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MONTANA DEPARTMENT OF FISH AND GAME
ECOLOGICAL SERVICES DIVISION

JOB PROGRESS REPORT
RESEARCH PROJECT STATEMENT

State Montana Title Middle Missouri River

Project Number FW-3-R-5 Planning Project

Job Number 1-a Fisheries

Period Covered July 1, 1976 through June 30, 1977

ABSTRACT

Field inventory of the aquatic resources and factors influencing the resources will be the basis for an aquatic resource management plan for the middle Missouri River. The study area consists of a 184-mile reach of the mainstem of the river in northcentral Montana from Morony Dam to Robinson Bridge. The project was initiated October 1, 1975.

Fish populations were inventoried by boom shocking and experimental gill netting in eight study sections on the middle Missouri River from early March through late October 1976. A total of 31 species representing 14 families of fish was sampled during the inventory period. The annual migration of paddlefish from Fort Peck Reservoir into the Missouri River was monitored by electrofishing with the boom shocker during the spring of 1977. Most of the paddlefish counted during the migration period were observed in the lower reach of the Missouri River between Robinson Bridge and Fort Peck Reservoir, and the peak of the run occurred in about mid-May. Spawning migrations of shovelnose sturgeon and sauger within the Missouri River mainstem and migrations from the Missouri River into the lower Marias River were also monitored.

A paddlefish creel census study was conducted on a 15-mile reach of the Missouri River located immediately upstream from Fort Peck Reservoir during the annual spring migration period in 1977. An estimated 1,625 anglers fished 2,526 man-days and harvested 666 paddlefish. The estimated total weight of the 1977 paddlefish harvest was 35,195 pounds (17.6 tons). Total fishing pressure and total paddlefish harvest was higher in 1977 than during any of the previous years when creel censuses were conducted. Low water levels in the Missouri River during the snagging season in 1977 may have been partly responsible for the increased angler pressure and harvest. The average length and weight of paddlefish harvested in 1977, 61.0 inches and 55.6 pounds, was similar to the average size of fish harvested in previous years. Females accounted for 41.6 percent of the paddlefish examined in the 1977 harvest while males comprised 58.4 percent. Data on paddlefish tagging and angler residence are also presented.

Water temperature was monitored at three stations on the Missouri River during 1976. Water temperatures at the Coal Banks Landing and

Robinson Bridge stations during the periods of record for 1976 averaged only 0.4 and 0.3 F higher, respectively, than the Fort Benton station. Preliminary findings on the ordinal composition and longitudinal distribution of aquatic macroinvertebrates in the middle Missouri River are presented.

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 middle Missouri River in Montana supports a significant fishery and basic inventory data on the aquatic resources of this area are lacking.

The aquatic resources of Montana are becoming increasingly threatened by an expanding population. Not only is more recreational use being placed on the resources, but human activities are encroaching on the aquatic habitat at an alarming rate. Man's activities on the floodplain, streambanks and headwaters have altered many of our streams beyond the point at which they can naturally adjust.

Because of the increasing human demand for Montana's limited water supplies for industrial, agricultural and domestic uses, the prospect for water resource development plans on streams such as the middle Missouri River in Montana appears likely. Projects which remove or impound substantial amounts of streamflow will undoubtedly alter the existing flow regimens and associated aquatic communities. Unless basic inventory data are collected and present and future problems are identified, little can be done to evaluate conflicting resource demands and minimize adverse impacts on the aquatic resource.

OBJECTIVES

The long-range objective of the study is to follow the inventory procedures developed on the Smith River (Wipperman 1973) and the upper Yellowstone-Shields River (Berg 1975) drainages to prepare recommendations for aquatic resource management on the middle Missouri River. Basic inventory data will be collected from the middle Missouri River to formulate the plan. Physical, chemical and biological characteristics of the waters of importance, or potential importance, to the recreational fishery of the study area will be determined. Immediate and future problems affecting the aquatic resource will be identified, and some recommendations to alleviate the problems will be proposed. The study was initiated on October 1, 1975.

DESCRIPTION OF THE STUDY AREA

The study area consists of a 184-mile reach of the mainstem of the middle Missouri River in northcentral Montana from Morony Dam near Great Falls, Montana to Fred Robinson Bridge near Landusky, Montana (Figure 1). The Missouri River forms at the confluence of the Gallatin, Jefferson, and Madison rivers near Three Forks in southwestern Montana. It drains the greater part of the eastern slopes of the Rocky Mountains in the state before entering the study area at Morony Dam.

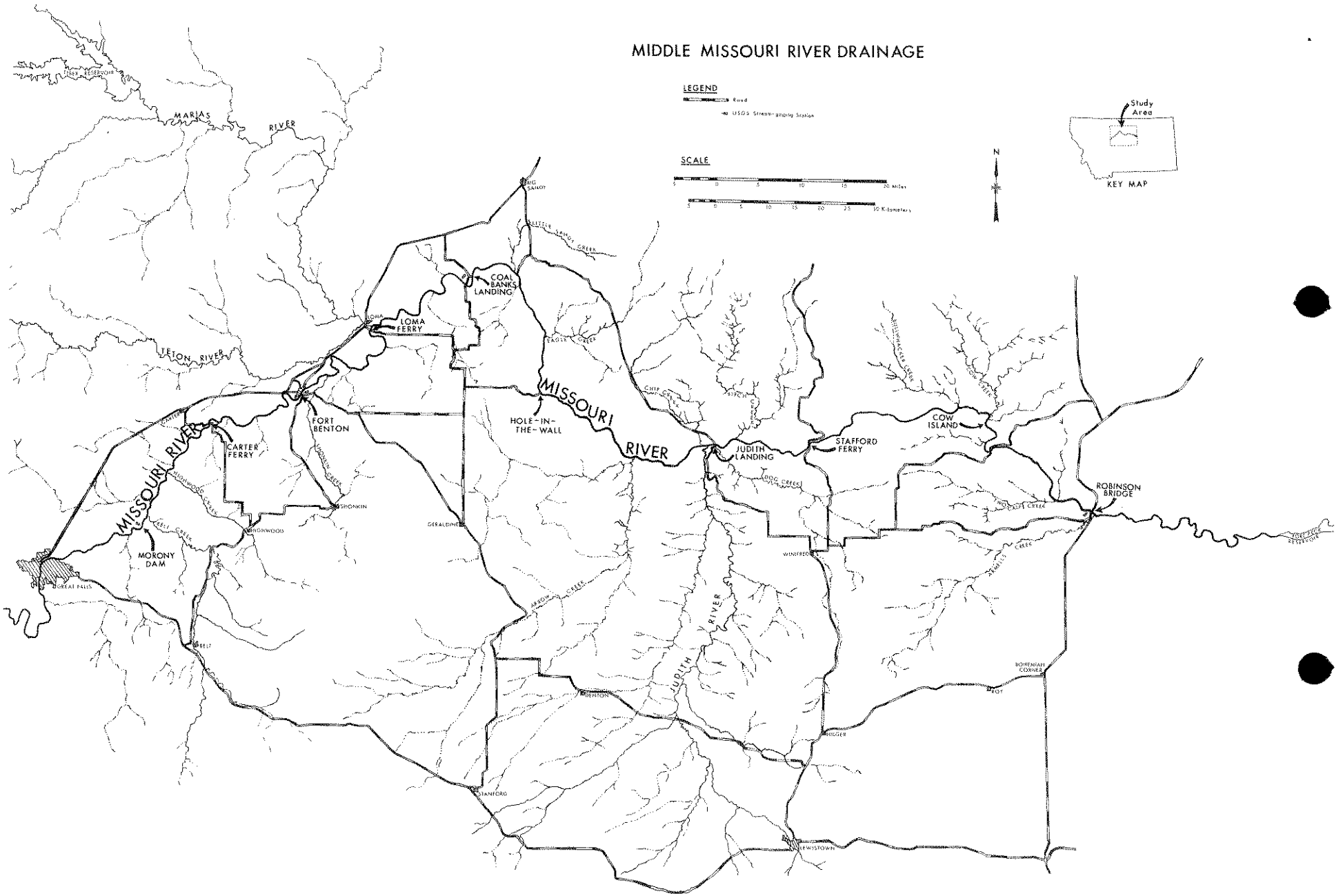


Figure 1. Map of middle Missouri River drainage in Montana.

The Missouri is the nation's longest river. The 184-mile reach covered by this study represents the last major free-flowing portion of the entire 2,475-mile-long river. From Three Forks to Great Falls, the Missouri is characterized by several dams and intensive bottomland cultivation. From Fort Peck to its junction with the Mississippi, the river has been heavily engineered with channel pilings, flood walls, dams and reservoirs which have impaired the river's natural values.

The land contiguous to the Missouri River in the study area has retained most of its primitive characteristics. It consists primarily of rolling plains, interrupted at considerable distances from the river by isolated areas of mountain uplift (Missouri River Joint Study 1963). The gorge-like river valley, which lies 500 to 1,000 feet below the average elevation of the adjacent upland plains, is comprised largely of spectacular, varied and highly scenic badlands and breaks areas ranging from 2 to 10 miles in width.

Because of its extraordinary historical, recreational, scenic and natural values, a 149-mile segment of the Missouri River in the study area from Fort Benton to Robinson Bridge has been 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 the 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 diversion 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 Marias River from the north, including its tributary the Teton River, and the Judith River from the south are the principal tributaries entering the Missouri River in the study area. Other tributary drainages entering the Missouri River from the north in the study area include Little Sandy, Eagle, Chip, Birch, Bullwhacker and Cow creeks. Belt, Highwood, Shonkin, Arrow, Dog, Two Calf, and Armells creeks enter from the south.

TECHNIQUES AND EQUIPMENT DEVELOPMENT

Water Temperature

Thirty-day continuous recording thermographs were used to monitor water temperature regimes. The recorder box was positioned on the streambank as far above the high water mark as possible. A thermocouple lead, varying in length from 25 to 50 feet, was extended into the water through flexible plastic sewer pipe.

Macroinvertebrates

Aquatic macroinvertebrate samples were taken using a rectangular framed (8 x 18 inches), conical net kick sampler with fine mesh (300 micron) pores. The net was positioned on the streambottom so that the current

flowed into it. Macroinvertebrates were washed into the net by an operator standing in front of the net kicking downwards into the substrate. A variety of habitat types (cobble, gravel, sand, mud, 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.

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 aquatic macroinvertebrates were separated from vegetation and bottom materials. Separation of macroinvertebrates was accomplished by picking each sample twice. Macroinvertebrates were identified to the lowest taxon practical using keys by Ward and Whipple (1959), Pennak (1953), Brown (1972) and Roemhild (1976).

Fish Populations

The middle Missouri River is a substantially larger stream than the Smith or upper Yellowstone River drainages where the previous inventory and planning investigations were conducted. The Missouri has a greater diversity of aquatic habitat types and a larger variety of fish species than the aforementioned drainages. Natural turbidity, deep water and deceptive current velocities present problems for survey operations in many areas.

Because of these problems, many of the fish population sampling procedures developed during the previous inventory and planning studies cannot be used on the Missouri River. A basic objective of this study is to become familiar with proven sampling methods on large rivers and develop sampling equipment and techniques adaptable to the Missouri River. The following fishery sampling gear and methods were tested and utilized during this report period. A continuing effort will be made to refine sampling techniques already in use and to develop new techniques.

Boom-Suspended Electrofishing Apparatus

Alternating or direct current shockers with electrodes suspended from fixed booms have been relatively successful for sampling fish populations in large rivers such as the lower Yellowstone River in Montana (Peterman and Haddix 1975), the Missouri River in Nebraska (Morris 1965 and Stuckey 1973), the Missouri River in Missouri (Robinson 1973 and 1977), and other large rivers (FAO 1975).

A boom shocker was constructed for use on the middle Missouri River during the report period. Basic design of the boom shocker was adapted largely from boom shockers used in Wisconsin (Novotny and Priegel 1974) with specific modifications similar to those used on the lower Yellowstone River in Montana (Peterman and Haddix 1975). Assistance in constructing the boom shocker was provided by Larry Peterman, Ecological Services Division, Montana Department of Fish and Game, Miles City.

The electrofishing apparatus was mounted on a 22-foot semi-vee aluminum boat powered by a 245-horsepower inboard jet. An aluminum boat offers the advantage of simple reliable grounding of all electrical equipment by the physical attachment of the equipment to the boat (Novotny and Priegel 1974). A metal railing was constructed around the front deck of the boat for safety and to facilitate collection of stunned fish with dip nets.

The electrode system of this boat consists of positive and negative arrays. Since the boat was intended primarily for operation with direct current, the electrode configurations were designed specifically for this operating mode. However, the electrode system is also adequate for operation in the alternating current mode.

The positive electrode system consists of two anodes suspended from fiberglass booms approximately 6 feet ahead of the bow of the boat. The booms are spread 7 feet apart and are adjustable for height by means of pin-locked adjustments. Each anode consists of either (1) a spherical electrode, 15 inches in diameter, constructed from 3/8-inch diameter copper tubing; or (2) an array of 12 to 15 "dropper" electrodes clipped to a 3-foot diameter aluminum support ring. The support ring provides mechanical support and an electrical connection for the droppers which actually carry the current into the water. Individual "droppers" consist of 6-inch lengths of 5/8-inch diameter stainless steel tubing supported by an 18-inch length of heavy gauge insulated copper wire with a 20 amp test clip to attach to the support ring. By moving a sleeve of insulating material (5/8-inch diameter auto wire loom) exposure of the stainless steel "droppers" can be adjusted for waters of varying conductivity.

The negative electrode system consists of two cathode arrays, one mounted on each side of the boat. Each array consists of a set of five 4-foot lengths of 3/4-inch diameter flexible conduit supported by an 8-foot length of fiberglass boom. Each length of conduit is fastened to the support boom by a chain and rubber insulator. The top of each length of conduit is insulated with electrical tape to reduce an unnecessary electrical field near the surface of the water.

Power is supplied to the positive and negative electrodes through 1/2-inch diamater metal conduit and watertight junction boxes. Industrial duty electronic plugs and receptacles (screw-in type) provide positive watertight connections between junction boxes, electrodes and power source.

The power source for the electrofishing system is a 2,500 watt, 230 volt (60 Hz. single phase) alternating current generator. A Coffelt Model VVP-15 rectifying unit is used to change the alternating current to various forms of pulsed or continuous direct or alternating current. Output from the rectifying unit is selectable from 0 to 600 volts and from 0 to 25 amps. Pulse frequency is adjustable from 20 to 200 pulses per second and pulse width is adjustable from 20 to 80 percent. Meters are used to monitor all voltages, current output, frequency and pulse width.

Most of the aquatic habitat of the Missouri River in the study area consists of deep mainstem areas with a few large side channels and backwaters. The boom suspended electrofishing apparatus was the most effective technique for sampling these areas. Other procedures such as mobile electrofishing apparatus, gill nets, hoop nets, frame traps and seining were primarily effective only in restricted habitat areas such as shorelines, quiet pools, backwaters and small side channels.

Mobile Electrofishing Apparatus

A mobile electrode apparatus was used for sampling fish populations in the lower Marias River and in shallow, restricted side channel and backwater areas of the Missouri River. Maneuverability of the relatively small mobile unit in these confined habitat areas proved to be highly advantageous.

The mobile electrofishing unit consists of a 14-foot fiberglass boat containing a hand-held mobile positive electrode, a stationary negative electrode (fastened to the bottom of the boat) and a portable 2,500-watt, 115 volt (60 Hz. single phase) alternating current generator. A Fisher Model FS-103 rectifying unit is used to change the alternating current to various forms of pulsed or continuous direct current. The direct current output is adjustable from 0 to 500 volts. A 40-horsepower jet outboard was used for mobility in deep water areas where the electrofishing boat could not be maneuvered by hand.

Gill Nets

Fish were also captured with standard experimental sinking nylon gill nets (125 x 6-foot with graduated mesh size from 3/4 to 2-inch square measure). Overnight stationary sets with these nets in areas of the river with little or no current generally produced good catches of a wide variety of fish species. Stationary gill net sets in areas of the river with any significant amount of current were largely unsuccessful because the nets usually became badly fouled with debris and, in some cases, were washed downstream by the current.

In some main channel areas of the Missouri River with moderate current, heavy duty large mesh sinking nylon gill nets were drifted perpendicular to the current in an attempt to capture fish. These nets were 8-feet deep and varied in length from 50 to 150 feet. The nets could be drifted only in areas of the river relatively free from snags and with sufficient current to carry the nets. In many areas the current was too swift for drifting the nets.

Drifting gill nets with 3-inch square measure mesh was effective and fairly selective for sampling shovelnose sturgeon and blue suckers. Paddlefish were taken readily by drifting gill nets with 5-inch square measure mesh in the Missouri River below Robinson Bridge. The 5-inch mesh appeared to be exclusively selective for paddlefish.

Frame Traps

Spawning migrations of sauger and other species were followed on the lower Marias River and on the Missouri River in the Loma Ferry and Fort Benton sections with 3-foot high by 4-foot long frame traps. The traps were constructed from 1-inch square mesh fence wire and 1/2-inch diameter reinforcing rod material. Similar traps had been used successfully by Posewitz (1963) to capture fish in the middle Missouri River and the lower reaches of its tributaries.

The frame traps were set in the river with the open throat facing downstream. One or two lead nets, 3 to 6 feet high, with 1-inch square mesh and from 10 to 50 feet long, were stretched at various angles downstream from the trap. The angle depended on the force of the current at the trap site.

The frame traps were successful for sampling a substantial number of migrating adult game fish, especially sauger, during their spawning seasons. Posewitz (1962) believed the traps were selective for sauger in the lower Marias River. Selectivity toward adult fish was probably due to the relatively large 1-inch square mesh size of the traps and leads. Ricker (1971) reported that underwater frame traps are selective by species, and have been selective for the larger fish of a size class above the minimum imposed by the physical dimensions of the net (mesh). Traps and leads of a mesh size smaller than 1 inch cannot be fished effectively in the Missouri River because they impede streamflow, trap debris and are washed out much more easily than the large mesh.

Seines

Fifty and 25 x 4-foot nylon bag seines with 1/4 and 1/8-inch square mesh were used to collect forage fish samples. Most of the seining sites were in confined areas of the river, such as backwaters and side channels, where the presence of forage fish was considered to be likely. Some forage fish were also taken in selected unconfined portions of the open river, such as shoreline and shallow riffle areas.

Fish Sample Processing and Tagging

Fish captured by the various techniques were anesthetized with MS-222, measured to the nearest 0.1 inch in total length, and weighed to the nearest 0.01 pound. In addition, paddlefish and shovelnose sturgeon were also measured to the nearest 0.1 inch in fork length. Sex and spawning condition (gravid, ripe or spawned) were recorded for fish captured during their spawning season. All fish were released near the capture site.

In addition to the above, a number of fish species was marked with individually numbered tags. Tag return data will be used to provide an indication of fisherman harvest rates and to determine movement patterns of individual fish, particularly spawners, and establish their home ranges.

Individually numbered plastic cinch-up spaghetti tags anchored through the base of the adipose fin were used to mark channel catfish. Shovelnose sturgeon were tagged with individually numbered monel wing band tags clipped over the anterior rays of the pectoral fin or with individually numbered plastic cinch-up spaghetti tags inserted through the posterior portion of the fleshy keel at the base of the dorsal fin. All other game fish species and several nongame species, including blue suckers, bigmouth buffalo, smallmouth buffalo and freshwater drum were tagged with individually numbered Floy T-tags inserted near the base of the dorsal fin. Information signs were placed at accessible points along the river in the study area in an effort to encourage anglers to provide information about tagged fish in their creel.

Creel Census and Fisherman Survey

Paddlefish Creel Census

A creel census study was conducted on the paddlefish fishery on the Missouri River immediately upstream from Fort Peck Reservoir during the spring of 1977. The creel census method was adapted largely from Needham (1973). Based on field tests of various creel census methods, Needham selected this technique because it was the most reliable one for the Missouri River study area.

Creel census data was collected on as many days as possible throughout the entire spring paddlefish snagging season. Weekend days and holidays received much heavier fishing pressure than week days. Therefore, a larger proportion of weekend-holiday days were creel censused than week days. Estimates of fisherman pressure and catch on noncensus days were based on data from preceding and following census days. In addition, some information on pressure and harvest on noncensus days was provided by U. S. Fish and Wildlife Service personnel stationed on the Charles M. Russell National Wildlife Range which borders the study area and by game wardens from the Montana Department of Fish and Game.

As many fishermen as possible were interviewed on completion of their fishing day. On most days the absolute number of fishermen and their harvest could be determined. Data recorded on angler interviews included angler residency, length of trip, estimated time spent fishing, method of fishing (bank or boat), number of paddlefish caught and number of paddlefish kept.

As many of the anglers' fish as practical were measured to the nearest 0.5 inch in total length, fork length and eye-fork length. Weights were determined to the nearest 1.0 pound with a Chatillon Model 100A straight spring scale. Sex was determined by weight, body configuration, presence of tubercles and examination of the gonads and urogenital pore.

Dentary bones were taken from a number of paddlefish for age determination. Ages will be estimated from cross sections of the dentary bone prepared in the manner described by Adams (1942).

A number of paddlefish in good condition caught by fishermen who did not wish to keep them were tagged and released near the capture site. The tags used were individually numbered monel poultry bands anchored around the dentary bone near its symphysis. Tag returns will provide information on fisherman harvest rates and movements.

Missouri River Fisherman Survey

A fisherman creel survey was initiated in the spring of 1977 on the sport fishery which exists on the Missouri River from Great Falls to Fort Peck Reservoir. This survey is a partial census in which samples (i.e., interviews) of fishermen are used to obtain estimates of angling data. The survey technique, formulated with the assistance of George Holton, Fisheries Division, Montana Department of Fish and Game, utilizes a fish species identification chart and postcard-sized fisherman survey forms (Appendix Figures 1 and 2).

The fisherman survey forms are of two different types - "voluntary" and "interview." The "voluntary" survey form relies on voluntary compliance in answering the survey and returning the postpaid card. "Voluntary" forms are distributed to parties of fishermen by personnel from the Bureau of Land Management (Lewistown) and Northwestern University (Chicago, Illinois) during the course of their recreational use surveys on the river.

With the "interview" survey form, partial trip data is obtained during interviews with individual fishermen. The "interview" form is recorded in duplicate, with the original copy retained by the census taker and the carbon copy given to the fisherman. Upon completion of his fishing trip, the fisherman voluntarily records complete trip data and returns the postpaid carbon copy of the "interview" form. As many interviews as possible are obtained during the course of our research activities, such as electrofishing and gill netting on the river. In addition, a number of days, especially weekend days and holidays, were devoted exclusively to collecting fisherman survey data. Weekend days and holidays normally receive much heavier fishing pressure than week days.

Data recorded on the fisherman survey forms include angler residency, party size, length of trip, estimated time spent fishing, type of fishing (bank or boat), method of fishing (setline, angling or snagging), type of lure used and number and kind of fish kept and released.

AQUATIC HABITAT PARAMETERS

Drainage Area and Stream Discharge

The drainage area of the middle Missouri River increases from 23,292 square miles to 40,987 square miles, or by about 75 percent, between Morony Dam and Robinson Bridge (USGS 1974). However, due to the semi-arid nature of the area's climate, the increase in mean annual streamflow is only about 18 percent. The climate is characterized by moderately low rainfall, a dry atmosphere, hot summers, cold winters and a large proportion of sunny days (Gieseker 1931). Precipitation averages about 13 inches annually, of which about 8.5 inches occurs during the months of May through September (Missouri River Joint Study 1963).

Streamflow regimens are being monitored by the U. S. Geological Survey at four locations on the mainstem of the middle Missouri River. The stations are located at Morony Dam, Fort Benton, Coal Banks Landing and Robinson Bridge. Mean annual discharges for an 18-year period of record at Morony Dam, an 84-year period of record at Fort Benton, a 39-year period of record at Coal Banks Landing and a 40-year period of record at Robinson Bridge were 5.569 million acre feet (MAF) (7,687 cfs), 5.572 MAF (7,691 cfs), 6.079 MAF (8,391 cfs), and 6.593 MAF (9,100 cfs), respectively (USGS 1974). The maximum flows recorded at the four stations, respectively, were 72,000 cfs (June 10, 1964), 140,000 cfs (June 6, 1908), 122,000 cfs (June 5, 1953) and 137,000 cfs (June 6, 1953). The recorded minimums were 1 cfs (Sept. 16, 1962, powerplant shutdown) at Morony Dam, 627 cfs (July 5, 1936) at Fort Benton, 638 cfs (July 5, 1936) at Coal Banks Landing and 1,120 cfs (July 8, 1936) at Robinson Bridge. The present day flow regimens are not entirely natural because of regulation and storage at several dams in the drainage upstream from the study area.

Stream Gradient and Velocity

The Missouri River enters the study area immediately below Morony Dam at an elevation of 2,809 feet msl, dropping 550 feet to an elevation of 2,259 feet msl at Robinson Bridge. Stream gradient averages 2.99 ft/mile and varies from over 10 ft/mile in the extreme upper reaches to less than 2 ft/mile in some sections (Table 1). A longitudinal profile of the Missouri River from Morony Dam to Fort Peck Reservoir is shown in Figure 2. Stream gradients were determined by measurements taken from U. S. Geological Survey topographic maps (1:24,000 scale). A river mileage chart for the middle Missouri, also taken from the topographic maps, is presented in Appendix Table 1.

Velocity of the middle Missouri River is closely associated with stream width, discharge and gradient. Mean velocities vary from about 3.5 to 2.0 feet per second at a discharge of 6000 cubic feet per second (USDI 1975).

Water Temperature

Water temperatures are being monitored during the ice-free period by continuous recording thermograph stations located on the Missouri River at Fort Benton, Coal Banks Landing and Robinson Bridge. The 5 day average maximum and minimum water temperatures during 1976 at the three stations are shown in Appendix Figures 3, 4 and 5, respectively. The Coal Banks Landing Station is operated by the U. S. Geological Survey and the others are maintained by the Department of Fish and Game.

At the Fort Benton station during 1976, water temperature warmed progressively from late April through early June (Appendix Figure 3). The average maximum water temperature increased from 46 degrees to 60 degrees during this time period. Water temperature was stabilized during June with the average maximum temperature in the lower 60 degrees range. Another warming trend occurred from early July through early August when the average maximum water temperature rose from 61 degrees to 74 degrees. The highest annual water temperatures at the Fort Benton station were achieved during late July and early August. During the period from July 16 to August 11, water temperatures reached 73 degrees

Table 1. Stream gradients of the middle Missouri River from Morony Dam to Fort Peck Lake. Confluence of the Missouri River with the normal pool of Fort Peck Lake is mile 0.0.

River Mile	Elevation (feet)	Gradient (ft/mile)
207.0 (Morony Dam)	2809	
206.3	2800	16.41
205.2	2780	18.69
203.1	2760	9.34
201.2	2740	10.81
196.5	2720	4.19
192.2	2700	4.66
189.1	2680	6.41
185.0	2660	4.88
179.9	2640	3.95
175.4	2620	4.45
168.4	2600	2.84
162.5	2580	3.41
158.4	2560	4.88
149.4	2540	2.20
140.0	2520	2.13
126.6	2500	1.49
117.3	2480	2.13
107.5	2460	2.05
98.7	2440	2.30
92.1	2420	3.01
83.0	2400	2.20
70.4	2360	3.17
56.3	2320	2.82
40.8	2280	2.59
23.2 (Robinson Bridge)	2259	2.08
0.0 (Fort Peck Lake)	2246	0.83

or higher on 22 days. The highest temperature recorded at the Fort Benton station during 1976 was 75 degrees on July 25 and 26. Temperatures cooled gradually from mid-August through December.

At the Coal Banks Landing and Robinson Bridge stations during 1976, shorter periods of record were available than for the Fort Benton station. However, seasonal trends of average maximum-minimum water temperatures as presented in Appendix Figures 4 and 5 are similar to those previously described for the Fort Benton station. The highest water temperature recorded at the Coal Banks Landing and Robinson Bridge stations during 1976 was 76 degrees. This temperature was achieved on July 26 at Coal Banks Landing and on July 25 and 26 at Robinson Bridge. Water temperature at the Coal Banks Landing and Robinson Bridge stations during the periods of record for 1976 averaged only 0.4 and 0.3 degrees higher, respectively, than the Fort Benton station. The mean diurnal differences between the average maximum and average minimum temperatures were 4.53, 4.07 and 2.26 degrees for the Fort Benton, Coal Banks Landing and Robinson Bridge stations, respectively.

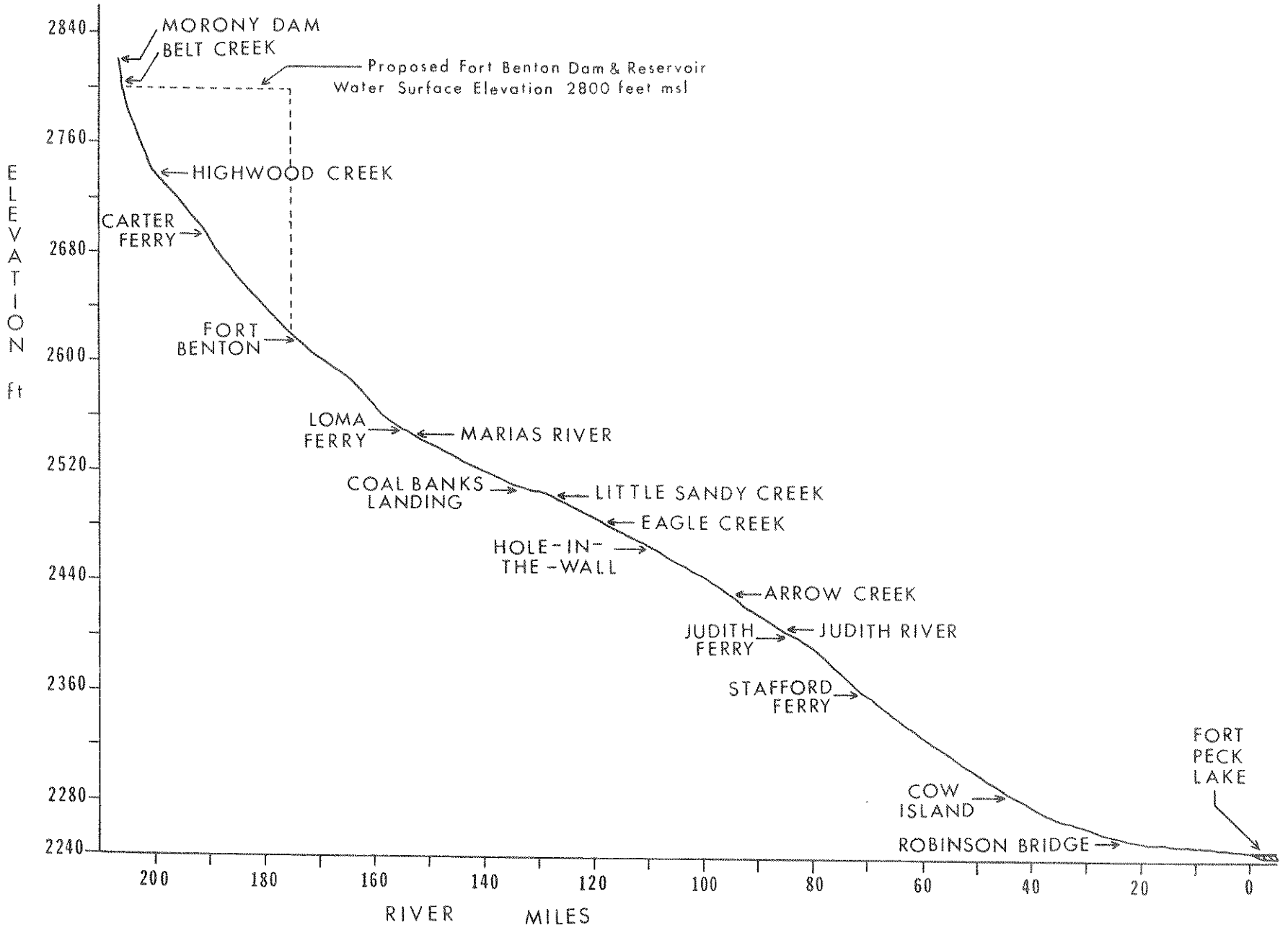


Figure 2. Longitudinal profile of the Missouri River from Morony Dam to Fort Peck Reservoir.

MACROINVERTEBRATES

Aquatic macroinvertebrate sampling was initiated at five study stations on the middle Missouri River beginning in late October 1976. The stations are located at Morony Dam, Fort Benton, Coal Banks Landing, Judith Landing and Robinson Bridge (Figure 1). Samples have been taken at approximately 6-week intervals. Findings contained in this progress report are based on analyses of samples taken in late October, early December, late January and mid-March 1976-77. Findings presented at this time are not necessarily final and may be subject to change because additional samples are presently being gathered and analyzed.

A total of 20,261 macroinvertebrates representing 15 orders was collected during the four sampling periods. The number of macroinvertebrates per individual kick sample ranged from 62 to 6,901. The ordinal composition for each station with each sampling date weighted equally and for all stations combined is given in Table 2. Diptera, Ephemeroptera, Trichoptera and Plecoptera comprised 45, 27, 18 and 2 percent of the macroinvertebrates collected, respectively. The orders Ephemeroptera, Trichoptera, Diptera, and Plecoptera contained representatives of 6, 4, 4 and 3 families, respectively.

Table 2. Preliminary findings on the percent composition (by order) of the aquatic macroinvertebrate community in the middle Missouri River, late October through mid-March 1976-77.

	Station					
Order	Morony Dam	Fort Benton	Coal Banks Landing	Judith Landing	Robinson Bridge	Combined Average
Ephemeroptera	25	22	15	40	31	27
Plecoptera	0	<1	<1	7	5	2
Trichoptera	33	19	6	16	14	18
Diptera	39	53	66	32	38	45
Others	3	6	13	5	12	8

The longitudinal distribution of aquatic macroinvertebrates throughout the study area is presented in Table 3. The families Heptageniidae, Baetidae, Hydropsychidae and Chironomidae were sampled regularly at all the stations. In addition, the families Ephemerellidae, Perlodidae, Corixidae, and Dytiscidae were sampled regularly at all the stations except Morony Dam.

Table 3. Preliminary findings on the longitudinal distribution of aquatic macroinvertebrates in the middle Missouri River, late October through mid-March 1976-77.

Taxa	Station				
	Morony Dam	Fort Benton	Coal Banks Landing	Judith Landing	Robinson Bridge
Gordiida	*	*			
Oligocheata	*	*	*	*	*
Decapoda					
Astacidae *Orconectes*	*				
Ephemeroptera					
Leptophlebiidae *Leptophlebia*					*
Siphlonuridae *Ameletus*					*
Parameletus					*
Tricorythidae *Tricorythodes*	*	*		*	*
Ephemerellidae *Ephemerella*		*	*	*	*
Heptageniidae *Rhithrogena*		*	*	*	*
Stenonema	*	*	*	*	*
Cinygma		*	*	*	*
Baetidae *Baetis*	*	*	*	*	*
Pseudocloeon	*		*	*	
Centroptilum			*		
Odonata					
Gomphidae *Octogomphus*					*
Plecoptera					
Nemouridae *Brachyptera*			*		*
Capnia				*	*
Perlidae *Acroneuria*		*		*	*
Perlodidae *Acrynopteryx*		*	*	*	*
Isoperla		*	*	*	*
Heteroptera[1/]					
Corixidae *Trichocorixa*		*			*
Hesperocorixa		*			
Sigara		*	*	*	*
Coleoptera					
Haliplidae *Haliplus*		*			
Dytiscidae *Hydrovatus*				*	*
Hydroporus		*	*		
Dytiscus		*			
Elmidae *Optioservus*	*	*			

Table 3. Preliminary findings on the longitudinal distribution of aquatic macroinvertebrates in the middle Missouri River, late October through mid-March 1976-77. (continued)

Taxa	Station				
	Morony Dam	Fort Benton	Coal Banks Landing	Judith Landing	Robinson Bridge
Trichoptera					
Hydropsychidae *Hydropsyche*	*	*	*	*	
Cheumatopsyche	*	*	*	*	*
Hydroptilidae *Agraylea*	*	*	*		
Leptoceridae *Oecetis*	*	*	*	*	
Brachycentridae *Brachycentrus*		*		*	*
Lepidoptera					
Pyralidae *Cataclysta*	*	*			
Diptera					
Tipulidae *Hextoma*	*				
Chironomidae	*	*	*	*	*
Simuliidae *Simulium*		*	*	*	
Empididae		*			
Acari					
Eylaidae *Eylais*		*			
Pulmonata					
Ancylidae *Ferrissia*		*			
Total Number of Taxa	15	29	19	20	22

1/ Formerly Hemiptera

Kick samples of aquatic macroinvertebrates at 6-week intervals will be continued at the five previously mentioned stations on the mainstem of the Missouri River until one full year of data is obtained in the fall of 1977. Seasonal kick sampling of macroinvertebrate communities will be initiated on the lower reaches of the Marias and Judith Rivers. In addition, macroinvertebrate sampling with a Petersen dredge and artificial substrates will be initiated during 1977 at the five stations on the mainstem of the Missouri River to ensure that the longitudinal distribution of a majority of the aquatic macroinvertebrates can be determined.

FISH POPULATIONS

Species Distribution, Relative Abundance and Size Composition

Forty-nine species representing 14 families of fish are known to occur in the middle Missouri River drainage between Morony and Fort Peck Dams (Table 4). Thirty-five species are found in the mainstem of the Missouri River in the present study area from Morony Dam to Robinson Bridge. Known distribution of the remaining 14 species is limited to Fort Peck Reservoir or tributaries to the middle Missouri River. However, it is likely that most of the latter species occur at least as transients in the mainstem study area. Additional species will probably be added to the list during the course of the present investigation.

Fish populations were inventoried by boom shocking and experimental gill netting in eight study sections on the middle Missouri River from early March through late October 1976. A total of 4,418 fish representing 31 species was sampled during the inventory period. The primary objective of the surveys was to determine species distribution, relative abundance and size composition of fish populations in the study area. The study sections were located at Morony Dam, Carter Ferry, Fort Benton, Loma Ferry, Coal Banks Landing, Judith Landing, Cow Island and Robinson Bridge (Figure 1).

Longitudinal distribution of fish species sampled during 1976 is shown in Table 5. Walleye, sauger, burbot, white sucker, longnose sucker, shorthead redhorse, river carpsucker, carp and goldeye were the most cosmopolitan fish species, each occurring throughout the entire 184-mile length of the study area. Mountain whitefish, rainbow trout, brown trout, mountain suckers and mottled sculpin were most abundant in the upstream study sections with only an occasional specimen found in the lower reaches. Shovelnose sturgeon, flathead chubs, emerald shiners, silvery minnows, blue suckers, smallmouth buffalo, bigmouth buffalo, channel catfish and freshwater drum were common in the Missouri River below the confluence of the Marias River. Only an occasional transient specimen was sampled in the Missouri River upstream from the Marias River. Paddlefish were found seasonally in the Missouri River, particularly in the lower reaches of the study area. They occurred primarily during the spring when they migrate upstream from Fort Peck Reservoir into the Missouri River presumably to spawn, but occasional specimens were also observed in the summer and fall.

Catch rate summaries for electrofishing and gill net surveys conducted during 1976 are presented in Tables 6 and 7, respectively. The catch rate summaries provide an indication of species composition in each study section and allow for a general comparison of relative abundance of fish populations between study sections. Total catch, average size and size range for individual species sampled in each study section are shown in Appendix Tables 2 through 14.

Life History Studies

In addition to determining their longitudinal distribution, size composition and relative abundance, research is being conducted to define some of the basic life history requirements of common or important fish species in the study area, especially game fish.

Table 4. Fish species recorded for the middle Missouri River drainage in Montana between Morony and Fort Peck Dams (family, scientific, and common names).

ACIPENSERIDAE (Sturgeon family)
- *Scaphirhynchus albus* - Pallid sturgeon
- *Scaphirhynchus platorynchus* - Shovelnose sturgeon

POLYODONTIDAE (Paddlefish family)
- *Polyodon spathula* - Paddlefish

HIODONTIDAE (Mooneye family)
- *Hiodon alosoides* - Goldeye

SALMONIDAE (Trout family)
- *Prosopium williamsoni* - Mountain whitefish
- *Onocorhynchus kisutch* - Coho salmon*
- *Onocorhynchus nerka* - Kokanee*
- *Salmo clarkii* - Cutthroat trout*
- *Salmo gairdneri* - Rainbow trout
- *Salmo trutta* - Brown trout
- *Salvelinus fontinalis* - Brook trout
- *Salvelinus namaycush* - Lake trout*

ESOCIDAE (Pike family)
- *Esox lucius* - Northern pike

CYPRINIDAE (Minnow family)
- *Cyprinus carpio* - Carp
- *Carassius auratus* - Goldfish
- *Notemigonus crysoleucas* - Golden shiner*
- *Phoxinus eos* - Northern redbelly dace*
- *Phoxinus neogaeus* - Finescale dace*
- *Hybopsis gracilis* - Flathead chub
- *Couesius plumbeus* - Lake chub*
- *Notropis atherinoides* - Emerald shiner
- *Hybognathus hankinsoni* - Brassy minnow
- *Hybognathus placitus* - Plains minnow*
- *Hybognathus nuchalis* - Silvery minnow*
- *Pimephales promelas* - Fathead minnow
- *Rhinichthys cataractae* - Longnose dace

CATOSTOMIDAE (Sucker family)
- *Carpoides carpio* - River carpsucker
- *Cycleptus elongatus* - Blue sucker
- *Ictiobus bubalus* - Smallmouth buffalo
- *Ictiobus cyprinellus* - Bigmouth buffalo
- *Moxostoma macrolepidotum* - Shorthead redhorse
- *Catostomus catostomus* - Longnose sucker
- *Catostomus commersoni* - White sucker
- *Catostomus platyrhynchus* - Mountain sucker

Table 4. Fish species recorded for the middle Missouri River drainage in Montana between Morony and Fort Peck Dams (family, scientific, and common names). (Continued)

ICTALURIDAE (Catfish family)
Ictalurus melas - Black bullhead
Ictalurus punctatus - Channel catfish
Noturus flavus - Stonecat

GADIDAE (Codfish family)
Lota lota - Burbot

GASTEROSTEIDAE (Stickleback family)
Culaea inconstans - Brook stickleback*

CENTRARCHIDAE (Sunfish family)
Lepomis macrochirus - Bluegill*
Micropterus salmoides - Largemouth bass*
Pomoxis annularis - White crappie
Pomoxis nigromaculatus - Black crappie*

PERCIDAE (Perch family)
Perca flavescens - Yellow perch
Stizostedion canadense - Sauger
Stizostedion vitreum - Walleye
Etheostoma exile - Iowa darter*

SCIAENIDAE (Drum family)
Aplodinotus grunniens - Freshwater drum

COTTIDAE (Sculpin family)
Cottus bairdi - Mottled sculpin

* Known distribution is limited to Fort Peck Reservoir or tributaries to the middle Missouri River.

Table 5. Longitudinal distribution of fish species sampled in the middle Missouri River during 1976.

Fish Species	Study Section							
	Morony Dam	Carter Ferry	Fort Benton	Loma Ferry	Coal Banks Landing	Judith Landing	Cow Island	Robinson Bridge
Shovelnose sturgeon			*	*	*	*	*	*
Paddlefish					*			*
Goldeye	*	*	*	*	*	*	*	*
Mountain whitefish	*	*	*		*			
Rainbow trout	*					*		
Brown trout	*		*					
Northern pike	*			*				
Carp	*	*	*	*	*	*	*	*
Flathead chub			*	*	*	*	*	*
Emerald shiner				*	*	*		*
Silvery minnow					*		*	
Fathead minnow							*	
Longnose dace			*		*	*		
River carpsucker	*	*	*	*	*	*	*	*
Blue sucker			*	*	*	*	*	*
Smallmouth buffalo			*	*	*	*	*	*
Bigmouth buffalo			*	*			*	*
Shorthead redhorse	*	*	*	*	*	*	*	*
Longnose sucker	*	*	*	*	*	*	*	*
White sucker	*		*	*	*	*		*
Mountain sucker	*		*		*			
Black bullhead				*				
Channel catfish					*	*		*
Stonecat			*	*	*	*		
Burbot	*	*	*	*	*	*	*	*

Table 5 continued. Longitudinal distribution of fish species sampled in the middle Missouri River during 1976.

Fish Species	Study Section							
	Morony Dam	Carter Ferry	Fort Benton	Loma Ferry	Coal Banks Landing	Judith Landing	Cow Island	Robinson Bridge
White crappie					*	*		*
Yellow perch				*	*			
Sauger	*	*	*	*	*	*	*	*
Walleye	*		*	*	*	*		*
Freshwater drum			*	*	*	*	*	*
Mottled sculpin	*	*	*					
Total Number of Species	15	9	21	20	24	20	15	19

Table 6. Catch rate summary for electrofishing surveys on the middle Missouri River in 1976, expressed as number of fish sampled per electrofishing hour.

Fish Species	Study Section							
	Morony Dam	Carter Ferry	Fort Benton	Loma Ferry	Coal Banks Landing	Judith Landing	Cow Island	Robinson Bridge
Shovelnose sturgeon			0.1	1.1	1.1	0.4	1.0	0.8
Goldeye	17.5	20.1	8.8	16.5	25.5	16.1	19.8	11.4
Mountain whitefish	0.8	0.5	tr[1/]	-	0.1	-	-	-
Rainbow trout	0.2	-	-	-	-	tr	-	-
Brown trout	0.2	-	tr	-	-	-	-	-
Northern pike	0.2	-	-	0.2	-	-	-	-
Carp	2.5	1.3	4.0	4.7	8.5	4.6	11.5	3.3
Flathead chub	-	-	0.6	5.9	1.5	1.4	1.7	2.9
Emerald shiner	-	-	-	1.5	-	0.3	-	0.7
Longnose dace	-	-	0.5	-	-	-	-	-
River carpsucker	2.5	1.3	1.1	3.9	3.2	4.8	2.0	1.4
Blue sucker	-	-	0.2	0.2	0.6	0.4	3.2	0.7
Smallmouth buffalo	-	-	0.2	1.1	0.8	1.3	1.2	0.1
Bigmouth buffalo	-	-	0.1	0.2	-	-	0.2	0.1
Shorthead redhorse	15.0	18.0	23.6	18.8	28.8	19.3	6.2	2.6
Longnose sucker	15.0	30.0	12.9	18.9	9.8	4.5	0.2	0.2
White sucker	5.0	-	1.0	0.5	0.3	0.9	-	0.1
Mountain sucker	0.5	-	0.2	-	0.1	-	-	-
Channel catfish	-	-	-	-	-	0.5	-	0.1
Stonecat	-	-	tr	-	0.1	0.1	-	-
Burbot	0.8	0.5	tr	0.2	0.2	0.3	0.2	0.1
White crappie	-	-	-	-	-	0.1	-	0.1
Yellow perch	-	-	-	0.4	-	-	-	-
Sauger	9.3	7.5	9.4	7.3	4.9	7.1	2.5	5.1
Walleye	0.2	-	0.1	0.6	-	tr	-	0.1
Freshwater drum	-	-	0.5	0.9	0.3	0.4	0.5	0.3
Mottled Sculpin	0.2	0.3	0.4	-	-	tr	-	-
Total	69.9	79.5	63.7	82.9	85.8	62.5	50.2	30.1

1/ tr - trace (less than 0.05 fish/electrofishing hour)

Table 7. Catch rate summary for experimental gill net surveys on the middle Missouri River in 1976, expressed as number of fish captured per overnight net set.

Fish Species	Study Section				
	Fort Benton (8) [1/]	Loma Ferry (7)	Coal Banks Landing (5)	Judith Landing (1)	Robinson Bridge (1)
Shovelnose sturgeon	0.38	6.71	-	-	-
Goldeye	11.00	40.14	16.60	2.00	3.00
Mountain whitefish	-	-	-	-	-
Rainbow trout	-	-	-	-	-
Brown trout	0.13	-	-	-	-
Northern pike	-	-	-	-	-
Carp	2.13	1.14	0.20	-	-
Flathead minnow	0.63	0.57	0.20	-	2.00
River carpsucker	0.75	2.00	0.20	-	-
Blue sucker	0.63	-	-	-	-
Smallmouth buffalo	0.25	0.29	-	-	-
Bigmouth buffalo	0.50	-	-	-	-
Shorthead redhorse	2.63	1.86	3.60	-	1.00
Longnose sucker	5.25	2.57	0.80	-	-
White sucker	0.63	0.14	1.00	1.00	1.00
Mountain sucker	0.38	-	-	-	-
Black bullhead	-	0.29	-	-	-
Channel catfish	-	-	0.40	-	-
Stonecat	0.25	0.14	0.20	-	-
Burbot	0.25	-	-	-	-
White crappie	-	-	0.20	4.00	1.00
Yellow perch	-	-	0.20	-	-
Sauger	2.63	2.00	11.60	3.00	10.00
Walleye	0.13	-	0.20	-	1.00
Freshwater drum	1.63	0.29	-	-	-
Total	30.18	58.14	35.40	10.00	19.00

1/ Number of net sets.

During the spring of 1977 research efforts were directed primarily toward identifying and monitoring spawning migrations of sauger, shovelnose sturgeon and paddlefish. Migrations of these species within the Missouri River mainstem and migrations from the Missouri River into the lower Marias River were identified and monitored.

Paddlefish

Paddlefish are native to Montana and are found in both the Yellowstone and Missouri River drainages. Their presence in the state was first documented in the lower Yellowstone River in the early 1900's (Elser 1976). Today, significant numbers of paddlefish are found seasonally in the lower Yellowstone River and in the Missouri River in the dredge cut complex below Fort Peck Dam. Another paddlefish population inhabits the middle and upper portions of Fort Peck Reservoir. A portion of this population seasonally migrates upstream from Fort Peck Reservoir into the present study area on the middle Missouri River presumably to spawn.

The paddlefish was formerly abundant throughout much of the Mississippi-Missouri River system but has undergone a drastic decline since 1900 (Pflieger 1975, Rehwinkel 1975 and Vasetskiy 1971). A combination of destructive influences, including overharvest and loss of habitat in some areas, have contributed to this decline. Only seven known spawning populations of paddlefish exist today (Rehwinkel 1975). One of these populations occurs in the middle Missouri River and Fort Peck Reservoir.

The annual migration of paddlefish from Fort Peck Reservoir into the Missouri River was studied during 1977. The main objective of the study was to monitor the migration to determine timing of the run, relative abundance of paddlefish involved in the run and the extent (i.e., distance) of their upstream movements in the Missouri River.

The migration was monitored by electrofishing with the boom shocker. A direct current of 6 to 8 amps and 120 to 150 volts pulsed at 120 to 160 pulses per second with a pulse width of 40 to 50 percent was sufficient to make census counts of paddlefish involved in the run. A direct current of 8 to 10 amps and 150 to 200 volts pulsed at the same frequency and width was required to stun the paddlefish sufficiently to capture them in dip nets.

A total of 12 electrofishing census runs was made on the Missouri River in 1977 during a 119-day period from April 6 to August 2. Specific census dates and locations of river sections surveyed on each date are shown in Table 8. Since only a small portion of the total number of days during the migration period were censused, and only one census run was made on each day sampled, the paddlefish counts presented in this report represent only a portion of the total run and do not necessarily reflect its absolute magnitude.

Table 8. Number of paddlefish counted in electrofishing census runs on the middle Missouri River in 1977.

River Section	Census Dates, 1977											
	4/06	4/07	4/14	4/19	4/21	5/02	5/05	5/19	6/02-6/03	6/14-6/18	6/29-7/08	7/18-8/02
Marias River (152.4)[1/] to Coal Banks Landing (132.1)										0	0	0
Coal Banks Landing (132.1) to Hole-in-the-Wall (110.0)										0	0	0
Hole-in-the-Wall (110.0) to Judith Landing (84.3)										0	0	0
Judith Landing (84.3) to Stafford Ferry (70.8)									0	0	0	0
Stafford Ferry (70.8) to Bird Rapids (57.2)									0	0	0	0
Bird Rapids (57.2) to Cow Island (43.6)									0	0	0	0
Cow Island (43.6) to Grand Island (31.4)									0	0	0	0
Grand Island (31.4) to Robinson Bridge (23.2)						0	0	0	0	3	0	0
Robinson Bridge (23.2) to Slippery Ann (17.2)	0		0	0	2	3	5	7	2	3		
Slippery Ann (17.2) to Rock Creek (10.1)	0	0	0	1	7	8	11	12	12	8		
Rock Creek (10.1) to Fort Peck Res. (0.0)	0	0	3	9	12	30	36	44	24	19		
Total	0	0	3	10	21	41	52	63	38	33	0	0

1/ River miles upstream from Fort Peck Reservoir.

Most of the paddlefish counted in electrofishing census runs during the migration period in 1977 were observed in the lower reach of the Missouri River between Robinson Bridge and Fort Peck Reservoir (Table 8). Only three paddlefish were censused in the Missouri River above Robinson Bridge in 1977. All three were observed on June 18, and the farthest upstream observation was at river mile 25.2, or 2.0 miles above Robinson Bridge. The peak of the paddlefish migration in the lower reach of the Missouri River in 1977 occurred in about mid-May with 63 paddlefish censused between Robinson Bridge and Fort Peck Reservoir on May 19.

Extremely low water conditions in the Missouri River in 1977 undoubtedly account for the relatively small number of paddlefish observed in the Missouri River and the minimal extent of their upstream movements during the migration period. Normally, a substantial number of paddlefish are found in the Missouri River above Robinson Bridge during the migration period. According to Brown (1971) numerous paddlefish observations have been reported in the Missouri River, upstream to the Marias River, 152.4 miles upstream from Fort Peck Reservoir. Brown also reports a paddlefish in the Marias River below Tiber Dam, at a location approximately 80 miles upstream from the mouth.

In a reconnaissance survey of a reach of the Missouri River from Fort Benton to Judith Landing on June 30, 1976, a total of seven paddlefish were counted by visual observation of the fish near the surface of the water. All seven fish were observed in a reach of the Missouri River near the mouth of Little Sandy Creek, 125.6 to 130.0 miles upstream from Fort Peck Reservoir. In addition, two paddlefish were observed in an electrofishing survey near the Little Sandy Creek campground on August 24, 1976. These two fish were believed to be females because of their large size, estimated at 95 pounds each.

An important sport fishery normally occurs each year on the Missouri River in the vicinity of the Little Sandy Creek campground (George Baxter, personal communication). Peak abundance of paddlefish in the Little Sandy Creek area usually occurs around mid-June, compared to a normal peak in mid-May for paddlefish in the Missouri River below Robinson Bridge. The earliest confirmed paddlefish catch by sport fishermen in the Little Sandy Creek area during recent years occurred on May 25, and the latest reported catch was on July 4.

Judging by the concentration of paddlefish that normally occurs during the spawning season, it is likely that the Little Sandy Creek area is a spawning ground for paddlefish in the Missouri River. Other paddlefish spawning grounds are also probably found in the Missouri River in the study area. An attempt will be made during the paddlefish migration period in 1978 to confirm spawning grounds in the Little Sandy Creek area and to locate other paddlefish spawning grounds. Electrofishing survey runs will be used to locate general areas where paddlefish are concentrated. Specific spawning sites will then be identified in these areas using a procedure developed by Purkett (1961). Purkett identified spawning sites of paddlefish on the

Osage River in Missouri by visual observations of spawning fish. He believed that most of the spawning activity of paddlefish on the Osage River occurred underwater, but their spawning behavior also involved appearances of paddlefish on the surface of the water. Paddlefish visible at the surface would agitate the caudal fin several times, then disappear after a few seconds. Surface appearances occurred every few minutes throughout the late afternoon and evening. After dark the "sound" of the agitation at the surface was the only evidence of spawning. Suspected paddlefish spawning grounds on the Missouri River will be observed during the migration period in 1978 to determine if paddlefish in the study area exhibit spawning behavior similar to those on the Osage River.

Other Species

Spawning migration research findings on species other than paddlefish are preliminary at this time, and specific conclusions are unwarranted because of the limited amount of data. Stream flow and water temperature data which have been collected by the U. S. Geological Survey will be analyzed in an attempt to determine correlation of these parameters with the spawning migrations. Research findings will be presented in the next progress report.

Future life history research will be directed toward locating spawning sites of common or important game fish species. Water depth and velocity will be measured at the spawning sites in an attempt to define stream flow requirements for spawning. Identification and monitoring of spawning migrations will be continued. Fish tagging operations will be continued to determine movement patterns of individual spawning fish. An attempt will be made to collect eggs and larval fish to determine incubation period, hatching time and hatching success.

Forage Fish Study

Piscivorous game and nongame fish populations depend, in part, on an adequate forage fish base for their food supply. The major fish species in the middle Missouri River which utilize forage fish for all or part of their diet include sauger, walleye, northern pike, channel catfish, burbot and goldeye.

A forage fish, strictly defined, is any fish that is used as a source of food by other fish (Newell 1975). All fish species during the early stages of their life are small enough to be utilized as a forage food. However, for the purposes of this report, forage fish are defined as those species which, as adults, seldom exceed six inches in length and remain as a food source for their entire lives. This definition was used by Haddix and Estes (1976) in a fishery study on the lower Yellowstone River in Montana.

Forage fish populations were inventoried during 1976 in the eight fish population study sections mentioned previously. The main objective of the sampling was to determine taxonomic composition, longitudinal distribution and habitat requirements (i.e., preferences) of forage fish populations in the study area. Forage fish samples were taken with bag seines and mobile or boom-suspended electrofishing gear.

Most of the forage fish sampling sites were located in confined areas of the river, such as backwaters and side channels, where the presence of forage fish was considered to be likely. Some forage fish were also taken in the main channel, particularly in shoreline and shallow riffle areas.

The most common forage fish species taken in 1976 included flathead chubs, emerald shiners, silvery minnows, longnose dace, mountain suckers, stonecats and mottled sculpin. Mottled sculpins, longnose dace and mountain suckers were most abundant in the upper portion of the Missouri River above the confluence of the Marias River. Flathead chubs, emerald shiners, silvery minnows and stonecats were more common below the confluence of the Marias. Flathead chubs, emerald shiners and silvery minnows were common in backwater, main channel and side channel areas. Longnose dace, mountain suckers, stonecats and mottled sculpins were found exclusively in main channel and side channel areas and primarily in riffle habitat.

Forage fish sampling will be continued through the duration of this study. Additional findings will be presented in future progress reports.

SPORT FISHERY STUDIES

Paddlefish Creel Census

Background

Paddlefish are native to Montana waters, however, little angler interest in them occurred until 1962. At that time a number of paddlefish were taken by fishermen below an irrigation diversion structure on the Yellowstone River near Intake. This fishery stimulated interest in paddlefishing and, in addition to the Yellowstone River fishery, a good fishery now exists in the Missouri River immediately upstream from Fort Peck Reservoir and in the dredge cut pond complex below Fort Peck Dam.

Fishing pressure on paddlefish reportedly has increased considerably in recent years in the Missouri River immediately upstream from Fort Peck Reservoir (Needham 1973). This created the need for information required to evaluate the effect of fisherman harvest on the paddlefish population. In response to this need a creel census study was implemented in 1973 by the Fisheries Division of the Montana Department of Fish and Game (Needham 1973). The study also included tagging of paddlefish and collection of size and sex data. This research was continued by the Fisheries Division in 1974 and 1975 (Needham 1975 and 1976). Although the creel census was not repeated in 1976, general observations suggested that fishing pressure and harvest continued to remain high. Study efforts were therefore resumed on the research project in 1977.

The creel census study section consists of a 15-mile reach of the Missouri River located immediately upstream from Fort Peck Reservoir. Harvest occurs by snagging primarily in the spring as paddlefish migrate upstream from the reservoir. Typical snagging gear consists of a heavy surf-casting rod and reel, 30-80 pound test line, large treble hooks and heavy weights. Occasionally, paddlefish are also caught in the summer and fall, but due to the lower number taken in these seasons only spring harvest was determined.

Creel Period and Coverage

Creel census efforts in 1977 began when the first paddlefish catch was reported on April 15 and extended through June 12 when most of the fishing activity had ceased and harvest rates dropped to a negligible level. Twenty-five (42.4 percent) of 59 days during the creel period were censused. Fishing pressure and harvest were greatest on weekend days and holidays, and 15 (88.2 percent) of 17 of these days were included in the census. A total of 1,004 fishermen was interviewed during the creel census period in 1977. Completed trip data were obtained on 81.3 percent of the fishermen.

Fishing Pressure and Harvest

In 1977 an estimated 1,625 anglers fished 2,526 man-days (8,299 hours) and snagged 900 paddlefish (Table 9). The fisherman harvested 666 (74.0 percent) of the fish caught, and the remainder were released. The overall catch rate averaged 0.36 fish/angler/man-day (0.11 fish/angler/hour) or .55 fish/angler/trip. Harvest rate averaged 0.26 fish/angler/man-day (0.08 fish/angler/hour) or 0.41 fish/angler/trip. The average length of a fisherman trip was 1.55 days in 1977, and the average fisherman spent 3.29 hours per day snagging.

The estimated total weight of the 1977 paddlefish catch in the Missouri River upstream from Fort Peck Reservoir was 46,676 pounds (23.4 tons), with 35,195 pounds (17.6 tons) of paddlefish harvested. By comparison the estimated total harvest of paddlefish in the spring fishery on the Yellowstone River at Intake averaged 76,158 pounds (38.1 tons) annually during a 4-year period from 1972 to 1975 (Elser 1976). Estimated total harvest from a fishery in the tailwaters of Big Bend Dam on the Missouri River in South Dakota averaged 103,846 pounds (51.9 tons) annually during creel censuses conducted in 1970, 1971 and 1973 (Friberg 1974). Paddlefish harvest in a fishery on the Missouri River below Gavins Point Dam in South Dakota totaled 74,269 pounds (37.1 tons) in one snagging season (1972-73) during which a creel census was conducted. The largest sport fishery for paddlefish in the United States occurs in the Osage River above Lake of the Ozarks in Missouri. Total harvest during the two-month snagging season averages about 100 tons annually (Pflieger 1975).

Bank fishermen accounted for 56.6 percent (1,429 man-days) of the estimated total fishing pressure during 1977, but they took only 48.3 percent of the total number of paddlefish harvested for an average harvest rate of 0.23 paddlefish/fisherman/man-day (Table 9). Boat fishermen accounted for 43.4 percent (1,097 man-days) of the total pressure and 51.7 percent of the total harvest for an average harvest rate of 0.31 paddlefish/fisherman/man-day.

Weekend-holiday fishermen accounted for 48.3 percent (1,219 man-days) of the estimated total fishing pressure during 1977, but they took only 46.7 percent of the total number of paddlefish harvested for an average harvest rate of 0.26 paddlefish/fisherman/man-day (Table 9). Week day fishermen accounted for 51.7 percent (1,307 man-days) of the total pressure and 53.3 percent of the total harvest for an average harvest rate of 0.27 paddlefish/fisherman/man-day.

Table 9. Estimates of fisherman, fishing pressure, total catch and harvest, and success rates during the spring snagging season on the paddlefish fishery above Fort Peck Reservoir, April 15 to June 12, 1977.

Statistic	Weekend-Holiday Stratum			Week Day Stratum			Entire Season		
	Bank	Boat	Total	Bank	Boat	Total	Bank	Boat	Total
Number of Fishermen	463	366	829	445	351	796	908	717	1,625
Fisherman Man-days	687	532	1,219	742	565	1,307	1,429	1,097	2,526
Fisherman Hours	2,245	2,074	4,319	2,334	1,646	3,980	4,579	3,720	8,299
No. Paddlefish Caught	215	197	412	233	255	488	448	452	900
No. Paddlefish Harvested	136	175	311	186	169	355	322	344	666
Fish Caught/Man-day	0.31	0.37	0.34	0.31	0.45	0.37	0.31	0.41	0.36
Fish Harvested/Man-day	0.20	0.33	0.26	0.25	0.30	0.27	0.23	0.31	0.26
Avg. Length of Trip (days)	1.48	1.45	1.47	1.67	1.61	1.64	1.57	1.53	1.55
Avg. Hours Fished/Day	3.27	3.90	3.54	3.15	2.91	3.05	3.20	3.39	3.29

Estimates of fishing pressure and paddlefish harvest for the 1977 snagging season are compared with the 1973, 1974 and 1975 season estimate in Table 10. Total fishing pressure and total paddlefish harvest were higher in 1977 than during any of the three previous creel census periods. Low water levels in the Missouri River during the snagging season in 1977 may have been partly responsible for the increased angler pressure and harvest. A number of fishermen interviewed during the creel census period felt that the low water conditions facilitated the snagging of paddlefish. However, the overall fisherman success rate in 1977, in terms of paddlefish harvested/fisherman/man-day, was similar to previous years.

Table 10. A summary of fishing pressure, paddlefish harvest and harvest rates during the spring snagging seasons on the paddlefish fishery above Fort Peck Reservoir, 1973-1975 and 1977.

	Total Fishermen Man-days			Paddlefish Harvested			Harvest/ Fisherman/Day		
Year	Bank	Boat	Total	Bank	Boat	Total	Bank	Boat	Overall
1973	984 (64.9%)	532 (35.1%)	1,516	290 (62.1%)	177 (37.9%)	467	0.29	0.33	0.31
1974	1,422 (63.1%)	831 (36.9%)	2,253	396 (62.2%)	241 (37.8%)	637	0.28	0.29	0.28
1975	916 (61.8%)	566 (38.2%)	1,482	180 (46.7%)	205 (53.3%)	385	0.20	0.36	0.26
1977	1,429 (56.6%)	1,097 (43.4%)	2,526	322 (48.3%)	344 (51.7%)	666	0.23	0.31	0.26

Angler Residency

Angler residence was obtained for 761 fishermen interviewed during the creel census period in 1977. Montana residents accounted for 97.2 percent of the anglers (Table 11). Paddlefish snaggers represented 61 Montana cities and towns with the dominant ones being Billings, Lewistown, and Great Falls. The same three cities dominated in the angler residency of paddlefish snaggers interviewed during previous creel censuses conducted in the study area (Needham 1973, 1975 and 1976).

Size and Sex Composition of Harvested Paddlefish

Length, weight and sex data were obtained from 231 paddlefish harvested during the 1977 snagging season. The paddlefish examined were selected at random throughout the entire creel census period. Average length and weight of paddlefish harvested (males and females combined) was 61.0 inches and 55.6 pounds (Table 12). Females averaged 66.5

Table 11. Angler residence for 761 fishermen interviewed during the paddlefish creel census period in 1977.

Montana Residents	Number of Fishermen	Montana Residents	Number of Fishermen
Billings	122	Helena	14
Lewistown	88	Kalispell	13
Great Falls	85	Winifred	13
Missoula	35	Stanford	12
Bozeman	25	Other Cities[1/]	127
Butte	25		
Jordan	25	Resident Total	740
Laurel	23		
Malta	22	Nonresidents	
Park City	22	Wyoming	12
Grass Range	21	Idaho	6
Harlem	20	Washington	2
Roy	19	California	1
Havre	15		
Deer Lodge	14	Nonresident Total	21

1/ Cities in this category were each represented by 10 or less fishermen.

Table 12. Size of paddlefish harvested in the Missouri River above Fort Peck Reservoir during the spring of 1977.

	Number of Fish	Average Length[1/] (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Female	96	66.5	57.0-73.5	78.3	49-111
Male	135	57.1	46.5-68.5	39.4	10-84
Combined	231	61.0	46.5-73.5	55.6	10-111

1/ Length measurement is total length.

inches in length and 78.3 pounds in weight, compared to males which averaged 57.1 inches and 39.4 pounds in length and weight, respectively. The average size of male and female paddlefish harvested in 1977 was similar to the average size of fish harvested in seven previous years (Table 13).

Although the average female paddlefish harvested in 1977 outweighed the average male by a substantial margin, considerable overlap in weight-frequency of the two sexes was observed (Figure 3). Of the 231 paddlefish measured during the spring snagging season in 1977, 43.7 percent occurred in weight intervals which contained both male and female fish. The largest male paddlefish examined in the 1977 harvest weighed 84 pounds, while the smallest female weighed 49 pounds. Sex of these two fish was confirmed by autopsy and examination of gonads. Friberg (1974) also observed considerable overlap in weights of male and female paddlefish harvested in the tailwaters of Big Bend Dam on the Missouri River in South Dakota. The largest male in the Big Bend harvest weighed 65 pounds while the smallest female weighed 35 pounds. Conversely, Elser (1976) and Rehwinkel (1975) observed no overlap in weight-frequency of male and female paddlefish harvested on the Yellowstone River at Intake, Montana.

Females accounted for 41.6 percent of the paddlefish examined in the 1977 harvest, while males comprised 58.4 percent. Since fishermen often select for larger fish which are predominantly females, the observed sex ratio in the harvest may not be the sex ratio of the population.

Table 13. A summary of size data from paddlefish harvested in the Missouri River above Fort Peck Reservoir during eight spring snagging seasons, 1965 to 1977.

	Females			Males		
Year	Number of Fish	Average Length[1/] (Inches)	Average Weight (Pounds)	Number of Fish	Average Length (Inches)	Average Weight (Pounds)
1965	13	67.0	81.5	21	55.4	36.4
1966	36	64.0	74.4	30	53.3	32.1
1970	7	70.2	77.0	2	58.5	44.0
1971	10	66.7	85.7	1	57.0	44.0
1973	46	66.2	76.1	50	54.9	35.0
1974	58	65.3	74.5	67	55.0	32.8
1975	63	65.7	74.8	56	55.9	34.6
1977	96	66.5	78.3	135	56.9	39.4

1/ Length measurement is total length.

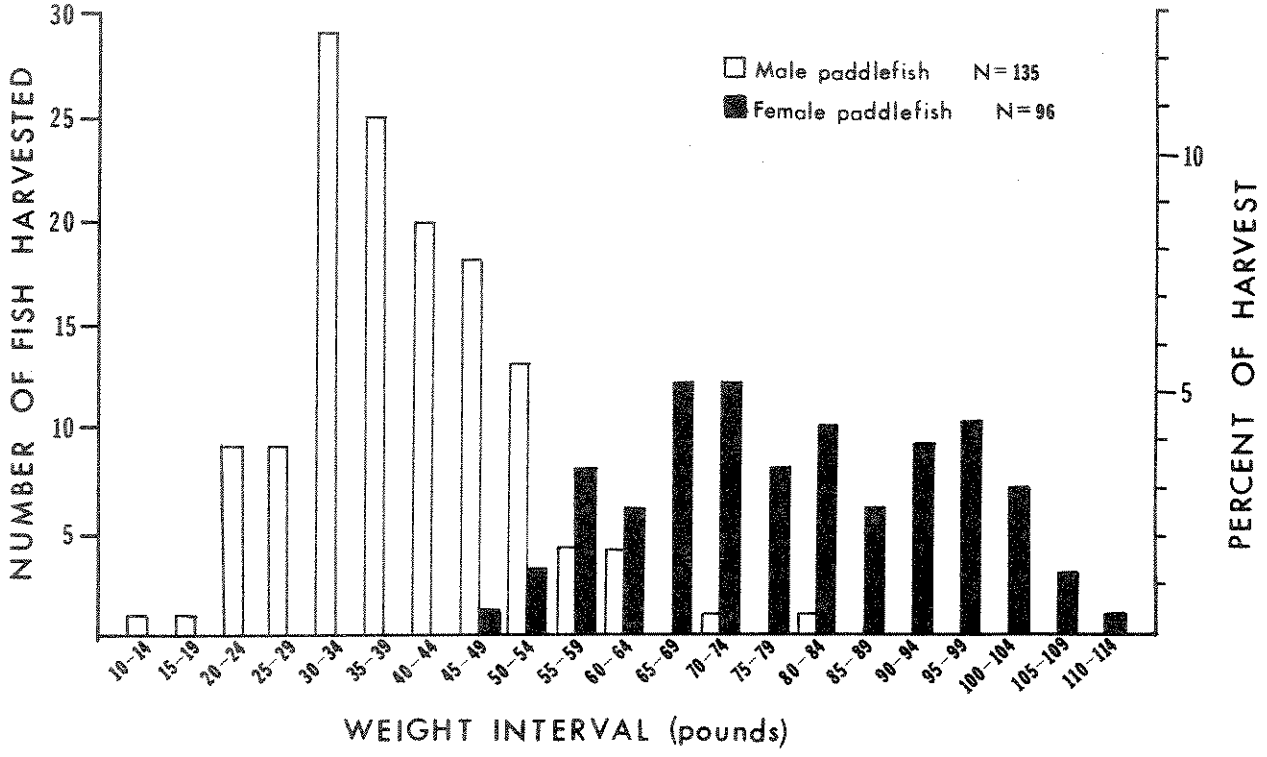


Figure 3. Weight-frequency and sex composition of 231 paddlefish harvested in the Missouri River above Fort Peck Reservoir during the spring of 1977.

Age Structure of Harvested Paddlefish

Dentary bones were collected from 142 paddlefish harvested by fishermen during the 1977 snagging season to determine the age structure of fish in the harvest. The dentary bones were collected at random throughout the entire creel census period, and the data therefore should be representative of the harvest. However, since fishermen often select for larger fish which are usually older in age, the observed age structure of paddlefish in the harvest may not be representative of the age structure of the population.

Paddlefish ages will be determined by cross-sectioning the dentary bones and "reading" the annuli in the mesial arm. Findings will be presented in the next progress report.

Paddlefish Tagging

Sixty-one paddlefish were tagged during the spring migration season in 1977 with individually numbered monel poultry band tags anchored around the dentary bones to obtain information on angler harvest and movement.[1/] Of the fish collected for tagging, 13 were sampled by electrofishing, 44 were taken by snagging and 4 were captured with large mesh gill nets drifted perpendicular to the current. All of the fish were captured in the Missouri River immediately upstream from Fort Peck Reservoir within the boundaries of the 15-mile creel census study section. This brings the total number of paddlefish tagged and released since 1973 to 213. To date, 15 (7.0%) of the tags have been returned by fishermen (Table 14). All of the recaptured fish were harvested in the creel census study section in the same area where they were tagged. Even assuming that all of the tagged fish harvested by fishermen are not reported, the 7.0 percent return figure indicates a relatively low rate of exploitation on the Missouri River-Fort Peck Reservoir paddlefish population.

Discussion

Data collected in research studies conducted since 1965 suggest that the Missouri River-Fort Peck Reservoir paddlefish population is vigorous and the current rate of exploitation by fishermen does not appear to be excessive. The overall success rate of fishermen in 1977, in terms of the number of paddlefish harvested/fisherman/man-day, was similar to previous years (Table 10). Also, the average size of male and female paddlefish harvested in 1977 was similar to previous years (Table 13). In addition, the total number of paddlefish harvested was higher in 1977 than during any of the previous years when creel censuses were conducted. If over exploitation does occur in a paddlefish population, the females will probably be affected first due to fisherman selection (Elser 1976).

1/ Paddlefish tagging assistance was provided by Mike Poore, Fisheries Division, Montana Department of Fish and Game, through Dingell-Johnson Project No. F-5-R-26, Job I-b.

Table 14. A summary of paddlefish tagging and fisherman tag returns in the Missouri River above Fort Peck Reservoir, 1973 to 1977.

Year Tagged	Number of Fish Tagged	Number of Fish Harvested						Percent Harvested
		1973	1974	1975	1976	1977	Total	
1973	45	0	1	1	0	1	3	6.7
1974	55	-	3	0	1	1	5	9.1
1975	29	-	-	0	0	1	1	3.4
1976	23	-	-	-	1	1	2	8.7
1977	61	-	-	-	-	4	4	6.6
Total	213						15	7.0

With only 7.0 percent of the tagged fish returned by fishermen, a relatively low rate of harvest is indicated for the Missouri River-Fort Peck Reservoir paddlefish population. By comparison, 13.8 percent of 3,661 paddlefish tagged on the Yellowstone River at Intake since 1964 have been returned by fishermen (Elser 1976). In data summarized by Carlander (1969), snagging by sport fishermen brought tag return rates 9.8, 12.6 and 12.4 percent in several studies conducted on the paddlefish sport fishery in the tailwaters of Big Bend Dam on the Missouri River in South Dakota. A tag return rate of 24.5 percent in three years following tagging of paddlefish on the Osage River in Missouri was considered by Purkett (1963) to be an excessive rate of exploitation. Angler harvest rates on the Missouri River-Fort Peck Reservoir paddlefish population do not approach this excessive rate. However, additional tagging of paddlefish and exposure of marked fish to the fishery, and further evaluation of fishermen success rates and size and sex composition of harvested fish will be necessary to properly evaluate the effects of exploitation rates on the Missouri River-Fort Peck Reservoir paddlefish population.

Potential habitat losses resulting from activities such as dam building or large-scale water withdrawals probably represent a greater threat to the Missouri River-Fort Peck Reservoir paddlefish population than over exploitation by fishermen. Every effort should be made to protect the middle Missouri River from this type of habitat alteration so the spawning migration can continue undiminished.

Missouri River Fisherman Survey

A fisherman creel survey was initiated in April 1977 on the sport fishery which exists in the 207-mile reach of the Missouri River from Great Falls to Fort Peck Reservoir. This area supports an excellent warm water fish population of great potential recreational value. The seven most common or important game fish species found in the study area include sauger, walleye, northern pike, shovelnose sturgeon, channel catfish, burbot and paddlefish.

The primary objective of the fisherman survey is to determine catch and harvest rates and species composition in the catch and harvest. Survey findings will aid in evaluating the sport fishery in the middle Missouri River so that a sound management plan can be formulated for maintaining and utilizing the resource. Creel survey findings will be presented in a later report when data accumulation becomes substantial enough to warrant interpretation.

LITERATURE CITED

Adams, L. A. 1942. Age determination and rate of growth in *Polyodon spathula*, by means of growth rings of the otiliths and dentary bone. Am. Mid. Nat. 28(3): 617-630.

Baxter, G. 1976. Pers. Com. Soil Cons. Ser., Big Sandy, Mont.

Berg, R. K. 1975. Fish and game planning, Upper Yellowstone and Shields River drainages. Job Comp. Rept., Fed. Aid to Fish and Wildl. Rest. Proj. No. F-3-R. Job Ia. 92 pp.

Brown, C. J. D. 1971. Fishes of Montana. Endowment and Res. Found., Mont. St. Univ., Bozeman. 207 pp.

Brown, H. P. 1972. Aquatic dryopoid beetles (Coleoptera) of the United States. U.S. Envt. Prot. Agency Proj. No. 18050 ELD. Washington, D. C. 82 pp.

Carlander, K. D. 1969. Handbook of freshwater fishery biology, Iowa St. Univ. Press, Ames. 752 pp.

Elser, A. A. 1976. Southeast Montana fisheries investigations. Job Prog. Rept., Fed. Aid to Fish and Wildl. Rest. Proj. No. F-30-R-12. Job Ia. Paddlefish investigations. 12 pp.

FAO. 1975. Symposium on methodology for the survey, monitoring, and appraisal of fishery resources in lakes and large rivers. 747 pp.

Friberg, D. V. 1974. Investigation of paddlefish populations in South Dakota and development of management plans, 1973. Job Prog. Rept., Proj. No. F-15-R-8, S. Dak. Dept. of Game, Fish and Parks. 33 pp.

Gieseker, L. F. 1931. Soils of Chouteau County. Mont. Agr. Exp. Stat. Bull. No. 252.

Haddix, M. H. and C. C. Estes. 1976. Lower Yellowstone River fishery study. Final Report, Mont. Dept. Fish and Game. 81 pp.

Missouri River Joint Study. 1963. Joint report on water and related land resources development by the U. S. Corps of Engineers and the Bureau of Reclamation. 60 pp.

Morris, L. A. 1965. Sauger and walleye investigations in the Missouri River. Job. Comp. Rept., Proj. No. F-4-R-10, Nebr. Game and Parks Comm. 7 pp.

Needham, R. G. 1973. Northeast Montana fisheries investigation. Job Prog. Rept., Fed. Aid to Fish and Wildl. Rest. Proj. No. F-11-R-20. Job IIa. 5 pp.

_____. 1975. Northeast Montana fisheries investigation. Job Prog. Rept., Fed. Aid to Fish and Wildl. Rest. Proj. No. F-11-R-22. Job IIa. 6 pp.

_____. 1976. Northeast Montana fisheries investigation. Job Prog. Rept., Fed. Aid to Fish and Wildl. Rest. Proj. No. F-11-R-23. Job IIa. 6 pp.

Newell, R. L. 1975. Yellowstone River invertebrate study. Prog. Rept. No. 1, Mont. Dept. Fish and Game. 20 pp.

Novotny, D. W. and G. R. Priegel. 1974. Electrofishing boats - improved designs and operational guidelines to increase the effectiveness of boom shockers. Wisc. Dept. of Natl. Res. Tech. Bull. No. 73. 48 pp.

Pennak, R. W. 1953. Fresh water invertebrates of the United States. The Ronald Press Co., N. Y., N. Y. 769 pp.

Peterman, L. A. and M. H. Haddix. 1975. Lower Yellowstone River fishery study. Prog. Rept. No. 1, Mont. Dept. Fish and Game. 56 pp.

Pflieger, W. L. 1975. The fishes of Missouri. Missouri Dept. of Cons., Jefferson City, Mo. 343 pp.

Posewitz, J. A. 1962. A fish population investigation in the Marias River below Tiber Dam. Fed. Aid to Fish and Wildl. Rest. Proj. No. F-5-R-11. Job IIa. 9 pp.

_____. 1963. Missouri River fish population study. Fed. Aid to Fish and Wildl. Rest. Proj. No. F-11-R-10. Job III. 9 pp.

Purkett, C. A. 1961. Reproduction and early development of the paddlefish. Trans. Am. Fish Soc. 90(2): 125-129.

_____. 1963. The paddlefish fishery of the Osage River and Lake of the Ozarks, Missouri. Trans. Am. Fish Soc. 92(3): 239-244.

Rehwinkel, B. J. 1975. The fishery for paddlefish at Intake, Montana during 1973 and 1974. M. S. Thesis, Mont. St. Univ., 37 pp. (unpublished).

Ricker, W. E. 1971. Methods for assessment of fish production in fresh waters. IBP handbook no. 3. Blackwell Scientific Pub., Oxford and Edinburgh, England. 348 pp.

Robinson, J. W. 1973. Missouri River habitat study. Final Rept., Proj. No. 4-3-R-8, Missouri Dept. of Cons. 15 pp.

_____. 1977. The utilization of dikes by certain fishes in the Missouri River. Final Rept., Proj. No. 2-199-R, Missouri Dept. of Cons. 17 pp.

Roemhild, G. 1976. The aquatic Heteroptera (True Bugs) of Montana. Mont. Agr. Exp. Stat. Research Rept. No. 102. 70 pp.

Stuckey, N. P. 1973. Effects of warm water discharges on fish in the Missouri River. Job Prog. Rept., Proj. No. F-4-R-18, Nebr. Game and Parks Comm. 14 pp.

U. S. Congress. 1975a. Hearings on S.1506, a bill to amend the wild and scenic rivers act, part 2 - Missouri River, Mont. U. S. Govt. Printing Office, Washington, D. C. 444 pp.

_____. 1975b. Designating a segment of the Missouri River in the state of Montana as a component of the national wild and scenic rivers system. Senate Rept. No. 94-502. 16 pp.

USDI. 1975. Missouri River - A wild and scenic river study. Bur. of Outdoor Rec. 95 pp.

USGS. 1974. Water resources data for Montana, Part I, surface water records. U. S. Dept. of Interior. 289 pp.

Vasetskiy, S. G. 1971. Fishes of the family Polyodontidae. Jour. of Icthyology 11(1): 18-31.

Ward, H. B. and G. C. Whipple. 1959. Fresh water biology. John Wiley and Sons, Inc., New York, N. Y. 1248 pp.

Wipperman, A. H. 1973. Smith River drainage inventory and planning investigation. Job Comp. Rept., Fed. Aid to Fish and Wildl. Rest. Proj. No. FW-1-R, Job Ia.

Appendix Table 1. River mileage chart for the middle Missouri River study area. Confluence of the Missouri River with the normal flood pool of Fort Peck Lake is river mile 0.0.

Location	River Mile
Morony Dam	207.0
Belt Creek	205.8
Highwood Creek	199.4
Carter Ferry	190.6
Fort Benton	174.7
Loma Ferry	154.2
Marias River	152.4
Spanish Island	146.2
Virgelle Ferry	135.2
Coal Banks Landing	132.1
Little Sandy Creek	127.2
Eagle Creek	118.0
Hole-in-the-Wall	110.0
Arrow Creek	95.8
Judith River	85.8
Judith Ferry	84.3
Stafford Ferry	70.8
Bird Rapids	57.2
Sturgeon Island	53.1
Cow Island	43.6
Grand Island	31.4
Robinson Bridge	23.2
Slippery Ann Campground	17.2
Rock Creek	10.1
Turkey Joe	0.9
Fort Peck Reservoir	0.0

Appendix Table 2. Species composition, number and size of fish sampled by electrofishing in the Morony Dam study section in 1976.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Goldeye	7	12.16	11.6-13.1	0.59	0.52-0.64
Mountain whitefish	5	12.28	11.2-14.7	0.86	0.60-1.69
Rainbow trout	1	14.6	-	1.07	-
Brown trout	1	21.9	-	4.08	-
Northern pike	1	22.8	-	2.82	-
Burbot	5	25.1	24.6-26.0	3.15	2.50-3.84
Carp	1	19.8	-	3.45	-
River carpsucker	1	16.5	-	2.20	-
Shorthead redhorse	6	18.2	16.3-20.4	2.61	1.92-3.62
Longnose sucker	6	13.7	8.4-18.4	1.36	0.28-2.64
White sucker	2	10.7	9.8-11.6	0.56	0.44-0.68
Mountain sucker	3	7.0	5.7- 8.0	0.18	0.11-0.25
Sauger	56	13.6	10.5-22.1	0.80	0.31-3.31
Walleye	1	30.3	-	11.80	-
Mottled sculpin	1	3.1	-	0.01	-
Total	97				

Appendix Table 3. Species composition, number and size of fish sampled by electrofishing in the Carter Ferry study section in 1976.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Goldeye	31	12.5	11.5-14.4	0.64	0.52-0.94
Mountain whitefish	2	8.7	6.2-11.1	0.25	0.06-0.44
Carp	2	19.6	19.4-19.7	3.52	3.26-3.78
River carpsucker	2	15.8	15.2-16.4	2.16	1.93-2.38
Shorthead redhorse	27	17.8	14.5-20.0	2.49	1.30-2.93
Longnose sucker	45	17.1	12.2-19.8	2.26	0.84-3.38
Sauger	30	14.3	11.4-17.2	0.88	0.44-1.42
Mottled sculpin	1	3.6	-	0.01	-
Total	140				

Appendix Table 4. Species composition, number and size of fish sampled by electrofishing in the Fort Benton study section in 1976.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Shovelnose sturgeon	3	35.5	32.2-40.0	7.13	5.7 - 9.4
Goldeye	92	12.4	11.3-15.1	0.60	0.42- 1.12
Mountain whitefish	1	3.9	-	0.02	-
Brown trout	1	15.7	-	1.48	-
Carp	42	19.5	12.3-24.3	3.65	1.12- 6.8
Flathead chub	13	6.4	3.3- 7.9	0.10	0.01- 0.18
Longnose dace	11	3.1	1.9- 4.6	0.02	0.01- 0.04
River carpsucker	9	15.8	14.3-17.6	1.84	1.30- 2.64
Blue sucker	6	27.0	26.1-28.0	6.18	5.2 - 6.8
Smallmouth buffalo	5	23.9	22.7-26.5	8.24	6.8 -10.8
Bigmouth buffalo	3	27.8	26.0-29.3	13.13	10.6 -15.4
Shorthead redhorse	248	16.6	9.1-19.7	1.96	0.30- 3.38
Longnose sucker	135	14.6	5.9-19.7	1.40	0.08- 2.92
White sucker	11	13.1	8.9-17.4	1.10	0.34- 2.12
Mountain sucker	5	5.2	3.4- 7.3	0.08	0.01- 0.19
Stonecat	1	5.6	-	0.09	-
Burbot	1	23.1	-	2.10	-
Sauger	242	12.1	7.3-23.7	0.55	0.08- 5.3
Walleye	2	26.3	23.2-29.4	8.26	4.41-12.1
Freshwater drum	13	12.6	10.5-14.5	1.06	0.60- 1.69
Mottled sculpin	13	3.2	2.2- 3.8	0.01	0.01
Total	858				

Appendix Table 5. Species composition, number and size of fish sampled by electrofishing in the Loma Ferry study section in 1976.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Shovelnose sturgeon	17	31.7	27.4-36.0	4.98	2.68- 8.0
Goldeye	96	12.0	11.0-13.9	0.56	0.42- 0.84
Northern pike	3	22.1	13.1-29.4	3.98	0.62- 7.6
Carp	33	18.4	9.9-22.7	3.05	0.48- 6.7
Flathead chub	89	4.6	3.1- 8.8	0.05	0.01- 0.24
Emerald shiner	22	2.8	2.0- 3.8	0.01	0.01
River carpsucker	32	15.6	5.3-20.0	1.88	0.10- 3.70
Blue sucker	3	26.2	25.7-26.5	5.73	5.4 - 6.2
Smallmouth buffalo	14	22.1	19.7-25.1	5.91	4.22- 8.6
Bigmouth buffalo	3	25.0	16.7-36.8	8.10	3.11-15.2
Shorthead redhorse	151	16.0	6.8-19.5	1.82	0.12- 3.28
Longnose sucker	151	15.7	5.0-19.5	1.76	0.08- 2.98
White sucker	4	13.2	10.7-16.2	1.04	0.50- 1.58
Burbot	3	20.3	18.6-21.6	1.33	1.06- 1.60
Yellow perch	7	5.6	4.3- 8.7	0.10	0.05 -0.25
Sauger	117	11.5	6.5-18.1	0.50	0.08- 1.86
Walleye	9	19.3	14.0-26.5	3.49	0.86- 8.1
Freshwater drum	14	11.8	10.4-14.9	0.74	0.54- 1.48
Total	768				

Appendix Table 6. Species composition, number and size of fish sampled by electrofishing in the Coal Banks Landing study section in 1976.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Shovelnose sturgeon	19	31.7	28.3-36.2	4.56	3.16-8.0
Goldeye	153	12.2	10.3-13.5	0.63	0.42-0.94
Mountain whitefish	2	7.0	6.7- 7.3	0.12	0.12
Carp	51	18.6	14.4-24.3	3.05	1.32-6.5
Flathead chub	26	6.7	3.7- 9.3	0.15	0.01-0.28
River carpsucker	19	16.4	14.7-18.6	2.04	1.58-3.06
Blue sucker	11	26.9	24.0-29.9	6.23	4.06-9.3
Smallmouth buffalo	13	21.6	18.9-24.2	5.54	3.24-8.5
Shorthead redhorse	173	15.2	3.0-19.7	1.60	0.03-3.58
Longnose sucker	49	14.1	8.0-19.2	1.22	0.02-2.74
White sucker	2	14.4	14.2-14.5	1.21	1.20-1.22
Mountain sucker	1	2.6	-	0.01	-
Stonecat	1	6.2	-	0.12	-
Burbot	4	19.5	10.5-28.0	1.71	0.24-3.90
Sauger	86	13.3	7.5-20.0	0.78	0.10-2.99
Freshwater drum	5	12.0	11.2-12.6	0.83	0.68-0.92
Total	615				

Appendix Table 7. Species composition, number and size of fish sampled by electrofishing in the Judith Landing study section in 1976.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Shovelnose sturgeon	8	29.7	26.1-32.9	3.67	2.10- 5.4
Goldeye	90	12.1	9.2-13.6	0.62	0.31- 1.00
Rainbow trout	1	16.8	-	1.48	-
Carp	26	18.6	15.9-21.9	3.27	1.96- 5.8
Flathead chub	31	6.1	3.5- 8.4	0.11	0.02- 0.28
River carpsucker	27	17.1	7.3-20.2	2.68	0.28- 4.10
Blue sucker	9	21.1	27.2-30.2	9.12	8.0 -12.1
Smallmouth buffalo	8	23.0	19.6-26.7	7.41	4.14-13.2
Shorthead redhorse	108	13.8	6.7-19.5	1.21	0.15- 3.32
Longnose sucker	25	13.0	4.4-18.1	1.06	0.05- 2.43
White sucker	6	10.6	6.5-14.7	0.67	0.07- 1.65
Channel catfish	10	23.6	18.6-27.3	5.79	2.38-10.4
Stonecat	2	6.5	6.5	0.11	0.09- 0.12
Burbot	7	16.4	9.7-21.0	0.87	0.18- 1.66
White crappie	2	7.6	7.0- 8.2	0.23	0.16- 0.30
Sauger	157	11.6	4.6-21.4	0.57	0.02- 3.08
Walleye	1	16.9	-	1.68	-
Freshwater drum	9	12.4	11.0-14.3	0.88	0.68- 1.21
Mottled sculpin	1	2.3	-	0.01	
Total	528				

Appendix Table 8. Species composition, number and size of fish sampled by electrofishing in the Cow Island study section in 1976.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Shovelnose sturgeon	6	28.9	24.7-36.0	2.66	1.12- 3.42
Goldeye	119	12.0	5.5-13.6	0.66	0.09- 1.00
Carp	69	18.8	15.9-24.7	3.11	1.82- 8.4
Flathead chub	10	6.0	3.9- 8.2	0.12	0.03- 0.26
River carpsucker	12	16.7	14.2-18.6	2.38	1.41- 3.55
Blue sucker	19	28.9	25.2-32.0	8.07	4.75-12.6
Smallmouth buffalo	7	22.0	19.3-24.6	5.67	3.76- 7.5
Bigmouth buffalo	1	29.9	-	16.0	-
Shorthead redhorse	37	14.2	8.2-18.3	1.25	0.30- 2.17
Longnose sucker	1	14.5	-	1.16	-
Burbot	1	8.5	-	0.70	-
Sauger	12	10.3	6.0-18.7	0.35	0.10- 1.06
Freshwater drum	3	11.3	10.6-12.1	0.70	0.51- 0.79
Total	297				

Appendix Table 9. Species composition, number and size of fish sampled by electrofishing in the Robinson Bridge study section in 1976.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Shovelnose sturgeon	7	27.9	26.0-29.7	2.51	2.06- 2.78
Goldeye	106	10.9	4.4-14.3	0.52	0.04- 1.10
Carp	30	18.3	12.7-21.9	2.76	0.82- 4.61
Flathead chub	28	4.9	2.5- 9.5	0.16	0.01- 0.31
Emerald shiner	5	3.3	2.8- 3.8	0.01	0.01
River carpsucker	13	17.4	16.0-19.2	2.76	2.09- 4.08
Blue sucker	6	30.4	27.7-33.4	9.38	7.5 -11.5
Smallmouth buffalo	1	24.1	-	7.5	-
Bigmouth buffalo	1	28.1	-	13.0	-
Shorthead redhorse	23	14.5	10.9-17.7	1.20	0.58- 2.18
Longnose sucker	2	9.3	7.9-10.7	0.40	0.21- 0.58
White sucker	1	8.5	-	0.22	-
Channel catfish	1	20.1	-	2.36	-
Burbot	1	25.2	-	3.60	-
White crappie	1	9.7	-	0.52	-
Sauger	36	10.8	5.1-19.7	0.47	0.03- 2.02
Walleye	1	14.0	-	0.75	-
Freshwater drum	3	11.9	10.2-13.0	0.79	0.48- 0.98
Total	266				

Appendix Table 10. Species composition, number and size of fish captured in eight overnight experimental gill nets in the Fort Benton study section in 1976.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Shovelnose sturgeon	3	36.1	34.1-38.0	7.2	6.2 - 8.6
Goldeye	88	12.4	11.1-15.1	0.60	0.40- 1.06
Brown trout	1	18.6	-	4.24	-
Carp	17	20.0	17.4-22.6	3.87	2.64- 5.3
Flathead chub	5	6.2	3.3 -7.8	0.13	0.01- 0.24
River carpsucker	6	16.3	14.8-17.8	1.98	1.26- 2.80
Blue sucker	5	26.9	25.8-27.6	6.00	5.0 - 6.8
Smallmouth buffalo	2	23.7	23.0-24.4	7.50	7.4 - 7.6
Bigmouth buffalo	4	24.1	18.5-28.4	9.18	4.00-13.8
Stonecat	2	5.6	5.4- 5.8	0.09	0.08- 0.10
Shorthead redhorse	21	16.3	11.2-19.3	1.84	0.60- 2.60
Longnose sucker	42	13.0	7.6-18.3	1.04	0.18- 2.88
White sucker	5	13.8	8.8-17.2	1.26	0.30- 2.05
Mountain sucker	3	4.0	3.3- 5.4	0.05	0.04- 0.07
Burbot	2	19.0	15.0-23.0	1.56	1.04- 2.08
Sauger	21	12.3	9.7-16.9	0.56	0.23- 1.20
Walleye	1	24.4	-	6.2	-
Freshwater drum	13	12.3	10.4-14.4	0.97	0.56- 1.62
Total	241				

Appendix Table 11. Species composition, number and size of fish captured in seven overnight experimental gill nets set in the Loma Ferry study section in 1976.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Shovelnose sturgeon	47	31.0	23.2-35.4	4.55	1.84-6.7
Goldeye	281	12.0	7.6-14.1	0.57	0.11-0.91
Carp	7	16.9	15.3-22.5	2.72	1.72-7.3
Flathead chub	3	7.4	6.5- 8.1	0.15	0.11-0.19
River carpsucker	14	15.1	12.3-16.8	1.66	1.05-2.34
Smallmouth buffalo	2	22.8	21.2-24.3	5.85	5.2 -6.7
Shorthead redhorse	13	15.5	8.2-19.3	1.81	0.21-2.96
Longnose sucker	18	16.6	13.9-19.5	2.03	1.28-2.90
Black bullhead	2	7.9	7.5- 8.2	0.17	0.13-0.20
Stonecat	1	7.9	-	0.22	-
Sauger	14	11.5	7.1-15.7	0.43	0.10-1.06
Freshwater drum	2	11.0	12.0-14.0	0.99	0.78-1.20
Total	404				

Appendix Table 12. Species composition, number and size of fish captured in five overnight experimental gill nets set in the Coal Banks Landing study section in 1976.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Goldeye	83	12.1	8.4-13.4	0.60	0.22-0.88
Carp	1	16.1	-	2.08	-
River carpsucker	1	15.8	-	1.70	-
Shorthead redhorse	18	15.1	9.9-19.0	1.46	0.41-2.84
Longnose sucker	4	15.9	15.5-16.5	1.69	1.56-1.88
White sucker	5	14.0	12.7-16.6	1.27	0.89-1.88
Channel catfish	2	29.0	29.0	11.55	10.9 -12.2
Stonecat	1	6.5	-	0.12	-
White crappie	1	6.1	-	0.14	-
Yellow perch	1	7.7	-	0.28	-
Sauger	58	12.4	9.0-19.6	0.63	0.20-2.99
Walleye	1	14.2	-	1.04	-
Total	176				

Appendix Table 13. Species composition, number and size of fish captured in one overnight experimental gill net set in the Judith Landing study section in 1976.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Goldeye	2	11.4	10.2-12.6	0.49	0.36-0.62
White sucker	1	10.3	-	0.42	-
White crappie	4	7.4	7.1- 7.5	0.21	0.18-0.24
Sauger	2	14.1	14.0-14.1	0.73	0.73
Total	9				

Appendix Table 14. Species composition, number and size of fish captured in one overnight experimental gill net set in the Robinson Bridge study section in 1976.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Goldeye	3	12.6	12.5-12.7	0.70	0.66-0.76
Flathead chub	2	8.6	7.7- 9.4	0.24	0.17-0.30
Shorthead redhorse	1	10.9	-	0.58	-
White sucker	1	13.4	-	0.88	-
White crappie	1	7.2	-	0.22	-
Sauger	10	13.9	11.8-15.6	0.79	0.59-1.16
Walleye	1	14.7	-	1.24	-
Total	19				

Seven of the most important or common game fish species found in the middle Missouri River in Montana are shown on this IDENTIFICATION CHART. These species are of particular interest to the Montana Department of Fish and Game, and the department is presently surveying fishermen to provide information about them. Please record your catch for each of these species on the appropriate line of the FISHERMAN SURVEY card.

Most fishermen will also catch some of the other common fish species in the river, such as goldeye, carp, river carpsuckers, longnose and white suckers, etc. If you catch any of these fish, please record the total number you caught on the "Other Kinds" line of the FISHERMAN SURVEY card.

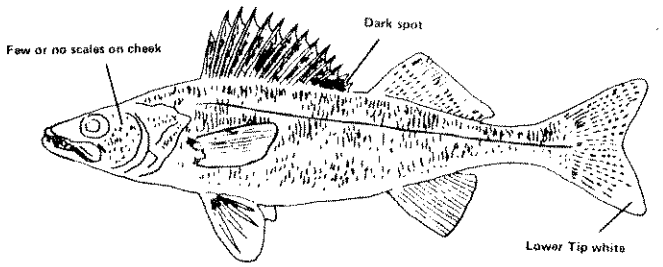
Please mail your completed FISHERMAN SURVEY card. It is postpaid. Your cooperation is appreciated.

Thank you,

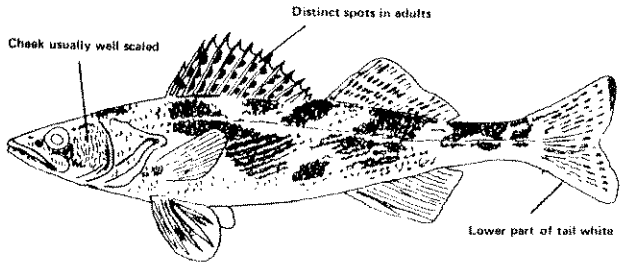
MONTANA DEPARTMENT OF FISH AND GAME

IDENTIFICATION CHART

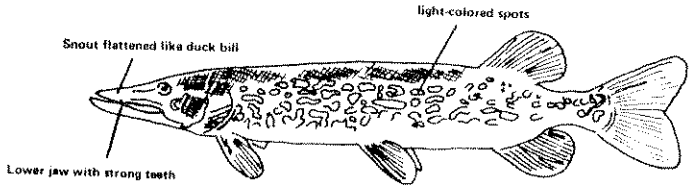
IMPORTANT GAME FISH · MISSOURI RIVER – GREAT FALLS To FORT PECK LAKE



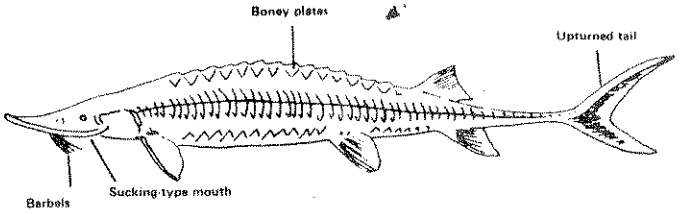
WALLEYE



SAUGER



NORTHERN PIKE



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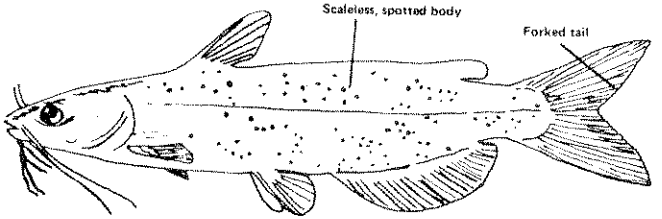
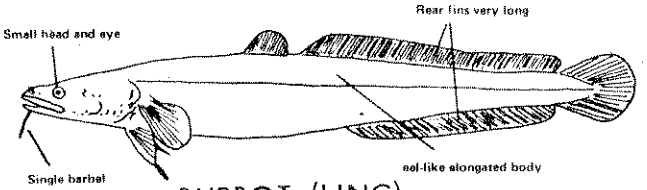
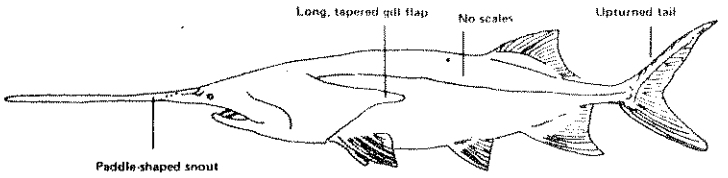


CHANNEL CATFISH



BURBOT (LING)



PADDLEFISH

Appendix
Figure 1. Fish species identification chart for Missouri River fisherman survey.

MONTANA DEPARTMENT OF FISH AND GAME
MISSOURI RIVER FISHERMAN SURVEY – ONE PARTY, ONE TRIP

Please answer the following questions as a combined total for all persons in your party who fished during your trip. Return the card even if you caught no fish.

Number of anglers in party _____ Angler's residence(s) _____
Date(s) fished _____ Section of river fished _____
Total hours spent fishing _____ (combined total for party)
Fishing from: ( )Bank, ( )Boat, ( ) Combination
Method(s): ( ) Setline, ( ) Angling (hand-held line with lure), ( ) Snagging
Lure(s): ( ) Live bait, ( ) Prepared bait, ( ) Artificial lure, other (specify) _____

Fish Species	CATCH	
	Number Kept	Number Released
Sauger		
Walleye		
Sturgeon		
Catfish		
Northern Pike		
Burbot (ling)		
Paddlefish		
Other kinds		

Please mail your completed card. It is postpaid. Your contribution will help to provide a better fisheries resource for Montana sportsmen.

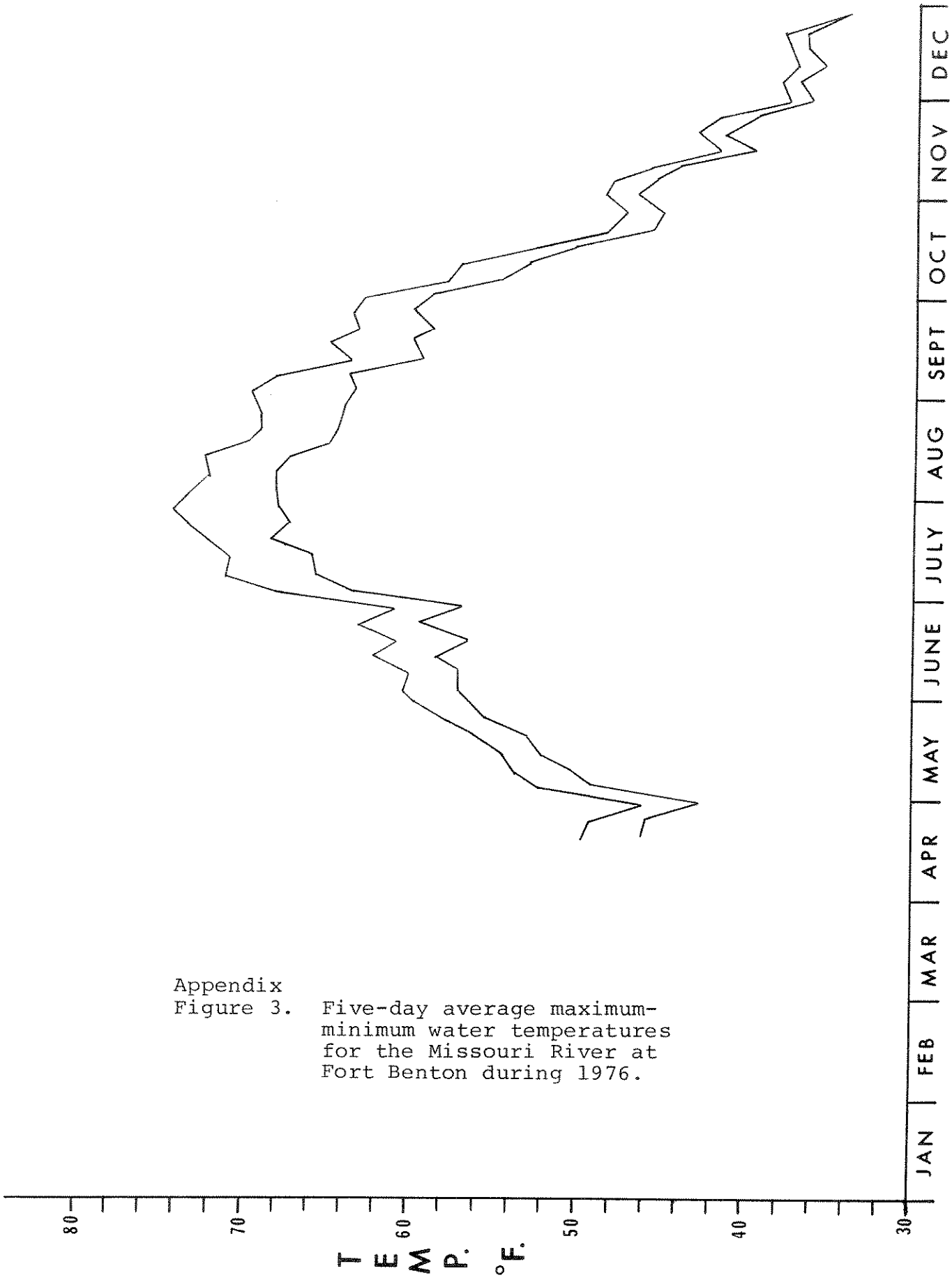
MONTANA DEPARTMENT OF FISH AND GAME
MISSOURI RIVER FISHERMAN SURVEY – ONE ANGLER, ONE TRIP

Angler's residence (city, state) _____ Interview No. _____
Date(s) fished _____ Section of river fished _____
Total hours spent fishing: _____ Fishing Trip: ( ) Complete, ( ) Not Complete
Fishing from: ( ) Bank, ( ) Boat, ( ) Combination
Method(s): ( ) Setline, ( ) Angling (hand-held line with lure), ( ) Snagging
Lure(s): ( ) Live bait, ( ) Prepared bait, ( ) Artificial lure, other (specify) _____

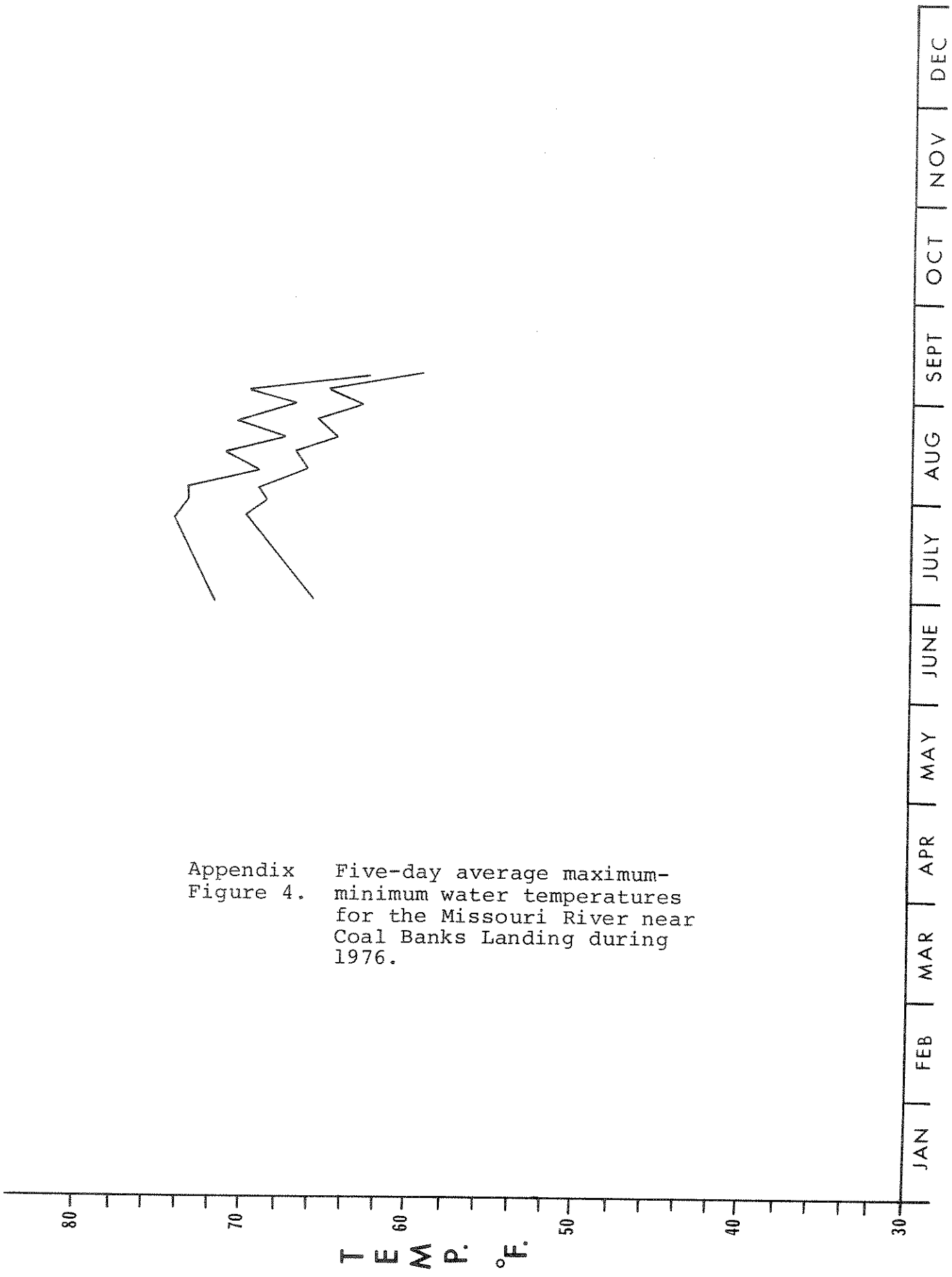
Fish Species	Catch When Interviewed		Additional Catch After Interview	
	Number Kept	Number Released	Number Kept	Number Released
Sauger				
Walleye				
Sturgeon				
Catfish				
Northern Pike				
Burbot (Ling)				
Paddlefish				
Other kinds				

If your fishing trip was not complete when you were contacted, please record any additional fish caught after the interview in the last columns (above). Answer for yourself only, do not include fish caught by others in your party. Additional number of hours spent fishing after interview _____ . Additional date(s) fished after interview: _____ . Please mail your completed card. It is postpaid. Your contribution will help to provide a better fisheries resource for Montana sportsmen.

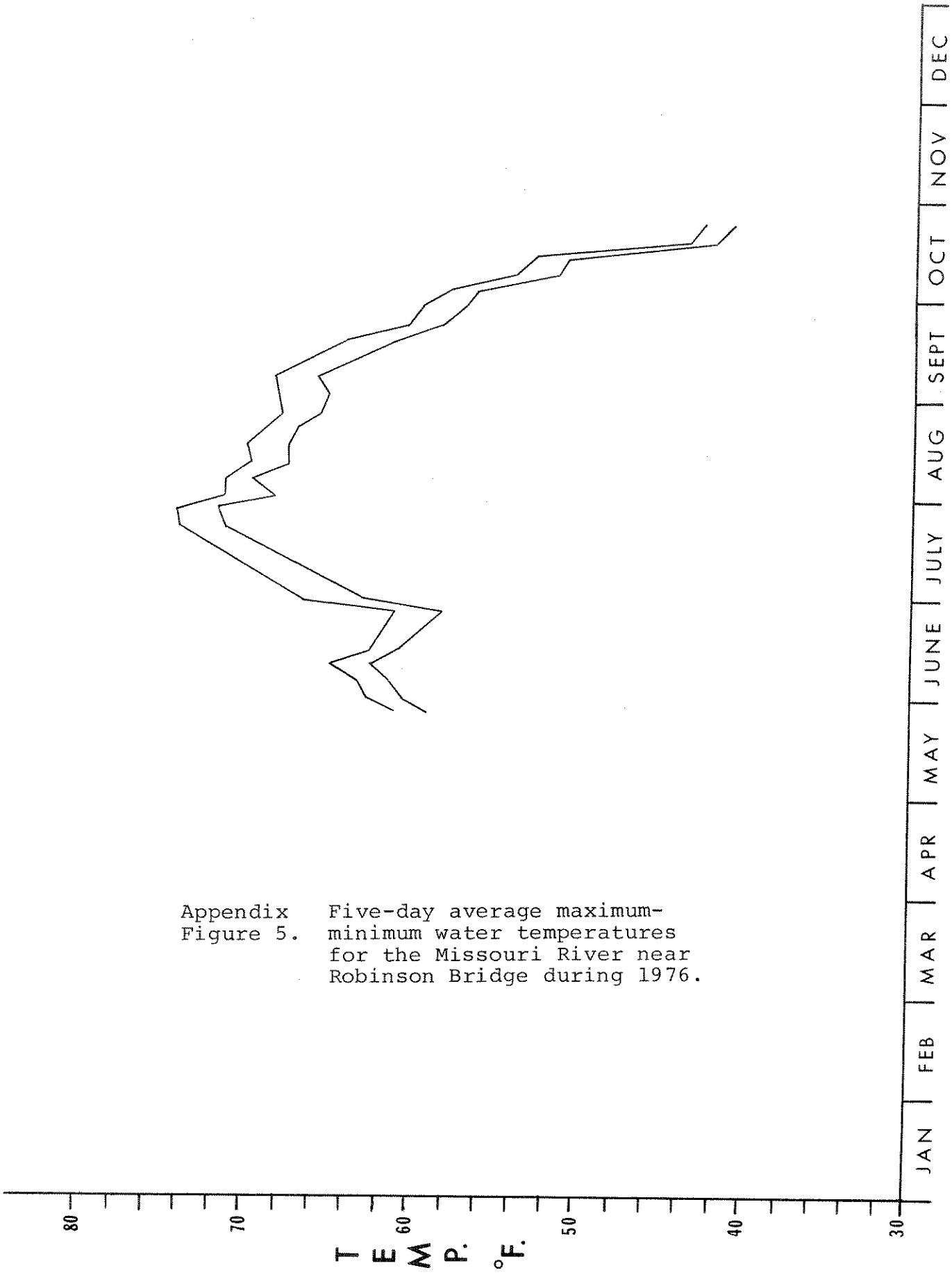
Appendix Figure 2. "Voluntary" (top) and "interview" (bottom) fisherman survey forms used in Missouri River fisherman survey.



Appendix
Figure 3. Five-day average maximum-minimum water temperatures for the Missouri River at Fort Benton during 1976.



Appendix Figure 4. Five-day average maximum-minimum water temperatures for the Missouri River near Coal Banks Landing during 1976.



Appendix Figure 5. Five-day average maximum-minimum water temperatures for the Missouri River near Robinson Bridge during 1976.