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FISH POPULATION STUDIES ON THE MADISON RIVER*

Richard Vincent

Fisheries Biologist, Montana Fish and Game Department

ABSTRACT

A trout population study was started on the Madison River in April, 1967. Population estimates were made on two sections of the Madison River during April-May of 1967 and 1968. One section was located about seven miles south of Ennis, Montana (Varney), and the other was about 28 miles west of Bozeman, Montana (Norris). A basic Petersen mark-and-recapture method was used to estimate the standing crop (total numbers and biomass) in these two sections. From the total numbers estimate, the age structure was estimated. Electrofishing gear was used to sample the fish population. Electrofishing was carried out while floating through each section of river in a flat-bottomed fiberglas boat. This boat carried a stationary negative electrode, a mobile positive electrode, a portable 1500 watt a.c. generator with a rectifying unit to change the alternating current to various forms of direct current, and a live box to retain captured fish. Numbered dart tags were placed in the trout to be used for estimates of angler mortality.

Trout populations in these two sections were studied in relation to habitat changes in the river and hatchery plants of rainbow trout. The main commercial use of water from the Madison River is for the generation of electric power. To generate this power, two reservoirs were built about 50 miles apart; the upstream one to store water during the spring and then release it to the lower one for power generation during the summer and fall. The storage and release patterns from the upstream reservoir affect the condition of the habitat in the two downstream study sections. In the past, two different methods of filling the upstream reservoir were used: (1) the storage started in late February prior to the start of spring runoff and ended in May or early June, or, (2) storage started in early May during the spring runoff and finished in June. When the storage started in February, the Madison River below the reservoir was dewatered 36-60% for a two to three month period. This seriously reduced the amount of good trout habitat in the study sections. During the winter of 1967-68, an agreement with the local power company was made to insure good flows during the early spring months. Population estimates were made before and after this change in flow patterns. The Norris section showed a trout population (trout greater than 7.0 inches) change from 1,695 trout per mile in the spring of 1967 to 2,455 in 1968, while the Varney section changed from 414 trout per mile in 1967 to 547 in 1968.

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Hatchery rainbow plants are also made in certain sections of the Madison River to provide additional fish for the anglers and to possibly increase the overall population. Rainbow are stocked in the Varney section, but not the Norris section. Population estimates show 160-290 rainbow per mile in the unstocked section versus 57-58 per mile in the stocked section. The annual mortality rate of hatchery rainbow (catchables) was about 99%. A year after these catchable rainbows were planted (April, 1968), they only comprised 1.6% of the estimated trout population.

Information from fish tags returned by anglers shows that there is a low rate of harvest of catchable-sized fish by anglers. In the Norris section, there was a 10.9% return in 1967 and 8.9% in 1968. In Varney, the return was 13.9% in 1967 and 11.4% in 1968.

Introduction

The Madison River is one of the most important trout streams in Montana, if not in the United States. The Madison River, located in Southwestern Montana, is formed by the Gibbon and Firehole Rivers in Yellowstone National Park (Figure 1). It is 140 miles in length and flows in a northerly direction, joining with the Jefferson and Gallatin Rivers to form the Missouri River. There are two man-made impoundments on the river: (1) Hebgen Reservoir, located three miles downstream from the park boundary, and (2) Ennis Reservoir, located 67 miles downstream from Hebgen Reservoir.

The Madison River is one of the larger trout streams in Montana. The width ranges from 200-250 feet and the depth from zero to 10 feet. The discharge rate varies from 700 c.f.s. near Hebgen Reservoir during low water to 5,600 c.f.s. near Ennis Reservoir at high water. The peak of the spring runoff generally occurs in May and June, while the lowest flows occur during the winter months.

There are three main uses of water from the Madison River: generation of power, irrigation and recreation. As in many cases, the commercial and recreational uses of water show a conflict of interests. To generate electric power from the Madison River, two reservoirs were built about 50 miles apart; the upstream one (Hebgen) to store water during the spring and then release it to the lower one (Ennis) for power generation during the summer and fall. The storage and release patterns from the upstream reservoir affect the condition of the habitat in the river below this reservoir. Two different methods of filling Hebgen Reservoir have been used: (1) the storage started in late February prior to the start of spring runoff and ended in May or early June, or, (2) storage was started in early May during the spring runoff and finished in June. When storage started in February, the Madison River below Hebgen Reservoir was dewatered 36-60% of normal for a two to three month period. This seriously reduced the amount of good trout habitat. During the winter of 1967-68, an agreement was made with the local power company to insure adequate flows during the early spring months.

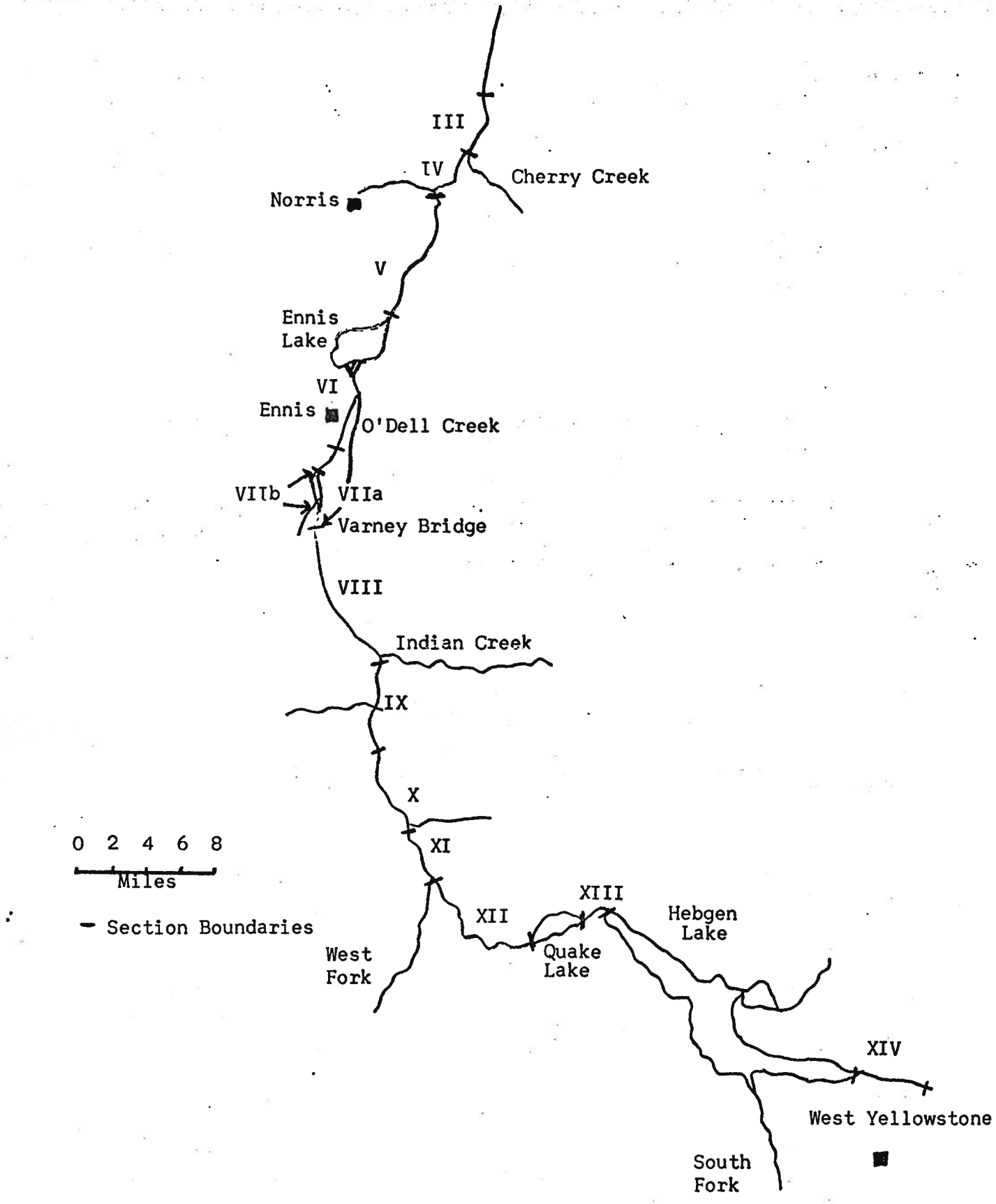

Figure 1. Map of the Madison River showing study sections.

In the spring of 1967, a trout population study was started on the Madison River to determine the effect of various spring flow patterns on the existing trout populations. Population estimates were made on two sections of the Madison River during April-May of 1967 and 1968. One section was located about 43 miles downstream from Hebgen Reservoir (Varney), and the other 68 miles downstream from Hebgen Reservoir (Norris).

Catchable hatchery rainbow plants are also made in certain sections of the Madison River to provide additional fish for the anglers and to possibly increase the overall population. Catchables are planted in the Varney section, but not in the Norris section.

Methods

Electrofishing gear was used to sample fish populations in the Madison River. Electrofishing was carried out while floating through each section of stream in a flat-bottomed fiberglas boat. This boat contained a stationary negative electrode (fastened to the bottom of the boat), a mobile positive electrode, a portable 1500 watt a.c. generator with a unit to rectify the alternating current into pulsed or continuous direct current, a container to retain captured fish, and other gear necessary to weigh, measure and tag the fish. Captured fish were periodically anesthetized with MS222 (Tricane Methanesulfonate), measured to the nearest 0.1 inch in total length, weighed to the nearest 0.02 pound, tagged with a Floy dart tag or fin clipped and then released.

Estimates of the trout population (trout two years old and older or greater than 7.8 inches in length) were based on the mark-and-recapture technique of Petersen, using Chapman's formula as shown in (Ricker, 1958). Since various size groups had different catchability, estimates were made by size groups which were set up on the basis of age. To obtain an adequate number of fish in the mark-and-recapture samples, multiple mark and recapture trips were necessary. Using scales taken during the shocking period (20 per inch group), the size range for each age group was determined. Confidence intervals at the 95% level were calculated for each estimate by formula 3.8 in (Ricker, 1958). Tagged fish which were caught and reported by anglers were used to give an indication of angler harvest.

Results

Two different early spring flow patterns were observed during the period of study on the Madison River. The U.S.G.S. gaging station at Hebgen Reservoir shows that during the spring of 1967, water storage began on February 26 and continued into June. This storage pattern resulted in a serious dewatering of the Madison River downstream from Hebgen Reservoir during March, April and part of May. The degree of dewatering varied from 47% in the Varney section to 36% in the Norris section. In the spring of 1968, water storage did not begin until the spring runoff started in early May, thus no serious early spring dewatering occurred.

Trout population estimates made after the dewatered condition during the spring of 1967 and after the good flow pattern in the spring of 1968 are shown in Table 1. The estimates show that there were significant increases in the trout populations in both study sections. The Norris section showed the greatest increase, as the total numbers increased 45% and the total weight 19%. The Varney section had an increase of 32% in total numbers and 28% in total weight. Brown trout made up most of the population in both sections (85% in Norris, 1968, and 87% in Varney, 1968).

Table 1. Estimated trout populations for two sections of the Madison River during the spring periods of 1967 and 1968. Estimates are made for trout two years old and older. Confidence intervals at the 95% level are shown in parentheses.

	Norris Section April, 1967 4 miles 1/	Norris Section March, 1968 4 miles	Varney Section April, 1967 5.5 miles	Varney Section April, 1968 5 miles
Brown Trout				
Total Number	4,707 (±2,206)	8,341 (±2,728)	1,877 (±888)	2,383 (±972)
Number/Mile	1,177	2,085	341	477
Total Pounds	4,297	5,117	1,796	2,153
Pounds/Mile	1,074	1,279	326	431
Rainbow Trout				
Total Number	2,072 (±1,768)	1,477 (±1,014)	402 (±370)	353 (±182)
Number/Mile	518	369	73	71
Total Pounds	1,154	634	314	292
Pounds/Mile	289	159	57	58
Total Trout				
Total Number	6,779	9,818	2,279	2,736
Number/Mile	1,695	2,455	414	547
Total Pounds	5,451	5,751	2,110	2,445
Pounds/Mile	1,363	1,438	383	489

1/ Length of section.

In the spring and summer of 1967, approximately 10,500 catchable rainbows were stocked in the Varney section. A population estimate was made in the spring of 1968 to determine how many were left in the population. Only 43 or 0.4% survived a year in this section.

Information from fish tags returned by anglers indicates that there is a low rate of harvest of catchable-sized wild trout. In the Norris section, there was a 10.9% return of tagged rainbow and brown trout in 1967 and 8.9% in 1968. In Varney, the return was 13.9% in 1967 and 11.4% in 1968.

Discussion

An adequate means of population manipulation must be found to properly manage the existing trout streams in Montana. The stocking of catchable rainbow trout is commonly used with the idea of maintaining and/or increasing trout populations. Another method is to improve the existing trout habitat, so the stream can maintain a higher population of wild trout. Some types of habitat improvement are bank stabilization, pollution control, and maintaining adequate water flows below reservoirs.

The Madison River has had a serious water flow problem below Hebgen Reservoir due to water storage patterns. From trout population data taken in 1967, the local power company agreed to alter their water storage procedure to insure good early spring water flows in the Madison. Thus both commercial and recreational interests were satisfied at no cost to the angling public. These improved spring flows resulted in substantial increases in the wild trout populations, as trout numbers have increased 32-40% in the two study sections.

Catchable-sized rainbows have been planted in the Madison River since the early 1940's, with the river receiving 40-70,000 annually. In 1957, the stocking was discontinued on the portion of the Madison below Ennis Reservoir. At the present time, approximately 70,000 catchables are stocked annually between Hebgen and Ennis Reservoirs. These hatchery rainbow seem to contribute little to the wild trout population. Only 0.4% survive in the river a complete year, and the few which do survive only comprise 1.6% of the total numbers in the river. The stocking of large numbers of rainbow has little long-term effect on the population size, as there were five times as many rainbow per mile in the Norris section (369 in 1968) where none are stocked as were in the Varney section (79 in 1968) where they are stocked. Angling pressure probably has little effect on the trout populations, as the 1968 returns were 8.9% in the Norris section and 11.9% in Varney.

LITERATURE CITED

Ricker, W. E. 1958. Handbook of computations for biological statistics of fish populations. Fish. Res. Bd. Canada, Bull. 119, 300 p.

ADDENDUM

1969 Madison River Data.

Since the spring water flow patterns were altered in 1968 to eliminate the dewatering period from mid-February to mid-May, the wild trout populations in the Madison River have shown significant increases. Population estimates were made on two sections (Varney and Norris) during 1967, 1968, and 1969. Table 2 shows the changes in the brown and rainbow trout populations from 1967 through 1969. The Norris section has shown a 42% increase in numbers and a 25% increase in total pounds of catchable brown and rainbow trout since the spring of 1967. The spring estimates in the Varney section show a 32% increase in numbers and a 16% increase in total pounds of brown trout. The fall Varney estimates show a 62% increase in numbers and a 10% increase in the total pounds of brown trout. The wild rainbow trout have increased 76% in numbers and 86% in total pounds since 1967.

A large portion of the fall increase in brown trout numbers was due to substantial increases in the yearling age group (6-10 inches in length). The number of yearlings per mile ranged from 284 in 1967 to 865 in 1968.

It will probably take several more years of good spring flows to create a stable condition in this section of the river. Thus the maximum trout population may not be realized for several years.

TABLE 2. Estimated trout populations for two sections of the Madison River during 1967, 1968, and 1969. Spring estimates are for trout two years old and older and fall estimates are for trout one year old and older.

	Norris Section			Varney Section		
	Brown	Rainbow	Total	Brown	Rainbow	Total
Spring, 1967						
No./Mile	1,177	518	1,695	341	73	414
Lbs./Mile	1,074	289	1,363	326	57	383
Fall, 1967						
No./Mile		No Estimates		554	87	641
Lbs./Mile				411	37	448
Spring, 1968						
No./Mile	2,085	369	2,455	477	71	547
Lbs./Mile	1,279	159	1,438	431	58	489
Fall, 1968						
No./Mile		No Estimates		1,090	91	1,181
Lbs./Mile				517	84	601
Spring, 1969						
No./Mile	1,738	670	2,408	450	No Estimates 1/	
Lbs./Mile	1,390	318	1,708	378	No Estimates 1/	
Fall, 1969						
No./Mile		No Estimates		895	153	1,048
Lbs./Mile				450	69	519

1/ Insufficient data for estimate.