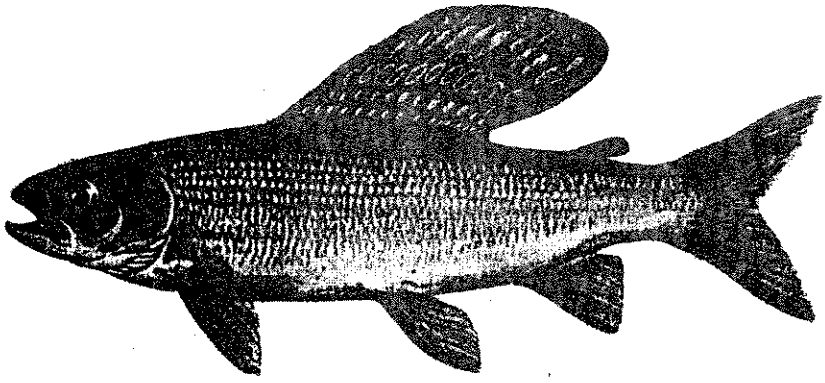

BIG HOLE RIVER ARCTIC GRAYLING RECOVERY PROJECT:

ANNUAL MONITORING REPORT 1997

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Fluvial Arctic Grayling Workgroup

and

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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 substantial in spring and early summer due to high snowpack and prolonged runoff. Average summer precipitation maintained flows above critical levels for the third consecutive year. Water temperatures were cooler than 1996, but still approached sub-lethal limits in the "warmed reach". In the Wisdom reach, the Arctic grayling population increased to 96 age 1+ per mile, the highest estimate since 1983 before dramatic declines. The population also increased in the Sportsmans-Eastbank reach to 73 age 1+ per mile. The age structure of age 1+ grayling and older continues to be balanced, however numbers of young-of-year grayling were lower. In the Wisdom area, brook trout populations increased substantially, the population estimate was 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 390,000 eggs were collected and transported to the hatchery for rearing. To maintain the brood reserve, 1760 young of the year (YOY) Axolotl progeny were planted back into the lake in September. Systematic hook and line sampling proved to be a useful technique in assessing grayling distribution in the Big Hole basin. The Big Hole Watershed Committee adopted a drought plan designed to conserve water and protect fisheries in the Big Hole River.

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).

Objectives of the project from April 1 through October, 1996 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. Complete investigations of competitive interactions between grayling and rainbow and brown trout.

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

Results are reported for objectives A through D in this report. Progress on objective E and F will be reported separately.

METHODS

Discharge and Water Temperature

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 min intervals and Onset Instruments Hobotemp and Stowaway thermographs at five stations recording at 36 to 144 min intervals.

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

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 (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.

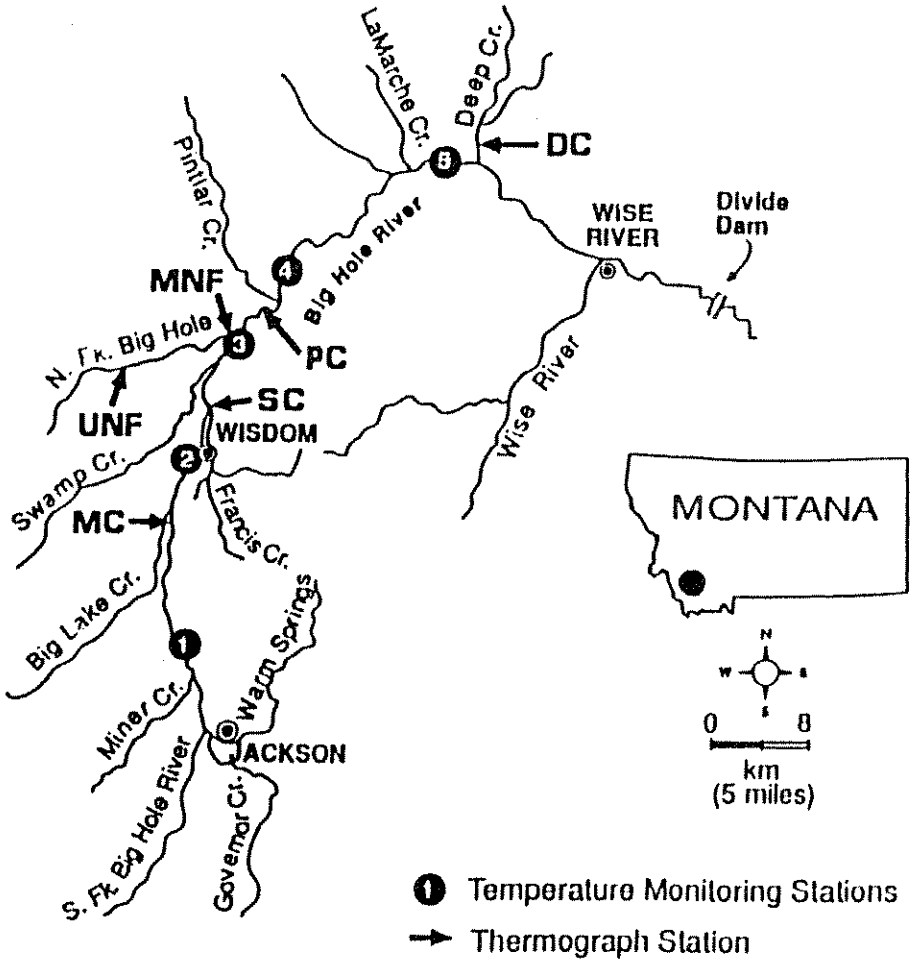

Figure 1. Map of the upper Big Hole River temperature monitoring stations. Stations are: 1 = Peterson Bridge, MC = McDowell Section, 2 = USGS gage at Wisdom, SC = Steel Creek, 3 = Buffalo Ranch, MNF = mouth of North Fork Big Hole River, UNF = Upper North Fork Big Hole River, PC = mouth of Pintlar Creek,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

The spawning population of grayling was censused 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 21 and 29. To assess contributions of tributary spawning to recruitment, we sampled Swamp and Deep creeks April 17 and 18, 1996.

Fall population surveys of the McDowell and Wisdom sections have been conducted since 1983 to provide an index of grayling abundance and recruitment. In 1995, the Sportsmans-Eastbank section was established 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 3 and 8 and recaptured on September 15, 1997. Wisdom West was marked on September 4 and 10 and recaptured September 16. Wisdom East was marked September 11 and 17 and recaptured on September 25, 1997. Sportmans-Eastbank was marked September 23 and 29 and recaptured on October 7, 1997. We monitor Deep Creek, a productive tributary for spawning, rearing and adults, every two years. In 1997, Deep Creek was marked on October 1 and 10 and recaptured October 16, 1997.

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 2 and recaptured on September 18. 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 10, 1997.

Electrofishing data were entered and analyzed with Mark-Recapture 4.0 (Montana Fish, Wildlife, and Parks (MFWP) 1994). We calculated population estimates using Log-Likelihood or modified Peterson methods (Chapman 1965). 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.

Hook and Line Grayling Distribution Survey

As an alternative method to electrofishing, a systematic hook and line survey was used to assess the distribution and relative abundance of grayling in the upper Big Hole River basin. Three representative reaches were chosen for sampling: Jackson to Twin Lakes Road, McDowell-Wisdom Section, and the North Fork Big Hole River (Figure 1). Four sampling sites per reach were selected using river miles generated at random. Sampling sites were plotted on USGS quads with descriptive notes. A team of 3 to 6 anglers floated through each reach, stopped at designated sites, angled for 1 hour, and recorded each anglers catch. Grayling were held in live cars or buckets until the hour passed

and were measured, tagged, and released. All other species were released immediately after capture. We calculated catch per hour for each group, by species and sampling site, and averaged catch rates by river reach.

Axolotl Lake Brood

The Arctic grayling brood reserve at Axolotl Lakes, planted in 1989 and supplemented in 1992, 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 and hook-and-line 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 in the lake. Grayling were spawned with assistance from personnel of the U. S. Fish and Wildlife Service (USFWS) Ennis National Fish Hatchery and MFWP Washoe Park State Hatchery. We spawned grayling on May 21. Eggs were stripped from up to five female grayling, pooled, and fertilized with milt aspirated from 2 to 5 males. After fertilization, eggs were rinsed, packed in ice, and transported to Washoe Park State Hatchery. Personnel from MFWP Fish Health Laboratory sampled ovarian fluid, fecal matter, and various tissues for disease screening. We released remaining grayling after processing. We estimated grayling abundance in the lake with the modified Peterson model (Chapman 1965).

RESULTS

Discharge and Water Temperatures

For the third consecutive year, discharge in the upper Big Hole River was ample and did not reach critically low levels (Figure 2). Snowpack was 142% of long-term average by April 1 (Natural Resource Conservation Service Snotel Surveys). Heavy snowpack resulted in a prolonged runoff, where discharge exceeded 1000 cfs on 49 days (Figure 2). Instantaneous peak flow occurred on June 9, at 4170 cfs. This is the second highest recorded peak flow since the installation of the gage in 1988 (the highest occurred in 1995 at 4200 cfs). Ample flows remained throughout the fall due to the sufficient ground water storage and average summer precipitation. The minimum flow was 70 cfs on August 29 (Table 1). August-September water yield in 1997 was 2.2 times greater than 1996, and is the historic high yield (Table 1).

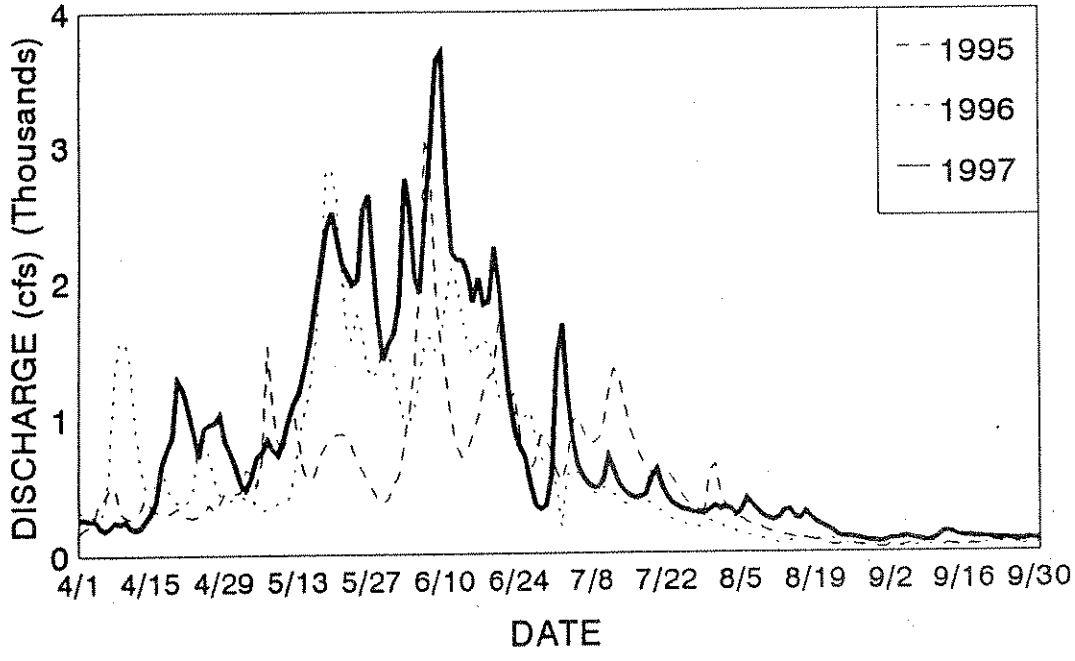

Figure 2. Hydrograph of the Big Hole River measured at the USGS gage at Wisdom, 1995, 1996, and 1997.

Table 1. Comparisons of Big Hole River discharge parameters measured at the USGS gage at Wisdom, 1988 to 1997. 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	1080	0	8/27-9/21	213
1989	0	4	978	12	8/20	3790
1990	1	0	667	18	5/23	5820
1991	0	16	3830	10	9/4	3690
1992	18	32	479	3.3	5/26	2760
1993	0	0	1700	55	10/5	17490
1994	11	55	976	1.9	8/30	1821
1995	0	0	4200	31	9/3	11150
1996	0	0	2960	39	8/29, 9/14	8600
1997	0	0	4170	70	8/29	18910

Mean daily water temperatures in 1997 were generally cooler than 1996. In-stream temperatures peaked at most thermograph stations on July 23 or August 3 (Table 2). Thermographs at station 1, 2, 5 and 6 did not operate from July 10-July 18. Thermograph 5 was not installed until July 18. Lethal temperature levels of 77°F reported by Lohr et al. (1996) were not recorded at any station. On August 3, the maximum water temperature of 75.1°F was recorded at the mouth of the North Fork Big Hole River (MNF) in spite of ample in-stream-flows.

Table 2. Maximum daily (T_{max}) and maximum mean daily water temperature at thermograph stations in the Big Hole River 1997. 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.

Station	T_{max} (°F)	Max T_{mean} (°F)
1	69.8	63.2
MC	70.7	65.4
2	72.5	67.1
SC	73.5	65.2
3	73.4	67.8
MNF	75.1	66.1
UNF	70.2	63.2
PC	74.1	68.2
4	74.3	67.9
5	68.0	61.0
DC	68.2	62.0

In the future, maintaining minimum flows during dry years will be facilitated using stockwater developments. Eight wells have been drilled or developed in 1995 and 1996. Construction should be completed by July 1998. An additional 4 wells were drilled in November 1997, and will be ready to use in 1998. Funding for additional wells has been secured, logistical planning and alternative conservation investigations are in progress. An efficiency test of utilizing ground-water wells as a stockwater source instead of ditches is planned for August, 1998. Additional projects addressing riparian health should be

investigated to minimize temperature problems.

Population Monitoring

Spawning and Recruitment

High snowpack limited river access and spawning surveys. In addition, cold temperatures delayed spawning, which resulted in a low sample size (N=63). Two of the 63 Arctic grayling captured were age 1 fish. We sampled from April 17 to 29 and did not encounter any ripe female grayling. Overall sex ratio was skewed toward males at 2.1:1, which is indicative of pre-spawning ratios. The small sample size of spawners is typical of sampling conducted before the peak of spawning. Grayling normally spawn in the Big Hole River when daily maximum temperatures exceed 50°F. In 1997, water temperatures did not reach and maintain that threshold until May 2. Peak spawning most likely occurred between May 2-6, when daily mean temperatures ranged from 43.5 to 47.7 °F, and discharged averaged from 563 to 919 cfs. Predicted time of emergence of larval grayling was May 16 to 19. During predicted emergence, daily discharge averaged 2200 cfs (Figure 2).

The age distribution of grayling captured during spawning surveys indicates a continued strong spawning population structure. Approximately 82% 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. A length frequency distribution of spawning grayling also reflects a stable age distribution (Figure 3). The proportion

of age 4+ spawners (59%) is higher than previous years. With average over-winter survival the spawning population should be strong in 1998.

Two tributaries of the Big Hole River were sampled during Spring 1997. In Deep Creek, three age 2+ spawners were captured. In Swamp Creek no grayling were captured. However, sampling occurred prior to spawning migrations, delayed by cold water temperatures.

Table 3. Percent composition by age class of Arctic grayling captured during spawning surveys in the upper Big Hole River, 1989 - 1997.

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

Catch rates of young-of-the year (YOY) grayling during fall electrofishing surveys provides an index of recruitment. In 1997, catch rates were lower than 1995 and 1996 in the Wisdom section, and slightly increased in the McDowell section (Table 4). In the Sportmans-Eastbank section catch-per-effort was lower in 1997 (0.66) than 1996 (3.7) but similar to 1995 (0.33).

Deep Creek, an important spawning and rearing tributary, yielded a catch-per-effort of 7.33 YOY grayling. One YOY grayling was captured in the 40 Bar section.

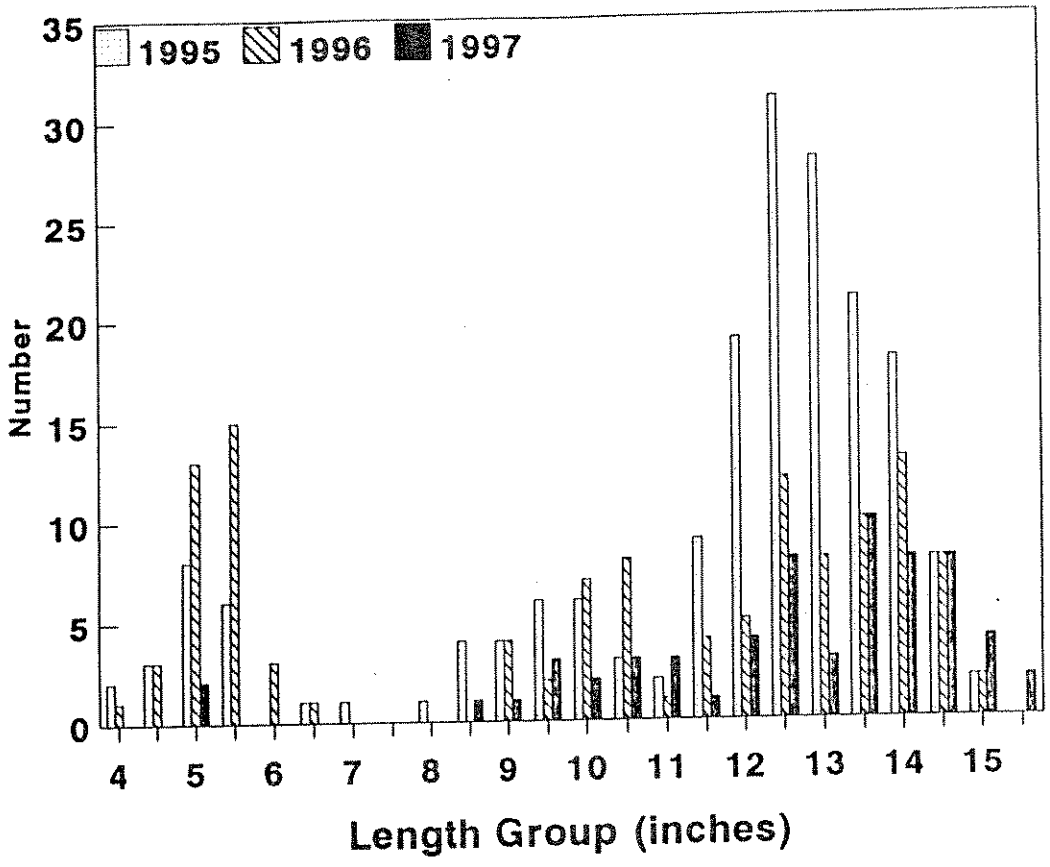

Figure 3. Length-frequency histogram of Arctic grayling captured during Big Hole River spawning surveys, 1995 - 1997.

Table 4. Catch rates (catch-per-effort (CPE)) of young-of-the-year (YOY) grayling captured in the McDowell and Wisdom sections of the Big Hole River, 1983 - 1997.

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

Fall Population Surveys

The status of the fluvial grayling population of the upper Big Hole River continued to improve in 1997. Estimates of age 1+ grayling abundance in both the Wisdom and Sportsman-Eastbank sections increased in 1997. The population estimate for the Wisdom Section was 96 age 1+ per mile (95% confidence interval ± 66) an increase from the 1996 estimate of 64 (± 26) age 1+ per mile. This is the highest estimate since 1983, prior to dramatic

declines of grayling densities (Table 5). In the Sportsmans-Eastbank section we estimated 73 (± 50) age 1+ grayling per mile, increasing from 47 (± 35) age 1+ grayling per mile in 1996, and 37 (± 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 2 adult grayling and found 1 angler caused adult mortality in the 40 Bar section. We captured record high numbers of grayling in our pool surveys. The average catch in the three pools for the past five years has been 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 overwinter habitats. High catch rates may be attributed to timing of the grayling moving into overwinter habitats as well as increased grayling numbers.

In Deep Creek, we estimated 34 (± 21) age 1+ grayling per mile down from 68 (± 36) age 1+ grayling per mile in 1995. Deep Creek has a unique fall migration of grayling from the Big Hole River (Byorth 1994). These fish move into the stream for a short period of time before the majority migrates back into the Big Hole River. Grayling movements coincide with brook trout, brown trout and mountain whitefish spawning migrations. Grayling may follow these species upstream to feed on eggs. Thus, estimates may be biased up or down according to the timing of migrations and sampling.

The length frequency distribution of the fall grayling sample supported spawning survey data, which indicated a stable

and balanced age structure (Figure 4). Older age classes of grayling predominated in the Pools and Sportsmans-Eastbank section, which is consistent with past surveys (Byorth 1991). Yearling and YOY grayling were primarily captured in the Wisdom section, while age 2 and 3 grayling were distributed throughout the mid- and upper Big Hole River. In Deep Creek YOY and yearling grayling are more common, but all year classes were captured.

Table 5. Estimated number per mile of Arctic grayling, brook trout, and rainbow trout from 1978 to 1997 in the upper Big Hole River, Montana. McWisdom is the McDowell and Wisdom sections combined.

SECTION	YEAR	ARCTIC GRAYLING > 6 IN	BROOK TROUT > 4 IN	RAINBOW TROUT ALL
McDowell	1978	69	109	0
Wisdom	1983	111	234	14
Wisdom	1984	74	274	11
McDowell	1985	38	208	26
Wisdom	1986	33	331	5
McWisdom	1987	51	211	27
McWisdom	1988	30	82	3
McWisdom	1989	22	62	3
McWisdom	1990	34	65	6
McWisdom	1991	34	-	-
McWisdom	1992	31	94	2
McWisdom	1993	32	134	2
Wisdom	1994	65	240	6
Wisdom	1995	70	202	4
Wisdom	1996	64	194	6
Wisdom	1997	96	604	6

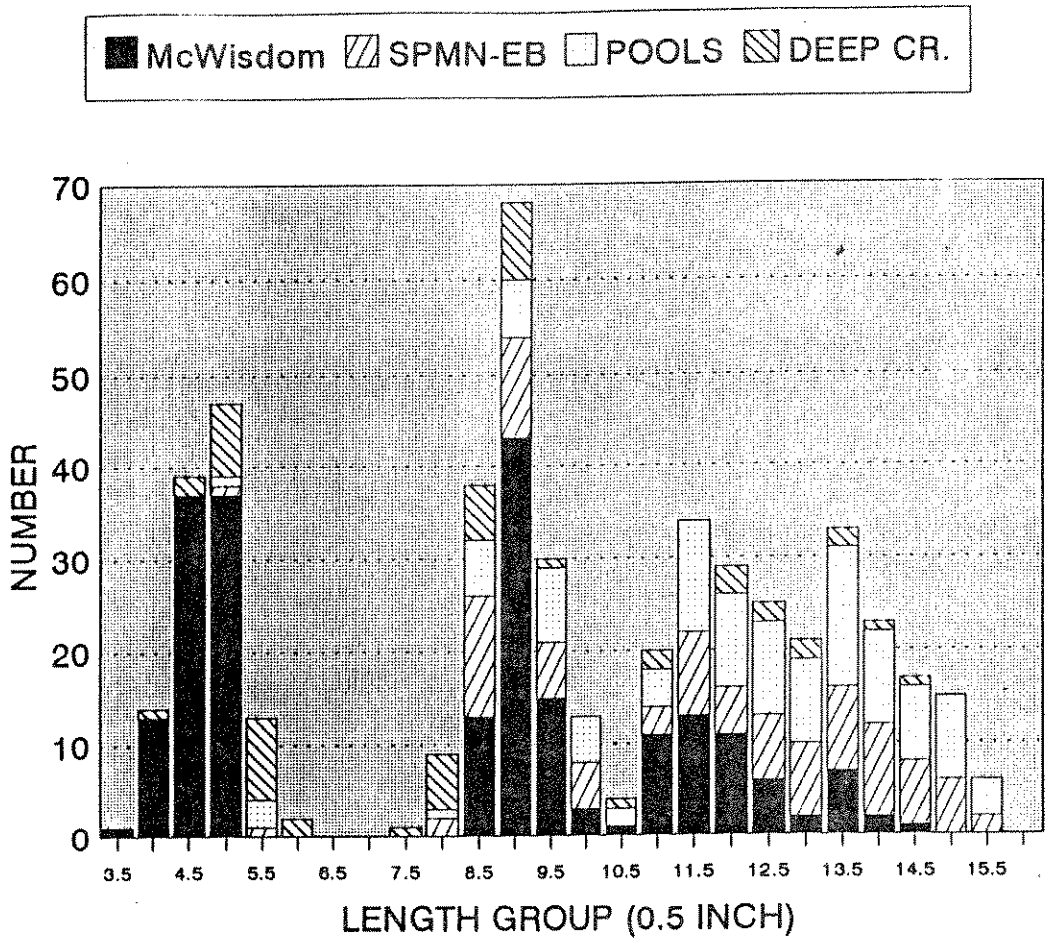

Figure 4. Length-frequency histogram of Arctic grayling captured in Fall population surveys in the Big Hole River sampling sections: McWisdom, Sportsmans-Eastbank, Three Pools and Deep Creek, 1997.

Brook trout numbers apparently increased in the McDowell and Wisdom sections of the upper Big Hole. Brook trout numbers declined in the late 80's and bottomed out in 1989 (Table 5). Populations began to increase but were set back by drought in 1994. With three consecutive years of ample flows brook trout populations have responded. Numbers of brook trout 4 inches and longer in the McDowell section decreased from 186 per mile in 1995 to 109 (± 59) per mile in 1996, then increased to 149 (± 60)

in 1997. This was the first increase after the third consecutive year of decline. In the Wisdom section, the brook trout population (≥ 4.0 inches) increased three fold from 194 per mile (± 31) in 1996 to 604 (± 114)in 1997. This represents the highest estimate since monitoring began in 1978. Although spawning movements may have biased estimates upward, high recapture rates in 1996 and 1997 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. In 1997, we had few recaptures and thus were unable to estimate the brook trout population in the Sportsmans-Eastbank section.

We sampled the 40 Bar section to assess distribution of grayling and gather baseline data on brook trout densities. While brook trout densities increased in the Wisdom and McDowell sections in 1997, densities were slightly lower in the 40 Bar section. Brook trout decreased from 282 (± 160) per mile ≥ 8.0 inches in 1996 to 260 (± 168) ≥ 8.0 inches in 1997.

Deep Creek supports a productive resident brook trout fishery in addition to providing recruitment to the Big Hole River. We estimated 675 (± 398) brook trout ≥ 4.0 inches per mile in Deep Creek in 1997. In 1995, brook trout ≥ 5.0 inches were estimated at a density of 470 (± 220) per mile.

Rainbow trout densities remain low in the upper Big Hole

River. In the McDowell, Wisdom, and 40 Bar sections, we estimated abundance at less than 10 rainbow trout per mile (Table 5). In the Sportsmans-Eastbank Section, the rainbow trout population is stable. In 1995, we estimated rainbow trout densities at 226 (± 92) per mile ≥ 6.0 inches, 222 (± 64) in 1996, and 257 (± 140) in 1997. In Deep Creek we estimated 316 (± 114) rainbow trout ≥ 4.0 inches per mile, down from 409 (±126) in 1995.

Hook and Line Distribution Surveys

Electrofishing is an intensive technique subject to variables which can diminish its efficiency in capturing grayling. To assess the distribution of grayling throughout the upper Big Hole basin we used hook-and-line sampling. Grayling are highly catchable which makes hook-and-line sampling more efficient than electrofishing during summer, when water temperatures are too warm for efficient electrofishing. Catch-per-unit-effort, too, is subject to vagaries of weather and fishes' feeding cycles, but still proved useful to assess relative abundance and distribution of fishes throughout the upper basin. Catch rates are summarized in Table 6.

Table 6. Catch per unit effort (number per angler hour) of fish species captured in upper Big Hole River hook-and-line surveys, July 1996 and 1997. Species codes are: GR-grayling, EB-brook trout, MWF-mountain whitefish, RB-rainbow trout, LL-brown trout.

SECTION	N_{ang}	N_{hr}	GR	EB	MWF	RB	LL	All Fish
Jackson-40 Bar 1996	4	16	0	0.31	0.25	0	0	0.56
Jackson-40 Bar 1997	6	24	0.04	1.25	0.21	0	0	1.50
McDowell-Wisdom 1996	3	12	0.25	0	0	0	0	0.20
McDowell-Wisdom 1997	4	15	0.67	0.20	0.20	0	0	1.07
North Fork BHR 1996	5	20	0.15	4.35	2.45	0	0	6.95
North Fork BHR 1997	6	24	0.21	5.54	2.21	0	0	7.96

In 1997 one grayling was caught in the Jackson - 40 Bar reach. No grayling were caught in this section in 1996. This is similar to spring and fall electrofishing surveys where few grayling are captured. The North Fork of the Big Hole River is a spawning and rearing area for grayling. Of the six grayling caught in that reach, four were yearlings, between 7.2 and 7.8 inches long, and two were age 2 (10.1 and 11.8 inches). Catch rates and lengths were similar in the North Fork section between 1996 and 1997. The highest catch rate for grayling occurred in the McDowell-Wisdom reach, the core area for grayling in the Big

Hole basin. Fourteen grayling were captured in the McDowell-Wisdom reach, 8 yearlings (7.6-8.7 inches) and 6 age 2 (11.0-11.9 inches). Catch rate and lengths in this section are representative of electrofishing surveys: high catch rates and a predominance of young fish.

In general, catch rates of grayling and other species was representative of their distribution and analogous to fall electrofishing results. Brook trout were predominant in the Jackson-40 Bar and North Fork Sections. In the North Fork of the Big Hole River, catch rates of brook trout were over 5 per hour. Rainbow trout and brown trout were not captured in the 3 reaches. Mountain whitefish are ubiquitous in the Big Hole River and were caught in each reach.

Axolotl Lakes Brood

We monitored the Axolotl Lakes brood and gathered gametes for reintroductions and research. The 1988 year class has dwindled from 2,800 planted in 1989 to 66 (± 34). In 1996, the age 8 fish did not produce gametes. However in 1997, the majority of age 9 fish produced gametes. These older grayling apparently are not able to spawn annually but still manage to produce gametes. Mean length increased slightly from 13.8 to 13.9 inches and condition factor was also slightly greater than in 1996.

The 1992 cohort was estimated to have 420 (± 110) fish remaining of the 3,000 planted. The estimate is less than half

of the 1996 estimate of 1067 (± 187). 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 5, 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. For comparison, the mean length of the 1988 cohort was 13.4 inches at age 5. Planting rates may have exceeded the carrying capacity of the lake and reduced growth rates. A lower number of fish should be used in future plants so carrying capacity is not exceeded. The grayling population in the Axolotl Lakes brood reserve is approximately 500 fish. Thus, we recommended an additional plant of 500 age 1+ grayling in the spring of 1998, post-spawning. However, a surplus of YOY grayling from the Axolotl brood reserve raised at Bluewater State Hatchery became available, and 1760 were planted on September 24, 1997. We will monitor these fish in spring 1998 to assess their survival. If survival was poor additional stocking may be necessary in 1998.

On May 21, we collected an estimated 390,000 eggs from 151 females (140 age 5, 11 age 9) and spawned them with 119 males (91 age 5, 28 age 9). Fecundity averaged 2500 eggs per female (Bob Snyder, MFWP Washoe Park State Hatchery, personal communication). All of the eggs were transported to Washoe Park State Hatchery for incubation. Approximately 185,000 eggs eyed and were transported to Bluewater State Hatchery for rearing.

Grayling spawning behavior was consistent with observations in the past (Byorth 1997). Ice off occurred between May 5 and 8. Males were ripe around May 10, when grayling began to congregate into schools and fed voraciously. We sampled as this behavior ceased (May 13). Catch rates declined dramatically when grayling schooled in shallow areas. Historically, females have become ripe three to four days following the cessation of feeding. In 1997, this was the case as the majority of females captured on May 19 and 20 were ripe. Spawning on May 21 was ideal for collecting gametes. Almost all males and females were ripe and easily spawned. Consistent behavioral patterns facilitate prediction of ideal spawning times.

DISCUSSION

For the third consecutive year, stream flow was ample in the upper Big Hole River. High snowpacks yielded record high flows and a prolonged runoff that extended into July. Average summer precipitation and high snow pack levels maintained discharge above 70 cfs throughout the summer. August and September discharge yield was the highest on record.

While water temperatures remained cooler in 1997, temperatures in the "warmed reach" still reached 75°F. This illustrates the relatively narrow margin between sublethal and lethal temperatures in the "warmed reach" of the Big Hole River. Seasonal high temperatures almost always occur in the last week of July or first week of August. Even with substantial flows,

temperatures approach sublethal levels at certain points. As we develop methods to maintain instream flows, projects stimulating riparian health should be investigated to alleviate temperature problems.

The status of the fluvial Arctic grayling population of the Big Hole River has continued to improve. Grayling densities have nearly returned to record high levels in 1983 (111/mile). A balanced age structure, with high adult survival and moderately successful recruitment has bolstered the population in both the Wisdom area and in mid-river reaches. Although catch rates of YOY were slightly lower in 1997, they were comparable to the previous three years. Record runoff in 1997 appeared potentially unfavorable to larval grayling, however sampling efficiency for YOY is poor, and has not proven to be a dependable index to assess recruitment. Yearling estimates have proven a better index of recruitment. Fall sampling indicates a strong age 1 year class recruiting into the population. Spawning in 1998 should incorporate a stable proportion of age 3+ year classes. Combined spawning and fall censuses indicate the grayling population will probably continue to thrive at current levels into next year, barring severe winter losses.

Hook and line surveys largely reflected known species distribution in the upper Big Hole River. The North Fork of the Big Hole River, documented as a spawning and rearing stream in the past, also provides summer feeding habitat. The Big Hole River above the McDowell section supports few grayling. Five

grayling were captured in the upper Big Hole River in the 40 Bar section during summer hook and line, and fall censuses. This is an encouraging increase. As the population has increased it has expanded up and downstream. One YOY grayling was captured in the 40 Bar section which may indicate limited spawning in the area. This reach should be investigated to determine if fish passage is restricted or entrainment of young fish limits reproduction. Grayling are also dispersing downstream. MFWP crews monitoring rainbow and brown trout populations have documented increased grayling catch rates over the past three years in the lower river (MFWP files). Although this may be attributed to three years of high runoff displacing fish downstream, it may be attributable to an increasing population of grayling.

The grayling population has increased to near the pre-decline levels. However, it is important to remain vigilant. Grayling densities declined from 111 grayling per mile in 1983, following high runoff in 1984, which may have limited recruitment. Severe drought through mid 1980's resulted in poor adult survival and weak recruitment and consequent decline. These conditions may be repeated in the near future. However, a cooperative watershed drought plan in conjunction with stockwater wells will be used to maintain flows at critical times. Testing the efficiency of the stockwater wells and continued development of alternative water conservation methods should be a priority in 1998.

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