Madison River Drainage Fisheries

and

Madison River Drainage Westslope Cutthroat Trout Conservation and Restoration Program

2009
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-river.cfg/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
Whirling Disease Foundation.........................www.whirling-disease.org

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An electronic version of this and other FWP reports are available at
http://fwp.mt.gov/wildthings/wildlifelib/default.aspx

FERC Articles addressed in this report

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EXECUTIVE SUMMARY

Beach seining for young-of-the-year Arctic grayling and mountain whitefish was conducted in October. One young-of-the-year Arctic grayling and 5 young-of-the-year whitefish were captured in Meadow Creek Bay. Other species captured at index sites were juveniles of rainbow trout, brown trout, Utah chub, long-nose dace and white sucker. Rainbow trout over six inches were estimated at 1500 – 2500/mile in the Pine Butte and Norris sections. In Varney, the rainbow trout estimate decreased significantly to less than 500/mile from the most recent estimate of over 1500/mile in 2007. Brown trout were estimated at 1000 – 2000/mile in all three sections. Water temperature was monitored at 14 sites and air temperature at 7 sites within the Madison Drainage. Eighteen locations in the Madison Drainage were sampled for New Zealand mudsnails and selected other aquatic nuisance species. Sentinel fish from captive rainbow trout stock are still severely infected by whirling disease in the river, but the wild rainbow trout population has rebounded to approximately 60 percent of its pre-whirling disease level . The Sun Ranch hatchery was used to incubate eggs for the southwest Montana westslope cutthroat trout conservation and restoration program. The Cherry Creek Native Fish Introduction Project continued in 2009 with a treatment of a portion of Phase 3 where fish were located. Westslope cutthroat trout eyed egg introductions were continued in Phase 2 and initiated in Phase 3. The number of rainbow trout captured during annual Hebgen Reservoir gillnetting decreased from 2008 but remained near the high end of annual catch over the past 15 years. The proportion of rainbow trout over 14 inches in the Hebgen gillnet catch has increased noticeably since 2005. Trapping of rainbow trout immigrating into Hebgen tributaries to spawn continued. Zooplankton density in Hebgen Reservoir was monitored.

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INTRODUCTION

Montana Fish, Wildlife, & Parks (MFWP) 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, MFWP 1995, MFWP 1996, MFWP 1997, MFWP 1998a, MFWP 1999a, MFWP 2000, MFWP 2001, MFWP 2002, MFWP 2003, MFWP 2004a, MFWP 2005, MFWP 2006, MFWP 2007a, MFWP 2008, MFWP 2009). 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 MFWP 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 money that is provided to them by PPL Montana to address the requirements of PPL Montana's FERC license for operating the Madison & Missouri dams. The Madison Fisheries Technical Advisory Committee (MadTAC) is composed of personnel of PPL Montana, MFWP, 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 Federal Energy Regulatory Commission (FERC) license number that authorizes their operation. The Federal Energy Regulatory Commission issued PPL Montana a license to operate the 2188 Project for 40 years (Federal Energy Regulatory Commission 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 (MUCAWCTM). The MUCAWCTM, which was formalized in 1999 (MFWP 1999b), 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

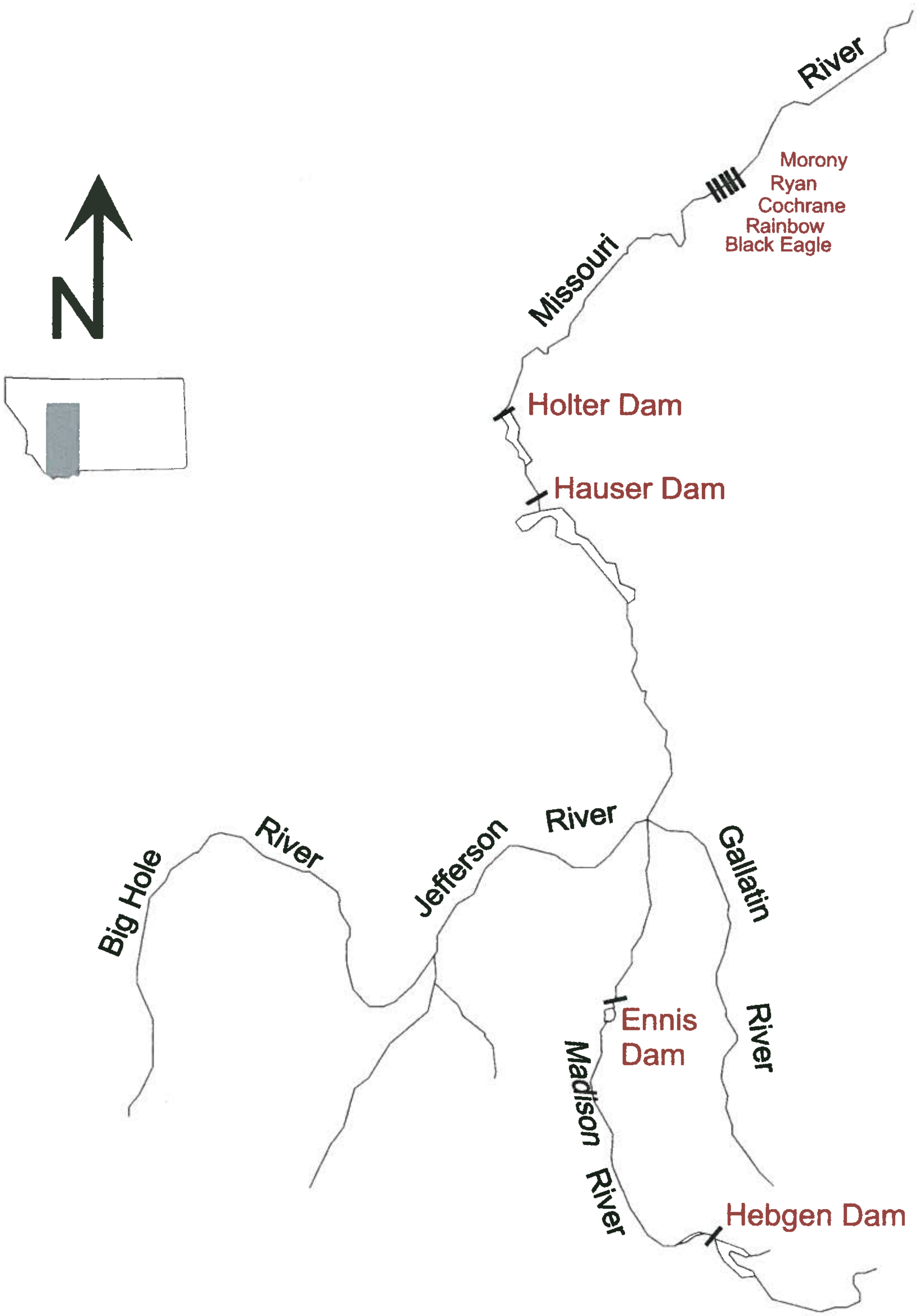


Figure 1. Locations of PPL Montana dams on the Madison and Missouri rivers (FERC Project 2188).

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.

Entities participating in the development of the MUCAWCTM were American Wildlands, Montana Chapter of the American Fisheries Society, Montana Department of Natural Resources and Conservation (MDNRC), Montana Farm Bureau, MFWP, Montana Stockgrowers Association, Montana Trout Unlimited, Montana Wildlife Federation, Natural Resource Conservation Service, BLM, USFS, USFWS, and private landowners.

In 2006, the MUCAWCTM was updated and combined with a similar document for Yellowstone Cutthroat Trout *Oncorhynchus clarki bouvieri* (MFWP 2007b).

Late in 1996, MFWP initiated a program entitled "The Madison River Drainage Westslope Cutthroat Trout Conservation and Restoration Program". The goal of this 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 MFWP 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 MUCAWCTM objectives 3, 4, & 5. MFWP 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, MFWP 1998b). MFWP, 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 implemented in 2003.

In 2001, the Sun Ranch entered into an agreement to assist MFWP 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.

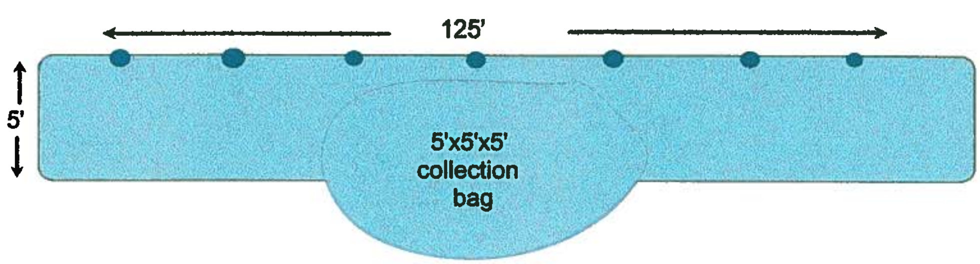


Figure 3. Depiction of seine used during beach seining

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,

Figure 4. Locations of Ennis Reservoir 2009 seining sites.

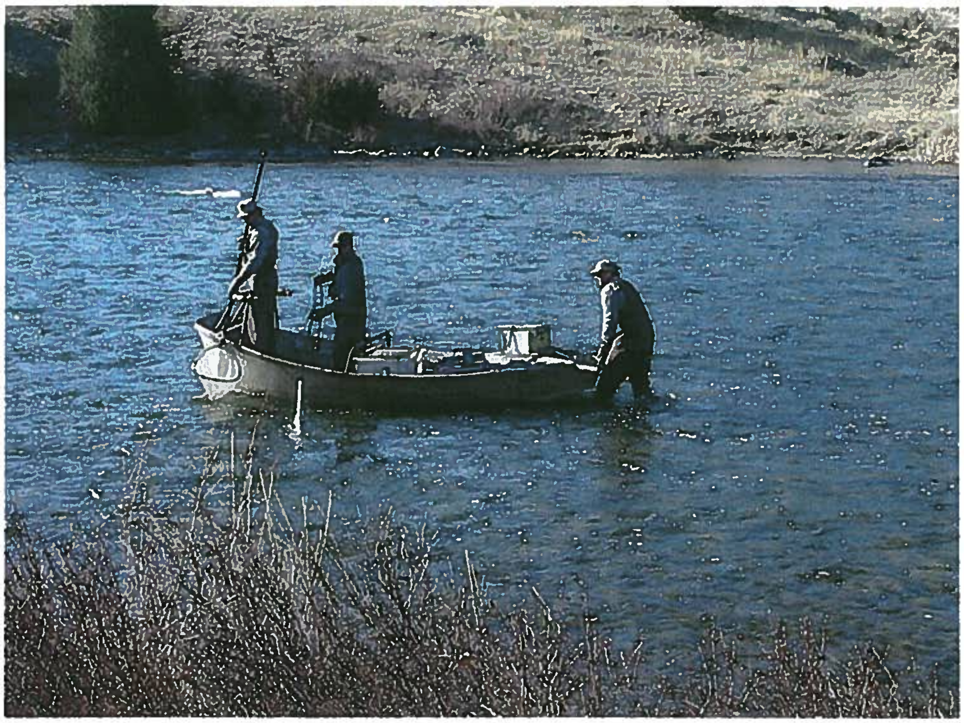


Figure 5. Electrofishing (shocking) in the Norris section of the Madison River.

marked with a fin clip, and released. A log-likelihood statistical analysis (MFWP 2004b) is used to estimate trout populations.

In recent years estimates for all sections and all years have been converted from age-based estimates to length-based estimates due partially to the major time requirement necessary to age fish, and to maximize the statistical probability that the estimates are accurate.

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 accomplish this. 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 1100 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

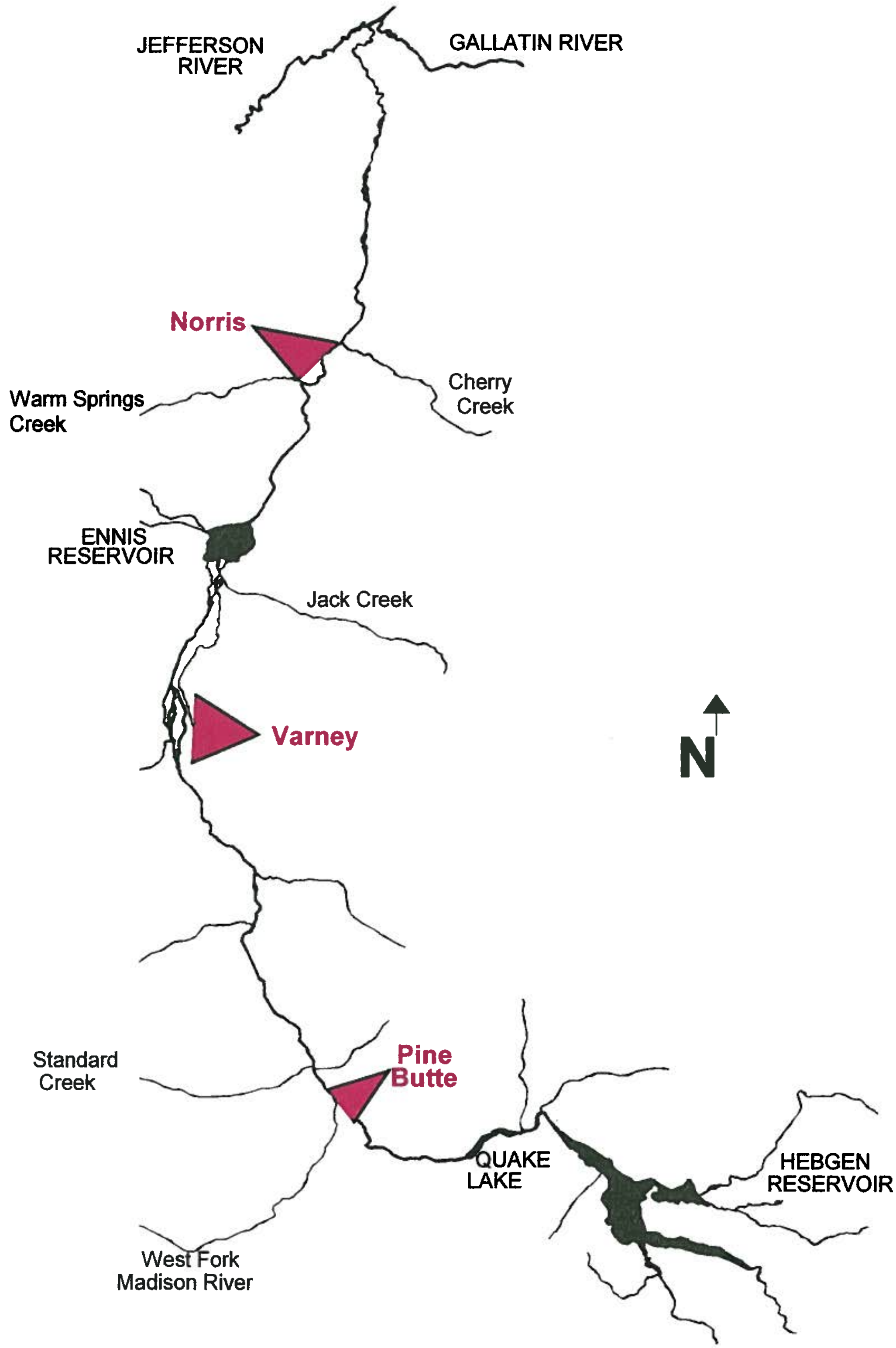


Figure 6. Locations of Montana Fish, Wildlife, & Parks 2009 Madison River population estimate sections.

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	

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 soil for terrestrial vegetation and other wildlife needs.

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 14 sites and air temperature at seven sites throughout the course of the Madison River from above Hebgen Reservoir to the mouth of the Madison River at Headwaters State Park (Figure 7). Optic StowAway temperature loggers recorded temperature in Fahrenheit every 30 minutes. 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 mudsnails in the Madison River and Hebgen Reservoir, and instructs them on methods of reducing the likelihood of transporting New Zealand mudsnails 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.

The State of Montana 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. The ANS Coordinator is an employee of FWP.

In 2009 FWP initiated 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

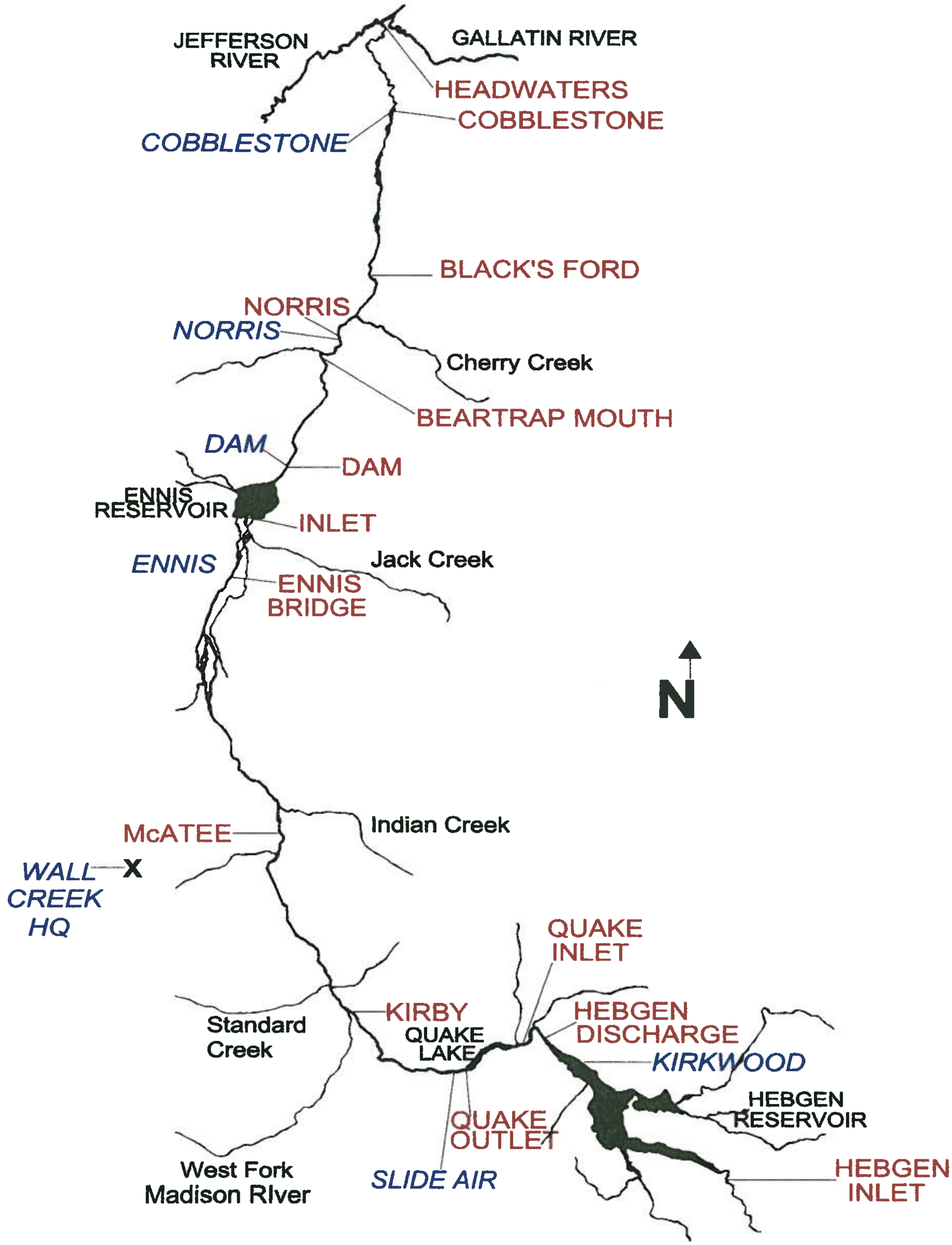


Figure 7. Locations of Montana Fish, Wildlife, & Parks annual temperature monitoring sites. Air temperature sites are blue, water temperature sites are in red.

Figure 8. Roadside sign announcing the Traveler Information System at West Yellowstone.

limit the distribution of zebra and quagga mussels. Survival of the larvae and size of adult established populations are both thought to increase with increasing levels of calcium.

New Zealand Mudsnails

New Zealand Mudsnails 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 between various rivers by using a consistent measuring base.

In 2009, eight sites in the Madison below Hebgen were monitored for whirling disease infection risk. Two cages were simultaneously deployed at each site to measure risk at the upper and lower ends of each site. The sites monitored were side channels at South Slide, Slide Inn, Pine Butte, Kirby, Lyons, Palisades and Varney, and the main channel of the West Fork near the West Fork Camp bridge.

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 (MFWP 1998a, Sloat et al. 2000). Backpack electrofishing was used to survey fish species. Removal of non-native species will 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 & sperm) for the Sun Ranch Westslope Cutthroat Trout program were collected from three streams in 2009. No eggs were collected from the Sun Ranch Broodstock in 2009 due to poor production of the brood fish. All fertilized eggs were transported to the Sun Ranch Hatchery for incubation and hatching (Figure 9). A portion of the resulting fry from two of the streams and the Sun brood were introduced to the Sun Ranch Brood Pond (Figure 10) to contribute to the Sun Ranch brood development. One of the two contributing streams was a new population not previously represented in the brood. Two of the wild populations did not contribute to the Sun brood in 2008 because they contributed in previous years. Fry from the Sun Ranch Pond broodstock were used for introductions in Cherry Creek and stocked into the pond to facilitate development of the Sun Ranch brood.

Occasionally, when project personnel are unavailable to do so, USFWS personnel from the Ennis National Fish Hatchery caretake 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 11) approximately 8 miles upstream of the Madison River confluence. The only fish species present in the project area in 2003 were brook trout, rainbow trout, and Yellowstone cutthroat trout (YCT) (Figure 12). The large size of the project area requires that the project be completed in phases. Each phase will be treated for at least two consecutive years. In 2009 a portion of the Phase 3 mainstem was treated to remove fish that leapt the barrier during Spring runoff.

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 previous years treatments.

Figure 9. Sun Ranch Hatchery rearing troughs.

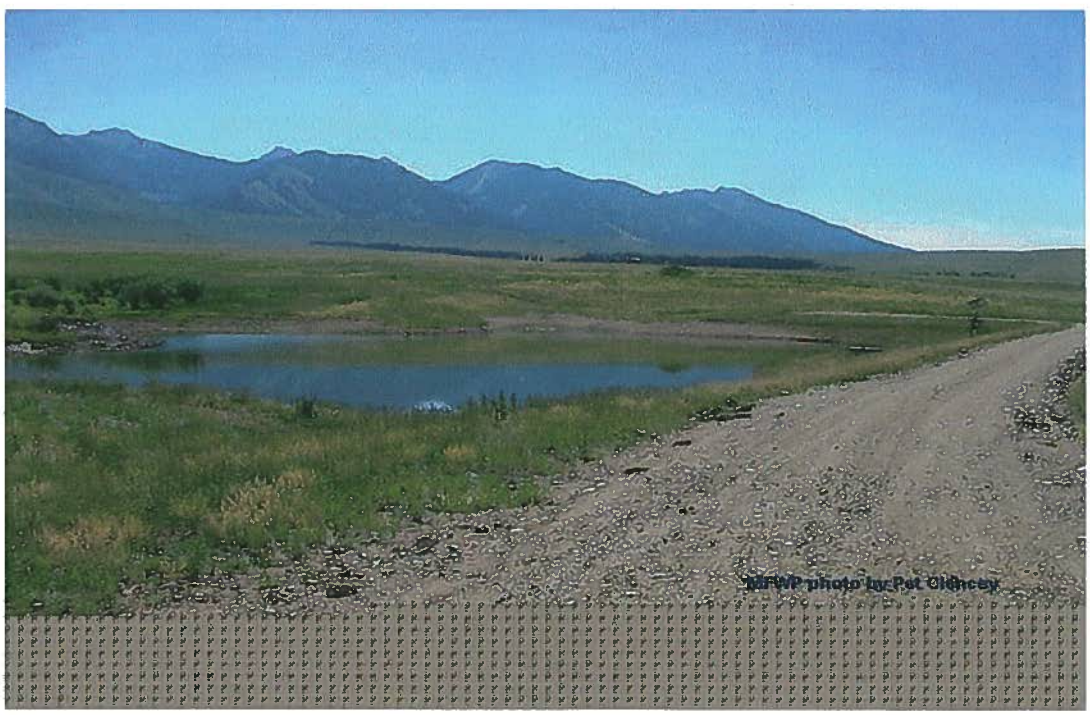


Figure 10. Sun Ranch Brood Pond.

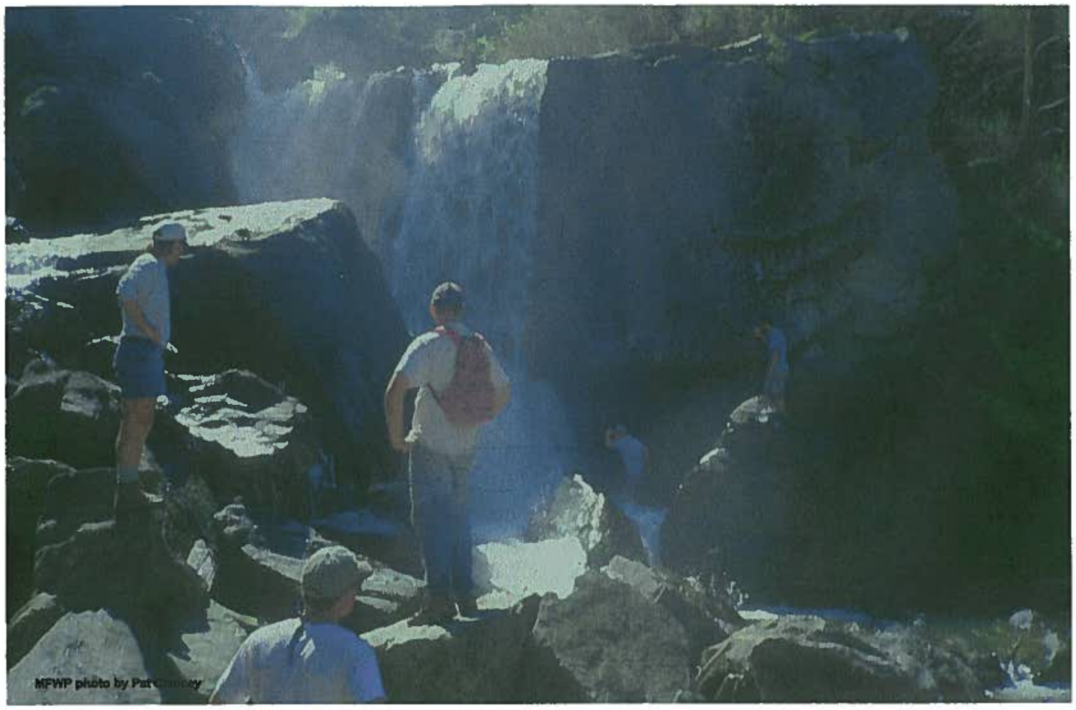


Figure 11. Cherry Creek waterfall at stream mile 8.0. This falls is the downstream extent of the project area.

Fintrol became unavailable for use at Cherry Creek in 2007 due to a production problem, so a rotenone product called CFT Legumine 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.

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.

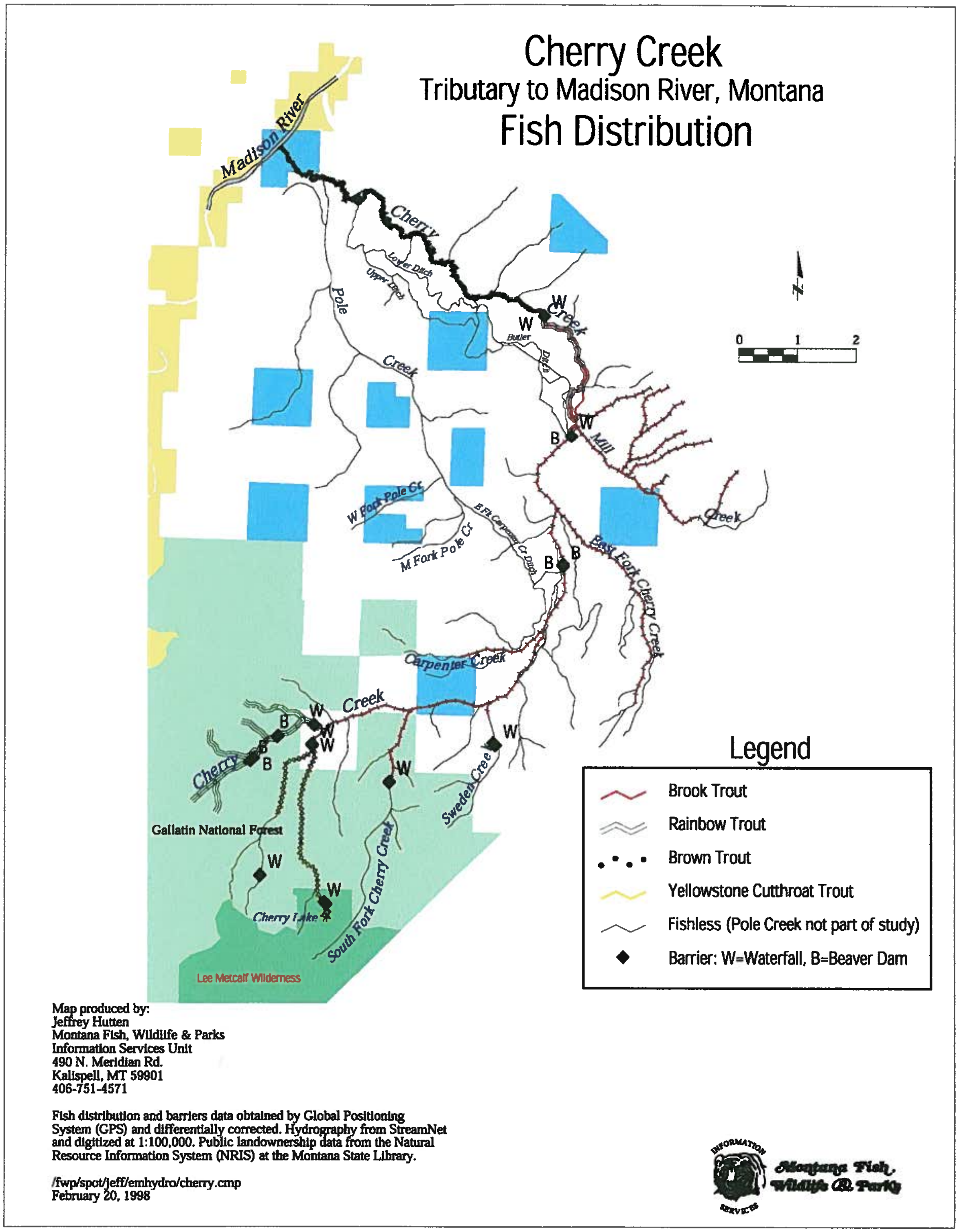


Figure 12. Cherry Creek Drainage. Landownership patterns have changed since this map was produced.

Table 2. Results of CFT Legumine rotenone bioassays in the East Fork of Cherry Creek 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 gravely ill at 1455 hrs (2:22 hours of exposure)

[3/] 100% mortality of sentinel fish was confirmed the following morning at 11:45

Stream treatments were made using trickle application systems (Figure 13). 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 14), and a longer section of garden hose attach the assembly to the dog waterer. The bucket is partially filled with filtered stream water, the CFT is added, then 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 15). 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.

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.

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 16) in the Cherry Lake fork of Phase 1 and in Phase 2. Eggs completed incubation in the RSI, hatched, and fry departed the RSI into the stream under their own power. 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 13. 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 above the one shown here.

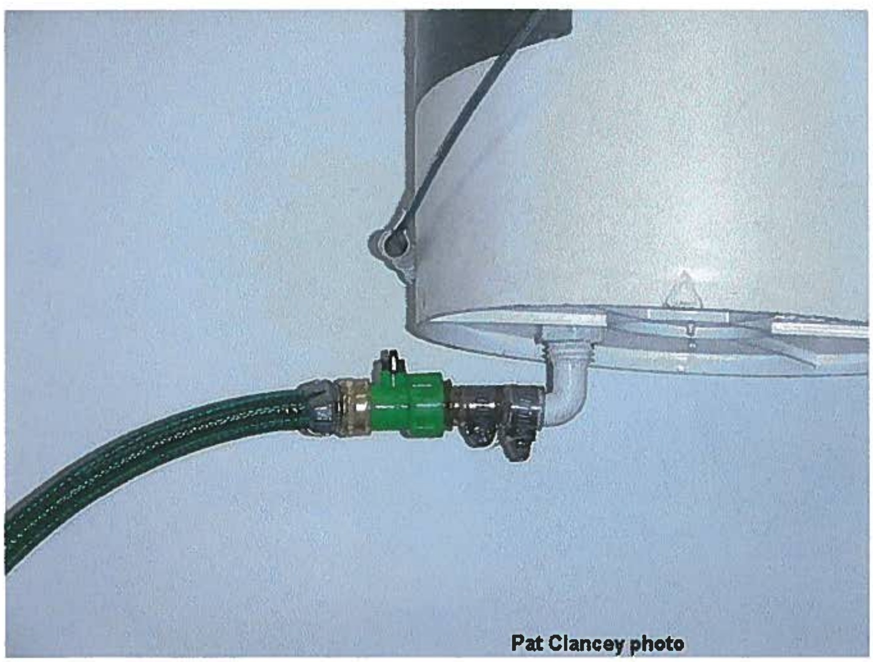


Figure 14. Elbow & gate valve assembly.

Figure 15. Close-up view of the dog waterer trickling CFT/streamwater mixture into the stream during the Cherry Creek Project.

Figure 16. 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 to funnel water for operation of a sluice box and water wheel pump (Figure 17) to deliver water 500 vertical feet to an offsite water trough for livestock. Brown trout migrate up Lake Creek for spawning, but in some years fish passage around the dam is blocked by tarps 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.

O'Dell Creek

O'Dell Creek is a spring creek that originates south of Ennis and flows 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, maximize available rangeland for cattle, and simplify irrigation. In 2005, DJP Consulting and the Granger Ranches received funding from PPL Montana Madison Fisheries and PPL Montana Wildlife technical advisory committees and other sources to restore form and function to portions of O'Dell Creek and associated wetlands on Granger Ranch property (Table 3, Figure 18). Backfilling of the East Ditch resulted in groundwater resuming its original flow pattern into the wetland and also resulted in increased streamflow in other stream channels. Fisheries monitoring is conducted at six sites in the project area (Figure 19). Future plans include channel narrowing and vegetation development in the Above Falls and Below Falls sections.

Figure 17. Water wheel at Smith Lake Dam on Lake Creek. MFWP photo by Travis Lohrenz.

Table 3. Summary of stream restoration actions on fish monitoring sites at O'Dell Creek, 2005 - 2009.

Fish Monitoring Site	Result of Stream Channel Modification
O'Dell Ditch	Backfilled
O'Dell Spring North	Increase in stream discharge, no physical modifications
Old Middle	Historic channel reconnected and reconstructed
O'Dell West	Channel narrowed & deepened, increase in stream discharge
Above Falls	Increase in stream discharge, stream channel restoration
Below Falls	Increase in stream discharge, no physical modifications

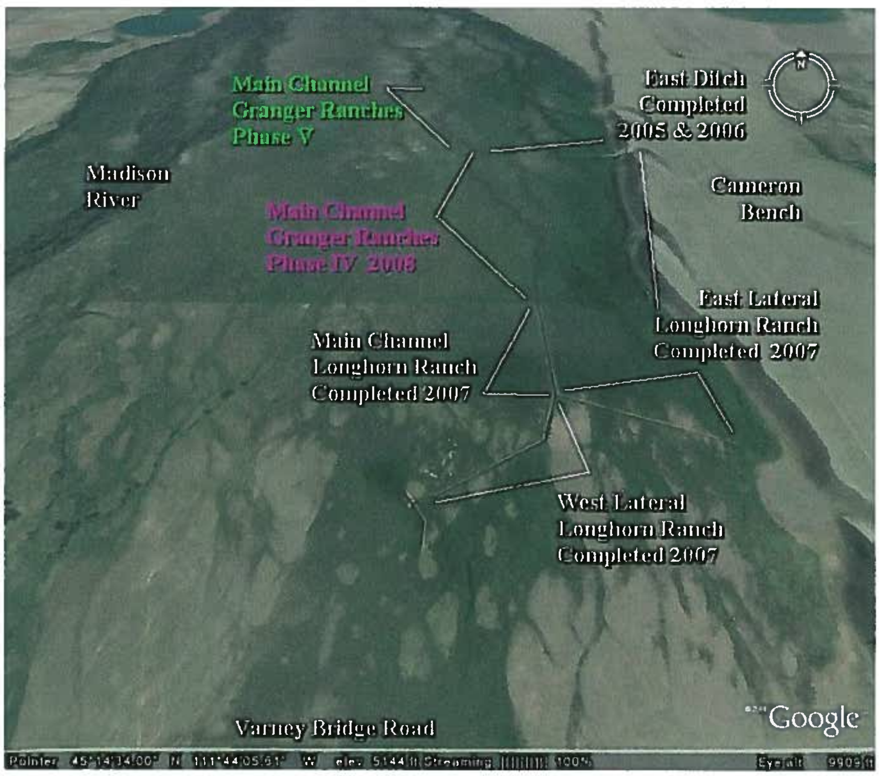


Figure 18. Schedule of stream improvement activities on O'Dell Creek, Granger and Longhorn ranches, from Peters 2009.

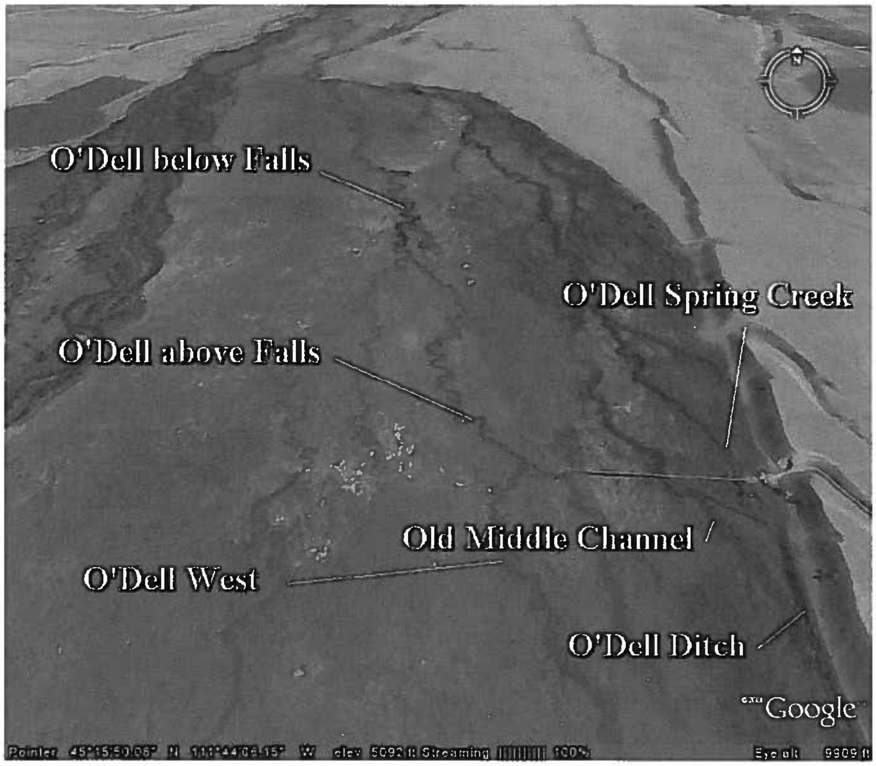


Figure 19. Map depicting approximate locations of fish sampling sites on O'Dell Creek, from Peters 2009.

Hebgen Basin

Hebgen Reservoir and its tributaries are shown in Figure 20.

Hebgen Reservoir Gillnetting

Gillnetting has been conducted annually on Hebgen Reservoir by MFWP 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 experimental gillnets, 125 foot long, were deployed overnight at index sites on Hebgen Reservoir (Figure 21) over a three-day period during New Moon in early June. A total of 25 gill nets (14 surface and 11 bottom 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. Total length and weight were recorded and scales removed from rainbow trout, brown trout and mountain whitefish for age determination. 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.

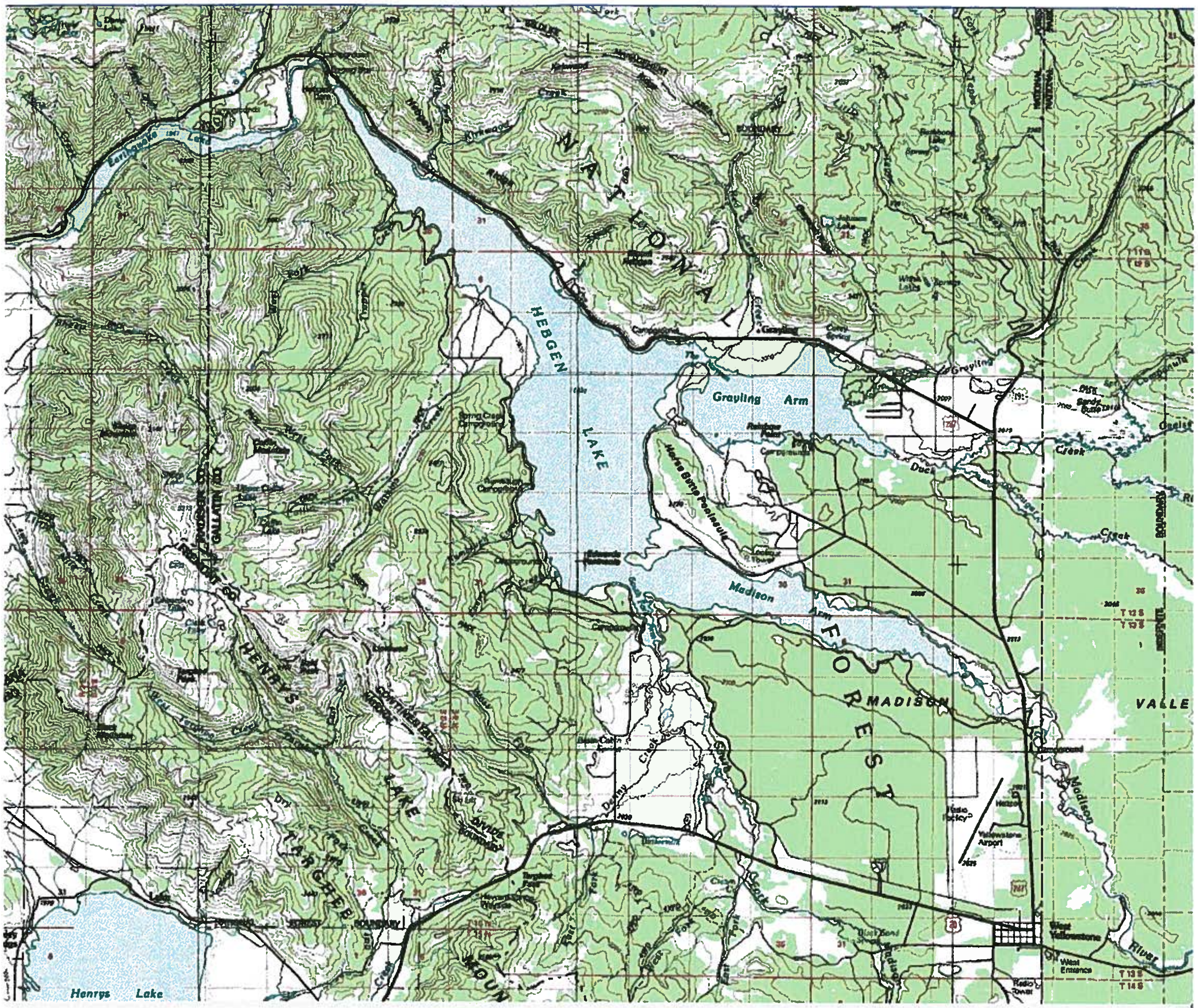


Figure 20. Hebgen Reservoir and surrounding area.

Additionally, vertebrae were extracted from rainbow trout specimens and examined for the presence of oxy-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. Oxy-tetracycline is typically administered to hatchery-reared fish through feeding prior to stocking.

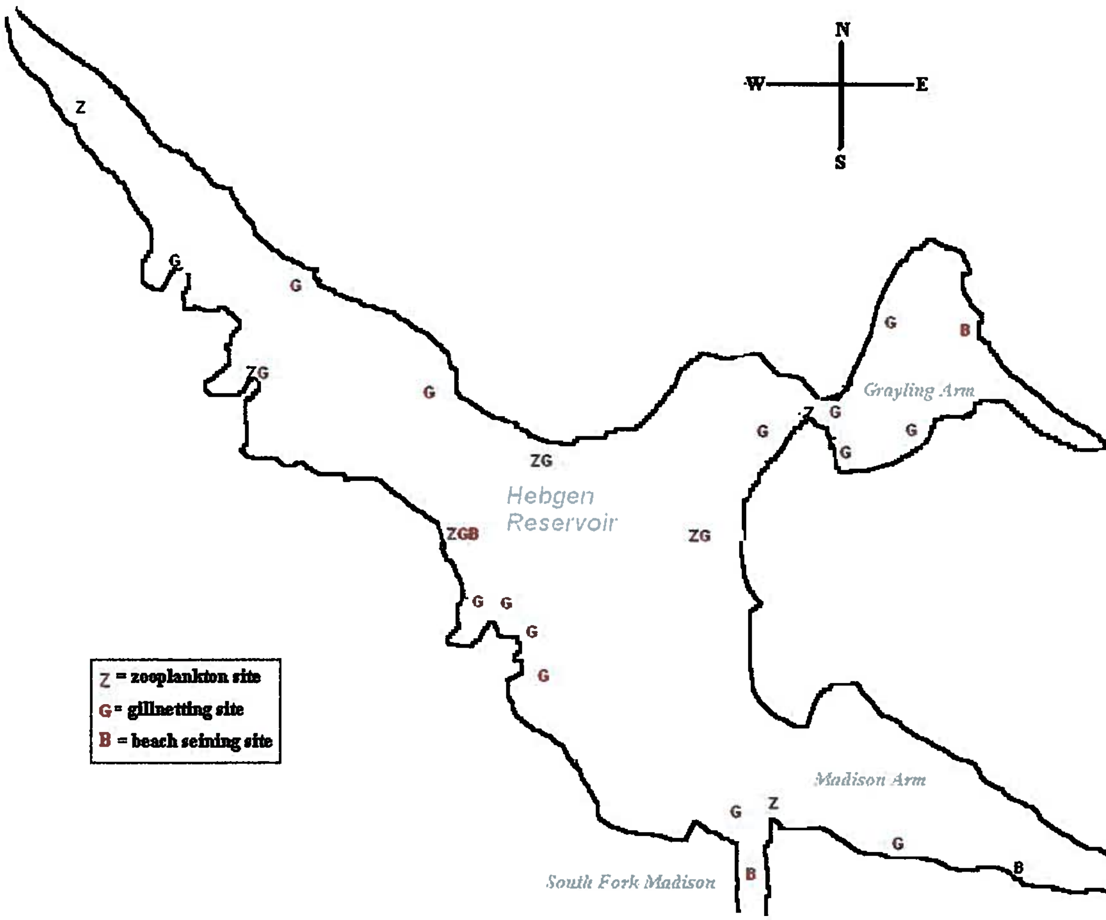


Figure 21. Locations of Hebgen Reservoir zooplankton, gillnetting, and beach seining sites.

Hebgen Basin Disease Monitoring

Whirling Disease

Sentinel fish cages containing young-of-the-year Eagle Lake rainbow trout were deployed in two 10-day exposures, June 18 – 28 and June 28 – July 8, in three Hebgen tributaries (Duck Creek, Black Sands Springs, and South Fork Madison) to test for the presence of whirling disease. Sentinel fish were reared in isolation tanks for another 80 days at the MFWP 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 for whirling disease infection and were rated on MacConnell-Baldwin scale (Appendix A), which grades infection from 0-5 with 0 being no infection and 5 being severe infection.

Hebgen Basin Tributary Trapping

Rigid panel weirs (Figure 22) were constructed and operated on Duck Creek and the South Fork Madison River and a floating panel weir (Figure 23) was constructed and operated on the mainstem Madison River above Hebgen Reservoir to monitor rainbow trout spawning escapement and recruitment to the adult population in 2008. Weirs were placed in a shallow glide with uniform streambed elevation and water depth between two and three feet at base flow. The trap box was positioned to capture rainbow trout ascending tributaries to spawn. When numbers of fish captured fell below five fish/day for a one-week duration, the trap was removed.

Figure 22. Rigid weir assembly used to trap immigrating rainbow trout on Duck Creek and the South Fork Madison. MFWP photo by Travis Lohrenz.

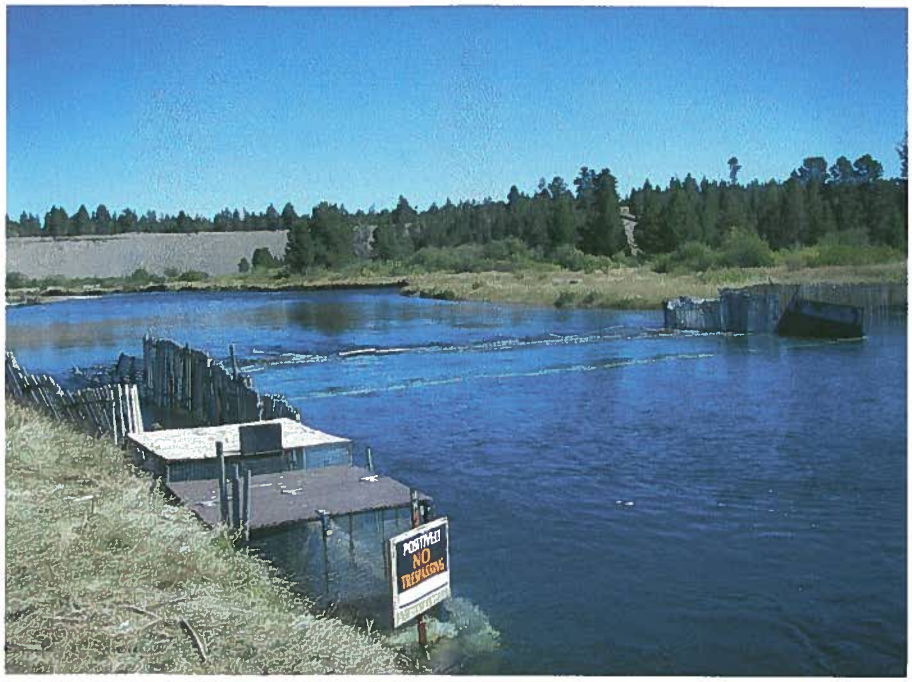


Figure 23. Rigid panel weir used on the Madison River, 2007 - 2009. MFWP photo by Travis Lohrenz.

All fish captured were anesthetized prior to being worked to reduce handling time and stress. Data collection for individual fish included total length and weight, scale collection for age determination, and external examination. Additionally, individuals were inspected for coded-wire-tags, administered to young-of-the-year and yearling rainbow trout at the Duck Creek and South Fork Madison rotary screw traps from 2004-2006, and a uniquely numbered floy-tag which were attached to adult rainbow trout during weir operations from 2005-2007 (Figure 24). If no floy-tag was observed, one was administered to the fish for future identification.

Hebgen Reservoir Shoreline Juvenile Fish Sampling

Beach seining was not conducted at Hebgen index sites in 2009.

Hebgen Reservoir Zooplankton Monitoring

Monthly zooplankton tows were conducted at seven established sites on Hebgen Reservoir to evaluate plankton community densities and composition (Figure 21). 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.

Figure 24. Floy tagged Hebgen Reservoir rainbow trout.

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.

RESULTS AND DISCUSSION

Madison Grayling

One young-of-the-year Arctic grayling was captured during beach seining in Ennis Reservoir in 2009 (Appendix B).

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 also make such conditions available. The duration and severity of the Madison River ice gorge (Figure 25) may affect the spawning success of the Ennis Reservoir grayling.

The USFWS re-evaluated the petition to list fluvial (river-dwelling) Arctic grayling as a Threatened species in light of a lawsuit filed in 2003 by the Center for Biological Diversity (CDB), concluding in 2007 that listing Arctic grayling under the Threatened and Endangered Species Act was not warranted. A listing would have likely included all grayling populations regardless of behavioral traits or genetic similarity to Big Hole River fluvial grayling.

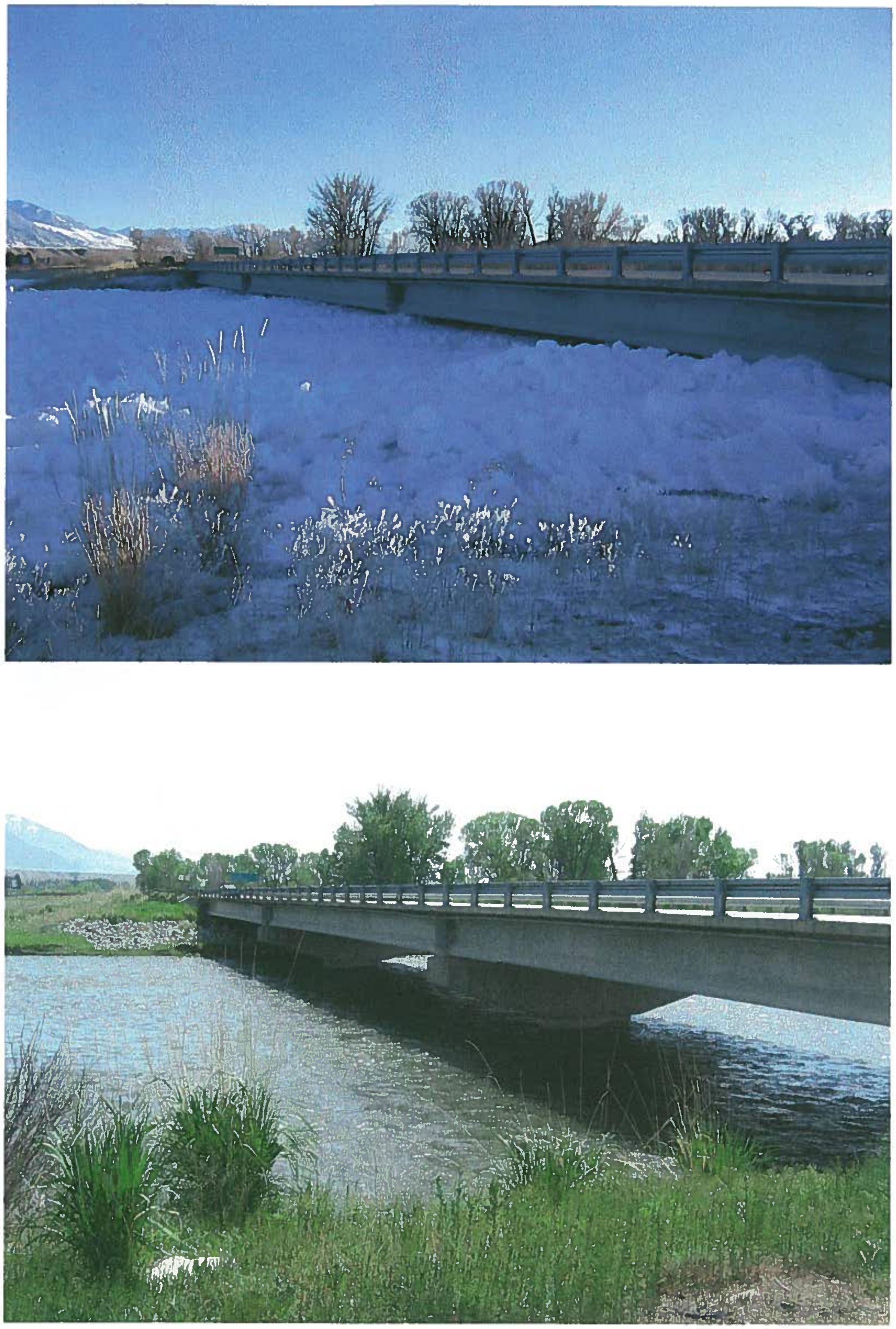


Figure 25. The Madison River at the U.S. Highway 287 Bridge at Ennis, illustrating ice-gorged and ice-free conditions.

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.

MFWP has developed 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 not warranted, landowners and irrigators continue to enroll in the program. Currently 36 landowners have enrolled 157,291 acres, with an additional 5,390 acres of State land enrolled.

Population Estimates

Population estimates were conducted in the Norris section in March and in the Pine Butte and Varney sections in September (Figure 6).

Figures 26-28 illustrate population levels of six inch and larger rainbow trout per mile. The rainbow population in Pine Butte exhibited a slight increase from 2008, but in the Varney section decreased significantly to levels not seen since the mid-late 1990's. In the Norris section rainbows increased slightly over the 2008 level.

Figures 29 - 31 illustrate numbers of six inch and larger brown trout. Brown trout in the Pine Butte and Norris sections exhibited slight increases from the previous year, but decreased in Varney.

In 2005, FWP Regional Management personnel began reporting population numbers greater than six inches rather than using fish length to assign 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 (MFWP 1995 – 2008). Appendix C2 contains historic total population levels of two year old & older rainbow and brown trout (+ 80% C.I.) for each section.

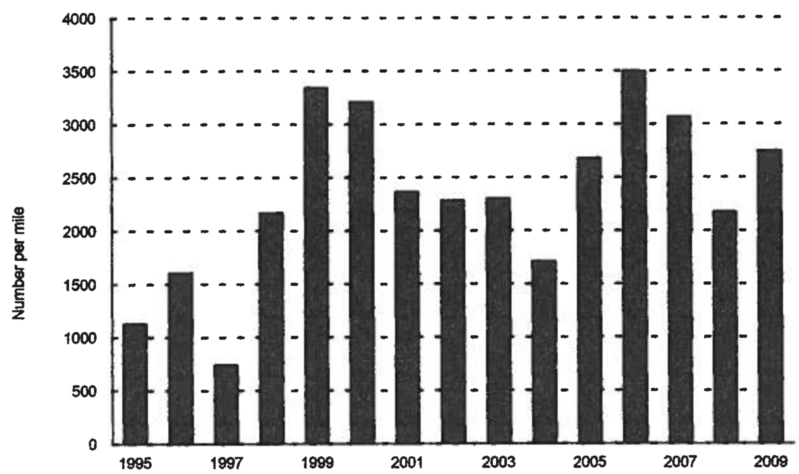


Figure 26. Rainbow trout (≥ 6") estimates in the Pine Butte section of the Madison River, 1995–2009, fall estimates.

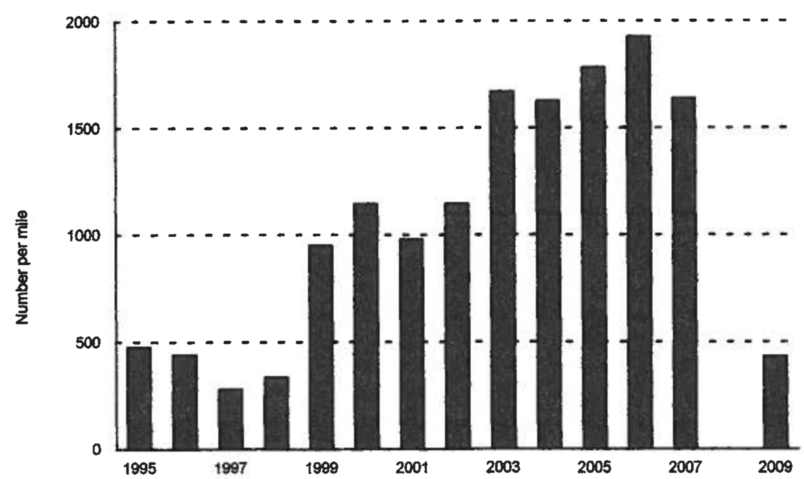


Figure 27. Rainbow trout (≥ 6") estimates in the Varney section of the Madison River, 1995–2009, fall estimates.

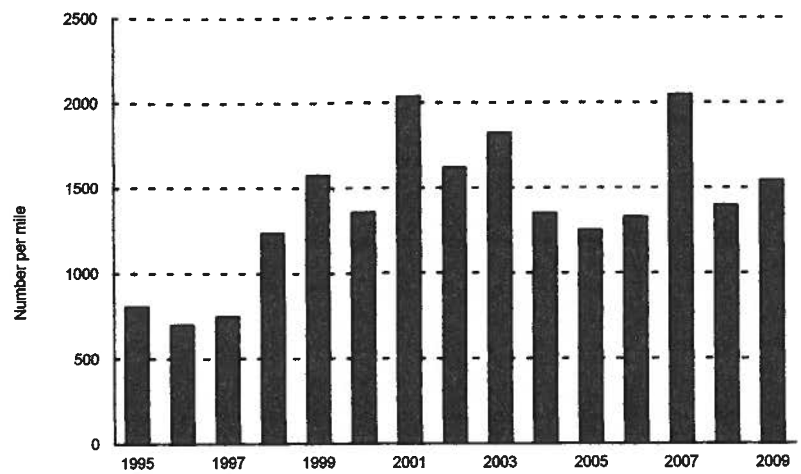


Figure 28. Rainbow trout (≥ 6") estimates in the Norris section of the Madison River, 1995–2009, spring estimates.

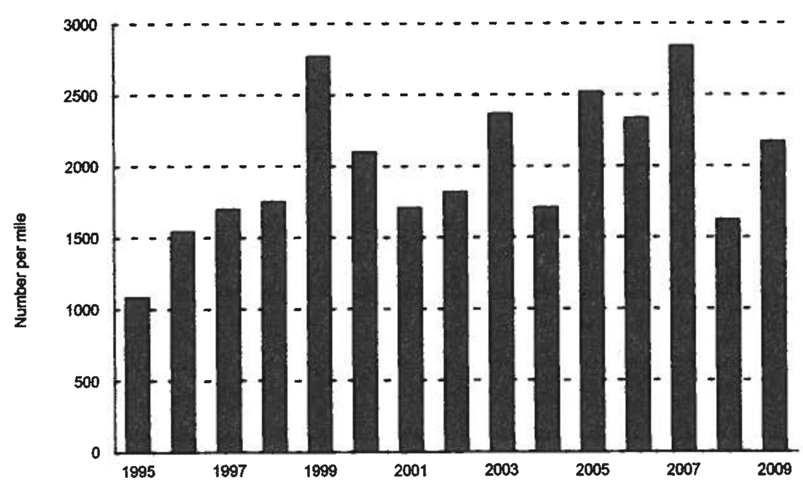


Figure 29. Brown trout (≥ 6") estimates in the Pine Butte section of the Madison River, 1995–2009, fall estimates.

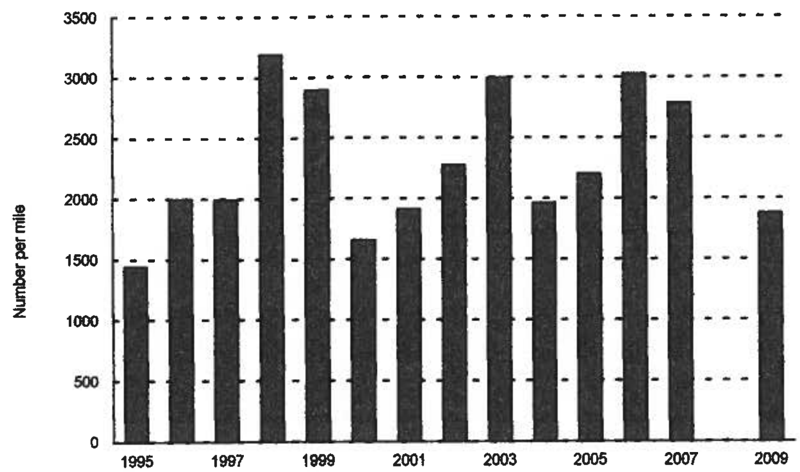


Figure 30. Brown trout (≥ 6") estimates in the Varney section of the Madison River, 1995–2009, fall estimates.

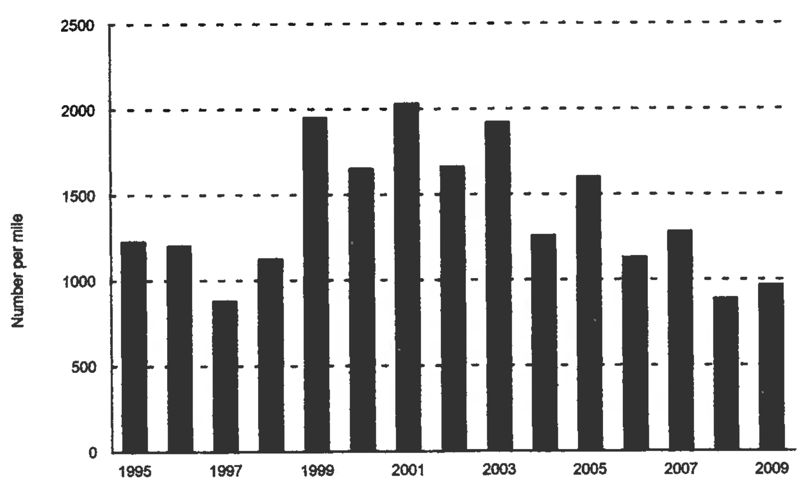


Figure 31. Brown trout (≥ 6") estimates in the Norris section of the Madison River, 1995–2009, spring estimates.

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 2009.

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

Optic StowAway 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 2009. 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). It is estimated that about 42% of the species on the Threatened or Endangered species lists are at risk primarily because of alien-invasive species.

In 1994, two invasive species were detected in the Madison Drainage – New Zealand mudsnails (*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. During the 2010 the FWP ANS crew will continue efforts toward early detection and monitoring of existing ANS throughout Region 3, including collection of additional samples to evaluate calcium levels throughout the region.

<u>New Zealand Mudsnails</u>

Sampling for NZMS was conducted at 18 sites within the Madison Drainage in 2009 (Ryce 2009). Notable NZMS densities occurred at Darlinton Ditch and in the Madison River upstream of Hebgen Reservoir.

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

1) Listing New Zealand mudsnails as a Prohibited species in Montana.
2) Assisting in development of a regional management plan for New Zealand mudsnails, an important portion of which will describe actions to be undertaken when New Zealand mudsnails are found in or near a hatchery.
3) Establishing statewide monitoring efforts.

Table 5. Maximum and minimum temperatures (°F) at selected locations in the Madison River Drainage, 2009. Air and water temperature data were recorded from April 24 –October 6 (43,456 data points). Thermographs for each location are in Appendix D.

	Site	Max	Min
Water	Hebgen inlet	77.8	41.9
	Hebgen discharge	66.6	37.2
	Quake Lake inlet	67.2	35.9
	Quake Lake outlet	65.1	37.7
	Kirby Bridge[2/]	70.4	35.6
	McAtee Bridge	70.2	34.0
	Ennis Bridge	71.8	35.7
	Ennis Reservoir[1/] Inlet	NA	NA
	Ennis Dam	73.0	40.0
	Bear Trap Mouth	78.4	39.6
	Norris	78.2	34.7
	Blacks Ford	79.6	37.9
	Cobblestone	80.8	38.0
	Headwaters S.P.[1/] (Madison mouth)	NA	NA
Air	Kirkwood	93.4	18.0
	Slide	NA[2/]	21.1
	Wall Creek HQ	91.7	20.9
	Ennis	99.1	25.5
	Ennis Dam	91.5	24.7
	Norris	84.8	30.2
	Cobblestone	89.6	22.8

[1/] Recorders at Ennis Reservoir Inlet and Headwaters State Park were not recovered
[2/] Maximum temperature at Slide was 137.9, but the recorder had been moved by an unknown party from its shaded position to a point in the full sun.

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

The MFWP 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 mudsnails has slowed and appears to be confined 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 mudsnails 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 level that results in population effects according to the MacConnell- Baldwin Scale (Appendix A).

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 is still at high levels in the Madison River, 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 26-27). 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 from the 2004 spawners exhibited a lower proportion of fish in the highly infective categories compared to those from 1998 (Figure 32). For rainbow trout, average histology scores above 2.5 are associated with high mortality of young-of-the-year and significant decreases in population. In Figure 32, 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, June 9 – 19, 2009.

Site	Average infection score		Percent of fish infected	
	Upper cage	Lower cage	Upper Cage	Lower cage
South Slide	0.08[1/]	4.94	2.0	100.0
Slide Inn	0.42	0.11	16.7	7.1
Pine Butte	4.69	4.74	100.0	97.4
Kirby	4.53	4.24	100.0	93.1
Lyons	4.42	4.98	88.5	100.0
Palisades	4.93	2.96	100.0	52.0
Varney	4.79	5.00	95.8	100.0
West Fork	2.64	4.73	60.7	97.8

[1/]Cage located in main river channel near head of South Slide SC.

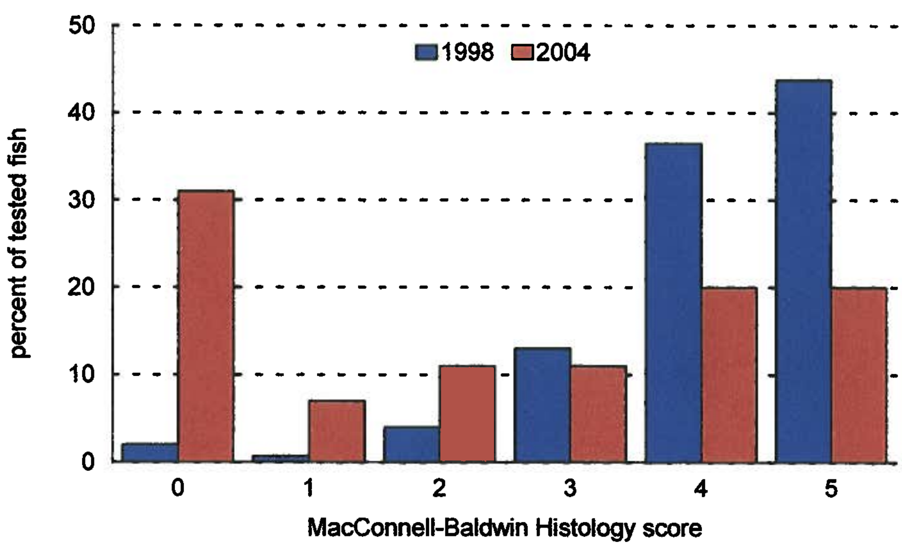


Figure 32. Percent of young-of-the-year Madison River rainbow trout within MacConnell-Baldwin histology ratings in 1998 and 2004. See Appendix A for MacConnell-Baldwin definitions.

Vincent (2007) speculated that high levels of whirling disease spores persist in the Madison River because some rainbow trout produced in the late 90's through early 2000's still survive in the river, and their offspring are not resistant. He further speculated that as those older fish fall out of the spawning population, only fish that have developed resistance to whirling disease will remain, and the number of whirling disease spores in the river will diminish.

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

Westslope Cutthroat Trout Conservation and Restoration

Habitat projects conducted by the Madison Ranger District of the Beaverhead-Deerlodge National Forest and project feasibility surveys by Yellowstone National Park are summarized in Appendix F.

Sun Ranch Westslope Cutthroat Trout Program

The Sun ranch Brood produced no viable eggs or fry in 2009 but three donor streams produced 6,551 eyed eggs for introduction into Cherry Creek and 609 fry for introduction into the Sun Pond.

Over 9,872 eggs from donor stream wild populations were incubated at the Sun Hatchery in 2009. Eyed eggs were introduced into Cherry Creek, into Cottonwood Creek in FWP Region 4, into the Specimen Creek Drainage in YNP, and each donor stream contributed to the Sun Ranch Brood Pond. Additionally, over 400 fry produced from eggs reared in the Sun Hatchery were introduced into Cherry Lake. No Sun Ranch brood fish produced viable eggs 2009.

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 Program

In 2009, 9,140 eyed eggs from three wild donor streams and 1,714 eyed eggs from the Washoe Park Hatchery were placed in RSIs in Phases 2 and 3 (Figure 33), resulting in 4,024 and 4,241fry, respectively, released into each Phase. Wild eggs were reared to the eyed stage at the Sun Ranch Hatchery then placed in RSI's (Figure 16). 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.

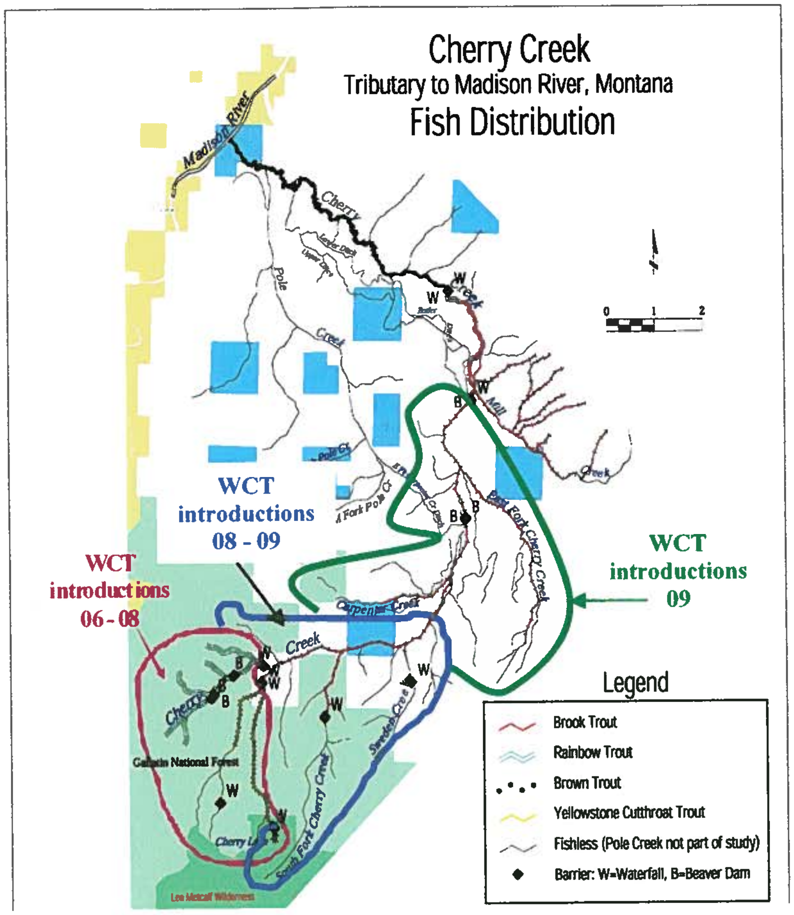


Figure 33. Phases 1 - 3 of the Cherry Creek Native Fish Introduction Project where westslope cutthroat trout were introduced in 2006 - '09 following eradication of non-native Yellowstone cutthroat, rainbow, and brook trout in 2003 – '08.

Personnel from MFWP, Montana State University, Gallatin National Forest, and Turner Enterprises spent approximately 16 worker-days completing the project in 2009, including all preparatory and support activities and chemical treatments. A total of 5.7 gallons of CFT and ½ pound of powdered rotenone were required to complete treatments in 2009, all in Cherry Creek and tributaries (Table 7).

Fish Habitat Enhancement

Smith Lake

The aged stock water delivery system on Lake Creek is being deactivated in favor of a more efficient system that will eliminate the need to manipulate streamflow at Smith Lake Dam. Plans were developed and grants applied for to drill a well and develop a delivery system that will deliver water to the stock tanks, eliminating 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 is expected to be completed in 2010.

Table 7. Schedule of Cherry Creek piscicide treatments, the number of stream miles treated, number of worker days, and quantity of piscicide used, 2003 – 09.

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

O'Dell Creek

No fish monitoring activities were conducted on the O'Dell Creek restoration in 2009, but will resume in 2010 and are expected to be conducted biannually thereafter.

Hebgen Basin

Hebgen Reservoir Gillnetting

Table 8 summarizes characteristics of fish captured during 2009 Hebgen gillnetting.

The number of rainbow trout captured by gillnetting in 2009 decreased from 2008, 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 34). The number of rainbows captured per year has varied from 47 in 2001 to 194 in 2008.

Table 8. Summary of 2009 Hebgen Reservoir gillnet catch.

Species	Number caught	Average Length (range)	Average weight (range)
Rainbow trout	110	15.8	1.49
Brown trout	212	17.1	1.72
Whitefish	127	15.8	1.58
Utah Chub	701	10.5	0.59

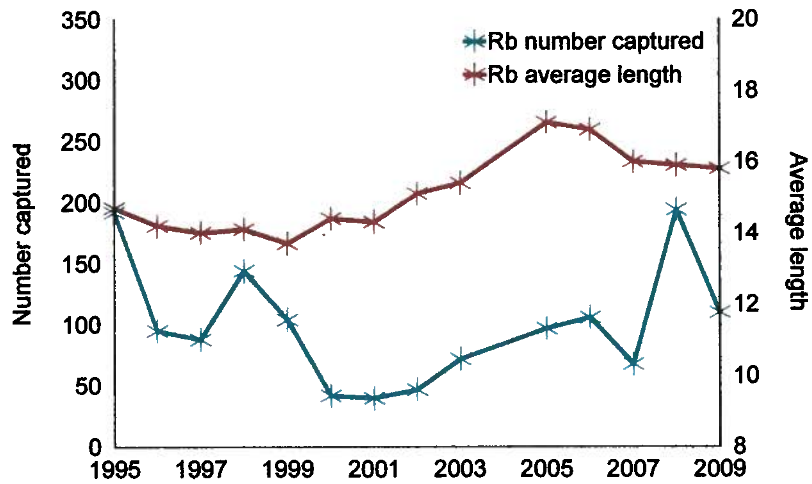


Figure 34. Rainbow trout average length (inches) vs. number captured during annual Hebgen gillnetting, 1995-2009. 2004 data set not shown because of sampling error.

Average length of rainbow 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 35).

Four of 91 (4.4%) rainbow trout vertebrae examined were positive for tetracycline marks, indicating fish of hatchery origin. Tetracycline can be added to hatchery pellets to put a mark in the vertebrae, creating a positive identification feature for hatchery raised fish. Three of the four marked fish also exhibited dorsal fin erosion. Dorsal fish erosion is often associated with hatchery produced trout. Applying the 4.4% tetracycline ratio to the full 110 rainbow captured, five rainbow trout can be assigned to hatchery origin.

Two (1.0%) coded-wire-tagged rainbow trout from tributary traps were recovered during gillnetting. One fish was snout tagged, which indicates its tributary of origin was the South Fork Madison. The location of the tag on the other fish failed to be recorded during processing.

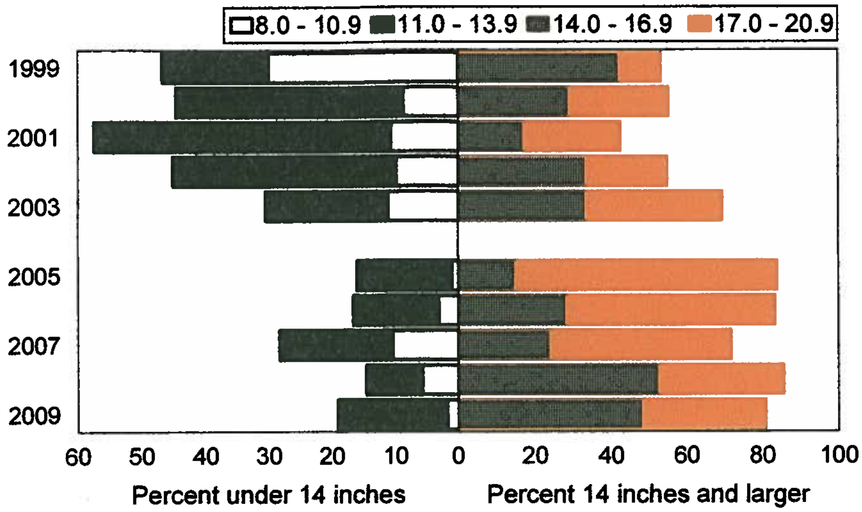


Figure 35. Percent of Hebgen Reservoir rainbow trout gillnet catch under and over 14 inches, 1999-2009. 2004 data set not shown because of sampling error.

Brown trout numbers have fluctuated widely with no consistent trend evident for more than a few consecutive years (Figure 36). The number of fish captured annually has ranged from 61 in 2002 to 326 in 1999. Average length is trending upward over the past ten years.

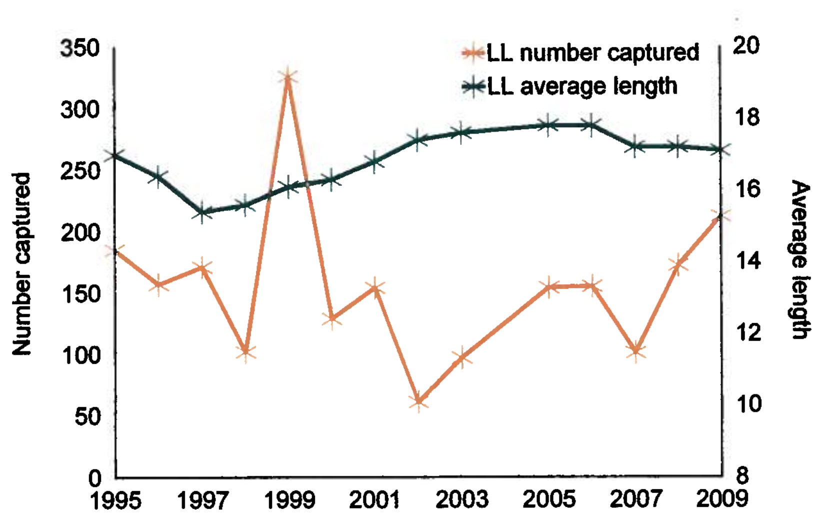


Figure 36. Brown trout average length (inches) vs. number captured during annual Hebgen gillnetting, 1995-2009. 2004 data set not shown because of sampling error.

The number of whitefish captured decreased significantly in 2002, but has remained relatively stable since (Figures 37). The number captured per year has varied from 83 in 2005 to 272 in 1999. Average length has shown a generally upward trend, though it has decreased each of the past two years.

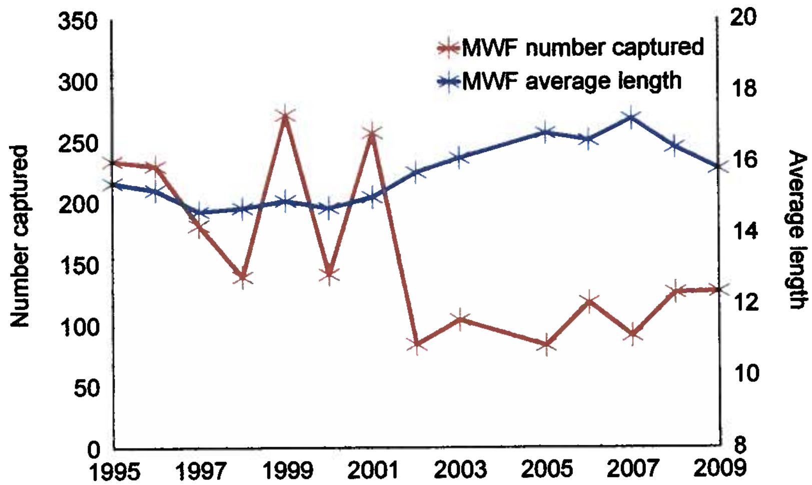


Figure 37. Mountain whitefish average length (inches) vs. number captured during annual Hebgen gillnetting, 1995-2009. 2004 data set not shown because of sampling error.

The number of Utah chub captured decreased significantly in 2005, but average length has shown no consistent trend since 1995 (Figure 38). The number of Utah chub captured annually has ranged from 305 in 2007 to 2308 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 39). Utah chub were illegally introduced into Hebgen Reservoir in the 1930's.

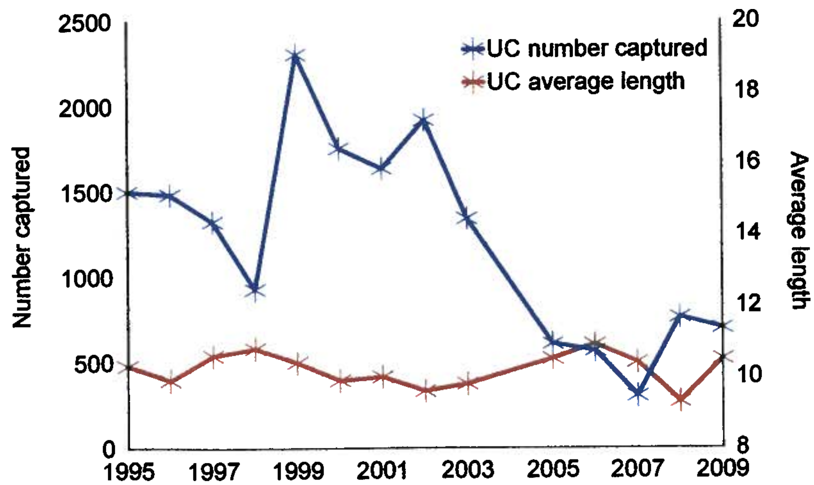


Figure 38. Utah chub average length (inches) vs. number captured during annual Hebgen gillnetting, 1995-2009. 2004 data set not shown because of sampling error.

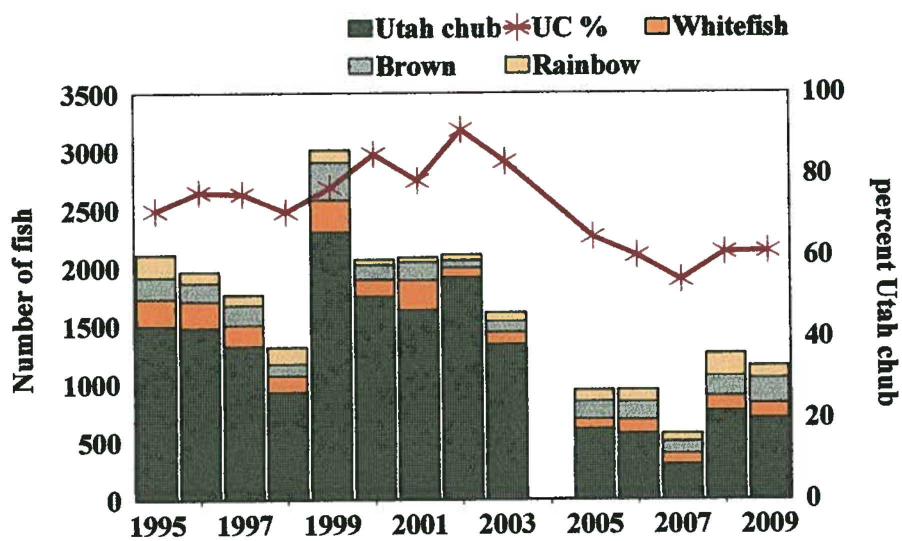


Figure 39. Species composition of Hebgen gillnet catch, 1995 – 2009.

Hebgen Basin Disease Monitoring

Whirling Disease

The 2009 whirling disease samples for Hebgen tributaries were inadvertently destroyed prior to processing for analyses. Monitoring in previous years indicates a moderate – high infection on the MacConnell-Baldwin scale (Appendix A) in the South Fork Madison but no infection in other Hebgen tributaries (Table 9). Some rainbow trout spawners ascending Duck Creek in previous years exhibit external characteristics of whirling disease.

Table 9. Whirling disease infection severity of South Fork Madison[1/] sentinel rainbow trout, 2007 – 2008. The 2009 samples were inadvertently destroyed prior to completing the proper incubation period.

Dates of exposure	Average infection score
2007	
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
2008	
Jun 18 – 28	3.30
Jun 28 – Jul 8	2.46

[1/] No other Hebgen tributaries have exhibited whirling disease scores higher than 0.20.

Hebgen Basin Tributary Trapping

Table 10 summarizes characteristics of Spring spawning rainbow trout in Duck Creek and the South Fork Madison River, and Fall spawning rainbow trout, brown trout and whitefish in the mainstem Madison River upstream of Hebgen Reservoir in 2009.

Table 10. Summary of length (inches) and weight (pounds) for Spring spawning rainbow trout in Duck Creek and the South Fork Madison River, and Fall spawning rainbow trout in the mainstem Madison River, 2009. Rb = rainbow trout, LL = brown trout, MWF = whitefish.

			Madison River		
	Duck Creek	SF Madison	Rb	LL	MWF
Number captured	279	145	90	28	19
Average Length	17.5	17.8	18.2	17.8	17.4
Length range	8.5 – 20.5	15.0 -20.8	16.2 – 21.3	16.7-20.2	14.6-18.6
Average Weight	1.82	2.03	2.29	2.12	2.33
Weight range	0.18 – 2.53	1.24 – 2.84	1.71- 3.46	1.88- 2.65	1.33-3.00

Duck Creek

In 2009, adult trapping efforts on Duck Creek captured 279 rainbow trout (147 ♀, 132 ♂) and one brown trout. Peak 2009 spawning immigration occurred May 26 – May 29 with 158 rainbow trout passing through the trap.

Three of the 279 rainbow trout sampled (1.1%) were positive for the presence of a coded-wire-tag that they received while emigrating as juvenile fish. To date, ten of 2,628 (0.4%) fish injected with coded-wire tags have been recaptured, all at the Duck Creek spawner trap. Juvenile Duck Creek fish injected with a coded-wire tag were all yearlings or older when captured in the screw trap, at least 3-4 inches in length at emigration.

Another three individuals (1.1%) had floy-tags that they received in previous years after being captured in the upstream spawner trap. One of those fish was tagged in 2006, the other two in 2008.

None of the rainbow trout captured in 2009 exhibited hatchery dorsal fin characteristics and none were missing adipose fins. Adipose fins were removed from a portion of hatchery reared fish planted in the reservoir in an effort to determine hatchery contribution to the fishery.

South Fork of the Madison

The South Fork Madison adult trap was operated from April 16 – May 19, capturing 145 (71 ♀, 74 ♂) rainbow trout. Peak immigration of spawning adults occurred in mid - late April when mean daily water temperatures were approximately 45°F.

Three of the 145 rainbow trout sampled (2.1%) in 2009 were positive for the presence of a coded-wire-tag that they received while emigrating as young-of-the-year fish. In the South Fork, 4 fish of 29,951 (0.01%) have been recovered, three in the South Fork spawner trap in 2009, and one during gillnetting in 2008. All South Fork fish injected with coded-wire tags were young-of-the-year captured in the screw trap, all less than one inch at emigration. Additionally, three rainbows (2.1%) had floy-tags they received in previous years after being captured in the upstream spawner trap. One of those fish was tagged in 2007, the other two in 2008.

There was no external evidence of hatchery reared fish among those captured in the South Fork spawner trap.

Holton and Johnson (2003) concluded that, in general, rainbow trout in lentic environments in Montana live to be no more than 7 or 8 years old. Analysis of rainbow trout scale samples from fish captured in the Duck Creek and South Fork Madison traps shows that 66% and 40%, respectively, of the 2009 spawning runs were comprised of six years old or older fish (Figure 40).

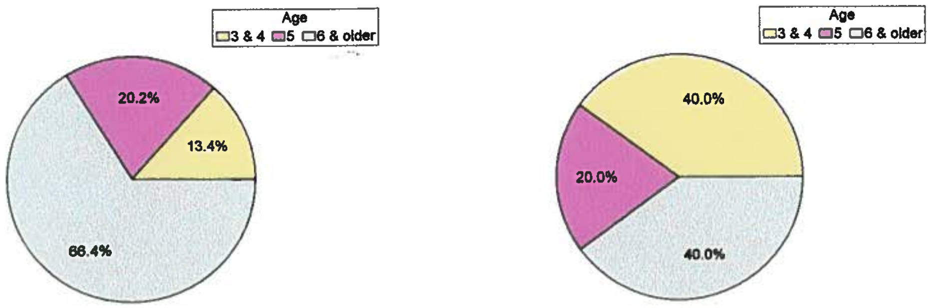


Figure 40. Age composition of rainbow trout captured in the Duck Creek (left) and South Fork Madison (right) adult spawning traps in 2009.

Madison River mainstem

The Madison River resistance panel weir was operated periodically from September 24 to October 23, 2009. A total of 137 fish were captured (Table 11). One rainbow trout was originally captured and tagged October 24, 2007. The greatest movement of fish occurred October 21, when the mean daily water temperature was 52° F and daily discharge was 416 cubic feet per second (cfs). One rainbow trout exhibited hatchery dorsal fin characteristics. Gender composition of fish captured at the weir in 2009 is shown in Figure 41.

Table 11. Number of fish handled by month at the Madison weir in 2009.

Month	Rainbow	Brown	Whitefish	Total
September	35	6	0	41
October	55	22	19	96
Total	90	28	19	137
Percent of Total	65.7	20.4	13.9	

One rainbow trout mortality was attributed to handling at the Madison weir in 2009, while weir mortality accounted for one rainbow and eight whitefish mortalities. A fishing closure was implemented from 100 yards upstream of the trap to 100 yards downstream of it to prevent angling of fish concentrated just below the trap and on fish that had been released after capture in the trap. The incidence of hooking scars on fish captured in the trap decreased 90 percent from a rate of 7 percent in 2008 to 0.7 percent in 2009.

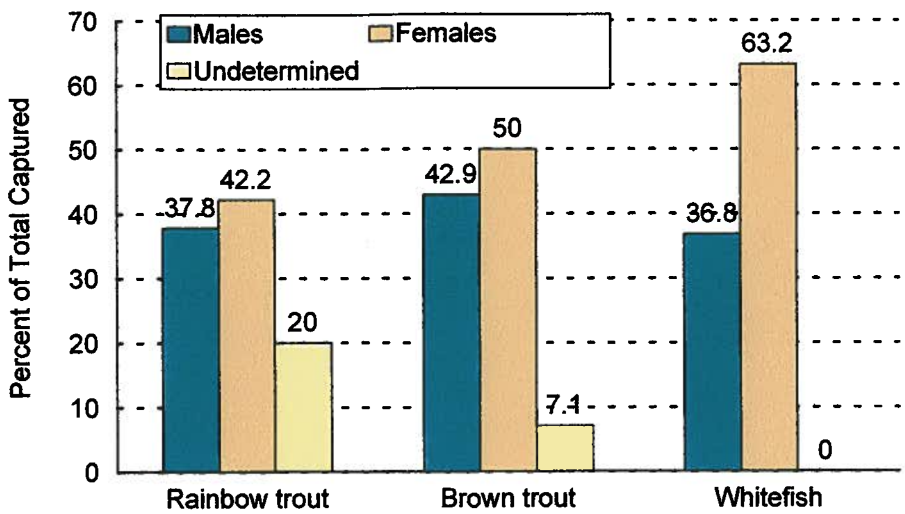


Figure 41. Percent gender composition of fish handled at the Madison weir in 2009.

Table 12 compares catch at the Madison weir in 2007 – 2009.

The contribution of the Madison River rainbow trout spawning run to the Hebgen Reservoir fishery is unquantified. High Spring flows make operation of the screw trap difficult and decrease capture efficiency of the trap. Large floating debris often plugs the trap or jams the rotating drum, which prevents capture of emigrating fish. Sampling efforts in 2006 & 2007 indicate that young-of-the-year and juvenile rainbow trout are emigrating as early as March, prior to the time of rainbow spawning in other Hebgen tributaries.

Information regarding the Fall rainbow spawning run initially came from limited young-of-year emigration and temperature data collected in 1990 (Fredenberg 1991), which indicated that rainbows may be spawning as early as January. Water temperature directly affects the rate of egg development and hatching. For example, rainbow trout eggs incubated at a constant water temperature of 40° F require 640 temperature units to hatch (Piper et al. 1982), where a temperature unit is defined as 1° above 32° F for a 24-hour period. A constant water temperature of 40° F would provide 8 temperature-units per day, requiring 80 days for eggs to hatch. Another 1,080 temperature-units are required by sac fry for yolk absorption before swim up (Fredenburg 1991). Back calculation to time of emergence, based upon first observance of young-of-the-year rainbow trout in the Madison screw trap and water temperature, suggests that rainbow trout are spawning as early as mid September in the Madison River. This is four months earlier than Fredenburg (1991) suggested, but coincides with local angler reports of catching sexually mature or "ripe" rainbow trout during the months of September and October. The Madison weir was installed to investigate the Fall rainbow trout spawning run.

Table 12. Summary of Madison weir operation, 2007 - 2009. Handling mortality is defined as mortality caused directly by handling, or mortality of handled fish found within 24 hours after handling. Weir mortality is defined as mortality caused by fish becoming impinged in the weir panels or mortality caused by stress/crowding in the trap box. Handled fish exhibited unique marks or tags that did not occur on unhandled fish, allowing their differentiation.

	2007	2008	2009	
Begin operation	Sept 15	Sept 3	Sept 24	
End operation	Nov 7	Oct 31	Oct 23	
Begin & end reservoir elevations	6526.12 6526.70	6532.87 6525.63	6533.13 6532.89	
Total # days operated	36	35	15	Trap not operated some weekends or if adequate number of crew unavailable
Total rainbows captured (# morts)	733 (4 handling; 4 weir)	197 (0)	90 (1 handling; 1 weir)	
Total brown captured (# morts)	772 (2 handling; 5 weir)	233 (0 handling; 1 weir)	28 (0)	
Total whitefish captured (# morts)	491 (4 handling; 158 weir[1/])	154 (1 handling; 22 weir)	19 (0 handling; 8 weir)	1/ 49 whitefish weir morts on 10/24/07 when 143 whitefish caught in trapbox. 47 whitefish morts on 11/6&7/07 when panels were raised to maximize capture for whitefish egg-take for whirling disease research
Total Captured – all species (# morts)	1996 [10 handling (0.5%), 167 weir (8.4%)]	584 [1 handling (0.2%), 22 weir (3.8%)]	137 [1 handling (0.7%); 9 weir (6.6%)]	Weir morts may not be handled fish

It is uncertain why rainbow trout are spawning in the Madison River in the Fall. The Fall spawning run may be linked to the warm thermal regime of the Gibbon and Firehole rivers in Yellowstone National Park. In a study of the reproductive biology of rainbow trout and brown trout in the Firehole River above the Firehole Falls, rainbow trout were observed spawning in the Fall of the year. It was hypothesized that the Fall spawning was likely an adaptation to the thermal regime of the river (Kaya 1977). Another possible explanation is that the run developed out of past stocking practices. Since 1954, several strains of rainbow trout have been used to augment the Hebgen Reservoir fishery. MFWP began stocking wild strains of Eagle Lake and DeSmet rainbow trout in 1987. Prior to that domesticated Arlee and Shasta strains were used. In some instances, domesticated hatchery strains have been observed to spawn at times uncharacteristic of rainbow trout as a result of selective breeding in hatchery systems. In order to maximize productivity and increase the size of fish being stocked, hatcheries developed Fall spawning individuals to maximize the size of fish to be planted (Leitritz 1959). Strain analysis of rainbow trout collected in Duck and Grayling creeks Spring spawning run and the mainstem Madison River Fall spawning run indicates genetic differences between the three sources are insignificant. All three sources contain relatively similar ratios of primarily Eagle Lake, but also Kamloops and one unknown source of rainbow genes. These results indicate that the Madison Fall spawning run is from the same population as the normal Spring spawning Hebgen rainbows.

Hebgen Basin Juvenile Fish Sampling

Rotary screw traps (Figure 42) were operated in Duck Creek and the SF Madison in 2009 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.

The majority of yearling rainbow trout emigration from Duck Creek June 11 - 27 when mean daily water temperatures ranged from 53.1° to 56.5° F (Figure 43).

Figure 42. Rotary screw trap used to sample young-of-the-year and juvenile fish on Hebgen tributaries.

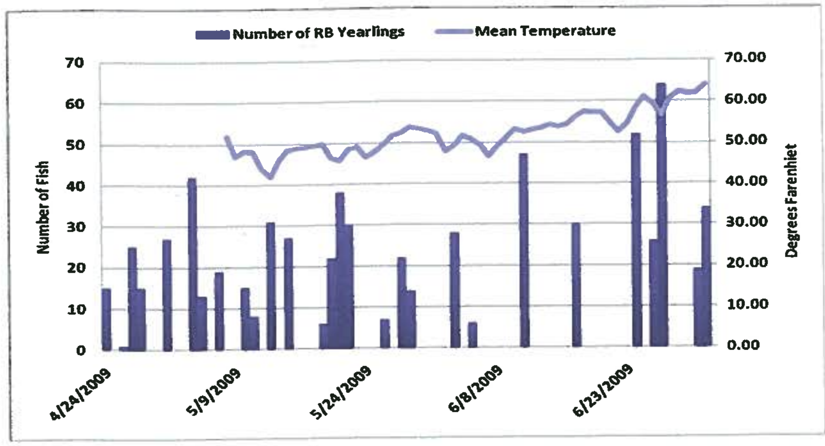
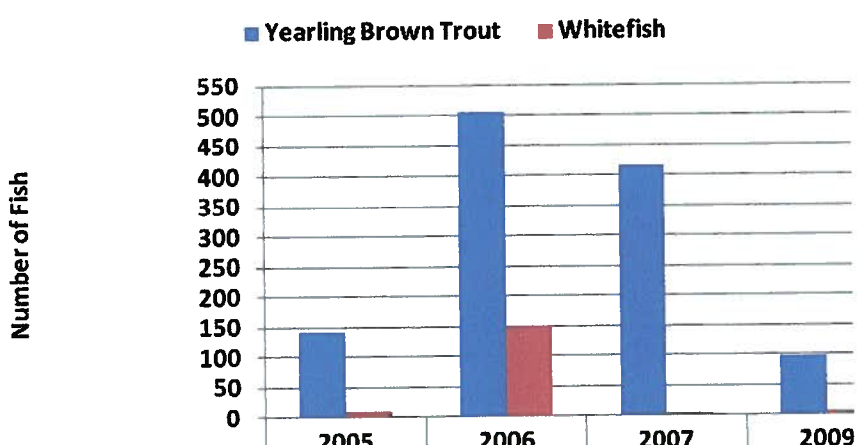


Figure 43. Duck Creek rainbow trout emigration vs mean daily temp. The water temperature recorder was not placed in the stream until May 7.

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 of this cascade, 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, screw trap capture of juveniles of both species declined to pre-construction levels (Figure 44).



	2005	2006	2007	2009
Yearling Brown Trout	143	505	416	98
Whitefish	11	149	4	6

Figure 44. Number of juvenile brown trout and whitefish captured in the Duck Creek screw trap. 2005 – 2009.

The largest number of yearling rainbow trout captured in the South Fork Madison rotary screw trap was 112 on May 8 when mean daily water temperature peaked at 55.1˚F (Figure 45). Peak emigration duration of yearling rainbow trout lasted until May 19. Four yearling rainbow trout had physical abnormalities characteristic of whirling disease.

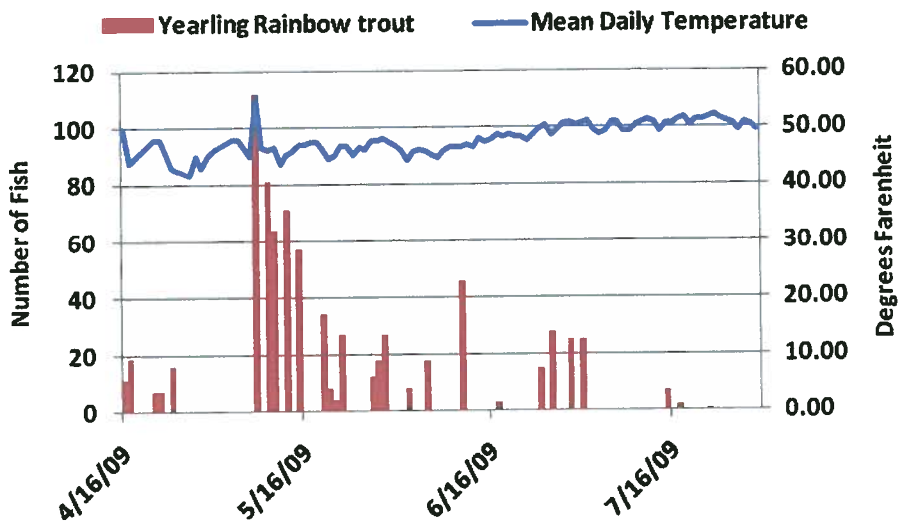


Figure 45. South Fork Madison rainbow trout emigration vs mean daily temperature.

The number of young-of-the-year rainbow trout captured in the South Fork Madison rotary screw trap was down markedly from previous years with only 256 sampled, compared to 18,306 in 2005 and 11,027 in 2004. Additionally, the number of whitefish decreased from 54 in 2004 and 37 in 2005 to 4 in 2009.

Table 13 lists whirling disease scores for Hebgen Reservoir tributaries. 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 (Vincent 2004; Sipher and Bergersen 2001).

A list of all fish captured at the Duck Creek and South Fork Madison rotary screw traps in 2009 are listed in Table 14.

Table 13. Whirling disease scores for the South Fork Madison River, 2007 & 2008. Sentinel fish from 2009 were inadvertently destroyed prior to completion of the required 90 incubation period, so 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

Table 14. Numbers of young-of-the-year and juvenile trout, and numbers of other fish species captured in the Duck Creek and South Fork Madison screw traps, 2009.

	Duck Creek		SF. Madison	
Species	Yearling	Y-O-Y	Yearling	Y-O-Y
Rainbow trout	683	20	402	256
Brown trout	98	15	2251	1127
Brook trout	59	0	0	0
Whitefish	6	0	0	0
Longnose dace	850	0	1	0
Mottled sculpin	213	0	18	0
Utah chub	5	0	0	0

Studies of lake versus tributary rearing Bonneville Cutthroat trout in Strawberry Reservoir, Utah (Knight et al 1999) and rainbow trout in Lake Alexandria, New Zealand (Hayes 1995) show the recruitment of early migrants to 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 early 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 on 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. Table 15 lists the actual and estimated number of yearling and older rainbows and young-of-the-year for each stream since 2004.

Table 15. Actual and estimated number of captured yearling & older and actual captured young-of-the-year rainbow trout for Duck Creek and the South Fork Madison, 2004 – 2009.

	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

Hebgen Reservoir Shoreline Juvenile Fish Sampling

Shoreline juvenile fish monitoring was not conducted in 2009. Results of previous years monitoring are shown in Figure 47.

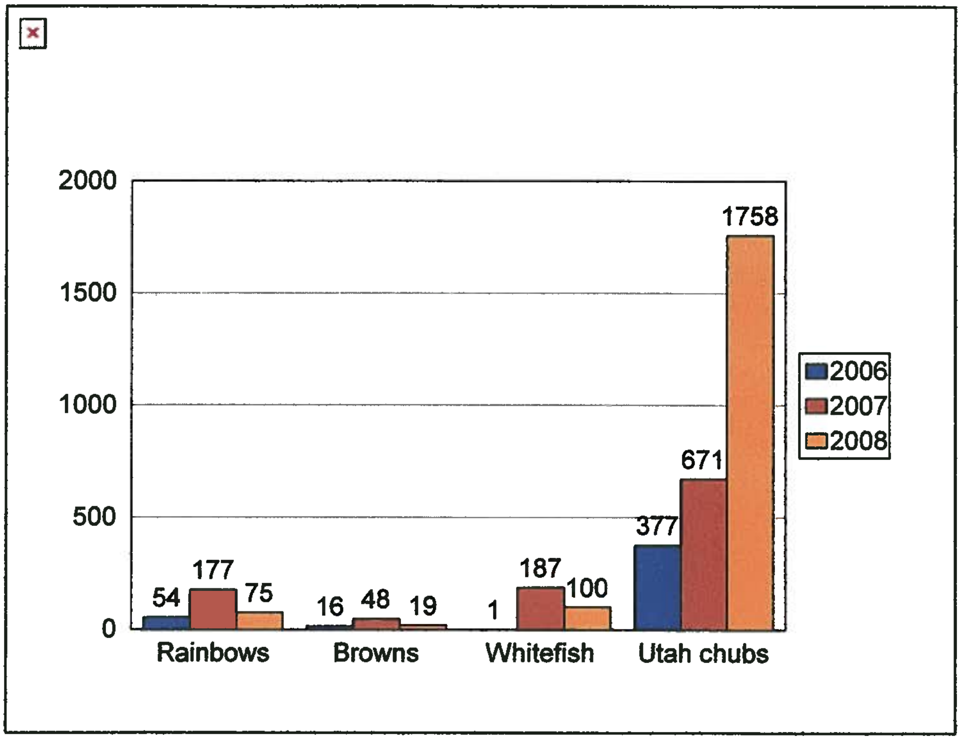


Figure 47. Number of young-of-the-year captured during Hebgen Reservoir beach seining, 2006 – 2008.

Utah chub spawning has been observed in May through late August in Hebgen Reservoir. Typically, spawning takes place in shallow near-shore zones often with submergent or emergent vegetation and inundated terrestrial vegetation. Vegetation has been suggested to be key to the success of spawning for Utah chub (Teuscher and Lueke 1996). Similarly, studies have shown that shoreline vegetation is important for the rearing of young-of-the-year adfluvial salmonids that emigrate to lakes and reservoirs. However, given the fecund nature of the Utah chub, with mature females from Hebgen averaging 40,750 eggs (Graham, 1955), a quick hatch rate, typically 6 to 9 days at 65.0°F to 67.0°F, and territorial behavior of young chubs, emigrating young-of-the-year rainbow trout may be precluded from rearing habitat within the vegetated near-shore portion of the reservoir.

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 48 & 49). Hebgen Reservoir ice-off generally occurs in May.

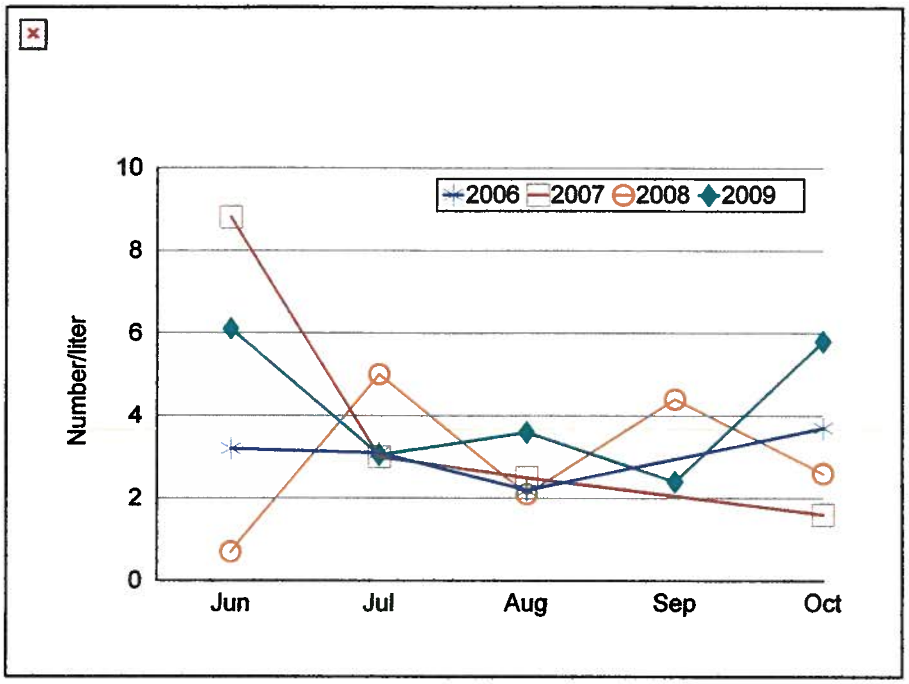


Figure 48. Cladoceran densities (individuals/liter) by month, 2006-2009.

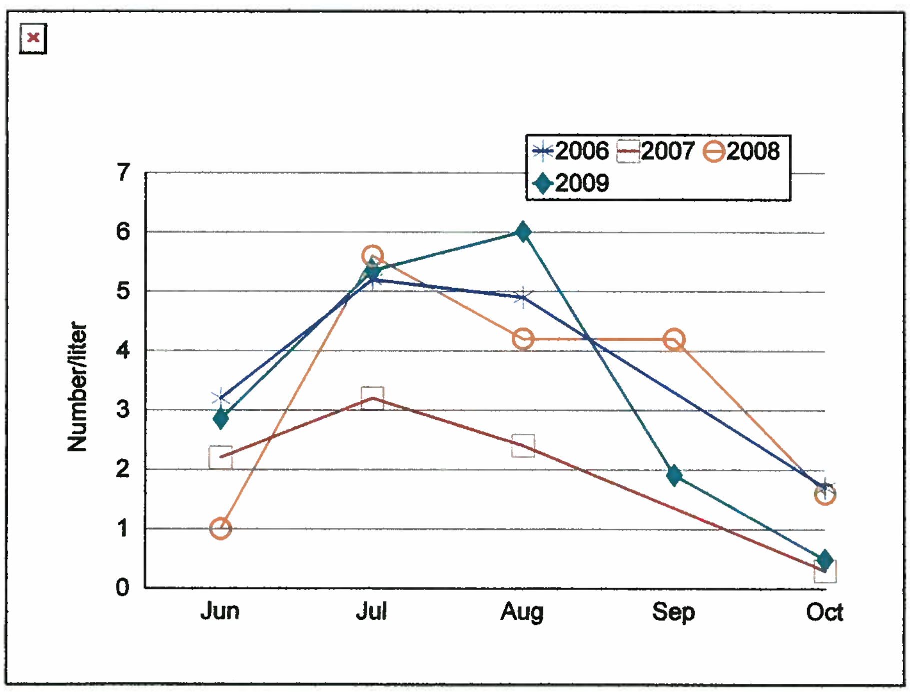


Figure 49. Copepod densities (individuals/liter) by month, 2006-2009.

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 39) and may be influencing zooplankton densities through grazing. Cladoceran densities in Hebgen also seem inversely related to the ratio of adult Utah chub/brown trout (Figure 50).

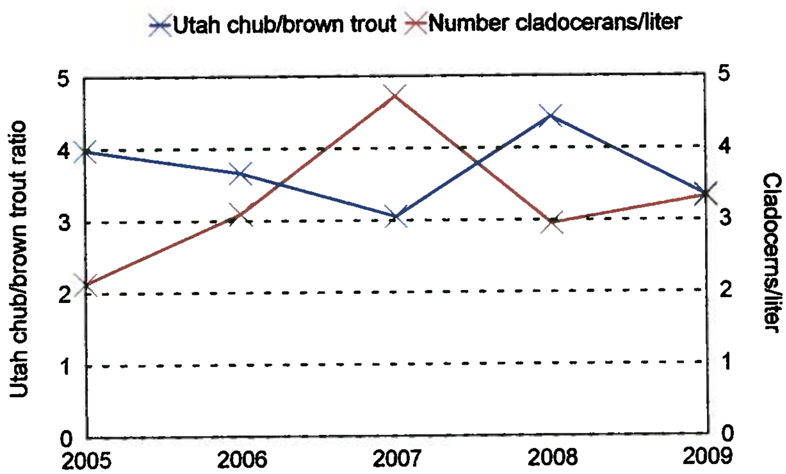


Figure 50. Number of Utah chub per brown trout (calculated from annual spring gillnetting) and annual mean cladoceran density, 2005 - 2009.

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 shoreline grazing by Utah chub on zooplankton to be detrimental to the survival of young-of-the-year cutthroat and rainbow trout. Similarly, enclosure experiments with Utah chub and kokanee showed that increased densities of Utah chub reduced zooplankton densities and negatively affected kokanee growth (Teuscher and Lueke 1996).

Short duration growing season is often associated with an increase in elevation, reducing the total number of 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 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.

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.

Population estimates will continue to be conducted annually in the Madison River. These data are necessary for setting 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 resistance to whirling disease.

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

In 2009, adult WCT from the Sun Pond were spawned but the eggs were non-viable. Fertilized eggs from three wild donor populations were reared in the Sun hatchery and introduced into recipient streams as eyed eggs. Additionally, each wild donor population contributed fry to the Sun Brood Pond.

The Cherry Creek Native Fish Introduction Project will continue with the goal for 2010 to be the completion of chemical removals of non-native fish from the project area and continued introductions of wild donor populations into Phases 3 and 4.

In 2009 a well was drilled to provide water to stock tanks on a Forest Service livestock pasture near Lake Creek, eliminating the need to use tarps to pool water behind Smith Lake Dam to run a water-wheel driven pump. In 2010 priority will be given to completing installation of the delivery system from the well to the stock tanks. Activation of the well and delivery system will allow permanent removal of tarps on Smith lake Dam and provide year-round passage for spawning brown trout and other aquatic species.

Though lower than 2008, the number of rainbow trout captured during Hebgen Reservoir gillnetting in 2009 remained at levels not seen in ten years. The proportion of the catch over 14 inches has increased noticeably since 2003.

The South Fork of the Madison, 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.

In 2009, rainbow trout six year old and older comprised 66 percent and 40 percent of the fish ascending Duck Creek and the South Fork of the Madison, respectively, to spawn.

Only 137 fish were captured in the Madison weir in 2009, compared to 1996 in 2007 and 584 in 2008. Anecdotal reports from anglers indicate that the Fall spawning run of rainbow trout has been diminishing for over 10 years.

Cladoceran and copepod zooplankton densities in Hebgen Reservoir showed diverse patterns in 2009. Cladoceran density was highest in early Spring and Fall, but copepod density was highest in summer.

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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 - 2009

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

Appendix B2

Description of young-of-the-year Arctic grayling beach seining locations in Ennis Reservoir, and catch at each site. See Figure 3 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	mottled sculpin

Site and time seined	AG	MWF	Note
Meadow Ck FAS North shore & west shore willows 10/22/09 Fig 3 site 1	1	5	No macrophytes 4 y-o-y UC 2 y-o-y WSU
South shore ¾ mile east of Moores Ck 10/1/09 Fig 3 site 2	0	0	No macrophytes 75 y-o-y Rb 22 y-o-y LND 8 y-o-y LL 6 y-o-y WSu 29 y-o-y UC
Madison River mouth 10/1/09 Fig 3 site 3	0	0	No macrophytes 64 y-o-y Rb 4 y-o-y UC 6 y-o-y WSu 22 y-o-y LL 3 y-o-y LND 2 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

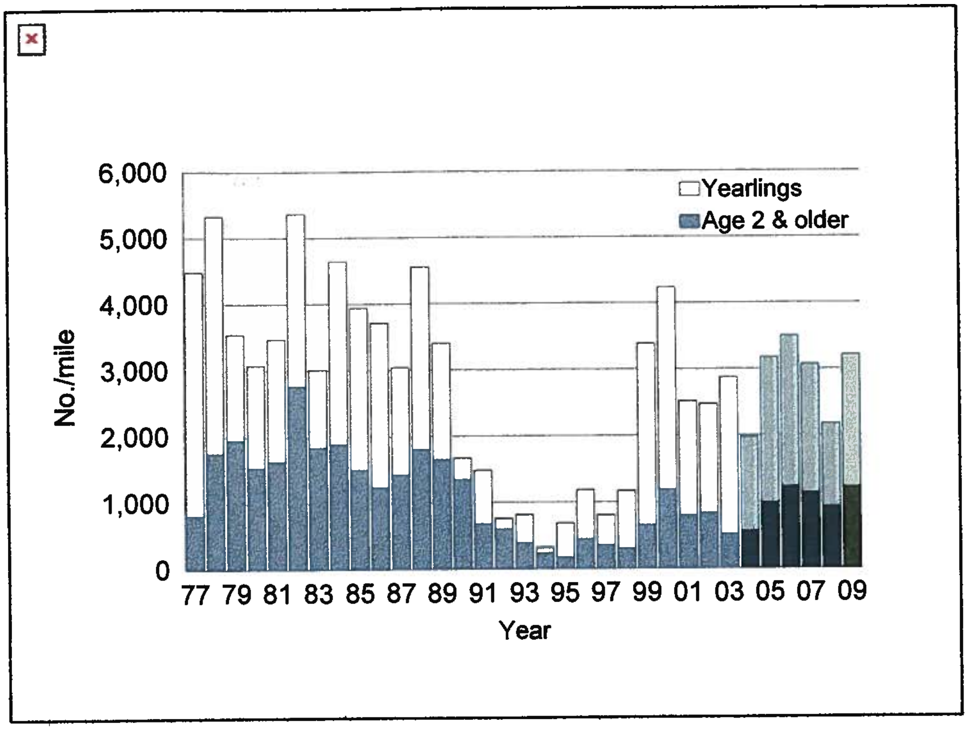


Figure C1 - 1. Rainbow trout populations in the Pine Butte section of the Madison River, 1977-2009, fall estimates. Estimates for 2004 - 2009 are not aged.

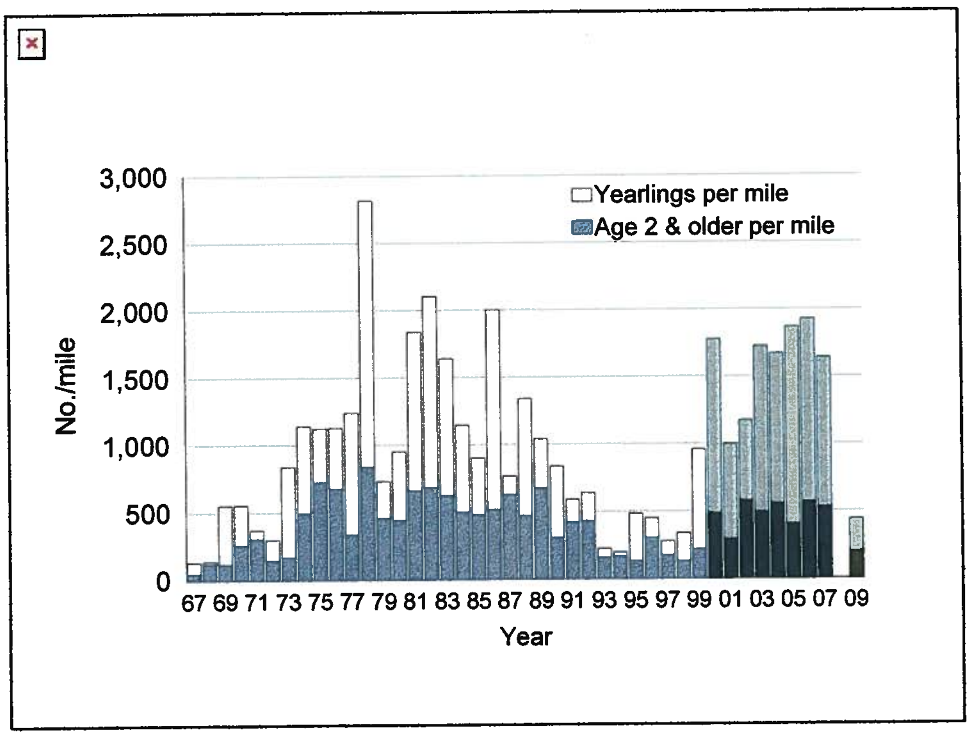


Figure C1 – 2. Rainbow trout populations in the Varney section of the Madison River, 1967-2009, fall estimates. Estimates for 2000 - 2009 are not aged. Estimates were not conducted in Varney in 2008.

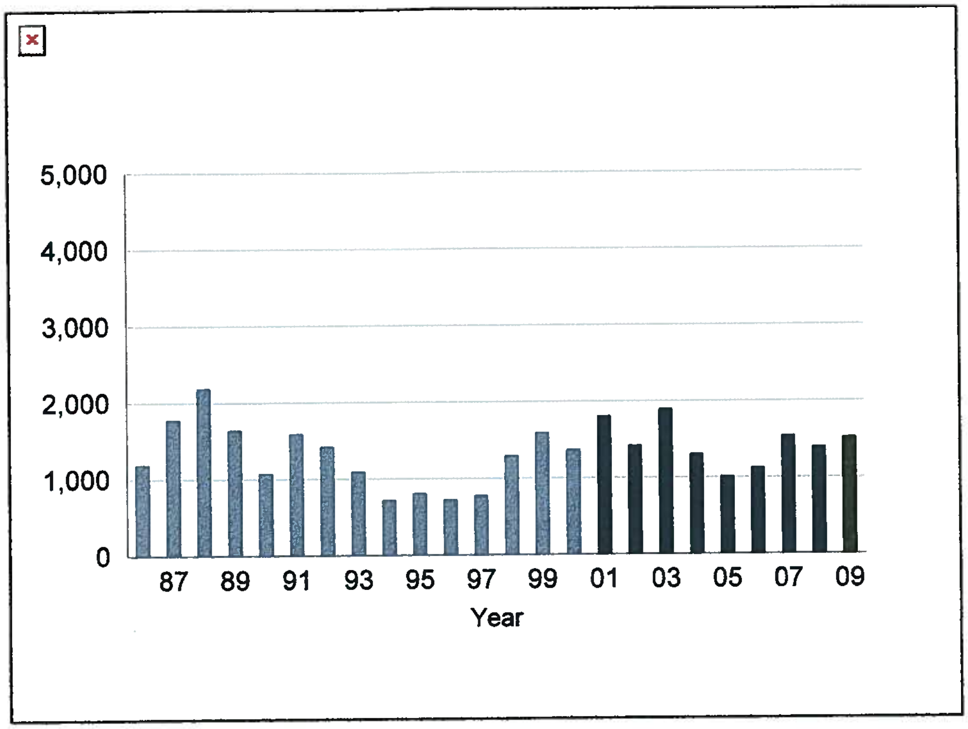


Figure C1 – 3. Rainbow trout populations in the Norris section of the Madison River, 1986-2009, spring estimates. Estimates for 2001 - 2009 are not aged.

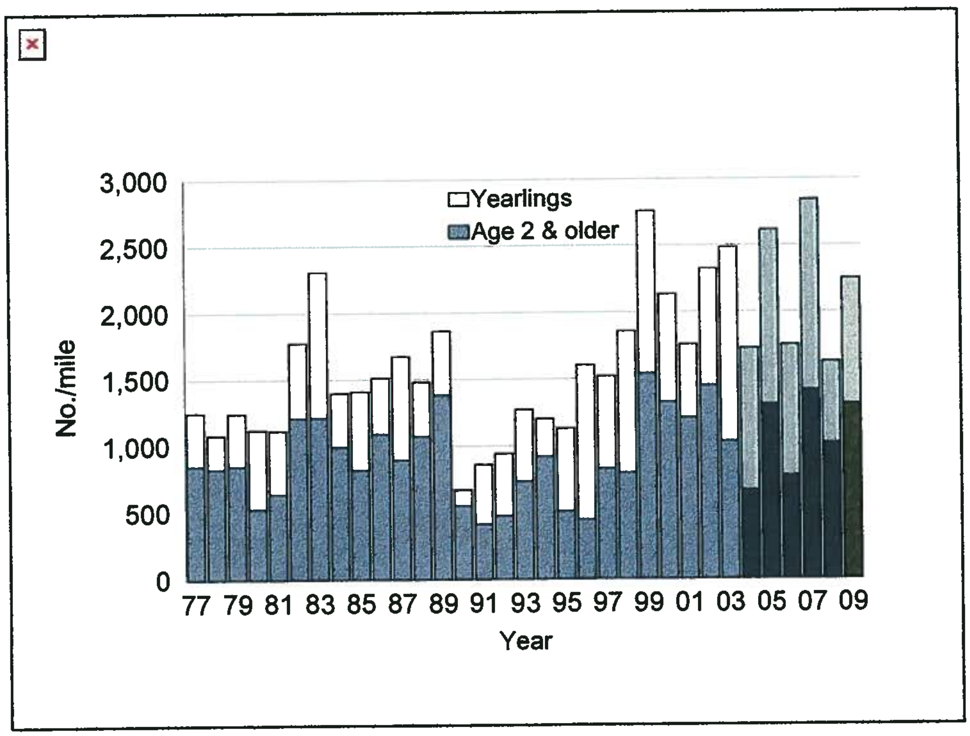


Figure C1 - 4. Brown trout populations in the Pine Butte section of the Madison River, 1977-2009, fall estimates. Estimates for 2004 - 2009 are not aged.

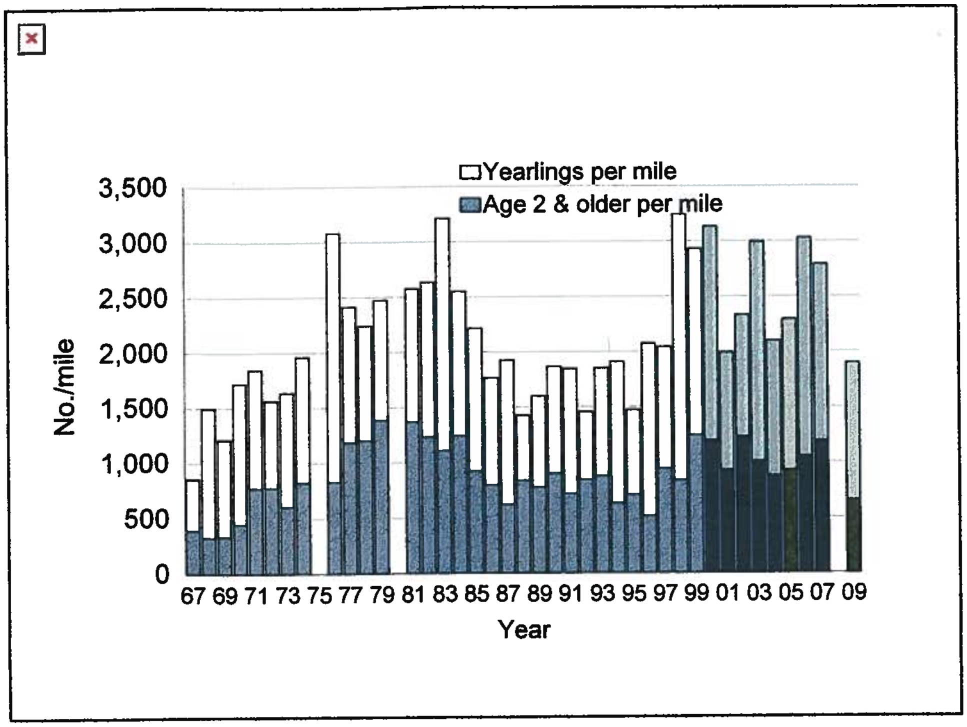


Figure C1 - 5. Brown trout populations in the Varney section of the Madison River, 1967-2009, fall estimates. Estimates for 2000 - 2009 are not aged. Estimates were not conducted in Varney in 2009.

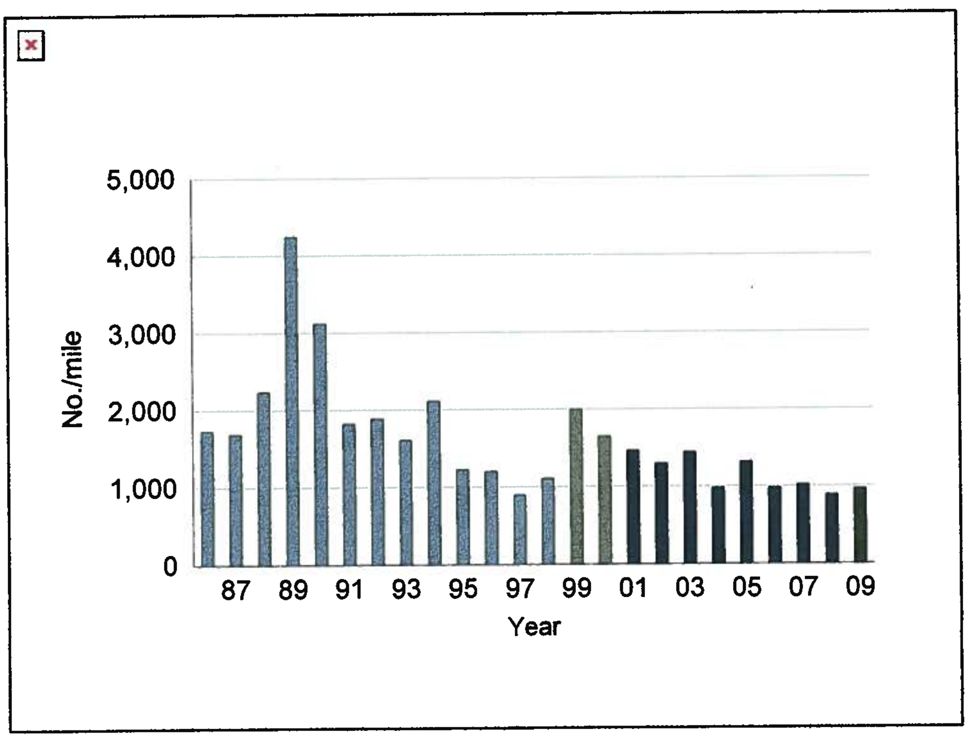


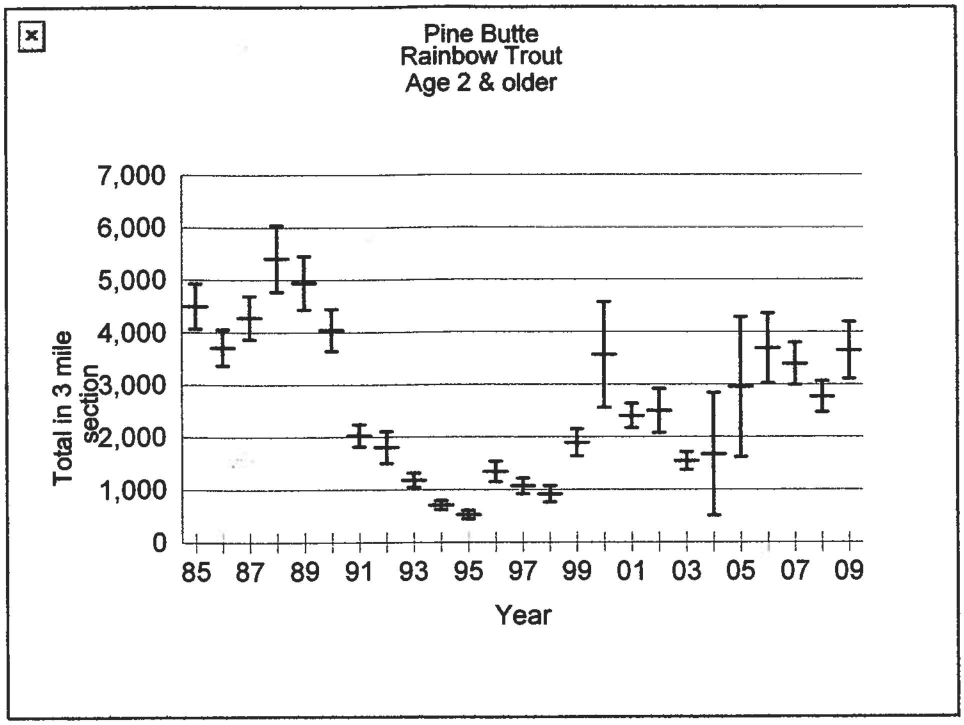
Figure C1 – 6. Brown trout populations in the Norris section of the Madison River, 1986-2009, spring estimates. Estimates for 2001 - 2009 are not aged.

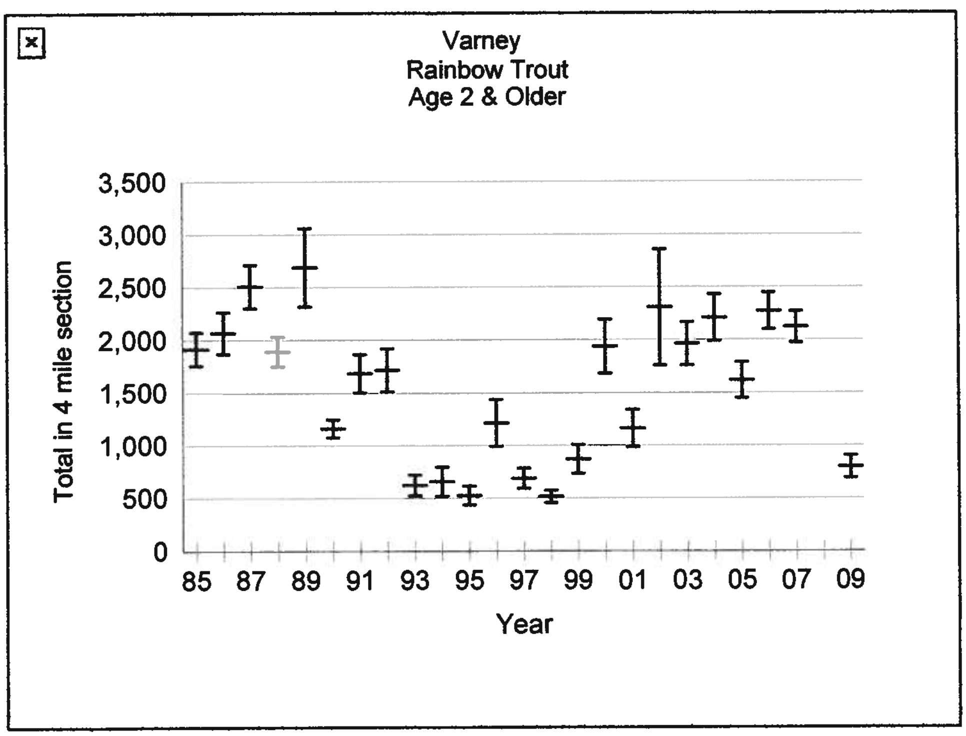
Appendix C2

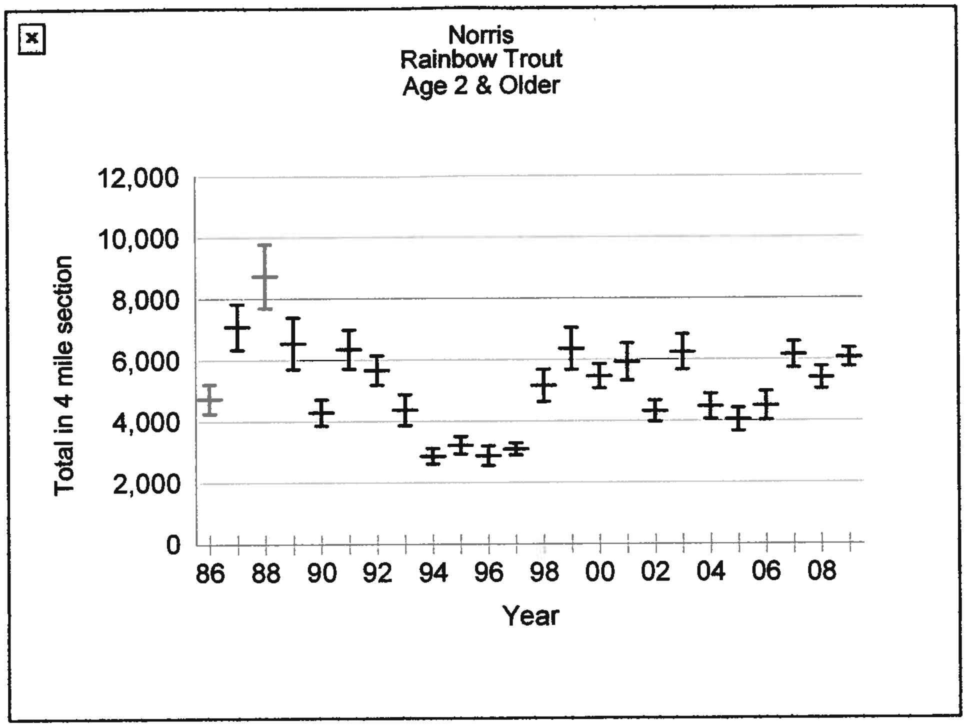
Population estimates (total number in section± 80 percent Confidence Intervals)
of age 2 & older rainbow and brown trout in the Madison River
See Figure 5 for section locations

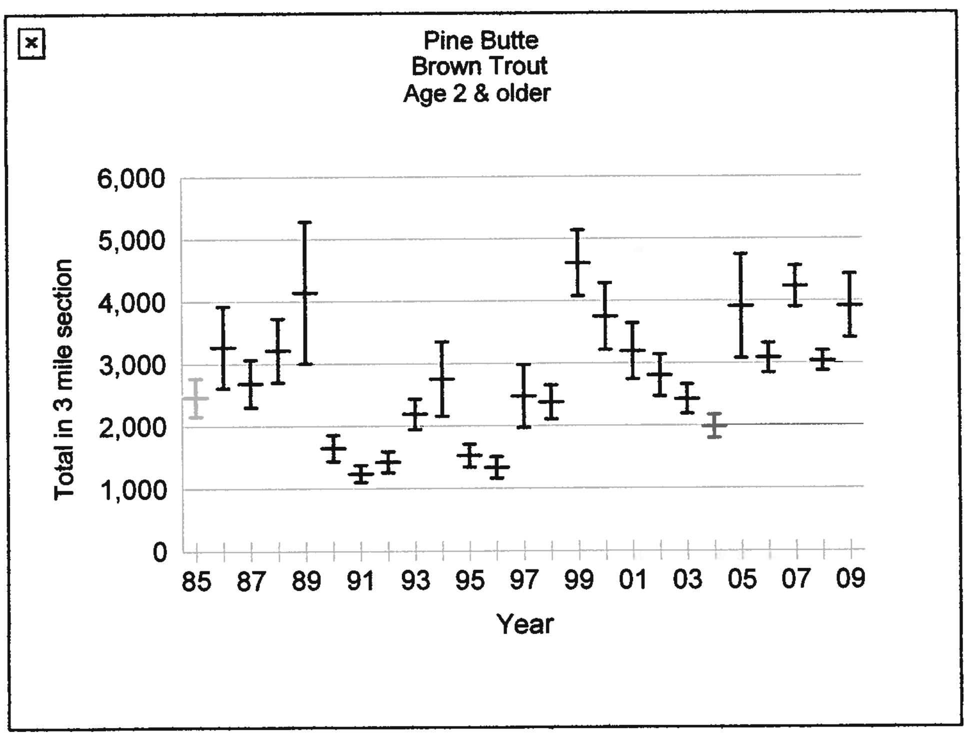
<u>section lengths</u>

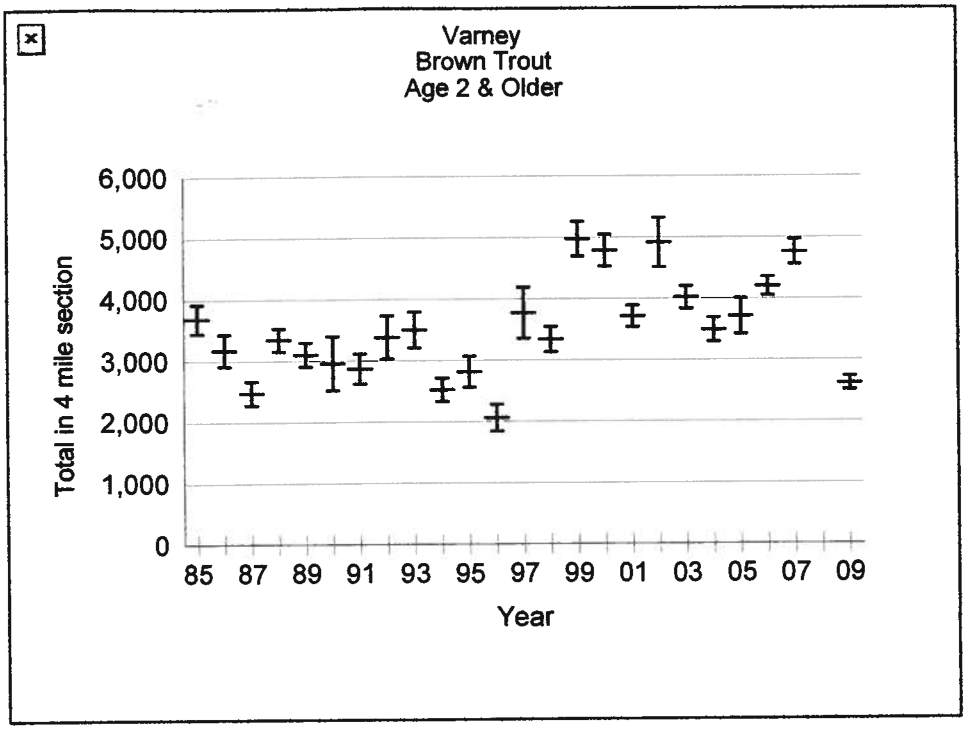
Pine Butte – 3 miles
Varney – 4 miles
Norris – 4 miles

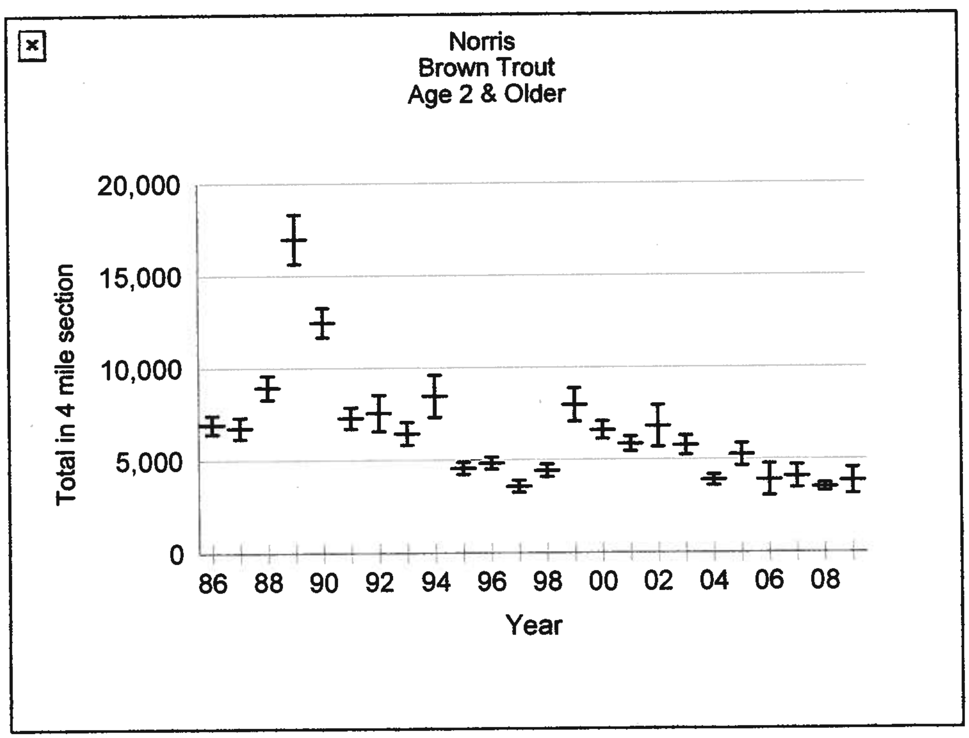

Pine Butte
Rainbow Trout
Age 2 & older
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Total in 3 mile section
85
87
89
91
93
95
97
99
01
03
05
07
09
Year


Varney
Rainbow Trout
Age 2 & Older
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Total in 4 mile section
85
87
89
91
93
95
97
99
01
03
05
07
09
Year


Norris
Rainbow Trout
Age 2 & Older
12,000
10,000
8,000
6,000
4,000
2,000
0
Total in 4 mile section
86
88
90
92
94
96
98
00
02
04
06
08
Year


Pine Butte
Brown Trout
Age 2 & older
6,000
5,000
4,000
3,000
2,000
1,000
0
Total in 3 mile section
85
87
89
91
93
95
97
99
01
03
05
07
09
Year


Varney
Brown Trout
Age 2 & Older
6,000
5,000
4,000
3,000
2,000
1,000
0
Total in 4 mile section
85
87
89
91
93
95
97
99
01
03
05
07
09
Year

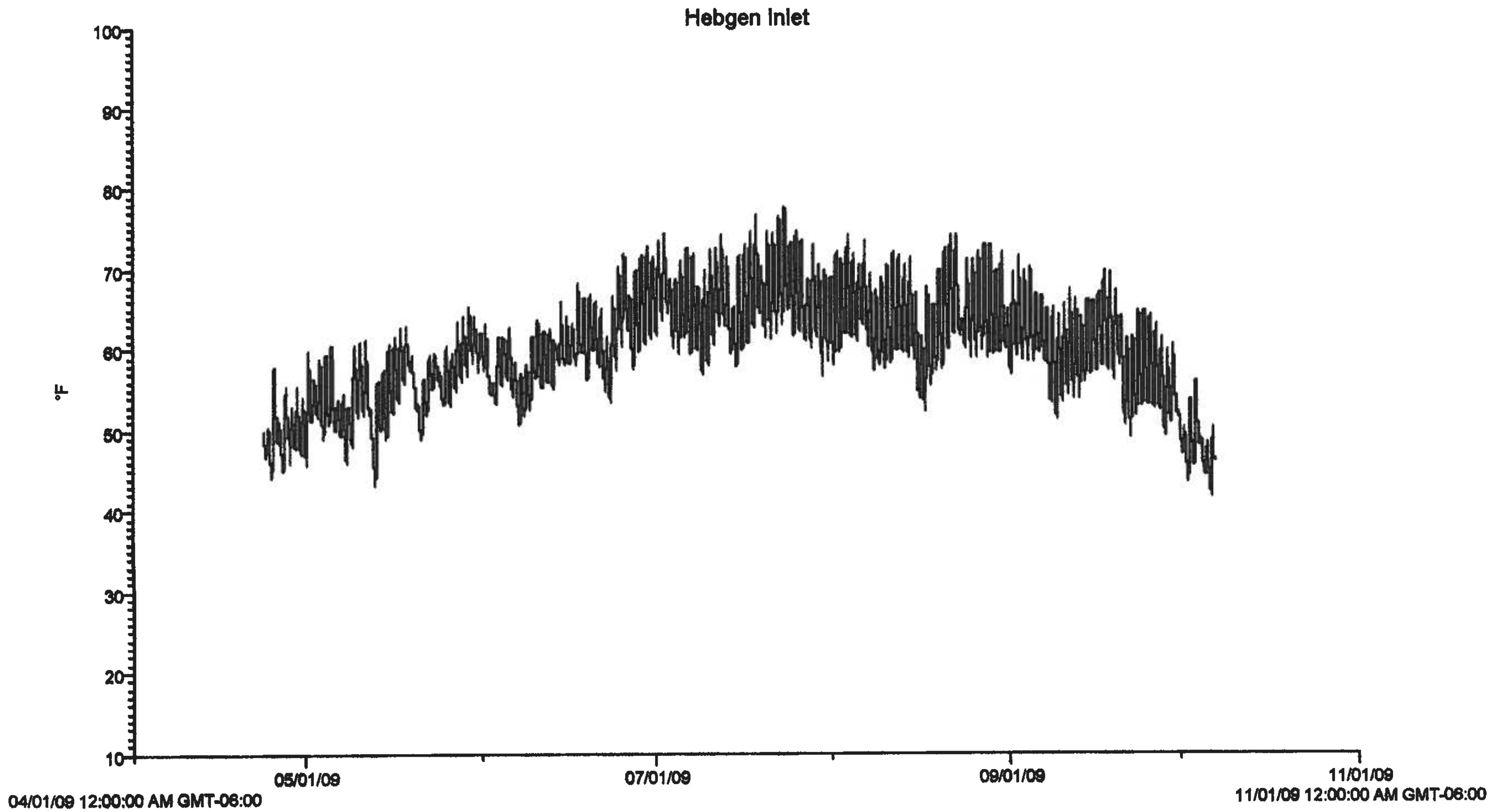

Norris
Brown Trout
Age 2 & Older
20,000
15,000
10,000
5,000
0
Total in 4 mile section
86
88
90
92
94
96
98
00
02
04
06
08
Year

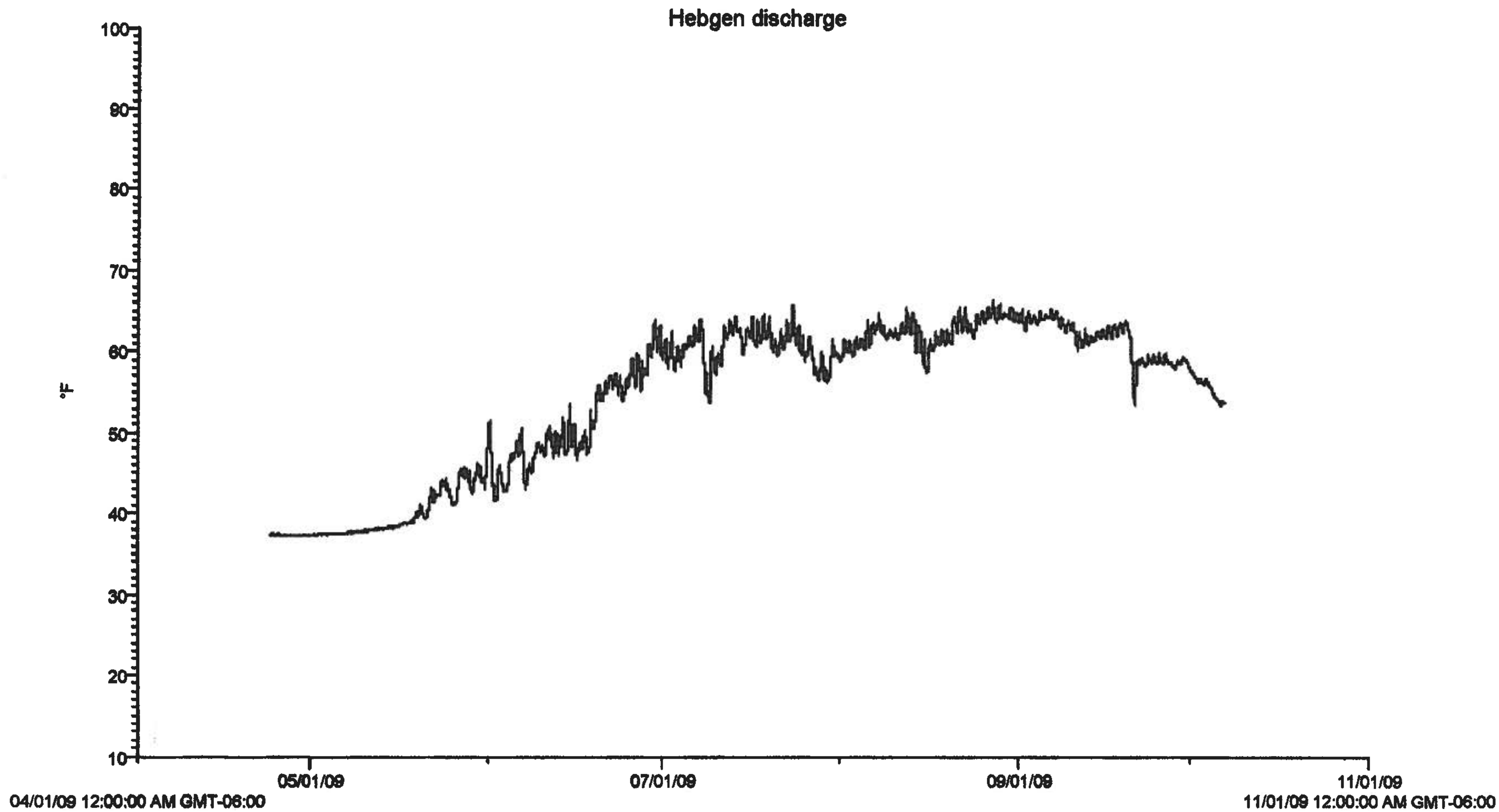
Appendix D

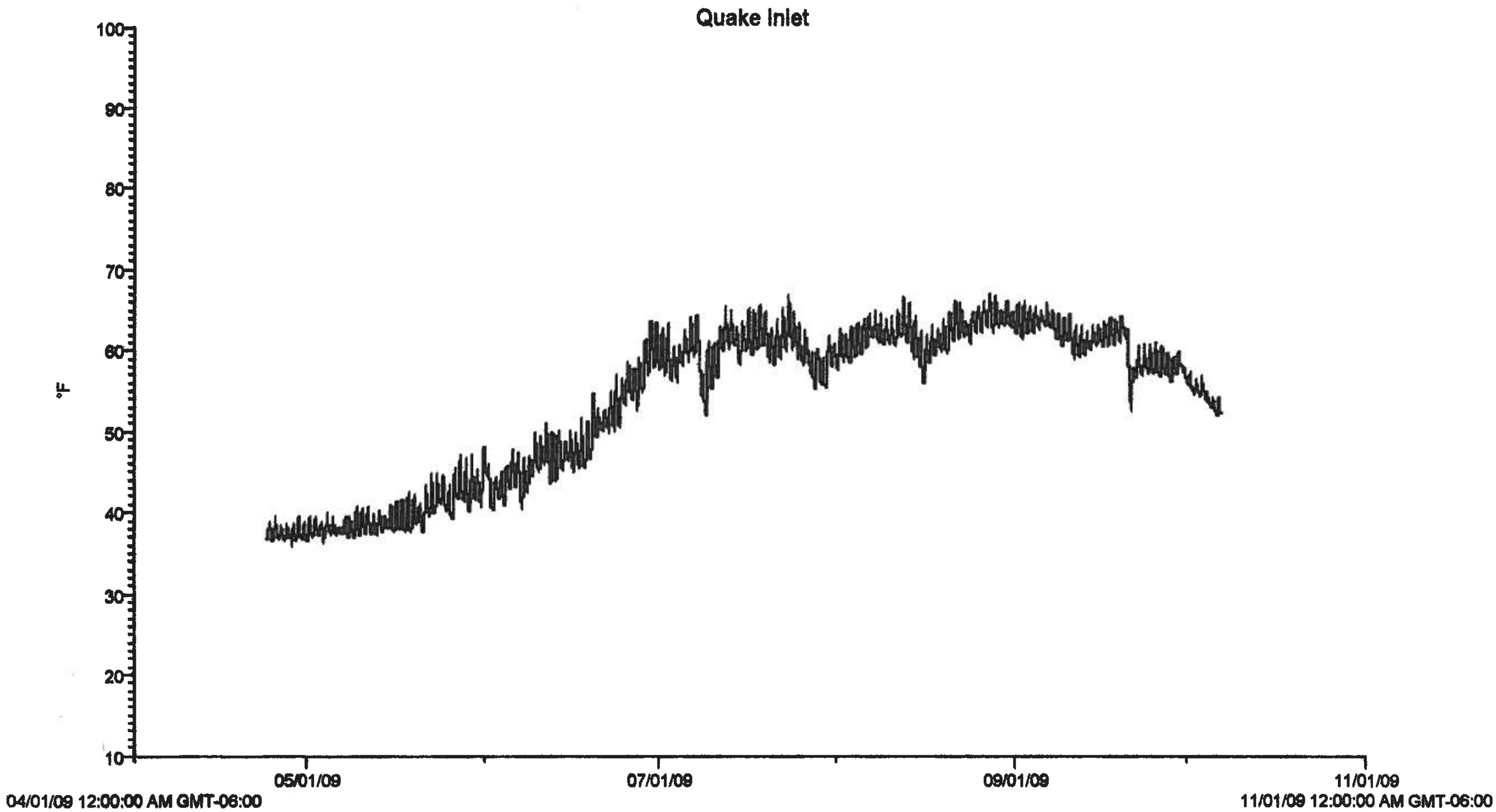
Temperature recordings from monitoring sites on the Madison River
See Figure 6 for locations

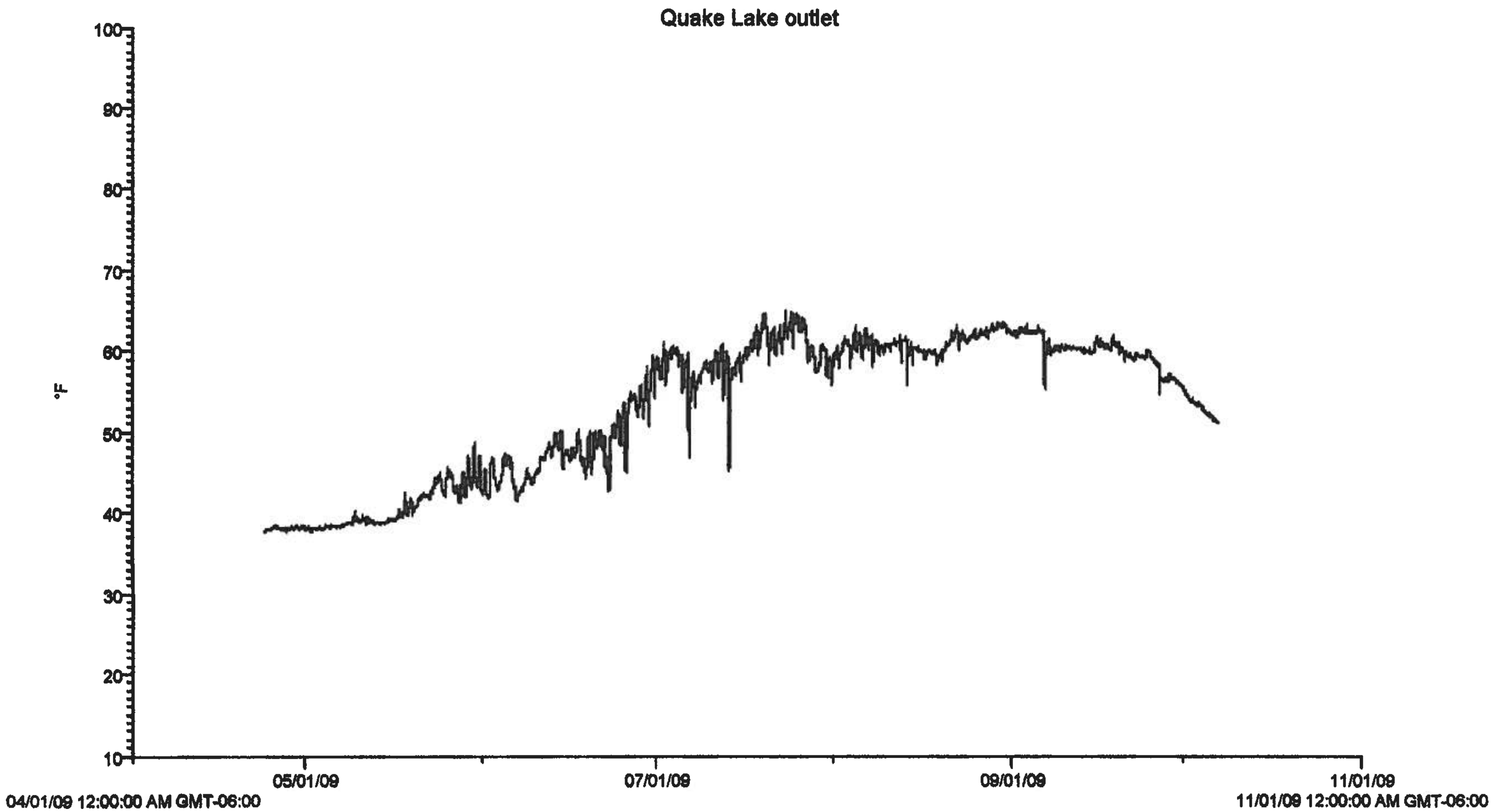
NOTES:

- Recorders at Ennis Reservoir Inlet and Headwaters State Park were not recovered
- Maximum air temperature recorded at Slide was 137.9, but the recorder had been moved by an unknown party from its shaded position to a point in the full sun. Only data prior to June 25 are shown.


Hebgen Inlet
°F
100
90
80
70
60
50
40
30
20
10
04/01/09 12:00:00 AM GMT-06:00
05/01/09
07/01/09
09/01/09
11/01/09
11/01/09 12:00:00 AM GMT-06:00


Hebgen discharge
°F
100
90
80
70
60
50
40
30
20
10
04/01/09 12:00:00 AM GMT-06:00
05/01/09
07/01/09
09/01/09
11/01/09
11/01/09 12:00:00 AM GMT-06:00


Quake Inlet
100
90
80
70
60
50
40
30
20
10
°F
04/01/09 12:00:00 AM GMT-06:00
05/01/09
07/01/09
09/01/09
11/01/09
11/01/09 12:00:00 AM GMT-06:00


Quake Lake outlet
°F
100
90
80
70
60
50
40
30
20
10
04/01/09 12:00:00 AM GMT-06:00
05/01/09
07/01/09
09/01/09
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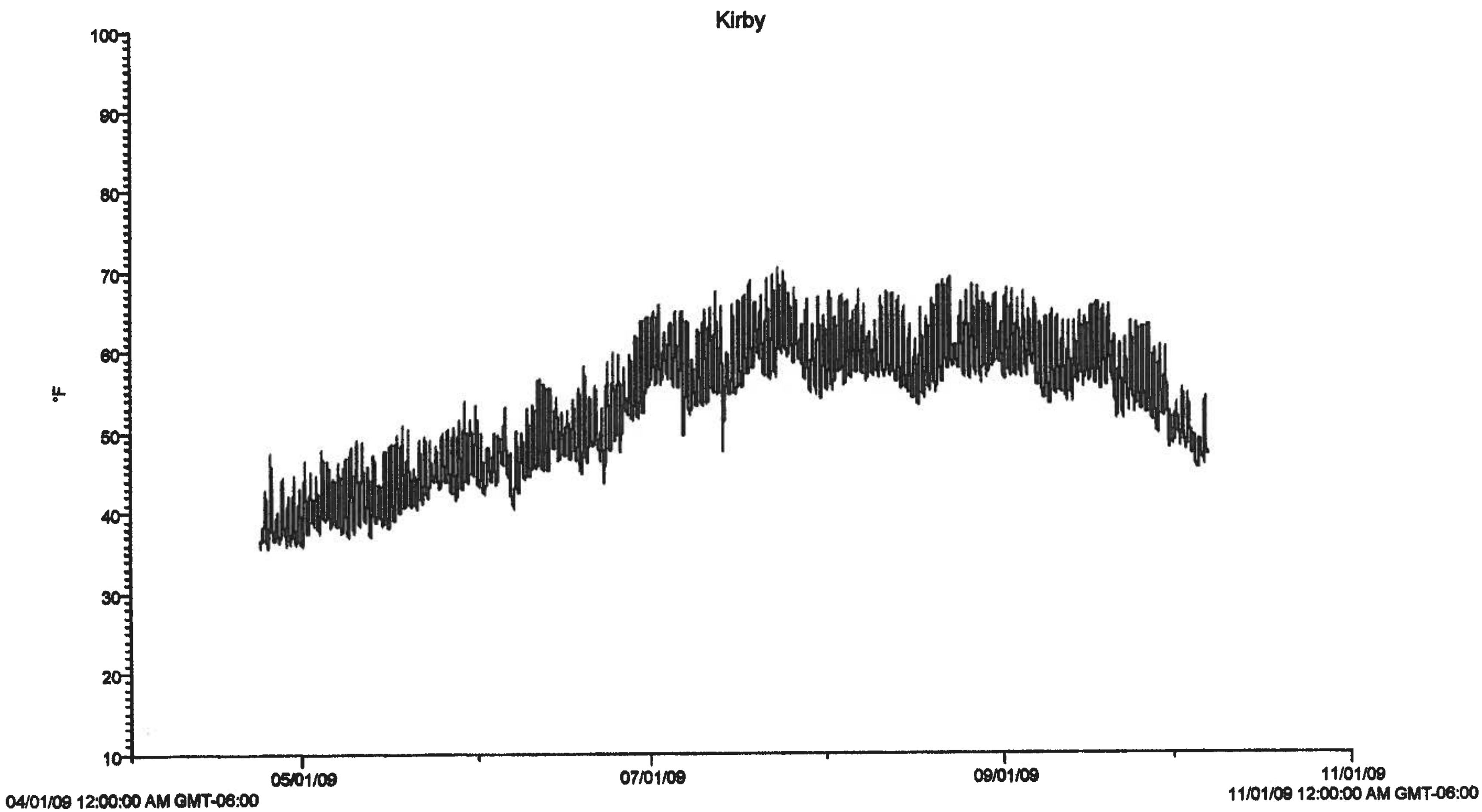

Kirby
°F
100
90
80
70
60
50
40
30
20
10
04/01/09 12:00:00 AM GMT-06:00
05/01/09
07/01/09
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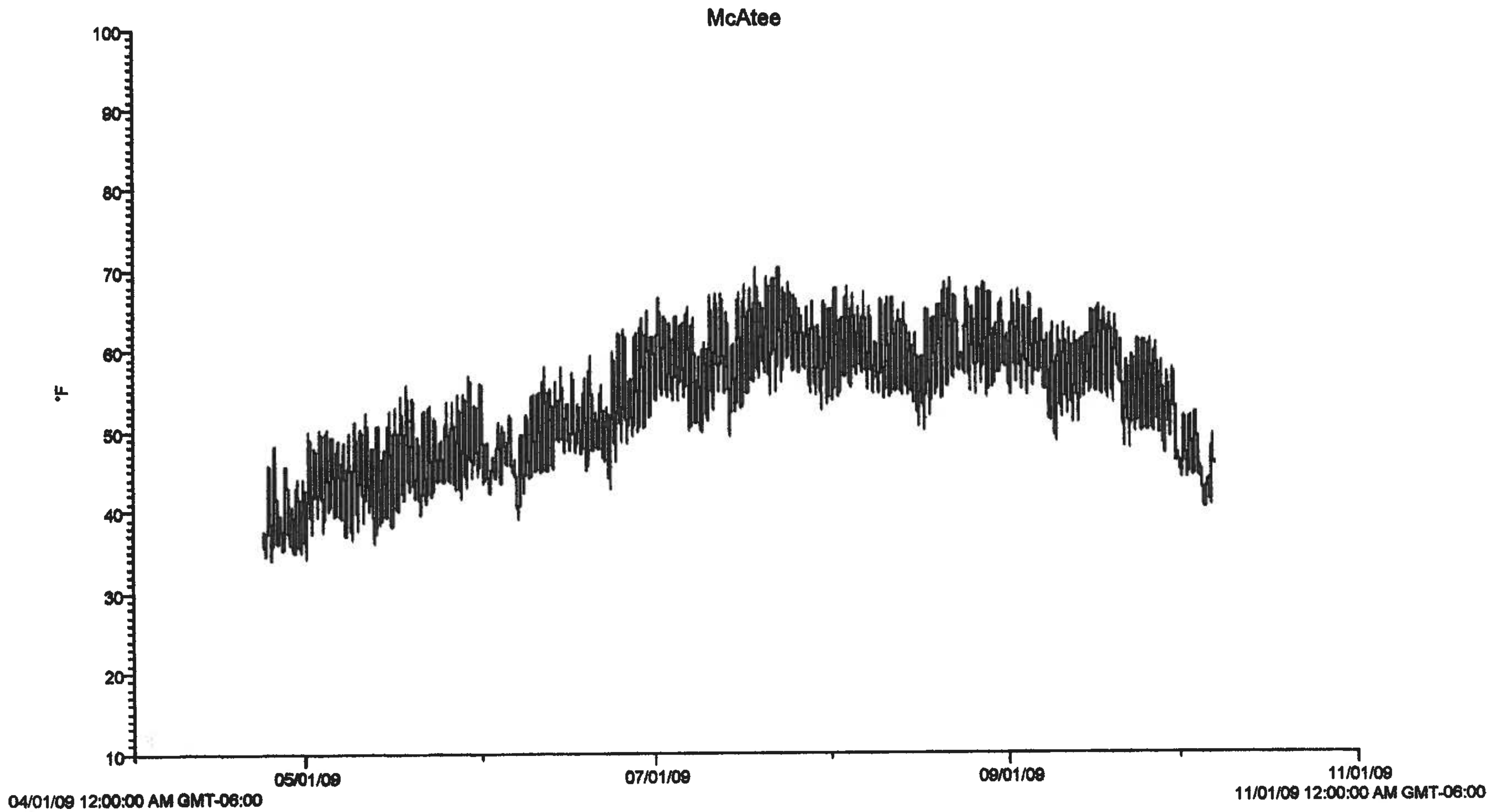
McAtee
°F
100
90
80
70
60
50
40
30
20
10
04/01/09 12:00:00 AM GMT-06:00
05/01/09
07/01/09
09/01/09
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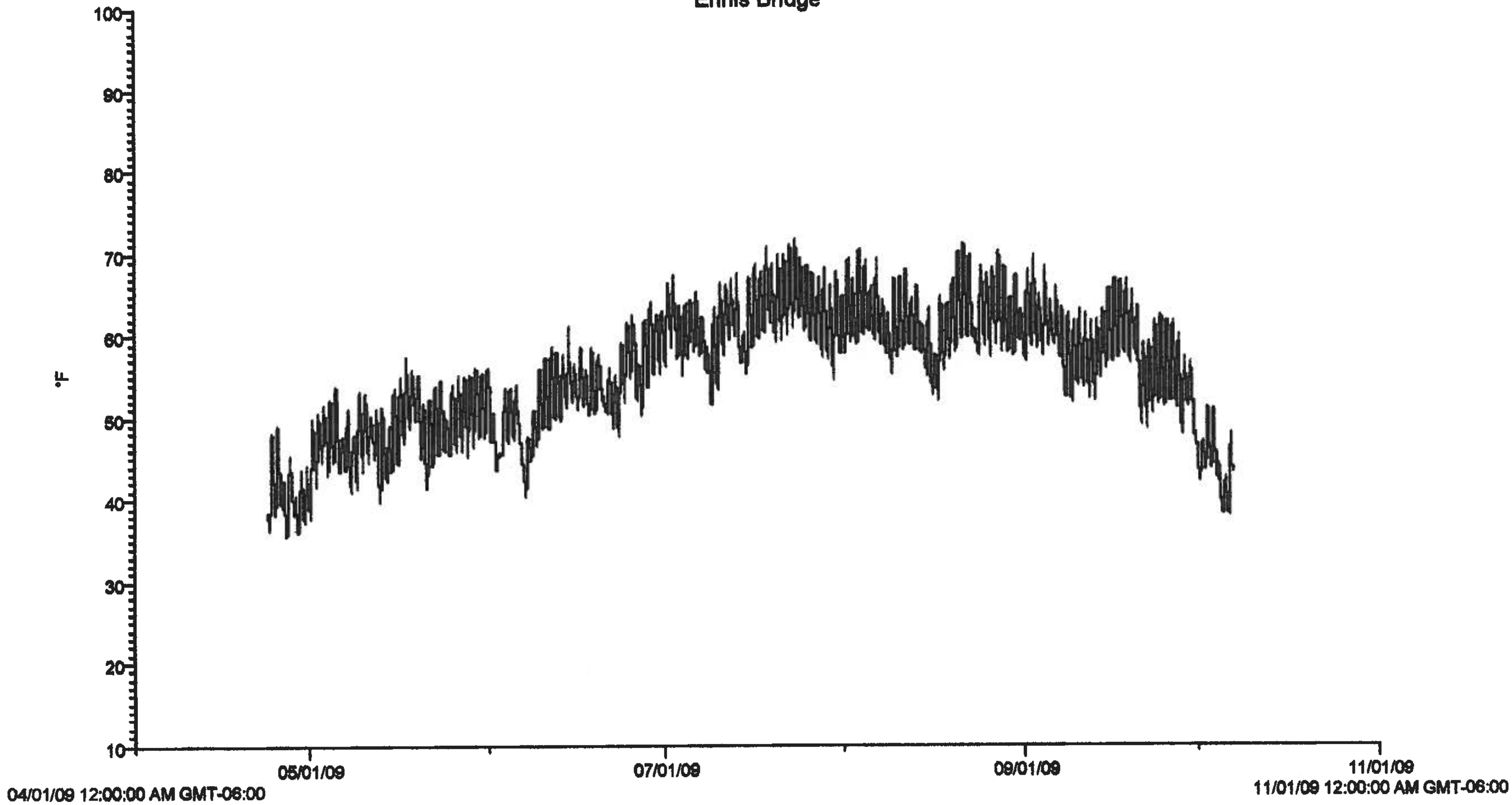
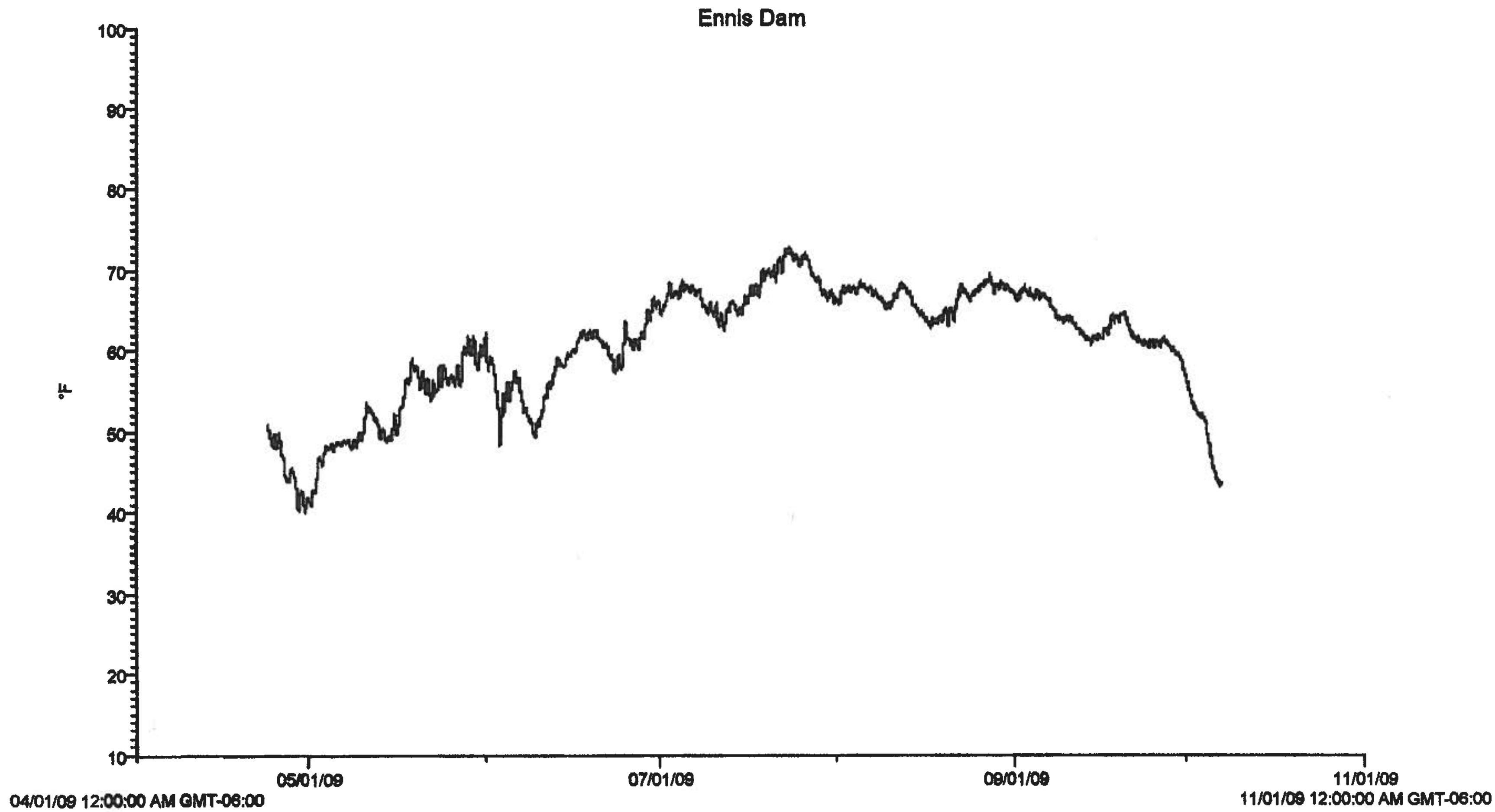
Ennis Bridge




Ennis Dam
°F
100
90
80
70
60
50
40
30
20
10
04/01/09 12:00:00 AM GMT-06:00
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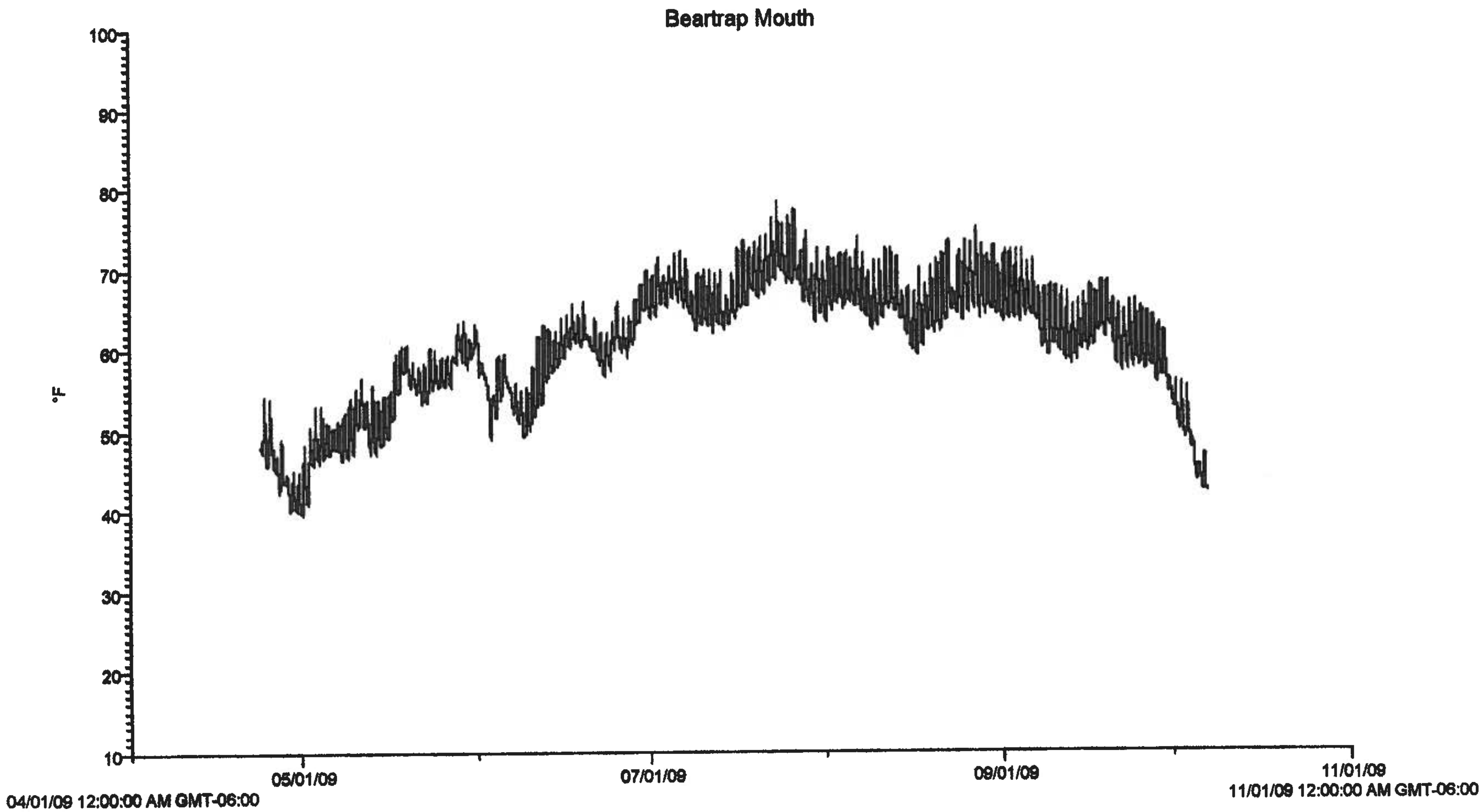

Beartrap Mouth
°F
100
90
80
70
60
50
40
30
20
10
04/01/09 12:00:00 AM GMT-06:00
05/01/09
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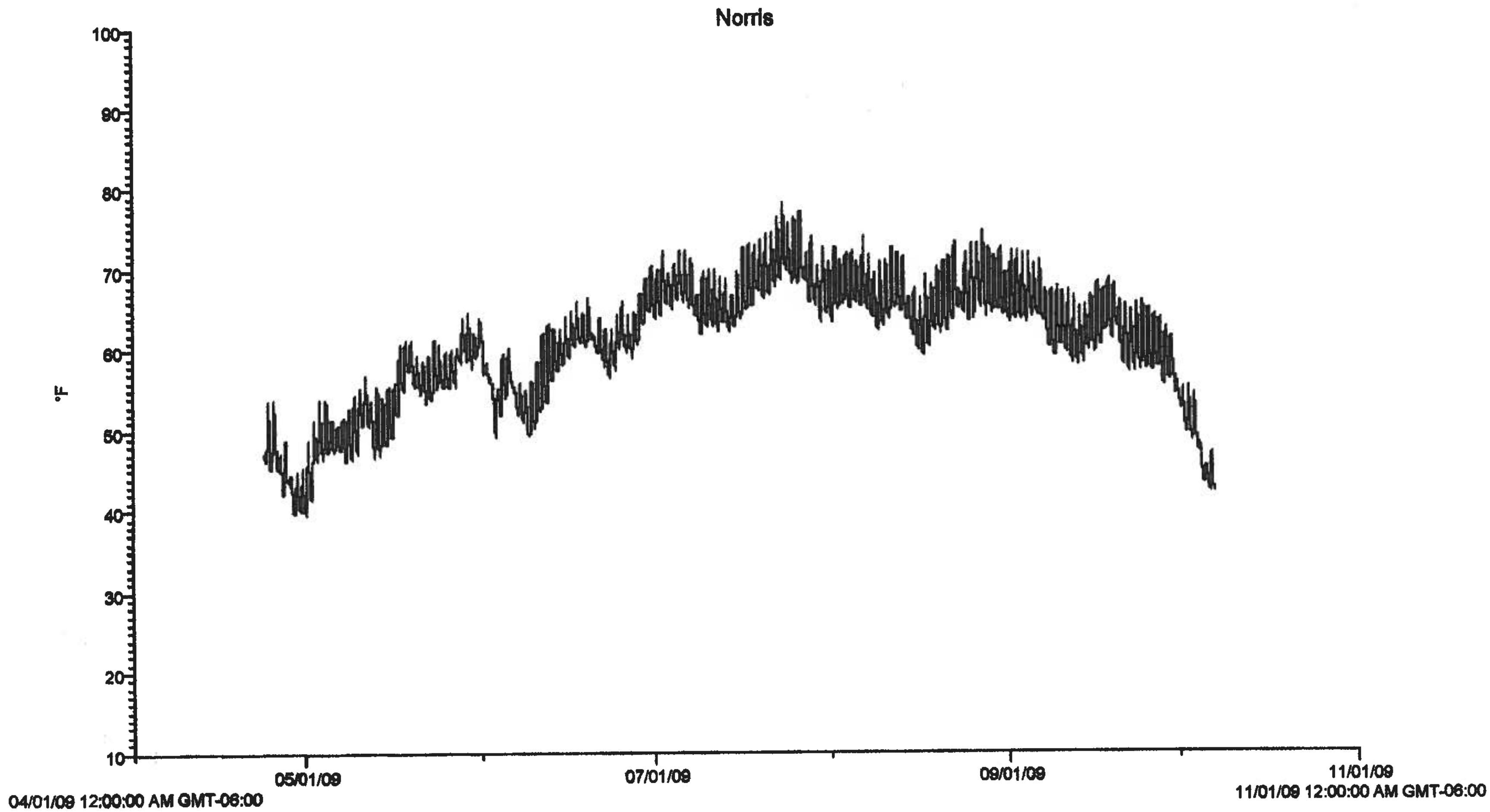
Norris
°F
100
90
80
70
60
50
40
30
20
10
04/01/09 12:00:00 AM GMT-06:00
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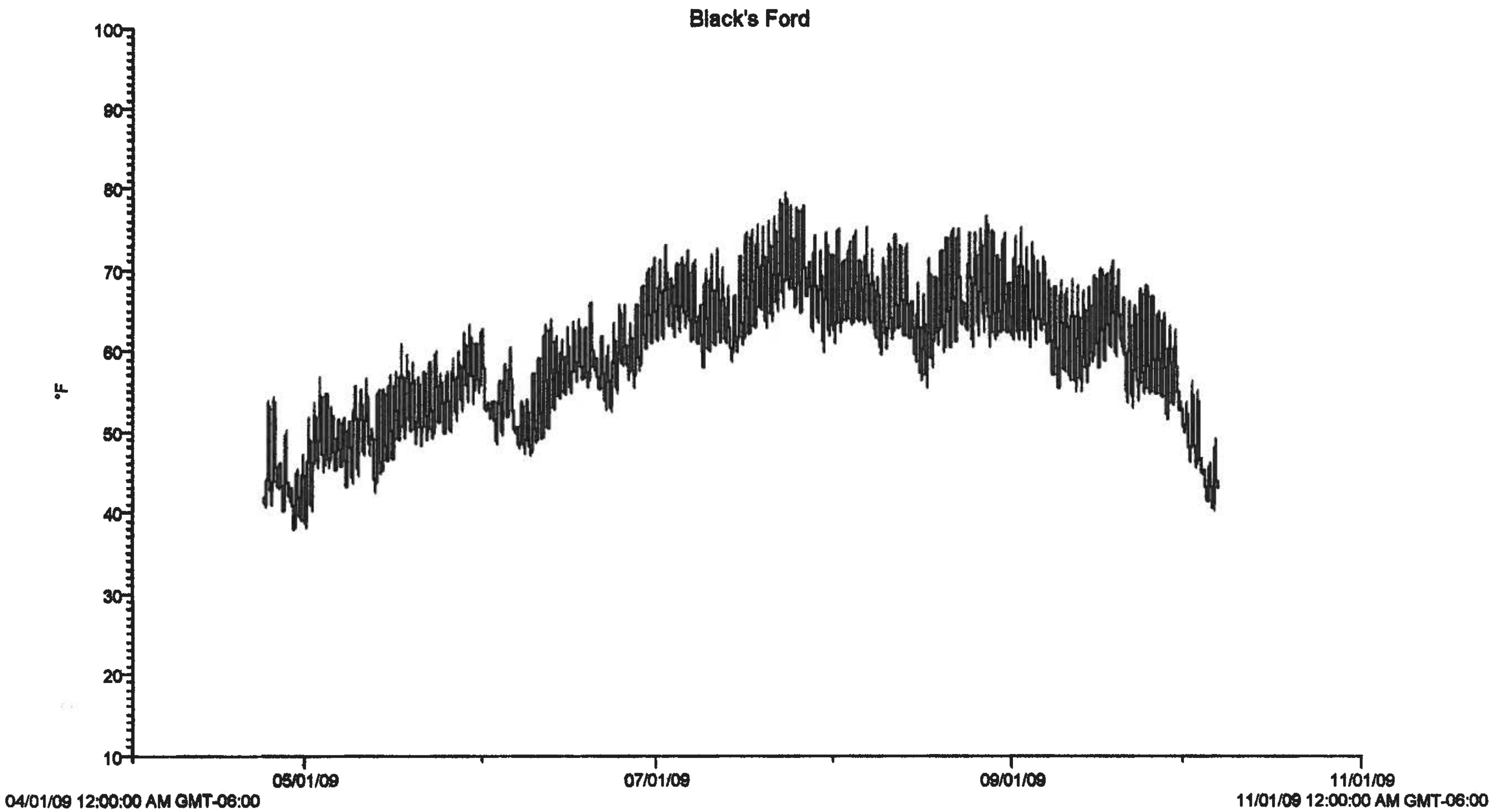
Black's Ford
°F
100
90
80
70
60
50
40
30
20
10
04/01/09 12:00:00 AM GMT-06:00
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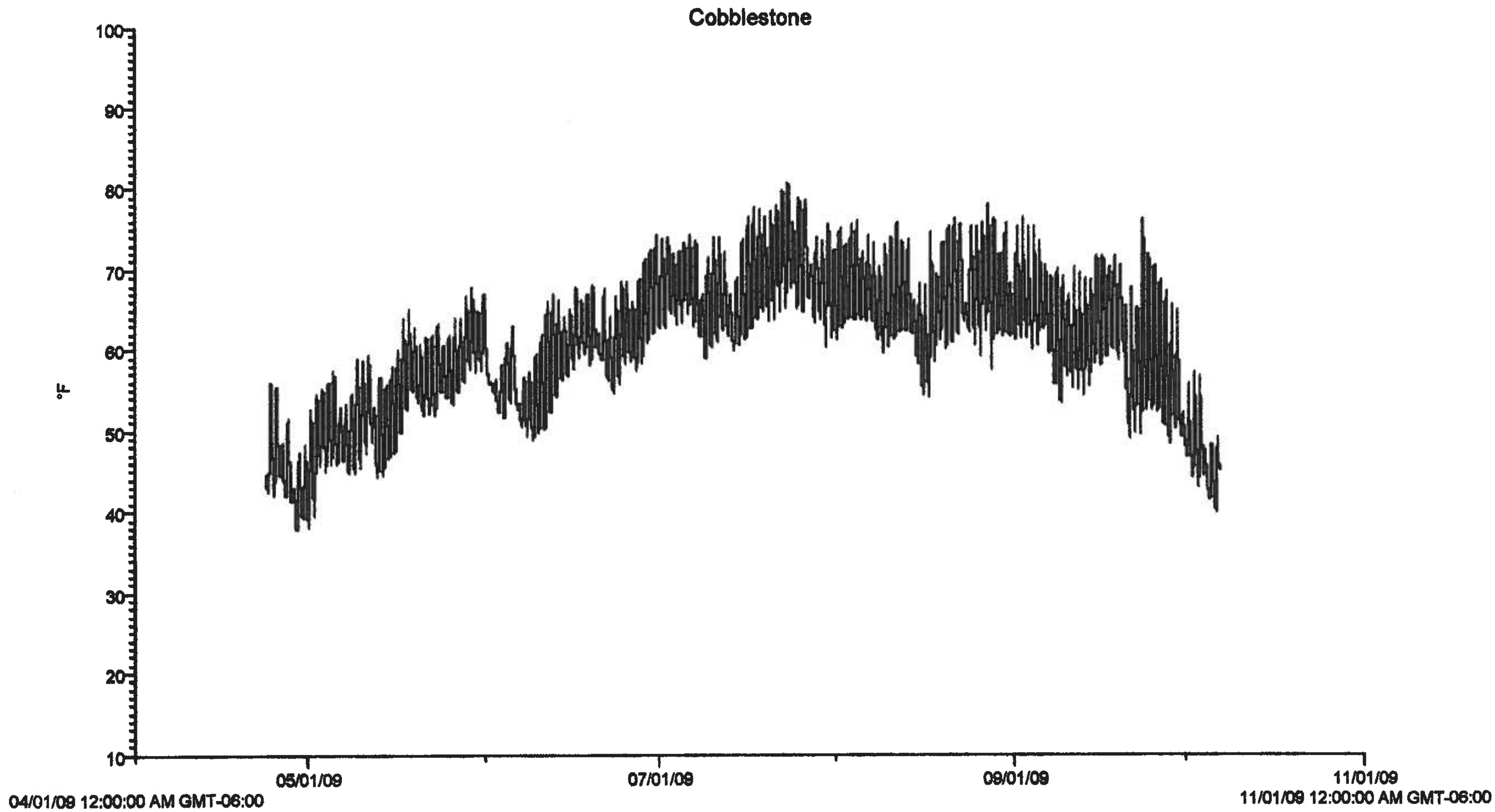
Cobblestone
°F
100
90
80
70
60
50
40
30
20
10
04/01/09 12:00:00 AM GMT-06:00
05/01/09
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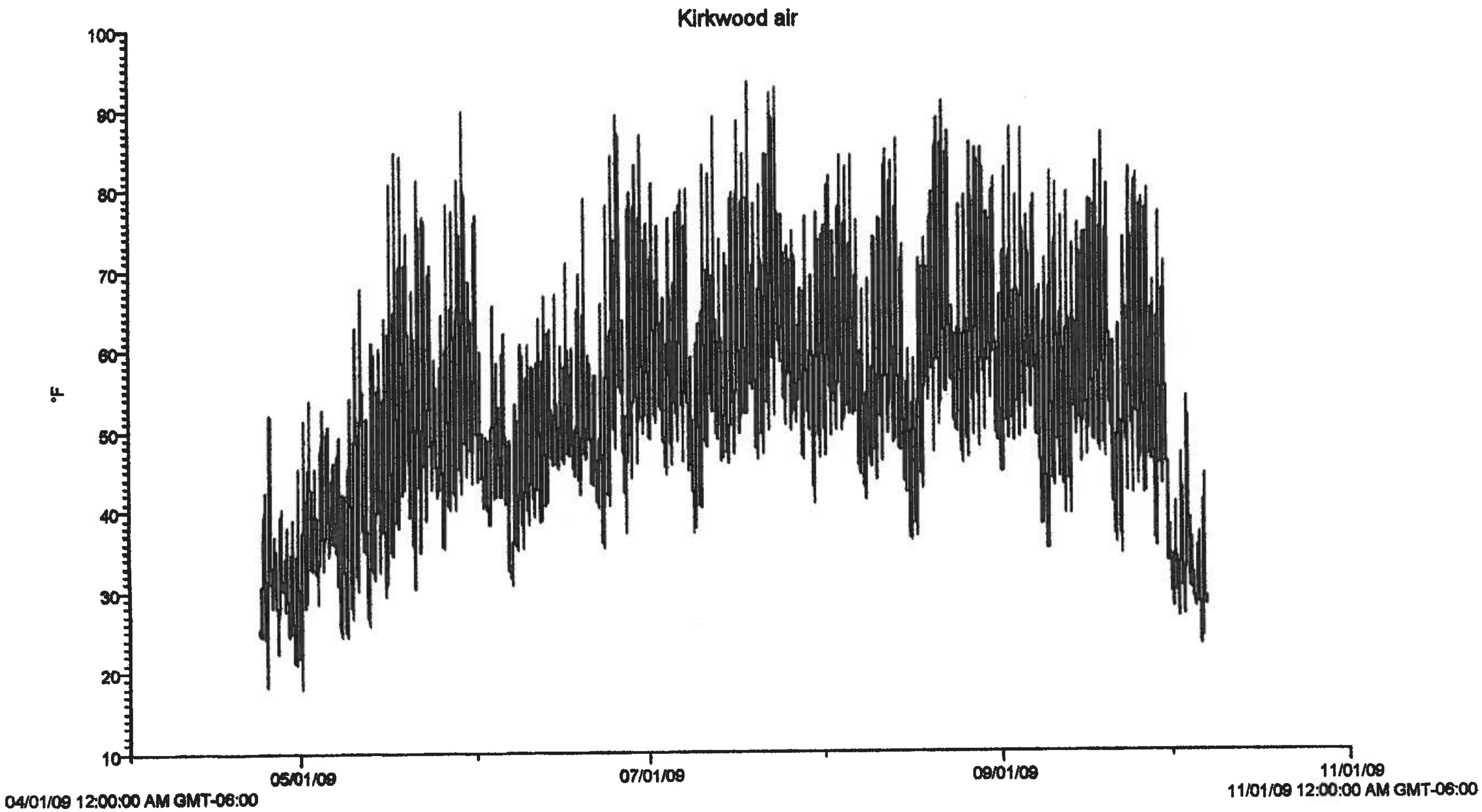

Kirkwood air
100
90
80
70
60
50
40
30
20
10
°F
04/01/09 12:00:00 AM GMT-06:00
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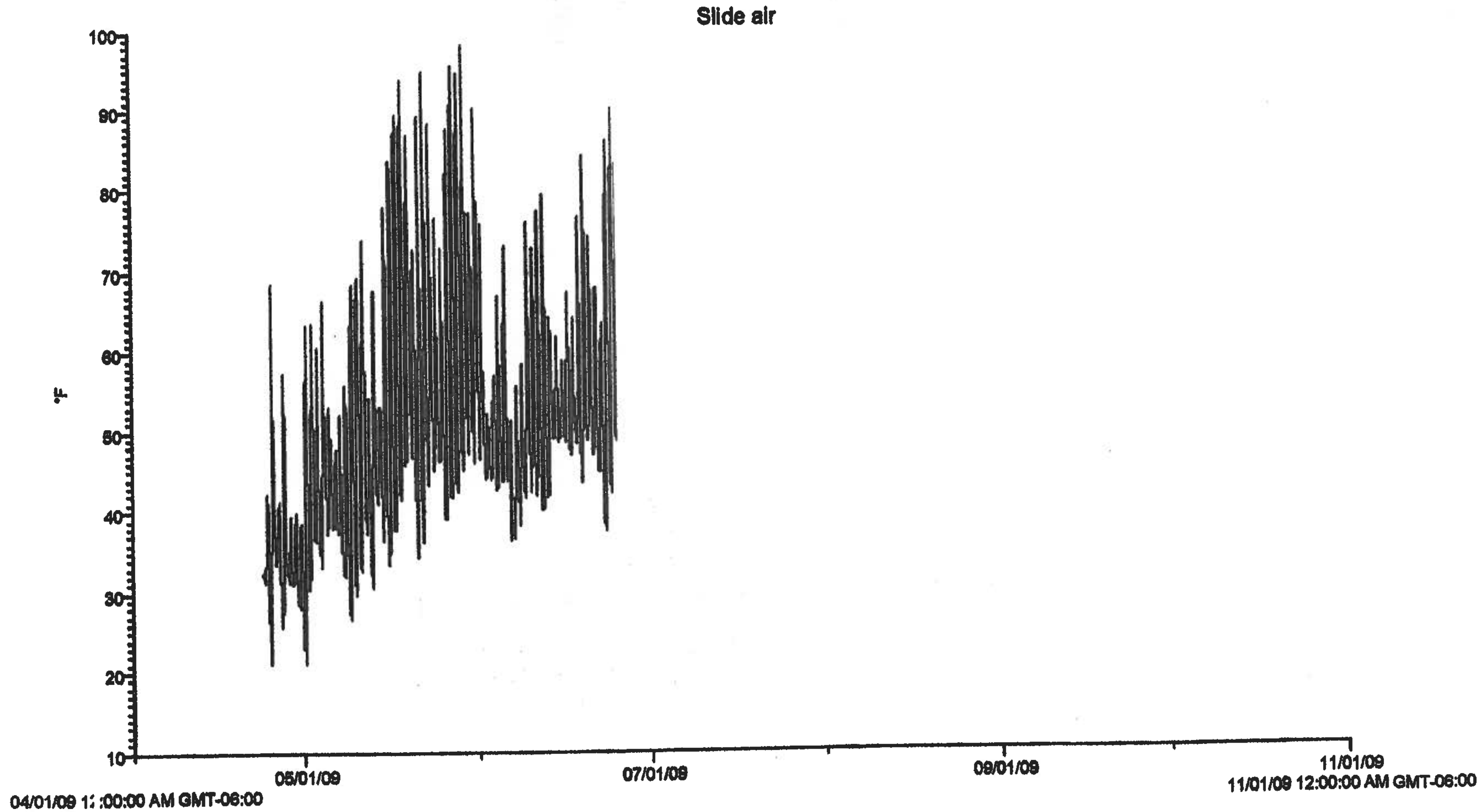

Slide air
°F
100
90
80
70
60
50
40
30
20
10
04/01/09 1: :00:00 AM GMT-06:00
05/01/09
07/01/09
09/01/09
11/01/09
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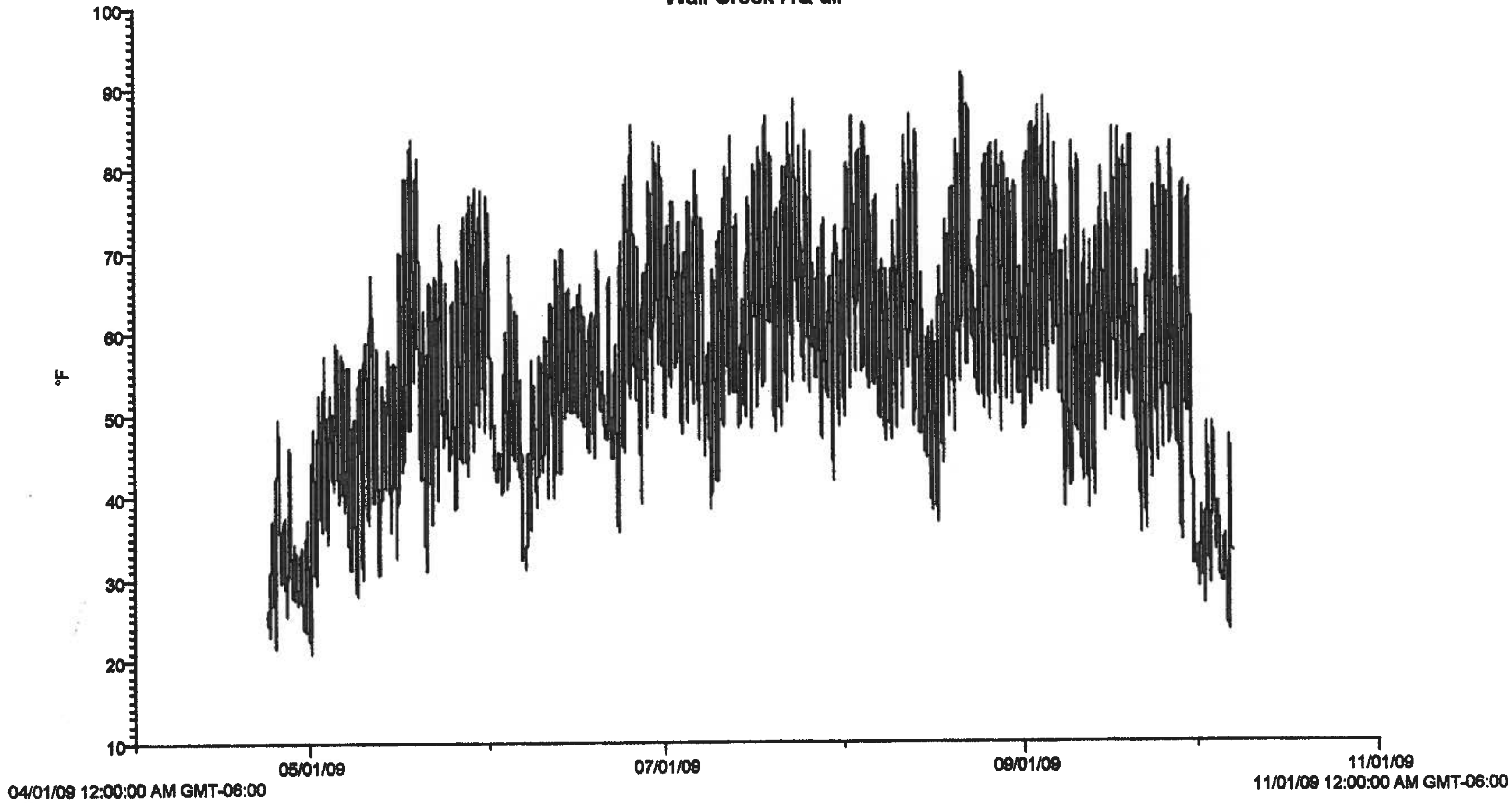
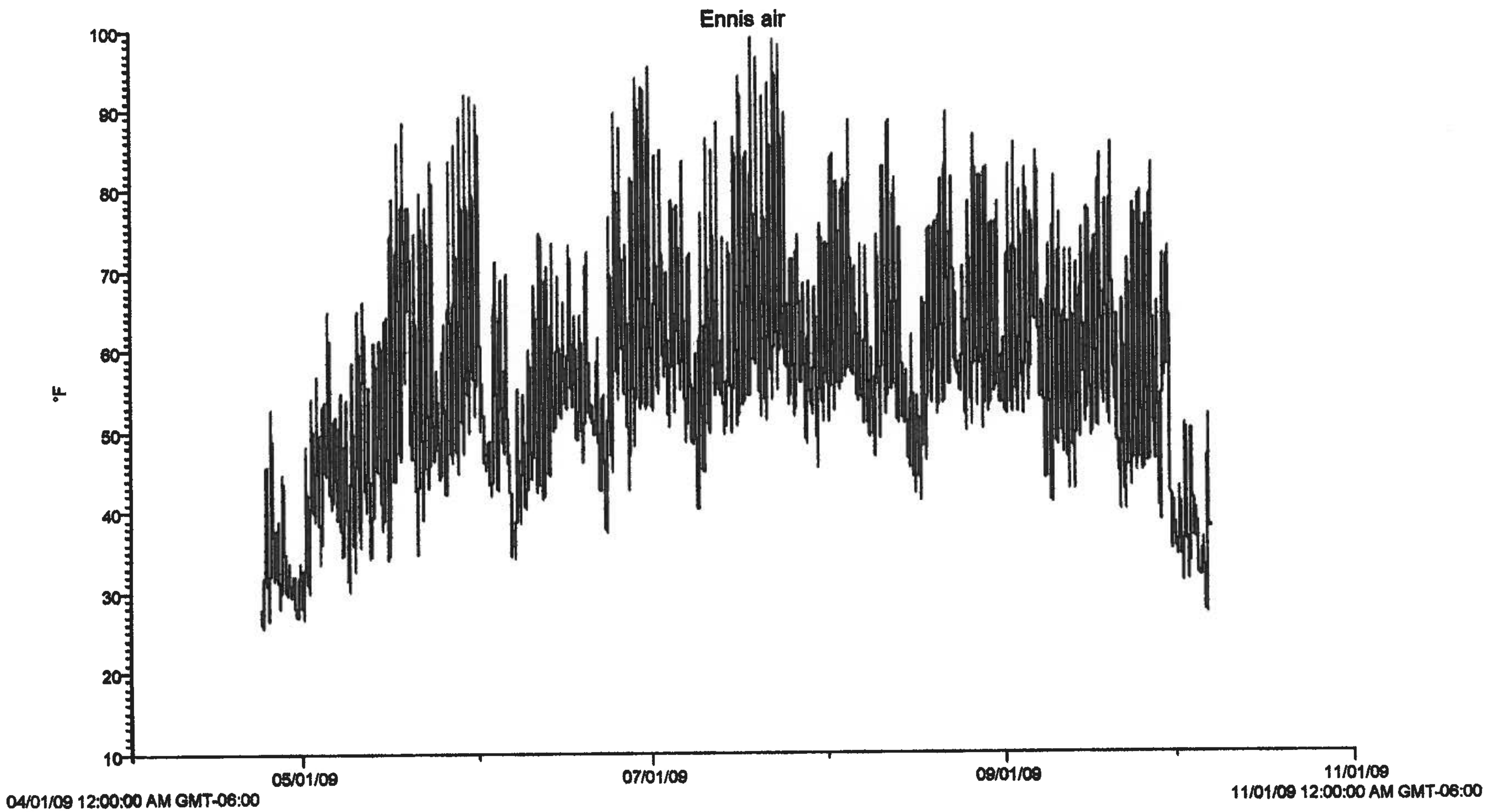
Wali Creek HQ air

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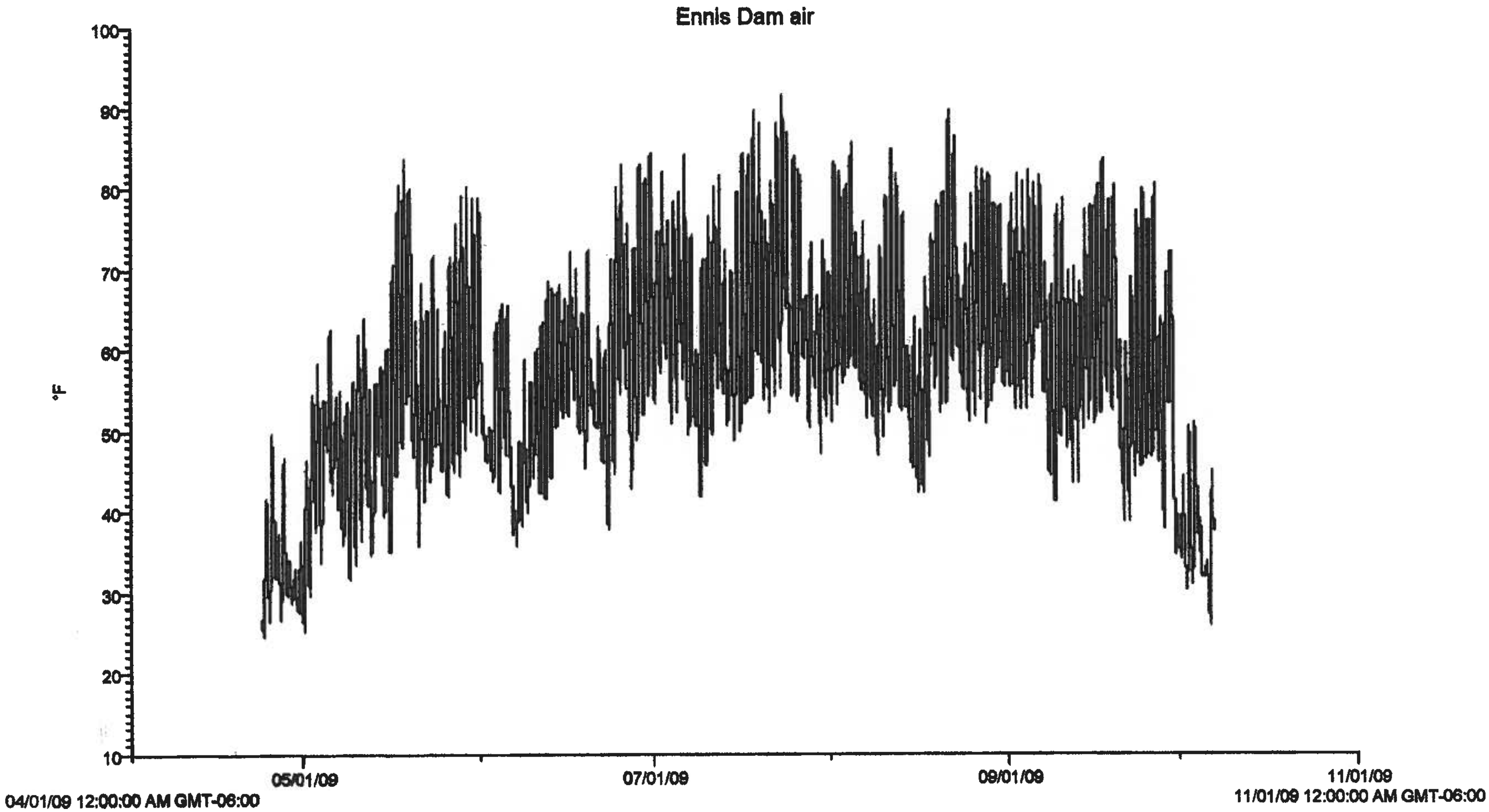
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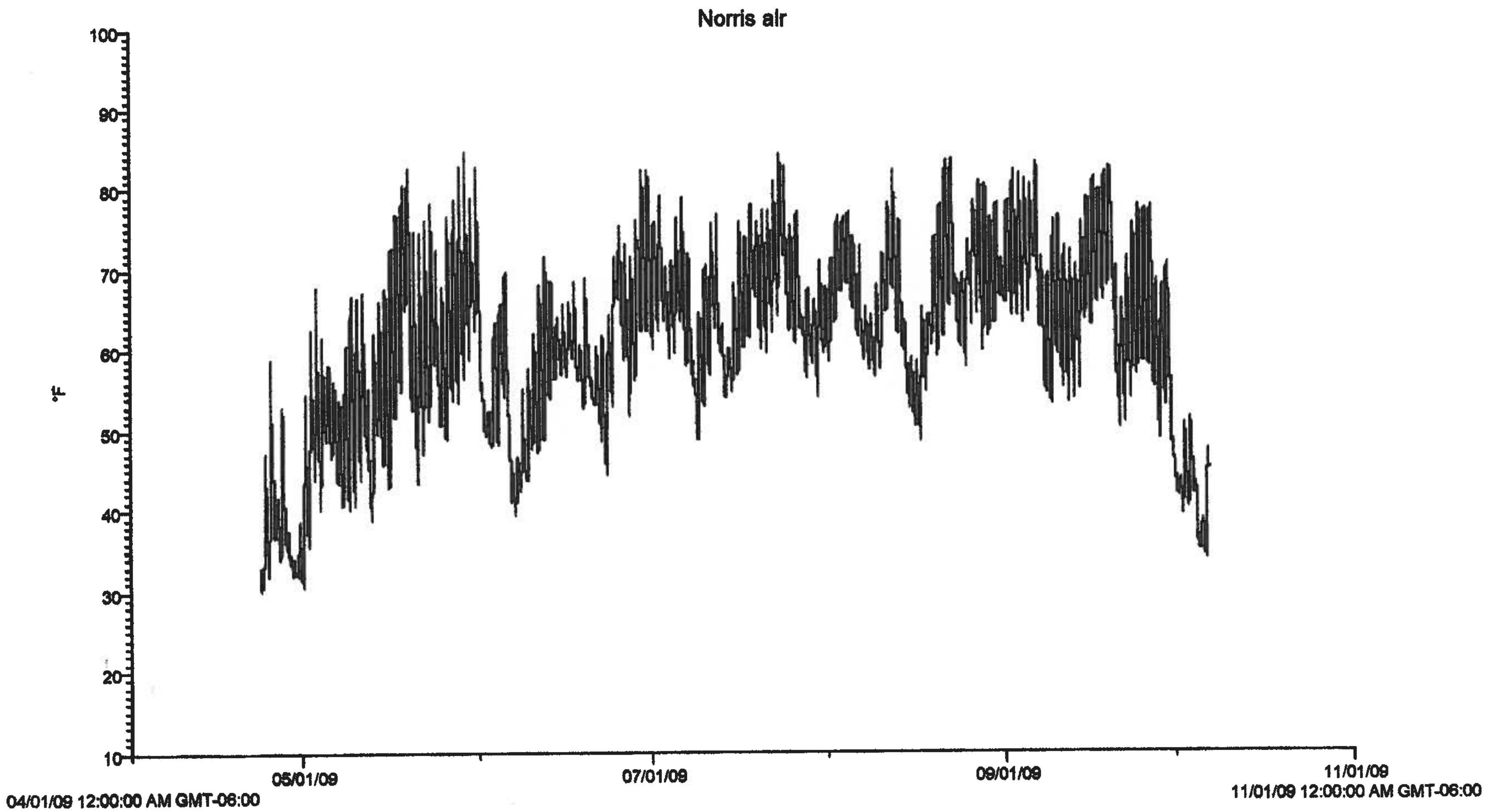
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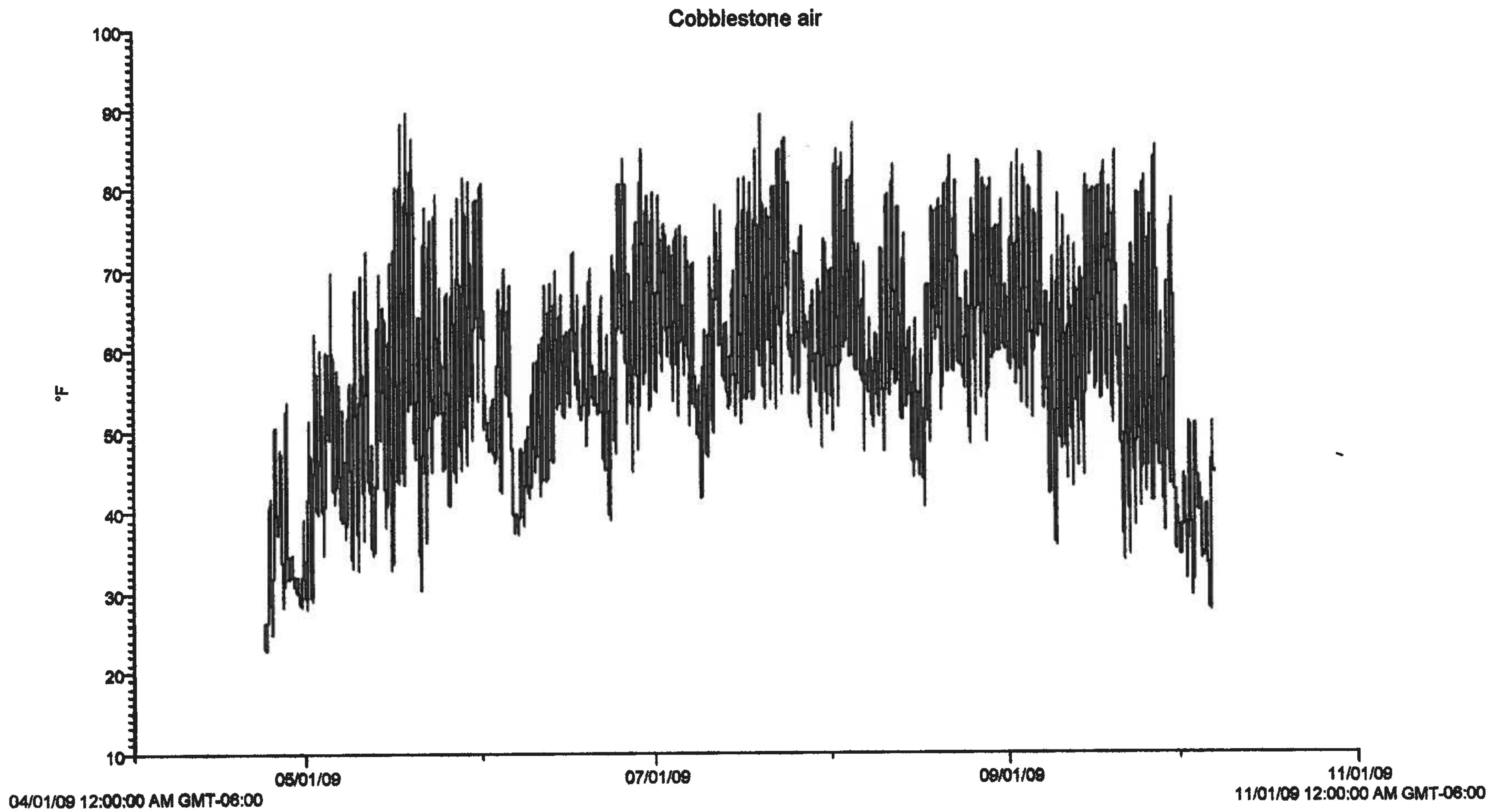

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Appendix E

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 mudsnails, 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 Mudsnails has been completed. All state, federal and private hatcheries have been inspected for New Zealand Mudsnails. One private hatchery contains New Zealand mudsnails, strategies have been implemented to prevent the spread of this invasive through hatchery operations. The spread of New Zealand mudsnails 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 mudsnails. 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".

Appendix F

2009 Monitoring Reports

Madison Ranger District: Tepee Creek
Wigwam Creek

Yellowstone National Park: Grayling Creek

Stream Habitat Restoration Monitoring
Tepee Creek, Madison Ranger District
Beaverhead-Deerlodge National Forest
2009

Background

Tepee Creek originates on the east flank of the Gravelly Mountains as a tributary to Horse Creek, flowing into the Madison River near Cameron, Montana. Historic trapping of beaver and over grazing have caused the stream channel to down cut and over-widen; this system currently experiences a high fine sediment load. Although livestock grazing ceased 25 years ago, the channel had yet to restore itself. Tepee Creek still experiences light to moderate trampling and heavy browsing by ungulates associated with the nearby Wall Creek Wildlife Management Area. 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.

The goal of restoration in Tepee Creek is to influence natural stream processes, particularly fine sediment deposition, to restore channel morphology. A secondary objective is improved watershed function by reducing fine sediment loads transported to the Madison River, an impaired water body on the MT Dept. of Environmental Quality's 303d list.

Installation of willow weirs - channel spanning dams constructed of wooden stakes, woven willow, and sedge clumps - has have trapped fine sediments and built point bars and stream banks, particularly where sedges have expanded as they respond to increased water storage and soil moisture. Weirs are particularly effective as they mimic beaver dams, trapping fine sediment and increasing stream bed elevation (Fig. 1). Baffles, where wooden stakes are pounded into the stream bed in a triangle dot-grid and the interstices are filled with cobble, willow, and sedge plugs to direct flow against the opposite bank and induce stream meandering (Figure 2). Sediment also deposits on top of and in the back eddy created by these baffles, but not as effectively as the weirs. By creating a series of baffles and weirs, the stream bed elevation is raised and a meander-pool-point bar morphology is created.

Figure 1. View looking downstream at a series of baffles built in 2006 that induced meandering, July 2007.

Figure 2. Channel spanning log weir, inundating older structures in previous figure, August 2009.

Figure 3. Channel spanning log weir, viewed looking upstream, August 2009.

Results
Riffle and baffles were initially installed in September 2004, with monitoring and further construction continuing through 2008. In 2005 all structures survived winter ice jams and spring flows intact while trapping fine sediment. Channel cross sections were established in order to monitor channel morphology (Figures 3-6), supplemented with photographs. The cross sections in 2005 showed an increase in stream bed elevation, indicating successful sediment deposition. While the structures did survive the 2006 season, little increase in stream bed elevation occurred, indicating no further sediment deposition. It appeared that the structures had reached their capacity to trap sediment in the first year. In 2006 weir structures were installed in an effort to increase the amount of sediment deposition; monitoring results from subsequent years indicate that these structures have been quite effective in this regard.

In 2008, some weirs incurred small water breaches as a result of the long duration of spring runoff. This resulted in lowered water surface elevations upstream of the structures. Breached weirs were sealed with bio-degradable sandbags and sedge chunks that blocked upstream flow. The cross sections from 2008 indicate another year of sediment deposition, in addition to evidence of channel narrowing (Figures 3-6). Photographs indicate that large quantities of sediment deposited upstream of weirs, creating bars, recruiting sedges, and narrowing the channel (Figure 7).

While large amounts of sediment have been deposited, it is generally fine and highly mobile. In order to stabilize this sediment sedge plugs were planted in 2007 and 2008. As these plugs mature, their root masses will stabilize the point bars. Also, baffle and weir construction continued upstream, expanding the restoration reach. Further monitoring, construction, and maintenance will continue into the near future. However, someday, through sediment deposition and vegetation recruitment Tepee Creek should return to historic conditions and support a native population of WCT.

Funding
This project has received considerable funding support from PPL-Montana in each year under the authority of Article 409 of the PPL FERC license on the Madison River, specifically part (3) "fish habitat enhancement both in the main stem and tributary streams, including enhancement for all life stages of fishes" and part (9) "riparian habitat restoration". The Madison-Beaverhead Counties RAC also provided funds toward the purchase of supplies in 2005-6.

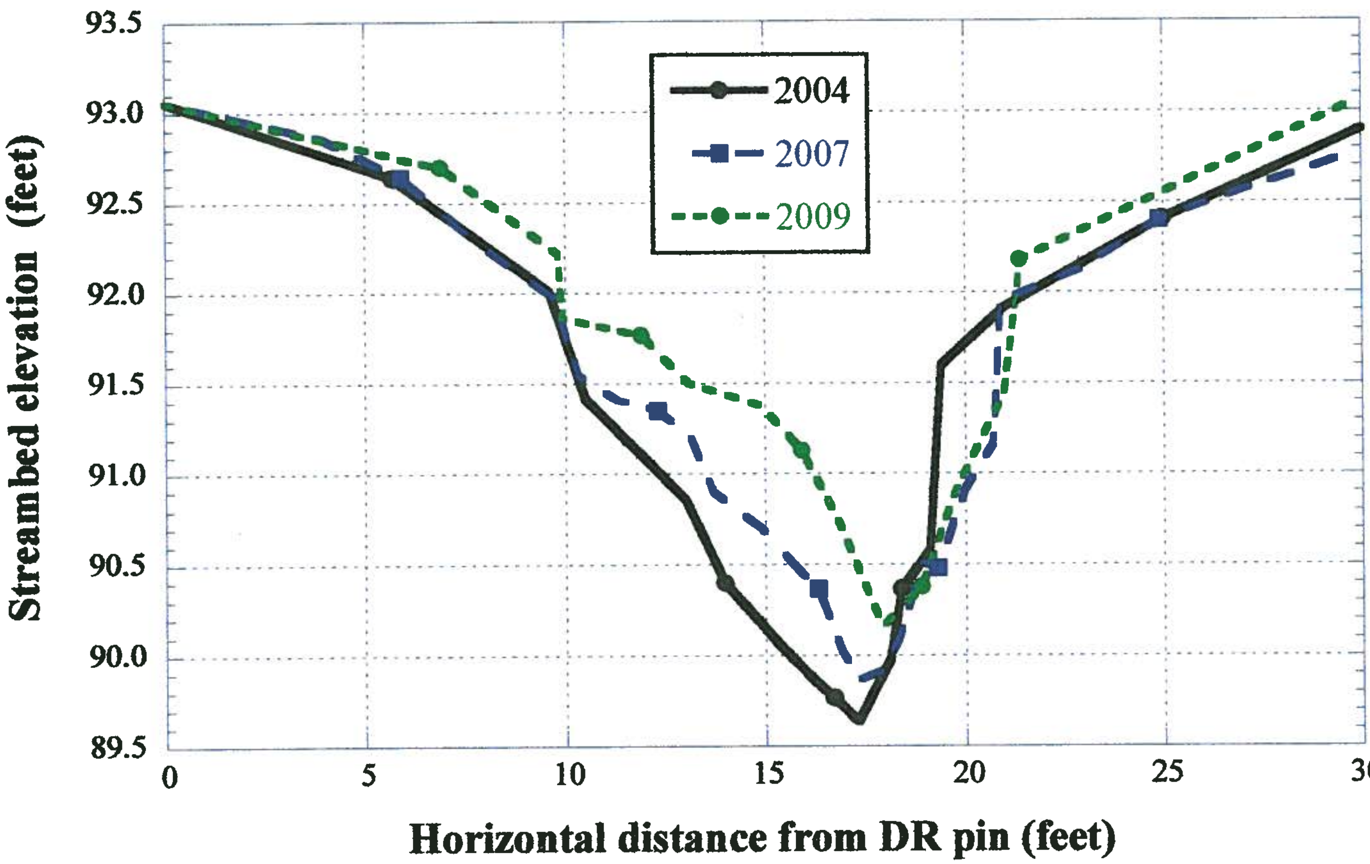

Figure 3. Transect #1; note in 2009 the large sediment deposition at left and how sediment is now depositing in the floodplain.

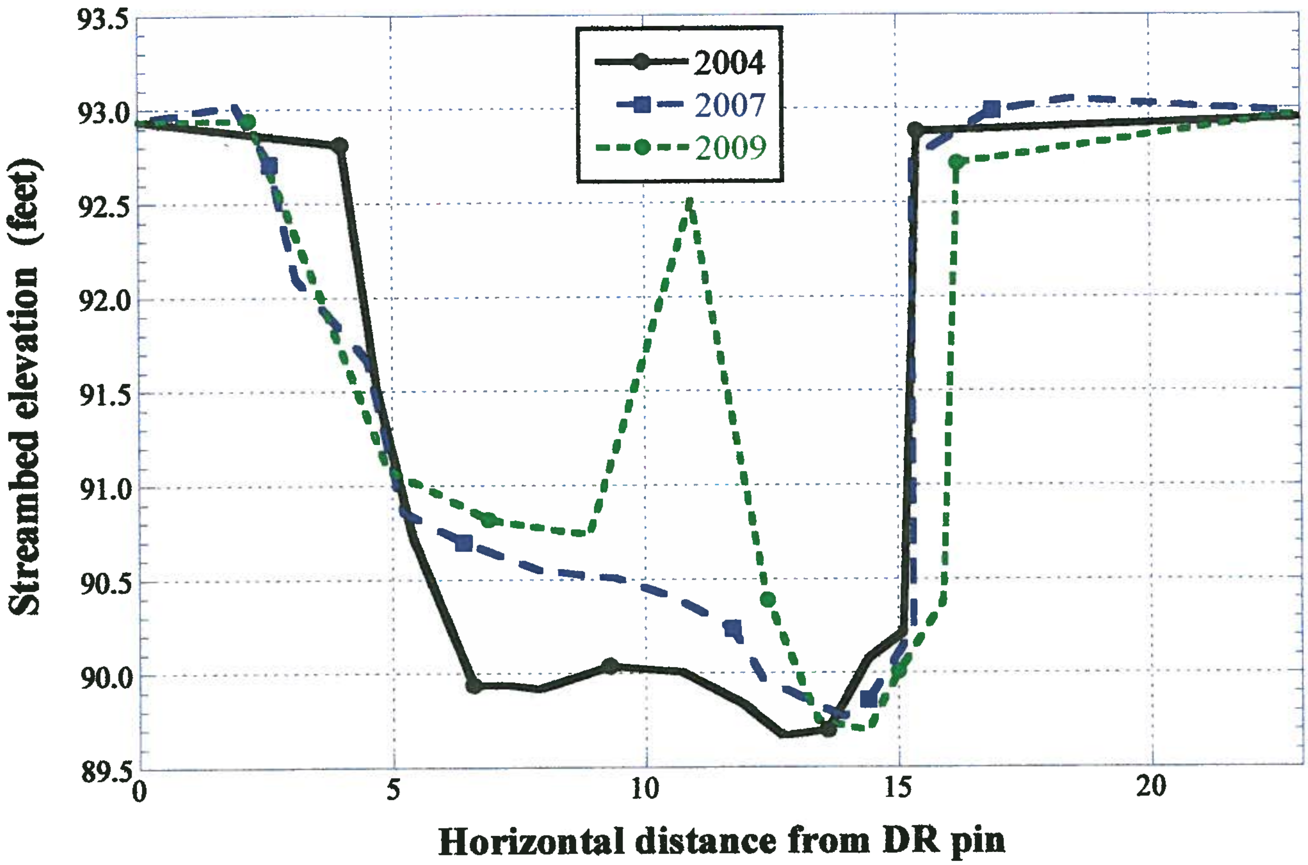

Figure 4. Transect #2, relates annual increases in sediment deposition and streambed elevation.

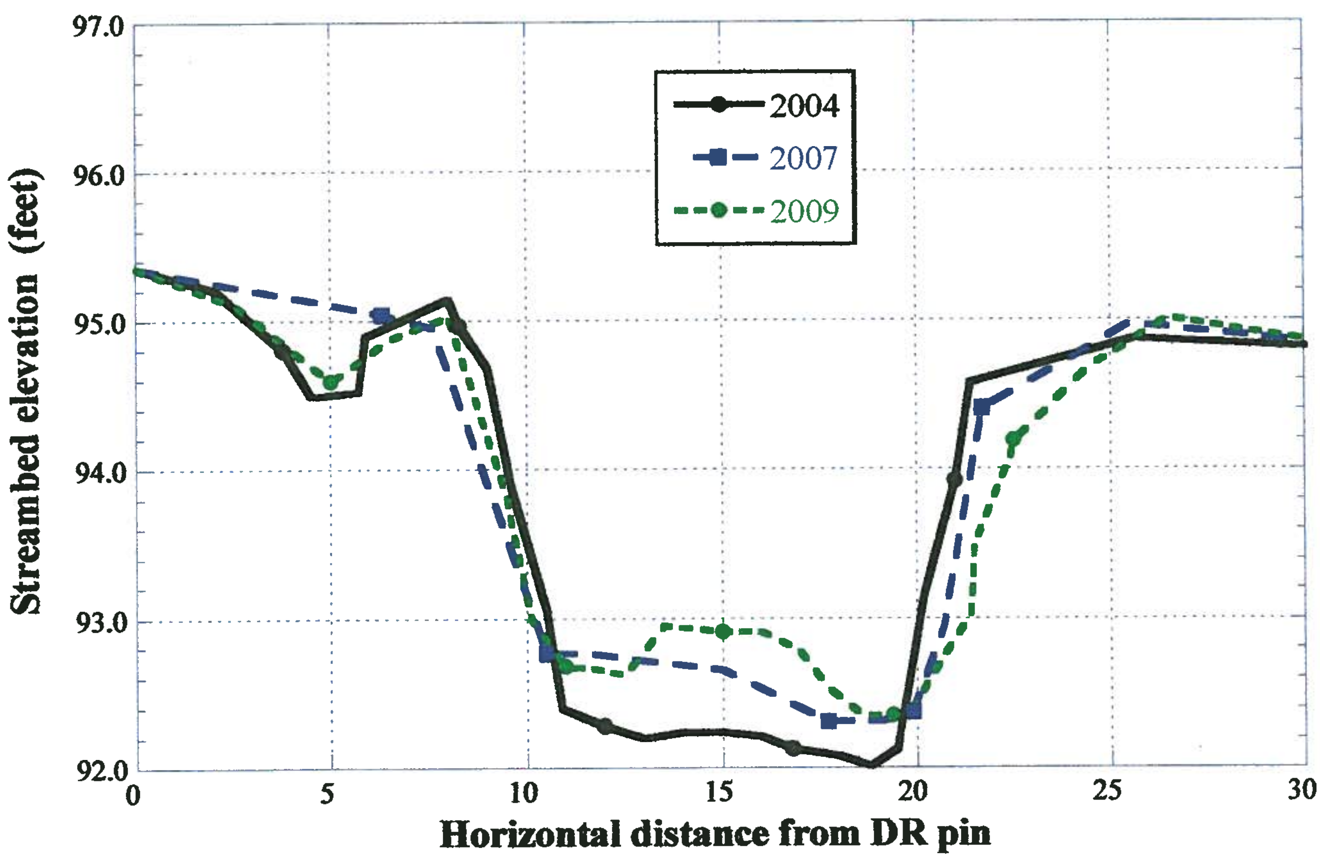

Figure 5. Transect #3, located immediately over Riffle #6, depicts increases in sediment deposition from 2004 to 2009

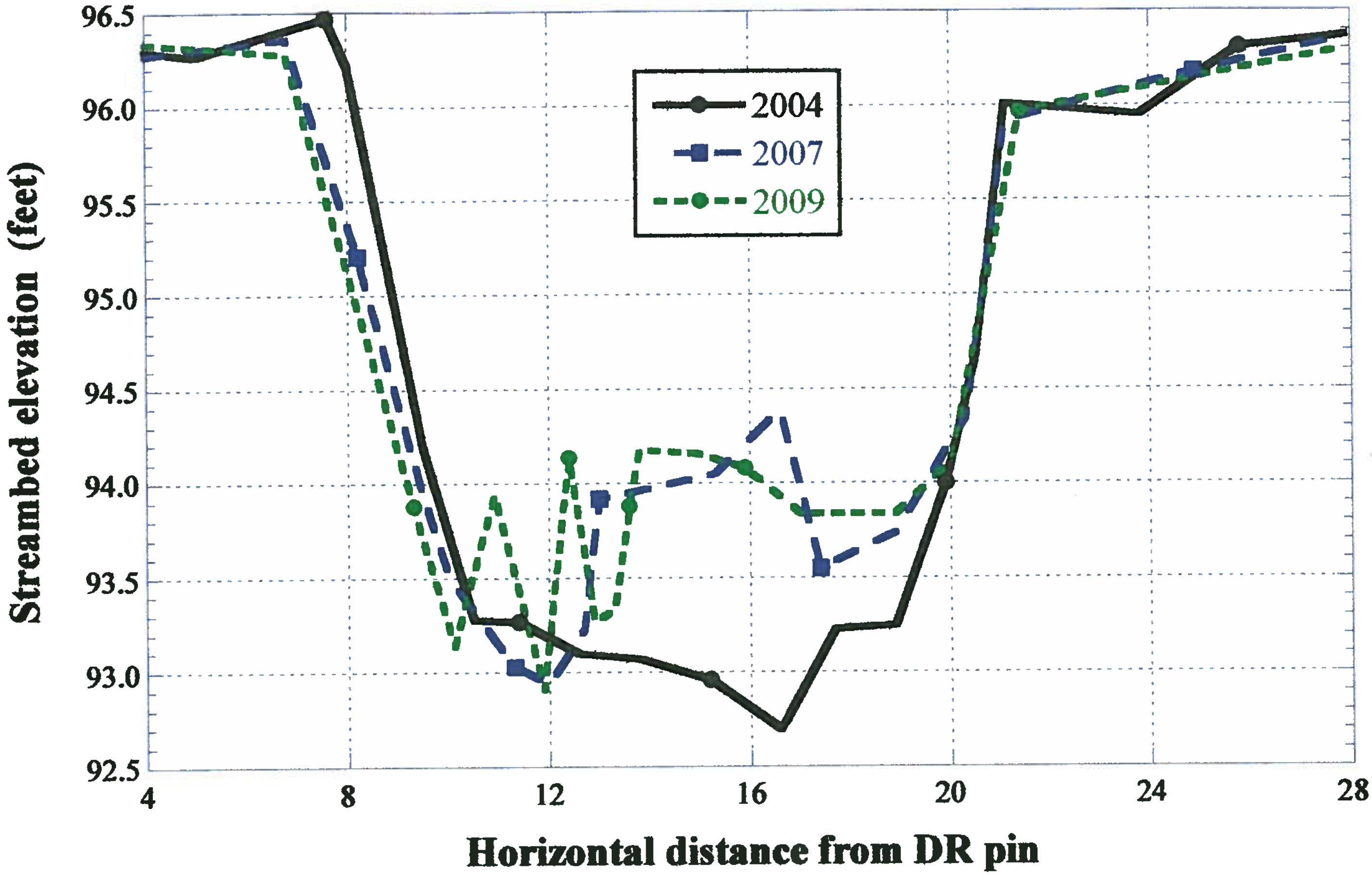

Figure 6. Transect #4, located just upstream of Riffle #6, depicts sediment deposition from 2004 through 2009.

Figure 7. A weir trapping large amounts of sediment and raising the surface water level, July 2008. Sedge recruitment is already occurring on the point bars, and spawning gravel has been sorted in the thalweg below the weir.

Westslope Cutthroat Trout Habitat Restoration Monitoring
Wigwam Creek, Madison Ranger District
Beaverhead-Deerlodge National Forest
2009

Background
Wigwam Creek originates on the east flank of the Gravelly Mountains and flows into the Madison River near Cameron, Montana. The removal of beaver from this drainage, combined with failed water diversions and historic overgrazing by livestock, has resulted in considerable down cutting and over-widening of the stream channel, along with an elevated fine sediment load. Wigwam Creek is currently grazed by livestock under Amendment 7 riparian standards; light trampling and willow browse occurs from elk and moose. The treatment segment of Wigwam Creek supports a population of WCT; molecular analysis indicates that the genetic integrity of this population varies from 95-82%.

The goal of channel restoration in Wigwam Creek is to reverse its over-widened channel geometry. The means to accomplishing this objective is to influence natural processes such as sinuosity, fine sediment deposition, stream bank formation, and floodplain connectivity to accelerate the rate of channel recovery. Secondary objectives include increased pool frequency and depth, along with improved watershed function with reduced fine sediment load being exported downstream into the Madison River system.

The installation of low-head riffles and baffles using native rock and wooden stakes is designed to influence deposition of fine sediments during springtime high flows. The elevated load of fine sediment in Wigwam Creek, normally interpreted as a negative, actually provides the natural material to rebuild point bars and stream banks. Riffles are constructed as channel-spanning features, generally installed to influence upstream sediment deposition. Baffles are not intended to span the channel, instead acting to form point bars and increase sinuosity in the channel. Riffles and baffles typically exhibit an elevation gradient across the channel, influencing flow against one bank and deposition against the other bank, particularly in the downstream backwater area.

Riffle and baffles were initially installed in September 2004, with work continuing during the summer of 2007. This project has received considerable funding support from PPL-Montana in each year under the authority of Article 409 of the PPL FERC license on the Madison River, specifically part (3) "fish habitat enhancement both in the main stem and tributary streams, including enhancement for all life stages of fishes" and part (9) "riparian habitat restoration". In the past, the Madison-Beaverhead Counties RAC have provided funds for supplies and funding and volunteer labor have been provided by the Madison River Foundation and the Madison-Gallatin chapter of TU. Restoration efforts in this treatment reach are close to complete; in 2008 and 2009 only limited maintenance of structures was performed.

Results
In 2009, spring runoff was about average to above average for the second consecutive year. Duration of runoff was also extended for a second year with a cool wet spring and early summer, resulting in greater scouring of the channel. Considerable deposition of gravel and finer sediments was obvious from visual inspection. Annual grazing impacts to the channel and riparian have varied in the restored channel reach, however structure integrity appears relatively high, however continued trampling effects would, over time, require considerable maintenance of structures for them to be effective. Wigwam Creek is scheduled to be excluded from livestock grazing by the implementation of exclosures and improved water facilities in 2010, which should allow these structures to function unhindered.

Quantitative monitoring of morphological parameters in 2009 indicates that the channel continues to adjust and improve, with some interesting changes. Bankfull width actually increased slightly, likely due to grazing impacts, but possibly also confounded by the extended spring runoff. Sinuosity and length of channel did not change (Table 1), which may be a clue that the channel has reached its potential under its current alignment and valley morphology.

Most interesting is how pool habitat has improved the last three years. Pool frequency and residual depth both increased considerably after 2006, with a concurrent reduction in pool spacing, all likely a function of narrowing of the channel (Table 1), along with the extended spring runoff in 2008 and 2009. However, 2006 also experienced an above average and extended spring runoff, but without improvement in pool habitat characteristics. This result suggests that this restoration technique is successful in initially influencing the narrowing and sinuosity of a degraded channel, after which channel geometry and scouring flows allow pool development.

These conclusions benefit from continued monitoring in following the various changes in channel response, and have been useful in making management decisions adaptively.

Table 1. Channel characteristics, Wigwam Creek, 2004-2007

Channel characteristic	2004	2005	2006	2007	2008	2009
Channel length (m)	405	440	437	489	490	465
Stream bed gradient (%)	2.45	2.25	2.28	2.03	2.03	2.14
Sinuosity	1.02	1.11	1.10	1.23	1.23	1.17
Mean bankfull width (m)	2.65	2.51	2.29	2.04	2.18	2.17
Pool frequency (pools / km)	24.7	34.1	34.3	49.1	57.1	62.4
Pool spacing	15.3	11.7	12.7	10.0	8.0	7.8
Mean residual pool depth (m)	0.23	0.21	0.22	0.21	0.27	0.26

Figure 1. Wigwam Creek restored reach upstream of the bridge, early August 2009.

Grayling Creek Summary: 2009 Field Operations

Background

In 2009 multiple survey efforts were conducted in the Grayling Creek watershed within Yellowstone National Park. The goal of these activities was to provide information on fish distribution, composition, and genetic integrity that will be integral to proposed future westslope cutthroat trout and Arctic grayling restoration projects. Initial surveys of aquatic invertebrates and amphibians were also conducted in the drainage. While Yellowstone National Park coordinated these efforts cooperation from other agencies and partners was extensive (see below).

Methods

Over multiple sampling events the vast majority of the tributaries to Grayling Creek upstream of the small waterfall (canyon reach adjacent to HWY 191) were sampled via backpack electrofisher. Information collected included GPS locations of sampling reaches; number, species, and length of fish captured; and an estimate of tributary size. Genetic samples (fin clips) were collected from all cutthroat/hybrids captured.

Genetic analyses will be completed using standard methods to detect hybridization by the University of Montana Conservation Genetics Lab. Analysis of species composition and distribution for aquatic invertebrates will be conducted by Aquatic Biology Associates (Corvallis, OR).

Yellowstone National Park is incorporating the information collected into a GIS database and will coordinate analysis of the genetic samples and aquatic invertebrates.

Results

Fish were found to be widely distributed throughout the drainage with cutthroat trout (likely hybrids) occurring to the headwaters of the South Fork Grayling Creek and its tributaries, and nearly to the headwaters of East Fork Grayling Creek. At least 4 other tributary systems appear to support adult fish, and likely spawning enclaves. Many small tributaries contained juvenile fish, suggesting they support spawning from Grayling Creek.

While some fish populations that appear to be at least partially isolated were identified, none appeared to be genetically pure WCT. Final determination of genetic status is pending until genetic analyses are completed.

Future Work

Several tributaries not found on existing maps were identified during the 2009 survey. When encountered these waters were surveyed if time and logistics allowed, however, some of these tributaries were not surveyed. Give this, at least one more survey trip into the drainage will be required and is likely to occur in 2010. In addition to the fish distribution surveys more complete aquatic invertebrate and amphibian surveys are being planned for the coming years. In order to provide a detailed picture of all areas that would require treatment in the event of a full-scale restoration project, a complete hydrologic survey of the drainage is being considered.

Grayling Creek Partnership

The work being conducted on Grayling Creek is a cooperative effort being undertaken by a network of partner agencies and work groups. Project partners are listed below.

Agency	**Office/Work Group**	**Contact Person**
Yellowstone National Park	Fisheries and Aquatic Sciences Section	Todd Koel
Montana State University	Big Sky Institute	Mike Ruhl
Montana Fish Wildlife and Parks	Ennis Fisheries Office	Pat Clancey
Montana Fish Wildlife and Parks	Arctic Grayling Recovery Program	Jim Magee
Gallatin National Forest	Bozeman Ranger District	Bruce Roberts
PPL Montana Corp.	Hydro Licensing and Compliance	Brent Mabbott

Appendix G

Sun Hatchery Contributions and Production
2001 – 2009

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 Pond	483 fry
	MF Cabin Ck - Madison	?:3	Sun Pond	104 fry
2003	Ray Ck - Elkhorns	25;9	Sun 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 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 Pond	528 fry
			disease testing	11 fry
	Browns Ck - Beaverhead	10;5	Sun Pond	646 fry
	Sun Pond	37;16	Sun 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 Pond	284 fry
	Muskrat Ck - Elkhorns	16;8	Sun Pond	184 fry
			Cherry Ck	1750 eyed eggs
	Whites Gulch - Elkhorns	3;3	Cherry Ck	726 eyed eggs
2007	Muskrat Ck - Elkhorns	11;22	Cherry Ck	5445 eyed eggs
			Sun Pond	291 fry
	Ray Ck - Elkhorns	13;25	Cherry Ck	3467 eyed eggs
			Sun Pond	194 fry
	Whites Gulch - Elkhorns	4;8	Cherry Ck	1015 eyed eggs
			Sun Pond	59 fry
	Sun Pond	37;17	Cherry Ck	2994 eyed eggs
			Sun 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 - Elkhorns	23;12	Cherry Ck	1700 eyed eggs
	Whites Gulch - Elkhorns	11;6	Cherry Ck	1015 eyed eggs
			Sun Pond	117 fry
	Sun Pond	28;10	Cherry Ck	3218 eyed eggs
			Sun Pond	571 fry
			High Lake (YNP)	2844 eyed eggs
	Last Chance Ck - Madison (YNP)	13;8	High Lake (YNP)	286 eyed eggs
			Sun Pond	70 fry
2009	Muskrat Ck - Elkhorns	24;12	Cherry Ck	4134 eyed eggs
			Sun Pond	311 fry
	Whites Gulch - Elkhorns	8;5	Cherry Ck	630 eyed eggs
			Sun Pond	283 fry
			Cottonwood Ck (R4)	1350 eyed eggs
	Ray Ck - Elkhorns	20;10	Cherry Ck	1911 eyed eggs
			Sun Pond	15 fry
	Geode Ck (YNP)	17;16	High Lake YNP	838 eyed eggs
	WF Wilson Ck - Gallatin	NA	eggs destroyed - hybridized	

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
Arasta	7/14/2005	25	87%Wx8%Rx5%Y
Bean Ck	10/29/2001	54	98% W x 2% R; only 1 fish displayed R alleles
Bean Ck	9/18/2006	25	100% W
Bear Ck	10/29/2001	53	100% W
Bear Ck	9/19/2006	25	100% W
Brays Canyon	10/1/2009	50	100% W
Browns	6/28/2005	15	100% W
Browns	6/22/2006	25	100% W
Buford	???	11	85.7%Wx12.6%Rx1.7%Y
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
Cherry Lake	numerous dates 2009	50	100% W
Cottonwood Ck - Blacktail	6/1/2004	33	100% W
Cottonwood Ck - Blacktail	6/1/2005	19	swarm - 1 fish had 3 Rb alleles; 18 fish no R alleles detected
English George	8/4/2009	25	93.4%W x 4.3%Y x 2.3%R
Halfway	9/26/2007	50	99.9% W x 0.1% R
Hall	7/9/2004	2	100% W
Hall	9/20/2007	50	100% W
Hellroaring Ck	7/26/2005	10	27%Wx17%Yx56%R swarm
Hyde	8/5/2009	25	88.5%W x 7.3%Y x 4.2%R
Jones Ck	10/30/2001	25	WxYxR; some individuals exhibited Y alleles, one exhibited R alleles
Last Chance	6/5/2006	30	100% W
Last Chance	6/18/2007	20	100% W
Last Chance	7/2/2008	21	100% W
Little Elk River	7/19/2005	10	100% Y

McClure	7/1/2004	8	100% W	
McClure	10/7/2009	49	100% W	
Muskrat	6/30/2004	22	100% W	
Muskrat	6/21/2006	24	100% W	
Muskrat	6/20/2007	38	100% W	
Muskrat	6/18/2008	52	100% W	
NF English George	10/18/2001	9	WxRxY, too few fish to discern percentages	
Prickly Pear	10/1/2009	50	100% W	
Ray	7/1/2004	5	100% W	
Ray	6/20/2006	35	100% W	
Ray	6/21/2007	45	100% W	
Ray	6/19/2008	60	100% w	
SF English George Ck	10/18/2001	23	80.4%Wx19.6%Y swarm	
Soap Ck	6/8/2005	10	94% Wx3% R swarm	
Soap Ck	?	51	98% W x 2% R	
Stone	2004	50	100% WCT	
Stone	2005	30	100% WCT	
Tepee Ck of Grayling Ck	8/25/2008	8	51.5%W x 26.6%Y x 21.9%R.	
Little Tepee of Tepee of Grayling	10/1/2009	10	92.3%W x 1.9%Y x 5.8%R	
Upper Fox	9/18/2008	18	97% W x 3% R	
Wall Ck	10/19/2001	25	99% W x 1% R	
WF Wilson	10/1/2001	48	100% W	
Whites Gulch	9/8/2005	50	100% W	
Whites Gulch	6/12/2006	31	100% W	
Whites Gulch	6/12/2007	24	100% W	
Whites Gulch	6/11/2008	54	100% W	
Wild Horse	7/17/2008	30	100% W	