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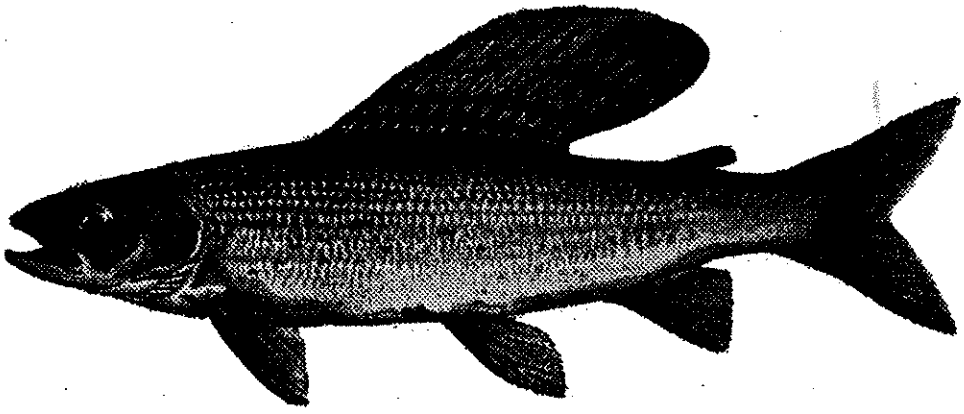

BIG HOLE RIVER ARCTIC GRAYLING RECOVERY PROJECT:

ANNUAL MONITORING REPORT 1998

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Submitted To:

Fluvial Arctic Grayling Workgroup

and

Beaverhead National Forest
Bureau of Land Management
Montana Chapter, American Fisheries Society
Montana Council, Trout Unlimited
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ABSTRACT

We annually monitor the fluvial Arctic grayling population in the upper Big Hole River and other factors such as discharge, water temperatures, and abundance of potential competitors. Discharge of the upper Big Hole River was moderate in spring and early summer due to near normal snowpack and above average June precipitation. Average summer precipitation maintained flows through mid-August. Phase One of the Big Hole Watershed Dry Year Plan was initiated on August 20 when flows declined below 60 cfs. Flows decreased to 45 cfs on September 5, 1999 before precipitation increased flows. Water temperatures were warmer than recent years and reached lethal levels at five of the eleven thermograph stations. In the Wisdom reach, the Arctic grayling population estimate decreased from 96 age 1+ per mile in 1997 to 76 age 1+ per mile. The population estimate also decreased in the Sportsmans-Eastbank reach from 73 age 1+ per mile in 1997 to 23 age 1+ per mile. Numbers of older grayling captured decreased, however, age structure of age 1-4 grayling remains balanced. Catch rates of young-of-year grayling were lowest since 1987. In the Wisdom area, brook trout population estimates increased substantially for the second consecutive year and were the highest since surveys began in 1978. Rainbow trout abundance remained low in the McWisdom section and stable in the Sportsmans-Eastbank section. The brood reserve stock at Axolotl Lakes was successfully spawned and 132,000 eggs were collected and transported to hatcheries for rearing. A back up brood reserve lake was established in Green Hollow II Lake on Turner Enterprise's Flying D Ranch. In October, 2,235 yearling grayling originating from the Axolotl Brood Reserve were planted into the lake. Work continued on the Big Hole River flow Enhancement Project with a total of 12 wells and two springs operational for stockwater use.

INTRODUCTION

The fluvial Arctic grayling (Thymallus arcticus) of the Big Hole River represent the last, strictly fluvial native population in the continental United States. After the population severely declined in abundance during the mid-1980's, the Arctic Grayling Recovery Program was initiated to determine ecological factors limiting the population, monitor their abundance, and inform the general public of their plight. Results of monitoring and research have been reported annually since 1991 (Byorth 1991, 1993, 1994, 1995, 1997, Magee and Byorth 1994, Magee and Byorth 1995, Byorth and Magee 1996, Magee and Byorth 1998).

Objectives of the project from April 1 through October, 1998 were:

A. Monitor water temperatures and discharge in the upper Big Hole River and tributaries,

B. Maintain minimum flows by promoting water conservation among Big Hole basin water users,

C. Monitor abundance and distribution of grayling and potential competitors in the upper Big Hole Basin,

D. Monitor the reserve stock of grayling at Axolotl Lakes and collect gametes,

E. Remove resident fish, plant, and monitor grayling brood reserve in Green Hollow II Lake,

F. Implement and monitor habitat enhancement project on Deep Creek,

G. Complete investigations of competitive interactions between grayling and rainbow and brown trout,

H. Reintroduce, monitor abundance, and distribution of grayling and potential competitors, in the Upper Ruby River,

I. Complete investigations, an Environmental Assessment, and Reintroduction Plan for the North and South Forks of the Sun River.

Results are reported for objectives A through E in this report. Progress on objectives F, G, H, and I will be reported separately.

METHODS

Discharge, and Water Temperatures

Discharge of the Big Hole River was monitored by the U. S. Geological Survey (USGS) April through October at the Wisdom Gage Station. Water temperature was also monitored at the Wisdom Gage and at 10 thermograph stations (Figure 1). Four thermograph stations have been operated since 1992 and an additional 6 were established in 1995 (Byorth and Magee 1996). We used Omnidata DP-212 thermographs at five stations recording at 120 minute intervals and Onset Instruments Hobotemp and Stowaway thermographs at five stations recording at 36 to 144 minute intervals.

Data were downloaded into DBase IV files and reduced to daily maximum, minimum, and average temperatures using DBase IV programs.

Water Conservation

Water Conservation efforts continued on the upper Big Hole Flow Enhancement project. Construction and development of stock water wells in the upper Big Hole River continued to progress. These wells provide an alternative to stock water diversion ditches utilizing flows from the Big Hole River and tributaries. Stock water wells will stabilize flows in the Wisdom area during low flow periods. A grant secured by the Beaverhead Conservation District allowed development of additional wells and springs. We provided assistance in developing stock water wells, construction of protective fences around stock tanks and power systems, and worked closely with U.S. Fish and Wildlife Service Partners for Wildlife Program personnel at overseeing and scheduling specific tasks.

Population Monitoring

We census the Arctic grayling population of the Big Hole River each spring and fall 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) are also sampled to document densities and relative abundances. We electrofished with 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. Stunned target species were captured and held in a live well. We anesthetized fish for

processing in a Tricaine Methanesulfonate (MS-222) bath, measured total length (to 0.1 inches) and weight (to 0.01 lbs), notched a fin as a temporary mark, and collected scales. We tagged grayling with a visible implant (VI) tag in transparent adipose tissue immediately posterior to an eye.

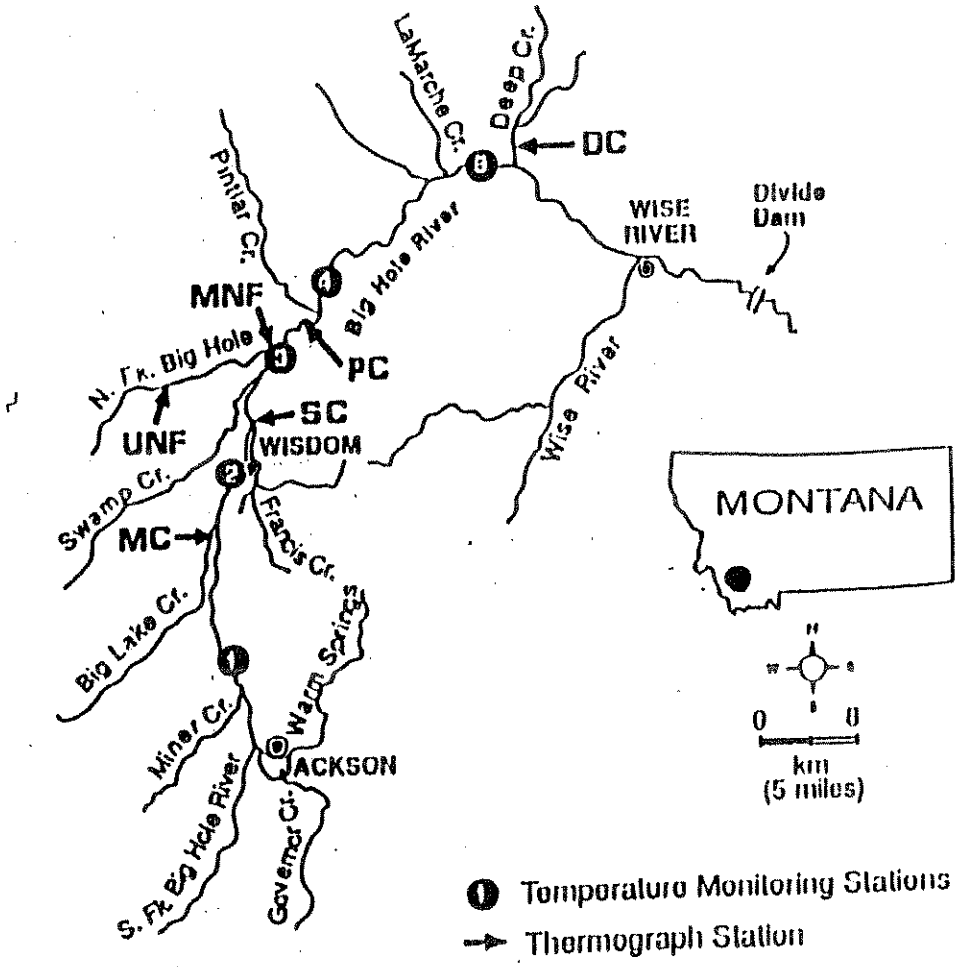

Figure 1. Map of the upper Big Hole River temperature monitoring stations. Stations are: 1 = Peterson Bridge, MC = McDowell Section, 2 = USGS gage at Wisdom, SC = Steel Creek, 3 = Buffalo Ranch, MNF = mouth of North Fork Big Hole River, UNF = Upper North Fork Big Hole River, PC = mouth of Pintlar Creek, 4 = Christianson Ranch, 5 = Sportsmans Park, and DC = Deep Creek.

The spawning population of grayling was surveyed by electrofishing the McDowell, Wisdom East and West, North Fork, and Pintlar-Squaw sections of the Big Hole River. A single electrofishing pass was made through each section between April 20 and 27. To assess contributions of tributary spawning to recruitment, we sampled Swamp and Deep Creeks April 14 and 15, 1998, respectively.

Fall population surveys of the McDowell and Wisdom sections have been conducted since 1983 to provide an index of grayling abundance and recruitment. The Sportsmans-Eastbank section was established in 1995 to provide additional information on the segment of the grayling population residing in mid-river reaches and to monitor rainbow trout populations. We conducted dual marking runs in each section to decrease bias and increase statistical validity of population estimates (Byorth 1997). We marked grayling and brook trout in the McDowell section September 9 and 14 and recaptured the section on September 21, 1998. Wisdom West was marked on September 10 and 15 and recaptured on September 22. Because we only obtained one recapture on September 22 we conducted an additional recapture run for the Wisdom West section on September 28, 1998. Wisdom East was marked September 16 and 23 and recaptured on October 6, 1998. Sportsmans-Eastbank was marked September 24 and 30 and recaptured on October 12, 1998. We monitor Deep Creek, a productive tributary for spawning, rearing, and adults, every two years.

Deep Creek was surveyed in 1997, and will next be monitored in 1999.

To assess brook trout abundance and upstream grayling distribution we conducted a single mark and recapture experiment on the 40 Bar section near the town of Jackson. The 40 Bar section was marked on September 8 and recaptured on September 17.

A one pass survey is conducted annually in Fishtrap and Sawlog pools to analyze age structure of adult population. Fishtrap and Sawlog pool were surveyed on October 15, 1998.

Electrofishing data were entered and analyzed with Mark-Recapture 4.0 (Montana Fish, Wildlife, and Parks 1994). We calculated population estimates using Log-Likelihood or modified Peterson methods (Ricker, 1958). Catch-per-unit-effort (number per electrofishing pass) of young-of-the-year grayling (YOY) was calculated as an index of recruitment. Estimates for the McDowell and Wisdom sections were calculated separately, and combined as the McWisdom section, to compare with previous years.

BROOD RESERVE

Axolotl Lake Brood

The Arctic grayling brood reserve at Axolotl Lakes, planted in 1989 and supplemented in 1992 and 1997, provides a source of fluvial grayling gametes to supplement the captive brood stock and provide young fish for reintroductions. We monitor the reserve population annually to determine abundance and collect gametes. Fyke nets, hook-and-line, and floating gill nets were

employed to capture grayling. Most captured grayling were processed as described above, marked for population estimates, and released. As grayling became gravid, they were sorted by sex and retained in separate live cars. Grayling were spawned with assistance from personnel of the U.S. Fish and Wildlife Service Ennis National Fish Hatchery and Washoe Park Trout Hatchery on May 16. Eggs were stripped from up to five female grayling, pooled, and fertilized with milt aspirated from two to five males. After fertilization, eggs were rinsed, packed in ice, and transported to Washoe Park Trout Hatchery and Big Springs Trout Hatchery. Personnel from FWP Fish Health Laboratory sampled ovarian fluid, fecal matter, and various tissues for disease screening. We released the remaining grayling after processing. Grayling abundance in the lake was estimated with the modified Peterson model (Ricker, 1958).

Green Hollow II Lake

Due to the uncertainties of the disease problems at the U.S. Fish and Wildlife Bozeman Fish Technology Center and the recent "For Sale" listing of the Axolotl Lakes Properties we pursued an additional brood site for Fluvial Arctic grayling. Turner Enterprises Incorporated offered the Green Hollow II Lake on the Flying D Ranch for this use. On September 17, after lake levels were decreased, personnel from FWP, Turner Enterprises, and the U.S. Fish and Wildlife Service Bozeman Fish Health Lab collected resident yellowstone cutthroat and brook trout for disease

analysis and screening with a beach seine. Following the completion of the disease analysis, on October 5, we used floating gill nets and a beach seine to remove as many resident cutthroat, brook, and rainbow trout to avoid potential competition with the planted brood stock. The lake levels was reduced to an absolute minimum to increase efficiency. Following removal, water levels were increased and age 1 Arctic grayling were planted on October 14, 1998.

RESULTS

Discharge and Water Temperatures

In 1998, spring run off was dramatically different than the previous three years. Runoffs in 1995, 1996, and 1997 were large and prolonged with record high flows in 1997. In 1998, runoff was of a considerably lower magnitude. Snowpack was 80% of the long-term average by April 1 (Natural Resources Conservation Service Snotel Surveys). Warm temperatures in late April and May, in combination with an average snow pack resulted in moderate run off conditions during the month of May. Above average late May and June precipitation maintained instream flows through July and mid-August (Figure 2). Instantaneous peak flow occurred on May 24, at 1,550 cubic feet per second (cfs) compared to 4170 cfs on June 9 in 1997. Ample flows remained through mid-August due to the sufficient ground water storage and average summer precipitation. The minimum flow at Wisdom was 45 cfs on September 5 (Table 1). August-September water yield in 1998 was

above average at 10,310 Acre-Feet (AC-FT) (Table 1).

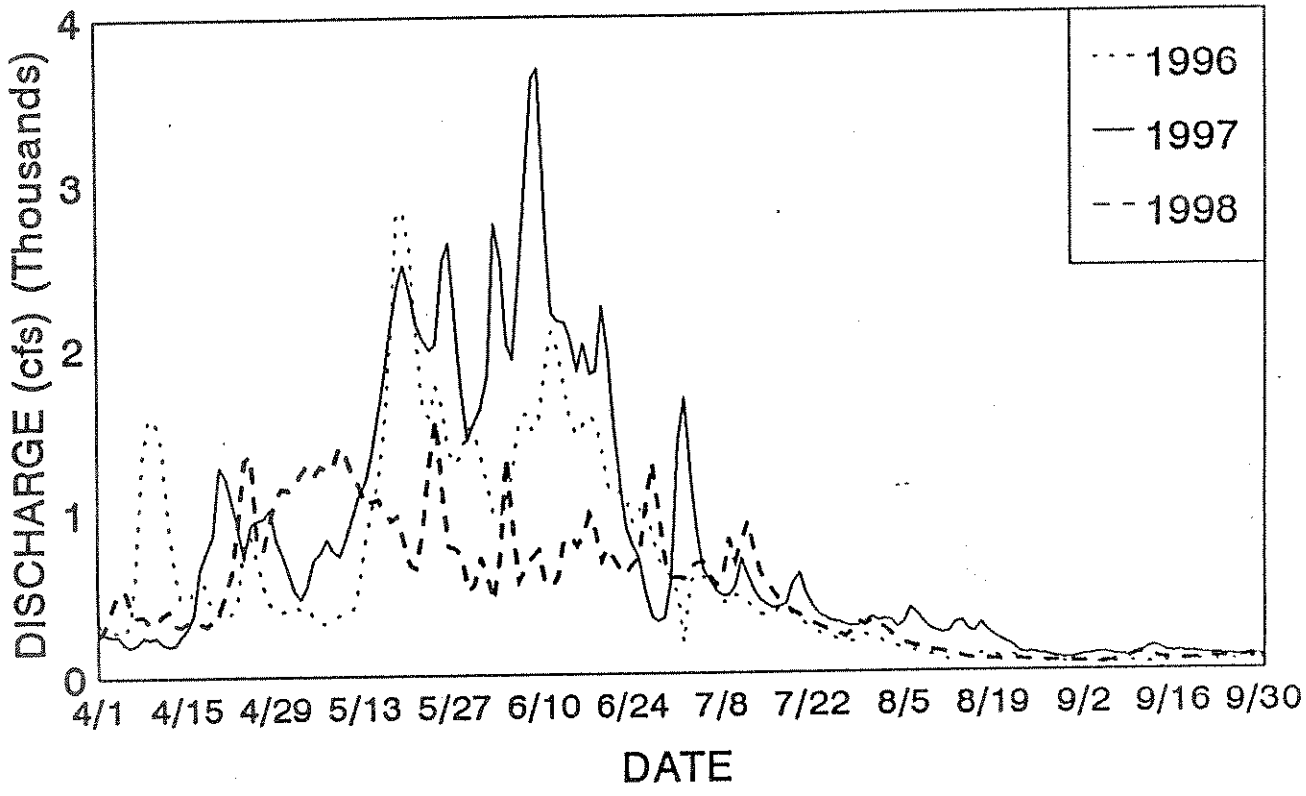

Figure 2. Hydrograph of the Big Hole River measured at the USGS gage at Wisdom, 1996, 1997, and 1998.

Table 1. Comparisons of Big Hole River discharge parameters measured at the USGS gage at Wisdom, 1988 to 1998. Yield is the total volume of water passing the Wisdom gage during August and September.

Year	# Days less than 20 cfs		Max Flow (cfs)	Min Flow (cfs)	Dates at Min	Yield Aug-Sept (ac-ft)
	Apr-June	July-Sept				
1988	0	78	1,080	0	8/27-9/21	213
1989	0	4	978	12	8/20	3,790
1990	1	0	667	18	5/23	5,820
1991	0	16	3,830	10	9/4	3,690
1992	18	32	479	3.3	5/26	2,760
1993	0	0	1,700	55	10/5	17,490
1994	11	55	976	1.9	8/30	1,821
1995	0	0	4,200	31	9/3	11,150
1996	0	0	2,960	39	8/29, 9/14	8,600
1997	0	0	4,170	70	8/29	18,910
1998	0	0	1,550	45	9/5	10,310

Mean daily water temperatures in 1998 were warmer than the previous years. Instream temperatures peaked at most thermograph stations on July 18 or 26 and 27 (Table 2). Thermograph data at Station 5 and Pintlar Creek were suspect due to human interference with the temperature probes. Temperatures were not recorded at the USGS Wisdom Bridge station for the periods of July 25 to August 5, and August 14 to 25 and thus maximums and means may have been higher. Lethal temperature levels of 77°F reported by Lohr et al. (1996) were recorded at five of the eleven stations. On July 26, the maximum water temperature of

82.4°F was recorded at the McDowell Station. This extremely warm temperature at this location is an anomaly and somewhat suspect. In the "warmed reach", where the highest temperatures normally occur, (Stations 3, MNF, PC and Station 4) temperatures exceeded lethal levels and Station 4 recorded 80.6 °F on July 26.

Table 2. Maximum daily (T_{max}) and maximum mean daily water temperature at thermograph stations in the Big Hole River 1998. Stations are: 1 = Peterson Bridge, MC = McDowell, 2 = USGS gage at Wisdom, SC = Steel Creek, 3 = Buffalo Ranch, MNF = mouth of North Fork Big Hole River, UNF = Upper North Fork Big Hole River, PC = mouth of Pintlar Creek, 4 = Christianson Ranch, 5 = Sportsmans Park, DC = Deep Creek. (* denotes suspect data).

Station	T_{max} (°F)	Max T_{mean} (°F)
1	73.4	66.2
MC	*82.4	*72.4
2	75.2	69.8
SC	76.0	67.8
3	77.0	70.3
MNF	78.8	69.4
UNF	72.0	66.5
PC	*78.5	71.7
4	80.6	71.5
5	*NA	70.6
DC	73.5	67.6

Water Conservation

The Flow Enhancement project, initiated in 1995, is designed to maintain instream flows by using ground-water wells instead of water diverted from the Big Hole River and its tributaries to water stock. As of October 1998, twelve wells and two springs have been completed and are operable (Figure 3). Two FWP Future Fisheries Improvement Grants have been obtained to develop an additional two springs and supply power to an existing well in 1999. A drought plan developed by the Big Hole Watershed Committee (BHWC) recommends utilizing stock water developments when flows at the Wisdom bridge reach 40 cfs. Potentially, eight diversion ditches may be shut down by using the stock water wells and springs. This may add from 20-30 cfs in the mainstem Big Hole River at Wisdom. An efficiency test of utilizing the stock water wells and springs is planned for summer, 1999. Additional projects addressing riparian health should be investigated to minimize temperature problems.

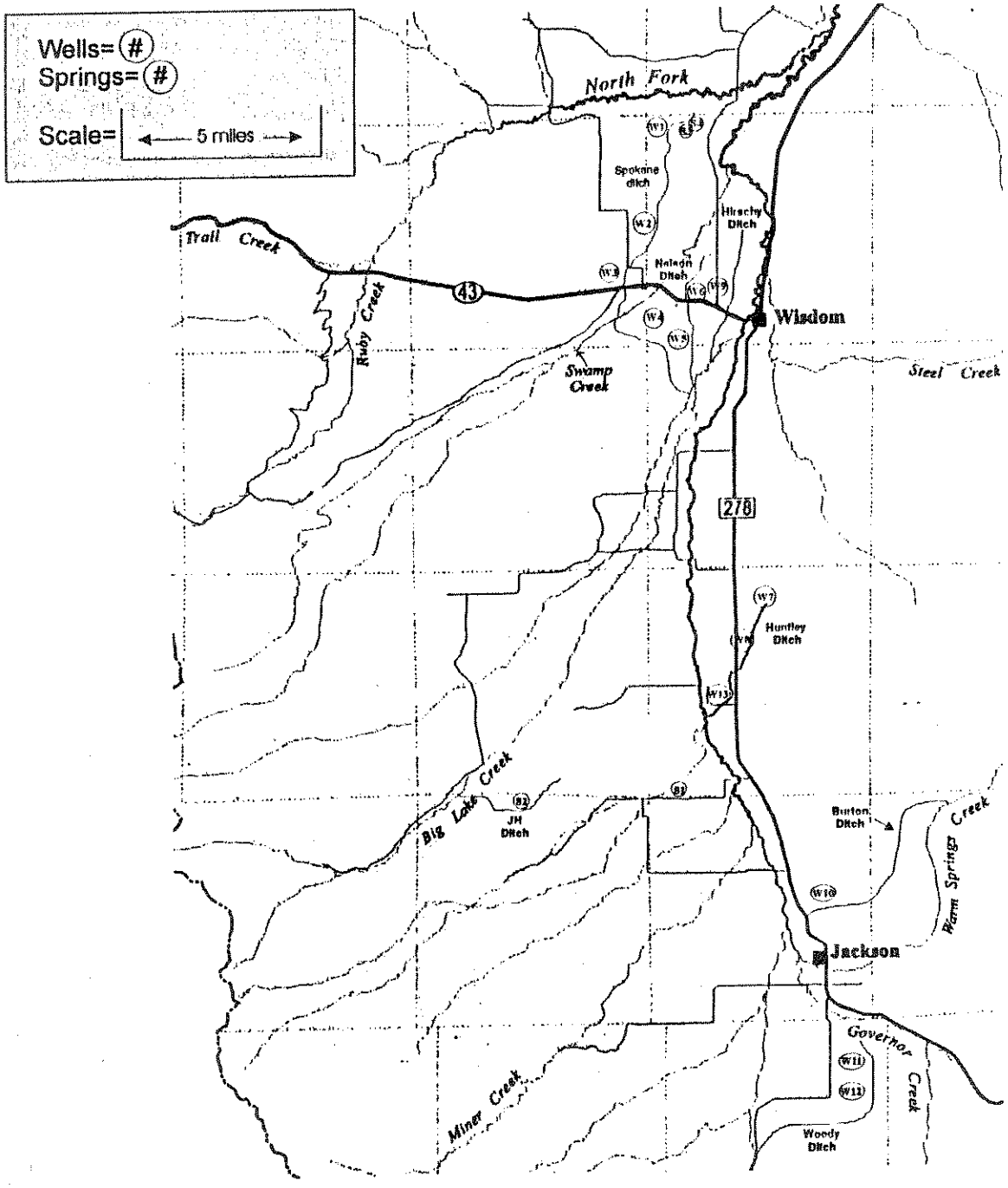

Figure 3. Stock water wells and springs with associated diversion ditches developed for flow enhancement in upper Big Hole River, 1999.

Population Monitoring

Spawning and Recruitment

We captured 165 grayling during spawning surveys, of which 18 were age 1 fish. We sampled from April 14-27 and encountered two ripe females on April 27. The overall sex ratio was skewed toward females at 1.4.:1, which is indicative of near-spawning ratios. Grayling normally spawn in the Big Hole River when daily maximum temperatures exceed 50°F. Unseasonably warm weather during late April brought water temperatures up to the 50 °F by April 27. Peak spawning most likely occurred between April 28-May 1, when daily mean temperatures ranged from 49.3 to 52.8 °F, and mean daily discharge ranged from 943 to 1140 cfs. Predicted time of emergence of larval grayling was May 11-16. Mean daily discharge averaged 1092 cfs during predicted emergence (Figure 2).

The age distribution of grayling captured during spawning surveys indicates a continued strong spawning population structure. Approximately 57% of spawning age grayling captured were Age 3 and older (Table 3). This proportion of mature grayling in the spawning population has been stable since 1992. The proportion of Age 4+ spawners (34%) was the lowest since 1992. With average over-winter survival the spawning population should be dominated by age 3 and 4 fish in 1999.

Two tributaries of the Big Hole River were sampled during Spring 1998. Three age 2+ spawners were captured in Deep Creek.

In Swamp Creek, only two mature males were captured, indicating sampling occurred prior to most spawning migrations.

Table 3. Percent composition by age class of Arctic grayling captured during spawning surveys in the upper Big Hole River, 1989 - 1998.

Year	N	% by Age Class				
		2	3	4	5	6
1989	143	25	63	6	6	1
1990	150	46	20	32	1	1
1991	144	44	35	13	8	0
1992	120	19	53	28	0	0
1993	122	12	39	42	6	0
1994	80	30	26	26	16	1
1995	145	15	39	27	15	2
1996	81	24	24	41	10	0
1997	61	18	23	41	16	2
1998	147	43	23	19	10	5

Catch rates of young-of-the-year (YOY) grayling during fall electrofishing surveys provide an index of recruitment. Catch rates in 1998 were the lowest since 1987 in the Wisdom section, and remained low in the McDowell section (Table 4). We captured no YOY grayling in the Sportsmans-Eastbank section compared to a catch-per-unit-effort of 0.66 in 1997, 3.7 in 1996 and 0.33 in 1995. No YOY grayling were captured in the 40 Bar section in 1998, whereas one was captured in 1997.

Table 4. Catch rates (catch-per-unit-effort (CPE)) of young-of-the-year (YOY) grayling captured in the McDowell and Wisdom sections of the Big Hole River, 1983 - 1998.

Year	McDowell Section			Wisdom Section		
	# YOY	# Runs	CPE	#YOY	# Runs	CPE
1983	---	---	---	2	6	0.33
1984	---	---	---	5	7	0.71
1985	0	3	0	0	3	0
1986	145	4	38.2	---	---	---
1987	3	1	3.0	0	1	0
1988	---	---	---	---	---	---
1989	178	2	89.0	90	2	45.0
1990	58	2	29.0	98	4	24.5
1991	10	2	5.0	41	2	20.5
1992	42	2	21.0	83	4	20.75
1993	2	2	1.0	31	4	7.75
1994	---	---	---	39	2	17.5
1995	12	3	4.0	97	6	16.2
1996	6	3	2.0	97	6	16.2
1997	8	3	2.7	80	6	13.3
1998	6	3	2.0	41	7	5.9

Fall Population Surveys

Estimates of age 1+ grayling abundance in both the Wisdom and Sportsman-Eastbank sections decreased in 1998. The population estimate for the Wisdom Section was 76 age 1+ per mile (SD ± 30) a decrease from the 1997 estimate of 96 (SD ± 66) age 1+ per mile (Figure 4). In the Sportsmans-Eastbank section we estimated 23 (SD ± 13) age 1+ grayling per mile, decreasing from

73 (SD ± 50) age 1+ grayling per mile in 1997, 47 (SD ± 35) 1996, and 37 (SD ± 33) per mile in 1995. An estimate could not be calculated for the McDowell section due to few recaptures, as has been the case for the last several years. We captured only 1 adult grayling in the 40 Bar section. The catch-per-unit effort for the pool surveys was 21 grayling per pool. The average catch in the three pools from 1992-1996 is 14 grayling per pool, in 1997 the average number of grayling caught per pool was 42. These pools (Sportsmans Park, Fishtrap, and Sawlog) are important summer and over-winter habitats. Variability in catch rates may be attributed to timing of the grayling moving into over-winter habitats as well as overall grayling numbers.

The length-frequency distribution and scale analysis of the fall grayling sample indicates strong age 1-3 year classes (Figure 5). Contrary to 1997, we captured few older\larger (age 4+, > 13.5 inches) grayling in 1998. These older grayling are typically more numerous in the Pools and Sportsmans-Eastbank section, while yearling and YOY grayling are primarily captured in the Wisdom section, and age 2 and 3 grayling are distributed throughout the mid- and upper Big Hole River (Byorth 1991).

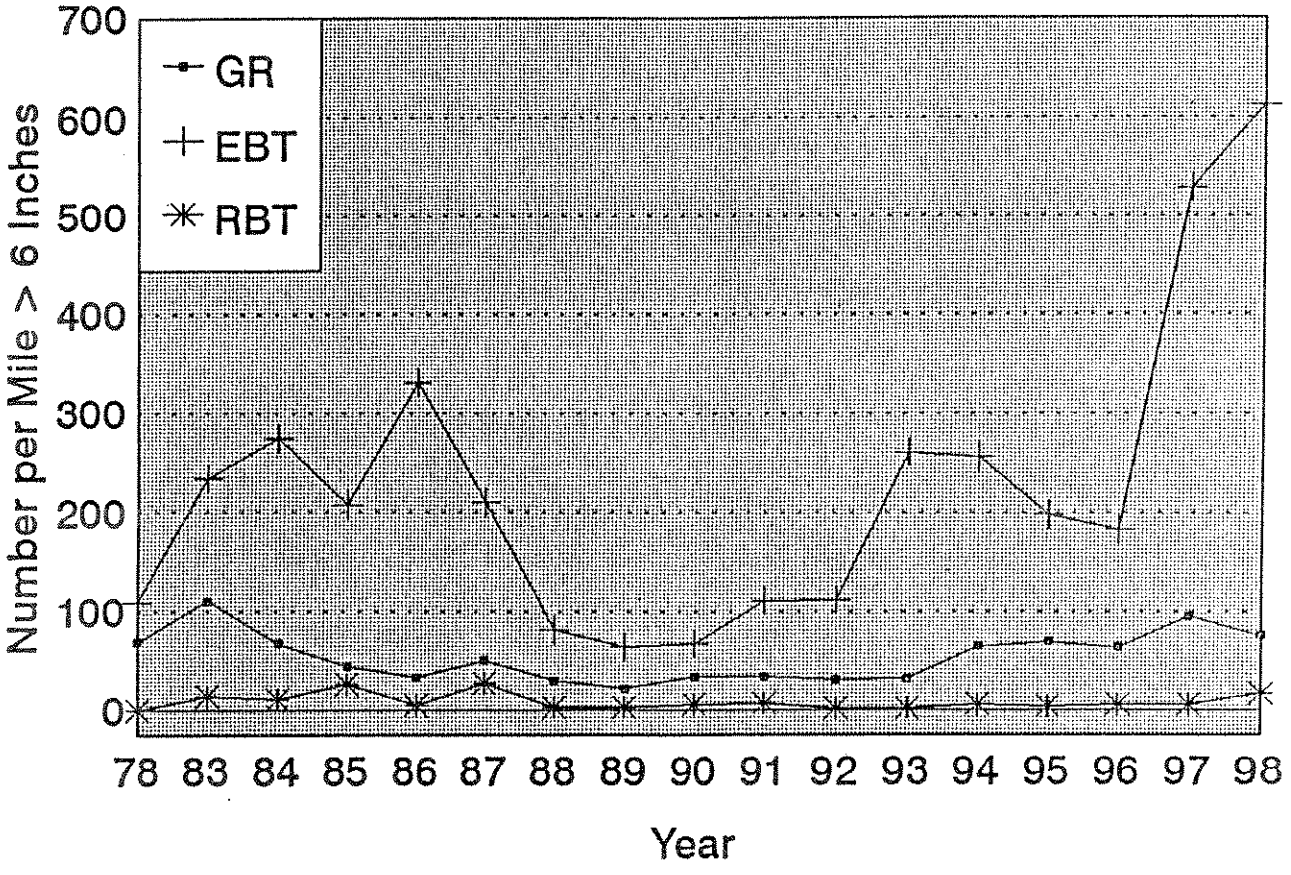

Figure 4. Estimated number of Arctic grayling and Eastern brook trout greater than 6 inches per mile, and rainbow trout of all sizes in the McDowell, Wisdom, or McWisdom sections of the Big Hole River, from electrofishing mark recapture experiments 1978-1998.

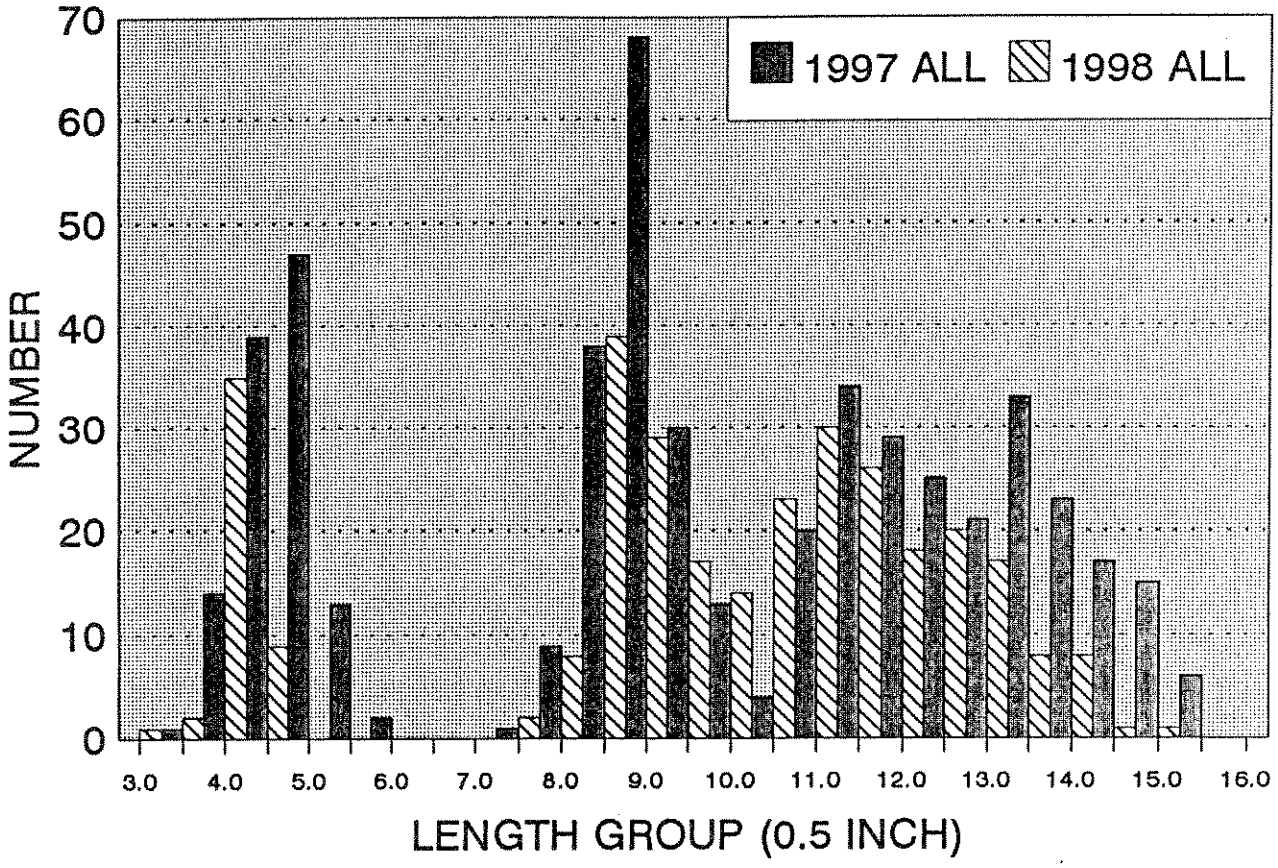

Figure 5. Length-frequency histogram of Arctic grayling captured in Fall population surveys in the Big Hole River sampling sections: McWisdom, Sportsmans-Eastbank, Three Pools, for 1997 and 1998.

Brook trout numbers in the upper Big Hole River declined dramatically in the mid 80's to a low of 62 (greater than 6 inches) fish per mile, in 1989 in the McWisdom section (Figure

4). Thereafter, populations began to increase but were set back by drought in 1994. With four consecutive years of ample flows brook trout populations have responded. In the 40 Bar section we estimated 408 (SD ± 189) brook trout greater than 8 inches. This increase from the 1997 estimate of 260 (SD ± 168) and 1996 of 282 (SD ± 160) is consistent with the trends in the McDowell and Wisdom sections. Numbers of brook trout 6 inches and longer in the McDowell section have increased from 97 (SD ± 27) per mile in 1996, to 148 (SD ± 84) in 1997, and 193 (SD ± 32) in 1998. In the Wisdom section, the brook trout population (≥ 6.0 inches) has increased dramatically from 183 (SD ± 15) per mile in 1996, to 529 (SD ± 54) in 1997, and 613 (SD ± 43) in 1998. This represents the highest estimate since monitoring began in 1978. Although spawning movements may have biased estimates upward, high efficiency rates have resulted in fairly robust estimates and provide a good index of population demographics.

The Sportsmans-Eastbank section is a transitional reach from brook trout to rainbow trout predominance. Unbiased estimates are difficult to obtain due to low capture and recapture rates attributed to spawning movements and lower densities. We estimated 33 (SD ± 26) brook trout greater than 6 inches per mile in 1998.

Rainbow trout densities remain low in the upper Big Hole River. Only 3 rainbow trout were captured in the 40 Bar section. In the McDowell section we estimated 3 (SD ±1) rainbow trout per mile, and in the Wisdom section 17 (SD ± 9) rainbow trout per

mile (Figure 4). In the Sportsmans-Eastbank section, the rainbow trout population is stable. We estimated rainbow trout densities at 226 (SD ± 92) per mile ≥ 6.0 inches in 1995, 222 (SD ± 64) in 1996, and 257 (SD ± 140) in 1997, and 232 (SD ± 96) in 1998.

Axolotl Lakes Brood

We monitored the Axolotl Lakes brood and gathered gametes for reintroduction efforts. The 1988 year class has dwindled from 2,800 planted in 1989 to 94 (SD ± 23). The majority of these age 10 fish produced gametes. Mean length increased slightly from 13.9 inches to 14.2 inches.

The 1992 cohort has decreased to 249 (SD ± 25) from 420 (SD ± 110) fish in 1997 of the 3,000 planted. Predation is most likely one of the major causes of mortality. We witnessed osprey capturing grayling on several occasions and also observed great blue herons and bald eagles in the vicinity. The age 6, 1992 cohort of grayling has grown at a slow but consistent rate of approximately 1.0 inch per year since 1994 and averaged 11.7 inches in 1997 and 12.7 inches in 1998. For comparison, the mean length of the 1988 cohort was 13.8 inches at age 6. Planting rates may have exceeded the carrying capacity of the lake and reduced growth rates. We estimate the number of mature grayling (1988 and 1992 year classes) in Axolotl Lake to be 343 (SD ± 32) prior to disease sampling that sacrificed 60 fish.

The 1,760 YOY grayling planted in September 1997 were approximately four inches in length. We captured only three of

these 1997 cohorts. The sampling techniques used are not efficient for these smaller fish. However, we observed large schools of yearlings actively cruising and feeding and it appeared there was good survival of the 1997 plant. Additional stocking is recommended for 1999 to establish multiple year classes of mature adults for egg-take operations.

We collected an estimated 132,400 eggs from 58 females (51 age 6, 7 age 10) and spawned them with 93 males (68 age 6, 25 age 10) on May 16. Fecundity averaged 2,276 eggs per female (Bob Snyder, FWP Washoe Park Trout Hatchery, personal communication). Big Springs Trout Hatchery took 53,600 eggs for eye up and the remaining 78,800 were eyed at Washoe Park Trout Hatchery. After eye up at Washoe Park, 50% of the eggs were sent to Big Springs Trout Hatchery and 50% were sent to Bluewater Springs Trout Hatchery for rearing.

Grayling spawning behavior was consistent with observations in the past (Byorth 1997). Ice off occurred in the end of April or the first few days in May. Males were ripe by May 7, when grayling began to congregate into schools and feed voraciously. This behavior ceased May 12. Catch rates declined dramatically when grayling schooled in shallow areas and ceased feeding. Historically, females have become ripe three to four days following the cessation of feeding. In 1998, a cold front delayed egg development. Spawning on May 16 was most likely two to three days early, as approximately 20% of the females still had green eggs.

Green Hollow II Brood Reserve

Disease analysis for resident fish proved negative for pathogens. We removed approximately 300 resident cutthroat, brook, and rainbow trout prior to stocking. Approximately 2,235 yearling grayling (progeny of the Axolotl Lakes brood and raised at Bluewater Springs Trout Hatchery) were planted on October 14. Average length was 9.8 inches. A number of mortalities in early November were collected along the shore of the lake and sent to the USFWS Health Lab in Bozeman for analysis. Results indicated drawn-down of the lake had caused septic type conditions and planted fish were exposed to poor water quality and developed bacterial infections. These conditions should be alleviated as water levels increase. Monitoring will began in spring 1999 to assess survival. Additional plants should be made in 2000 or 2001 to establish multiple year classes.

DISCUSSION

Following three consecutive years of high and prolonged spring runoff, moderate runoff conditions occurred in 1998. Near average snowpack and above average June precipitation maintained instream flows into mid-August. Flows dropped substantially in mid-August and the Big Hole Watershed Committee Dry Year Plan was initiated when flows decreased to 60 cfs at the Wisdom Bridge on August 20. At this point landowners in the upper Big Hole were

contacted and asked to conserve water to maintain flows. A news release on August 21 also advised anglers of potential stresses to fisheries during low water periods. Water levels decreased to 45 cfs on September 5 before precipitation events increased flows. Instream flows from 59-100 cfs occurred through September.

Water temperatures were warmer in 1998 than recent years. Temperatures exceeded lethal levels at 5 of the 11 thermograph stations. Fortunately, above average flows and reaches with well developed pools and riparian areas provided thermal refugia. Typically, temperatures in the "warmed reach" are higher than other stations. High temperatures occurred on July 26 and 27 when flows were 240 cfs at the USGS Wisdom gauging station, ten times the flows on the same date in 1994 when we documented a substantial fish kill in the "warmed reach". We visually surveyed this area on July 26 and documented one mountain white fish (Prosopium williamsoni) and two longnose sucker (Catostomus catostomus) mortalities. Although we did not see numerous mortalities, temperatures reaching lethal levels even with thermal refugia were certainly stressful to resident fish populations. This illustrates the relatively narrow margin between sublethal and lethal thermal conditions in the "warmed reach" of the Big Hole River. If instream flows are not adequate the potential for thermal kills is ever present. As we continue to develop methods to maintain instream flows, projects stimulating riparian health should be investigated to alleviate

temperature problems.

Arctic grayling population estimates with low variance are difficult to calculate. Sampling efficiencies are effected by low species densities and seasonal migrations. Arctic grayling population estimates have not changed significantly from year to year since 1978 (Figure 6). Grayling estimates are best used as indicators of population trends and in conjunction with age class data. These data indicate stability of the grayling population in the upper Big Hole River. Age 1+ Arctic grayling densities are estimated at 76 (± 30) per mile. Balanced age structure, with moderate adult survival and recruitment has maintained population stability in the Wisdom area. The decrease in grayling numbers in the Wisdom and Sportsman to Eastbank section can be attributed to a combination of factors. In 1997, we captured high numbers of older\larger grayling (age 4+, > 13.5 inches) in both spawning and fall surveys. Fewer older\larger grayling were captured in 1998. High natural mortality of older fish occurred in 1998 as seen in both the spawning and fall length-frequency histograms supported by scale analysis. Warm September temperatures allowing grayling to remain dispersed through-out the river also accounted for lower numbers in fall surveys. The Sportsman to Eastbank section contains numerous pools and runs of key overwintering habitat. Historically, the timing of our estimates find grayling in these habitats, however those movements may have been delayed.

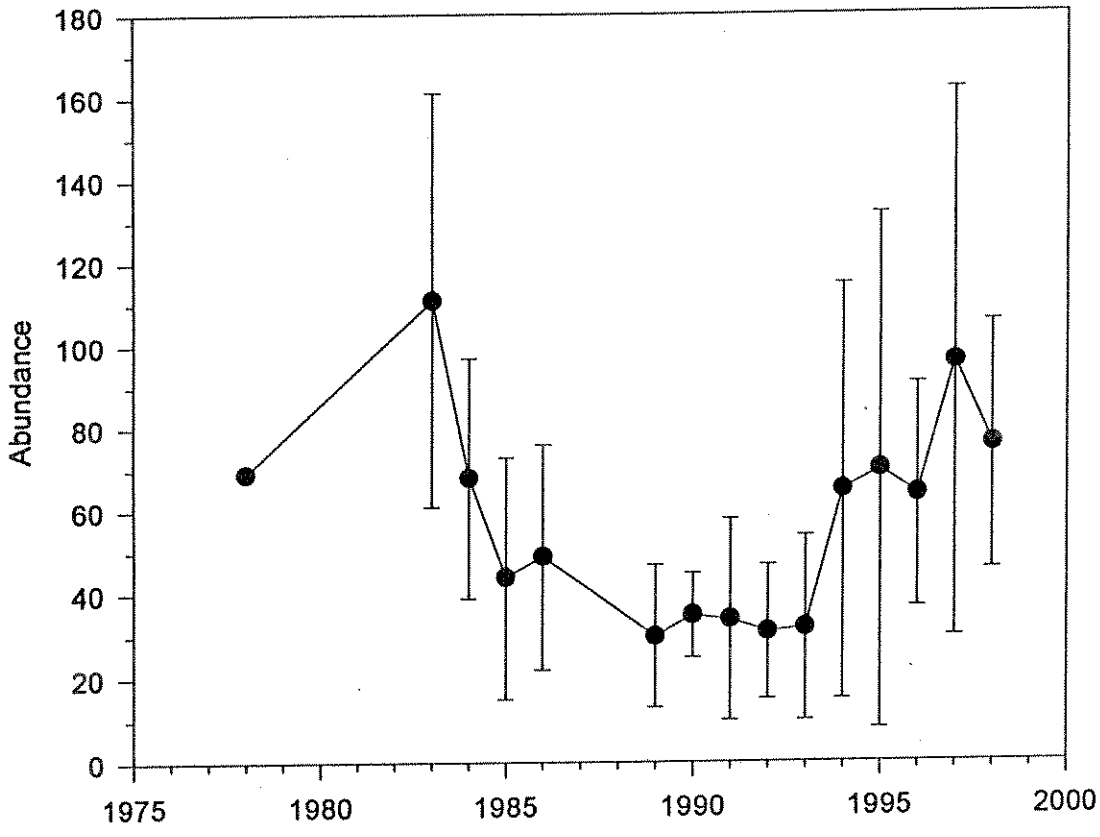

Figure 6. Abundance of age 1+ Arctic grayling in the upper Big Hole River ± one standard deviation from 1978-1998.

Catch rates of YOY were lowest since 1987. Young-of-the-year catch rate efficiency may be affected by numerous factors (flows, crew experience, temperatures) and has not proven to be a dependable index to assess recruitment. High and prolonged spring runoffs in 1995, 1996, and 1997 were potentially

unfavorable to larval grayling. Moderate flows in 1998 should have been favorable to newly emerging larva. However, our YOY sampling did not indicate this was the case. Yearling estimates have proven a better index of recruitment. While YOY catch rates have declined over the past two years yearling numbers have remained stable, illustrating the inefficiencies of YOY sampling. Fall sampling, in 1998, indicates a strong age 1 year class recruiting into the population. Spawning in 1999 should incorporate a stable proportion of age 3+ year classes. Combined spawning and fall surveys indicate strong age 1-3 year classes which should maintain stability into next year, barring severe winter losses.

One potential concern is the increased numbers of brook trout in the upper Big Hole River over the past three years. While adult grayling and brook trout co-exist by utilizing different micro-habitats (Byorth and Magee 1998), predation could affect recruitment of juvenile grayling. Past studies found little evidence of predation of juvenile grayling by brook trout (McMichael 1990, Streu 1990), however, the number of brook trout were never at current levels. The prey base for piscivorous species is plentiful in the upper Big Hole (longnose dace (Rhinichthys cataractae), suckers (Catostomus ssp.), Mountain whitefish, brook trout, burbot, Mottled sculpins (Cottus bairdi) and grayling), but the affect that record high numbers of brook trout could have on grayling recruitment is unknown.

Although the grayling population appears stabilized at

relatively high levels, it is important to remain vigilant. High grayling densities in 1983 declined dramatically following the large runoff in 1984, which may have limited recruitment. Severe drought through mid 1980's resulted in poor adult survival, weak recruitment, and consequent decline. These conditions may be repeated in the near future. However, the cooperative watershed drought plan in conjunction with stockwater wells will be used to maintain flows during low flow periods. Testing the efficiency of the stockwater wells and continued development of alternative water conservation methods will be a priority in 1999. As progress continues on flow enhancement alternatives, other investigations should be initiated to address riparian health, diversion efficiency, and juvenile entrainment in diversion systems.

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APPENDIX A

Table 5. Estimated number per mile of Arctic grayling, brook trout, and rainbow trout from 1978 to 1998 in the upper Big Hole River, Montana. McWisdom Section is the McDowell and Wisdom sections combined. Standard deviations shown in parenthesis.

SECTION	YEAR	ARCTIC GRAYLING > 6 IN	BROOK TROUT > 6 IN	RAINBOW TROUT ALL
McDowell	1978	69	109	0
Wisdom	1983	111 (50)	234	14
Wisdom	1984	68 (29)	274	11
McWisdom	1985	44 (29)	208	26
Wisdom	1986	33	331	5
McWisdom	1987	51	211	27
McWisdom	1988	30	82	3
McWisdom	1989	22	65 (14)	3
McWisdom	1990	34	68 (10)	6
McWisdom	1991	34 (24)	111 (24)	7
Wisdom	1992	31 (16)	112 (14)	2
Wisdom	1993	32 (22)	260 (86)	2
Wisdom	1994	65 (50)	256 (47)	6
Wisdom	1995	70 (62)	198 (34)	4
Wisdom	1996	64 (27)	183 (15)	6
Wisdom	1997	96 (66)	529 (54)	6
Wisdom	1998	76 (30)	613 (43)	17 (9)