FISHERIES INVESTIGATIONS IN THE MADISON AND GALLATIN RIVER BASINS

ANNUAL REPORT FOR 2006, 2007

Federal Aid Project F-113-R- 5

MICHAEL W. VAUGHN
TIM WEISS

Montana Fish, Wildlife and Parks
1400 South 19th
Bozeman, Montana 59718

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ABSTRACT

Estimates of fish abundance for fish six inches total length or longer were 1,309 rainbows and 1,127 brown trout/mile in the Norris section of the Madison River in spring 2006 and 2,047 rainbow and 1,279 brown trout/mile in 2007. In spring 2006, abundance was 1,185 rainbows and 1,257 brown trout/mile in the Pine Butte section. Fall 2006 numbers for this section were 3,500 rainbows and 2,336 brown trout/mile. In 2007 we found 1,790 rainbows and 1,643 brown trout/mile in spring and 3,071 rainbows and 2,841 brown trout/mile in fall. Fall Varney section numbers for rainbow were 1,928/mile in 2006 and 1,637/mile in 2007. Brown trout here totaled 3.022/mile in 2006 and 2,786/mile in 2007. In the Snoball section we found 1,448 rainbows and 1,342 brown trout/mile in fall 2007. These values suggest stable fish abundance in river sections above Ennis when compared to other recent sampling, a hopeful sign that fish are adjusting favorably to the presence of *Myxobolus cerebralis.*

The Logan section of the Gallatin River was sampled in spring of 2005, 6, and 7. Low numbers of fish result in somewhat poor mark/recapture population estimates. Analysis of length frequency data suggests that brown trout numbers and sizes are remaining stable in this reach albeit at low numbers. Numbers of rainbow trout over 15 inches fell considerably in 2007 compared to 2005 and 2006. On the other hand numbers of rainbow 10-13 inches are higher in 2006 and 2007 than in 2005. This section of river suffers from chronic low water conditions and high water temperatures. The Jack Smith Bridge section of the Gallatin River was sampled during fall 2006 and an estimate was obtained for rainbow trout over 6 inches of 4,796/mile.

Estimates of fish abundance for fish six inches in total length or longer were 520 rainbow and 366 brown trout/mile in the Thompson section of the East Gallatin River in spring 2006. Water conditions did not allow sampling in 2007. Abundance was 1,041 rainbow and 1,089 brown trout/mile in the Upper Hoffman section, and 1,231 rainbow and 529 brown trout/mile in the Lower Hoffman section in the fall of 2007. Estimates from the Hoffman sections especially indicate declining trout abundance compared to other sampling in recent years. These declines coincide with a significant increase in *M. cerebralis* infection rates for rainbow trout fry exposed to river water in recent bioassays of the East Gallatin River.

The average size of rainbow trout caught in gillnets at Hebgen Reservoir in 2006 and 2007 were 16.9 and 16.0 inches respectively. Brown trout in those years averaged 17.8 and 17.2 inches. These average lengths are similar to lengths from other comparable sampling in recent years. Catch rates decreased somewhat in 2007.

The total number of adult Yellowstone Cutthroat trout counted above Hyalite Reservoir in the West Fork of Hyalite Creek in spring 2006 was 7478 fish and 3,948 fish in 2007. The number per count is lower than the high reached in 2005 but do represent the second and third highest rate since the survey was started in 1997. The total number of adult arctic grayling was 815 fish in 2006 and 1,341 fish in 2007, nearly equaling in 2006 and besting in 2007 the previous high count in 2005. The increasing number of fish spawning in this area of the creek over the last few years coincides with the installation of artificial logjams in 2002 that were intended to improve fish habitat. The consequence that this increased spawning activity may have for the recreational fishery of the reservoir, however, is uncertain at this time.

OBJECTIVES

Funds for this project are provided by grants from the Federal Aid in Sport Fish Restoration Act (16 U.S.C. 777-777k) supporting the Montana Statewide Fisheries Management Program. This program consists of two elements: Fisheries Management in Montana, and Statewide Program Coordination. The Fisheries Management element includes four activities, each with associated objectives:

State Program Activities and Objectives

1. *Survey and Inventory*: To survey and monitor the characteristics and trends of fish populations, angler harvest and preferences, and to assess habitat conditions in selected waters.

2. *Fish Population Management*: To implement fish stocking programs and/or fish eradication actions to maintain fish populations at levels consistent with habitat conditions and other limiting factors.

3. *Technical Guidance*: To review projects by government agencies and private parties, which have the potential to affect fisheries resources, provide technical advice or decisions to mitigate effects on these resources, and provide landowners and other private parties with technical advice and information to sustain and enhance fisheries resources.

4. *Aquatic Education*: To enhance the public's understanding, awareness and support of the state's fishery and aquatic resources and to assist young people to develop angling skills and to appreciate the aquatic environment.

Statewide activities and objectives are addressed locally by ongoing fisheries investigations and management activities intended to enhance aquatic habitats and recreational fisheries in the Madison and Gallatin River basins.

Local Project Objectives

In fiscal year 2006 and 2007 (July 1, 2005 to June 30, 2007), project objectives for state project number 3340 (the Madison and Gallatin River drainages) were identical to the statewide objectives listed above. Project objectives are intended to guide continuing efforts to maintain and enhance local fisheries. In support of these efforts, the following data collections, compilations, and analyses are reported here under separate headings:

A. Estimates of trout abundance in four sections of the Madison River based on spring and fall sampling in 2006 and 2007.

B. Estimates of trout abundance in four sections of the Gallatin River based on spring and fall sampling in 2006 and 2007.

C. Estimates of trout abundance in three sections of the East Gallatin River based on spring sampling in 2006 and fall sampling in 2007.

D. Summary of gillnet catches at Hebgen Reservoir in 2006 and 2007.

F. Summary of spawner counts at Hyalite Reservoir in 2006 and 2007.

State survey, inventory, and fish population management objectives are addressed under headings A through F. Technical guidance and aquatic education objectives are addressed on an ongoing basis by meetings with various angler groups, school groups, journalists, and the public. In 2006 and 2007 these meetings included educational seminars for local school children, watershed associations, and meetings with local angling groups to discuss a variety of fisheries topics. Landowner contacts and consultations occurred routinely each month in conjunction with administration of the *Montana Natural Streambed and Land Preservation Act* and the *Montana Stream Protection Act*.

PROCEDURES

A. Estimates of trout abundance in four sections of the Madison River based on spring and fall sampling in 2006 and 2007.

We sampled trout abundance in four sections of the Madison River (Table 1; Figure 1) normally examined as part of routine fisheries surveys in this drainage (e.g., Tohtz 2005; Byorth 2000a). Fish\[A] were sampled in each section with electrofishing gear mounted on a drift boat. This gear included a 5,000-watt generator and a Coffelt Model VVP-15 rectifying unit. The cathode was a steel plate attached to the bottom of the drift boat, the anode was a single hand held (mobile) electrode connected to the power source by about 30 feet of cable. Fish were collected in live cars, identified, measured to the nearest 0.1 inch\[B], and weighed to the nearest 0.01 pound. Trout were marked with fin clips and returned to the stream. Recapture sampling was conducted about two weeks later in each section. Data were processed using FA+, a computer program developed by FWP for processing electrofishing records (Anon. 2004, 2008). Fish numbers were estimated using the log-likelihood model. Estimates were evaluated for reliability at alpha = 0.05. Fish were separated into one-inch length groups for most analyses.

Table 1. River sections where trout abundance was sampled in the Madison River in 2006 and 2007.

Section name	Last mark date	Length (ft)	Boundary	Upstream	Downstream\[1]
Pine Butte	09/07/07	15,840	North	45.87111	44.89993
			West	111.56582	111.59168
Snoball	09/13/07	23,760	North	45.92696	45.96682
			West	111.50744	111.64141
Varney	09/18/07	21,120	North	45.23119	45.29844
			West	111.75187	111.75400
Norris	03/08/07	21,120	North	45.58512	45.62219
			West	111.59400	111.55028

1. Latitude and longitude (decimal degrees, WGS84 datum).

A. Common names are used in this report. Scientific names are listed in Appendix A.

B. Unless otherwise noted, all fish lengths in this report are total lengths (TL).

Figure 1. River sections where trout abundance was sampled in the Madison River in 2006 and 2007. Finer detail of each section is provided in Appendix B.

B. Estimates of trout abundance in four sections of the Gallatin River based on spring and fall sampling in 2006 and 2007.

In fall of 2006 we sampled trout abundance in two sections of the upper Gallatin River with a third section being sampled in fall of 2007 (Table 2; Figure 2) as part of our routine fisheries surveys (e.g., Tohtz 2005; Byorth 2000b). We also sampled a section of the lower Gallatin River in spring of 2007. Fish handling and marking procedures were identical to those described in Part A, above. Recapture sampling was conducted about two weeks later in each section. Data were processed using FA+, a computer program developed by FWP for processing electrofishing records (Anon. 2004, 2008). Fish numbers were estimated using the log-likelihood model. Estimates were evaluated for reliability at alpha = 0.05. Fish were separated into one-inch length groups for most analyses. Fish numbers in a fourth section sampled in spring 2005, 2006, and 2007 were not conducive to a population estimate and reported using length frequency analysis.

Table 2. River sections where trout abundance was sampled in the Gallatin River in 2006 and 2007.

Section name	Last mark date	Length (ft)	Boundary	Upstream	Downstream\[1]
Jack Smith	09/01/06	11,616	North	45.27964	45.29753
			West	111.22525	111.20899
Porcupine	08/31/06	12,376	North	45.22593	45.26370
			West	111.24842	111.25222
Williams	08/30/07	15,000	North	45.54040	45.57616
			West	111.23381	111.21420
Logan	03/23/07	22,704	North	45.89148	45.88789
			West	111.33614	111.38801

1. Latitude and longitude (decimal degrees, WGS84 datum).

Figure 2. River sections where trout abundance was sampled in the Gallatin River in 2006 and 2007. Finer detail of each section is provided in Appendix B.

Photo 1. Portion of the Pine Butte sampling section of the Madison River.

Photo 2. Portion of the Varney sampling section of the Madison River.

Photo 3. Portion of the Norris sampling section of the Madison River.

Photo 4. Portion of the Logan sampling section of the Gallatin River.

C. Estimates of trout abundance in three sections of the East Gallatin River based on spring and fall sampling in 2006 and 2007.

In spring of 2006 we sampled one section and in fall 2007 we sampled fish abundance in two sections of the East Gallatin River (Table 3; Figure 3). Fish were sampled in each section with electrofishing gear mounted on a small drift boat. This gear included a 4,500-watt generator and a Leach direct current rectifying unit. The cathode was a steel plate attached to the bottom of the drift boat; the anode was a single hand held (mobile) electrode connected to the power source by about 30 feet of cable. Fish handling and marking procedures were identical to those described in Part A, above. Recapture sampling was conducted about two weeks later in each section. Data were processed using FA+, a computer program developed by FWP for processing electrofishing records (Anon. 2004, 2008). Fish numbers were estimated using the log-likelihood model. Estimates were evaluated for reliability at alpha = 0.05. Fish were separated into one-inch length groups for most analyses.

Table 3. River sections where trout abundance was sampled in the East Gallatin River in 2006 and 2007.

Section name	Last mark date	Length (ft)	Boundary	Upstream	Downstream\[1]
Upper Hoffman	09/25/07	3,907	North	45.72578	45.72894
			West	111.06575	111.07160
Lower Hoffman	09/25/07	5,280	North	45.72913	45.73881
			West	111.73875	111.06902
Thompson	03/15/06	6,336	North	45.80669	45.81944
			West	111.13220	111.14043

1. Latitude and longitude (decimal degrees, WGS84 datum).

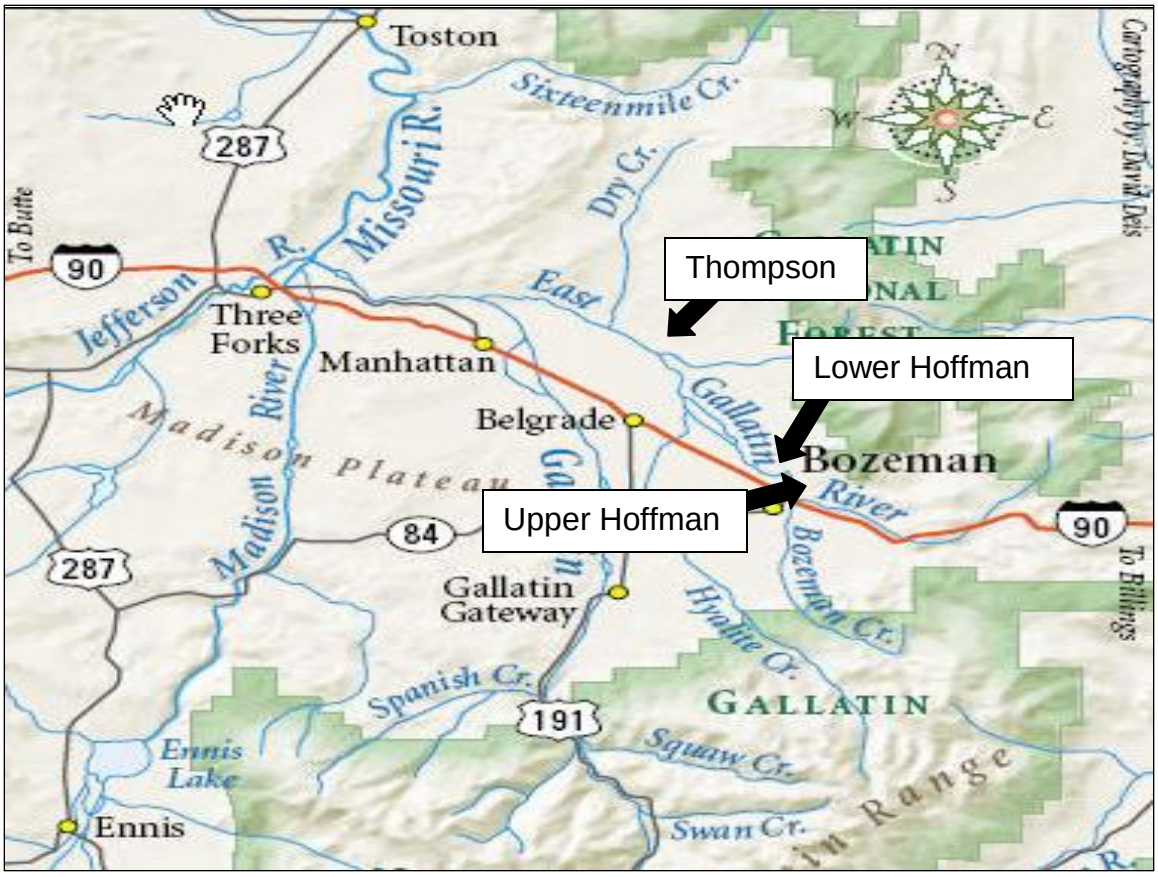

Figure 3. River sections where trout abundance was sampled from the East Gallatin River in 2006 and 2007. Finer detail of each section is provided in Appendix B.

Photo 5. Portion of the Upper Hoffman sampling section of the East Gallatin River.

Photo 6. Portion of the Lower Hoffman sampling section of the East Gallatin River.

Photo 7. Portion of the Thompson sampling section of the East Gallatin River.

D. Summary of gillnet sampling at Hebgen Reservoir in spring 2006 and 2007.

Gillnet sampling of Hebgen Reservoir in 2006 and 2007 mimicked previous spring sampling (e.g., Byorth and Weiss 2003). We used 11 sinking and 14 floating experimental gillnets deployed over the course of three nights at nineteen different locations (Figure 4) for a total of 25 net nights to determine the entire sample. Each net was six-feet wide and 125 feet long with five equal-size panels of different mesh size graded by half-inch increments from one to three inches (bar measure).

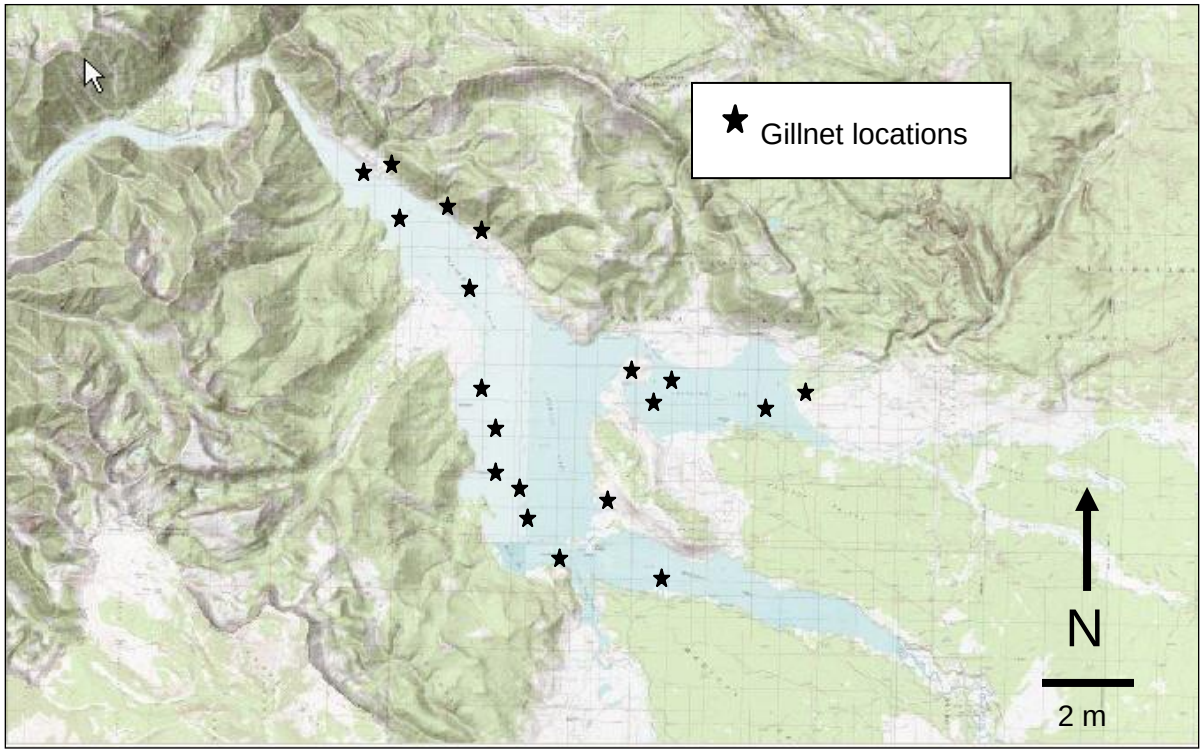

Figure 4. Location of gillnets used to sample fish from Hebgen Reservoir in spring 2006 and 2007.

Photo 8. Hebgen Reservoir.

E. Summary of gillnet sampling at Quake Lake in 2007.

Quake Lake was sampled with gillnets in 2007. We used three floating experimental gillnets deployed overnight at different locations for a total of three net nights to determine the entire sample. Each net was six-feet tall and 125 feet long with five equal-size panels of different mesh size graded by half-inch increments from one to three inches (bar measure).

F. Summary of spawner counts at Hyalite Reservoir in 2006 and 2007.

Spawner surveys of Yellowstone cutthroat trout and arctic grayling were performed above Hyalite Reservoir in the West Fork of Hyalite Creek at least once each week throughout the spawning season. Observers counted adult fish while walking upstream, beginning at the reservoir and ending at a point approximately one-half mile above the reservoir.

RESULTS AND DISCUSSION

A. Estimates of trout abundance in four sections of the Madison River based on spring and fall sampling in 2006 and 2007.

Most of our data for rainbow and brown trout from each of the sections sampled in 2006 and 2007 fit the log-likelihood model well. Individual and pooled data\[C] for trout captured in the Madison River sections modeled at probability values greater than than 0.05 (Table 4).

Table 4. Trout/mile in four sections of the Madison River based on spring and fall sampling in 2006 and 2007. Estimates are for fish six inches (TL) or longer.

Section (last mark date):			Overall model			Pooled model		
Fish species	N	SD	DF	Chi-square	P	DF	Chi-square	P /1
Pine Butte (3/23/2006):								
Rainbow trout	1,185	86	8	6.66	0.57	6	6.43	0.38
Brown trout	1,257	112	3	6.76	0.08	3	6.76	0.08
Pine Butte (9/18/2006):								
Rainbow trout	3,500	252	7	5.55	0.59	7	5,55	0.59
Brown trout	2,336	117	9	5.02	0.83	9	5.02	0.83
Pine Butte (3/14/2007):								
Rainbow trout	1,790	84	9	13.13	0.16	8	2.96	0.94
Brown trout	1,643	78	9	16.23	0.06	8	15.80	0.05
Pine Butte (9/7/2007):								
Rainbow trout	3,071	224	7	6.36	0.50	7	6.36	0.50
Brown trout	2,841	156	10	16.84	0.08	10	16.84	0.08
Varney (9/14/2006):								
Rainbow trout	1,928	136	10	10.43	0.40	10	10.43	0.40
Brown trout	3,022	119	8	11.86	0.16	8	11.86	0.16
Varney (9/18/2007):								
Rainbow trout	1,637	103	9	15.56	0.08	9	15.56	0.08
Brown trout	2,786	77	11	11.48	0.40	11	11.48	0.40

1. N=estimated number; SD=standard deviation; DF=degrees of freedom; P=probability value.

Table 4 cont.

Section (last mark date): Fish species	N	SD	Overall model DF	Overall model Chi-square	Overall model P	Pooled model DF	Pooled model Chi-square	Pooled model P /1
Norris (3/8/2006)								
Rainbow trout	1,309	94	4	5.80	0.21	3	4.68	0.20
Brown trout	1,100	171	4	3.17	0.53	3	3.17	0.37
Norris (3/8/2007)								
Rainbow trout	2,047	108	5	2.37	0.80	5	2.37	0.80
Brown trout	1,279	138	6	9.29	0.16	5	8.84	0.12
Snoball (9/13/2007)								
Rainbow trout	1,448	117	7	10.23	0.18	6	6.67	0.35
Brown trout	1,342	82	9	10.46	0.31	9	10.46	0.31

1. N=estimated number; SD=standard deviation; DF=degrees of freedom; P=probability value.

Pine Butte Section

Our surveys in the Pine Butte section of the Madison River showed rainbow and brown trout abundance similar to estimates from surveys made in the past few years (Figure 5; Figure 6; see also Figures 7 and 8). This is a welcome result. Recent surveys suggest an increase in rainbow trout abundance compared to surveys conducted in the mid 1990s. Declining abundance at that time was attributed especially to the effects of whirling disease on trout fry (e.g. Byorth 2000a). Rainbow trout now seem to be adapting to the presence of life with *Myxobolus cerebralis.* Other lines of evidence suggest that this adjustment includes the possibility that rainbow trout are developing some resistance to whirling disease effects (Vincent et al. 2005; Figure 10). If true, this resistance may partly explain better survivorship of young fish observed in recent years (Figure 9).

C. Our analyses include a procedure that "pools" data by combining one-inch length groups of fish into new groups that contain at least three recaptured fish. Results of this analysis are reported in Table 4 as outputs of the pooled model.

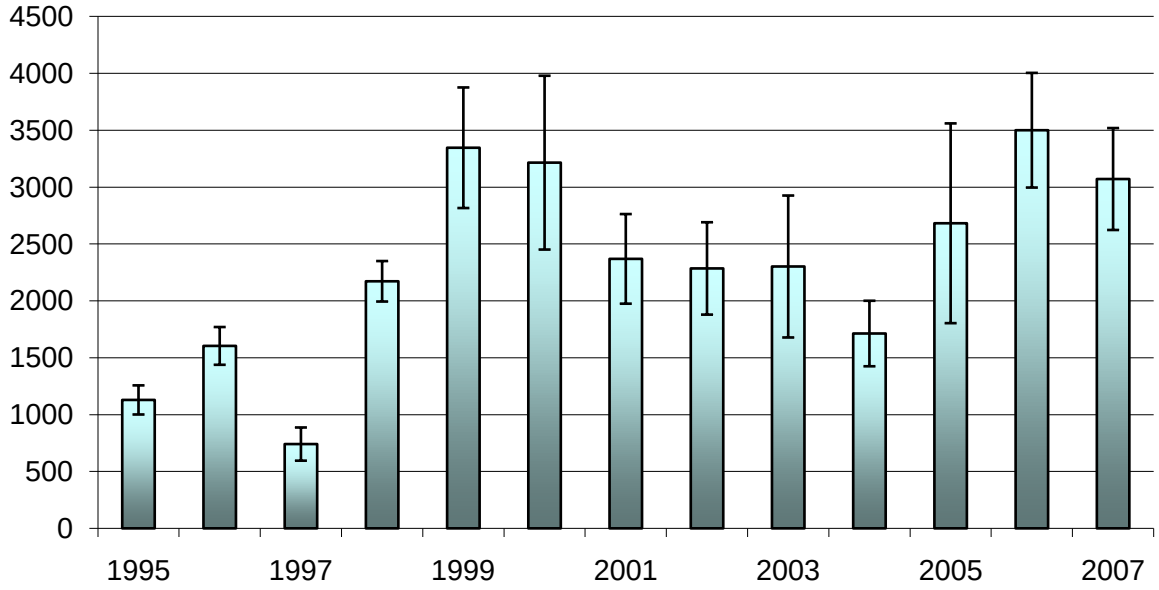

Figure 5. Rainbow trout abundance in the Pine Butte section of the Madison River based on fall sampling from 1995 through 2007. Estimates are for fish six inches (TL) or longer. Error bars show plus or minus 2 SD of each estimate.

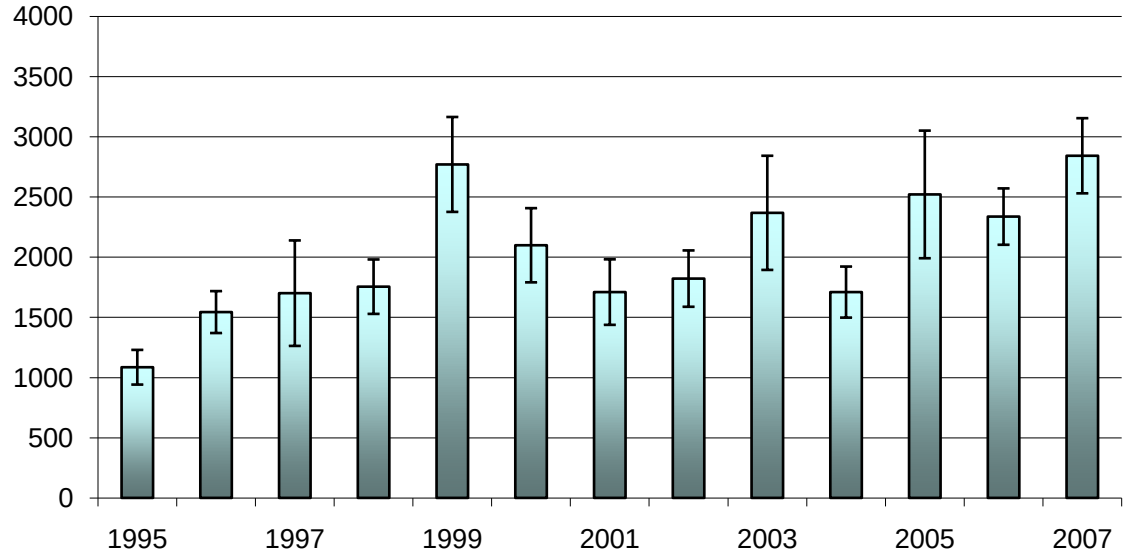

Figure 6. Brown trout abundance in the Pine Butte section of the Madison River based on fall sampling from 1995 through 2007. Estimates are for fish six inches (TL) or longer. Error bars show plus or minus 2 SD of each estimate.

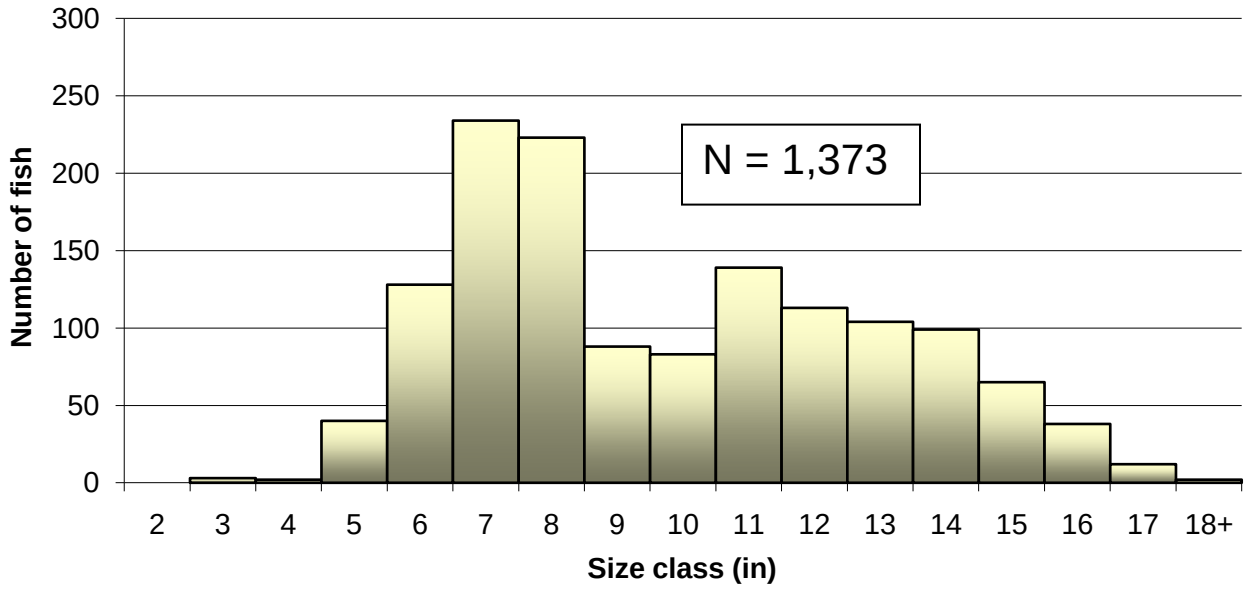

Figure 7. Length frequency distribution of rainbow trout captured in the Pine Butte section of the Madison River in September 2007.

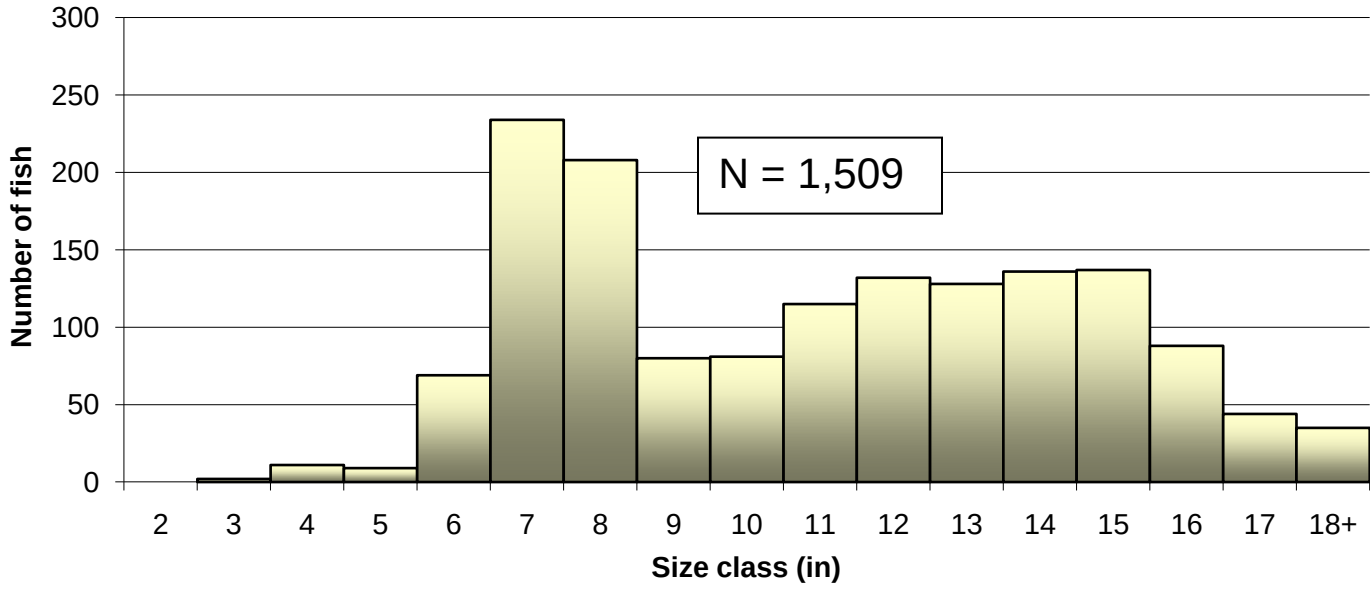

Figure 8. Length frequency distribution of brown trout captured in the Pine Butte section of the Madison River in September 2007.

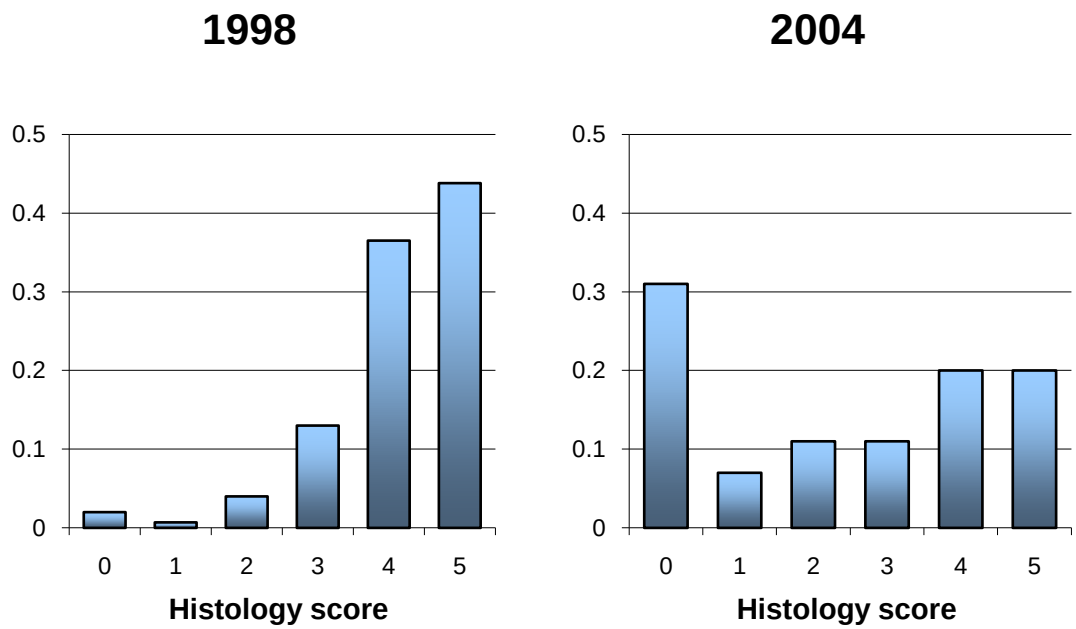

Figure 9. Proportion (vertical axes) of newly hatched rainbow trout assigned to different histology score categories after fish were exposed to controlled numbers of infective *Myxobolus cerebralis* spores under laboratory conditions. Histology scores are an index of infection intensity. For rainbow trout, histology scores above 2.5 are associated with significant fish mortality at very young age that has measurable effects on population abundance. Fish in this experiment were hatched from eggs taken from rainbow trout in the Pine Butte section of the Madison River in 1998 and 2004. Fifty fish were exposed in each experiment. All data and information adapted from Vincent et al. 2005.

Varney Section

Our estimates of rainbow trout abundance in the Varney section of the Madison River were similar to 2004 and 2005 and continue to show increased abundance of rainbow trout in this section compared to estimates from samples collected in the mid 1990s (Figure 10; see also Figure 11). The rainbow trout population in this portion of the river has apparently recovered significantly from dramatic population declines of the 1990s attributed to whirling disease (Vincent 1996; Byorth 2000a).

Brown trout abundance was somewhat higher in 2006 and 2007 compared to estimates in 2004 and 2005 and was at the high end of estimates for the last ten years. These estimates are well within the usual variation in abundance we have observed in this section for at least the last ten years, suggesting stable recruitment and survivorship year to year (Figure 12; see also Figure 13).

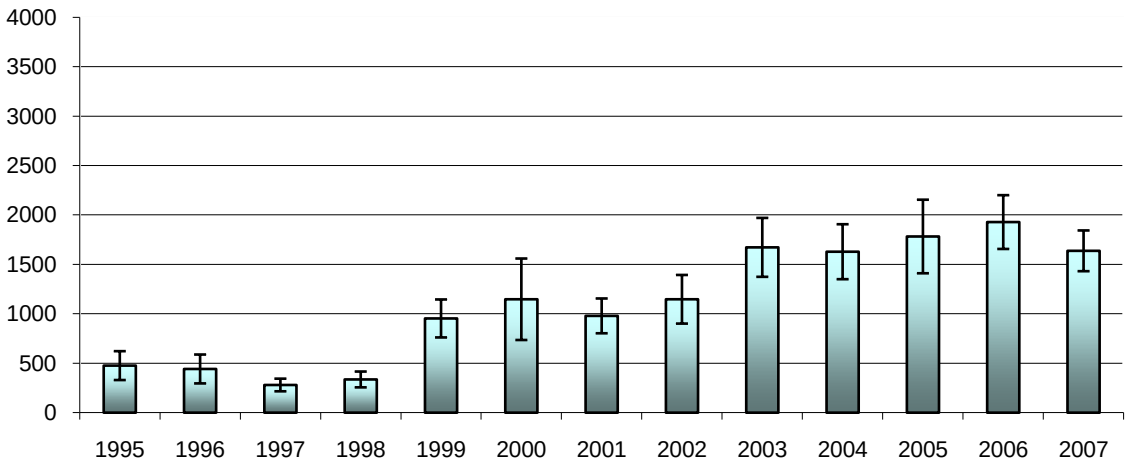

Figure 10. Rainbow trout abundance in the Varney section of the Madison River based on fall sampling from 1995 through 2007. Estimates are for fish six inches (TL) or longer. Error bars show plus or minus 2 SD of each estimate.

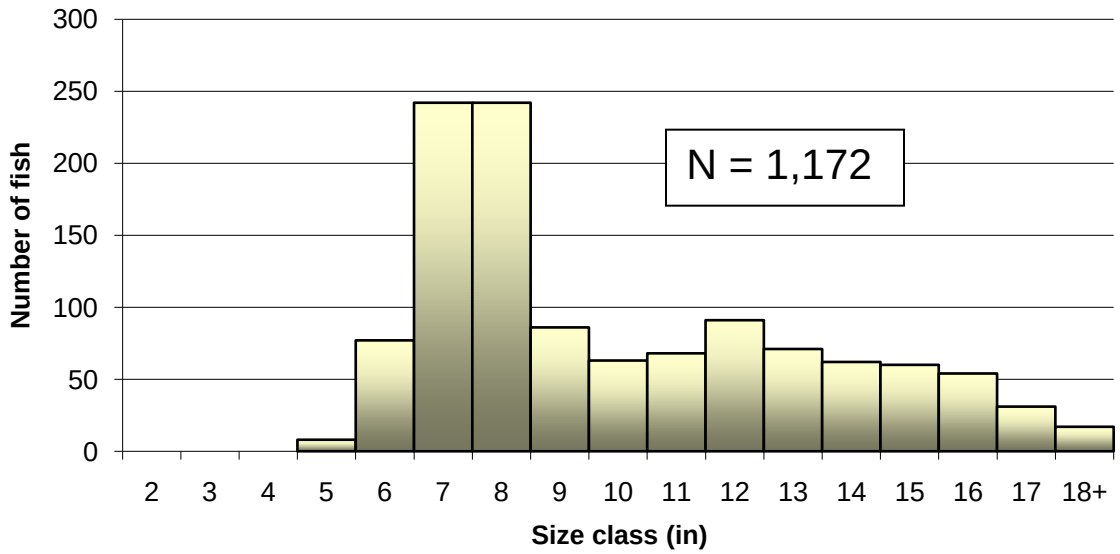

Figure 11. Length frequency distribution of rainbow trout captured in the Varney section of the Madison River in September 2007.

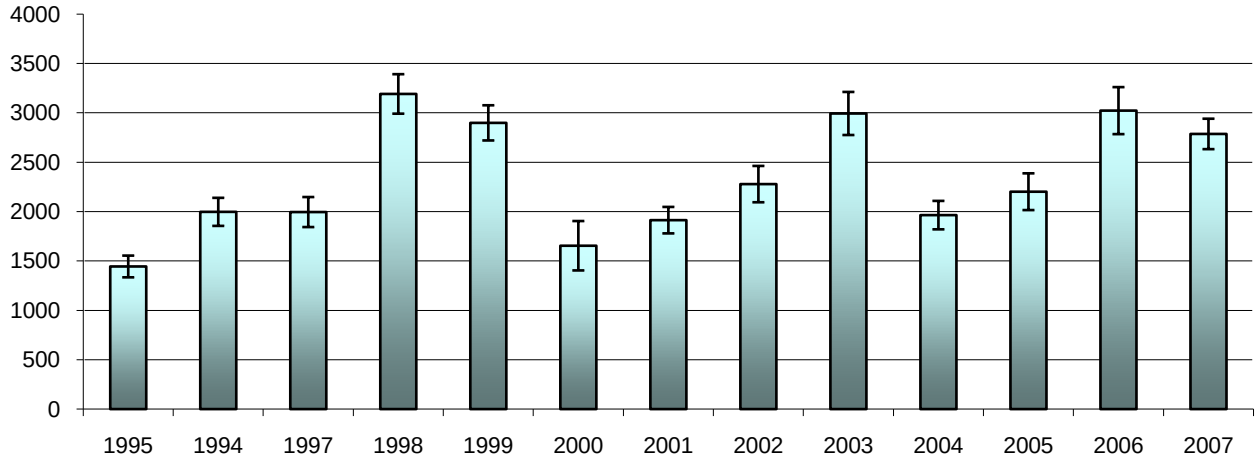

Figure 12. Brown trout abundance in the Varney section of the Madison River based on fall sampling from 1995 through 2007. Estimates are for fish six inches (TL) or longer. Error bars show plus or minus 2 SD of each estimate.

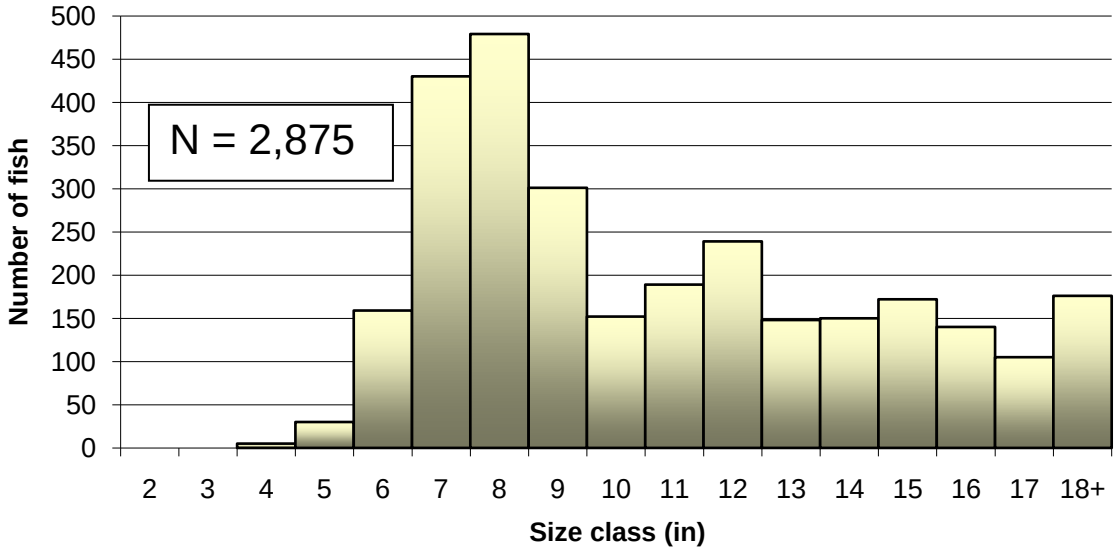

Figure 13. Length frequency distribution of brown trout captured in the Varney section of the Madison River in September 2007.

Norris Section

Rainbow and brown trout abundance in the Norris section of the Madison River were similar this year compared to last year. Abundance of both species is within the usual variation in abundance we have observed since 1998, the year that rainbow trout first began to show meaningful population increases while adjusting to the presence of *M. cerebralis* in the drainage (Figure 16; Figure 17; see also Figures 18 and 19).

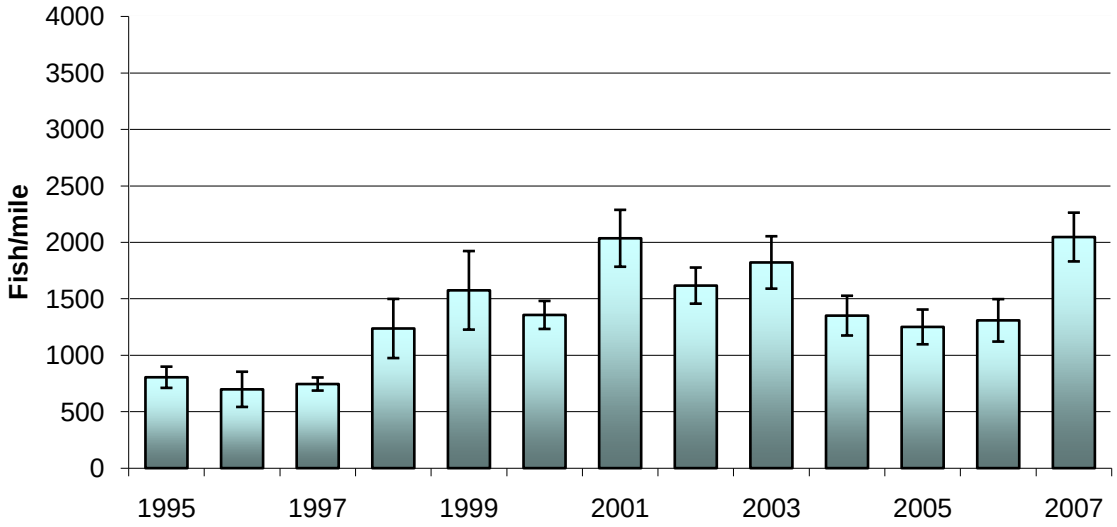

Figure 14. Rainbow trout abundance in the Norris section of the Madison River based on spring sampling from 1995 through 2007. Estimates are for fish six inches (TL) or longer. Error bars show plus or minus 2 SD of each estimate.

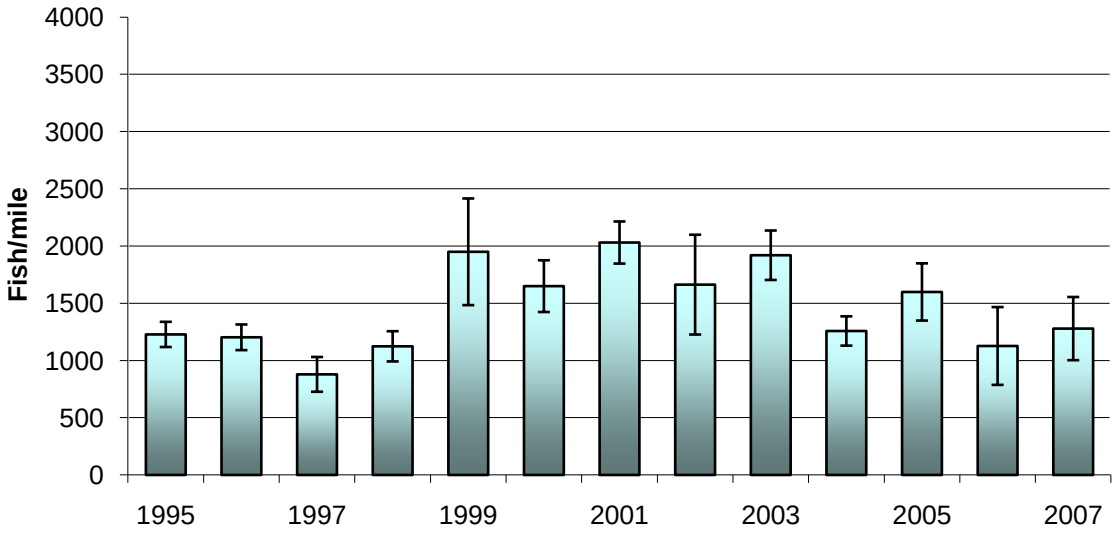

Figure 15. Brown trout abundance in the Norris section of the Madison River based on spring sampling from 1995 through 2007. Estimates are for fish six inches (TL) or longer. Error bars show plus or minus 2 SD of each estimate.

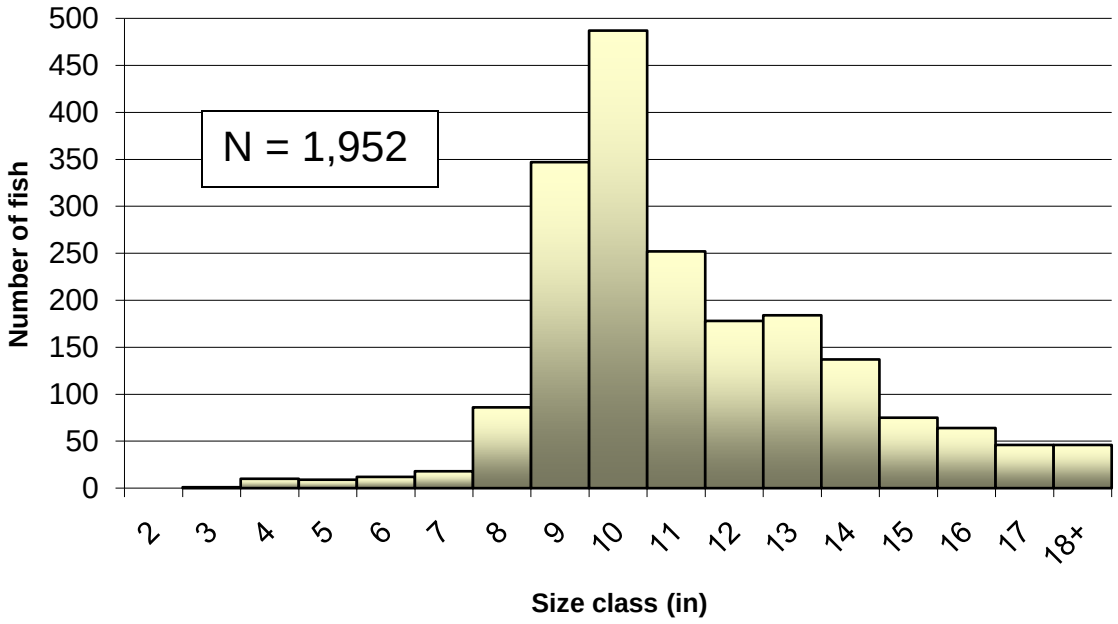

Figure 16. Length frequency distribution of rainbow trout captured in the Norris section of the Madison River in March 2007.

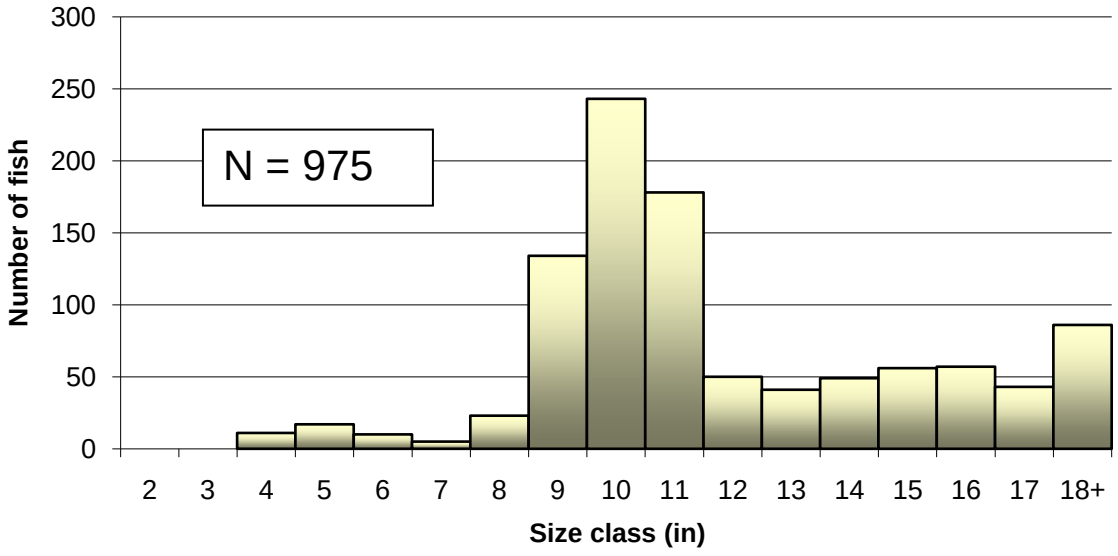

Figure 17. Length frequency distribution of brown trout captured in the Norris section of the Madison River in March 2007.

B. Estimates of trout abundance in four sections of the Gallatin River based on spring and fall sampling in 2006 and 2007.

Data for rainbow and brown trout collected from four sections of the Gallatin River generally fit the log-likelihood model well (Table 5).

Table 5. Trout/mile in four sections of the Gallatin River based on spring and fall sampling in 2006 and 2007. Estimates are for fish six inches (TL) or longer.

Section (mark date):			Overall model			Pooled model		
Fish species	N	SD	DF	Chi-square	P	DF	Chi-square	P \[1]
Porcupine (8/31/2006)								
Rainbow trout	2,429	164	6	8.68	0.19	6	8.68	0.19
Jack Smith Br. (9/1/2006)								
Rainbow trout	4,796	351	3	5.11	0.16	3	5.11	0.16
Williams Br. (8/30/2007)								
Rainbow trout	2,415	177	7	15.11	0.03	7	15.11	0.03
Brown trout								
Logan (3/14/2006)								
Rainbow trout	493	75	7	12.94	0.07	4	11.67	0.02
Brown trout	141	16	3	4.63	0.20	3	4.63	0.20
Logan (3/23/2007)								
Rainbow trout	385	58	6	12.32	0.06	2	4.43	0.11
Brown trout	399	51	7	9.03	0.25	2	4.80	0.09

1. N=estimated number; SD=standard deviation; DF=degrees of freedom; P=probability value.

Porcupine Section

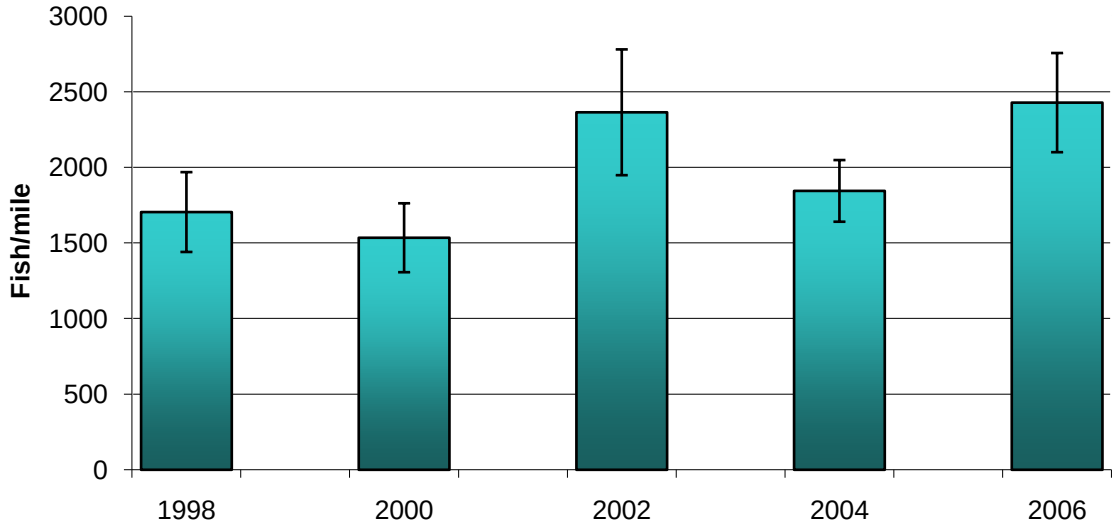

Figure 18. Rainbow trout abundance in the Porcupine section of the West Gallatin River based on fall sampling in even numbered years from 1998 through 2006. Estimates are for fish six inches (TL) or longer.

Jack Smith Section

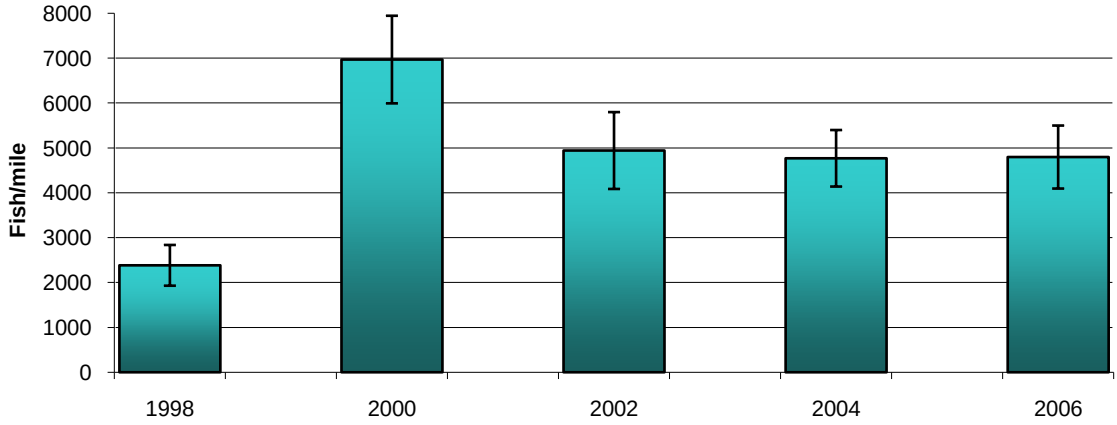

Figure 19. Rainbow trout abundance in the Jack Smith section of the West Gallatin River based on fall sampling from 1994 through 2006. Estimates are for fish six inches (TL) or longer.

Williams Bridge Section

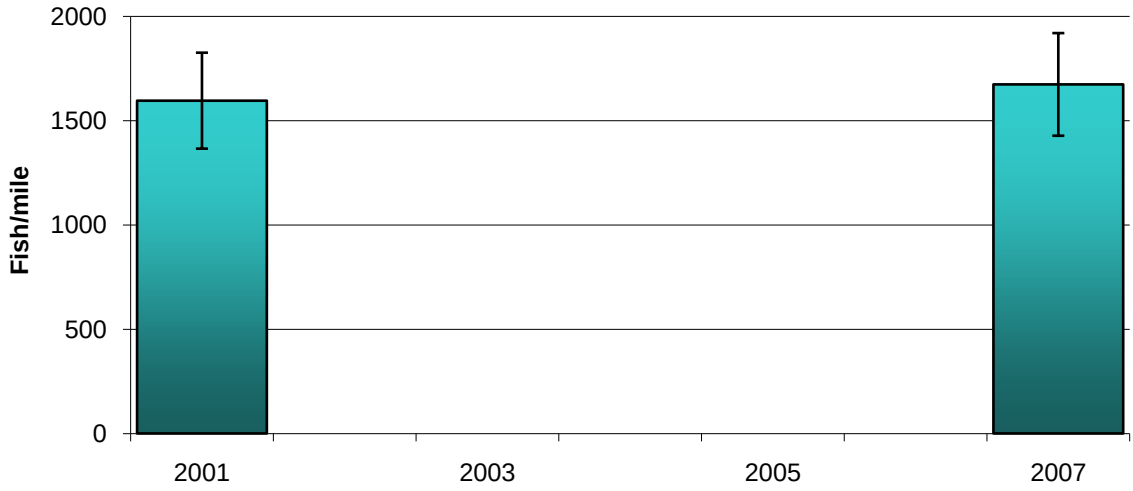

Figure 20. Rainbow trout abundance in the Williams Bridge section of the West Gallatin River based on fall sampling in 2001 and 2007. Estimates are for fish six inches (TL) or longer.

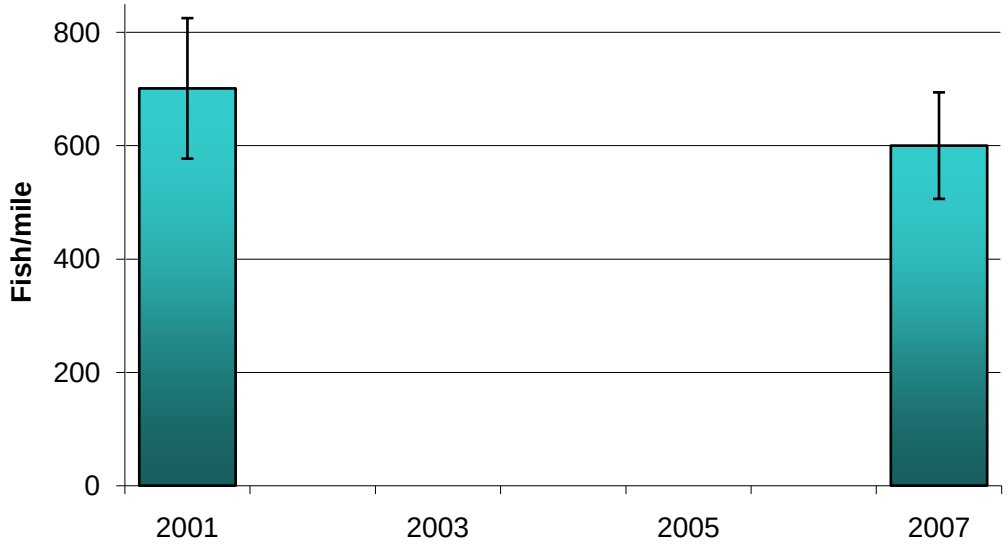

Figure 21. Brown trout abundance in the Williams Bridge section of the West Gallatin River based on fall sampling in 2001 and 2007. Estimates are for fish six inches (TL) or longer.

Logan Section

Our estimates of rainbow trout abundance in the Logan section of the Gallatin River were similar to estimates made in the past few years (Figure 20; see also Figure 21). Taking into account the high variance of the 2004 estimate, similar abundance year to year suggests stable recruitment and survivorship in this area of the river.

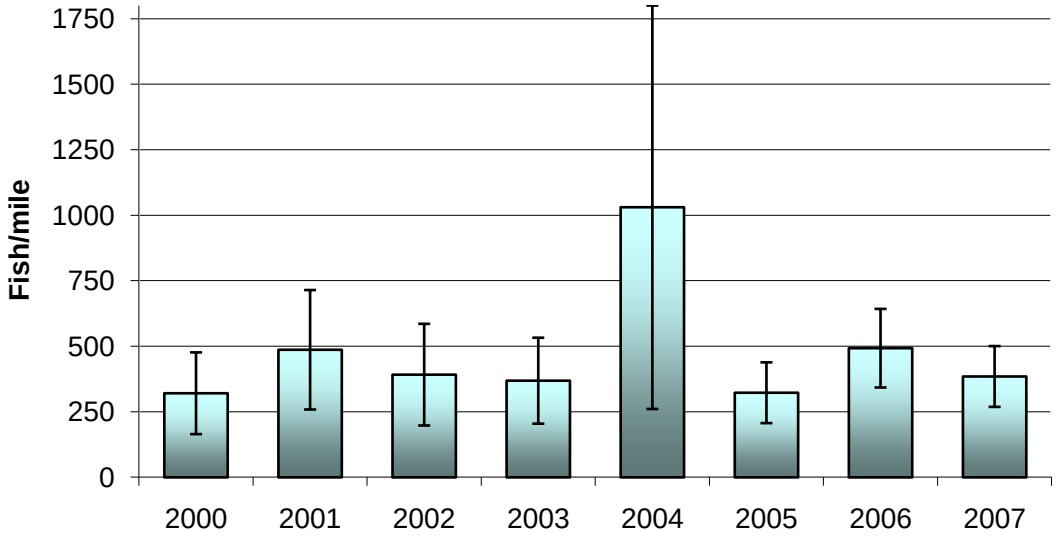

Figure 22. Rainbow trout abundance in the Logan section of the Gallatin River based on spring sampling from 2000 through 2007. Estimates are for fish six inches (TL) or longer. Error bars show plus or minus 2 SD of each estimate.

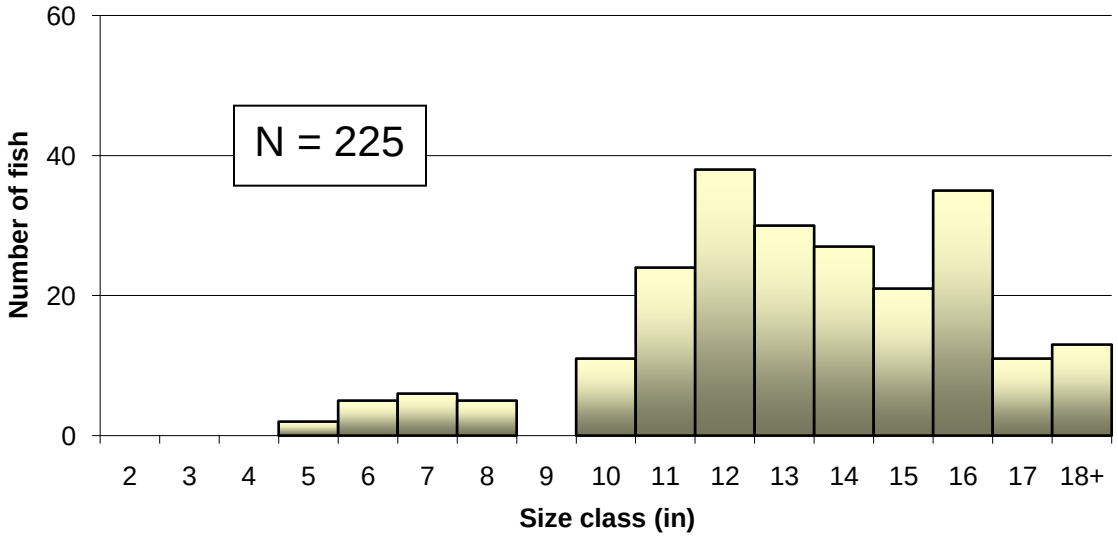

Figure 23. Length frequency distribution of rainbow trout captured in the Logan section of the Gallatin River in March 2005.

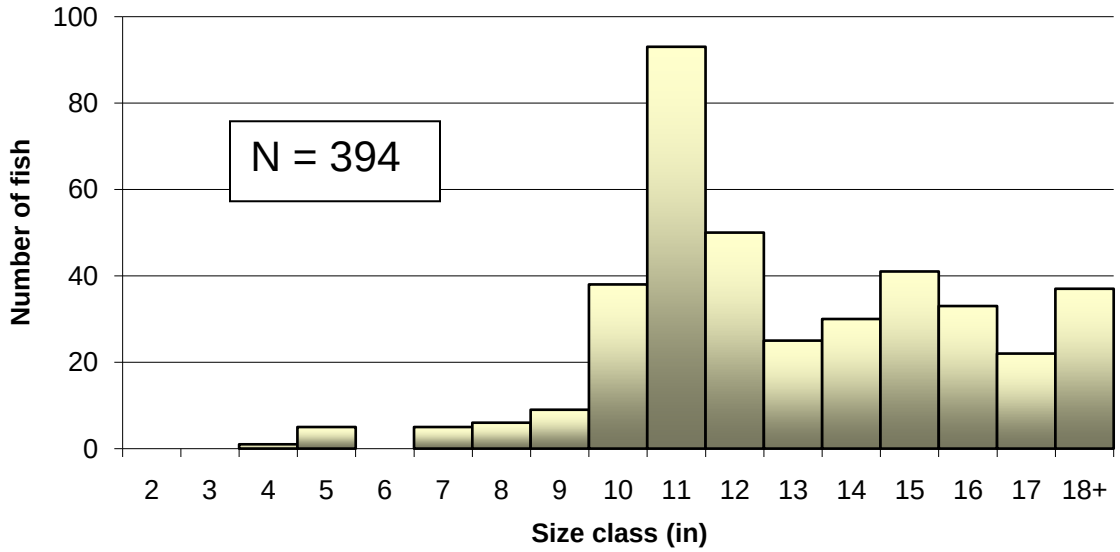

Figure 24. Length frequency distribution of rainbow trout captured in the Logan section of the Gallatin River in March 2006.

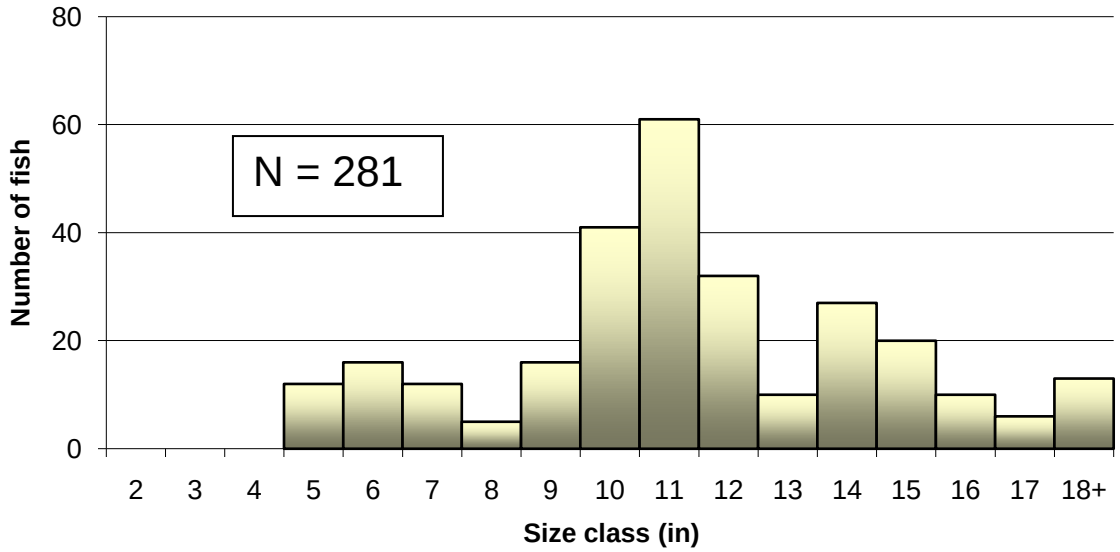

Figure 25. Length frequency distribution of rainbow trout captured in the Logan section of the Gallatin River in March 2007.

Our brown trout estimates in two of the last three years were slightly higher than in previous years (Figure 22; see also Figure 23), perhaps indicating a reversal in the pattern of population decline suggested by estimates from this portion of the Gallatin River in recent, drought influenced, years.

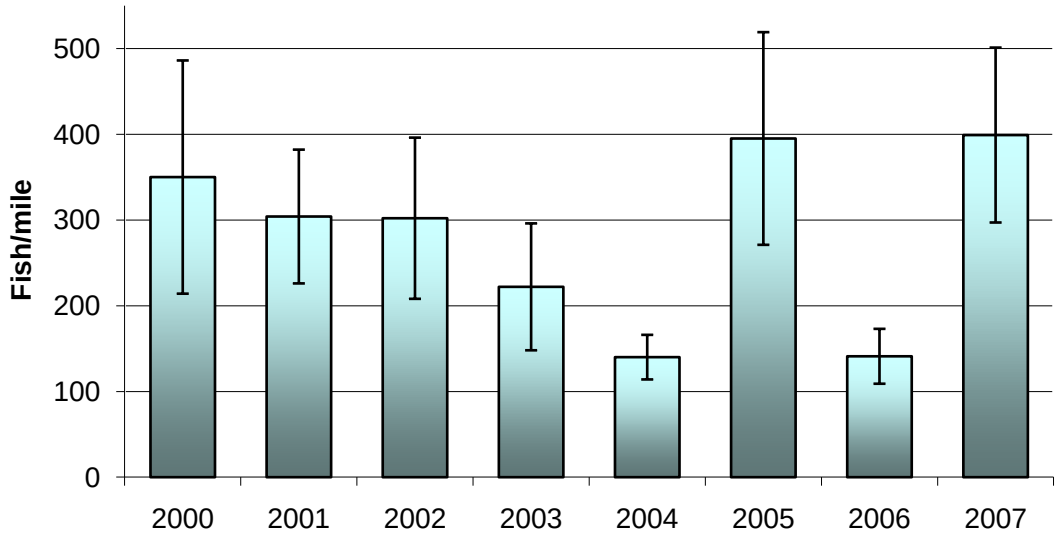

Figure 26. Brown trout abundance in the Logan section of the Gallatin River based on spring sampling from 2000 through 2007. Estimates are for fish six inches (TL) or longer. Error bars show plus or minus 2 SD of each estimate.

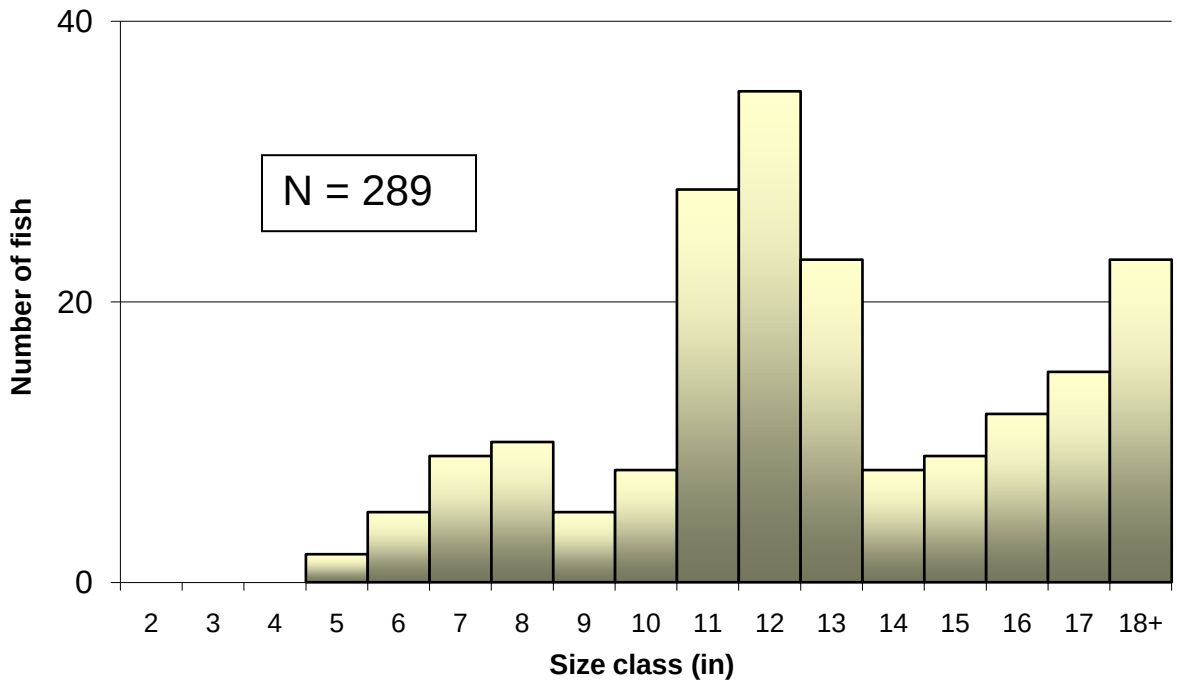

Figure 27. Length frequency distribution of brown trout captured in the Logan section of the Gallatin River in March 2005.

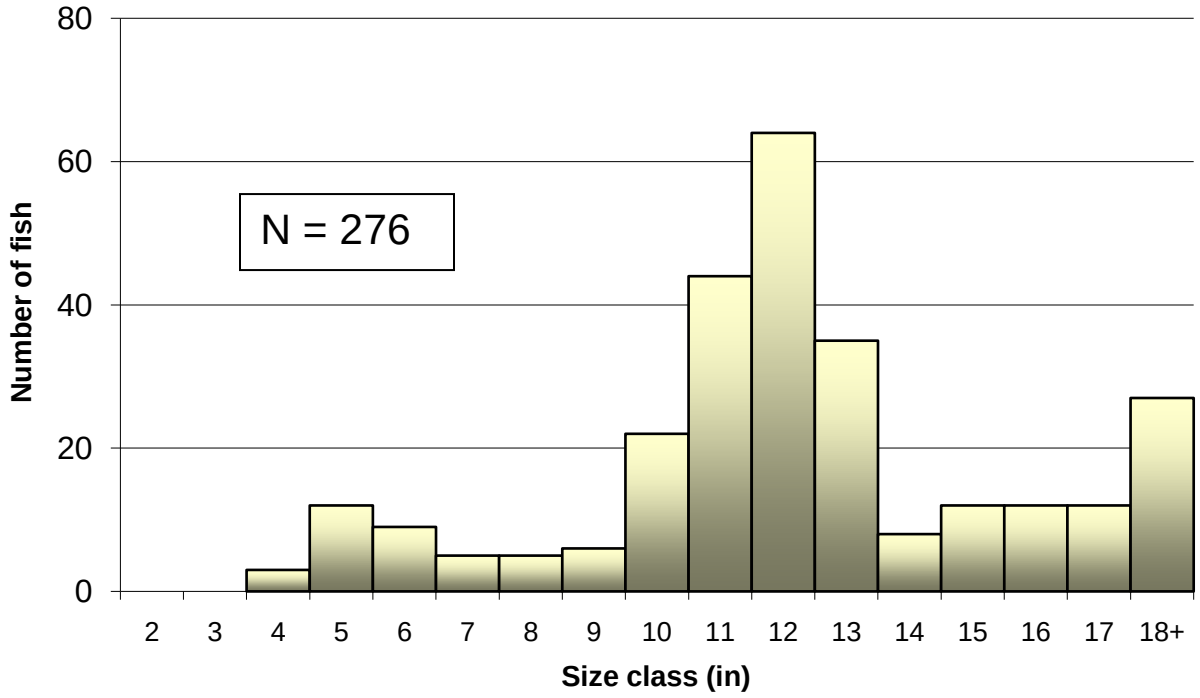

Figure 28. Length frequency distribution of brown trout captured in the Logan section of the Gallatin River in March 2006.

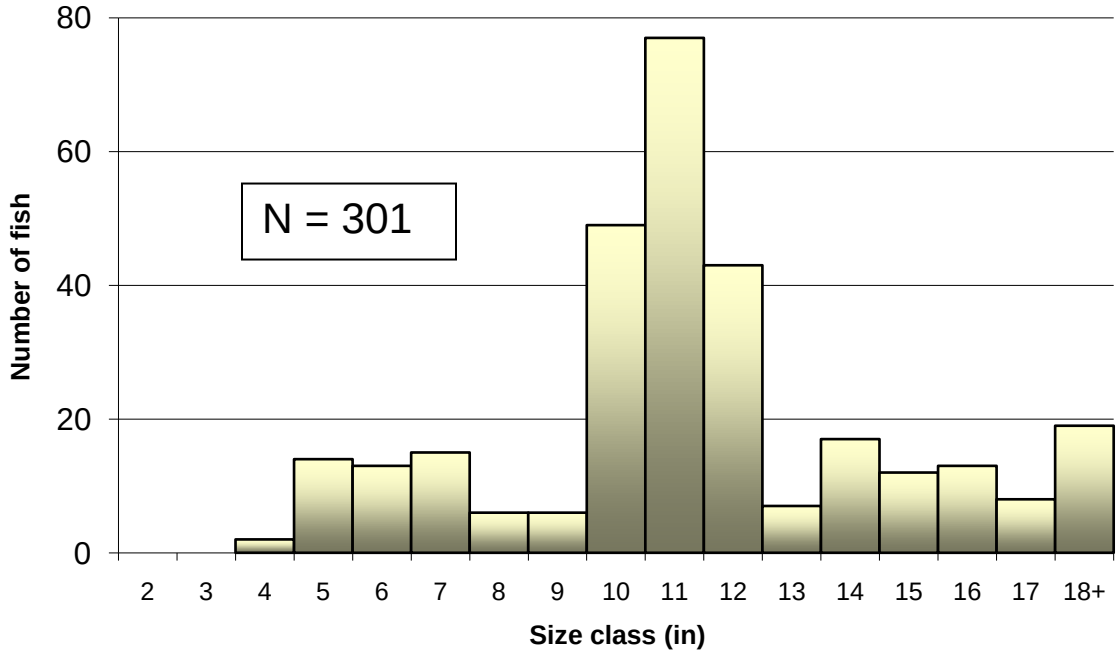

Figure 29. Length frequency distribution of brown trout captured in the Logan section of the Gallatin River in March 2007.

C. Estimates of trout abundance in three sections of the East Gallatin River based on spring and fall sampling in 2006 and 2007.

Data for rainbow and brown trout from each section of the East Gallatin River sampled in 2006 and 2007 fit the log-likelihood model well. Individual and pooled data for trout captured in the Thompson and Upper and Lower Hoffman sections modeled at probability values greater than 0.05 (Table 6).

Estimates of rainbow trout abundance in the Hoffman sections, and to a lesser extent the Thompson section (see below), continue to be less than was usual before the onset of whirling disease. As previously discussed (Tohtz 2005), less abundance can be attributed in part to loss of smaller fish associated with a significant increase in *M. cerebralis* infection rates for rainbow trout fry. Continuing drought is likely a factor as well, perhaps exacerbating the influence of *M. cerebralis* by concentrating the parasites in less water, especially in spring. Although numbers of rainbow trout are significantly lower today than in pre-whirling disease populations, the current numbers and sizes of fish in the East Gallatin River produce a substantial, high quality fishery.

Table 6. Trout/mile in three sections of the East Gallatin River based on spring and fall sampling in 2006 and 2007. Estimates are for fish six inches (TL) or longer.

Section (mark date):			Overall model			Pooled model		
Fish species	N	SD	DF	Chi-square	P	DF	Chi-square	P \[1]
Thompson (3/15/06):								
Rainbow trout	520	30	6	8.70	0.19	6	8.70	0.19
Brown trout	366	52	6	7.22	0.30	3	2.66	0.45
Upper Hoffman (9/25/2007):								
Rainbow trout	1,041	72	5	2.79	0.73	4	2.75	0.60
Brown trout	1,089	66	6	9.62	0.14	5	9.29	0.10
Lower Hoffman (9/25/2007):								
Rainbow trout	1,231	33	9	8.77	0.46	9	8.77	0.46
Brown trout	529	39	5	1.60	0.90	3	1.02	0.80

1. N=estimated number; SD=standard deviation; DF=degrees of freedom; P=probability value.

Upper Hoffman Section

Rainbow trout abundance in the Upper Hoffman section of the East Gallatin River was low again this year especially compared to estimates from the late 1990s (Figure 24; see also Figure 25). Brown trout abundance has remained much more stable and similar year to year throughout this same sampling period with 2007 numbers at the high end of the range (Figure 26; see also Figure 27).

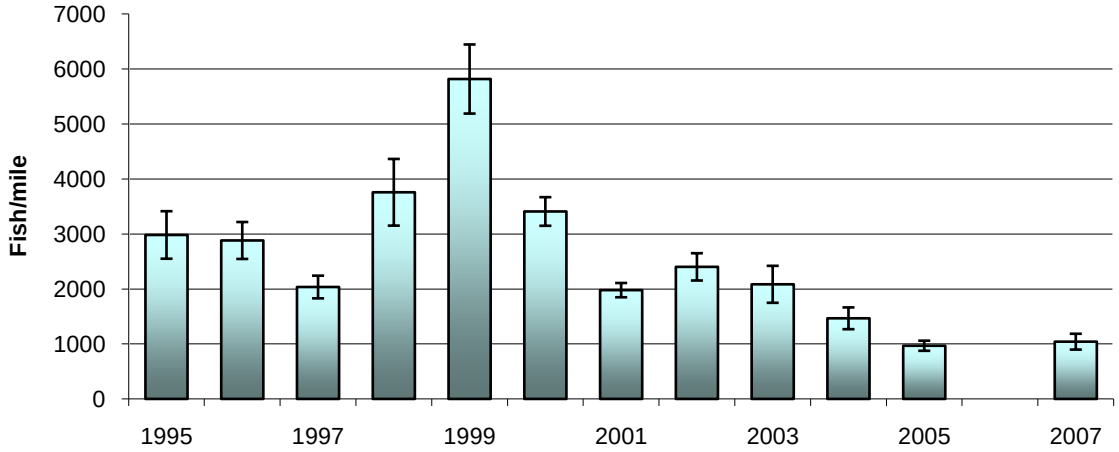

Figure 30. Rainbow trout abundance in the Upper Hoffman section of the East Gallatin River based on fall sampling from 1995 through 2007. Estimates are for fish six inches (TL) or longer. Error bars show plus or minus 2 SD of each estimate.

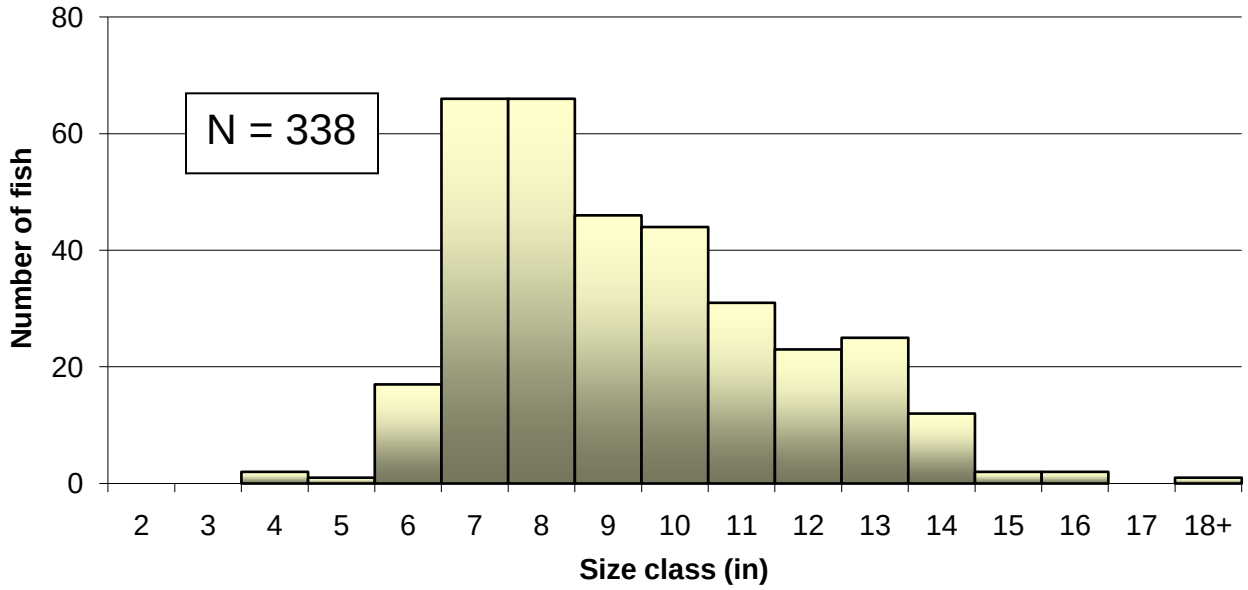

Figure 31. Length frequency distribution of rainbow trout captured in the Upper Hoffman section of the East Gallatin River in September 2007.

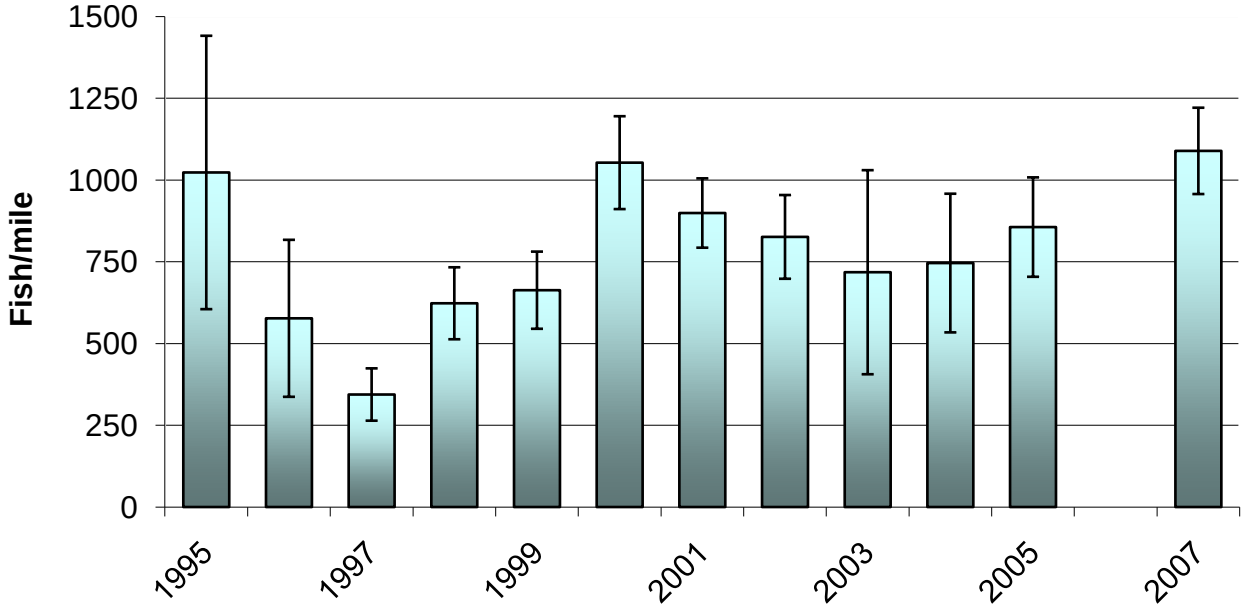

Figure 32. Brown trout abundance in the Upper Hoffman section of the East Gallatin River based on fall sampling from 1995 through 2007. Estimates are for fish six inches (TL) or longer. Error bars show plus or minus 2 SD of each estimate.

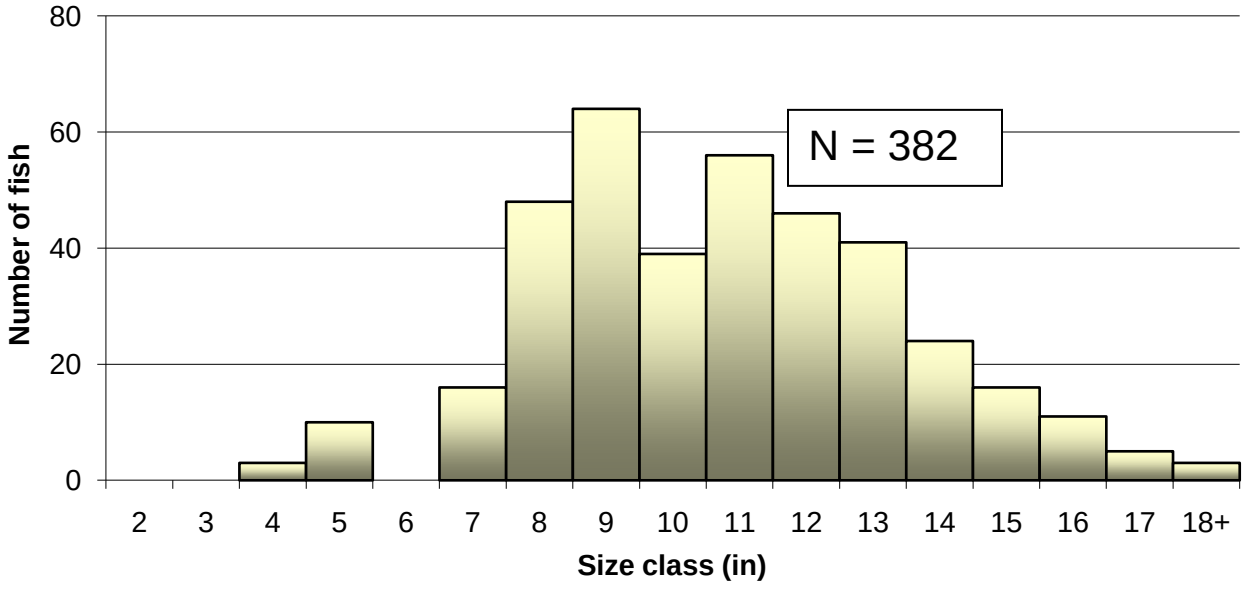

Figure 33. Length frequency distribution of brown trout captured in the Upper Hoffman section of the East Gallatin River in September 2007.

Lower Hoffman Section

The Lower and Upper Hoffman sections fall close together and are physically very similar to each other. The main feature distinguishing the two sections is the fact that the Lower section is downstream from the Bozeman Sewage Treatment Facility's effluent discharge to the East Gallatin River. Nutrient effects in particular alter the character of the East Gallatin River below this point of discharge. The effluent discharge can also provide significantly more flow below the point of discharge at certain times, for example during low flow periods in late summer which have recently been exacerbated by drought. Although the ecological character of the river is different in the Upper and the Lower Hoffman sections, rainbow trout abundance shows a similar pattern of decrease in both sections in recent years (Figure 28; see also Figure 29). Low rainbow trout abundance was evident in the Lower section again in 2007 but average size is currently larger than in pre-whirling disease populations. Brown trout abundance this year was in the mid range of long-term averages (Figure 30; see also Figure 31).

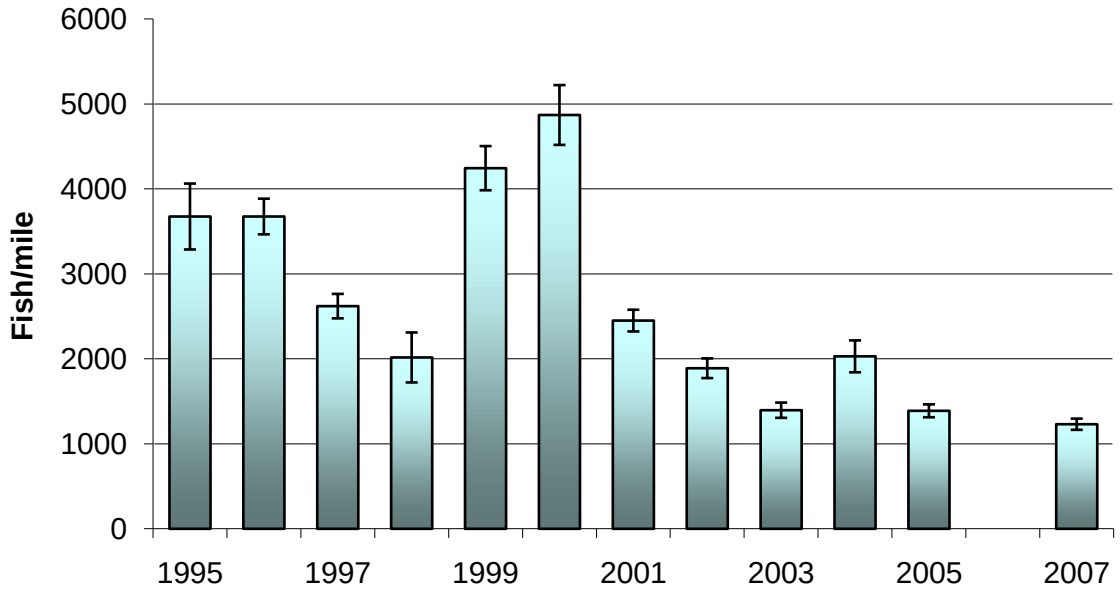

Figure 34. Rainbow trout abundance in the Lower Hoffman section of the East Gallatin River based on fall sampling from 1995 through 2007. Estimates are for fish six inches (TL) or longer. Error bars show plus or minus 2 SD of each estimate.

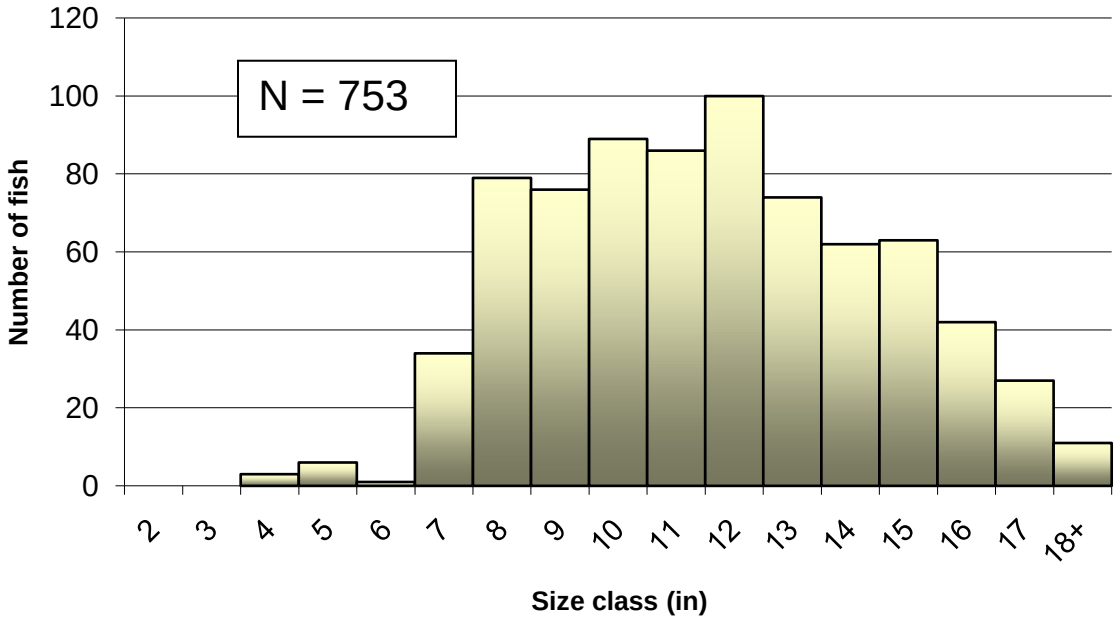

Figure 35. Length frequency distribution of rainbow trout captured in the Lower Hoffman section of the East Gallatin River in September 2007.

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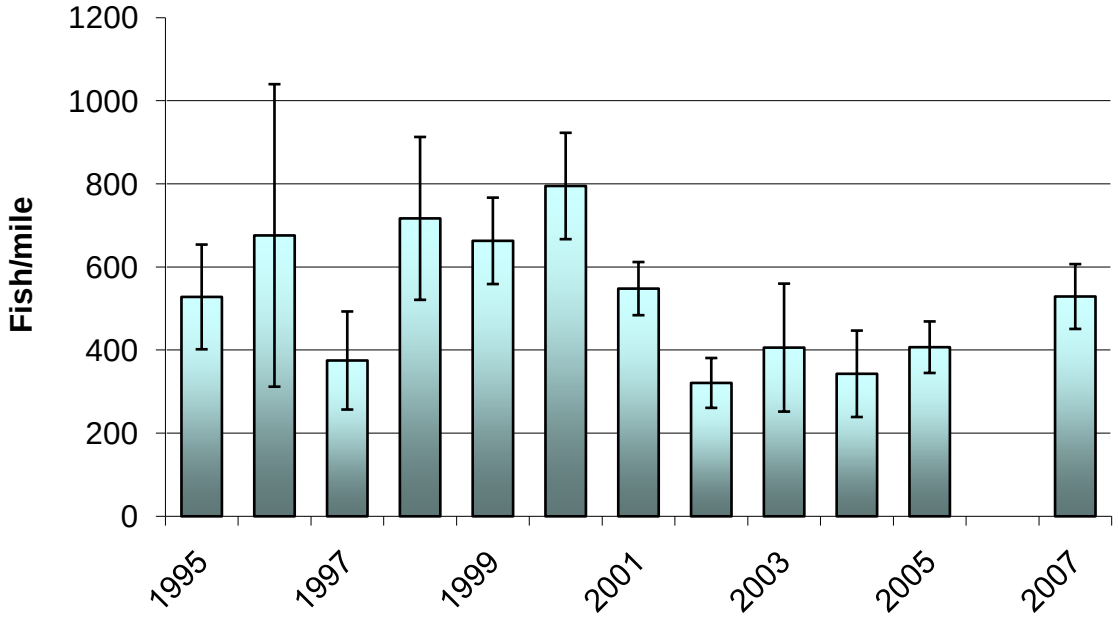

Figure 36. Brown trout in the Lower Hoffman section of the East Gallatin River based on fall sampling from 1995 through 2007. Estimates are for fish six inches (TL) or longer. Error bars show plus or minus 2 SD of each estimate.

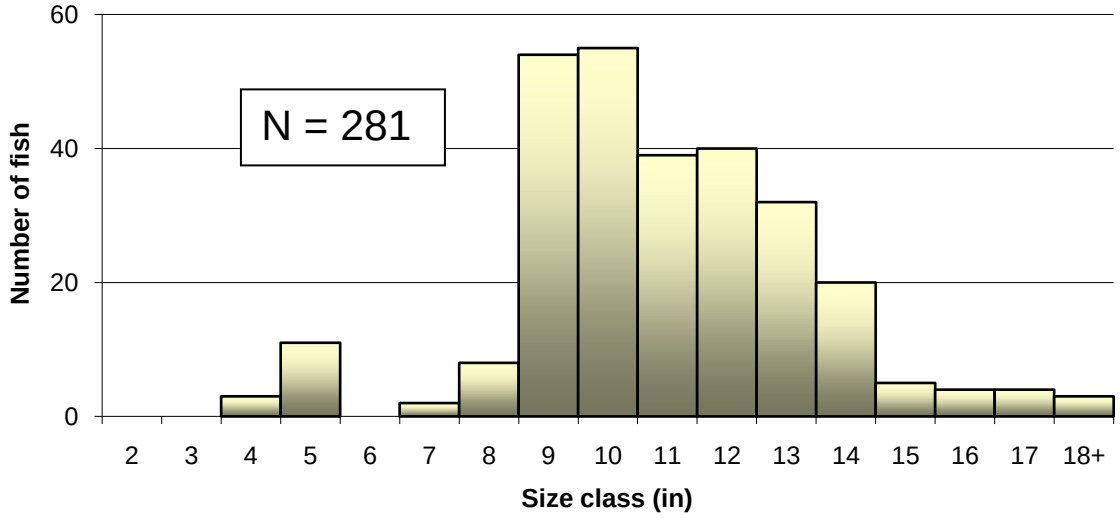

Figure 37. Length frequency distribution of brown trout captured in the Lower Hoffman section of the East Gallatin River in September 2007.

Thompson Section

Rainbow and brown trout abundance in the Thompson section of the East Gallatin River has been similar in recent years (Figure 32; Figure 33: see also Figures 34 and 35), however population monitoring was reinstated in this section only in 2001, many years after any sampling had previously been conducted in this area of the East Gallatin River. It is possible that rainbow trout declines evidenced in the Hoffman sections (see above) occurred here as well. Sampling will continue in this section for at least the next few years to follow population trends especially as compared to upstream sections.

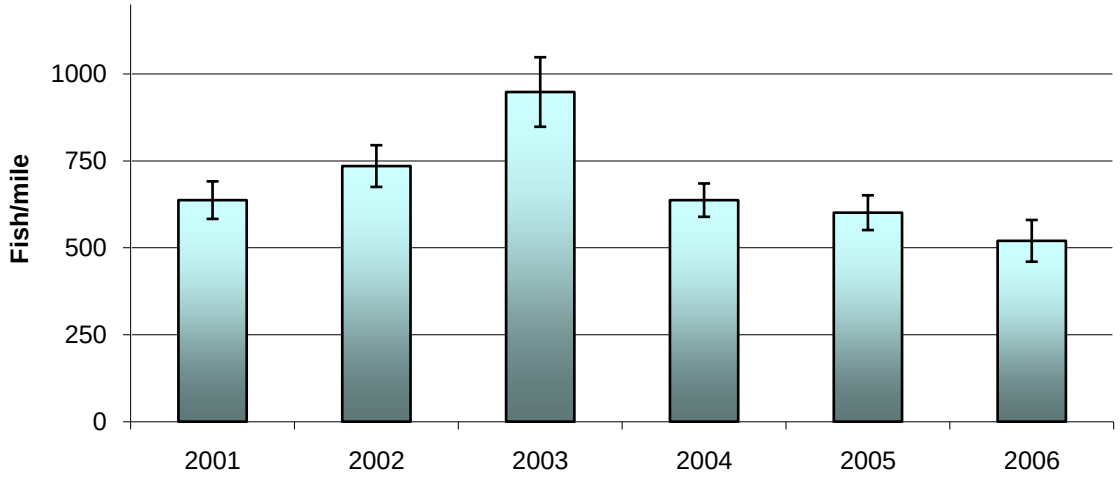

Figure 38. Rainbow trout abundance in the Thompson section of the East Gallatin River based on spring sampling from 2001 through 2006. Estimates are for fish six inches (TL) or longer. Error bars show plus or minus 2 SD of each estimate.

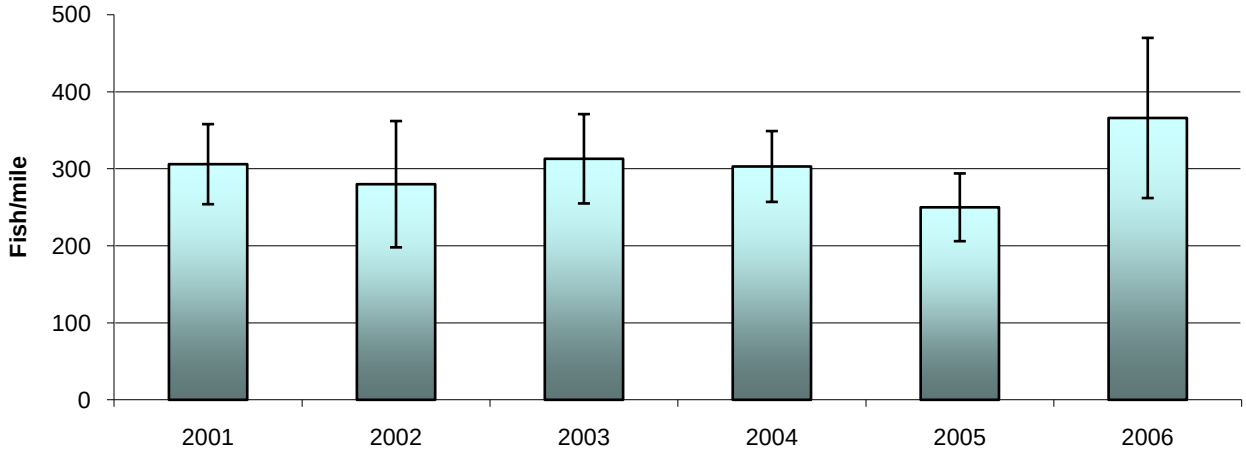

Figure 39. Brown trout abundance in the Thompson section of the East Gallatin River based on spring sampling from 2001 through 2006. Estimates are for fish six inches (TL) or longer. Error bars show plus or minus 2 SD of each estimate.

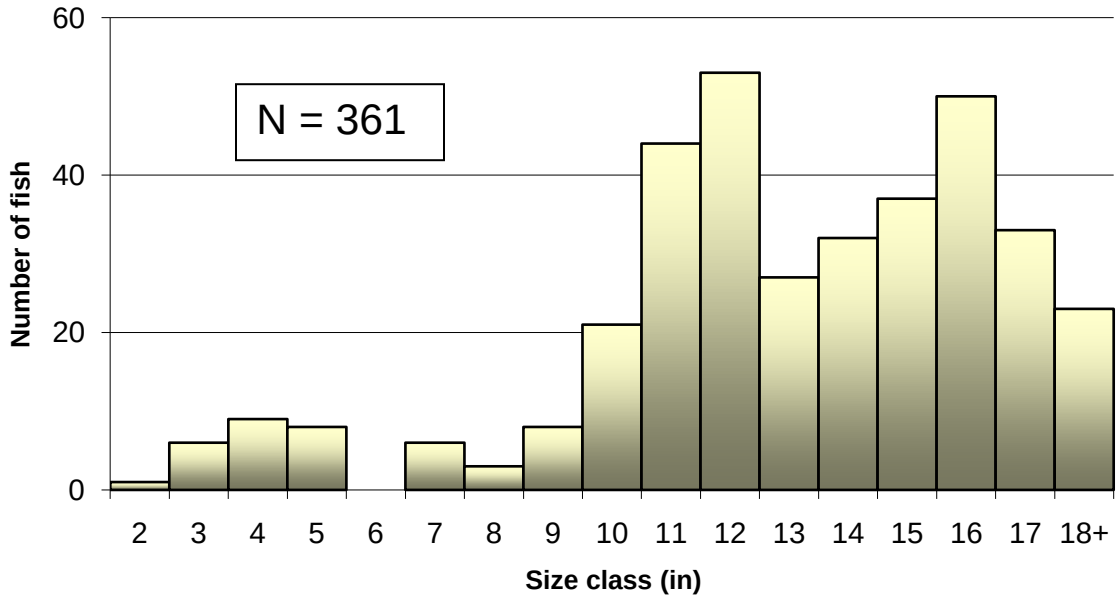

Figure 40. Length frequency distribution of rainbow trout captured in the Thompson section of the East Gallatin River in September 2006.

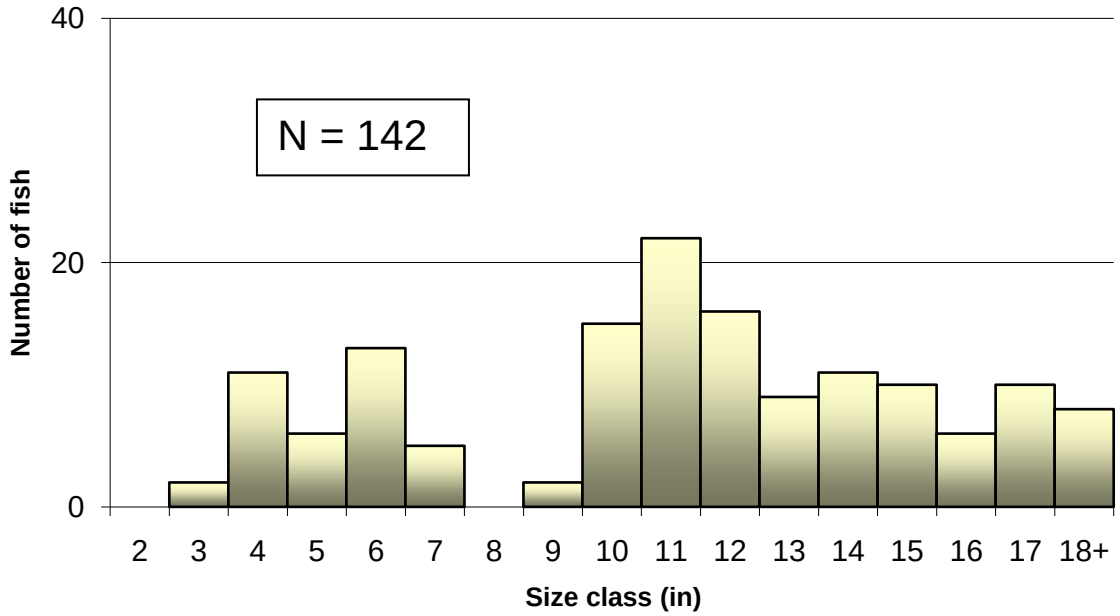

Figure 41. Length frequency distribution of brown trout captured in the Thompson section of the East Gallatin River in September 2006.

D. Summary of gillnet sampling at Hebgen Reservoir in 2006 and 2007.

The average number of game fish caught in each gillnet at Hebgen Reservoir in spring 2006 was near long term averages but numbers were lower in 2007. Utah chub numbers per net have been trending lower during the past few years to a current low of 10.7 fish per net in 2007. This is well below the high of 89.8 fish per net in 1999. (Table 7).

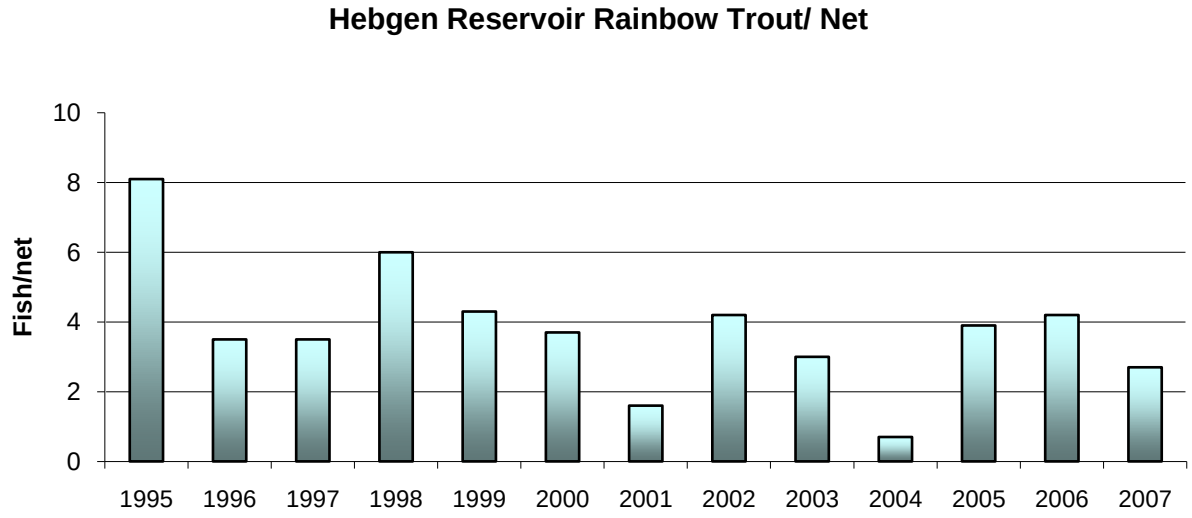

Figure 42. Average number of rainbow trout captured per net at Hebgen Reservoir, 1995 through 2007.

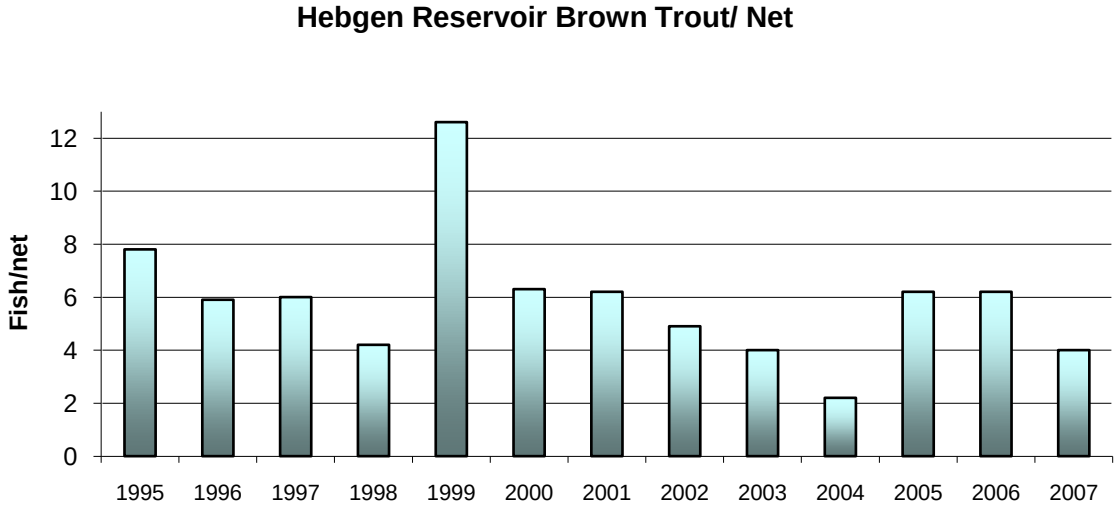

Figure 43. Average number of brown trout captured per net at Hebgen Reservoir, 1995 through 2007.

Table 7. Summaries of gillnet catches at Hebgen Reservoir based on spring sampling from 1995 through 2007.

Year	Rainbow trout		Brown trout		Mountain whitefish		Utah chub	
	TL Fish/net	Mean (inches)	Fish/net	Mean TL (inches)	Fish/net	Mean TL (inches)	Fish/net	Mean TL (inches)
1995	8.1	14.7	7.8	17.0	9.8	15.5	16.2	10.4
1996	3.5	14.2	5.9	16.4	8.4	15.5	55.0	10.2
1997	3.5	14.0	6.0	15.4	7.2	14.1	60.8	10.5
1998	6.0	14.1	4.2	15.6	5.6	15.7	49.0	10.7
1999	4.3	13.5	12.6	16.0	9.7	14.9	89.8	10.6
2000	3.7	14.1	6.3	16.0	5.3	15.5	68.4	10.1
2001	1.6	14.4	6.2	16.9	8.1	15.0	25.4	10.0
2002	4.2	16.7	4.9	17.3	5.4	15.8	80.7	9.4
2003	3.0	15.4	4.0	17.6	4.2	16.1	52.8	9.9
2004	0.7	15.7	2.2	17.5	3.9	16.8	21.0	10.8
2005	3.9	17.3	6.2	17.8	3.3	16.8	24.4	10.5
2006	4.2	16.9	6.2	17.8	4.7	16.6	22.6	10.9
2007	2.7	16.0	4.0	17.2	3.6	17.2	10.7	10.4

The average length of rainbow and brown trout in recent samples continues to remain near historic highs. This trend may be associated with less fish abundance, although our catch rate in gillnets does not support this assertion (Table 7). Our ability to detect small variations in population size, however, is very limited in this type of sampling.

The low catch rate of Utah Chubs in 2007 may be explained by what appears to be a regular cycle of increasing and decreasing abundance of this species in Hebgen Reservoir (Tohtz 2005). The decrease this year was large however (Figure 36). Unkown factors, possibly including recent drought, may be exerting strong influence on fish populations in the reservoir at this time.

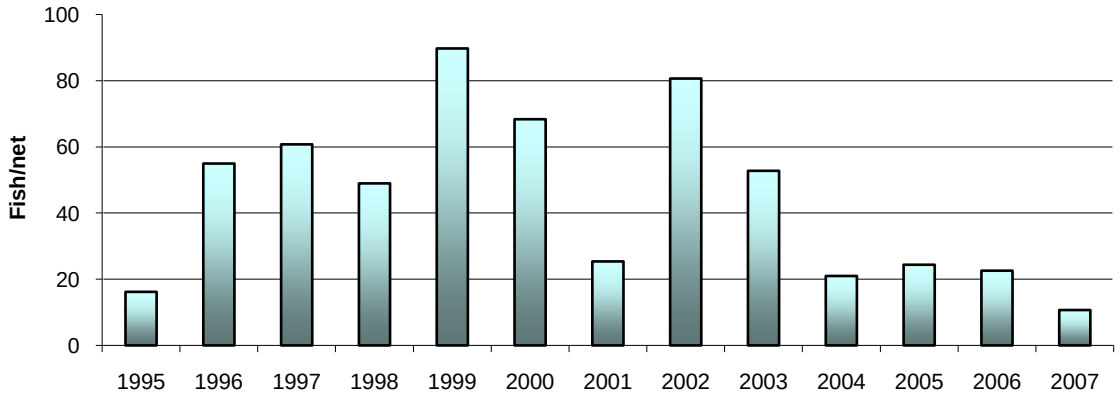

Figure 44. Average number of Utah chubs captured per net at Hebgen Reservoir, 1995 through 2007.

Table 8. Rainbow trout stocked in Hebgen Reservoir from 1995 through 2007.

Year	Stocking date	Variety	Number	Mean length (inches)
1995	June 21	Eagle Lake	49,537	4.6
	August 22	DeSmet	55,315	2.4
1996	July 2	Eagle Lake	37,602	4.1
	July 8	Eagle Lake	87,847	3.7
1997	July 7	Eagle Lake	40,272	3.1
	July 15	Eagle Lake	56,381	4.9
1998	July 7	Eagle Lake	39,853	4.2
	July 8	Eagle Lake	18,624	4.2
	July 16	Eagle Lake	48,384	3.0
1999	July 6	Eagle Lake	56,432	4.4
	July 14	Eagle Lake	41,856	3.1
2000	June 14	Eagle Lake	19,720	2.9
	June 26	Eagle Lake	19,352	3.0
	July 11	Eagle Lake	61,072	5.0
2001	July 17-19	Eagle Lake	107,620	6.0
2002	July 22-24	Eagle Lake	107,509	6.0
2003	June 23-24	Eagle Lake	119,195	4.5
2004	June 15-16	Eagle Lake	103,276	4.4
2005	July 6-8	Eagle Lake	97,998	5.3
2006	June 12	Eagle Lake	107,828	4.0
2007	May 24	Eagle Lake	44,108	3.6
	September 10	Eagle Lake	22,464	6.8

Well over 1,000,000 rainbow trout have been stocked in Hebgen Reservoir since 1995. Although significant in terms of the number stocked each year (Table 8), the benefit to the recreational fishery is uncertain. Byorth (2004) determined that hatchery rainbow trout caught by anglers during an extensive creel survey of Hebgen Reservoir in 2000 and 2001 comprised three percent of total catch based on the presence of tetracycline marks but up to 47 percent of the total catch based on highly subjective interpretations of growth marks on scales. Indications of hatchery fish caught in gillnet samples have been similarly variable. On average about 7.9 percent of rainbow trout caught in gillnets have shown tetracycline marks since that marker was first used in 2000 (Figure 37). However, the occurrence of this mark has varied from zero to twenty-five percent of the total sample. This variability probably indicates as much about the degree to which chance alone determines gillnet samples in this reservoir as it indicates about hatchery contributions to the fishery.

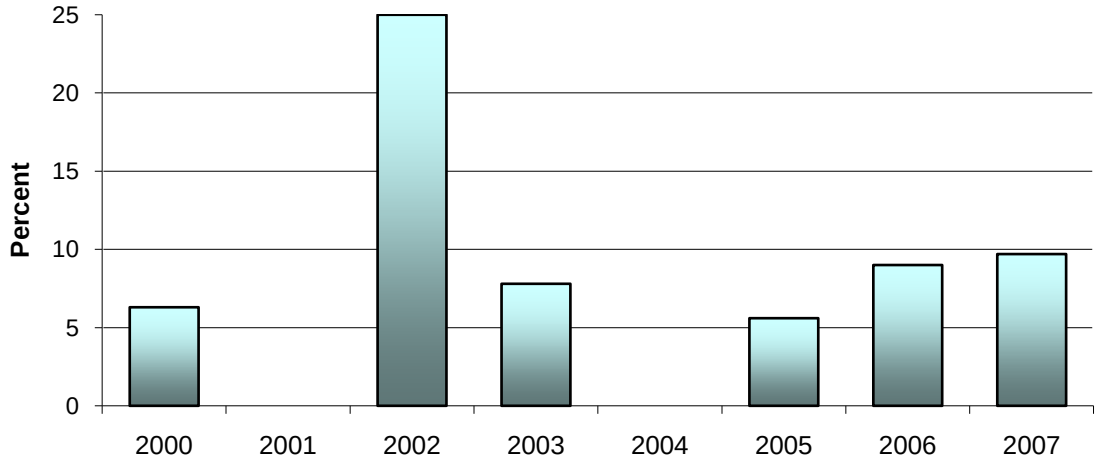

Figure 45. Percent of rainbow trout caught in spring gillnets at Hebgen Reservoir that showed tetracycline marks certainly related to a hatchery origin of the fish.

Adipose clips, used on average on 25 percent of fish stocked annually since 2001, have been observed on average in only 3.5 percent of rainbow trout caught in gillnets. Values have ranged from zero to 5.9 percent of the total catch in any year (Figure 38).

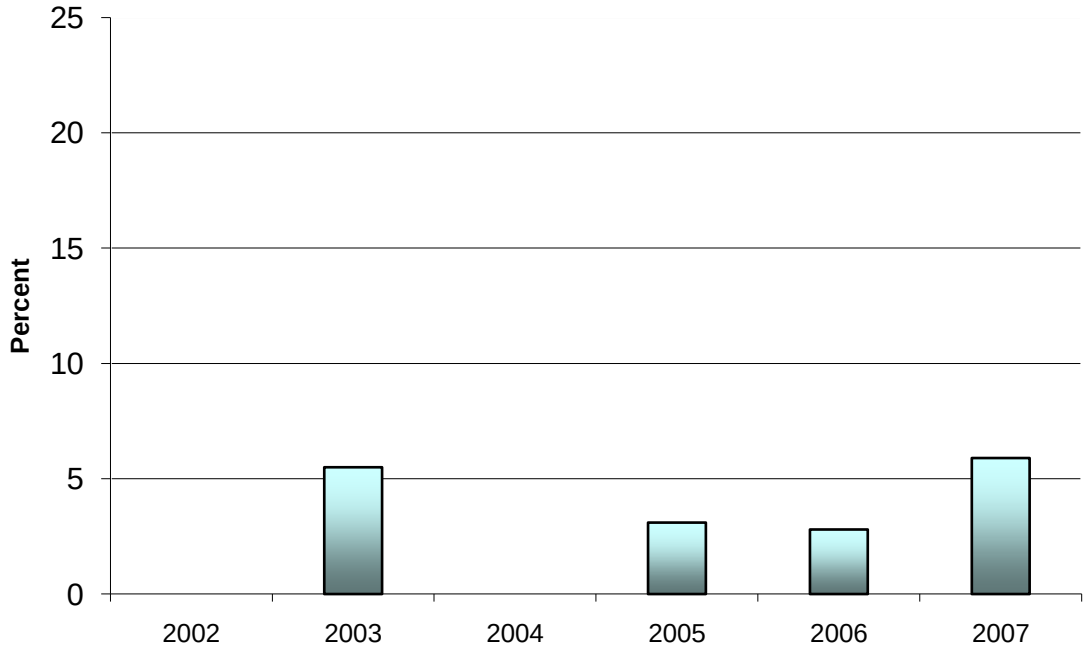

Figure 46. Percent of rainbow trout caught in spring gillnets at Hebgen Reservoir that showed adipose fin clips likely related to a hatchery origin of the fish. Fish with adipose clips were first stocked in Hebgen reservoir in 2001, after the spring 2001 gillnet sampling had already been completed.

Although a less conclusive indicator of hatchery origin, fin erosion (particularly deformed dorsal fin rays) has been consistently observed in a similar percentage of fish caught in gillnets over time. Since 1995 fin erosion has been noted on average for 10.7 percent of all rainbow trout in the samples (Figure 39). This percentage has varied between 3.9 and 16 percent in any given year.

Among fish that show other signs of hatchery origin (tetracycline mark, adipose fin clip) 71.8 percent also show fin erosion. Acknowledging that considerable variation occurs in gillnet sampling over time, and relying more heavily on the more confident indicators

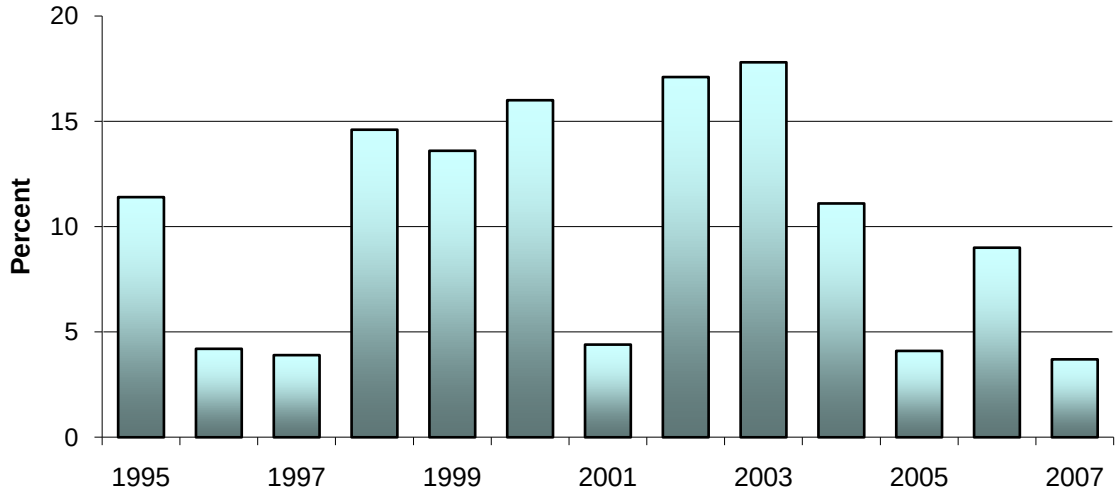

Figure 47. Percent of rainbow trout caught in spring gillnets at Hebgen reservoir that showed fin erosion that is possibly related to a hatchery origin of the fish.

of hatchery origin (tetracycline marks, adipose fin clips) than less confident indicators (fin erosion, scale check marks), on balance it appears that less than ten percent of rainbow trout caught in gillnet samples come from hatchery plants. An even lower contribution of hatchery fish to the recreational fishery also seems likely. Byorth (2004) estimated rainbow catch rate at 0.31 fish/hour at Hebgen Reservoir between June 2000 and June 2001. Estimated fishing pressure for this period was 64,811 angler hours. Total harvest was roughly 10,000 rainbow trout, or about half of the total catch. Even assuming the very high estimate that 47 percent of all rainbow trout in the creel were of hatchery origin as suggested by Byorth as an extreme, it would appear that less than ten percent of the 100,000 rainbow stocked each year at Hebgen Reservoir contribute to the annual total catch. If tetracycline marks are accepted as a better indicator of the presence of hatchery fish in the creel, the percentage of rainbow trout harvested each year from the hatchery plants is less than one.

E. Summary of gillnet sampling at Quake Lake in 2007.

A total of three gillnets were set overnight at Quake Lake in spring of 2007 for a total of three net nights. Along with 25 rainbow trout captured, three brown trout, one Utah chub, five longnose suckers and 12 white suckers were caught.

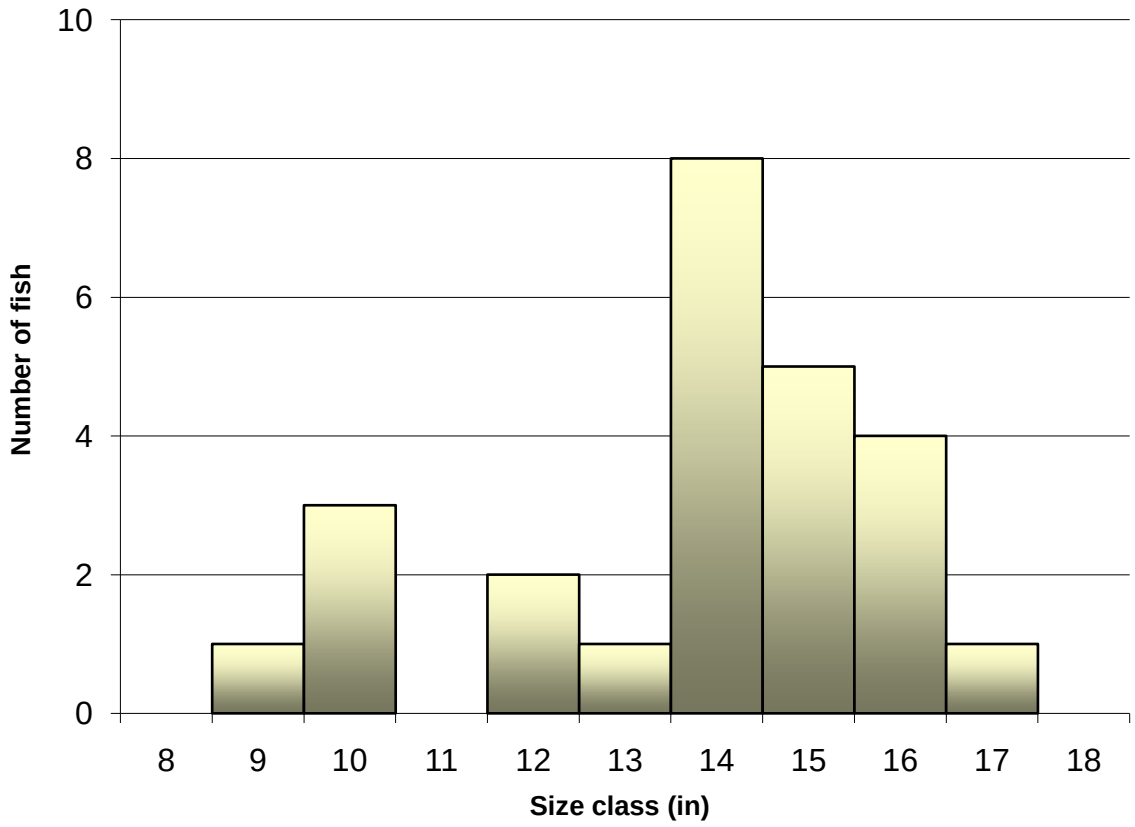

Figure 48. Length frequency distribution of rainbow trout captured in gillnets at Quake Lake in spring of 2007.

F. Summary of spawner counts at Hyalite Reservoir in 2006 and 2007.

Surveys of Yellowstone cutthroat trout and arctic grayling spawning above Hyalite Reservoir have been conducted on a consistent basis since 1997. These surveys have been counts of fish at regular intervals (usually once each week) throughout the spawning season to assess spawner numbers whose reproduction might contribute to the recreational fishery of the reservoir itself. Since 2002, these surveys have also been intended to provide information to help evaluate the efficacy of log structures placed by the USFS to enhance fish habitat and use in West Fork Hyalite Creek above the reservoir.

In 2006 and 2007 our counts of Yellowstone cutthroat trout remained well above surveys prior to 2004 (Table 10). Spawning activity in the survey area has increased substantially

Table 9. Numbers of Yellowstone cutthroat trout observed during spawner counts in the West Fork of Hyalite Creek from 1997 through 2007.

Year	Surveys	Count	Fish/survey	Date most fish observed
1997	8	364	44	June 23
1998	16	1,891	118	May 28
1999	11	1,704	155	June 11
2000	9	1,640	182	June 2
2001	8	2,643	330	June 6
2002	7	1,980	282	June 7
2003	8	1,563	195	June 16
2004	15	3,438	229	June 2
2005	8 \[1]	6,070	867	June 3
2006	16	7,478	467	May 30
2007	14	3,948	282	May 17

1. Water conditions on June 17, 2005 prevented fish counts on that survey day.

since 2003, perhaps in response to the 2002 stream treatments. Similarly, counts of spawning arctic grayling in 2007 exceeded all previous surveys (Table 11). Stream conditions above the reservoir are apparently especially favorable for spawning fish in recent years. It is difficult at this time, however, to assess what increasing spawning escapement may have meant for the recreational fishery. A significant number of Yellowstone cutthroat trout are stocked each year at Hyalite reservoir (Table 12). Interestingly, arctic grayling have never been legally stocked in Hyalite reservoir, and their original introduction into the reservoir is unexplained. Regardless, arctic grayling are obviously naturally self-sustaining at this time.

Table 10. Numbers of arctic grayling observed during spawner counts in the West Fork of Hyalite Creek from 1997 through 2007.

Year	Surveys	Count	Fish/survey	Date most fish observed
1997	5	5	1	June 23
1998	14	498	36	June 22
1999	7	143	20	June 21
2000	3	130	43	June 19
2001	5	202	40	June 19
2002	7	235	34	June 24
2003	7	551	79	June 16
2004	9	470	52	June 17
2005	7	849	121	June 20
2006	10	815	82	June 14
2007	9	1,341	149	June 15

Table 11. Yellowstone cutthroat trout stocked in Hyalite Reservoir from 1995 through 2007.

Year	Stocking date	Variety	Number	Mean length (inches)
1995	September 12	McBride	21,354	2.0
	September 12		8,646	2.6
1996	September 18	McBride	30,000	2.5
1997	September 17	McBride	30,000	2.6
1998	September 18	McBride	17,540	3.0
	September 18		12,460	2.2
1999	September 15	McBride	31,500	2.6
2000	September 20	McBride	29,274	2.5
2001	September 15	McBride	30,000	2.4
2002	September 17	McBride	28,500	2.4
2003	September 16	McBride	30,000	2.5
2004	September 20	McBride	1,050	3.4
	September 20	McBride	4,000	1.2
	September 20	McBride	7,500	2.5
	September 20	McBride	23,400	2.2
2005	July 29	McBride	30,000	2.0
2006	July 25	McBride	29,424	2.3
2007	July 24	Goose Lake	27,550	2.7

Significant increases in the numbers of Yellowstone cutthroat trout and arctic grayling spawning above Hyalite reservoir raise at least two questions about current fish management: Could hatchery stocking of Yellowstone cutthroat trout at the reservoir be stopped to take better advantage of wild fish reproduction? And, is the catch and release only fishing regulation for arctic grayling still necessary? Answering these questions will require more information than we currently have, including better information about fish abundance in the reservoir, angling pressure, and harvest.

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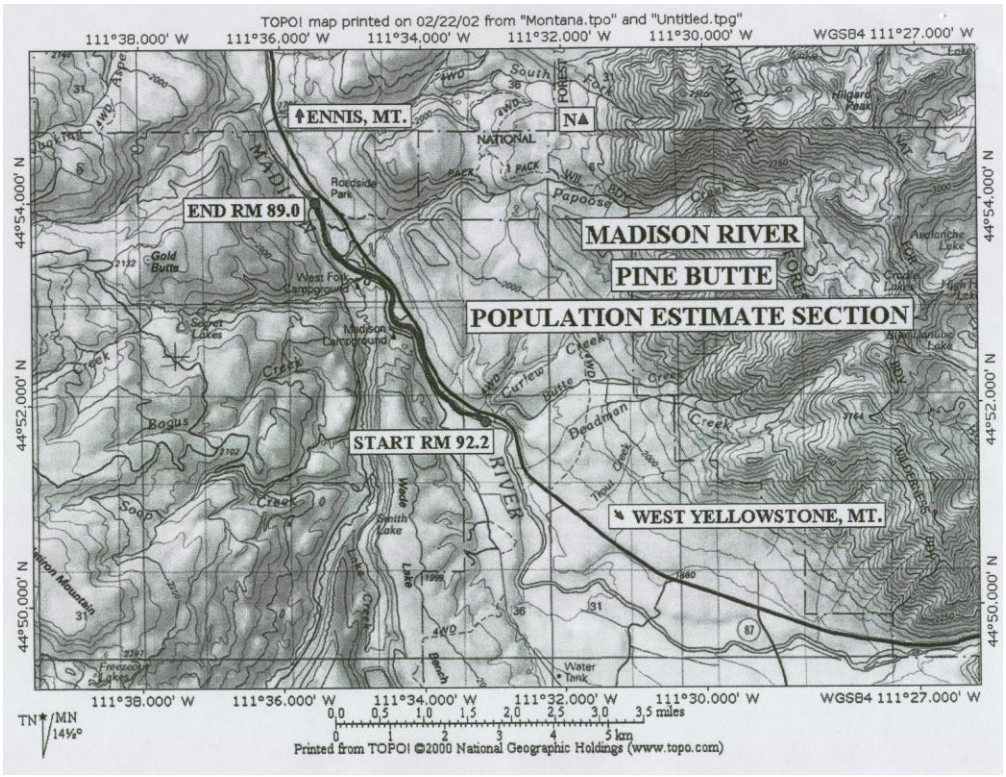
APPENDIX A: Common and scientific names for fish referred to in this report.

Common name	Scientific name
Brown trout	*Salmo trutta*
Mountain whitefish	*Prosopium williamsoni*
Rainbow trout	*Oncorhynchus mykiss*
Utah chub	*Gila atraria*
Yellowstone cutthroat trout	*Oncorhynchus clarki bouvieri*

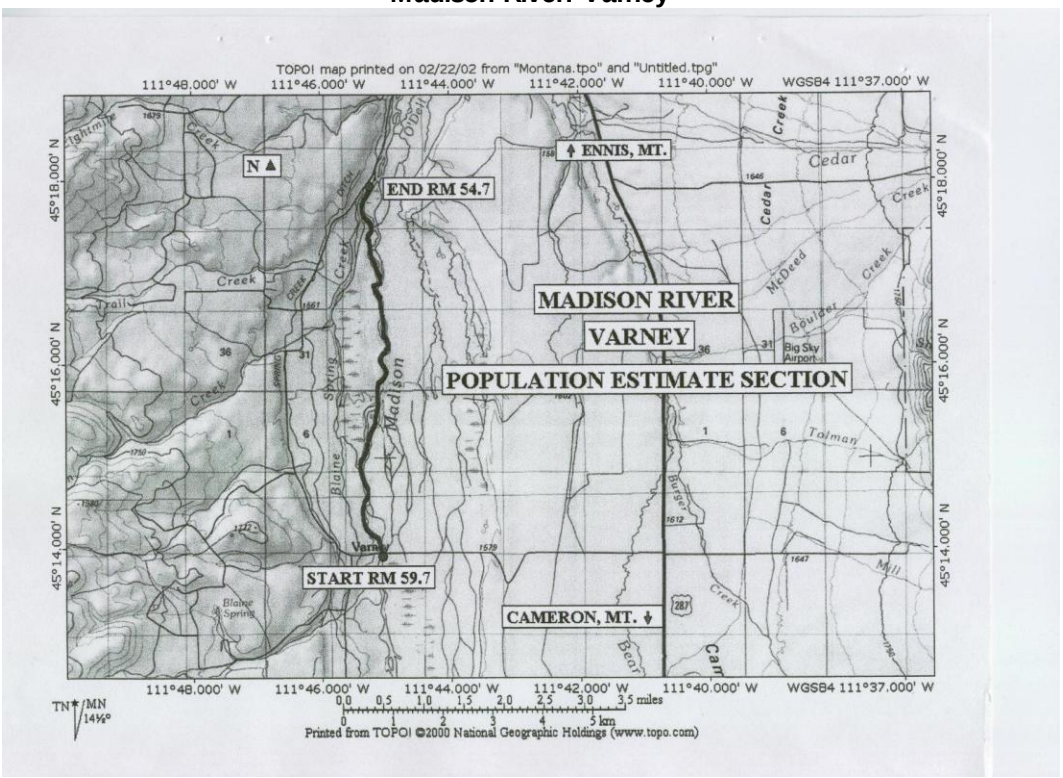
A1

APPENDIX B: Map details of river sections sampled in 2005. Adapted from Byorth and Weiss 2003.

Madison River: Pine Butte



Madison River: Varney



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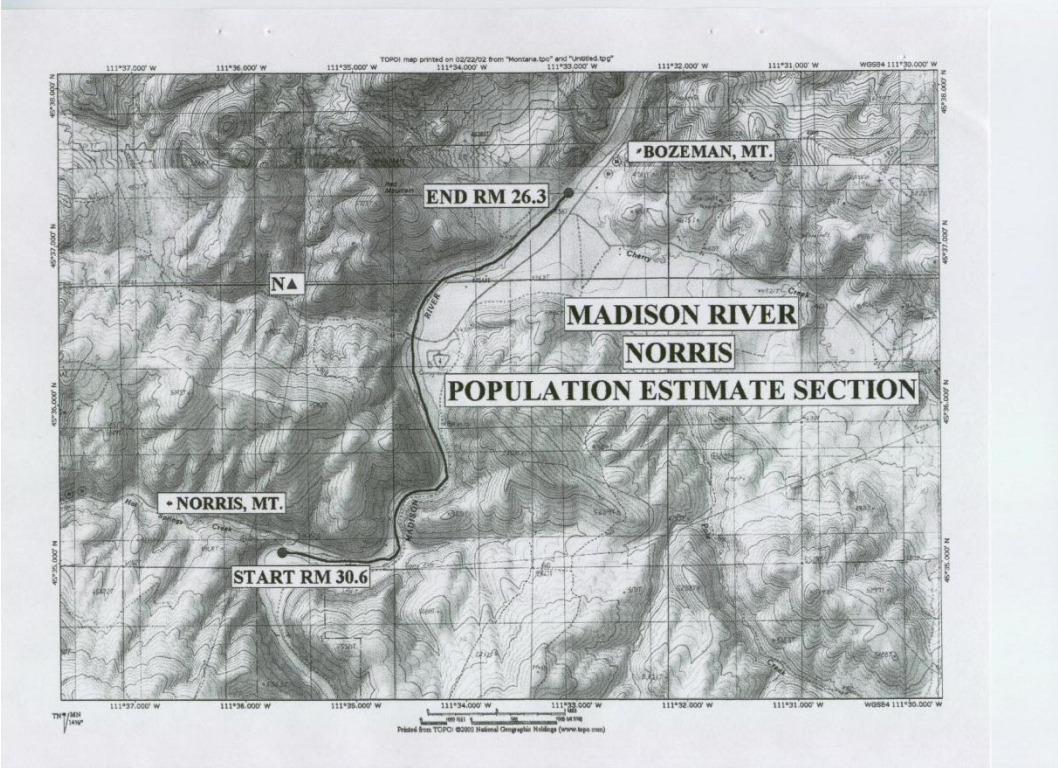
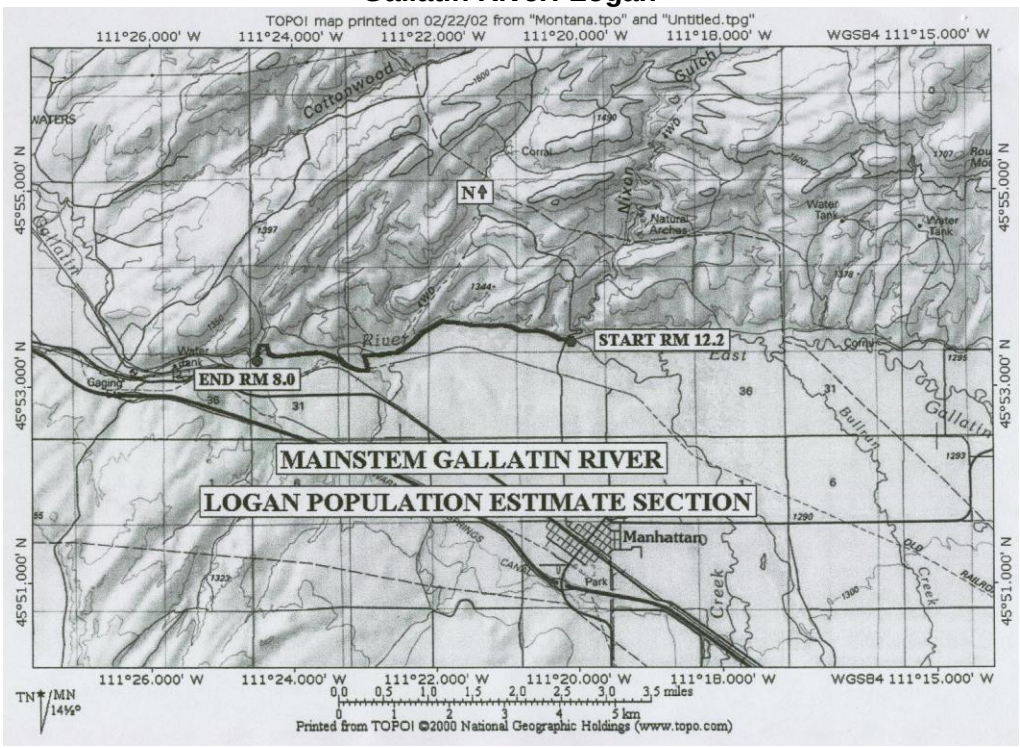
Madison River: Norris



Gallatin River: Logan



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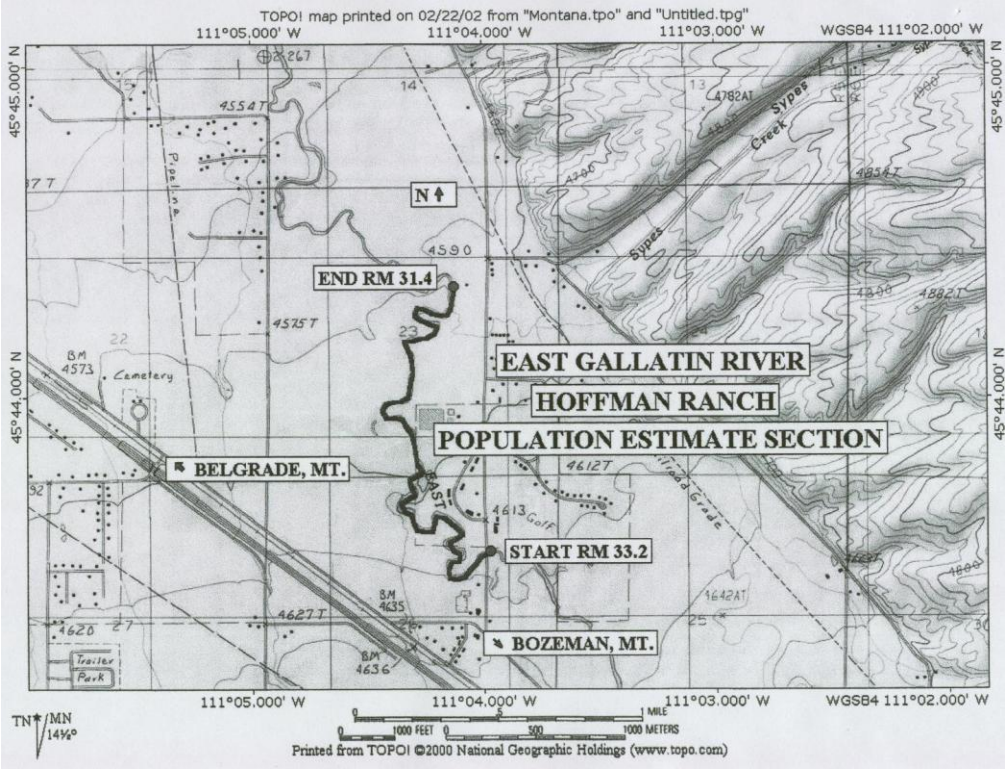
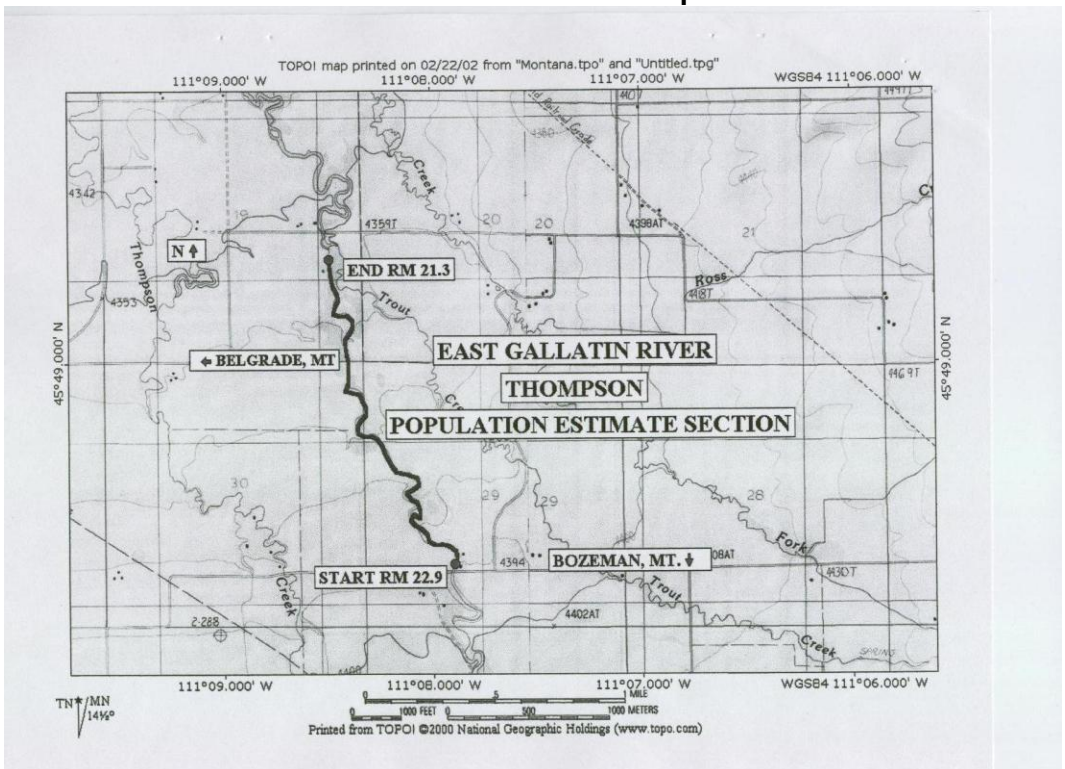
East Gallatin River: Upper and Lower Hoffman



East Gallatin River: Thompson



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