MONTANA DEPARTMENT OF FISH AND GAME
ECOLOGICAL SERVICES DIVISION

JOB PROGRESS REPORT

State Montana Title Middle Missouri River

Project Number FW-3-R-6 Planning Project

Job Number 1-a Fisheries

Period Covered July 1, 1977 through June 30, 1978

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 10 study sections on the middle Missouri River from early March through early November 1977. A total of 2,707 fish representing 30 species 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 1978. Concentrations of paddlefish were observed at nine localities along the Missouri River. Although those nine areas encompassed only 38 miles, or 18 percent, of the 207-mile reach of free flowing Missouri River found upstream from Fort Peck Reservoir, they contained 83 percent of the paddlefish which were observed in the electrofishing census counts.

Channel catfish populations were sampled in the Judith Landing and Turkey Joe study sections during the 1977 field season using baited hoop nets. A total of 815 channel catfish weighing 1793 pounds was captured in 106 net-days in the two study sections. Catch rate averaged 1.1 channel catfish per net day in the Judith Landing study section compared to 10.1 channel catfish per net day in the Turkey Joe study section.

Aquatic macroinvertebrate sampling was conducted at five study stations on the middle Missouri River from late October through mid-September, 1976-77. A total of 62,096 macroinvertebrates representing 13 orders was collected during the inventory period. Diptera, Ephemeroptera, Trichoptera and Plecoptera comprised 37, 32, 18 and 1 percent of the macroinvertebrates collected, respectively.

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.

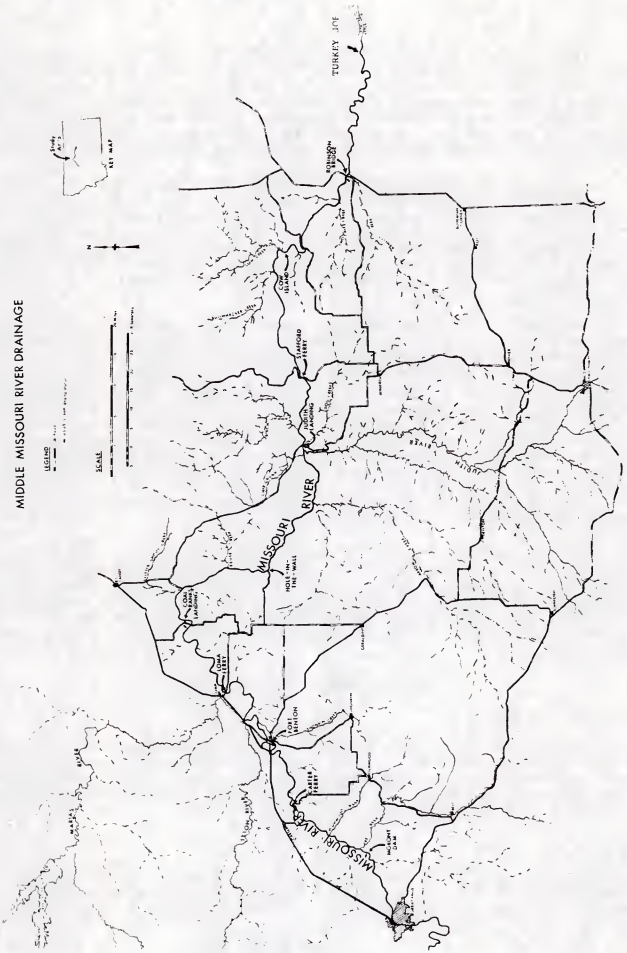
OBJECTIVES

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.

Baited Hoop Nets

Baited hoop nets were used to sample for channel catfish in the study area. The nets were constructed of 1-1/4 inch square mesh tarred nylon netting on a matched set of four 2-1/2 foot diameter wood hoops with an overall length of 6-1/2 feet (Figure 2). This type of hoop net has been used successfully by commercial fishermen to capture channel catfish in the Missouri and Mississippi rivers (Ragland and Robinson 1972 and Helms 1973). The nets are fairly selective for channel catfish although a few other species are taken occasionally.

The hoop nets were set in the river with the open throat facing downstream. A bait bag containing from 1 to 2 pounds of rotten cheese was attached to the bottom of the rear hoop inside the net. The bait bags were constructed from rubber tire inner tubes perforated as much as possible to facilitate feeding out of the bait. A weight of from 50 to 100 pounds was attached to the rear of the net. This weight anchored the hoop net on the stream bottom. The exact amount of weight required to anchor the net depended on the force of the current at the netting site. A second weight of about 5 pounds was attached to the bottom of the front hoop to keep the net stretched out in position on the stream bottom. A 10 to 20 foot nylon line with a buoy was attached to the top of the front hoop to mark the location of the set.

The most important element in sampling for channel catfish in large rivers is to locate the specific site to set the net. The lack of success in capturing catfish is usually due to set location rather than to inefficiency of the hoop net or bait.

Set location varies to some extent with the seasonal distribution of channel catfish. During spring from about mid-March through mid-June, a substantial number of catfish are found in side channels of the Missouri River in pools near undercut banks. A limited number of sets can be made in these areas during the spring. However, it is generally impractical to set hoop nets in the Missouri River during the spring because of the great amount of debris being carried by the river. As stream flow levels rise, the nets often become badly fouled with debris and, in some cases, are washed downstream by the current.

The best results in sampling for channel catfish in the Missouri River were obtained during the summer and fall period from mid-June through late October. Most of the channel catfish are found in deep pools in main channel areas in or near the thalweg during this time period. The sets were placed on stable gravel or sand and gravel substrate at the head of the larger pools in water at least 5 feet deep. Sets placed on unstable substrate, such as sand or mud, usually resulted in poor catches, and the nets often became partially buried and were difficult to retrieve. To facilitate feeding out of the cheese bait the sets were placed in areas with current velocity as swift as possible without washing away the nets.

The first nets set in each section were left in the water for 48 to 72 hours to allow sufficient time for the cheese bait to feed out. The nets were then raised and data on the catch was recorded. After the first set, the nets were checked approximately once every 48 hours. Information on the time of setting and raising, correct to the nearest 5 minutes was recorded for each net.

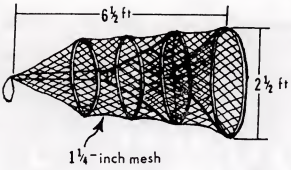


Figure 2. Diagram of baited hoop net used to sample channel catfish in the Missouri River.

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.

Scales or other structures were taken from certain fish species for age and growth determination. Scale samples were taken from sauger, walleye northern pike, blue suckers, bigmouth buffalo and smallmouth buffalo. Age and growth determinations for these species will be made by reading the scale samples following a procedure described by Tesch (1971). Dentary bones were collected from a number of angler harvested paddlefish during creel census surveys conducted on the Missouri River in the Slippery Ann area. Ages were estimated from cross sections of the dentary bone prepared in the manner described by Adams (1942). Pectoral spines and anterior pectoral fin rays were taken from channel catfish and shovelnose sturgeon, respectively. Age and growth statistics for channel catfish will be determined from cross sections of the pectoral spines prepared in the manner described by Ragland and Robinson (1972), Marzlof (1955) and Sneed (1951). An attempt will be made to determine ages of shovelnose sturgeon by reading cross sections of the anterior pectoral fin rays according to a procedure described by Cuerrier (1951) and Helms (1974).

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 in-

terviews 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 3. 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.

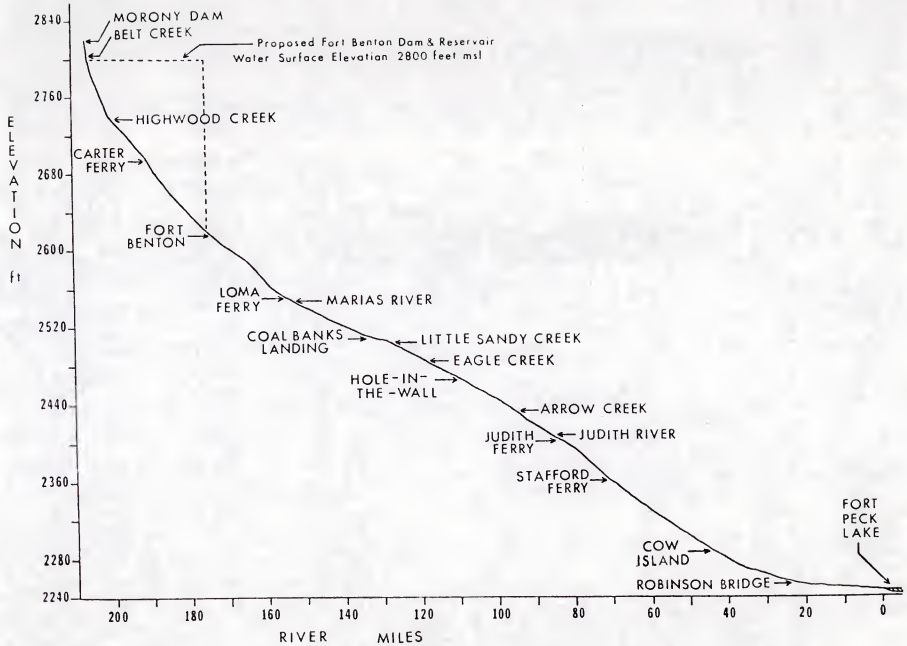


Figure 3. Longitudinal profile of the Missouri River from Morony Dam to Fort Peck Reservoir.

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

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 were monitored during the ice-free period by continuous recording thermograph stations located on the Missouri River at Morony Dam, Fort Benton, Coal Banks Landing and Robinson Bridge and on the Marias River 3.2 miles upstream from the mouth. The daily maximum and minimum water temperatures during 1977 at the five stations are shown in Appendix Tables 2 through 6. 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 five stations during 1977, water temperature warmed progressivel from late March through early June. The highest annual water temperatures were achieved during a period from early June through mid-August. The highest temperatures recorded at the Morony Dam, Fort Benton, Coal Banks Landing and Robinson Bridge stations during 1977 were 68, 78, 80 and 78 degrees F, respectively. The highest temperature recorded on the Marias River was 84 degrees F.

Water temperatures at the Coal Banks Landing and Robinson Bridge stations during a period of record from mid-April through early November 1977 averaged 2.1 and 1.8 F degrees higher, respectively, than the Fort Benton station. At the Morony Dam station during 1977 a shorter period of record was available than for the other three Missouri River stations. However, during a period of record from early June through early September of 1977, water temperature at the Morony Dam station averaged 6.7 F degrees lower than the Fort Benton station. During 1977, the mean diurnal differences between the average maximum and average minimum water temperatures were 5.10, 4.87, 4.39 and 3.86 F degrees for the Morony Dam, Fort Benton, Coal Banks Landing and Robinson Bridge stations, respectively. The mean diurnal difference on the Marias River was 7.42 F degrees.

Water Quality

Basic water quality parameters are being monitored by the U. S. Geological Survey at two stations on the middle Missouri River. The stations are located at Coal Banks Landing and Robinson Bridge. Additional stations and parameters of water quality in the study area will be monitored during 1978 and 1979 to augment the existing data. Meetings have been held with personnel of the Water Quality Bureau of the Montana Department of Health and Environmental Sciences in Helena, and a water quality monitoring program has been initiated. The Fish and Game Department will collect the samples, and laboratory analyses will be made by the Water Quality Bureau in Helena. Sampling "runs" will be made during four periods: (1) low flow, warm water - August, (2) low flow, cold water - January, (3) pre-runoff - April, and (4) runoff - June. The water samples will be taken at six stations including: Ulm (above Great Falls), Morony Dam, Fort Benton, Coal Banks Landing, Judith Landing and Robinson Bridge. The last five stations are existing study sites for aquatic macroinvertebrates and fish populations. Possible correlations between water quality and biological parameters will be evaluated. Findings will be presented in a future report.

MACROINVERTEBRATES

Aquatic macroinvertebrate sampling was conducted at five study stations on the middle Missouri River from late October through mid-September, 1976-77. The stations were located at Morony Dam, Fort Benton, Coal Banks Landing and Robinson Bridge (Figure 1). Samples were collected at approximately 6 week intervals.

A total of 62,096 macroinvertebrates representing 13 orders was collected during the eight sampling periods. The number of macroinvertebrates per kick sample ranged from 62 to 9,200. The ordinal composition and average number of subordinal taxa 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 37, 32, 18 and 1 percent of the macroinvertebrates collected, respectively. The average number of subordinal taxa ranged from 12.5 at Morony Dam to 17.4 at Fort Benton. The number of subordinal taxa provide an indication of macroinvertebrate diversity at each sampling station and allow for a general comparision of diversity between sampling stations.

Table 2. Percent composition (by order) and average number of subordinal taxa (in parentheses) of the aquatic macroinvertebrate community in the middle Missouri River, late October through mid-September 1976-77.

	Station					
Order	Morony Dam	Fort Benton	Coal Banks Landing	Judith Landing	Robinson Bridge	Combined Average
Plecoptera	<1 (0.2)	<1 (1.0)	1 (0.6)	4 (2.0)	4 (1.8)	1
Ephemeroptera	20 (2.5)	19 (4.4)	24 (4.3)	44 (6.1)	52 (6.5)	32
Trichoptera	24 (4.5)	31 (4.8)	8 (3.6)	18 (3.7)	9 (1.8)	18
Diptera	52 (2.0)	44 (2.4)	55 (1.5)	19 (1.3)	15 (1.5)	37
Others	4 (3.3)	6 (5.3)	12 (2.6)	15 (3.9)	20 (4.8)	12
Total Average No. of Subordinal Taxa	(12.5)	(17.4)	(12.6)	(17.0)	(16.5)	-

The longitudinal distribution of aquatic macroinvertebrates throughout the study area is presented in Table 3. The orders Ephemeroptera, Trichoptera, Diptera and Plecoptera contained representatives of 9, 6, 5 and 3 families, respectively. The families Heptageniidae, Tricorythidae, Baetidae, Hydropsychidae and Chrionomidae were sampled regularly at all stations. In addition, the families Ephemerellidae, Perlodidae and Corixidae were sampled regularly at all the stations except Morony Dam.

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

Table 3. Longitudinal distribution of aquatic macroinvertebrates in the middle Missouri River, late October through mid-September 1976-77.

Taxa	Station: Morony Dam	Fort Benton	Coal Banks Landing	Judith Landing	Robinson Bridge
Plecoptera					
Nemouridae *Brachyptera*			*		*
Capnia				*	*
Perlidae *Acroneuria*	*	*		*	*
Perlodidae *Isogenus*		*	*	*	*
Isoperla		*	*	*	*
Odonata					
Gomphidae *Gomphus*	*	*	*		*
Ophiogomphus					*
Ephemeroptera					
Baetiscidae *Baetisca*			*		
Leptophlebiidae *Leptophlebia*			*	*	*
Paraleptophlebia		*			
Traverella			*	*	*
Ephemeridae *Hexagenia*				*	*
Siphlonuridae *Ametropus*					*
Tricorythidae *Tricorythodes*	*	*	*	*	*
Caenidae *Caenis*					*
Ephemerellidae *Ephemerella*	*	*	*	*	*
Heptageniidae *Rhithrogena*	*	*	*	*	*
Stenonema	*	*	*	*	*
Cinygma		*	*	*	*
Baetidae *Baetis*	*	*	*	*	*
Heteroptera					
Corixidae *Trichocorixa*	*	*	*	*	*
Hesperocorixa		*		*	
Sigara	*	*			
Cenocorixa		*	*	*	*
Coleoptera					
Gyrinidae *Gyrinus*			*		
Haliplidae *Haliplus*		*			
Dytiscidae *Hydrovatus*				*	*
Hydroporus		*	*		
Dytiscus		*			
Hydrophilidae *Paracymus*	*				*
Chrysomelidae *Donacia*			*	*	
Dryopidae *Pelonomus*		*			
Chelonariidae *Chelonarium*				*	
Elmidae *Dubiraphia*		*		*	*
Ordobrevia		*	*	*	*
Stenelmis				*	*
Optioservus	*	*			

Table 3 continued. Longitudinal distribution of aquatic macroinvertebrat in the middle Missouri River, late October through mi September 1976-77.

Taxa	Station				
	Morony Dam	Fort Benton	Coal Banks Landing	Judith Landing	Robinson Bridge
Trichoptera					
Hydroptilidae *Hydroptila*	*	*	*		
Leucotrichia	*				
Hydropsychidae *Hydropsyche*	*	*	*	*	*
Cheumatopsyche	*	*	*	*	*
Psychomyidae *Psychomyia*	*				
Leptoceridae *Oecetis*	*	*	*	*	*
Helicopsychidae *Helicopsyche*			*		
Brachycentridae *Brachycentrus*	*	*	*	*	*
Amiocentrus	*				
Lepidoptera					
Pyralidae *Cataclysta*	*	*			
Synclita			*		
Diptera					
Tipulidae *Tipula*		*			
Hexatoma	*				
Chironomidae	*	*	*	*	*
Simuliidae *Simulium*	*	*	*	*	*
Empididae	*	*	*		*
Tabanidae	*				
Gordiida	*	*			*
Oligochaeta	*	*	*	*	*
Pulmonata					
Ancylidae *Ferrissia*		*			
Psysidae *Physa*			*		
Amphiboda					
Talitridae *Hyllela*	*				
Decapoda					
Astacidae *Orconectes*	*	*			

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
- *Oncorhynchus kisutch* - Coho salmon*
- *Oncorhynchus 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.

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.

Longitudinal distribution of fish species sampled during the first two field seasons, 1976 and 1977, 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.

Fish populations were inventoried by boom shocking and experimental gill netting in 10 study sections on the middle Missouri River from early March through early November 1977. A total of 2,707 fish representing 30 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 Carter Ferry, Fort Benton, Loma Ferry, Coal Banks Landing, Hole-in-the-Wall, Judith Landing, Stafford Ferry, Cow Island, Robinson Bridge and Turkey Joe (Figure 1).

Catch rate summaries for electrofishing and gill net surveys conducted during 1977 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 7 through 25.

Channel catfish are a common and important game fish in the Missouri River. However, they respond poorly to many kinds of sampling techniques. Boom shocking, gill netting, frame trapping and seining all failed to produce a sufficient sample of channel catfish in the study area. Other researchers have also reported problems in sampling for channel catfish in main channel areas of large rivers (Haddix and Estes 1976 and Schmulbach 1974). However, good success has been reported by researchers in Missouri (Ragland and Robinson 1972) and Iowa (Helms 1973) in sampling for channel catfish in large rivers with baited hoop nets.

Table 5. Longitudinal distribution of fish species sampled in the middle Missouri River during 1976 and 1977.

Fish Species	Morony Dam	Carter Ferry	Fort Benton	Loma Ferry	Coal Banks Landing	Hole-in-the-Wall	Judith Landing	Stafford Ferry	Cow Island	Robinson Bridge	Turkey Joe
Pallid sturgeon									*	*	*
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	*		*		*						

Table 5 continued. Longitudinal distribution of fish species sampled in the middle Missouri River during 1976 and 1977.

Fish Species	Morony Dam	Carter Ferry	Fort Benton	Loma Ferry	Coal Banks Landing	Hole-in-the-Wall	Judith Landing	Stafford Ferry	Cow Island	Robinson Bridge	Turkey Joe
Black bullhead				*							
Channel catfish					*		*		*	*	*
Stonecat			*	*	*		*	*			
Burbot	*	*	*	*	*	*	*	*	*	*	*
White crappie					*		*			*	*
Yellow perch				*	*		*			*	
Sauger	*	*	*	*	*	*	*	*	*	*	*
Walleye	*		*	*	*	*	*			*	
Freshwater drum			*	*	*	*	*		*	*	*
Mottled sculpin	*	*	*		*	*	*				
Total Number of Species	15	11	23	22	26	14	24	13	19	24	16

Table 6. Catch rate summary for electrofishing surveys on the middle Missouri River in 1977, expressed as number of fish sampled per electrofishing hour.

Fish Species	Study Section								
	Fort Benton	Loma Ferry	Coal Banks Landing	Hole-in-the-Wall	Judith Landing	Stafford Ferry	Cow Island	Robinson Bridge	Turkey Joe
Pallid sturgeon							0.1		
Shovelnose sturgeon	0.4	4.0	4.1	2.3	3.6	1.5	3.6	3.6	0.3
Goldeye	27.5	56.7	p[1]	p	10.0	1.3	1.0	32.0	10.3
Mountain whitefish	6.5	0.4					0.1		
Rainbow trout	0.1								
Brown trout	0.1								
Northern pike		0.1							0.3
Carp	7.5	13.3	p	p	1.8	2.1	1.5	1.4	4.1
Flathead chub	0.3	0.7	0.2	0.5	0.4	0.2	0.3	0.2	
Emerald shiner								0.6	
Silvery minnow	0.1							1.2	0.3
Longnose dace	0.1								
River carpsucker	2.0	20.0	p	p		0.6	0.2	0.4	0.8
Blue sucker	0.2	2.1	0.9	1.2	1.5	2.1	1.3	0.3	
Smallmouth buffalo	0.4	1.9	1.2	0.4	0.2	0.1	0.8		
Bigmouth buffalo		0.4	0.1	0.2	0.1				
Shorthead redhorse	90.0	23.3	p	p	18.2			1.8	
Longnose sucker	43.3	1.0	p	p	1.8	0.4			
White sucker	3.0		p	p					
Mountain sucker	0.1								
Channel catfish							0.1		
Stonecat			0.1						
Burbot	0.3				0.2	0.1	0.1	0.1	1.0
Sauger	5.6	1.7	1.5	0.9	0.5	0.5	0.3	2.5	7.9
Walleye	0.1		0.1						
Freshwater drum		0.2	0.1	tr[2]					
Mottled sculpin	0.1		0.2	tr					
Total	187.7	125.8			38.3	8.9	9.4	44.1	25.0

1/ p - present in study section, but not sampled for during electrofishing surveys.
2/ 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 1977, expressed as number of fish captured per overnight net set.

Fish Species	Carter Ferry(4) 1/	Fort Benton(4)	Loma Ferry(4)	Coal Banks Landing(4)	Hole-in-the-Wall(4)	Judith Landing(8)	Stafford Ferry(4)	Cow Island(4)	Robinson Bridge(4)	Turkey Joe(24)
Shovelnose sturgeon				1.25		0.25				
Goldeye	0.25	2.00	23.00	1.25	3.75	3.00		1.75	72.75	11.46
Rainbow trout									0.25	
Northern pike	0.50		0.25						0.75	0.04
Carp						0.63				0.42
Flathead chub						0.25				
River carpsucker			1.25		0.25				6.75	1.25
Smallmouth buffalo										0.04
Shorthead redhorse	0.50	0.75	7.25	0.50	1.00	0.63	0.50			0.42
Longnose sucker	0.75		1.25	0.50		1.38				
White sucker	0.50	1.25								
Channel catfish						0.13			0.25	0.13
Stonecat							0.25			
Burbot			0.25		0.25	0.13				
White crappie										0.25
Yellow perch			0.25			0.13			0.25	
Sauger	2.25	0.50	0.75	1.75	1.00	2.88	0.50	3.75	17.50	7.58
Walleye			0.25	0.25	0.25				0.50	
Freshwater drum										0.17
Total	4.75	4.50	34.50	5.50	6.50	9.41	1.25	5.50	99.00	21.76

1/ Number of net sets.

Sampling was initiated in two study sections on the Missouri River during the 1977 field season to determine the feasibility of using baited hoop nets to sample for channel catfish. The study sections were located at Judith Landing and Turkey Joe, and the sampling was conducted during a period from late July through August of 1977.

A total of 815 channel catfish weighing 1,793 pounds and 19 fish of other species weighing 41 pounds was captured in 106 net-days in the two study sections during 1977. Catch rate averaged 1.1 channel catfish per net-day in the Judith Landing study section compared to 10.1 channel catfish per net-day in the Turkey Joe study section (Table 8). A net-day represents one baited hoop net fished for a 24-hour period. The catch rate data can be used to compare relative abundance of channel catfish populations between study sections. However, since the hoop nets are selective for channel catfish, the catch rate data cannot be used to determine relative abundance of other species. Total catch, average size and size range of channel catfish and other species sampled in the hoop nets during 1977 are shown in Tables 9 and 10 for the Judith Landing and Turkey Joe study sections, respectively.

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.

During this report period 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. This is one of the last known "stable" populations of paddlefish (USDI 1978).

Table 8. Catch rate summary for baited hoop net surveys on the Missouri River in 1977, expressed as number of fish captured per net-day.

Fish Species	Study Section: Judith Landing (28) [1]	Turkey Joe (78)	Combined Average (106)
Channel catfish	1.1	10.1	7.7
Shovelnose sturgeon	tr [2]		tr
Sauger	0.1	tr	0.1
Goldeye	tr	tr	tr
Carp		tr	tr
Smallmouth buffalo		tr	tr
Shorthead redhorse	tr	tr	tr
River carpsucker		tr	tr
Freshwater drum		tr	tr
Total	1.3	10.2	7.9

1/ Number of net-days.
2/ Tr - trace (less than 0.05 fish/net-day).

Table 9. Species composition, number and size of fish captured in baited hoop nets in 28 net-days in the Judith Landing study section in 1977.

Fish Species	No. Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Channel catfish	30	20.2	11.8-32.4	4.70	0.62-15.8
Shovelnose sturgeon	1	32.2		5.1	
Sauger	3	18.8	14.0-21.8	2.35	0.95-3.43
Goldeye	1	12.0		0.59	
Shorthead redhorse	1	14.0		1.28	
Total	36				

Table 10. Species composition, number and size of fish captured in baited hoop nets in 78 net-days in the Turkey Joe study section in 1977.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Channel catfish	785	16.9	9.0-35.9	2.10	0.21-23.2
Sauger	3	18.4	16.0-20.4	1.78	1.10- 2.54
Goldeye	2	11.6	11.2-11.9	0.56	0.47- 0.64
Carp	2	16.3	16.2-16.4	2.18	2.12- 2.24
Smallmouth buffalo	1	23.5		6.3	
Shorthead redhorse	3	15.8	15.6-16.1	1.45	1.42- 1.48
River carpsucker	1	17.4		2.54	
Freshwater drum	1	18.4		3.00	
Total	798				

The annual migration of paddlefish from Fort Peck Reservoir into the Missouri River was studied during 1977 and 1978. 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 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.

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 (Berg 1977). Most of the paddlefish counted during the migration period in 1977 were observed in the lower reach of the Missouri River between Robinson Bridge and Fort Peck Reservoir. Only three paddlefish were censused in the Missouri River above Robinson Bridge in 1977. Extremely low water conditions in the Missouri River in 1977 undoubtedly accounted for the relatively small number of paddlefish observed in the river and the minimal extent of their upstream movements during the migration period. Due to the small amount of suitable spawning substrate in the Missouri River below Robinson Bridge, it is doubtful that spawning success of paddlefish was very high in 1977.

In 1978, streamflow in the Missouri River was about normal during the migration period, and a substantial number of paddlefish were found in the Missouri River above Robinson Bridge (Table 11). The early spring runoff during March through May was slightly above normal, while the June peak was slightly below normal (USGS preliminary data). A total of six electrofishing census runs was made on the Missouri River during a 128-day period from April 26 through August 21, 1978.

Concentrations of paddlefish were observed at certain localities along the Missouri River during the migration period in 1978 (Figure 4). Nine areas of particular importance which were identified are: (1) Slippery Ann-Robinson Bridge area - river miles 18 to 23, 132 paddlefish (2) Upper & Lower Two Calf Islands area - river miles 28 to 31, 68 paddlefish (3) Cow Island-Power Plant Ferry area - river miles 35 to 44, 245 paddlefish (4) Dauphine Rapids area - river miles 70 to 72, 19 paddlefish (5) Holmes Rapids area - river miles 80 to 82, 9 paddlefish (6) Deadmans Rapids area - river miles 85 to 88, 7 paddlefish (7) Little Sandy Creek area - river miles 121 to 131, 13 paddlefish (8) Virgelle Ferry-Boggs Island area - river miles 134 to 138, 11 paddlefish and (9) Three Islands area - river miles 145 to 146, 7 paddlefish. Although these nine areas encompassed only 38 miles, or 18 percent, of the 207-mile reach of free flowing Missouri River found upstream from Fort Peck Reservoir, they contained 83 percent of the paddlefish which were observed in the electrofishing census counts.

A large portion of the paddlefish counted in electrofishing census runs during the migration period in 1978 were observed in the Missouri River below Cow Island (Figure 4). A particularly heavy concentration was found in a 10 mile section of river located immediately below Cow Island. This indicates that physical characteristics of the Missouri River in the vicinity of Cow Island (e.g. shallow, swift water) probably constituted a partial barrier to upstream passage for a majority of the paddlefish population during 1978. During years when a greater volume of streamflow is found in the Missouri River, particularly during the June high water period, a better distribution of paddlefish to the sites upstream from Cow Island should be expected. Since streamflow in the Missouri River during June of 1978 was slightly below normal, it is reasonable to assume that distribution of paddlefish to the upstream sites was also slightly below average.

Present knowledge concerning reproduction and early development of paddlefish is based largely on studies made on the Osage River in Missouri since 1960 (Purkett 1961). Research indicates that paddlefish move upstream into the Osage River from Lake of the Ozarks during high water generally after the stream temperature has warmed up to 50 degrees F. Spawning areas consist of silt-free gravel bars. Flood water of several days duration is required for the adult paddlefish to finish spawning and for the eggs to hatch. Since floods are of insufficient magnitude or do not come at the proper time every year, spawning is not very successful during some years.

Spawning sites of paddlefish were located on the Osage River by visual observations of the spawning act. Most of the spawning activity of paddlefish on the Osage River occurred under water, but their spawning behavior also involved appearances of paddlefish on the surface of the water. Specific spawning sites were tentatively identified from abrupt movements of paddlefish, which leaped to the surface in one place. When the river

Table 11. Number of paddlefish counted in electrofishing census runs on the middle Missouri River in 1978.

River Section	Census Dates, 1978 4/26-4/27	5/10-5/14	5/23-5/26	6/13-6/16	7/19-7/25	8/14-8/21
Highwood Creek (199.4)[1/] to Carter Ferry(190.6)					0	0
to Fort Benton (174.7)					0	0
to Marias River (152.4)				0	0	0
to Coal Banks Landing (132.1)			10	8	4	0
to Hole-in-the-Wall (110.0)		3	7	7	2	0
to Judith Landing (84.3)		7	0	4	1	0
to Stafford Ferry (70.8)		8	1	2	1	0
to Bird Rapids (57.2)		4	8	12	1	0
to Cow Island (43.6)		16	7	9	0	0
to Grand Island (31.4)	7	127	40	56	3	0
to Robinson Bridge (23.2)	26	31	10	15	1	0
to Slippery Ann (17.2)	30	32	15	17	2	
to Rock Creek (10.1)	6	5	6	4	1	
to Fort Peck Reservoir (0.0)	22	11	3	4	2	
Total	91	244	107	138	18	0

1/ River miles upstream from Fort Peck Reservoir.

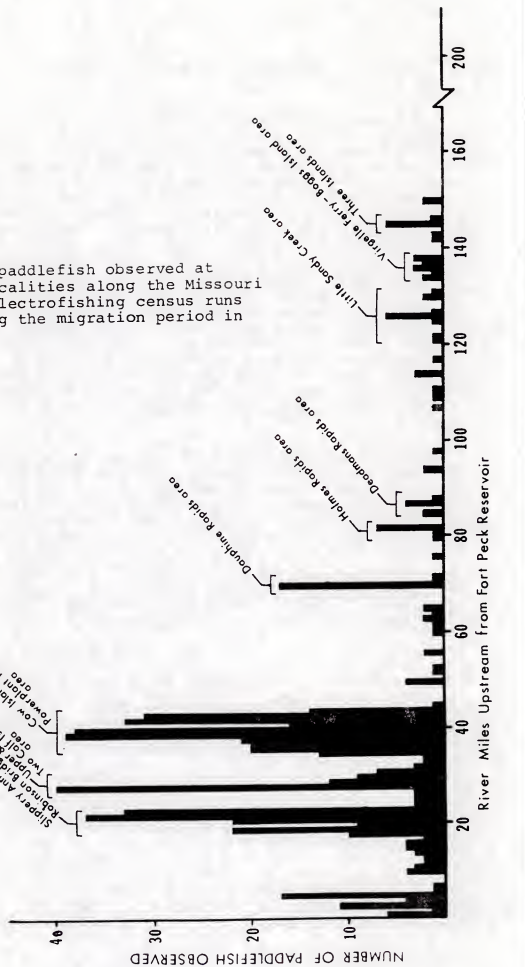


Figure 4. Number of paddlefish observed at various localities along the Missouri River in electrofishing census runs made during the migration period in 1978.

level lowered, attached eggs and newly hatched larvae were found in these areas.

Suspected paddlefish spawning grounds on the Missouri River were observed during the migration period in 1978 to determine if these paddlefish exhibited spawning behavior similar to those on the Osage River. Observations were made in the nine general areas where paddlefish were known to be concentrated as indicated by our electrofishing surveys. Spawning behavior similar to that reported for the Osage River was observed at two of the localities along the Missouri River. These were in the Little Sandy Creek and Dauphine Rapids areas. Spawning behavior was observed on May 23 and June 14 in the Little Sandy Creek area and on June 15 and June 27 in the Dauphine Rapids area. In addition, gravid female paddlefish have been captured, tagged and released in each of these two locations. An 81 pound gravid female (Tag No. 249) was taken near the Little Sandy Creek campground on May 23, 1978, and a 98 pound gravid female (Tag No. 250) was captured at Dauphine Rapids on June 15, 1978. A number of larval fish samples were taken in 1978 during the paddlefish migration period in an attempt to further confirm spawning activity in the Little Sandy Creek and Dauphine Rapids areas and in the other areas where paddlefish spawning activity was suspected. Sorting and identification of these samples will be completed sometime this winter. Findings will be presented in a future report.

Only a limited amount of time was spent in attempting to observe paddlefish spawning behavior in the Missouri River during 1978. Most of our time was spent moving continuously down the river on the electrofishing boat in an attempt to maintain a reasonable schedule for completion of our electrofishing runs. Very little time could be spent waiting around to observe anticipated spawning activity. Therefore, in the two areas where the spawning activity was observed, our data indicates only the occurrence of spawning activity and does not necessarily reflect its duration or magnitude. In the areas where no spawning activity was observed, additional observations need to be made during the next spawning season to more definitely confirm the presence or absence of spawning activity.

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 1977 in the ten 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 1977 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

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.

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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. Daily maximum and minimum water temperatures (degrees F) for the Missouri River near Morony Dam during 1977.

Day	April Min.	April Max.	May Min.	May Max.	June Min.	June Max.	July Min.	July Max.	Aug. Min.	Aug. Max.	Sept. Min.	Sept. Max.	Oct. Min	Oct. Max
1							56	62	61	68	54	59		
2							59	63	62	67	52	59		
3							55	61	61	64	56	61		
4							55	59	59	63	56	63		
5							56	63	59	63	59	63		
6						66	58	61	59	63	56	63		
7					60	67	56	60	59	65	55	63		
8					60	67	55	63	59	65	57			
9					63	67	56	62	60	62				
10					58	61	57	58	58	63				
11					57	58	56	62	53	63				
12					56	60	58	64	58	64				
13					55	62	58	60	60	61				
14					57	62	56	62	60	61				
15					57	62	63	65	57	60				
16					56	60	58	66	58	63				
17					56	63	60	64	57	65				
18					56	64	61	66	59	65				
19					57	63	62	65	61	65				
20					58	64	59	65	63	65				
21					59	65	60	67	61	65				
22					58	64	62	68	62	63				
23					57	65	62	67	60	65				
24					59	65	62	65	59	64				
25					58	67	59	61	56	62				
26					59	65	61	66	54	60				
27					63	65	61	67	55	59				
28					56	60	62	68	52	59				
29					58	60	62	66	56	60				
30					53	63	60	61	55	58				
31							59	64	53	58				

Appendix Table 3. Daily maximum and minimum water temperatures (degrees F) for the Missouri River at Fort Benton during 1977.

Day	April		May		June		July		Aug.		Sept.		Oct.	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max
1	36	41	53	57			65	72	68	75	58	63	52	53
2	36	41	54	59			64	70	69	74	57	63	51	56
3	36	40	55	59			64	73	68	71	60	65	51	54
4	40	45	52	56			63	67	66	70	61	68	49	54
5	41	47	51	55	41	47	63	71	66	70	63	69	48	51
6	42	48	51				57	68	66	70	62	68	48	52
7	44	50					57	67	66	72	62	68	50	51
8	46	53					63	71	65	72	61	65	47	51
9	49	53					65	71	64	69	59	65	47	49
10	48	52		61			63	65	62	70	61	67	45	48
11	48	52	54	59			61	70	64	71	60	65	45	49
12	47	53	55	61			66	72	65	69	59	65	46	51
13	47	53	56	62			64	68	65	68	62	65	48	51
14	48	51	58	62		68	64	73	63	72	60	65	47	50
15	47	52	55	56	62	67	66	72	64	71	60	63	47	52
16	49	54	54	57	62	67	66	78	64	68	59	61	49	54
17	42	53	52	55	61	73	63	71	63		58	59	49	53
18	43	52	50	53	63	70	67	71			57	62	49	53
19	47	50	49	51	65	70	68	74			57	62	50	53
20	47	51	49	54	63	71	66	71	67	70	57	62	50	53
21	45	50	50	55	67	74	67	75	66	72	57	62	49	52
22	47	54	51	58	68	74	70	77	66	70	56	60	49	52
23	47	53	54	60	67	74	71	77	65	71	54	59	49	53
24	46	56	57	59	69	73	70	75	66	69	55	57	49	51
25	49	57	57	59	69	74	67	70	62	68	53	58	49	51
26	54	59	56	64	69	74	69	75	65	67	54	59	48	50
27	54	59	58	60	68	72	69	76	61	64	53	57	45	50
28	54	59	53	59	65	72	70	77	59	64	54	56	47	50
29	55	59			63	67	70	75	60	63	54	55	47	49
30	55	60			62	74	68	70	59	60	53	55	46	49
31							67	73	57	64			44	47

Appendix Table 4. Daily maximum and minimum water temperatures (degrees F) for the Missouri River near Coal Banks Landing during 1977.

Day	April		May		June		July		Aug.		Sept.		Oct.	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
1	39	43	57	61	63	69	67	74	70	76	60	64	52	53
2	39	42	55	62	64	68	70	74	71	77	58	63	50	55
3	37	40	58	63	63	68	66	73	72	74	61	65	51	53
4	40	45	55	59	65	72	66	70	69	71	61	67	50	51
5	43	49	52	57	67	74	65	72	65	71	65	68	48	51
6	45	52	53	56	68	76	67	71	67	72	64	69	47	51
7	47	53	52	59	72	78	65	69	69	74	64	69	49	51
8	49	55	56	61	72	76	64	71	69	74	61	64	49	51
9	52	56	57	64	70	75	65	72	68	73	59	64	46	50
10	52	56	61	65	69	72	68	70	64	71	60	67	44	48
11	51	55	59	62	65	68	65	71	65	72	61	65	44	48
12	51	56	58	65	65	66	67	73	68	72	61	65	46	50
13	51	57	59	66	63	68	69	71	69	70	60	65	49	51
14	51	54	61	66	65	70	66	73	64	69	61	66	48	50
15	50	56	56	62	67	72	69	75	63	67	60	64	46	50
16	52	58	55	58	67	69	70	77	65	71	58	60	48	51
17	51	55	53	56	65	71	72	76	67	72	57	58	49	52
18	49	55	51	54	67	74	71	74	66	73	55	61	48	52
19	50	53	53	54	69	75	70	75	68	72	58	61	49	52
20	50	53	52	57	67	71	69	74	67	71	59	61	49	51
21	49	53	54	60	68	73	68	75	66	72	58	60	48	51
22	49	56	55	62	69	75	73	79	66	70	56	61	48	51
23	52	58	58	63	70	76	75	80	65	70	56	59	48	51
24	53	60	59	63	71	77	74	77	67	70	55	57	48	51
25	55	61	59	61	71	77	69	73	64	68	53	58	49	50
26	56	61	58	65	71	77	69	74	62	66	55	58	47	49
27	56	62	61	64	71	75	72	78	62	65	53	57	45	50
28	57	63	58	62	69	73	73	79	61	64	54	55	47	50
29	58	64	55	61	67	70	71	77	60	63	53	54	49	51
30	58	64	56	64	65	73	68	70	58	60	53	54	47	50
31			59	67			68	74	57	64			46	48

Appendix Table 5. Daily maximum and minimum water temperatures (degrees F) for the Missouri River near Robinson Bridge during 1977.

Day	April		May		June		July		Aug.		Sept.		Oct.	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
1			61	64	63	70	65	75	69	75	60	64	51	53
2			59	62	66		64	72	70	78	60	65	51	54
3			60	62	65	70	63	74	71	75	61	66	51	52
4			58	60		72	66	71	65	70	62	68	48	51
5			54	57	67		66	72	65	71	65	68	47	49
6			54	57			67	72	66	70	65	70	47	49
7			56	60			64	70	66	69	66	71	46	49
8			60	62			65	70	67	71	62	66	47	51
9			62	66			65	72	64	68	61	66	46	49
10			65	67			66	67	63	69	61	66	44	46
11			65	68			62	68	64	69	61	66	43	46
12			63	67			64	71	66	71	61	66	43	47
13		57	64	68			62	69	65	68	60	66	46	48
14	55	57	66	68			64	71	64	66	62	66	48	51
15	53	57	60	65			67	73	63	65	60	62	47	50
16	54	58	57	60			69	76	62	66	60	63	47	50
17	54	55	55	58			72	73	63	69	57	59	47	49
18	52	55	52	55			71	77	66	72	56	60	47	50
19	52	54	52	55	68	73	70	76	68	71	57	60	48	51
20	51	53	52	56	67	69	69	72	68	72	58	61	50	52
21	50	53	55	59	67	70	68	73	68	72	56	60	49	51
22	52	57	58	62	68	73	71	77	65	68	56	59	48	51
23	54	59	61	63	70	75	73	78	65	68	56	60	48	50
24	55	60	62	66	71	76	73	78	66	69	55	58	48	50
25	57	62	60	64	72	77	68	71	66	68	54	58	49	50
26	58	63	60	64	72	77	67	73	62	65	54	58	48	50
27	60	63	61	64	72	76	69	75	62	65	53	57	46	48
28	59	63	59	62	70	74	70	77	60	66	54	57	46	48
29	60	64	58	62	69	71	72	76	63	65	53	54	47	48
30	62	66	58	64	65	73	66	69	58	61	53	54	48	49
31			60	66			66	72	58	62			45	47

Appendix Table 6. Daily maximum and minimum water temperatures (degrees F) for the Marias River near the mouth during 1977.

Day	April		May		June		July		Aug.		Sept.		Oct.	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
1	37	43	55	63	64	71	68	76	66	80	60	67	52	54
2	36	41	54	63	62	72	69	74	70	81	59	67	49	56
3	36	40	57	64	66	77	63	73	71	76	62	70	51	54
4	39	46	52	59	67	79	64	68	68	70	63	72	47	52
5	42	51	46	56	70	83	63	74	63	74	67	74	44	49
6	45	55	49	54	74	82	66	71	65	75	65	75	44	51
7	48	58	50	64	72	78	60	71	67	77	65	73	47	50
8	51	61	58	66	69	79	63	75	67	78	63	70	46	51
9	53	60	59	71	66	71	66	75	64	72	57	67	47	49
10	52	58	63	71	63	65	65	70	60	73	61	70	41	47
11	49	58	59	67	61	64	61	74	63	75	61	68	40	48
12	49	59	58	71	60	69	67	76	67	74	59	68	43	53
13	50	60	61	73	64	73	66	70	68	71	59	68	49	54
14	51	56	64	70	65	72	64	77	63	68	61	69	48	53
15	48	59	54	64	65	69	68	79	61	69	61	66	45	52
16	52	60	51	56	64	73	70	81	62	74	59	62	48	54
17	48	56	49	55	66	78	72	75	65	77	56	59	47	52
18	47	57	47	51	68	77	70	74	69	80	54	63	46	53
19	47	53	49	52	65	75	68	77	70	78	56	63	48	52
20	47	53	50	60	67	75	66	74	70	76	59	64	48	52
21	47	53	54	64	67	75	67	79	68	78	57	63	47	51
22	48	59	57	67	67	77	72	83	68	72	55	62	45	51
23	51	62	61	68	68	78	75	84	65	73	53	61	46	52
24	53	65	62	67	70	79	71	79	67	72	54	57	47	50
25	56	66	58	69	71	80	68	70	63	69	51	60	48	50
26	56	65	60	66	69	80	67	77	62	68	53	60	47	50
27	54	64	55	61	70	76	70	79	61	67	51	57	52	47
28	54	66	51	62	67	72	70	82	59	67	54	56	44	49
29	56	67	54	67	65	72	73	77	61	65	53	56	47	49
30	59	67	60	72	65	75	64	70	57	60	54	56	45	49
31			66	75			62	75	57	66			42	45

Appendix Table 7. Species composition, number and size of fish sampled by electrofishing in the Fort Benton study section in 1977.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Shovelnose sturgeon	5	31.9	27.0-36.1	6.16	3.66-8.0
Goldeye	12	12.2	11.2-13.1	0.60	0.44-0.84
Mountain whitefish	89	14.7	8.0-19.2	1.56	0.23-3.14
Brown trout	1	15.1	-	1.44	-
Rainbow trout	1	15.7	-	2.08	-
Carp	4	19.4	13.9-24.0	4.36	1.53-6.8
Flathead chub	4	6.3	3.7- 8.0	0.15	0.01-0.25
Silvery minnow	2	3.9	3.8- 3.9	0.06	0.05-0.06
River carpsucker	7	16.3	15.3-17.4	2.18	1.78-2.44
Blue sucker	3	28.0	26.3-29.5	7.60	5.8 -8.6
Smallmouth buffalo	6	22.5	20.8-25.0	6.22	4.60-8.0
Shorthead redhorse	28	17.1	4.3-20.2	2.58	0.05-4.76
Longnose sucker	16	14.1	7.5-19.6	1.62	0.20-3.62
White sucker	5	12.3	10.3-15.5	1.01	0.54-1.76
Mountain sucker	1	5.7	-	0.08	-
Burbot	4	23.6	22.9-24.6	2.54	2.08-3.43
Sauger	75	14.8	10.8-19.7	1.00	0.28-2.56
Walleye	2	16.0	12.7-19.3	1.73	0.70-2.75
Mottled sculpin	2	3.8	3.5-4.1	0.03	0.01-0.04
Total	267				

Appendix Table 8. Species composition, number and size of fish sampled by electrofishing in the Loma Ferry study section in 1977.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Shovelnose sturgeon	45	30.5	25.4-37.0	5.56	2.83-8.6
Mountain whitefish	4	14.9	13.8-16.7	1.88	1.13-2.71
Northern pike	1	24.0	-	3.54	-
Flathead chub	8	8.0	6.7- 8.9	0.22	0.10-0.31
Blue sucker	23	22.5	21.7-31.2	7.94	4.40-12.4
Smallmouth buffalo	21	22.2	19.2-25.2	6.60	3.94-11.1
Bigmouth buffalo	5	28.8	23.4-32.2	15.5	7.8 -27.0
Longnose sucker	26	14.6	10.1-17.8	1.44	0.50-2.85
Sauger	19	15.1	9.0-18.1	1.09	0.19-1.83
Freshwater drum	2	13.3	12.6-13.9	1.06	1.00-1.12
Total	154				

Appendix Table 9. Species composition, number and size of fish sampled by electrofishing in the Coal Banks Landing study section in 1977.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Shovelnose sturgeon	73	32.3	25.6-37.5	5.57	2.61-9.9
Flathead chub	3	7.1	5.6- 8.0	0.20	0.19-0.23
Blue sucker	16	27.5	23.8-31.3	7.14	4.30-10.2
Smallmouth buffalo	22	22.0	19.2-25.0	6.44	3.90- 9.2
Bigmouth buffalo	2	27.6	27.5-27.7	12.25	11.8 -12.7
Longnose sucker	1	7.0	-	0.14	-
Stonecat	1	3.5	-	0.02	-
Sauger	25	14.5	10.0-19.7	1.07	0.33-2.55
Walleye	1	15.8	-	1.22	-
Freshwater drum	2	12.4	11.7-13.1	0.94	0.85-1.03
Total	146				

Appendix Table 10. Species composition, number and size of fish sampled by electrofishing in the Hole-in-the-Wall study section in 1977.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Shovelnose sturgeon	49	32.1	27.3-36.5	5.63	3.40- 9.6
Flathead chub	10	8.0	6.0-11.4	0.25	0.11- 0.65
Blue sucker	26	28.2	25.2-30.3	7.79	4.50-10.2
Smallmouth buffalo	9	23.2	18.6-25.8	7.14	3.60-10.1
Bigmouth buffalo	4	28.3	26.3-32.0	15.2	10.9 -27.0
Sauger	19	14.0	8.0-19.6	1.03	0.18- 2.24
Freshwater drum	1	12.0	-	0.82	-
Total	118				

Appendix Table 11. Species composition, number and size of fish sampled by electrofishing in the Judith Landing study section in 1977.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Shovelnose sturgeon	45	32.5	26.3-37.4	5.81	2.90- 9.5
Goldeye	11	12.9	12.1-13.5	0.74	0.63- 0.90
Carp	2	19.1	17.9-20.2	3.41	2.62- 4.20
Flathead chub	5	6.8	5.1- 8.1	0.15	0.04- 0.20
Blue sucker	19	28.3	24.2-32.6	7.39	4.30-11.6
Smallmouth buffalo	3	24.1	23.0-25.9	9.20	8.1 -10.0
Bigmouth buffalo	1	26.1	-	10.9	-
Shorthead Redhorse	20	15.7	14.2-19.0	1.65	1.10- 2.90
Longnose sucker	2	11.1	10.1-12.0	0.73	0.46- 1.00
Burbot	2	12.0	10.8-13.1	0.43	0.28- 0.58
Sauger	6	12.9	8.1-17.0	0.80	0.14- 1.58
Total	116				

Appendix Table 12. Species composition, number and size of fish sampled by electrofishing in the Stafford Ferry study section in 1977.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Shovelnose sturgeon	21	31.8	27.8-35.8	5.14	2.60- 7.1
Goldeye	7	12.3	11.8-13.6	0.58	0.51- 0.84
Carp	11	19.4	17.8-20.5	3.71	2.90- 5.3
Flathead chub	3	8.4	7.2- 9.5	0.24	0.20- 0.30
River carpsucker	3	17.1	16.0-18.8	2.53	1.78- 3.50
Blue sucker	29	28.5	25.1-31.7	8.15	5.0 -11.8
Smallmouth buffalo	2	23.9	23.1-24.6	7.35	6.6 - 8.1
Longnose sucker	2	11.9	8.8-15.0	0.91	0.30- 1.51
Burbot	2	14.8	12.5-17.1	0.59	0.48- 0.70
Sauger	7	13.3	11.6-16.7	0.67	0.21- 1.30
Total	77				

Appendix Table 13. Species composition, number and size of fish sampled by electrofishing in the Cow Island study section in 1977.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Shovelnose sturgeon	51	30.6	23.5-38.0	4.69	1.80-10.1
Goldeye	5	12.0	11.7-12.9	0.58	0.51- 0.68
Mountain whitefish	1	6.1		0.08	
Carp	7	18.7	15.1-22.0	3.60	1.70- 6.4
Flathead chub	5	6.9	6.4- 8.1	0.11	0.09- 0.14
River carpsucker	1	18.2		2.71	
Blue sucker	19	28.3	24.0-31.2	8.13	4.00-12.3
Smallmouth buffalo	11	22.8	20.6-26.5	6.98	4.50-14.1
Channel catfish	1	27.0		10.2	
Burbot	1	10.5		0.32	
Sauger	4	11.4	10.4-12.4	0.41	0.30- 0.48
Total	106				

Appendix Table 14. Species composition, number and size of fish sampled by electrofishing in the Robinson Bridge study section in 1977.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Shovelnose sturgeon	45	29.4	25.3-36.4	4.09	1.87- 8.3
Goldeye	211	11.9	7.1-14.5	0.57	0.12- 1.11
Carp	14	18.6	14.6-23.2	3.03	1.53- 5.7
Flathead chub	4	3.9	2.6- 5.3	0.05	0.01- 0.06
Emerald shiner	9	3.0	2.1- 3.5	0.02	0.01- 0.02
Silvery minnow	24	4.3	3.6- 4.9	0.04	0.02- 0.06
River carpsucker	27	15.0	8.7-18.3	1.91	0.36- 3.51
Blue sucker	5	29.6	27.6-30.6	9.26	5.8 -12.6
Shorthead redhorse	17	12.0	9.0-19.5	0.72	0.32- 2.58
Burbot	2	23.3	15.8-30.8	3.16	0.71- 5.6
Sauger	49	12.3	7.2-19.6	0.59	0.09- 2.33
Total	417				

Appendix Table 15. Species composition, number and size of fish sampled by electrofishing in the Turkey Joe study section in 1977.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Shovelnose sturgeon	1	27.0		3.06	
Goldeye	40	10.7	6.8-14.0	0.51	0.12-1.07
Northern pike	1	23.6		3.00	
Carp	16	14.5	8.8-19.7	1.67	0.42-3.25
Silvery minnow	1	4.2		0.03	
River carpsucker	3	15.2	9.9-18.0	2.05	0.48-2.88
Burbot	4	20.6	19.0-22.3	1.82	1.09-2.30
Sauger	30	12.6	8.2-16.8	0.61	0.14-1.53
Total	96				

Appendix Table 16. Species composition, number and size of fish captured in four overnight experimental gill net sets in the Carter Ferry study section in 1977.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Goldeye	1	13.2		0.79	
Northern pike	2	28.3	27.6-29.0	5.56	4.84-6.3
Shorthead redhorse	2	18.0	17.9-18.1	2.51	2.48-2.53
Longnose sucker	3	16.6	16.5-16.7	1.96	1.82-2.11
White sucker	2	17.1	16.3-17.8	2.35	2.04-2.66
Sauger	9	13.5	12.4-14.9	0.74	0.54-0.94
Total	19				

Appendix Table 17. Species composition, number and size of fish captured in four overnight experimental gill net sets in the Fort Benton study section in 1977.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Goldeye	8	12.7	12.2-13.1	0.69	0.60-0.89
Shorthead redhorse	3	16.5	13.3-19.5	2.27	0.97-3.71
White sucker	5	12.6	7.3-14.5	1.08	0.17-1.44
Sauger	2	12.4	12.2-12.6	0.54	0.47-0.60
Total	18				

Appendix Table 18. Species composition, number and size of fish captured in four overnight experimental gill net sets in the Loma Ferry study section in 1977.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Goldeye	50	12.6	11.3-13.7	0.69	0.47-0.96
Northern pike	1	22.3	-	2.73	-
River carpsucker	5	16.3	14.4-17.8	2.28	1.70-2.89
Shorthead redhorse	29	17.1	13.5-19.8	2.28	0.90-3.49
Longnose sucker	5	14.4	8.9-17.9	1.54	0.28-2.59
Burbot	1	28.8	-	4.53	-
Yellow perch	1	7.9	-	0.25	-
Sauger	3	13.8	12.3-16.2	0.86	0.56-1.47
Walleye	1	25.4	-	6.4	-
Total	96				

Appendix Table 19. Species composition, number and size of fish captured in four overnight experimental gill net sets in the Coal Banks Landing study section in 1977.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Shovelnose sturgeon	5	30.1	25.6-30.5	3.86	2.61-5.4
Goldeye	5	13.0	12.5-13.6	0.74	0.63-0.87
Shorthead redhorse	2	13.9	13.8-14.0	1.19	1.12-1.26
Longnose sucker	2	13.3	10.6-15.9	1.07	0.46-1.67
Sauger	7	11.3	8.9-12.4	0.43	0.17-0.55
Walleye	1	10.8	-	0.40	-
Total	22				

Appendix Table 20. Species composition, number and size of fish captured in four overnight experimental gill net sets in the Hole-in-the-Wall study section in 1977.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Goldeye	15	12.5	12.1-13.5	0.69	0.57-0.84
River carpsucker	1	16.2	-	2.29	-
Shorthead redhorse	4	17.2	16.9-19.5	2.45	1.80-3.15
Burbot	1	11.7	-	0.39	-
Sauger	4	13.7	11.3-17.7	0.85	0.36-1.82
Walleye	1	25.7	-	6.7	-
Total	26				

Appendix Table 21. Species composition, number and size of fish captured in eight overnight experimental gill net sets in the Judith Landing study section in 1977.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Shovelnose sturgeon	2	29.4	28.8-30.0	3.95	3.80-4.1
Goldeye	24	11.5	10.4-12.8	0.52	0.38-0.71
Carp	5	18.6	16.1-20.3	3.07	2.03-4.20
Flathead chub	2	6.6	6.2- 7.0	0.12	0.09-0.14
Shorthead redhorse	5	14.3	6.5-18.6	1.68	0.10-2.78
Longnose sucker	11	11.6	8.6-12.6	0.61	0.23-0.79
Channel catfish	1	26.5	-	8.9	-
Burbot	1	14.8	-	0.61	-
Yellow perch	1	7.0	-	0.19	-
Sauger	23	11.3	7.8-16.6	0.42	0.14-1.30
Total	75				

Appendix Table 22. Species composition, number and size of fish captured in four overnight experimental gill net sets in the Stafford Ferry study section in 1977.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Shorthead redhorse	2	13.4	6.5-20.2	1.35	0.10-3.59
Stonecat	1	3.0		0.01	
Sauger	2	14.9	13.6-16.2	1.02	0.70-1.33
Total	5				

Appendix Table 23. Species composition, number and size of fish captured in four overnight experimental gill net sets in the Cow Island study section in 1977.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Goldeye	7	12.5	12.2-13.4	0.68	0.52-0.7
Sauger	15	14.2	11.0-18.6	0.84	0.35-1.8
Total	22				

Appendix Table 24. Species composition, number and size of fish captured in four overnight experimental gill net sets in the Robinson Bridge study section in 1977.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Goldeye	291	11.23	6.5-14.2	0.51	0.07-0.88
Rainbow trout	1	18.6		2.87	
Northern pike	3	25.8	25.7-26.0	4.01	3.60-4.50
River carpsucker	27	15.0	8.7-18.3	2.01	0.36-3.54
Channel catfish	1	26.5		9.00	
Sauger	70	12.7	8.1-17.2	0.63	0.15-1.57
Walleye	2	15.9	13.7-18.1	1.48	0.87-2.08
Yellow perch	1	7.6		0.19	
Total	396				

Appendix Table 25. Species composition, number and size of fish captured in 24 overnight experimental gill net sets in the Turkey Joe study section in 1977.

Fish Species	Number Sampled	Average Length (Inches)	Length Range (Inches)	Average Weight (Pounds)	Weight Range (Pounds)
Goldeye	275	12.1	7.6-13.8	0.61	0.22-0.98
Northern pike	1	31.8		6.90	
Carp	10	16.2	11.2-19.8	2.13	0.86-3.26
River carpsucker	40	16.8	9.6-18.2	2.38	0.44-3.52
Smallmouth buffalo	1	24.3		8.6	
Shorthead redhorse	10	15.7	9.4-18.2	1.42	0.32-2.14
Channel catfish	3	15.5	12.2-17.3	1.33	0.59-1.72
White crappie	6	9.4	7.7-11.3	0.56	0.31-0.92
Sauger	181	14.0	8.7-21.5	0.82	0.19-2.58
Freshwater drum	4	11.3	10.1-12.9	0.66	0.48-1.00
Total	531				

MISSOURI RIVER FISHERMAN SURVEY

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

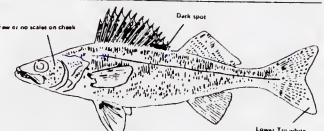
Please mail your completed FISHERMAN SURVEY card. It is postpaid. Your cooperation is appreciated.

Thank you,

MONTANA DEPARTMENT OF FISH AND GAME

IDENTIFICATION CHART

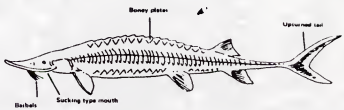
IMPORTANT GAME FISH - MISSOURI RIVER - GREAT FALLS To FORT PECK LAKE



WALLEYE

SAUGER

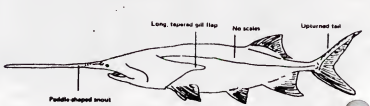
NORTHERN PIKE



SHOVELNOSE STURGEON

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.