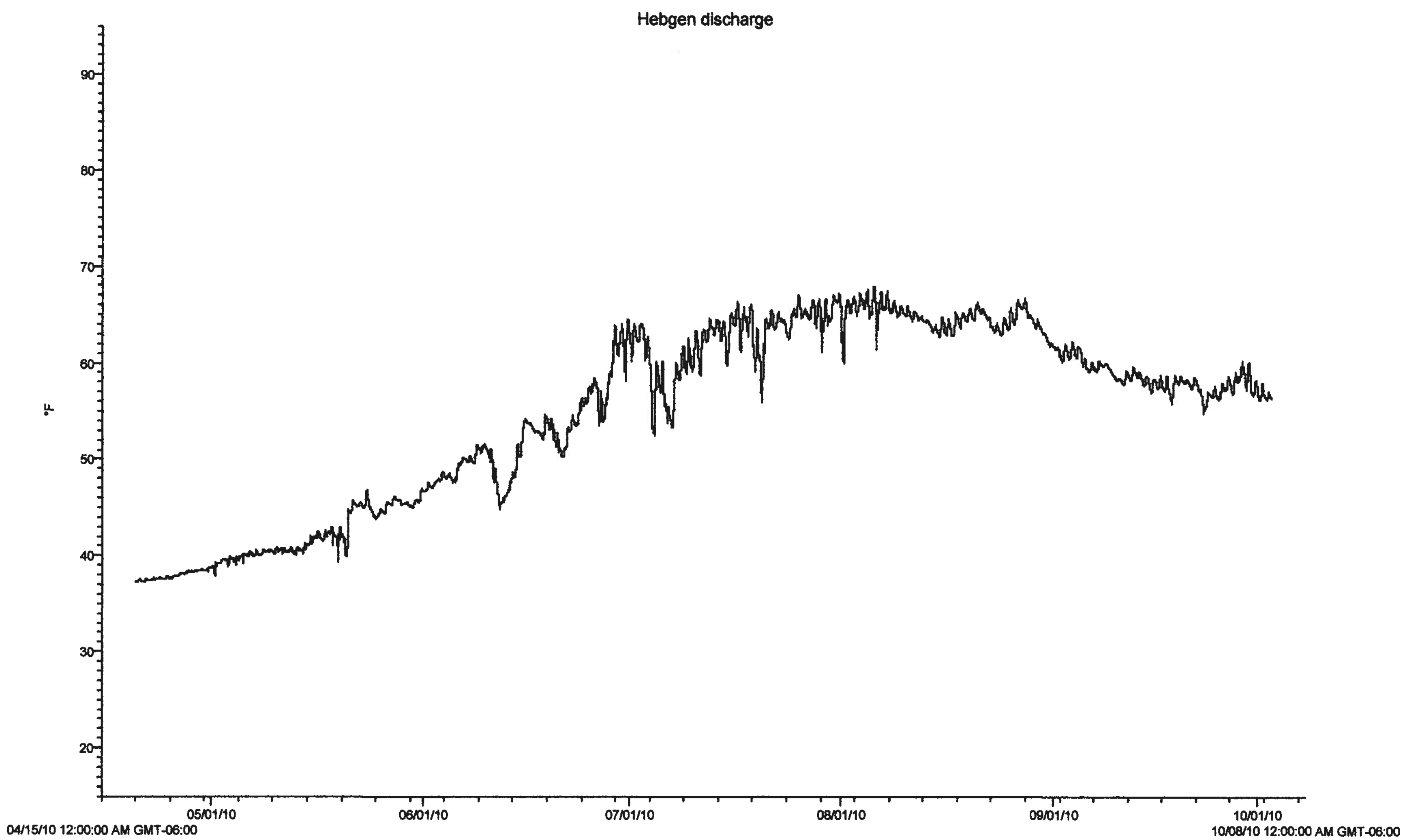


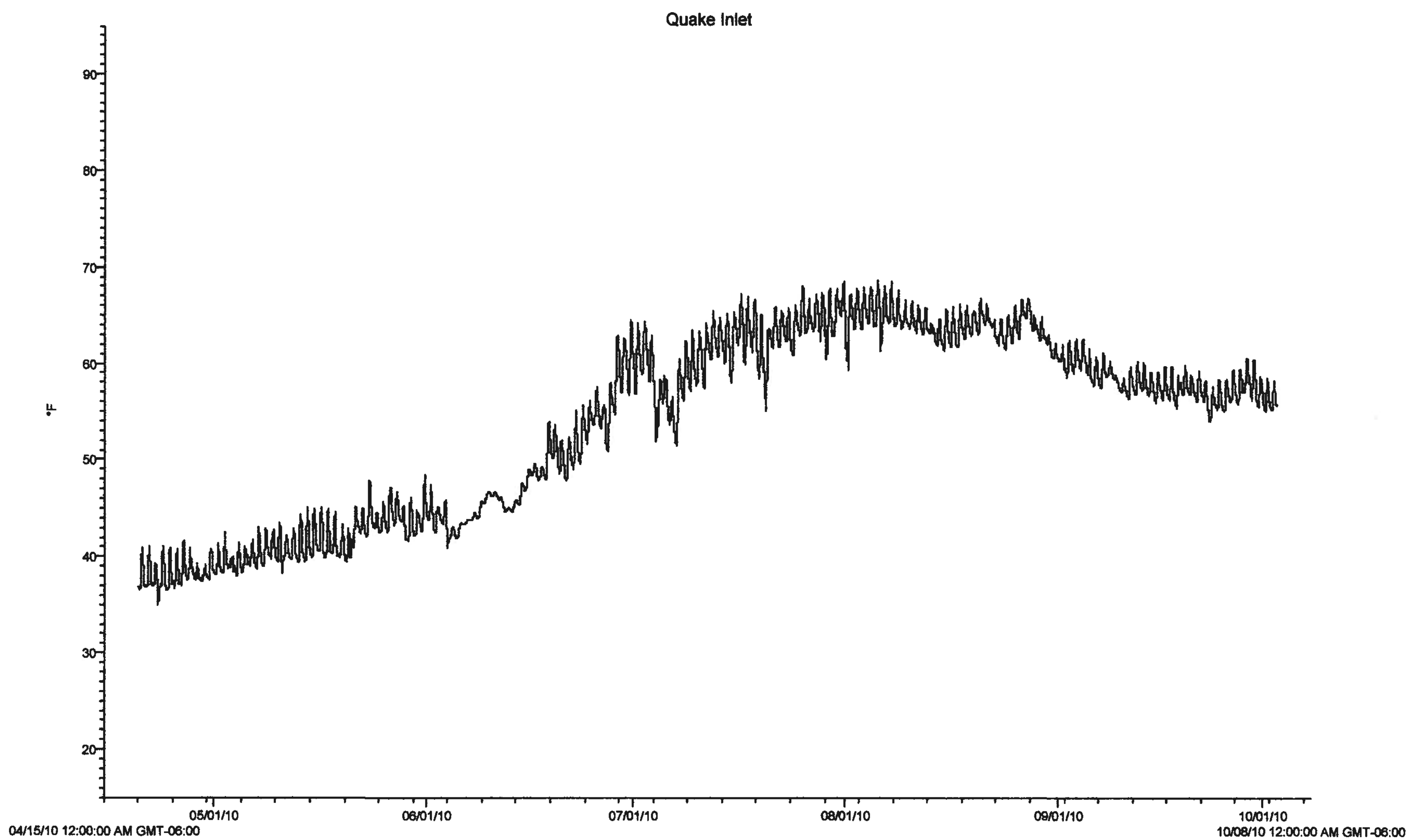
Appendix D

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

NOTES:

- Recorder at Hebgen Inlet was not recovered
- Maximum temperature at Ennis air was 123.2, but the recorder had been moved by an unknown party from its shaded position to a point in the full sun


Hebgen discharge
°F
90
80
70
60
50
40
30
20
05/01/10
06/01/10
07/01/10
08/01/10
09/01/10
10/01/10
04/15/10 12:00:00 AM GMT-06:00
10/08/10 12:00:00 AM GMT-06:00


Quake Inlet
°F
90
80
70
60
50
40
30
20
05/01/10
06/01/10
07/01/10
08/01/10
09/01/10
10/01/10
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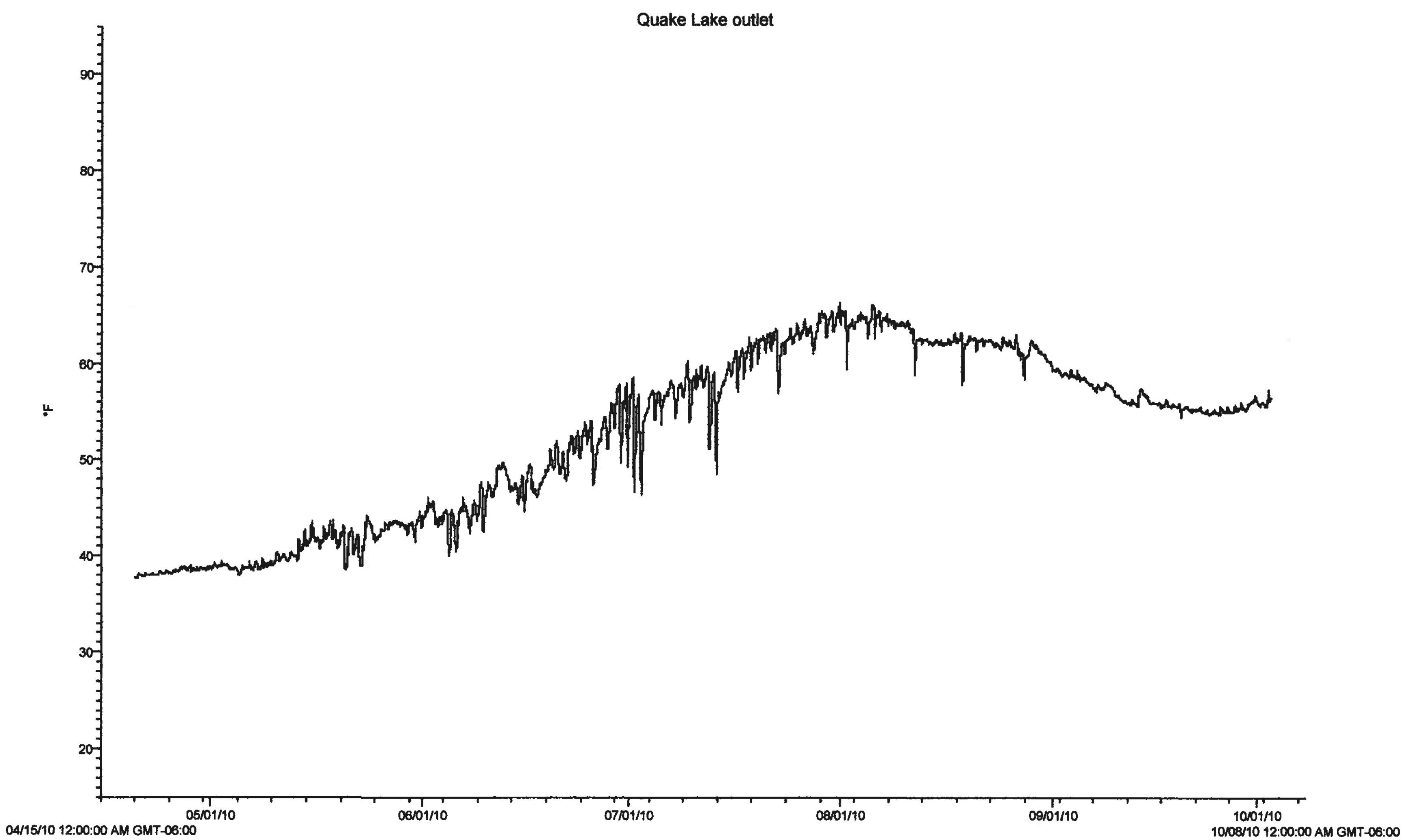
10/08/10 12:00:00 AM GMT-06:00


Quake Lake outlet
°F
90
80
70
60
50
40
30
20
05/01/10
06/01/10
07/01/10
08/01/10
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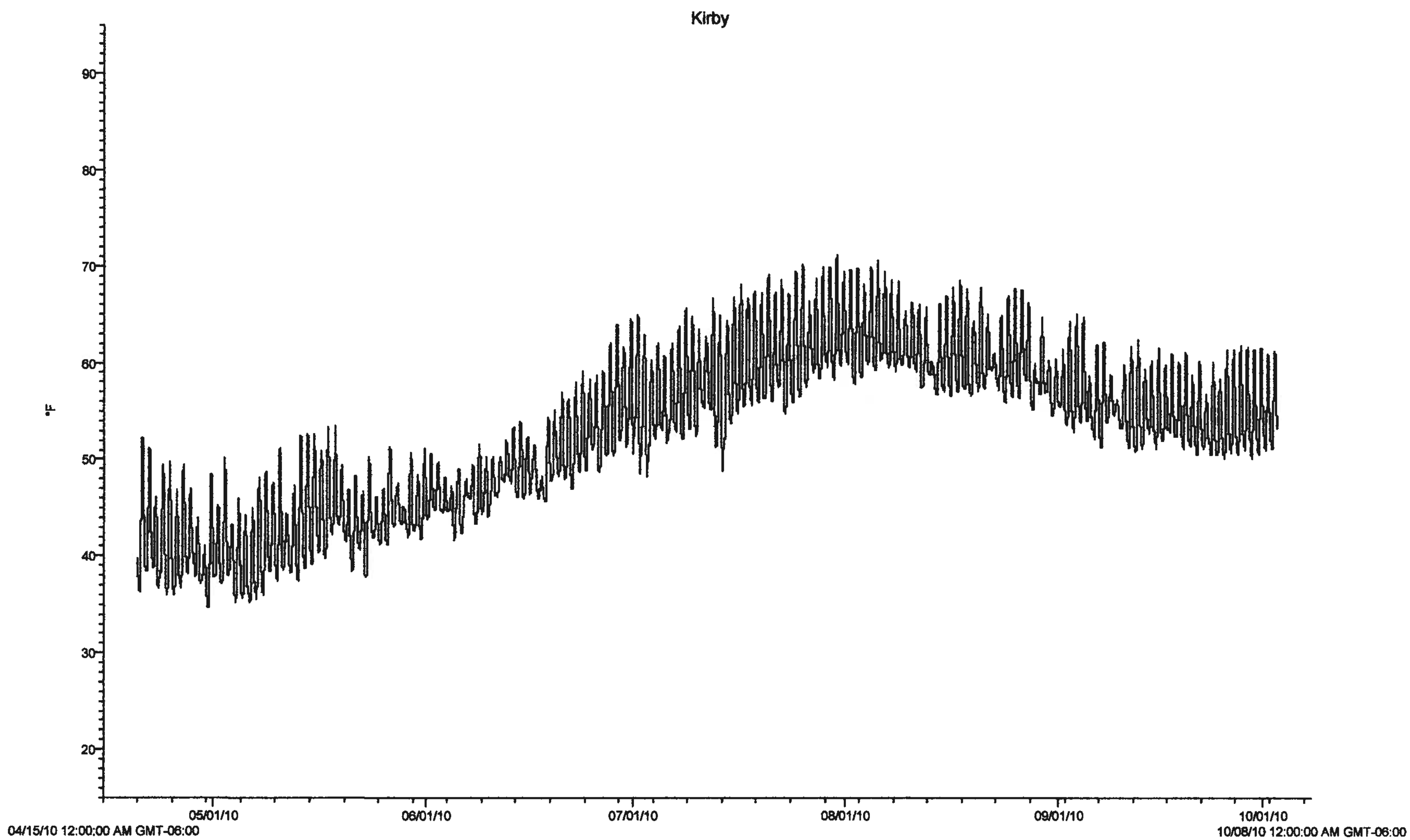
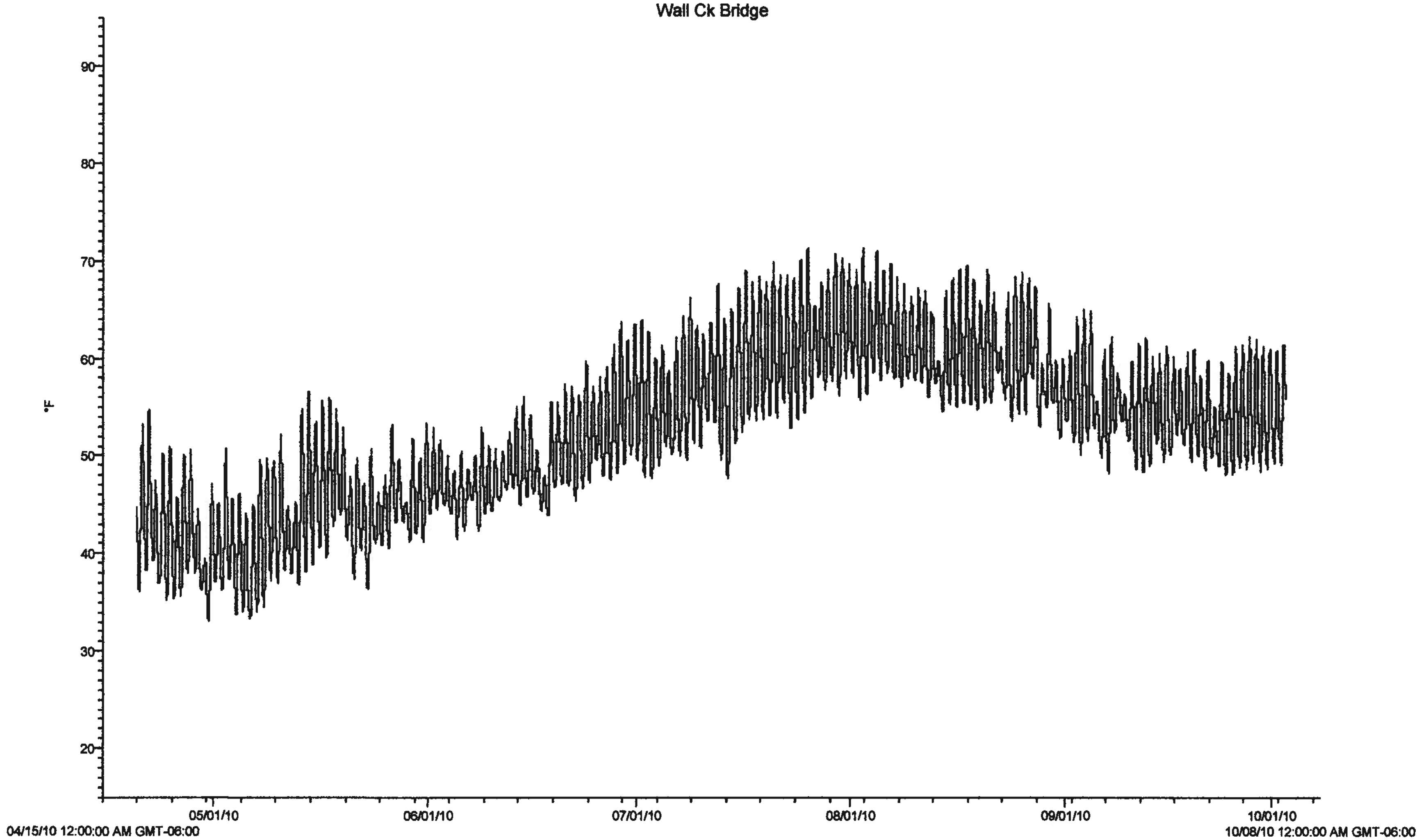
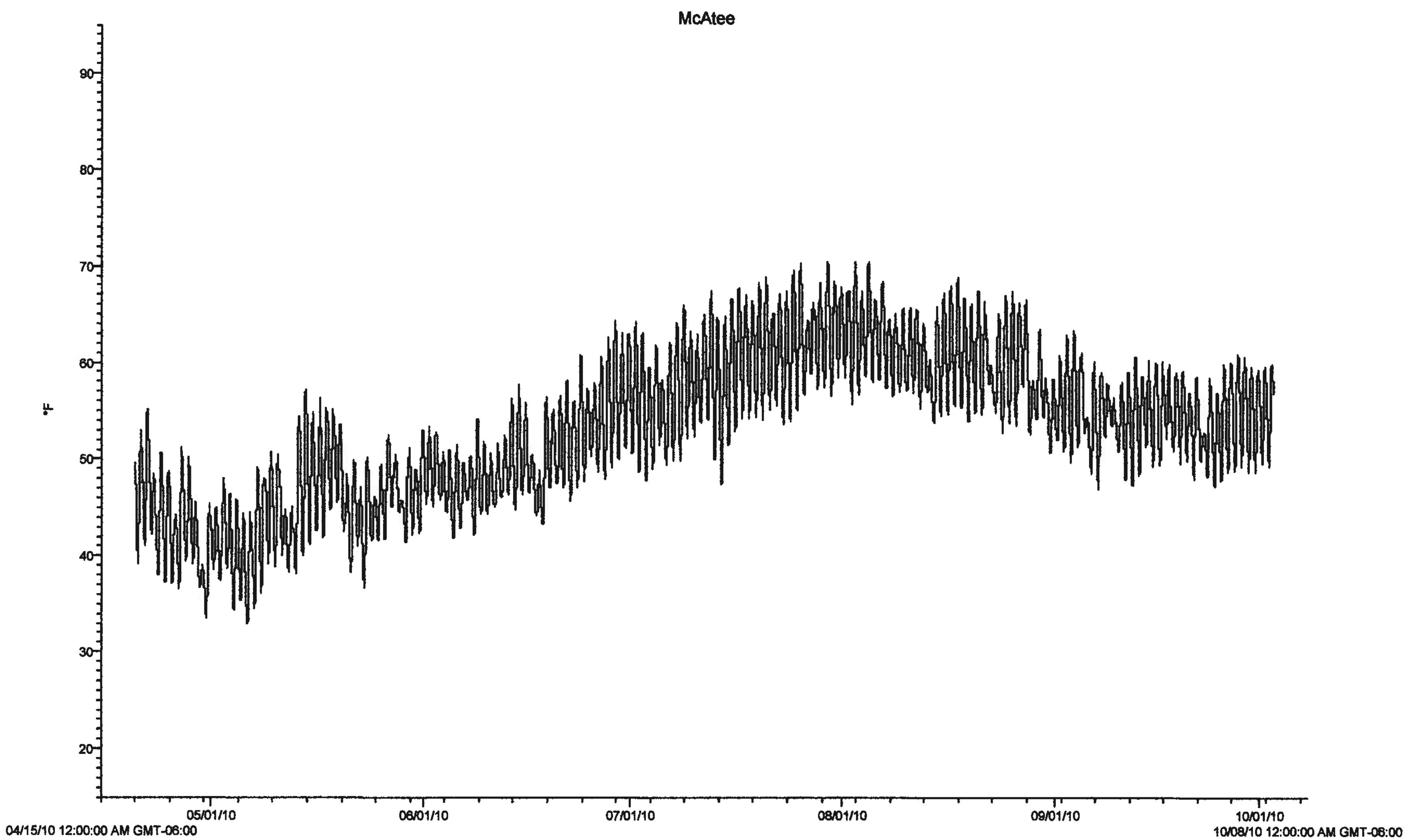

Kirby
°F
90
80
70
60
50
40
30
20
04/15/10 12:00:00 AM GMT-06:00
05/01/10
06/01/10
07/01/10
08/01/10
09/01/10
10/01/10
10/08/10 12:00:00 AM GMT-06:00

Wall Ck Bridge




McAtee
°F
90
80
70
60
50
40
30
20
05/01/10
06/01/10
07/01/10
08/01/10
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10/01/10
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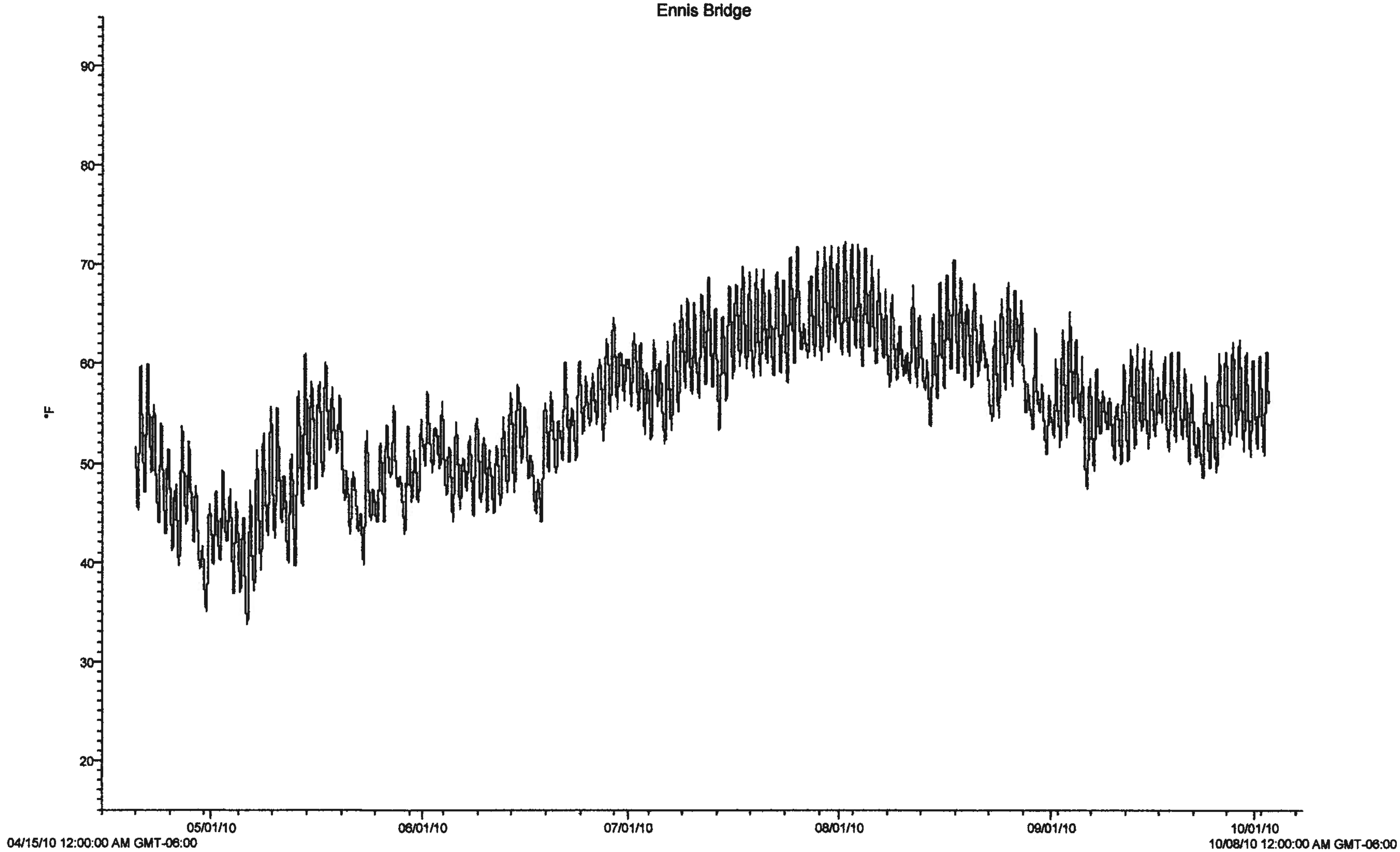
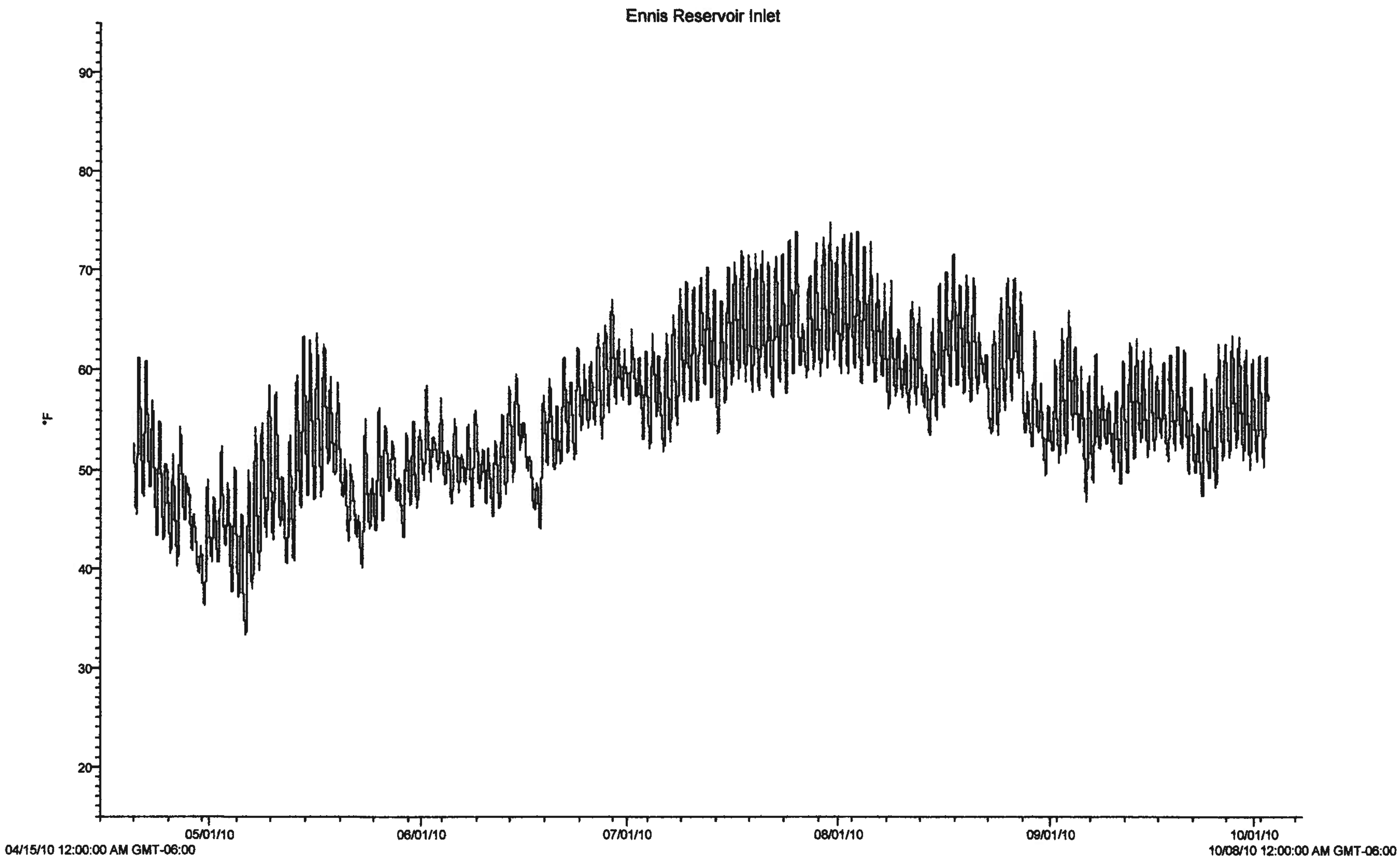
Ennis Bridge





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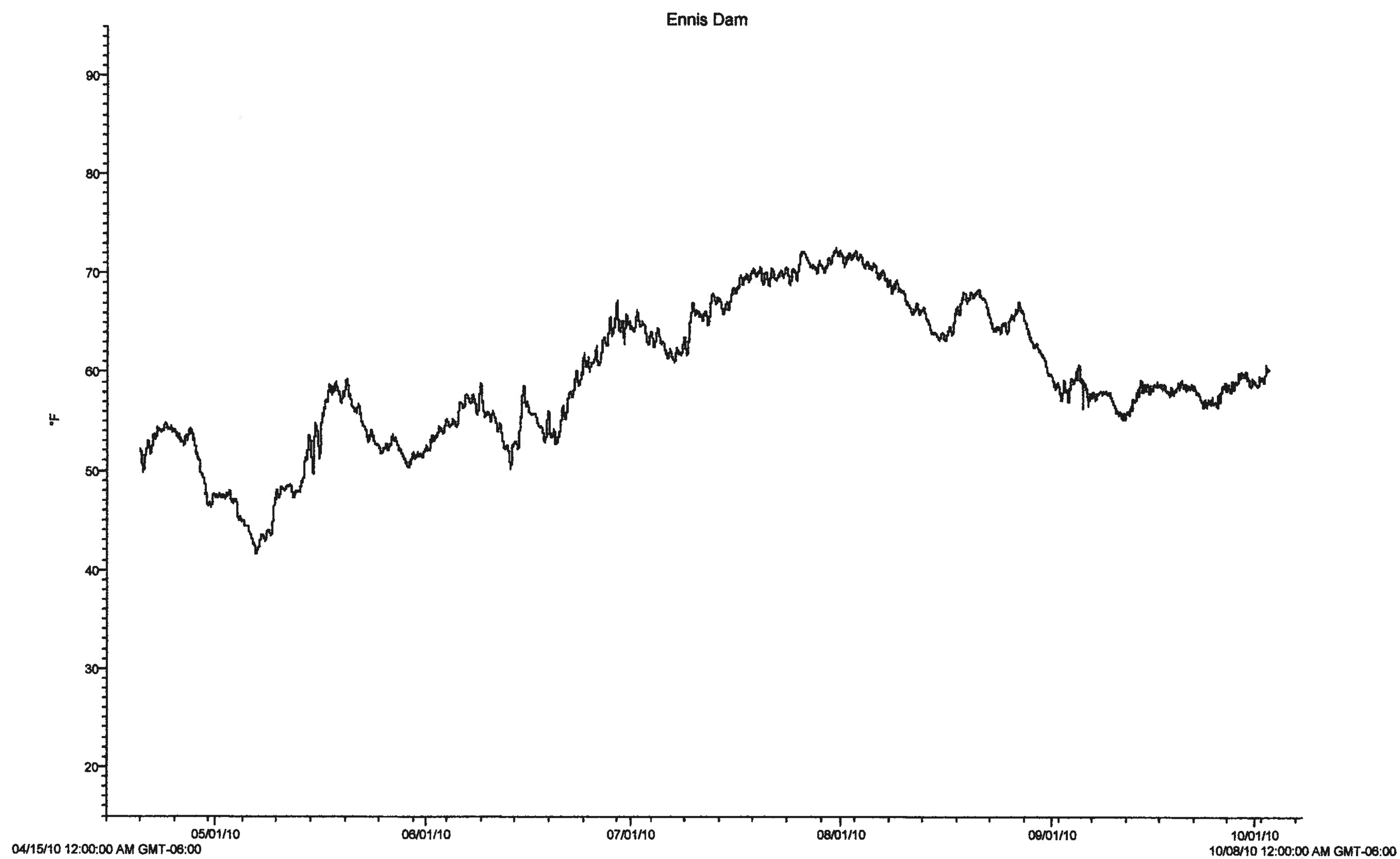
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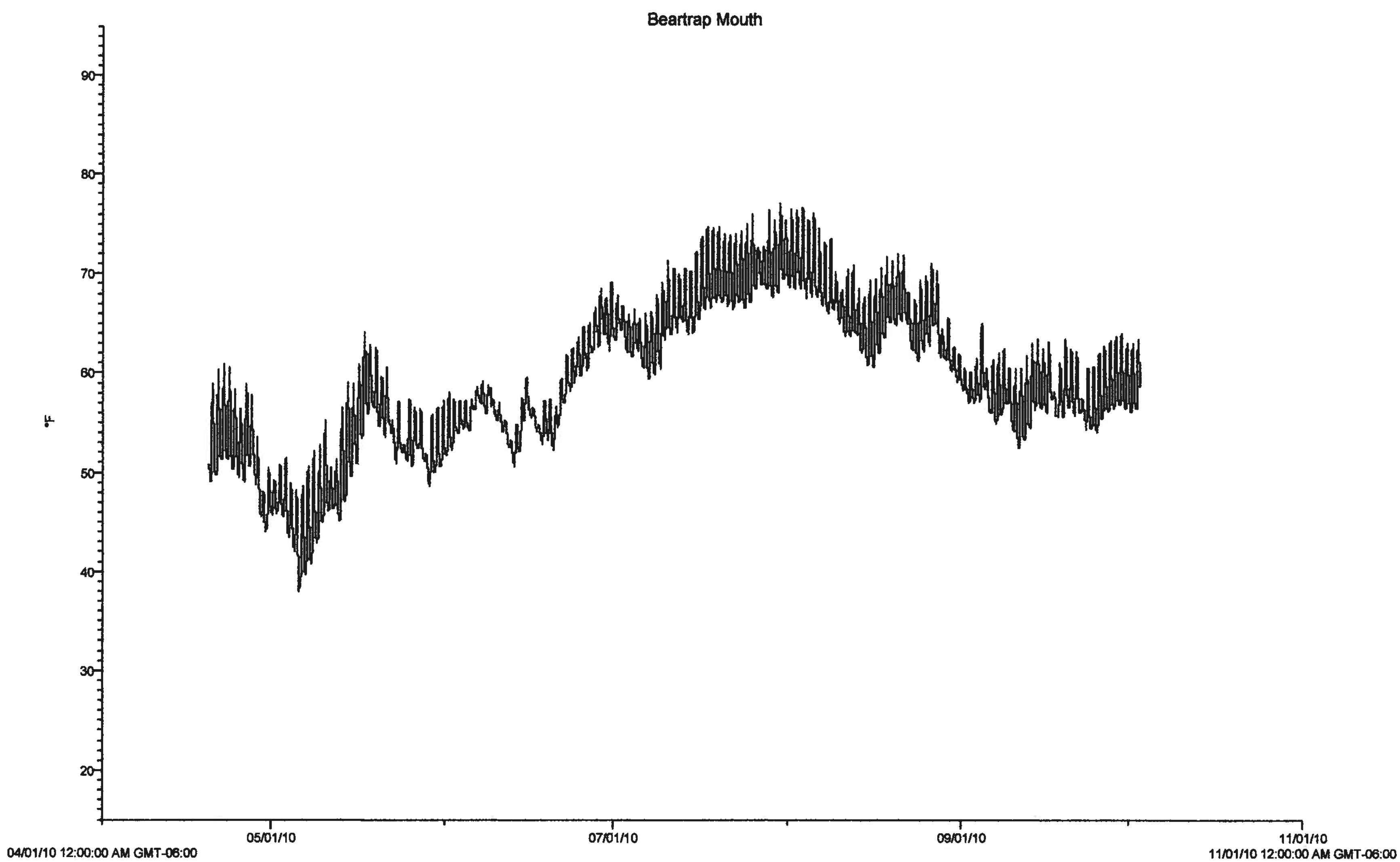
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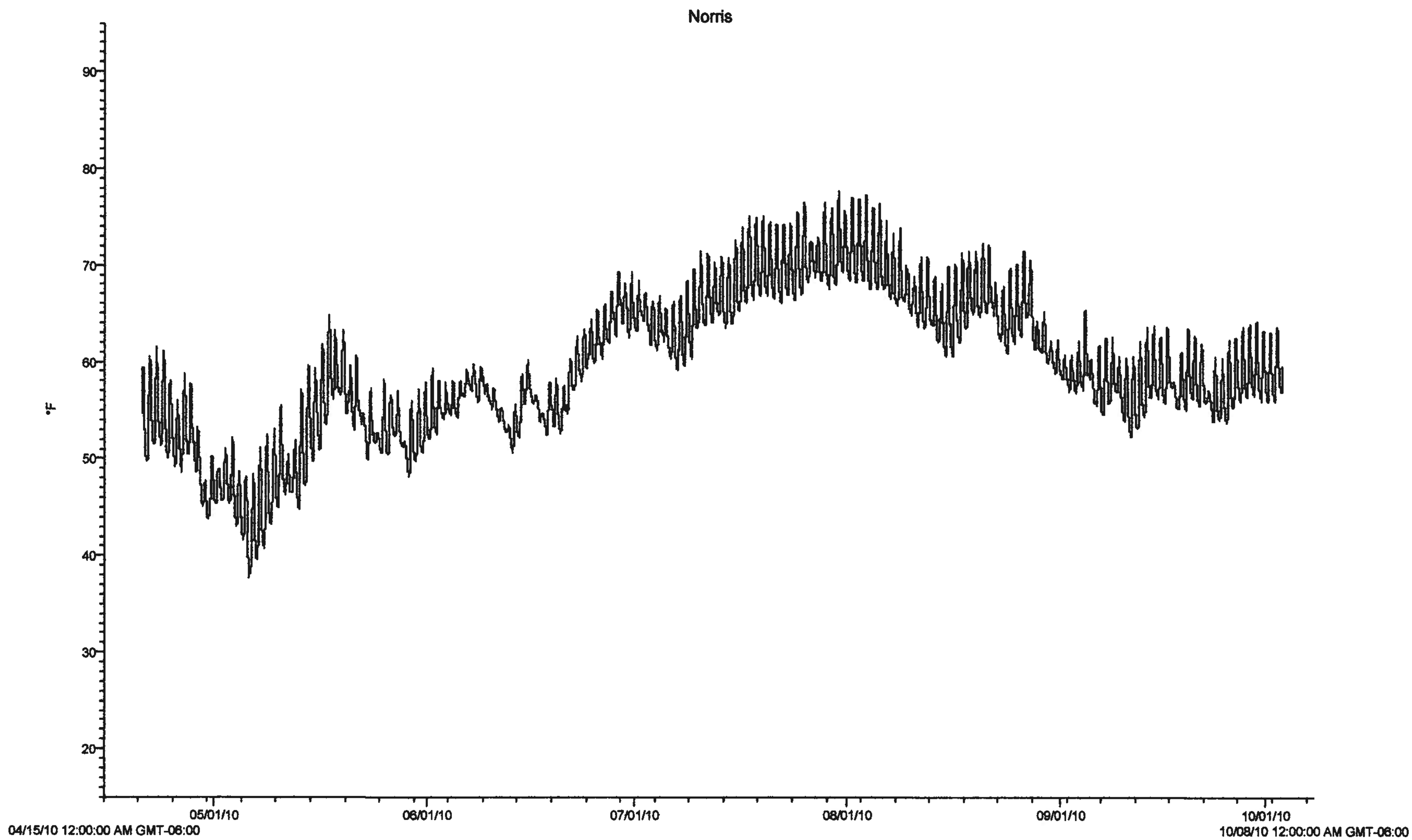
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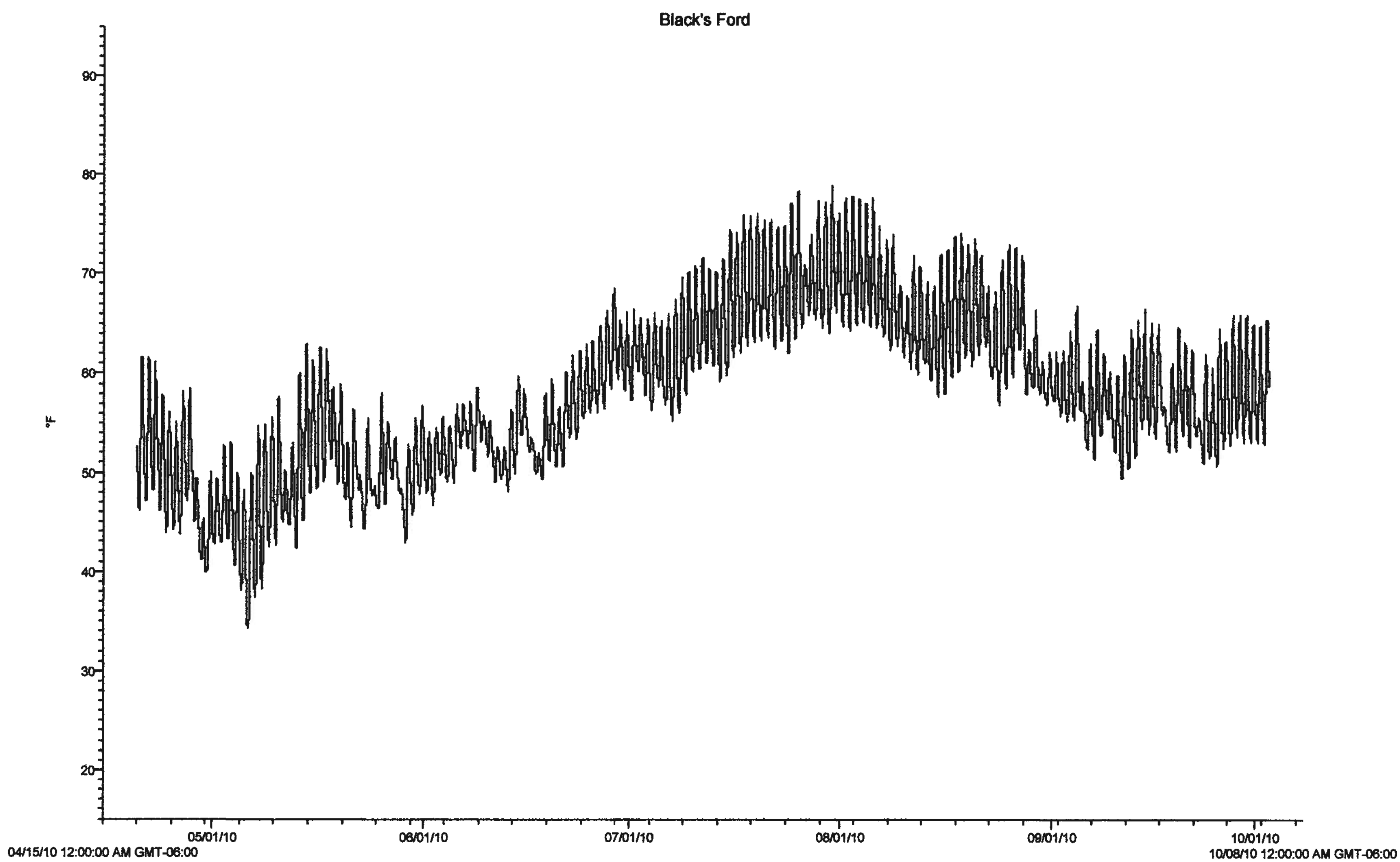

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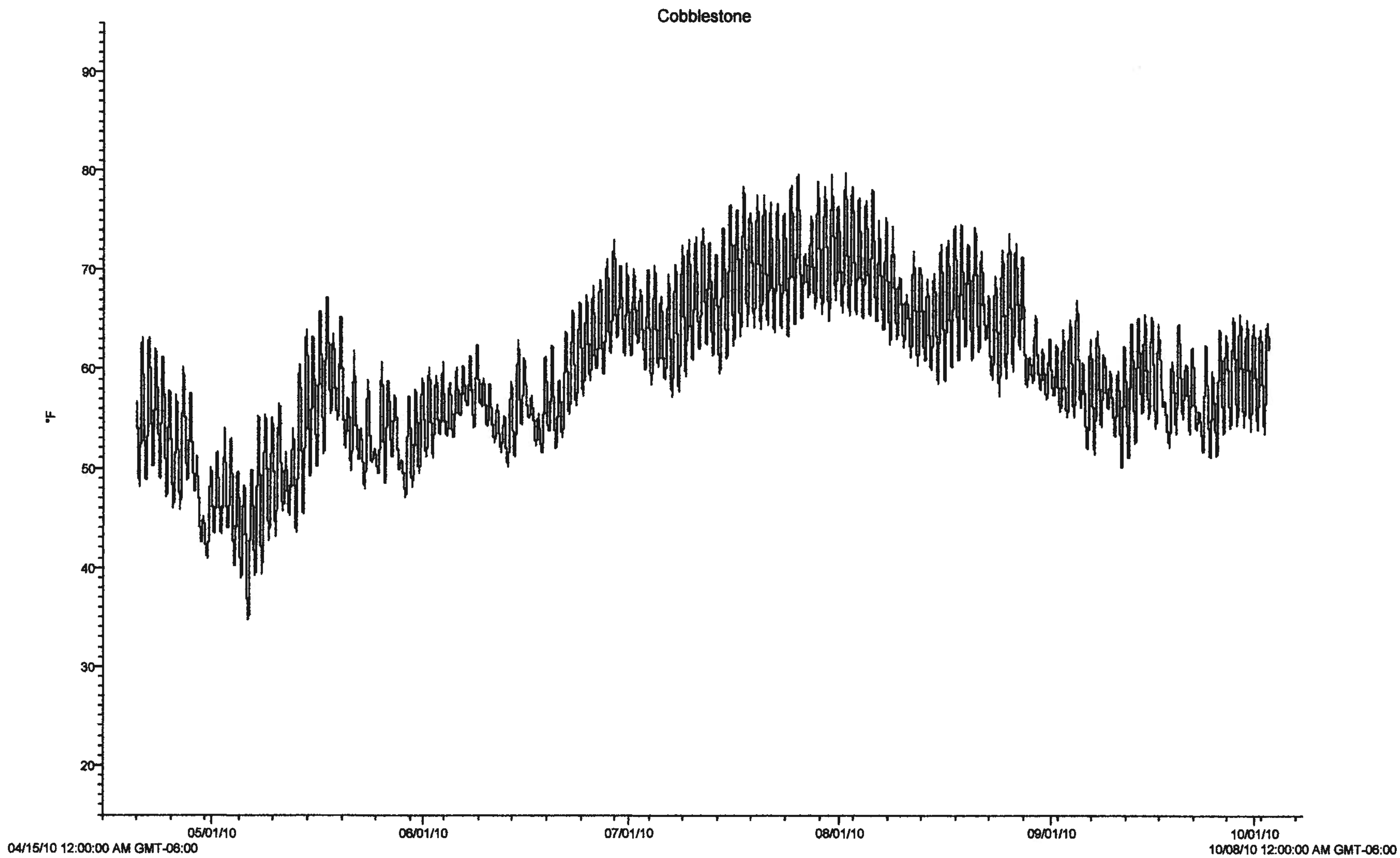

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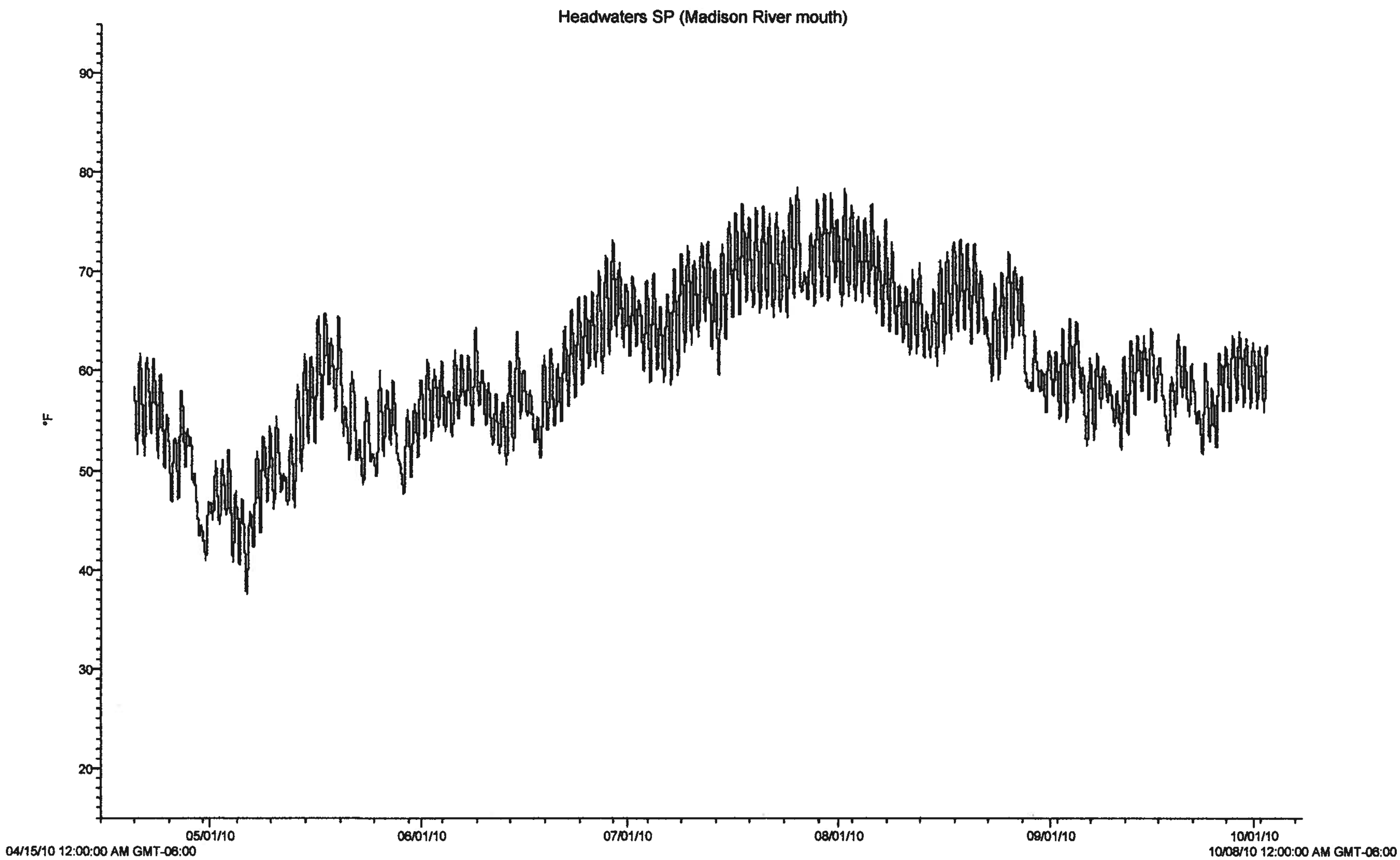
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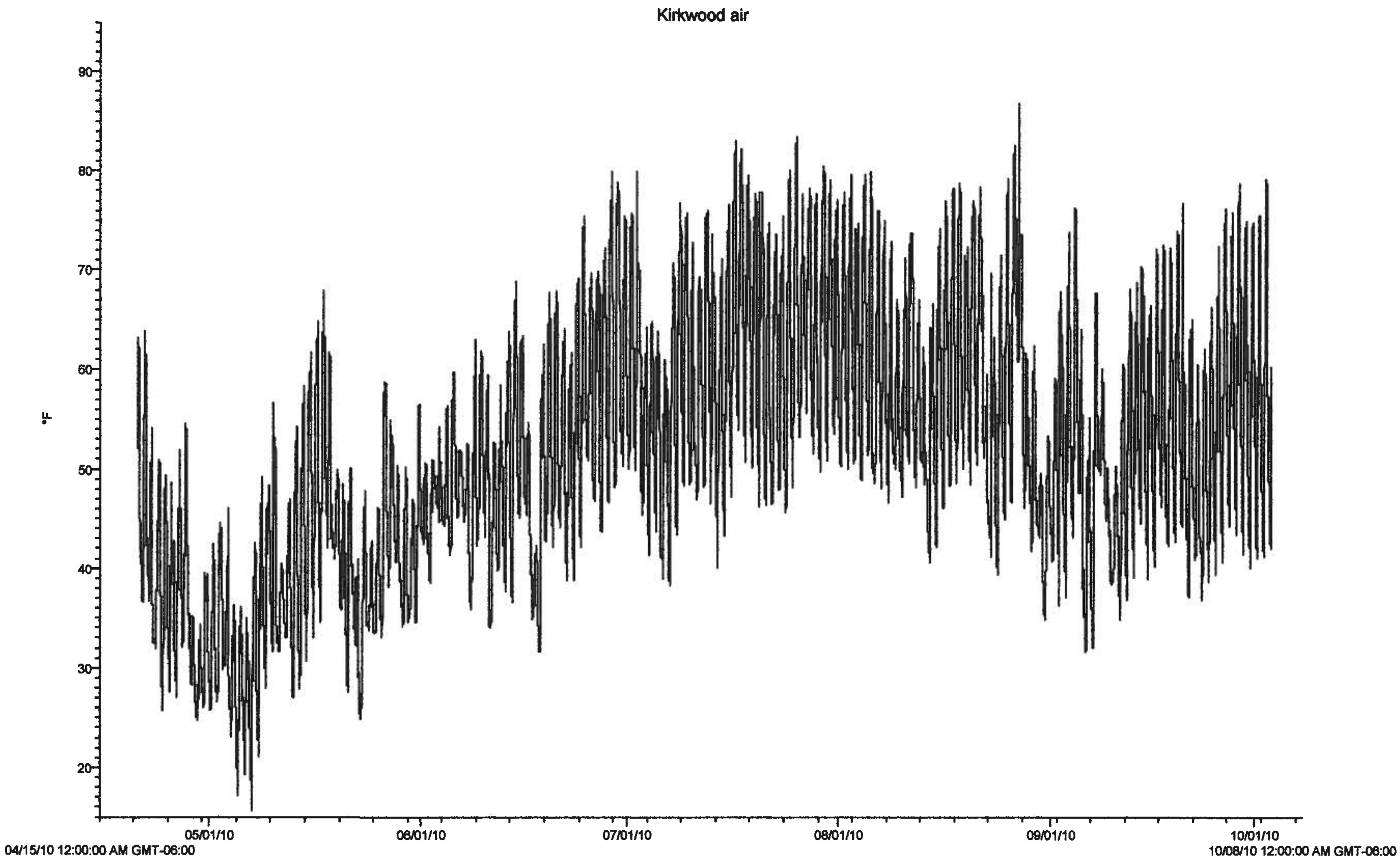
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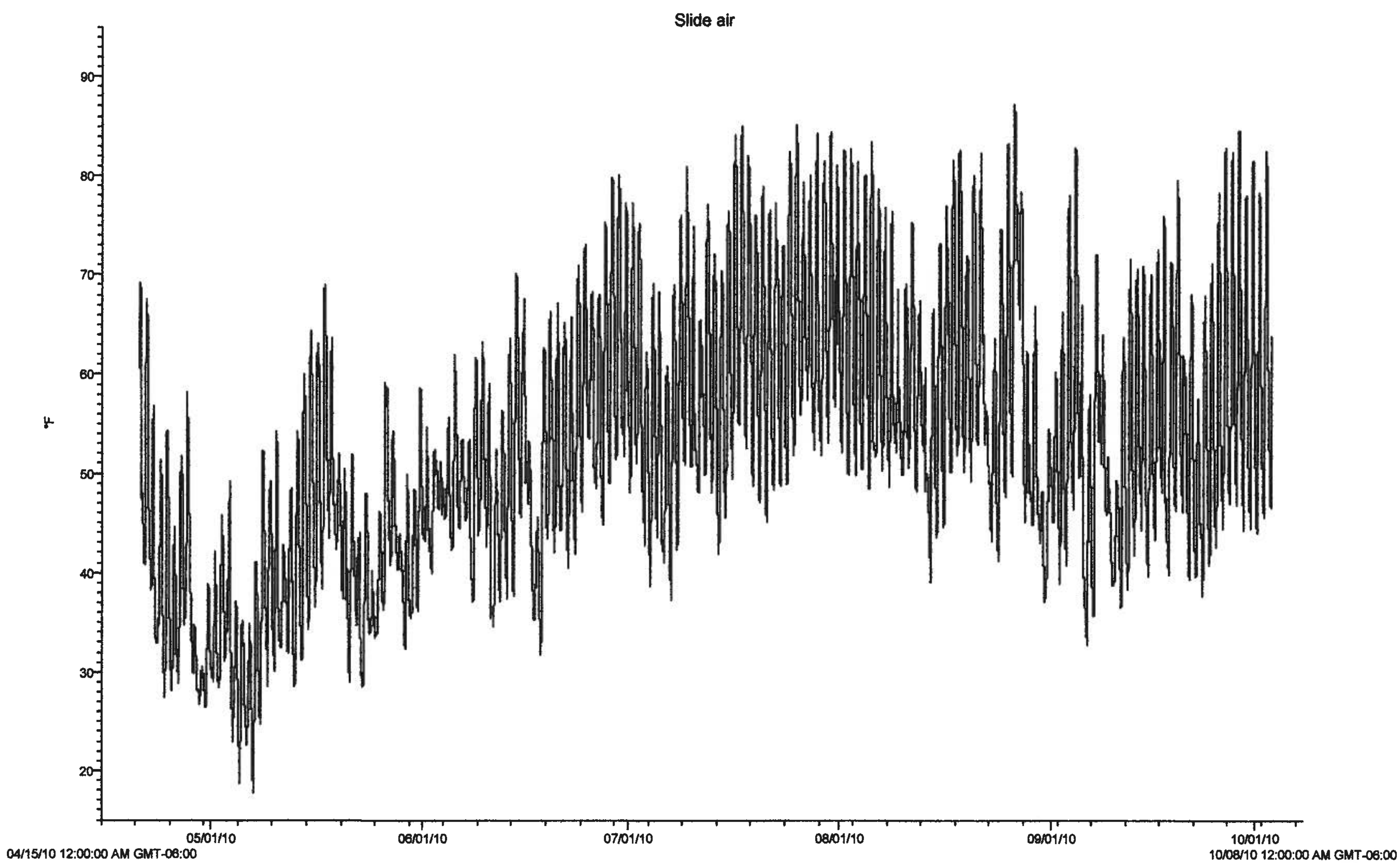
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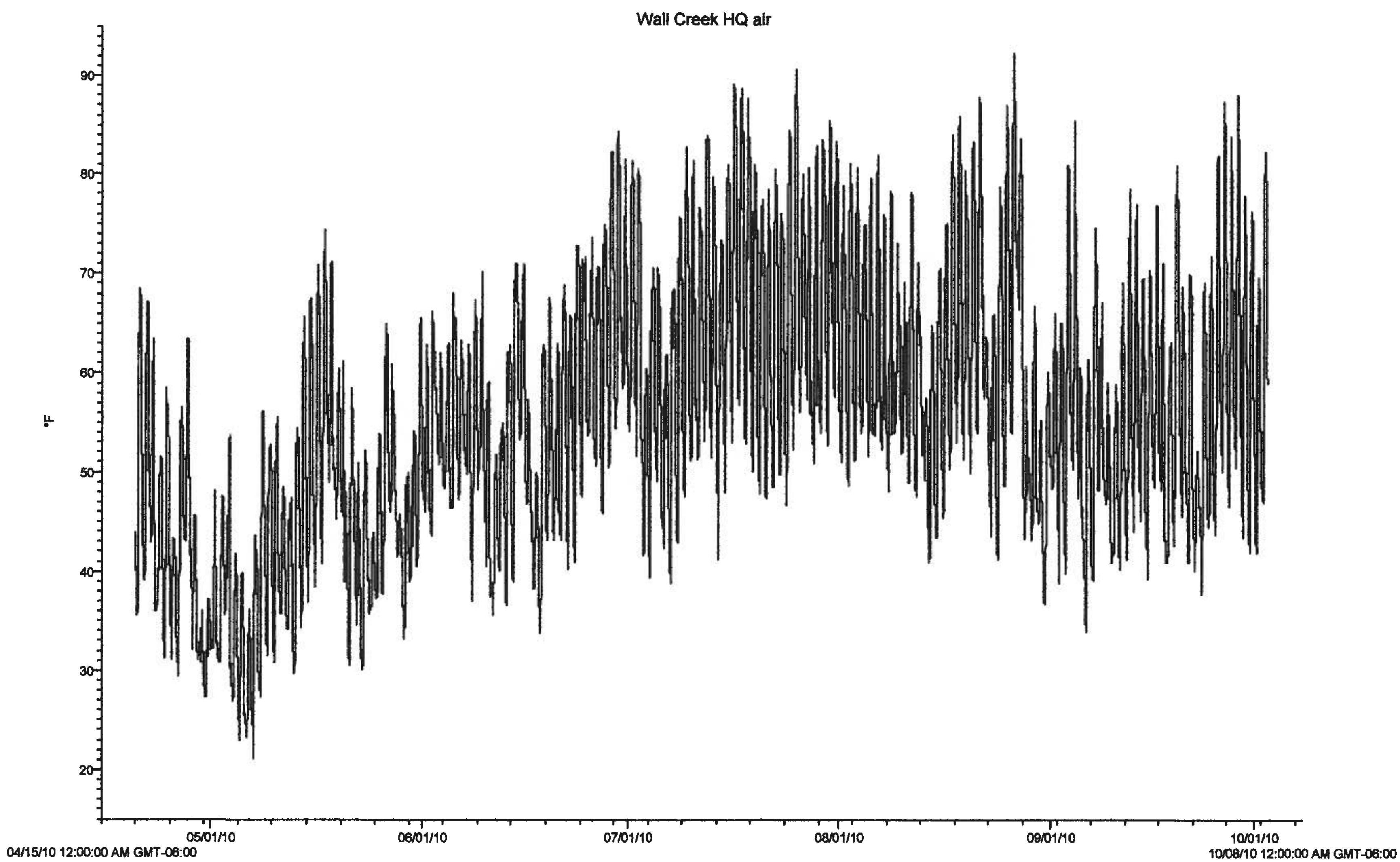
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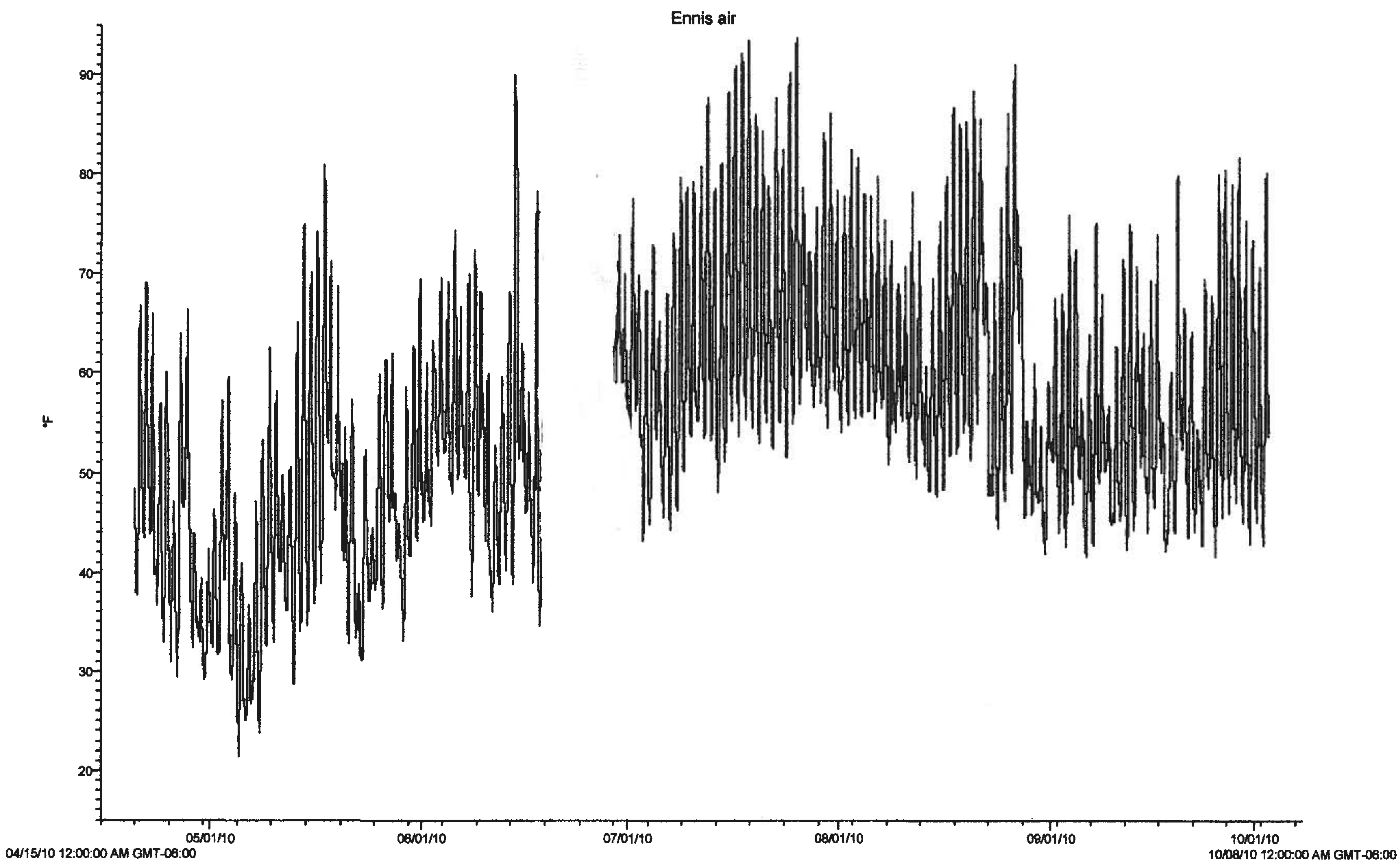
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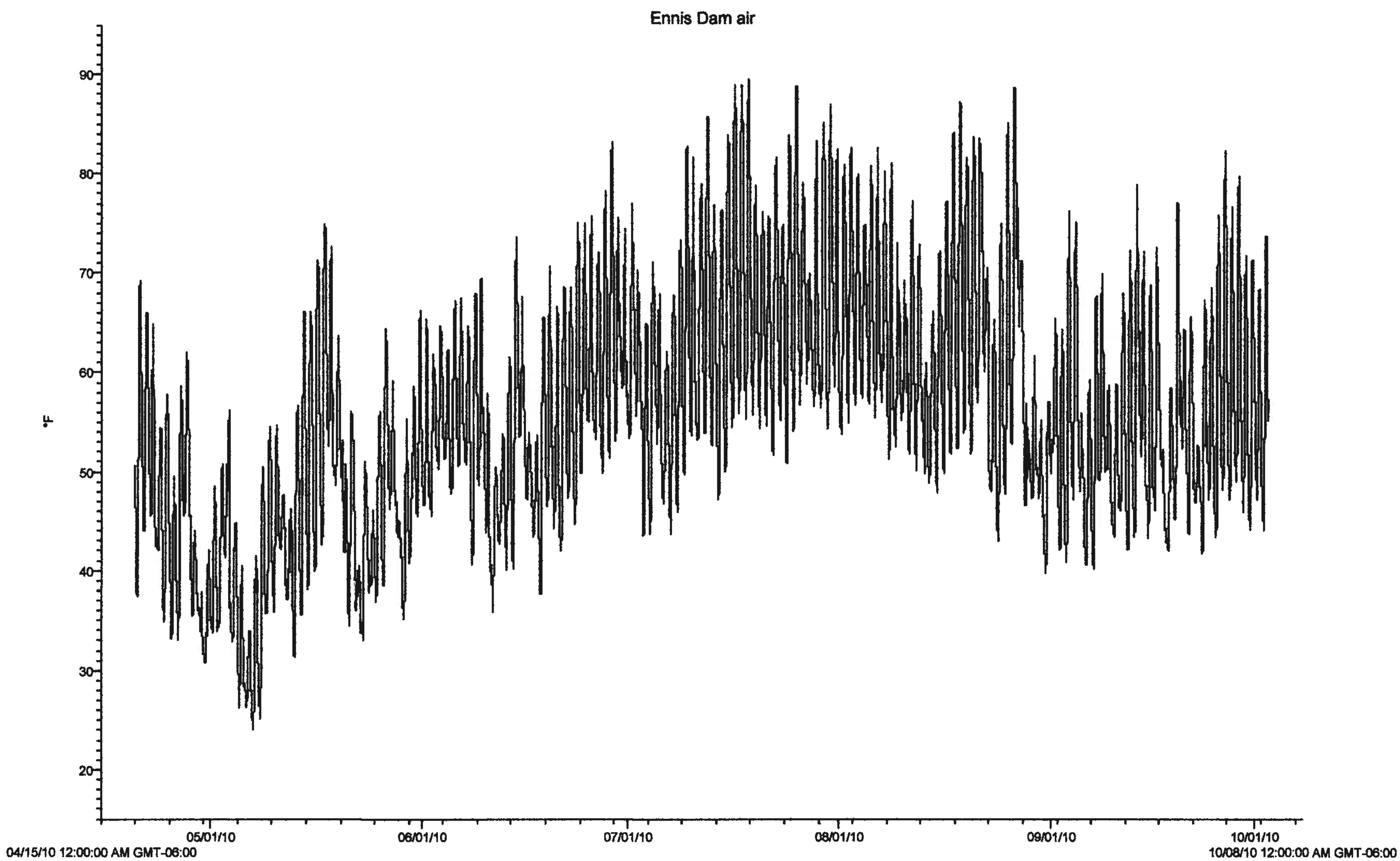

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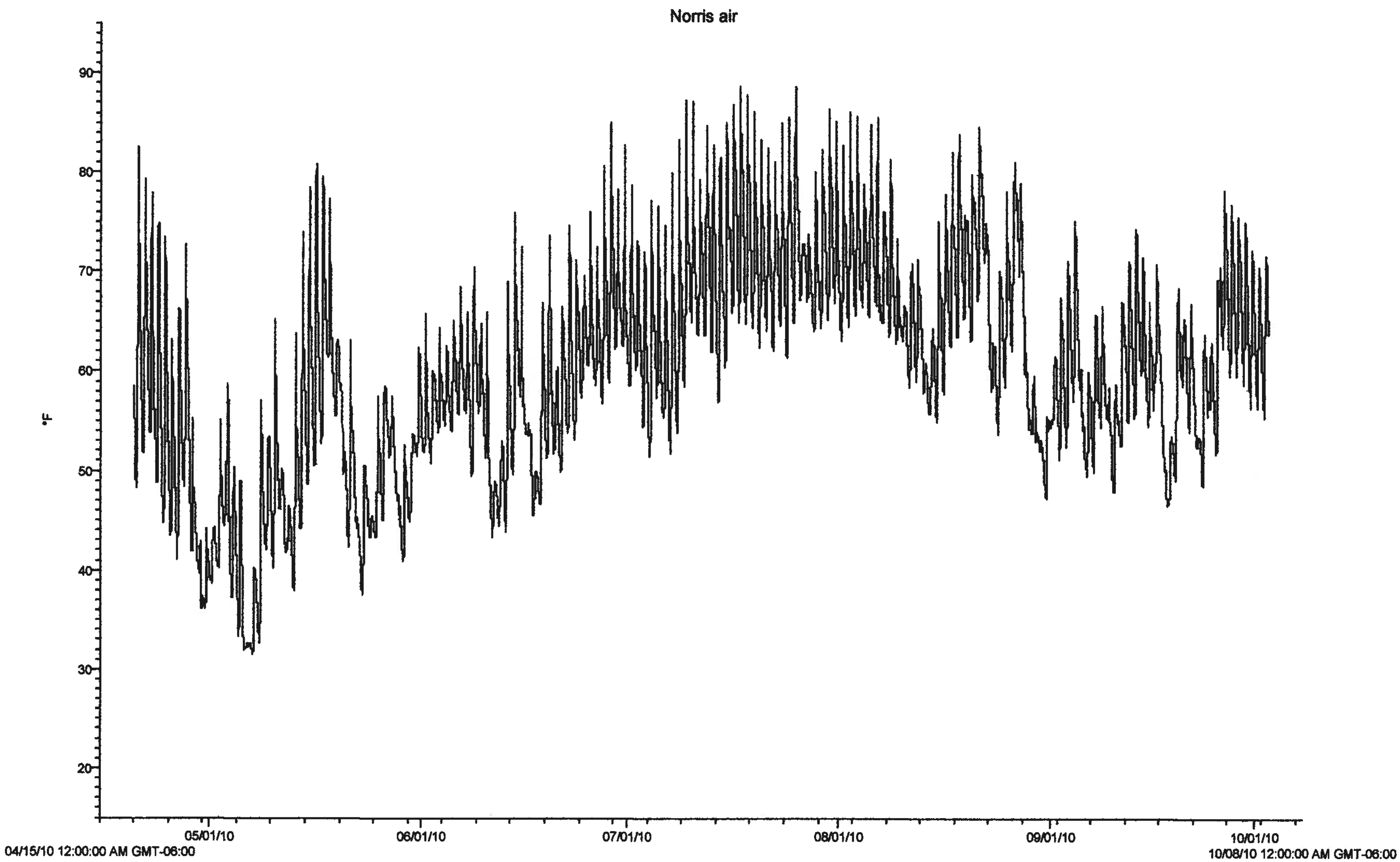
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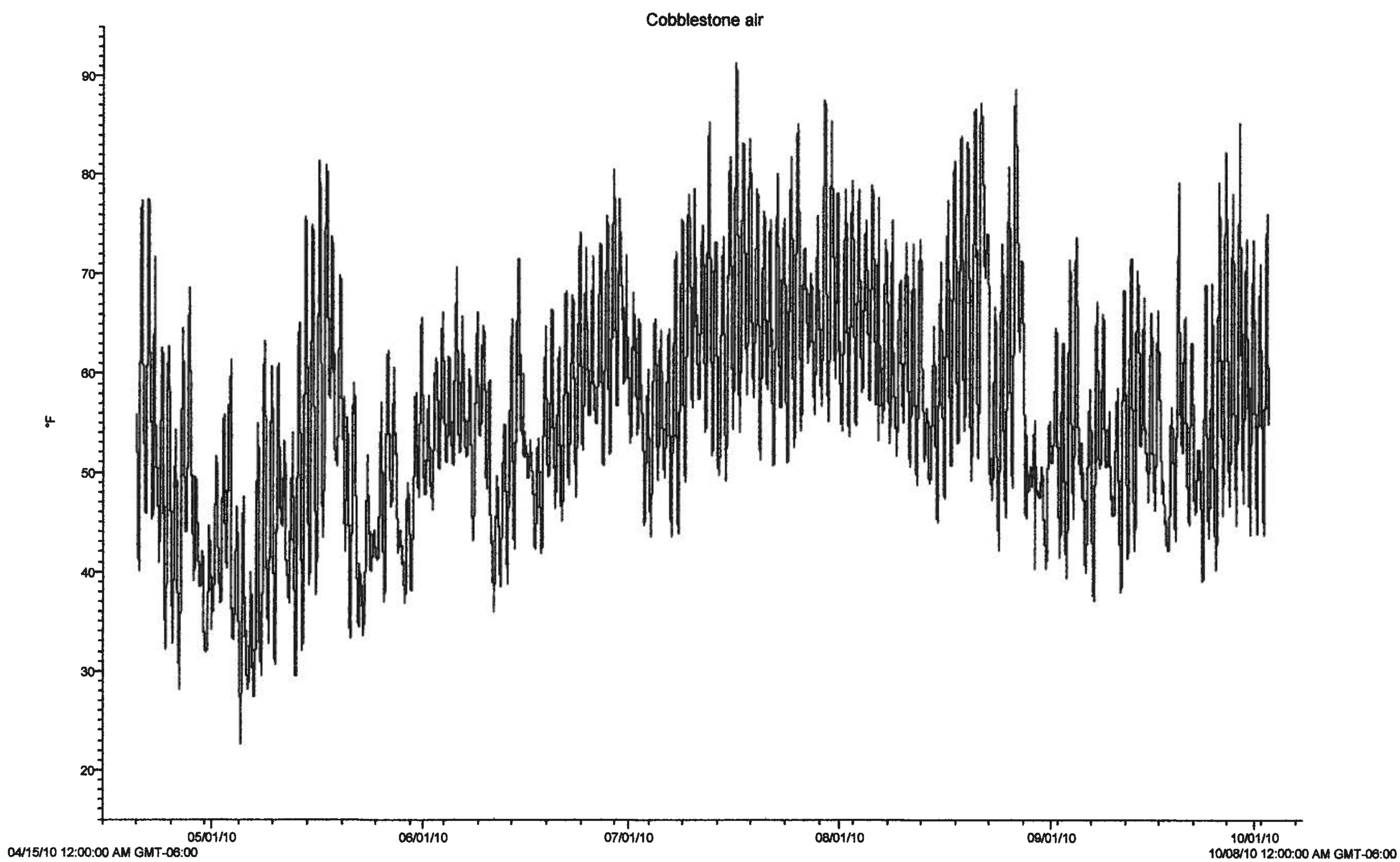
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Appendix E

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".

INSPECT. CLEAN. DRY.

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

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

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

STOP AQUATIC HITCHHIKERS!

Appendix F

2010 Monitoring Reports

Beaverhead-Deerlodge National Forest
Madison Ranger District: Tepee Creek
Wigwam Creek

Gallatin National Forest
Hebgen Ranger District: Watkins Creek

Stream Habitat Restoration
Tepee Creek, Madison Ranger District
Beaverhead-Deerlodge National Forest
2010

MAD TAC Project Completion Report

Summary:

Tepee Basin in the Gravelly Mountains has been the focus of stream habitat restoration efforts by the Beaverhead-Deerlodge National Forest since 2005. Historic impacts to the stream channel in this basin include beaver extirpation and historic over-grazing. Efforts to restore the channel in this basin have been focused mainly on sediment deposition, water storage, and the regeneration of riparian vegetation. Given the hydrograph and soil composition in this basin, restoration techniques consist mainly of weirs and point bars constructed of one or all of the following materials: woven willows, wooden stakes, log sills, and rock.

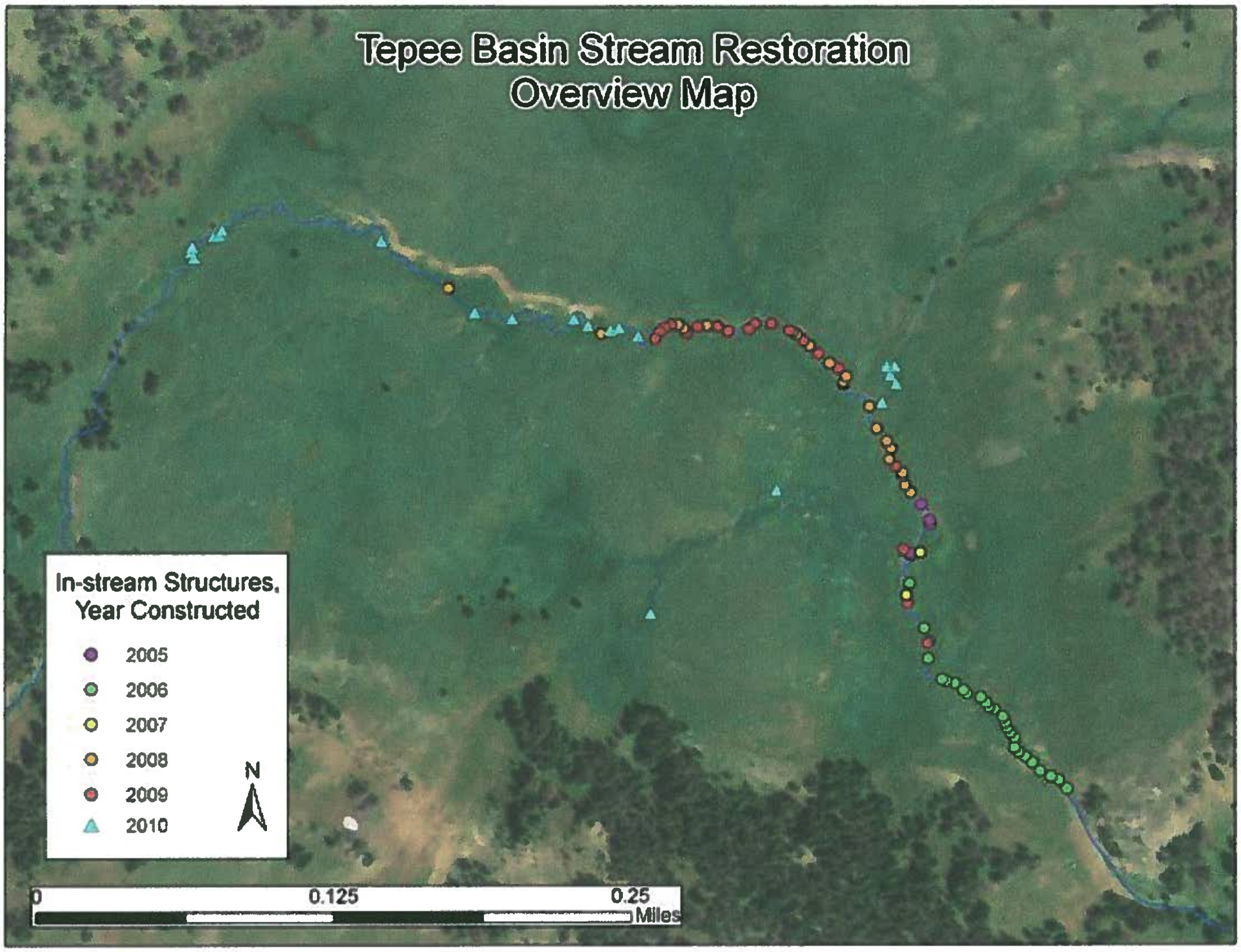
The USFS, Madison Ranger District, and the Madison River Foundation received funding from PPL MT (MAD TAC) to complete the stream restoration activities in Tepee Basin. The Madison Ranger District fisheries biologist, FS fisheries technicians, and Northwest Environmental Services LLC completed the project.

Project Goals:

The goal of restoration in Tepee Creek was to influence natural stream processes, particularly fine sediment deposition, to restore channel morphology. The primary focus was on several severely incised sections that displayed limited evidence of natural recovery. A secondary objective was to improve watershed function by reducing fine sediment loads transported to the Madison River. Tepee Creek in the project area is fishless due to a natural cascade barrier located just downstream of the treatment area. Molecular analysis of westslope cutthroat trout (WCT) downstream in Horse Creek indicates that this population is greater than 90% pure. Once habitat has been restored to acceptable levels in Tepee Creek, there is an opportunity to introduce pure WCT into this headwater tributary.

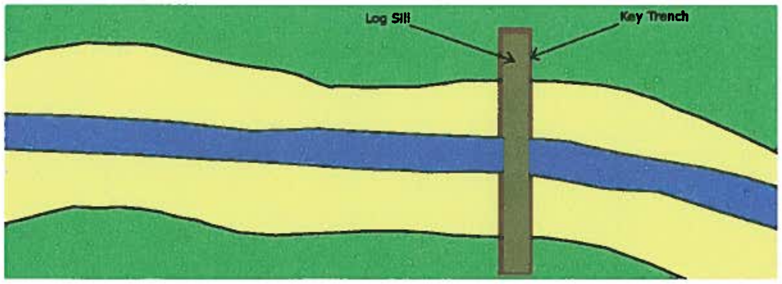
Techniques:

Hand tools and natural bio-degradable materials such as logs, wooden stakes, natural fiber burlap fabric, rock, and vegetation mats were used in the construction of weirs and point bars. The structures were strategically placed to accelerate natural restorative forces.

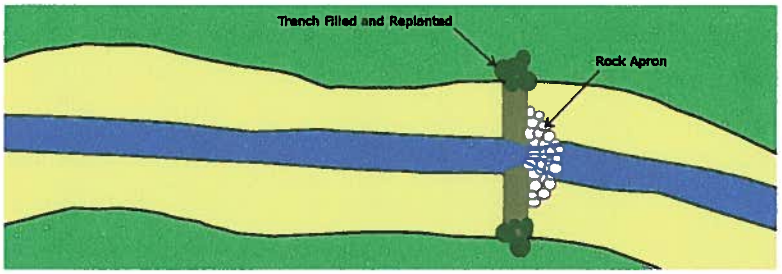


Map of Project Area: This map displays the scale of restoration work in Tepee Basin from 2005 thru 2010.

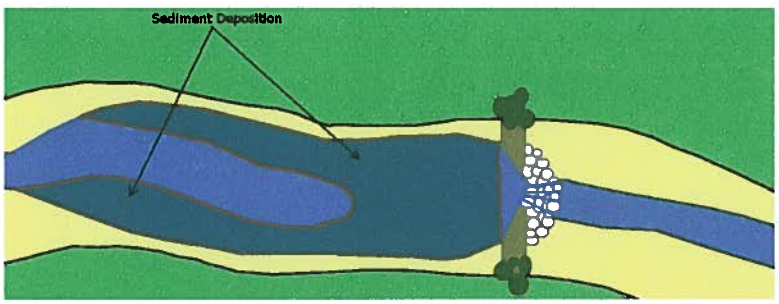
The diagrams below illustrate the construction and function of weir structures in Tepee Basin.



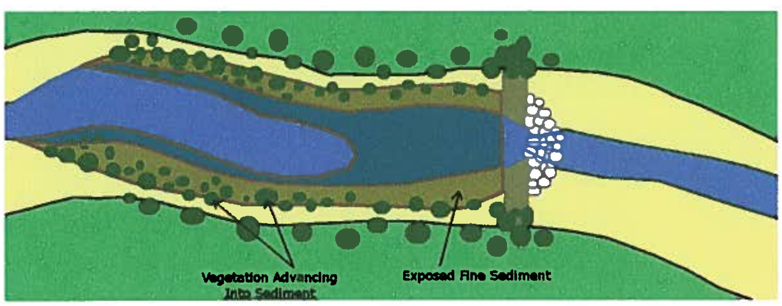
Log weirs were constructed by digging or keying out the banks on either side of the creek at the site of the weir. The key trench was excavated until the floor of the entire trench was equal in elevation with the creek bed. Logs were put into place and staked to prevent movement.



The key trench is filled in and replanted with grasses and willows. The upstream side of the log was covered with burlap and backfilled with rocks, soil, and clay found onsite. A rock apron is placed on the downstream side of the weir structure to prevent downstream scouring.



Storage upstream of structure reduces water velocity enabling sediments to drop out of the water column and deposit along the sides and center upstream of the structure.



Eventual desired state of the weir structure. The stabilizing of sediments through rooted vegetation and a newly formed, elevated, more sinuous channel is the overall goal of the structures.

Previous structure function: Below are some examples of the sediment deposition that has occurred behind weir structures that were constructed in Tepee Basin prior to 2010.

The photo's above are of the same structure taken three years apart.

Sediment deposition influencing the main channel after one year.

Sediment deposit upstream of weir structure.

2010 Structures:
Fourteen log weir and 7 point bar structures were constructed during the summer of 2010. The following photographs depict before and after conditions at 6 of the stream enhancement sites.

Photo Group 1: Pont bars constructed near trail crossing. Undercut banks were re-contoured.

Before	After
	
	

Photo Group 1 (cont)

Before

Photo on left is looking upstream before treatment.

After

Photo on right is looking downstream after treatment.

Photo Group 2: Log sill weirs.

Before	After
	
	
	

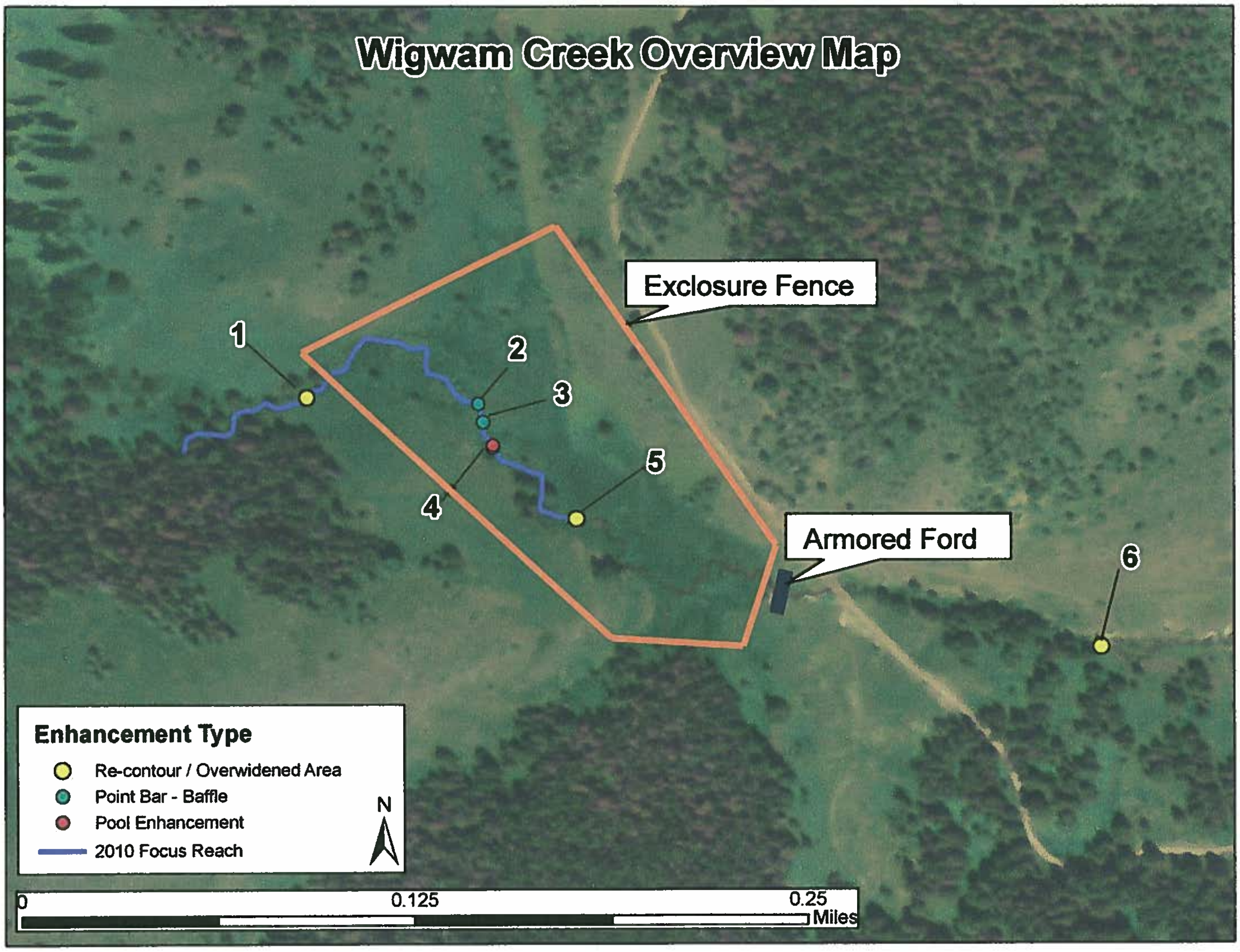
Westslope Cutthroat Trout Habitat Restoration and Enhancement
Wigwam Creek, Madison Ranger District
Beaverhead-Deerlodge National Forest
2010

MAD TAC Project Completion Report

Summary:
In the summer of 2010, Wigwam Creek, in the northern part of the Gravelly Mountains, was the focus of a multifaceted westslope cutthroat trout habitat enhancement project. This project included the installation of a riparian exclosure fence, construction of off-channel livestock watering facilities and an armored ford, and active stream restoration in degraded areas of upper Wigwam Creek. The USFS, Madison Ranger District, and the Madison River Foundation received funding from PPL MT (MAD TAC) to complete the project. The Madison Ranger District fisheries, range, and fire staff, FS seasonal technicians, Madison River Foundation volunteers, the Bar 7 Ranch, and Northwest Environmental Services LLC completed the project.

Project Goals:
The purpose of this project was to restore and protect spawning, rearing and over-wintering habitat for a conservation population of westslope cutthroat trout in upper Wigwam Creek. A 30-acre exclosure fence was erected to protect stream improvement structures and to reduce grazing impacts to streambanks and riparian areas that were historically degraded by livestock. An armored ford was constructed immediately downstream of the exclosure fence to provide livestock a hardened area for watering and crossing the creek. Stream restoration efforts were focused on six over-widened areas where the effects of livestock trampling had accelerated streambank erosion and created unstable channel conditions.

Techniques:
Fencing was accomplished by hand and a backhoe was utilized to construct the armored ford. Hand tools and natural bio-degradable materials such as wooden stakes, rock, and vegetation mats were used in the construction of baffles, pool aprons, and the restructuring / contouring of stream banks. Stream enhancement structures (6 in 2010) were strategically placed to accelerate natural restorative forces and to enhance the quality and diversity of westslope cutthroat trout habitat.



Map of Habitat Enhancement Area: The 2010 stream restoration reach is highlighted in blue. Locations of treatment areas are shown as points with numbers that coincide with some of the figures in this document.

Photo 1. Exclosure fence construction.

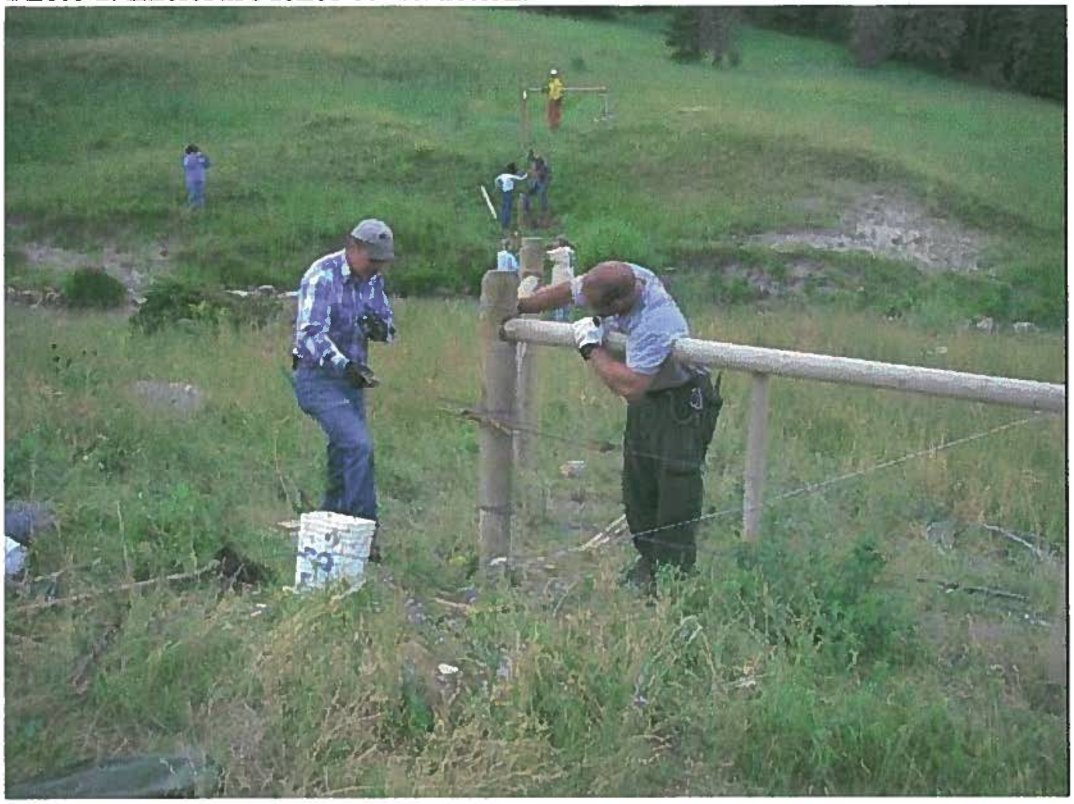
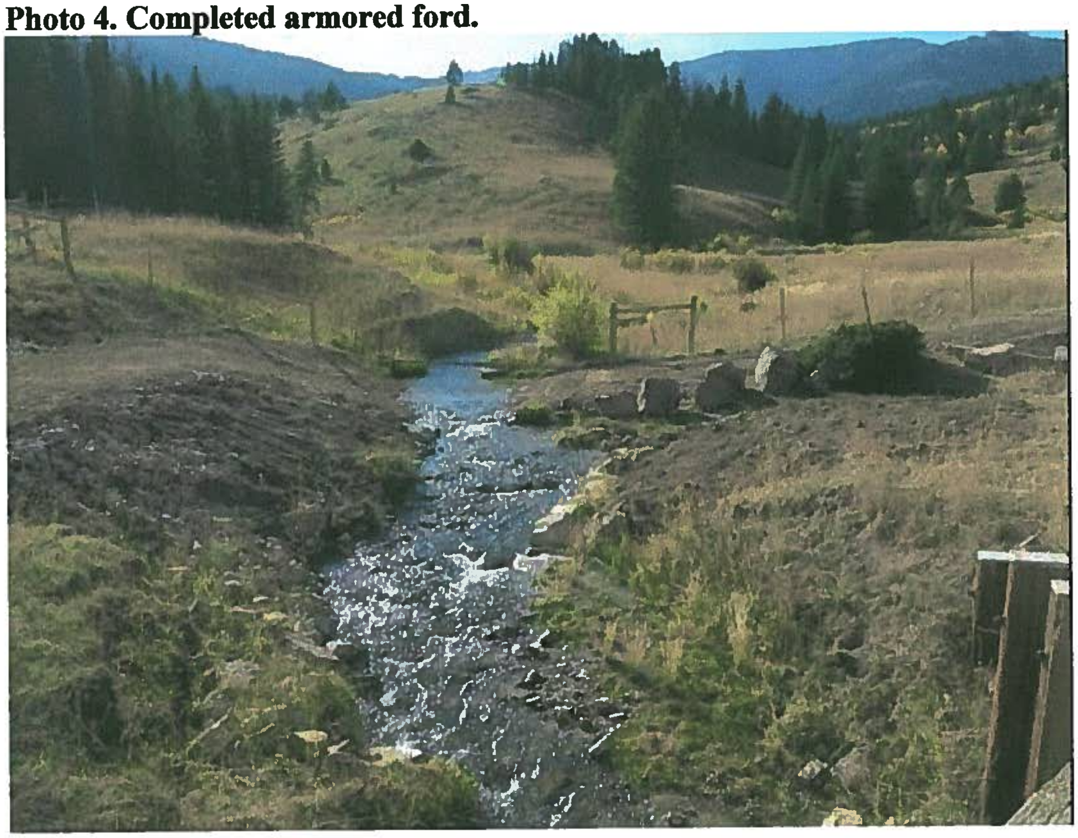


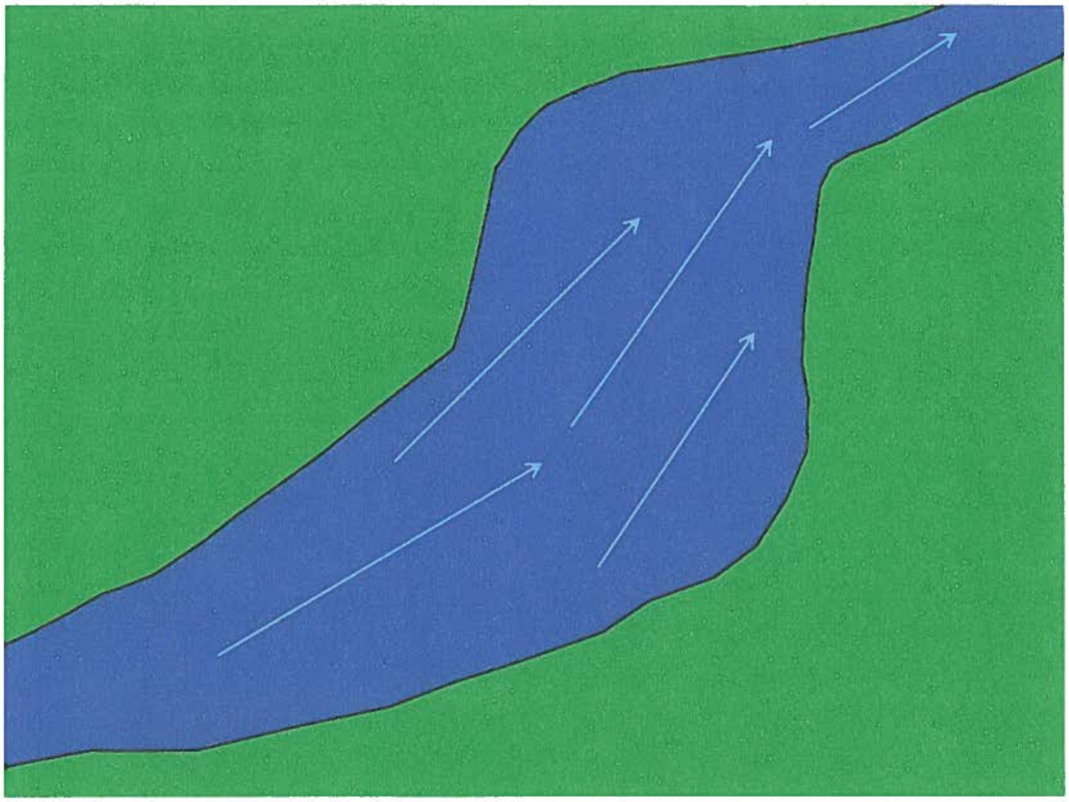
Photo 2. Completed riparian exclosure and armored ford site, preconstruction.

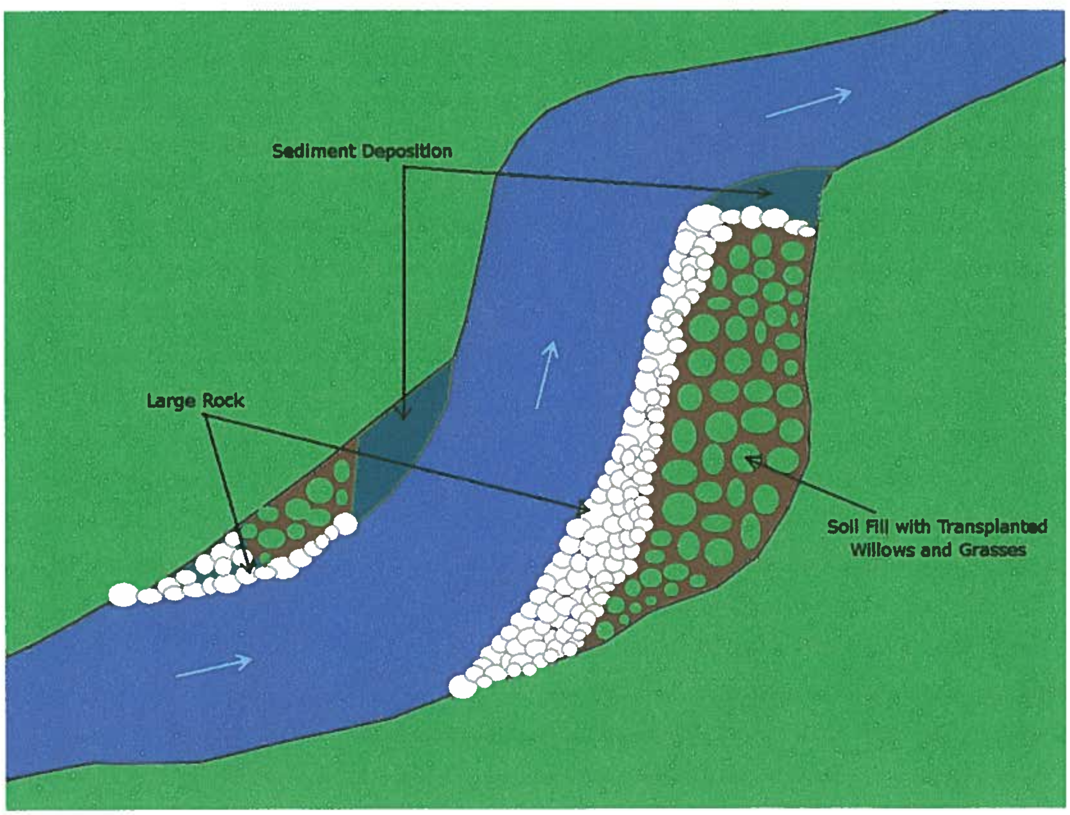
Photo 3. Armored ford construction, note base layer of compacted cobble and gravel.

Photo 4. Completed armored ford.



<u>Figure 1 (corresponds with site 1 on project Map):</u> Graphical depiction of an over-widened stream reach before and after treatment.





Photos 5 & 6: (corresponds with site 1 on project Map). The top photo shows the original over-widened condition found at this site. Large rock was used to narrow the channel and re-contour the stream-bank (right). Sod mats with rooted grasses and willow were used behind the rock to extend the eroded stream-bank and to help stabilize the structure. The structure at this site not only reduces channel width but also adds sinuosity and increases stream depth.

<u>Photos 7 & 8 (corresponds with site 5 on project map).</u> Large rock was used to delineate a narrower channel with increased sinuosity. Sod mats with rooted grasses and willow were used to fill in the dewatered areas between the newly placed rock and the previous stream bank. Large rock submerged in the channel provided habitat diversity and reduced hydraulic energy.

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.

Appendix G

Sun Ranch Hatchery Contributions and Production 2001 – 2010

Year	Donor Stream	M:F spawned	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	Sun brood pond	566 fry
			Bar None Pond	560 fry
	Prickly Pear Ck - Missouri	4:1	Prickly Pear	28
			Eureka Ck	120
			Little Tizer	52
	Hall Ck - Elkhorns	4:1	Hall	20
			Little Tizer	91
2004	Cottonwood Ck - Blacktail	12:6	Sun brood pond	820 fry
	Muskrat Ck - Elkhorns	15:7	Bar None Pond	814 fry
	Ray F x McClure M (Madison)	4:8		
	Ray F x Hall M	2:1		
2005	Cottonwood Ck - Blacktail	13:6	Sun brood pond	528 fry
			disease testing	11 fry
	Browns Ck - Beaverhead	10:5	Sun brood pond	646 fry
	Sun brood pond	37:16	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	SF Crow Ck	2262 eyed eggs
2006	Browns Ck	1:1	Sun brood pond	284 fry
	Muskrat Ck - Elkhorns	16:8	Sun brood pond	184 fry
			Cherry Ck	1750 eyed eggs
	Whites Gulch - Big Belt Mtns	3:3	Cherry Ck	726 eyed eggs

Year	Donor Stream	M:F spawned	Recipient Water	# eggs/fry out
2007	Muskrat Ck - Elkhorns	11:22	Cherry Ck	5445 eyed eggs
			Sun brood pond	291 fry
	Ray Ck - Big Belt Mtns	13:25	Cherry Ck	3467 eyed eggs
			Sun brood pond	194 fry
	Whites Gulch - Big Belt Mtns	4:8	Cherry Ck	1015 eyed eggs
			Sun brood pond	59 fry
	Sun brood pond	37:17	Cherry Ck	2994 eyed eggs
			Sun brood pond	326 fry
			High Lake (YNP)	1611 eyed eggs
	Last Chance Ck - Madison (YNP)	12:8	High Lake YNP	177 eyed eggs
2008	Muskrat Ck - Elkhorns	28:14	Cherry Ck	3199 eyed eggs
	Ray Ck - Big Belt Mtns	23:12	Cherry Ck	1700 eyed eggs
	Whites Gulch - Big Belt Mtns	11:6	Cherry Ck	1015 eyed eggs
			Sun brood pond	117 fry
	Sun brood pond	28:10	Cherry Ck	3218 eyed eggs
			Sun brood pond	571 fry
			High Lake (YNP)	2844 eyed eggs
	Last Chance Ck - Madison (YNP)	13:8	High Lake (YNP)	286 eyed eggs
			Sun brood pond	70 fry
2009	Muskrat Ck - Elkhorns	24:12	Cherry Ck	4134 eyed eggs
			Sun brood pond	311 fry
	Whites Gulch - Big Belt Mtns	8:5	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	Cherry Ck	1911 eyed eggs
			Sun brood pond	15 fry
	Geode Ck (YNP)	17:16	High Lake YNP	838 eyed eggs
	WF Wilson Ck - Gallatin	NA	eggs destroyed - hybridized	

Year	Donor Stream	M:F spawned	Recipient Water	# eggs/fry out
2010	Last Chance - Yellowstone NP	5:5	Little Tepee - Hebgen basin	443 eyed eggs
	Wally McClure - Hebgen trib	10:0	Little Tepee - Hebgen basin	
	Brays Canyon	7:7	Cherry Creek	1066 eyed eggs
			Sun brood pond	123 fry
	Prickly Pear - Elkhorn Mtns	8:4	Eureka Creek - Elkhorn Mtns	641 eyed eggs
	Wild Horse	5:3	Elkhorn - Gallatin	678 eyed eggs
			Wild Horse	76 eyed eggs
	Geode Creek - YNP	24:18	EF Specimen Creek	4156 eyed eggs
	Sun brood pond	10:5	Cherry Creek	398 eyed eggs 3400 fry
			Sun brood pond	496 fry
	WF Wilson	1:1	eggs discarded - male was hybrid	

Appendix H

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
Buford	???	11	85.7%Wx12.6%Rx1.7%Y
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
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% WCT
Stone	2004	50	100% WCT
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