F-78-R-1
through 5
Region 3

Madison River Trout Population Surveys:

July 1994 – June 1999

Project 3302

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Preface and Acknowledgments

This report summarizes population censuses in the Madison drainage in fulfillment of Federal Aid reporting requirements. Population data reported herein are summarized as point estimates generated by a complex statistical model. Point estimates are reported to indicate trends and should not be considered statistically defensible in absence of variance and other parameters. This information is available through Montana Fish, Wildlife, and Parks if the reader requires more information.

Data was collected by Montana Fish, Wildlife, and Parks electrofishing crews including Tim Weiss, Pat Clancey, Dave Barnes, Josh Hadley, Gary Senger, Jason Selong, Jody Hupka, and the author. Mark Lere conducted field sampling and analyzed much of the population data. Pat Clancey provided graphics and data analysis. E. R. Vincent provided historical perspective and information on whirling disease.

Introduction

The Madison river of southwest Montana is arguably one of the most popular trout streams in the United States (Sample 1998, Ross 1999). The Madison River begins at the confluence of the Firehole and Gibbon Rivers in Yellowstone National Park and flows into Montana just upstream of Hebgen Reservoir (Figure 1). From Hebgen Dam, the Madison travels approximately 110 miles to its confluence with the Gallatin and Jefferson rivers, where they form the Missouri River. The stature of the Madison's fishery stems from a long history beginning in 1919 with the arrival of rainbow and brown trout which drifted downstream from Yellowstone Park. Stocking catchable-sized trout persisted in much of the Madison River until 1969, when "wild trout management" was initiated (Vincent et al. 1990). All stocking was eliminated from the Madison River by 1973.

Several reaches of the Madison River have been electrofished for Mark-Recapture estimation of trout abundance. The Varney Section has been electrofished annually since 1967. Annual monitoring allowed scientific basis for management decisions such as angling regulations, water management, and habitat protection. These long-term data on the Varney Section illustrate 4 primary "eras" described by Vincent et al. 1990. The first era was stocking and transition era, when Vincent (1987) documented the harmful effects of stocking catchable-sized trout in the Madison River. Cessation of stocking resulted in a substantial increase in trout biomass in the Madison River. The second era, 1973 to 1977, was characterized by a 10 fish limit which provided substantial harvest. Concern for older age classes led to the third era when a restrictive 3 fish limit was placed on the Varney section. This apparently resulted in increased survival of yearlings, leading to high densities, which impaired growth rates and condition, especially among brown trout. The final era described by Vincent et al. (1990) was under a five fish limit, only one of which could be a rainbow trout. This regulation provided a stable, sustainable harvest and restored growth and condition factors of brown trout while minimizing harvest on rainbow trout.

A new era befell the Madison River near the beginning of the 1990's. After an extensive, 4-year search for factors driving declines in rainbow trout abundance throughout the upper Madison River, whirling disease was discovered for the first time in 1994 (Vincent 2000). In 1991, initial declines in rainbow trout abundance were observed in the Pine Butte section. Infection had depressed rainbow trout abundance in the Varney section by 1993 (Vincent 2000)(Figure 1). Since the infection by Myxobolus cerebralis has intensified, rainbow trout abundance has dropped as low as 90% of pre-whirling disease levels in some reaches of the Madison River.

The objectives of this report are to summarize population data gathered in annual censuses and assess the efficacy of regulations and closures in maintaining trout populations in the Madison River in the presence of whirling disease.

Study Sections

Five study sections characterize the Madison River trout populations (Figure 1). Electrofishing derived, fall population estimates dating back to 1967 provide a unique long-term set of data on which management decisions have been based. Spring population estimates have been done intermittently. The Pine Butte section lies approximately 12.0 miles below Quake Lake. It is 3.0 miles long, extending from Pine Butte Creek to Lyons Bridge. The Madison River through the reach is fairly uniform gradient run habitat, with a network of side channels that influence spawning and recruitment. The West Fork Madison River enters the Pine Butte Section approximately 0.6 miles above Lyons Bridge. Fishing regulations on this reach have been catch-and-release only for trout since 1978 and no fishing was allowed from boats since 1974. Since 1995, angling was restricted to after the third Saturday in May above Macatee Bridge to protect spawning rainbow trout. Population estimates have been conducted on the Pine Butte Section since 1977.

The Snoball Section, named after an historic inn, lies between Squaw Creek and Windy Point. A 4.5 mile section has been electrofished intermittently since 1975. The section was shortened to 4.0 miles in 1994. The Madison River in this reach has fewer large tributaries and fewer side channels. Snoball provided a laboratory to study the impacts of angling, regulations, and disease since 1977 when it was closed to all fishing. It was opened to catch-and-release fishing for trout and fishing from boats in March 1983 (M. Lere personal comm. and MFWP Files). To study the impacts angling and whirling disease, it was closed to fishing again between March 1995 and February 1997.

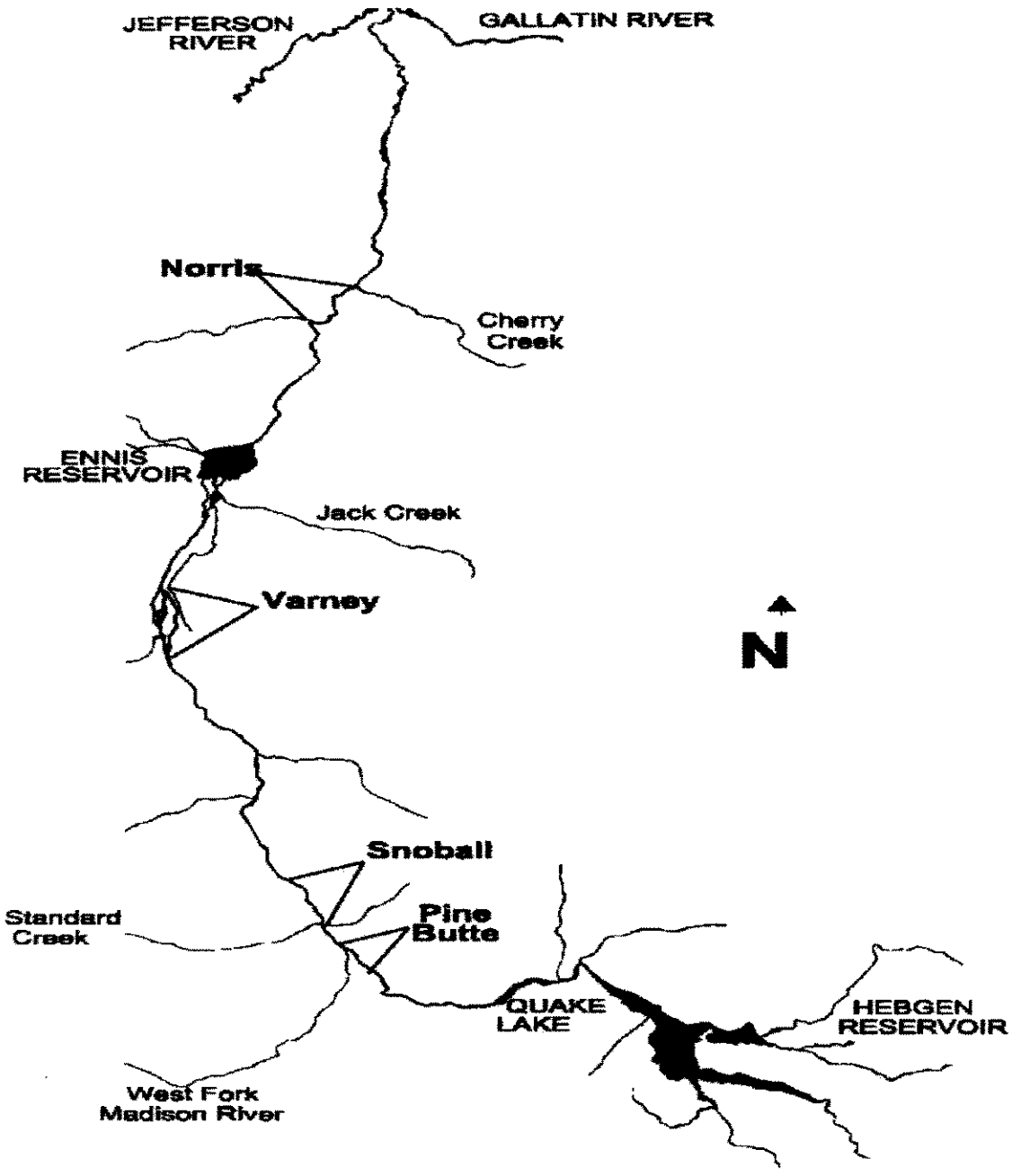

Figure 1. Map of Madison River and Study Sections from Clancey (2000).

The Madison River changes character considerably in the Varney Section, approximately 40 miles downstream from Quake Lake. The 4.0 mile study section extends from Varney Bridge to Eight Mile Ford Fishing Access Site. Brown trout predominate in this heavily braided channel which provides much more complex and heterogeneous habitat than the upper sections. Habitat in the Varney section is highly influenced by ice gorging (Vincent 1990). The Varney Section has provided annual fall population surveys since 1967. Fishing regulations below Varney bridge have allowed harvest of 5 brown trout, only one over 18 inches long, with catch-and –release only for rainbow trout since 1992.

Below Ennis Reservoir, the Madison River changes character again. After traveling some 8 river miles through Beartrap canyon, the gradient flattens and it takes on characters of a spring creek: broad and shallow with extensive weed beds. Water temperature is the primary limiting factor in this reach due to Ennis reservoir acting as a heat sink. Water temperatures increase to near lethal levels in mid-summer, causing fish kills in dry, and hot years (Vincent et al. 1981). The Norris section extends 4.0 miles from the mouth of Warm Springs Creek to the mouth of Cherry Creek. This reach is open year round with combined trout limits set at 5 fish, only 1 over 18 inches long. Rainbow and brown trout are found in roughly equal proportions. Sampling has been conducted in spring annually in the Norris Section since 1970.

Methods

Electrofishing is used to conduct Mark-Recapture experiments for trout population estimation. A drift-boat mounted, mobile positive electrode system is used to capture rainbow and brown trout. We use a driftboat equipped with a 4,500 Watt generator and Coffelt Mark XXII-M rectifying Unit. During electrofishing runs, trout are anesthetized in an MS-222 bath, measured to 0.1 inches in total length, weighed to 0.01 lbs, marked with a fin clip, and released after recovering. Scale samples are collected for age determination. Three marking runs are followed by three recovery runs, 10 to 14 days after marking. The ratio of marked to unmarked fish in the recovery sample is used to estimate abundance according to FWP's computerized Mark Recapture Log-likelihood model.

Results

Population estimates are summarized by section, for the reporting period in Table 1. In general, brown trout populations are near or above historic averages. Rainbow trout in each section, other than the Norris Sections declined severely in the mid-1990's due to the impacts of whirling disease on recruitment of young rainbow trout.

Table 1. Madison River trout population estimates by study section, 1994-1999.

Pine Butte Section – 3.0 Miles above Lyons Bridge – Fall Section

Rainbow Trout

Year	Age 1 Per Mile	Age 2 and older Per Mile	Total Age 1 and older Per Mile
1994	94	236	330
1995	510	175	685
1996	735	447	1182
1997	454	267	809
1998	847	305	1152

Brown Trout

Year	Age 1 Per Mile	Age 2 and older Per Mile	Total Age 1 and older Per Mile
1994	282	919	1201
1995	620	509	1129
1996	1158	446	1604
1997	831	929	1760
1998	1018	794	1812

Table 1. (continued)
Snoball Section, below Squaw Creek to Windy Point, 4.0 miles - Fall Section
Rainbow Trout

Year	Age 1 Per Mile	Age 2 and older Per Mile	Total Age 1 and older Per Mile
1994	232	289	521
1995	384	208	592
1996	348	406	754
1997	227	190	417

Brown Trout

Year	Age 1 Per Mile	Age 2 and older Per Mile	Total Age 1 and older Per Mile
1994	360	559	919
1995	566	612	1178
1996	855	1182	2037
1997	633	604	1237

Varney Section – Varney Bridge to Eight-mile Ford, 4.0 miles – Fall Section
Rainbow Trout

Year	Age 1 Per Mile	Age 2 and older Per Mile	Total Age 1 and older Per Mile
1994	33	166	199
1995	351	132	483
1996	145	304	449
1997	106	113	282
1998	192	139	331

Brown Trout

Year	Age 1 Per Mile	Age 2 and older Per Mile	Total Age 1 and older Per Mile
1994	1278	631	1909
1995	770	704	1474
1996	1558	515	2073
1997	1122	949	2071
1998	2180	1061	3241

Norris Section – Warm Springs Creek to Cherry Creek, 4.0 miles – Spring Section
Rainbow Trout

Year	Age 2 Per Mile	Age 3 and older Per Mile	Total Age 2 and older Per Mile
1995	273	531	804
1996	184	535	719
1997	552	220	772
1998	555	736	1291
1999 preliminary	681 (7 to 10.9 inches)	903 (over 11.0 inches)	1584

Brown Trout

Year	Age 2 Per Mile	Age 3 and older Per Mile	Total Age 2 and older Per Mile
1995	435	706	1141
1996	696	510	1206
1997	294	613	882
1998	601	507	1108
1999 preliminary	836 (7 to 11.9 inches)	1070 (over 12 inches)	1906

Pine Butte

The Pine Butte Section of the Madison River produced substantial rainbow trout populations throughout the 1977 to 1990 period (Figure 2). The first indication of a decline in rainbow trout recruitment due to whirling disease was apparent in 1990. By 1994, rainbow trout abundance had fallen by 90% of historic averages. Intermittent years of moderate recruitment (e.g. 1995 and 1997) appear to be related to temperature and flow conditions hampering the parasites ability to infect young rainbow trout and promoting emergence and growth during periods of low infectivity.

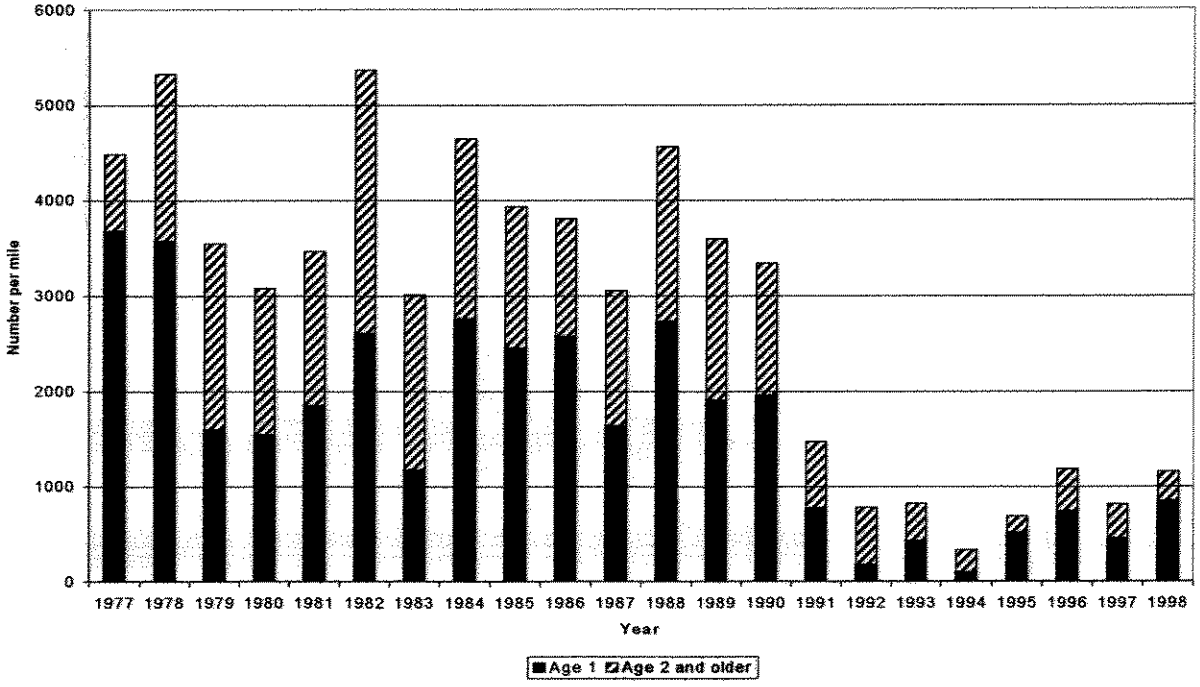

Figure 2. Rainbow trout population estimates in the Pine Butte Section of the Madison River, Fall 1977 – 1999.

Brown trout populations appear to have remained stable through the period in which whirling disease impacted rainbow trout in the Pine Butte Section (Figure 3). Strong recruitment years in 1995 and 1997 mirrored that of rainbow trout.

Snoball Section

The Snoball section is sampled intermittently for research purposes. Through the 1994 to 1999 reporting period it was sampled fall and spring from 1994 to 1997 to assess mortality rates relative to Pine Butte. The Snoball closure of 1995 and 1996 did not demonstrate increased survival rates of rainbow or brown trout. During the Snoball closure period, mortality rates for brown trout were 26.0% in Pine Butte and 32.3% in Snoball. Rainbow trout mortality rates in 1995 for Age 3 and older appeared significantly different (68% for Pine Butte, 7% for Snoball) based on low quality spring estimates. From Fall 1994 to Fall 1995, however, rainbow trout mortality was much higher in Snoball in spite of the closure. Between Age 1 and Age 2, rainbow trout in Pine Butte suffered 28% mortality with angling, while that same year class in Snoball had a mortality rate of 71.1% without angling pressure. Apparently, whirling disease is such a powerful controlling factor that catch-and-release angling has a negligible effect on mortality and survival.

Brown trout abundance in the Snoball section has varied considerably over the years, and is currently well within historic ranges, on an upward trend (Figure 4). Rainbow trout populations were severely impacted by whirling disease by 1994 (Figure 5).

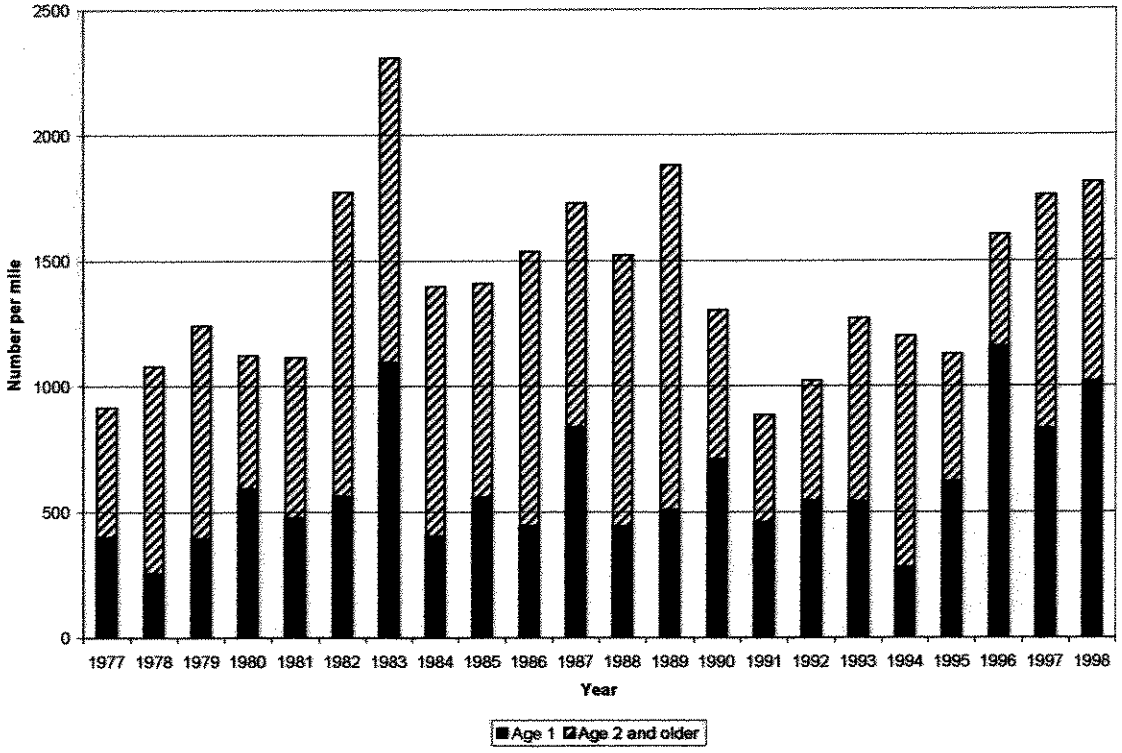

Figure 3. Brown trout population estimates on the Pine Butte Section of the Madison River, Fall 1977-1998

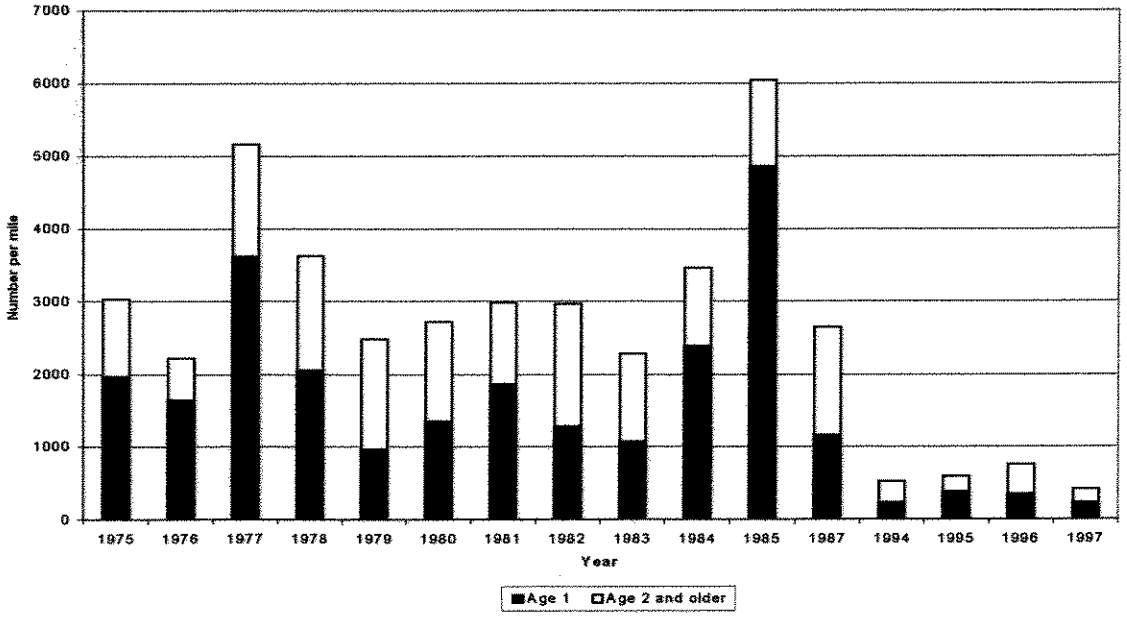

Figure 4. Rainbow trout population estimates on the Snoball Section of the Madison River, Fall 1975 - 1997

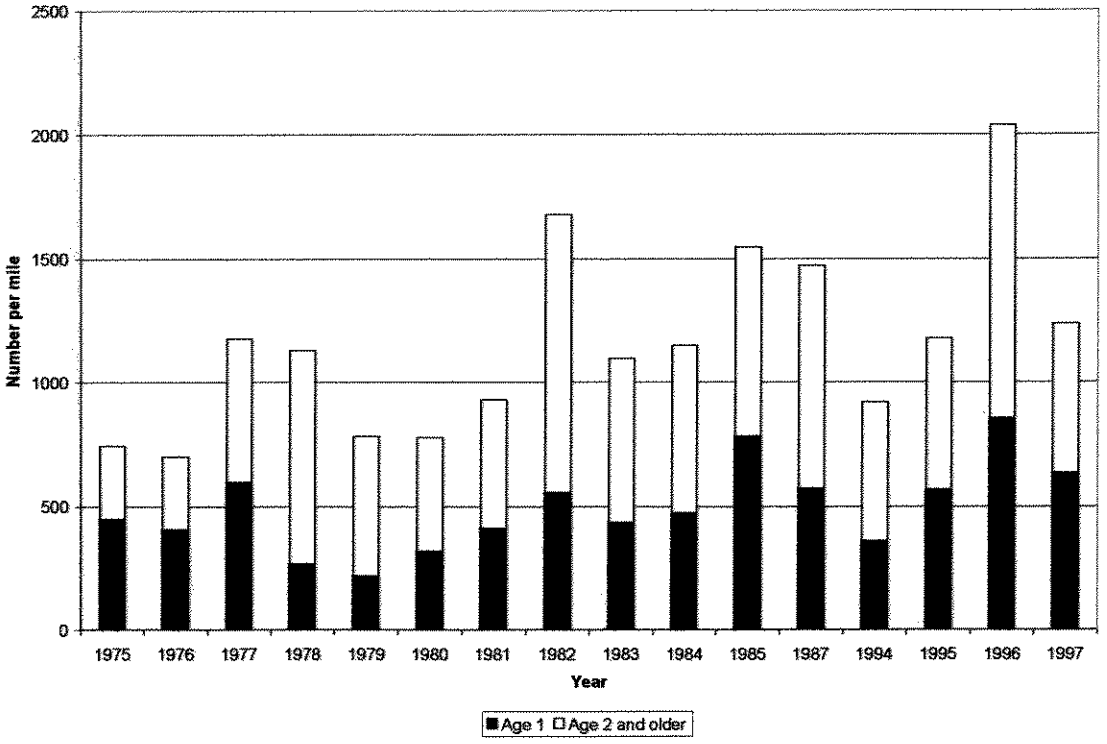

Figure 5. Brown trout population estimates on the Snoball Section of the Madison River, Fall 1975-1977.

Varney Section

Brown trout are the predominant species in the Varney section, and have been historically. The 1998 brown trout population estimate was at an all-time high, bolstered by excellent recruitment since 1995 (Figure 6). Rainbow trout populations in the Varney section declined due to whirling disease, but it wasn't until 1993 that declines were fully realized (Figure 7). The 1998 population estimates for rainbow trout are the lowest on record for the Varney section. The delayed infection by M. cerebralis in downstream reaches suggests the origin of the infection was in or near the Pine Butte Section.

Norris Section

Trout populations in the Norris section have avoided major impacts of whirling disease, most likely due to thermal limitations on the parasite. Brown trout have generally predominated in the Norris section, but rainbow trout biomass has intermittently surpassed that of brown trout (Figures 9 and 10) . Recent population trends for both species is upward after several years of lower numbers through the mid-1980's. Investigations should test whether whirling disease, over-harvest , or other factors may have influenced the recent low population cycle.

Conclusions

Trout populations in the Madison River have provided world class fishing throughout the late 20th century. Through the period, a variety of factors have affected trout abundance from stocking hatchery catchables, to more advanced creel limit regulations, to whirling disease. The full extent and impacts of the whirling disease infection throughout the Madison basin remains to be seen. Future work should be oriented toward circumventing the impacts of whirling disease by encouraging rainbows to spawn at times and in areas where the parasite is limited by temperature, flow, or other factors. In the upper Madison River, brown trout populations are strong and will continue to provide the backbone of the fishery. Recent changes in drafting schedules of Hebgen Dam have increased over-winter habitat for both species and effects should be monitored.

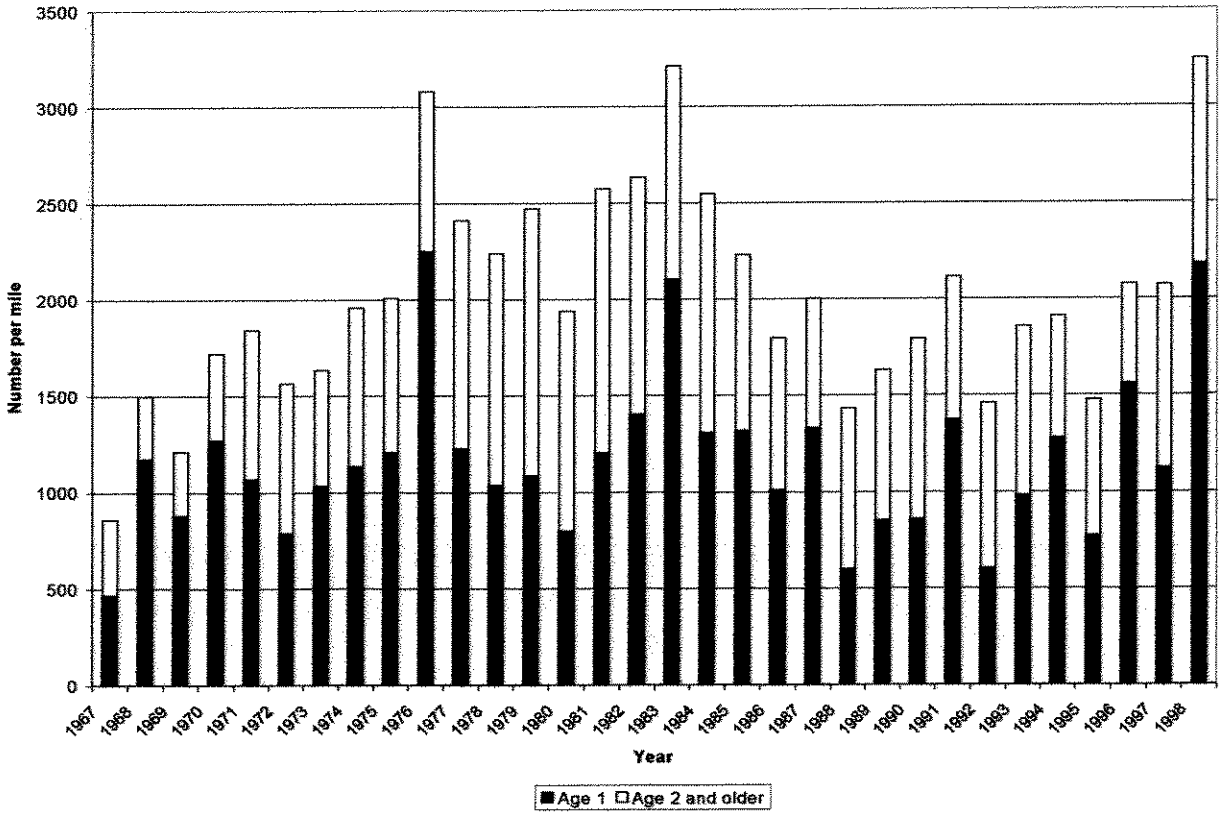

Figure 6. Brown trout population estimates in the Varney Section of the Madison River, Fall 1967 – 1998.

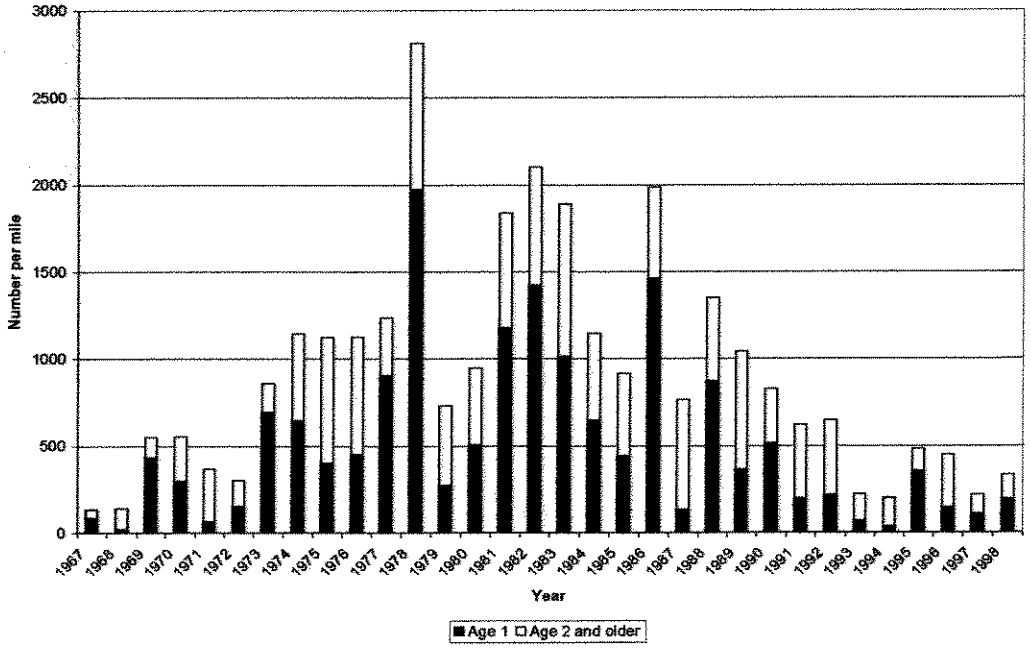

Figure 7. Rainbow trout population estimates in the Varney Section of the Madison River, Fall 1967 – 1998.

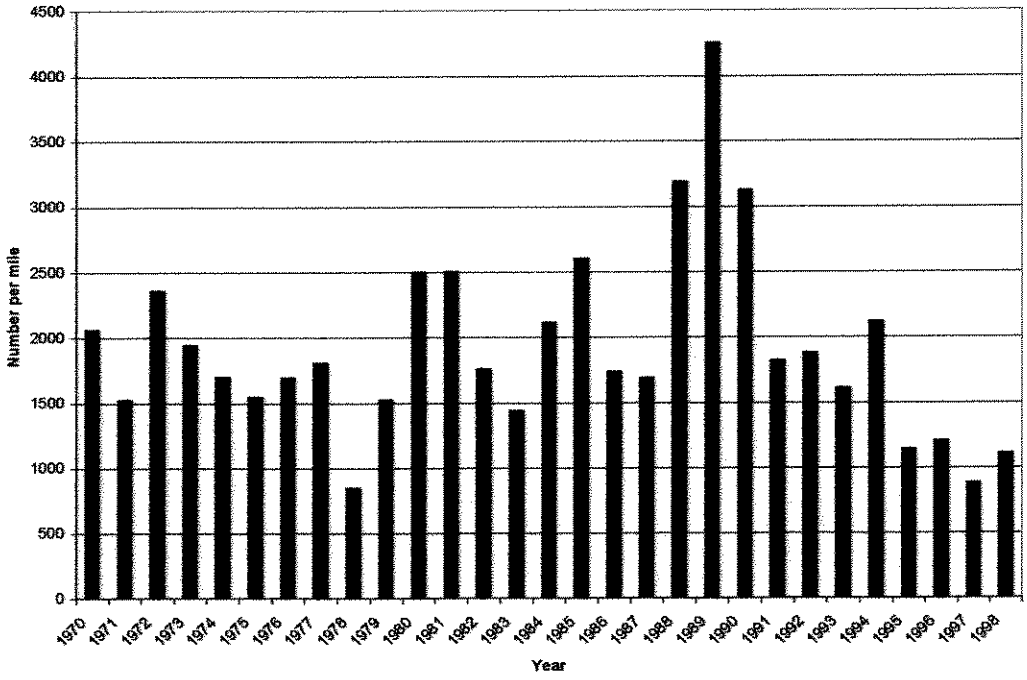

Figure 8. Brown trout population estimates in the Norris Section of the Madison River, Spring 1970 – 1998.

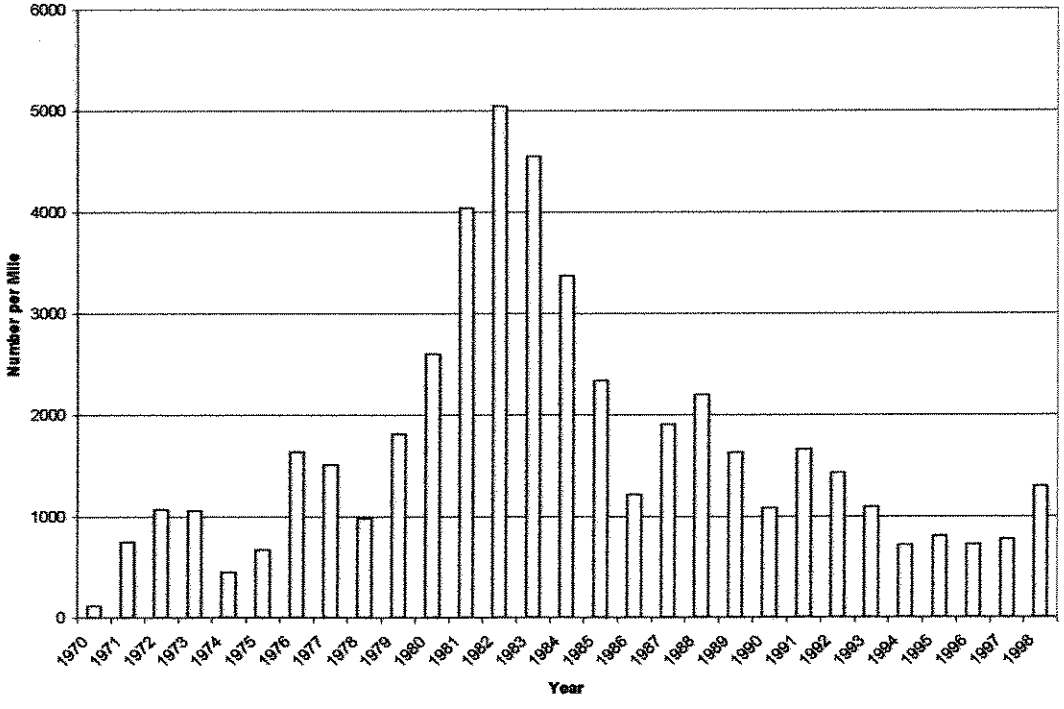

Figure 9. Rainbow trout population estimates in the Norris Section of the Madison River, Spring 1970 – 1998.

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