MONTANA FISH AND GAME DEPARTMENT
FISHERIES DIVISION

JOB PROGRESS REPORT

State Montana

Project No. F-9-R-19 Title Southwestern Montana Fisheries Study

Job No. III-a Title Evaluation of River Fish Populations

Period Covered July 1, 1970 to June 30, 1971

ABSTRACT

A flat-bottomed fiberglas boat was considered to be superior to a flatbottomed aluminum boat because (1) it was easier to repair; (2) a negative can be easily fastened to the bottom; and (3) it was safer for the shocking crew because it was made of a non-conducting material.

The basic Peterson mark-and-recapture formula was used to estimate the standing crop (total numbers and biomass). The age structure and mortality rates were also determined.

Population estimates were made on two sections of the East Gallatin River. No young-of-the-year trout were found in shocking samples in the two study sections. Annual mortality rates ranged from 23% for wild browns in Section X to 89% for hatchery rainbows in Section X. Angler tag returns ranged from 2.7% on brown trout in Section X to 3.1% for rainbow trout in Section X. Information from tagged fish which were recaptured by electrofishing showed that detectable movement was more extensive in sections heavily polluted by sewage than in the unpolluted sections.

Trout population estimates were made on three sections of the Madison River. Population estimates from 1967, 1968, 1969, and 1970 show that improved spring flows in 1968, 1969, and 1970 were followed by significant increases in the spring trout population on Section IV and large increases in the fall population of yearling trout in Section VIIa, but due to heavy overwinter mortality, the fall population of large trout has not shown these increases. After a 20-year catchable rainbow stocking program ceased on Section VIIa, the fall 1970 population estimate showed an 81% increase in total number and 78% increase in the total biomass of two-year-olds and older brown and rainbow trout since the fall of 1967.

Population estimates were made on two sections of O'Dell Creek. One section (IV-II-II) received a plant of 4,000 hatchery rainbow trout and the other (V) had no planted rainbow. The planted section showed an increase in movement out of the study section after stocking.

Population estimates were made on a section of the South Fork Madison River and one section of the West Gallatin River (Porcupine).

BACKGROUND

Effective fisheries management of larger rivers and creeks depends on the quality of the fish population data available. Information on standing crops, mortality rates, age structure, production rates, and movement must be obtained. Mortality rates for several periods in the year, such as summer and winter, are necessary to determine when mortality is occurring and then what is causing it. Age structure information is necessary to determine if reproduction or recruitment is adequate to maintain the existing standing crop. Production rates are useful in determining how much of the standing crop can be harvested before endangering the resource. Movement should be evaluated to determine the importance of spawning runs, certain spawning areas and movement as a factor in recruitment. The amount of movement sometimes indicates favorable or unfavorable habitat.

OBJECTIVES

The overall objective of this job was to develop shocking gear and techniques for sampling fish populations of large rivers and to compile data that reflect the status of river trout populations.

PROCEDURES

Electrofishing gear was used to sample fish populations in the East Gallatin River, Madison River, O'Dell Creek and West Gallatin River. These streams divided into sections ranging in length from 875 feet to 5 miles. To aid in the detection of movement, the main population sections were then divided into subsections ranging in length from 500 to 2,500 feet. Electrofishing was carried out while floating through a section in a flat-bottomed fiberglas boat. The shocking boat contained a stationary negative electrode (fastened to the bottom of the boat), a mobile or stationary positive electrode, a portable 2,000 watt AC generator with a rectifying unit to change the alternating current to various forms of direct current, and a live box to retain captured fish. The captured fish were weighed, measured and marked with a fin clip or fish tag and then released at various points within each section.

Population estimates were made by using the Petersen-type mark-and-recapture method using Chapman's modified formula (Chapman, 1951), which is as follows:

$$N = \frac{(M+1)\ (C+1)}{R+1}$$

Where: N = population estimate.
M = the number of fish marked
C = the number of fish in the recapture sample.
R = the number of marked fish in the recapture sample (C).

Two or more "marking" and/or "recapture" trips were required where sample sizes were small. There was usually at least a two- to three-day time interval between the marking run(s) and the recapture run(s). Scales were taken to determine age and rate of growth. Total number, total biomass, age structure, mortality

rates, and confidence intervals were determined for most of the study sections. The actual mathematical computations were made by an IBM computer programmed to use the methods described by Vincent (1971). This computer program enabled faster, more accurate and more thorough calculations of the various populations parameters from the raw data. Movement and angler mortality were determined by the use of a numbered plastic fish tag which was inserted in the fish just behind the dorsal fin on the back, with the barbs engaging the pterygiophores. These tags were inserted by means of a tagging gun.

FINDINGS

Electrofishing Gear and Techniques

A flat-bottomed fiberglas boat was used to carry out the electrofishing operations on the various rivers and large creeks. The fiberglas boat is more suitable for electrofishing operations than an aluminum metal boat because: (1) it is easier to maintain and repair; (2) a negative electrode can be easily fastened to the bottom without becoming dangerous to the shocking crew; and (3) it is safer for the shocking crew from the electrical standpoint because the boat is made of a non-conductor.

When electrofishing in rivers and large creeks, an occasional rock or other hard objects are hit and/or the boat must be pulled over shallow riffles. This can damage the bottom of the boat. Aluminum, which requires welding, is much more difficult to repair than fiberglas, which can be repaired quite easily by inexperienced people. After much use, aluminum appears to become brittle and impossible to repair.

The negative electrode can be easily fastened to the bottom of the fiberglas boat without the boat's becoming energized as part of the negative, as happens with metal boats. With the negative fastened to the bottom of the boat, the cumbersome negative boom can be eliminated and a large negative surface area is practical. From the safety standpoint, placing the negative under the boat is desirable because it is in a position where no member of the crew can directly touch it when it is energized. This, then, eliminates someone from simultaneously touching both the positive and negative electrodes, which is the most dangerous situation when electrofishing. Another safety feature is that fiberglas is a non-conductor, so any contact with the boat by the positive electrode or by shocking personnel is safe.

Fish Population Data

East Gallatin River and Tributaries

The East Gallatin River was divided into 14 sections ranging in length from 4,400 to 26,000 feet (Figure 1). Certain sections were then further divided into subsections ranging in length from 500 to 1,000 feet. Trout were tagged in 2 of the 14 sections to determine the extent of trout movement within a section.

Population Estimates. Population estimates for wild brown and rainbow trout were made on two sections (X and XII) in the East Gallatin River and for hatchery rainbow on one section. The summer shocking efficiencies (percentage of marked fish recaptured) for section X were 11 - 17%, and for section XII 12 - 17%. A summary of the trout population estimates for the two sections is presented in Table 1.

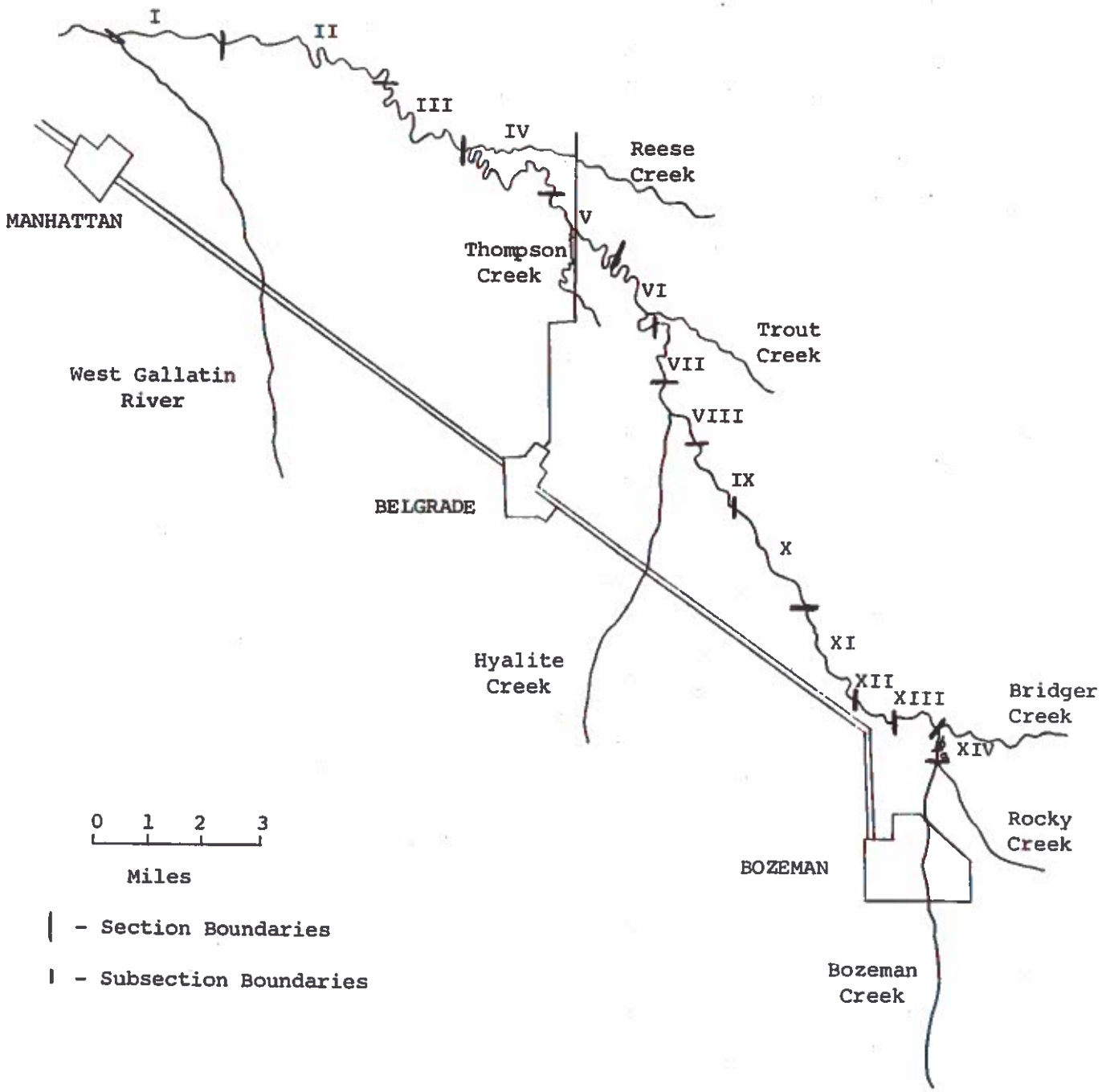

Figure 1. Map of the East Gallatin River showing study sections.

Table 1. Estimated trout populations for two sections of the East Gallatin River. Confidence intervals for the population and biomass estimates expressed at the 95% level are shown in parentheses.

Species	Sec. X - 8,000 ft.[1/] July, 1970 Total No.	No. / acre	Total lbs.	Lbs./	Sec. XII - 8,125 ft. July 1970 Total No.	No. / acre	Total lbs.	Lbs. / acre
Wild rainbow trout	488 (±107)	85	434 (±175)	76	1,148 (±273)	197	471 (±108)	81
Wild brown trout	280 (±110)	50	220 (±89)	39	901 (±370)	155	372 (±205)	64
Total wild trout	768	135	654	115	2,049	352	843	145
Hatchery rainbow trout	454 (±76)	79	179 (±29)	31	No Data			

1/ Length of section.

Age Structure. Age composition (percent) and age-group population numbers were calculated for each of the sections on which population estimates were made. A summary of the population estimates for each age-group of wild rainbow and brown trout for the two sections is given in Table 2.

Table 3 shows the relative abundance of each age-group of wild rainbow and brown trout in the two sections with population estimates.

Effect of Habitat Conditions. The East Gallatin River has a serious water pollution problem. The outlet of the Bozeman Municipal Sewage Treatment Plant enters the river about 1500 feet below the confluence of Bozeman Creek or about 1.5 miles above the start of section XII and 7.5 miles above the start of section X (Figure 1).

The most seriously polluted portion of the river is within the first 12 miles below the sewage outlet. The two sections on which trout population estimates were made lie within this area. This form of pollution appears to have a serious effect on trout populations within a 12 mile area downstream, especially on the younger age group (0 and I+). Age structure information on sections X and XII show poor recruitment of younger fish into the population, as one-year-olds only make up 10 and 13% of the total rainbow; and 36 and 27% of the total brown trout population in sections X and XII, respectively.

Mortality Rates. Total mortality was calculated for wild rainbow in sections X and XII, and for wild brown trout and hatchery rainbow trout in section X (Table 4). This is for the period from August, 1969 to July, 1970. The difference in the two population estimates of the same age group was assumed to be mainly the result of natural and angler mortality. Table 4 also gives a summary of the percent of trout caught by anglers during the 1969-70 period.

Table 2. Estimated age structure of wild rainbow and brown trout for sections X and XII of the East Gallatin River. (Numbers per acre are shown in parentheses).

Section and date	Age Group I	II	III	IV+	Total
			Rainbow Trout		
X	5.3-7.1"1/	6.6-11.0"	9.5-15.2"	13.0-19.9"	
July, 1970	51	126	115	196	488
	(9)	(22)	(20)	(34)	(85)
XII	3.8-6.5"	6.1-9.8"	9.1-14.1"	11.5-19.2"	
July, 1970	152	510	217	269	1148
	(20)	(88)	(37)	(46)	(197)
			Brown Trout		
X	5.4-9.3"	8.4-13.1"	12.6-17.5"	15.9-21.9"	
July, 1970	100	101	47	32	280
	(18)	(18)	(8)	(6)	(50)
XII	4.9-7.3"	7.4-11.8"	10.3-23.9" 2/		
July, 1970	240	423	238		901
	(41)	(73)	(41)		(155)

1/ Length Range
2/ Age group includes all brown trout three-year-olds and older.

Table 3. Relative abundance for each age group of wild rainbow and brown trout expressed as percent of total numbers.

Section	Age Group I	II	III	IV+
			Rainbow Trout	
X	10	26	24	40
XII	13	44	19	24
			Brown Trout	
X	36	36	17	11
XII	27	47	26 1/	

1/ Percent for three-year-olds and older

Table 4. Overall mortality rates of wild rainbow trout, wild brown trout, and hatchery rainbow trout for the period August, 1969, to July, 1970, plus angler harvest rates for the same period - East Gallatin River.

Section	Population estimates August, 1969	Population estimates July, 1970	Mortality rate	Angler harvest
	Age Groups II-IV+	Age Groups III-IV+		
	Rainbow Trout			
X	414	311	25%	3.1%
XII	780	486	38%	2.8%
	Brown Trout			
X	102	79	23%	2.7%
	Hatchery Rainbow Trout			
X	4000[1]/	454	89%	no data

1/ Number stocked as 5-7" trout in August, 1969.

Mortality rates for wild trout in section X and XII were considerably lower than the hatchery rainbows stocked in section X. Angling pressure on these two sections is rather light as is shown by the low tag return rate (2.7-3.1%). This would indicate that most of the overall mortality was due to factors other than angling and that these other factors affected the hatchery trout to a greater degree than the wild trout.

Movement. Study sections X and XII were subdivided into small subsections (500-800 feet) to determine more detailed wild trout movement. Brown and rainbow trout were tagged in each of these subsections. Table 5 shows the degree of movement (greater than 500 feet) after one year of the 1969 trout.

Table 5. Movement of wild brown and rainbow trout within the East Gallatin River over a period of one year, 1969 to 1970, as indicated by tagged fish recaptured by electrofishing.

Section		No Movement	Movement	Total	Percent Movement
X	Rainbow	10	10	20	50
	Brown	4	2	6	33
	Total	14	12	26	46
XII	Rainbow	35	8	43	19
	Brown	15	1	16	6
	Total	50	9	59	15

The degree of movement within the East Gallatin River varies considerably from polluted to nonpolluted (Vincent, 1969). Sections X and XII lie within the polluted zone on the East Gallatin River and detectable movement (46% in section X and 15% in section XII) is higher than that found in nonpolluted sections. Vincent (1969) found no detectable movement in section III (below pollution zone). Water

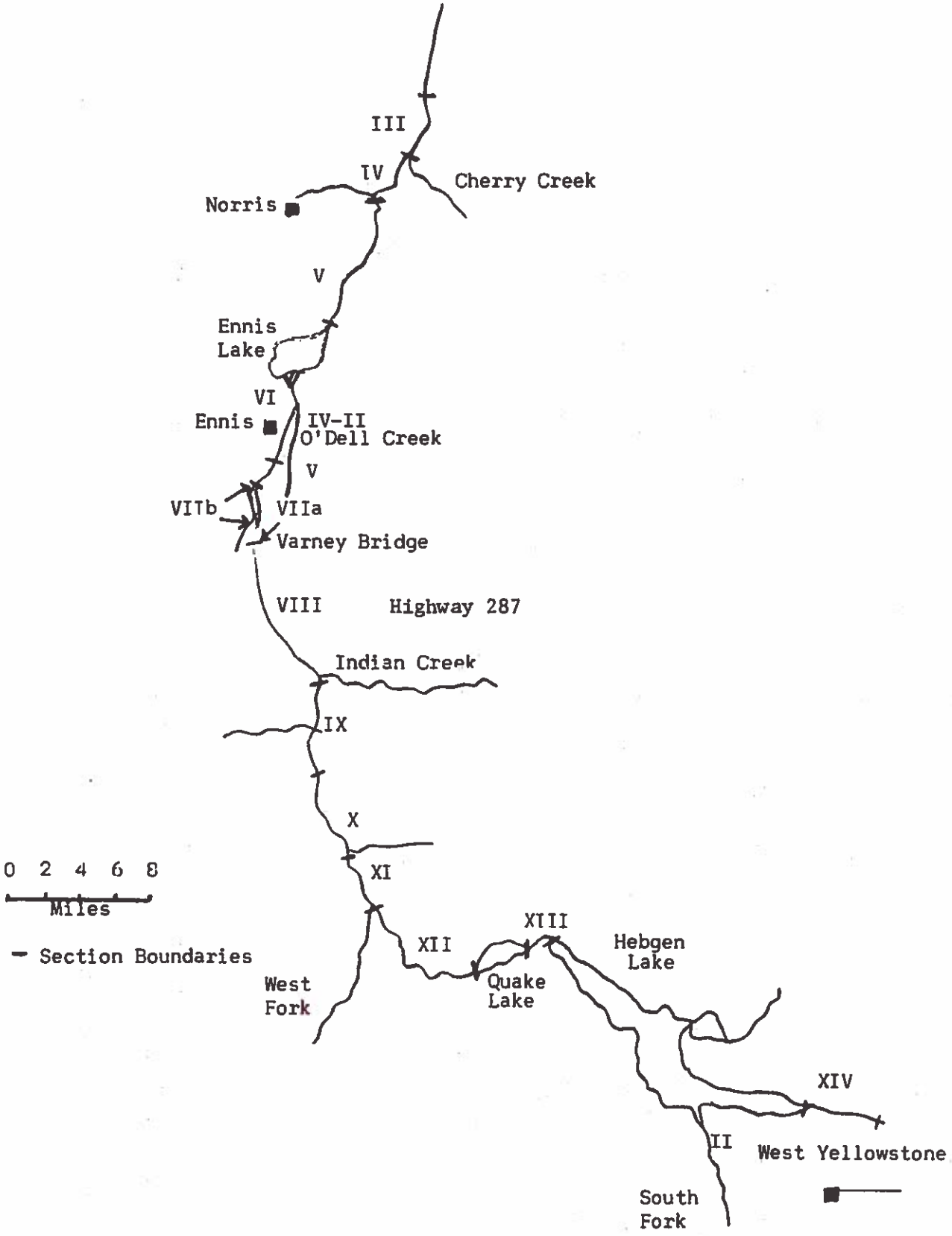

Figure 2. Map of the Madison River showing study sections.

pollution could result in an unstable environment which would increase trout movement. During the 1969-70 period movement downstream (75%) predominated over upstream movement (25%).

Madison River

The Madison River was divided into 15 sections ranging in length from four to nine miles (Figure 2). The three study sections were then divided into subsections ranging in length from 2000 to 2500 feet for more detailed study of movement.

Population Estimates. Trout population estimates were made on four sections of the Madison River. The shocking efficiencies on these three sections were as follows: IV, April 2.7 to 5.4%; IV, October 1.7 to 3.8%; VIIa, East Channels Varney, April 2.4 to 6.8%; VIIa, East Channels Varney, September 4.5 to 6.1%; West Channel, VIIb, April 20.2 to 23.3%; and West Channel, VIIb, September 13.3 to 17.6%. A summary of the trout population estimates is presented in Table 6.

Age Structure. Age composition (percent) and age group population numbers were calculated for sections IV and VIIb West Channel, Spring, 1970; and for section VIIa Varney East Channels, Spring and Fall, 1970. Table 7 gives a summary of the population estimates for each age group of brown and rainbow trout.

Effects of Habitat Conditions. The Madison River has a serious problem involving water releases from Hebgen Reservoir during the late winter. Water is stored during the spring in Hebgen Reservoir and then released from July through November for electrical power generation at Ennis Dam and other downstream power dams. The storage pattern varied from year to year. In some years, as in 1967, water storage began in late February or early March prior to spring runoff. This created a serious low-water condition in the Madison River channel downstream from Hebgen. In other years, the storage did not begin until the spring runoff started (late April or early May). During the springs of 1968, 1969 and 1970, good flow conditions were maintained from February through May. This was in contrast to the poor flow pattern in 1967.

Population estimates made on sections IV and VIIa during 1967, 1968, 1969 and 1970 show the effect of this flow pattern change on the wild trout population. Table 8 shows the change in the numbers of two-year-olds and older trout in both sections in the spring and the number of yearlings in the fall on section VIIa. Since the spring flow patterns were altered in 1968, section IV has shown significant population increases, while VIIa shows only small increases. Fall population estimates on section VIIa show a substantial increase in yearlings since 1967, but these yearlings have suffered high over-winter mortalities (September through March) and thus do not substantially increase the spring populations of two-year-olds and older. Some factor other than spring flow patterns evidentally regulates the survival of this age group.

Effect of Hatchery Rainbow Trout. The Madison River above Ennis Reservoir has been stocked with catchable rainbow trout since the early 1950's, but stocking was discontinued below Ennis Reservoir in 1959. The Varney study section (VIIa E.C.) had received from 10,000-20,000 catchable rainbows from 1967-69. It is possible that the stocking of catchable rainbows may adversely affect the wild trout populations. Section VIIa (planted area) has shown no significant population increases since the

Table 6. Estimated trout populations for four sections of the Madison River for spring and fall 1970. Confidence intervals for the total number and total biomass expressed at the 95% level are shown in parentheses.

Section length and date	Brown Trout				Rainbow Trout				Total Trout			
	Total No.	No./ 1000'	Total lbs.	Lbs./ 1000'	Total No.	No./ 1000'	Total lbs.	No./ 1000'	Total No.	No./ 1000'	Total lbs.	No./ 1000'
IV 4.0 miles 1/ March, 1970	8947 (±2021)	417	5548 (±1292)	258	3301 (±1648)	154	1255 (±340)	58	11,148	571	6803	316
IV 4.0 miles Oct., 1970	11,322 (±2526)	527	9328 (±2821)	434	3782 (±1120)	176	1729 (±582)	81	15,104	703	11,057	514
VIIa E.C. 2/ 5.0 miles April, 1970	2121 (±853)	81	1667 (±465)	63	379 (±188)	15	327 (±159)	12	2500	96	1994	75
VIIa E.C. 2/ 5.0 miles Sept., 1970	5694 (±1103)	217	3582 (±1165)	136	1794 (±941)	68	1021 (±472)	39	7488	285	4603	175
VIIb W.C. 2/ 3.0 miles April, 1970	1554 (±451)	97	1214 (±217)	77	265 (±154)	17	171 (±66)	11	1819	114	1385	88
VIIb W.C. 2/ 3.0 miles Sept., 1970	4408 (±820)	278	2670 (±590)	169	702 (±522)	44	339 (±176)	21	5110	322	3009	190

Table 7. Estimated age structure of brown and rainbow trout in three sections of the Madison River (numbers per 1000 feet are shown in parentheses). Figures in inches are length range (T.L.) of fish.

Section and date	Age Group I	II	III	IV+
		Brown Trout		
IV		6.7-11.9"	10.9-17.3"	15.0-21.9"
March, 1970		5713	2441	793
		(266)	(114)	(37)
VIIb W.C.		6.0-11.5" 1/	10.5-16.6" 1/	15.1-23.9" 1/
April, 1970		701	575	278
		(44)	(36)	(17)
VIIa E.C.		1108	568	445
		(42)	(22)	(17)
VIIa E.C.	5.4-11.0"	9.8-15.7"	13.5-18.2"	17.4-21.9"
Sept., 1970	3876	930	463	425
	(147)	(35)	(18)	(17)
		Rainbow Trout		
IV		7.4-11.1"	10.5-14.4"	14.1-20.9"
March, 1970		2749	495	57
		(128)	(23)	(3)
VIIb W.C.		7.5-12.1" 1/	11.5-15.1" 1/	13.3-20.4" 1/
April, 1970		158	51	56
		(10)	(3)	(4)
VIIa E.C.		204	47	128
		(8)	(2)	(5)
VIIa E.C.	6.4-10.2"	9.0-15.0"	13.3-17.1"	15.5-21.7"
Sept., 1970	869	737	103	85
	(33)	(28)	(4)	(3)

1/ Data was combined for sections VIIa E.C., April, 1970, and VIIb W.C., April, 1970.

flow improvement, while section IV (unplanted area) has increased 88% in total numbers and 29% in total biomass (Table 8).

In 1970, stocking of catchable rainbows in section VIIa was stopped to determine their effect on the wild trout populations. The 1970 fall population estimate on section VIIa showed a 81% increase in total numbers and a 78% increase in total biomass of adult (two-year-old and older) wild brown and rainbow trout since 1967 (Table 9).

Table 8. Comparison of 1967, 1968, 1969, and 1970 brown trout population estimates for sections IV and VII a. April estimates are for two-year-olds and older and the September estimates are for yearlings. Estimates are expressed as numbers and pounds per 1000 feet.

	Section IV (April)		Section VIIa April		Section VII a September	
Year	Number	Pounds	Number	Pounds	Number	Pounds
1967 1/	222	200	58	55	24	7
1968 2/	388	238	76	84	167	40
1969 3/	323	259	90	75	120	22
1970	417	258	81	63	147	29

1/ Data from Vincent 1968
2/ Data from Vincent 1969
3/ Data from Vincent 1970

Table 9. Comparison of 1967, 1968, 1969, and 1970 fall population number and biomass for section VIIa, Madison River. Estimates are for two-year-olds and older.

	Brown Trout		Rainbow Trout		Total	
Year	Number	Pounds	Number	Pounds	Number	Pounds
1967 1/	1379	1938	138	118	1517	2056
1968 2/	1126	1396	406	421	1532	1817
1969 3/	1196	1490	191	197	1387	1687
1970	1818	2806	925	844	2743	3650

1/ Data from Vincent 1968
2/ Data from Vincent 1969
3/ Data from Vincent 1970

Tag Returns: An indication of angler harvest was determined by the use of angler-returned fish tags. Wild trout were tagged with numbered T-tags during the spring electrofishing period. Hatchery rainbow were tagged prior to stocking with colored plastic T-tags. Hatchery trout were planted in all sections of the Madison River between Quake Lake and Ennis Dam except in the study area (VIIa). A total of 55,927 hatchery rainbows were stocked from July 2, 1970 through August 3, 1970. Table 10 gives a summary of the tag returns for wild brown and rainbow trout during the April 1970 to March 1971 period for sections IV, VIIa and VIIb; plus hatchery rainbow for sections VI and VIII through XII. Even though not all tagged fish caught are reported, the low level of tag returns (5.1-13.7%) indicates that angling had little effect on the existing wild trout populations in the three study areas.

An effort was made to determine the percent of tagged fish which were actually caught and were then reported. This was done by conducting a census on section IV between June 1970 and August 12, 1970 (all creel days were week days).

During the days censused, most of the anglers were contacted and tags were collected from those tagged trout caught. The tag return rate (tags per day) on census days (week days) were compared to non-census days (week days) in which the only method on obtaining tags was from a voluntary return. In fourteen days of complete

census, six tags were obtained, while in 45 non-census days, 14 tags were turned in voluntarily. This information indicated that 73% of the tagged trout caught were later reported.

Table 10. Percent of fish tags returned by anglers for the period April, 1970 through March, 1971

Section		Number tagged	Tags returned	Percent of Tags returned
IV	Brown Trout	466	45	9.7
	Rainbow Trout	156	20	12.8
	Total	622	65	10.5
VIIa	(Varney)			
	Brown Trout	347	30	8.6
	Rainbow Trout	97	12	12.4
		444	42	9.5
VIIb	W. C.			
	Brown Trout	297	15	5.1
VI &	VII-XII			
	Hatchery Trout	4000	313	7.8

O'Dell Creek

Population Estimates. Population estimates were made on two sections of O'Dell Creek during the spring prior to fishing season (May) and then again in September (Figure 2). One section was located below Highway 287 (sections IV-III-II) and one was located above the highway (section V). Table 11 gives a summary of the population estimates for the two sections during the spring and fall periods.

Effect of Hatchery Rainbow Trout. During June and July of 1970, the lower study section on O'Dell Creek (IV-III-II) received 400 catchable rainbow trout. They ranged in length from seven to nine inches. This was the first known plant in O'Dell Creek during the last 20 years. This plant was part of the study to determine the effect of stocking hatchery rainbows on wild trout populations.

Mortality Rates. Total mortality was calculated for wild brown trout for sections IV-III-II and V; and hatchery rainbow trout for section IV-III-II. The mortality rates covered the time period from May, 1970 through September, 1970. A summary of the mortality rates and angler tag returns is given in Table 12.

Total mortality is a combination of natural mortality and angler harvest. Angler harvest was estimated by using angler returns of tagged fish. Table 12 shows that the summer mortality for wild brown trout was 24 and 31% on the two sections, while the anglers only took 5.9 and 4.6% of the trout. This low rate of harvest suggests that anglers are under-harvesting these populations.

Table 11. Estimated brown trout population and age structure during the spring and fall time periods on sections IV-11 and V of O'Dell Creek. Confidence intervals for the total population and total biomass expressed at the 95% level are shown in parentheses.

	Age Group				Total No.	No./ Acre	Total lbs.	Lbs./ Acre
	I	II	III	IV+				
Section IV-II	3.8-8.1" 1/	7.5-12.9"	11.1-16.3"	15.6-20.8"				
May, 1970	1972	609	358	96	3035	257	781	66
	6.1-9.7"	9.4-13.6"	12.4-16.8"	15.8-22.3"				
Sept., 1970	1257	387	243	72	1959	167	889	75
Section V	3.3-7.5"	7.2-12.5"	11.2-16.4"	15.7-21.8"				
May, 1970	3474	422	174	37	4107	1245	589	179
	5.5-10.5"	9.8-14.5"	13.2-16.7"	15.6-27.0"				
Sept., 1970	964	183	88	73	1308	396	585	177

1/ Length Range

A total of 4000 catchable rainbow trout were stocked in section IV-III-II during June, 1970. By September, 1970, only 431 of these survived (89% summer mortality) and 2.3% were caught by anglers.

Table 12. Total mortality and percent tag returns of brown trout for sections IV-III-II and V; plus hatchery rainbow trout for section IV-III-II for the time period May, 1970 through September, 1970.

Section	Initial Population estimate	Final Population estimate	Mortality rate (percent)	Percent Tag return
		Brown Trout		
	Age Groups III-IV+	Age Groups III-IV+		
IV-III-II	454	314	31	4.6
IV	211	161	24	5.9
		Hatchery Rainbow Trout		
IV-III-II	4000 1/	431	89	2.3

1/ Number stocked June, 1970.

Movement. A total of 307 wild brown and rainbow trout were tagged in section IV-III-II and 105 in section V during the spring of 1970. During the summer of 1970, anglers returned 14 trout which were tagged in O'Dell Creek, section IV-III-II and then later caught in the Madison River. In the previous years of 1967, 1968 and 1969 only a total of six such trout were caught (average of two per summer). The wild trout tagged in section V were later caught in the Madison River. This information suggests that during the summer of 1970 there was increased movement of wild trout out of the planted section (IV-III-II) and into the Madison River.

South Fork Madison River

Population Estimate. A brown trout population estimate was made on one section of the South Fork of the Madison River (Figure 2). A summary of this population estimate is shown in Table 13.

The brown trout population consisted primarily of yearling trout (96%) with few adult trout. As Hebgen Reservoir lies only 1.5 miles downstream from this section, the preponderance of yearling trout might suggest that the South Fork is primarily a spawning stream for the reservoir and has few resident adult trout.

Table 13. Estimated trout populations and age structure for section II on the South Fork Madison River and the Porcupine section on the West Gallatin River. Confidence intervals for the total population and total biomass expressed at the 95% level are shown in parentheses.

Section	Age Group I	II	III	IV+	Total No.	No./ 1000'	Total Lbs.	Lbs./ 1000'
				Brown Trout				
So. F. Madison-II	3.4-6.9" 1/	6.5-11.9"	8.8-17.2"	14.3-22.9"				
Aug., 1970	10,556	266	90	126	11,038 (±6195)	1393	857 (±305)	108
W.Gallatin-Porcupine	7.5-8.6"	8.7-11.7"	9.9-15.1"	14.3-21.6"				
Aug., 1970	6	43	106	41	196 (±103)	18	201 (±132)	17
				Rainbow Trout				
W. Gallatin-Porcupine	4.5-6.3"	5.5-9.1"	7.6-11.8"	10.5-17.6"				
Aug., 1970	50	274	486	133	943 (±457)	80	320 (±142)	27

1/ Length Range

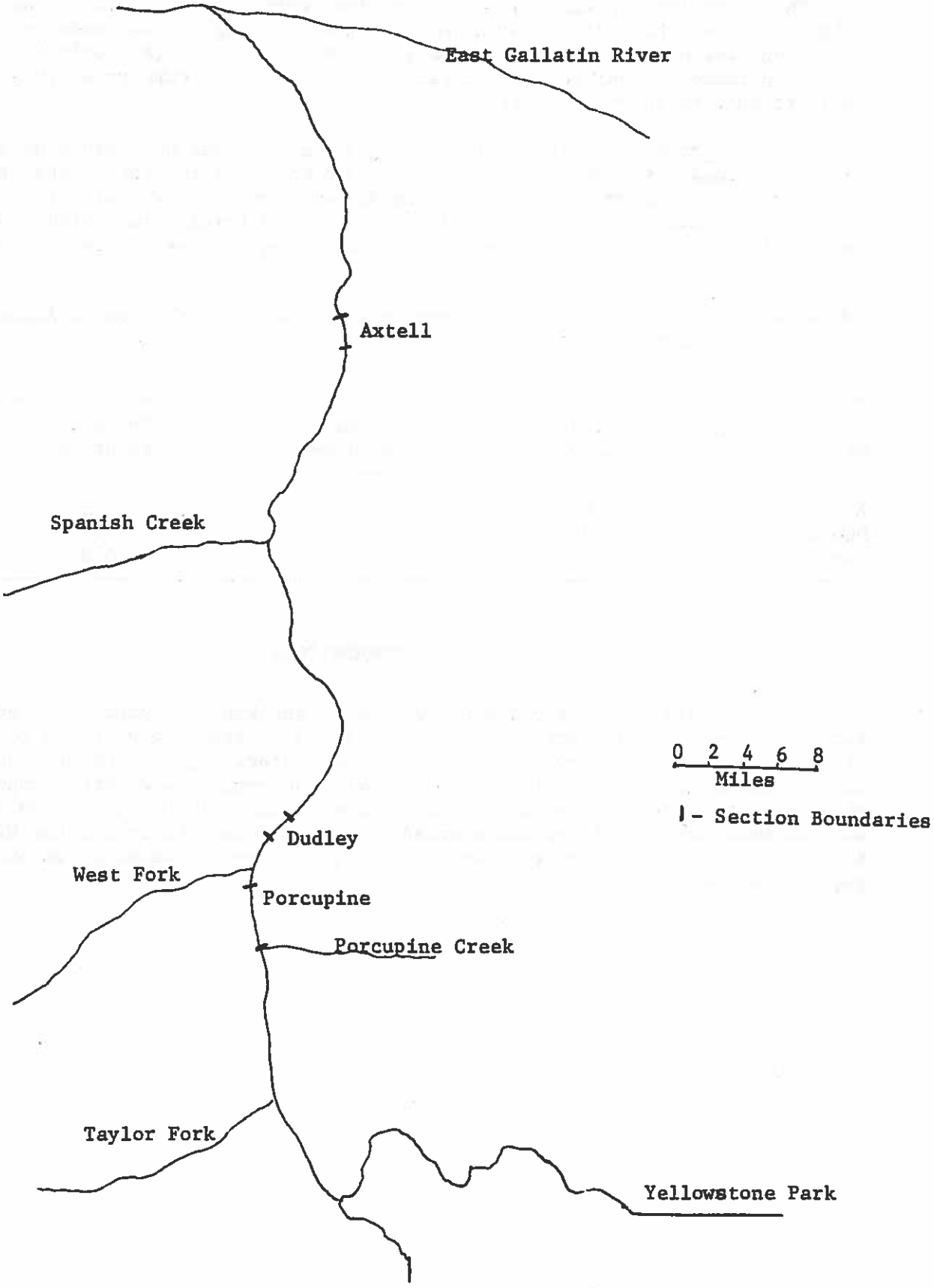

Figure 3. Map of West Gallatin River showing Study Sections.

West Gallatin River

Three sections on the West Gallatin River were electrofished during 1970 (Figure 3). On three of the sections, only one shocking run was made to tag wild trout for angler harvest information. On one section (Porcupine), a wild brown and rainbow trout population estimate was made. A summary of this population estimate is shown in Table 13.

Angler Harvest. An indication of angler harvest was determined by the use of angler-returned fish tags. Table 14 gives a summary of the tag returns for combined brown and rainbow trout during the August, 1969 through July, 1970 period for the three study sections. The low level of tag returns indicates that angling had little effect on the existing trout populations in these three sections.

Table 14. Percent of trout tags returned by anglers for the period August, 1969 through July, 1970.

Section	Number Tagged	Tags Returned	Percent Returned
Axtell	94	5	5.3
Dudley	26	3	11.5
Porcupine	192	13	6.8

RECOMMENDATIONS

There should be continued work to improve shocking equipment and techniques. Various types of boom electrodes should be tried on the larger rivers to determine if there is a satisfactory way to sample these waters. Estimates of standing crops, age structure, mortality rates, production rates and species composition should be continued on the East Gallatin River, the Madison River, O'Dell Creek and the West Gallatin River and started on the Jefferson River and the Missouri River. The effects of habitat destruction, pollution and water flows on trout populations should be studied.

LITERATURE CITED

Chapman, D. C. 1951. Some properties of the hypergometrical distribution with application to zoological censuses. Univ. Calif. Pub. Stat., 1(7):131-160.

Vincent, E. R. 1968. Evaluation of river fish populations. Job Completion Report, Federal Aid in Fish and Wildlife Restoration Acts. Montana Project No. F-O-R-16, Job VII.

Vincent, E. R. 1969b. Evaluation of river fish populations. Job Completion Report, Rederal Aid in Fish and Wildlife Restoration Acts. Montana Project No. F-9-R-17.

Vincent, E. R. 1970. Evaluation of river fish populations. Job Completion Report, Federal Aid in Fish and Wildlife Restoration Acts. Montana Project No. F-9-R-18, Job No. 111-a.

Vincent, E. R. 1971. River electrofishing and fish population estimates. Prog. Fish Cult. 33(3): 163-167.

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Waters Referred to:

9-1710-1	13-3440-1
9-6878-1	13-4400-1
9-6916-1	13-5400-1
13-3400-1	