MONTANA DEPARTMENT OF FISH, WILDLIFE AND PARKS
ECOLOGICAL SERVICES DIVISION

JOB PROGRESS REPORT

State Montana Title Lower Missouri River Basin Investigations

Project Number FW-2-R-11

Job Number 1-b Title Planning Inventory, Fisheries

Period Covered July 1, 1981 through June 30, 1982

ABSTRACT

Fish population and aquatic invertebrate survey and inventory work were continued on the Missouri River in Montana from Fort Peck Dam to North Dakota. Fish populations were sampled using electrofishing, gill nets, baited hoop nets, seines and towed larval fish nets.

Limited sampling of aquatic macroinvertebrates indicates exclusion of some genera in upstream areas because of cold-water releases from Fort Peck Dam. A larger number of genera was found at downstream stations.

Three previously unsampled fish species were found in the Missouri River in 1981. These were the sicklefin chub, brook stickleback and smallmouth bass. Nongame fish species were sampled for the first time by electrofishing and data indicating their status are presented. The order of abundance of the most common nongame species was goldeye, carp, shorthead redhorse, river carpsucker and flathead chub. A large concentration of blue suckers was found just downstream of the Milk River.

At least 12 species of larval fish were sampled. Density of larval fish was 6 times greater in the mouths of tributary streams than in the Missouri River. Young-of-the-year of 14 species were sampled in 1981, with YOY of 4 species being sampled for the first time.

Paddlefish counts were made over the length of the study area. Density of paddlefish varied with season and location. No evidence for paddlefish spawning was found. Paddlefish avoided tributary streams.

Sauger made up 68% of fish sampled in "game fish only" electrofishing. They were much more abundant in fall than spring. Sauger spawned in the lower half of the study area from mid-May through early June, and YOY reared from Wolf Creek to the North Dakota border. Sauger moved upstream in large numbers in fall, with the mouth of the Milk River being used as a

"stopping off" point on the way to the dredge cuts tailwaters area. Average size of sauger has increased greatly since 1979. Walleye were much less abundant than sauger.

Northern pike were mostly sedentary with fall YOY numbers insufficient to maintain the abundance of older age groups. No evidence for channel catfish or shovelnose sturgeon reproduction has been found. Burbot were second in abundance in "game fish only" electrofishing, making up 14% of total game fish numbers. Burbot often reached a weight of over 10 pounds. Large numbers of small burbot, probably yearlings, were present in the study area in 1981. Rainbow trout produced YOY in 1981 and possibly 1980. The rainbow smelt has become established in the study area.

BACKGROUND

Results of aquatic studies in 1979 and 1980 on the Missouri River from Fort Peck Dam to the Montana-North Dakota border (lower Missouri River) were reported earlier (Stewart 1980, 1981). This report gives results of field work done in 1981 with comparisons to previous years.

Spring runoff in 1981 was very low and similar to 1980. Tributary streams did not add significantly to the flow of the Missouri River in the study area until June. Periodic rainfall occurred from June to October, causing tributaries to rise briefly, but did not add greatly to the flow of the Missouri River. Streamflows were maintained at typical levels in 1981 by releases from Fort Peck Reservoir.

Possible water developments which could threaten Missouri River fish populations were described previously (Stewart 1980, 1981).

OBJECTIVES

Overall project objectives consist of the inventory of game and nongame fish populations, determination of the status of individual species, determination of important factors upon which game fish depend, location of critical reaches or tributary streams for various game species, and formulation of instream flow recommendations to protect game fish populations.

More specific objectives for the report period include the following:

(1) Tag all game fish captured for movement studies.
(2) Make paddlefish counts over the length of the river and sample paddlefish for tagging and length and weight measurements.
(3) Sample game species in the lower portions of tributaries during spring migrations.
(4) Sample game fish populations over the length of the river in spring, summer and fall.
(5) Locate concentrations of game species.
(6) Determine game fish spawning locations and reproductive success by sampling adult spawners, eggs on the river bottom, drifting larval fish and YOY.
(7) Sample nongame species over the length of the river.
(8) Collect river bottom macroinvertebrates at four or five stations from early spring to fall.

DESCRIPTION OF THE STUDY AREA

The study area is described in a previous report (Stewart 1980). Figure 1 is a map of the study area.

PROCEDURES

Most procedures have been described in previous reports (Stewart 1980, 1981). Only new procedures will be described here.

Stream bottom macroinvertebrates were sampled by agitation of the substrate with a wide-toothed garden rake upstream of a 500 micron mesh net. Organisms were picked from samples in the field if relatively little debris was present and stored in formalin. If amounts of debris in field samples were larger, the whole sample was placed in a jar with formalin. Organisms were then picked from the debris in the laboratory.

Macroinvertebrates were identified to genus or to family in some cases using keys by Pennak (1953) and Ward and Whipple (1959). William Gardner (MDFWP) assisted with identification. Dr. George Roemhild, Montana State University, verified identifications except for chironomids. Dan McGuire, Montana State University, identified chironomids. A new publication (McGuire 1981) was used in larval fish identification in addition to larval fish keys cited previously (Stewart 1980).

Some changes were made in the boat-mounted electrofishing gear in October 1981. A second gang of positive "dropper" electrodes was added. Only one had been used previously. Also, a pulse frequency of 20 pulses per second rather than 60-100 was used. These changes were suggested by Novotny and Priegal (1976) and seemed to increase sample size of sauger, and to a lesser extent, other species.

FINDINGS

Macroinvertebrates

Identification to genus, or in some cases to a higher taxon, of macroinvertebrate, is shown in Table 1. Results are somewhat tentative because more sampling is needed and drifting invertebrates collected in larval fish samples have not been identified yet. Chironomids were collected, but not identified, at the Highway 13 bridge and Nohly bridge station. Additional macroinvertebrate data will be included in a future report.

The station labeled "Scott's Ranch" in Table 1 was sampled only one time, in March 1981. This station was not sampled at later dates because no river gravel or rock is present in that area and very few organisms were found on the sand-silt substrate present. Sand-silt substrates were sampled at other stations, but very few macroinvertebrates were found. Rock-gravel substrates are present at the other stations in Table 1.

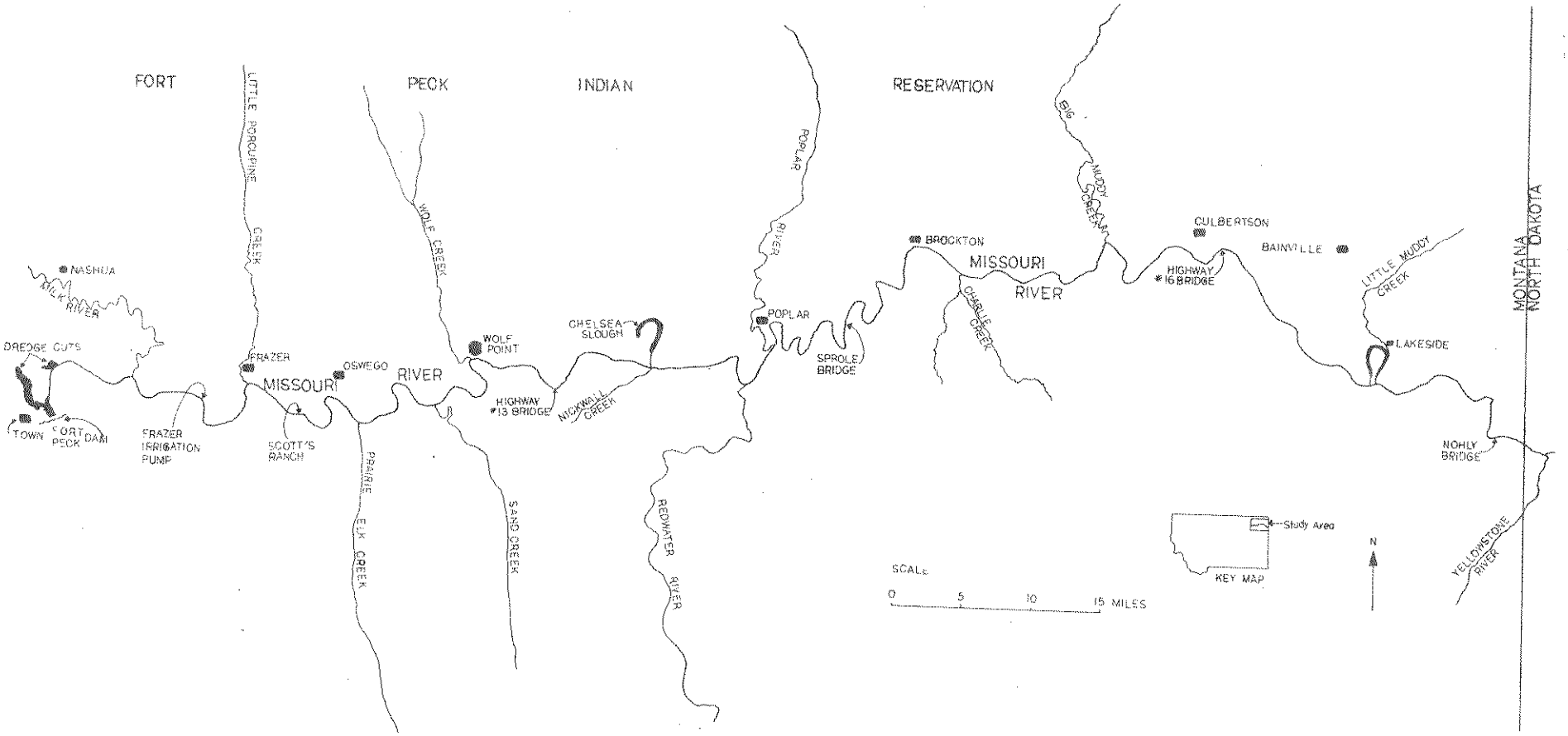

Figure 1. Map of lower Missouri River drainage in Montana.

Table 1. Preliminary results of aquatic macroinvertebrate sampling in the Missouri River from late March to late October 1981.

Taxa	Station					
	2 Mi. Below Ft Peck Dam	Near Little Porcupine Creek	Scott's Ranch	Highway #13 Bridge	Highway #16 Bridge	Nohly Bridge
Gordioidea	x					
Oligochaeta		x			x	
Amphipoda						
Gammarus	x	x				
Plecoptera						
Perlodidae						
Isoperla				x	x	x
Ephemeroptera						
Leptophlebiidae						
Traverella				x	x	x
Siphlonuridae						
Analetris				x	x	x
Isonychia						x
Ephemeridae						
Hexagenia						x
Caenidae						
Brachycercus					x	
Ephemerellidae						
Ephemerella	x	x	x	x	x	x
Heptageniidae						
Heptagenia					x	x
Baetidae						
Baetis	x	x		x	x	x
Polymetatarsidae						
Ephoron					x	x
Odonata						
Gomphidae						
Gomphus						x
Heteroptera						
Corixidae	x	x	x	x	x	x
Trichoptera						
Hydropsychidae						
Hydropsyche		x		x	x	x
Brachycentridae						
Brachycentrus	x	x		x	x	x
Polycentropodidae						x

Table 1 continued.

Taxa	Station: 2 Mi. Below Ft Peck Dam	Near Little Porcupine Creek	Scott's Ranch	Highway #13 Bridge	Highway #16 Bridge	Nohly Bridge
Diptera						
Chironomidae	x	x	x	x	x	x
Phaenopsectra	x	x				
Cricotopus	x	x	x		x	
Orthocladius	x					
Paraphaenocladius	x					
Monodiamesia		x	x		x	
Eukiefferiella			x		x	
Brillia			x			
Paracladopelma			x			
Diamesia	x	x			x	
Psectrocladius		x				
Potthastia		x				
Polypedilum		x				
Dicrotendipes		x				
Tanytarsus		x				
Simuliidae						
Simulium	x	x	x	x	x	
Muscidae						
Limnophora	x					
Empididae						x
Gastropoda						
Physidae						
Physa		x		x		

Effects on macroinvertebrate communities below dams with cold water discharges are described in Ward and Stanford (1979). These effects include reduced macrobenthic diversity, reduction or extirpation of Heptageniid mayflies, amphipod enhancement and reduction or elimination of stoneflies. All of these appear to be true in the Missouri River downstream from Fort Peck Dam. Fewer mayfly genera were collected at upstream stations. Heptageniid mayflies were found only at the lowermost two stations and stoneflies only at the lower three stations. Amphipods were collected only at the two stations nearest the dam.

Caddis fly larvae diversity also decreases in an upstream direction. Only one genus was sampled immediately below the dam, while at least three genera were collected at the Nohly bridge near the North Dakota border.

Fish Species Composition, Distribution and Relative Abundance

Three previously uncollected species were sampled in the study portion of the Missouri River in 1981. These are the sicklefin chub Hybopsis meeki (Cyprinidae); brook stickleback, Culaea inconstans (Gasterosteidae); and the smallmouth bass, Micropterus dolomieui (Centrarchidae). The smallmouth bass is common in the Poplar River, which is the likely souce of the single individual sampled in the Missouri River near the Highway #13 bridge in October 1981. One brook stickleback was collected in a backwater near the Highway 16 bridge in September 1981. Brown (1971) considered this species an obligate resident of small, clear streams. unable to tolerate high, sustained turbidity. This species is probably not a permanent Missouri River resident.

The sicklefin chub was first collected in April 1981 in the Missouri River near the mouth of Big Muddy Creek. A few more were found later in the year at downstream points. This fish had previously been collected in the Missouri River upstream of Fort Peck Reservoir (Berg 1981) and is well known from the Missouri River in North Dakota and downstream locations, so its presence in the study area was previously suspected. The sicklefin chub is a resident only of large, turbid rivers (Pfliegar 1975).

The remainder of the species present in the study area are listed in a previous report (Stewart 1981). A total of 37 species in 16 families has been collected or are otherwise known to occur.

The longitudinal distribution of fish species in the study area is shown in Table 2, with the exception of the pallid sturgeon which is known only from a few angler catches. The distribution of 10 species in Table 2 was enlarged by sampling in 1981.

Results of Fish Sampling Techniques

Electrofishing Surveys

A total of 1830 fish was sampled during 13 days of electrofishing for all species in 13 river sections from the lower dredge cut to the North Dakota border in August 1981. Results are shown in Tables 3 and 4. Electrofishing for nongame fish species had not been done previously. Nongame species had been sampled by gill nets and seines previously, but only in backwaters and channel margins. The electrofishing was done so that nongame species could be sampled in all habitat types and with gear less selective for certain species and fish sizes than gill nets and seines.

Game species comprised 10% of the total fish catch. This is similar to 1980 gill net samples in which game fish made up 14% of the total catch (Stewart 1981). In the electrofishing samples, goldeye made up approximately 40% of the total number of fish captured. The order of abundance after goldeye was carp, shorthead redhorse, river carpsucker, flathead chub, sauger. Carp were much less abundant in 1980 gill net samples. The order of abundance for other species in gill net samples varies also from electrofishing samples.

Table 2. Longitudinal distribution of fish species captured in the lower Missouri River in 1979, 1980 and 1981.

	Ft Peck Dr Cuts & Tailwaters	vic Milk River	Frazer Pump	Scott's Ranch	vic Sand Creek	Highway 13 Bridge	Chelsea	vic Poplar River	Sprole Bridge	Brockton	vic Big Muddy Cr	Highway 16 Bridge	Lakeside	Nohly Bridge
Shovelnose sturgeon	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Paddlefish	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Shortnose gar	x													
Goldeye	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Rainbow trout	x	x	x	x	x	x		x	x	x			x	x
Brown trout								x						
Lake trout	x													
Rainbow smelt	x	x		x	x	x	x	x		x	x	x	x	x
Northern pike	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Carp	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Flathead chub		x	x	x	x	x	x	x	x	x	x	x	x	x
Sicklefin chub											x		x	x
Lake chub	x	x		x	x	x					x		x	x
Emerald shiner	x	x	x	x	x	x		x	x	x	x	x	x	x
Silvery minnow	x													
Fathead minnow	x	x	x	x	x	x		x					x	x
River carpsucker	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Blue sucker	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Smallmouth buffalo	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Bigmouth buffalo	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Shorthead redhorse	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Longnose sucker	x	x	x	x	x	x	x	x	x	x	x	x	x	x
White sucker	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Black bullhead						x							x	
Channel catfish	x		x			x	x	x		x	x		x	x
Stonecat											x		x	x
Burbot	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Brook stickleback												x		
White bass	x													x
Smallmouth bass						x								
White crappie				x	x	x		x			x	x	x	x
Yellow perch	x	x	x	x		x		x		x	x	x	x	x
Sauger	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Walleye	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Iowa darter												x		
Freshwater drum		x	x	x	x	x			x	x	x	x	x	x

Table 3. Summary of fish sampled during all species electrofishing in the Missouri River, summer 1981.

Species	Number Captured	Average Length (inches)	Length Range (inches)	Average Weight (pounds)	Weight Range (pounds)
Shovelnose sturgeon	15	25.1	22.5-28.5	1.59	0.55- 2.84
Goldeye	705	10.5	6.4-14.6	0.37	0.07- 1.16
Rainbow trout	6	11.3	2.6-26.1	2.42	0.01- 7.10
Rainbow smelt	1	7.2	-	0.08	-
Northern pike	26	25.4	10.2-33.5	4.20	0.23- 9.3
Carp	383	19.4	14.3-26.3	3.58	1.28- 8.9
Flathead chub	115	6.2	3.3-10.2	0.08	0.01- 0.34
River carpsucker	122	15.6	2.2-21.3	1.96	0.01- 5.10
Blue sucker	68	25.2	22.3-28.8	5.02	3.40- 8.9
Smallmouth buffalo	46	20.5	15.3-24.5	4.41	2.01- 8.1
Bigmouth buffalo	19	22.4	16.5-27.6	7.22	2.40-14.1
Shorthead redhorse	142	10.7	4.3-18.1	0.69	0.03- 2.48
Longnose sucker	21	12.9	3.8-22.2	1.35	0.01- 5.28
White sucker	18	12.2	4.1-18.3	1.15	0.02- 2.80
Burbot	35	8.6	4.3-14.5	0.16	0.02- 0.65
Sauger	94	15.8	7.8-20.9	1.26	0.11- 3.02
Walleye	13	12.8	4.1-23.3	1.08	0.02- 4.42
Freshwater drum	1	18.7	-	2.90	-
Total	1830				

Electrofishing captured a wide range of sizes of most species. Although most aging has not yet been done, electrofishing failed to sample sizes that include YOY or yearlings only for shovelnose sturgeon, carp, blue sucker, smallmouth buffalo, bigmouth buffalo and drum. The larger sizes were well sampled.

Abundance of the various species along the length of the study area was quite even for some species, and very uneven for others (Table 4). Species with reasonably constant abundance were shovelnose sturgeon, goldeye, northern pike, carp, river carpsucker, shorthead redhorse and sauger. Flathead chub, burbot, sauger and walleye were more abundant in downstream areas. Both buffalo, blue sucker, longnose sucker and white sucker were more abundant in upstream areas.

Distribution of the blue sucker was especially uneven. A total of 68 was sampled in the study area; of these, 59 (87%) were sampled in 2 miles immediately downstream from the Milk River in the warm, turbid plume created by the Milk River water entering the colder, clearer Missouri River. This was not a spawning concentration, because sampling was done in August and none of the fish were in a ripe condition.

Table 4. Electrofishing catch rates (number of fish per hour) summary for all species electrofishing in the Missouri River in summer 1981.

Species	Nelson Dr Cut to Milk River	Milk River to Frazer Pump	Frazer Pump to Scott's Ranch	Scott's Ranch to Sand Creek	Sand Creek to Highway 13 Br	Highway 13 Br to Chelsea	Chelsea to Poplar River	Poplar River to Sprole Bridge	Sprole Bridge to Brockton	Brockton to Big Muddy Cr	Big Muddy Cr to Highway 16 Br	Highway 16 Br to Lakeside	Lakeside to ND Border	Average
Shovelnose sturgeon	0.5	0.8		0.3		0.3	2.8	0.5	0.3			0.2		0.4
Goldeye	2.1	26.8	3.1	10.8	7.3	20.3	19.8	12.2	30.1	17.0	20.8	30.0	19.3	16.9
Rainbow trout	2.6												0.3	0.2
Rainbow smelt							0.4							0.03
Northern pike	0.5		0.7	0.3	1.8	0.6	0.8	0.3	0.3	1.0	0.6	0.2	0.6	0.6
Carp	25.1	8.7	7.3	6.0	6.4	3.1	27.8	11.7	8.8	9.7	11.1	2.0	4.1	10.1
Flathead chub		0.8	0.2	0.3	2.1	0.3	2.4	3.0	10.2	3.7	6.5	2.0	2.3	2.6
River carpsucker	5.1	6.3	3.1	0.3	6.4	3.1	6.3	0.8	2.2	3.4	3.6	1.0	0.6	3.2
Blue sucker		46.5	0.2		0.6		0.4		0.3	0.5		0.2	0.3	3.8
Smallmouth buffalo	5.6	7.9	2.0	2.4	0.3	0.3		0.5	0.6	0.5				1.5
Bigmouth buffalo	0.5	0.8	0.7	0.9	0.6	0.9	0.8	0.3	0.3	0.3			0.3	0.5
Shorthead redhorse	1.5	6.3	0.7	2.7	5.8	1.7	6.7	8.1	5.8	3.1	2.6	1.0	0.6	3.6
Longnose sucker	1.5	7.9	0.9	0.9						0.3				0.9
White sucker	1.5	4.7	1.5		0.6									0.6
Burbot			0.2			0.3	0.4	0.5	0.6	1.3	2.3	2.9	1.2	0.7
Sauger	0.5	0.8	0.7	0.9	3.7	2.9	2.8	1.6	4.4	3.4	3.9	1.2	1.2	2.2
Walleye					0.6	0.9	1.6	0.3	0.3	0.3		0.2		0.3
Freshwater drum									0.3					0.02
Total	47.0	118.3	2.13	25.8	36.2	34.7	73.0	39.8	64.5	44.5	51.4	40.9	30.8	48.2

Electrofishing for game species only was done over the length of the study area from the Milk River to the North Dakota border, rather than using isolated sections. By this procedure, any concentration of fish would probably not be missed. Twelve electrofishing sections were used. These were the same sections shown in Table 4, except that the section from the lower dredge cut to the Milk River was not used. Each of these segments could be electrofished in approximately 1 day. Game fish species were sampled from each section at least three times in 1981, once each in the months of April, July and October. Only game fish (except paddlefish) were retained for tagging, weighing and measuring, but the presence of other species was noted.

Results of game fish electrofishing are shown in Tables 5 and 6. Of the total of 1,619 game fish sampled, sauger made up 68%, walleye 5%, burbot 14%, shovelnose sturgeon 4% and northern pike 7%. Other game species made up less than 2 percent and included rainbow trout, channel catfish and smallmouth bass. These percentages are similar to those of 1980 (Stewart 1981) except relatively more burbot and fewer shovelnose sturgeon were sampled in 1981.

The abundance of sauger, as indicated by electrofishing catches, changed greatly through the year (Tables 5 and 6). An average of 3.8 sauger per day was sampled in April, 20.0 in July and 50.6 in October-November. A part of the fall increase may have been caused by changes in electrodes and gear operation (Procedures section), but electrodes and electrofishing gear operation were identical in April and July. Data suggest that few sauger winter in the Missouri River study area.

Total numbers of game fish decreased in the lowermost two sections as compared to upstream points in 1981 (Table 6). This was not observed in 1980. Numbers of game fish were also lower in the first section downstream from the Milk River.

Catch rates for burbot were much higher in 1981 than in 1980. The average number of burbot sampled per electrofishing day was 6.4 in 1981 and 1.0 in 1980. Both 1980 and 1981 data indicate burbot are more abundant at downstream locations.

Fish were also sampled by electrofishing in the lowermost 2 miles of tributary streams (Table 7). Spring streamflows were extremely low in tributary streams in 1981. The Poplar River and Big Muddy Creek were sampled only in April. Very low numbers of game species were found. Significant numbers of sauger were found in the Milk River, but numbers were much lower than in 1980, despite similar streamflows in the 2 years.

Gill Netting Surveys

Only limited gill netting was done in 1981. Ten overnight sets were made in the Fort Peck Dam tailwaters and dredge cuts and two in the Milk River near its mouth. Results are in Tables 8 and 9. Sets in the tailwaters-dredge cuts were made to continue monitoring the fish populations supporting an important angler fishery in that area. Milk River sets were made for purposes of comparison to the previous year and to check the results of 1981 electrofishing.

Table 5. Number and size of game fish captured by electrofishing in the Missouri River from the Milk River to North Dakota in 1981.[a]

Species	Number Captured	Average length (inches)	Length range (Inches)	Average weight (pounds)	Weight range (pounds)
		April - 12 days electrofishing			
Sauger	46	14.3	6.9-20.5	1.07	0.07- 2.97
Walleye	14	19.6	8.1-24.5	3.24	0.12- 6.10
Northern Pike	35	25.0	14.3-34.8	4.17	0.66-12.8
Burbot	65	18.2	4.5-35.6	2.10	0.10-10.4
Shovelnose sturgeon	21	25.5	21.2-28.9	1.88	1.02- 2.88
Rainbow trout	1	8.2	-	.27	-
Rainbow smelt	25	6.6	5.8- 7.3	.06	0.04- 0.08
		July - 12 days electrofishing			
Sauger	240	15.7	7.1-24.5	1.27	0.07- 5.27
Walleye	19	16.1	6.9-29.0	2.22	0.08-10.2
Northern pike	20	27.0	20.0-33.8	5.02	1.74-10.1
Burbot	69	10.0	3.3-27.9	0.34	0.01- 3.62
Shovelnose sturgeon	29	25.1	19.5-29.5	1.76	0.46- 3.41
		October-November - 16 days electrofishing			
Sauger	809	16.3	3.3-24.8	1.39	0.01- 6.70
Walleye	55	16.1	4.9-24.1	1.90	0.02- 6.10
Northern pike	58	26.5	9.9-36.5	5.04	0.18-13.2
Burbot	89	14.0	7.2-40.5	1.19	0.07-12.6
Shovelnose sturgeon	18	25.9	22.5-29.0	2.02	1.34- 3.12
Rainbow trout	3	4.6	3.3- 5.5	0.04	0.01- 0.06
Channel catfish	2	14.3	12.0-16.0	0.89	0.58- 1.20
Smallmouth bass	1	8.1	-	0.33	-

a - Paddlefish and rainbow trout spawners not shown because separate runs were made for these species.

Table 6. Electrofishing catch rate (number of fish per day) summary for game fish species in the Missouri River, 1981.

Season	River Section: Milk River to Frazer Pump	Frazer Pump to Scott's Ranch	Scott's Ranch to Sand Creek	Sand Creek to Highway 13 Bridge	Highway 13 Bridge to Chelsea	Chelsea to Poplar River	Poplar River to Sprole Bridge	Sprole Bridge to Brockton	Brockton to Big Muddy Creek	Big Muddy Creek to Highway 16 Bridge	Highway 16 Bridge to Lakeside	Lakeside to ND Border	Season Totals
Sauger													
Spring	1	6	6	3	1	6	3	3	5	6	5	1	46
Summer	1	5	23	22[a]	21	19	17	19	39[a]	39[a]	26	18	240
Fall	18	41	45[a]	40[a]	49	52	34	86	86[a]	70[a]	34	16	571
Location totals	20	52	74	65	71	77	54	108	130	106	65	35	857
Walleye													
Spring	2	2	1	0	1	0	0	1	3	1	3	0	14
Summer	0	1	2	1[a]	2	4	0	2	1[a]	1[a]	2	3	19
Fall	1	2	2[a]	2[a]	4	3	4	6	7[a]	7[a]	0	2	40
Location totals	3	5	5	3	7	7	4	9	11	9	5	5	73
Northern Pike													
Spring	0	0	4	0	5	7	5	3	2	6	2	1	35
Summer	0	1	2	3[a]	6	1	0	1	2[a]	0[a]	1	3	20
Fall	0	5	2[a]	3[a]	11	10	5	0	3[a]	3[a]	2	2	46
Location totals	0	6	8	6	22	18	10	4	7	9	5	6	101
Burbot													
Spring	0	0	5	5	9	9	9	0	9	4	11	4	65
Summer	0	2	2	2[a]	7	3	2	4	16[a]	15[a]	9	7	69
Fall	1	5	7[a]	2[a]	4	6	5	4	8[a]	15[a]	2	1	60
Location totals	1	7	14	9	20	18	16	8	33	34	22	12	194

Table 6 continued.

Season	River Section: Milk River to Frazer Pump	Frazer Pump to Scott's Ranch	Scott's Ranch to Sand Creek	Sand Creek to Highway 13 Bridge	Highway 13 Bridge to Chelsea	Chelsea to Poplar River	Poplar River to Sprole Bridge	Sprole Bridge to Brockton	Brockton to Big Muddy Creek	Big Muddy Creek to Highway 16 Bridge	Highway 16 Bridge to Lakeside	Lakeside to ND Border	Season Totals
Shovelnose sturgeon													
Spring	1	1	4	1	1	4	3	1	0	5	0	0	21
Summer	0	2	4[a]	9[a]	3	4	2	2	0[a]	0[a]	1	0	27
Fall	2	4	3[a]	1[a]	1	1	1	0	1[a]	0[a]	0	0	14
Location totals	3	7	11	11	5	9	6	3	1	5	1	0	62
Totals of above species													
Spring	4	9	20	9	17	26	20	8	19	22	21	6	181
Summer	1	11	33[a]	37[a]	39	31	21	28	58[a]	46[a]	39	31	375
Fall	22	57	59[a]	48[a]	69	72	49	96	105[a]	95[a]	38	21	731
Location totals	27	77	112	94	125	129	90	132	182	163	98	58	1287

a - Average of 2 days of electrofishing

Table 7. Number and size of game fish captured by electrofishing near the mouths of Missouri River tributary streams in 1981.

Species	Number captured	Average length (inches)	Length range (inches)	Average weight (pounds)	Weight range (pounds)
		Milk River - 4 days electrofishing			
Sauger	95	14.6	9.1-21.9	0.92	0.18-3.25
Walleye	8	13.4	8.9-21.0	0.92	0.20-3.03
Northern pike	10	26.4	24.8-29.7	4.29	3.06-6.50
		Poplar River - 1 day electrofishing			
Northern pike	1	23.2	-	3.00	-
		Big Muddy Creek - 1 day electrofishing			
Northern pike	12	24.6	22.1-28.6	3.52	2.40-5.45
Burbot	3	14.1	11.4-17.5	0.61	.30-1.14

Table 8. Number, size and percentage composition of fish sampled in 10 overnight experimental gill net sets in the Fort Peck Dam tailwaters and dredge cuts in August 1981.

Species	Number captured & % of total	Average length (inches)	Length range (inches)	Average weight (pounds)	Weight range (pounds)
Shovelnose sturgeon	83(21.6)	26.1	19.2-31.8	2.25	0.67-4.39
Goldeye	190(49.4)	12.1	9.4-14.2	0.51	0.22-0.80
Rainbow smelt	4(1.0)	7.1	6.9-7.6	0.08	0.08-0.10
Carp	10(2.6)	18.7	14.4-23.9	3.04	1.34-5.26
River carpsucker	12(3.1)	15.2	14.2-17.2	1.72	1.22-3.06
Blue sucker	2(0.5)	24.1	23.1-25.2	4.05	3.14-4.96
Smallmouth buffalo	1(0.3)	24.3	-	6.25	-
Shorthead redhorse	2(0.5)	16.4	16.3-16.5	1.98	1.87-2.08
Longnose sucker	4(1.0)	15.1	9.2-17.3	1.67	0.37-2.16
White sucker	18(4.7)	12.5	7.5-17.4	1.04	0.14-2.65
Channel catfish	4(1.0)	17.3	12.4-19.7	1.86	0.58-2.50
Sauger	47(12.2)	15.0	11.3-19.3	0.93	0.35-1.82
Walleye	8(2.1)	17.7	14.1-22.8	1.94	1.08-3.70
Total	385				

Table 9. Number, size and percentage composition of fish sampled in two overnight experimental gill net sets in the Milk River near its mouth in August 1981.

Species	Number captured & % of total	Average length (inches)	Length range (inches)	Average weight (pounds)	Weight range (pounds)
Shovelnose sturgeon	3(1.5)	28.2	2.22-3.17	2.84	1.50-3.80
Goldeye	156(78.0)	11.9	9.1-14.3	0.51	0.21-9.5
Northern pike	6(3.0)	30.1	27.5-32.8	7.17	5.04-10.70
Carp	2(1.0)	16.1	15.7-16.5	1.84	1.79-1.90
River carpsucker	8(4.0)	15.7	14.9-17.8	1.89	1.36-3.18
Smallmouth buffalo	1(0.5)	26.4	-	8.80	-
Shorthead redhorse	8(4.0)	15.0	6.4-17.7	1.50	0.09-2.20
Channel catfish	1(0.5)	18.0	-	1.61	-
Sauger	15(7.5)	14.7	11.0-19.8	0.95	0.37-2.17
Total	200				

Results of netting were similar to 1980 for both areas, with the exception of sauger in the mouth of the Milk River. Sauger at this location made up 13.5% of the catch in 1980 and only 7.5% in 1981. These results are discussed more fully later in the report under the headings of individual species.

Seining Surveys

Backwater and channel margin seining was done in late August and early September at six locations distributed over the length of the study area to find any previously uncollected species and to determine reproductive success by sampling YOY of various species which are not generally collected using other sampling methods. Results are given in Table 10. Adults of larger species were often captured in seines, but data for these species are not shown as it would add little to data developed by other sampling techniques.

New species collected by seining in 1981 were the sicklefin chub and the brook stickleback. The known ranges in the study area of the following species were expanded: lake chub, fathead minnow, white crappie, yellow perch and freshwater drum. YOY of 14 species were sampled. YOY sampled for the first time by seining were carp, smallmouth buffalo, bigmouth buffalo, walleye and goldeye. Distribution of YOY within the study area will be discussed in a later report after aging has been done for most species.

Larval Fish Sampling

Larval fish were sampled at 13 Missouri River stations and at stations on three of the tributary streams (Table 11) in 1981. This sampling was done to determine spawning locations and spawning times for the various fish species. Sampling was done from mid-May to early August to cover the larval period of development for most species, including late spawners such as channel catfish. Results are in Tables 11 and 12.

A total of at least 12 species was collected in larval fish samples. The actual number of species may have been greater. The exact number of species sampled could not be determined because some larvae could be identified only to genus or family.

Few larvae were caught in May. Sixty-five yellow perch larvae in the Poplar River were the only larval fish sampled in May. The largest numbers of larval fish were sampled in June, with numbers peaking in mid-June on tributary streams and late June for the Missouri River (Table 12). Catostomids were numerically dominant in samples and percids second.

Although only 19% of the sampling effort was in tributary streams, 60% of the larval fish were captured in tributaries, suggesting that density of larval fish was six times greater in tributary streams. A greater tributary-Missouri River difference was found in previous years (Stewart 1981).

Table 10. Young-of-the-year and small forage fish species captured in backwater and channel margin seine hauls in the Missouri River during late August and early September 1981.

Location	Species	Number Captured	Average Length (inches)	Length Range (inches)
Near Milk River (6[a])	Carp	17	2.0	1.2-2.8
	Flathead chub	2	3.8	3.8-3.8
	Lake chub	2	2.3	2.1-2.5
	Fathead minnow	7	1.9	1.7-2.0
	Longnose sucker	27	2.0	1.7-2.3
	White sucker	78	1.8	1.0-2.7
	Yellow perch	1	2.1	-
	Total	134		
Near Scott's Ranch (2)	Carp	43	2.1	1.5-3.8
	Lake chub	53	2.3	2.0-2.7
	Emerald shiner	1	3.2	-
	Fathead minnow	41	1.6	1.4-1.7
	River carpsucker	106	1.8	1.5-2.6
	Smallmouth buffalo	81	1.5	1.2-2.2
	Bigmouth buffalo	90	1.5	1.3-2.0
	Shorthead redhorse	1	2.7	-
	Longnose sucker	29	1.8	1.6-1.9
	White sucker	216	1.3	1.1-5.3
	White crappie	63	1.9	1.7-2.4
	Yellow perch	25	2.9	2.1-6.7
	Total	749		
Near Wolf Creek (6)	Flathead chub	13	4.2	3.7-4.9
	Lake chub	5	2.1	2.0-2.3
	Fathead minnow	19	1.6	1.2-2.1
	River carpsucker	2	3.4	3.0-3.7
	Smallmouth buffalo	1	1.5	-
	Shorthead redhorse	1	3.9	-
	Longnose sucker	9	2.4	2.0-2.8
	White sucker	97	2.0	1.0-3.2
	White crappie	8	1.8	1.5-2.3
	Sauger	2	4.0	3.5-4.6
	Walleye	5	4.2	3.6-5.2
	Freshwater drum	38	2.2	1.7-3.0
	Total	200		

Table 10 continued.

Location	Species	Number captured	Average length (inches)	Length range (inches)
Near Brockton (5)	Carp	1	1.6	-
	Flathead chub	5	4.5	3.8-6.9
	Fathead minnow	2	1.2	1.0-1.4
	River carpsucker	2	2.7	1.9-3.5
	Shorthead redhorse	1	2.0	-
	Longnose sucker	11	2.2	1.8-2.6
	White sucker	22	2.3	1.8-3.5
	White crappie	17	2.7	1.8-3.3
	Yellow perch	2	3.9	2.9-4.6
	Sauger	4	3.8	2.7-5.0
	Walleye	1	5.8	-
	Freshwater drum	2	2.2	1.8-2.6
	Total	70		
Near Highway 16 Bridge (6)	Goldeye	1	2.0	-
	Northern pike	1	12.5	-
	Carp	5	1.9	1.7-2.3
	Flathead chub	1	4.1	-
	Fathead minnow	1	1.8	-
	River carpsucker	2	2.4	2.0-2.8
	Shorthead redhorse	1	5.4	-
	Longnose sucker	1	2.0	-
	White sucker	9	2.3	1.6-2.7
	Brook stickleback	1	2.1	-
	White crappie	12	3.4	2.7-5.7
	Sauger	1	5.5	-
	Freshwater drum	1	2.5	-
	Total	37		
Above Nohly Bridge (7)	Goldeye	7	3.7	2.1-4.3
	Sicklefin chub	3	2.8	2.7-2.9
	Flathead chub	23	3.7	2.1-6.2
	Emerald shiner	5	3.3	2.3-4.2
	Fathead minnow	1	2.6	-
	River carpsucker	12	2.9	2.2-3.2
	Longnose sucker	1	3.0	-
	White sucker	2	2.5	1.9-3.2
	White crappie	8	2.9	2.2-5.4
	Yellow perch	4	3.5	3.0-4.7
	Sauger	10	3.4	2.9-5.1
	Freshwater drum	3	2.0	1.6-2.6
	Total	79		

Table 11. Larval fish sampled with towed nets in the Missouri River and mouths of tributary streams from 5/18 to 8/4/81.

	No. of samples	*Stizostedion* sp.	Carp	River carpsucker	Blue sucker	*Ictiobus* sp.	Shorthead redhorse	White sucker	Yellow perch	Freshwater drum	Unknown Catostomidae	Other
Above Milk R	6							9				
Milk R	6		8	2	2	23		3		8	50	1[a]
Below Milk R	6		2		1	4		71		1	5	
Frazer pump	6		3					3				
Near Wolf Cr	6	No larval fish captured										
Highway 13 Bridge	6		2					1				
Above Poplar R	6										2	
Poplar R	6		2				1		66			
Below Poplar R	6	3			1	1		1				
Sprole Bridge	6				1							
Brockton	5	2	1	1								1[b]
Above Big Muddy Cr	6	2				1					2	
Big Muddy Cr	6	2	1	1			1	4	26		1	1[c]
Below Big Muddy Cr	6	4										
Highway 16 Bridge	6	No larval fish captured										
Nohly Bridge	5	8	1							1		
Totals		21	20	4	5	29	2	92	92	10	60	3

a - Goldeye
b - Unknown Cyprinidae
c - *Lepomis* sp./*Pomomis* sp.

Table 12. Larval fish captured by sampling periods in the Missouri River and mouths of tributary streams, 1981

	5/18,19	6/3,4	6/11,12	6/22,23	7/6,7	8/3,4
			Missouri River			
Stizostedion sp.		4	10	5		
Carp		2	5	2		
River carpsucker			1		1	
Blue sucker		1		2		
Ictiobus sp.		3	1			2
Shorthead redhorse						
White sucker			2	81	1	
Yellow perch						
Freshwater drum		2				
Unknown Catostomidae				5	3	
Totals	0	12	19	95	5	2
			Mouths of Tributary Streams			
Stizostedion sp.			1	1		
Carp		5	3	2	1	
River carpsucker				1		
Blue sucker			2			
Ictiobus sp.		11		12		
Shorthead redhorse					1	1
White sucker				2	1	4
Yellow perch	65	1	26			
Freshwater drum		2	5		1	
Unknown Catostomidae			50		1	
Goldeye				1		
Totals	65	19	87	19	5	5

Larval fish were present in samples for the first time in 1981 in the Missouri River upstream of the Milk River. On June 22, 1981, nine larval white suckers were sampled at this location. Larval fish concentrations on the Missouri River were greatest at the station just downstream of the Milk River in the plume of warm, turbid water in the Missouri River originating from the Milk River. Eighty-four of 133 larval fish (63%) captured from the Missouri River were collected at this one station. Some of the larval fish sampled here may have originated in the Milk River where larval densities were also high (Table 12).

Fish Species Data and Discussion

Paddlefish

The general status of the paddlefish in the study area and its relationship to the Yellowstone River and Garrison Reservoir were discussed previously (Stewart 1981). Paddlefish work in 1981 consisted of determination of migration timing, counting of paddlefish over the length of the study area to find concentrations and areas of the river used, and capture for tagging and size measurement. Counts made for the periods 5/4-5/14, 5/22-6/2, 6/8-6/17, 6/18, 19 and 7/8-7/10 were made during electrofishing runs specifically for counting paddlefish. Other counts shown in Table 13 were made incidental to electrofishing for other species. Counts not made specifically for paddlefish may have been somewhat lower because more electrofishing was done in relatively shallow locations not generally frequented by Missouri River paddlefish.

Results of paddlefish counts are given in Table 13. Because the electrical field used to count paddlefish covered only a small portion of the river's width, counts are only a sample of numbers present and not a complete enumeration. Relatively few paddlefish were present in the study area in April when water temperatures were mostly below 50 F. By early May, numbers had risen sharply except for areas upstream of Prairie Elk Creek (river mile 135.5) where still relatively few paddlefish were present. In late May and early June, the migration had reached the vicinity of the Milk River. At this same time, the downstream half of the study area had cleared of paddlefish. Almost no paddlefish were present downstream of river mile 90 (near the Poplar River mouth) (Table 13).

Once the migration had passed upstream out of the lower river, concentrations of paddlefish did not reform in this area. It appears that paddlefish did not remain in areas downstream of the Poplar River, but simply used this area for passage to upstream locations.

In mid-June, numbers of paddlefish continued to increase from approximately the Scott's Ranch area to the Milk River. There was also an increase in the Wolf Creek area, but numbers were low from Chelsea downstream. After the middle of June, paddlefish numbers decreased in all parts of the study area and by the second week of July, relatively few paddlefish remained in the study area. Numbers continued on a downward trend through the summer. Only two paddlefish were observed during the August count (Table 13) and none in October.

Table 13. Number of paddlefish counted during electrofishing on the Missouri River in 1981.

River mile[b]	Electrofishing Count Dates									Average No. per Count
	4/10-4/31	5/14-5/14	5/22-6/2	6/8-6/17	6/18-6/19	7/8-7/10	7/13-7/30	8/5-8/25	10/5-11/6	
174.9-170.0	0	1	2	23	7	0	1	0	0	3.8
169.9-165.0	0	4	11	27	20	0	1	0	0	7.0
164.9-160.0	0	0	3	18	18	0	2	0	0	4.5
159.9-155.0	0	1	0	5	1	3	4	0	0	1.6
154.9-150.0	0	10	7	12	9	0	4	0	0	4.7
149.9-145.0	1	4	3	5	2	2	0	0	0	1.9
144.9-140.0	0	0	1	0	0	0	0	0	0	0.1
139.9-135.0	0	1	5	5	1	8	2	0	0	2.4
134.9-130.0	0	3	1	1	1	2	1	0	0	1.0
129.9-125.0	0	3	4	10	4	3	5	0	0	3.2
124.9-120.0	3	23	7	16	14	7	5	0	0	8.3
119.9-115.0	2	16	18	6	6	2	1	0	0	5.7
114.9-110.0	0	8	10	11	a	4	9	0	0	5.2
109.9-105.0	1	18	14	12	a	6	13	0	0	8.0
104.9-100.0	13	12	11	9	a	3	6	1	0	6.9
99.9- 95.0	2	16	16	1	a	2	1	0	0	4.8
94.9- 90.0	3	26	2	0	a	a	0	0	0	4.4
89.9- 85.0	6	14	0	2	a	a	0	0	0	3.1
84.9- 80.0	3	20	1	2	a	a	0	0	0	3.7
79.9- 75.0	2	9	0	0	a	a	3	0	0	2.0
74.9- 70.0	0	3	1	0	a	a	0	0	0	0.6
69.9- 65.0	2	3	0	a	a	a	0	0	0	0.8
64.9- 60.0	0	3	0	a	a	a	0	0	0	0.5
59.9- 55.0	1	6	0	a	a	a	0	0	0	1.2
54.9- 50.0	0	3	0	a	a	a	0	0	0	0.5
49.9- 45.0	0	14	0	a	a	a	1	0	0	2.5
44.9- 40.0	1	3	0	a	a	a	0	0	0	0.7
39.9- 35.0	0	11	0	a	a	a	0	0	0	1.8
34.9- 30.0	0	8	0	a	a	a	0	0	0	1.3
29.9- 25.0	0	9	1	a	a	a	0	0	0	1.7
24.9- 20.0	1	4	0	a	a	a	0	0	0	0.8
19.9- 15.0	1	9	0	a	a	a	0	0	0	1.7
14.9- 10.0	0	12	0	a	a	a	0	0	0	2.0
9.9- 5.0	0	11	0	a	a	a	0	0	0	1.8
4.9- 0.0	2	5	0	a	a	a	0	1	0	1.3
Totals	44	293	118	165	83	42	59	2	0	

a - No counts made - numbers of paddlefish present assumed to be low.
b - River miles measured from North Dakota border (mile 0.0) to Milk River (mile 174.9).

A similar seasonal migration pattern was noted in 1980, except that no paddlefish concentration developed in the area downstream of the Milk River in 1980 as occurred in 1981. The maximum flow in the Milk River near the mouth in May and June 1980 was 92 cfs and much of the time streamflow was in the 20-50 cfs range (USGS 1980). These flows were insufficient to produce a warm, turbid plume on the north side of the Missouri River downstream of the Milk River. Milk River flows in June 1981 were considerably larger, although exact numbers have not yet been reported by the US Geological Survey, and significant numbers of paddlefish were present in the warm, turbid plume downstream of the Milk River in June 1981 (Table 13).

Paddlefish did not enter tributary streams in any significant numbers in 1981. Only one paddlefish was noted in the Milk River. This occurred in early June a few hundred yards upstream from the mouth.

The unequal distribution of paddlefish and areas of concentration are difficult to understand, although they do not result from random movements because areas avoided and areas of concentration coincided to a considerable extent in both 1980 and 1981. For example, the areas near Wolf Creek (river mile 121.7) and Chelsea (river mile 104.6) were areas of concentrations in both years, and only a single paddlefish was counted in 2 years from river mile 140 to 144.9 (between Scott's Ranch and Prairie Elk Creek). The concentrations do not result from physical barriers such as the one described by Rehwinkel (1978), nor are they related to spawning. One hundred thirty-three paddlefish were examined over the period 1979-81, most of them during the normal May-June spawning season, but no ripe males or females were observed. Very little of the clean gravel required for successful paddlefish spawning is present in the lower portion of the study area and in the upper 40 river miles of the study area where clean gravel bars are common, water temperatures usually do not exceed 56-58 F in late spring and early summer when paddlefish would normally spawn.

One tagged paddlefish was caught by an angler in 1981. The fish was tagged in the Missouri River near Wolf Creek in June 1980, and was caught in North Dakota near the confluence of the Missouri and Yellowstone rivers in May 1981, over 100 river miles downstream. No paddlefish were recaptured by field sampling techniques in 1981.

The weight distribution of 130 paddlefish, sampled largely by electrofishing, is given in Table 14. The bimodal distribution is due to females being considerably larger than males (Rehwinkel 1978) and indicates males are more abundant in the sample than females. The modal male weight was 20-24 pounds and the modal female weight 55-59 pounds.

Average size and range in size for paddlefish captured in 3 years are shown in Table 15. Averages and ranges are constant from year to year, suggesting a stable population. Sizes are very similar to those reported by Rehwinkel (1978).

Table 14. Weight distribution of 130 paddlefish sampled from the Missouri River in 1979, 1980 and 1981.

Weight Class (Pounds)	>20	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74
Number of Fish	7	36	24	13	7	5	5	6	12	10	5	1

Table 15. Length and weight of paddlefish sampled from the Missouri River in 1979, 1980 and 1981.

Year	Number sampled	Mean length (inches)	Length range (inches)	Mean weight (pounds)	Weight range (pounds)
1979	43	57.0	50-69	35.5	16-63
1980	28	57.8	51-69	35.1	19-65
1981	60	56.8	44-67	36.4	15-70

Sauger

The sauger appears to be the most abundant game fish species in the study area. In electrofishing samples, it usually makes up 65-85% of all game fish. Several nongame species are probably more abundant, including goldeye, carp, flathead chub, river carpsucker and shorthead redhorse (Tables 3 and 4). In 1981, 1,150 sauger were sampled by electrofishing and tagged for movement studies in the Missouri River and an additional 95 in the Milk River.

Very little sampling for adult sauger was done during the spawning period in 1981, but dates on which larval sauger were captured (Table 12) indicate spawning occurred from approximately mid-May through the first few days of June. Water temperatures in the lower half of the study area during this period, as determined by measurement at random times, were in the 50-60 F range.

A total of 21 larval Stizostedion was sampled between June 3 and June 23, 1981 (Table 12). Because sauger are much more abundant than walleye, it is believed that most, if not all, Stizostedion sampled were sauger.

Two were collected in the mouth of Big Muddy Creek and the remainder in the Missouri River between the Poplar River and the North Dakota border (Table 11). This suggests that little, if any, sauger spawning took place upstream of the Poplar River. Streamflows in Big Muddy Creek were extremely low in late May and early June, with only a trickle of water over gravel riffles, suggesting that the two Stizostedion sampled in the mouth of Big Muddy Creek may have originated in the Missouri River.

Sauger YOY were sampled in backwaters and channel margin areas in late August and early September 1981 (Table 10). If there were any doubt from external examination, sauger YOY were easily distinguished from walleye by pyloric caeca number and size. Seventeen YOY were captured in 32 seine hauls. None was sampled upstream of Wolf Creek, indicating only the lower two-thirds of the study area was used by sauger YOY. An additional 6 sauger YOY were captured by electrofishing in fall 1981. All of these were downstream of Wolf Creek, and four of the six were near Big Muddy Creek, corroborating the distribution observed by seining.

An average of 0.76 and 0.71 sauger YOY per seine haul was sampled in 1980 and 1981, respectively, in the Missouri River between Wolf Creek and the North Dakota border. These capture rates are similar to an average of 0.50 sauger YOY per seine haul reported by Gardner and Berg (1980) for the Missouri River upstream of Fort Peck Reservoir.

Seasonal abundance and distribution of sauger in the study area are shown in Table 6. Very few sauger were present in any part of the Missouri River from the Milk River to North Dakota in April 1981. Numbers increased by summer and increased even further by fall. A part of the apparent increase in the fall may be accounted for by changes in the electrofishing apparatus, but it is felt that most of the fall increase was due to larger numbers of sauger present in the river, because a similar seasonal increase is not nearly as evident for the other species listed in Table 6. The ratio of catch rates for sauger in spring:summer:fall were 1:5.2:12.4. Movement into the study area by sauger from Garrison Reservoir and the Missouri River in North Dakota may have caused the observed seasonal increase in electrofishing catch rates.

Abundance of sauger within the study area was similar in the upstream and downstream halves of the study area in April (Table 6). By summer, numbers were lowest from the Milk River to Scott's Ranch. In fall, average catch rates were not greatly different between upstream and downstream halves of the study area.

Contact with anglers in 1980 and 1981 indicates the presence of much larger numbers of sauger in the Ft. Peck Dam dredge cuts and tailwaters than in recent previous years. Gill netting statistics strongly support that conclusion. In dredge cut-tailwaters gill net sets in 1979, the average sauger catch was 0.6 sauger per net. Corresponding numbers in 1980 and 1981 were 6.8 and 4.7. Similarly, in 1979 sauger made up only 1.7% of all fish caught in experimental gill nets, while corresponding percentages for 1980 and 1981 were 13.5 and 12.2. These differences

might be at least partially caused by rainbow smelt, an important forage species. This fish moved from Garrison Reservoir in spring 1980 into the Missouri River upstream. Smelt have been present in the dredge cuts-tailwaters since that time.

Average sizes of Missouri River sauger have increased greatly since 1979 (Table 16). In 1979, average lengths and weights decreased somewhat from spring to fall, but in 1980 and 1981 average sauger size increased through the seasons. Average sauger lengths were 12.5 inches in 1979, 12.9 inches in 1980, and 16.1 inches in 1981. The corresponding average weights were 0.58, 0.82 and 1.35 pounds. It has not been determined if these size increases are due to a shift in the age structure toward older sauger, or to increased growth rates, or both. Again, the rainbow smelt is suspected as a cause of increased sauger sizes. Scales were collected from sauger in fall 1981 to examine changes in age structure and growth rates. Results will be given in a future report.

Table 16. Average length and weight of sauger sampled by electrofishing in three seasons of 1979, 1980 and 1980 in the Missouri River.

	Length			Weight		
	Spring	Summer	Fall	Spring	Summer	Fall
1979	13.2(250)[a]	12.5(146)	11.7(220)	0.65(250)	0.57(146)	0.50(220)
1980	11.1 (59)	12.1(221)	14.8(158)	0.50 (59)	0.64(221)	1.18(158)
1981	14.3 (46)	15.7(240)	16.3(809)	1.07 (46)	1.27(240)	1.39(809)

[a] sample size in parentheses.

Sauger were sampled in the lower parts of tributary streams in spring 1981, and also during the summer in the Milk River (Table 7). Significant numbers of sauger were found only in the Milk River from the mouth to a point approximately 2 miles upstream. None were found here in April, and the first sauger were sampled in mid-May. By September, sauger appeared to be absent from this area of the Milk River. Numbers captured were considerably lower than in 1980.

Sauger in the study area are highly migratory, although data to date suggest that most sauger migrations are related to activities other than spawning. The following information is based on combined angler and field sampling tag returns from 1,150 sauger tagged in 1981, with tag returns occurring over the period of April 1981 to January 1982:

A. There was a total of 33 sauger tag returns from fish at large one month or more.

B. Nine fish were at large 1 month or more and moved less than 10 river miles (considered to be non-movement).

C. Twenty-two sauger moved more than 10 miles in an upstream direction or moved from the Milk River to the dredge cuts-tailwaters area.

D. Two sauger moved more than 10 miles in a downstream direction.

E. Five sauger moved from the lowermost 2 miles of the Milk River upstream to the dredge cuts-tailwaters area.

F. Thirteen sauger moved upstream from some point in the Missouri River to the dredge cuts-tailwaters area.

G. Four sauger moved more than 10 miles upstream in the Missouri River, but not as far upstream as the dredge cuts-tailwaters area.

All of the sauger that moved from downstream locations in the Missouri River to the dredge cuts-tailwaters in 1981 were tagged in fall, although sauger were also tagged in spring and summer. The preceding indicates a strong fall movement of sauger from downstream areas to the area immediately below Fort Peck Dam.

More complete data on sauger movement for a 3-year period are shown in Table 17. A combined total of 209 sauger tag returns from anglers and field sampling was recorded from 1979 to 1981. A majority, 103 of 179 (60%) of sauger at large more than 1 month, moved 10 or more miles from the tagging location. Upstream movement exceeded downstream movement by a ratio of 4.7:1. Each year the percentage of sauger tag returns from the dredge cuts-tailwaters area increased. In 1981, 52% of tag returns from fish moving 10 miles or more, were from the dredge cuts-tailwaters area. No sauger have been tagged in this area, so all tag returns from the dredge cuts-tailwaters area represent upstream movement. Over half (58%) of fish caught by anglers in the dredge cuts-tailwaters area were tagged in the lowermost 2 miles of the Milk River. Sixteen percent of sauger that moved 10 miles or more (16 of 103 sauger) moved between the Missouri and Yellowstone rivers. Most of this movement was from the Yellowstone River to the Missouri River, and were fish recaptured in the Milk River mouth or dredge cuts-tailwaters area.

The preceding information suggests a single, highly mobile population of sauger in the Missouri and Yellowstone rivers, which probably inhabits the upper portion of Garrison reservoir in North Dakota with the principal migration route being up the Missouri River. The mouth of the Milk River is an important "stopping off" point before reaching the farthest upstream point below Fort Peck Dam. Fall is the season with the heaviest movement. The result is concentrations of sauger in the dredge cuts-tailwaters area. No sauger have been tagged in Garrison Reservoir or the Missouri River in North Dakota. Tagged fish in these locations would help to complete the understanding of the migration.

Table 17. Sauger movement and nonmovement in the Missouri River and tributary streams, 1979, 1980 and 1981[a].

Category	Number of Tag Returns			
	1979	1980	1981	Total
Total number of tag returns	23	93	93	209
Tag returns from dredge cuts and tailwater	1	16	37	54
Tag returns from Missouri River excluding dredge cuts and tailwater	12	8	33	53
Tag returns from Lower[b] Milk River	6	67	12	85
Tagged and recaptured in Lower Milk River	3	61	11	75
Moved 10 miles or more or moved from Milk River to dredge cuts or tailwater	16	30	57	103
Moved from Milk River to dredge cuts or tailwater	0	14	17	31
Moved from Milk River to Missouri River except dredge cuts and tailwater	5	1	4	10
Moved from Missouri River in Montana to Garrison Reservoir, North Dakota	2	2	2	6
Moved between Missouri and Yellowstone rivers	4	6	6	16
Moved from Missouri River downstream of Milk River to dredge cuts or tailwater	0	2	19	21
Moved from Poplar River to Missouri River	1	1	0	2
Moved from Poplar River to Garrison Reservoir	3	0	0	3
Moved from Yellowstone River to Poplar River	1	0	0	1
Not moving[c] and at large less than one month	3	21	14	38
Not moving[c] and at large more than one month	5	44	22	71
Not moving[c] and at large more than one year	0	0	8	8
Moved upstream	8	22	47	77
Moved downstream	8	8	10	26

a- Based on angler tag returns and field sampling recapture of tagged fish.
b- Lower = mouth to distance 2 miles upstream.
c- Not moving = recaptured within 10 miles of tagging location.

Walleye

The walleye is distributed over the entire length of the study area, but is much less abundant than the sauger, to which it is closely related. In electrofishing catches sauger usually outnumber walleye by a factor of 10 or 15. Walleye made up 5.7% of all game fish in electrofishing samples. A total of 101 walleye was sampled by electrofishing in 1981. Only a few were captured in limited gill netting. Average sizes of walleye sampled in 1981 were largest in spring (19.6 inches and 3.24 pounds) and smaller in other seasons. The overall average sizes in 1981 were 16.1 inches and 2.04 pounds.

No ripe female walleye were sampled in April 1981, but green females were found in that month. Spawning, if there was any, probably occurred in May.

The distribution of walleye YOY was very uneven. Of ten YOY sampled in late summer and fall, eight were found within a few miles of Wolf Creek and two at downstream points. This distribution is not understood. These walleye YOY could have originated from the lower Poplar River where spawning is well recognized (Stewart 1979).

Distribution of all walleye sampled in game fish electrofishing is shown in Table 6. Numbers were somewhat higher in the lower half of the study area, but differences were not large.

Table 18 categorizes movement and nonmovement of tagged walleye within, into and out of the study area. Angler tag returns and field sampling have yielded a total of 26 walleye tag returns over a three-year period. Walleye in the study area are highly mobile, with 18 of 26 recaptured fish (69%) moving 10 or more miles from the tagging location. Upstream and downstream movements were approximately equal among the recaptured walleye. There was significant movement into the dredge cuts-tailwaters area; six of 26 recaptured walleye (23%) were recaptured in that location. There were 5 tag returns of walleye from Garrison Reservoir of fish tagged in the Missouri River and tributary streams in the study area. These could be fish that had moved from Garrison Reservoir to the Missouri River and then returned to Garrison Reservoir, where the species is abundant.

Northern Pike

Northern pike, although not as abundant as sauger, are an important and common game species in the Missouri River from Fort Peck Dam to North Dakota. A total of 139 northern pike was sampled by electrofishing in 1981 in the Missouri River. This species made up 7.1% of game fish sampled by electrofishing in 1981.

Northern pike in the Missouri River are generally found in backwaters or slow-flowing channel margin areas. Electrofishing in any of the larger backwaters will usually produce at least one or two northern pike.

Electrofishing in spring 1981 collected four ripe or freshly spent females. These female spawners were found over the period of April 10 to April 29 between the Highway #13 Bridge and Big Muddy Creek. This

Table 18. Walleye movement and nonmovement in the Missouri River and tributary streams[a].

Category	Number of Tag Returns			
	1979	1980	1981	Total
Total number of tag returns	7	7	12	26
Tag returns from dredge cuts and tailwater	2	1	3	6
Tag returns from Missouri River excluding dredge cuts and tailwater	1	4	6	11
Tag returns from Lower[b] Milk River	2	0	0	2
Tagged and recaptured in Lower Milk River	2	0	0	2
Moved 10 miles or more or moved from Milk River to dredgecuts or tailwater	6	4	8	18
Moved from Milk River to dredge cuts or tailwater	0	1	1	2
Moved form Milk River to Missouri River except dredgecuts and tailwater	0	0	0	0
Moved from Missouri River in Montana to Garrison Reservoir, North Dakota	2	0	3	5
Moved between Missouri and Yellowstone River	0	2	0	2
Moved from Missouri River downstream of Milk River to dredge cuts or tailwater	0	0	2	2
Moved from Poplar River to Missouri River	2	0	0	2
Moved from Poplar River to Garrison Reservoir	2	1	0	3
Moved from Yellowstone River to Poplar River	0	0	0	0
Not moving[c] and at large less than one month	0	1	0	1
Not moving[c] and at large more than one month	1	2	4	7
Not moving[c] and at large more than one year	0	0	0	0
Moved upstream	3	2	5	10
Moved downstream	3	2	3	8

a- Based on angler tag returns and field sampling recapture of tagged fish.
b- Lower = mouth to distance 2 miles upstream.
c- Not moving = recaptured within 10 miles of tagging location.

was the first year that female spawners were found outside of the Poplar River, indicating some degree of spawning in the Missouri River. Larval northern pike have not been collected except in the Poplar River (Stewart 1979). Three out of 58 (5%) northern pike sampled during fall electrofishing in 1981 were age 0+ (YOY). No YOY were sampled in 1980 and 16 % of the fall 1979 northern pike sampled were YOY. No YOY were collected in late summer 1981 backwater seine hauls. The number of YOY rearing in the Missouri River does not seem to be sufficient to support the numbers of older age groups present and populations may be supported by the Poplar and Redwater rivers where large numbers of YOY are produced in some years.

Data from tag returns indicate northern pike in the Missouri River are much more sedentary than sauger or walleye. A total of 32 tagged northern pike have been recaptured (Table 19). Of these, 24 (75%) did not move significantly from the tagging location. Of the eight that did move, all moved in an upstream direction (Table 19). Five of these eight moved from the mouth of the Milk River to the dredge cuts tailwaters area.

Channel Catfish

Little work was done with the species in 1981. Channel catfish are rarely sampled by electrofishing; only two were collected by this method in 1981. Larger numbers were collected in baited hoop nets (Stewart 1981), but numbers sampled were still low. In 1981 baited hoop nets were placed on gravel and rock substrate to determine if larger numbers could be collected here than on sand substrates where nets often sink several inches into the substrate. Catch rates in 1981 were no higher than 1980 when nets were set on sand bottoms. Only five fish were sampled in four net days. Berg (1978) found much higher catch rates in the Missouri River upstream of Fort Peck Reservoir. Data suggest that channel catfish are not abundant in the study area.

No evidence has been found of channel catfish spawning in the study area, as would be indicated by sampling of larval fish. Larval fish samples were collected in July and August 1981 from tributaries and Missouri River stations, so that larvae of this late spawner would be found, if present. None were sampled.

Four tagged channel catfish were recaptured in 1981. Two of these moved from the Missouri River downstream from Big Muddy Creek to the Yellowstone River. One moved from the Milk River to the dredge cuts-tailwaters area. The fourth was tagged and recaptured near Big Muddy Creek. The Missouri River-Yellowstone River interchange suggests that Missouri River channel catfish may be migrants from the Yellowstone River where this species is more abundant.

Shovelnose Sturgeon

The presence of significant numbers of the shovelnose sturgeon in the study area is somewhat an anomaly. Sexually ripe individuals of either sex have not been found. Neither have larval sturgeon or YOY

Table 19. Northern pike movement and nonmovement in the Missouri River and tributary streams[a].

Category	Number of Tag Returns			
	1979	1980	1981	Total
Total number of tag returns	2	13	17	32
Tag returns from dredge cuts and tailwater	1	3	2	6
Tag returns from Missouri River excluding dredge cuts and tailwater	1	8	14	23
Tag returns from Lower[b] Milk River	0	2	1	3
Tagged and recaptured in Lower Milk River	0	0	1	1
Moved 10 miles or more or moved from Milk River to dredge cuts or tailwater	1	4	3	8
Moved from Milk River to dredge cuts or tailwater	1	3	1	5
Moved from Milk River to Missouri River except dredge cuts and tailwater	0	0	0	0
Moved from Missouri River in Montana to Garrison Reservoir, North Dakota	0	0	0	0
Moved between Missouri and Yellowstone rivers	0	0	0	0
Moved from Missouri River downstream of Milk River to dredgecuts or tailwater	0	0	0	0
Moved from Poplar River to Missouri River	0	1	0	1
Moved from Poplar River to Garrison Reservoir	0	0	0	0
Moved from Yellowstone River to Poplar River	0	0	0	0
Not moving[c] and at large less than one month	0	1	1	2
Not moving[c] and at large more than one month	1	8	10	19
Not moving[c] and at large more than one year	0	0	3	3
Moved upstream	1	4	3	8
Moved downstream	0	0	0	0
Moved within Missouri River, outside of dredge cuts and tailwater	0	0	2	2

a - Based on angler tag returns and field sampling recapture of tagged fish
b - Lower = mouth to distance two miles upstream
c - Not moving = recaptured within ten miles of tagging location

been sampled in the study area. In downstream areas where spring water temperatures would encourage spawning, suitable spawning gravel is very limited. In upstream areas where gravels are more common, water temperatures may be too low to allow spawning. Very few shovelnose sturgeon have been collected in tributary streams during any season.

In spite of the preceding considerations, large concentrations of shovelnose sturgeon persist in the dredge cuts-tailwaters area. In 10 to 12 experimental gill net sets each year in this area in 1979, 1980 and 1981, catches of shovelnose sturgeon have averaged from 6.6 to 11.4 fish per overnight net set. In the same years this species made up from 13.1% to 34.7% of all fish sampled in experimental gill nets. Gill net catches were much lower in the river downstream of the dredge cuts with shovelnose sturgeon making up only 1.0% and 1.4% of all fish sampled in gill nets in 1979 and 1980.

Percentages of shovelnose sturgeon in Missouri River electrofishing samples and absolute numbers sampled have varied during sampling years. For 1979, 1980 and 1981, totals of 18, 114, and 68 fish were sampled by electrofishing with similar effort among the years. These numbers constituted 2.8, 14.6 and 4.2% of the total number of game fish in electrofishing samples. These numbers would suggest that greatly differing numbers of shovelnose sturgeon are present in the study area portion of the Missouri River in different years. The differences are unexplained.

Only one tagged shovelnose sturgeon has been recaptured. This fish was tagged in the Yellowstone River near Intake in May 1979 and was recaptured in the Missouri River several miles downstream from the Milk River in July 1980. This information, together with the absence of spawning in the Missouri River and tributaries, suggests that migration from the Yellowstone River and possibly from the Missouri River in North Dakota may be important in maintaining shovelnose sturgeon in the study area.

Burbot

The burbot is common in the study area and is sought by anglers, especially in the early spring when many are caught by hook and line. This species may have benefited from the cooler water temperatures in the study portion of the Missouri River caused by deep water releases from Fort Peck Dam. Scott and Crossman (1973) indicate an upper temperature limit for burbot of 74 F and an optimum range of 60-65. Temperatures in the Missouri River from Fort Peck Dam to the Highway #16 Bridge (35.1 river miles upstream from the North Dakota border) reached a maximum of 71.5 F in the six-year period from 1974 through 1979. In five of the six-years the maximum temperature did not exceed 70 F (USGS 1974-1979). Maximum river temperatures are lower at upstream points and probably increase somewhat downstream from the Highway #16 Bridge. Although no data analysis has been made, Fort Peck Dam may also extend the period of river temperatures in the 60-65 F preferred range.

Maximum river temperatures are higher upstream of Fort Peck Dam. For the period 1976 to 1979, the maximum temperature was 80 F and maximum temperatures exceeded 75 F in all four years at the Robinson Bridge approximately 24 river miles upstream of Fort Peck Reservoir (Berg 1981). Burbot are also smaller and less numerous upstream of Fort Peck Reservoir. Berg (1981) sampled only 72 burbot, with a maximum weight of 5.6 pounds in four years of electrofishing upstream of Fort Peck Reservoir. In these four years, burbot made up 1.8% of game fish in electrofishing samples. Downstream of Fort Peck Reservoir 242 burbot were sampled by electrofishing in 1981, with 16 burbot weighing between 5 and 13 pounds. Burbot made up 14% of game fish in electrofishing samples, although the corresponding figure was only 4.6% in 1980. Berg's (1981) catch rate was 0.2 burbot per electrofishing hour; the 1981 figure for downstream of Fort Peck Reservoir was 1.3 burbot per hour of electrofishing. Burbot in the lower Yellowstone River are also recognized to be much smaller than in the study area (Stewart 1980), and maximum annual temperatures in the Yellowstone reach 80 F (Peterman and Haddix 1975).

Length and weight distribution of burbot sampled in the Missouri River from the Milk River to the North Dakota border are shown in Table 20. Burbot have not been aged yet, but data on length of burbot at various ages (Scott and Crossman 1973) suggest that burbot in Table 20 less than 10 inches in length are age 0+ and age 1+, indicating that burbot spawn successfully and rear in the study area. The numerical predominance of fish under 10 inches in length suggests a strong year class formed in 1980. The increased numbers of large burbot sampled in 1981 (Table 20) are unexplained, although limited use of smooth DC electrofishing in 1981 suggested that smooth DC was more effective in sampling burbot than pulsed DC.

Burbot were found in 1981 over the length of the study area, although fewer were found in the colder, upstream area, especially upstream of Scott's Ranch.

Rainbow Trout

Large rainbow trout spawners congregated in spring 1981 in the shallow east channel immediately downstream of Fort Peck Dam. This concentration was also observed in 1979 and 1981. Data for spawners sampled in spring 1981 are given in Table 21. A total of 50 was captured. Average size was somewhat smaller than in 1980, but fish were still large with both sexes averaging more than three pounds in weight. Three rainbow trout spawners tagged in spring 1980 below the dam were recaptured in spring 1981 as spawners in the same location. An additional two spawners tagged in 1980 were caught by anglers below Fort Peck Dam in spring 1981. One spawner tagged in April 1981 was caught by an angler in one of the dredge cuts in July 1981. An additional two large adult rainbow trout were sampled electrofishing in August 1981; one near the Nohly Bridge near North Dakota and one between the dredge cuts and the Milk River. It appears that the spawners spend the remainder of the year in the Missouri River and the dredge cuts-tailwaters area. Only 22 spawners were tagged in 1980 with several tag returns in 1981 from these 22 fish. The relatively large number of tag returns suggests that the spawning population of rainbow trout is made up of relatively few fish.

Table 20. Length and weight distribution of burbot sampled by electrofishing in 1979-1980, and in 1981 in the Missouri River.

Length Groups (inches)	1979 & 1980	1981	Total-all years	Weight Groups (pounds)	1979 & 1980	1981	Total-all years
<5.0	1	6	7	<0.5	24	164	188
5.0 - 9.9	14	104	118	0.5 - 0.99	8	21	29
10.0 - 14.9	13	65	78	1.0 - 1.99	14	20	34
15.0 - 19.9	16	20	36	2.0 - 2.99	4	11	15
20.0 - 24.9	10	22	32	3.0 - 3.99	4	9	13
25.0 - 29.9	3	12	15	4.0 - 4.99	2	1	3
30.0 - 34.9	4	7	11	5.0 - 5.99	2	3	5
35.0 - 39.9	2	5	7	6.0 - 6.99	1	1	2
40.0 - 44.9	0	1	1	7.0 - 7.99	2	3	5
				8.0 - 8.99	0	2	2
Totals	63	242	305	9.0 - 9.99	2	3	5
				>10.0	0	4	4
				Totals	63	242	305

Table 21. Number and size of rainbow trout spawners captured in the Fort Peck Dam tailwaters, April 1981.

	Number Captured	Average Length (inches)	Length Range (inches)	Average Weight (pounds)	Weight Range (pounds)
Males	17	20.3	12.3 - 26.4	3.13	0.74 - 6.00
Females	33	22.4	14.9 - 24.8	3.92	1.50 - 5.80

In 1981, 14 juvenile rainbow trout were sampled in the study area. Fingerling rainbow trout were planted in the dredge cuts in spring 1980 and spring 1981. The 1981 plant was adipose clipped, but no fin clip was made on the 1980 plant. Juveniles sampled in 1981 had no fin clips and ranged in length from 2.7 to 8.2 inches. These fish were sampled mostly near the dam, but some were found as far downstream as Wolf Creek, approximately 60 river miles from the dam. Four juvenile rainbow trout were sampled from August to October and were 2.6 to 3.6 inches total length. These were much too small to have originated from the spring 1980 plant and are an indication of successful spawning below the dam in 1981. Two sampled in fall 1981, 5.0 and 5.1 inches long, probably also represent successful spawning in 1981. Larger individuals from 4.9 to 8.2 inches and sampled in spring could have originated from spawning or from planting in spring 1980.

This species may have the potential for becoming a major sport fish in the study area. The fact that water temperatures downstream from Fort Peck Dam are suitable for trout makes it surprising that rainbow trout have not become more numerous, at least in the upper half of the study area.

Rainbow Smelt

The rainbow smelt was first sampled in the study area in fall 1979. This was also the first record of this fish in Montana. Stewart (1981) gives a brief history of this species in the study area.

Large numbers of rainbow smelt in 1981 were first noted in the study area on April 16 approximately two miles downstream from the Highway #16 bridge to Lakeside; the large numbers continued from Lakeside to the North Dakota border on April 17. A sample of only 25 of these fish was collected for weight and length measurement (Table 5), but several hundred smelt were seen on April 16 and 17. Sizes were similar to those sampled in 1980 and determined to be age II. Large numbers of smelt were not observed at upstream points except in the dredge cuts-tailwaters area.

Rainbow smelt have persisted in the dredge cuts-tailwaters area since they reached that area in the spring "run" in 1980. A total of 40 were sampled in August 1981 in the dredge cuts and tailwaters, with four in ten overnight experimental gill net sets and 36 in four overnight 0.5 inch mesh gill net sets. Smelt from this area have not been aged but are of the same size as the 2-year-olds sampled from the Lower Missouri River.

Rainbow smelt also entered the Lower Milk River in 1981, but not until June. Sauger sampled here regurgitated smelt, and one smelt was seen in the electrical field.

No evidence for rainbow smelt reproduction in the study area has been found. No larval fish or YOY have been collected by any sampling method.

LITERATURE CITED

Berg, R.K. 1978. Middle Missouri River planning project. Job Progress Report, Fed. Aid to Fish and Wildlife Rest. Proj. No. FW-3-R-6, Job 1-a. 53 pp.

_____. 1981. Fish populations of the wild and scenic Missouri River, Montana. Fed. Aid to Fish and Wildlife Rest. Proj. No. FW-3-R, Job 1-a. 242 pp.

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

Gardner, W.M. and R.K. Berg. 1980. An analysis of the instream flow requirements for selected fishes in the wild and scenic portion of the Missouri River. Montana Dept. of Fish, Wildlife and Parks. Ecol. Serv. Div., Helena. 50 pp.

McGuire, D.C. 1981. Annotated key to the larval suckers (Catostomidae) of the Missouri River drainage, Montana, Proc. Mont. Acad. Sci. 40:1-8.

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

Pennak, R.W. 1953. Fresh-water invertebrates of the United States. The Ronald Press Co. New York. 769 pp.

Peterman L.G and M.H. Haddix. 1975. Lower Yellowstone River fishery study. Prog. Rept. No. 1. Montana Dept. of Fish & Game. 56 pp.

Pfliegar, W.L. 1975. The fishes of Missouri. Missouri Dept. of Conservation. 343 pp.

Rehwinkel, B.J. 1978. The fishery for paddlefish at Intake, Montana during 1973 and 1974. Trans. Am. Fish. Soc. 107(2):263-268.

Scott, W.B. and E.J. Crossman. 1973. Freshwater fishes of Canada. Fish. Res. Bd. of Canada, Ottowa. Bulletin 184. 966 pp.

Stewart, P.A. 1979. Lower Missouri River basin investigations. Job Prog. Rept., Fed. Aid to Fish and Wildlife Rest. Proj. No FW-2-R-8, Job 1-b. 44 pp.

_____. 1980. Lower Missouri River basin investigations. Job Progress Report, Fed. Aid to Fish and Wildlife Rest. Proj. No. FW-2-R-9. Job 1-b. 40 pp.

_____. 1981. Lower Missouri River basin investigations. Job Progress Report, Fed. Aid to Fish and Wildlife Rest. Proj. No. FW-2-R-10. Job 1-b. 50 pp.

USGS. 1974-1980. Series of seven annual reports entitled, Water resources data for Montana. US Dept. of Interior.

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

Ward, J.V. and J.A. Stanford, eds. 1979. The ecology of regulated streams. Plenum Press, N.Y. 398 pp.

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