ARCTIC GRAYLING RECOVERY PROGRAM

FLUVIAL ARCTIC GRAYLING MONITORING REPORT 2005

Big Hole River and Reintroduction Efforts

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INTRODUCTION

The fluvial Arctic grayling (Thymallus arcticus) of the Big Hole River represent the last, strictly fluvial, native grayling population in the contiguous United States. After the population declined during the mid-1980's, the Arctic Grayling Recovery Program (AGRP) was formed, which now includes representatives from Montana Fish, Wildlife & Parks (FWP), the Bureau of Land Management (BLM), U.S. Forest Service (USFS), U.S. Fish and Wildlife Service (USFWS), Montana Natural Heritage Program (MNHP), Montana State University (MSU), University of Montana (UM), Montana Chapter of the American Fisheries Society (MCAFS), Montana Trout Unlimited (TU), Pennsylvania Power and Light (PPL), and the National Park Service (NPS). The program's goals are to address ecological factors limiting the Big Hole grayling population, monitor and enhance essential habitats, monitor abundance and population demographics, restore additional grayling populations within their native range, develop relationships that promote conservation actions and inform the general public of the graylings plight. Monitoring and research results have been reported annually since 1991 (Byorth 1991, 1993, 1994, 1995a, 1997, Byorth and Magee 1996, Magee and Byorth 1991 and 1998, Magee 1999 and 2002, Magee and Opitz 2000, Magee and Lamothe 2003, Magee, Rens and Lamothe 2005).

Objectives of the project in the Big Hole River from January 1 through December 31, 2005 were to:

A. Continue to progress towards developing and implementing a Candidate Conservation Agreement with Assurances Program (CCAA) in the Upper Big Hole River drainage.

B. Promote and initiate habitat improvement projects that include riparian enhancement, improving fish passage, minimizing entrainment, and improving stream flow dynamics among Big Hole basin landowners, and serve as a technical advisor for the Big Hole Watershed Committee.

C. Monitor water temperatures and discharge in the Big Hole River and its tributaries.

D. Monitor abundance and distribution of grayling and potential fish competitors in the Upper Big Hole basin.

E. Manage grayling broodstock populations at Axolotl Lake and Green Hollow II Reservoir, collect gametes, and supplement additional year classes as needed.

F. Continue to stock hatchery-reared grayling or use Remote Site Incubators (RSIs) and monitor survival and abundance of these efforts on the Upper Ruby, the North Fork of the Sun, and Missouri River Headwaters restoration sites.

Results for objectives A through D are reported in the Big Hole River section and Appendix A. Objectives E and F are reported in the Reintroduction Efforts section of the report.

STATUS

The fluvial form of Arctic grayling in the upper Missouri River drainage in Montana satisfy both the discreteness and significance criteria of the Distinct Population Segment (DPS) Policy relative to populations in Canada and Alaska and, thus, are a distinct population segment of the taxon (USFWS Fed. Reg. 1996, Campton and Ardren 2004, Leary 2005). Fluvial Arctic grayling in Montana are designated as a “Species of Special Concern” by FWP, the Endangered Species Committee of the American Fisheries Society, the Montana Chapter of the American Fisheries Society and the Montana Natural Heritage Program (Holton 1980: Williams et al. 1989: Clark 1989, Genter 1992, MNHP 2004). The United States Forest Service and the Bureau of Land Management classify fluvial Arctic grayling as a sensitive species. In October 1991, the United States Fish and Wildlife Service (USFWS) received a petition to list fluvial grayling in Montana

throughout its historic range under the Endangered Species Act (ESA). The USFWS 1994 finding classified fluvial grayling in Montana as a Category 1 species, which indicates that there is enough information on file to support a proposal to list the grayling as threatened or endangered (USFWS Fed. Reg. 1994). In March 2004, the USFWS elevated grayling in listing priority for a DPS from a level 9 to a level 3 (USFWS Fed. Reg. 2004). This is the highest priority level given to a DPS. The priority level was elevated because; 1) the current distribution of fluvial grayling represents less than 5% of the historic range, and 2) recent population surveys suggest a decline in the Big Hole River population. In May of 2004, the USFWS was sued to emergency list the fluvial grayling. The courts decision in August 2005 mandated the USFWS must make a final determination of ESA status for Montana fluvial Arctic grayling by April 16, 2007.

Candidate Conservation Agreements with Assurances

A CCAA is an agreement between the USFWS and any non-federal entity whereby non-federal property owners who voluntarily agree to manage their lands or waters to remove threats to species at risk of becoming threatened or endangered, receive assurances against additional regulatory requirements should that species be subsequently listed under the ESA.

The goal of the CCAA program is to secure and enhance the population of fluvial (river-dwelling) Arctic grayling within the upper reaches of the Big Hole River drainage. Under the CCAA, FWP will hold an ESA Section 10(a)(1)(A) Enhancement of Survival Permit issued by the USFWS. Once this CCAA is executed, FWP will issue Certificates of Inclusion to non-federal property owners within the project area who agree to comply

with all stipulations of the CCAA and develop an approved site-specific management plan. Site-specific plans will be developed with each landowner by an interdisciplinary technical team made up of individuals representing FWP, USFWS, NRCS, and DNRC. Conservation measures under the agreement will: 1) Improve streamflow dynamics, 2) Improve and protect the function of stream and riparian habitats, 3) Identify and reduce or eliminate entrainment threats for grayling, and 4) Remove barriers to grayling migration.

In 2005, FWP worked with the USFWS, NRCS, and the DNRC to develop the CCAA umbrella document that outlines conservation measures and responsibilities of all involved parties should the CCAA be implemented. In addition, efforts were made to inform and gage interest of publics, special interest groups, and private landowners in the CCAA Program. Landowner enrollment was open during the period from April 1-April 15, 2005. Open house enrollment forums were held in Wisdom and Jackson on April 5th and 6th respectively. Interest in the CCAA was substantial, with 40 non-federal landowners controlling approximately 250,000 of the 380,000 non-federal acres in the designated CCAA area enrolled as of December 31, 2005 (Figure 1). Landowners enrolling during this period were considered the highest priority for developing site-specific plans. Enrollment of additional landowners can occur until 90 days prior to a listing action.

The CCAA delineates the upper Big Hole into five management reaches (Figure 1). Conservation measures described above will be implemented in each management reach. Stream flow, temperature, habitat, channel morphology and population monitoring will be completed in each reach. In 2005, we began collecting stream flow, temperature,

and channel morphology data, and completed fish population surveys included in the results section of this report. Rapid Assessments were completed on all enrolled properties. These assessments identified potential immediate threats to grayling (chemical spills, oil leaking into river from vehicle rip-rap, etc.) as well as habitat concerns (barriers, degraded banks, stock crossings, diversions). Results from those surveys will be reported separately.

The CCAA umbrella document and accompanying federal and state Environmental Assessments were completed and open for public comment from November 23, 2005 – January 23, 2006. If approved, development of site-specific plans with non-federal landowners will begin in 2006**.**

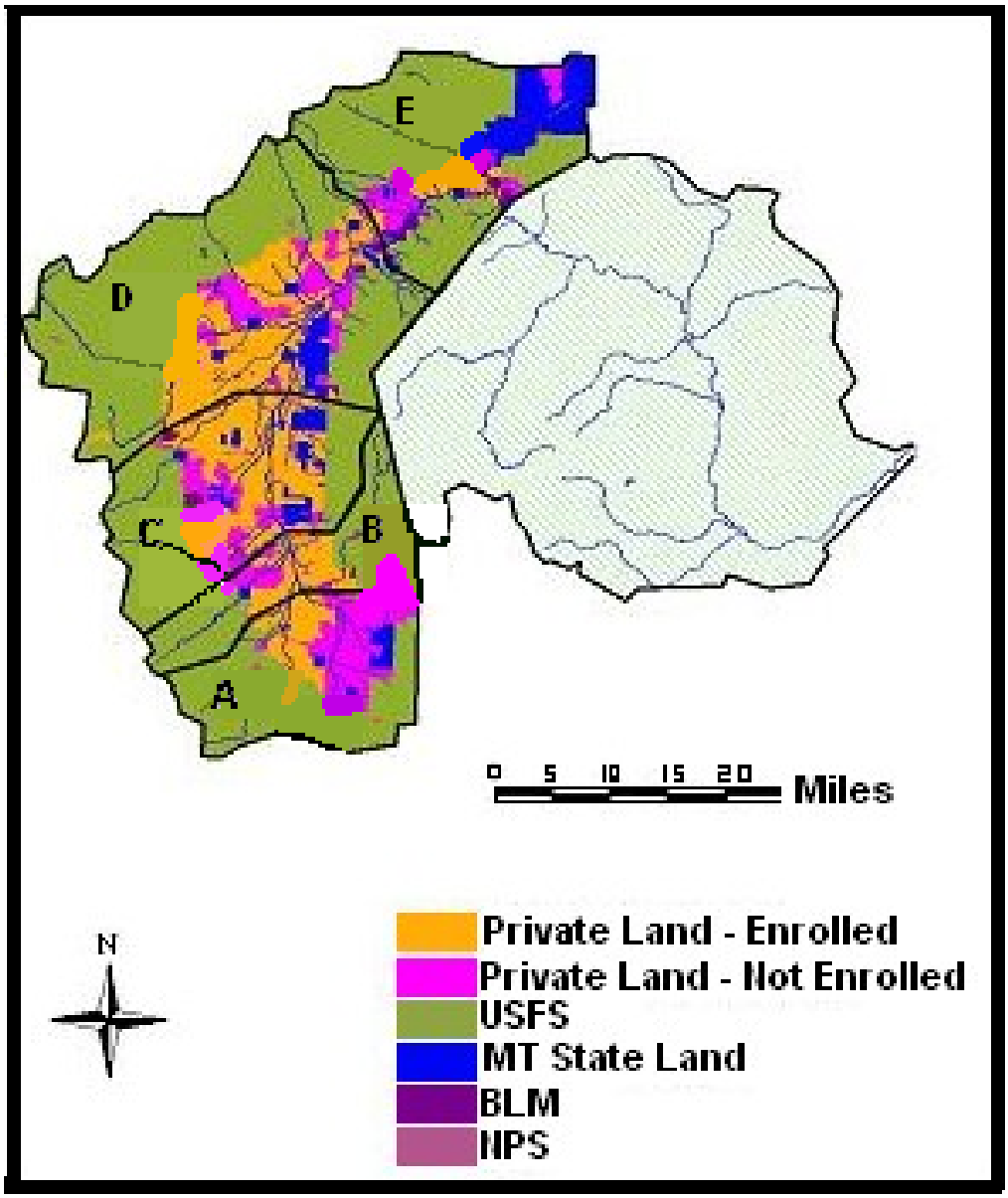

Figure 1. Map of CCAA program and property ownership showing enrolled properties.

BIG HOLE RIVER

METHODS

Conservation Efforts and Projects

Conservation efforts and projects initiated in 2005 included the conservation measures outlined in the CCAA program that address improving streamflow dynamics, riparian and channel morphology, fish passage and entrainment. Due to below average snow pack and precipitation in winter/spring 2005 and projected below average runoff, FWP biologists, DNRC hydrologists, Big Hole Watershed Committee (BHWC) members, landowners and the local water commissioner organized a conservation plan to enhance instream flows. Montanan Trout Unlimited provided funding to hire the local water commissioner to assist in implementing and tracking voluntary conservation measures. In April, FWP provided landowners with an informational leaflet on grayling biology, habitat requirements, and migration patterns within the Big Hole Valley. This brochure also provided landowners with a list of conservation measures that would enhance instream flows, improve access for grayling to essential seasonal habitats, and reduce grayling entrainment into irrigation diversions. Landowners were asked if they would voluntarily reduce diversions to facilitate suitable stream flows during spring spawning. Additional projects were initiated that improved irrigation efficiency, stabilized banks, reduced sedimentation, protected riparian corridors, improved fish passage and enhanced instream habitats to benefit Arctic grayling and sympatric species.

Water Temperatures and Stream Discharge

The U.S. Geological Survey (USGS) measured discharge of the mainstem Big Hole River from April through October at the Wisdom Station, the Mudd Creek Station, and year round at the Melrose Station (USGS 2005, http://waterdata.usgs.gov/nwis) (Figure 2). Aqua rods (Sequoia Version 4.0 2003) were also installed to spatially assess flow dynamics in the Upper Big Hole River and tributaries. Aqua rods were placed on the mainstem Big Hole River at Saginaw Bridge, Miner Creek Road Bridge, Petersons Bridge, Little Lake Creek Road Bridge, Twin Lakes Road Bridge, below the mouth of Steel Creek, and at Dickie Bridge. Additional Aqua rods were installed in tributaries located at the mouth of the North Fork, Steel Creek and LaMarche Creek (Figure 2). Water temperature was monitored at the USGS Wisdom and Melrose stations, at six aqua rod sites and 16 thermograph stations located in the mainstem Big Hole or tributaries (Figure 2). FWP used Onset Hobotemp and Stowaway thermographs to record temperatures at 60-minute intervals. Data were downloaded into Microsoft Excel and reduced to daily maximum, minimum, and average temperatures.

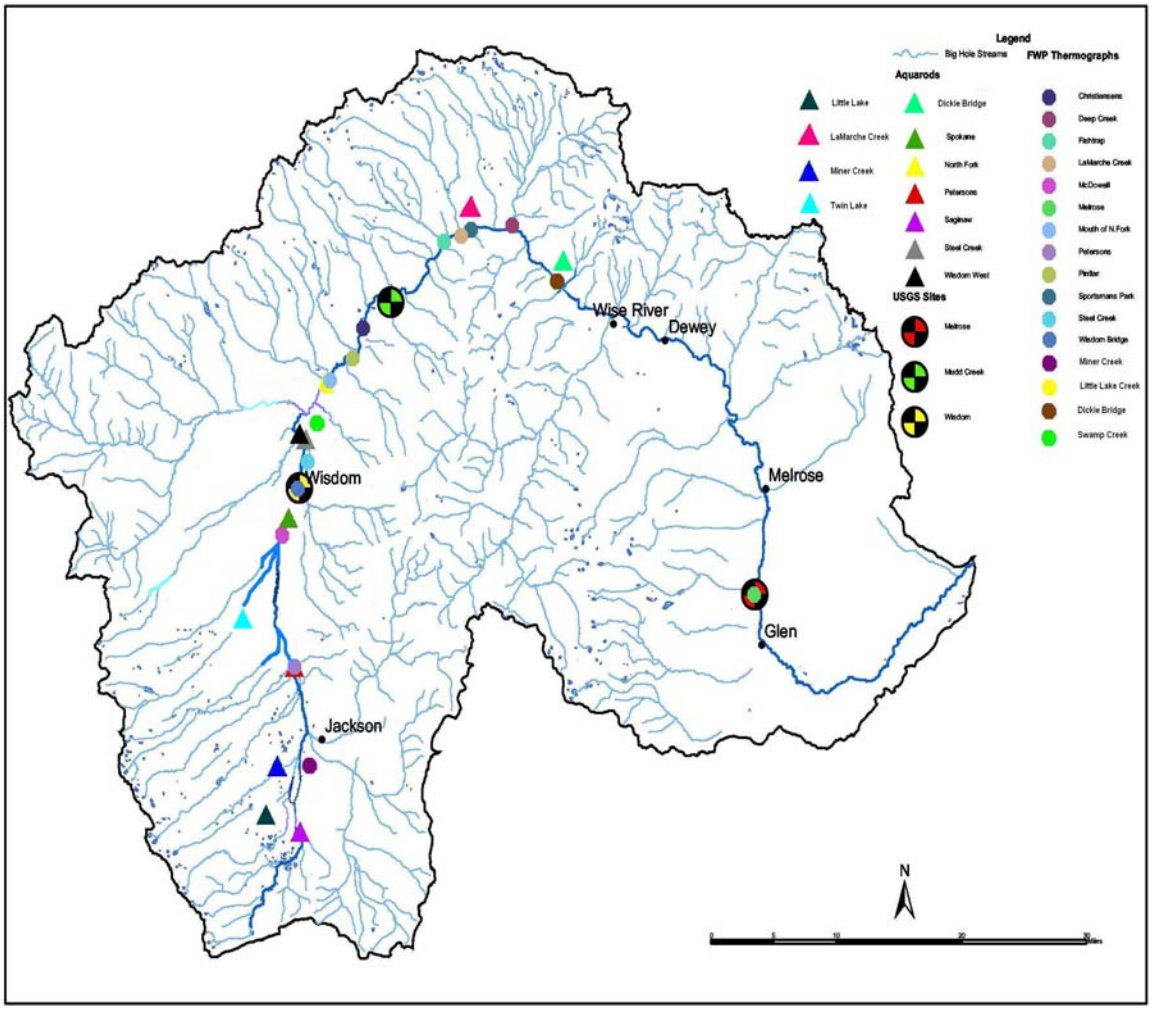

Figure 2. Map of the Big Hole River delineating locations of Aqua rods, thermographs, and USGS gages.

Population Monitoring

FWP monitors the Big Hole River grayling population to document population abundance, recruitment, age class strength, and distribution. Rainbow trout (Oncorhynchus mykiss), brown trout (Salmo trutta), brook trout (Salvelinus fontinalis), and burbot (Lota lota) greater than 6 inches are also sampled to document densities and relative abundance. All sizes of grayling are sampled.

Electrofishing sampling uses a mobile-anode DC system powered by 4,000-watt generator coupled with a Coffelt Mark XXII-M rectifying unit mounted on a drift boat or Coleman Crawdad. Target species are captured and held in a live well. Fish are anesthetized, measured (total length (± 0.1 in.) and weight (± 0.01 lb.)), fins are notched as a temporary mark, and scales are collected for aging. Grayling greater than 6 inches are tagged with a visible-implant (VI) tag in transparent adipose tissue immediately posterior to the eye.

Fall population surveys in the Upper Big Hole River and tributaries provide an index of grayling abundance and recruitment. FWP conducted electrofishing surveys between September 12 and October 26, 2005. One-pass surveys were completed on a mainstem and a tributary reach in each of the 5 CCAA management reaches. These reaches will be referred to CCAA (A), CCAA (B), CCAA (C), CCAA (D) and CCAA (E) on the mainstem and include Governor, Miner, Rock, Steel and Deep Creeks sections on the Tributaries (Figure 3). Additional surveys were conducted on mainstem reaches, including, Little Lake Creek, 40 Bar, Wisdom West, and the "Pools", (including Sawlog, Fishtrap and Sportsmans pools) and on tributaries including the North Fork, Big Lake Creek, Swamp Creek, Mudd Creek, Fishtrap Creek, LaMarche Creek, and Seymour Creek (Figure 3). An additional FWP crew annually monitors trout populations in the lower river, and surveys were completed on the Jerry Creek and Melrose Sections in the Fall of 2005. Multiple mark and recapture runs were completed between September 19 and October 6, 2005 (Figure 3).

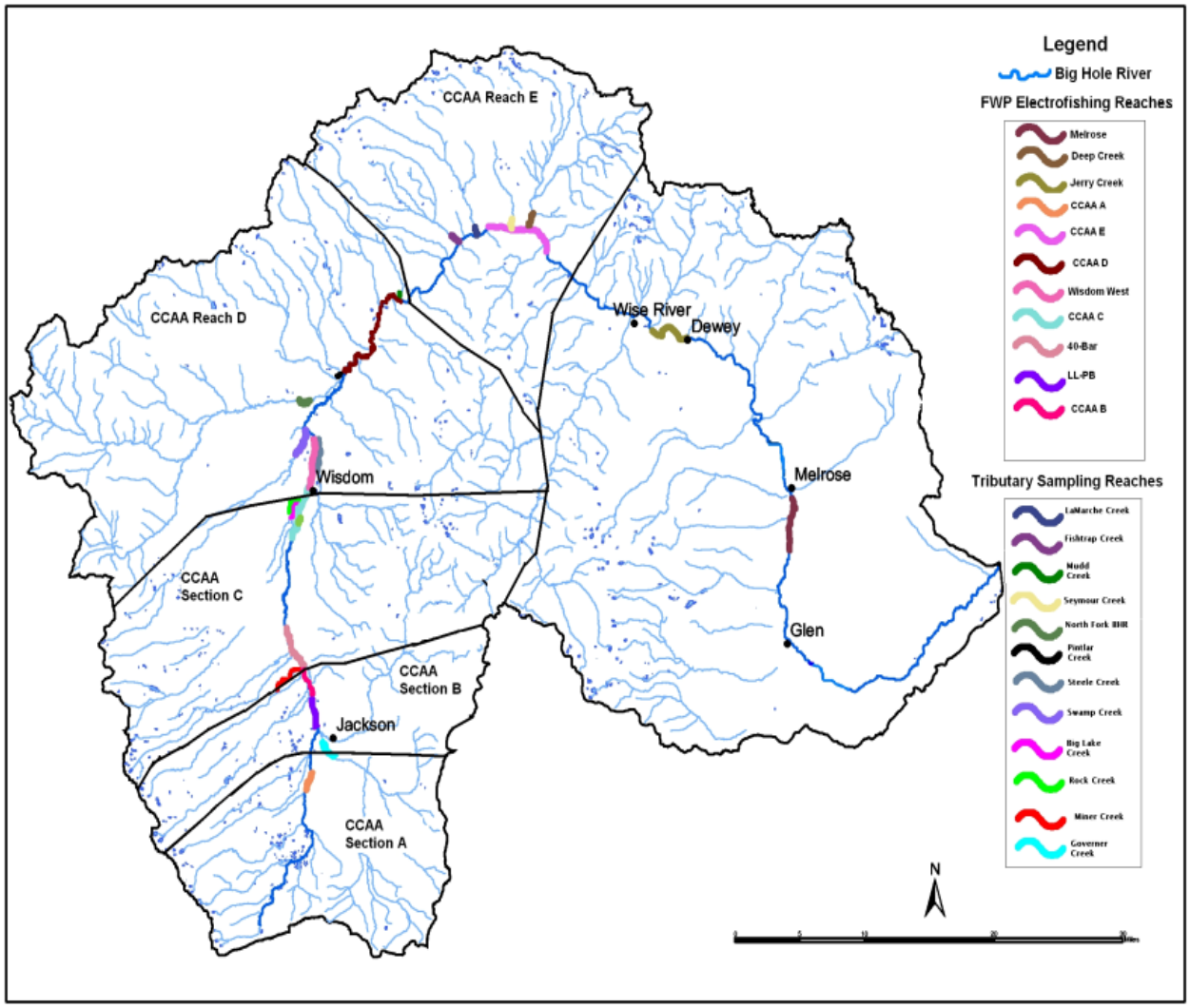

Figure 3. Map of the Big Hole River showing Montana Fish, Wildlife, and Parks electrofishing reaches in fall 2005, and CCAA management reaches.

Electrofishing data are entered and summarized with Fisheries Analysis 1.0.8 (Montana Fish, Wildlife and Parks 2004). Catch-per-unit-effort (CPUE) for all age classes is reported as number of fish captured per mile and used to show trends of grayling population abundance and spatial distribution. Length–frequency analysis are used to summarize population age structure.

RESULTS

Conservation Efforts and Projects

Due to below average snow pack and spring instream flows the efforts to organize conservation actions began in March 2005. As part of the CCAA enrollment, landowners (n=40) agreed to participate in conservation measures that would improve instream flows beginning in mid-April. Landowners individually reduced or delayed diversions to enhance instream flows. Snow pack conditions were considerably worse in 2005 than 2004 (52% vs. 71% of Period Of Record (POR)). These efforts improved flows substantially during the graylings spawning period (Figure 4).

Big Hole River peak runoff generally occurs from June 1 – June 15, and flows typically decline thereafter through August. The Big Hole Drought Management Plan (DMP) promotes instream flow conservation measures and implements angling closures to further reduce stress to aquatic species during extreme low flow periods. The DMP for the upper reach of the Big Hole (from Rock Creek Road to the Mouth of the North Fork) stipulates 20 cfs as a flow that maintains a wetted channel and allows fish species access to other reaches and tributaries that may have improved conditions. At this flow (20cfs), FWP implements an angling closure to reduce additional potential stress. In 2005, an angling closure occurred on the upper reach from August 26 - October 14, 2005, when flows dropped below 20 cfs (BHWC DMP 2001). This was an improvement from 2004 when the upper reach was closed to angling the entire season: May 21-November 30, 2004.

In 2005, instream flows improved (despite continued drought conditions) due to voluntary agreements with landowners and water conservation projects. Landowners reduced flow diversions, replaced non-functioning headgates, improved diversion structures and developed alternative stock water sources to mitigate poor snowpack and below average precipitation.

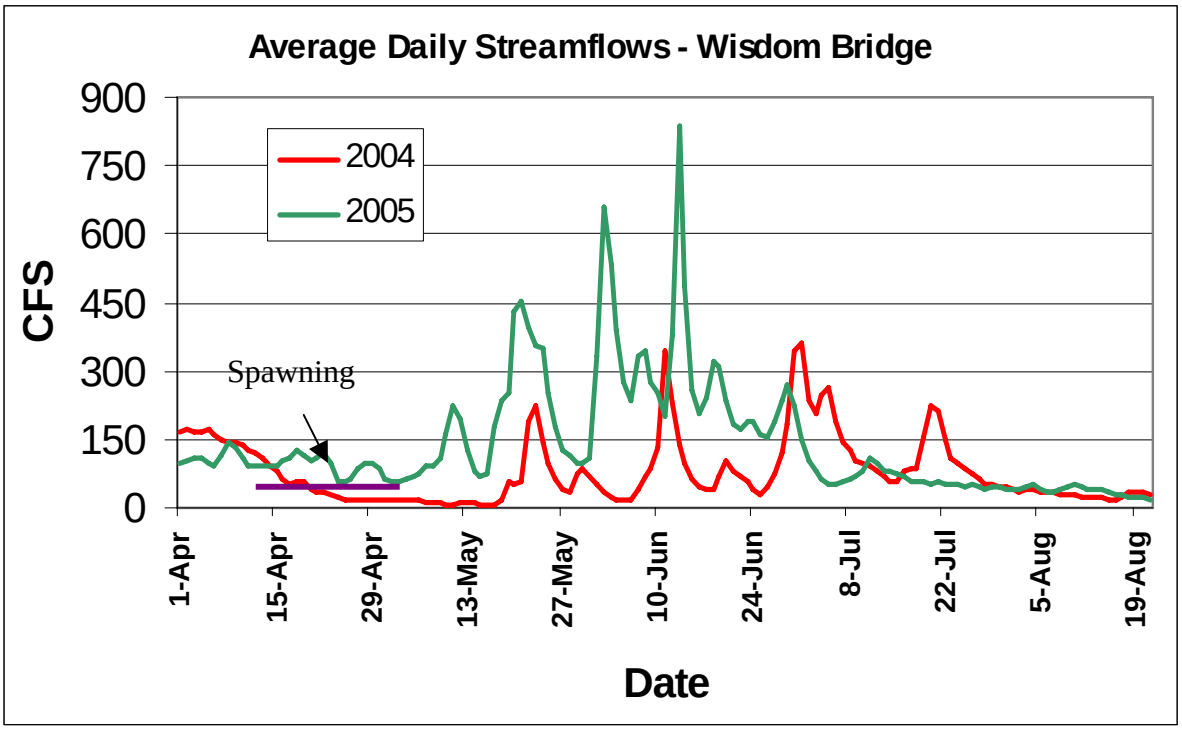

Figure 4. Hydrograph at the USGS gage at Wisdom, MT showing instream flows in 2004 and improved flows in 2005 despite lower snow pack, due to conservation efforts.

In 2005, numerous conservation projects were initiated and completed on the Big Hole River and its tributaries. These projects improved fish passage, irrigation efficiency, riparian vegetation, bank stability, and pool availability (Figure 5, Table 1). Projects were funded cooperatively by FWP, BHWC, PFWP, NRCS, BLM and individual landowners.

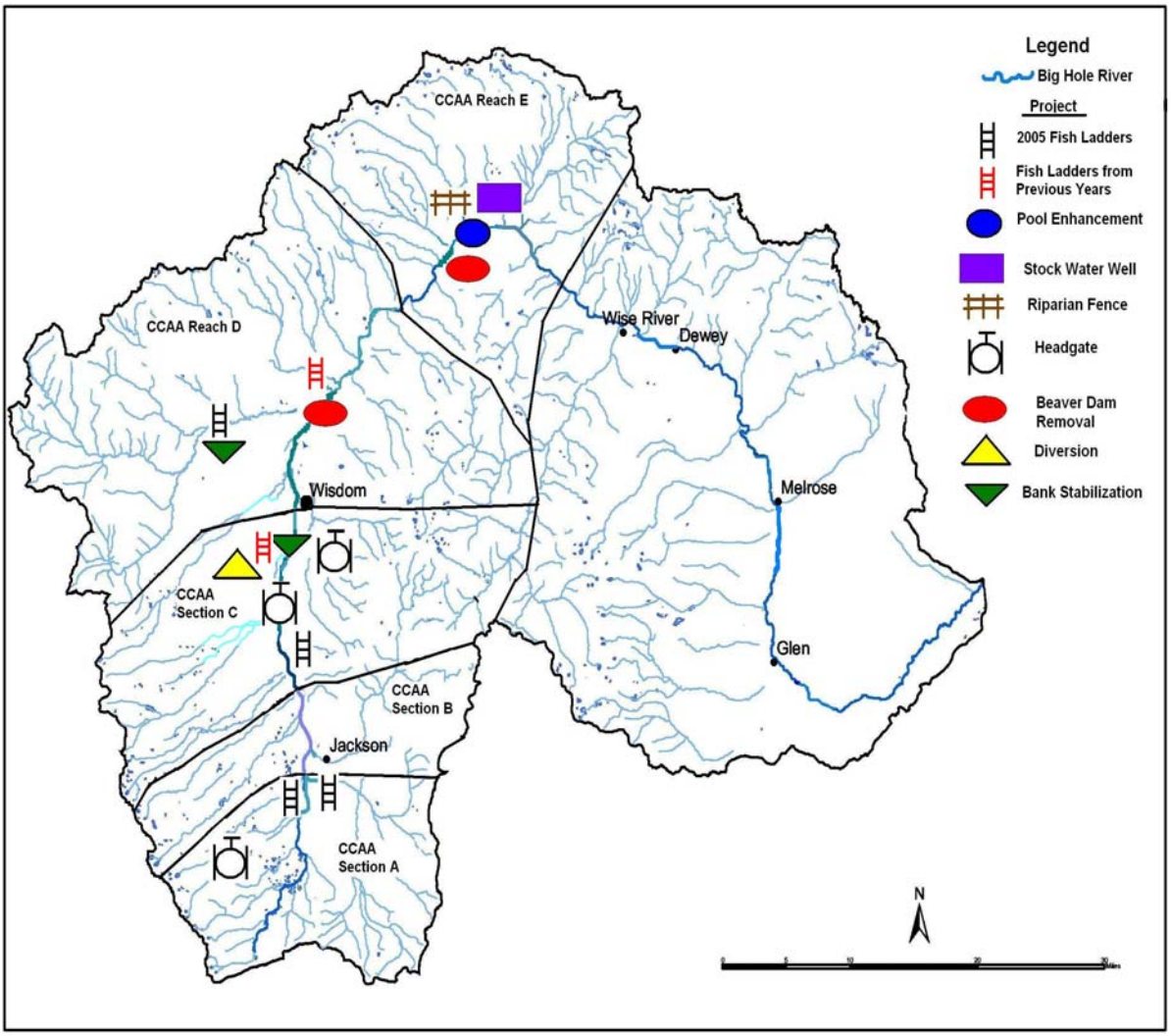

Figure 5. Habitat projects initiated and/or completed in 2005 and previously installed fish ladders on the Big Hole River and its tributaries.

Table 1. Conservation projects initiated or completed in the upper Big Hole River and tributaries in 2005.

Type	Stream	CCAA Reach	Purpose
Headgates (2)	Little Lake Creek	A	Irrigation Efficiency
Fish Ladders (2)	Big Hole River	A	Fish Passage
Diversion	Big Hole River	C	Irrigation Efficiency, Fish Passage
Headgate	Big Hole River	C	Irrigation Efficiency
Headgate	Big Hole River	C	Irrigation Efficiency
Bank Stabilization	Big Hole River	C	Stabilize Banks, Remove Sediment
Fish Ladder	Big Hole River	C	Fish Passage
Bank Stabilization	North Fork	D	Stabilize Banks, Remove Sediment
Beaver Dam Removal/Notching	Steel Creek	D	Fish Passage
Fish Ladder	North Fork	D	Fish Passage
Riparian Fence	LaMarche Creek	D	Riparian Conservation
Pool Enhancement	LaMarche Creek	E	Instream Habitat Enhancement
Stock Water Well	LaMarche Creek	E	Riparian Conservation, Irrigation Efficiency
Beaver Dam Notching/Removal	Fishtrap Creek	E	Fish Passage

Water Temperatures and Stream Discharge

Instream temperatures are a result of air temperature, photoperiod, riparian health, channel morphology and streamflow. Maximum stream temperatures in the upper Big Hole River typically peak in July and decrease in August with cooler nighttime temperatures and decreasing photo period. Maximum temperatures in 2005 occurred on July 13 and July 23 for most thermograph sites (Figures 6a & 6b). Instream temperatures increased from the headwaters (Miner Creek site) downstream to Christiansen's and then decreased at the Sportsman's and Dickie Bridge sites. Mainstem sites (Christiansen's, Pintlar and Sportsmans) with high width to depth ratios and little woody riparian vegetation exceeded upper incipient lethal temperatures (77°F) for Arctic grayling (Lohr et. al. 1996)(Figure 6a and 7). The Steel Creek and the mouth of the North Fork sites had

similar thermal regimes as nearby mainstem reaches, while the other tributaries (Swamp, Fishtrap, LaMarche and Deep Creek) were cooler (Figures 6a, 6b and 7).

The snowpack in the Big Hole basin was 52% of the POR and 71% of the 2004 snowpack on April 1, 2005. Lowest mean daily flow at the USGS Wisdom gage was 15 cfs on September 9 and the highest mean daily flow was 835 cfs on June 13, 2005. Precipitation from May-September was approximately 0.64 inches above the long-term mean at Wisdom. However, due to poor snowpack and cumulative drought conditions, stream flows were 43%, 64%, and 55% of the POR for the Wisdom, Mudd Creek and Melrose USGS gages respectively (Figure 8).

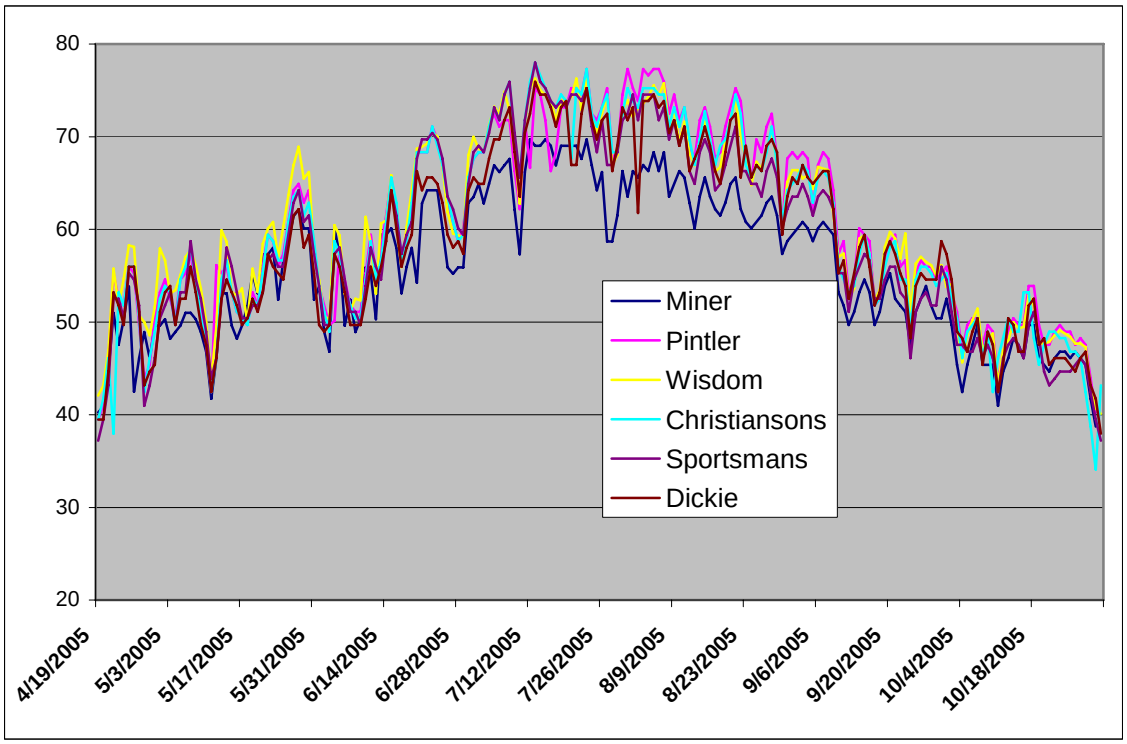

Figure 6a. Big Hole River maximum daily mean temperatures from MFWP Hobo temp-loggers on the Big Hole River, 2005.

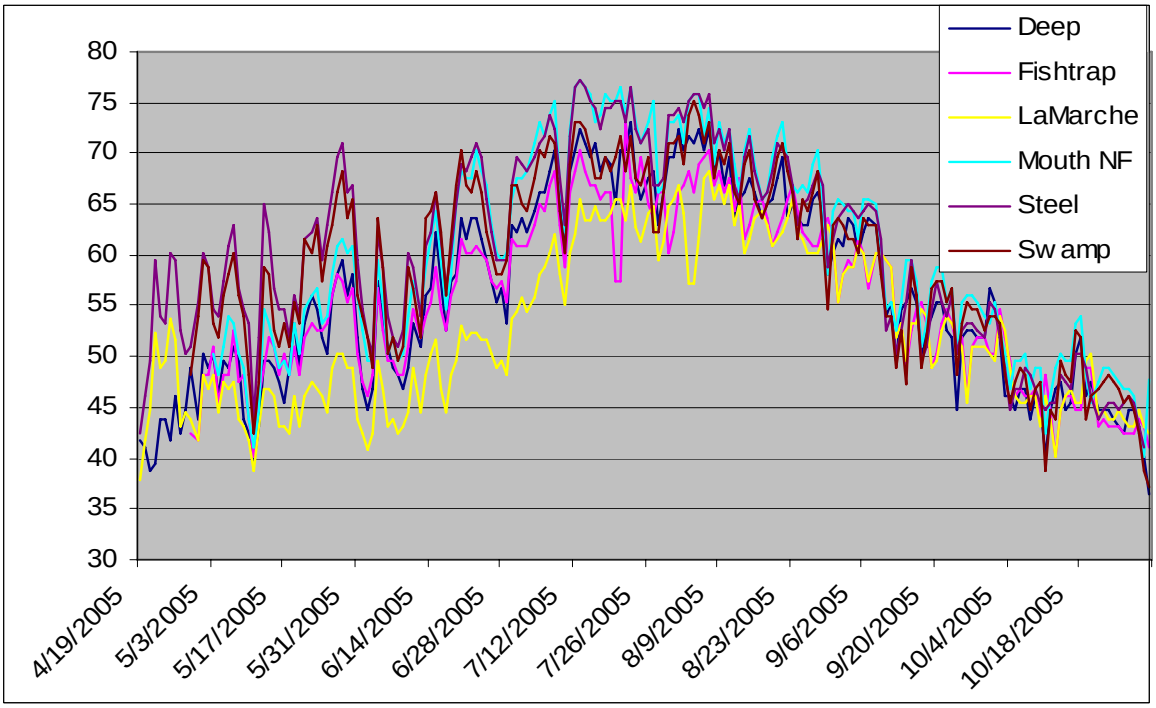

Figure 6b. Big Hole River tributary maximum daily mean temperatures from MFWP Hobo temp-loggers on the Big Hole River, 2005.

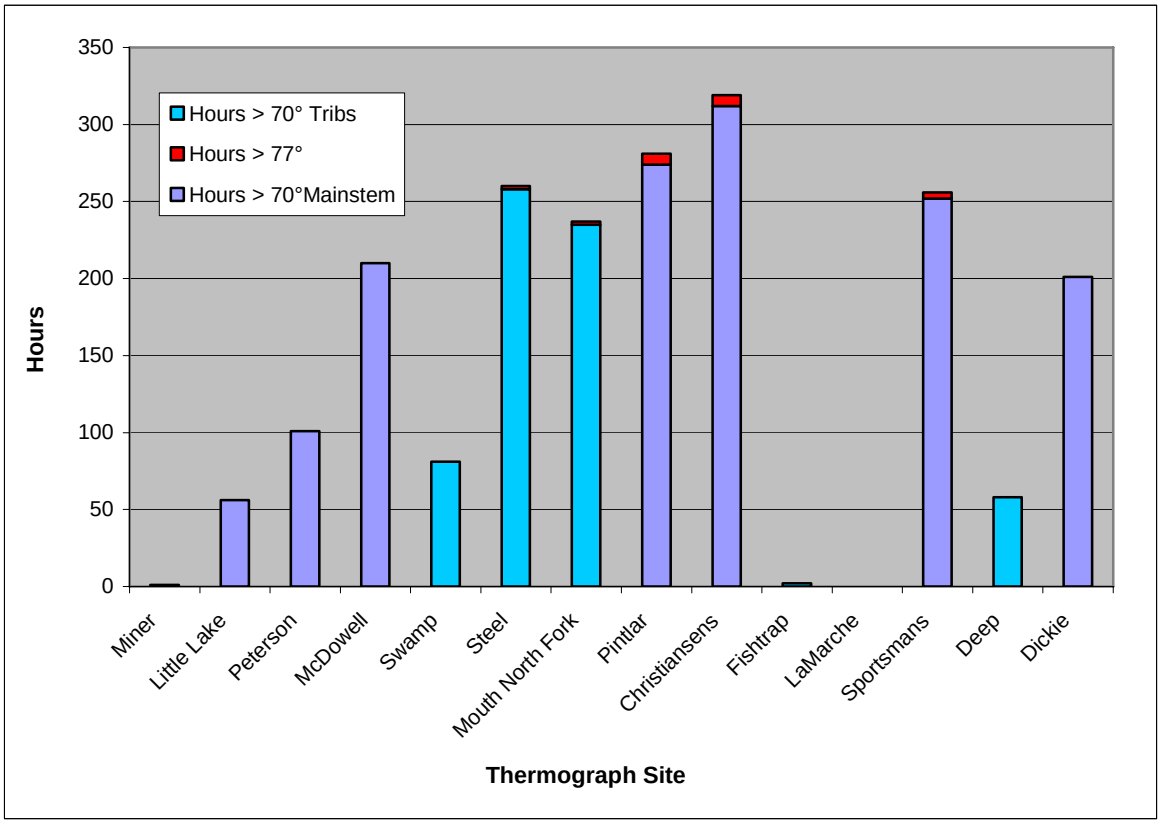

Figure 7. The total number of hours recorded at each thermograph station that exceeded 70 and 77 degrees from April to October 2005.

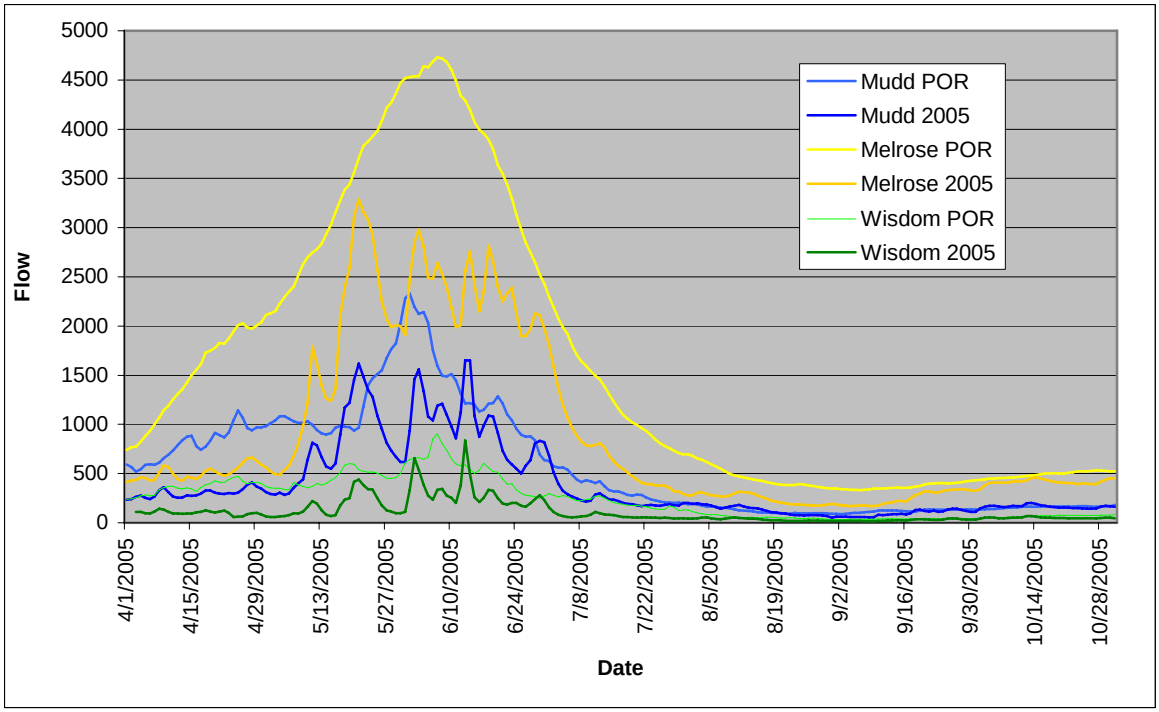

Figure 8. Mean Daily Flow and Period of Record for Mudd Creek, Melrose, and Wisdom USGS gages for 2005 (data is provisional).

Population Monitoring

Fall surveys indicate the current Big Hole grayling population age composition is dominated by juvenile grayling with approximately 30% Young-of-the-Year (YOY) (<6inches), 26% age 1 (7-9 inches) and 29% age 2 (10-12 inches) of total the captured grayling (N=99) (Figure 9). CPUE indicates reduced YOY abundance from 2003 and 2004; however, the strong YOY age-class from 2003 can be seen as age-2 grayling in the fall of 2005 (Figure 9). Age-2 grayling were dispersed throughout the Big Hole and tributaries from Jerry Creek section upstream to CCAA C (Figure 10). Age-3 and older grayling (>12 inches) remain at low abundance exemplified by lower CPUE in the "Pools" compared to past years (Figure 11). Poor recruitment over the past few years has resulted not only in this low abundance, but also a population structure dominated by

juvenile age classes. Successful reproduction of the 2003 cohort (which reaches maturity in 2006) will be a positive step to reversing current population trends.

In recent years, tributaries have provided habitat and conditions utilized by all age classes of grayling and have had the highest abundance of grayling in fall surveys compared to mainstem Big Hole reaches (Figure 10). Tributaries also provide favorable conditions to other species; Fishtrap, LaMarche and Deep Creek had among the highest catch rates of grayling as well as brook trout, rainbow trout, and burbot (Appendix A, Table 1). The Schindler reach in the mainstem Big Hole had the highest CPUE of brook trout for mainstem reaches (Appendix A, Table 2). Rainbow trout and brown trout are more abundant in downstream reaches and tributaries (Deep Creek, CCAA (E) (Appendix A, Tables 1 and 2).

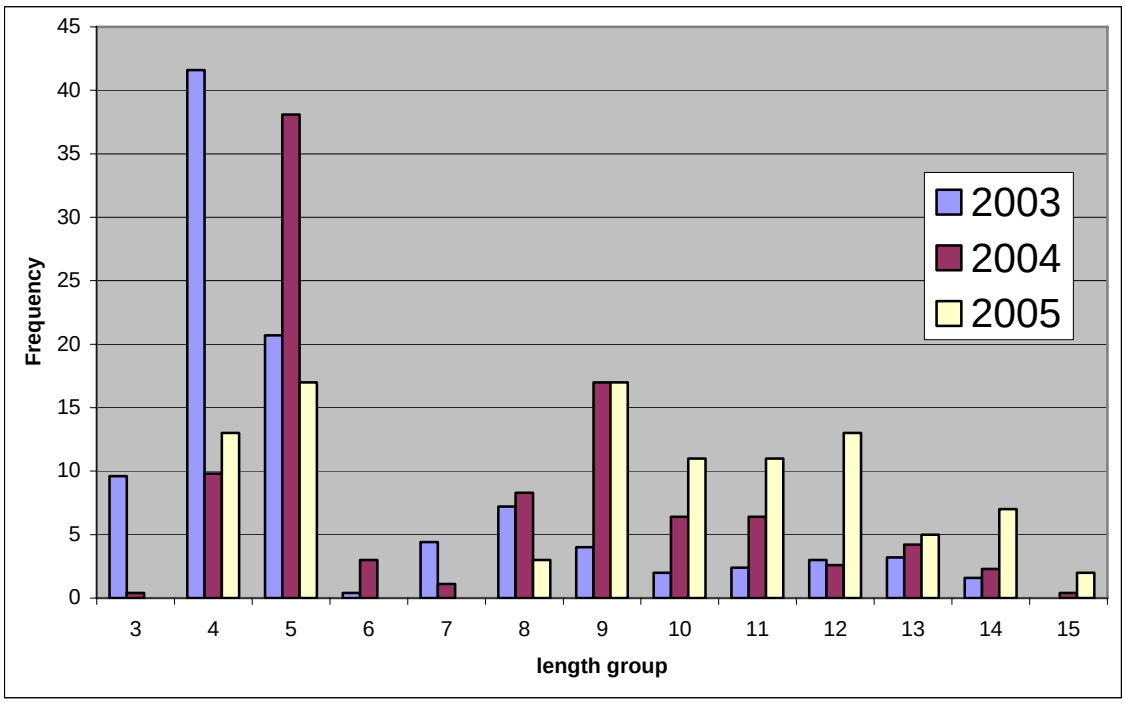

Figure 9. Arctic grayling Length-Frequency histogram from fall 2003-2005 MFWP electrofishing surveys on the Big Hole River, Montana.

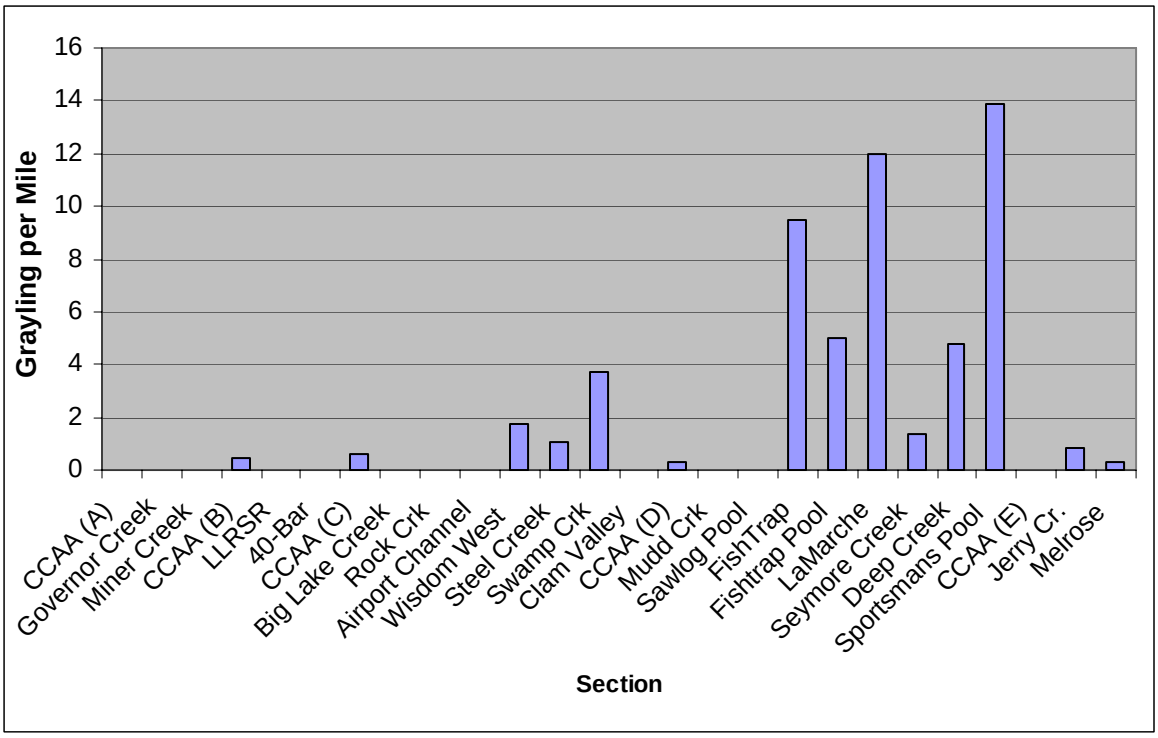

Figure 10. Catch per Effort (grayling per mile) for MFWP fall 2005 electrofishing sections on the Big Hole River, Montana.

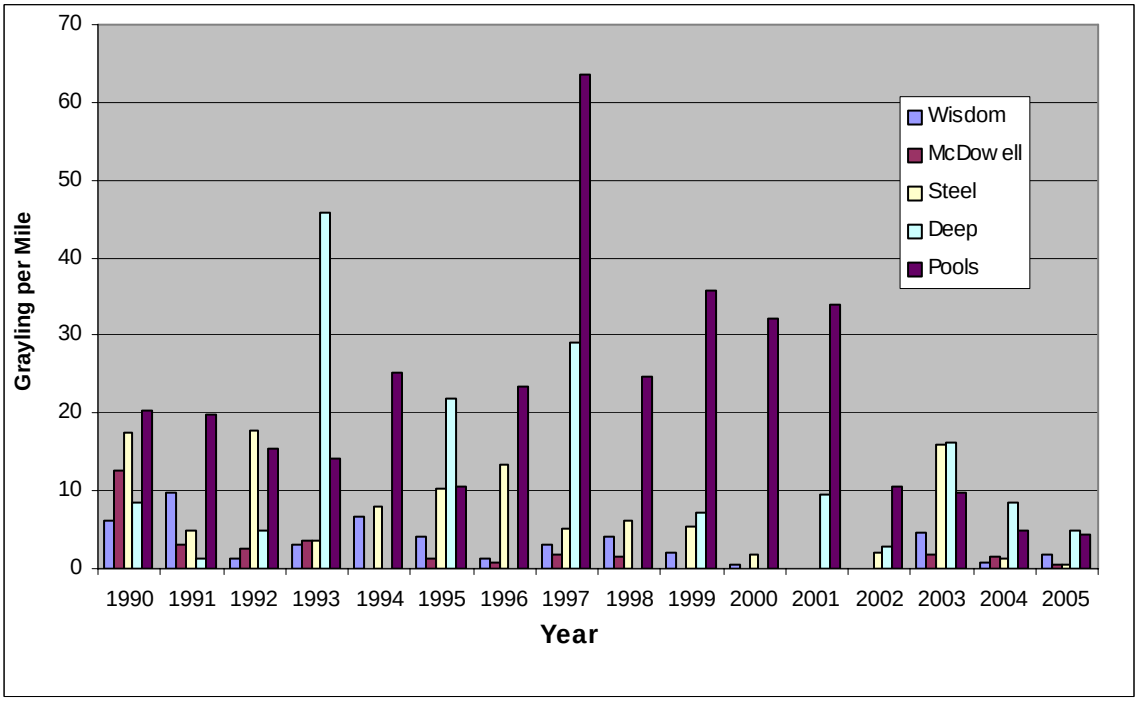

Figure 11. Arctic grayling (fish per mile) for MFWP electrofishing sections: Wisdom, McDowell, Steel, Deep Creek, and "Pools" sections of the mainstem Big Hole River from 1990 – 2005. Note: no surveys were completed in the McDowell from 1999-2001, in Wisdom in 2001 and 2002, in Steel Creek in 2001, and in Deep Creek in 1994,1996, 1998, and 2000 due to adverse environmental conditions.

DISCUSSION

Spatial distribution of grayling and sympatric species is a function of habitat availability, access, migration patterns and instream thermal and flow conditions. Optimal habitat conditions increase carrying capacity, however, unimpeded spatial and temporal access to these habitats is essential for grayling propagation and survival. Population surveys in 2005 found grayling distributed in the mainstem and tributaries from Melrose upstream to CCAA Reach B (approximately 77 miles). The expansive range of grayling reiterates the need for basin-wide conservation efforts that include habitats necessary for all life history stages. Conservation measures must address factors limiting grayling habitat that include improving stream flow dynamics, riparian and channel health, fish passage and entrainment.

Tributaries with intact riparian areas, healthy channel morphology and unimpeded access (such as Fishtrap, LaMarche, and Deep Creek) have had the highest abundance of grayling and sympatric species over the past few years. Similarly, management segments with reaches on the mainstem Big Hole River (CCAA Reaches A and B) with healthy channel morphology and riparian corridors also have high abundance of trout species. In contrast, fall surveys indicate these upstream mainstem reaches have few grayling, again, emphasizing the need to manage habitat on a basin wide scale and ensure connectivity of suitable habitats throughout the Big Hole and it's tributaries.

With a snowpack of 52% of the POR in 2005, the Big Hole River suffered from drought conditions for the seventh consecutive year. Percent snowpack was less than 2004, yet flows were improved. Voluntary conservation measures implemented by

landowners were invaluable towards improving needed timely stream flows. Conservation projects that improve irrigation efficiency have been initiated and will continue in 2006. While much of the attention over the past 15 years has been focused on upper river instream flows (particularly at the Wisdom Bridge), it is imperative that conservation efforts include limiting factors other than instream flows (identified in the CCAA) and on a broader scale.

The majority of the current range of Arctic grayling in the Big Hole River is on private lands. The CCAA represents a unique opportunity to implement conservation efforts on private lands that will benefit Arctic grayling and the entire Big Hole River ecosystem while working with the landowners on an individual and community basis. Forty non-federal landowners have enrolled approximately 250,000 acres in the CCAA that will encompass conservation efforts for Arctic grayling. Efforts in 2006 will focus on developing site-specific conservation plans with the landowners enrolled in the CCAA Program.

Montana Fish, Wildlife and Parks and partners in the Arctic Grayling Recovery Program will work to implement the CCAA and establish additional populations in 2006. Efforts to work with landowners, watershed and interest groups, and cooperative agencies will continue in 2006 to conserve, protect, and enhance fluvial Arctic grayling in Montana.

REINTRODUCTION EFFORTS

INTRODUCTION

The long-term restoration goal for Montana Arctic grayling is to establish five populations (including the Big Hole) within the species' historic drainages by 2020 (Montana Fluvial Arctic Grayling Restoration Plan, 1995). The fluvial grayling brood program was developed to ensure that the genetic integrity of fluvial grayling was secured, and to provide a source of gametes for restoration efforts. Three fluvial brood populations have been developed, and are located at FWP Big Timber State Hatchery, Axolotl Lake and Green Hollow II Reservoir. Restoration efforts were initiated in 1997 in the Upper Ruby River and have expanded to the North and South forks of the Sun, the lower Beaverhead and the Missouri River Headwaters since 1999. Due to drought conditions and limited resources in 2002, the Fluvial Arctic Grayling Workgroup recommended focusing reintroduction efforts on the Upper Ruby River and to continue other efforts as funding, workload and resources allowed. In 2005, FWP continued to assess limiting factors and survival of previous plants or continued to plant grayling or use remote stream incubators (RSIs) in the North Fork of the Sun River, Missouri River Headwaters, and the Upper Ruby River. Specific objectives of the restoration efforts reported in this summary were to:

A. Monitor grayling brood stock populations at Axolotl Lake and Green Hollow II Reservoir, collect gametes, and supplement additional year classes as needed.

B. Monitor abundance and distribution of planted grayling and potential competitors at each of the restoration sites.

C. Monitor to determine if natural reproduction of grayling has occurred at each of the restoration sites.

D. Monitor physical factors such as stream flows and temperatures that may affect success of establishing grayling populations at each of the restoration sites where possible.
E. Continue to stock hatchery-reared grayling or use Remote Site Incubators (RSIs) on the Upper Ruby, North and South Fork of the Sun, and Missouri River Headwaters.

BROOD PROGRAM

The Arctic grayling brood reserves at Axolotl Lake and Green Hollow II Reservoir provide gametes that are developed to eyed eggs, fingerlings or yearlings for reintroduction efforts in streams or rivers in historical native drainages of fluvial Arctic grayling. These brood populations are sampled annually to determine abundance and collect gametes. Fyke nets and hook-and-line techniques are employed to capture grayling. As per the FWP fish health protocol, all grayling (including fertilized eggs) are tested prior to relocating to state hatcheries, or planting into restoration streams.

METHODS

Axolotl Lake Brood

The grayling brood reserve was first planted in Axolotl Lakes in 1989 and has been supplemented periodically with progeny of the fluvial grayling brood stock derived from Big Hole River grayling. For fish health testing, kidney samples were taken from 60 grayling on April 26, 2005 and ovarian fluids were taken from 60 spawning grayling on May 19, 2005 and tested for various pathogens.

Most captured grayling were weighed, measured, marked for population estimates, and released. As grayling became gravid, they were sorted by sex and retained

in separate live cars. Big Springs Trout Hatchery personnel directed egg collection on May 19 and May 26, 2005.

Eggs were stripped from female grayling, pooled, and fertilized with milt from males. After fertilization, eggs were rinsed, packed in ice, and transported to Big Springs State Fish Hatchery. Stripped grayling were then released back in to the lake.

Green Hollow II Reservoir Brood

The Arctic grayling brood reserve was first planted in 1998 in Green Hollow II Reservoir on Turner Enterprises' Flying D Ranch and is supplemented periodically with progeny of the fluvial grayling brood stock derived from Big Hole River grayling.

For fish health testing, kidney samples were taken from 58 grayling, 14 brook trout, and 5 rainbow-cutthroat trout hybrids on April 12, 2005 and ovarian fluids were taken from 60 grayling after being spawned on May 12, 2005 and tested for various pathogens. Big Springs Trout Hatchery personnel directed egg collection on May 12, 2005.

To reduce the risk of BKD, as per request of the FWP Fish Health Committee, we continued a brook, rainbow, and rainbow/cutthroat hybrid trout removal program from Green Hollow II Reservoir. All captured fish except grayling were removed from the lake during population surveys and gamete collections efforts.

RESULTS

Axolotl Lake Brood

All samples submitted for disease analysis tested negative for pathogens. We captured 734 Arctic grayling for gamete collection and population estimate purposes. Grayling captured were ages 5, 7 and 8. Average length for all grayling captured was

11.6 inches. Mark-recapture analysis estimated n= 1,175 (±185) grayling in the Axolotl Brood Lake population. On May 19, we spawned 93 females and collected approximately 200,000 eggs. A second spawning occurred on May 26, when 50 females were spawned and approximately 108,000 eggs were collected. Due to the increasing presence of larger, older fish, fecundity increased dramatically over the past four years from 419 eggs per female in 2002 to 2,155 eggs per female in 2005. Fertilized eggs were taken to Big Springs State Fish Hatchery for development to eye-up. On June 6 we transported 38,000-eyed eggs from the 2nd spawning efforts to RSIs in the upper Ruby River drainage. The remaining eyed eggs from both spawns were transported to Bluewater State Fish Hatchery to be raised to yearlings for restoration efforts in 2006. A total 45,000 age one grayling will be available for restoration efforts for spring 2006.

Green Hollow II Reservoir Brood

All grayling and trout samples submitted for disease analysis tested negative for pathogens. We collected 646 grayling for gamete collection. Mature grayling captured were age 5 and 6, with a mean length of 11.7 inches. On May 12, we spawned 110 females and collected approximately 300,000 eggs. Fecundity averaged 2,600 eggs per female (up from 1,595 in 2004). On May 21, 45,000-eyed eggs were transported to the North Fork of the Sun River and placed in RSI's. On May 23, 40,000 eyed eggs were transported to the upper Ruby River for RSI efforts. A total of 29 brook trout and 3 rainbow-cutthroat trout hybrids were removed from the lake during spawning activities.

UPPER RUBY RIVER REINTRODUCTION EFFORTS

METHODS

RSI and Stocking Efforts

Reintroductions began in the Upper Ruby River in 1997. Age 1 and 2 hatchery reared fluvial Arctic grayling have been planted annually thereafter. RSIs have been used to produce fry that have developed under the selective mechanisms of the stream system since 2003. These have proven successful at producing fry, and will potentially generate mature grayling that return to natal RSI streams to spawn. In 2005, we continued stocking hatchery-raised grayling derived from the fluvial brood population at Axolotl Lakes and RSI reintroduction efforts. Eyed eggs from Green Hollow II brood population were developed to swim up fry at 6 locations using 22 RSIs from May 23 – June 6 (Figure 1). Eyed eggs from Axolotl brood population developed to swim up fry at 7 locations using 22 RSIs from June 6 – June 20 (Figure 1). Each RSI received from 1,400 – 8,400 eggs depending on RSI location, flow and size. Hatchery raised grayling were planted at three locations between May 9-May 17, 2005 (Figure 1).

Population Monitoring

In order to assess distribution, abundance and population demographics of stocked, RSI, and potentially naturally reproduced grayling; we completed electrofishing surveys in 5 reaches in April 2005 and 10 reaches in September and October 2005. Surveys were distributed from Ruby Reservoir upstream to Divide Creek. Springs surveys include Lower Letter, Canyon, Vigilante Bridge – Vigilante Station, Bear Creek, and Middle Fork sections (Figure 2). Spring surveys were limited upstream of Middle Fork Bridge due to ice conditions. Fall surveys were completed on Upper Letter,

Greenhorn, Canyon, Vigilante, Three Forks, Coal Creek, Corral, West Fork, Middle Fork Culvert and Divide Creek Sections (Figure 2). Electrofishing data were entered and summarized with Fisheries Analysis 1.0.8 (Montana Fish, Wildlife and Parks 2004). Density estimates are reported in the text as number per mile with the standard deviation at p= 0.05 presented in parentheses. Catch-per-unit-effort (CPUE) for all age classes is reported as number of fish captured per mile and used to show trends of grayling population abundance and spatial distribution. Length–frequency histograms are used to summarize population age structure. Mark-recapture estimates were completed for the Vigilante, Canyon, and Three-Forks sections in the Fall of 2005.

Water Temperature and Stream Discharge

Stream flows are monitored annually using the USGS gage station just upstream from Ruby Reservoir (Figure 1). Water temperature was monitored at Sweetwater, Canyon, Warm Spring Creek, Vigilante and Three Forks sections (Figure 1). FWP used Onset Hobotemp and Stowaway thermographs to record temperatures at 60-minute intervals. Data were downloaded into Microsoft Excel and reduced to daily maximum, minimum, and average temperatures.

Figure 1. Map showing thermograph sites, stocking locations, RSI sites and the USGS gage in the Upper Ruby River, 2005.

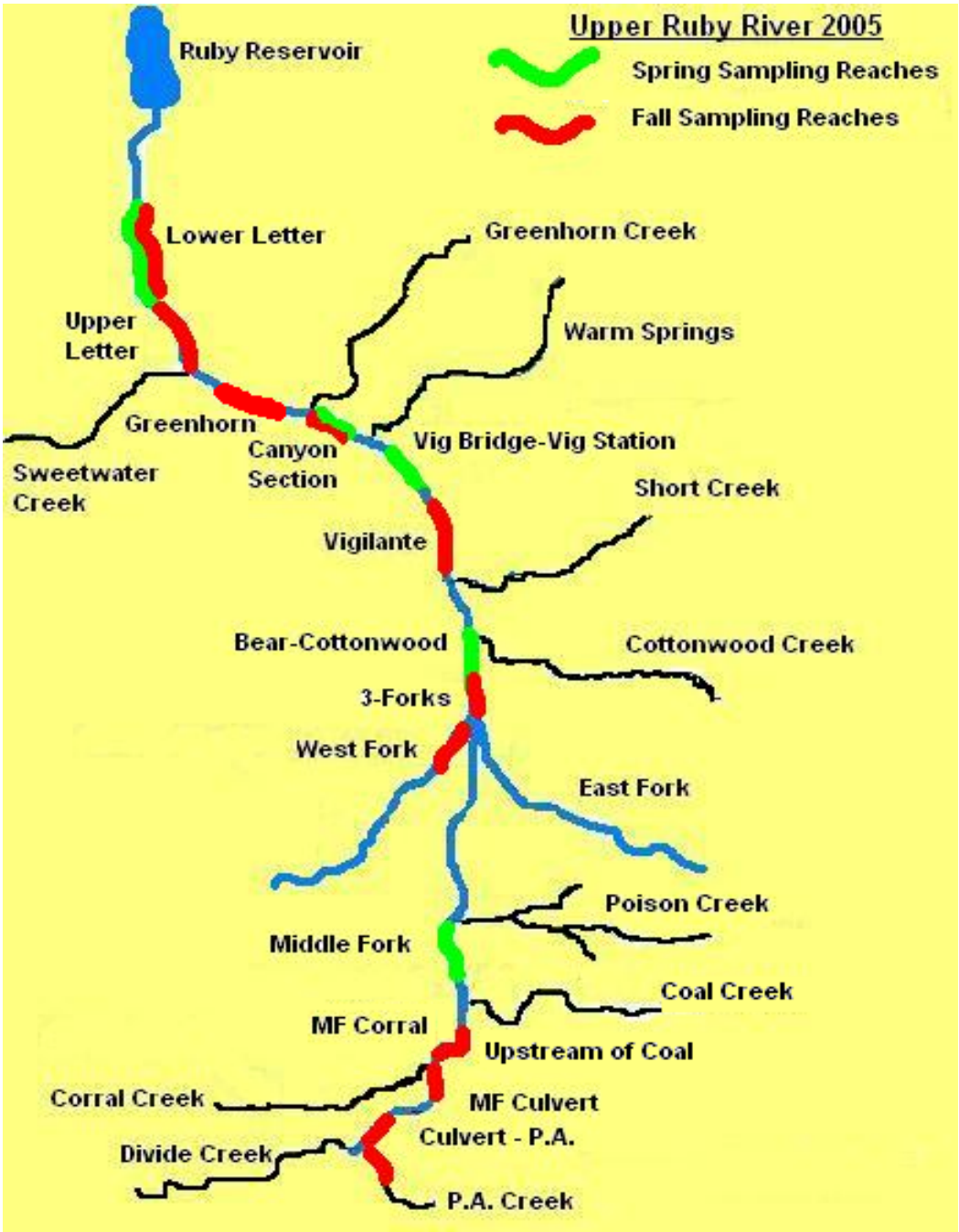

Figure 2. MFWP spring and fall electrofishing survey reaches in Upper Ruby River Drainage, 2005.

RESULTS

RSI and Stocking Efforts

We planted 14,470 age 1 grayling raised at the Bluewater State Fish Hatchery in the Upper Ruby River in 2005. Average length of stocked grayling was 8.1 inches. Grayling were planted at 3 locations upstream of Vigilante Guard Station between May 9 and May 17, 2005.

In the spring of 2005, two consecutive efforts at producing fry in RSI's were completed. Grayling YOY produced from RSI and/or potentially natural recruitment ranged from 2.0-5.6 inches (Figure 3). Stocked grayling from 2003 (age 3), 2004 (age 2) and 2005 (age 1) ranged from 8-12.6 inches in length (Figure 3). We also caught numerous age 1 and 2 grayling that were not stocked but were either produced from RSI or from natural recruitment in 2003 and 2004. Scale analysis was used to identify wild (produced from RSI or from natural recruitment) and hatchery raised grayling. Hatchery raised grayling exhibited constant growth patterns due to an unchanging and stable environment. In contrast, wild grayling scales showed growth patterns more typical of fish exposed to natural thermal regimes and less dependable energy sources.

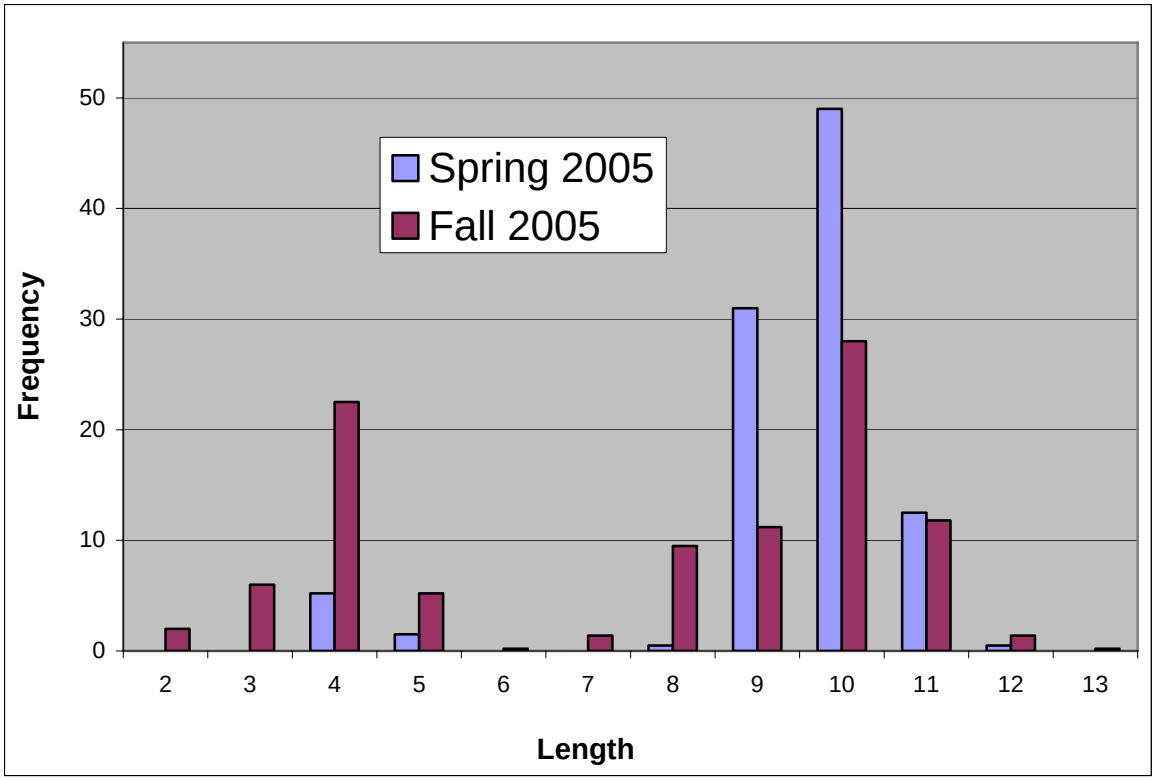

Figure 3. Length-Frequency Histogram for Arctic grayling captured by MFWP electrofishing surveys in Spring and Fall 2005 in the Upper Ruby River, Montana.

Population Monitoring

Spring electrofishing surveys were completed in 5 reaches and fall surveys were completed in 10 reaches to assess previous plant survival, RSI fry production, distribution, abundance and population demographics. Spring surveys found highest densities of grayling in the Vigilante Bridge – Vigilante Station reach (Figure 4). Spring surveys most likely underestimated yearling and age 1 grayling distributed in upper portions of the drainage where surveys could not be completed due to ice conditions. In contrast, fall surveys found the highest densities of grayling in the upper survey reaches (Figure 4 & 5). These grayling were a combination of planted grayling, grayling produced from RSIs, and possibly some from natural recruitment. The highest CPUE for grayling in fall surveys was in the Culvert section of the Middle Fork (Figure 4). The

majority of the grayling captured in this section were YOY (57%), and the remaining were age 1 or older (43%). Fall 2005 mark/recapture grayling estimates (reported as the number of grayling per mile) were 37 (± 3.4) in the Vigilante Section, 62 (± 17.9) in the Canyon Section, and 110 (± 8.7) in the Three-Forks Section grayling per mile.

Few grayling were found in the lower reaches (downstream of the Canyon Section) (Figure 4). This may be due to the distance from RSI or planting locations, habitat limitations, and possibly the presence of brown trout. No brown trout were found upstream of the Canyon Section (Figure 5). Rainbow/cutthroat trout abundance is highest in the Canyon and Coal Creek sections, and decreases up and downstream from these reaches (Figure 5). Grayling were the only species captured upstream of Corral Creek.

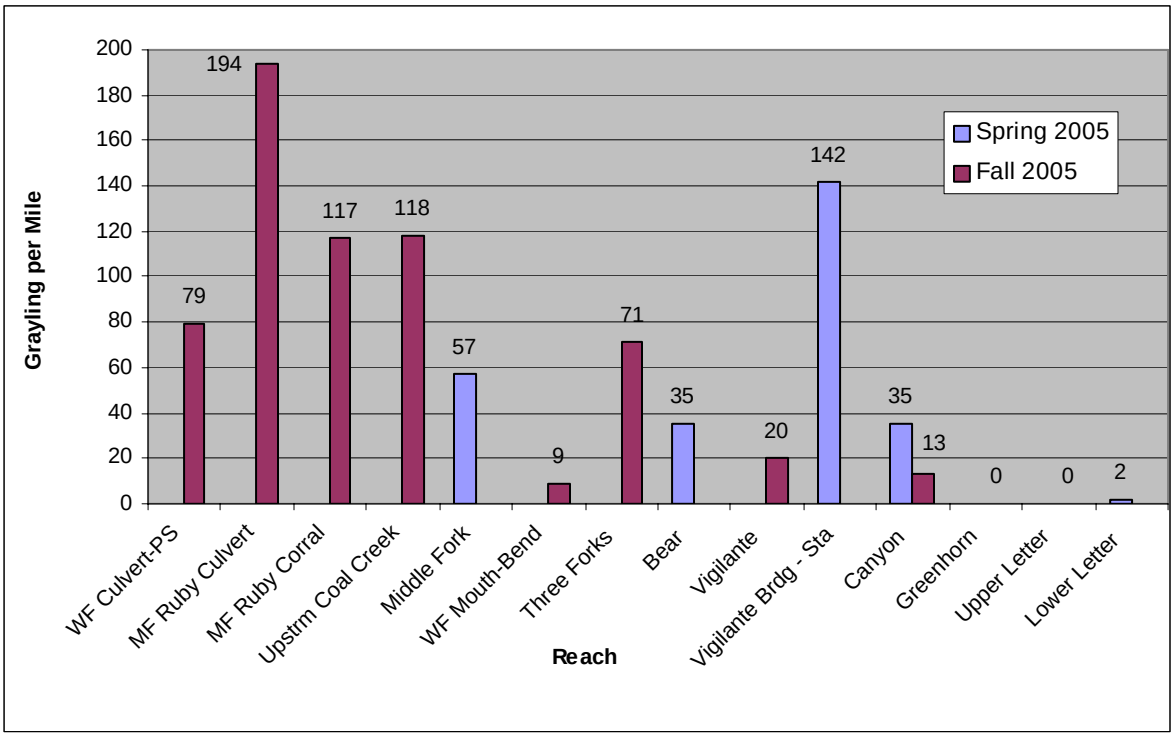

Figure 4. Catch Per Unit Effort (fish/mile) for Arctic grayling by reach in Spring and Fall 2005 from MFWP electrofishing surveys in the Upper Ruby River, Montana.

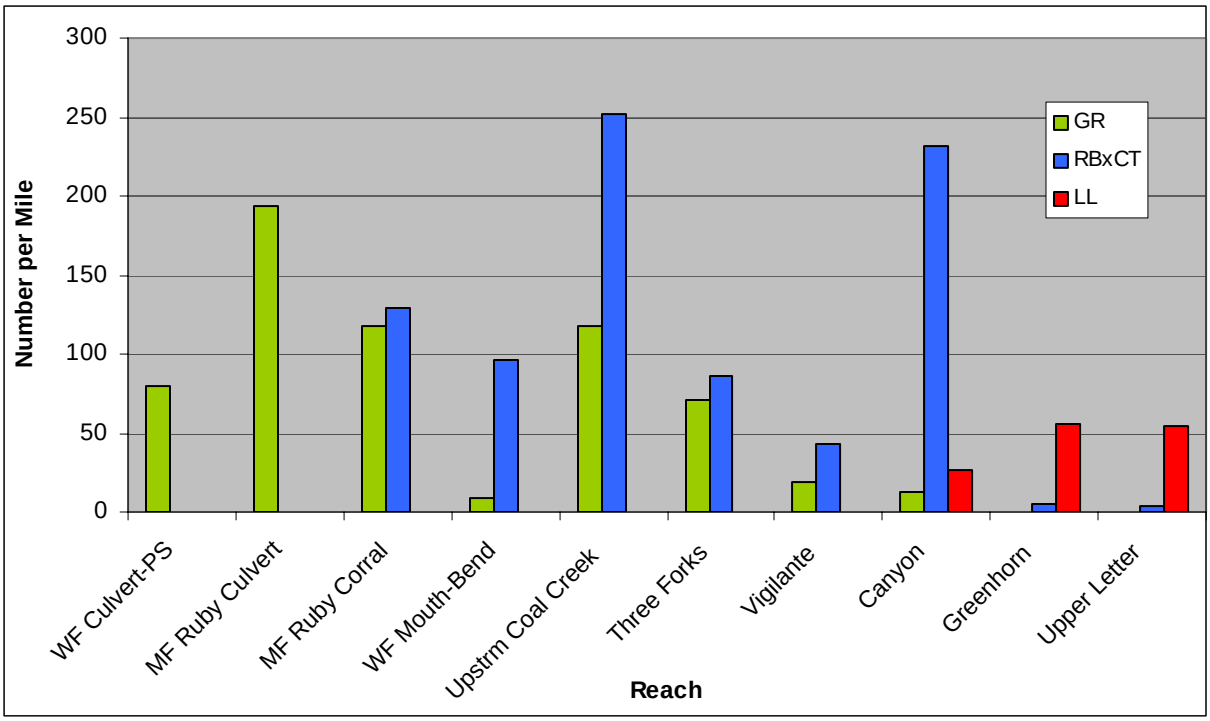

Figure 5. Catch Per Unit Effort (fish/mile) for Arctic grayling (GR), brown trout (LL), and rainbow/cutthroat trout hybrids (RbxCT) by reach for MFWP electrofishing surveys in fall 2005 in the Upper Ruby River, Montana.

We captured more YOY (age-0) and age-1 grayling in 2005 than previous years. The number of grayling captured less than 7 inches in length (YOY) has increased from 17 in 2004, to 151 in 2005 with similar sampling efforts. These grayling may be from successful RSI fry production in 2005 and/or natural recruitment. Fall surveys indicate that at least 37% of the grayling captured in 2005 were produced from RSIs or natural recruitment.

The majority of grayling fry were found upstream from the mouth of Coal creek. No YOY were found downstream from the Vigilante section. Grayling produced in RSIs in 2003 survived over winter to age 1 and were captured in spring of 2004 surveys at total lengths ranging from 2.5-5.5 inches and in fall at lengths ranging from 7-8 inches. Similarly, grayling produced in RSIs in spring 2004 were captured in fall 2004 surveys

with lengths ranging from of 2.5-4.5 inches and captured in fall 2005 as yearlings from 7-8 inches (Figure 3).

Water Temperatures and Stream Discharge

Maximum stream temperatures in the upper Ruby River typically peak in mid-July and August, and decrease in mid-August due to cooler air temperatures and decreasing photo period. Maximum temperatures in 2005 occurred on July 15 and July 23 for most thermograph sites (Figure 6). Instream temperatures increased from the Middle and West Forks (thermographs located highest upstream) downstream to the Sweetwater site. Warm Springs Creek has a thermal influence on the mainstem river downstream from its confluence with the Ruby River to the Canyon site (Figure 6.)

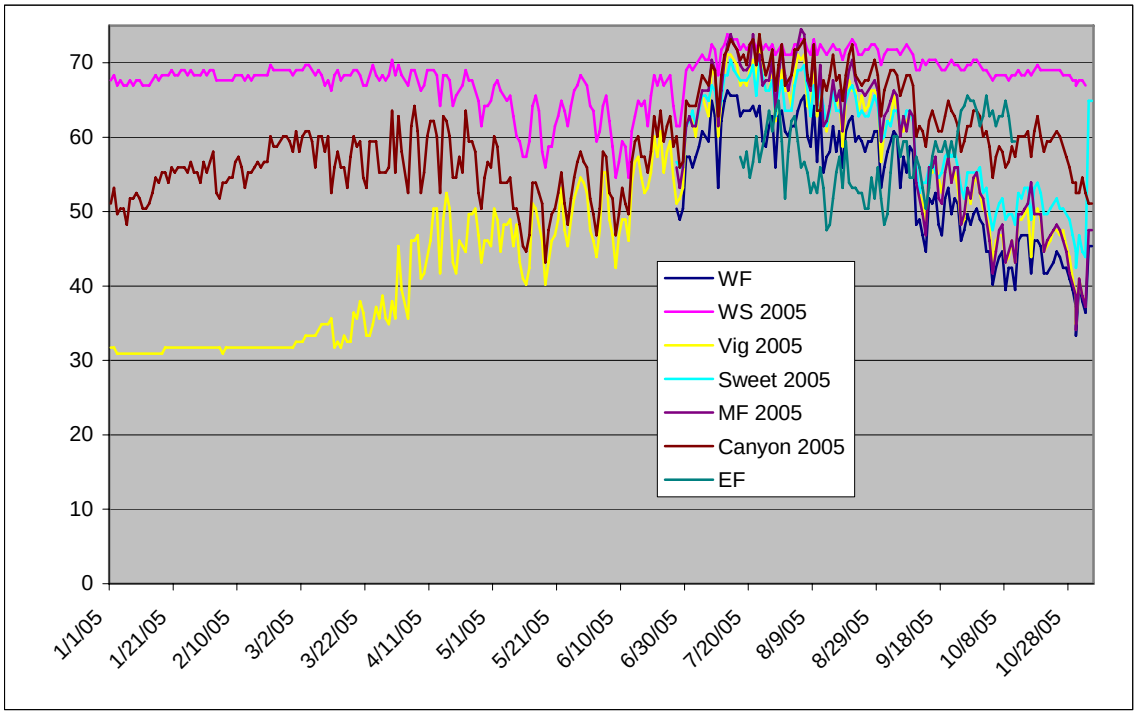

Figure 6. Maximum daily temperatures from 6 thermograph stations on the Upper Ruby River, 2005.

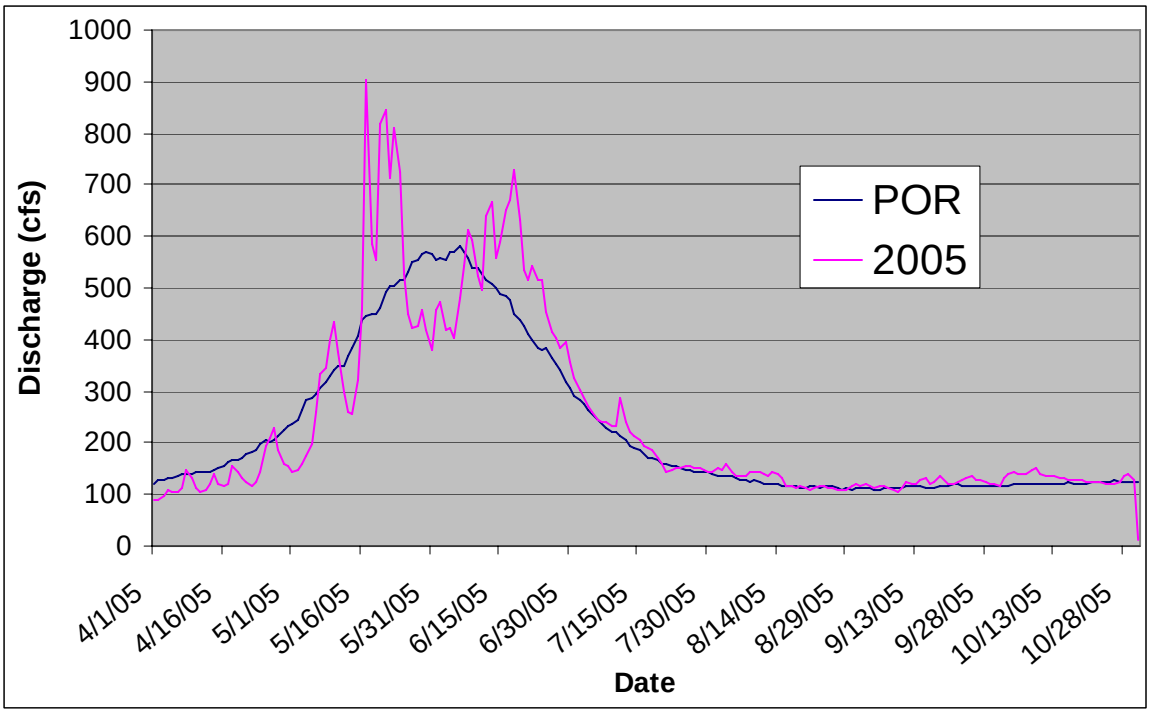

Figure 7. Mean daily flow (cfs) in 2005 and the Period of Record at the USGS Alder gage above Ruby Reservoir (data is provisional)**.**

Monthly flows were over 100% of the Period of Record from May through October (Figure 7). The lowest mean daily flow at the USGS Alder gage was 88 cfs on April 1 and the highest mean daily flow was 904 cfs on May 17, 2005. Adequate flow and thermal regimes may have positively impacted survival rates of RSI and stocked or wild grayling.

SUN RIVER REINTRODUCTION EFFORTS

METHODS

The North and South Forks of the Sun River Reintroduction efforts began in 1999. A total of 34,500 age 1 grayling were stocked from 1999-2001. In 2004 and 2005, Remote Site Incubators were used to develop and produce grayling fry in the North Fork of the

Sun River. A combination of electrofishing, snorkeling, angling, and trapping methods have been used to assess overall population demographics, distribution, survival, and to determine if natural recruitment has occurred. Electrofishing surveys were conducted at the confluence of the North and South forks of the Sun River on June 9, 10, 20 and 21, 2005. Four fyke traps were used to sample Gibson reservoir for grayling and other trout species for two nights on June 21,and June 22, 2005. Snorkel surveys were completed at the mouth of the North and South forks on June 16, 2005. A mark/recapture snorkeling and angling survey was completed on a 1-mile reach on the North Fork near Circle Creek on July 19 and 20, 2005.

From May 9-12, 2005, 25 RSI sites were constructed at the mouth of Biggs and Headwater Creek near Gates Park on the North Fork of the Sun River. On May 21, 45,000-eyed eggs that were collected from the Axolotl brood population and incubated at Big Spring State Fish Hatchery were transported to the RSIs. Incubators were checked daily from May 22-June 10 to regulate optimal flow for incubation and to monitor emergence.

RESULTS

A total of 8 grayling were captured during electrofishing surveys ranging from 11.0-12.7 inches (Table 1). All grayling captured were in spawning condition. A total of 16 grayling were captured in Gibson Reservoir in traps, ranging from 8.5-11.8 inches in length (Table 1). Most grayling originated from stocking efforts from 1999-2001 and were age 5, 6 and 7. However, one 8.5-inch grayling was captured in Gibson reservoir near the mouth of Lange Creek that scale analysis verifies as age 2. This is the first

grayling captured that has been naturally recruited from stocking efforts from 1999-2001. . Snorkel surveys at the mouth of the North and South forks observed 13 grayling in the pools below the waterfall on the South fork. . The majority of these grayling were mature adults (11-13 inches, however, one juvenile grayling (approximately 8.5 inches) was observed, again indicating that natural recruitment has occurred. All grayling were actively feeding in the water column with other trout, and appeared to be in excellent condition. No grayling were found in the mark/ recapture survey on the North Fork.

Most fry emerged from RSIs between June 7 and June 13. Based on the number of undeveloped eggs remaining in the incubators, approximately 35,000 fry were produced and entered into the North Fork drainage.

Table 1: Montana Fish, Wildlife and Parks trapping and electrofishing effort with number of grayling captured and size range in Gibson reservoir and at the confluence of the North and South forks of the Sun River from 2001-2005.

Year	Gibson Res. # traps/nets	Number Grayling	Size Range	Sun Forks # grayling	Effort Seconds	Size Range
2001	3	67	8.1-11.7	55	2,764	7.9-11.9
2002	6	159	8.6-12.1	19	5,876	8.6-11.2
2003	5	17	9.4-11.7	9	2,400	10.3-12.3
2004	4	3	10.7-11.7	8	3,424	10.7-12.2
2005	8	16	8.5-11.8	8	13,184	11.0-12.7

MISSOURI RIVER HEADWATERS REINTRODUCTION EFFORTS

METHODS

The Missouri River Headwaters Reintroduction efforts began in 2000 and stocking of age 1 and YOY grayling has taken place on annually from 2000-2005. In 2005, age-1 grayling progeny of the Axolotl brood stock were planted in April and May. On the Madison River, a total of 11,145 grayling were planted near the Greycliff and

Milwaukee Bridge Fishing Access Sites on April 11 and May 17, 2005. On the Gallatin River, a total of 25,206 grayling were planted on April 8 and 12 and May 3-4, 2005 near the town of Logan**.** Fall electrofishing surveys are conducted to document survival, dispersal, population density, and fish community composition. Survey reaches included: the Greycliff section on the Madison, Logan section on the Gallatin, and the Trident section on the Missouri River. Jet boat electrofishing surveys were completed on the lower Gallatin, lower Madison, and the Missouri River on November 7, 2005.

RESULTS

In 2005, approximately 36,351 yearling grayling averaging 8.0 inches were planted in the Madison and Gallatin Rivers respectively. No grayling were captured during fall electrofishing surveys in the Trident section on the Missouri River, or the Greycliff section of the Madison River. Two grayling were captured by electrofishing in the lower ¼ mile of the Gallatin River, and were 11.2 and 11.8 inches in length.

DISCUSION

In 2005, continued efforts in the Upper Ruby, North Fork of the Sun, and Missouri Rivers can be attributed in part to the success of the brood program. As the grayling in both Green Hollow and Axolotl brood lakes have matured, fecundity has increased substantially, thereby increasing the number of eggs available for stocking and RSI efforts. Additionally, maintaining the disease-free status of our brood populations has allowed us the continued opportunity to utilize grayling from the brood populations.

Upper Ruby River

Reintroduction efforts in the Ruby are encouraging. Not only have we documented natural recruitment in both 2000 and 2002, but also during the past three years, RSI techniques have improved, thereby increasing the numbers of grayling fry entering the Upper Ruby River. In 2005 we captured substantially more YOY and yearlings produced from RSI's or natural recruitment . These grayling have been developed and have survived under natural selective mechanisms. The YOY and age-1 grayling are distributed from Divide Creek to Vigilante Station (approximately 23 miles) indicating that rearing habitat is available at some level in this reach. However, the majority of the YOY grayling were captured upstream of Coal creek, where other native and non-native fish species are less abundant and the potential for inter-specific competition or predation is limited. Abundance of grayling in upper reaches may also partially be attributed to a healthy riparian corridor and numerous beaver ponds that provide quality winter habitat for both YOY and older grayling. Focusing RSI and stocking efforts farther upstream than in previous years may be effective in keeping the stocked grayling in upstream sections where brown trout and rainbow/cutthroat hybrids are less abundant and where over-wintering habitat from beaver dams is beneficial. In 2006, we will expand RSI efforts to encompass other areas in the upper Ruby drainage. Ideally, dispersing RSIs in areas with potential spawning habitat will imprint developing fry to return to these reaches at age 3 to spawn.

North and South Forks of the Sun River

Reintroduction efforts on the North Fork of the Sun River in 2005 were both encouraging and successful. Remote Site Incubator techniques improved and produced more grayling fry in 2005 than in 2004. The presence of age-2 grayling in Gibson reservoir and the South Fork of the Sun River is the first indication that grayling stocked in 1999-2001 spawned successfully. Future sampling will be necessary to identify additional natural recruitment and investigate life history patterns (fluvial, adfluvial/lacustrine). RSI efforts and monitoring surveys will continue in 2006.

Missouri River Headwaters

Efforts to restore fluvial Arctic grayling populations in the Missouri River Headwaters have been challenging and have occurred over a period of extreme drought. Very few grayling were captured during fall population surveys in 2005. This could be a result of limited sampling efforts in a large river system, the timing of surveys, habitat limitations exacerbated by stressful drought conditions, and most likely a combination of all of the above. In 2006, stocking and population monitoring to assess survival, distribution, and population demographics will continue.

Establishing additional fluvial populations is essential for the preservation of this life-history form of Arctic grayling in Montana. In 2006, The Arctic Grayling Recovery Program will continue current restoration efforts in the Upper Ruby, North Fork of the Sun, and Missouri River Headwaters in attempts to establish additional populations and assess future restoration opportunities in other systems.

REFERENCES

Byorth, P.A. 1991. Population surveys and analysis of fall and winter movements of Arctic grayling in the Big Hole River. 1991 Annual Report. Submitted to: Fluvial Arctic Grayling Workgroup. Montana Department of Fish, Wildlife and Parks, Bozeman.

Byorth, P.A. 1993. Big Hole River Arctic Grayling Recovery Project: Annual monitoring report 1992. Submitted to: Fluvial Arctic Grayling Workgroup. Montana Department of Fish, Wildlife and Parks, Bozeman.

Byorth, P.A. 1994. Big Hole River Arctic Grayling Recovery Project: Annual monitoring report 1993. Submitted to: Fluvial Arctic Grayling Workgroup. Montana Department of Fish, Wildlife and Parks, Bozeman.

Byorth, P.A. 1995a. Big Hole River Arctic Grayling Recovery Project: Annual monitoring report 1994. Submitted to: Fluvial Arctic Grayling Workgroup. Montana Department of Fish, Wildlife and Parks, Bozeman.

Byorth, P.A. and J.P. Magee. 1996. Big Hole River Arctic Grayling Recovery Project: Annual monitoring report 1995. Submitted to: Fluvial Arctic Grayling Workgroup. Montana Department of Fish, Wildlife and Parks, Bozeman.

Byorth, P.A. 1997. Big Hole River Arctic Grayling Recovery Project: Annual monitoring report 1996. Submitted to: Fluvial Arctic Grayling Workgroup. Montana Department of Fish, Wildlife and Parks, Bozeman.

Campton, D. E., and W. R. Ardren. 2004. Should fluvial Arctic grayling in the Big Hole River, Montana be considered a distinct population segment (DPS) under the U.S. Endangered Species Act? An evaluation of existing genetic information. Draft Report. United States Fish and Wildlife Service Conservation Genetics Laboratory, Abernathy Fish Technology Center.

Holton, G.D. 1980. The riddle of existence: fishes of “special concern”. Montana Outdoors 11(1): 2-6

Lamothe, P.J. and J.P. Magee. 2004. Reintroducing fluvial Arctic grayling (*Thymallus arcticus)* to the Upper Ruby River, MT – a progress report. Submitted to: Fluvial Arctic Grayling Workgroup. Montana Department of Fish, Wildlife and Parks, Bozeman.

Leary, R.F. 2005. Review of the draft report: Should fluvial Arctic grayling in the Big Hole River, Montana be considered a distinct population segment (DPS) under the U.S. Endangered Species Act? An evaluation of existing genetic information (Campton and Ardren 2004). Montana Conservation Genetics Laboratory, Missoula , MT.

Lohr, S. C., P.A. Byorth, C.M. Kaya, and W.P. Dwyer. 1996. High temperature tolerances of fluvial Arctic grayling and comparisons with summer water temperatures of the Big Hole River, Montana. Transactions of the American Fisheries Society 125:933-939.

Magee, J.P. and P.A. Byorth. 1995. Competitive interactions of fluvial Arctic grayling sympatric species in the Upper Big Hole River, Montana. p. 46-56. Proceedings of the first joint meeting of the Montana/North Dakota Palid sturgeon workgroup and the Fluvial Arctic Grayling Workgroup. Montana Fish, Wildlife & Parks, Bozeman.

Magee, J.P. and P.A. Byorth. 1998. Big Hole River Arctic Grayling Recovery Project: Annual monitoring report 1997. Submitted to: Fluvial Arctic Grayling Workgroup. Montana Department of Fish, Wildlife and Parks, Bozeman.

Magee, J.P. 1999. Big Hole River Arctic Grayling Recovery Project: Annual monitoring report 1998. Submitted to: Fluvial Arctic Grayling Workgroup. Montana Department of Fish, Wildlife and Parks, Bozeman.

Magee, J.P. and S.T. Opitz. 2000. Big Hole River Arctic Grayling Recovery Project: Annual monitoring report 1998. Submitted to: Fluvial Arctic Grayling Workgroup. Montana Department of Fish, Wildlife and Parks, Bozeman.

Magee, J.P. 2002. Big Hole River Arctic Grayling Recovery Project: Annual monitoring report 2000-2001. Submitted to: Fluvial Arctic Grayling Workgroup. Montana Department of Fish, Wildlife and Parks, Bozeman.

Magee, J.P. and P.J. Lamothe. 2003. Big Hole River Arctic Grayling Recovery Project: Annual monitoring report 2002. Submitted to: Fluvial Arctic Grayling Workgroup. Montana Department of Fish, Wildlife and Parks, Bozeman.

Magee, J.P. and P.J. Lamothe. 2004. Big Hole River Arctic Grayling Recovery Project: Annual monitoring report 2003. Submitted to: Fluvial Arctic Grayling Workgroup. Montana Department of Fish, Wildlife and Parks, Bozeman.

Magee, J.P., and E.N. Rens, and P.J. Lamothe. 2005. Big Hole River Arctic Grayling Recovery Project: Annual monitoring report 2004. Submitted to: Fluvial Arctic Grayling Workgroup. Montana Department of Fish, Wildlife and Parks, Bozeman.

Montana Fluvial Arctic Grayling Workgroup. 1995. Montana Fluvial Arctic Grayling Restoration Plan. Montana Fish, Wildlife, and Parks. Helena, MT.

Montana Natural Heritage Program. 2004. Montana Animal Species of Concern. Montana Natural Heritage Program and Montana Fish, Wildlife and Parks. Helena, MT.

Ricker, W.E. 1958. Handbook of computations for biological statistics of fish populations. Fisheries Research Board of Canada, Bulletin 119. 300 p.

U.S. Fish and Wildlife Service, Federal Register. 1994. Endangered and threatened wildlife and plants; finding on a petition to list the fluvial population of the Arctic grayling as endangered. Federal Register 59 (141):
37738-37741 (July 25, 1994).

U.S. Fish and Wildlife Service, Federal Register. 1996. Policy regarding the recognition of distinct vertebrate population segments under the Endangered Species Act. Federal Register 61 (26): 4722-4725 (February 7, 1996).

U.S. Fish and Wildlife Service, Federal Register 2004. Endangered and Threatened Wildlife and Plants; Review of Species That Are Candidates or Proposed for Listing as Endangered or Threatened; Annual Notice of Findings on Resubmitted Petitions; Annual Description of Progress on Listing Actions Proposed Rules. Federal Register 69 (86): 24875-24904.

U.S. Geological Survey. 1988-2005. Water Resource Data, Montana. Montana Water Data Report. MT-01-1. Helena, Montana.

APPENDIX A

APPENDIX A

Table 1. Catch Per unit effort (fish/mile) of all species for Big Hole River tributaries for FWP electrofishing reaches in fall 2005.

Tributaries	EBT	RBT	LL	GR	LING
Governor Creek	95.89	2.57	0.68	0	9.59
Miner Creek	88.9	0	0	0	2.22
Big Lake Creek	28	0	0	0	0
Rock Crk	1.3	29.41	0	0	0
Steel Creek	23.6	1.04	0.35	1.04	13.54
Swamp Crk	50	3.05	0.74	3.68	4.78
Clam Valley	247.8	0	15.79	0	2.63
Mudd Crk	729.4	0.68	17.64	0	0
FishTrap	352.68	138.79	3.45	9.48	6.03
LaMarche	215	0	0	12	7
Seymore Creek	116	121	0	1.33	0
Deep Creek	24.2	146.2	15.24	4.76	1.43

Table 2. Catch Per unit effort (fish/mile) of all species for mainstem Big Hole River for FWP electrofishing reaches in fall 2005.

Mainstem	EBT	RBT	LL	GR	LING
CCAA A	513	28.5	0	0	5
CCAA B	140.9	11.49	7.66	0.43	11.49
LittleLake - Swamp	34.4	0	5	0	3.33
40-Bar	12.8	0.27	0.27	0	16.31
CCAA C	13.9	1.64	0.15	0.6	2.09
Airport Channel	1.4	0	0	0	0.38
Wisdom West	9	1.71	0	1.71	7.86
CCAA D	1.69	9.33	0.31	0.31	0.77
CCAA E	0	14.67	10.6	0	0.27
Pools comb.	2.97	61.9	12.26	4.32	5.54