Life History and Flow Requirements of Paddlefish, Shovelnose Sturgeon, Channel Catfish and Other Fish in the Lower Yellowstone River System

By

Russell F. Penkal
Montana Department of Fish, Wildlife and Parks

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ABSTRACT

This work is an extension of previous studies to quantify flow requirements and assess the impacts of energy development on the aquatic resource of the lower Yellowstone River and its tributaries. Principle species included in the study are paddlefish, shovelnose sturgeon, burbot and channel catfish.

The paddlefish spawning migration was monitored with electrofishing gear in 1979 and 1980. Paddlefish were first observed downstream from Intake diversion when water temperatures were 15°C or warmer; May 22 and May 6 during 1979 and 1980, respectively. Numbers of paddlefish were positively related to discharge and suspended sediment. The minimum flow necessary to stimulate paddlefish movement to Intake diversion was estimated to range between 15,000 and 18,000 cfs. The allocated instream flows, (December 15, 1978) during May and June are 12,000 and 25,000 cfs, respectively. Fourteen paddlefish eggs were collected with a drag dredge from an 8 km reach of river downstream from Intake diversion in 1980.

Spawning areas for shovelnose sturgeon include the Tongue River, Powder River, and Yellowstone River downstream from Intake. Sturgeon prolarvae were collected from the Tongue River during 1978 through 1980 and from the Powder River in 1979. No sturgeon larvae were collected in the mainstem upstream from the two tributaries during 1978 through 1980. The minimum flow necessary to trigger adult stugeon movement into the Tongue River was between 500 and 600 cfs while optimum spawning flow, as indicated by density of larval drift, was considerably greater (1000+ cfs). The allocated instream flow for the Tongue River, 75 cfs, would abolish the spawning run in this tributary. Flows in the Powder River during May and June in 1980, 280 and 600 cfs, respectively, were too low to result in effective sturgeon reproduction. Allocated instream flow during May and June, 424 and 184 cfs, is insufficient for sturgeon reproduction in the Powder River.

Only 10 catfish alevins were captured (from July 10-21, 1978). The spawning habits of catfish make their young less susceptible to drift. Catfish were the only game fish captured in plankton nets upstream from the Tongue River establishing the fact that spawning grounds for this species do exist upstream. Small tributaries offer areas of preferred spawning habitat not readily available in the mainstem of the Yellowstone, Tongue or Powder rivers.

The Tongue River supported a spawning run of longnose suckers, shorthead redhorse suckers, river carpsuckers, blue suckers, goldeye, and flathead chubs. Total densities of eggs and larval drift in the Tongue River are as much as 80 times concentrations in the Yellowstone River. Total concentrations of drift in the Powder River were as great as 14 times the density in the Yellowstone River. Backwater sampling in the mainstem of the Yellowstone indicated that most of these species were susceptible to long distance downstream drift as larvae.

INTRODUCTION

Eastern Montana underwent extensive energy development during the 1970's. The Yellowstone River and two major tributaries, the Tongue and Powder rivers, meander through lands undergoing or slated to undergo energy development. The purpose of this study was to gain a better understanding of the ecology of the lower Yellowstone River system in order to predict potential impacts from energy related development.

One of the major potential impacts of energy development in this semi-arid region is the removal of vast amounts of water for energy conversion facilities such as coal generation and gasification plants. The historic average annual discharge of the Yellowstone River near its mouth was 11 to 12 million acre-feet (MAF) (J. Dooley - pers. comm.). At the 1970 level of water depletions the mean annual discharge at Sidney was calculated to be 8.8 MAF (NGPRP 1974). The 1973 Montana Legislature established the Montana Water Use Act which recognized the value of fish and wildlife and allowed bodies of federal and state government and their political subdivisions to file for instream flows. When the number of requests for large volumes of Yellowstone River water drastically increased, particularly from the industrial sector, the 1974 Yellowstone River Moratorium was passed. This act provided time for present water users (including fish and wildlife) to quantify flow needs. On December 15, 1978, the Board of Natural Resources granted an instream flow reservation of 5.5 million acre feet (MAF) for the Yellowstone River near its mouth (Peterman 1979). Section 85-2-316 paragraph 7, MCA, stated:

> The board shall, periodically but at least once every 10 years, review existing reservations to ensure that the objectives of the reservation are being met. Where the objectives of the reservation are not being met, the board may extend, revoke, or modify the reservation.

Therefore, a major objective of this report is to provide information for this review process. This report identified spawning areas and further determined necessary flows for paddlefish (*Polyodon spathula*), shovelnose sturgeon (*Scaphirhynchus platorynchus*), and channel catfish (*Ictalurus punctatus*). The effects of drift of fish larvae on distribution, life history and instream flow needs of fish in the Yellowstone River system were also studied.

DESCRIPTION OF STUDY AREA

The Yellowstone River originates in the mountains of northwestern Wyoming and flows in a general northeasterly direction to its confluence with the Missouri River in North Dakota, 1091 km downstream. This study encompassed the lower, warmwater section of the river from Huntly, Montana, downstream (Figure 1). Penkal (1981) described this reach of river in detail.

RELATIONSHIP OF PADDLEFISH MIGRATIONS TO DISCHARGE, SUSPENDED SEDIMENT, AND WATER TEMPERATURE

Methods

During 1979 and 1980 the paddlefish migration was monitored by electrofishing both sides of an 8 km reach of the Yellowstone River beginning immediately downstream from Intake diversion (river km 114-106). Electrofishing was accomplished from a 5.2 m flat bottomed aluminum boat powered by an 85 hp motor (Graham et al. 1979). Output current, which varied with conductivity and temperature of the water ranged from 8-15 amps at 100-300 volts. The pulse frequency was 80-100 pulses per second and the pulse width was 50-80 percent.

The numbers of paddlefish observed while moving downstream at a relatively fast pace (motor speed of 1500 rpm) were tallied. The boat was moving fast enough to avoid counting stunned fish twice while those on the periphery of the electrical field had little time for avoidance. Paddlefish were not in the electrical field long enough to suffer adversely from the electrical current. Water temperatures and flows were obtained from U.S. Geological Survey data or thermographs maintained by the DFWP.

Results and Discussion

The first paddlefish were observed while electrofishing on May 22 and May 6, 1979 and 1980, respectively. Mean water temperatures on these dates were 15.5 and 17.0°C, respectively (Figure 2). The water temperature was unusually cool for an extended period of time in spring 1979 and was probably responsible for the delayed migration in 1979. Mean water temperature during May 1979 and 1980, was 13.5 and 17.0°C, respectively.

The pattern and magnitude of discharge of the Yellowstone River was almost identical in 1979 and 1980 (Figure 3). The maximum number of paddlefish observed in a single run in 1979, 84, was only 15 percent of the maximum in 1980, 560. Because flows were very similar, the cool water temperature in 1979 was probably responsible for the depressed paddlefish run. Purkett (1961) noted that upstream migration of paddlefish did not occur in the Osage River, Missouri until water temperatures reached 10°C and spawning occurred at 16°C. Mean water temperature of the Yellowstone was never below 13.5°C during May of 1980 while temperatures were as low as 8°C during May 1979. Water temperatures during peaks of the paddlefish migrations ranged from 16 to 22°C in the Yellowstone River.

Fluctuations in numbers of paddlefish observed downstream from Intake diversion during 1979 and 1980 mirrored major changes in discharge of the Yellowstone River (Figure 3). Because of a slight lag in paddlefish response to drastically increasing or decreasing flows, correlation coefficients did not accurately measure the relationship between paddlefish numbers and discharge; r values of 0.618 and 0.736 in 1979 and 1980, respectivley. Purkett (1963) and

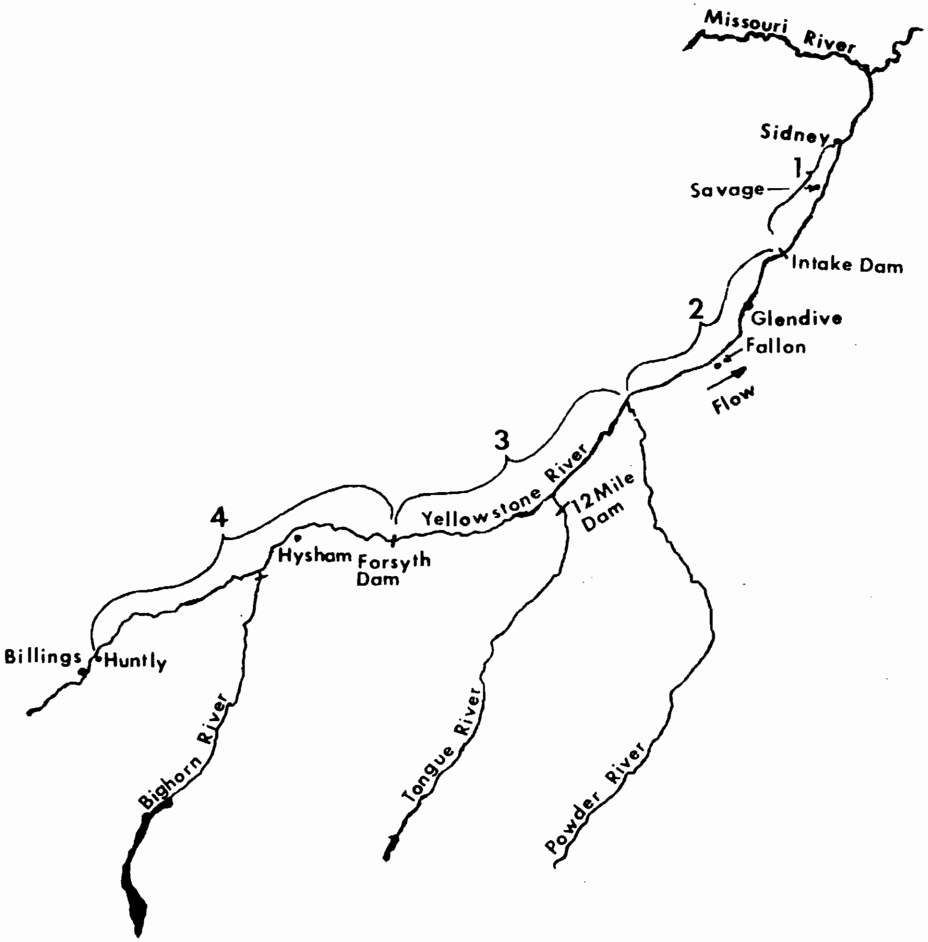


Figure 1. Map of lower Yellowstone River and four study areas.

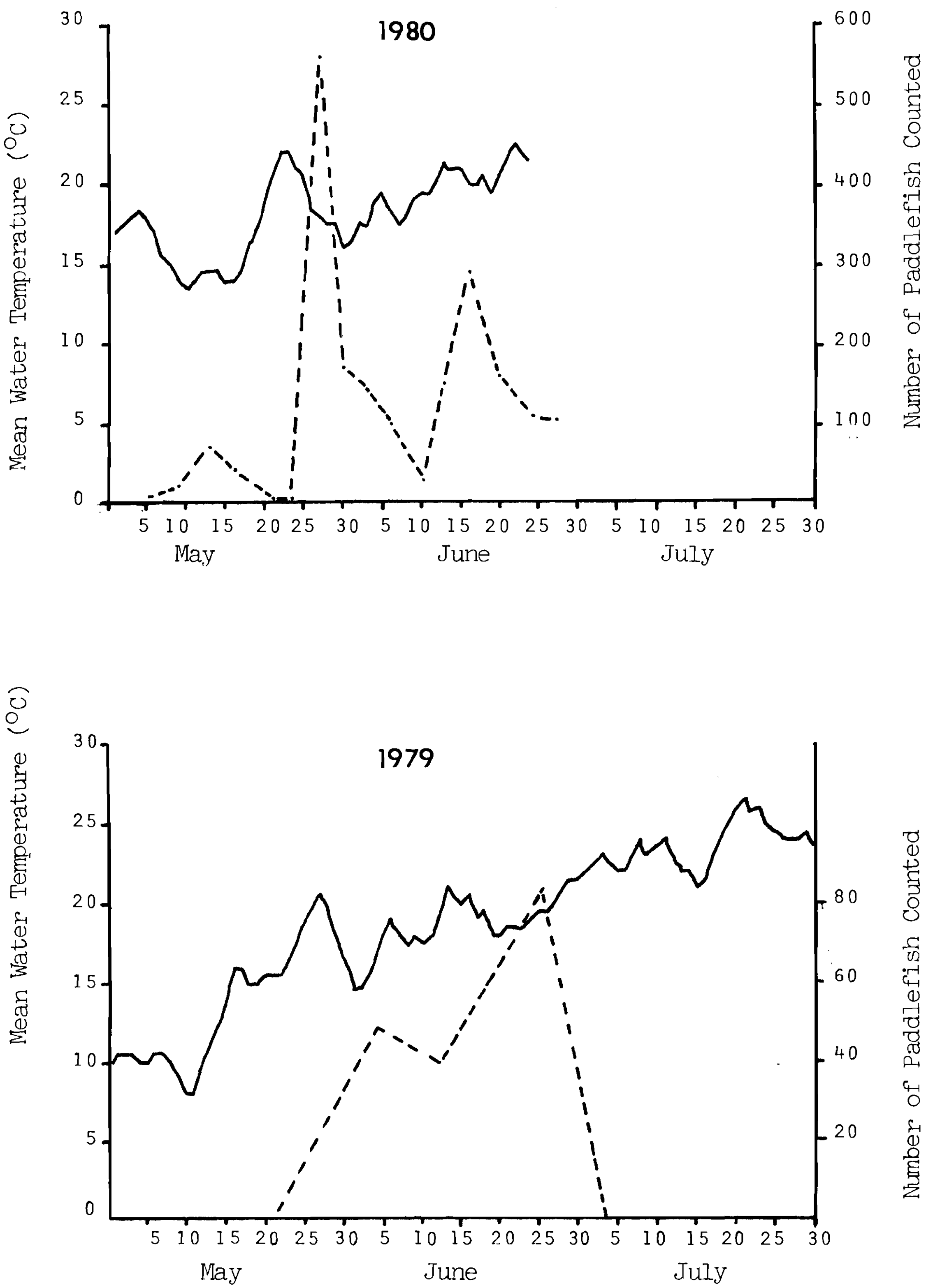


Figure 2 . Mean daily water temperature (——) and number of paddlefish observed (---) while electrofishing an 8 km reach of the Yellowstone River downstream from Intake diversion, 1979 and 1980.

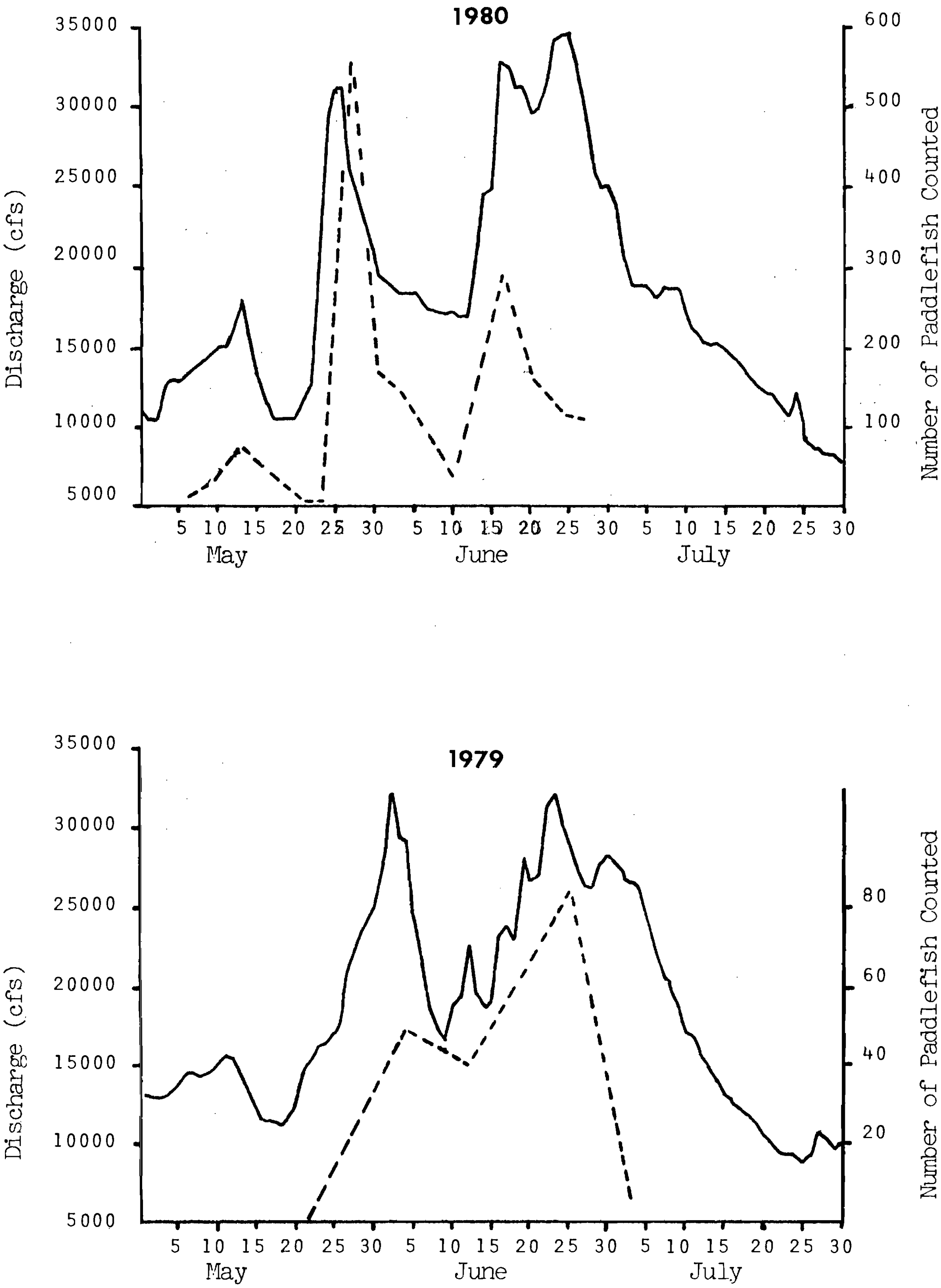


Figure 3. Mean daily discharge (——) and number of paddlefish counted (- - -) while electrofishing an 8 km reach of the Yellowstone River downstream from Intake diversion, 1979 and 1980.

Stockard (1907) made observations that spawning runs in the Missouri and Mississippi rivers were triggered by increasing flows. When flows declined in the Yellowstone, numbers of paddlefish declined quicker, indicating that a regimen of increasing flows was at least as important in maintaining upstream paddlefish migration as was absolute magnitude of the discharge. Elser (1980) also noted that in years when discharge was increasing over a long period of time, paddlefish migrated farther up the Yellowstone River and remained longer than in years of short duration of increasing flows.

It should be noted that the mean daily discharge of the Yellowstone at Sidney during June 1979 and 1980, 24,100 and 24,900 cfs, respectively, was 15,700 and 14,900 cfs lower than the 39 year mean daily discharge during June, 39,800 cfs. For this reason changes in discharge during the moderately low flow years of 1979 and 1980 may more noticeably influence paddlefish migrations than during years of high flow. Rehwinkel (1978a) found little correlation ($r=0.249$) between total discharge and fisherman catch rate of paddlefish downstream from Intake diversion in 1974. Mean daily discharge during June 1974, 49,700 cfs, was 25,000 cfs greater than the mean daily discharge during June in 1979 and 1980. Although Rehwinkel (1978a) found a low correlation coefficient between discharge and catch rate a general trend can be depicted from his 1974 data (Figure 4).

The Y intercept of discharge regressed on number of paddlefish (the estimated flow at which no paddlefish would migrate to Intake diversion) was 18,050 and 15,060 cfs during 1979 and 1980, respectively. Elser (1980), however, noted paddlefish were first caught on May 7, 1977 when flows were only 11,000 cfs. The allocated instream flow reservation of the Yellowstone River at Sidney is 12,000 cfs during May which may or may not be large enough to stimulate upstream migration of great numbers of paddlefish. The allocated discharge of 25,000 cfs during June is large enough to stimulate paddlefish migration to Intake diversion. Paddlefish will not be permitted access around Intake diversion in significant numbers until a discharge of 45,000 cfs is reached (Peterman 1977). Passage around Intake diversion would give paddlefish access to 267 km more of the mainstem of the Yellowstone as well as access to two important tributary streams. The extent of paddlefish spawning downstream from Intake diversion is not known but reproduction does occur below the diversion as documented by the collection of paddlefish eggs in 1980.

Fluctuations in numbers of paddlefish observed downstream from Intake diversions in 1979 and 1980 also could be correlated to fluctuations in suspended sediment (Figure 5). The correlation coefficient of number of paddlefish observed versus suspended sediment was 0.902 and 0.734 for 1979 and 1980, respectively. Correlations of change in paddlefish numbers versus change in suspended sediment were even higher, 0.926 and 0.788 during 1979 and 1980, respectively. Rehwinkel (1978a) found a correlation of 0.611 between fisherman catch rates and suspended sediment in 1974.

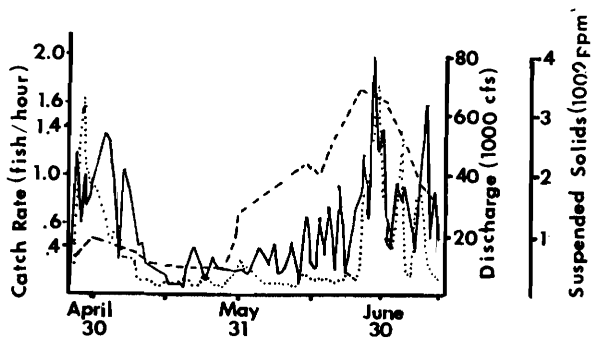


Figure 4 . Catch rate of paddlefish (——), mean daily suspended solids (••••), and discharge (---) in the Yellowstone River, 1974.

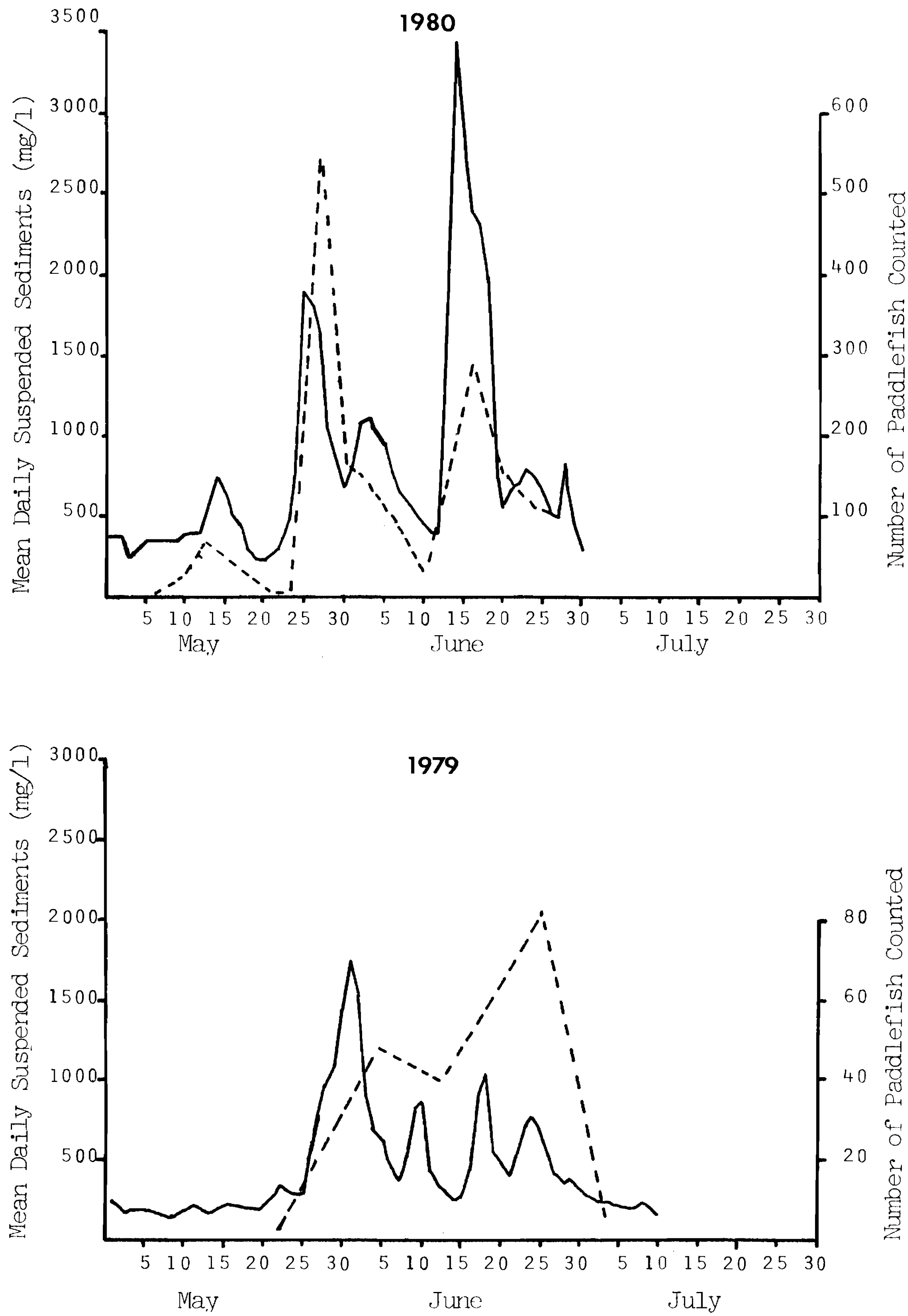


Figure 5 . Mean daily suspended sediments (——) and number of paddlefish observed (---) while electrofishing an 8 km reach of the Yellowstone River downstream from Intake diversion, 1979 and 1980.

Since suspended sediments and discharge are interrelated it is difficult at this point to separate which variable may be more important to stimulate paddlefish migration upstream. It is very probable that these variables are both important factors in paddlefish migration. Multiple regressions of paddlefish numbers versus discharge and suspended sediment produced correlations of 0.9222 and 0.790 during 1979 and 1980. Multiple regressions of change in paddlefish numbers versus change in discharge and change in suspended sediment produced correlations of 0.949 and 0.919, respectively.

Russell et al. (1980) tried to induce paddlefish to migrate up tributaries of the Osage River by releasing large volumes of water in the tributaries during the spawning run. Paddlefish did not migrate up these tributaries probably because of the low turbidity and slightly lower water temperatures. It is possible that if suspended sediment is below a certain level in the Yellowstone River, the paddlefish migration may be impaired. High levels of suspended solids are also probably necessary to promote successful reproduction. In the lab, eggs spawned without a coating of silt get very adhesive and tend to clump together causing high mortality (Russell et al. 1980).

DISTRIBUTION OF EGGS AND LARVAE AND QUANTIFICATION OF DRIFT

Methods

Fish eggs and larvae were collected as they drifted downstream by suspending 0.5 m standard plankton nets (mesh size of 760 microns) just below the surface of the water (Figure 6). Nets were secured to bridges or fence posts driven into the substate. Water velocity, measured at the mouth of the nets, and length of time sampled were recorded to determine volume of water sampled. Drift samples were collected at 8 locations: (1) the Yellowstone River 3.2 km upstream from the mouth of Tongue River, (2) the Tongue River 0.8 km upstream from its confluence with the Yellowstone, (3) the Yellowstone River 1 to 3 km upstream from the mouth of the Powder River, (4) the Powder River 0.8 km upstream from its mouth, (5) the Yellowstone River 0.2 km upstream from Intake Diversion Dam, (6) Intake diversion canal approximately 0.2 km from its source, (7) the Yellowstone River 1.4 km downstream from Intake Diversion, and (8) the Yellowstone River approximately 19 km upstream from its confluence with the Missouri (Figure 1).

Paddlefish eggs were collected with a drag dredge modified from a description by Fast (1968) (Figure 7). The dredge consisted of two sections connected by four 10 mm (3/8 inch) square iron bars. The first section was made from a 508 mm (20 inch) piece of iron pipe (irrigation pipe), 0.4 mm (5/32 inch) thick, with an inside diameter of 267 mm (10.5 inches). The forward edge of the pipe was rimmed with spikes 13 mm (0.5 inch) in diameter and 38 mm (1 1/2 inch) long. Five evenly spaced bars, 10 mm (3/8 inch) in diameter, were welded across the front orifice.

Figure 6. Drift of fish larvae and eggs was sampled by suspending 0.5 m standard plankton nets just below the surface of the water.

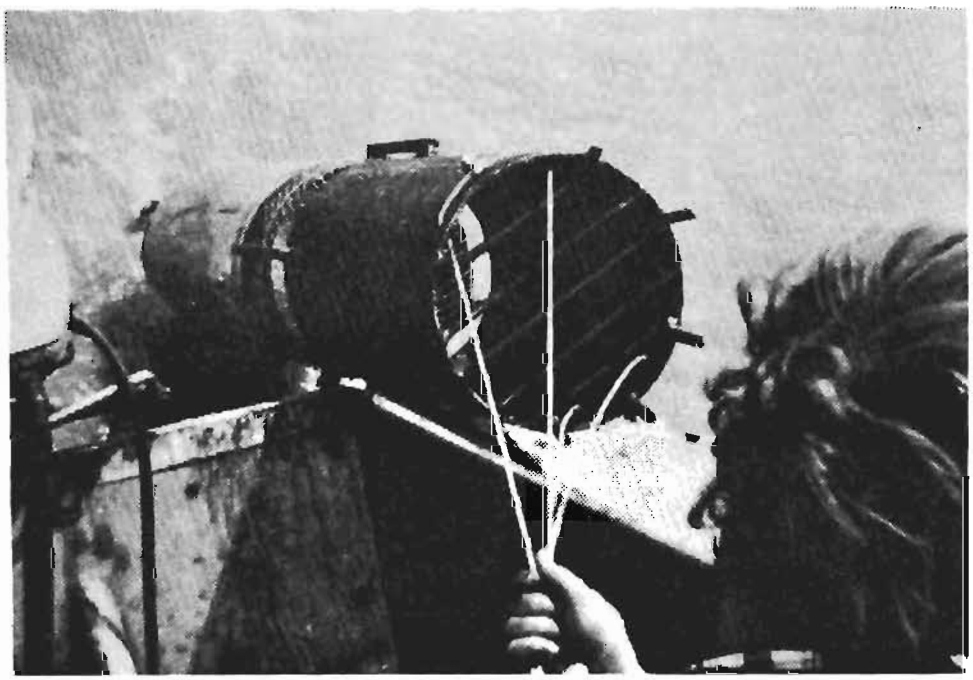


Figure 7. Paddlefish eggs were sampled by towing a dredge upstream with a large boat.

The forward opening to the second section, made of a 254 mm (10 inch) length of 267 mm (10 1/2 inch) diameter pipe, was 70 mm (2 3/4 inches) from the rear opening of the first section. The orifice to the second section was covered by a 38 mm (1 1/2 inch) wire mesh. The two sections were connected together by four 229 mm (9 inch) lengths of 10 mm (1/2 inch) square rods. These rods were not welded directly to the pipe but to 51 mm (2 inch) pieces of 10 mm (1/2 inch) square rod, four pieces of which had previously been welded to both the front and rear section of pipe. These four spacers were mounted 38 mm (1 1/2 inches) back from the orifice of the rear section of pipe. This allowed placement of a hose clamp over the anterior portion of the second section which held the wire screen in place.

A conical net (mesh size of 270 microns) 711 mm (28 inches) in length was fitted over the rear edge of the second section. The posterior end of the net was fitted to a 76 mm (3 inch) diameter plankton bucket. A cylinder, made of heavy sheet metal, was slipped over both the net and 152 mm (6 inches) of the second section of pipe. A large metal hose clamp secured both the cylinder and net in place. The sheet metal cylinder was 610 mm (24 inches) long and slightly larger in diameter than the pipe. The purpose of the cylinder was to protect the net from abrasion on rocks and debris. Total weight of the dredge was 27 kg (60 pounds).

The dredge was towed from a large boat at a slow speed in an upstream direction. Length of tows were timed (usually 5 minutes). Nine sample sites were established from Intake Dam to 8 km downstream from the dam.

Samples were preserved in a 10 percent formaldehyde solution mixed with a red dye (Phloxine B). The dye colored larvae and eggs which facilitated sorting. Fish eggs and larvae were identified from descripions given by Nelson (1968), Scott and Crossman (1973), Hogue et al. (1976), Purkett (1961), Ballard and Needham (1964), Snyder (1980), and McGuire (1981). Individual specimens were sent to various biologists to verify identification.

Definitions of fish developmental stages used in this paper include: (1) prolarvae - yolk sac visible, (2) postlarvae - yolk sac absorbed, and (3) juvenile - resembles adult fish. The term alevin was used for young catfish which transform directly from the prolarvae to juvenile stage.

Results and Discussion

Paddlefish

Preliminary sampling along the substrate with a long handled net resulted in the collection of 2 paddlefish larvae in 1977. A third was also collected that was probably a paddlefish. All three larvae were collected in an eddy immediately downstream from Intake diversion on the south side of the river. Two of the larvae were collected on June 20 and one on June 21. Maximum discharge and water temperature on these dates were 18,300 cfs and 20^{o}C.

Only one possible paddlefish larvae was collected in drift nets during 1978 through 1980. This specimen was collected downstream from Intake diversion on June 3, 1980. Because of the poor condition of the specimen it could not be positively separated from sturgeon larvae.

A total of 14 paddlefish eggs was collected in an 8 km reach of the Yellowstone downstream from Intake diversion during 1980 (Figures 8 and 9). Eggs were collected from May 30 until June 20. All eggs collected were covered by particles of sand substantiating that these eggs were adhesive. Purkett (1961) noted that unfertilized eggs were nonadhesive while fertilized eggs were very adhesive. Mean daily water temperature during the period that eggs were collected ranged from 16 to 21.5°C.

Most eggs were found at two locations: (1) a shallow gravel reach, which extends over 2 km downstream from Intake diversion on the north side of the river below a stable gravel bar, and (2) an area of rapids approximately 5 km downstream from the diversion dam (Figure 9). Five and seven paddlefish eggs were collected at the first and second site, respectively. One egg was collected downstream from both of these sites. No eggs were collected immediately downstream from Intake diversion or 2.5 km downstream from the diversion on the south side of the river (Figure 9). Depth ranged from 1-2 m and substate was dominated by cobbles and pebbles at the upstream egg collection site. Depth ranged from 1 to 3 meters in the downstream most egg collection area (rapids) where substrate ranged from fine pebbles to bedrock.

Shovelnose sturgeon

Shovelnose sturgeon prolarvae were collected in the Tongue River during 1978, 1979 and 1980 (Figures 10, 11 and 12). Seven prolarvae were collected on May 19, the first day of sampling in 1978, while none were collected in later samples. Six sturgeon prolarvae were collected during the sample period of June 5 through June 14 in 1979. On June 13, 1980 two shovelnose sturgeon prolarvae were collected, the only larvae collected in 1980.

The much later date of larval collection in 1980 was likely due to low flows in the Tongue River during May which prevented adult shovelnose sturgeon from ascending the Tongue River. Adult shovelnose stugeon were not captured in the Tongue River until June 9 in 1980 while the six previous years sturgeon were first captured from April 22 to May 15 (Table 1). Discharge during May of 1980 never exceeded 200 cfs (Figure 12) and averaged 150 cfs while mean May discharge the 6 previous years ranged from 528 to 2983 cfs (Table 1). Dicharge the day the first adult shovelnose sturgeon was captured in 1980 was 600 cfs which compares with 520 to 1200 cfs the previous 6 years (Table 1). Elser et al. (1977) failed to capture adult shovelnose sturgeon in the Tongue River when flows were lower than 300 cfs. The minimum flow necessary to trigger sturgeon spawning migrations into the Tongue River is probably between 500 to 600 cfs.

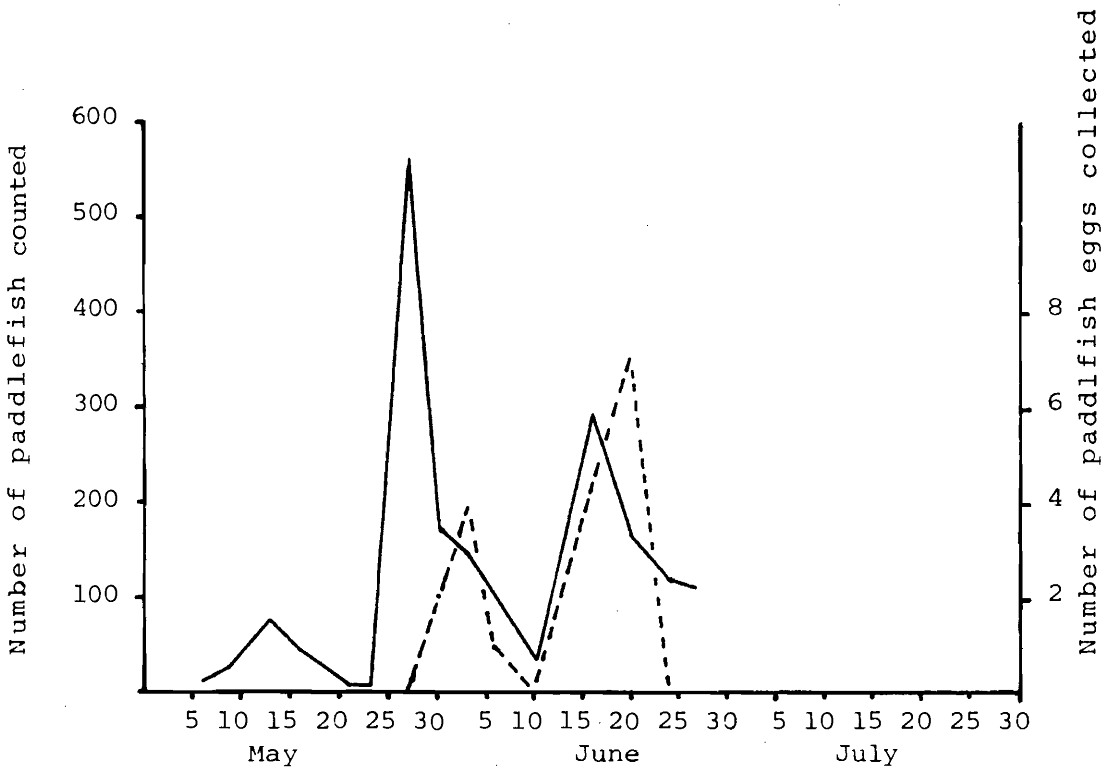
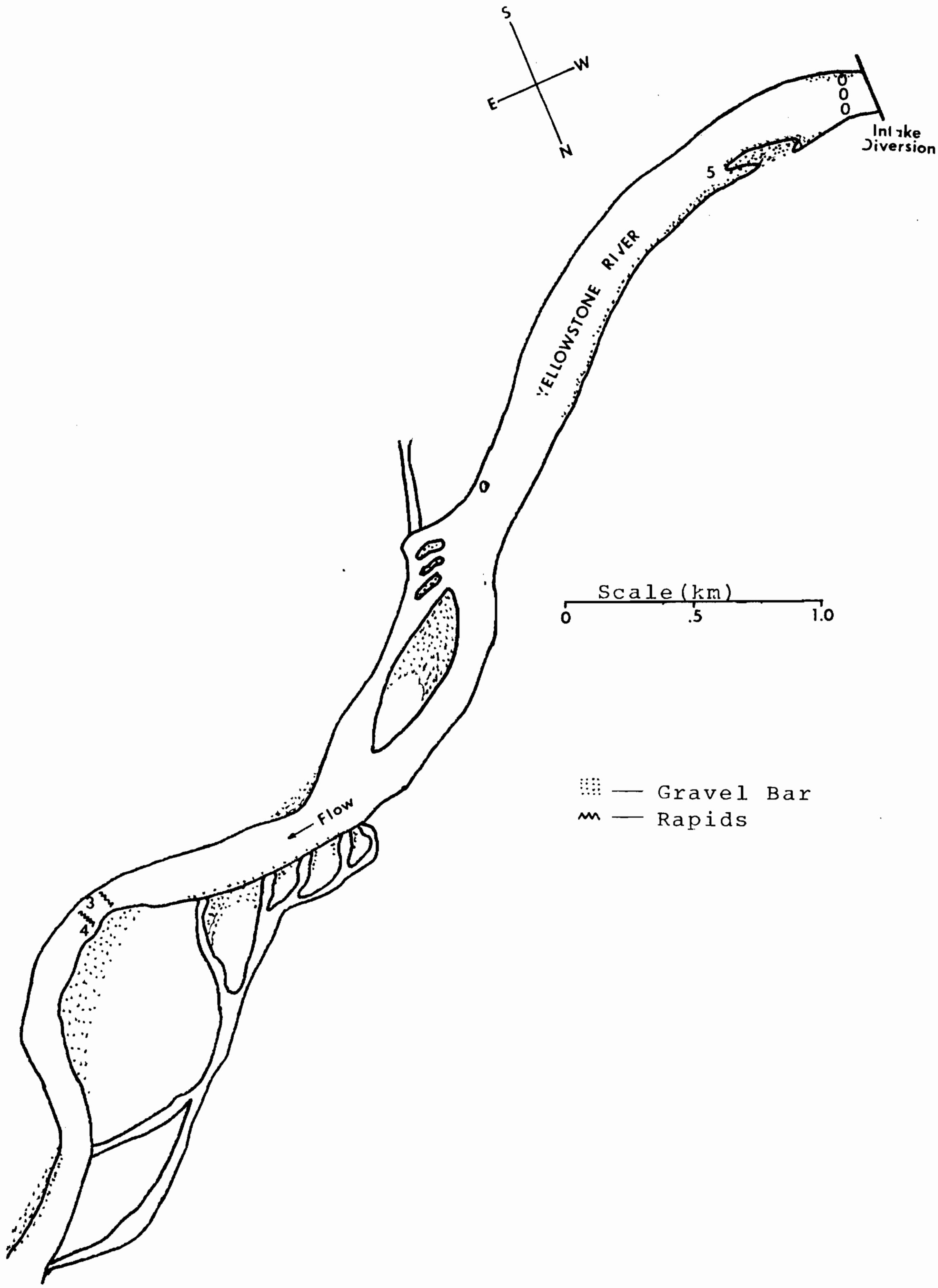


Figure 8. Number of paddlefish eggs (---) collected in dredge samples and adult paddlefish (——) observed while electrofishing an 8 km reach of the Yellowstone River downstream from Intake Diversion, 1980.

Figure 9. Paddlefish egg sampling sites in a 8 km reach of the Yellowstone River downstream from Intake diversion. Number of paddlefish eggs collected in 1980 is indicated at each site.



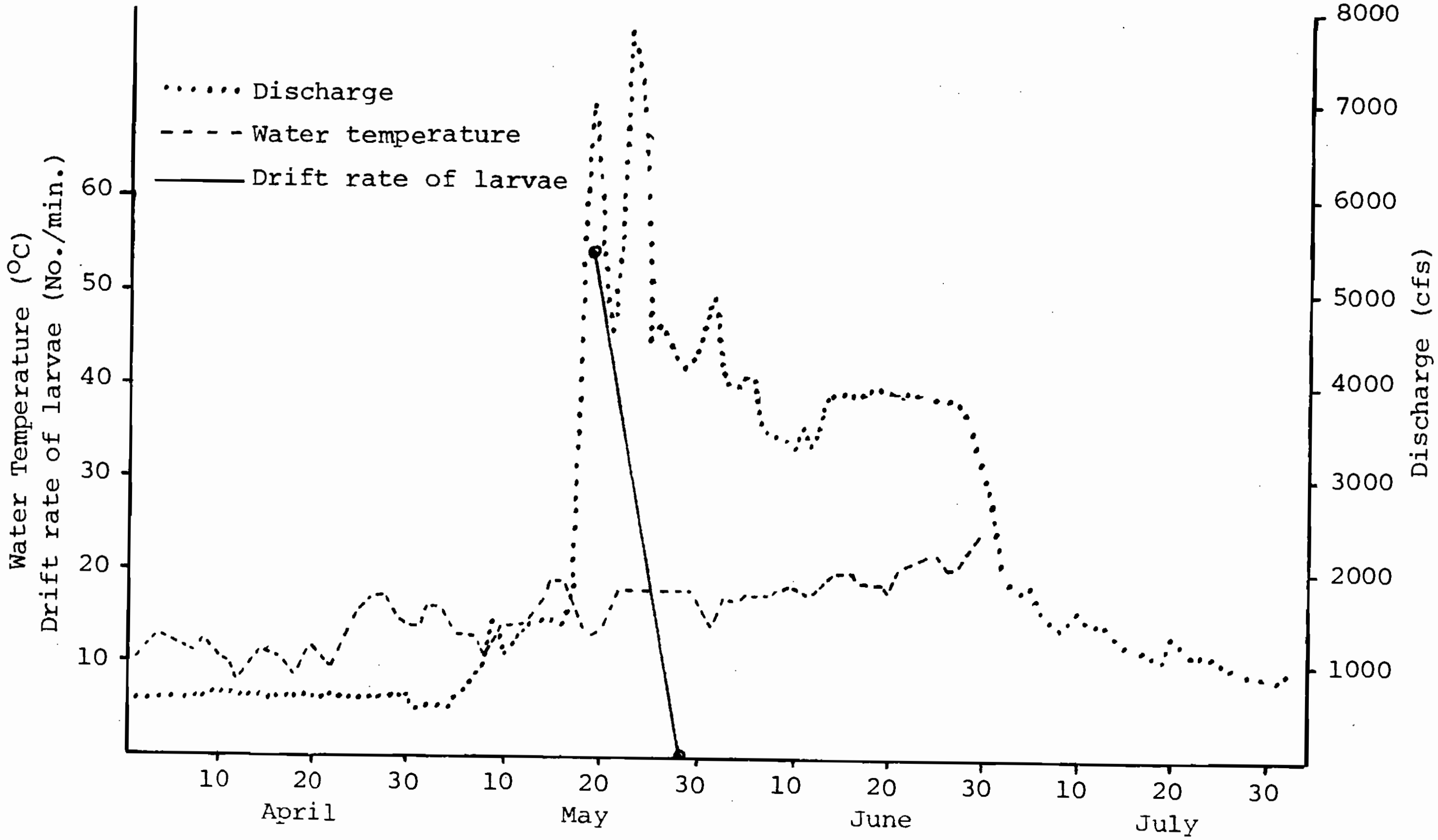


Figure 10. Drift rate of larval shovelnose sturgeon (calculated as number drifting by a point per minute for comparison), discharge, and water temperature in the Tongue River during 1978.

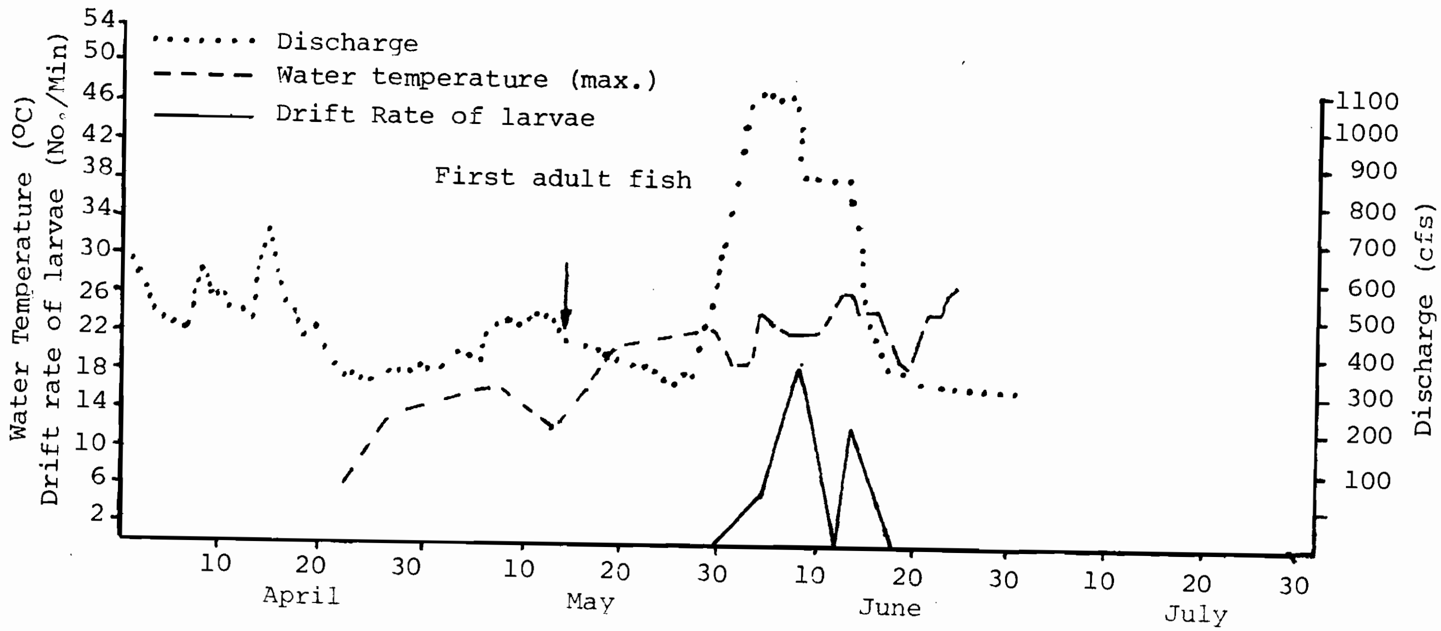


Figure 11. Drift rate of larval shovelnose sturgeon (calculated as number drifting by a point/minute for comparison), discharge, and water temperature in the Tongue River during 1979.

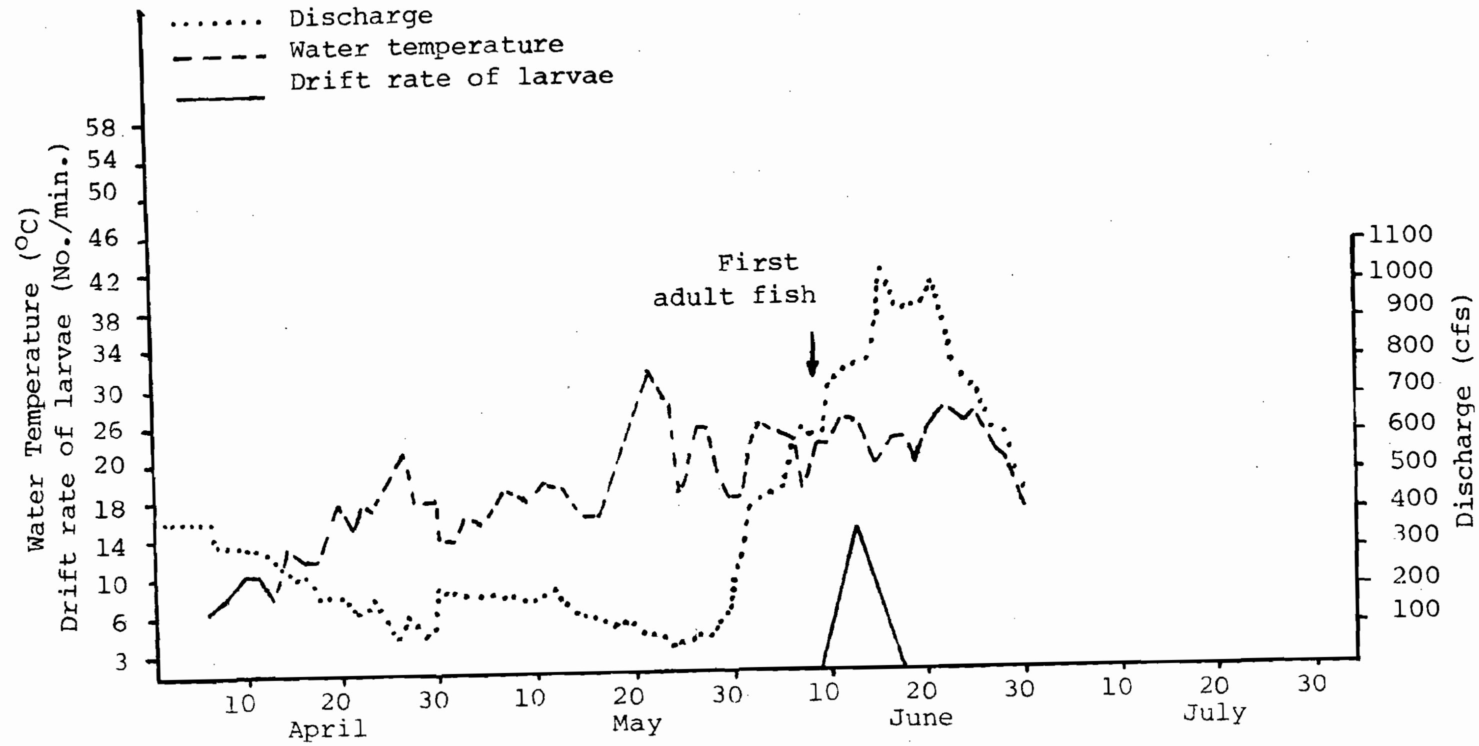


Figure 12. Drift rate of larval shovelnose sturgeon (calculated as number drifting by a point/minute for comparison), discharge, and water temperature in the Tongue River during 1980.

Temperature did not play a role in the late spawning of shovelnose sturgeon in the Tongue River during 1980. Actually, mean water temperature during May 1980, 19°C, was the highest of the seven year period (Table 1). From previous years' sampling, 15 to 16°C seems to be the temperature at which sturgeon entered the Tongue River. This water temperature first occurred on April 27 during 1980, six weeks prior to sturgeon first entering the Tongue River (Figure 12). Sturgeon did not enter the Tongue in 1980, however, until flow increased to 600 cfs.

One shovelnose sturgeon prolarvae and 3 dead or unfertilized sturgeon eggs were collected from the Powder River on June 27, 1979 (Figure 13), nine days after the last sturgeon larvae was collected in the Tongue River during the same year. The Powder was not sampled for larvae in 1978 and no sturgeon larvae were collected from the Powder in 1980 (Figure 13). The mean discharge of the Powder River during May and June in 1979, 700 and 650 cfs, and 1980, 280 and 600 cfs, was much lower than the 30 year median mean discharges for these months, 888 and 1112 cfs. Adult sturgeon never entered the Powder River in large numbers in 1980 probably because of low flows. Allocated instream flows of the Powder River during May and June, 424 and 184 cfs, respectively, are insufficient for sturgeon reproduction. Shovelnose sturgeon probably also spawned in the Yellowstone River between Intake and Fairview, as evidenced by collection of larvae. Three larvae were collected in 1978, one just downstream from Intake diversion on June 13, one the same location on June 29, and one near Fairview on June 16. One was also collected near Fairview on July 10, 1979. Although larval samples were collected from the Yellowstone River in 1980, no larval sturgeon were found.

Channel catfish

A total of 10 channel catfish alevins was collected in the Yellowstone River from July 10 through July 21 in 1978. Sampling occurred from May 15 to July 25 in 1978. The location and number of alevins collected at each site include: the Yellowstone upstream from Tongue River - 1, the Yellowstone downstream from Tongue River - 1, the Yellowstone upstream from Intake diversion - 5, and the Yellowstone near Fairview - 3. Total length of the alevins was very uniform, 15 to 17 mm. Maximum daily water temperature of the Yellowstone during the period that alevins were captured ranged from 20.0 to 23.5°C. The Powder River was not sampled for larval fish in 1978; however, Rehwinkel (1978b) found good numbers of young-of-year catfish in the Little Powder River and indicated this tributary of the Powder River was an important spawning area for migratory Yellowstone River catfish. No catfish alevins were captured in the Tongue River in 1978; however, this could have been related to sampling efficiency rather than lack of reproduction. Elser et al. (1977) documented a strong run of Yellowstone River catfish into the Tongue River during the spring. Tag returns indicate that Pumpkin Creek, a tributary of the lower Tongue River, may be an important area for reproduction. Young-of-year catfish were collected in the lower Tongue River during autumn.

The following habits of catfish suggest that their larvae may be less susceptible to drift than larvae of other species and may explain why no prolarvae and only 10 alevins were collected during sampling in 1978; (1) catfish spawn during periods of declining flows, (2) catfish spawn in protected areas, (3) male catfish guard their eggs, and (4) catfish larvae do not swim up from the nest until they are 2 to 5 days old (Scott and crossman 1973).

No catfish prolarvae or alevins were collected during 1979 or 1980 as sampling was terminated too early, July 11 and June 27, respectively.

Catfish alevins were collected upstream from the mouth of the Tongue River (river km 298) establishing that spawning grounds for catfish exist upstream from the Tongue River. One likely spawning area is lower Rosebud Creek (river km 361). Elser and Schreiber (1978) collected 60 catfish of large size in Rosebud Creek, most of which were captured from mid-May to August. However, a 2 m high dam on Rosebud Creek, 6.4 km upstream from its mouth, prevented catfish access beyond this point. Sarpy Creek (river km 426) might also be used by spawning catfish. Local fishermen reported catching large catfish during spring and early summer in this tributary.

There are several additional small tributaries in the lower Yellowstone drainage which may be important as catfish spawning areas. Perhaps the most important of these is O'Fallon Creek (river km 208) and its tributary, Sandstone Creek. Morris et al. (1981) reported that catfish (young-of-year through adult) were captured throughout this tributary. Other creeks where Morris et al. (1981) reported catfish include: First Hay (Yellowstone River km 26), Fox (Yellowstone River km 52), Crane (km 66), Cottonwood (km 104), Thirteenmile (km 116), Deer (km 138), and Upper Sevenmile (km 154).

Small tributaries may be vital for catfish reproduction in the lower Yellowstone system. Small streams offer protective spawning sites for catfish such as undercut banks, rocks, and fallen trees in areas of slow to moderate current. Because of the seasonally variable flow and wide channel, the mainstem of the Yellowstone offers few areas of undercut banks. Perhaps the most likely place for catfish reproduction in the mainstem is in backwaters or quiet side channels; however, even in these areas protective cover is not abundant.

Other species

Dates of collection of various species of prolarval fish are summarized in Table 2. Catostomus sp. prolarvae were collected at all sites except Fairview. Sampling was initiated too late at the Fairview site to collect Catostomus sp. prolarvae; however, post larvae were collected at this location.

Table 1. Mean discharge and water temperature during May and on the day the first adult sturgeon was collected in the Tongue River, 1974-1980.

Year	May Mean Discharge	May Mean Water Temperature	Day First Sturgeon Collected Date	Day First Sturgeon Collected Maximum Water Temperature	Day First Sturgeon Collected Discharge
1980	150	18	June 9	24	600
1979	528	17	May 15	15	520
1978	2983	14.5	May 10	14	1140
1977	1195	17.5	April 23	16	570
1976	582	16	May 13	16	625
1975	1785	13	May 9	12	1200
1974	767	14.5	April 30	17	600

Table 2. Collection date and site (1=Yellowstone River upstream from the mouth of Tongue River, 2=Mouth of Tongue River, 3=Yellowstone River upstream from the mouth of Powder River, 4=Mouth of Powder River, 5=Yellowstone River upsteam from Intake diversion, 6=Intake diversion canal, 7=Yellowstone River downstream from Intake diversion, 8=Yellowstone River near Fairview) of fish prolarvae collected on the Yellowstone River system, 1977-1980.

	Date of Collection	Collection Site[1]
Stizostedion canadense	4/21 - 5/23	2,4,5,7
Stizostedion vitreum	5/17	7
Catostomus sp[2]	4/21 - 5/31	1,2,3,4,5,6,7
Cycleptus elongatus	5/9 - 5/22	5,7
Hiodon alosoides[3]	5/20 - 6/25	3,4,5,6,7,8
Moxostoma macrolepidotum	5/21 - 6/15	2,3,7
Scaphirhynchus platorynchus	6/5 - 7/10	2,3,7,8
Ictiobinae[4]	6/5 - 7/25	2,3,4,5,6,7,8
Polyodon spathula	6/20 - 6/21	7
Noturus flavus[5]	7/21	2
Ictalurus punctatus[5]	7/11 - 7/21	1,5,8
Cyprinidae[6]	June and July	1,2,3,4,5,6,7,8

[1] The Fairview site (number 8) was only sampled during June and July, the site upstream from the Powder River (number 3) was only sporadically sampled, and Intake canal (number 6) did not have water in it until April 30 to May 20 and was not sampled until after the *Stizostedion* sp. drift passed.

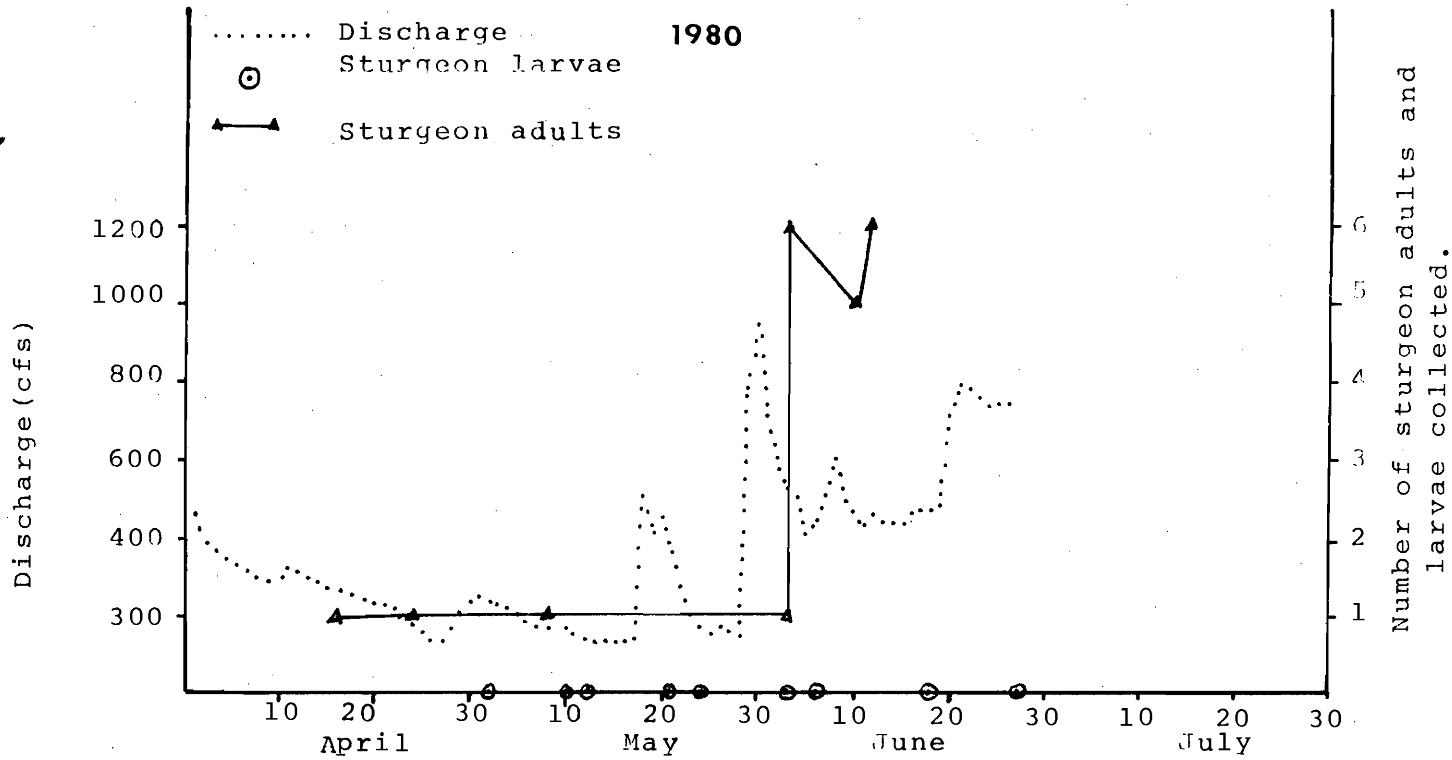
[2] Includes: *Catostomus catostomus* and *C. commersoni*

[3] Goldeye were spawning in Tongue River as concentrations of adults were observe and their eggs were collected.

[4] Includes: *Carpoides carpio, Ictiobus bubalus,* and *I. cyprinellus*

[5] Alevins

[6] Includes: *Hybopsis* sp., *Rhyncihthys cataractae, Hybognathus* sp., *Cyprinus carpio.*



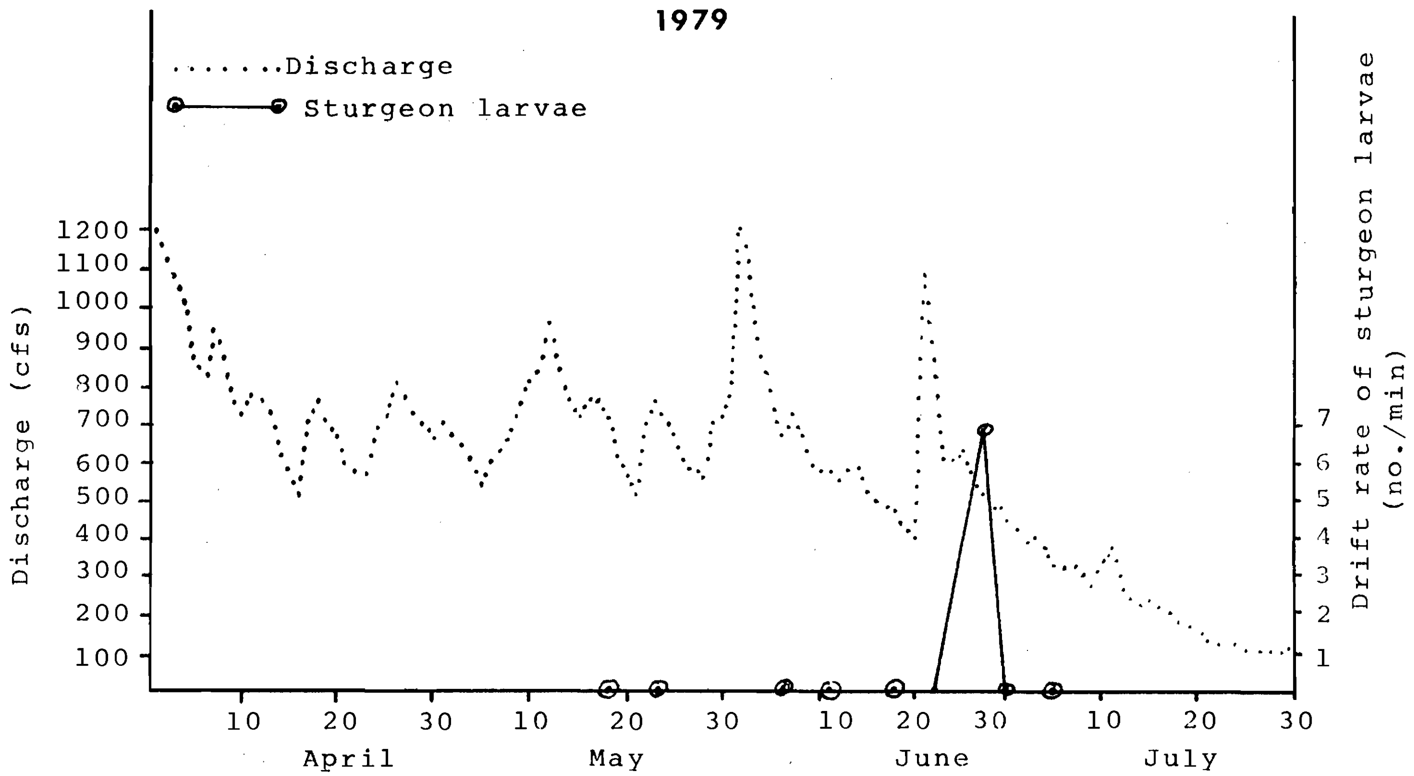


Figure 13. Drift rate of larval shovelnose sturgeon (number drifting by a point per minute) and discharge in the Powder River during 1979 and 1980.

Duration of drift of _Catostomus_ sp. prolarvae lasted from 2 to 3 weeks during any one year. Of 333 and 949 larvae captured during the early sampling period (April 21 - May 23) in 1979 and 1980, respectively, 70 and 96 percent, respectively, were _Catostomus_ sp. (Table 3).

Goldeye larvae were captured at all locations except the Tongue River and the Yellowstone River upstream from the Tongue River (Table 2). Goldeye, however, were spawning in the Tongue River as their semi-boyant eggs were captured in drift nets in this tributary. Goldeye made up 47 and 42 percent of the larvae captured during the second (May 24 - June 15) and third (June 15 - July 11) sampling periods in 1980 while few goldeye were collected in 1979 (Table 3). Cool water temperatures during spring in 1979 may have suppressed goldeye reproduction in 1979.

Shorthead redhorse prolarvae were captured from May 21 to June 15 (Table 2). Redhorse were captured in the Tongue River, the Yellowstone River upstream from the Powder River and the Yellowstone downstream from Intake diversion. The only positively identified spawning ground for redhorse was in the Tongue River. Rehwinkel (1978b) noted that relatively few redhorse migrated into the Powder River. Shorthead redhorse comprised 16 percent of the the larvae captured during the second sample period in 1979 and 1980 (Table 3).

River carpsucker (_Cyprinus_ _carpios_) and buffalo (_Ictiobus_ sp.) prolarvae were difficult for this author to separate so specimens from both genera were lumped into the group Ictiobinae.

Prolarvae were collected from June 5 to July 25. A few postlarval and juvenile (25 mm) _Ictiobus_ sp. were collected on July 18, 1978, the same date that carpsucker prolarvae were also captured. _Ictiobus_ sp. larvae were positively identified in the Tongue River, Intake canal, the Yellowstone River downstream from Intake diversion, and the Yellowstone near Fairview. Individuals from the group Ictiobinae were not collected during the first sampling period while they comprised 75 and 4 percent of all larvae captured during the second sampling period during 1979 and 1980, respectively (Table 3). Ictiobinae comprised 93 and 40 percent of the larvae collected during the third period in 1979 and 1980, respectively.

Most Cyprinids were not identified beyond family but the following observations were noted: (1) _Hybopsis_ sp. were collected from the Tongue River, Yellowstone River above Intake diversion, Yellowstone River near Fairview, (2) _Rhynichthys_ _cataractae_ were collected from the Intake canal, and (3) _Cyprinus_ _carpio_ were collected from the Tongue River and Intake Canal.

Densities of fish eggs and larvae

Total concentrations of fish eggs and larvae were higher in the Tongue River than at any other sample location during 1979 and 1980.

Table 3. Number (percent) of fish larvae collected in the Yellowstone, Tongue and Powder rivers during 1979 and 1980.

	April 21-May 23		May 24-June 15		June 16-July 11	
Taxonomic group	**1979**	**1980**	**1979**	**1980**	**1979**	**1980**
Stizostedion sp	99(30)	28(3)	0	0	0	0
Catostomus sp.	233(70)	913(96)	7(4)	4(9)	5(2)	2(4)
Cycleptus elongatus	1	1	0	0	0	0
Hiodon alosoides	1	6(1)	4(2)	21(47)	1	22(42)
Moxostoma macrolepidotum	0	1	31(16)	7(16)	5(2)	0
Scaphirhynchus platorynchus	0	0	6(3)	2(4)	2(1)	0
Ictiobinae	0	0	149(75)	2(4)	215(93)	21(40)
Polyodon spathula	0	0	0	1(2)	0	0
Noturus flavus	0	0	0	0	1	0
Cyrinidae	0	0	2(1)	8(18)	2(1)	8(15)
Total	334	949	199	45	231	53

In 1979 fish eggs and larvae were 9 times more concentrated in the Tongue than Powder River, the sample site with the next highest density (Table 4). In 1980 the Tongue River supported densities 3.5 times that of the Powder River (Table 5). Fish eggs and larvae were 80 and 50 times more concentrated in the Tongue River, during 1979 and 1980, respectively, than in the Yellowstone River upstream from the mouth of the Tongue River. Concentrations of fish eggs and larvae were 9 to 14 times greater in the Powder River than in the Yellowstone upstream from the Tongue River. Concentrations in the mainstem generally were greater downstream than upstream.

In 1979, the Tongue River supported higher concentrations of fish eggs and larvae than any other site during all three sample periods (Table 4). In 1980, however, concentrations in the Powder River equalled or exceeded concentrations in the Tongue River during the second and third sample periods. Abnormally low flows in the Tongue River during 1980 probably resulted in much suppressed spawning runs of adult fish and/or reduced reproductive success.

SIZE DISTRIBUTION AND MOVEMENT OF FISH

Methods

Sauger, walleye, shovelnose sturgeon, burbot, and channel catfish were collected with electrofishing gear in four sections of the Yellowstone River during autumn, 1977 through 1980. Penkal (1981) described the equipment and methods in detail. Fish lengths were analyzed by river section for the following sections of the Yellowstone River: (1) mouth of the Yellowstone River to Intake diversion (river km 0 to 114), (2) Intake diversion to 8 km downstream from the mouth of the Powder River (river km 115-233), (3) 8 km downstream from Powder River to Forsyth diversion (river km 234-381), and, (4) Forsyth diversion to Huntley diversion (river km 382-575) (Figure 1).

Because electrofishing was selective for larger catfish and was a relatively ineffective method, baited hoop nets were also fished in river sections 1, 3, and 4 during the summer of 1979. These nets were 0.8 m (2.5 feet) in diameter, 2.0 m (6.5 feet) long, and the braided nylon net had a bar mesh size of 3.2 cm (1.25 inches). Nets were fished in areas where current would carry the scent of bait downstream. The nets were effective in capturing catfish larger than 280 mm. Berg (1978) described these nets and their use.

At the time of capture fish were tagged with individually numbered Floy FD-67 anchor (sauger, walleye, and burbot) or FT-4 cinch-up (catfish and shovelnose sturgeon) tags. Movement data were obtained from fishermen returns or recapturing tagged fish.

Table 4. Densities of fish eggs and larvae (number per $1000m^3$) in the Tongue, Powder, and Yellowstone rivers during 1979.

Location	April 21 - May 23			May 24 - June 15			June 18 - July 11			Total		
	No.of Samples	Vol. Water Sampled (m^3)	No. eggs & Larvae /$1000m^3$	No. of Samples	Vol. Water Sampled (m^3)	No.eggs &Larvae /$1000m^3$	No. of Samples	Vol. Water Sampled (m^3)	No. eggs &Larvae /$1000m^3$	No. of Samples	Vol. Water Sampled (m^3)	No. eggs & Larvae /$1000m^3$
Yellowstone R. Upstream from Tongue	7	4382	0	4	1482	4	4	3828	2	15	9692	1
Tongue R.	9	6378	48	5	1993	108	4	2013	155	18	10385	80
Yellowstone R. upstream from Powder R.	2	2470	11	2	1418	4	4	5852	2	8	9740	4
Powder R.	3	8197	0.4	3	843	75	6	1671	10	12	10712	9
Yellowstone R. upstream from Intake Div.	5	5498	0.9	0	-	-	0	-	-	-	-	-
Intake Canal	0	-	-	1	483	10	5	3979	7	-	-	-
Yellowstone R. downstream from Intake Diversion	5	8153	8	2	785	32	4	6897	7	11	15835	8
Yellowstone R. near Fairview	0	-	-	1	946	152	4	2819	15	-	-	-
Total	31	35078	12	18	7950	58.3	31	27059	17		70089	19

Table 5. Densities of fish eggs and larvae (number per 1000m3) in the Tongue, Powder and Yellowstone Rivers during 1980.

Location	April 21 - May 23			May 24 - June 15			June 18 - July 11			Total		
	No.of Samples	Vol. Water Sampled (m^3)	No. eggs & Larvae /1000m^3	No. of Samples	Vol. Water Sampled (m^3)	No.eggs &Larvae /1000m^3	No. of Samples	Vol. Water Sampled (m^3)	No. eggs &Larvae /1000m^3	No. of Samples	Vol. Water Sampled (m^3)	No. eggs & Larvae /1000m^3
Yellowstone R. Upstream from Tongue	3	574	4	1	4302	4	3	4358	1	7	9234	3
Tongue R.	11	4461	200	4	1008	46	4	1054	32	19	6523	149
Yellowstone R Upstream from Powder R.	5	2002	4	0	-	-	2	753	7	-	-	-
Powder R.	8	4159	36	4	826	90	3	699	32	15	5685	43
Yellowstone R. Upstream from Intake Div.	6	7111	2	3	3695	5	4	2970	3	13	13776	3
Intake Canal	4	3836	11	5	2662	11	4	2492	5	13	8990	7
Yellowstone R. Downstream from Intake Div.	6	6044	3	5	5020	16	4	3753	2	15	14817	4
Total	40	27187	40	22	17513	15	24	16079	6		61779	23

Results and Discussion

Length of fish and river location

Sauger, collected while electrofishing during the fall of 1977, 1978, and 1979, were significantly (95% level of confidence) smaller in section 1 than all other sections (Tables 6, 7, and 8). Mean sauger length in section 3 was significantly longer than in section 2 during 1978 and 1979. Sauger were much larger in section 4 than in the other 3 sections.

Differences in mean sauger size in the four sections were not caused by growth rate, but by differences in age structure (see Penkal 1981). Young sauger were abundant in section 1, but were increasingly less abundant in upstream sections. This situation emphasizes the importance of the Yellowstone River from Intake to its confluence with the Missouri River, as a rearing area for young sauger.

Table 6. Mean total length (except shovelnose sturgeon which is fork length) in millimeters and mean weight in grams for various species of fish collected in the Yellowstone River while electrofishing during late summer and fall, 1977.

Species	Section (River km)	N	Mean Length (95% C.I.)[a]	Mean Weight
Catfish	1 (0-114)	6	532 (375-689)	1896
Catfish	2 (115-232)	10	432 (327-536)	989
Catfish	3 (233-381)	173	498 (479-517)	1450
Catfish	4 (382-575)	28	598 (564-632)	2670
Burbot	1	18	327 (278-376)][b]	266
Burbot	2	24	394 (355-432)][b]	333
Burbot	3	53	345 (323-367)	245
Burbot	4	4	693 (648-738)	-
Sauger	1	326	318 (309-326)	291
Sauger	2	168	341 (330-352)	378
Sauger	3	430	348 (342-354)	389
Sauger	4	41	415 (401-428)	754
Shovelnose sturgeon	1	133	569 (544-594)	850
Shovelnose sturgeon	2	8	698 (621-775)	1187
Shovelnose sturgeon	3	287	770 (761-779)	2311
Shovelnose sturgeon	4	0	-	-

a No overlap of confidence intervals indicates significance at 95% level of confidence.

b Overlapping confidence intervals with significantly different means at the 95% confidence level.

Table 7. Mean total length (except shovelnose sturgeon which is fork length) in millimeters and weight in grams for various species of fish collected in four sections of the lower Yellowstone River while electrofishing during late summer and fall, 1978.

Species	Section (River km)	N	Mean Length (95% C.I.)[c]	Mean Weight
Catfish	1 (0-114)	0	-	-
Catfish	2 (115-232)	29	473 (420-527)	1372
Catfish	3 (233-381)	208	429 (413-446)	985
Catfish	4 (382-575)	18	498 (458-538)	1275
Burbot	1	13	294 (224-364)]b	196
Burbot	2	33	366 (331-401)]	299
Burbot	3	27	357 (317-397)	298
Burbot	4	34	625 (570-680)	1469
Sauger	1	231	296 (289-304)	162
Sauger	2	317	338 (329-347)]	367
Sauger	3	560	345 (339-351)]a	363
Sauger	4	79	440 (430-450)	842
Shovelnose sturgeon	1	15	514 (442-586)]b	657
Shovelnose sturgeon	2	6	701 (585-817)]	1463
Shovelnose sturgeon	3	22	719 (672-766)	1902
Shovelnose sturgeon	4	0	-	-

[a] Overlapping confidence intervals with significantly different means at the 90% confidence level.

[b] Overlapping confidence intervals with significantly different means at the 95% confidence level.

[c] No overlap of confidence intervals indicates signficance at 95% level of confidence.

Shovelnose sturgeon also had a similar size distribution pattern. The mean length of shovelnose sturgeon was signficiantly (95% level of confidence) smaller in section 1 than section 2 or 3 in autumn electrofishing samples during 1977 and 1978 (Table 6 and 7). Although the sample size was small the mean sturgeon length in section 3 was slightly greater than in section 2. No sturgeon were collected in section 4, suggesting that Forsyth diversion is a barrier to upstream movement. The size distribution pattern (Figure 14) suggests that young sturgeon tended to remain in the downstream section number 1. Sturgeon were not aged.

The few burbot collected in section 1 during 1977 and 1978 had a length significantly smaller than those collected upstream (Tables 6 and 7). Burbot collected in section 4 were much larger than those downstream (Tables 6, 7 and 8). Mean length of burbot in sections 2 and 3 was intermediate. The length frequency distribution (Figure 15) indicates that the rearing area extends

Table 8. Mean total length (except shovelnose sturgeon which is fork length) in millimeters for various species of fish collected in four sections of the lower Yellowstone River while electrofishing during late summer and fall, 1979.

Species	Section (River km)	N	Mean Length (95% C.I.)[a]	Mean Weight
Catfish	1 (0-114)	0	-	-
Catfish	2 (115-232)	8	545 (416-674)	1784
Catfish	3 (233-381)	165	423 (401-445)	978
Catfish	4 (382-575)	0	-	-
Burbot	1	4	332 (115-549)	225
Burbot	2	12	332 (274-390)	205
Burbot	3	59	296 (265-328)	198
Burbot	4	36	568 (537-599)	1078
Sauger	1	176	277 (268-287)	184
Sauger	2	162	311 (298-323)	288
Sauger	3	1052	343 (339-348)	372
Sauger	4	49	470 (448-493)	1052
Shovelnose sturgeon	1	2	413	245
Shovelnose sturgeon	2	1	458	250
Shovelnose sturgeon	3	24	773 (741-804)	2444
Shovelnose sturgeon	4	0	-	-

[a] No overlap of confidence intervals indicates significant at 95% level of confidence

from Forsyth diversion (river km 381) downstream. Young burbot from 100 to 399 mm were almost absent in section 4 while they were common in all 3 downstream sections. Burbot greater than 400 mm were not common in section 1. The length frequency distribution in sections 2 and 3 was intermediate to sections 1 and 4.

The mean length of channel catfish, captured in trap nets, was significantly (95% level of confidence) greater in section 4 than sections 3 or 1 (Table 9). The mean length of catfish captured in section 3 was signifciantly greater than in section 1. Catfish with lengths of 250 to 399 mm dominated the catch in section 1 while few fish at this length were captured in section 4 (Figure 16). It appeared that the catfish population from Intake diversion downstream was dominated by smaller, younger fish. From fish aged from pectoral spine sections, most catfish in this length range were age class 3 to 5. Muncy (1959) observed that catfish of this length range in the Des Moines River, Iowa, were age 3 to 6. The length frequency distribution of catfish in section 3 was intermediate to sections 1 and 4.

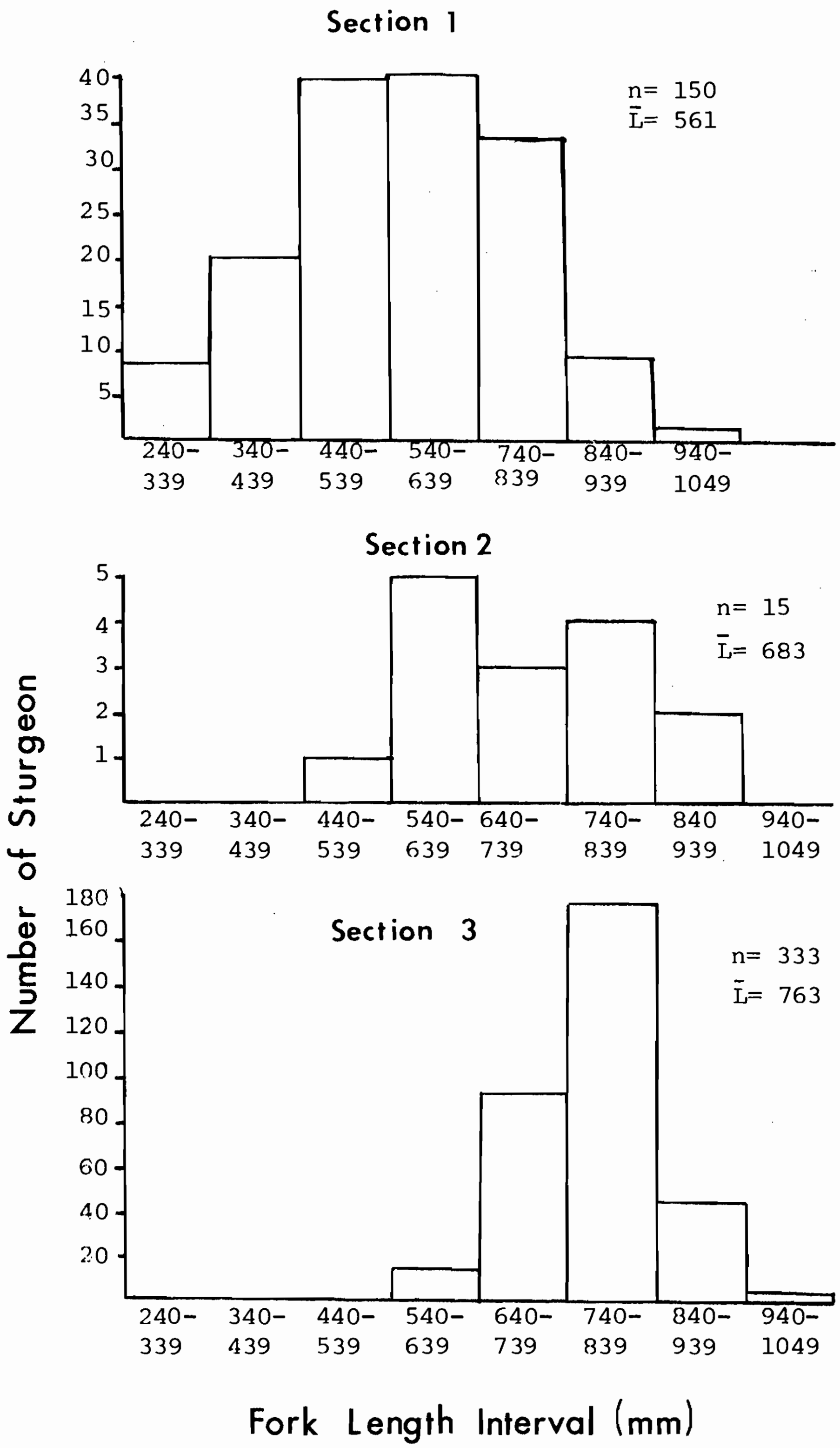


Figure 14. Length frequency of shovelnose sturgeon collected while electrofishing 3 sections of the Yellowstone River during late summer and autumn, 1977 through 1979.

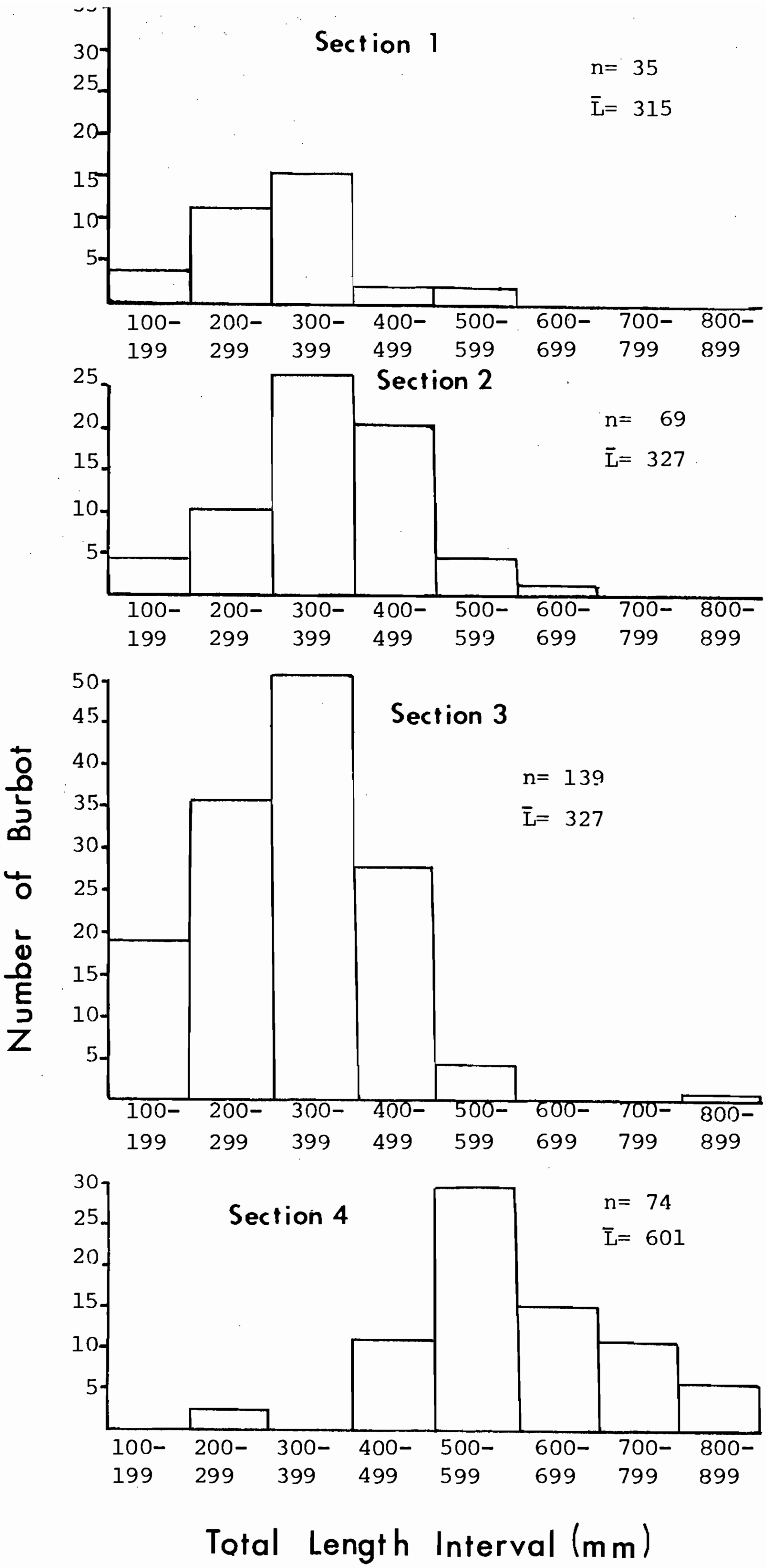


Figure 15. Length frequency of burbot collected while electrofishing 4 sections of the Yellowstone River during late summer and autumn, 1977 through 1979.

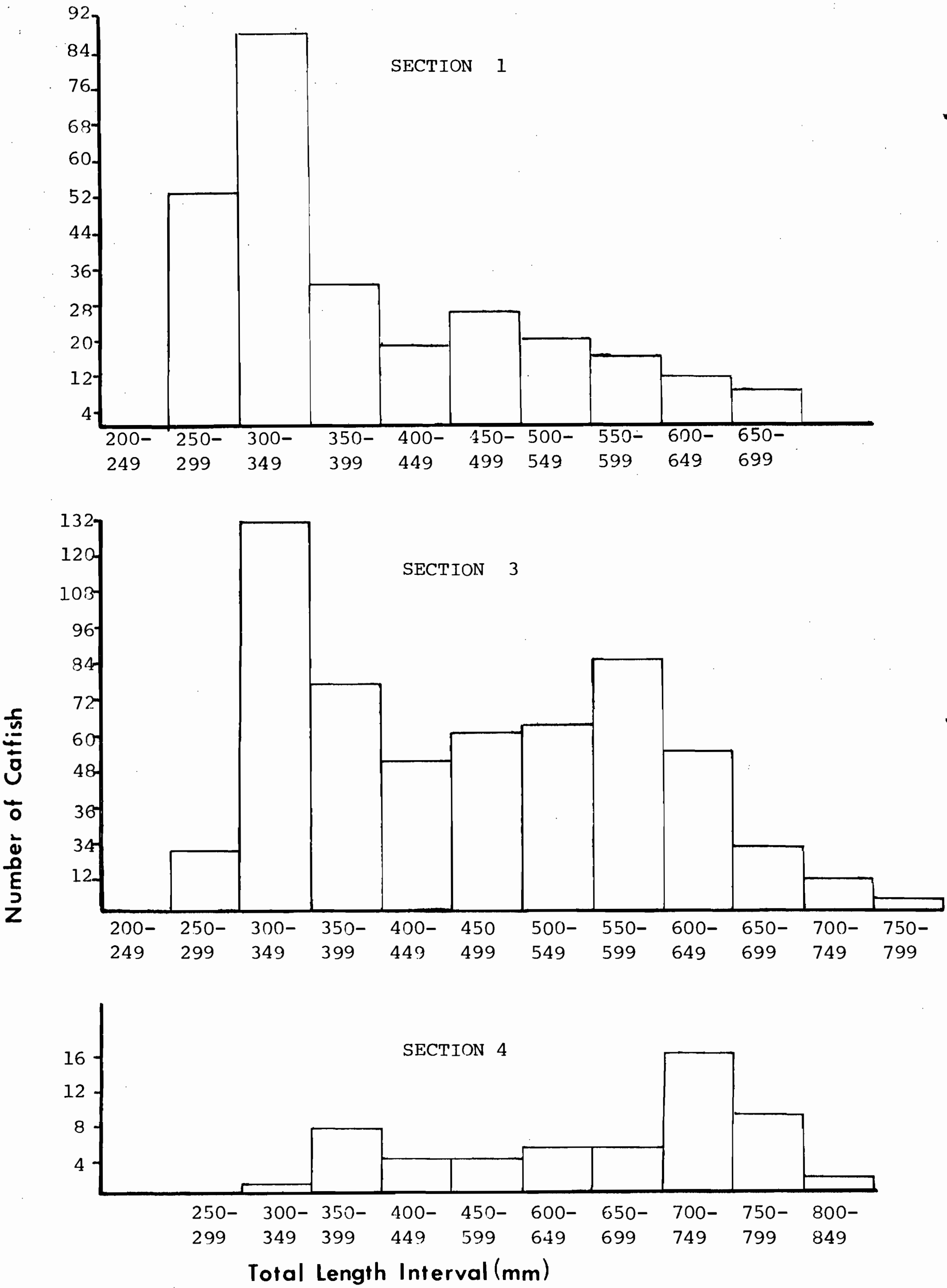


Figure 16. Length frequency of channel catfish captured with trap nets in three sections of the Yellowstone River, summer 1979.

Table 9. Mean length, ninety-five percent confidence interval of mean lengh, and length range of catfish captured in trap nets in three sections of the Yellowstone River, summer 1979.

Section	Number	Mean length (mm)	95% Confidence Interval (mm)	Length Range Captured (mm)
1	278	396	382-409	263-741
3	581	463	453-473	280-790
4	53	565	534-595	320-725

While electrofishing backwaters during the summer of 1980 it was observed that fish of most species were smaller and younger downstream than upstream. This was particularly noted for sauger (Penkal 1981), river carpsuckers, shorthead redhorse, buffalo, and goldeye. This indicates that downstream portions of the Yellowstone River are important as rearing areas for fish that reach upstream areas later in life.

Tag returns and movement

Shovelnose sturgeon

A total of 3751 shovelnose sturgeon was tagged from 1973 through 1980 in the Yellowstone, Tongue, and Powder rivers (Table 10). Of these, 66 tags were returned by fishermen representing a minimum harvest of 1.8 percent. An additional 245 sturgeon were recaptured by DFWP personnel (other than the same season and location tagged).

Fourteen sturgeon, tagged in section 1 (downstream from Intake diversion), were subsequently recaptured (excluding returns at the same location during the same season and year). Thirteen of these shovelnose sturgeon were recaptured at the site of tagging; twelve of the sturgeon were recaptured at Intake within two years after tagging while one was recaptured 3 years later. The other sturgeon was captured near the mouth of the Powder River 126 km upstream from Intake diversion. This sturgeon was captured on September 10, 1980, over 5 years after it was first tagged, May 14, 1975.

No sturgeon captured in section 2 were subsequently recaptured. A total of 11, 26, and 259 sturgeon that were tagged in section 3 of the Yellowstone River, the Powder River, and Tongue River, respectively, was subsequently recaptured at a different location, season, or year (Figures 17, 18, and 19).

Tag returns of shovelnose sturgeon indicate that after spawning in the Tongue and Powder rivers (May through early July) most sturgeon return to the Yellowstone River and migrate upstream. Large concentrations of sturgeon of large size were found in a slow deep run approximately 2.5 to 5 km downstream from Forsyth diversion.

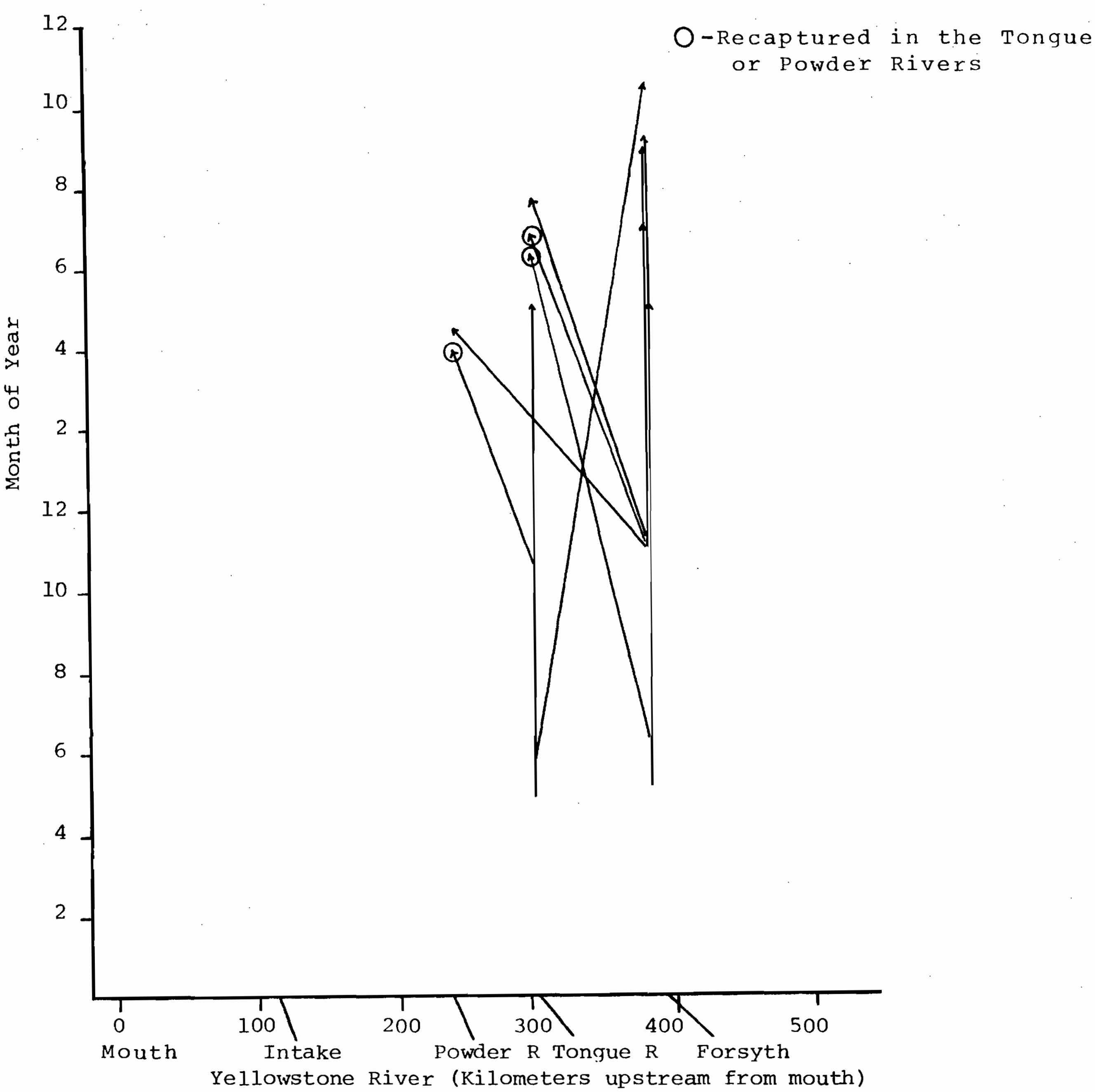


Figure 17. Shovelnose sturgeon tagged in section 3 of the Yellowstone River, 1973-1980, and recaptured at a different location, season, or year.

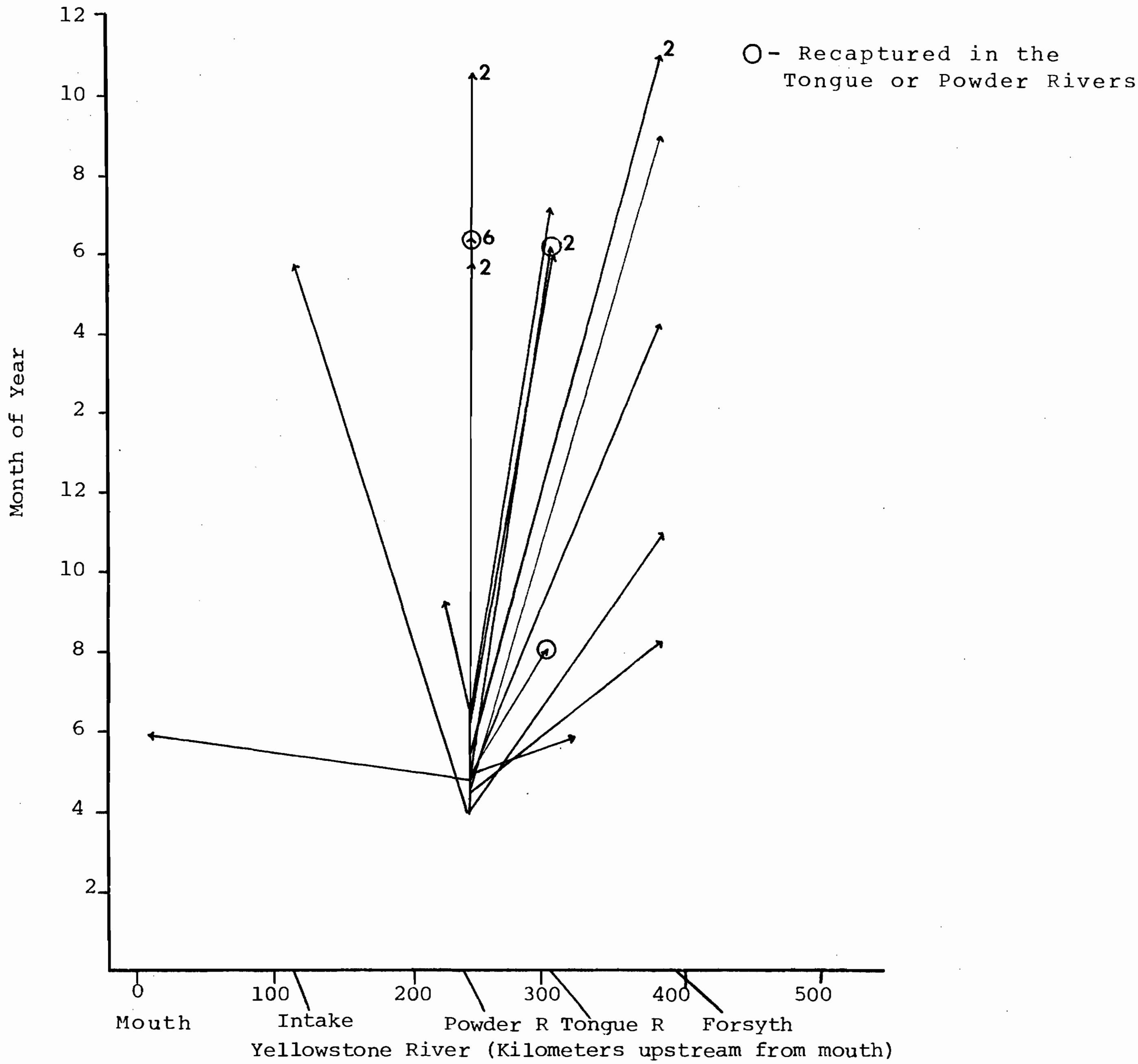


Figure 18. Shovelnose sturgeon tagged in the Powder River, 1973-1980, and recaptured in a different season, location or year.

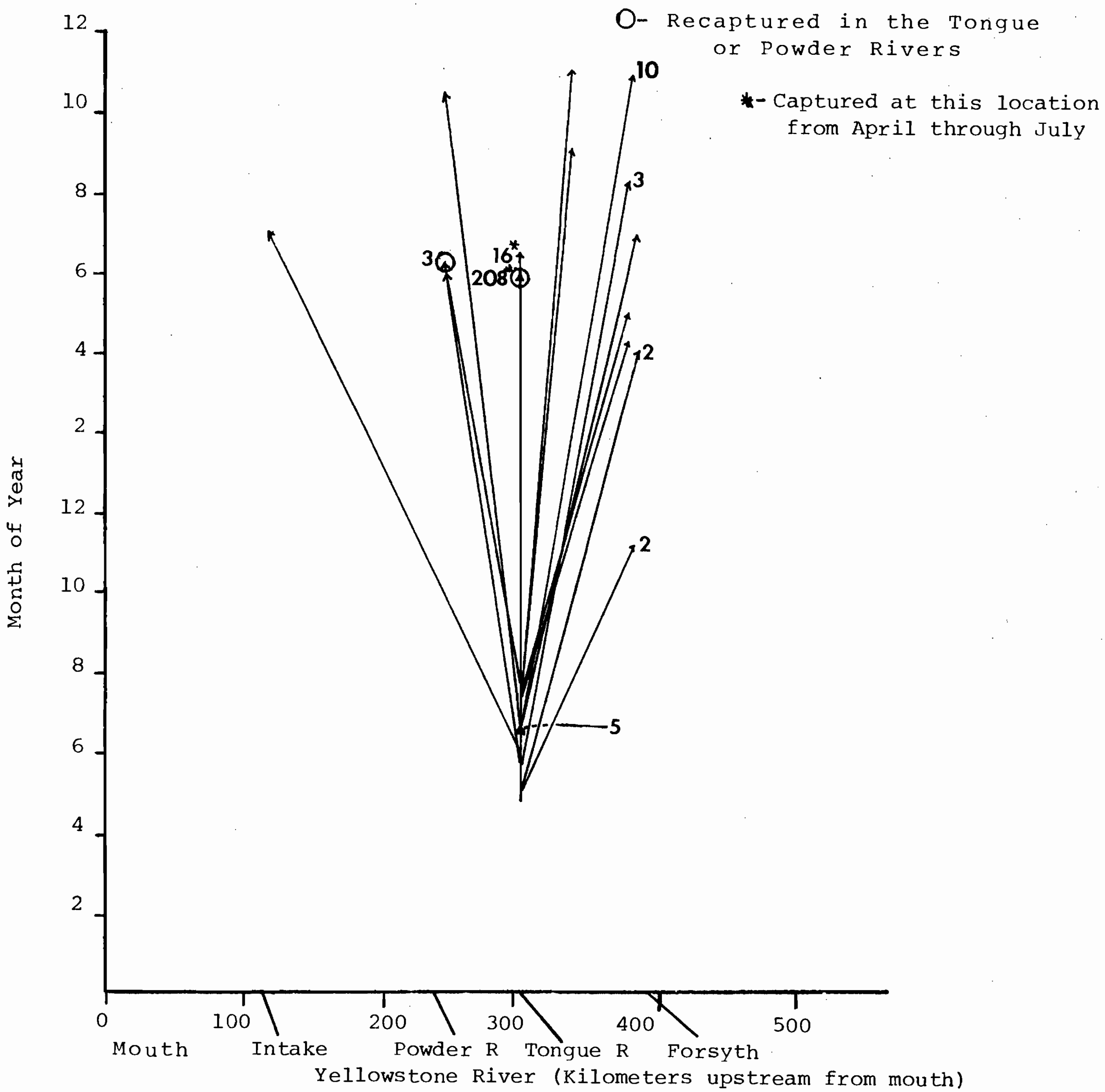


Figure 19. Shovelnose sturgeon tagged in the Tongue River, 1973-1980, and recaptured in a different year or location.

Table 10. Number of shovelnose sturgeon and channel catfish tagged and recaptured in the Yellowstone, Tongue and Powder Rivers.

	Yellowstone River						
	Sec. 1	Sec. 2	Sec. 3	Sec. 4	Tongue River	Powder River	Total
Shovelnose sturgeon							
Number tagged	536	21	471	0	2152	571	3751
Fisherman returns	10	0	5	0	39	12	66
DFWP recaptures[1]	5	0	6	0	220	14	245
Channel catfish							
Number tagged	386	73	1286	91	729	341	2798
Fisherman returns	15	2	36	1	51	20	125
DFWP recaptures[1]	0	0	6	0	5	8	19

[1] Does not include DFWP recaptures of the same location, season and year tagged.

Sturgeon may congregate in this area because further upstream movement is impeded by Forsyth diversion dam.

Interchange of sturgeon between the Powder and Tongue river spawning grounds was indicated by the recapture of two sturgeon which were initially captured in one tributary and subsequently recaptured in the other.

Channel catfish

A total of 2798 channel catfish was tagged from 1973 through 1980 in the Yellowstone, Tongue, and Powder rivers (Table 10). Of these, 125 tags were returned by fishermen, representing a minimum harvest of 4.5 percent. An additional 19 catfish were recaptured by DFWP personnel (other than the same season and location tagged).

Twelve channel catfish, tagged in section 1 of the Yellowstone River, were subsequently recaptured (in a different location, season, or year) (Figure 20). Seven (58 percent) were recaptured upstream and 4 (33 percent) moved downstream. Mean upstream movement was 182 km and downstream movement 38 km. The longest observed movement by a catfish tagged in section 1 was a fish caught by a fishermen 388 km up the Powder River (near Clear Creek, Wyo.), representing a total movement of 515 km. This fish was tagged in August of 1979 and recaptured in June of 1980.

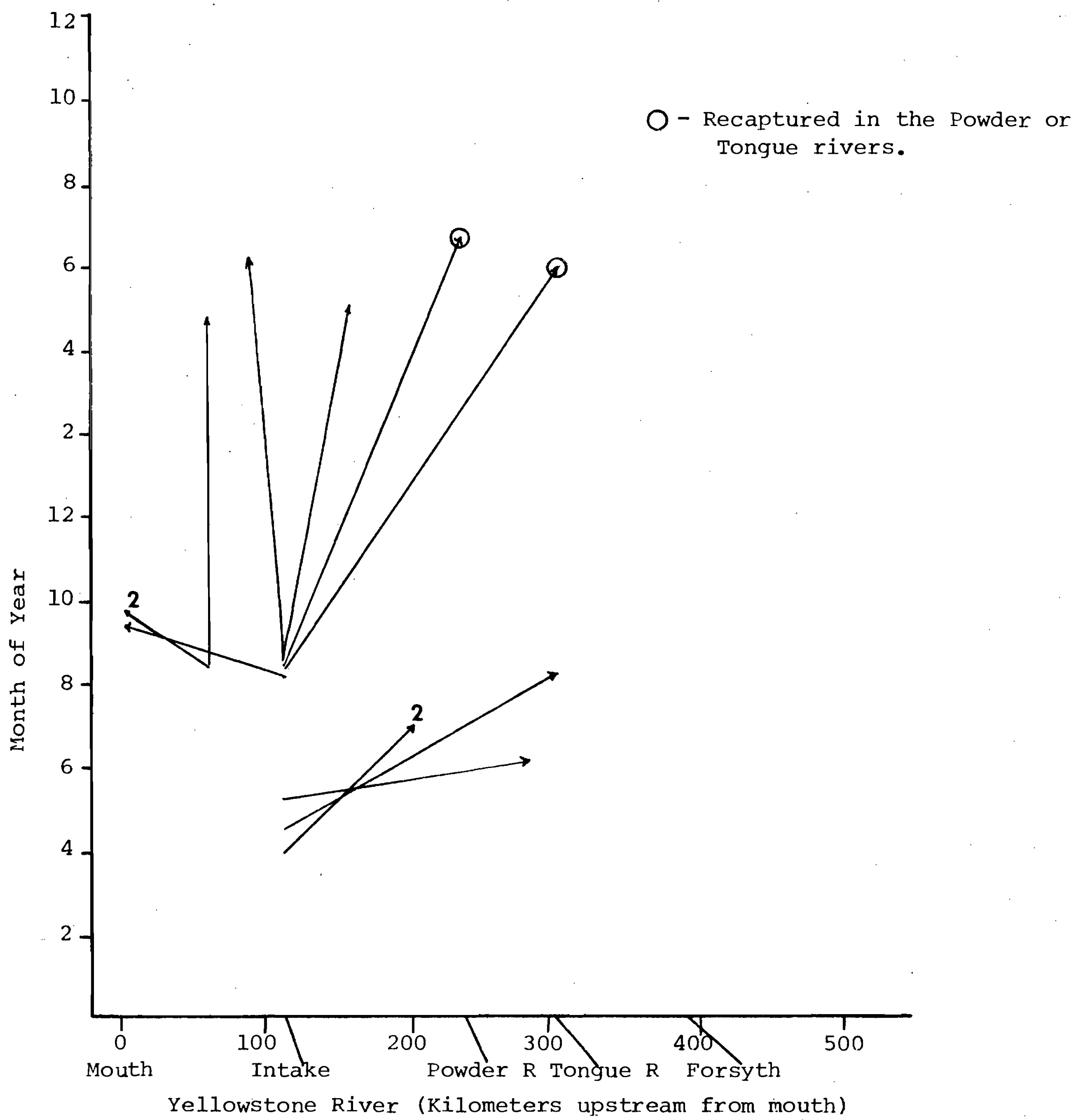


Figure 20. Channel catfish tagged in section 1 of the Yellowstone River 1973-1980, and recaptured in a different season, location or year.

Only two catfish tagged in section 2 of the Yellowstone River were recaptured (both by fishermen). One catfish was tagged and recaptured near Fallon (river km 209) during the summer of 1979. The other fish was tagged near Terry (river km 233) on April 20, 1980 and was recaptured 40 km upstream (near Sunday Creek) in September 1980.

Forty-one channel catfish, tagged in section 3 of the Yellowstone River were subsequently recaptured (excluding returns at the same location, season, and year). Seventeen (41%) were recaptured upstream either in the Yellowstone or a tributary (Figure 21). Three (7%) moved downstream in the Yellowstone and then up the Tongue or Powder rivers. Only 5 (12%) showed a downstream only movement. Sixteen (39%) were captured near the site of tagging. Average upstream movement was 68 km while downstream movement averaged 48 km. The longest distance moved by a catfish tagged in section 3 of the Yellowstone was a fish recaptured 270 km up the Powder near Broadus during June 1981. This fish was tagged 5 km upstream from the Tongue River in July 1979 and represents a total distance moved of 334 km. Another catfish, which moved 116 river km, was tagged in the Yellowstone near Forsyth during August and recaptured 32 km up the Tongue River the following June. Five of the eleven catfish recaptured in the Tongue River moved all the way to Twelve Mile Dam (a barrier to upstream fish migration located 32 km from the mouth). One catfish, tagged downstream from Forsyth diversion on April 26, 1978, was recaptured 82 km upstream from this irrigation structure on August 13, 1978.

Only one catfish tagged in section 4 of the Yellowstone River was recaptured (by a fisherman). This fish was captured near Hysham (river km 457) during August and recaptured 51 km downstream during mid-April the following year.

Twenty-eight channel catfish tagged in the Powder River, were subsequently recaptured (Figure 22). Twenty-seven of these tag returns were from catfish which were tagged near the mouth of the Powder (the lower 8 km) during spring. Five of these 27 catfish were recaptured in the Yellowstone River (Figure 22). Thirteen catfish were recaptured in the Powder River (all upstream) the same year they were tagged: 1 was recaptured near Clear Creek, Wyoming (388 river km), 10 in or near the Little Powder River (247-279 river km), and 2 near Powderville (145 river km). Average distance moved upstream was 251 km. Nine catfish, tagged near the mouth of the Powder River, were recaptured in the Powder River a subsequent year; 5 were recaptured near the mouth, 1 near Mizpah Creek (76 river km), 1 near Crooked Creek (217 river km), and 1 near Belle Creek in the Little Powder River (311 river km). Average distance recaptured upstream was 187 km. The one catfish tagged at a location other than near the mouth of the Powder River (tagged 249 km up the Powder River in the Little Powder River on June 1, 1977) was recaptured in the Yellowstone (near Sunday Creek) 34 km upstream from the mouth of the Powder River during July 1978.

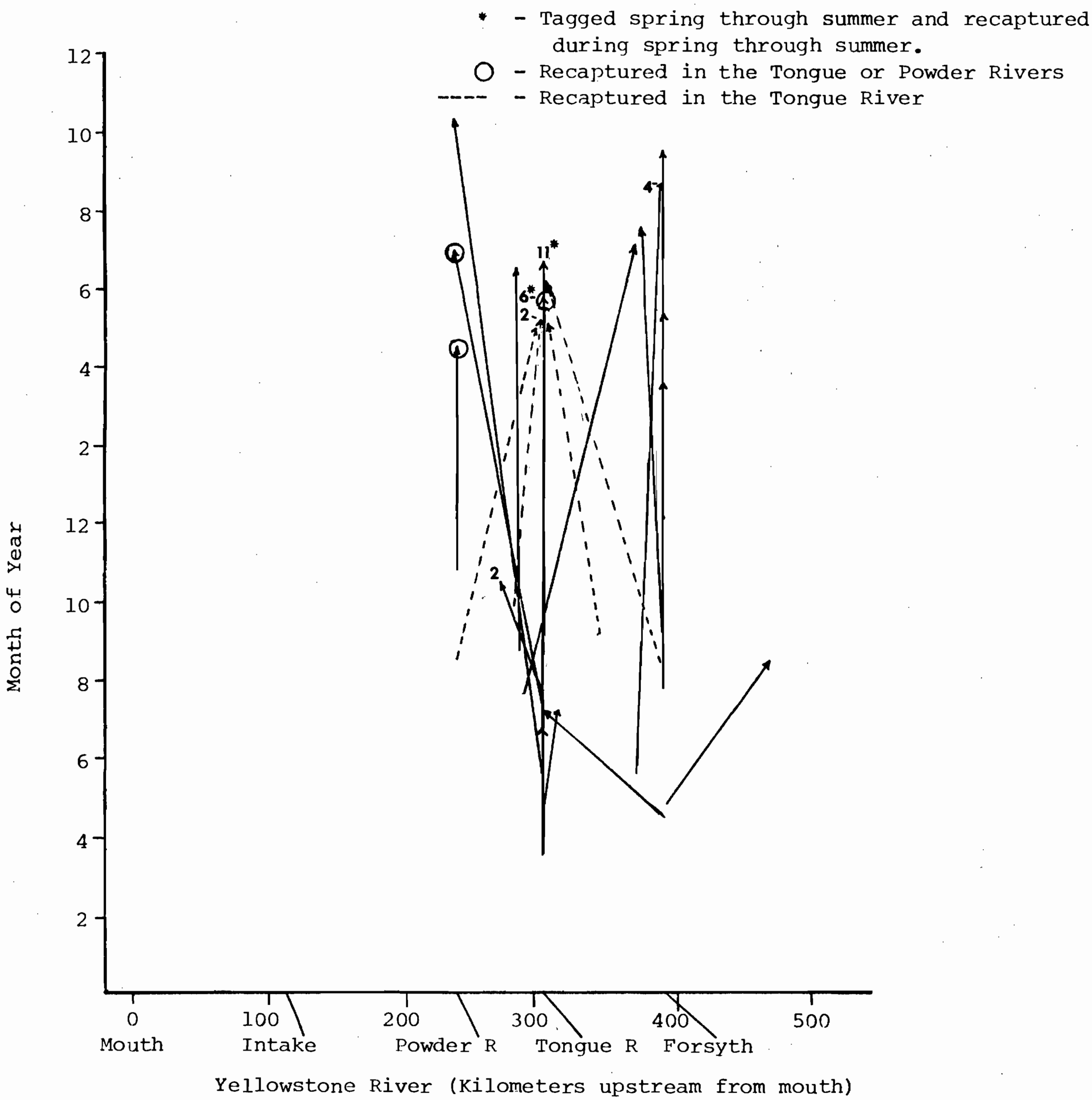


Figure 21. Channel catfish tagged in section 3 of the Yellowstone River, 1973-1980, and recaptured in a different season, location, or year.

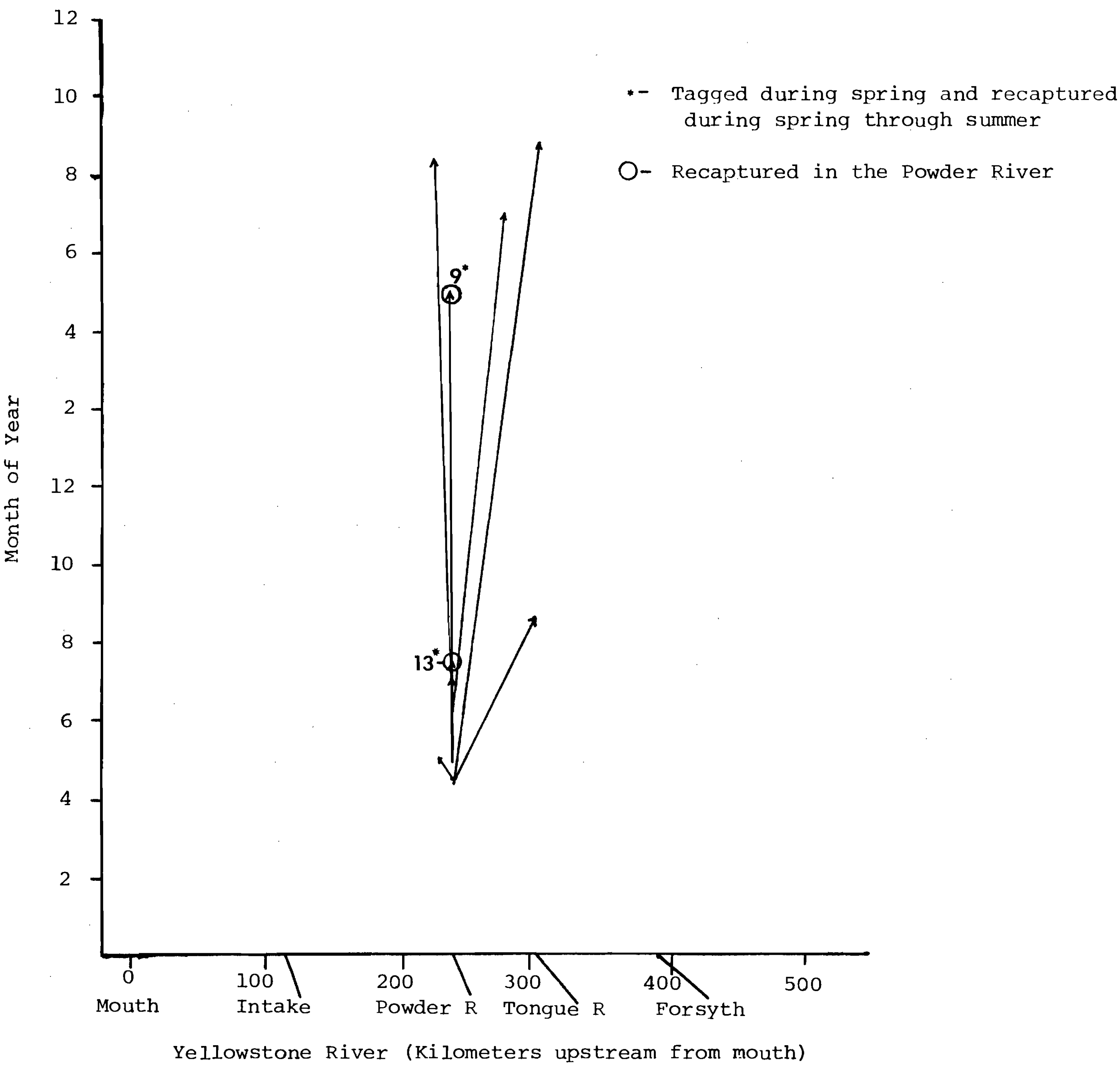


Figure 22. Channel catfish tagged in the Powder River, 1973-1980, and recaptured in a different season, location or year.

Fifty-four catfish, tagged in the lower 10 km of the Tongue River, were recaptured (a different location, season or year). Thirty-two were recaptured in the Yellowstone or Powder rivers (Figure 23). Three catfish moved up the Tongue River an average of 21 km the same year they were tagged. Two of these were recaptured downstream from Twelve Mile Dam (river km 32). Nineteen channel catfish were recaptured in the Tongue River during subsequent years; nine were recaptured downstream from Twelve Mile Dam, an average movement up the Tongue River of 26 km, five were recaptured near their tagging site in the Tongue River, while 5 were recaptured downsteam an average of 5.5 km.

Channel catfish generally showed an upstream movement in section 1 of the lower Yellowstone River (7 catfish moved upstream versus 4 downstream). Catfish tagged in section 3 appeared to migrate to the Tongue River vicinity, whether tagged upstream or downstream in the Yellowstone. Catfish tagged in the Powder River showed a high incidence of return to this tributary and migrated long distances upstream in the Powder. Catfish tagged in the Tongue River showed a high return rate. Twenty-eight of 38 (74%) catfish recaptured in subsequent years were caught in or near the Tongue River. Catfish migrated upstream in this tributary as far as possible (river km 32). As with sauger and shovelnose sturgeon, the Tongue and Powder rivers may play a major role in the reproduction of channel catfish of the lower Yellowstone River. Large numbers of young-of-year catfish were seined from the Little Powder River and Mizpah Creek (tributaries to the Powder River) and the mainstem of the Powder (Rehwinkel 1978b) as well as from Pumpkin Creek (a tributary to the lower Tongue River) and the lower Tongue River (Elser 1980). Young-of-year catfish were captured 32 km upstream from the mouth of Pumpkin Creek which enters the Tongue River at river km 32.

SUMMARY AND CONCLUSIONS

During 1979 and 1980 the paddlefish migration was monitored by electrofishing an 8 km reach of the Yellowstone River downstream from Intake diversion (river km 114). Paddlefish first arrived at Intake when water temperatures were 15°C or warmer; May 22 and May 6 during 1979 and 1980, respectively. Cool water temperature may have been responsible for much depressed magnitude of paddlefish numbers in 1979. Fluctuations in numbers of paddlefish mirrored major changes in discharge of the Yellowstone River. The minimum flow necessary to stimulate paddlefish movement to Intake diversion was estimated to range between 15,000 to 18,000 cfs. The allocated instream flows during May and June are 12,000 and 25,000 cfs, respectively. Paddlefish numbers were also positively correlated to suspended sediment.

Fish eggs and larvae were sampled at several sites in the mainstem of the Yellowstone and at the mouths of the Tongue (river km 298) and Powder rivers, two major tributaries of the lower Yellowstone. Three paddlefish larvae were captured downstream from Intake diversion in 1977 and another questionable specimen was collected at the same location in 1980. Fourteen paddlefish eggs were collected with a drag dredge from an 8 km reach of the Yellowstone downstream

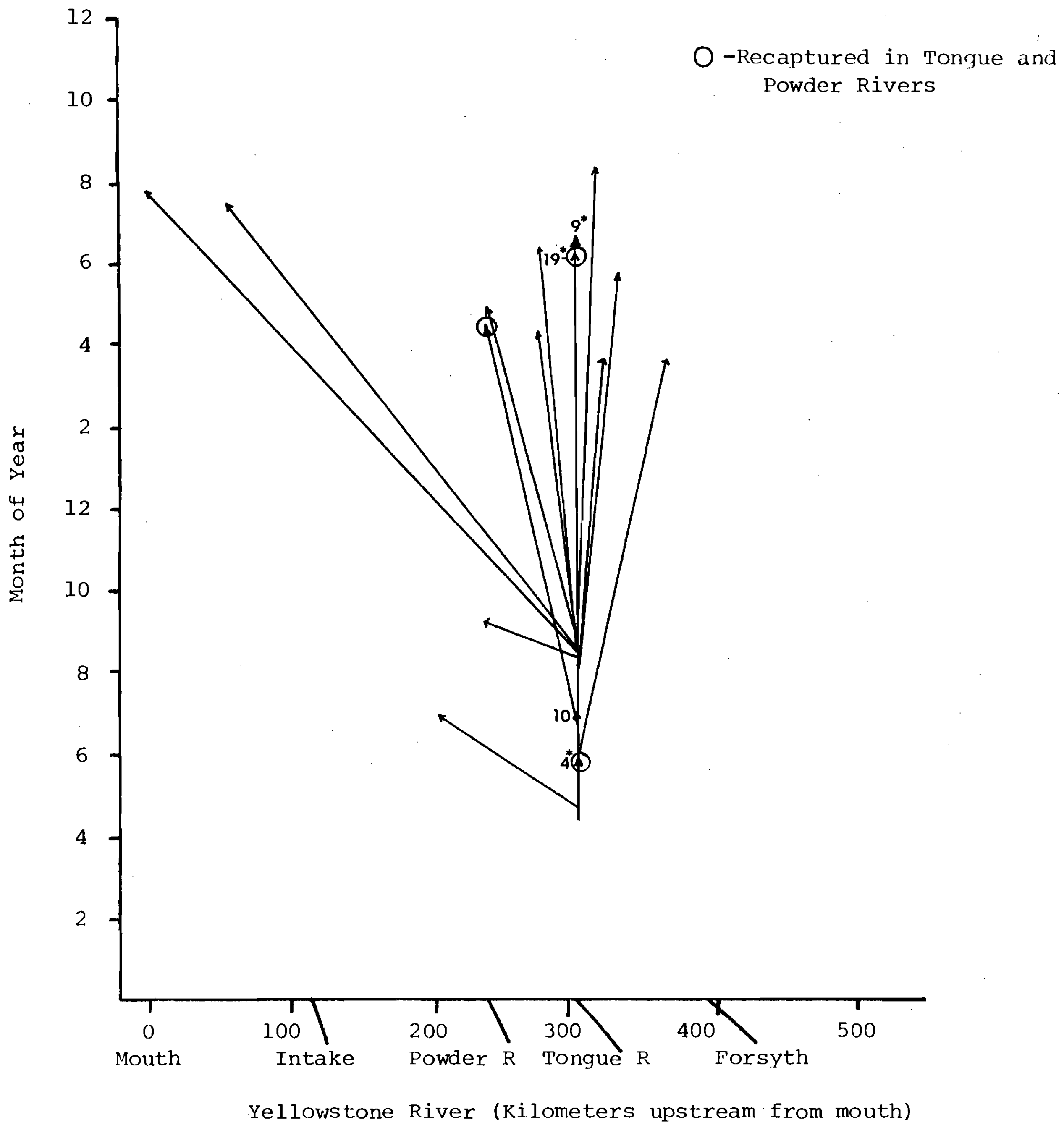


Figure 23. Channel catfish tagged in the Tongue River, 1973-1980, and recaptured in a different season, location, or year.

from Intake diversion in 1980. Two spawning locations for paddlefish were identified, one over an extensive gravel area with a depth of 1-2 m and another in an area of bedrock rapids with a depth of 1-3 m.

The only known spawning areas for shovelnose sturgeon are the Tongue and Powder rivers and likely the Yellowstone River downstream from Intake. Sturgeon prolarvae were collected from the Tongue River during 1978 through 1980, from the Powder River in 1979 and from the Yellowstone River at two points downstream from Intake in 1978 and 1979. No sturgeon larvae were collected in the mainstem upstream from the Tongue River during 1978 through 1980. The minimum flow necessary to trigger adult sturgeon movement into the Tongue River was between 500 to 600 cfs. The allocated instream flow for the Tongue River, 75 cfs, would abolish the spawning run in this tributary. Flows in the Powder River during May and June in 1980, 280 and 600 cfs, respectively, were too low to result in effective sturgeon reproduction. Allocated instream flows during May and June, 424 and 184 cfs, are insufficient for sturgeon reproduction in the Powder River.

Only 10 catfish alevins were captured (from July 10-21, 1978). The spawning habits of catfish may make their young less susceptible to drift. A catfish alevin was captured upstream from the Tongue River establishing the fact that spawning grounds for this species do exist upstream, possibly in small tributaries. Small tributaries offer areas of preferred spawning habitat not readily available in the mainstem of the Yellowstone, Tongue or Powder rivers. To maintain the present rate of channel catfish recruitment in the lower Yellowstone it is essential that flows in the small tributaries are maintained and access is not blocked to migrating catfish.

The Tongue River supported spawning runs of several species. Total densities of egg and larval drift in the Tongue River were as much as 80 times concentrations in the Yellowstone River. Total concentration of drift in the Powder River was as great as 14 times the density in the Yellowstone River. Backwater sampling in the mainstem of the Yellowstone indicated that most of these species were susceptible to long distance downstream drift as larvae.

The Tongue and Powder rivers are integral components of the lower Yellowstone River system. If these two tributaries are lost as spawning streams the entire fish community in the lower Yellowstone River will be adversely affected. Great effort should be spent to preserve instream flows and increase them where necessary. More work should be done to analyze the adequacy of instream flows in the Yellowstone for paddlefish reproduction and recruitment.

The lower Yellowstone River (from Intake downstream) is especially important to the system as a rearing area for several species of fish.

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Waters Referred to:

Cottonwood Creek	-
Crane Creek	21-0125
Deer Creek	21-0140
First Hay Creek	21-0235
Fox Creek	21-0250
Little Powder River	21-0550
Mizpah Creek	21-0675
O'Fallon Creek	21-0700
Powder River	21-0750
Pumpkin Creek	21-0800
Rosebud Creek	22-5028
Sandstone Creek	21-0880
Thirteen Mile Creek	21-1070
Tongue River	21-1150
Upper Sevenmile Creek	21-1290
Yellowstone River Section 1	21-1350
Yellowstone River Section 2	21-1400
Yellowstone River Section 3	22-7001