MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS

FISHERIES DIVISION

JOB PROGRESS REPORT

State: Montana

Project No.: F-5-R-30 Title: Northcentral Montana Fisheries Study

Job No.: I-a Title: Inventory and Survey of Waters in the Western Half of Region Four

Period Covered: July 1, 1980 through June 30, 1981

## ABSTRACT

A total of 8 lakes and reservoirs, 7 small lakes and farm ponds and 9 streams were inventoried during the report period. Rainbow trout growth and angler success is discussed for four reservoirs with Bynum and Nilan Reservoirs showing the best growth and Nilan Reservoir exhibiting best angler success. Natural reproduction of walleye in Lake Frances was documented. In Pishkun Reservoir, northern pike were tagged and the population estimated. Survival and growth of planted rainbow trout in Pishkun Reservoir appears to be good. Additional documentation was made on natural reproduction of kokanee in Pishkun Reservoir. Northern pike and walleye tagging studies continued in Tiber Reservoir. Accumulative angler returns for walleye approach 100 percent three years after tagging. Routine inventory electrofishing was conducted on the Teton River below Choteau, the Sun River near Vaughn, and Muddy Creek and its tributaries. Brook trout populations were estimated in two sections of the Teton River in relation to a debris removal project. Minimum flow requirements for maintaining the fishery in the Smith River were recommended. Trout populations were estimated in two sections of the Smith River.

## OBJECTIVES AND DEGREE OF ATTAINMENT

1.) To determine stocking densities, growth rates and angler success for rainbow trout in five reservoirs and lakes. Information was collected and is included in this report.

2.) To estimate the northern pike population and to determine the survival and growth of rainbow trout and natural reproduction of kokanee in Pishkun Reservoir. This work was done and is included in this report.

3.) To determine population trends, fisherman harvest and food habits of northern pike, walleye and burbot in Tiber Reservoir and Lake Frances. Also to determine composition and abundance of indigenous forage species. This information is included in this report with the exception of stomach analysis of food habits.

4.) To evaluate management of five small ponds and lakes with rainbow and cutthroat trout. Also to determine fishery potential in new ponds. Data was collected on three existing trout waters and on two potential ponds. Data is also presented on two non-trout lakes.

5.) To inventory trout populations in four streams to update management files. This work is included in this report.

6.) To moniter stability of stream habitat on the Teton River where flood debris was mechanically removed and where it was not removed and to estimate brook trout populations in these areas. Information was gathered and appears in this report.

7.) To determine and recommend minimum flow requirments for maintaining aquatic life in the Smith River. This was done and recommended water filings submitted to the Department of Natural Resources are included.

8.) To inventory trout populations in study sections on the Smith River. This was done and data are included.

## PROCEDURES

Fish were sampled with 3 x 4 foot and 4 x 6 foot frame net traps (¼, ½, and 1 inch mesh), 6 x 125 foot experimental gill nets (3/4 to 2 inch mesh), a 300-volt DC electrofish shocker and by hook and line. Measurements of fish include total lengths to the nearest tenth of an inch and weights to the nearest hundredth of a pound. Scale and otolith samples were collected for age and growth studies. Northern pike and walleye were tagged with T-tags and the left pelvic fin removed to help determine tag loss. Harvest determinations were made through voluntary angler tag returns. Population estimates were made by mark and recapture techniques. Trout were examined for fluorescent markings with the aid of a black light.

## ACCOMPLISHMENTS

### Lakes and Reservoirs

Gill net summaries for the lakes inventoried are presented in Table 1. Individual discussion of various waters follows.

#### Bean Lake

Sampling of the trout population with gill nets in the spring of 1980 revealed good carry-over of trout planted in 1979. However, netting in the fall of 1980 revealed poor survival of rainbow trout planted in the spring of 1980. Only 20,000 hatchery trout were planted in the spring of 1980 and an additional 16,000 wild rainbow trout fingerlings were planted in the fall. The wild trout were planted to compare growth and longevity with our hatchery stock.

Gill netting conducted in April, 1981 revealed fair carry-over of hatchery trout planted in 1980 and one 6.9 inch wild rainbow was taken (Table 1). Growth of carry-over hatchery rainbow in the spring of 1981 was one inch greater than those collected in the spring of 1980. The 1981 spring sampling also took a good number of trout planted in 1978 and 1979. These trout averaged 15.4 inches total length and weighed 1.42 pounds. Further evaluation of growth and survival of various stocks of rainbow trout will be conducted in this lake.

Table 1. Summary of gill netting of lakes and reservoirs, 1980

| Area (Date Sampled) | Surface Acres* | No. of Nets | Species** | No. of Fish | Length Range (Average) | Weight Range (Average) |
|---|---|---|---|---|---|---|
| Bean Lake | 200 | | | | | |
| (May 7, 1980) | | 2 | Rb | 82 | 9.7-12.1(11.1) | 0.38-0.74(0.58) |
| | | | | 17 | 12.7-17.5(14.7) | 0.86-2.06(1.28) |
| (Oct. 28, 1980) | | 3 | Rb | 19 | 10.1-11.8(11.3) | 0.40-0.76(0.60) |
| | | | | 14 | 14.1-16.5(15.1) | 1.11-1.73(1.36) |
| (Apr. 28, 1981) | | 2 | Rb | 27 | 11.4-12.9(12.1) | 0.58-0.87(0.73) |
| | | | | 17 | 14.3-17.1(15.4) | 1.14-2.00(1.42) |
| | | | Wild Rb | 1 | ( 6.9) | (0.13) |
| Bynum Res. (Oct. 2) | 3,000 | 2 | Rb | 9 | 10.9-12.1(11.2) | 0.47-0.59(0.54) |
| | | | | 7 | 12.8-14.4(13.7) | 0.78-1.14(0.95) |
| | | | KOK | 64 | 13.0-18.4(16.6) | 0.90-1.87(1.52) |
| Eureka Res. (Oct. 3) | 300 | 3 & Creel Census | Rb | 19 | 8.3-11.5( 9.6) | 0.22-0.52(0.33) |
| | | | | 9 | 12.5-15.5(13.5) | 0.66-1.40(0.92) |
| | | | LL | 3 | 17.8-18.8(18.2) | 1.82-2.20(2.07) |
| | | | WSu | 43 | | |
| | | | LnSu | 10 | | |
| Lake Frances (Sept. 24) | 4,200 | 3 | WE | 3 | 8.6- 9.6( 9.2) | 0.20-0.28(0.25) |
| | | | | 2 | 14.1-15.2(14.7) | 1.00-1.28(1.14) |
| | | | | 5 | 16.8-22.3(18.6) | 1.75-3.93(2.39) |
| | | | NP | 1 | ( 9.0) | (0.19) |
| | | | | 8 | 17.8-23.7(20.9) | 1.36-3.61(2.40) |
| Nilan Res. (Oct. 24) | 350 | 2 | Rb | 13 | 10.5-12.0(11.2) | 0.42-0.72(0.60) |
| | | | | 3 | 12.8-15.4(13.8) | 0.80-1.08(0.90) |
| Pishkun Res. (July 10) | 1,200 | 4 | NP | 7 | 12.0-19.2(14.7) | 0.44-1.62(0.82) |
| | | | Rb | 1 | (21.8) | (4.02) |
| | | | KOK | 1 | ( 7.0) | (0.12) |
| | | | | 3 | 10.8-11.9(11.3) | 0.46-0.56(0.51) |
| | | | | 21 | 13.7-16.4(15.3) | 0.96-1.64(1.32) |
| | | | YP | 41 | 5.8-10.0( 6.6) | 0.10-0.48(0.17) |

Table 1. (Cont.)

| Area (Date Sampled) | Surface Acres* | No. of Nets | Species** | No. of Fish | Length Range (Average) | Weight Range (Average) |
|---|---|---|---|---|---|---|
| Tiber Res. (Sept. 25,26) | 11,600 | 16 | WE | 24 | 8.1-10.7( 9.9) | 0.14-0.37(0.29) |
| | | | | 97 | 11.0-15.5(12.8) | 0.40-1.21(0.67) |
| | | | | 34 | 16.1-22.4(19.4) | 1.32-3.94(2.49) |
| | | | NP | 20 | 16.2-20.7(18.6) | 0.86-1.95(1.43) |
| | | | | 16 | 21.0-26.7(23.4) | 2.21-5.05(3.12) |
| | | | Rb | 4 | 14.7-22.4(18.8) | 1.24-2.88(2.11) |
| | | | LT | 1 | (23.5) | (3.47) |
| | | | Ling | 1 | Released | |
| | | | YP | 44 | 5.5- 8.3( 6.5) | 0.08-0.26(0.13) |
| | | | | 6 | 9.3-12.4(10.3) | 0.38-0.82(0.52) |
| | | | WF | 1 | (13.6) | (1.07) |
| | | | WSu | 67 | | |
| | | | LnSu | 2 | | |
| Willow Ck. Res. (Oct. 24) | 1,300 | 3 | Rb | 15 | 9.9-11.1(10.5) | 0.30-0.50(0.41) |
| | | | | 10 | 12.7-14.9(13.5) | 0.74-0.98(0.84) |

* Approximate surface acres at time of survey.

** Species abbreviations: Rb-rainbow trout; KOK-kokanee; LL-brown trout; WSu-white sucker; LnSu-longnose sucker; WE-walleye; NP-northern pike; YP-yellow perch; LT-lake trout; Ling-burbot; WF-mountain whitefish.

Growth Rates of Rainbow Trout in Four Reservoirs

Gill nets were fished in four irrigation storage reservoirs to moniter rainbow trout growth (Table 1). These included Bynum, Eureka, Nilan and Willow Creek Reservoirs. Bynum and Nilan Reservoirs exhibit good growth rates while Eureka and Willow Creek Reservoirs are about a third slower (Table 2). Fishing pressure and angler success is greatest at Nilan, while the other three reservoirs experience comparable pressure and success at a lower level.

All four reservoirs experience fluctuating water levels during the summer due to irrigation withdrawals. Eureka is most affected by the fluctuations. Poor growth rates of trout are attributed to competition with suckers as the reservoir level decreases.

Trout growth in Bynum has increased since kokanee plants were discontinued in 1978. The last remaining year class of kokanee should have matured in the fall of 1980, however, there is a possibility of carry-over as five-year-olds or a chance of some natural reproduction.

Table 2. Rainbow trout gain/month and condition factor (C) in Four Reservoirs, 1980

| Lake | Gain/Month Length (inches) | Gain/Month Weight (lbs.) | C | Stocking Rate No./Acre | Months in Lake* |
|---|---|---|---|---|---|
| Bynum Res. | 1.47 | .098 | 38.0 | 16 | 4.9 |
| Eureka Res. | 1.21 | .059 | 36.9 | 125 | 4.6 |
| Nilan Res. | 1.11 | .093 | 42.4 | 154 | 5.6 |
| Willow Ck. Res. | 1.14 | .061 | 35.2 | 51 | 5.7 |

* Months in Lake = From date planted to date sampled.

## Lake Frances

Three gill nets fished in September caught only 10 walleye and 9 northern pike (Table 1). Although few fish were taken, it is apparent that natural reproduction of walleye is occurring, based on fish ranging from 8.6 - 15.2 inches in length. Walleye larger than 16.8 inches are probably the result of stockings made in 1977 or earlier years. A much larger population of both walleye and northern pike are thought to be present based on netting results from last year.

A plant of 40,000 kokanee was made in Lake Frances in 1979. No kokanee were taken in the September netting. It is doubtful that many of these survived predation by pike.

## Pishkun Reservoir

A total of 25 trap days from April 22 to April 27, 1980, caught 134 northern pike, 3 rainbow trout, 8 yellow perch, 1 kokanee salmon and 101 white sucker.

The spring survey gathered information on the trends of the northern pike population as to whether it is increasing, decreasing or remaining stable. This information is necessary to determine whether or not it is feasible to continue planting rainbow trout. A population estimate was made for northern pike and 93 pike were tagged.

The population estimate was made using the Schnabel Method as described by Rounsefell and Everhart (1960) with the final estimate and confidence limits determined by formulas described by Chapman and Overton (1966). Of the 134 northern pike taken during trapping, 93 were marked (tagged) and released, 13 were recaptures, 3 were released without marking and 38 were small fish and not included in the estimate. A population estimate of 278 pike Table 3) was calculated for fish 16 inches or larger. This compares to population estimates of 272 (1979) and 279 (1978). Previous estimates made in 1970-72 ranged between 1,232 and 2,086.

Table 3. Northern pike population estimate for Pishkun Reservoir, 1980

| Time Interval (t) | Marked Fish at Large M(t) | Fish Captured C(t) | Marked Fish Recaptured R(t) | M(t-1) C(t) | M(t-1) C(t) / R(t) | Cumulative E | Cumulative D | G / H |
|---|---|---|---|---|---|---|---|---|
| A | B | C | D | E | F | G | H | I |
| 1 | 27 | | | | | | | |
| 2 | 49 | 26 | 4 | 702 | 176 | 702 | 4 | 176 |
| 3 | 59 | 11 | 1 | 539 | 539 | 1,241 | 5 | 248 |
| 4 | - | 45 | 8 | 2,655 | 332 | 3,896 | 13 | 300 |

From Chapman and Overton (1966)

Population = 278

$\lambda = \sum n_i M_i = 3896$

$x = \sum x_i = 13$

$\hat{N} = \frac{\lambda}{x+1} = \frac{3896}{14} = 278$

Confidence Limits

$P\ (.0400 \leq \frac{N}{\lambda} \leq .133) = .95$

$P\ (.0400 \leq \frac{N}{3896} \leq .133) = .95$

$P\ [(3896)(.04) \leq N \leq (3896)(.133)] = .95$

$P\ [156 \leq N \leq 518] = .95$

The average length of 93 tagged pike was 21.4 inches. This is the first year that a decrease in average size was noticed. Prior to this year, average length progressively increased from 20.5 in 1970 to 24.0 inches in 1979. The population is probably being replaced by greater numbers of smaller individuals.

A total of 21 tags were returned by fishermen during 1980 for a 22.6 percent return. Of these tags, 7 were males, 10 were females and 4 were of unknown sex. During June of 1980, a large pike (40.5 inches, 24.5 pounds) was caught by a fisherman. This fish was tagged April 14, 1971, as a four-year old female, measured 23.7 inches long and weighed 3.5 pounds.

A fairly high percentage of pike taken during trapping showed scars from spear marks(Table 4). These are fish that escaped after being hit by fishermen throwing spears. The percentage increases with size of fish. It became legal to spear pike in Montana in 1969. The season runs from December 1 through March 31.

Table 4. Incidence of northern pike showing spear marks, 1980

| Size of Fish | No. Fish Examined | No. With Spear Marks | % With Spear Marks |
|---|---|---|---|
| 16" and larger | 96 | 10 | 10.4 |
| 18" and larger | 64 | 10 | 15.6 |
| 20" and larger | 46 | 9 | 19.6 |
| 25" and larger | 25 | 8 | 32.0 |

Based on the apparent small population size and the relatively high harvest rate of northern pike, rainbow trout will continue to be stocked in Pishkun Reservoir for at least another year.

Survival of rainbow trout appears to be good with little or no predation by pike being detected. Growth has been very good, with fish planted in 1977 reaching seven to eight pounds and those planted in 1978 approaching five pounds. The plants are distinguishable by fluorescent dye marking.

Gill nets were fished periodically throughout the summer to gather data on kokanee salmon. The July netting (Table 1) collected three age groups of kokanee. The age II group (10.8 - 11.9) represents natural reproduction of 1978, a year in which kokanee were not planted. Gill netting surveys in April and August took additional kokanee of this year class. Although some natural reproduction is occurring, it is not felt to be sufficient to provide a suitable fishery without additional stocking. Mature kokanee snagged by fishermen in the fall were all aged as III+ and averaged 16.0 inches (range 13.7 - 18.4) and 1.28 pounds (range 0.70 - 1.97).

## Tiber Reservoir

Trends in the population of northern pike and walleye in Tiber Reservoir were monitored by trap nets during the spring of 1980. Both species were tagged, length measurements taken and random scale samples collected for age and growth. As in previous surveys, larger average northern pike were taken in the Bootlegger Trail area while larger average walleye were taken in the Willow Creek Arm (Table 5). Some of the fish (8 walleye, 4 pike) taken in the Willow Creek Arm in 1980 were recaptured 7 - 18 days later in the Bootlegger Trail area.

In the Willow Creek Arm during April 15 - 22, 1980, 35 trap days caught of total of 167 northern pike, 271 walleye, 18 burbot, 2 rainbow trout, 41 yellow perch, 360 white and longnose sucker, 11 carp and 19 black crappie.

An equal number of trap days in the Bootlegger Trail area from April 28 - May 5, 1980, caught 162 northern pike, 424 walleye, 22 burbot, 1 rainbow trout, 12 yellow perch, 83 white and longnose sucker, 17 carp and 2 black crappie. One soft-shelled turtle was also caught.

Table 5. Average length and number of northern pike and walleye tagged, Tiber Reservoir, 1980

| | Northern pike | | Walleye | |
|---|---|---|---|---|
| | No. Tagged | Length Range (Avg.) | No. Tagged | Length Range (Avg.) |
| Male: | | | | |
| Willow Creek Arm | 62 | 16.0-39.5(20.6) | 108 | 13.5-21.8(18.2) |
| Bootlegger Trail | 65 | 15.7-36.4(21.6) | 132 | 13.8-21.3(17.8) |
| Female: | | | | |
| Willow Creek Arm | 78 | 16.0-45.0(22.9) | 110 | 15.7-23.1(20.9) |
| Bootlegger Trail | 63 | 16.1-40.0(23.3) | 107 | 13.8-24.6(19.0) |
| Immature: | | | | |
| Willow Creek Arm | 3 | 14.8-15.5(15.2) | 4 | 14.2-16.8(15.4) |
| Bootlegger Trail | - | | 2 | 14.4-15.1(14.8) |

Of 329 northern pike taken in traps in 1980, 271 were tagged, 47 were recaptures (tagged in previous years) and 11 were small fish. The recaptures represent 6 fish tagged in 1977, 15 tagged in 1978, and 26 tagged in 1979.

During 1980, fishermen returned a total of 59 tags from northern pike representing tagging years 1976 through 1980. Table 6 presents tag returns on an accumulative precentage basis for the years 1977 through 1980. Refer to Progress Report F-5-R-29, Job I-a (Hill, 1980) for an explanation of lower case letters a to k in Table 6. When tag loss is included in the calculations, accumulative angler returns for northern pike range from 26.5 percent in 1977 to 9.6 percent in 1980. Although not shown in Table 6, one tag from the 1976 tagging year was returned during 1980, bringing the accumulative angler harvest to 17.0 percent for that year.

A total of 687 walleye were taken in traps in 1980. Of these, 464 were tagged, 28 were recaptures of fish tagged in previous years and 195 were small fish. Two recaptures were from walleye tagged in 1978 while 26 were tagged in 1979.

Table 7 gives a breakdown for walleye tag returns from 1977-80. Including tag loss, accumulative angler tag returns range from 100 percent in 1977 to 10.2 percent in 1980. A total of 46 walleye tags were returned by fishermen during 1980.

Tag loss is considerably higher for walleye than it is for northern pike. Walleye tag loss the first year ranges from 28.5 percent to 85.0 percent, and in some tagging years, has increased to 100 percent by the third year. Conversely, northern pike tag losses range from zero to 4.7 percent the first year, building to a high of 33.3 percent the third year, for one particular tagging year. A mistake was made in Progress Report F-5-R-29 in figuring percent tag loss. This error has been corrected and incorporated in this report in Tables 6 and 7.

Table 6. Accumulative tag returns for northern pike, Tiber Reservoir, 1977-1980

| Year Tagged | Year Returned | a Number Tagged | b Angler Returns | c a-b | d Percent Tag Loss | e Tags Lost | f c-e | g b+f | h Angler Harvest Annual(%) | i Angler Harvest Accum(%) | j Total Tags Removed Annual(%) | k Total Tags Removed Accum(%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1977 | 1977 | 595 | 56 | 539 | 4.4 | 24 | 515 | 571 | 56(9.8) | 56( 9.8) | 80(13.4) | 80(13.4) |
| | 1978 | 515 | 28 | 487 | 7.4 | 36 | 451 | 479 | 28(5.8) | 84(15.7) | 64(12.4) | 144(24.2) |
| | 1979 | 451 | 13 | 438 | 33.3 | 146 | 292 | 305 | 13(4.3) | 97(24.9) | 159(35.3) | 303(50.9) |
| | 1980 | 292 | 6 | 286 | 0.0 | 0 | 286 | 292 | 6(2.1) | 103(26.5) | 6( 2.1) | 309(51.9) |
| 1978 | 1978 | 405 | 36 | 369 | 4.7 | 17 | 352 | 388 | 36(9.3) | 36( 9.3) | 53(13.1) | 53(13.1) |
| | 1979 | 352 | 15 | 337 | 0.0 | 0 | 337 | 352 | 15(4.3) | 51(13.1) | 15( 4.3) | 68(16.8) |
| | 1980 | 337 | 8 | 329 | 0.0 | 0 | 329 | 337 | 8(2.4) | 59(15.2) | 8( 2.4) | 76(18.8) |
| 1979 | 1979 | 300 | 27 | 273 | 3.7 | 10 | 263 | 290 | 27(9.3) | 27( 9.3) | 37(12.3) | 37(12.3) |
| | 1980 | 263 | 19 | 244 | 0.0 | 0 | 244 | 263 | 19(7.2) | 46(15.9) | 19( 7.2) | 56(18.7) |
| 1980 | 1980 | 271 | 26 | 245 | 0.0 | 0 | 245 | 271 | 26(9.6) | 26( 9.6) | 26( 9.6) | 26( 9.6) |

Table 7. Accumulative tag returns for walleye, Tiber Reservoir, 1977-1980

| Year Tagged | Year Returned | a Number Tagged | b Angler Returns | c a-b | d Percent Tag Loss | e Tags Lost | f c-e | g b+f | h Angler Harvest Annual(%) | i Angler Harvest Accum((%) | j Total Tags Removed Annual(%) | k Total Tags Removed Accum(%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1977 | 1977 | 472 | 26 | 446 | 45.5 | 203 | 243 | 269 | 26( 9.7) | 26( 9.7) | 229(48.5) | 229(48.5) |
| | 1978 | 243 | 8 | 235 | 75.0 | 176 | 59 | 67 | 8(11.9) | 34(36.6) | 184(75.7) | 413(87.5) |
| | 1979 | 59 | 3 | 56 | 100.0 | 56 | 0 | 3 | 3(100.0) | 37(100.0) | 59(100.0) | 472(100.0 |
| | 1980 | 0 | 0 | Original tagged fish all caught or have lost tags | | | | | | | | |
| 1978 | 1978 | 508 | 45 | 463 | 85.0 | 394 | 69 | 114 | 45(39.5) | 45(39.5) | 439(86.4) | 439(86.4) |
| | 1979 | 69 | 6 | 63 | 85.7 | 54 | 9 | 15 | 6(40.0) | 51(85.0) | 60(87.0) | 499(98.2) |
| | 1980 | 9 | 1 | 8 | 66.7 | 5 | 3 | 4 | 1(25.0) | 52(94.5) | 6(66.7) | 505(99.4) |
| 1979 | 1979 | 500 | 42 | 458 | 51.9 | 238 | 220 | 262 | 42(16.0) | 42(16.0) | 280(56.0) | 280(56.0) |
| | 1980 | 220 | 10 | 210 | 60.0 | 126 | 84 | 94 | 10(10.6) | 52(38.2) | 136(61.8) | 416(83.2) |
| 1980 | 1980 | 464 | 35 | 429 | 28.5 | 122 | 307 | 342 | 35(10.2) | 35(10.2) | 157(33.8) | 157(33.8) |

Examination of Table 7 indicates that angler harvest of walleye is very high. It appears that fish tagged in a given year are essentially all harvested or have lost their tags by three years later, as shown by accumulative angler harvest for tagging years 1977 and 1978. Walleye are apparently quite vulnerable to hook and line.

Anglers returned most tags during May and June of 1980. This compares to previus years in which June accounts for the majority of the tagged fish being taken.

Table 8 compares the overall catch of fish in spring trap nets from 1973 to 1980. Increases were noted for yellow perch and sucker in 1980 while burbot and northern pike decreased. Walleye abundance remained approximately the same.

Table 8. Relative abundance of several species in Tiber Reservoir as determined by trap nets (spring sampling)

| Year | Fish per Trap Day | Total Catch | Trap Days | Percent of total catch | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | YP | Sucker* | Burbot | NP | WE | Rb | Other** |
| 1973 | 20.9 | 418 | 20 | 2.2 | 27.3 | 64.8 | 4.3 | - | 0.2 | 1.2 |
| 1974 | 34.7 | 1041 | 30 | 4.5 | 63.4 | 27.1 | 1.3 | 0.6 | 0.8 | 2.3 |
| 1975 | 39.8 | 1671 | 42 | 35.9 | 19.2 | 21.5 | 3.7 | 15.6 | 0.5 | 3.7 |
| 1976 | 53.3 | 2398 | 45 | 7.3 | 41.7 | 0.2 | 32.9 | 16.5 | 0.2 | 1.3 |
| 1977 | 33.7 | 2358 | 70 | 5.9 | 12.8 | 3.8 | 27.2 | 47.6 | 0.9 | 1.8 |
| 1978 | 55.0 | 1704 | 31 | 0.6 | 6.3 | 1.6 | 37.6 | 46.9 | 0.2 | 6.8 |
| 1979 | 24.6 | 1674 | 65 | 1.1 | 23.7 | 3.2 | 25.0 | 43.8 | 0.4 | 2.9 |
| 1980 | 23.1 | 1620 | 70 | 3.3 | 27.3 | 2.5 | 20.7 | 43.0 | 0.2 | 3.0 |

YP-yellow perch; NP-northern pike; WE-walleye; Rb-rainbow trout.

* Sucker - white and longnose.

** Others - carp, mountain whitefish, black crappie.

Analysis of scale samples reveal the northern pike and walleye growth rates are considered below average, with two year old fish averaging 17.6, and 10.1 inches, respectively. Growth of these two species, as well as burbot, is directly related to available forage fishes, mainly yellow perch. Forage fish numbers should increase once Tiber Reservoir is operated at higher elevations. Completion of spillway modifications and the raising of the dam will permit higher reservoir elevations starting in 1982. The Bureau of Reclamation has tentatively agreed to manipulate levels at this time. Considerable acreage of vegetation can be flooded and should produce abundant primary organisms, yellow perch and other forage fishes, as well as a strong year class of northern pike.

A total of 317 fish representing 9 species were taken in 16 gill nets on September 25 and 26, 1980 (Table 1). Table 9 compares the relative abundance of several species taken in fall gill net surveys. Percentages of yellow perch and sucker decreased in 1980 while northern pike increased slightly. Walleye increased the most with approximately 78 percent of the total taken being less than 16 inches. This large proportion of small fish reveals that walleye are adequately reproducing from the initial introductions made during 1971 through 1974.

Table 9. Relative abundance of several species in Tiber Reservoir as determined by gill nets (fall sampling)

| Year | Fish per Net | Total Catch | No. of Nets | Percent of Total Catch | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | YP | Sucker* | NP | WE | Rb | Others** |
| 1960 | - | 1054 | ? | - | 71.0 | - | - | 29.0 | - |
| 1961 | - | 331 | ? | - | 85.0 | - | - | 15.0 | - |
| 1968 | 53.7 | 1934 | 36 | 59.0 | 39.0 | - | - | 1.0 | 1.0 |
| 1971 | 38.0 | 380 | 10 | 78.2 | 16.3 | - | - | 2.4 | 3.2 |
| 1972 | 35.0 | 70 | 2 | 65.7 | 32.9 | - | - | - | 1.4 |
| 1973 | 26.2 | 367 | 14 | 17.7 | 64.9 | 0.5 | 9.8 | 4.6 | 2.5 |
| 1974 | 14.6 | 262 | 18 | 11.5 | 42.4 | 1.9 | 40.5 | 2.3 | 1.5 |
| 1975 | 31.6 | 284 | 9 | 17.6 | 31.4 | 22.9 | 20.4 | 4.9 | 2.8 |
| 1976 | 19.3 | 308 | 16 | 9.7 | 19.8 | 17.2 | 52.3 | 0.3 | 0.6 |
| 1977 | 28.7 | 344 | 12 | 8.1 | 16.2 | 7.0 | 66.9 | 0.3 | 1.5 |
| 1978 | 16.2 | 259 | 16 | 4.2 | 26.2 | 9.7 | 56.0 | 1.9 | 1.5 |
| 1979 | 13.6 | 231 | 17 | 20.8 | 32.0 | 10.4 | 33.3 | 2.6 | 0.8 |
| 1980 | 19.8 | 317 | 16 | 15.8 | 21.8 | 11.4 | 48.9 | 1.3 | 0.9 |

YP-yellow perch; NP-northern pike; WE-walleye; Rb-rainbow trout;

* Sucker - white and longnose.

** Others - Carp, mountain whitefish, burbot, lake trout, shovelnose sturgeon.

Small mesh trap nets were also fished during the September survey to sample forage fishes and reproduction of crappie that were introduced in May of 1979. Eight trap nets caught the following young-of-the-year fish: 6 carp, 3 white sucker, 32 emerald shiner, 24 lake chub and 8 yellow perch. Nine young-of-the-year crappie were also collected, some in the Willow Creek Arm and some in the Bootlegger Trail areas of the reservoir.

## Newlan Creek Reservoir

This reservoir is located on Newlan Creek about seven miles north of White Sulphur Springs. Constructed under authority of PL 566, the dam was completed in 1976. The reservoir was to serve as a multiple-purpose facility providing supplemental water for downstream irrigation, flood control, fish and wildlife benefits and general recreation purposes. Due to funding shortage and water rights disputes, the irrigation system was not constructed.

The dam is an earthfill structure faced with rip-rap and contains a concrete overflow spillway. At normal operational levels, the reservoir is about 300 surface acres with water storage of about 12,000 acre-feet. The reservoir is approximately 2½ miles long with a maximum depth of about 100 feet.

Trout were first stocked when the reservoir started filling in 1976. Most of the water was drained from the reservoir in the spring of 1977 when a seepage problem occurred along the south abutment of the dam. After this problem was repaired, the reservoir was filled and water levels have remained constant to the present time.

Trout planting and gill net survey data since 1976 is presented in Table 10. The initial fertility of the reservoir was lost when the water was drained, however, growth rates of trout were still good. Brook trout inhabiting the inundated stream within the reservoir area made up a considerable portion of the fishery in 1978 and 1979. Yellowstone cutthroat trout were introduced in 1976, 1978 and 1979. These trout grew considerable slower than rainbow trout, but did contribute considerably to the lake fishery.

Newlan Creek Reservoir has become a popular recreation and fishing area. It was noted that anglers came considerable distances regularly to fish. Over 300 anglers were observed using the lake over two, three-day holidays in 1980.

Table 10. Summary of trout stocking and gill net surveys in Newlan Creek Reservoir

| Year | Stocking Records Species | Stocking Records Number | Gill Netting Records[1] Species | Number | Length Range (Average) | Weight Range (Average) |
|---|---|---|---|---|---|---|
| 1976 | Rb[2] | 4,300 | | | | |
| | Ct | 4,400 | | | | |
| 1977 | Rb | 24,950 | | | | |
| 1978[3] | Rb | 35,000 | Rb | 46 | 6.9-11.8(10.1) | 0.16-0.69(0.45) |
| | Ct | 21,600 | Rb | 14 | 13.5-16.1(14.5) | 0.86-1.74(1.21) |
| | | | Eb | 1 | 15.0 | 1.03 |
| | | | LnSu | 2 | | |
| 1979[4] | Rb | 25,100 | Rb | 8 | 7.1- 8.0( 7.5) | 0.16-0.20(0.18) |
| | Ct | 28,000 | Rb | 42 | 10.1-14.4(12.2) | 0.43-1.05(0.74) |
| | | | Ct | 17 | 6.0- 8.9( 6.9) | 0.08-0.25(0.12) |
| | | | Eb | 29 | 7.7-14.6(11.1) | 0.19-1.68(0.68) |
| | | | LnSu | 6 | | |
| 1980[3] | Rb | 25,000 | Rb | 17 | 7.3-10.8( 9.7) | 0.17-0.48(0.39) |
| | | | Rb | 9 | 12.4-15.6(13.7) | 0.71-1.66(1.04) |
| | | | Ct | 31 | 8.9-14.4(12.9) | 0.24-1.00(0.76) |
| | | | Eb | 3 | 10.7-12.6(11.5) | 0.45-0.88(0.62) |
| | | | LnSu | 24 | | |

1/ Two 125' experimental gill nets.

2/ Abbreviations: Rb-rainbow trout; Ct-cutthroat trout; Eb-brook trout; LnSu-longnose sucker.

3/ October sampling.

4/ July sampling.

## Small Lakes and Farm Ponds

Gill nets were fished in Kiyo and Fitzpatrick Lakes to determine abundance and growth rates (Table 11). Beavers have dammed the inlets of Kiyo Lake and apparently are limiting natural reproduction as indicated by only large fish being collected. Growth continues to be very good in Fitzpatrick Lake. An algae bloom in Furnell Pond was reported in late July. Oxygen samples and temperature profiles taken on August 5, 1980, were adequate. Trout were not collected or observed.

Table 11. Gill net survey of small lakes and farm ponds, 1980

| Lake (Date) | Species* | No. of Fish | Length Range (Average) | Weight Range (Average) |
|---|---|---|---|---|
| Fitzpatrick Lake (10/6) | Rb | 34 | 10.3-13.2(11.7) | 0.55-1.14(0.74) |
| | | 4 | 15.0-18.4(17.2) | 1.84-2.70(2.46) |
| | | 1 | 22.4 | 5.20 |
| Kiyo Lake (7/30) | YCt | 4 | 16.1-18.0(16.8) | 1.82-3.20(2.40) |
| Priest Butte Lake (11/6) | WSu | 31 | | |

* Rb-rainbow trout; YCt-yellowstone cutthroat trout; WSu-white sucker.

Two waters were surveyed for fishery potential. A mountain lake below Walling Reef was considered too marginal for fish as the surface acreage is too small and of insufficient depth. Ostle Reservoir on the newly acquired Blackleaf Game Range covers approximately 30 acres and has a maximum depth of 10 feet. Rainbow trout have survived in this reservoir in the past but the spillway needs repair and a new outlet structure is needed.

Other waters surveyed include Priest Butte Lake and Freezout Lake. Introductions of yellow perch and/or largemouth bass and black crappie have been proposed for Priest Butte Lake (Hill, 1980). Gill nets fished in Priest Butte Lake (11/6/80) collected only white sucker while small mesh trap nets collected lake chub and white sucker. Small mesh trap nets in Freezout Lake (6/26/80) caught yellow perch, fathead minnow, brassy minnow and lake chub. Freezout Lake drains into Priest Butte Lake and a man-made drain flows from Priest Butte Lake into the Teton River.

## Streams

The Teton River below Choteau, Sun River near Vaughn, Muddy Creek and tributaries upstream from Gordon were electrofished and the Pine Butte Swamp was sampled by hook and line (Table 12). These surveys were conducted to update management files. Data from the Teton and Sun Rivers and the Muddy Creek Drainage may be important if the Muddy Creek restoration project becomes a reality. The Pine Butte Swamp is a unique area as it is characterized by underground streams, isolated pools and beaver dams.

Table 12. Streams sampled by electrofishing and hook and line, 1980-81

| Stream (Date) | Species | No. of Fish | Length Range (Average) | Weight Range (Average) |
|---|---|---|---|---|
| Teton River (10/8) (above Priest Butte Lake discharge) | Rb | 1 | 8.5 | 0.22 |
| | | 2 | 16.3-17.5(16.9) | 1.50-2.13(1.82) |
| | LL | 26 | 3.7- 6.0( 5.0) | |
| | | 22 | 7.8-12.5(10.1) | 0.16-0.78(0.41) |
| | | 5 | 13.9-16.1(15.3) | 1.31-1.70(1.50) |
| | | 15 | 18.2-22.4(20.0) | 2.34-3.88(2.98) |
| | Wf | 1 | 14.5 | 1.19 |
| | | 1 | 18.1 | 2.30 |
| (below Priest Butte Lake discharge) | Rb | 5 | 9.8-11.7(10.7) | 0.40-0.63(0.53) |
| | | 2 | 16.2-18.5(17.4) | 1.72-2.52(2.12) |
| | LL | 14 | 4.0- 5.5( 5.0) | |
| | | 27 | 8.2-12.5(10.2) | 0.24-0.71(0.45) |
| | | 2 | 14.0-14.1(14.1) | 1.03-1.04(1.04) |
| | | 12 | 17.0-20.8(19.4) | 1.84-3.39(2.63) |
| | Wf | 1 | 6.1 | 0.09 |
| | | 13 | 12.4-14.5(13.3) | 0.74-1.12(0.84) |
| | | 3 | 16.6-16.8(16.7) | 1.75-1.85(1.81) |
| | | 17 | 18.3-20.6(19.2) | 2.42-3.28(2.72) |
| Sun River (3/11/81) (above Muddy Creek) | Rb | 2 | 10.7-16.1(13.4) | 0.57-1.50(1.04) |
| | LL | 6 | 9.6-11.7(10.9) | 0.30-0.61(0.49) |
| | LL | 3 | 14.5-20.8(18.2) | 1.06-3.12(2.12) |
| | NP | 1 | 33.1 | 10.00 |
| | Carp, Wf, LnSu, WSu | | | |
| (below Muddy Creek) | Rb | 1 | 7.6 | 0.19 |
| | LL | 1 | 9.8 | 0.38 |
| | LL | 9 | 13.2-21.2(15.7) | 0.92-3.00(1.43) |
| | Ling | 1 | 28.5 | 3.00 |
| | Carp, Wf, LnSu, WSu | | | |
| Muddy Creek (3/13/81) T22N,R2W, NW¼ 5 | Rb | 2 | 11.9-13.7(12.8) | 0.74-1.00(0.87) |
| | WSu, F. chub, L chub, Ln Dace, B. minnow, Minnow sp. | | | |
| T22N,R1W, SE¼ 3 | L chub, WSu, LnSu, Mt Su, Sculpin, Minnow sp. | | | |
| T22N,T22N,R1E, NE¼ 32 | LL | 2 | 10.8-19.7 | 0.44-3.02 |
| | Wf | 1 | 13.0 | 0.90 |
| | LnSu, Sculpin | | | |

Table 12. Continued.

| Stream (Date) | Species | No. of Fish | Length Range (Average) | Weight Range (Average) |
|---|---|---|---|---|
| Muddy Creek Tributaries (3/13/81) | | | | |
| T23N,R2W, SE¼ 36 | Sculpin, Ln Dace, L. chub, WSu | | | |
| T22N,R1W, SW¼ 11 | Rb | 3 | 11.2-13.8(12.2) | 0.62-1.25(0.83) |
| T22N,R1W, NW¼ 14 | Eb | 1 | 6.3 | (0.09) |
| | Mt Su, Ln Dace, Sculpin, L. Chub | | | |
| Pine Butte Swamp (10/10) | Eb | 1 | 5.5 | |
| | | 8 | 8.2-10.1( 8.9) | 0.20-0.43(0.28) |
| | | 2 | 11.8-12.6(12.2) | 0.69-0.74(0.72) |

Rb-rainbow trout; LL-brown trout; Wf-mountain whitefish; NP-northern pike; LnSu-longnose sucker; WSu-white sucker; Ling-burbot; F chub- flathead chub; L chub-lake chub; Ln Dace-longnose dace; B minnow-brassy minnow; Mt Su-mountain sucker.

Habitat Study - Teton River

Investigations continued on two sections of the Teton River west of Choteau to measure differences in fish populations and stream stability where debris was removed or left intact. Brook trout estimates (Table 13) were made in these sections during May. Section II, where debris was left, continues to have greater numbers and pounds per acre than Section I. Standing crop per acre in Section I has steadily decreased for both number and weight since the study began in 1978. In Section II, numbers have also decreased but not as dramatically. Weight estimates decreased from 1978 to 1979 and then increased slightly in 1980. This portion of the river is characterized by fluctuating flows (due to irrigation withdrawals), low productivity and unstable river gravels.

The Teton River has changed little since the 1975 flood, mainly because there has been little runoff. No detectable erosion has taken place. There has been an increase in the number of pools in Section II; 60 in 1977 compared to 74 in 1980. Pools in Section I decreased slightly from 61 to 58. The increase in Section II is attributed to the debris piles having a tendency to deflect the current, thereby creating new pools. Willows, sweetclover and other vegetation is re-establishing in the flood damaged areas.

Future surveys of fish populations and river stability will be scheduled only after significant runoff to determine any changes. However, these parameters will be investigated in 1985 even if no significant changes in habitat occur.

Table 13. Physical and biological characteristics of two sections of the Teton River, May, 1980

| | | Length (ft.) | Avg. Width (ft) | Area (acres) |
|---|---|---|---|---|
| Section I | (Debris removed) | 6,420 | 36.4(range 23-49) | 5.4 |
| Section II | (Debris intact) | 5,170 | 25.6(range 14-43) | 3.0 |

Brook Trout Estimates

| Section I | | | | Section II | | | |
|---|---|---|---|---|---|---|---|
| Length Group (inches) | Avg. Length (inches) | Number Estimate | Weight Estimate (pounds) | Length Group (inches) | Avg. Length (inches) | Number Estimate | Weight Estimate (pounds) |
| 3.1- 4.9 | 4.2 | 141 | 4 | 2.9- 4.9 | 4.2 | 273 | 7 |
| 5.0- 6.9 | 6.0 | 69 | 5 | 5.0- 6.9 | 5.9 | 79 | 5 |
| 7.0-11.1 | 8.6 | 41 | 10 | 7.0-10.3 | 8.5 | 45 | 11 |
| Totals | | 251 | 19 | | | 397 | 23 |
| | | Number | Weight | | | Number | Weight |
| Standing crop/1000 ft. 1980 | | 39 | 3.0 | | | 77 | 4.5 |
| Standing crop/acre 1980 | | 46 | 3.5 | | | 132 | 7.7 |
| Standing crop/acre 1979 | | 74 | 4.8 | | | 144 | 7.3 |
| Standing crop/acre 1978 | | 137 | 5.6 | | | 250 | 11.0 |

## Smith River

Trout population estimates were conducted in two river sections in early September, 1980. Results are presented in Tables 14 and 15.

Rainbow trout estimates in the Access Section were comparable to those in 1978 and had increased about 12 and 40 percent by numbers and weight respectively when compared to 1979 estimates. Brown trout decreased about 32 and 37 percent by number and weight respectively from 1978 estimates. Too few brown trout were collected in 1979 for an estimate.

Table 14. Trout population estimates from Access Section, Smith River, 1980

| Species | Age | Length(inches) Range | Length(inches) Average | Number | Weight (Pounds) |
|---|---|---|---|---|---|
| Rainbow trout | I | 7.5- 9.9 | 8.8 | 28 | 7.66 |
| | II | 8.7-12.6 | 10.5 | 152 | 66.68 |
| | III & older | 9.7-15.5 | 12.1 | 240 | 157.98 |
| | | | | 420±75 | 232.32±39 |
| Brown trout | I | 7.9-12.2 | 9.9 | 47 | 17.36 |
| | II | 11.5-12.7 | 12.3 | 25 | 17.87 |
| | III & older | 13.9-20.7 | 16.4 | 60 | 101.22 |
| | | | | 132±43 | 136.45±45 |
| Grand total | | | | 552 | 368.77 |
| Standing crop/1,000 feet | | | | 53 | 35.46 |
| Standing crop/acre | | | | 46 | 30.99 |

Table 15. Trout population estimates from Zieg Section, Smith River, 1980

| Species | Age | Length(inches) Range | Length(inches) Average | Number | Weight (pounds) |
|---|---|---|---|---|---|
| Rainbow trout | I | 6.2- 8.6 | 7.7 | 553 | 96.86 |
| | II | 8.2-11.1 | 9.8 | 863 | 298.96 |
| | III & older | 9.1-15.0 | 11.3 | 903 | 474.80 |
| | | | | 2319±291 | 870.62±111 |
| Brown Trout | I | 7.3-10.8 | 8.9 | 87 | 22.71 |
| | II | 9.4-14.5 | 12.4 | 32 | 25.17 |
| | III | 13.9-17.6 | 16.2 | 27 | 43.59 |
| | IV & older | 16.1-21.2 | 17.8 | 14 | 27.41 |
| | | | | 160±55 | 118.88±46 |
| Grand Total | | | | 2479 | 989.50 |
| Standing crop/1,000 feet | | | | 230 | 92.05 |
| Standing crop/acre | | | | 118 | 47.28 |

The number of rainbow trout estimated in the Zieg Section was down slightly from 1979 but their overall weight increased about 18 percent. The weight on rainbow trout is higher than any of the estimates made in this section since 1969. Brown trout numbers remain at relatively low numbers in this section although the greatest number of yearlings were estimated since population studies started in 1969.

An attempt to estimate trout populations was made in a 13,000-foot section of the lower Smith River near the mouth of Hound Creek. Too few trout were captured for an estimate. This portion of the Smith River contains several deep pools but the river channel is quite unstable due to past rechanneling practices. A total of 65 brown trout and 17 rainbow trout yearling and older in age were collected. Some young-of-the-year brown trout were also observed.

## Smith River Flow Requirements

The Montana Department of Fish, Wildlife and Parks, under provisions of an act passed by the 1969 Legislature, filed for instream water rights for purposes of preserving fish and wildlife habitat in a 72 mile reach of the Smith River between the confluence of Hound Creek and the Fort Logan Bridge. For the 33 mile reach in Cascade County, the Department filed on December 17, 1970 for 400 cfs from April 1 to August 31 and 150 cfs from September 1 to March 31. For the 39 mile reach in Meagher County, the Department filed on December 22, 1970 for 150 cfs from April 1 to August 31 and 125 cfs from September 1 to March 31.

The 1973 State Legislature basically changed the water law of Montana by adopting the Montana Water Use Act. This act recognizes and confirms all existing rights to the use of any waters for any useful or beneficial purpose. The Department filings on instream reservations were recognized as valid rights, however, the Board of Natural Resources could appropriate water from reservations. In February of 1976, the Board of Natural Resources adopted Water Reservation Rules. These rules state that Montana must be responsive to the need for maintaining stream flows for the protection of existing water rights, aquatic life and water quality, and for establishing options for future consumptive and non-consumptive uses of Montana's water resources.

The 1979 Montana Legislature passed Senate Bill 76, which amends the Montana Water Use Act to expedite and facilitate the adjudication of existing water rights. Provisions of Senate Bill 76 state all holders of water rights in existence or claimed prior to July 1, 1973, must refile claims with the Department of Natural Resources and Conservation by January 1, 1982. If a right is not reclaimed, then abandonment is assumed under the law. The passage of SB 76 lends urgency to the quantification of instream filed rights.

Two methodologies were used to quantify instream flows on the Smith River. These were the dominant discharge/channel morphology concept for the high flow period and the wetted perimeter concept for low flow periods. The dominant discharge concept is described by Leopold, Wolman and Miller, 1964, U. S. Bureau of Reclamation 1973, and Emmett 1972 and 1975. Guidelines for using the wetted perimeter program were described by Nelson, 1980.

To properly quantify flows in the Smith River, the instream filing in Meagher County was divided into two river sections because of water availability. Following are the quantified flow claims submitted to the Department of Natural Resources as required by S.B. 76:

| Stream Reach | Time Period | Amount (cfs) |
|---|---|---|
| Confluence of Hound Creek to Cascade County Line | May 1 to May 15 | 372 |
| | May 16 to June 15 | 400 |
| | June 16 to June 30 | 398 |
| | July 1 to April 30 | 150 |
| Cascade-Meagher County line to confluence of Sheep Creek | April 1 to April 30 | 140 |
| | May 1 to June 30 | 150 |
| | July 1 to Aug. 30 | 140 |
| | Sept. 1 to March 31 | 125 |
| Confluence of Sheep Creek to Fort Logan Bridge | May 1 to June 30 | 150 |
| | July 1 to April 30 | 90 |

High flow recommendations often exceed the amounts filed on above, however, constraints were imposed by the original instream filings made in December, 1970. The final claims could be less than, but not exceed, the original filings. Future fish population surveys will be conducted to help firm up these flow recommendations.

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Prepared by: William J. Hill and Alfred H. Wipperman

Date: Jan 20, 1982

Code numbers of waters referred to in this report are:

| | |
|---|---|
| 14-4040 | North Fork Willow Creek (Pine Butte Swamp) |
| 14-6000 | Teton River Sec. 01 |
| 14-6040 | Teton River Sec. 02 |
| 14-7080 | Bynum Reservoir |
| 14-7320 | Eureka Reservoir |
| 14-7370 | Fitzpatrick Lake |
| 14-7440 | Lake Frances |
| 14-7445 | Freezout Lake |
| 14-7450 | Furnell Pond |
| 14-8000 | Kiyo Lake |
| 14-8420 | Ostle Reservoir |
| 14-8540 | Priest Butte Lake |
| 14-9240 | Tiber Reservoir |
| 17-6832 | Smith River |
| 17-8720 | Bean Lake |
| 17-9330 | Newlan Creek Reservoir |
| 20-0750 | Muddy Creek |
| 20-6050 | Sun River Sec. 01 |
| 20-6100 | Sun River Sec. 02 |
| 20-7900 | Nilan Reservoir |
| 20-7950 | Pishkun Reservoir |
| 20-8500 | Willow Creek Reservoir |

Key Words:

Trout, Rainbow - growth
Trout, Rainbow - longevity

Population survey

Pike, northern - tagging returns
Walleye - tagging returns

Stream - Habitat change
Fish Management - walleye
Instream flow needs

MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS

FISHERIES DIVISION

JOB PROGRESS REPORT

State: Montana

Project No.: F-5-R-30

Job No.: I-b

Title: Northcentral Montana Fisheries Study

Title: Inventory and Survey of Waters in the Eastern Half of Region Four

Period Covered: July 1, 1980 through June 30, 1981

ABSTRACT

Netting surveys were conducted on 6 large reservoirs and 12 farm ponds located within the study area. Eight BLM reservoirs and 9 farm ponds were investigated for fisheries potential. Streambed stabilization projects and habitat conditions were monitered and documented along Big Spring Creek and its tributaries. Invertebrate bottom samples were collected at the nine established stations along the stream and its tributaries. Trout population estimates were made in two sections of Big Spring Creek. Flow requirements for maintaining the aquatic community in Big Spring Creek were determined for two locations by correlating discharge measurements with stream cross-section profile measurements. Limited sampling was done on the Missouri River, Louse Creek and the Lost Fork of the Judith River. Erosion transects were measured and photographed along the Lost Fork.

OBJECTIVES AND DEGREE OF ATTAINMENT

The objectives of this job were:

1. To obtain information on present management, survival and growth of rainbow trout, cutthroat trout, kokanee and largemouth bass in six reservoirs and twelve farm ponds. This work was done and the findings are included.

2. To survey new ponds for possible addition to our management program. This work was done.

3. To moniter habitat changes and rainbow trout and brown trout populations in Big Spring Creek. This work was done for two stream sections and the findings are included.

4. To determine survival of fingerling rainbow trout stocked in a section of Big Spring Creek. This work was done and the findings are included.

5. To determine the effect of land management practices on stream habitat along the Lost Fork of the Judith River. This work was done and the findings are included.

6. To determine flow requirements for maintaining aquatic life in Big Spring Creek. This work was done, however, the data and recommendations will be included in F-5-R-31, Job I-b, next year.

## PROCEDURES

Fish were sampled with sinking and floating nylon gill nets 125-foot by 6-foot (with graduated mesh sizes from 3/4- to 2-inch); 4-foot by 6-foot frame trap nets (1/2- and 1-inch mesh); 3- by 4-foot frame trap nets (1/4-inch mesh); a 300 volt D.C. electrofish shocker; a 0-500 variable voltage D.C. electrofish shocker; and by hook and line. Fish captured were measured to the nearest tenth of an inch (total length) and weighed to the nearest hundredth of a pound. Scales were collected for growth analysis. Occasional creel census and fisherman interviews were employed to check harvest, fishing pressure, and success of trout stocking in the more important reservoirs and streams. Invertebrate bottom samples were collected with a Surber Sampler. Population estimates for Big Spring Creek were made using the mark and recapture method described by Vincent (1971 and 1974). Erosion and habitat changes were measured from established transects and photo points. Determining flow requirements for maintaining aquatic life in Big Spring Creek was done through correlating discharge measurements with stream cross-section measurements by using the wetted perimeter computer program (Nelson 1980).

## ACCOMPLISHMENTS

### Large Reservoirs

Six of the seven larger Department of Natural Resources reservoirs located within the study area were sampled during 1980 and 1981. The results of this work are given in Table 1. War Horse Reservoir was not sampled because the water level was so low that it was not possible to launch a boat. Heavy rains during May of 1981 filled the lake enough so that it can probably be sampled in the fall of 1981. Netting should be done to check on the success of a perch introduction in 1980.

Severe drought conditions in the eastern part of the study area coupled with heavy irrigation demand resulted in very low water levels in Yellow Water and Petrolia Reservoirs. In addition, Petrolia was drained to dead storage capacity in the fall of 1980 to inspect the irrigation outlet structure. Netting in the spring of 1981 confirmed that most of the rough fish population along with the walleye population was flushed from the lake into the stream below. Rainbow trout were planted in the reservoir after it filled in June of 1981 and may provide good fishing until the carp and sucker populations build up again.

Table 1. Summary of netting data from large lakes and reservoirs, 1979-80

| Location (Date Sampled) | Surface Acres | No. & Type of Net | Species | No. of Fish | Length Range Inches (Average) | Weight Range Pounds (Average) |
|---|---|---|---|---|---|---|
| Ackley Lake May 18-19, 1981 | 247 | 2 Gill | Rb | 11 | 10.0-11.2(10.7) | 0.33-0.44(0.38) |
| | | | KOK | 22 | 7.3-14.1(11.9) | 0.10-0.92(0.61) |
| | | | FSu | 47 | - | - |
| | | | CSu | 85 | - | - |
| | | 1 Trap | CSu | 1081 | - | - |
| | | | FSu | 147 | - | - |
| | | | Rb | 1 | 10.5 | 0.35 |
| Bair Reservoir (Sept. 17-18, 1980) | 272 | 2 Gill | Rb | 14 | 8.6-12.6(10.6) | 0.21-0.71(0.38) |
| | | | Eb | 11 | 7.6-11.5( 9.4) | 0.12-0.49(0.24) |
| | | | CSu | 287 | - | - |
| Petrolia Res. (Oct. 20-24, 1980) | 515 | 5 Trap | WE | 53 | 9.0-29.2(11.8) | 0.18-9.32(0.63) |
| | | | YP | 2 | 10.0-10.5(10.3) | 0.45-0.48(0.47) |
| | | | Ling | 1 | 15.7 | 0.54 |
| | | | LL | 2 | 15.1-15.7(15.4) | 1.10-1.32(1.21) |
| | | | CSu | 170 | - | - |
| | | | Carp | 35 | - | - |
| | | | FSu | 2 | - | - |
| Apr. 23-28, 1981 | | 5 Trap | WE | 3 | 10.4-12.6(11.4) | 0.26-0.49(0.36) |
| | | | YP | 1 | 8.3 | 0.22 |
| | | | CSu | 46 | - | - |
| | | | Carp | 9 | - | - |
| Martinsdale Res. Sept. 18-19, 1980 | 1000 | 2 Gill | Rb | 53 | 10.2-15.1(12.2) | 0.40-1.28(0.78) |
| | | | LL | 1 | 19.0 | 2.44 |
| | | | CSu | 10 | - | - |
| | | | FSu | 3 | - | - |
| Smith River Res. Sept. 17-18, 1980 | 327 | 2 Gill | Rb | 16 | 10.0-15.0(13.7) | 0.36-1.09(0.77) |
| | | | Eb | 2 | 10.4-11.0(10.7) | 0.38-0.40(0.39) |
| | | | Ling | 1 | 12.9 | 0.31 |
| | | | FSu | 54 | - | - |
| | | | CSu | 83 | - | - |
| Yellow Water Res. (May 5-11, 1981) | 600 | 2 Trap | Rb | 3 | 17.7-19.8(18.5) | 2.00-3.30(2.53) |
| | | | CSu | 896 | - | - |
| | | | Carp | 2 | - | - |

Species Abbreviations: Rb-rainbow trout; LL-brown trout; Eb-brook trout; KOK-kokanee; CSu-white sucker; FSu-longnose sucker; WE-walleye; YP-yellow perch; Ling-Burbot

## Farm Ponds

Twelve farm ponds and small reservoirs stocked by the Department were netted during the report period and the results are given in Table 2. Eight BLM reservoirs and nine private ponds were checked to determine their fisheries potential. Water levels were low in most local reservoirs and ponds because of a dry summer and fall. Winter losses in the trout ponds were minimal because of the mild weather and lack of snow. A number of ponds along the northern and eastern portions of the project area were dry or water levels were too low for fish to survive. Some of these ponds contained bass, perch and crappie populations, which were lost. In some areas, most ponds filled with runoff from heavy rains during May of 1981, but other areas had very little runoff and water levels remain critical.

Table 2. Results of sampling ponds and reservoirs, 1980-1981

| Pond (Year) | No. of Nets | Species | No. of Fish | Length Range Inches (Average) | Weight Range Pounds (Average) |
|---|---|---|---|---|---|
| Breaks Pond (1981) | 1 | NP | 1 | 28.7 | 5.63 |
| Buffalo Wallow (1980) | 1 | Rb | 1 | 15.0 | 1.66 |
| C-1 (1981) | 1 | Rb | 16 | 8.6-16.6(13.0) | 0.28-1.77(0.98) |
| East Fork Res. (1980) | 2 | Rb | 1 | 11.9 | 0.48 |
| | | CSu | 27 | -- | -- |
| | | FSu | 2 | -- | -- |
| Holgate Res. (1981) | 1 | Rb | 3 | 9.8-12.0(10.6) | 0.30-0.52(0.38) |
| | | Eb | 3 | 8.5-11.4(10.1) | 0.29-0.50(0.42) |
| | | CSu | 37 | -- | -- |
| Holland Res. (1980) | 1 | Rb | 1 | 15.0 | 1.38 |
| Jakes Dam (1981) | 1 | YP | 1 | 6.6 | 0.27 |
| Knutson Res. (1981) | 1 | 0 | 0 | -- | -- |
| Kingsbury Res. (1981) | 1 | Rb | 24 | 11.7-17.3(14.6) | 0.70-2.14(1.39) |
| Ridgeway Res. (1981) | 1 | Rb | 19 | 11.0-13.4(12.3) | 0.50-0.90(0.72) |
| Senef Res. (1981) | 1 | Rb | 25 | 9.1-12.4(10.8) | 0.26-0.65(0.45) |
| Urs Res. (1981) | 1 | 0 | 0 | -- | -- |

Species abbreviations: Rb-rainbow trout; Eb-brook trout; CSu-white sucker; NP-northern pike; FSu-longnose sucker; YP-yellow perch

## Streams

Big Spring Creek - Flows in Big Spring Creek during the report period were below normal during 1980 because of reduced mountain snow pack and below average rainfall. The same was true for 1981 with a mild winter, very little snowpack and a dry spring until May, when heavy rains filled the watershed dams. Big Spring Creek ran bank-full for nearly a month as the dams drained down. Peak flows through Lewistown were around 1,100 cfs. Erosion rates and habitat destruction within the upper watershed were not too severe. Several years of low flows had allowed the stream channel, banks and riparian vegetation in some areas to heal and stabilize to some degree. These factors coupled with a number of stream stabilization projects combined to help minimize erosion and sedimentation. Erosion and habitat destruction along lower Spring Creek, below the confluence of Cottonwood Creek, was much more pronounced. High flows coupled with old channel alterations and unstable banks contributed to the problem.

Naturally occurring stream channel stabilization processes are very evident throughout much of the watershed downstream from Lewistown. These processes are very evident even at normal and below normal stream flows. Habitat changes were monitered and documented with photos and measurements. The photos are used to update our erosion slide series which documents the effects of stream channelization.

Invertebrate bottom samples were collected at the nine established stations located along Big Spring Creek and its tributaries and the results are given in Table 3. The total number of invertebrates collected from all the sampling sites in 1980 combined (9,488) was the highest total collected during the twelve years the samples have been gathered. High invertebrate numbers is a reflection of the stable stream flows Big Spring Creek has had for the past several years. Lower than normal mountain snowpack and limited spring rains over the last two years have resulted in moderate to low stream discharge. It appears that the flushing and scouring action of high flows, particularly in the spring, is the primary limiting factor for invertebrate populations.

Trout population estimates were made in two sections of Big Spring Creek during the fall of 1980. The results of population estimates for 1979 and 1980 are summarized in Table 4.

Because of a gradual decline in the rainbow trout population in Section B, a study was started in 1979 to determine if the problem was related to spawning success and recruitment. Twenty-thousand 4-6 inch rainbow trout were dye marked and planted in and near the section in 1979. Mark retention has proved to be a major problem due to the erosive action of flowing water. During the 1980 electrofishing runs, only two dye marked fish were taken although a number of fish judged to be of hatchery origin were handled. In order to continue the study, an additional 20,000 marked fish will be stocked in the same area during July of 1981. These fish will be marked with an adipose fin clip instead of fluorescent dye.

Table 3. Number and families of organisms collected in two one-square foot bottom samples from nine stations on Big Spring Creek and East Fork on July 28 and 29

| Organism | Hatchery | East Fork | Burleigh's | Montana Power | St. Leo's School | Above Sewer | Below Sewer | Trestle | Spring Cr. Colony |
|---|---|---|---|---|---|---|---|---|---|
| Trichoptera | | | | | | | | | |
| Limnephilidae | | | | | | | | | 95 |
| Brachycentridae | 604 | 42 | 437 | 611 | 405 | 313 | 24 | 101 | 7 |
| Leptoceridae | 344 | | 492 | 98 | 10 | 35 | 4 | 19 | 2 |
| Rhyacophilidae | 57 | 2 | 128 | 133 | 112 | 54 | 22 | 327 | 44 |
| Hydropsychidae | | | 1 | 39 | 3 | 87 | 1 | 69 | 724 |
| Hydroptilidae | | 69 | | 57 | 27 | 31 | | 1 | 40 |
| Psychomyiidae | | | | 1 | | 1 | | | |
| Helicopsychidae | | | | | | | | 2 | |
| Gastropoda | | | | | | | | | |
| Planorbidae | | 38 | 3 | | 2 | | | 1 | 1 |
| Physidae | 5 | 2 | 2 | 1 | 1 | 9 | 31 | 24 | 1 |
| Diptera | | | | | | | | | |
| Ephydridae | | | | | | | | | |
| Tipulidae | 19 | 79 | 43 | 467 | 100 | 354 | 44 | 88 | 62 |
| Tendipedidae | 44 | 24 | 8 | 96 | 53 | 261 | 263 | 40 | 242 |
| Rhagionidae | 1 | 25 | 1 | | | | | 1 | 2 |
| Empididae | 1 | | | 1 | 2 | 2 | | | |
| Simuliidae | | 1 | | 69 | 3 | 13 | 1 | | 92 |
| Tabanidae | | 1 | | | | | | | |
| Tricladida | | | | | | | | | |
| Planariidae | 7 | 1 | 2 | | | 5 | 12 | 4 | |
| Ephemeroptera | | | | | | | | | |
| Baetidae | 30 | 37 | 20 | 155 | 44 | 103 | 94 | 126 | 195 |
| Hertageniidae | 1 | | 4 | 2 | 1 | 1 | 2 | 8 | 3 |

σ

Table 3. Continued.

| Organism | Hatchery | East Fork | Burleigh's | Montana Power | St. Leo's School | Above Sewer | Below Sewer | Trestle | Spring Cr. Colony |
|---|---|---|---|---|---|---|---|---|---|
| Plecoptera | | | | | | | | | |
| Perlodidae | | | 8 | 7 | | 4 | 3 | 5 | 11 |
| Chloroperlidae | | | | | | | | | |
| Perlidae | | | 1 | 2 | | 2 | 1 | | 1 |
| Nemouridae | | | | 4 | | | | | |
| Annelida | | | | | | | | | |
| Oligochaeta | 3 | | | | 2 | | 14 | | |
| Pelecypoda | | | | | | | | | |
| Sphaeriidae | | | 3 | | | | | | |
| Coleoptera | | | | | | | | | |
| Elmidae | 1 | 3 | | 30 | 19 | 13 | 3 | 29 | 13 |
| Hydracarina | 16 | 27 | | 17 | | 76 | | 1 | 10 |
| Odonata | | | | | | | | | |
| Gomphidae | | | | | | | | | |
| Hemiptera | | | | | | | | | |
| Corixidae | | 1 | | | | | | | |
| Station Totals | 1134 | 352 | 1153 | 1790 | 784 | 1364 | 519 | 846 | 1546 |
| Org. No./Sq. Foot | 567 | 176 | 577 | 895 | 392 | 682 | 260 | 423 | 773 |
| No. of Families | 14 | 15 | 15 | 18 | 15 | 18 | 15 | 17 | 18 |

Table 4. Summary of trout population estimates for Big Spring Creek, late August, 1979 and 1980

| Section | Year | Rainbow Trout No. | Rainbow Trout Weight (lbs.) | Brown Trout No. | Brown Trout Weight (lbs.) |
|---|---|---|---|---|---|
| B | 1979 | 1782 | 329 | 55 | 110 |
| B | 1980 | 495 | 382 | 95 | 178 |
| D | 1979 | 909 | 497 | 386 | 211 |
| D | 1980 | 1577 | 1099 | 559 | 449 |

| Section | (Year) | Rainbow Trout Age Group | Rainbow Trout No. | Rainbow Trout Size Range | Brown Trout Age Group | Brown Trout No. | Brown Trout Size Range |
|---|---|---|---|---|---|---|---|
| B | 1979 | I | 1567 | 5.0- 9.6 | II | 8 | 11.9-14.9 |
| | | II | 86 | 9.4-11.7 | III | 12 | 15.2-15.8 |
| | | III | 68 | 11.3-13.6 | IV + older | 35 | 15.8-19.9 |
| | | IV + older | 61 | 12.4-15.6 | | | |
| D | 1979 | I | 438 | 5.0-10.2 | I | 219 | 5.0-10.3 |
| | | II | 214 | 10.0-13.8 | II | 90 | 10.3-12.4 |
| | | III | 181 | 11.5-14.1 | III | 33 | 12.4-14.1 |
| | | IV + older | 66 | 13.6-17.5 | IV + older | 30 | 14.5-18.6 |
| B | 1980 | I | 84 | 5.8-12.4 | III | 7 | 14.3-15.7 |
| | | II | 147 | 10.5-12.8 | IV | 35 | 15.0-17.0 |
| | | III | 196 | 12.2-13.7 | V + older | 53 | 16.4-19.5 |
| | | IV + older | 68 | 13.4-16.5 | | | |
| D | 1980 | I | 662 | 5.0-10.0 | I | 208 | 5.0-11.0 |
| | | II | 159 | 9.8-12.4 | II | 201 | 9.8-13.9 |
| | | III | 366 | 11.8-14.4 | III | 63 | 13.8-15.4 |
| | | IV + older | 390 | 13.5-17.6 | IV + older | 87 | 15.1-19.6 |

Rainbow trout estimates were down considerably in section B when compared to 1979 estimates but the 1979 estimates are made up primarily of hatchery fish from age group I (88%). Fish in age group III showed a three fold increase over 1979 estimates. A number of fish in this age group may have moved into the section from other areas of the stream. The average weight of rainbows within the section showed a significant increase during the period. Even though total numbers for 1980 were down, total weight increased about 16%.

Brown trout numbers increased by 72% between 1979 and 1980, but most of these fish appear to be moving into the section from other parts of the stream. Nearly all the brown trout sampled are age III and older. Examination of the brown trout population age structure still indicates major problems with spawning success and recruitment.

Rainbow trout and brown trout population estimates in section D were up 73% and 45%, respectively, when compared to 1979 figures. Total weight estimates increased 121% for rainbow trout and 112% for brown trout. The increase was in all age groups except age II for rainbow trout and age I for brown trout. Spawning and recruitment appear to be adequate within section D. Total number of fish within the section (2,136) and total weight (1,548 lbs.) are the highest recorded over twelve years of data collection. The high fish population appears to be in response to stable flows and abundant invertebrate populations noted over the past two years.

An attempt was made to determine flow requirements for maintaining aquatic life in Big Spring Creek. The method used was described by Nelson (1980) and relates wetted perimeter and discharge for selected channel cross-sections. Cross-section profiles were measured at two locations, upstream from Lewistown and below the confluence of Cottonwood Creek. Stage-discharge data was collected at a high, intermediate, and low flow. This information was analyzed by the WETP computer program and the resultant data is currently being evaluated. This information, along with various biological data will form an important part of the Department's re-filing for water reservations on Big Spring Creek as mandated by the Department of Natural Resources.

Missouri River - Limited sampling was done on the Missouri River immediately upstream from Fort Peck Reservoir. Fishermen were also interviewed on several occasions. This work is part of a continuing study to inventory and sample waters located within the project area.

Louse Creek - A short section of stream on Louse Creek was electrofished. This work is part of a continuing study to inventory and sample waters located within the project area. Electrofishing revealed an average of 30 brook trout per 400 feet of stream.

Lost Fork - Erosion transects were measured along the Lost Fork of the Judith River during 1981 and photos were taken at established photo points. Bank erosion at the two original transects established in 1968 was minimal. The area was grazed August 22 to October 15, 1980. At the new transect established in 1978 all but two of the marker stakes had been removed. Measurements taken at the two remaining stakes showed minimal erosion. This pasture was grazed from July 16 through August 21, 1980.

The U.S. Forest Service plans to build an exclosure along several thousand feet of the Lost Fork during 1981 to study the effects of grazing on bank stability, riparian vegetation and water quality. They plan to use the sag-tape method for measuring cross section profiles. It may be possible to work in cooperation with them on this project.

## Literature Cited

Nelson, F. A. 1980. Guidelines for Using the Wetted Perimeter (WETP) Computer Program of the Montana Department of Fish, Wildlife and Parks. Montana Department of Fish, Wildlife and Parks, 8695 Huffine Lane, Bozeman, MT 59715. 12 pp.

Vincent, Richard. 1971. River Electrofishing and Fish Population Estimates. Progressive Fish-Culturist, Volume 33, No. 3. pp. 163-169.

Vincent, Richard. 1974. Addendum to River Electrofishing and Fish Population Estimates, Progressive Fish-Culturist, Volume 36, No. 3, pp. 182.

Prepared By: Michiel D. Poore

Date: August 1, 1981

Code Numbers of waters referred to in this report are:

| | |
|---|---|
| 16-0300 | Big Spring Creek Sec. 01 |
| 16-0310 | Big Spring Creek Sec. 02 |
| 16-2140 | Lost Fork Judith River |
| 16-2160 | Louse Creek |
| 16-2520 | Missouri River Sec. 06 |
| 16-4300 | Ackley Lake |
| 16-4590 | C-1 |
| 16-4950 | East Fork Spring Creek Reservoir |
| 16-5535 | Hanson Creek Reservoir |
| 16-5960 | Holgate Reservoir |
| 16-6260 | Kingsbury Reservoir |
| 16-6325 | Knutsen Reservoir |
| 16-7949 | Ridgeway Reservoir |
| 16-8208 | Senef Reservoir |
| 16-8660 | Urs Reservoir |
| 17-9616 | Smith River Reservoir |
| 18-7340 | Buffalo Wallow Reservoir Upper |
| 18-7750 | Bair Reservoir |
| 18-7840 | Holland Reservoir |
| 18-8380 | Martinsdale Reservoir |
| 18-8720 | Petrolia Reservoir |
| 18-9440 | War Horse Reservoir |
| 18-9500 | Yellow Water Reservoir |

MONTANA DEPARTMENT OF FISH, WILDLIFE, & PARKS
ECOLOGICAL SERVICES DIVISION

# JOB PROGRESS REPORT

STATE: Montana
PROJECT NO. FW-3-R-9
JOB NO. 1-a Fisheries

TITLE: Middle Missouri River Planning Project

PERIOD COVERED: July 1, 1980 through June 30, 1981


## ABSTRACT

A fishery inventory and planning study was initiated on the blue ribbon portion of the Missouri River from Holter Dam to the confluence of the Smith River on April 1, 1980. Nineteen species representing eight families of fish occur in this study area. Rainbow and brown trout and mountain whitefish are the most common game fish, and they comprise the bulk of the sport fishery.

Brown trout preferred side channels of the Missouri River rather than the main channel for spawning. Only 6 of 38 (16 percent) of brown trout redds located in fall 1980 were found in the main channel. For comparable habitats YOY rainbow and brown trout were significantly more abundant in side channels than in the main channel. Tributaries were relatively more important as spawning and rearing areas for rainbow trout, while side channels of the Missouri River were relatively more important for brown trout.

Movement data provided by recaptured tagged fish indicated 31 percent of rainbow trout moved from the site where they were tagged, while only 14 percent of the brown trout moved. More rainbow trout moved during the spring/summer period than during fall/winter, while the reverse of this pattern was observed for brown trout.

Creel survey in 1980 indicated anglers caught 0.38 trout/hour in the Missouri River. Catch rates ranged from 0.21 trout/hour in June to 0.77 trout/hour in August. Brown trout comprised 26.1 percent of the catch at Cascade compared to only 1.1 percent at Holter. Boat fishermen caught 0.90 trout/hour while bank fishermen caught only 0.31 trout/hour. Anglers have harvested 4.56 percent of brown trout tagged in the study area compared to only 3.77 percent of the rainbow.

Work was continued on an instream flow study for the Missouri River. In addition, data were collected on aquatic macroinvertebrates, fish larvae, forage fish, and adult rainbow trout food habits.


## BACKGROUND

A basic inventory is essential in formulating management plans for maintaining and utilizing the fishery resources of a given area. Seldom is this information complete for an entire area or drainage. The Missouri River from Holter Dam to the confluence of the Smith River supports a cold water fishery of considerable significance, and prior to this study, basic data on the aquatic resources of this area were lacking.

Because of the increasing demand for Montana's limited water supplies for hydropower, irrigation, industrial and domestic uses, water resource development proposals for this section of the Missouri River appear likely. Proposals which remove significant amounts of stream flow or modify existing flow regimes could ultimately affect the fishery resource and the associated aquatic community. Unless stream flow levels necessary to maintain the aquatic resources of the middle Missouri River are determined, little can be done to evaluate conflicting demands and minimize adverse impacts on the fishery. For these reasons the Montana Department of Fish, Wildlife, and Parks (DFWP) initiated this study on April 1, 1980.

## DESCRIPTION OF STUDY AREA

The study area lies in north central Montana and includes a 99.0 kilometer (km) (61.5-mile) reach of the mainstem of the Missouri River from Holter Dam to the confluence of the Smith River. Four study sections, Craig, Hardy, Cascade, and Ulm were established in this reach (Figure 1). In addition, limited studies were conducted on the lower reaches of the Dearborn River, and Little Prickly Pear, Sheep, Rock, Stickney, Hardy, and Wegner creeks. These are the principal tributaries to the Missouri River in the study area. The tributaries add considerable flow to the Missouri during spring runoff, but they contribute very little flow during the remainder of the year.

The Missouri is the nation's longest river, 3982 km in length from its origin at Three Forks, Montana, to its confluence with the Mississippi River at St. Louis, Missouri. The river segment covered by this study represents one of the last free-flowing reaches of the entire river. Most of the Missouri River has been impounded by dams and reservoirs.

The river flows in a north easterly direction through two distinct geologic zones in the study area. From Holter Dam to the confluence of Sheep Creek, a distance of 38.7 km, the river flows through a mountain canyon having an average width of 1,000 m. The Big Belt Mountains lie to the southeast, while the east front of the Rocky Mountains lies to the northwest. A narrow band of riparian vegetation consisting primarily of willow and some cottonwood lies along the riverbanks. Several brushy islands surrounded by extensive side channels are found in the upper portion of this reach between Holter Dam and the confluence of the Dearborn River (Craig study section, Figure 1). From the Dearborn River to the confluence of Sheep Creek, the river is confined by precipitous rock cliffs and other hydraulic controls to a single, deeper channel with very few islands and side channels (Hardy study section, Figure 1). Below the confluence of Sheep Creek, the river abruptly leaves the mountain area and meanders through a wide and generally flat prairie zone. The upper portion of this zone, from Sheep Creek to Cascade, is characterized by well defined pools and riffles with some large brushy islands and side channels (Cascade study section, Figure 1). The lower segment of the prairie zone, from Cascade to the confluence of the Smith River, is characterized by a deep meandering channel with very few riffles. Several old oxbows have created shallow sloughs and backwater areas in this reach (Ulm study section, Figure 1). Extensive growths of riparian vegetation consisting of a willow/cottonwood overstory are found on the floodplain throughout most of the prairie zone.

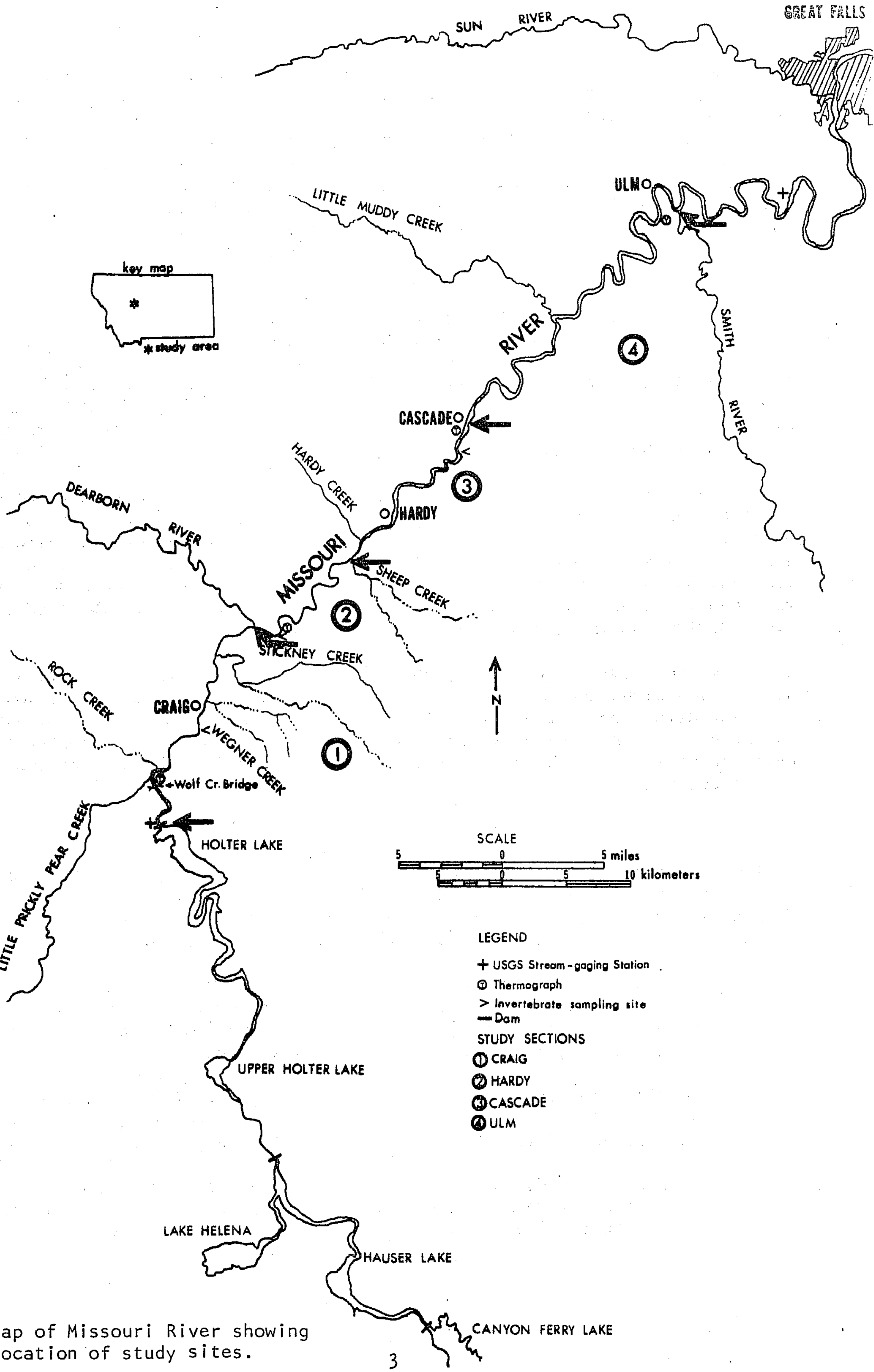


Figure 1. Map of Missouri River showing location of study sites.

The 99.0-km reach of the Missouri River from Holter Dam to the confluence of the Smith River is classified by the Montana Fish and Game Commission as a blue ribbon trout fishery (Brown et. al., 1959). This is one of the longest single reaches of blue ribbon trout stream in Montana, and it represents 14 percent of the state's 727 km (452 miles) of blue ribbon water. An excellent fishery exists in this area for trophy-sized rainbow and brown trout. Many trout from 2.3 to 4.5 kilograms (kg) (5 to 10 pounds [lb]) are taken each year as well as a good number of trout larger than 4.5 kg. Fish larger than 4.5 kg are predominantly brown trout. Mountain whitefish are several times more abundant than trout and provide an important winter fishery.

Many species of waterfowl are seasonally associated with the river. Mallards, mergansers, Canada geese, and teal nest along the river on islands, backwater areas, and sloughs. Some mallards, goldeneyes, and geese spend the winter in ice-free areas along the river. During spring migration, the river is often an important resting area for thousands of pintails, mallards, and other waterfowl enroute to northern nesting areas. Several species of shore birds such as killdeer, snipe, phalarope, and gulls are also seasonally associated with the river.

The extensive riparian vegetation along the lower half of the study section provides excellent habitat for many important wildlife species. Large numbers of white-tailed deer, mule deer, and ring-necked pheasant are found here year-around. Small patches of riparian vegetation along the river in the mountain canyon area also provide habitat for a few deer. Mink, muskrat, beaver, raccoon, and a few river otter are found throughout the study section. Bald eagles are often observed along the river corridor during the winter.

Access to the river is good throughout the study area. There are several public access areas along the upper half of the river. Old U.S. Highway 91, now designated as a recreation road, parallels considerable portions of the river and also provides easy access. River flow is always good for floating, and many recreationists take advantage of this sport. The outstanding scenery and fishing add to the enjoyment of this activity.

## OBJECTIVES AND DEGREE OF ATTAINMENT

The long range objective of the study is to follow inventory procedures developed in earlier studies (Wipperman 1973, Berg 1975 and 1981) and use the resulting data to prepare recommendations for aquatic resource management on this section of the Missouri River. Specific objectives during this report period were:

(1) Continue to conduct baseline surveys of resident adult fish populations in four study sections of the Missouri River from Holter Dam to the confluence of the Smith River to determine species composition, longitudinal distribution, relative abundance, and size composition of the population.

(2) Continue to identify and monitor spawning migrations of rainbow and brown trout in the Missouri River below Holter Dam and in the lower reaches of the Dearborn River, Little Prickly Pear Creek, Sheep Creek, and Rock Creek.

(3) Attempt to locate spawning sites of rainbow and brown trout by searching for redds. Determine the conditions required for successful spawning by measuring physical parameters including water depth, velocity, and substrate

composition of the redds. Determine hatching time and success of spawning by sampling for larval fishes.

(4) Continue to tag important fish species with individually numbered tags to determine fisherman harvest and monitor movement patterns.

(5) Continue to conduct a partial creel survey on the mainstem of the Missouri River from Holter Dam to the confluence of the Smith River to determine success rate, species composition, and size composition of the catch. Continue to collect stomach contents of angler harvested trout to determine food habits of adult fish.

(6) Begin to conduct surveys in the lower reaches of the Dearborn River, Little Prickly Pear Creek, Sheep Creek, and Rock Creek to determine the importance of these tributaries as rearing areas for juvenile rainbow and brown trout.

(7) Begin to conduct surveys in the mainstem of the Missouri River to determine habitat types utilized as rearing areas for juvenile trout. Determine the amount of instream flow required to maintain trout rearing habitat.

(8) Continue to sample aquatic macroinvertebrates at four sites on the Missouri River to determine taxonomic composition and longitudinal distribution.

(9) Continue to collect forage fish samples in conjunction with adult fish population surveys to determine species composition and longitudinal distribution of forage fish.

(10) Begin to determine instream flow requirements for the fishery resource of the Missouri River.

(11) Maintain thermograph stations at three study sites to monitor water temperature.

(12) Continue to supervise BLM-funded instream flow study on the Missouri River from Morony Dam to Fort Peck Reservoir.

Progress was accomplished on all of the objectives. Findings are presented in the appropriate sections of this report.

## PROCEDURES

### Water Temperature

Thirty-day continuous recording thermographs were used to monitor water temperature. The recorder box was positioned on the streambank as far above the high water mark as possible. A thermocouple lead, varying in length from 8 to 23 m, was extended into the water through flexible, plastic sewer pipe.

### Macroinvertebrates

Aquatic macroinvertebrate samples were collected using a rectangular framed 20 x 45 cm, conical net kick sampler with fine mesh (300 micron) pores. The net was positioned on the streambed so the current flowed into it. Macroinvertebrates were washed into the net by an operator standing in front of the net kicking into the substrate. A variety of habitat types (cobble, gravel, sand, submerged vegetation, etc.) were sampled at each station to obtain a representative sample. Samples were transferred to jars containing an identifying label and preserved with 10 percent formaldehyde.

## Larval Fish

Drifting larval fish were sampled with a 0.5 m diameter by 1.6 m long Nitex plankton net (750 micron mesh) fitted with a threaded ring sewn at the distal end to accomodate a wide mouth, pint mason jar as the collecting bucket. The net was fished in a stationary position immediately below the surface of the water in main channel border areas of the river. The net was anchored in position in the current by a 4 m length of rope. The net was fished for a measured period of time, usually 30 to 60 minutes. On some occasions the net was fished for less than 30 minutes because of excessive amounts of debris collecting in the nets.

Larval fish located near the border of the stream channel were sampled with a hand-held rectangular framed 25 x 45 cm, conical shaped dip net with fine mesh (300 micron) pores. Since Salmonidae larvae rarely are found in drift samples, this technique was utilized principally to collect Salmonidae.

After the net was retrieved from the river, its contents were thoroughly washed into a collecting jar containing an identifying label. Samples were preserved in a 10 percent solution of formaldehyde colored with phloxine-B dye, a deep pink coloring agent which penetrated the fish larvae and aided in separating them from aquatic vegetation and debris. Larvae were identified to the lowest taxon practical using keys by Hogue et. al., (1976) and May and Gasaway (1967). For purposes of this study, larval fish were defined as those fish exhibiting undeveloped pectoral, anal, and dorsal fin rays, essentially as suggested by May and Gasaway (1967).

## Juvenile and Adult Fish

### Boom-suspended Electrofishing System

A boom-suspended electrofishing system was used to sample fish populations on the mainstem of the Missouri River. The electrofishing system was adapted from Novotny and Priegel (1974) and is described by Berg (1981). The electrofishing apparatus was mounted on a 4.5 m (14.6 foot) aluminum drift boat powered by a 9.9 horsepower outboard.

The boom-suspended electrofishing apparatus was the most effective technique for sampling fish in the Missouri River mainstem. Other procedures such as mobile electrofishing and seining were effective only in restricted habitat areas such as shorelines, backwaters, and side channels.

### Mobile Electrofishing System

A mobile electrofishing system was used to sample juvenile and forage fish in shoreline and side channel areas of the Missouri River. The system was also used to sample adult, juvenile, and forage fish in tributaries of the Missouri. The mobile electrofishing system consisted of a hand-held mobile positive electrode, a stationary negative electrode mounted on a 1.0 $m^2$ float attached to the boat, and a portable 1350-watt, 115 volt (60 Hz. single phase) alternating current generator. A Coffelt Model VVP-2C rectifying unit was used to change the alternating current to pulsed direct current. Output from the rectifying unit was adjustable from 0 to 300 volts half-wave

60 hz. in 25 and 50 volt increments. The electrofishing system was carried in a 5.8 m (19 foot) aluminum freight canoe. In tributaries where the freight canoe could not be floated, electrofishing with this system was accomplished by bank shocking with 76.2 m (250 feet) of 16/2 electrical cord.

## Seines

Juvenile and forage fish were collected from some habitats on the mainstem of the Missouri River with 15.2 x 1.2 m (50 x 4 feet) beach seines with 3.2 mm (1/8 inch) square mesh. Fish collected were identified and associated habitat types were recorded.

## Fish Sample Processing and Tagging

Fish captured by various methods were measured to the nearest mm in total length and weighed to the nearest 10 g. Sex and spawning condition (gravid, ripe, or spawned) were recorded for fish captured during their spawning season. Several thousand catchable game fish were marked with individually numbered Floy t-tags to evaluate growth rate, movement, and angler harvest. All fish were released near the capture site.

## Fish Population Estimates

Population estimates were made using the Petersen mark-recapture formula as modified by Chapman (1951):

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

where: N = population estimates
M = the number of marked fish
C = the number of fish in the recapture sample
R = the number of marked fish in the recapture sample (C)

Multiple marking and recapture runs were needed to collect an adequate sample size. A partial fin clip or fin punch was used to mark the fish. A minimum of two weeks was allowed before recapture runs were made. Additional methods used for population and standing crop estimates are described by Vincent (1971 and 1974).

## Fish Aging

Scales were collected from some fish for age determination. The scale samples were imprinted on an acetate slide, and the imprints were projected at 44X with a Bausch and Lomb optical projector. Annuli were identified and ages assigned following procedures described by Tesch (1971) and Lagler (1956).

## Trout Food Habits

Stomach contents were collected from juvenile rainbow and brown trout and from angler harvested adult rainbow trout for food habits analysis. The entire intestinal tract was collected from angler harvested fish. Stomach contents were pumped from juvenile trout with 10 ml Manostat Aqueous Minipet, and the fish were released near the sample site. Based on autopsy examinations of a representative sample of juvenile trout whose stomachs had been pumped, it was concluded that the pump was a satisfactory technique for collecting stomach contents.

All stomach contents collected from adult and juvenile trout were placed in a jar containing an identifying label and preserved with a 10 percent solution of formaldehyde. In the laboratory, stomach contents were placed in an enamel sorting pan where the food items were separated and sorted into taxonomic groups. Food items were identified to the lowest taxon practical using keys by Ward and Whipple (1959), Pennak (1953), Brown (1972), Roemhild (1976), and Merritt and Cummins (1978). Volumetric measurements of each type of food item were made using a variety of standard graduated cylinders.

## Missouri River Creel Survey

An angler creel survey was conducted on the sport fishery which exists on the Missouri River from Holter Dam to the confluence of the Smith River. The survey was a partial census in which interviews of fishermen were used to obtain estimates of angling data. With a postcard-sized survey form, partial trip data were obtained during interviews with individual anglers (Figure 2). The interview form was recorded in duplicate, with the original copy retained by the census taker and a carbon copy given to the angler. Upon completion of his/her fishing trip, the angler voluntarily recorded complete trip data and returned the postpaid carbon copy of the interview form.

# FINDINGS - PHYSICAL CHARACTERISTICS

## Drainage Area and Stream Discharge

The drainage area of the middle Missouri River increases from 44,416 $km^2$ to 54,237 $km^2$, or by about 29 percent, between Holter Dam and the confluence of the Smith River (USGS 1979). The climate is characterized by moderately low rainfall, a dry atmosphere, hot summers, cold winters, and a large proportion of sunny days.

Streamflow is monitored by the USGS at gages located 0.6 km downstream from Holter Dam (Holter Dam gage) and 14.6 km downstream from the confluence of the Smith River (Ulm gage). Mean annual discharge for a 33-year period of record at Holter Dam is 4.99 $km^3$/yr (4,051,000 acre-feet/year) compared to 6.09 $km^3$/yr (4,938,000 acre-feet/year) for a 21-year period of record at the Ulm Gage (USGS 1978). The maximum flow recorded at Holter Dam was 986 $m^3$/second (34,800 cfs) on June 8, 1948, while the maximum at Ulm was 779 $m^3$/second (27,500 cfs) on June 22, 1964.

Present day flow regimens of the Missouri River are not natural because of regulation and storage at several dams in the drainage upstream from the study area. Flow is largely controlled by Canyon Ferry Reservoir, the largest of three consecutive upstream reservoirs. Canyon Ferry was completed in 1953, and it is operated by the U.S. Bureau of Reclamation for irrigation, hydropower, flood control, recreation, and supplemental water supply for the City of Helena. Canyon Ferry has a surface area of 14,245 hectares (35,200 acres) and a storage capacity of 2.529 $km^3$ (2,051,000 acre-feet). Hauser and Holter reservoirs lie downstream of Canyon Ferry Dam and provide head for power generation (Figure 1). Hauser and Holter dams are owned and operated by Montana Power Company.

## Stream Gradient

The Missouri River enters the study area immediately below Holter Dam at an elevation of 1056.1 m (3,465 feet) msl, dropping 44.2 m (145 feet) to an elevation of 1011.9 m (3,320 feet) msl near the confluence of the Smith River (Table 1). Stream gradient averages 0.39 m/km (2.04 feet/mile) and varies from 1.49 m/km (7.84 feet/mile) at Halfbreed Rapids to 0.10 m/km (0.52 feet/mile) near Ulm (Figure 3). Stream gradients were determined by measurements taken from USGS topographic maps.

Table 1. Stream gradients of the Missouri River from Holter Dam to Black Eagle Dam at Great Falls, MT.

| River Kilometer | Approximate Location | Elevation (meters, msl) | Gradient (m/km) | Gradient (ft/mi) |
|---|---|---|---|---|
| 0.0 | Black Eagle Dam | 1005.8 | - | - |
| 5.0 | BN RR Bridge at Gr. Falls | 1008.9 | 0.67 | 3.22 |
| 36.0 | Ulm | 1011.9 | 0.10 | 0.52 |
| 93.3 | Cascade | 1018.0 | 0.11 | 0.56 |
| 107.9 | Finigan Creek | 1024.1 | 0.42 | 2.21 |
| 112.0 | Sheep Creek | 1030.2 | 1.49 | 7.84 |
| 121.0 | Andy Creek | 1036.3 | 0.67 | 3.56 |
| 126.4 | Mid-Canon | 1042.4 | 1.14 | 6.01 |
| 135.1 | Craig | 1048.5 | 0.70 | 3.68 |
| 146.0 | L. Prickly Pear Creek | 1054.6 | 0.56 | 2.96 |
| 150.3 | Holter Dam | 1056.1 | 0.35 | 1.87 |

## MISSOURI RIVER CREEL CENSUS (Holter to Ulm)

**Date** ______________________ **Interview** __________

**Location** Holter, Craig, Hardy, Cascade, Ulm

**No. Persons In Party** ______________________ **Bank/Boat**

**Where From** ______________________

**Type Of Tackle** Artificial Lure, Bait, Flies __________

**Hrs. Fished** __________ **After Interview** __________

| | | | **Fish Caught After Interview** |
|---|---|---|---|
| **No. Fish Kept** ________ | **Rainbow** | ________ | ________ |
| | **Brown** | ________ | ________ |
| | **Whitefish** | ________ | ________ |
| | **Other** | ________ | ________ |
| **No. Fish Released** ________ | **Rainbow** | ________ | ________ |
| | **Brown** | ________ | ________ |
| | **Whitefish** | ________ | ________ |
| | **Other** | ________ | ________ |

**Completed Trip? Yes** ________ **No** ________

*Courier Printing*

Figure 2. Forms used in Missouri River creel survey.

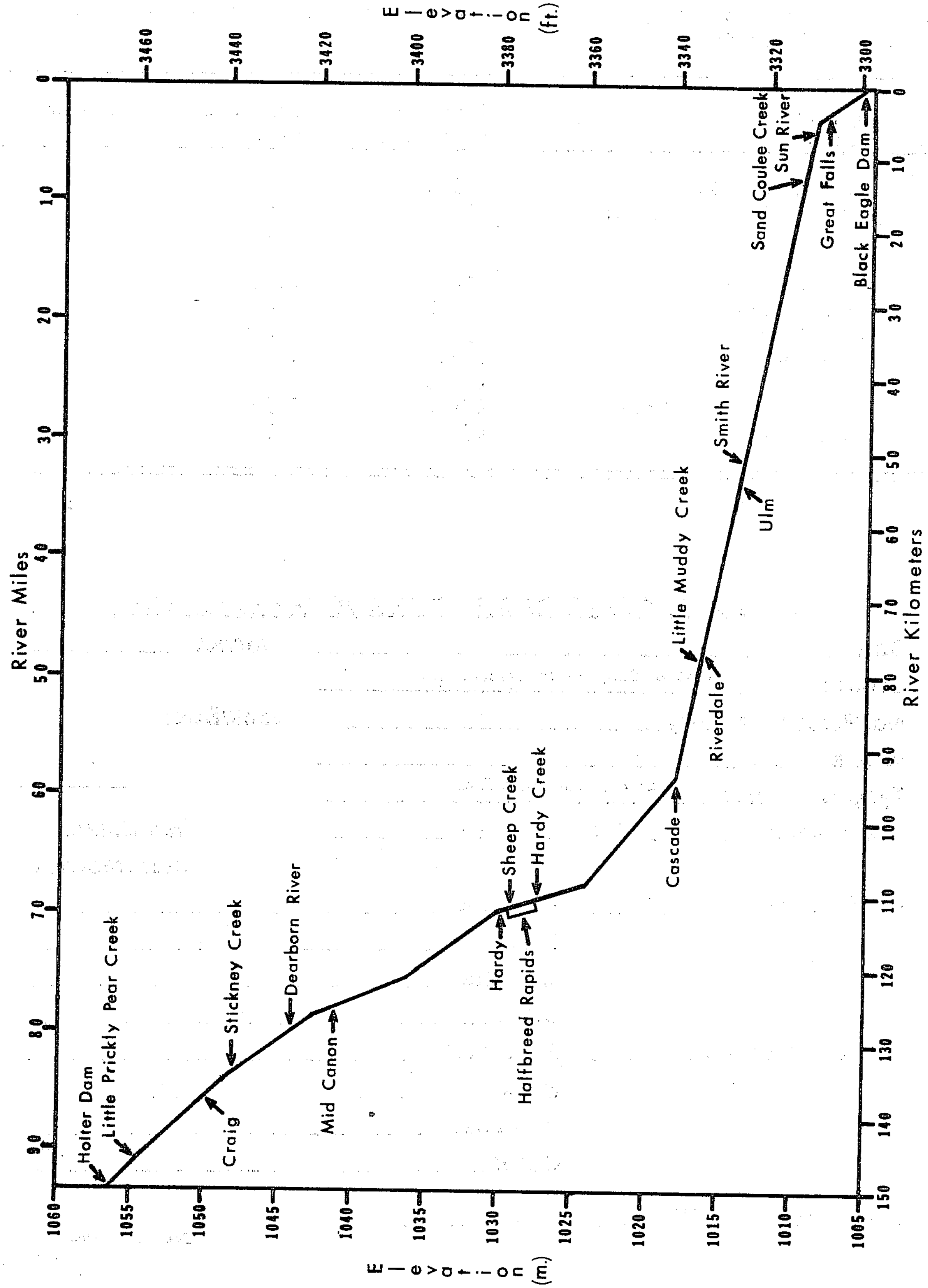


Figure 3. Longitudinal profile of the Missouri River from Holter Dam to Black Eagle Dam near Great Falls.

## Water Temperature

Water temperatures were monitored during the ice-free period by continuous recording thermographs located in the Craig, Hardy, and Cascade study sections (Figure 1). At each of the three thermograph sites, water temperature warmed progressively from mid-April through late July (Figure 4). Erratic temperatures observed during May were probably related to abnormal flow fluctuations. The highest annual water temperatures were achieved in late July and early August. The maximum temperatures recorded in 1980 at the Craig, Hardy, and Cascade stations were 19.4, 21.1, and 20.0 degrees C (67, 70, and 68 degrees F), respectively. These temperatures were achieved at each station on August 1, 1980.

Water temperature exceeded 19.4 degrees C (67 degrees F) on 0, 17, and 3 days at the Craig, Hardy, and Cascade stations, respectively, in 1980. The greater number of warm days at Hardy is related to a larger diurnal temperature fluctuation at this station, which, in turn, is probably related to the influence of the Dearborn River. Mean diurnal fluctuation of water temperature at the Hardy station was 3.17 C degrees (5.71 F degrees) compared to only 1.38 C degrees (2.49 F degrees) and 1.58 C degrees (2.84 F degrees) at the Craig and Cascade stations, respectively. Diurnal fluctuations of water temperature are greater in the Dearborn River than in the Missouri River, and the Dearborn River enters the Missouri River only 3.4 km upstream from the Hardy station.

Since average minimum water temperatures at the Hardy station were consistently cooler than the other stations, mean temperatures at each of the thermograph stations follow a more logical sequence with progressive warming in a downstream direction. However, the Hardy and Cascade stations averaged only 0.20 and 0.24 C degrees (0.36 and 0.44 F degrees) warmer, respectively, than the Craig station.

The data essentially indicate that water temperature is optimal for trout survival from at least Holter Dam to Cascade. A thermograph installed near Ulm in the lower few kilometers of the blue ribbon trout segment didn't function properly in 1980 and was returned to the manufacturer for repair. In 1981 a thermograph will be installed near Ulm to monitor water temperature.

# MACROINVERTEBRATES

Aquatic macroinvertebrates were collected during the report period at the Craig, Hardy, Cascade, and Ulm stations (Figure 1). Sorting and identification of the samples is in progress. Findings will be presented in a future progress report when data accumulation is substantial enough to warrant interpretation. The study is being conducted to determine taxonomic composition and longitudinal distribution of aquatic macroinvertebrates.

# FISH POPULATIONS

## Species Composition, Distribution, and Relative Abundance

Nineteen species representing eight families of fish occur in the Missouri River between Holter Dam and the confluence of the Smith River (Table 2). Rainbow and brown trout and mountain whitefish are the most common game fish, and they comprise

Table 2. Fish species found in the Missouri River in Montana between Holter Dam and the confluence of the Smith River.

| | |
|---|---|
| SALMONIDAE (Trout family) | |
| *Prosopium williamsoni* | Mountain whitefish (A)[1] |
| *Oncorhynchus nerka* | Kokanee (R)* |
| *Salmo clarkii* | Cutthroat trout (R)** |
| *Salmo gairdneri* | Rainbow trout (A) |
| *Salmo trutta* | Brown trout (A) |
| *Salvelinus fontinalis* | Brook trout (R)** |
| CYPRINIDAE (Minnow family) | |
| *Cyprinus carpio* | Carp (A) |
| *Couesius plumbeus* | Lake chub (C) |
| *Pimephales promelas* | Fathead minnow (C) |
| *Rhinichthys cataractae* | Longnose dace (A) |
| CATOSTOMIDAE (Sucker family) | |
| *Catostomus catostomus* | Longnose sucker (A) |
| *Catostomus commersoni* | White sucker (A) |
| ICTALURIDAE (Catfish family) | |
| *Ictalurus melas* | Black bullhead (R) |
| *Noturus flavus* | Stonecat (R) |
| GADIDAE (Codfish family) | |
| *Lota lota* | Burbot (C) |
| CENTRARCHIDAE (Sunfish family) | |
| *Lepomis gibbosus* | Pumpkinseed (R) |
| PERCIDAE (Perch family) | |
| *Perca flavescens* | Yellow perch (C) |
| *Stizostedion vitreum* | Walleye (R) |
| COTTIDAE | |
| *Cottus bairdi* | Mottled sculpin (A) |

1 Relative abundance - A=Abundant, C=Common, R=Rare.
* Rare transients found in the river, apparently from Helena Regulating Reservoir.
** Common in some tributaries of the Missouri in the study area.

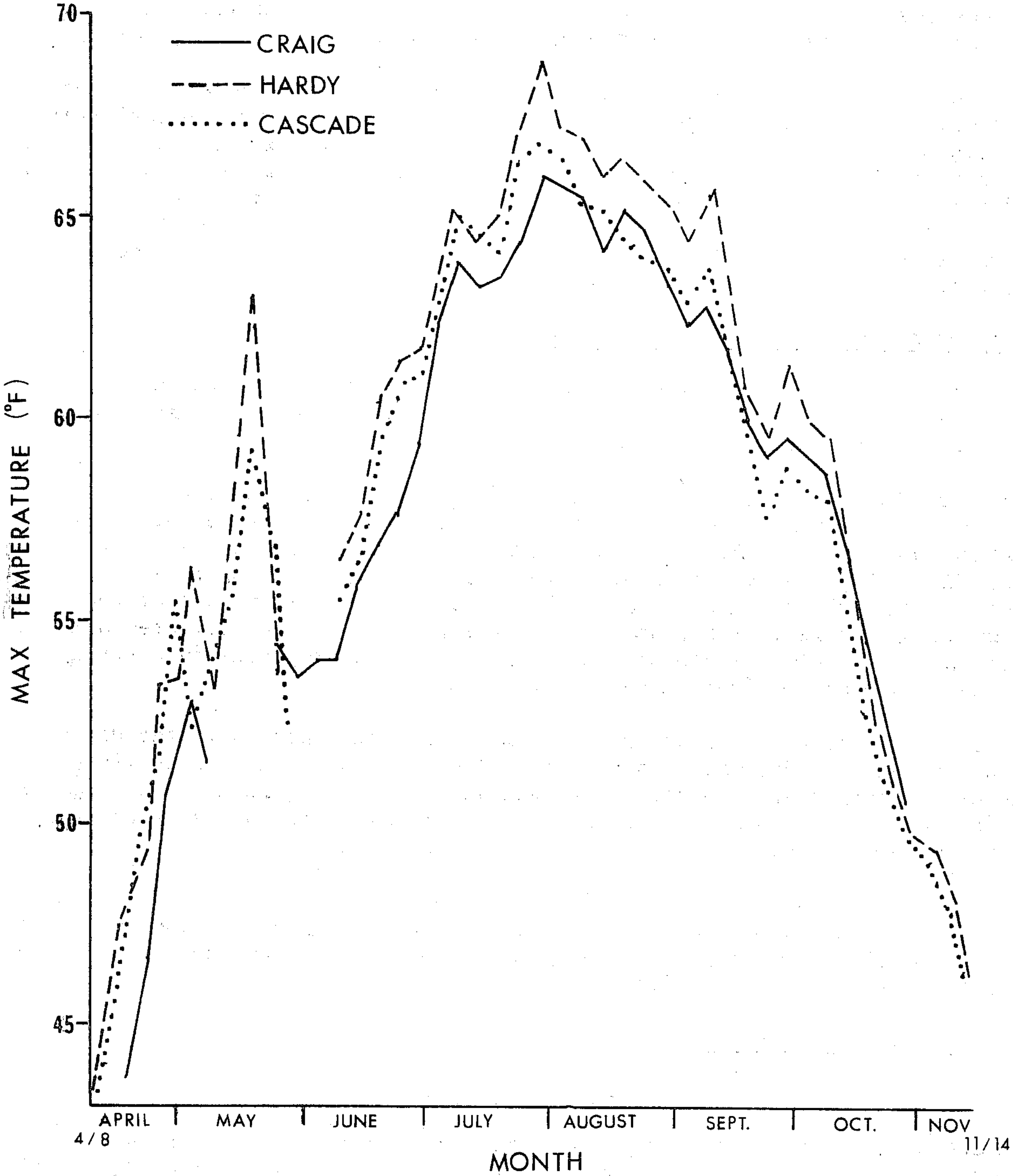


Figure 4. Five-day average maximum water temperatures for the Missouri River near Craig, Hardy and Cascade in 1980.

the bulk of the sport fishery. A few burbot and walleye are found in the river; however, they are not nearly as common as the former species. Longnose and white suckers, carp, longnose dace and mottled sculpin are the prevalent nongame species.

No particular longitudinal distribution pattern was evident for game or nongame fish species sampled during this report period. Most species occurring in the river were found throughout the entire length of the study area from Holter Dam to the Smith River. Catch per unit effort (CPUE) statistics are currently being compiled from electrofishing and seining surveys to provide a more accurate appraisal of the relative abundance of various fish species. Since a large data base is required to compile reliable CPUE statistics, the surveys will be continued during the next report period.

Trout Population Estimates and Growth Rates

Trout populations were estimated in a 9.2 km reach of the Hardy section in spring 1980, fall 1980 and spring 1981. Trout populations were also estimated in a 6.2 km reach of the Cascade section in spring 1980 and spring 1981.

All of the population estimates were successfully completed. However, problems have been encountered in aging trout from scale samples collected during the population estimate studies. Therefore, final population estimate statistics have not been compiled. The aging problem is probably related to complicated sources of recruitment from various tributaries, as well as difficulties generally encountered in aging trout from scale samples. Trout age assessments and population estimates will be finalized during the next report period by comparing length-frequency distribution data to age data compiled from re-reading the scale samples.

Length-frequency distributions of rainbow and brown trout sampled in the Hardy section during spring and fall estimates conducted in 1980 are shown in Figures five and six. When age class assessments are made, the data indicate spring population estimates can be made for two distinct age classes, while fall estimates can probably be made for three distinct age classes.

A comparison of the length-frequency distributions of rainbow trout sampled during the spring of 1980 indicated rainbow trout growth was better in the Cascade section than in the Hardy section (Figure 7). The sample of brown trout from the study sections was too small for a valid comparison.

Spawning and Recruitment Studies

Salmonid Spawning

Most members of the trout family migrate during the spawning season in search of suitable spawning sites (Hubbs and Lagler 1970). Spawning movements of lake dwelling salmonid populations into inlet or outlet streams have been extensively documented for rainbow (Rayner 1942, Hartman et al. 1962, Calhoun 1966, Scott and Crossman 1973) and brown trout (Fenderson 1958, Stuart 1957) and mountain whitefish (Snyder 1918, Calhoun 1966).

Less information is available on spawning movements of river dwelling salmonid populations into feeder streams. Calhoun (1966) reports resident rainbow trout populations in streams tend to move upstream, and if possible into tributaries to spawn. River dwelling brown trout in Ontario normally seek tributary streams for spawning purposes

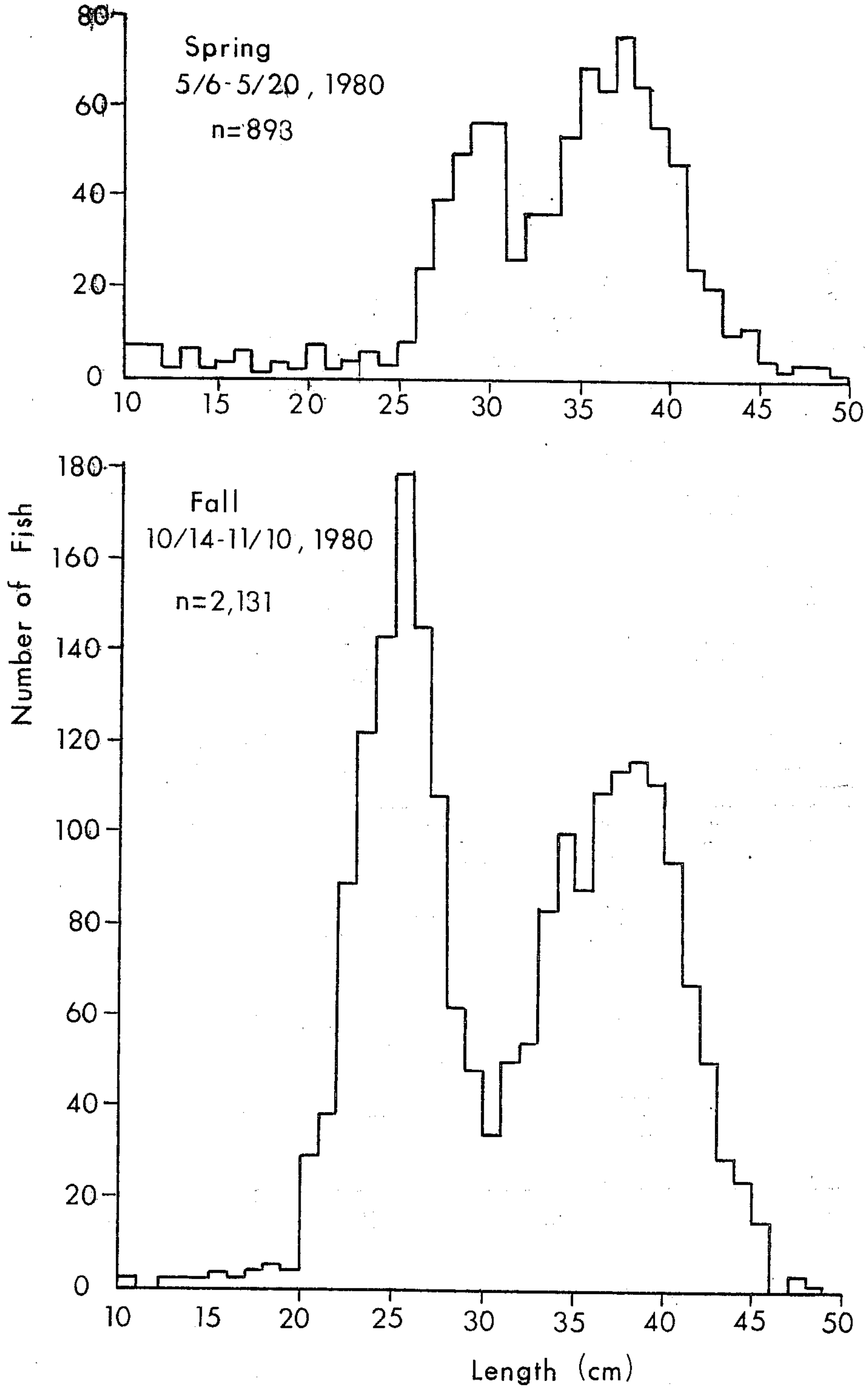


Figure 5. Length-frequency distribution of rainbow trout sampled in the Hardy section during spring and fall 1980.

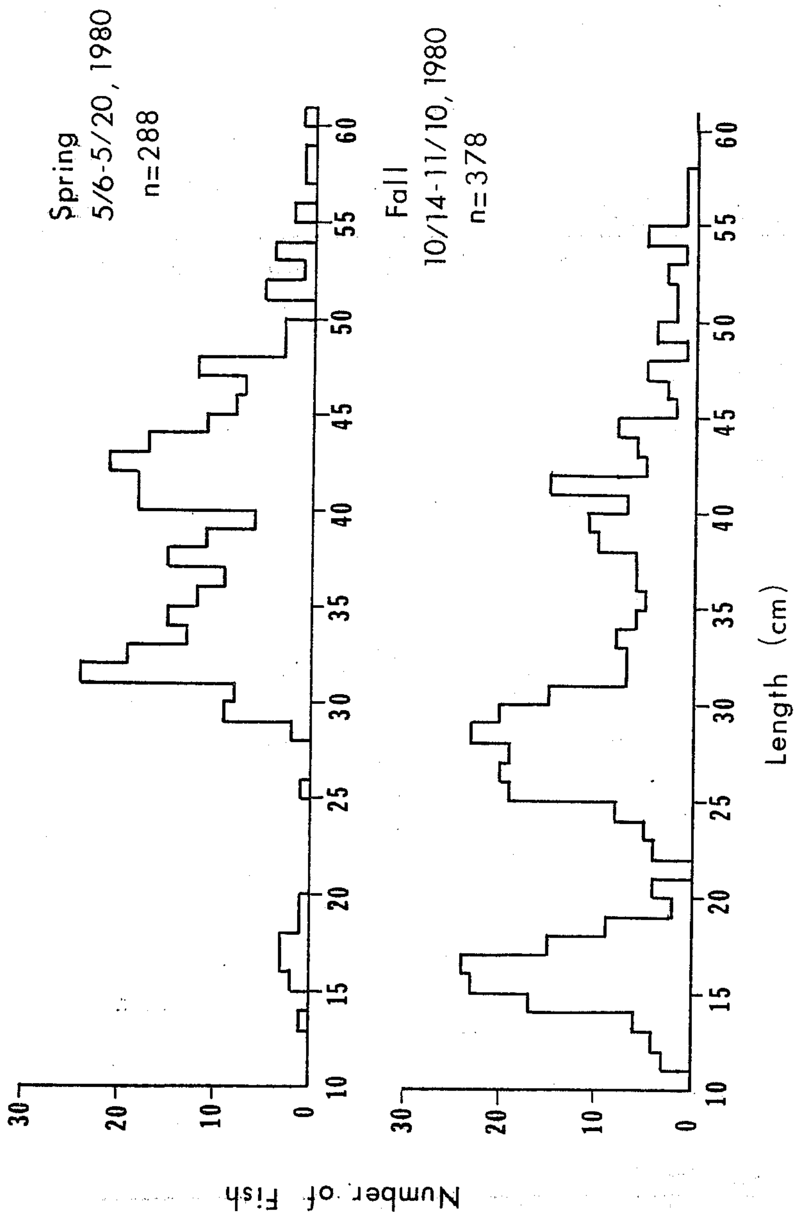


Figure 6. Length-frequency distribution of brown trout sampled in the Hardy section during spring and fall 1980.

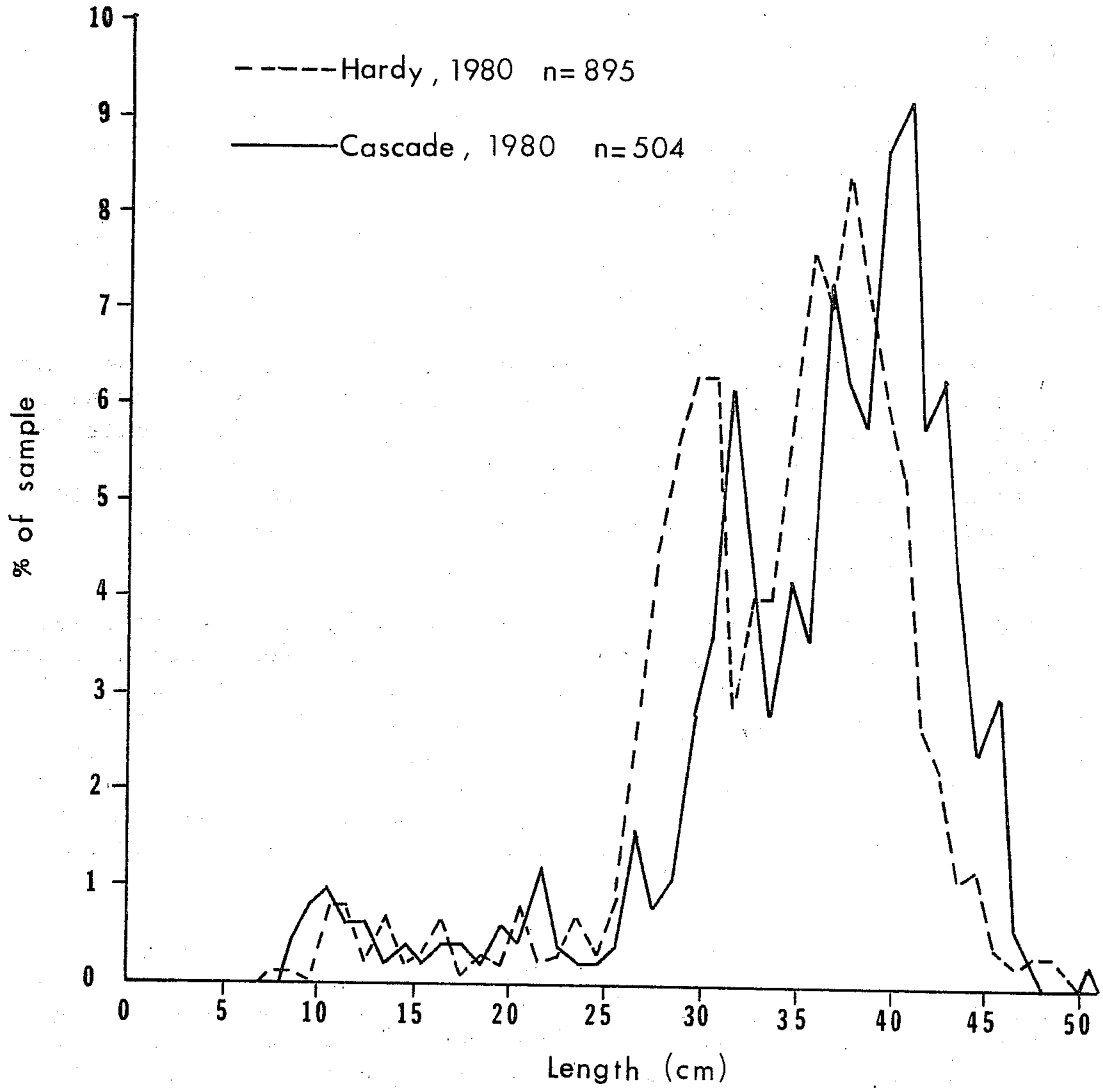


Figure 7. A comparison of the length-frequency distributions of rainbow trout sampled in the Hardy and Cascade sections during spring 1980.

(MacKay 1963). Spawning movements of mountain whitefish from larger streams into some tributaries have been observed in Montana (Liebelt 1970, Brown 1971).

In an effort to better understand the relationship between the Missouri River and its feeder streams, the lower reaches of several tributaries were electrofished during brown trout and mountain whitefish spawning seasons to document the possible presence of spawning runs. The tributaries were electrofished prior to the spawning runs to determine the size and abundance of resident salmonids. Fish captured in the tributaries during the spawning season were assumed to be from the Missouri River if they were in a ripe spawning condition and obviously oversize or overabundant for the habitat present. Also, some fish captured in tributaries had tags attached from fish population study sections on the Missouri River which confirmed the fish's origin.

Our sampling efforts on each tributary during the salmonid spawning migration periods were very limited. Numbers of spawners given in this report represent only a small portion of the total runs, since only selected days out of the total spawning periods and only one capture run was made on each day sampled. Also, the sections surveyed represent only a small portion of the total spawning area available on most tributaries. Therefore, in the tributary streams where migrant salmonids were captured, our data document only the presence of a run and do not necessarily reflect its magnitude. In tributary streams where no migratory fish were found, more intensive sampling is needed to definitely confirm the presence or absence of spawning runs.

The lower reaches of Little Prickly Pear, Sheep and Rock creeks and the Dearborn River were electrofished during the fall of 1980 to document the possible presence of brown trout and mountain whitefish spawning runs. These were the only tributaries in the study area which contained enough flow to sustain fall spawning runs. The Smith and Sun rivers also contained enough flow to sustain spawning runs; however, these tributaries are located at and below the lower boundary of our study area and were not included in the survey.

Brown trout spawning runs were found in Little Prickly Pear, Rock and Sheep creeks while mountain whitefish runs were found in Little Prickly Pear and Sheep creeks and the Dearborn River (Table 3). Several brown trout tagged in the Missouri River prior to the spawning period were recaptured in tributaries during or following the spawning period (Table 4). In addition, brown trout tagged in tributaries during the spawning period have been recaptured in the Missouri after the spawning period. Brown trout migrated from 2 to 26 km upstream and from 2 to 131 km downstream in the Missouri River to reach spawning streams, and they moved from 1 to 114 km upstream in the tributaries to spawn.

In summary, electrofishing and tag return evidence indicate that brown trout from the blue ribbon segment of the Missouri River utilize Little Prickly Pear, Rock and Sheep creeks and the Smith and Sun rivers for spawning. In addition, brown trout probably utilize the Dearborn River for spawning. The Dearborn was sampled on only one occasion in the fall of 1980 and only the lower 1 km was surveyed. More intensive sampling is needed on the Dearborn to confirm the presence or absence of brown trout spawning runs.

In the three tributaries where migratory mountain whitefish were found, large numbers of fish were involved in the runs. Capture efficiency for mountain whitefish ranged from about 20 percent on the Dearborn River to about 60 percent in Sheep Creek. Males generally predominated in samples collected in late October while females were

Table 3. Numbers of mature brown trout and mountain whitefish sampled in four tributaries of the Missouri River during the spawning period in 1980.

| | | | Number of Mature Fish | | | | | |
|---|---|---|---|---|---|---|---|---|
| Tributary | Date Sampled | Species | Male Ripe | Not Ripe | Female Gravid | Ripe | Spent | TOTAL |
| L. Prickly Pear Cr. | 10/30/80 | brown trout | 2 | 0 | 20 | 3 | 1 | 26 |
| " | " | mountain whitefish | Observed in large numbers, not sampled | | | | | |
| Sheep Cr. | 10/29/80 | brown trout | 3 | 1 | 6 | 0 | 1 | 11 |
| " | " | mountain whitefish | 95 | 0 | 2 | 27 | 1 | 125 |
| Rock Cr. | 10/27/80 | brown trout | 1 | 1 | 0 | 1 | 0 | 3 |
| " | " | mountain whitefish | 0 | 0 | 0 | 0 | 0 | 0 |
| Dearborn R. | 11/4/80 | brown trout | 0 | 0 | 0 | 0 | 0 | 0 |
| " | " | mountain whitefish | 18 | 0 | 3 | 18 | 7 | 46 |

Table 4. Spawning movements of tagged mature brown trout between the Missouri River and its tributaries.

| Tag | | Recapture | | Distance moved in Missouri River (km) | | Distance moved in tributary (km) | | TOTAL Distance |
|---|---|---|---|---|---|---|---|---|
| Date | Location[1] | Date | Location[1] | Up-stream | Down-stream | Up-stream | Down-stream | Moved (km) |
| 9-30-80 | HR 116 | 11-04-80 | SM 42 | | 64 | 42 | | 106 |
| 6-24-80 | CS 105 | 10-26-80 | SU 114 | | 99 | 114 | | 213 |
| 9-23-80 | CR 137 | 1-21-81 | SU 60 | | 131 | 60 | | 191 |
| 6-25-80 | CS 109 | 10-29-80 | SC 1 | 2 | | 1 | | 3 |
| 6-10-80 | CR 147 | 10-30-80 | LP 1 | | 2 | 1 | | 3 |
| 6-16-80 | CR 129 | 10-30-80 | LP 1 | 16 | | 2 | | 18 |
| 6-10-80 | CR 139 | 10-30-80 | LP 1 | 6 | | 2 | | 8 |
| 0-20-80 | HR 119 | 10-30-80 | LP 1 | 26 | | 2 | | 28 |
| 6-10-80 | CR 148 | 9-02-80 | LP 1 | | 3 | 1 | | 4 |
| 9-02-80 | LP 1 | 6-04-81 | CR 145 | 0 | 0 | | 1 | 1 |
| 0-27-80 | RC 1 | 4-14-81 | HR 124 | | 20 | | 1 | 21 |

Tag and recapture location abbreviations: (1) Missouri River mainstem locations - CR=Craig section, HR=Hardy section, CS=Cascade section, (2) Tributary locations - SM=Smith River, SU=Sun River, SC=Sheep Creek, LP=Little Prickly Pear Creek, RC=Rock Creek. Numbers with abbreviations are distances (km) upstream from Black Eagle Dam for mainstem Missouri locations and upstream from the confluence with the Missouri for tributary locations.

more abundant in early November. This probably indicates that spawning peaked in early November.

Sampling will be continued in tributaries to furthur document their importance as spawning areas for migratory salmonids from the Missouri. The tributaries will be surveyed in the spring to document possible rainbow trout spawning runs and again in the fall to monitor brown trout and mountain whitefish runs.

In addition to tributary streams, rainbow and brown trout and mountain whitefish utilize side channels of the Missouri River itself for spawning. Preliminary data indicate that tributaries are relatively more important as spawning areas for rainbow trout, while side channels of the Missouri are relatively more important for brown trout.

A portion of brown and rainbow trout spawning activity involves the female digging a shallow depression in the gravel for a redd(Brown 1971). Eggs are fertilized by an accompanying male as they are deposited into the redd and settle into the interstices of the gravel.

The Missouri River was searched extensively in the fall of 1980 for brown trout spawning activity, and a total of 38 brown trout redds were located (Table 5). Although equal effort was spent searching main channel and side channel areas of the river, 32 of the 38 redds (84%) were found in side channels of the river. The preference of side channels for brown trout spawning is apparently related to more suitable depth, velocity, substrate and adjacent cover characteristics in the side channels.

To define physical conditions required for brown trout spawning in the Missouri, water depth and velocity were measured at the redd sites. The measurements were made at the upstream edge of the redds. Water velocity was measured with a Price AA current meter at mid-depth (0.6 of the depth) and at the streambottom with the current meter positioned as close to the bottom as possible without experiencing interference.

Bottom velocity over the 38 brown trout redds averaged 0.44 m/sec (1.43 ft/sec) and ranged from 0.27 to 0.65 m/sec (0.88 to 2.13 ft/sec). Velocity at mid-depth averaged 0.74 m/sec (2.44 ft/sec) and ranged from 0.43 to 0.97 m/sec(1.41 to 3.18 ft/sec). Average bottom velocity over 213 brown trout redds measured in the upper Yellowstone River was 0.53 m/sec with a range from 0.22 to 1.22 m/sec (Berg 1975). Hooper (1973) found bottom velocity averaged 0.47 m/sec and ranged from 0.30 to 0.76 m/sec over brown trout redds in the Pleasant Valley Spawning Channel, California.

Average water depth at the upstream edge of redds measured in the Missouri River was 0.53m (1.75 ft) with a range of 0.30 to 0.73m (1.0 to 2.4 ft). In the upper Yellowstone River water depth over brown trout redds averaged 0.34m and ranged from 0.12 to 0.88m (Berg 1975).

Substrate excavated in redds by brown trout was predominantly gravel ranging from 0.5 to 7.5 cm (0.25 to 3 inches) in diameter found in riffles or runs at the tail end of pools. Other researchers have also found rainbow and brown trout select substrate of this composition for spawning (Brown 1971, Calhoun 1966).

Brown trout initiated spawning in side channels of the Missouri River in about mid-October 1980. Spawning peaked in early November, and the incubation period for

Table 5. Water depth and velocity over brown trout redds located in the Missouri River during fall 1980.

| Habitat and Id. Number | Location | | | No. of Redds | Mid-depth Velocity (m/sec) | | Bottom Velocity (m/sec) | | Depth (m) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | T | R | S | | Average | Range | Average | Range | Average | Range |
| Side channel 2 | 15N | 3W | 29 | 7 | 0.86 | 0.63-0.97 | 0.55 | 0.39-0.65 | 0.55 | 0.46-0.70 |
| Side channel 4 | 15N | 3W | 28 | 1 | 0.61 | - | 0.40 | - | 0.30 | - |
| Side channel 6 | 15N | 3W | 16 | 5 | 0.49 | 0.43-0.58 | 0.30 | 0.27-0.33 | 0.43 | 0.37-0.49 |
| Side channel 7 | 15N | 3W | 10 | 7 | 0.80 | 0.76-0.85 | 0.46 | 0.40-0.50 | 0.60 | 0.43-0.73 |
| Side channel 12 | 16N | 3W | 35 | 4 | 0.90 | 0.79-0.95 | 0.48 | 0.39-0.53 | 0.57 | 0.52-0.64 |
| Side channel RI | 16N | 2W | 29 | 8 | 0.68 | 0.58-0.74 | 0.38 | 0.27-0.50 | 0.52 | 0.40-0.67 |
| Main channel RI | 16N | 2W | 20 | 4 | 0.73 | 0.68-0.77 | 0.42 | 0.34-0.47 | 0.50 | 0.43-0.58 |
| Main channel CR | 15N | 3W | 10 | 2 | 0.79 | 0.77-0.81 | 0.45 | 0.39-0.51 | 0.67 | 0.64-0.70 |
| All sites combined | | | | 38 | 0.74 | 0.43-0.97 | 0.44 | 0.27-0.65 | 0.53 | 0.30-0.73 |

brown trout eggs extended through late April and early May. Rainbow trout spawned in side channels in late March and early April and some eggs incubated until mid-May. Detailed findings on rainbow trout spawning in side channels will be presented in the next progress report. Based on these considerations, adequate flow must be maintained in side channels for trout spawning and incubation from mid-October through mid-May.

## Larval Fish Survey

Larval fish samples were collected at four study sites on the mainstem of the Missouri River from late April through early July 1980 in an attempt to determine timing and location of hatching and emergence of important fish species. Samples were also collected from the Dearborn River and Stickney Creek just upstream from their confluence with the Missouri. 15 drift samples were collected with a 0.5 m net, and four samples were collected at the edge of the stream with a hand-held dip net.

A total of 294 larvae was collected in 15 samples from the Missouri River, and 222 larvae were taken in four samples from the Dearborn River and Stickney Creek (Table 6). Catostominae (Suckers) accounted for 98 percent of the fish larvae sampled, while Salmonidae accounted for the remaining 2 percent. Salmonidae, Cyprinidae and Catostominae are the most common fish in the study area. The scarcity of Salmonidae and the lack of Cyprinidae in the samples is probably related to time of sampling. Due to an unusually high spring flood and resultant sampling difficulties, larval fish were not collected from the Missouri during the first three weeks of May. Most of the Salmonidae probably hatched during this time period. From late May through June, Catostominae predominated in the samples. Catostominae larvae were declining in numerical abundance at all of the mainstem study sites by late June, indicating that the peak of the hatch had probably passed. Larval fish sampling was terminated in late June, prior to the hatching of most Cyprinidae.

Larval fish sampling will be continued during the next report period to determine the hatching time of Salmonidae and Cyprinidae. Since Salmonidae are less likely to be found in drift than Catostominae or Cyprinidae, sampling of stream borders with hand-held dip nets will be intensified in an attempt to collect more Salmonidae.

## Trout Rearing

### Habitat Preference in the Missouri River

Baseline surveys were conducted on the mainstem of the Missouri River to identify habitat types utilized as rearing areas by young-of-the-year (YOY) trout. To facilitate interpretation of rearing data, the river channel was categorized into 10 habitat types:

(1) Main channel riffle-run - a zone of the main channel with a depth of 1 m or less, velocity of 0.3 to 1.0 m/sec, and substrate comprised principally of gravel 2.5 to 7.5 cm in diameter.
(2) Main channel eddy pool - a zone of the main channel with a depth of 1 m or less and velocity of less than 0.3 m/sec, formed by eddys behind gravel bars or projections from the river bank.
(3) Main channel riffle-run brush border - habitat equivalent to main channel riffle-run with overhanging brush or debris cover adjacent to the shoreline.

TABLE 6. FISH LARVAE SAMPLED IN THE MISSOURI RIVER, DEARBORN RIVER AND STICKNEY CREEK IN 1980

| Sample Site | Date | Larvae Collected |
|---|---|---|
| Missouri River Craig | 4-30-80 | 2 Mountain Whitefish |
| | 5-25-80 | 2 Catostominae |
| | 6-6-80 | 12 Catostominae |
| | 6-25-80* | 82 Catostominae |
| | 6-27-80 | 1 Catostominae |
| Missouri River Hardy | 4-30-80 | 1 Mountain Whitefish |
| | 4-30-80 | 1 Mountain Whitefish |
| | 6-6-80 | 30 Catostominae |
| | 6-18-80 | 18 Catostominae |
| Missouri River Cascade | 4-30-80 | 1 Mountain Whitefish |
| | 6-24-80 | 18 Catostominae |
| | 6-26-80* | 88 Catostominae |
| | 6-28-80 | 12 Catostominae |
| Missouri River Ulm | 5-25-80 | 16 Catostominae |
| | 6-27-80 | 2 Catostominae |
| Dearborn River | 5-14-80 | 1 Catostominae |
| | 5-25-80 | 3 Mountain Whitefish |
| Stickney Creek | 7-1-80* | 1 Catostominae & 1 Rainbow Trout |
| | 7-1-80* | 216 Catostominae |

* Sample collected with a hand-held dip net.

(4) Main channel rock border - a zone along the bank of the river comprised of large rocks 0.2 to 1.0 m in diameter. The rocks may include riprap placed in the river.
(5-8) Side channel riffle-run, side channel eddy pool, side channel riffle-run brush border and side channel rock border - side channel habitats with physical characteristics equivalent to their main channel counterparts.
(9) Side channel pool brush border - the border of a side channel pool with over-hanging brush or debris cover.
(10) Backwater - a pool of stagnant water usually lying in a peninsula shaped depression adjacent to the stream border.

Rearing habitats sampled essentially consisted of peripheral areas of the river less than 1 m deep where the presence of juvenile fish was considered likely. The five channel "border" habitats (types 3, 4, 7, 8 and 9) were effectively surveyed by electrofishing while the five "mid-channel" habitats were effectively sampled only by seining.

Rearing habitat surveys were initiated in the Craig and Cascade sections in early August 1980. For comparable habitats YOY trout were significantly more abundant in side channels than in the main channel. In riffle-run brush borders, the most common trout rearing habitat type, an average of 2.38 YOY trout per electrofishing minute (trout/min) were sampled in side channels of the Craig section compared to only 1.02 trout/min in the main channel (Table 7). In the Cascade section, 0.80 trout/min were sampled in side channel riffle-run brush borders, while only 0.41 trout/min were collected in the same habitat in the main channel. Side channel rock borders contained 2.93 and 1.14 trout/min in the Craig and Cascade sections, respectively, compared to 2.46 and 0.28 trout/min in the main channel.

YOY trout were abundant in all of the "border" habitat types in the Craig and Cascade sections, while very few were found in "mid-channel" habitat types. This indicates YOY trout prefer "border" habitat.

Rearing studies were continued in side channels of the Missouri until early November 1980. The average catch rate in the side channels declined from 2.29 YOY trout/min in August to 2.12 YOY trout/min in early October, a reduction of only 0.17 YOY trout/min during this time period. In early November the catch rate in the side channels declined significantly to an average of only 0.38 YOY trout/min, indicating that a large number of YOY trout had moved from the side channels to the main channel. In summary, information gathered in 1980 indicates side channels are vital for trout rearing until about mid-October.

YOY brown trout were significantly more abundant than YOY rainbow trout in rearing habitat surveys conducted on the Missouri River in 1980. The scarcity of YOY rainbow trout may have been related to a sharp reduction of flow in the Missouri River in early May 1980 related to repair of spillway gates at Holter Dam by Montana Power Company. The drawdown occurred while rainbow trout eggs were incubating in redds. The drawdown may have exposed some redds or reduced water depth and velocity over some redds impairing hatching success. If so, this could explain the weak year class. Most brown trout probably hatched before the flow reduction in early May.

It is also possible that rainbow trout may be more dependent on tributary streams for spawning and rearing than brown trout. If so, YOY rainbow trout may never be

Table 7. Habitat types utilized by young-of-the-year (YOY) rainbow and brown trout in the Craig and Cascade study sections during August 1980.

| "Border" Habitat Type | Minutes Electrofished* | No. of YOY trout per electrofishing minute: Craig | | Cascade | | "Mid-channel" Habitat Type | Number of Seine Hauls* | No. of YOY trout per seine haul: Craig | | Cascade | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | LL** | Rb | LL | Rb | | | LL** | Rb | LL | Rb |
| Main channel riffle-run brush border | 130/10 | 0.84 | 0.18 | 0.35 | 0.06 | Backwater | 5/0 | 0.0 | 0.0 | - | - |
| Main channel rock border | 28/22 | 2.42 | 0.04 | 0.23 | 0.05 | Main channel eddy pool | 2/10 | 0.0 | 0.0 | 0.1 | 0.0 |
| Side channel riffle-run brush border | 239/146 | 1.74 | 0.64 | 0.72 | 0.08 | Main channel riffle-run | 12/10 | 0.0 | 0.0 | 0.0 | 0.0 |
| Side channel rock border | 27/30 | 2.89 | 0.04 | 0.97 | 0.17 | Side channel eddy pool | 4/7 | 0.0 | 0.0 | 0.0 | 0.0 |
| Side channel pool brush border | 63/0 | 0.17 | 0.03 | - | - | Side channel riffle-run | 11/6 | 0.0 | 0.0 | 0.2 | 0.0 |

* Craig section / Cascade section

** LL = brown trout, Rb = rainbow trout

as abundant as YOY brown trout in the mainstem of the Missouri. Trout rearing studies will be continued on the mainstem of the Missouri River in 1981 to evaluate the relative importance of the Missouri River and its tributaries.

## Tributary Trout Rearing

Electrofishing surveys were made on the lower reaches of the Dearborn River and Little Prickly Pear, Sheep and Rock creeks in the fall of 1980 to evaluate the importance of the tributaries as rearing areas for YOY and yearling trout. Each tributary was sampled on two occasions, and scale samples were collected from a representative sample of the juvenile fish for age determination.

A composite average of 0.60 YOY rainbow trout per electrofishing minute (trout/min) was collected compared to only 0.38 brown trout/min (Table 8). For yearling fish, averages of 0.51 rainbow and 0.08 brown trout per minute were sampled. The tributaries appear to be more important as rearing areas for rainbow trout than brown trout. In addition, the data suggest that a significant percentage of rainbow trout may rear in the tributaries as YOY and yearlings, while a greater percentage of brown trout appear to emigrate from the tributaries as yearlings. Trout rearing studies will be continued in tributaries of the Missouri River during the next report period.

## Trout Food Habits

### Adult Rainbow Trout

Stomach contents of 50 angler harvested rainbow trout were collected from June through October 1980 to determine food habits of adult fish. Since the fish were all adults, ranging in length from 217 to 458 mm, food habits data for each month were combined to facilitate interpretation.

Adult rainbow utilized mostly very small food items. During the high water period in June, Daphnia was a very important food source (Table 9). As flows receded in July, aquatic insects increased in importance with Trichopterans and Ephemeropterans comprising the bulk of the diet. In August, a large hatch of Tricorythidae (mayflies) was heavily exploited by adult rainbow. The Tricorythidae hatch persisted and was an important food source until mid-October. By late October the bulk of the diet was comprised of Chironomidae and Baetidae.

One of the most interesting findings in the diet of adult rainbow is the relatively small size of most food items utilized. The adult rainbow apparently prefer to feed in shallow, low velocity portions of side channels where substantial quantities of invertebrates accumulate. The scarcity of forage fish in the diet of adult rainbow trout may be related, in part, to time of sampling. Forage fish could comprise a larger portion of the diet from November through May. However, rainbow trout normally do not feed extensively during this time period, and growth increments usually occur following the spawning period from June through October.

A more detailed analysis of food habits of adult rainbow trout will be presented in the completion report for this project. The frequency of occurrence and volumetric importance of various food items will be calculated and presented along with numerical data. In addition, some food groups, such as Plecoptera and Trichoptera, will be classified into lower taxonomic groups.

Table 8. Numbers of young-of-the-year (YOY) and yearling trout sampled in four tributaries of the Missouri River in 1980.

| | | | | Rainbow Trout | | | | Brown Trout | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Tributary | Date Sampled | Minutes Electrofished | Section Length (m) | Number Sampled | Length Range (mm) | Avg. Length (mm) | CPUE* | Number Sampled | Length Range (mm) | Avg. Length (mm) | CPUE* |
| | | | | YOY | | | | YOY | | | |
| L. Prickly Pear Cr. | 9/2 | 187 | 1525 | 22 | 62-96 | 74.8 | 0.12 | 40 | 74-124 | 93.4 | 0.21 |
| " | 10/30 | 190 | " | 22 | 77-113 | 90.8 | 0.12 | 10 | 108-131 | 119.2 | 0.05 |
| Sheep Cr. | 8/22 | 136 | 275 | 455 | 43-91 | 62.8 | 3.35 | 98 | 58-123 | 73.7 | 0.72 |
| " | 10/29 | 112 | " | 125 | 55-110 | 78.5 | 1.12 | 34 | 69-124 | 87.9 | 0.30 |
| Rock Cr. | 9/3 | 45 | 180 | 0 | - | - | 0.00 | 44 | 78-136 | 103.1 | 0.98 |
| " | 10/27 | 43 | " | 3 | 95-106 | 99.0 | 0.07 | 19 | 101-135 | 119.1 | 0.44 |
| Dearborn R. | 9/3 | 39 | 460 | 2 | 73-82 | 77.5 | 0.05 | 13 | 85-123 | 102.6 | 0.33 |
| " | 11/4 | 40 | " | 0 | - | - | 0.00 | 0 | - | - | 0.00 |
| | | | | Yearling | | | | Yearling | | | |
| L. Prickly Pear Cr. | 9/2 | 187 | 1525 | 50 | 120-197 | 161.2 | 0.27 | 13 | 142-197 | 182.4 | 0.07 |
| " | 10/30 | 190 | " | 19 | 125-198 | 168.7 | 0.10 | 0 | - | - | 0.00 |
| Sheep Cr. | 8/22 | 136 | 275 | 117 | 97-190 | 135.1 | 0.86 | 29 | 134-192 | 156.2 | 0.21 |
| " | 10/29 | 112 | " | 24 | 120-194 | 152.5 | 0.21 | 8 | 138-184 | 165.4 | 0.07 |
| Rock Cr. | 9/3 | 45 | 180 | 2 | 177-181 | 179.0 | 0.04 | 0 | - | - | 0.00 |
| " | 10/27 | 43 | " | 3 | 139-198 | 162.3 | 0.07 | 12 | 140-168 | 151.9 | 0.28 |
| Dearborn R. | 9/3 | 39 | 460 | 41 | 132-197 | 162.1 | 1.05 | 0 | - | - | 0.00 |
| " | 11/4 | 40 | " | 58 | 141-198 | 173.7 | 1.45 | 1 | 147 | 147 | 0.03 |

* No. fish sampled/electrofishing minute

Table 9. Food habits of adult rainbow trout in the Missouri River from June through October 1980 based on stomach samples collected from angler harvested fish.

| Food Organism | Total number of food organisms in all stomachs combined: June | July | August | September | October |
|---|---|---|---|---|---|
| Ephemeroptera | | | | | |
| Siphlonuridae | | 2 | | | |
| Tricorythidae | 3 | 4 | 1570 | 380 | 50 |
| Ephemerellidae | 170 | 22 | 4 | | 1 |
| Heptageniidae | 1 | | | | |
| Baetidae | 1 | 175 | 167 | 2 | 98 |
| Plecoptera | | | | | |
| Total | 2 | | 3 | | |
| Tricoptera | | | | | |
| Total | 91 | 79 | 290 | 3 | 84 |
| Diptera | | | | | |
| Tipulidae | 7 | 1 | | | |
| Simuliidae | | 58 | 121 | 65 | 43 |
| Chironomidae | 218 | 77 | 204 | 306 | 250 |
| Unidentified | | 1 | 1 | | |
| Heteroptera | | | | | |
| Corixidae | | 28 | 46 | 1 | 11 |
| Lepidoptera | | | | | |
| Pyralidae | 28 | 6 | | 1 | 1 |
| Pulmonata | | | | | |
| Total | | | | | 1 |
| Amphipoda | | | | | |
| Total | 30 | | | | |
| Decapoda | | | | | |
| Total | 1 | 3 | 2 | | 1 |
| Cladocera | | | | | |
| Daphnidae | 9751 | 403 | 4 | 1 | 67 |
| Isopoda | | | | | |
| Total | 30 | 1 | | | |
| Terrestrial Insects | | | | | |
| Total | 1 | 40 | 7 | 2 | 23 |
| Forage Fish | | | | | |
| Total | | 1 | | | 1 |
| Number of Stomachs Collected | 14 | 14 | 9 | 3 | 10 |

## Juvenile Trout

Stomach contents were collected from 89 juvenile rainbow and 152 juvenile brown trout in the Craig and Cascade sections from August through November 1980. Sorting, identification and analysis of the samples is in progress. Preliminary observations indicate zooplankton (Daphnia), when available are clearly the predominant food source utilized by juvenile trout. The diet shifts to Chironomids, Tricopterans and Tricorythidae when zooplankton are less available at low flows. Large numbers of zooplankton have been collected in drift samples as far downstream as Ulm. Thus, zooplankton are available as a food source for juvenile trout throughout the entire length of the study area.

## Forage Fish Survey

Piscivorous fish species depend, in part, on an adequate forage fish base for their food supply. The most important species in the study area which utilize forage fish for all or part of their diet are rainbow and brown trout, burbot, walleye and yellow perch.

Forage fish were inventoried in 1980 in the Craig and Cascade sections. The main objective of the survey was to determine taxonomic composition and habitat preferences of forage fish species. For the purposes of this report, a forage fish is broadly defined as any fish used by another fish as a food source. This definition includes nearly all YOY fish. Some species, such as mottled sculpin and longnose dace, seldom exceed 150 mm in length as adults. These species essentially remain as a food source for their entire lives.

To facilitate interpretation of forage fish data, the river channel was categorized into 10 habitat types. The habitat types are described in an earlier segment of this report (Trout rearing - Habitat preference in the Missouri River).

The most common forage species collected in 1980 were YOY mountain whitefish, YOY longnose and white suckers, juvenile yellow perch, mottled sculpin and longnose dace (Table 10). In the Craig section, YOY longnose and white suckers and juvenile yellow perch were most abundant in side channel riffle-run brush borders and backwaters. Mottled sculpin preferred rock borders, and mountain whitefish selected "mid-channel" riffle-runs. Longnose dace were collected only in side channel riffle-run brush borders.

In the Cascade section, habitat preferences for these species were similar. Fathead minnows and juvenile burbot were collected only in the Cascade section, and they preferred the side channel riffle-run brush border habitat. Forage fish were generally more abundant in the Cascade section than in the Craig section.

## Fish Movement and Angler Harvest

A total of 6340 game fish have been marked with individually numbered Floy t-tags since the inception of this study on April 1, 1980. Of this total, 5626 have been tagged in the mainstem of the Missouri, and 712 have been tagged in tributaries. The species tagged include 4951 rainbow, 1361 brown, 3 brook and 1 cutthroat trout, 13 burbot and 10 walleye.

Tagged fish recaptured in subsequent research surveys or by anglers provide some

Table 10. Habitat types utilized by forage fish in the Craig and Cascade study sections during August 1980.

| "Border" Habitat Type | Minutes Electro-fished* | Number of forage fish per electrofishing minute** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Craig Section | | | | | | Cascade Section | | | | | | | |
| | | LS | WS | YP | WF | SC | LD | LS | WS | YP | WF | SC | LD | FM | BT |
| Main channel riffle-run brush border | 130/0 | 0.08 | 0.08 | 0.02 | 0 | 0.07 | 0 | - | - | - | - | - | - | - | - |
| Main channel rock border | 28/22 | 0.14 | 0 | 0 | 0 | 0.29 | 0 | 0 | 0 | 0 | 0 | 0.59 | 0 | 0.05 | 0 |
| Side channel riffle-run brush border | 239/146 | 0.27 | 0.14 | 0.03 | 0 | 0.13 | 0.06 | 0.55 | 0.29 | 0 | 0 | 0.57 | 0.26 | 0.09 | 0.01 |
| Side channel rock border | 27/30 | 0 | 0 | 0 | 0 | 0.19 | 0 | 0.07 | 0.03 | 0 | 0 | 0.77 | 0 | 0 | 0 |
| Side channel pool brush border | 63/0 | 0.17 | 0.11 | 0 | 0 | 0.09 | 0 | - | - | - | - | - | - | - | - |

| "Mid-channel" Habitat Type | No. of seine hauls * | Number of forage fish per seine haul** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Craig Section | | | | | | Cascade Section | | | | | | | |
| | | LS | WS | YP | WF | SC | LD | LS | WS | YP | WF | SC | LD | FM | BT |
| Backwater | 5/0 | 5.40 | 7.00 | 11.20 | 0.20 | 0 | 0 | - | - | - | - | - | - | - | - |
| Main channel eddy pool | 2/10 | 0 | 0 | 4.50 | 0 | 0 | 0 | 0 | 0.10 | 1.10 | 15.8 | 0 | 1.20 | 0 | 0 |
| Main channel riffle-run | 12/10 | 0 | 0 | 0 | 6.75 | 0 | 0 | 0 | 0 | 0 | 5.90 | 0 | 0 | 0 | 0 |
| Side channel eddy pool | 4/7 | 0.25 | 0.75 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2.14 | 0 | 0 | 0 | 0 |
| Side channel riffle-run | 11/6 | 0 | 0 | 0 | 3.18 | 0 | 0 | 0.66 | 0.33 | 0 | 3.17 | 0 | 0 | 0 | 0 |

*Craig section/Cascade section

**LS=YOY longnose sucker, WS=YOY white sucker, YP= juvenile yellow perch, WF= YOY mountain whitefish, SC= mottled sculpin, LD= longnose dace, FM=fathead minnow, BT=juvenile burbot indication of fish movement and angler harvest rates. Movement was defined as those fish recaptured more than 2 km upstream or downstream from the tag site. Angler-returned tags were combined with tagged fish recaptured in research surveys to evaluate movement, if the angler reported a specific recapture site with his tag return. Obviously, angler harvest was determined using only angler-returned tags.

## Fish Movement in the Missouri River

Of 626 rainbow trout recaptured, 194 (31 percent) moved from the site where they were tagged (Table 11). Distances moved by individual fish ranged from 3 to 27 km upstream and from 3 to 39 km downstream.

Table 11. Movement of tagged trout in the Missouri River during the inventory period from April 1, 1980 through August 31, 1981.

| Trout Species | Period Recaptured* | Upstream Movement No. Fish | Upstream Distance Moved (km) Range | Upstream Distance Moved (km) Median | Downstream Movement No. Fish | Downstream Distance Moved (km) Range | Downstream Distance Moved (km) Median | No Movement No. Fish | Total Percent Movement |
|---|---|---|---|---|---|---|---|---|---|
| Rainbow | Spring/Summer | 61 | 3-27 | 5 | 60 | 3-39 | 6 | 235 | 34.0 |
| | Fall/Winter | 20 | 3-13 | 4 | 53 | 3-31 | 5 | 197 | 27.0 |
| Brown | Spring/Summer | 8 | 3-18 | 3.5 | 19 | 3-66 | 4 | 180 | 13.0 |
| | Fall/Winter | 4 | 3-46 | 4 | 11 | 3-49 | 7 | 74 | 19.7 |

* Spring/Summer = March through August
Fall/Winter = September through February

Fourteen percent of 296 recaptured brown trout moved from the site where they were tagged. Distances moved by individual fish ranged from 3 to 46 km upstream and from 3 to 66 km downstream.

More rainbow trout moved during the spring/summer period than during fall/winter, while the reverse of this pattern was observed for brown trout. Spring/summer movements of rainbow and fall/winter movements of brown trout are undoubtedly related, in part, to spawning.

Of the game fish species other than rainbow or brown trout which have been tagged, only one fish has been recaptured. This fish was a walleye tagged on June 11, 1980, in the Missouri River 4 km below the confluence of the Dearborn River. The walleye was recaptured 292 days later on March 29, 1981, in the Missouri River immediately below Holter Dam. The movement of 26 km upstream was apparently related to spawning.

## Fish Movement Between the Missouri River and Its Tributaries

Movements of brown trout from the Missouri River into tributary streams, and vice-versa, were described in an earlier section of this report (Salmonid Spawning). Data are currently being compiled on movements of tagged rainbow trout between the Missouri River and its tributaries. Findings will be presented in the next progress report.

## Angler Harvest as Indicated by Tag Returns

An indication of angler harvest of rainbow and brown trout in the Missouri River and its tributaries is being provided by angler-returned fish tags. Very few game fish other than rainbow and brown trout have been tagged, and data for these species are not significant enough to warrant interpretation.

A total of 3.82 percent of the rainbow trout tagged in the mainstem of the Missouri River has been harvested by anglers (Table 12). In tributaries, anglers have harvested 1.72 percent of the tagged rainbow trout. Harvest rates for brown trout are 4.77 and 2.40 percent in the mainstem and tributaries, respectively. In total, anglers have harvested 4.56 percent of the brown trout tagged in the Missouri River and its tributaries compared to only 3.77 percent of the rainbow. This finding was not anticipated, since most anglers believe brown trout are more difficult to catch than rainbow trout.

Since large numbers of tagged trout are still at large in the study area, harvest rates presented in this report are preliminary. Angler harvest rate statistics will be updated in the next progress report.

Table 12. Preliminary estimates of angler harvest of rainbow and brown trout as indicated by tags returned through August 1, 1981.

| | Rainbow Trout | | | Brown Trout | | |
|---|---|---|---|---|---|---|
| Missouri River Study Area | Number Tagged | Number Harvested | Percent Harvested | Number Tagged | Number Harvested | Percent Harvested |
| Craig Section | 1542 | 59 | 3.83 | 393 | 14 | 3.56 |
| Hardy Section | 2305 | 87 | 3.77 | 499 | 30 | 6.01 |
| Cascade Section | 500 | 20 | 4.00 | 323 | 15 | 4.64 |
| Ulm Section | 21 | 1 | 4.76 | 21 | 0 | 0.00 |
| Subtotal | 4368 | 167 | 3.82 | 1236 | 59 | 4.77 |
| Tributary Study Area | | | | | | |
| Sheep Cr. | 112 | 1 | 0.89 | 25 | 1 | 4.00 |
| L. Prickly Pear Cr. | 263 | 5 | 1.90 | 88 | 2 | 2.27 |
| Dearborn R. | 170 | 2 | 1.18 | 8 | 0 | 0.00 |
| Rock Cr. | 3 | 0 | 0.00 | 4 | 0 | 0.00 |
| Wegner Cr. | 6 | 0 | 0.00 | 0 | - | - |
| Hardy Cr. | 2 | 0 | 0.00 | 0 | - | - |
| Stickney Cr. | 27 | 2 | 7.41 | 0 | - | - |
| Subtotal | 583 | 10 | 1.72 | 125 | 3 | 2.40 |
| Grand Total | 4951 | 187 | 3.77 | 1361 | 62 | 4.56 |

## Missouri River Creel Survey

A creel survey was conducted from April through October 1980 on the sport fishery which exists in the blue ribbon segment of the Missouri River from Holter Dam to the confluence of the Smith River. The emphasis of the survey was to evaluate seasonal and longitudinal variation in catch and harvest rates of rainbow and brown trout. Study sections for the creel survey are identical to those shown in Figure 1, except that the Craig section was divided into two creel survey sections. The Holter creel survey section extended from Holter Dam to the Wolf Creek Bridge, and the Craig creel survey section extended from the Wolf Creek Bridge to Craig.

The catch rate ranged from a low of 0.21 trout per man-hour (trout/hr) during the runoff peak in June to a high of 0.77 trout/hr in August (Table 13). For all months combined, anglers caught 0.36 rainbow trout/hr compared to only 0.02 brown trout/hr. About 65 percent of the anglers interviewed in 1980 were from Great Falls.

Table 13. Monthly variation in catch and harvest rates of rainbow and brown trout as indicated by creel survey data collected from April through October 1980.

| Creel Survey Statistics | Apr. | May | June | July | Aug. | Sept. | Oct. | Total |
|---|---|---|---|---|---|---|---|---|
| No. Anglers Interviewed | 42 | 86 | 194 | 238 | 81 | 46 | 33 | 720 |
| Avg. Hrs Fished/Angler | 3.90 | 2.76 | 2.84 | 4.25 | 3.42 | 3.93 | 3.73 | 3.53 |
| Fish Caught/Man-hour | | | | | | | | |
| Rainbow trout | 0.31 | 0.27 | 0.19 | 0.32 | 0.75 | 0.71 | 0.29 | 0.36 |
| Brown trout | 0.01 | 0.03 | 0.02 | 0.01 | 0.01 | 0.00 | 0.02 | 0.01 |
| Total trout | 0.32 | 0.30 | 0.21 | 0.33 | 0.77 | 0.71 | 0.32 | 0.38 |
| Fish Harvested/Man-hour | | | | | | | | |
| Rainbow trout | 0.28 | 0.23 | 0.17 | 0.28 | 0.43 | 0.59 | 0.19 | 0.28 |
| Brown trout | 0.01 | 0.03 | 0.02 | 0.01 | 0.01 | 0.00 | 0.02 | 0.01 |
| Total trout | 0.29 | 0.26 | 0.19 | 0.29 | 0.44 | 0.59 | 0.20 | 0.30 |
| Composition of Catch | | | | | | | | |
| % Rainbow trout | 96.2 | 90.1 | 89.8 | 96.4 | 97.2 | 100.0 | 92.3 | 95.6 |
| % Brown trout | 3.8 | 9.9 | 10.2 | 3.6 | 2.8 | 0.0 | 7.7 | 4.4 |
| Angler Residency | | | | | | | | |
| % Local 1/ | 7.1 | 4.7 | 4.1 | 6.3 | 4.9 | 6.5 | 12.1 | 5.7 |
| % Great Falls | 59.5 | 83.7 | 63.9 | 62.2 | 59.3 | 78.3 | 39.4 | 64.7 |
| % Helena | 2.4 | 1.2 | 16.0 | 9.2 | 13.6 | 6.5 | 9.1 | 10.0 |
| % Other Montana | 26.2 | 3.5 | 10.3 | 13.9 | 16.0 | 4.3 | 12.1 | 11.9 |
| % Out-of-State | 4.8 | 7.0 | 5.7 | 8.4 | 6.2 | 4.3 | 27.2 | 7.6 |

1/ Local - Wolf Creek, Craig, Hardy, Cascade and Ulm.

The catch rate for rainbow decreased progressively in a downstream direction and ranged from 0.38 trout/hr at Holter to 0.08 trout/hr at Ulm (Table 14). Conversely, the catch rate for brown trout increased in a downstream direction. Brown trout comprised 26.1 percent of the catch in the Cascade section, compared to only 1.1 percent of the catch at Holter.

The high catch rate for rainbow trout in the Holter section in 1980 is probably related, in part, to an abnormally high amount of water released over the spillway of Holter Dam during the runoff period from late May through mid-July. Many of the rainbow trout observed in the creel survey in the Holter section visually appeared to be hatchery fish. These fish apparently came from Holter Reservoir, which is stocked annually with hatchery rainbow.

The success rate was significantly higher in 1980 for lure and fly fishermen than for fishermen who used bait or a combination of various methods (Table 15). Lure and fly fishermen caught 0.76 and 0.74 trout/hr, respectively, compared to only 0.31 and 0.33 trout/hr for bait and combination anglers. Brown trout comprised 15.7 percent of the catch for lure fishermen and less than 5 percent of the catch for other fishermen. Boat fishermen caught 0.90 trout/hr compared to only 0.31 trout/hr for bank fishermen.

Table 14. Longitudinal variation in catch and harvest rates of rainbow and brown trout as indicated by creel survey data collected from April through October 1980.

| Creel Survey Statistic | Creel Survey Section | | | | | Total |
|---|---|---|---|---|---|---|
| | Holter | Craig | Hardy | Cascade | Ulm | |
| No. Anglers Interviewed | 273 | 239 | 185 | 17 | 6 | 720 |
| Avg. Hrs. Fished/Angler | 4.10 | 3.14 | 3.10 | 5.09 | 2.17 | 3.53 |
| Fish Caught/Man-hour | | | | | | |
| Rainbow trout | 0.46 | 0.32 | 0.25 | 0.20 | 0.08 | 0.36 |
| Brown trout | 0.01 | 0.02 | 0.02 | 0.07 | 0.00 | 0.02 |
| Total trout | 0.47 | 0.34 | 0.27 | 0.27 | 0.08 | 0.38 |
| Fish Harvested/Man-hour | | | | | | |
| Rainbow trout | 0.38 | 0.21 | 0.22 | 0.17 | 0.08 | 0.28 |
| Brown trout | 0.00 | 0.02 | 0.02 | 0.05 | 0.00 | 0.01 |
| Total trout | 0.38 | 0.23 | 0.24 | 0.22 | 0.08 | 0.30 |
| Composition of Catch | | | | | | |
| % Rainbow trout | 98.9 | 93.8 | 91.0 | 73.9 | - | 95.6 |
| % Brown trout | 1.1 | 6.2 | 9.0 | 26.1 | - | 4.4 |

Table 15. A comparison of the success rates of anglers using various methods and modes of fishing.

| | No. of Anglers | % of Anglers | Avg. Hours Fished/ Angler | Fish Caught/Man-Hour | | | Composition of Catch | |
|---|---|---|---|---|---|---|---|---|
| | | | | Rainbow | Brown | Trout | % Rainbow | % Brown |
| Method: | | | | | | | | |
| Bait | 420 | 58.3 | 3.54 | 0.30 | 0.01 | 0.31 | 96.6 | 3.4 |
| Lure | 48 | 6.7 | 2.28 | 0.64 | 0.12 | 0.76 | 84.3 | 15.7 |
| Fly | 74 | 10.3 | 3.20 | 0.71 | 0.03 | 0.74 | 95.5 | 4.5 |
| Comb. | 178 | 24.7 | 3.99 | 0.32 | 0.01 | 0.33 | 97.9 | 2.1 |
| Mode: | | | | | | | | |
| Bank | 505 | 85.3 | 3.66 | - | - | 0.31 | - | - |
| Boat | 87 | 14.7 | 3.39 | - | - | 0.90 | - | - |

## INSTREAM FLOW STUDY

Adequate instream flow is essential to maintain fish populations in lentic environments. The increasing demand for Montana's limited water supplies comprises a potential threat to fishery resources that is often apparent even to casual observers. To maintain the fishery resource of the Missouri River below Holter Dam, minimum flows must be established to provide adequate spawning areas for adult fish, rearing areas for juvenile fish and sufficient food producing and cover areas for fish of all sizes.

A 1969 state law (Section 89-801, RCM 1947), the so-called "Murphy's Law," authorized the Montana Department of Fish, Wildlife & Parks (DFWP) to appropriate water for instream uses on 12 high quality trout streams in the state. On the Missouri River between Holter Dam and the confluence of the Smith River, DFWP filed a claim for 84.96 $m^3$/sec (3,000 cfs) from January 1 through December 31. As a result of a decision concerning a contested water right on one of the 12 "Murphy's Right" streams, it was determined that DFWP had an instream right, but it was not adequately quantified. Consequently, fish and wildlife data supporting the instream flow claims on all "Murphy's Right" streams had to be gathered before the claims could become effective. Senate Bill 76, entitled "An Act to Adjudicate Claims of Existing Water Rights in Montana," was passed by the 1979 Montana Legislature. This act formally required quantification of DFWP's existing instream flow rights on the "Murphy's Right" streams and established January 1, 1982 as the deadline for refiling to confirm existing rights. Since the Missouri River from Holter Dam to the confluence of the Smith River is a "Murphy's Right" stream, DFWP must file a claim by this date.

This portion of the Missouri is located only 123 km upstream from the Upper Missouri Wild and Scenic River which begins at Fort Benton, Montana, and it is the principal source of its water supply. As such, it is vital to secure and maintain flows in this reach for the benefit of downstream areas.

Since the inception of this project, efforts have been made to quantify the amount of flow required to maintain the fishery. Although work on the instream flow assessment will be continued during the next report period, flow recommendation periods will probably be as follows:

1. Mid-October through late March - This is the historic low flow period. Flow required to maintain wetted perimeter of riffle areas was determined in 1980 by studying 28 riffle-run transects in the Craig and Cascade sections. Water surface elevations were measured at the riffle transects at flows of about 155.8, 87.8 and 76.5 $m^3$/sec (5500, 3100 and 2700 cfs), and configurations of the stream channels were measured at low flow in October. The instream flow requirement for the riffles will be determined using a method employing a computer projected plot of wetted perimeter versus discharge.

An assessment also was made in 1980 and 1981 of the amount of flow required to maintain sufficient depth/velocity conditions in side channels for brown trout spawning and incubation. As described earlier in this report, brown trout preferred side channels for spawning. Eighty-four percent of the brown trout redds located in the fall of 1980 were found in side channels.

In summary, the flow recommendation for mid-September through late March will be based on the flow required to maintain wetted perimeter of riffles and sufficient depth/velocity conditions in side channels for brown trout spawning and incubation.

2. Late March through early July - This is the historic high flow, runoff period. Flow recommendation during this period will be based, in part, on the amount of flow required to maintain security of goose islands from predators. Dominant discharge will be recommended for a 24-hour period to flush sediments from the riverbed and maintain channel features such as side channels and islands. In addition, flow recommendations for paddlefish in the Missouri River below Fort Benton will be used to substantiate the high flow recommendation below Holter Dam.

3. Early July through mid-October - Flow gradually recedes from high flow to low flow during this time period. Substantial rearing of YOY rainbow and brown trout occurs in side channels of the Missouri River during this time period. Side channel rearing areas are critical for maintaining brown trout populations in the river, and are also important for propagating rainbow trout. The flow recommendation for this time period will be based on trout rearing requirements in the side channels.

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# AN ANALYSIS OF THE INSTREAM FLOW REQUIREMENTS FOR SELECTED FISHES IN THE WILD & SCENIC PORTION OF THE MISSOURI RIVER

Research Conducted by:

Montana Department of Fish, Wildlife and Parks
Ecological Services Division

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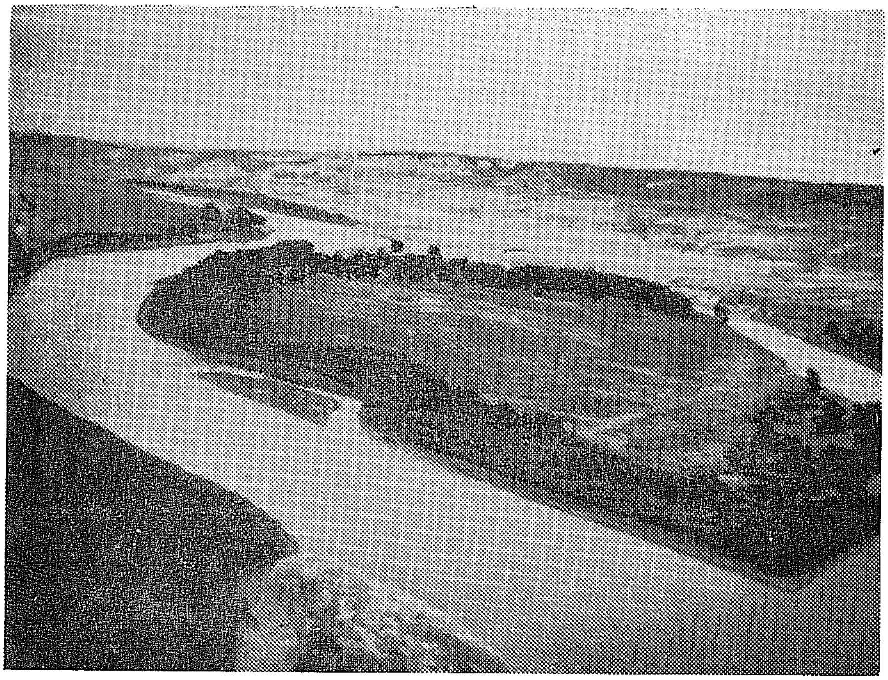

By: William M. Gardner
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SEPTEMBER 1980

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ABSTRACT

This study was initiated on the Wild and Scenic portion of the Missouri River to determine instream flow requirements of selected fish species. The study will form a basis for the Bureau of Land Management in applying for their federal reserve water right.

Rearing habitat preference studies conducted from July through September indicated that young-of-the-year sauger selected protected habitat in peripheral areas of the stream. Forty-three percent of the young-of-the-year sauger sampled in 1979 were found in side channel pools, and 70 percent of the fish collected were taken in a 70-km reach of stream below Cow Island. Peripheral habitat areas were also heavily utilized by forage fish. An average of 125, 104 and 81 forage fish per seine haul was taken in the backwater, main channel pool, and side channel pool habitat types, respectively. In 1980, the WETP instream flow methodology will be utilized to determine the amount of instream flow required to maintain sauger rearing and forage fish habitat.

A food habits study of adult shovelnose sturgeon collected during the ice-free seasons revealed that they foraged almost exclusively on aquatic insects in riffle areas. In 1980, WETP will be utilized to determine the amount of instream flow required to maintain sufficient wetted perimeter in riffle areas for aquatic insect production.

Resident fish populations were inventoried in the lower reaches of three major tributaries of the middle Missouri River. A total of 24, 21 and 15 species was sampled in the Marias, Teton and Judith Rivers, respectively. Sauger was the most common game fish found in all three tributaries. A sturgeon chub was collected in the Teton River, which is a significant extension of its known range.

Several sickle fin chubs were collected in the Missouri River below Cow Island. Previously, this species had been reported in the Missouri River only as far upstream as the confluence with the Little Missouri River in North Dakota. A radiotelemetry system was developed to follow movements of paddlefish in the middle Missouri River.

# INTRODUCTION

The middle Missouri River in northcentral Montana abounds with historical, scenic, recreational and natural values. The river is free-flowing in a 336-km reach from Morony Dam near Great Falls, Montana, to the headwaters of Fort Peck Reservoir. In addition, the land contiguous to the river in this area has retained most of its primitive characteristics. These qualities are rarely found in a river of this magnitude. Because of these considerations a 240-km section of the river from Fort Benton to Robinson Bridge was recently designated as part of the National Wild and Scenic Rivers System (U.S. Congress 1975a). This inclusion, signed into law on October 13, 1976, affords considerable protection for the last major free-flowing portion of the Missouri River. Under provisions of this legislation, no dams may be built on any of the protected waters, and specific protective regulations would be imposed on any new commercial development in designated areas surrounding the protected waters (U.S. Congress 1975b). The law does allow minor diversions and pumping of water from the protected area for agricultural uses. Private landowners in the area can continue with traditional grazing, farming, recreational and residential uses.

The enacting legislation also assigned the Bureau of Land Management (BLM) the responsibility to manage the river. In 1978, the BLM drafted a management plan which included an objective of determining instream flows required to maintain the river, commensurate with the purposes of the act (BLM 1978). Specifically, the determination was to be based on instream flow needs required to maintain fish and wildlife, vegetative, recreational and water quality benefits.

There is little need to review the circumstances which make the instream flow determination study particularly important at this time. It is sufficient to note that because of the increasing demand for Montana's limited water supplies for industrial, agricultural and domestic uses, water resource development plans on the Missouri River are imminent. On October 1, 1979, the U.S. Water and Power Resources Service (WPRS) began an appraisal study for potential damsites on or adjacent to the Missouri River in the vicinity of Fort Benton. In addition, the Montana Power Company (MPC) is currently evaluating three sites in the middle Missouri River drainage for possible construction of coal-fired power generating plants. These plants would require substantial amounts of water from the Missouri River or one of its tributaries for cooling processes. The proposed WPRS and MPC projects have the potential to significantly alter the natural flow regime of the river, and consequently, detrimental effects on the native aquatic fauna can be expected. Unless streamflow levels necessary to maintain the aquatic resources of the middle Missouri River are determined, little can be done to evaluate conflicting resource demands and minimize adverse impacts on the aquatic resources.

Since October 1, 1975, the Montana Department of Fish, Wildlife and Parks (MDFWP) has been conducting a fisheries inventory and planning study in the Wild and Scenic Missouri River. The MDFWP has expended considerable time and effort in becoming familiar with proven sampling methods on large rivers and in developing equipment and techniques adaptable to the Missouri River. The MDFWP study efforts parallel to some extent the effort to be made by the BLM on instream flow quantification. Based on these considerations, it was decided that the BLM and MDFWP should cooperate to develop a suitable methodology to determine instream flow requirements for the Wild and Scenic Missouri River. This study, funded by the BLM and conducted by the MDFWP, was initiated on April 1, 1979.

## DESCRIPTION OF STUDY AREA AND HABITAT TYPES

The study area consists of a 336-km reach of the mainstem of the middle Missouri River in northcentral Montana from Morony Dam near Great Falls to the headwaters of Fort Peck Reservoir near Landusky. The general basin characteristics, hydrogeology and physical/chemical characteristics of the river have been adequately described by Berg (1980) and Kaiser and Botz (1975). The two major tributaries entering the Missouri River in this reach are the Marias River from the north and the Judith River from the south. The present day flow regimen of the Missouri River in this study area is not entirely natural because of regulation and storage at several dams in the drainage upstream from the study area.

Forty-nine species, representing 14 families of fish, are known to occur in the middle Missouri River drainage between Morony and Fort Peck dams (Berg 1980). Basically, two fishery zones occur on the mainstem Missouri. In the upper reach, from Morony Dam to the mouth of the Marias River, a cold water/warm water fisheries transitional zone exists. Sauger is by far the predominant game fish species found in this reach, but significant numbers of trout, mountain whitefish, sculpins, longnose dace and suckers also occur. A warm water fisheries zone extends from the mouth of the Marias River downstream to the headwaters of Fort Peck Reservoir. Sauger, shovelnose sturgeon, paddlefish, channel catfish and a variety of chubs, minnows, suckers and shiners are the predominant species in this zone.

Eleven sampling sections were established on the mainstem Missouri in the study area (Fig. 1). The Morony Dam and Carter Ferry study sections contain rocky substrate and have very few islands and side channels. Stream gradients are relatively high, ranging from 0.76 to 3.4 meters per kilometer. The Fort Benton, Loma Ferry, Coal Banks Landing and Judith Landing study sections have considerably more islands and side channels. Stream gradients in those study sections range from 0.38 to 0.76 meters per kilometer. The Hole-in-the-Wall and Stafford Ferry study sections have similar gradients, but the river in these study sections is confined by steep, narrow canyons, and consequently, very few islands and side channels occur. The lowest three study sections, Cow Island, Robinson Bridge and Turkey Joe, are in a section of river characterized by a wide, meandering channel which contains numerous shifting sandbars and large developed islands. Many side channels and backwaters are found in these study sections.

Nine study sections were established on three tributaries of the middle Missouri River in the study area (Fig. 1).

To facilitate interpretation of rearing area and forage fish data, the river channel was categorized into five major habitat types which could be effectively seined. The habitat types were main channel border, main channel pool, side channel chute, side channel pool and backwaters (Fig. 2).

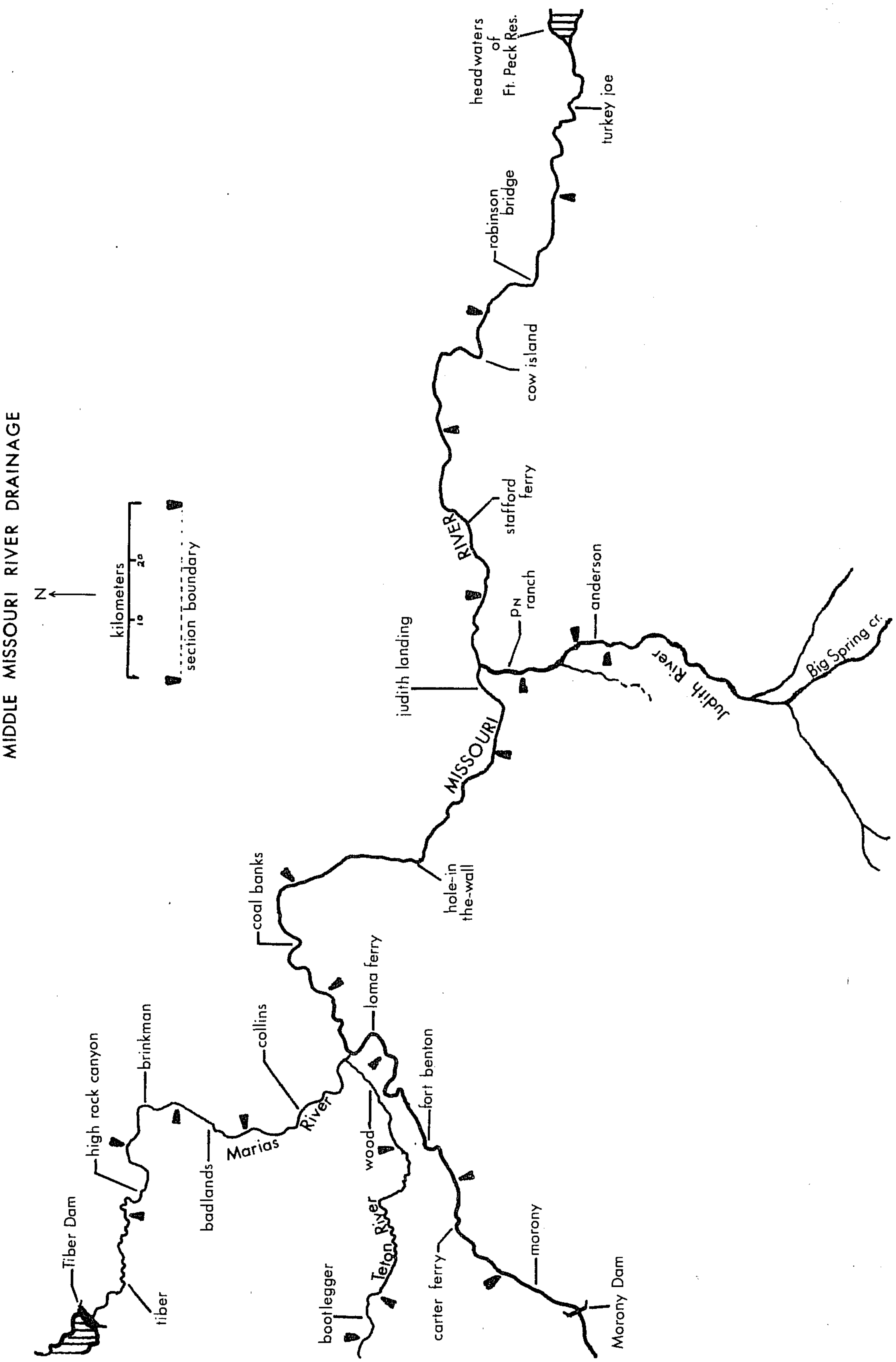


Figure 1. Map of middle Missouri River drainage and study area.

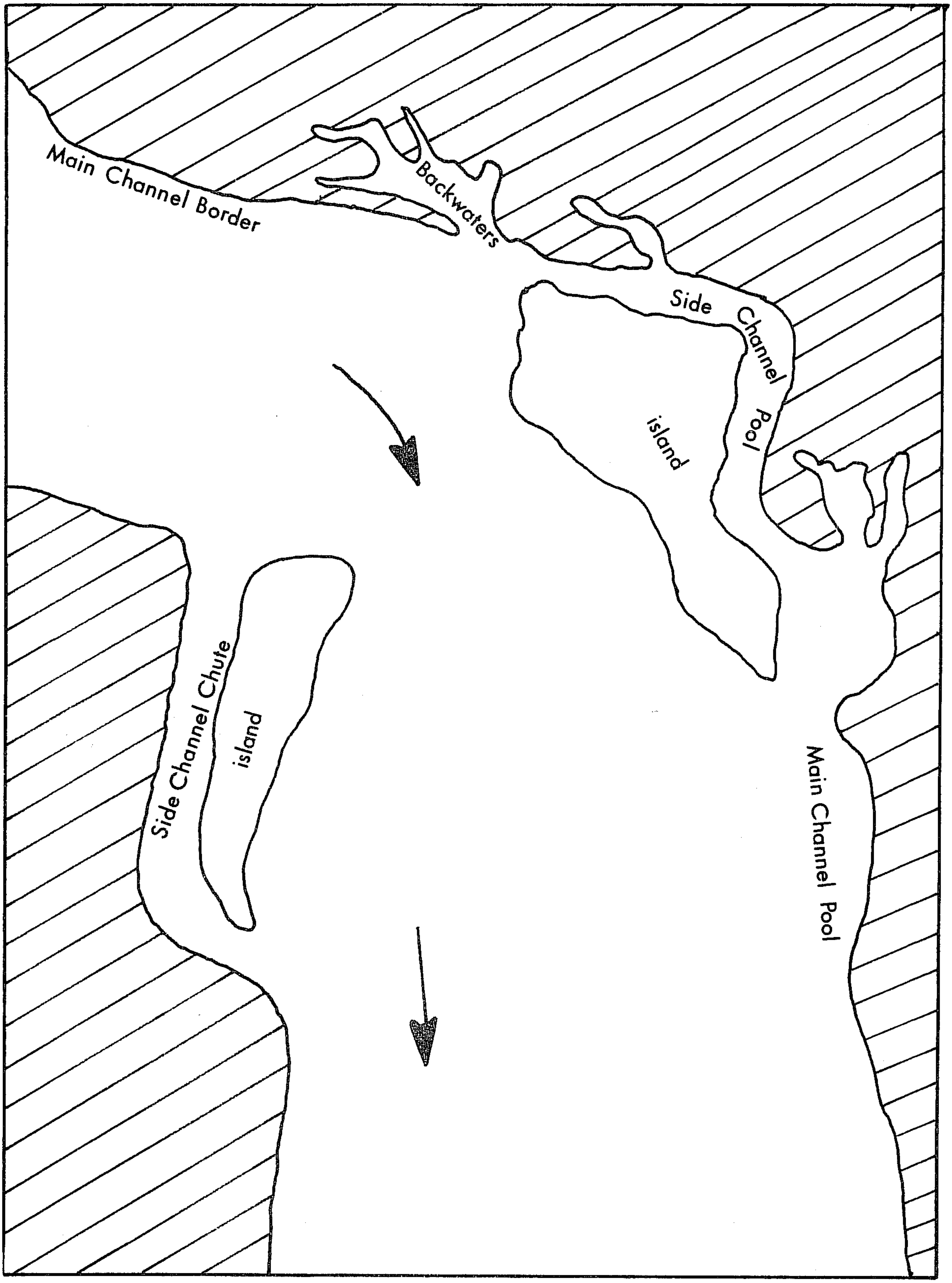


Figure 2. Diagrammatic representation of peripheral habitats in the middle Missouri River. (modified from Kallemeyn and Novotny 1977).

The main channel border habitat type was defined as a zone adjacent to the main channel bank which had an average current velocity of 15 to 45 cm/sec and a depth of 1 meter or less. This habitat type included slow runs, gravel bars and sandbars.

The main channel pool habitat type was defined as an area in the main channel along side the bank which had little current. Depth ranged from 0.4 to 1.0 meter. This habitat type included large wide pools and "pocket pools." "Pocket pools" are described in greater detail in the Results section.

Side channels, islands and backwaters are prominent features of river sections where peripheral channel development occurs. A side channel was defined as a channel diverging from the main channel and containing less than 20 percent of the river's flow. Side channels had an influent and an effluent connection with the main river which allows for a flushing action. A developed island was common with this type of channel divergence. The side channel chute habitat type was defined as a side channel without development of pools and riffles. This habitat type was equivalent to the main channel border type in current velocity and depth. The side channel pool habitat type was defined as a side channel with pools and riffles. Depth ranged from 0.4 to 1.0 meters in this habitat.

The backwater habitat type exhibited no perceptible current velocity and had only a single connection to the main or side channel of the river. Some of the backwaters were formed when the upstream end of a side channel was closed by aggradation or declining water levels.

## METHODS

Adult fish were collected by boom electrofishing in a 5.2-m (17 ft.) flat-bottomed aluminum boat powered by an 85-hp outboard motor equipped with a jet propulsion lower unit (Fig. 3). The electrode system and operation was similar to that described by Berg (1980). The boom electrofishing unit was utilized on the mainstem of the Missouri River during all flows and on the lower Marias River during spring flows. During summer flows, the Teton and Judith Rivers were sampled with a mobile electrofishing unit as described by Berg (1980), and the Marias River was sampled with a boom electrofishing unit mounted on a 4.2-m (13 ft.) fiberglass boat.

### Fish Eggs

Sampling for incubating fish eggs was accomplished with a screened 50-cm square, 13-cm deep handled scoop, similar to that described by Priegel (1969) (Fig. 4). With the scoop positioned in the current, a person kicked downward into the substrate, moving toward the scoop from a distance of approximately 3 meters. Gravel bars where known concentrations of sport fish were observed were sampled randomly at various depths up to 1 meter. The samples were sorted at the site, and the eggs were preserved in a 5 percent solution of formaldehyde. Eggs which could not be identified were sent to Mr. Bob Wallus, an early life stage fish taxonomist, at the TVA fish repository in Norris, Tennessee.

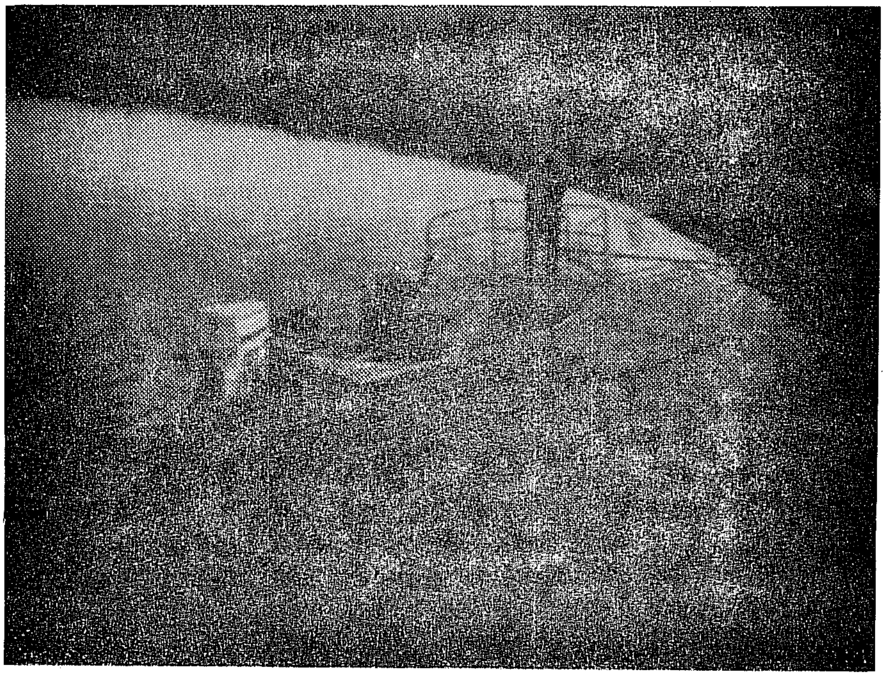

Figure 3. Electrofishing collections were made from a 5.2-meter aluminum boat.

Figure 4. A screened scoop was utilized to sample incubating eggs of important fish species.

## Larval Fish

Larval fish were sampled with a 0.5-meter diameter by 1.6-meter long Nitex plankton net (0.75 mm mesh) fitted with a threaded ring sewn at the distal end to accommodate a widemouth pint mason jar as the collecting bucket (Fig. 5). Two methods of collecting larval fish samples with the 0.5-meter net were employed, stationary sets and integrated width tows.

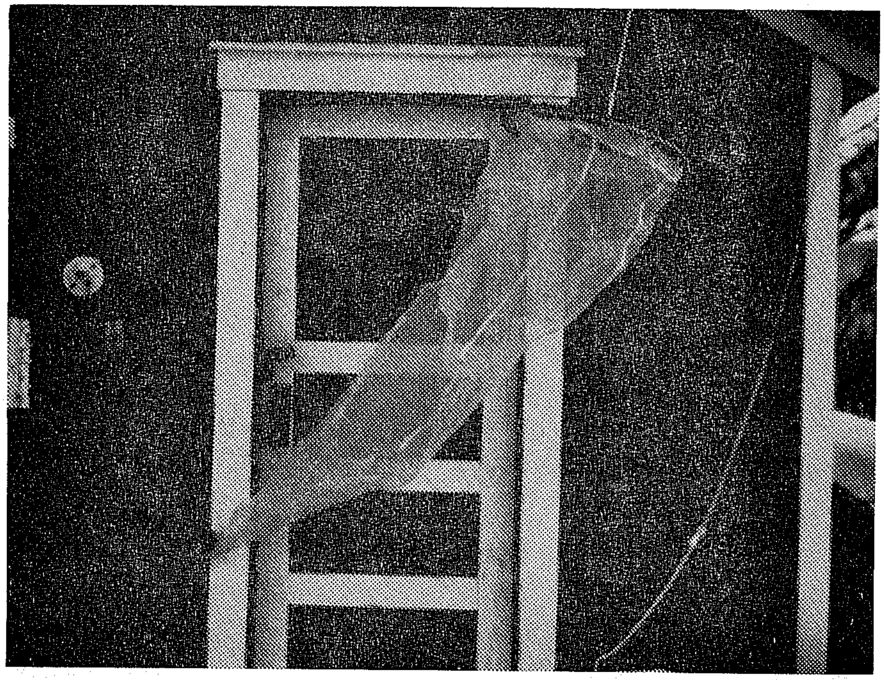

Figure 5. A 0.5-meter diameter larval fish net was used to collect drifting fish larvae in the middle Missouri River and its major tributaries.

The stationary sets involved fishing the 0.5-meter net immediately below the surface of the water in main channel border areas of the river. The net was held in position in the current by a 4-meter length of rope tied to an anchored post. The volume of water filtered was measured with a Price type AA current meter positioned at the center of the net orifice. The net was fished for a measured period of time, usually 30 minutes. On some occasions the net was fished for less than 30 minutes because of excessive amounts of debris collecting in the nets. Stationary set samples were taken at 2-week intervals at five established study stations. The samples were usually collected during the dusk to dawn hours of the day.

The second technique for collecting larval fish samples was the integrated width tows. This technique involved towing the 0.5-meter larval fish net under a boat while traversing the width of the river. The net was towed in this manner for 20 minutes. This method allowed a larger cross-sectioned area of the river to be sampled. The integrated width samples were taken immediately downstream from several sites on the river where spawning of sauger, shovelnose sturgeon or paddlefish was considered to be likely. Again, the samples were usually collected during the dusk or dawn hours of the day.

After the 0.5-meter net was retrieved from the stationary set or integrated width tows, its contents were thoroughly washed into the collection jar. All samples were preserved in a 10 percent solution of formaldehyde colored with phloxine-B dye. In the laboratory, the samples were washed on a U. S. series No. 30 screen. Material retained by the screen was transferred to an enamel sorting pan where the larval fish were extracted. Larvae were identified to the lowest taxon practical using taxonomic keys by Hague et al. (1976) and May and Gasaway (1967). For purposes of this study, larval fish were defined as those fish exhibiting underdeveloped pectoral and dorsal fin rays; essentially as suggested by May and Gasaway (1967).

## Young-of-the-Year Fish and Minnows

Young-of-the-year (YOY) fish and minnows were sampled with a 15.2 x 1.2-meter (50 x 4-ft) beach seine with 3.2 mm (1/8-inch) square mesh (Fig. 6). The seine was operated by two men and worked in as many different habitat types as the current and bottom characteristics allowed. Fish collected were identified, and associated habitat type was recorded.

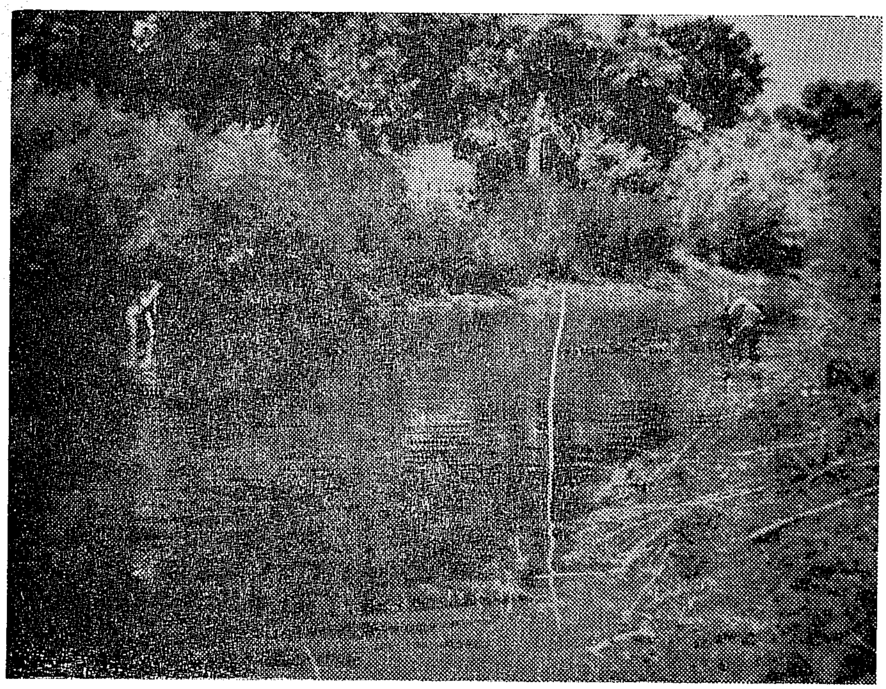

Figure 6. A beach seine was an effective device used to sample for young-of-the-year fish and minnows.

An attempt was also made to sample young-of-the-year fish and minnows with a 2.4-meter (8-ft) wide semi-balloon fry trawl fitted with 3.2-mm (1/8-inch) square mesh Ace webbing in the cod end. The trawl was used in deeper areas of the river which could not be effectively sampled by seining. Preliminary results of sampling with the trawl in 1979 were encouraging. Clams and small cobble substrate were collected, indicating that the trawl was being towed close to the river bottom. Further testing and modification of the trawl and its related rigging will be accomplished in 1980.

To facilitate interpretation of forage fish data, a grading scheme based on percent occurrence and percent composition was utilized. The grading scheme was as follows:

> For a grade of 3 (strong distribution) the species must average a percent composition in the seine hauls greater than 30 percent. This species must also occur in the hauls at least 50 percent of the time.
>
> For a grade of 2 (moderate distribution) the species must average a percent composition of 15-30 percent and occur in at least 50 percent of the hauls.
>
> For a grade of 1 (weak distribution) the species averages a percent composition of less than 15 percent or occurs in less than 50 percent of the hauls.

## Food Habits

Food habits were determined for shovelnose sturgeon and young-of-the-year-fish of several species. Specimens were preserved in a 10 percent solution of formaldehyde. In the laboratory, stomach contents were sorted and identified in the lowest taxon practical using Edmondson's (1959) key.

To facilitate interpretation of the shovelnose sturgeon food habits, a relative importance index (RI) as described by George and Hadley (1979) was utilized. The RI for a particular food item is obtained by summing the numerical percentage, volumetric percentage and percentage of occurrence of the food item in the diet, then dividing by the summation of all the food items in the diet. The formula is:

$$RI\ item_a = 100\ A\ item_a \Big/ \sum_{item_a = 1}^{n} AI\ item_a$$

Where AI $item_a$ = % frequency of occurrence + % total numbers + % total volume for food item a, and n is the number of different food types.

The percent of occurrence of each food item is simply the percentage of fish which consumed that particular food item. The average percent composition by number and volume is the average number or volume of that food item in the sample divided by the average total number or volume of all the food items in that sample, expressed as a percentage.

## RESULTS

### Life Cycle Stages

To determine instream flow requirements for the maintenance of a fish species, each life cycle stage and its requirements should be evaluated. The life cycle stages include: spawning, incubation, larval development, rearing and development to a mature adult. Each of these life cycle stages may require different habitat conditions which in some cases are related to the flow regime of the river. Because of the importance of the early life stages, the main effort of this study was directed in this area.

### Spawning

Attempts were made in the study area to locate spawning sites of shovelnose sturgeon and sauger. It is generally accepted that spawning for these species does not occur randomly, but at specific sites or spawning grounds. Electrofishing was utilized during the spawning period in an effort to locate possible concentrations of fish and identify spawning sites. Because of sampling limitations, this effort was made only on sauger and shovelnose sturgeon.

No unusually large concentrations of adult sauger or shovelnose sturgeon were observed in the study area during their reported spawning seasons in 1979. The inability to locate concentrations of these fish species is probably related in part to efficiency of the electrofishing sampling equipment. However, it is also possible that large concentrations of the spawning fish do not exist, and that spawning occurs in smaller concentrations over a wide area in the mainstem or in isolated tributaries.

The range of the spawning period for sauger and shovelnose sturgeon in the study area was determined by examining a sample of sexually mature fish captured in the electrofishing surveys. The result of these observations is presented in Tables 1 and 2.

Table 1. Spawning conditions of sauger sampled in the Fort Benton through Judith Landing study sections of the middle Missouri River during spring and early summer 1979.

| Date | Spawning Condition |
|---|---|
| May 14 - May 17 | gravid females; partially spent females; spent females; many not ripe fish; few ripe males |
| May 19 - May 24 | spent females; many not ripe fish; increased number of ripe males |
| Jun 4 - Jun 6 | spent females; fewer not ripe fish; many ripe males |
| Jun 16 - Jun 19 | many not ripe fish; fewer ripe males |
| Jul 9 - Jul 16 | all fish sampled not ripe fish |

Table 2. Spawning conditions of shovelnose sturgeon sampled in the Loma Ferry and Coal Banks Landing study sections of the middle Missouri River during late spring and summer 1979.

| Date | Spawning Condition |
|---|---|
| May 19 - May 24 | 52 observed; 17 examined<br>gravid females and not ripe fish |
| Jun 4 - Jun 6 | 46 observed; 12 examined<br>gravid females; not ripe fish; ripe males |
| Jun 5 | unfertilized shovelnose eggs taken from a collected shovelnose stomach |
| Jun 16 - Jun 19 | 77 observed; 8 examined<br>gravid females; 1 spent female; not ripe fish; ripe males |
| Jun 28 | 25 observed; 10 examined<br>2 spent females and ripe males |
| Jul 9 - July 16 | 65 observed; 22 examined<br>gravid females; 3 spent females; not ripe fish; ripe males |

For sauger, the entire spawning period could not be defined because several spent female sauger and a few gravid females were collected on the first sampling effort made on May 14, 1980 (Fig. 7). By May 19, no gravid females were found, and a larger number of spent females and ripe males were observed in the collections. Finally, during the first week of June, the last spent female was collected, and the number of ripe males in the samples decreased noticeably. These observations of the spawning conditions of sauger coincide with those reported by Elser et al. (1977) for the Tongue River during similar dates.

For shovelnose sturgeon, the spawning period was difficult to define. Moos (1978) reported that female shovelnose may take up to 3 years following spawning before their ovaries are again mature. Consequently, there are probably several different stages of ovarian development among sexually mature female shovelnose sturgeon present in the Missouri River population. Thus, it is difficult to determine sex and spawning condition of the fish. For the purposes of this study, sturgeon with distended and turgid abdomens were classified as gravid females, fish with very flaccid abdomens and of a large size were considered spent females, fish with a tight flat abdomen were classified as not ripe, and, if milt could be stripped the sturgeon was considered a ripe male. No ripe females, as evident by stripping eggs, were observed during the spawning period in this study area. The scarcity of ripe females with strippable eggs has also been reported by Moos (1978) and Elser et al. (1977).

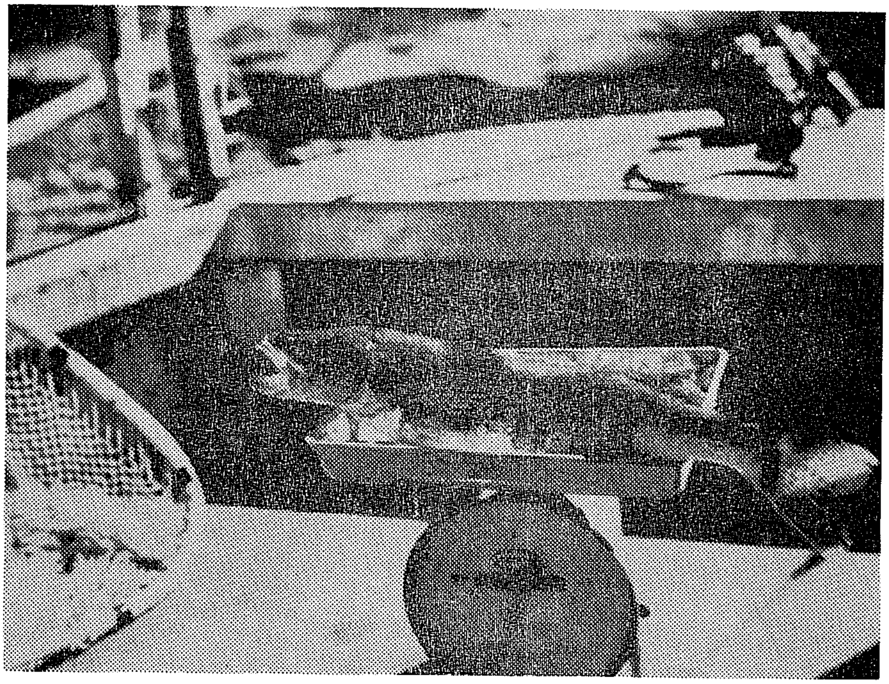

Figure 7. The sauger's spawning peak probably occurred in early May.

To verify our judgment of sex and spawning condition of female shovelnose sturgeon based on external characteristics, a technique for internal examination of the fish was developed. Internal examination provides positive confirmation of sex and spawning condition. The technique consisted of a 5-centimeter surgical incision of the abdomen to examine the gonads. After examination, the surgery was completed by closing the incision with five sutures. A number of shovelnose sturgeon were examined in this manner, and all appeared to be fully recovered within 24 hours. There appeared to be several stages of ovarian development among the female shovelnose examined during the spawning period. The stages included 1) ovaries developed into small size eggs, barely distinguishable, white to pink in color, 2) ovaries developed into small size eggs approximately 1-mm in diameter, white with an occasional black egg, and 3) mature ovarian development consisting of all black eggs approximately 3-mm in diameter. These stages probably represent the first, second and third years of development following a successful spawning season.

In 1979 the first occurrence of ripe male shovelnose sturgeon in the study area was during the first week of June, and the last ripe male was collected in mid July (Fig. 8). Sampling for shovelnose sturgeon was terminated on July 16. Spent female shovelnose sturgeon were noted during the third week in June and the second week in July. A shovelnose sturgeon stomach sample collected on June 5, 1979, for food habits analyses contained three unfertilized shovelnose sturgeon eggs. These preliminary observations indicate that spawning of shovelnose sturgeon in the Missouri River in 1979 occurred primarily during a period from early June through early July.

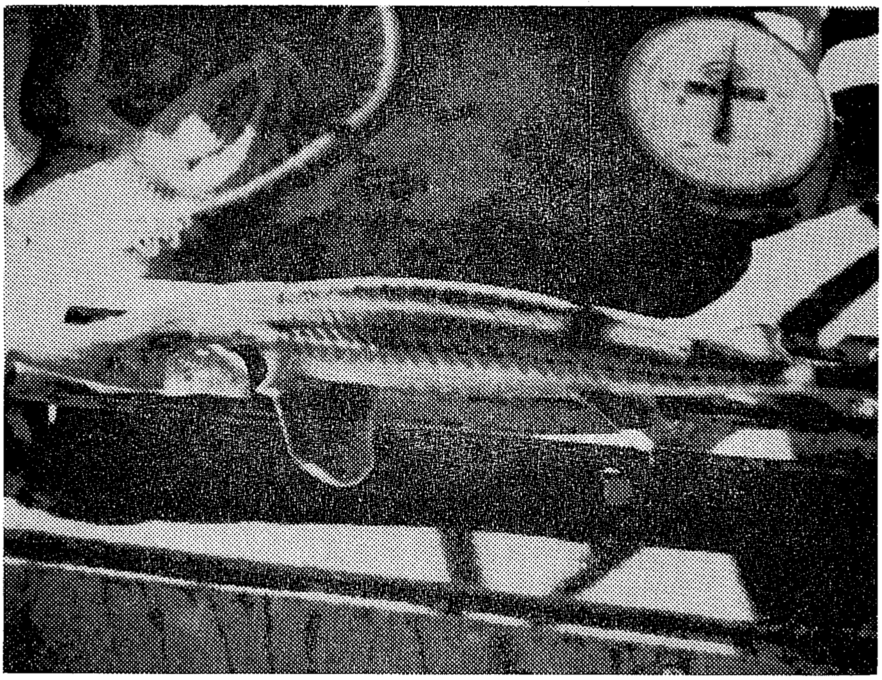

Figure 8. Shovelnose sturgeon were in spawning condition from early June to early July.

Internal examinations were made on a number of shovelnose sturgeon sampled during late August 1979. Several females contained large black eggs which were quite flaccid in nature. Others had smaller, more firm black eggs. It was believed that the former sturgeon were reabsorbing their eggs, while the latter were at the end of the second year of development.

Observations of sex and spawning condition of shovelnose sturgeon examined during the spawning period in 1979 on the Missouri River largely coincide with those reported by Moos (1978) for the Missouri River below Gavins Point Dam and Elser et al. (1977) for the Tongue River in Montana.

## Incubation

An attempt was made to locate fertilized eggs of sauger, paddlefish and shovelnose sturgeon at anticipated or known spawning sites for these speciesin the study area. Types of areas sampled were similar to those described by Nelson (1968) and Graham and Penkal (1978) for sauger, and Purkett (1961) for paddlefish. In general, these areas were usually shallow bars consisting of small gravel. Table 3 indicates the effort and number of eggs sampled in four study sections on the middle Missouri River during 1979. Although most of the incubating eggs collected were identified as goldeye, sucker or cyprinid eggs, one incubating paddlefish egg was collected near Stafford Ferry on June 12, 1979. This was approximately a 55-hour embryo as described by Ballard and Needham (1964). The embryo was sent to the TVA fish repository in Norris, Tennessee, and identification was verified by Bob Wallus, an early life history taxonomy specialist. Berg (1980) previously reported that the Stafford Ferry area, with its numerous gravel bars, was the most important spawning site utilized by migrating paddlefish in the Missouri River upstream from Cow Island.

Table 3. Number of egg samples taken and number of eggs collected (in parentheses) in four study sections on the middle Missouri River during 1979.

| | Loma Ferry | Coal Banks | Stafford Ferry | Cow Island |
|---|---|---|---|---|
| May 22-Jun 6 | 16(6) | 3(0) | 7(0) | 17(1) |
| Jun 12-Jun 20 | 4(7) | 8(17) | 18(12)* | 24(17) |
| Jun 27-Jul 3 | 15(44) | 14(0) | 17(0) | 15(2) |
| Jul 10-Jul 17 | 7(0) | 6(0) | 14(0) | - |
| Total No. | 42(57) | 31(17) | 56(12) | 56(20) |

* One paddlefish egg collected June 12

## Larval Fish

Larval fish were sampled in eight study sections in the middle Missouri River from late May through early July 1979. Results of the sampling are shown in Table 4. The larval fish sampling was conducted to determine timing and location of successful hatching and emergence of important fish species in the middle Missouri River. This information will eventually be examined to determine possible correlations of hatching success with stream discharge and water temperature. An example of larval fish sampled in the river is shown in Fig. 9.

Nine sauger and one salmonid were the only game fish collected in the larval fish samples taken in 1979. Of the nine sauger sampled, all were collected between May 28 and June 5. Assuming an incubation period of 13 to 21 days as described by Nelson (1968), sauger spawning occurred on May 7 at the earliest and May 23 at the latest.

Figure 10 indicates that at least two different seasonal distributions of larval fish existed in the study area during 1979. The curves for the Loma Ferry and Stafford Ferry study sections indicate a peak in the abundance of larval fish occurring between late May and mid-June. In contrast, the abundance of larval fish in the Cow Island study section gradually increases to a peak in early July. The relatively early peaks at Loma Ferry and Stafford Ferry are related to the dominance of Catostominae in the larval fish samples taken in these study sections. The predominance of cyprinid larvae explains the later peak in the Cow Island study sections. Berg (1980) observed similar seasonal distributions of larval fish in the middle Missouri River in 1978. Brown (1971) indicates that suckers spawn earlier and prefer swifter waters for spawning than cyprinids. The cyprinids show a preference for slower protected waters and this type of habitat is prevalent in the Cow Island study section.

Table 4. Taxonomic composition of fish larvae sampled by both stationary and integrated width tows in the middle Missouri River during late May - late July 1979.

| | | Total number of larvae sampled | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Study Section | Number of Tows | Goldeye | Salmonid | Catostominae | Ictiobinae/ cyprinidae group | Stonecat | Sauger | Sculpin |
| Carter Ferry | 4 | | 1 | 36 | | | | |
| Fort Benton | 5 | | | 81 | 1 | | | |
| Loma Ferry | 9 | 6 | | 734 | 130 | | 1 | |
| Coal Banks | 9 | | | 152 | 32 | | | |
| Judith Landing | 5 | 1 | | 40 | 21 | 1 | 1 | |
| Stafford Ferry | 7 | 2 | | 205 | 33 | | 1 | 1 |
| Cow Island | 14 | 1 | | 143 | 192 | | 1 | |
| Robinson Bridge | 2 | | | 15 | 4 | | 5 | |

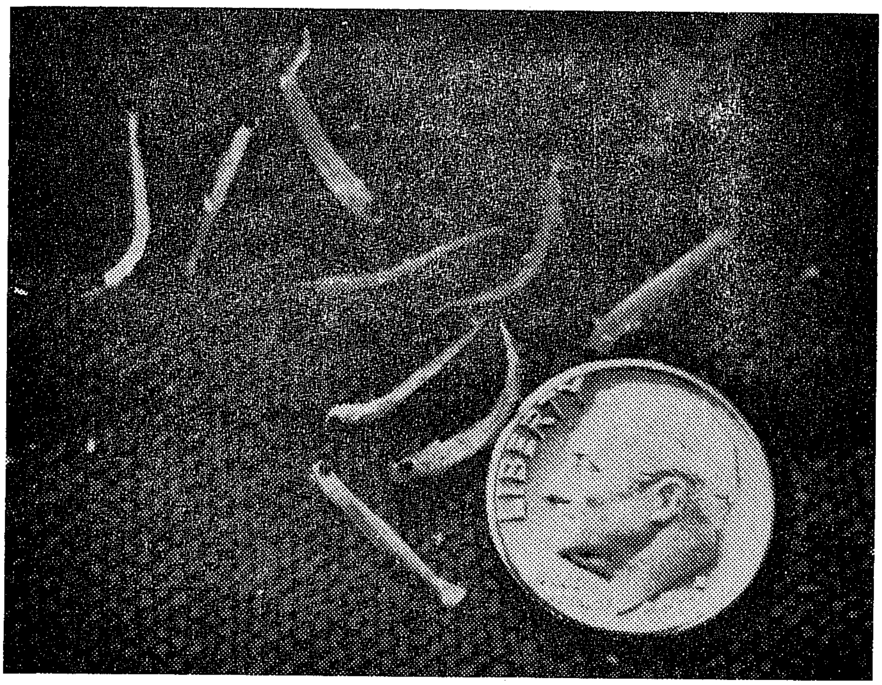

Figure 9. Fish larvae of eight subordinal taxa were collected in the middle Missouri River and its major tributaries.

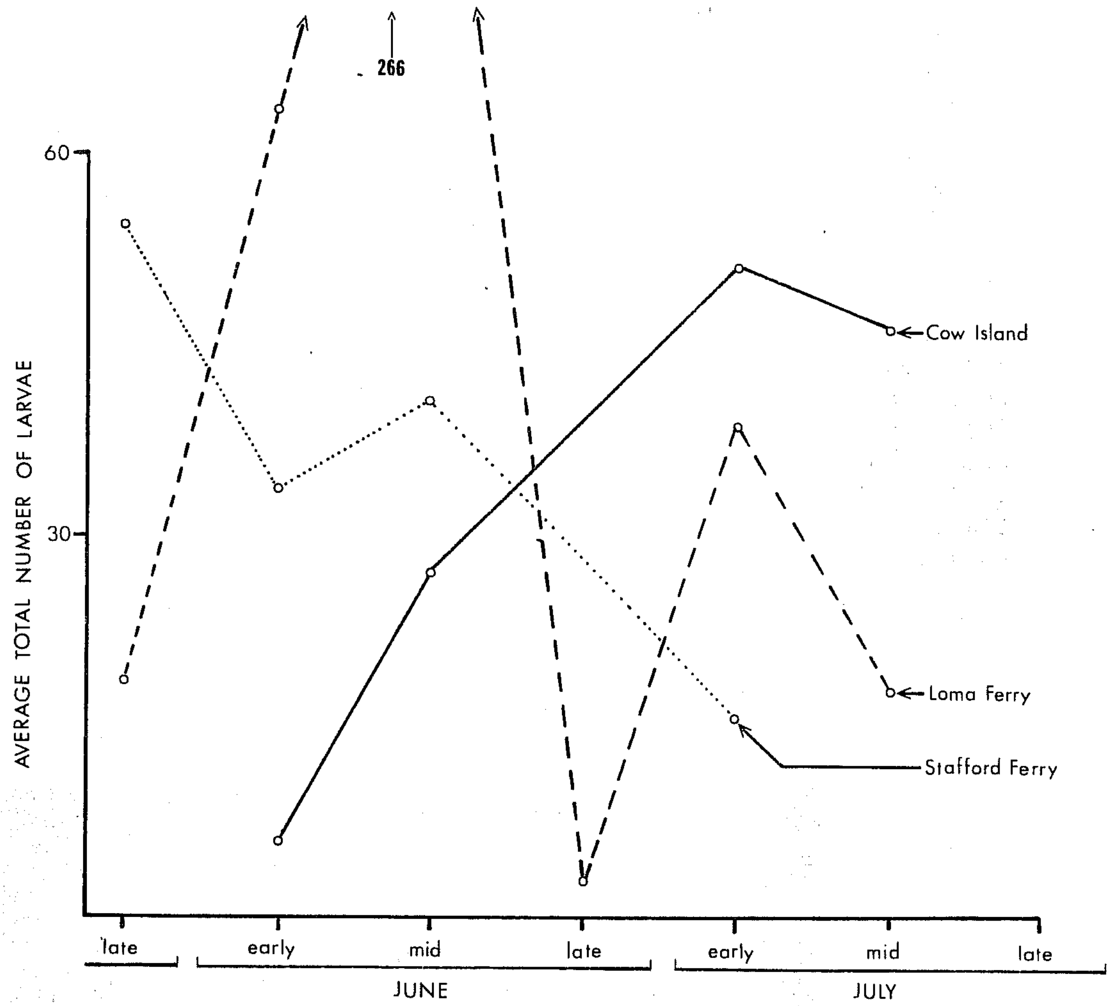


Figure 10. Average total number of fish larvae collected from 20-minute integrated width tows taken in three sections of the middle Missouri River during late May - mid-July, 1979.

In a study of the larval fish distribution and abundance for the Missouri River below Gavins Point Dam, Kallemeyn and Novotny (1977) observed noticeable increases of larval cyprinid catches during July and August. Disregarding the obvious effects of the dam, they observed a seasonal curve of larval fish abundance similar to that of the Loma Ferry or Stafford Ferry sites in this study area.

Larval fish were sampled near the mouths of the Marias, Teton and Judith Rivers from late May through early August 1979. The sampling was conducted to evaluate success of spawning in the tributaries and to determine importance of the tributaries in providing recruitment of larval fish to the mainstem of the middle Missouri River. Results of the sampling are shown in Table 5.

Table 5. Taxonomic composition and seasonal densities (number per 100 $m^3$ of river filtered) of fish larvae sampled in the three major tributaries of the middle Missouri River during 1979.

Total number of larvae sampled

| | Goldeye | Catostominae | Ictiobinae/ Cyprinidae | Channel Catfish | Stonecat | Sauger | total |
|---|---|---|---|---|---|---|---|
| Marias | | 938 | 87 | | | 1 | 1026 |
| Teton | 1 | 446 | 218 | | 1 | | 666 |
| Judith | 1 | 5 | 18 | 33 | | | 57 |

Density of larvae sampled (No./100 $m^3$)

| | late May | early June | mid-June | late June | early July | mid-July | late July | early August |
|---|---|---|---|---|---|---|---|---|
| Marias | 114 | 38 | | 68 | 92 | | 285 | 14 |
| Teton | 169 | 11 | | 137 | 189 | | 57 | 3 |
| Judith | 1 | | 3 | 1 | | 3 | | 18 |

Ninety-one percent of the 1,026 fish larvae collected from the Marias River in 1979 were Catostomiae. The remainder were primarily from the Ictiobinae/Cyprinidae group. Substantial spawning runs of sauger and shovelnose sturgeon were observed in the lower Marias River in 1979 (Berg 1980), but only one sauger larva and no sturgeon were collected. The scarcity of sauger and sturgeon larvae in the collections was probably related more to sampling efficiency than to lack of spawning success. Berg (1980) collected a large variety of fish larvae near the mouth of the Marias River in 1978. In addition to the species listed on Table 4, he collected channel catfish, stonecat, goldeye, and shovelnose sturgeon larvae. Peak densities of larval fish in the lower Marias River in 1979 occurred from late June through July. Very few larvae were collected before late May.

Sixty-seven percent of the 666 fish larvae collected from the Teton River in 1979 were Catostominae, and 33 percent were Ictiobinae/Cyprinidae. The percentage of Ictiobinae/Cyprinidae in the larval fish samples was substantially greater for the Teton River than for the Marias River. Goldeye and stonecat larvae were sampled in the Teton River in 1979, but they were sampled only once each. Peak densities of larval fish in the Teton River in 1979 were similar to the Marias River. A substantial spawning run of channel catfish was observed in the lower Teton River in 1979 (Berg 1980), but no catfish alevins were collected in the larval fish samples. The scarcity of catfish alevins is probably related more to insufficient sampling frequency than to lack of spawning success.

Fifty-eight percent of 57 fish larvae collected from the Judith River in 1979 were catfish alevins, 32 percent were Ictiobinae/Cyprinidae and 9 percent were suckers. Goldeye larvae were sampled on one occasion. The 33 catfish alevins collected on August 2, indicate that the Judith River is probably an important tributary for spawning of channel catfish. The catfish alevins were collected when water temperature of the Judith River was near its annual maximum. A water temperature of 25 C was was recorded at 2200 hours on August 2.

The predominance of Ictiobinae/Cyprinidae over Catostominae in the Judith River is in contrast to findings on the Marias and Teton Rivers. Also, total numbers and densities of larval fish collected in the Judith River were less than in the Marias and Teton Rivers. However, the large amount of suspended organic material carried by the Judith River probably reduced sampling efficiency. The relatively low larval fish densities could be a reflection of this problem.

## Rearing Areas

Ten study sections on the middle Missouri were sampled during 1979 in an effort to determine rearing habitat preferences of important fish species. Sampling was directed primarily toward peripheral habitat areas such as side channels and backwaters. Peripheral habitat areas are affected by reductions of stream flow levels much sooner than nonperipheral areas. If peripheral habitat areas are important in the life cycle of important fish species in the middle Missouri River, minimum flows required to maintain these habitats should be determined. If adequate flows are secured to maintain peripheral habitat areas, flow in nonperipheral habitat areas should be more than adequate.

Results of rearing habitat preference studies conducted on the middle Missouri River in 1979 indicate that young-of-the-year sauger (Fig. 11) select protected habitat in peripheral areas of the stream. During July, August and September, 43 percent of the 122 young-of-the-year sauger sampled in the Missouri River were found in the side channel pool habitat type (Fig. 12). The catch rate in side channel pool averaged 1.86 young-of-the-year sauger per seine haul (Fig. 13). Main channel pools, backwaters, main channel borders and side channel borders accounted for 30, 18, 7 and 2 percent of the young-of-the-year sauger, respectively. Catch rates also followed a similar pattern averaging 0.54, 0.46, 0.12 and 0.17 young-of-the-year sauger per haul for the previously mentioned habitat types.


Figure 11. Young-of-the-year sauger ranging in length from 40 to 188 millimeters were collected in various peripheral habitat types on the middle Missouri River.

Figure 12. This typical side channel pool, 2 kilometers in length, was intensively utilized by rearing young-of-the-year sauger in 1979.

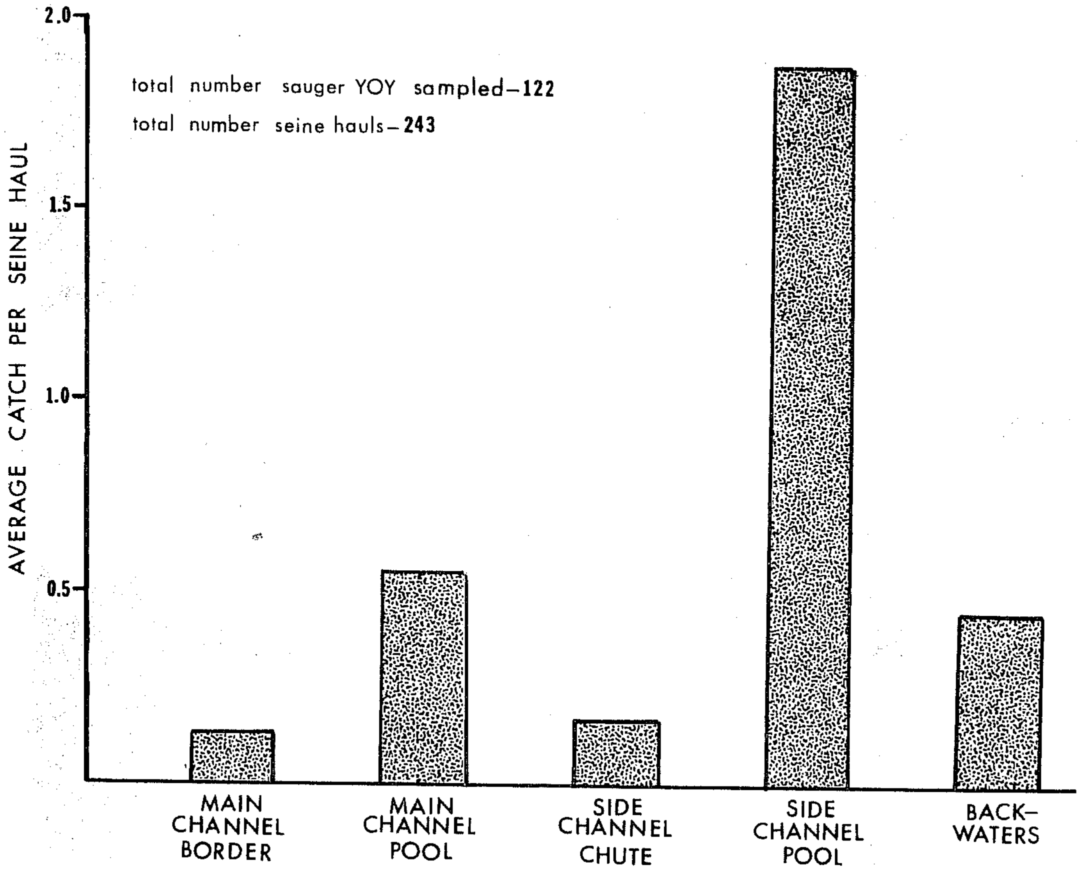


Figure 13. Young of the year (YOY) sauger habitat preferences as described by the average catch rates of YOY sauger seined in five habitat types of the middle Missouri River during Summer, 1979.

Seventy percent of the young-of-the-year sauger sampled during July, August and September were found in the Cow Island and Robinson Bridge study sections. Catch rates were highest in the Robinson Bridge study section averaging 1.57 young-of-the-year sauger per seine haul (Fig. 14). This indicates that the Cow Island and Robinson Bridge study sections contain a substantial amount of sauger rearing habitat. This area is probably vital for the maintenance of sauger populations throughout the middle Missouri River.

The Hole-in-the-Wall study section also contained a significant amount of sauger rearing habitat. Eighteen percent of the young-of-the-year sauger sampled during July, August and September were found in this study section, and catch rates averaged 0.71 young-of-the-year sauger per seine haul.

Habitat preferences probably had a large influence on the longitudinal distribution of young-of-the-year sauger in the middle Missouri River during 1979. The Robinson Bridge study section contained an extensive amount of the most preferred sauger rearing habitat type, the side channel pools. The Hole-in-the-Wall study section contained a considerable number of main channel "pocket pools" which provided important sauger rearing habitat. The "pocket pools" are formed by small peninsulas extending perpendicular to the channel margin. The "pocket pools" are located immediately downstream from and behind the peninsula (Fig. 15).

Of the major sport fish found in the middle Missouri River, sauger appears to be the only species which rears in shallow water habitat. Kallemeyn and Novotny (1977) and Kozel (1974) reported that of the few young-of-the-year sauger collected, most were found off shallow sandbars or in the backwaters habitats. Walburg (1976) reported that most of the young-of-the-year sauger which he collected were found in the shallow floodplain (shoals) of Lewis and Clark Reservoir.

In the fall of 1979, there appeared to be a change in sauger rearing habitat preferences in the study area. Catch rates in rearing areas which could be effectively seined decreased noticeably during October when compared to catch rates in the same areas during July, August and September. The preferred rearing areas apparently shifted to deeper water during October, and most of these areas could not be effectively seined. An attempt was made to sample this deeper water with a 2.4-meter (8-ft.) wide semi-balloon fry trawl. However, this trawl was lost in the river shortly after initial testing. Sampling with a trawl will be resumed in 1980 in an attempt to document the shift of sauger rearing habitat preference.

The WETP instream flow methodology will be utilized in 1980 in an effort to determine the amount of instream flow required to maintain sauger rearing habitat. Our knowledge of the habitat preference of young-of-the-year sauger will aid in selecting sites for measuring physical characteristics of the river. Available habitat will then be determined at various flows by examining the hydraulic simulation model generated by the WETP computer program. WETP is a simplified version of the IFG instream flow methodology developed by Nelson (1980).

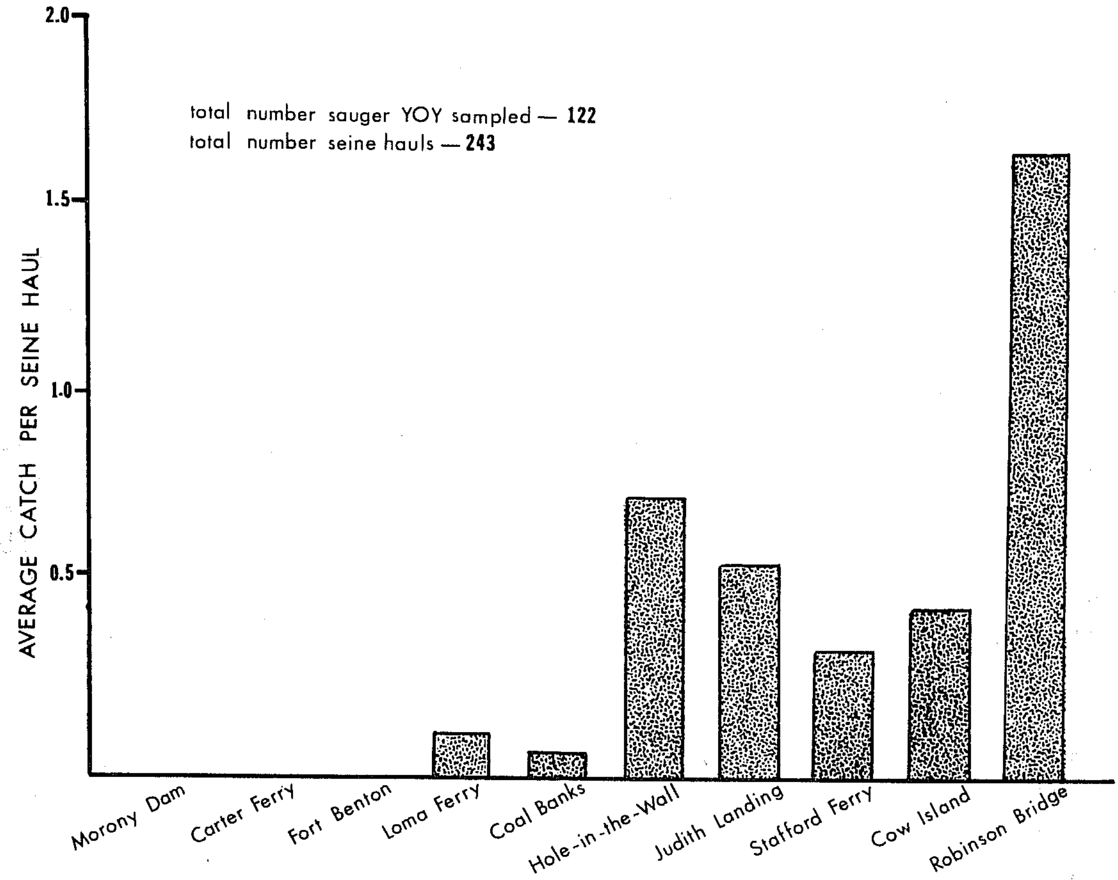


Figure 14. Longitudinal distribution and abundance (average catch rates) of young-of-the-year (YOY) sauger seined in the middle Missouri River during Summer, 1979.

Figure 15. The Hole-in-the-Wall section exhibited extensive channel margin development; several peninsulas perpendicular to the margin formed important sauger rearing "pocket pools."

Forage Fish

The forage fish community of the Missouri River plays a very important role in providing an adequate food base for piscivorous fish species such as sauger, northern pike, burbot, walleye and channel catfish. Therefore, it is important that habitat requirements are met to maintain these forage fish for the welfare of the sport fishery as well as for the welfare of the forage fish species themselves. This phase of the investigation was conducted to determine longitudinal distribution of forage fish species in the middle Missouri River and to identify their preferred habitat types. For the purposes of this study a forage fish was broadly defined as any fish utilized by another fish as a food source. This would include most age 0 fish and nearly all adult minnows.

The longitudinal distribution of forage fish sampled in the middle Missouri River during 1979 is shown in Table 6. Twenty-four species were collected within the 336-kilometer reach of river. Considering the minnow family only, all of the species reported by Brown (1971) to occur in the middle Missouri River mainstem were collected. A notable addition was the collection of several sicklefin chubs (*Hybopsis meeki*) which had been previously reported to be in the Missouri River only as far upstream as the confluence of the Little Missouri River in North Dakota. This minnow is described by Pflieger (1975) "as strictly confined to the main channels of large turbid, rivers where it lives in a strong current over a bottom of sand or fine gravel." In the 70-kilometer reach of the Missouri River from Cow Island to the headwaters of Fort Peck Reservoir where the sicklefin chubs were found, the river generally exhibits the features described by Pflieger. Because of its strict requirements for a limited habitat and its paucity in Montana rivers, the Department of Fish, Wildlife and Parks recently designated this fish as a species of special concern.

Table 6. Longitudinal distribution of forage fish species seined in the middle Missouri River during 1979.

| | Morony Dam | Carter Ferry | Ft. Benton | Loma Ferry | Coal Banks | Hole-in-the-Wall | Judith Landing | Stafford Ferry | Cow Island | Robinson Br. | Turkey Joe |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Goldeye | | | | | | * | * | | * | * | * |
| Mountain whitefish | | * | | | * | | | | | | |
| Carp | * | * | * | * | * | * | * | * | * | * | |
| Flathead chub | * | * | * | * | * | * | * | * | * | * | * |
| Sickle fin chub | | | | | | | | | * | * | * |
| Lake chub | * | * | * | * | * | * | * | | | | |
| Emerald shiner | * | * | * | * | * | * | * | * | * | * | * |
| Brassy minnow | | | | | | | | | | | * |
| Plains minnow | * | * | | * | | | | | | * | |
| Western silvery minnow | * | * | * | * | * | * | * | * | * | * | |
| Fathead minnow | * | * | * | * | * | * | | | | | |
| Longnose dace | * | * | * | * | * | * | * | * | * | * | * |
| River carpsucker | | | | * | * | * | * | * | * | * | * |
| Smallmouth buffalo | | | | | | | | | | | * |
| Shorthead red-horse sucker | * | * | * | * | * | * | * | * | * | * | * |
| Longnose sucker | * | * | * | * | * | * | * | | * | * | |
| White sucker | * | * | * | * | | * | | | | | |
| Channel catfish | | | | | | | | | * | * | |
| Stonecat | | * | | * | | * | * | * | * | | |
| Yellow perch | | * | * | | | | | | * | | * |
| Sauger | | | | * | * | * | * | * | * | * | * |
| Iowa darter | | * | | | | | | | | | |
| Freshwater drum | | | | | | | | | | | * |
| Mottled sculpin | * | * | | * | | * | | | | * | |

Another notable extension of a forage fish distribution was the collection of the Iowa darter in the Carter Ferry study section. Previous to this discovery the known range of Iowa darters in Montana was limited to tributaries of the Little Missouri River and to the Missouri River and its tributaries below Fort Peck Dam (Brown 1971). The habitat where Iowa darters were collected in the Carter Ferry study section is similar to Brown's description of their habitat. He described the habitat as being "clear slow-flowing streams with solid bottoms."

Peripheral areas of the stream channel appear to play an important role in the relative abundance and diversification of forage fish populations in the study area. The average number of forage fish captured was greatest in the backwaters, main channel pools and side channel pools (Table 7). An average of 125, 104 and 81 fish per seine haul was captured in each of these habitat types, respectively. Main channel border and side channel chute habitat types averaged 45 and 31 forage fish per seine haul, respectively. The backwaters habitat type had the greatest variety of forage fish species averaging 5.8 different species per seine haul. Side channel pools, main channel pools, main channel borders and side channel chutes averaged 5.5, 4.8, 3.6 and 3.3 species per seine haul, respectively. Considering both relative abundance and diversity, the backwaters were the most preferred forage fish habitat type, and side channel chutes were the least preferred. It is apparent that forage fish in the middle Missouri River prefer protected slow water habitat types.

Table 7. Relative abundance and diversity of forage fish seined in five habitat types of the middle Missouri River during 1979.

| Habitat Type | Ave. number fish/haul | Median number fish/haul | Ave. number species/haul | Mode of number species/haul | Total number of hauls |
|---|---|---|---|---|---|
| Main Channel Border | 45.2 | 19 | 3.6 | 3 | 84 |
| Main Channel Pool | 104.2 | 56 | 4.8 | 4 | 68 |
| Side Channel Chute | 30.6 | 10 | 3.3 | 3 | 18 |
| Side Channel Pool | 81.3 | 33 | 5.5 | 5 | 26 |
| Backwaters | 125.2 | 95 | 5.8 | 7 | 46 |

Longitudinal distribution and relative abundance of seven of the most widely distributed forage fish in the study area are presented in Fig. 16. Flathead chubs, enerald shiners and western silvery minnows were relatively more abundant in the lower gradient downstream study sections. In contrast, longnose dace and suckers were more prevalent in the swift habitat areas found in the upstream study sections.

Specific habitat preferences of the seven common forage fish species are shown in Fig. 17. With the exception of the longnose sucker, all of these species exhibited preferences for certain habitat types. Western silvery minnows and young-of-the-year carp and shorthead redhorse showed a preference for the protected habitat types, which include main channel pools,

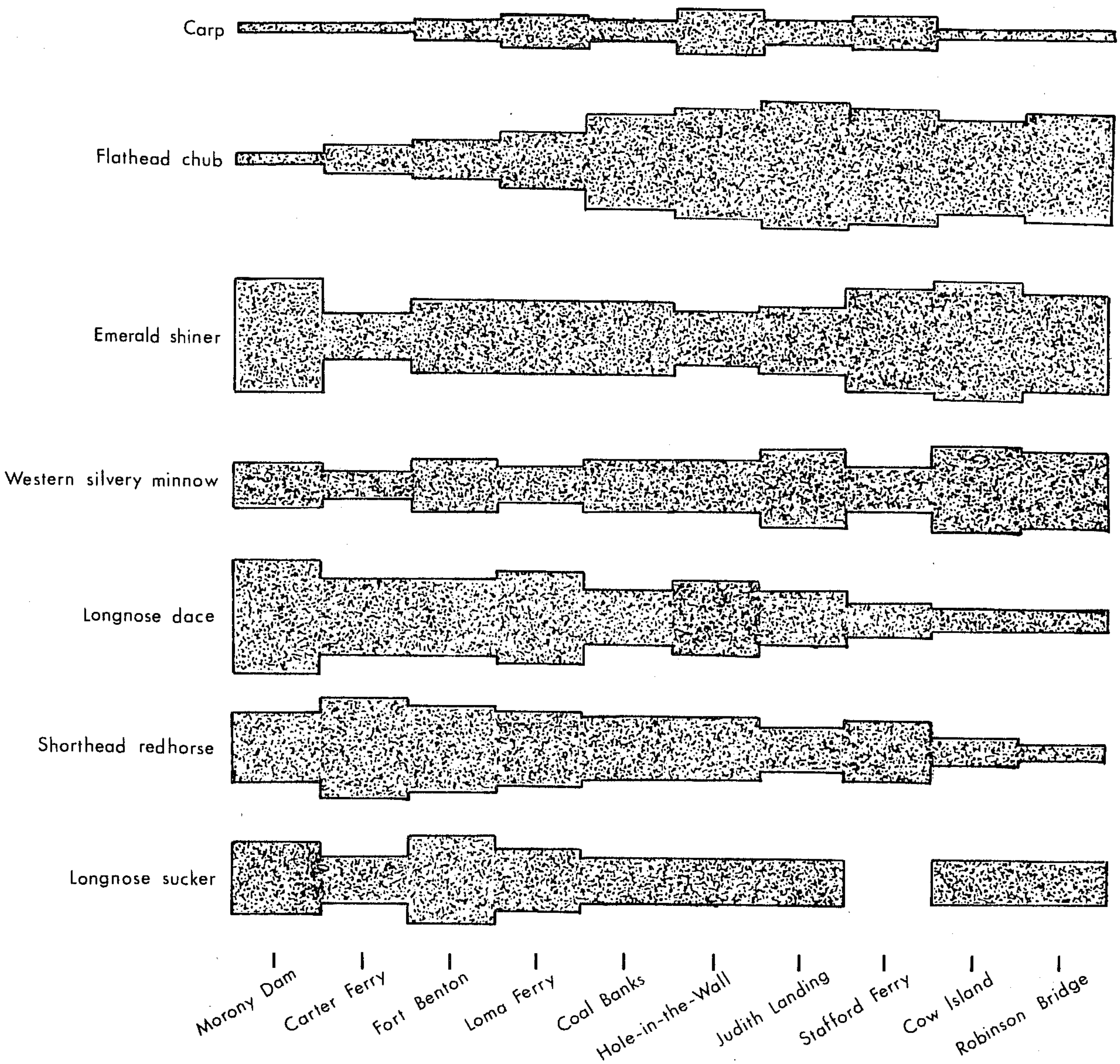


Figure 16. Longitudinal distribution and relative abundance (grade of occurrence) of seven common forage fish species seined in the middle Missouri River during 1979.

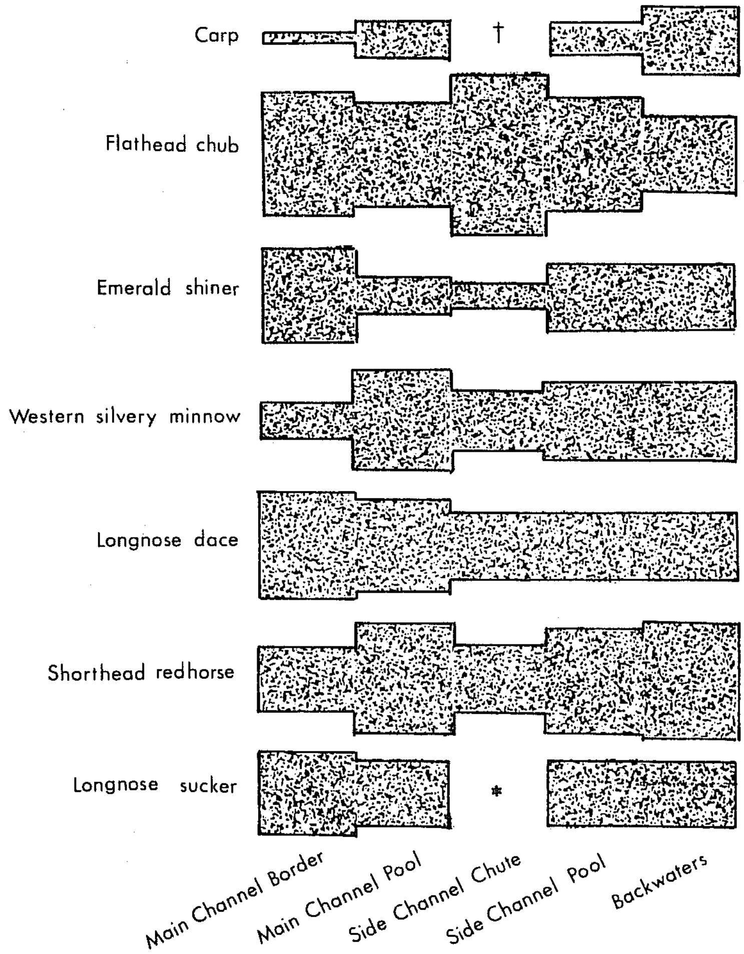


Figure 17. Forage fish habitat type preferences as described by the relative abundance (grade of occurrence) of seven common forage fish species seined in five habitat types of the middle Missouri River during 1979.
+ zero fish collected in this habitat type
* This habitat type not sampled in its preferred longitudinal range.

side channel pools and backwaters. Emerald shiners and longnose dace preferred the main channel border habitat type. Flathead chubs were most prevalent in side channel chutes and main channel borders.

The WETP instream flow methodology will be utilized in 1980 in an effort to determine the amount of instream flow required to maintain forage fish habitat. Our knowledge of the habitat preference of forage fish will aid in selecting sites for measuring physical characteristics of the river. Available habitat will then be determined at various flows by examining the hydraulic simulation data generated by the WETP computer program.

## Food Habits

An essential part of a fish species habitat is the area where it fulfills its food requirements. A thorough understanding of a fish species' food habits throughout the year is necessary in order to determine the importance of specific food organisms. After a fish species' food habits have been determined, a reasonable evaluation can be made of the amount of instream flow required to maintain the habitat of important food organisms.

### Shovelnose Sturgeon

Food habits analyses were completed for 68 adult shovelnose sturgeon collected by electrofishing in the Loma Ferry and Coal Banks Landing study sections of the middle Missouri River. The sturgeon were collected during the autumn of 1978 and during the spring, summer and autumn of 1979. The fish ranged in weight from 1200 to 4680 grams.

Results of the shovelnose sturgeon food habits analyses are presented in Table 8. The diet was basically comprised of a wide variety of aquatic insects. Twenty-three subordinal taxa of aquatic insects were observed in the diet.

The relative importance (RI) of mayflies in the diet of shovelnose sturgeon was high during all seasons. Mayflies were the most important order in the diet during the spring and summer with an average RI of 44 percent. Eight subordinal taxa of mayflies were observed in the sturgeon diet.

The stonefly order, represented by at least four subordinal taxa, exhibited an average seasonal RI of 12 percent, which was considered a moderate representation in the diets. The caddisfly order was also heavily utilized as food by shovelnose sturgeon. Represented by six subordinal taxa, caddisflies had an average RI of 29 percent for all seasons combined. Caddisflies were the most important order in the diet in the autumn with an average RI of 42 percent. The volumetric percentages of caddisflies in the diet were always high, averaging 63 percent for all seasons combined. Mayflies, by comparison averaged 29 percent of the volume in the diet for all seasons combined.

The trueflies, represented by at least 4 subordinal taxa, were the third most important food group in the diet of shovelnose sturgeon. Their average seasonal RI was 19 percent. Miscellaneous taxa were of little significance in the diets of shovelnose sturgeon, but it was interesting that fish tissue, as evident by skeletal features, was consumed.

Table 8. Percentages of occurrences, average total numbers and volumes of the food items found in the diets of adult shovelnose sturgeon in the middle Missouri River during 1978-1979.

| | 1978 Autumn | | | | 1979 Spring | | | | 1979 Summer | | | | 1979 Autumn | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | %O | %N | %Vol | RI | %O | %N | %Vol | RI | %O | %N | %Vol | RI | %O | %N | %Vol | RI |
| Mayfly | | | | | | | | | | | | | | | | |
| *Rhithrogena* | 65 | 2 | 1 | 7.4 | 73 | 8 | 9 | 8.4 | 100 | 9 | 15 | 11.0 | 29 | 1 | tr | 4.1 |
| *Heptagenia* | 70 | 1 | 1 | 8.0 | 45 | 1 | 1 | 4.4 | 20 | tr | tr | 1.8 | 43 | 1 | tr | 6.1 |
| *Baetis* | 53 | 2 | 1 | 6.1 | 73 | 18 | 6 | 9.0 | 100 | 13 | 5 | 10.5 | 43 | tr | tr | 5.9 |
| *Tricorythodes* | 33 | tr | tr | 3.6 | 0 | - | - | - | 50 | tr | tr | 4.4 | 29 | tr | tr | 4.0 |
| *Ephron* | 10 | tr | tr | 1.1 | 0 | - | - | - | 80 | 6 | 8 | 8.3 | 0 | - | - | - |
| *Ephemera* | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - | 14 | tr | tr | 1.9 |
| *Traverella* | 30 | 1 | tr | 3.4 | 0 | - | - | - | 100 | 29 | 43 | 15.3 | 29 | 1 | tr | 4.1 |
| *Ephemerella* | 23 | tr | tr | 2.5 | 100 | 16 | 26 | 13.2 | 30 | tr | tr | 2.7 | 14 | tr | tr | 1.9 |
| Stonefly | | | | | | | | | | | | | | | | |
| *Isogenus* | 38 | 1 | 2 | 4.5 | 45 | 1 | 1 | 4.4 | 30 | tr | 1 | 2.8 | 57 | 7 | 13 | 10.6 |
| *Isoperla* | 5 | tr | tr | 0.5 | 64 | 2 | 1 | 6.2 | 10 | tr | tr | 0.9 | 0 | - | - | - |
| *Acroneuria* | 23 | 1 | 3 | 3.0 | 27 | tr | 1 | 2.6 | 10 | tr | tr | 0.9 | 0 | - | - | - |
| *Claassenia* | 5 | tr | tr | 0.5 | 9 | tr | 1 | 0.9 | 0 | - | - | - | 0 | - | - | - |
| Unidentified | 13 | tr | tr | 1.4 | 18 | tr | tr | 1.7 | 60 | tr | tr | 5.3 | 14 | tr | tr | 1.9 |
| Caddisfly | | | | | | | | | | | | | | | | |
| Hydropsychidae* | 100 | 73 | 87 | 28.4 | 100 | 36 | 52 | 17.5 | 100 | 18 | 22 | 12.4 | 100 | 74 | 81 | 35.1 |
| *Oecetis* | 45 | tr | tr | 4.9 | 73 | tr | tr | 6.8 | 10 | tr | tr | 0.9 | 14 | tr | tr | 1.9 |
| *Brachycentrus* | 68 | 1 | 1 | 7.7 | 45 | tr | tr | 4.2 | 20 | tr | tr | 1.8 | 29 | 5 | 4 | 5.2 |
| *Glossosoma* | 0 | - | - | - | 0 | - | - | - | 10 | tr | tr | 0.9 | 0 | - | - | - |
| *Hydroptila* | 5 | tr | tr | 0.5 | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - |
| Truefly | | | | | | | | | | | | | | | | |
| Chironomidae (midge) | 95 | 17 | 2 | 12.5 | 91 | 10 | tr | 9.4 | 100 | 12 | 3 | 10.2 | 86 | 8 | tr | 12.9 |
| *Simulium* | 18 | 1 | tr | 2.1 | 91 | 6 | tr | 9.0 | 90 | 9 | 3 | 9.1 | 29 | 1 | tr | 4.1 |
| *Tipula* | 3 | tr | tr | 0.3 | 18 | tr | tr | 1.7 | 0 | - | - | - | 0 | - | - | - |
| Empididae | 0 | - | - | - | 9 | tr | tr | 0.8 | 0 | - | - | - | 0 | - | - | - |

Table 8 (continued). Percentages of occurrences, average total numbers and volumes of the food items found in the diets of adult shovelnose sturgeon in the middle Missouri River during 1978-1979.

| | 1978 Autumn | | | | 1979 Spring | | | | 1979 Summer | | | | 1979 Autumn | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0% | %N | %Vol | RI | %0 | %N | %Vol | RI | %0 | %N | %Vol | RI | %0 | %N | %Vol | RI |
| Others | | | | | | | | | | | | | | | | |
| Elmidae | 3 | tr | tr | 0.3 | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - |
| Coleoptera (unknown) | 8 | tr | tr | 0.9 | 0 | - | - | - | 0 | - | - | - | 0 | - | - | - |
| Corixidae | 3 | tr | tr | 0.3 | 0 | - | - | - | 10 | tr | tr | 0.9 | 0 | - | - | - |
| Fish eggs | 0 | - | - | - | 9 | - | tr | - | 0 | - | - | - | 0 | - | - | - |
| Fish tissue | 45 | - | tr | - | 18 | - | tr | - | 10 | - | tr | - | 14 | - | 2 | tr |

*Includes both *Cheumatopsyche* and *Hydropsyche* genera.

Seasonal comparisons of the relative importance (RI) of six major food groups utilized by adult shovelnose sturgeon in the middle Missouri River are shown in Figure 18. It is particularly interesting to compare the relative seasonal importance of the mayfly and caddisfly orders. During spring mayflies were only slightly more important than caddisflies in the shovelnose diet. However, during the summer months shovelnose fed much more heavily on mayflies than caddisflies. The relative importance (RI) of mayflies in the summer diet was 54 percent. Two mayfly taxa, *Rhithrogena* and *Traverella*, alone had a RI of 26 percent. In the autumn, the RI of the mayfly taxa was substantially reduced. Hydropsychidae, a caddisfly taxa, clearly dominated in the autumn diet of shovelnose sturgeon with a relative importance of 32 percent.

The seasonal diets of shovelnose sturgeon have been report by other investigators. Wallburg et al. (1971) and Modde (1973) found the shovelnose in the Missouri River below Gavins Point Dam to be mostly indiscriminate opportunistic feeders, and in the Yellowstone River Elser et al. (1977) reported nonselective foraging for *Traverella* during the summer followed by a resumption of feeding on hydropsychids in the autumn. Although no selectivity analysis was conducted for this investigation, based on the distribution and composition of the aquatic insect fauna as described by Berg (1980), it is believed that adult shovelnose sturgeon forage nonselectively on insects in swift current habitats in this study area. Furthermore, the seasonal diets of shovelnose sturgeon in the middle Missouri River correspond closely to the emergence of several major food taxa. For example, *Rhithrogena* and *Traverella* emerge mainly during the summer, and they are prominent in the summer diet of shovelnose sturgeon. *Ephemerella* and most of the species of Hydropsychidae had previously emerged during the spring and were unavailable as a food item during the summer.

Newell (1976) reported that the mayflies *Rhithrogena* and *Traverella* are insects which inhabit swift current areas. The four remaining taxa shown in Fig. 18 frequent a wide array of habitats, also including the swift current areas. Berg (1980) indicated that *Heptagenia* was a common insect in the middle Missouri River. However, this insect is not considered to be an important food item in the diet of shovelnose sturgeon in the study area. Newell (1976) reported that the velocity requirement for *Heptagenia* is substantially less than that of *Rhithrogenia* and *Traverella*. This observation provides further evidence to support the idea that shovelnose sturgeon feed nonselectively in swift current areas in the middle Missouri River.

Fish growth rates follow a seasonal pattern in response to temperature changes. For a warm water species, like the shovelnose, the summer period is probably the season when maximum utilization of food organisms occurs. Helms (1974) described the shovelnose sturgeon of the Mississippi River as having a low body condition value from February to mid-June, increasing to a peak value in early September, thereafter, declining to the low winter levels. Brett et al. (1969) reported a relationship between growth of sockeye salmon with that of varying temperatures and ration size. They concluded there was not only an optimal temperature for maximum utilization of food organisms by a fish, but also, at higher temperatures (which could be optimal temperatures for that species growth) the requirements for a given quantity of food were increased.

With these reported findings in mind, it is believed the summer diet is the most critical diet for the maintenance of the high quality shovelnose

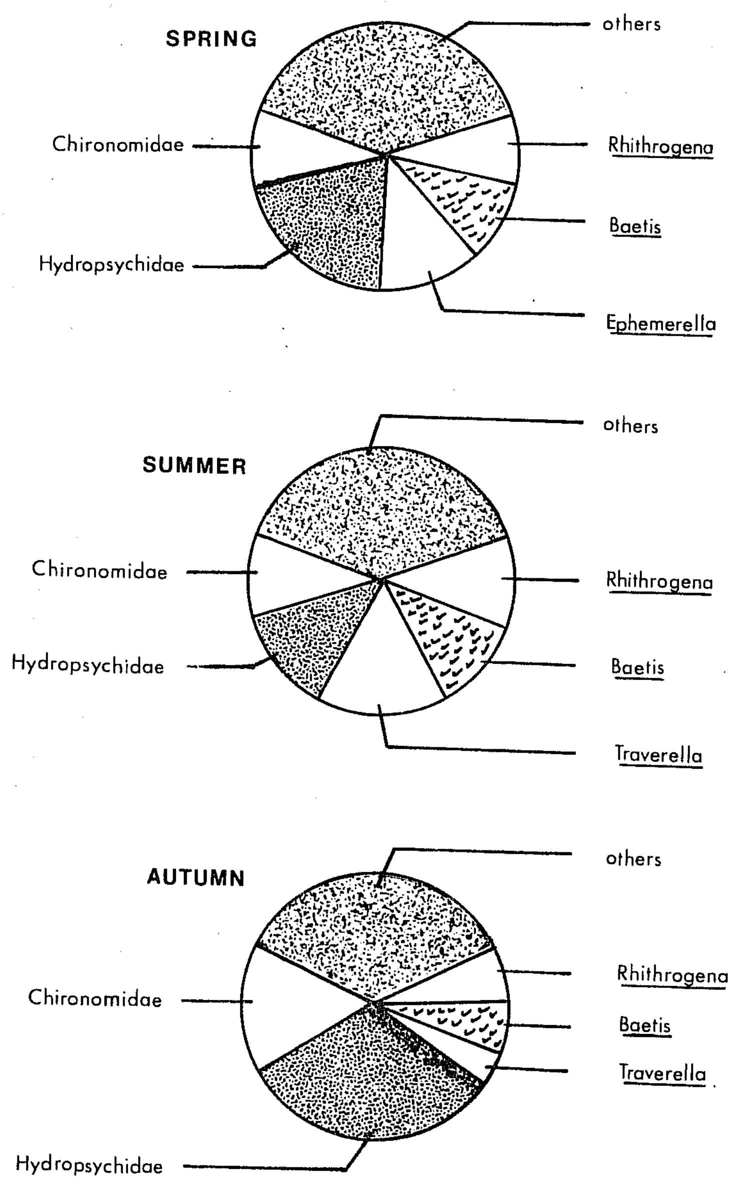


Figure 18. Seasonal comparisons of relative importance (RI) of the six major food groups utilized by adult shovelnose sturgeon in the Loma Ferry and Coal Banks Landing sections of the middle Missouri River, 1978-1979.

sturgeon fishery which exists in the middle Missouri River. Since the two mayflies *Rhithrogena* and *Traverella* together comprised 26 and 58 percent of the total RI and volume, respectively, in the summer diets, it is apparent that these two taxa are very important food sources for shovelnose sturgeon in the middle Missouri River. It should also be noted that these two taxa exhibit relatively little tolerance to alterations of physical and chemical characteristics of a river. Therefore, it is recommended that particular attention be given to the requirements of *Rhithrogena* and *Traverella* when instream flow determinations are made and future water development plans are proposed.

The WETP instream flow methodology will be utilized in 1980 in an effort to determine the amount of instream flow required to maintain sufficient wetted perimeter in riffle areas for aquatic insect production. Instream flow recommendations for the Missouri River, particularly during the critical low flow period through the winter, will be based largely on maintenance of the riffle areas.

## Young-of-the-Year Fish

Limited studies were made during 1979 of the food habits of young-of-the-year (YOY) sauger, goldeye and freshwater drum. Results of diet analyses for these species are shown in Table 9.

Table 9. Diets, expressed as percent composition by numbers, of young-of-the-year fish seined in the middle Missouri River during the summer and autumn 1979.

| Food Items | Sauger Jul 26 | Sauger Oct 15 | Goldeye Jul 26 | Goldeye Oct 15 | Freshwater Drum Aug 10 |
|---|---|---|---|---|---|
| *Ametropus* | | | 1 | | |
| *Baetis* | | | 20 | 11 | 1 |
| Hydropsychidae | | | 1 | 14 | |
| Culicidae | | | 1 | | |
| Chironomidae | | | 6 | 5 | 95 |
| Corixidae | | | 22 | 17 | |
| Terrestrial | | | 11 | | |
| Mayfly | | | | | |
| Antfly | | | | 40 | |
| Midge | | | | 6 | |
| Cladocera | | | 17 | | 4 |
| Fish larvae | 100 | | 8 | | |
| Minnows | | 100 | | | |
| Unidentified | | | 12 | 5 | |
| No. Sampled | N=17 | N=6 | N=25 | N=14 | N=10 |
| length range (mm) | 39-97 | 128-170 | 30-67 | 75-120 | 37-70 |

Findings indicated that the diet of YOY sauger in the middle Missouri River was chiefly piscivorous. Priegel (1969) reported that YOY sauger less than 50 mm in size fed chiefly on cladocerans, and those larger than 50 mm preferred YOY trout, perch, freshwater drum and white bass. However, if the YOY forage fish were not abundant or available, the YOY sauger larger than 50 mm continued with the plankton diet.

In the earlier discussion of findings about larval fish in the middle Missouri River it was indicated that the peak of abundance of larval fish in the upper study sections occurred in late May and early June. A later peak in early July was observed in the lower river. It was also found that there was a selection by YOY sauger for rearing sites in the lower river. Growth rates for YOY sauger sampled in the study area during 1979 were highest during July. Therefore, an adequate food supply is required during July to insure maximum growth during this critical period. This requirement is probably best fulfilled at the lower sites where larval fish are still available. Walburg (1976) reported the greatest growth of young sauger was in July and early August. Priegel (1969) also reported the greatest growth increases occurred during July, and further comparisons between years indicated the greatest growth was realized in years when forage fish were available by mid-July and then utilized by YOY sauger.

The diets of YOY goldeye were the most diversified of the three fish investigated. *Baetis*, corixids, and cladocerans comprised 69 percent of the diet during late July. In mid-October Hymenoptera, corixids, and cladocerans accounted for 71 percent of the diet. Food habits of the YOY goldeye appear to be correlated with the backwater and side channel pool habitats which they prefer as rearing areas. Since the rearing habitat preferences of YOY goldeye and sauger overlap to some extent, the invertebrate food items available to goldeye are also available to sauger. In spite of this abundant invertebrate food supply, the YOY sauger selected a diet comprised primarily of YOY forage fish.

Analysis of the diets of a number of YOY freshwater drum sampled near the headwaters of Fort Peck Reservoir in mid-August of 1979 revealed a strong preference for chironomids, which comprised 95 percent of the diet. A few cladocerans were also consumed.

## Tributary Resident Fish Populations

The two major tributaries of the middle Missouri River, the Marias/Teton and Judith Rivers, have an influence upon the physical, chemical and biological characteristics of the mainstem of the middle Missouri River. The tributaries each augment the flow, increase channel depth and width and, during spring, add sediment to the Missouri. In an intensive inventory of the fish populations of the middle Missouri River, Berg (1980) reported significant changes in the fish communities below these major tributaries, especially below the Marias River. Berg also documented substantial spawning migrations of several important fish species from the Missouri River into these tributaries. The importance of major tributary streams to the mainstem of a larger river has also been reported by Elser et al. (1977) and Rehwinkel et al. (1976).

Little information is known about the resident fish populations in tributaries of the middle Missouri River. Therefore, this phase of the study was conducted to determine species composition, longitudinal distribution, relative abundance and size composition of the resident fish populations in the tributaries.

A total of 24, 21 and 15 fish species was observed in the Marias, Teton and Judith Rivers, respectively, during electrofishing and seining surveys conducted on the tributaries in 1979 (Table 10). Most of these species are also found on the mainstem of the middle Missouri River between Morony Dam and Fort Peck Reservoir (Berg 1980).

Table 10. A list of fish species sampled by electrofishing and seining in the three major tributaries of the middle Missouri River during August-October 1979.

| | Marias | Teton | Judith |
|---|---|---|---|
| Goldeye | * | * | * |
| Mountain whitefish | * | * | * |
| Rainbow trout | * | | |
| Brown trout | * | | |
| Carp | * | * | * |
| Sturgeon chub | | * | |
| Flathead chub | * | * | * |
| Lake chub | * | * | |
| Emerald shiner | * | * | |
| Brassy minnow | | * | |
| Plains minnow | * | * | |
| Western silvery minnow | * | * | * |
| Fathead minnow | * | | |
| Longnose dace | * | * | * |
| River carpsucker | * | * | |
| Blue sucker | * | | |
| Smallmouth buffalo | * | | |
| Shorthead redhorse sucker | * | * | * |
| Longnose sucker | * | * | * |
| White sucker | * | * | * |
| Mountain sucker | * | * | * |
| Channel catfish | * | * | * |
| Stonecat | * | * | * |
| Burbot | * | * | * |
| Sauger | * | * | * |
| Walleye | * | | |
| Freshwater drum | | * | |
| Mottled sculpin | | | * |

## Marias River

The Marias River is the largest tributary of the middle Missouri River in the study area. Resident fish populations were surveyed in a 125-kilometer reach of the Marias River between Tiber Dam and the confluence with the Teton River near Loma, Montana. The Marias River in this reach has a narrow floodplain confined by step badlands, and very little off-channel development is evident. Stream gradient averages 0.6 meters per kilometer. Sand, gravel and small cobble are the predominant stream substrate materials.

At the head of the study reach is Tiber Dam, a reservoir with a storage capacity of 13,979 cubic hectometers (11,337,000 acre-ft). The reservoir was completed in 1956 to provide flood control, irrigation, recreational uses, municipal water supply and, possibly, hydroelectric power generation. However, its actual uses have been principally limited to flood control, recreation and municipal water supply.

The Marias River's flow and temperature regime are completely controlled by the operation of the dam. In general, spring runoff in the Marias River below Tiber Dam has been reduced since the dam was constructed, while flows during the fall and winter have been augmented (Missouri River Basin Commission 1978). Stober (1962) reported that the effect of cold water releases from Tiber Dam on the temperature regime of the Marias River were manifested as thermal constancy along with reduced summer water temperatures. He reported these effects were evident at least 38 kilometers below the dam.

Water quality of the Marias River in this reach is typical of large prairie rivers. Conductivity usually ranges from 500 to 600 micromhos/$cm^2$, and bicarbonate alkalinity ranges from 150 to 200 mg/l (Garvin and Botz 1975). Suspended sediments carried by the river are greatly reduced because of Tiber Reservoir (Stober 1962).

Five study sections were established on the Marias River between Tiber Dam and the mouth of the Teton River (Figure 1). The Tiber Dam study section was approximately 30 km in length, and it had a wide floodplain through which the river meandered. This section contained large mats of aquatic vegetation, primarily *Potamogeton* and *Chara*. The High Rock Canyon study section was 21 km long, and it had a narrower floodplain confined by precipitous cliffs. The Brinkman study section was also 21 km long. In this section the canyon opened, and the river was not as confined. The Badlands study section was 18 km long and began at the only major rapids of the entire reach. This section was surrounded by rugged badlands and breaks. Topography generally levelled off again through the Collins study section, which was 32 km in length and extended to the mouth of the Teton River.

Total catch, average size, size range and catch per unit effort for individual fish species sampled by electrofishing in each of the five study sections on the lower Marias River are shown in Tables 11 through 15. The Marias River in a 30-kilometer section immediately below Tiber Dam supports a significant salmonid fishery. Mountain whitefish are the predominant gamefish in this section, and a number of trophy size specimens larger than 1.8 kilograms (4 lbs) were sampled. The average size of mountain whitefish sampled in this section was significantly larger than in most other Montana streams. Rainbow and brown trout also attained large sizes in the Marias River below Tiber Dam. A few mountain whitefish were found throughout the entire length of the Marias River between Tiber Dam and the mouth of the Teton River. However, catch per unit effort for this species was substantially reduced downstream from the Tiber Dam study section. Rainbow trout were very ephemeral in their longitudinal distribututiom being confined exclusively to the Tiber Dam section. A few YOY rainbow trout and many YOY mountain whitefish were found in the surveys, indicating that successful natural reproduction of these species occurs in the Marias River below Tiber Dam.

The abundance of sauger in the Marias River increased gradually from Tiber Dam to the mouth of the Teton River. Sauger catch increased from 4.1 fish per electrofishing hour in the Tiber Dam section to 32.2 fish per hour in the Collins section. A number of YOY sauger were collected in the Badlands and Collins study sections indicating that spawning and rearing of this species occurs in the lower Marias River. Sauger are the most common gamefish in the Marias River below Tiber Dam, and they comprise the bulk of the sport fishery.

Other common gamefish found in the Marias River between Tiber Dam and the mouth of the Teton River include burbot, walleye, northern pike and channel catfish. These fish are known to permanently reside in this reach of the Marias. The scarcity of northern pike, channel catfish and burbot in the electrofishing sample is partly due to the poor response of these species to electrofishing. Posewitz (1962), utilizing frame traps as a sampling technique, found substantial populations of sauger, burbot and channel catfish throughout the Marias River below Tiber Dam. Berg (1980) reported substantial annual spawning migrations of several fish species from the Missouri River into the lower Marias River. The most important migrant species included sauger, shovelnose sturgeon, blue suckers and smallmouth and bigmouth buffalo.

Table 11. Catch statistics of fish sampled by electrofishing in the Tiber Dam section of the Marias River during August and October 1979.

| Species | Number Sampled | Average Length (mm) | Length Range (mm) | Average Weight (gm) | Weight Range (gm) | Catch per unit effort |
|---|---|---|---|---|---|---|
| Goldeye | 13 | 330 | 320-350 | 375 | 300- 430 | 3.7 |
| Mountain whitefish | 236 | 360 | 110-500 | 695 | 20-1840 | 26.7 |
| Rainbow trout | 13 | 338 | 80-530 | 899 | 10-2470 | 1.5 |
| Brown trout | 2 | 401 | 360-440 | 994 | 830-1160 | 0.2 |
| Carp | 36 | 485 | 420-650 | 1540 | 930-4130 | 10.3 |
| Longnose dace | 4 | 81 | 60-100 | 14 | 5- 20 | 2.9 |
| River carpsucker | 9 | 445 | 420-510 | 1076 | 930-1570 | 2.6 |
| Blue sucker | 1 | 660 | - | 2860 | - | 0.1 |
| Smallmouth buffalo | 3 | 605 | 570-650 | 3314 | 2630-3860 | 0.3 |
| Shorthead redhorse | 6 | 448 | 380-490 | 1058 | 550-1520 | 5.7 |
| Longnose sucker | 34 | 371 | 130-490 | 785 | 30-1450 | 9.7 |
| White sucker | 5 | 395 | 310-470 | 763 | 280-1140 | 4.0 |
| Burbot | 12 | 427 | 170-770 | 654 | 40-2910 | 1.4 |
| Sauger | 36 | 377 | 280-510 | 427 | 150-1070 | 4.1 |

Table 12. Catch statistics of fish sampled by electrofishing in the High Rock Canyon section of the Marias River during October 1979.

| Species | Number Sampled | Average Length (mm) | Length Range (mm) | Average Weight (gm) | Weight Range (gm) | Catch per unit effort |
|---|---|---|---|---|---|---|
| Mountain whitefish | 27 | 266 | 100-420 | 268 | 20- 770 | 9.8 |
| Carp | 12 | 472 | 420-530 | 1466 | 960-1990 | 6.9 |
| River carpsucker | 1 | 390 | - | 670 | - | 0.6 |
| Shorthead redhorse | 16 | 452 | 390-480 | 1058 | 640-1400 | 9.1 |
| Longnose sucker | 13 | 417 | 140-480 | 876 | 30-1130 | 7.4 |
| White sucker | 2 | 318 | 250-380 | 418 | 190- 640 | 1.1 |
| Sauger | 17 | 384 | 310-560 | 440 | 230- 840 | 6.2 |

Table 13. Catch statistics of fish sampled by electrofishing in the Brinkman section of the Marias River during October 1979.

| Species | Number Sampled | Average Length (mm) | Length Range (mm) | Average Weight (gm) | Weight Range (gm) | Catch per unit effort |
|---|---|---|---|---|---|---|
| Goldeye | *P | | | | | |
| Mountain whitefish | 15 | 315 | 140-420 | 359 | 40- 830 | 7.5 |
| Brown trout | 2 | 335 | 280-390 | 499 | 310- 680 | 1.0 |
| Carp | 2 | 451 | 440-460 | 1235 | 1200-1260 | 4.0 |
| River carpsucker | *P | | | | | |
| Shorthead redhorse | 3 | 446 | 420-480 | 940 | 840-1060 | 6.0 |
| Longnose sucker | 5 | 447 | 410-500 | 990 | 710-1590 | 10.0 |
| Burbot | *P | | | | | |
| Sauger | 11 | 363 | 320-430 | 363 | 260- 600 | 5.5 |

*P - Denotes this species was observed but not sampled.

Table 14. Catch statistics of fish sampled by electrofishing in the Badlands section of the Marias River during October 1979.

| Species | Number Sampled | Average Length (mm) | Length Range (mm) | Average Weight (gm) | Weight Range (gm) | Catch per unit effort |
|---|---|---|---|---|---|---|
| Goldeye | 1 | 380 | - | 420 | - | 1.0 |
| Mountain whitefish | 19 | 276 | 160-330 | 232 | 20- 420 | 6.3 |
| Carp | 18 | 472 | 420-510 | 1326 | 910-1680 | 18.0 |
| River carpsucker | 2 | 425 | 420-430 | 1000 | 960-1040 | 2.0 |
| Shorthead redhorse | 13 | 434 | 250-490 | 908 | 130-1230 | 13.0 |
| Longnose sucker | 31 | 413 | 360-470 | 740 | 500-1080 | 31.0 |
| White sucker | 3 | 361 | 270-420 | 590 | 220- 880 | 3.0 |
| Channel catfish | 1 | 690 | - | 5270 | - | 0.3 |
| Burbot | 1 | 460 | - | 530 | - | 0.3 |
| Sauger | 63 | 370 | 140-530 | 368 | 20-1060 | 21.0 |

Table 15. Catch statistics of fish sampled by electrofishing in the Collins section of the Marias River during October 1979.

| Species | Number Sampled | Average Length (mm) | Length Range (mm) | Average Weight (gm) | Weight Range (gm) | Catch per unit effort |
|---|---|---|---|---|---|---|
| Goldeye | 6 | 325 | 310-350 | 291 | 240- 340 | 3.0 |
| Mountain whitefish | 24 | 279 | 150-360 | 250 | 20- 540 | 5.7 |
| Brown trout | 2 | 351 | 300-400 | 508 | 290- 720 | 0.5 |
| Carp | 3 | 471 | 460-480 | 1402 | 1210-1660 | 1.5 |
| Shorthead redhorse | 3 | 216 | 120-400 | 277 | 10-810 | 1.5 |
| Longnose sucker | 20 | 298 | 200-420 | 286 | 270-780 | 10.0 |
| White sucker | 2 | 304 | 240-360 | 341 | 160-520 | 1.0 |
| Mountain sucker | 1 | 140 | - | 30 | - | 0.5 |
| Stonecat | 1 | 180 | - | 20 | - | 0.5 |
| Burbot | 1 | 320 | - | 170 | - | 0.2 |
| Sauger | 137 | 326 | 150-530 | 286 | 20-1230 | 32.2 |
| Walleye | 1 | 430 | - | 700 | - | 0.2 |

## Teton River

The Teton River is the largest tributary of the Marias River. It enters the Marias River just 1.5 kilometers above its confluence with the Missouri River near Loma, Montana. Resident fish populations were surveyed in a 123-kilometer reach of the lower Teton River from the Shannon bridge to the confluence with the Marias River. The Teton River in this reach has a fairly well developed floodplain which is confined by some extent by steep hills. The predominant stream substrate is small cobble heavily laden with silt and sand.

Five irrigation reservoirs with a combined storage capacity of 134.684 cubic hectometers (106,800 acre-ft) influence the natural flow regime of the Teton River. During the irrigation season, it is not uncommon for several sections of the lower Teton River to be dewatered to the extent that only larger pools remain.

Water quality data indicate that total dissolved solids in the Teton River are greater than in the Marias River (Garvin and Botz 1975). This is due primarily to increased amounts of magnesium, sodium and, especially, sulfate ions. Conductivity of the lower Teton River usually ranges from 700 to 800 micromhos/cm$^2$, and bicarbonate alkalinity ranges from 200 to 300 mg/l.

Two study sections were established on the Teton River between the Shannon bridge and the confluence with the Marias River (Figure 1). The Bootlegger study section was 10 km in length, and it had a well developed floodplain. Most of the river channel through this reach was deep and meandering with few riffles. Vegetative bank cover was extensive. The Wood study section was 39 km long. This section exhibited more youthful stream features. Channel depth and meandering were reduced, and riffles were more common than in the Bootlegger section.

Total catch, average size, size range and catch per unit effort for individual fish species sampled in each of the two study sections on the Teton River are shown in Tables 16 and 17. Sauger was the most common gamefish found in both study sections. The sauger were large, averaging 400 mm and 535 grams (15.7 inches and 1.17 pounds) in length and weight, respectively, for both study sections combined. No YOY sauger were found in either study section, indicating that the large sauger are probably seasonal migrants. The desirability of the lower Teton River for sauger is undoubtedly related in part to the abundant forage fish food base found in the river. Minimum flows which would enable the sauger to reside as year round residents would be desirable for the lower Teton River.

Table 16. Catch statistics of the fish sampled by electrofishing in the Bootlegger section of the Teton River during September and October 1979.

| Species | Number Sampled | Average Length (mm) | Length Range (mm) | Average Weight (gm) | Weight Range (gm) | Catch per unit effort |
|---|---|---|---|---|---|---|
| Goldeye | 35 | 327 | 300-370 | 272 | 190- 380 | 4.9 |
| Carp | 8 | 489 | 450-520 | 1430 | 1130-1870 | 1.1 |
| Flathead chub | 195 | 99 | 70-140 | 20 | 10- 20 | - |
| Lake chub | 1 | 80 | - | 10 | - | - |
| Brassy minnow | 2 | - | - | - | - | - |
| Plains minnow | 1 | - | - | - | - | - |
| Western silvery minnow | 75 | 136 | 130-150 | 20 | 20- 30 | - |
| Longnose dace | 19 | - | - | - | - | - |
| River carpsucker | 1 | 460 | - | 1050 | - | 0.1 |
| Shorthead redhorse | 31 | 266 | 60-360 | 200 | 10- 360 | 4.4 |
| Longnose sucker | 26 | 236 | 70-340 | 160 | 10- 380 | 3.7 |
| White sucker | 53 | 240 | 130-370 | 190 | 10- 540 | 7.5 |
| Mountain sucker | 39 | 113 | 70-220 | 20 | 10- 40 | 5.5 |
| Channel catfish | 1 | 50 | - | 10 | - | 0.1 |
| Stonecat | 4 | 119 | 70-150 | 20 | 10- 40 | 0.6 |
| Burbot | 1 | 530 | - | 800 | - | 0.1 |
| Sauger | 25 | 406 | 340-510 | 550 | 270-1080 | 3.5 |

Other gamefish sampled in the Teton River study sections included mountain whitefish, channel catfish and burbot. The low catches per unit effort for channel catfish and burbot are related in part to these species poor response to electrofishing. A YOY channel catfish was collected in the Bootlegger study section indicating that some reproduction and rearing of channel catfish occurs in the Teton River.

Common nongame fish sampled in the Teton River included carp, goldeye and several varieties of suckers. Flathead chubs, western silvery minnows, longnose dace and stonecats were the most common forage fish. Berg (1980) observed migrant use of the lower Teton River by sauger, channel catfish and blue suckers.

Table 17. Catch statistics of fish sampled by electrofishing in the Wood section of the Teton River during September 1979.

| Species | Number Sampled | Average Length (mm) | Length Range (mm) | Average Weight (gm) | Weight Range (gm) | Catch per unit effort |
|---|---|---|---|---|---|---|
| Goldeye | 5 | 340 | 320-370 | 341 | 260- 480 | 0.5 |
| Mountain whitefish | 1 | 160 | - | 20 | - | 0.1 |
| Carp | 24 | 483 | 100-640 | 1390 | 20-2210 | 2.6 |
| Flathead chub | 276 | 96 | 40-250 | 20 | 10- 140 | - |
| Western silvery minnow | 5 | 106 | 90-130 | 20 | 10- 20 | - |
| Longnose dace | 55 | 57 | 40- 80 | 10 | 10- 20 | - |
| River carpsucker | 7 | 432 | 390-510 | 917 | 710-1250 | 0.8 |
| Shorthead redhorse | 13 | 350 | 50-470 | 540 | 10-1020 | 1.4 |
| Longnose sucker | 47 | 111 | 60-240 | 27 | 10- 160 | 5.0 |
| White sucker | 4 | 214 | 120-300 | 150 | 10- 300 | 0.4 |
| Mountain sucker | 18 | 96 | 50-140 | 14 | 10- 20 | 1.9 |
| Channel catfish | 3 | 686 | 640-710 | 3677 | 3000-4540 | 0.3 |
| Stonecat | 19 | 144 | 40-220 | 45 | 10- 130 | 2.0 |
| Burbot | 3 | 357 | 250-460 | 268 | 80- 480 | 0.3 |
| Sauger | 28 | 394 | 320-530 | 520 | 230-1210 | 2.5 |
| Freshwater drum | 1 | 380 | - | 610 | - | 0.1 |

A limited amount of seining was done on the Teton River in 1979 in conjunction with the electrofishing surveys. An important species collected by seining, but not found in the electrofishing surveys, was the sturgeon chub. Brown (1971) reported that this species was found in Montana only in the lower Yellowstone River and its tributaries, making this collection a significant extension of its known range. The sturgeon chub in Montana is considered uncommon, and it is listed by the Montana Department of Fish, Wildlife and Parks as a species of special concern - class B.

## Judith River

The Judith River is the second largest tributary of the middle Missouri River in this study area. Resident fish populations were surveyed in a 32 kilometer reach of the lower Judith River between Anderson bridge near Winifred, Montana, and the confluence with the Missouri River. The Judith River in this reach has a fairly well developed floodplain, which is confined to some extent by steep hills. Small cobble and gravel are the predominant stream substrate materials. A significant feature of the flow regime of the Judith River drainage is the presence of several spring creeks which augment the flow at a constant rate throughout the year. Big Spring and Warm Springs Creeks, the two largest spring creeks in the drainage, have constant flows at approximately 200 cubic meters per minute (125 cfs).

The largest user of water in the Judith River drainage is irrigated agriculture. Stream dewatering and irrigation return flows undoubtedly have some influence on the water quality characteristics of the lower Judith River. The only major water storage facility in the Judith River drainage is Ackley Reservoir which has a storage capacity of 0.008 cubic hectometers (6,140 acre-ft).

Water quality of the lower Judith River is described by Kaiser and Botz (1975) as basically a calcium bicarbonate water of good quality. The chemical characteristics of the Judith River are similar to the Teton River. Conductivity of the lower Judith River usually ranges from 800 to 1000 micromhos/$cm^2$, and bicarbonate alkalinity ranges from 200 to 300 mg/l.

Two study sections were established on the lower Judith River between Anderson bridge and the confluence with the Missouri River (Fig. 1). The Anderson study section was 5 km in length. The river channel in this section was shallow with little pool development or meanders. Water velocity was relatively high, and the stream substrate was comprised primarily of large cobbles. The PN Ranch study section was 6.5 km in length. Pools and riffles were well developed in this study section, and the river meandered through a wide floodplain. Loose gravel and sand were the most common stream substrate materials.

Total catch, average size, size range and catch per unit effort for individual fish species sampled in each of the two study sections on the lower Judith River are shown in Tables 18 and 19. The results of electrofishing in both study sections were unsatisfactory because conductivity of the water was too high. In addition, the PN Ranch study section contained very deep pools which were difficult to electrofish.

Table 18. Catch statistics of fish sampled by electrofishing in the Anderson Bridge section of the Judith River during September 1979.

| Species | Number Sampled | Average Length (mm) | Length Range (mm) | Average Weight (gm) | Weight Range (gm) | Catch per unit effort |
|---|---|---|---|---|---|---|
| Goldeye | 3 | 338 | 320-360 | 436 | 380- 490 | 0.7 |
| Carp | 3 | 503 | 490-510 | 1748 | 1540-2010 | 0.7 |
| Flathead chub | 31 | 122 | 50-160 | 23 | 10- 60 | - |
| Longnose dace | 21 | 73 | 50- 90 | 10 | 10 | - |
| Longnose sucker | 24 | 310 | 160-420 | 350 | 40- 740 | 5.7 |
| White sucker | 1 | 300 | - | 300 | - | 0.2 |
| Mountain sucker | 18 | 154 | 120-220 | 36 | 20- 100 | 4.3 |
| Stonecat | 16 | 158 | 130-190 | 23 | 10- 90 | 3.8 |
| Burbot | 3 | 396 | 260-510 | 404 | 80- 780 | 0.7 |
| Sauger | 7 | 294 | 240-370 | 236 | 130- 420 | 1.7 |
| Mottled sculpin | 1 | 70 | - | 10 | - | 0.2 |

Table 19. Catch statistics of the fish sampled by electrofishing in the PN Ranch section of the Judith River during September 1979.

| Species | Number Sampled | Average Length (mm) | Length Range (mm) | Average Weight (gm) | Weight Range (gm) | Catch per unit effort |
|---|---|---|---|---|---|---|
| Goldeye | 1 | 320 | - | 230 | - | 0.3 |
| Mountain whitefish | 1 | 120 | - | 20 | - | 0.3 |
| Carp | 3 | 492 | 460-500 | 1575 | 1370-1850 | 0.8 |
| Flathead chub | 100 | 130 | 510-730 | 32 | 10- 120 | - |
| Longnose dace | 3 | 67 | 60- 80 | 10 | 10 | - |
| Shorthead redhorse | 3 | 214 | 60-380 | 245 | 10- 620 | 0.8 |
| Longnose sucker | 30 | 274 | 80-360 | 232 | 10- 410 | 8.1 |
| White sucker | 1 | 220 | - | 130 | - | 0.3 |
| Mountain sucker | 9 | 134 | 80-200 | 36 | 10- 110 | 2.4 |
| Channel catfish | 1 | 680 | - | 3810 | - | 0.3 |
| Stonecat | 4 | 139 | 120-160 | 23 | 10- 30 | 1.1 |
| Burbot | 3 | 415 | 390-430 | 300 | 300 | 0.8 |
| Sauger | 19 | 233 | 120-510 | 200 | 20-1090 | 5.1 |

Sauger was the most common gamefish sampled by electrofishing in the Judith River. Catch rate of sauger averaged 3.4 fish per electrofishing hour for both study sections combined. In addition, a number of YOY sauger were collected in the PN Ranch section, indicating that reproduction and rearing of this species occurs in the lower Judith River. Other gamefish sampled included mountain whitefish, channel catfish and burbot. Goldeye, carp and a variety of suckers were the most common nongame fish. Flathead chubs were by far the most abundant forage fish. Other common forage fish included longnose dace, mountain suckers and stonecats. The variety of minnows in the lower Judith River was probably underestimated because of ineffective sampling.

Based on the surveys conducted in 1979, it appears that the lower Judith River contains a moderate population of resident sauger. Although no efffort was made to investigate actual utilization of the lower Judith River by spawning channel catfish, circumstantial evidence indicates that this river is an important tributary for this species. Numerous cottonwood logs and other instream cover features necessary for catfish nests are found in the lower Judith River. As described in a previous section of this report, numerous channel catfish alevins were collected at the mouth of the Judith River in 1979. Channel catfish require very warm water temperatures for spawning, and summer water temperatures on the lower Judith River apparently meet their requirements. Based on these considerations, it appears that the lower Judith River is probably one of the most desirable spawning tributaries for channel catfish in the study area.

## Paddlefish Radiotelemetry Study

Paddlefish are one of the most important fish species found in the middle Missouri River. Because of their limited distribution and habitat requirements the Montana Department of Fish, Wildlife and Parks recently classified the paddlefish as a species of special concern - Class A. The paddlefish population in the middle Missouri River is considered to be one of the last known "stable" populations (Carlson 1980). Successful spawning of paddlefish in the study area has been documented by collecting numerous larvae and one incubating embryo.

The periodicity and peak of paddlefish spawning runs in the middle Missouri River and the extent of the upstream migration in normal water years have been determined by electrofishing surveys (Berg 1980). Berg monitored the spawning migration of paddlefish in the middle Missouri River in 1977, 1978 and 1979. He found that no significant spawning run occurred in 1977, a year when stream flow levels in the Missouri River were considerably below normal. In 1978 and 1979, stream flow levels in the Missouri River were near normal, and considerable numbers of paddlefish migrated as far upstream as the mouth of the Marias River, 245 kilometers above Fort Peck Reservoir.

Radiotelemetry studies were initiated in 1979 to aid in better determining instream flow requirements of paddlefish in the middle Missouri River. Objectives of the radiotelemetry study are:

1) to determine the amount of flow required by paddlefish for passage through shallow water areas which may act as hindrances or barriers to movement during the spawning period,

2) to evaluate responses of individual paddlefish to increases, decreases or sharp fluctuations of flow,

3) to aid in determining locations of spawning areas, periodicity of the spawning run and extent of upstream migrations of paddlefish.

The middle Missouri River is a large river with deep pools, and it contains water of a relatively high ionic conductivity. It is very difficult to develop an aquatic radiotelemetry system which functions adequately in this situation. Only limited success has been attained by researchers attempting to utilize radiotelemetry in streams similar to the middle Missouri River. Therefore, all of our effort in 1979 was spent in developing a radiotelemetry system which would be suitable for our requirements.

## Equipment

A Smith-Root RF40 tracking receiver with a frequency range between 40.000 and 41.000 MHz was used to monitor the radio transmitters. An omnidirectional whip antenna was matched with the receiving unit and mounted to the wing strut of a Super Cub airplane.

Two different types of radio transmitters were tested in 1979. The first type, Smith-Root P-40-250M, contained mercury power cells, and the second type, Smith-Root P-40-1000L, had lithium power cells (Fig. 19). The cylindrical transmitters were 1.9 cm in diameter, and lengths of the 250 m and 1000L were 12 and 18 cm, respectively. Their weights in water were 16 and 25 grams, respectively.

Several of the radio transmitters were placed in the Missouri River at various locations and depths to evaluate each tag's signal strength. Relocations

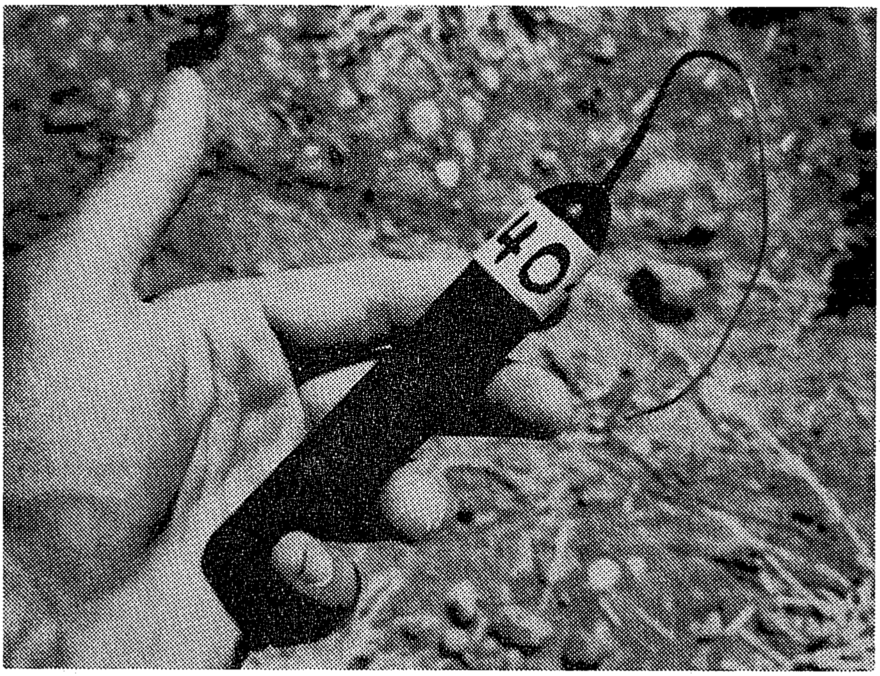

Figure 19. Radio transmitters were surgically implanted or attached to the rostrum of paddlefish to monitor their movements.

of the tags were made from the Super Cub flying the river's course. The 1000 L transmitters emitted a strong signal which could be received at a distance of 1.5 kilometers flying approximately 300 meters above the river. Life expectancy of the 1000 L transmitters is 90 days, which meets our requirements. The 250 M transmitter did not produce an adequate signal, and further testing of this unit was abandoned.

## Implantation and Attachment of Transmitters

To test the response of paddlefish to implantations and attachments of the 1000 L transmitters, five paddlefish, ranging in weight from 15 to 30 kilograms, were instrumented with transmitters and released in a small 4 hectare pond. Three of the five radio tags were implanted in the peritoneal cavity of the paddlefish. Using standard surgical procedures, a 7 cm incision was made with a scalpel, along the upper right ventrum immediately posterior to the pectoral fin (Fig. 20) and sterilized in a solution of Nolvasan. The incision was made at this site to avoid severing major vessels present along the ventral axis. After the incision was completed, a sterilized transmitter dipped in paraffin was inserted into the peritoneal cavity with the 10 cm antenna either extending from the incision or internally extending in the cavity. The incision was then closed with individual sutures spaced 5 mm apart. Finally, the fish was injected with an antibiotic at a dosage of 1 cc antibiotic per 4.5 kg of paddlefish body weight.

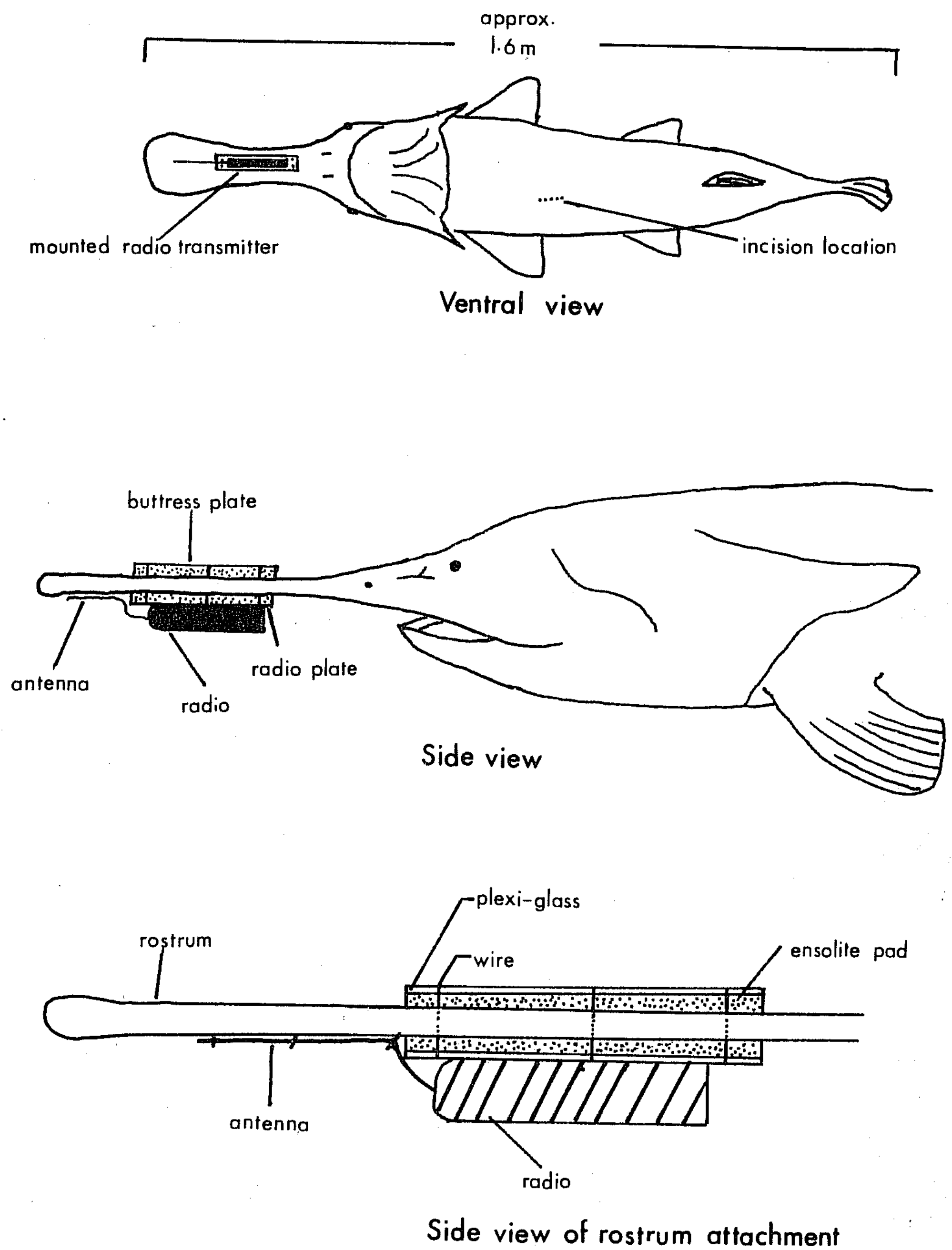


Figure 20. Attachment and implant sites for the radio transmitters for paddlefish.

Two of the five radio transmitters were attached to the rostrum of the paddlefish (Fig. 20). The transmitters were cemented to a 16 x 4 cm plexiglass plate similar to that described by Haynes (1978). Holes were drilled in the plate to facilitate threading of a stainless steel wire from the mounting plate through the rostrum to a buttress plate where the wire was anchored. The transmitter antenna was anchored to the rostrum by stitching it to the skin. Dave Combs (personal communication) first experimented with this method, and he reported good success because the technique does not circumscribe the rostrum and cause irritation as reported by Elser (1976).

## Feasibility Testing

All five paddlefish appeared to be minimally affected by implantation or attachment of the radio transmitters. When released into the testing pond they immediately swam away. Radios were monitored for proper signal transmission immediately before being released and at 4 hour intervals thereafter. Approximately 18 hours after instrumentation, locations of all five paddlefish were determined and movement was apparent.

Twenty days later an attempt was made to relocate the radio instrumented paddlefish from a fixed wing aircraft, however, no signals were received. Sixty days after the initial instrumentation an attempt was made to relocate the tagged fish from a boat. One tagged fish with a rostrum attachment was located and movements of the fish were apparent. An attempt was made to recover the five radio instrumented paddlefish by use of gill nets, a large seine and electrofishing to determine the cause of the assumed transmitter failures and examine the fish for possible rejection of the tag. None of the paddlefish could be collected by these methods. The poor results in relocating the radio instrumented paddlefish can probably be attributed to high conductivity of the water in the pond (exceeding 2000 micromhos/$cm^2$). The high conductivity of the pond apparently caused severe attenuation of the radio transmitter signals. Conductivity of the middle Missouri River during the paddlefish migration and spawning period ranges from about 400 to 600 micromhos/$cm^2$, and should present no problems for transmitting the radio signals.

Based on the above considerations, paddlefish radiotelemetry studies should be continued. An attempt will be made in the spring of 1980 to instrument thirty paddlefish with radio transmitters. The tagging will be done at the onset of the migration, and movements of the fish will be followed. Since the research program is still at an experimental stage, transmitters produced by three different commercial suppliers will be utilized. With diversification among several suppliers, the opportunity for success in the radio telemetry study should be greatly improved.

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