MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS
FISHERIES DIVISION
JOB PROGRESS REPORT

STATE: Montana | PROJECT TITLE: Statewide Fisheries Investigations

PROJECT NO.: F-46-R-5 | STUDY TITLE: Survey and Inventory of Warmwater Streams

STUDY NO.: III | JOB TITLE: Yellowstone River Paddlefish Spawning Study

JOB NO.: E

Period Covered: July 1, 1991 through June 30, 1992

ABSTRACT

A study to determine the locations of paddlefish spawning sites and evaluate spawning success in the lower Yellowstone and lower Missouri rivers was continued for the third year. Larval fish sampling with plankton nets collected a total of 21 paddlefish larvae and at least 13 eggs. All of the paddlefish larvae were sampled at the Confluence station on the Yellowstone River or the Nohly Bridge station on the Missouri. Most of the paddlefish eggs were collected at the Confluence in the Yellowstone, however, 4 paddlefish eggs were also collected at Intake and 1 at Glendive. Sampling for paddlefish larvae with nets positioned at the bottom of the river channel captured 14 of the 21 larvae, indicating that sampling near the bottom of the channel is far more effective at collecting drifting paddlefish larvae than the mid-depth or surface locations.

OBJECTIVES AND DEGREE OF ATTAINMENT

1. Locate paddlefish spawning areas. Efforts towards this objective were made and results are reported.

2. Evaluate paddlefish spawning success. Efforts towards this objective were accomplished and results are reported.

3. Determine effect of commercial roe harvest, if any, on the paddlefish population. This is discussed under the heading "Results and Discussion".

4. Report amount of roe harvested commercially. This is reported under the heading "Results and Discussion".

PROCEDURES

Larval fish sampling was used to evaluate paddlefish spawning success and locate spawning sites. Larval samples were obtained using boat mounted, plankton net samples. Conical, 20-inch diameter, 6 feet long Nitex nets (750 micron mesh) were used in tandem so that duplicate samples could be taken simultaneously. The nets had a 3-rope harness that was fastened to and suspended off a weighted line attached to each end of a cross-boom mounted on the bow of the boat.

Surface, mid-depth and bottom samples were collected while drifting slightly downstream. This allowed the nets to filter the sub-surface strata of water without the addition of excess weights. Most of the sampling occurred in strong current areas of the river, at a depth range of 6-12 feet, and therefore power was provided by an outboard motor to decrease the downstream drift rate. The nets were positioned in the river usually for a duration of 6-15 minutes, depending on the amount of debris suspended in the river. The volume of water filtered was determined using General Oceanic flow meters (Model 2030) mounted on the net apeture and positioned at one-third of the net diameter.

Larval samples were preserved with formalin in the field and later sorted in the laboratory. Retained larvae were identified to family using taxonomic keys by Auer (1982) and Wallus (1990). Mr. Darrel Snyder, director of the Colorado State University Larval Fish Laboratory, examined all Polydon and Scaphirhynchus larvae to insure that these two taxonomically similar fish were correctly identified.

INTRODUCTION

Every year during the late spring paddlefish from Lake Sakakawea migrate up the Yellowstone River to spawn. The Yellowstone contains one of the five known natural paddlefish spawning areas within their geographical range (U.S. Fish and Wildlife Service, 1990). Although paddlefish larvae have been collected in the river (Penkal 1981), exact spawning sites and habitat preferences have not been determined.

In 1989 the Montana Legislature passed House Bill 289 which allows for the commercial sale of paddlefish eggs from paddlefish harvested only in the Yellowstone River at the Intake fishing access area. The bill emphasized protection of the paddlefish population from overharvest. One of the methods of protection was to collect more information on spawning success and locate spawning sites so that effects of potential increased harvest of female paddlefish could be better evaluated.

DESCRIPTION OF STUDY AREA

The study area consists of a 185 mile reach of the lower Yellowstone River in southeastern Montana, from Miles City to the confluence with the Missouri River at Fort Buford, ND. Also included is the lower 10-mile portion of the Missouri River. The Yellowstone is one of the few remaining free-flowing rivers. The river is fairly large with a mean annual flow of 12,430 cfs (USGS 1992). The Tongue and Powder Rivers are the only two major tributaries entering the Yellowstone in the reach. The headwaters of Lake Sakakawea begin about 5 miles downriver of the confluence. Intake Diversion Dam is the only major diversion in the study area. This diversion is constructed of scattered boulders and spans the width of the river. The drop is approximately 4 feet in 100 feet and is characterized by very turbulent water (Graham and Penkal, 1978). The diversion acts as a partial barrier for upstream travel to most fish species.

The Missouri River is similar in size to the Yellowstone but unlike the Yellowstone, the Missouri's flow is completely regulated by Fort Peck Dam located 183 miles upstream. The mean annual flow is 10,570 cfs (USGS 1992). The Milk, Poplar and Redwater rivers are the three major tributaries in this reach.

Six sampling stations were established at 3 sites on the lower Yellowstone in the study area (Figure 1 and Table 1). The distances between successive sampling sites were 21 and 67 miles. Both the right (-R) and left (-L) side of the river channel were sampled at each of the 4 sites to evaluate whether drifting larvae orientated to a particular side.

One site on the lower Missouri River, 8 miles upriver from the confluence with the Yellowstone, was also sampled routinely. Sampling stations were established on both right and left sides of the river channel.

Table 1. Locations of sampling stations in the Yellowstone and Missouri rivers, 1991.

Station Number	Locality	River Mile	Legal Description
1-R	Glendive (Yel. R)	90	T16N R52E Sec 27
1-L	Glendive (Yel. R)	90	T16N R52E Sec 27
2-R	Intake (Yel. R)	69	T18N R56E Sec 36
2-L	Intake (Yel. R)	69	T18N R56E Sec 36
3-R	Confluence (Yel. R)	2	T152N R103W Sec 23
3-L	Confluence (Yel. R)	2	T152N R103W Sec 23
4-R	Nohly Bdg. (Mo. R)	8	T26N R59E Sec 16
4-L	Nohly Bdg. (Mo. R)	8	T26N R59E Sec 16

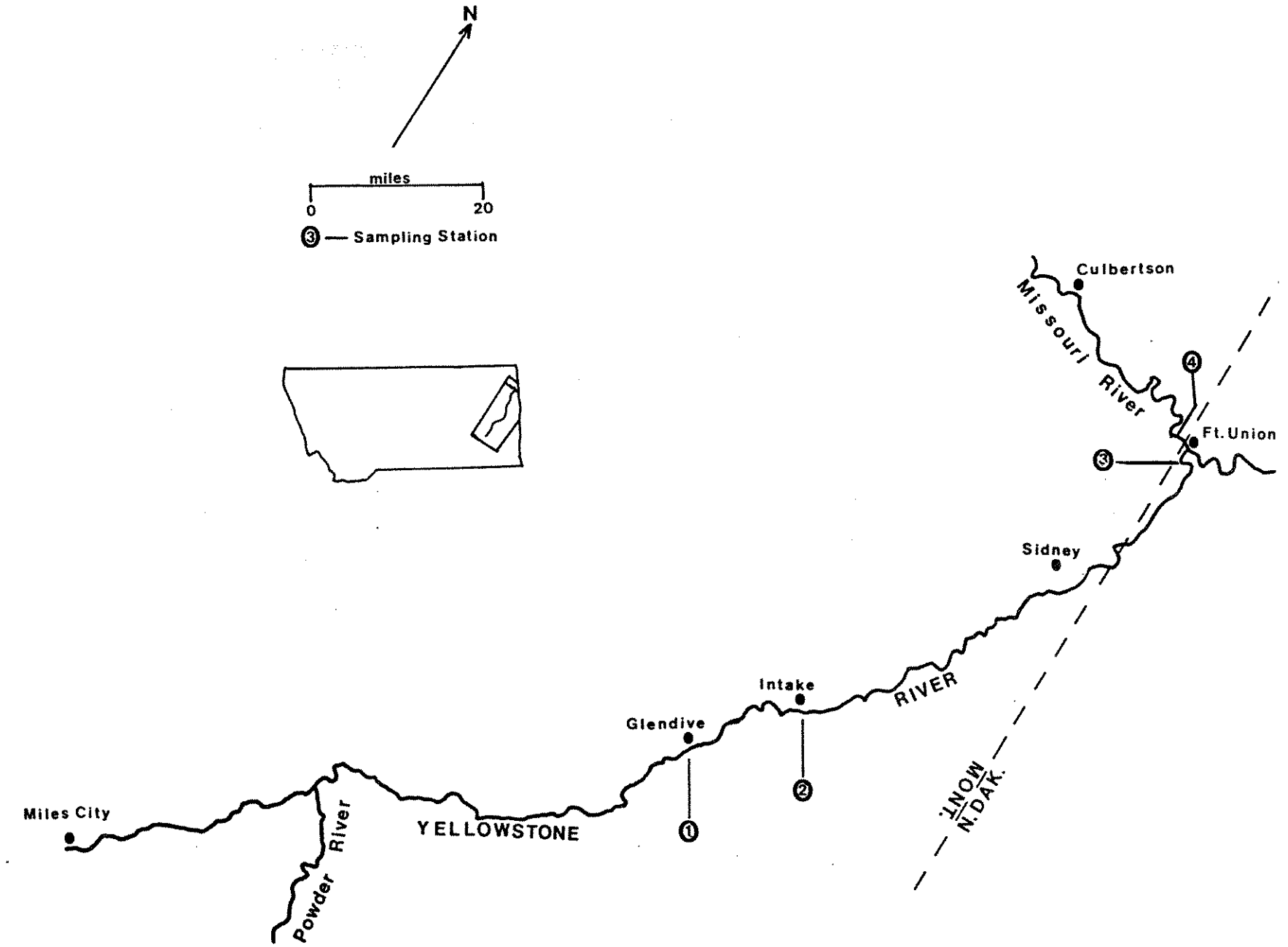

Figure 1. Map of the lower Yellowstone River.

RESULTS AND DISCUSSION

The Yellowstone River experienced above normal flows during the paddlefish spawning season. The monthly average flow for June, 1991 was 49,240 cfs, considerably greater than the 68-year average June flow of 37,230 cfs (USGS 1992). Paddlefish apparently responded to the excellent flow conditions and large numbers were found in the Intake area and other areas of the lower Yellowstone. Stewart (1992) reported that paddlefish snagging was good with the 1991 Intake angler harvest at 4,203 paddlefish. This compares with the 10 year average annual harvest of 2,813 paddlefish. The high June flows and occurence of numerous paddlefish in the river during the spawning season would indicate that 1991 was a good spawning year.

In contrast, river flows in the Missouri were slightly below normal during the paddlefish spawning. The monthly average flows for June and July, 1991 were 8,844 and 9,706 cfs compared to the 19-year June and July median flows of 9,590 and 10,600 cfs, respectively. The Milk River, the largest tributary to the Missouri in the study area (excluding the Yellowstone River) and an important paddlefish spawning stream (Gardner and Stewart 1987) experienced near normal run-off conditions except for very high flows in July. For the months of June and July, 1991 the average flows in the lower Milk were 711 and 2,664 cfs compared to the 19-year June and July median flows of 796 and 457 cfs, respectively.

Paddlefish Spawning Success and Spawning Locations

Larval fish were sampled in the Yellowstone and Missouri rivers from early June through mid July, 1991, to determine timing and location of paddlefish hatching and emergence. A variety of sampling methods with plankton nets were also attempted to improve sampling efficiencies.

A volume of 726,326 ft^3 of water was filtered (16.67 Ac.ft.) for both rivers combined. Physical parameters and sampling effort for each station are presented in Table 2.

A total of 481 larvae were collected in 285 samples representing 8 taxonomic families (Table 3). The family Catastomidae was the most common larval fish group sampled, comprising 73% of all the larvae collected. Average larval densities ranged from a low of 3.6 to a high of 13.6 larvae/10,000 ft^3 at stations 1L and 4L, respectively. Larval densities were generally the greatest during the last sampling period, mid-July.

Table 2. Physical measurements of larval fish samples taken in the Yellowstone and Missouri rivers, 1991.

Station Number	Number Samples	Avg. Depth at Station (ft.)	Average Net Velocity (ft/s)	Average Net Volume (ft^3)
1-R	40	11.2 (9 - 12)	2.9 (2.0 - 3.5)	2,695 (1816 - 4020)
1-L	32	10.0 (7 - 13)	3.0 (2.2 - 5.8)	2,783 (1974 - 5125)
2-R	36	8.0 (6 - 10)	2.8 (2.0 - 4.2)	2,444 (1787 - 3765)
2-L	40	9.0 (6 - 10)	2.8 (1.9 - 4.1)	2,494 (1713 - 3610)
3-R	38	10.0 (9 - 11)	2.3 (1.2 - 3.1)	2,126 (1095 - 2776)
3-L	36	10.0 (8 - 11)	2.3 (1.2 - 3.4)	2,141 (1031 - 3013)
4-R	29	10.0 (7 - 12)	1.8 (1.1 - 2.7)	2,932 (1618 - 3377)
4-L	34	10.0 (7 - 12)	2.0 (1.0 - 3.0)	2,907 (1466 - 4444)

Table 3. Summary statistics for larval fish collections sampled in the Yellowstone River, 1991.

Station Number	Number of Samples	Total No. Larvae	Avg Larval Density (No. Filtrd / 10,000 ft^3)	Total No. of Taxa
1-R	40	51	4.4 (0 - 36.5)	4
1-L	32	31	3.6 (0 - 13.3)	5
2-R	36	41	4.3 (0 - 9.1)	3
2-L	40	66	6.3 (0 - 43.0)	5
3-R	38	42	5.8 (0 - 31.7)	6
3-L	36	56	6.9 (0 - 43.6)	6
4-R	29	68	8.1 (0 - 53.2)	6
4-L	34	126	13.6 (0 - 76.2)	6
Totals	285	481	—	8

A total of 21 paddlefish larvae were sampled during 1991, all of which were collected at stations 3R, 3L, 4R, and 4L, the confluence area of the Yellowstone and Missouri rivers (Table 4). Paddlefish larvae represented 4% of the total larval catch and were the third most common taxonomic group.

It is difficult to determine when peak larval paddlefish hatching occurred during 1991. From Table 4 it is evident that larvae were found in the Yellowstone River samples from the first sampling date, June 4, through July 9. The greatest densities of paddlefish larvae were collected during the first sampling period, June 4. Paddlefish larvae were only collected in the Missouri samples July 2 and July 17, considerably later than the Yellowstone samples.

Table 4. Average densities (number/10,000 ft^3) of paddlefish larvae and chondrostean eggs (in parentheses) sampled in the Yellowstone and Missouri rivers, 1991.

	Sampling Period							Total
Station	Jun 4	Jun 12	Jun 19	Jun 26	Jul 2	Jul 9	Jul 17	Number
1-R			(0.8)					0 (1)
1-L				(0.6)				0 (1)
2-R				(0.8)	(2.5)			0 (5)
2-L	(3.4)	(5.4)				(0.6)		0 (14)
3-R	2.5	0.8 (0.8)	0.6 (1.1)	1.7 (1.4)	0.8 (1.7)			9 (7)
3-L	2.8 (0.8)	(2.3)	0.8	(1.7)	(2.3) 0.6	0.8 (0.8) NS	2.3	5 (8) 5 (0)
4-R	NS[1/]							
4-L						NS	1.1	2 (0)
Totals								
No. Larvae	7	1	2	2	2	1	6	21
No. Eggs	6	11	3	6	8	2	0	36

[1/] denotes that no sample was taken.

Several types and sizes of fish eggs were also collected in the samples. Of particular interest were the chondrostean eggs. The chondrostean eggs (paddlefish and sturgeon) differ from the teleostean eggs (modern boney fishes) by being very opaque and having a gray-brown color. Teleostean eggs of the species found in the study area are usually white and are more translucent. The 3 chondrostean species found in the study area are paddlefish,

shovelnose and pallid sturgeon; the paddlefish and shovelnose sturgeon are commonly occurring species while the pallid is considered rare. Therefore, probably all the chondrostean eggs found in the larval collections are either paddlefish or shovelnose eggs. Wallus (1990) reports that paddlefish egg diameter averages 3.5 or 3.0 mm, with sizes ranging 2.7-4.0 mm. In comparison, shovelnose egg diameters are smaller and reported to average 2.6 or 2.3 mm with sizes ranging 2.0-2.8 mm. Based on this information there appears to be a significant size difference between paddlefish and shovelnose eggs with paddlefish eggs being larger.

A total of 36 chondrostean eggs were collected in the 1991 samples. These eggs were collected at all stations except 4R and 4L, the Missouri River stations (Table 4). The diameters of these eggs were from 2.5 to 3.5 mm. It is probably safe to assume that all the chondrostean eggs 3.0 mm or greater in diameter are paddlefish eggs. In the collections, 1 of 2 eggs sampled at Glendive, 4 of 17 eggs sampled at Intake and 8 of 13 eggs sampled at Confluence were 3.0 mm or greater in diameter, and therefore most likely paddlefish eggs.

The regular occurrence of paddlefish larvae in samples taken at Station 3 confirms that a considerable amount of paddlefish spawning occurred upriver in the Yellowstone during 1991. The data further suggests that major paddlefish spawning areas are near the Confluence area (Station 3); probably within 50 miles upriver. All of the larvae found in Station 3 samples were comprised of 1-2 day post-hatch larvae, and therefore were probably mobile only for a few days. Paddlefish eggs were also more common at this station compared to other upstream stations. Both these observations indicate the sampling site was somewhat near to the source.

The occurrence and sizes of paddlefish larvae sampled in the Missouri (Station 4) were substantially different than for the Yellowstone station. Most noteably was that the larvae were considerably larger and more developed. The 7 paddlefish larvae collected from the Missouri had total lengths of 14-17 mm, compared to the 14 larvae collected from the Yellowstone which had total lengths 7-10 mm. The obvious explanation for the observed difference is related to the length of time the larvae were in the river before being collected.

Based on the paddlefish embryology studies reported by Ballard and Needham (1964) and Yeager and Wallus (1982), paddlefish larvae incubating in 70° F water (approximately, the average temperature of the Missouri and Yellowstone rivers at this time) would hatch in about 7 days after fertilization. At total lengths of 7-10 mm the larvae would only be 1-2 days post-hatch, and at a size of 14-17 the paddlefish larvae would be about 7 days post-hatch. This

represents a 5 day difference in time that the larvae had been in the river, with the Missouri larvae having the longer exposure time. The presence of older paddlefish larvae indicate that they probably drifted from areas far upriver. The absence of paddlefish eggs in all the Missouri samples further supports the contention that paddlefish spawning areas are located futher upriver in the upper or middle sections of this 183-mile reach. Gardner and Stewart (1987) docuemented paddlefish spawning in the Milk River. The Milk River, located about 165 miles upriver from Station 4, was probably the only place in the Missouri River below Fort Peck Dam that had the normal high flows during the 1991 paddlefish spawning season. Another departure from the paddlefish larval drift patterns of the Yellowstone was that Missouri samples contained paddlefish larvae only during the later sampling periods. This indicates there was some late spawning occurring in the system. During late June the Milk River flows doubled and on July 8 the Milk peaked at 6,150 cfs, which was nearly 1½ times the flow of the Missouri at their confluence. Apparently, at least a portion of the paddlefish reproduction was the direct result of the high flows in the Milk. This observation demonstrates the importance of the Milk River for paddlefish reproduction in the Missouri system.

Paddlefish larvae were only collected at Stations 3 and 4, however, paddlefish eggs were sampled at all the three Yellowstone stations. One paddlefish egg was collected at Station 1, Glendive, and 4 eggs were collected at Station 2, Intake. The collection of these eggs is evidence that in 1991 paddlefish spawned at least as far upriver as Glendive.

Methodology for more efficient sampling of paddlefish larvae and eggs is still not developed, therefore a variety of net positions were tested. Table 5 shows that the bottom positioned net collected far greater numbers of both larvae and eggs compared to the samples of the surface and mid-depth net positions. Sixty-seven percent of the larvae and 61% of the chondrostean eggs were found in the bottom samples compared to 24 and 31% for mid-depth and 9 and 8% for surface samples. These findings are similar to that reported for this study during 1989 and 1990 (Gardner 1991).

Table 5. Comparisons of paddlefish larvae and chondrostean egg collections fo nets sampled at the surface, mid-depth and bottom in the Yellowstone and Missouri rivers, 1991.

Net Location	No. Smpls	Volume Filtrd (ft^3)	Larval Density (No. / 10,000ft^3)	Number of Larvae	Egg Density (No. / 10,000ft^3)	Number of Eggs
Station 2						
Surface	26	70,273	0	0	0.1	1
Mid-dpth	26	61,750	0	0	0.8	5
Bottom	24	55,671	0	0	2.5	14
Station 3						
Surface	22	54,520	0.4	2	0.4	2
Mid-dpth	28	64,558	0.8	5	0.9	6
Bottom	24	37,837	1.9	7	2.1	8
Station 4						
Surface	19	61,965	0	0	0	0
Mid-dpth	22	69,839	0	0	0	0
Bottom	22	52,026	1.3	7	0	0
TOTALS						
Surface	67	186,758	0.1	2	0.2	3
Mid-dpth	76	196,147	0.3	5	0.6	11
Bottom	70	145,534	1.0	14	1.5	22

Another variable that could be affecting catch rates of larval paddlefish is sampling location along the channel cross-section. Location of the spawning sites favoring one or the other side of the bank could affect the orientation of drifting larvae. Also, the location of the channel thalweg and corresponding distribution of flow currents might tend to orientate drifting larvae with the main current.

Paddlefish larvae were sampled at stations 3R, 3L, 4R and 4L (-R denotes right side; -L left side). Visual inspection at these stations suggested that the left stations for both sites contained the greater portion of river flow. Table 2 confirms these observations by listing greater average net velocities for the left stations. Observations of paddlefish larvae were 9 and 5 larvae for stations 3R (right) and 3L (left), and 5 and 2 larvae for stations 4R and 4L, respectively. This reveals that the majority of paddlefish larvae were collected in samples from the side of

river with the lesser flow. It is interesting to note that larval densities for all species combined did not duplicate the paddlefish findings of orientating with the lesser current side. Table 2 shows that the greatest average larval densities for sites 3 and 4 were both on the left or greater current side. No explanation is given at this time for the observation of greater paddlefish larval densities associated with the lesser river currents.

Commercial Roe Harvest

The Glendive Chamber of Commerce and Agriculture continued their collection of paddlefish roe at Intake for a second year in 1991. The weight of roe collected and their gross income were much higher in 1991 than in 1990. Their offer to paddlefish snaggers of free fish cleaning in exchange for roe donation continued. The Chamber cleaned 3,090 fish of which 1,711 were females. From these fish a total of 10,672 pounds of caviar was produced giving the Chamber gross income of $292,563. Almost all anglers took advantage of the free fish cleaning; very few snaggers were interested in keeping the roe from their fish. To date the commercial roe harvest does not seem to have any negative effects on the paddlefish population.

RECOMMENDATIONS

1. Larval fish sampling should continue as a means for evaluating paddlefish spawning success and discvering spawning sites.

2. Improvements in sampling methodology for collecting paddlefish larvae are still needed. Efforts at improving sampling efficiencies along with futher study of paddlefish larvae drifting behaviour should continue to be addressed.

ACKNOWLEDGEMENTS

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Waters Referred to:

Yellowstone River Section 1	21-1350-02
Yellowstone River Section 2	21-1400-02
Missouri River Section 2	16-2420-02