MONTANA DEPARTMENT OF FISH AND GAME

POWDER RIVER AQUATIC ECOLOGY PROJECT

ANNUAL REPORT

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Prepared for:

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INTRODUCTION

Geology-Water Chemistry

The geologic formations of a drainage basin greatly affect the chemical nature of the drainage water. The Powder River watershed drains, in part, Precambrian formations of granites and schists. However, the most obvious contribution to the drainage water chemistry is from a thick series of sedementary strata that range in age from Cambrian to present. This sedementary material is made up of limestones, sandstones, shales, silt-stones, gypsum, shale and coal. Erosion of this substrate occurs at a moderate rate.

The chemical nature of the Powder River shown in Tables 1 and 2 and Appendix Tables 3 and 4 is the result of four contributing water types. The first is granitic water coming from Clear Creek and carrying large quantities of silica and calcium. The second type is limestone water flowing from high in the Middle Fork of the Powder River and carrying large amounts of calcium, magnesium, carbonate, chlorides and nitrates. The third water type is from the lower Middle Fork of the Powder River and is best described as a gypsum water. This water holds a great deal of sodium, potassium, and sulfate. The last type is shale water coming mainly from the Little Powder River. This water carries large amounts of sodium, potassium and sulfate (Swenson, 1953). The resultant water in the main stem of the Powder River has been described as a sodium, bicarbonate, sulfate water (Clark Judy, personal communication.).

Table 1. Physical and chemical parameters of the Powder River at Moorhead.*

Date	Discharge (m^3/min)	ALK as $CaCo_3$ (mg/l)	Specific Conductance (μmhos/cm)	Dissolved Oxygen (ppm)	Turbidity (JTU)	pH
Oct. 16	354	241	2250	10.0	390	7.9
Nov. 19	371	241	1980	12.9	320	8.4
Dec. 17	193	274	2150	12.8	15	8.6
Jan. 21	354	299	2180	8.5	30	8.1
Feb. 19	720	199	1750	11.7	50	8.1
Mar. 17	1290	241	2500	11.7	240	8.2
Apr. 29	959	189	1720	10.5	440	8.2

* Data from U.S.G.S.

Table 2. Physical and chemical parameters of the Powder River at Locate.*

Date	Discharge (m^3/min)	ALK as $CaCo_3$ (mg/l)	Specific Conductance (μmhos/cm)	Dissolved Oxygen (ppm)	Turbidity (JTU)	pH
Oct. 22	445	221	2180	12.4	5800	8.3
Nov. 19	588	236	1700	12.4	200	8.5
Dec. 17	1276	283	2400	12.5	140	8.1
Jan. 29	383	320	2340	7.1	40	7.8
Feb. 28	840	177	1380	12.4	130	8.0
Mar. 17	924	219	2030	12.8	120	8.2
Apr. 29	914	216	2000	10.8	720	8.3
May 18	2016	-	1090	8.4	-	8.4

* Data from U.S.G.S.

Climate

The climate of the Powder River drainage is characterized as semi-arid in the non-mountainous portion. Much of the area's precipitation (78 %) occurs between April and October with most of the drainage averaging less than 15 inches per year. The yearly discharge of the Powder River (Figure 1) is commonly bi-modal with a smaller March peak followed by the large June run-off and then tapering off to minimal flows for the rest of the year.

The air temperatures of this area vary from -36° to 40°C. with the hot summer temperatures causing rapid evaporative losses. This no doubt impacts the adjacent prairie and is in part responsible for the somewhat sparse vegetation and the resultant erosion. The daily mean water temperatures of the Powder River from April through mid-June 1976 are shown in Appendix Table 5.

River-Habitat

The river habitat is typical of a prairie stream. The Powder River is silt laden and subject to eratic fluctuations in flow with much of its substrate constantly shifting as bed load. The river develops only shallow pools and lacks aquatic vegetation. The extreme turbidity of the Powder River severely reduces primary productivity due to lack of light penetration resulting in low numbers of aquatic invertebrates.

A map of the study area is shown in Figure 3. The river gradient and area land marks are shown in Figure 4.

Scope of the Study

The Powder River provides water for man and his livestock and for irrigating croplands. Energy development in the Fort Union area has created a new potential demand for Powder River water. The lack of information concerning the aquatic resource of the Powder River coupled with this

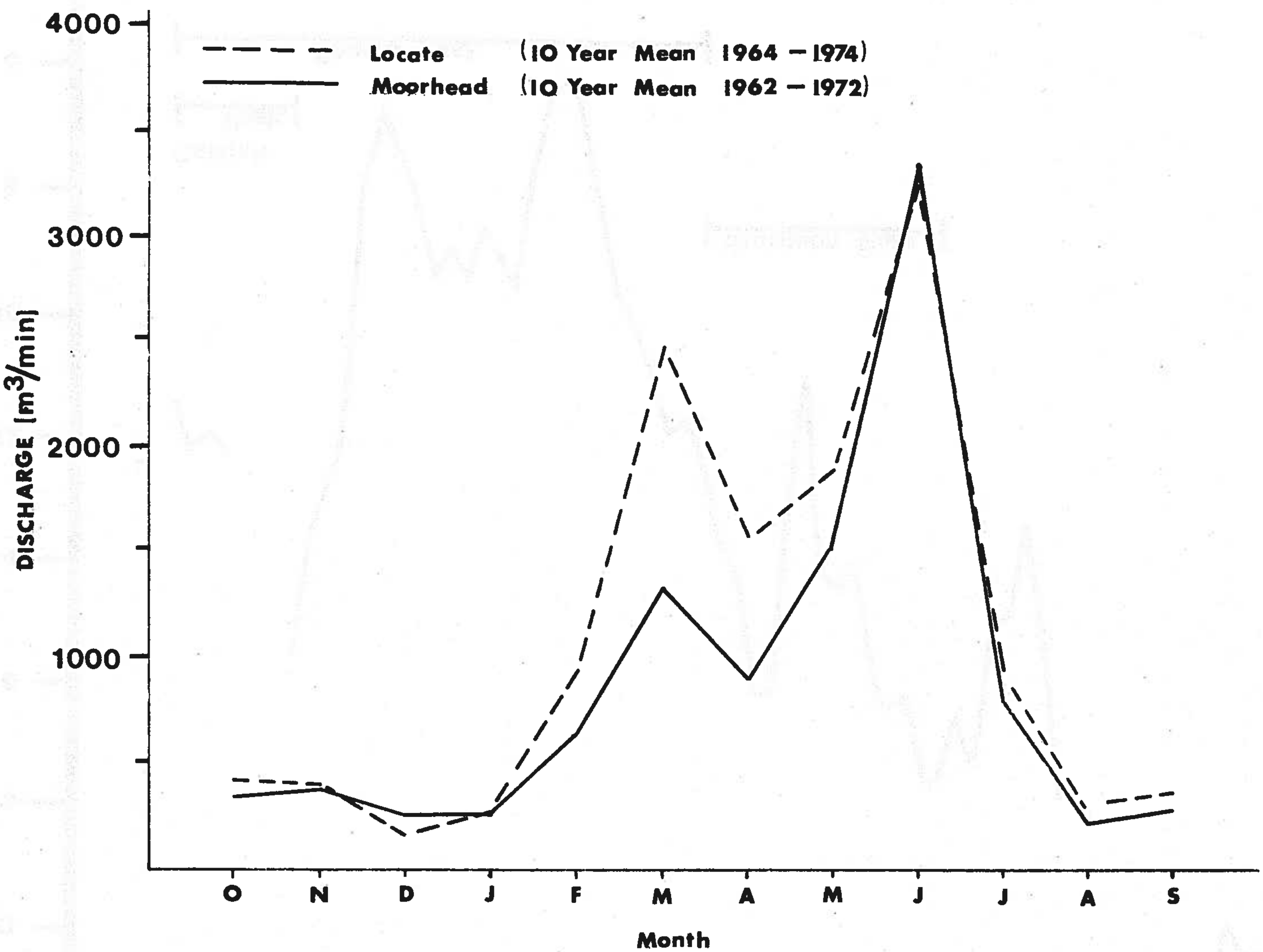


Figure 1. Summary of monthly mean discharges on the Powder River at Moorhead and Locate.

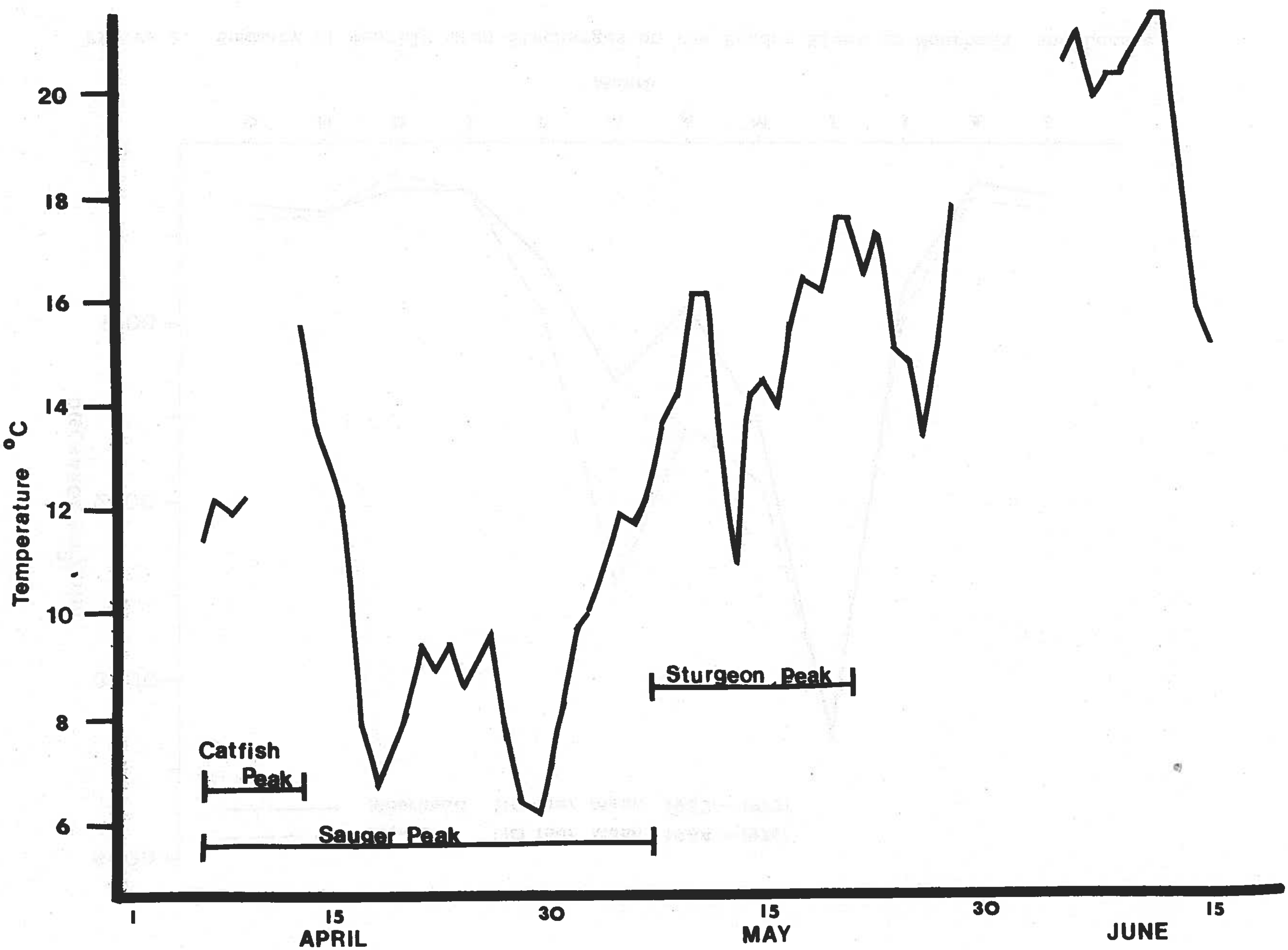


Figure 2. Powder River temperature at Section 1 near confluence with Yellowstone River.

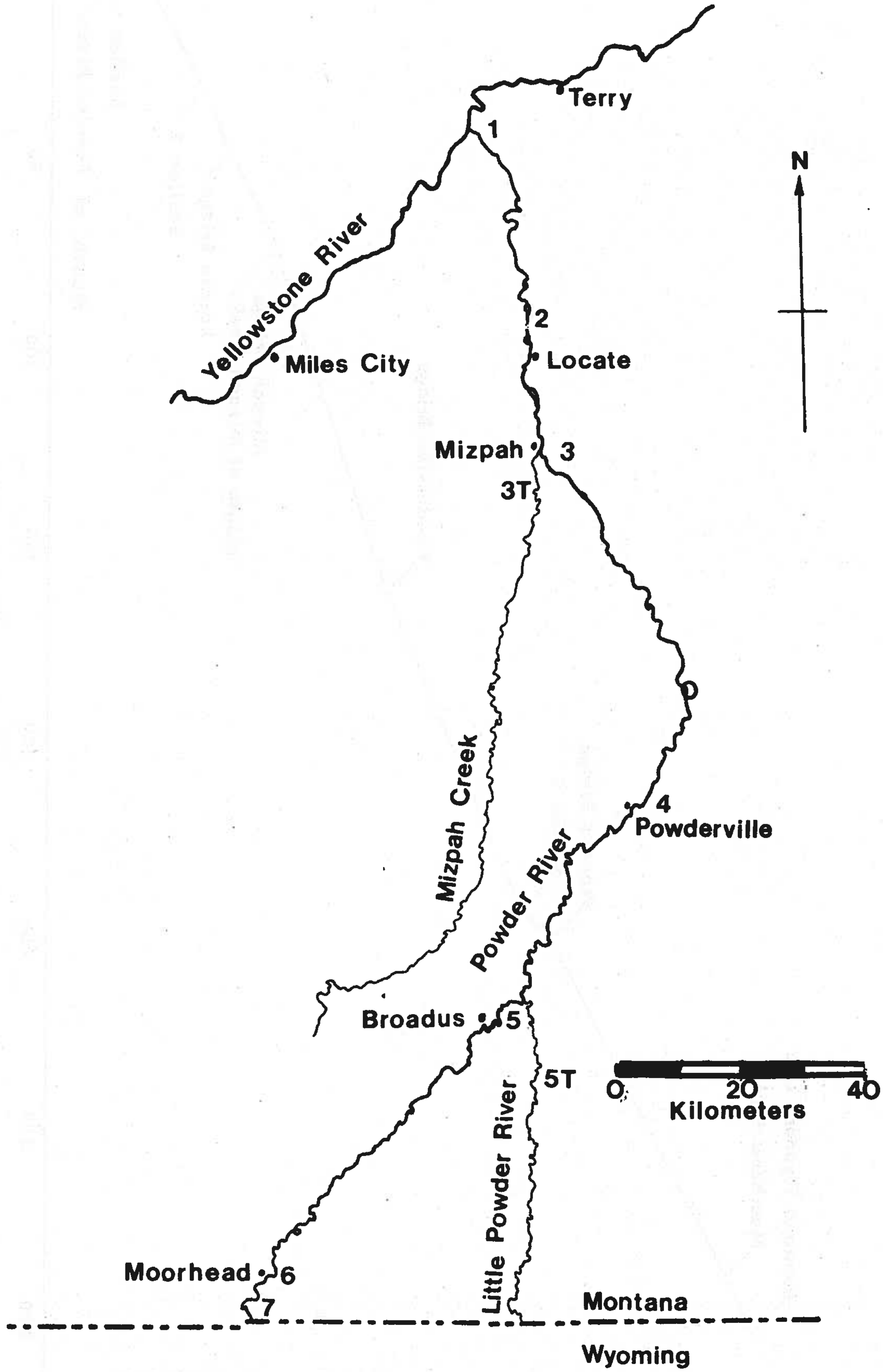


Figure 3. Map of the Powder River showing sampling sites.

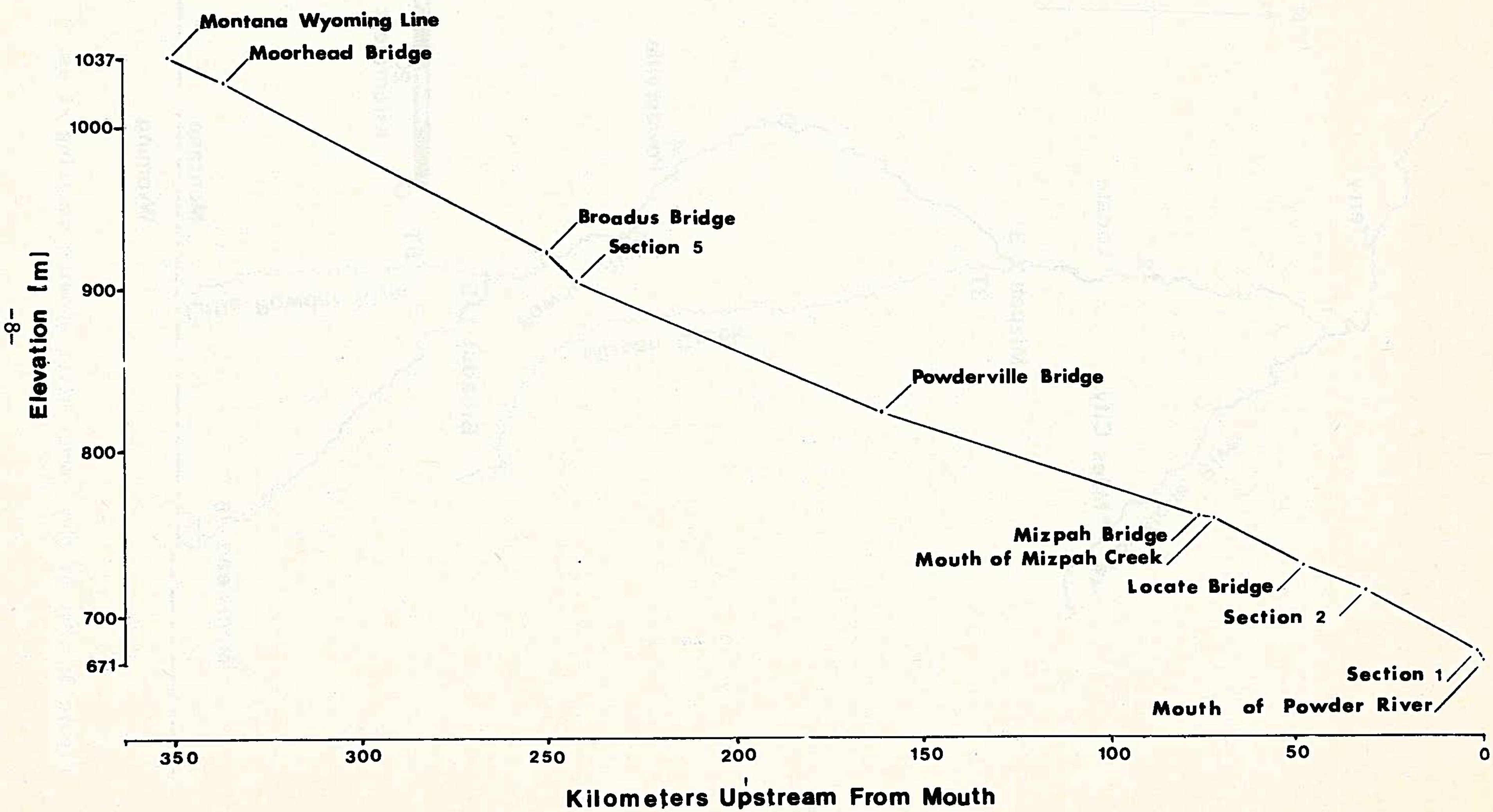


Figure 4. Longitudinal profile of Powder River.

potential new demand for its water created the need for this study which is financed by Utah International Inc.

The objective of the study is to collect baseline data of the Powder River to determine the effects of an impoundment and largescale water withdrawals. This report includes an inventory of fish populations and distribution, aquatic invertebrate distribution and relative abundance, and selected physical and chemical characteristics of the Powder River.

<u>Description of Sampling Sites</u>

Permanent fish sampling sections have been established as follows:

Section Number	Location
1	Above Interstate Bridge to Burlington Northern Bridge near confluence with the Yellowstone River
2	Near Locate on the A. Young ranch
3.	At Mizpah on the C. Balsam ranch
3T	Mizpah Creek on the Scott ranch
4	At Powderville on the Preston ranch
5	At Broadus on the Perry ranch
5T	Little Powder River on the Turnbough ranch
6	At Moorhead on the G. Fulton ranch
7	At the Wyoming line on the L. Sams ranch.

Permanent invertebrate sampling sites have been established as follows:

Station Number	Location
1	Above Interstate Bridge, above confluence with the Yellowstone River
2	Downstream from Locate
3	At Mizpah Bridge
3T	Mizpah Creek at the bridge
4	At Powderville Bridge
5	At Broadus Bridge

5T Little Powder River on the Turnbough ranch

6 Moorhead Bridge

METHODS AND MATERIALS

River temperatures were monitored with Taylor 30-day recording thermographs. Dissolved oxygen concentrations were measured with a Yellow Springs Instrument Co. oxygen meter and conductivities were measured with a Yellow Springs Instrument Co. conductivity and salinity meter. An Owens-Corning pH meter was used to record pH in situ. Alkalinities are being determined potentiometrically. Turbidity data is from the U.S.G.S.

Macroinvertebrates were collected with a Water's Round square foot sampler, a Needham kick screen and an adult net. Samples were preserved in 10 percent formalin and washed through a U.S. series 30 mesh screen. Invertebrates were separated from debris and stored in 75 percent isopropyl alcohol.

Fish were collected with the aid of pulsed D.C. electrofishing equipment, drifted 3-inch bar-mesh gill nets and a 50 foot 1/4-inch bag seine. Sport fish were weighed, measured, and tagged prior to release.

RESULTS

Fall Fish Sampling

During the fall of 1975 all seven of the original study sections were sampled. This information was gathered to show the relative abundance of the resident fish populations. A total of 18 species of fish were collected, with the flathead chub (*Hypopsis gracilis*) the dominant species in each section (Table 6). Section 2 (Locate) showed the greatest number of species (14), while Section 3 showed the fewest (1).

The species composition of the samples show only rare occurrences of

Table 6. Species composition in each of the Powder River sample areas, Fall, 1975.

Species	7	6	5	4	3	2	1
Flathead chub	346 87.8%	965 91.0%	250 79.6%	192 81.5%	108 100%	266 90.9%	106 89.2%
Lake chub	11 2.8%	33 3.1%	22 7.0%	19 8.0%		1 0.3%	
Sturgeon chub	12 3.0%	28 2.6%	27 8.6%	17 7.2%		5 1.7%	6 5.1%
Goldeye	14 3.5%	10 0.9%				2 0.7%	3 2.5%
River carpsucker	5 1.3%	3 0.3%	2 0.6%	1 0.4%		2 0.7%	1 0.8%
Shorthead redhorse	3 0.8%	7 0.7%					1 0.8%
Stonecat	2 0.5%					1 0.3%	
Carp	1 0.3%	4 0.4%	1 0.3%				
Longnose dace		3 0.3%	9 2.9%	2 0.8%		2 0.7%	
Channel catfish		1 0.1%	3 1.0%	5 2.1%		7 2.5%	1 0.8%
Sauger		1 0.1%					
Burbot						1 0.3%	1 0.8%
Brassy minnow						1 0.3%	
Green sunfish						1 0.3%	
Sand shiner		5 0.5%					
Plains minnow						1 0.3%	
Silvery minnow						1 0.3%	
Creek chub						2 0.7%	
Total	394	1060	314	236	108	293	119

game fish. Length information was taken and is presented in Table 7. Weight information is not included since most fish were small.

Length frequency distributions were compared for the flathead chub in two sections (1 and 7). These two areas showed close agreement with three definite modes occurring. The first mode was between 25 mm and 56 mm, the second between 56 mm and 97 mm and the third occurring between 91 mm and 122 mm. These modes closely agree with age groups zero, one and two according to Brown (1971). The scale method of aging flathead chubs was attempted but annuli could not be detected.

Fall 1975 sampling showed that high turbidities and low water temperatures made electrofishing quite impractical therefore most of the sampling was accomplished with a 50 foot 1/4 inch mesh bag seine. Study sections 2 and 6 were ideal for this technique and the fish samples shown in Table 7 reflect this with high diversities. However, section 3 was very difficult to seine successfully and the fish samples were all of one species; flathead chubs. This may be the only species present in this section but could reflect an inefficient sampling technique.

Future work on resident fish populations will include a varied technique approach to assure the most representative samples.

Spring Fish Sampling

On April 5, 1976 field work begun to determine the species composition and magnitude of game fish migrations into the Powder River from the Yellowstone River. Fish were captured using pulsed D.C. electrofishing gear, floating gill nets and seines. Captured game fish were measured, weighed and affixed with individually numbered tags. In an effort to tag as many migrating game fish as possible, section 1 (near the confluence with the

Table 7. Fish length (mean and range in mm) by species and study sections, Powder River, 1975.

Species	7	6	5	4	3	2	1
Flathead chub	73.66 (20-160)	80 (41-178)				73 (23-259)	
Lake chub	67 (41-99)	72 (38-132)	74 (46-112)	69 (48-89)		104	
Sturgeon chub	74 (41-79)	71 (66-76)	74 (38-89)	70 (43-79)		58 (28-79)	
Goldeye	301 (284-325)	301 (287-343)				303 (295-312)	86 971-102)
River carpsucker	110 (38-216)	68 (36-124)	42 (38-46)	28		30 (28-33)	97
Shorthead redhorse	218 (135-264)	285 (201-345)					224
Stonecat	94 (89-99)					180	
Carp	462	97 (81-122)	81				
Longnose dace		74 (66-81)	69 (56-79)	67 (64-71)		58 (53-64)	
Channel cat		58	49 (46-53)	54 (43-64)		58 (51-64)	66
Sauger		523					
Burbot						490	305
Bassy minnow						124	
Green sunfish						38	

Yellowstone River) was intensively sampled. Sections 2-8 were also sampled to monitor upstream movement of tagged and untagged game fish.

Prior to this study the importance of Yellowstone River game fish movements into the Powder River had not been assessed in terms of the potential or realized fishery of the Powder River or to the reproduction of Yellowstone River game fish.

Sauger

Sauger (*Stizostedion canadense*) are native to Montana and are one of the most important game fish of the lower Yellowstone River. From April 5 to May 18, 178 sauger averaging 381mm in length and 464 grams in weight were captured, affixed with individually numbered Floy tags and released. These fish were first captured in early April when stream temperature was mainly on the rise (Figure 2) and flow was increasing. Actual flow data will not be compiled by the U.S.G.S. until late 1976. The majority of these fish were captured by electrofishing although extreme turbidities (exceeding 3500 JTU) decreased efficiency of the technique.

The captured sauger were presumably on a spawning migration as indicated by their age structure (Table 8) and gonadal development, with ripe males representing over 95 percent of the captured fish. The period of capture (April 5 - May 18) corresponds to the spawning period of sauger in the lower Yellowstone River as reported by Peterman and Haddix (1975).

Scale samples from 113 sauger captured in the Powder River during the spring of 1976 were used for age and growth determination (Table 8). Captured sauger ranged from 230-535 mm and represented age classes II-VIII. Age IV sauger were the most commonly captured year class followed by ages V and III.

It should be emphasized that Table 8 does not represent the age and growth of a discrete population of sauger but rather of a grouping of

Table 8. Sauger age-growth from spring sample 1976.

Age Group	Number of Fish	Length Range (mm)	Mean Length (mm)	Average Annual Growth (mm)
II	4	282-322	305.5	12.0
III	20	230-387	317.5 (12.5)	12.0
IV	45	300-402	356.9 (14.0)	39.40
V	22	359-473	415.2 (16.3)	58.30
VI	15	349-498	421.3 (16.6)	6.10
VII	5	373-500	425.4 (16.8)	4.10
VIII	2	421-535	478.0	
	113			

sexually mature sauger, mostly males, from various habitats of the lower Yellowstone River. The growth rates of sauger captured in the Powder River are roughly similar to those reported in the lower Yellowstone (Peterman and Haddix, 1975).

Of the 178 sauger captured and tagged, 174 were captured in Section 1, one in Section 2 and 3 in Section 8. If the 3 sauger captured in Section 8 are Yellowstone River fish, they migrated over 324 km up the Powder River to a point above the proposed construction of the Moorhead dam.

The relatively few fish tagged (178) compared with the length of the river sampled (360 km) and the apparent minimal fishing pressure on the Powder River made upstream recaptures of tagged fish improbable. No tagged sauger were recaptured in the Powder River upstream from the point of tagging. However, a sauger was recaptured in the Tongue River, a tributary which enters the Yellowstone River 57.0 km upstream from the mouth of the Powder River. Another sauger, tagged in Section 1 of the Powder River was recaptured in the Yellowstone River near the mouth of Sand Creek (371 km) upstream from the mouth of the Powder. Another sauger was recaptured in Section 1 of the Powder on May 4 which had been released in the Yellowstone River at Miles City on April 21, 1976, a movement of 55 km in 13 days.

Channel Catfish

Classified as a game fish by the Montana Legislature in 1975, the channel catfish (*Ictalurus punctatus*) is a popular sport fish in the lower Yellowstone drainage system. Adult channel catfish are evidently highly migratory and may ascend tributary streams to spawn (Trautman 1957).

Fishermen interviews indicated that channel catfish provided the major contribution to the Powder River sport fishery and suggested that Yellowstone River channel catfish migrating up the Powder River may provide this fishery since catfish are only caught in the late spring and early summer. Channel catfish are caught seasonally by fishermen as far upstream as Arvada, Wyoming (Fred Dabny, personal communication), 434 km upstream from the mouth of the Powder River.

From April 5 to May 21, 95 channel catfish averaging 614 mm in length and 2660 gr in weight were captured in the Powder River and its tributaries using pulsed D.C. electrofishing gear, floating gill nets and seines. These fish were measured, weighed, affixed with an individually numbered plastic tag attached through the dorsal musculature with 0.032 inch diameter stainless steel wire as described by Pelgen and McCammon (1955) and released. Eighty-seven of these fish were captured in Section 1 as they moved up the Powder River and eight were captured in the Little Powder River, a tributary entering the Powder 249 km upriver. Greatest numbers of channel catfish were captured on April 12, when river temperatures were rising and flow was increasing (Figure 2). Stream discharge has been found to be a major factor influencing adult catfish migrations, with seasonal increases in spring expediting migrations (Van Eeckhout 1974).

The left pectoral spines from 30 channel catfish captured in the Powder River were removed and sectioned for age determination according to the methods of Sneed (1950). These catfish represented age classes II-VIII. Age IX and older catfish made up 90 percent of the sample which further indicates a spawning migration.

Three channel catfish tagged in Section 1 of the Powder River were recaptured upstream by anglers. Two fish were returned from Powderville

(145 km) 32 and 38 days following tagging. The remaining fish was caught at the mouth of the Little Powder River, representing a movement of 249 km in 33 days. These tag returns suggest the Yellowstone River channel catfish do migrate considerable distance upstream in the Powder River system.

Current field work is being directed toward capturing tagged channel catfish upriver from their point of tagging. This work also encompasses three tributary streams, Mizpah Creek (72 km upstream from the mouth), the Little Powder River (249 km upstream from the mouth) and Clear Creek which enters the Powder River in Wyoming approximately 434 km upstream from the mouth of the Powder.

Reproduction

No ripe (sex products easily extrudable) channel catfish have been collected in the Powder River. Of six fish taken by fishermen in Section 1 in late April, four were females with ovaries in the later stages of development. In the 1975 fall sampling, young-of-the-year channel catfish were captured in Sections 1, 2, 4, 5, and 6. This is a good indication of successful channel catfish reproduction in the Powder River or its tributaries.

Shovelnose Sturgeon

Shovelnose sturgeon (*Scaphirhynchus platorynchus*) are also native to Montana. Shovelnose sturgeon evidently ascend tributary streams of the Yellowstone River to spawn and large concentrations of them have been noted in the Tongue River by McFarland (personal communication). These fish provide a fishery for those fishermen who have learned where and how to catch them.

Migrating shovelnose sturgeon were captured in the Powder River by electrofishing with pulsed D.C. shocking equipment and by drifting 3-inch

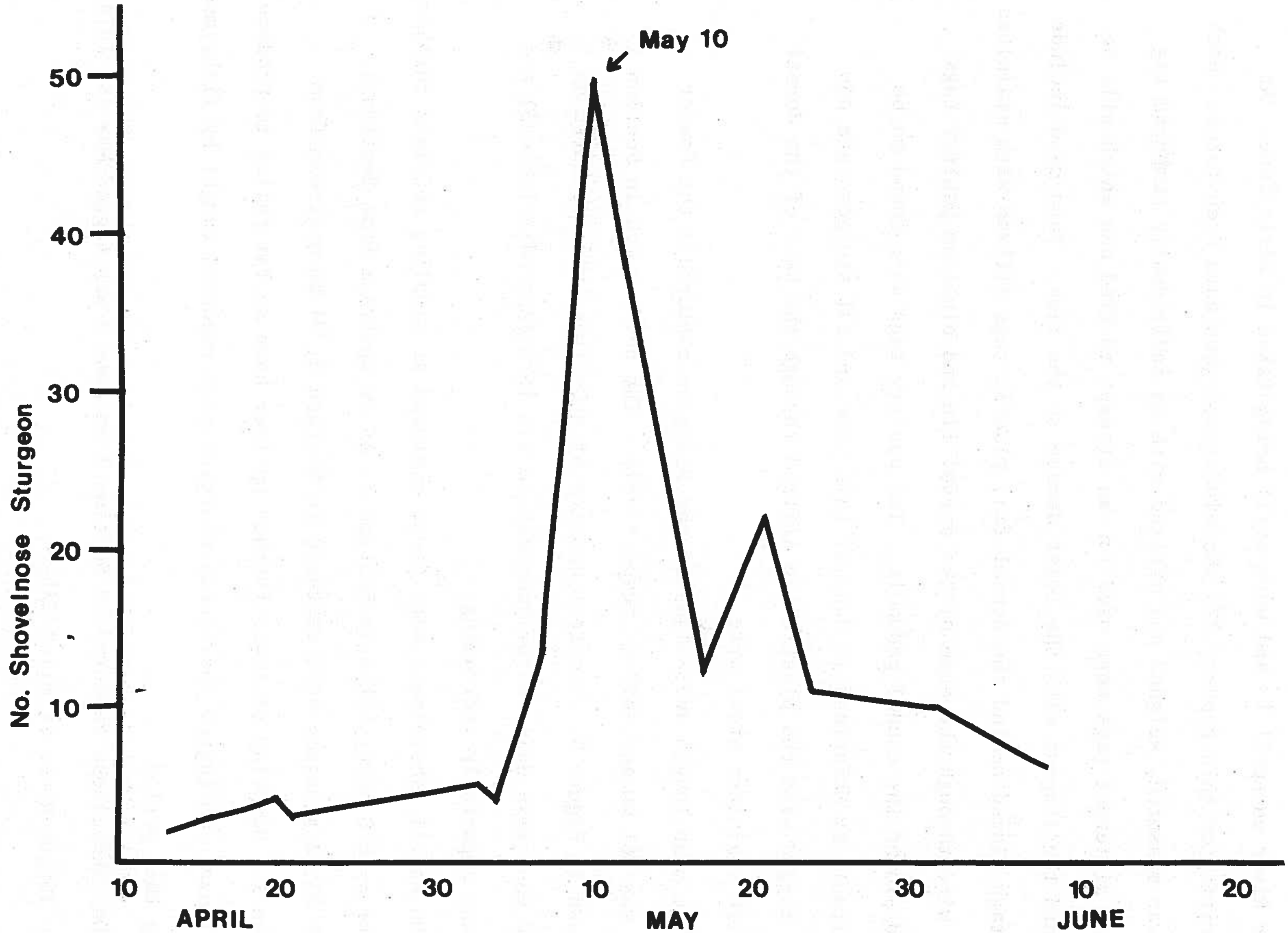


Figure 5. Numbers of shovelnose sturgeon per day at Section 1.

bar mesh gill nets. This latter technique is quite efficient for capturing shovelnose. Shovelnose were first captured in Section 1 of the Powder River on April 13 and were still being taken in early June. At the writing of this report, 179 shovelnose sturgeon have been taken. Each fish was measured, weighed and affixed with an individually numbered tag. Several different tags were used in an attempt to find one which will be retained the longest with the least damage to the fish. Tags used include Floy tags placed behind the dorsal fin, plastic tags affixed with stainless steel wire through the base of the dorsal fin and aluminum poultry tags placed around the caudal peduncle. The poultry tags were found to be undesirable by McFarland in June of this year and all sturgeon are now being tagged with the plastic tag affixed through the base of the dorsal fin with stainless steel wire.

The mean length and weight of the sturgeon captured in the Powder River was 761 mm and 2420 g respectively. The daily catch in Section 1 is shown in Figure 5. Greatest numbers of shovelnose were captured on May 10 when mean daily water temperature was 16°C (Appendix Table 3) and flow was apparently increasing.

On May 11 shovelnose were first captured at sampling sections further upriver with 8 being taken in Section 2, 48 km upstream from Section 1. On May 13, 4 sturgeon were captured in Section 3, 74 km upstream from Section 1. Sampling sections further upriver have so far failed to produce shovelnose. No tagged shovelnose sturgeon were reported caught by fishermen during this period.

One shovelnose captured in Section 1 on June 2 was tagged May 10, 1974 in the Tongue River at Miles City.

Age and growth information was not obtained since previous work suggests that pectoral fin ray sections are of dubious value and other techniques require sacrificing the fish. None of the 179 sturgeon were in a "ripe" condition and hence none were sexed.

Tributary Fish Sampling

All fish were captured using pulsed D.C. electrofishing equipment. Chemical and physical data collected are presented in Table 9.

Little Powder River

The Little Powder River is a permanent tributary that enters the Powder River 249 km upstream from the confluence with the Yellowstone. Two sampling runs were made on a 762 meter section approximately 8 km upstream. A mark and recapture population estimate was attempted to determine if it was feasible and applicable to the Powder River.

Flathead chubs (*Hybopsis gracilis*) were not handled due to time limitations. However, they appeared to be the most abundant fish in the stream. The river carpsucker (*Carpoides carpio*) followed by the shorthead redhorse (*Moxostoma macrolepidotum*) were the next most abundant fish species (Table 10). The redhorse appeared to be associated with gravel bottoms in areas of riffles while the carpsuckers were found mainly in areas of silted bottoms and still water.

Of the species present, an estimate using Chapmans modification of the Petersen estimator (Ricker 1958) was made for the shorthead redhorse and river carpsucker (Table 11).

Table 9. Chemical and physical data for two tributaries of the Powder River.

Tributary	Date	Salinity	Temp.	Specific Conductance	Dissolved Oxygen	pH
Mizpah Creek	6/11	1.0/1000	22.8°C	1340 μmhos/cm	9.4 ppm	8.90
Little Powder River	6/11	0.8/1000	21.2°C	1180 μmhos/cm	6.5 ppm	8.22

Table 10. Species and numbers of fish captured in the Little Powder River.

Species	Sample 1	Sample 2
Flathead chub (*Hybopsis gracilis*)	*	*
River carpsucker (*Carpoides carpio*)	85	66
Shorthead redhorse (*Moxostoma macrolepidotum*)	57	49
Carp (*Cyprinus carpio*)	54	18
Goldeye (*Hiodon alosoides*)	25	13
White sucker (*Catostomus commersoni*)	9	18
Green sunfish (*Lepomis cyanellus*)	7	3
Stonecat (*Noturus flavus*)	5	5
Channel catfish (*Ictalurus punctatus*)	3	5

Table 11. Estimated numbers of shorthead redhorse and river carpsuckers in the study section of the Little Powder River.

Species	Population Estimate (95 percent confidence intervals)
Shorthead redhorse	138 ($\pm$ 45)
River carpsucker	360 ($\pm$ 152)

Considering the success of this work, estimates are planned for the Powder River to quantitatively assess its fish populations during 1976.

Clear Creek, Wyoming

In an attempt to recover tagged migrating game fish, one sampling run was made on this tributary of the Powder River which enters near Arvada, Wyoming. Sampling problems limited the section to approximately 0.45 km. No sauger, channel catfish or sturgeon were collected. The results of this sampling run are given in Table 12.

Table 12. Species, numbers, mean lengths and mean weights of fish captured in Clear Creek.

Species	Number	Mean Length (mm)	Mean Weight (g)
White sucker (*Catostomus commersoni*)	27	215	116
Flathead chub (*Hybopsis gracilis*)	14	124	---
Shorthead redhorse (*Moxostoma macrolepidotum*)	12	287	221
Longnose sucker (*Catostomus catosumus*)	3	288	270
Goldeye (*Hiodon alosoides*)	3	306	180
Rockbass (*Ambloplites rupestris*)	2	125	35
River carpsucker (*Carpoides carpio*)	1	286	250
Carp (*Cyprinus carpio*)	1	455	1000
Brown trout (*Salmo trutta*)	1	290	200

Invertebrates

Data from October, 1975 and March, April and May, 1976 is included herein. Ice conditions from November through mid-March prevented bottom sampling, and June samples have not been analyzed. At each site on each collection data a Needham kick screen was used for one sample and a Water's Round Sampler was used for three samples. At the Mizpah Creek sample site an Ekman dredge sample replaced each of the normal samples in March and April due to low flows. Due to the shifting nature of the Powder River bottom, riffle areas with rocky, stable substrates were deliberately chosen for the Water's samples in an attempt to sample the more stable benthic communities. The Needham kick samples included all apparent habitat types at each sample site.

Table 13 shows the distribution of all invertebrates collected to date. Of the taxa identified in the Powder River system, only seven have not been reported from the Yellowstone and Tongue Rivers of eastern Montana (Newell 1975); these are the chironomids *Dicrotendipes*, *Polypedilum* and *Conchapelopia*, the dipteran familes Dolichopodidae and Stratiomyidae, and the mayflies *Habrophlebia* and *Coenis*. Stratiomyidae and *Caenis* have been identified from Rosebud Creek in eastern Montana (Gorges, personal communication).

Overall, Trichoptera and Diptera are the most abundant orders in the samples (Table 14); together they comprise more than 50 percent of the organisms collected. Plecoptera is just as abundant as Diptera in the samples from the main river. At the two tributary sites, Diptera and Ephemeroptera together comprise over 75 percent of the organisms collected.

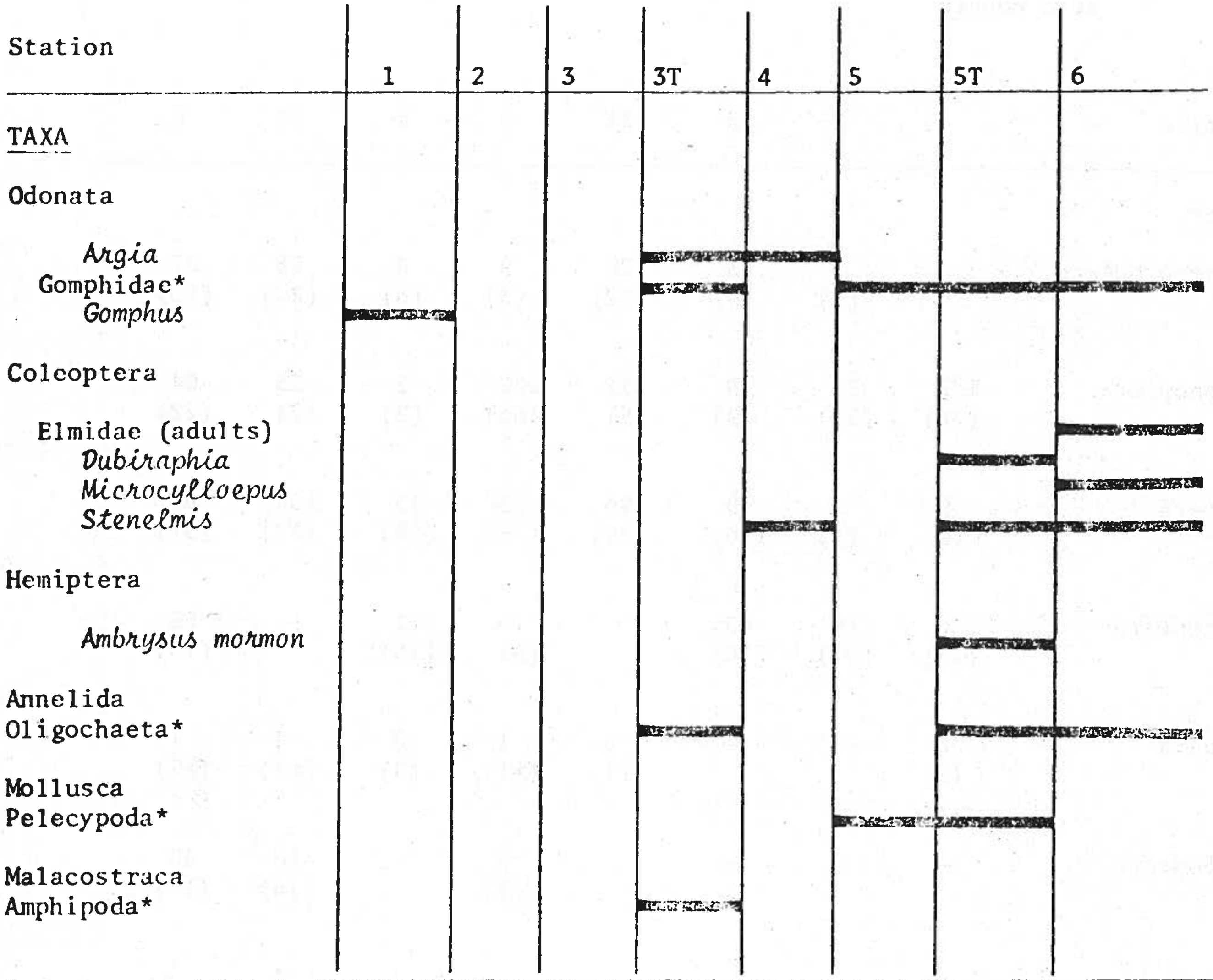
Table 15 shows the individual abundance of most of the identified taxa. Generic determination has not been completed on Chironomidae, Tipulidae, Elmidae, Perlodidae, and Gomphidae; therefore, they appear as families on Table 15. Over 60 percent of all the organisms collected were the caddisfly *Chematopsyche*, the stonefly family Perlodidae, and the dipteran families Simuliidae and Chironomidae. *Chematopsyche* and Chironomidae were the only organisms found at each collection site. The family Perlodidae was found at each site on the main river. In general, the upper three sites and the tributaries appear to have a more diverse benthic fauna than the sites closer to the mouth. Actual diversity indicies will be computed after one year of sampling has been completed. This should yield a reasonably large total number of individuals and should allow for some expert confirmation on species identification. Very low numbers of invertebrates have been found in our collections. The quantitative presentation will be developed after a year of sampling is completed.

Further sampling will probably expand the known distribution of some of the taxa identified to date and will probably increase the number of known taxa. The later instars and adults of the insects will be collected during summer sampling. This will facilitate species determination.

Table 13. Distribution of aquatic macroinvertebrates in the Powder River drainage.

Station	1	2	3	3T	4	5	5T	6
TAXA								
Ephemeroptera								
Ametropus sp.		X	X			X		
Baetis parvis				X			X	X
Caenis sp.				X			X	X
Epeorus sp.						X		X
Habrophlebia sp.					X		X	X
Leptophlebia sp.					X		X	X
Rhithrogena sp.					X			X
Stenonema sp.							X	X
Tricorythodes minutus								X
Trichoptera								
Brachycentrus sp.								X
Chematopsyche sp.	X	X	X	X	X	X	X	X
Hydropsyche sp.		X	X		X		X	X
Polycentropus sp.			X				X	
Diptera								
Ceratopogonidae				X				
Chironomidae	X	X	X	X	X	X	X	X
Cryptochironomus	X						X	X
Dicrotendipes							X	
Paralauterborniella							X	
Polypedilum							X	
Rheotanytarsus Group							X	
Conchapelopia							X	X
Cardiocladius		X	X		X	X		
Orthocladius							X	X
Dolichopodidae				X		X		
Empedidae			X		X	X	X	X
Simuliidae								
Simulium				X	X	X	X	X
Stratiomyidae				X				
Tipulidae*			X	X			X	X
Dicranota				X				
Plecoptera								
Acroneuria	X	X	X		X			X
Brachyptera						X		X
Perlodidae*	X	X	X		X	X		X
Isogenus		X	X		X			

Table 13 Continued.



* Organisms not identified to lower taxa due to their size or condition.

All identifications are tentative.

Table 14. Number of organisms in each Order and their percent* composition, in parentheses, for all collections at each site. Dashes indicate zero counts.

Station	1	2	3	3T	4	5	5T	6
Order								
Ephermeroptera	-	3 (5)	3 (5)	129 (52)	9 (3)	4 (6)	78 (22)	37 (13)
Trichoptera	122 (74)	31 (51)	5 (9)	12 (5)	222 (66)	2 (3)	25 (7)	64 (22)
Diptera	9 (5)	3 (5)	9 (16)	96 (39)	83 (25)	13 (19)	194 (54)	90 (31)
Plecoptera	30 (18)	19 (31)	40 (70)	-	18 (5)	11 (16)	-	55 (19)
Odonata	3 (2)	-	-	3 (1)	1 (>1)	2 (3)	1 (>1)	1 (>1)
Coleoptera	-	-	-	-	2 (1)	-	50 (14)	40 (14)
Hemiptera	-	-	-	-	-	-	1 (>1)	-
Others	-	5 (8)	-	7 (3)	-	35 (52)	7 (2)	1 (>1)

* Rounded to the nearest whole number.

Table 15. Numbers and percent composition (in parentheses), rounded to the nearest whole number, of all benthic organisms collected.

STATION	1	2	3	3T	4	5	5T	6
Number of Samples	12	16	16	12	16	12	8	16
TAXA								
Ephemeroptera								
Ametropus	-	3 (5)	3 (5)	-	-	2 (3)	-	-
Baetis	-	-	-	1 (>1)	-	-	4 (1)	2 (1)
Caenis	-	-	-	125 (51)	-	-	6 (2)	-
Epeorus	-	-	-	-	-	2 (3)	-	9 (3)
Habrophlebia	-	-	-	-	1 (>1)	-	-	11 (4)
Leptophlebia	-	-	-	3 (1)	2 (1)	-	52 (15)	4 (1)
Rhithrogena	-	-	-	-	6 (2)	-	-	2 (1)
Stenonema	-	-	-	-	-	-	16 (4)	1 (>1)
Tricorythodes	-	-	-	-	-	-	-	8 (3)
Trichoptera								
Brachycentrus	-	-	-	-	-	-	-	11 (4)
Chematopsyche	122 (74)	31 (51)	5 (9)	12 (5)	220 (66)	2 (3)	21 (6)	30 (10)
Hydropsyche	-	-	-	-	2 (1)	-	2 (1)	23 (8)
Polycentropus	-	-	-	-	-	-	2 (1)	-
Diptera								
Ceratopogonidae	1 (1)	-	1 (2)	3 (1)	-	-	-	-
Chironomidae	7 (4)	4 (5)	6 (11)	53 (21)	19 (6)	9 (13)	30 (8)	20 (7)
Dolichopodidae	-	-	-	2 (1)	-	2 (3)	-	-
Empedidae	1 (1)	-	1 (2)	-	3 (1)	1 (1)	2 (1)	17 (6)
Simuliidae	-	-	-	33 (13)	61 (18)	1 (1)	158 (40)	52 (18)
Stratiomyidae	-	-	-	1 (>1)	-	-	-	-
Tipulidae	-	-	1 (2)	4 (2)	-	-	4 (1)	1 (1)

Table 15. Continued

STATION	1	2	3	3T	4	5	5T	6
Number of Samples	12	16	16	12	16	12	8	16
TAXA								
Plecoptera								
Acroneuria	6 (4)	1 (2)	1 (2)	-	5 (1)	-	-	2 (1)
Brachyptera	-	-	-	-	-	1 (1)	-	3 (1)
Perlodidae	24 (15)	18 (30)	39 (68)	-	13 (4)	10 (15)	-	50 (17)
Odonata								
Argia	-	-	-	2 (1)	1 (>1)	-	-	-
Gomphidae	3 (2)	-	-	1 (>1)	-	2 (3)	1 (>1)	1 (>1)
Coleoptera								
Elmidae	-	-	-	-	2 (1)	-	50 (14)	40 (14)
Hemiptera								
Ambrysus	-	-	-	-	-	-	1 (>1)	-
Others	-	5 (8)	-	7 (3)	-	35 (52)	7 (2)	1 (>1)
Total Number of Organisms	164	61	57	247	335	67	356	288
Average Number Per Sample	13.7	3.8	3.6	20.6	20.9	5.6	44.5	18.0

APPENDIX

Table 3.

MOORHEAD

Date	Total Al (mg/1)	Dis Al	Total Cu (mg/1)	Total Fe (mg/1)	Dis Fe (mg/1)	Dis Boron (mg/1)	Nitrate (mg/1)	Dis Cu (mg/1)	Non-carb Hardness (mg/1)	Dis Ca (mg/1)	Dis Mg (mg/1)
Oct. 16	14,000	-	30	20,000	20	340	5.1	-	350	130	65
Nov. 19	14,000	10	40	15,000	0	770	14	2	310	130	55
Dec. 17	-	-	-	-	10	250	3.6	-	360	150	64
Jan. 21	1,300	-	10	2,100	0	320	6.6	-	270	130	59
Feb. 19	-	-	-	-	30	250	-	-	220	100	42
Mar. 17	-	-	-	-	10	310	9.3	-	330	140	54
Apr. 29	15,000	-	40	30,000	20	70	13	-	260	99	48

Date	Dis Na (mg/1)	K (mg/1)	CL (mg/1)	SO_4 (mg/1)	Dissolved Silica SiO_2 (mg/1)	Hardness Ca-Mg	CO_2 (mg/1)	BOD	Bicarb HCO_3 (mg/1)	Total P (mg/1)
Oct. 16	300	17	180	750	5.1	590	5.9	1.5	294	.39
Nov. 19	240	6.1	170	600	6.8	550	1.9	1.2	294	.01
Dec. 17	230	5.7	150	600	8.8	640	1.3	0.4	334	.00
Jan. 21	270	6.9	200	590	10	570	4.6	2.4	365	.03
Feb. 19	210	6.3	150	480	7.5	420	3.1	-	243	.07
Mar. 17	330	6.5	220	700	6.6	570	3.0	-	294	.30
Apr. 29	190	5.0	92	520	5.8	440	2.3	-	231	.68

* Provisional Data from U.S.G.S.

Table 4.

	Total Al (mg/l)	Dis. Al	Total Cu (mg/l)	Dis. Cu (mg/l)	Total Fe (mg/l)	Dis. Fe (mg/l)	Dis. Boron (mg/l)	Nitrate (mg/l)	Non-Carb Hardness (mg/l)	Dis. Ca (mg/l)
Oct. 22			50	7	28,000	20		3.4	250	100
Nov. 19			-	-	-	-		5.1	290	120
Dec. 17			-	-	-	-		5.8	410	160
Jan. 29			10	2	2,200	20		6.6	280	140
Feb. 28			-	-	-	-		7.5	160	80
Mar. 17			-	-	-	-		5.7	300	120
Apr. 29			70	6	55,000	10		16.0	290	120
May 18			-	-	-	-		34.0	-	-

Date	Dis Mg (mg/l)	Dis. Na (mg/l)	Dis. K (mg/l)	Total P (mg/l)	Ce (mg/l)	SO_4 (mg/l)	Dis SiO_2 (mg/l)	Hardness Ca-Mg	CO_2 (mg/l)	Bicarb HO_3 (mg/l)
Oct. 22	53	290	7.1	.72	140	670	5.8	470	2.2	270
Nov. 19	54	210	6.1	.51	110	600	6.5	520	1.5	288
Dec. 17	71	260	6.9	.17	160	710	8.8	690	4.4	345
Jan. 29	61	310	7.4	.08	190	660	10.0	600	9.9	390
Feb. 28	34	180	4.8	.14	100	400	6.6	340	3.5	216
Mar. 17	53	270	6.8	.15	110	690	7.3	520	2.7	267
Apr. 29	50	290	6.7	1.1	99	810	6.4	510	2.1	263
May 18	-	-	-	1.9	-	-	-	-	-	-

Table 5. Daily Mean Temperature ^{o}C Powder River.

Date		Interstate	Powderville	Moorhead
April	1			
	2			
	3		11.7	
	4		12.2	
	5		11.1	12.8
	6		12.5	11.7
	7	12.2	13.9	11.9
	8	11.9	14.4	12.2
	9	12.2	14.4	13.0
	10		13.6	11.1
	11		10.6	12.8
	12		10.3	14.2
	13	15.6	10.0	15.6
	14	13.6	10.0	13.6
	15	12.8	10.6	13.6
	16	11.9	10.8	9.7
	17	7.8		8.3
	18	6.7		10.3
	19	7.5		10.3
	20	8.0		10.0
	21	9.4		11.1
	22	8.9	11.1	10.6
	23	9.4	11.1	11.1
	24	8.6	10.3	12.2
	25	9.2	10.6	12.2
	26	9.7	10.0	10.0
	27	7.5	10.6	5.8
	28	6.4	6.4	5.6
	29	6.1	7.2	6.9
	30	6.9	9.7	10.0
	1	8.3	13.0	12.5
	2	9.7	12.8	12.8
	3	10.0	13.3	13.6
	4	11.1	15.0	15.0
	5	11.9	15.3	14.7
	6	11.7	15.8	13.9
	7	12.2	15.8	14.2
	8	13.6	16.9	16.6
	9	14.2	18.0	16.9
	10	16.1	18.3	17.8
	11	16.1	18.9	16.7
	12	13.1	14.7	13.0
	13	10.8	14.4	13.3
	14	14.2	No record	16.3
	15	14.4		14.4
	16	13.9		13.9
	17	15.6		15.6
	18	16.6		18.0
	19	16.1		19.2
	20	17.2		19.2

Table 5. Continued

Date		Interstate	Powderville	Moorhead
May	21	17.5	No record	18.0
	22	16.4		16.9
	23	17.2		14.7
	24	15.0		13.6
	25	14.7		16.9
	26	13.3		15.6
	27	15.3		16.9
	28	17.8		19.4
	29			18.3
	30			18.3
	31			19.2
June	1			20.3
	2			20.0
	3			20.0
	4			20.8
	5	20.6		17.5
	6	21.1		17.8
	7	19.4		21.7
	8	20.3		21.9
	9	20.3		22.5
	10	20.8		22.2
	11	21.4		
	12	21.4		
	13	18.6		
	14	15.8		
	15	15.0		
	16			
	17			
	18			
	19			
	20			
	21			
	22			
	23			

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