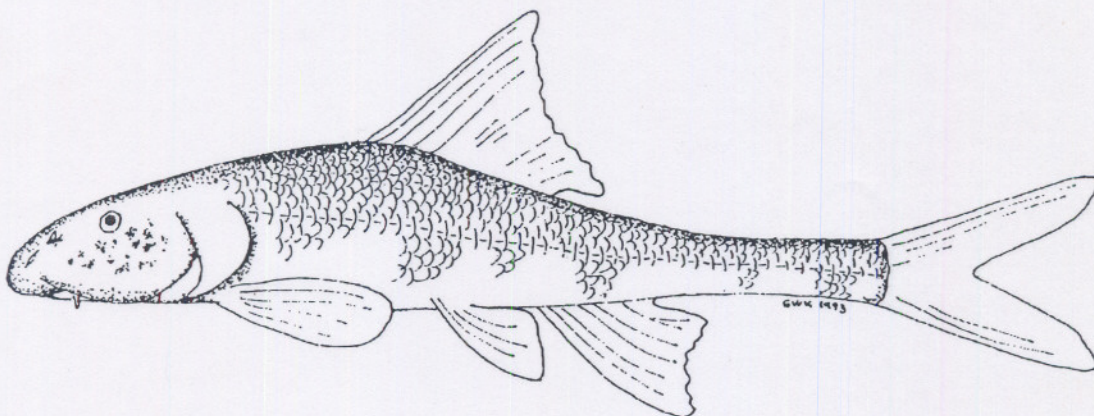


SURVEY OF THE FISHES OF THE LITTLE MISSOURI RIVER
FROM MARMARTH TO MEDORA, NORTH DAKOTA, 1993

Steven W. Kelsch
Department of Biology
University of North Dakota
Grand Forks, ND 58202
(701) 777-2621

31 December 1993



STURGEON CHUB
Macrhybopsis gelida

Funded by:
U. S. Forest Service
North Dakota Game and Fish Department

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INTRODUCTION

The Little Missouri River drains small portions of northeastern Wyoming, southeastern Montana, northwestern South Dakota and a larger region of southwestern North Dakota. It flows northward, then eastward until it joins Lake Sakakawea, a large mainstem reservoir on the Missouri River in North Dakota. Lake Sakakawea was formed by the closure of Garrison Dam in 1953.

The Little Missouri River has a relatively unique fish fauna compared to other Missouri River tributaries in the region due to different ecological conditions. It is characterized by high turbidity, intermittent flow, shifting sediments, and limited aquatic vegetation (Reigh 1978). The fishes that inhabit the river are primarily those that can tolerate these conditions and those that migrate into the River from Lake Sakakawea when conditions are suitable.

The fishes of the Little Missouri River have been studied previously. Hankinson (1929) was the first to list species collected in the Little Missouri River. Personius and Eddy (1955) surveyed the river from its headwaters in Wyoming to its confluence with the Missouri River just prior to the closure of Garrison Dam and the formation of Lake Sakakawea. Bailey and Allum (1962) and Bich and Scalet (1977) list species collected in the Little Missouri River in South Dakota, and Reigh (1978) conducted an extensive survey of the Little Missouri River in North Dakota.

Several species that have been collected from the Little Missouri River or are present in the region are of concern due to their limited distribution. The sicklefin chub *Macrhybopsis*

meeki (formerly *Hybopsis meeki*) was collected near the mouth of the Little Missouri River in 1950 (Personius and Eddy 1955), a portion of the River that has since been inundated by Lake Sakakawea. It has not been collected in the Little Missouri since that time. The sicklefin chub has been listed as endangered in North Dakota (Elsen et al. 1979) and has been included in a Notice of Review for consideration for possible addition to the federal List of Endangered and Threatened Wildlife (Department of the Interior 1985).

The sturgeon chub *Macrhybopsis gelida* (formerly *Hybopsis gelida*) was widely distributed in the Little Missouri River (Reigh 1978, Reigh and Owen 1979) but is absent from the other Missouri River tributaries in the region with the exception of the Yellowstone River. The sturgeon chub has been on the decline through much of its range (Jenkins 1980) and, therefore, is of special concern. The sturgeon chub was listed as threatened in North Dakota (Elsen et al. 1979), was included in a Notice of Review for consideration for possible addition to the federal List of Endangered and Threatened Wildlife (Department of the Interior 1985), and is considered a candidate endangered species (Werdon 1993).

Five other species that have been collected or are potentially present in the Little Missouri River (Reigh 1978, Reigh and Owen 1979, Reigh and Elsen, 1979, Owen et al. 1981) are of special concern due to their limited distributions in the region. The lake chub *Couesius plumbeus* has been listed as threatened and the longnose sucker *Catostomus catostomus* has been listed as peripheral in North Dakota (Elsen et al. 1979). Other species of special concern are the quillback (*Carpionodes cyprinus*), the blue sucker (*Cycleptus elongatus*), and the northern redbelly dace (*Phoxinus eos*).

The objectives of this study were:

1. to determine the current distribution of fishes in the Little Missouri River, North Dakota, from Marmarth to Medora, North Dakota;
2. to determine the current status of species of special concern within in the survey area;
and,
3. to compare the status of the current fish fauna with that determined in previous studies.

MATERIALS AND METHODS

To determine the current status of fishes in the Little Missouri River, collections were made along a 190 km (119 mi) reach of the Little Missouri River during an 8-day period in July of 1993. The survey reach was from Marmarth to Medora, North Dakota--a section that runs through an extensively eroded region known as the badlands (Fig. 1). This reach was selected for the survey by the U. S. Forest Service and the North Dakota Game and Fish Department due to the potential effects of increasing oil development in the region and the absence of recent surveys.

Collections were made at 24 sites spaced at 8-km (5-mi) intervals along the survey reach (Fig. 1). Collection sites were reached by canoe due to limited access to the river by roads and since existing roads were in poor condition due to a substantial amount of rainfall prior to and during the study period. Fishes were collected using common-sense seines with lengths of 3 (10 ft) and 6 m (20 ft), and bar mesh-sizes of 0.6 cm (1/4 in). At each site, collections were made along an approximately 200-meter stretch of river during a period of 35 to 60 minutes. An effort was made to sample every available habitat within the stretch.

Data recorded at each collecting site included species collected, and numbers individuals of each species. Accompanying field data included a physical description of the river at each site including width, depth, current velocity, water temperature, dissolved oxygen concentration, conductivity, pH, turbidity, substrate type, presence of vegetation, weather conditions, date, and time of collection. Width was visually estimated, depth was measured as approximate maximum depth, current velocity was measured as maximum velocity near shore (at a depth of approximately 0.5 m; velocity measurements at various sites were not necessarily comparable). Dissolved oxygen and temperature were measured with a YSI model 57 dissolved oxygen meter, conductivity was measured with a YSI model 33 conductivity meter, pH was measured with a Hach colorimeter, and turbidity was measured with a Secchi disk. All specimens were preserved in 10% formalin and returned to the laboratory. All individuals were identified to species if possible and total lengths were recorded to determine population structure and reproductive

success. All specimens were transferred to 40% isopropyl alcohol and accessioned into the ichthyological collection at the Department of Biology, University of North Dakota.

RESULTS

The weather of the summer of 1993 was characterized by unusually high rainfall and cool temperatures. Accordingly, the Little Missouri River experienced exceptionally high water levels and flows. Of the nine days spent in the region, it rained at least five days, two of which produced 1/2 inch of precipitation or more. A thunderstorm that occurred during the evening of 9 July produced marble-sized hail that covered the ground, and sufficient rain to overflow the back of our canoe which was out of the water on a 10° slope. Another storm on the morning of July 12 left at least 1/2 inch of water in empty buckets.

Water levels in the river fluctuated dramatically during the study period. Following the thunderstorm on 9 July, the water level rose vertically approximately 1 foot then dropped 2 to 2 1/2 feet over the next 36 hours as evidenced by water marks on the banks. We recorded water levels at the Logging Camp Ranch gauging station of 2.45 feet on 15 July and 2.70 feet on 16 July.

Thirteen species of fishes and 1248 individuals were collected throughout the 24 sampling sites (Table 1). In general, both catches and species diversity were low. Only three sampling sites yielded more than five species. Three species were found at most of the sampling sites and dominated the catch, comprising 95 % of individuals captured. The flathead chub (*Platygobio gracilis*) was captured at each sampling site and comprised 72 % of all individuals collected. The plains minnow (*Hybognathus placitus*) was probably the second-most dominant species although I was unable to distinguish most young (less than 35 mm total length) from other species of *Hybognathus* (*H. nuchalis* and potentially *H. hankinsoni*). Identified plains minnows were 8 %, undistinguished *Hybognathus* were 9 %, and longnose dace (*Rhinichthys cataractae*) were 15 % of the total catch. No other species was collected at more than five sites or made up more than 1.4 % of the total.

Table 1. Fishes collected in the Little Missouri River from Marmarth to Medora, North Dakota during July, 1993. Locations and descriptions of sites are given in Table 2.

SITE

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	N
<i>Hiodon alosoides</i>																							1		1
<i>Couesius plumbeus</i>						6									1							2	1		10
<i>Hybognathus nuchalis</i>						4											1								5
<i>Hybognathus placitus</i>	8	15	14		8	11	1				9	1		4	3		13		6		2				95
<i>Hybognathus</i> sp. (young)	1		3			1				3	1	1		3	15		24	2	4	2	9	5	15	12	101
<i>Notropis stramineus</i>						2									1										3
<i>Phoxinus eos</i>																					1	1			2
<i>Pimephales notatus</i>						7																			7
<i>Pimephales promelas</i>		9				4								2				1				1		3	20
<i>Platygobio gracilis</i>	8	2	11	16	13	29	12	4	7	28	73	19	34	65	57	16	75	22	46	42	46	43	90	61	819
<i>Rhinichthys cataractae</i>			10	5	1	13	4	2	3	5	5	5	15	10	12	7		3	2	17	15	18	17		169
Cyprinid larvae															2										2
<i>Catostomus commersoni</i>						3			1								2	3							9
<i>Culaea inconstans</i>						2																		1	3
<i>Lepomis cyanellus</i>						2																			2
N	17	26	38	21	22	84	17	6	11	36	88	26	49	84	91	23	115	31	58	61	73	70	124	77	1248
Number of Species	3	3	4	2	3	12	3	2	3	3	4	4	2	5	7	2	5	5	4	3	5	6	5	4	1248

Several patterns of species presence and abundance were apparent. All specimens collected tended to be pale in color--individual melanophores were often visible rather than solid color. Densities were low in many areas. At site 5, 13 consecutive seine-hauls were made with no catch. Few fish were present in swift water over 0.3 m deep. Longnose dace were collected in areas with sand or gravel and swift current. Flathead chubs were most common in areas with sand or gravel, mud, and vegetation. Plains minnows were commonly collected in areas with vegetation. Small longnose dace were often collected with flathead chubs. Other species tended to be collected in uncommon habitats such as around beaver dams (site 6) or in small tributary streams.

Ten species collected by Reigh (1978) from the section of the Little Missouri River running from Marmarth to Medora were not collected during this study (Fig. 2.) Five of these were not particularly prevalent, having been captured at four or fewer of the 20 sites sampled by Reigh (1978). These uncommon species were the carp (*Cyprinus carpio*, 4 sites), brassy minnow (*Hybognathus hankinsoni*, 1 site), creek chub (*Semotilus atromaculatus*, 3 sites), shorthead redhorse (*Moxostoma macrolepidotum*, 2 sites), and black bullhead (*Ameiurus melas*, 1 site). The other five species were noted for their absence from the current study: sturgeon chub (*Macrhybopsis gelida*, 15 sites), river carpsucker (*Carpionodes carpio*, 7 sites), channel catfish (*Ictalurus punctatus*, 12 sites), stonecat (*Noturus flavus*, 14 sites), and sauger (*Stizostedion canadense*, 7 sites).

Six species were collected during this study that were not collected by Reigh (1978) from this section of the Little Missouri River (Table 1). Two of these are apparently new records from the Little Missouri River: northern redbelly dace (*Phoxinus eos*, 2 sites), and bluntnose minnow (*Pimephales notatus*, 1 site). These two species were not reported by Hankinson (1929), Personius and Eddy (1955), Bailey and Allum (1962), Baxter and Simon (1970), Brown (1971), Bich and Scalet (1977), Reigh (1978), or Peterka (1993). However, these two species are known from the Missouri River Basin in the Dakotas including other western tributaries of the Missouri River (Lee and Shute 1980, Stasiak 1980). The other four species were recorded

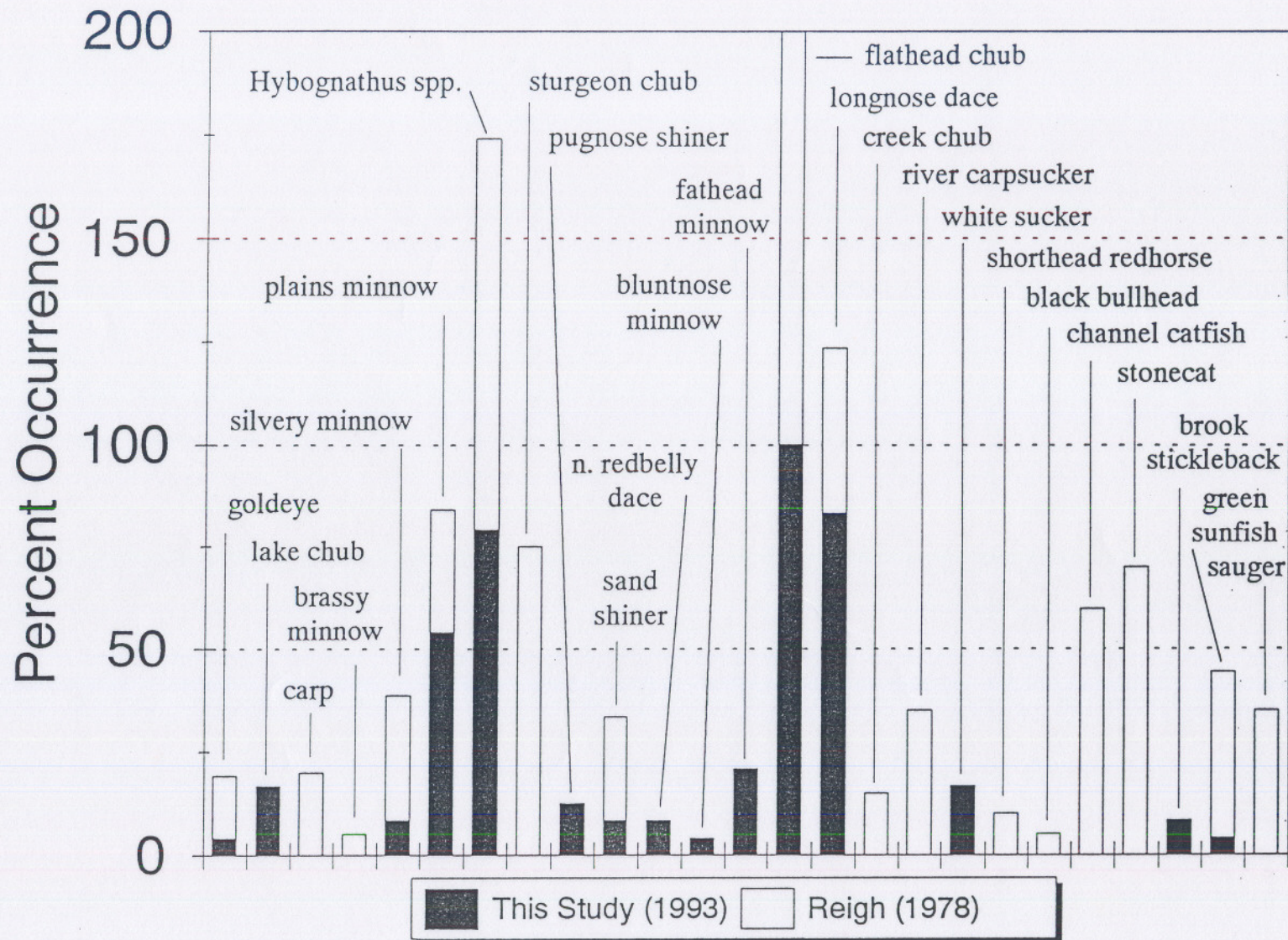


Fig. 2. Comparison of fishes collected in this study with those collected in the same stretch of river by Reigh (1978). Occurrence is the percent of total sites sampled at which a species was collected.

from the Little Missouri River by Reigh (1978) but not from the section from Marmarth to Medora: lake chub (*Couesius plumbeus*, 4 sites), fathead minnow (*Pimephales promelas*, 6 sites), white sucker (*Catostomus commersoni*, 4 sites), and brook stickleback (*Culaea inconstans*, 2 sites).

There was evidence of successful reproduction and multiple age groups for most of the species collected in this study. Length-frequency histograms for the lake chub (*Couesius plumbeus*), Mississippi silvery minnow (*Hybognathus nuchalis*), plains minnow (*H. placitus*), bluntnose minnow (*Pimephales notatus*), fathead minnow (*Pimephales promelas*), flathead chub (*Platygobio gracilis*), longnose dace (*Rhinichthys cataractae*), and white sucker (*Catostomus commersoni*) are included in Fig. 3. Multiple modes suggested the presence of different age groups, and the presence of smaller individuals indicated recent successful reproduction; although, I was not certain that in all cases such reproduction took place in 1993. Among those species with fewer than five individuals captured were: a single larval goldeye (*Hiodon alosoides*) with a length of 22 mm, three sand shiners (*Notropis stramineus*) with lengths of 42 to 45 mm, two northern redbelly dace (*Phoxinus eos*) with lengths of 32 and 35 mm, two unidentified larval minnows with lengths of 12 and 18 mm, three brook sticklebacks (*Culaea inconstans*) with lengths from 23 to 32 mm, and two green sunfish (*Lepomis cyanellus*) with lengths of 76 and 89 mm.

Collection sites were situated at 8-km intervals going downstream from Marmarth to Medora (Fig. 1). Legal and physical descriptions of the sites are given in Table 2. Water temperatures varied widely, from 15 to 22 °C, among the collection sites and tended to decrease during periods of rainfall and increase during periods of sunshine (Fig. 4). As would be expected in a flowing river, dissolved oxygen concentrations were adequate (greater than 5 mg/l) at all sites and appeared to be inversely correlated with water temperature (Fig. 4). Velocities tended to be high at all sites, ranging from 0.4 to 0.87 m/s (Fig. 5); however, due to the method of measurement used, variations in velocities among sites are not necessarily meaningful. Conductivity levels ranged from 330 to 700 micromhos/cm and steadily increased downstream

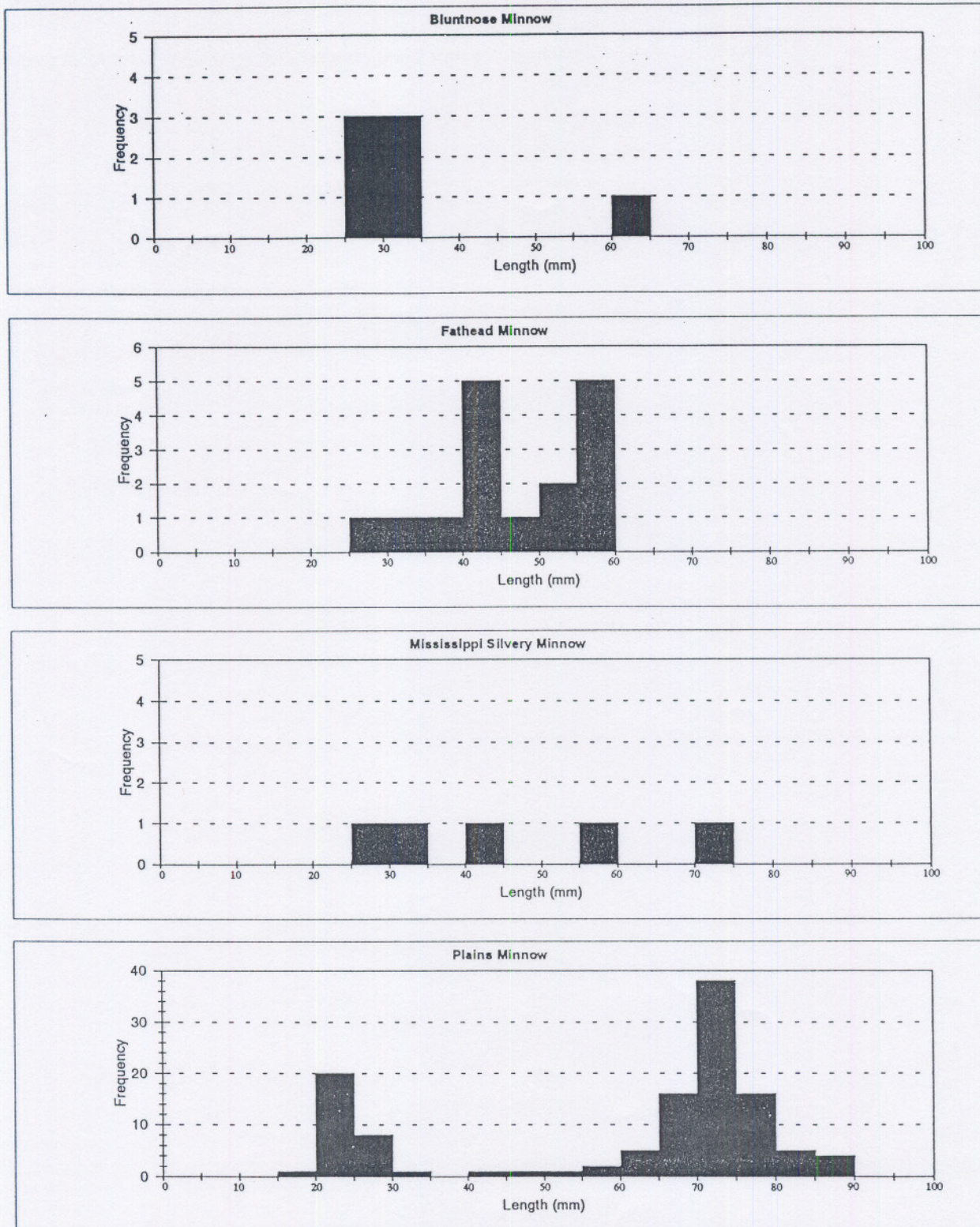


Fig. 3. Total-length frequencies of fishes collected in the Little Missouri River (scales not constant).

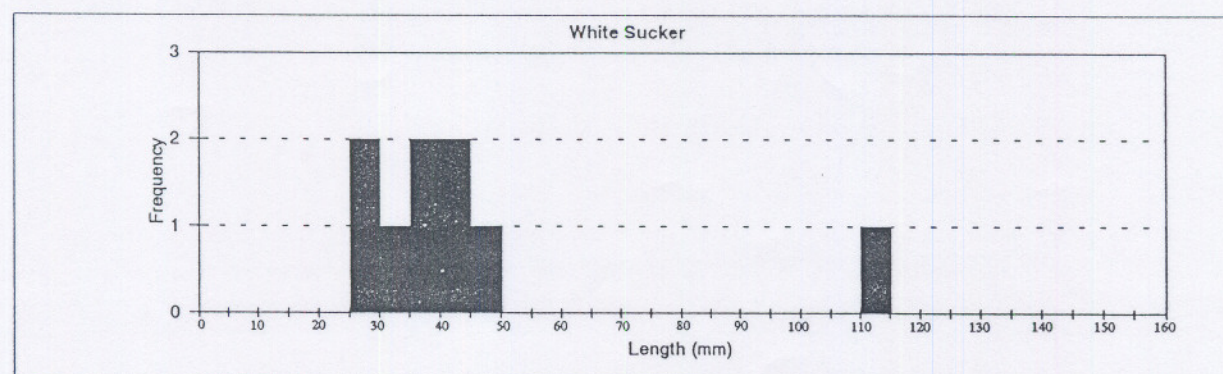
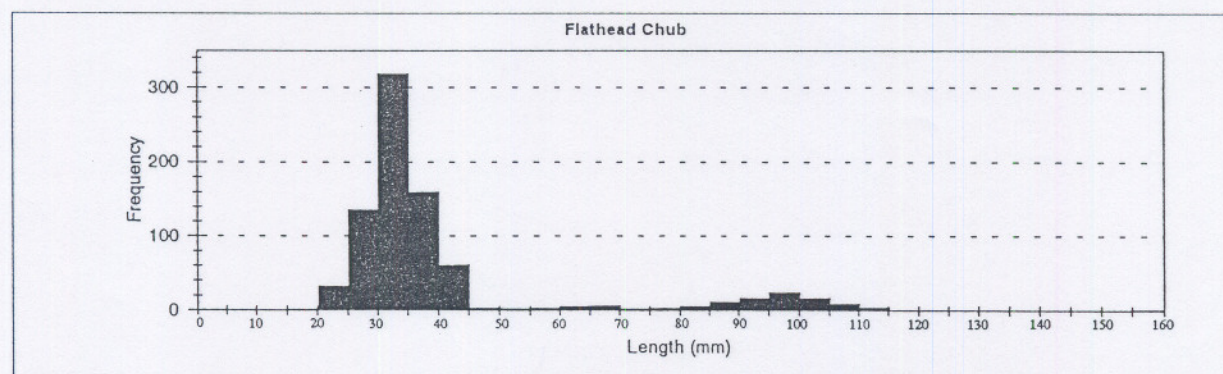
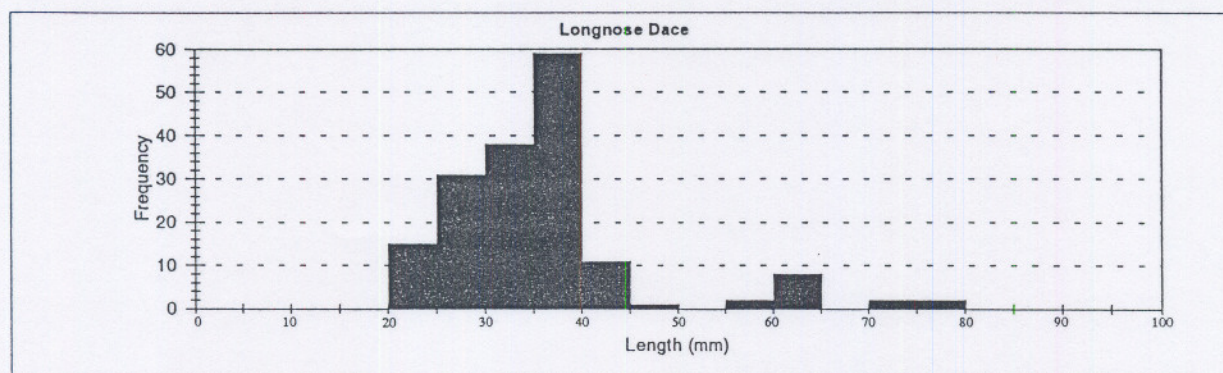
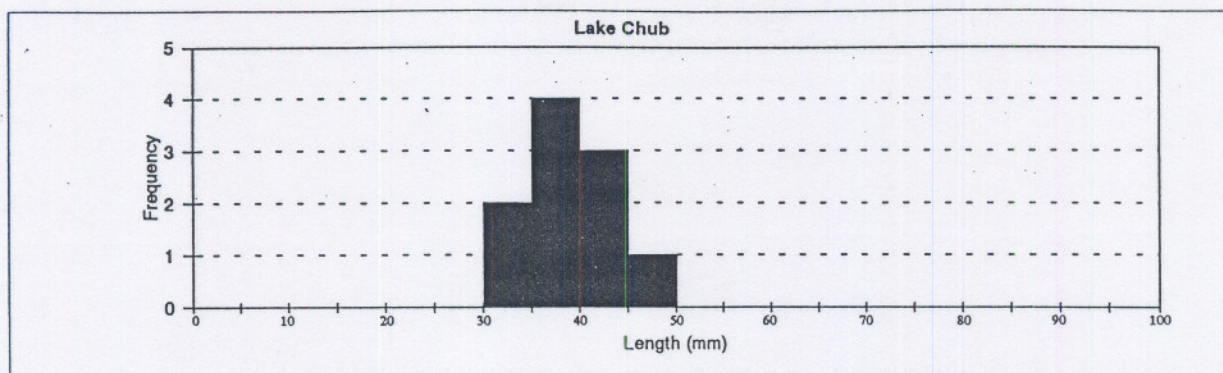


Fig. 3. Continued.

Table 2. Legal and physical descriptions of collecting sites on the Little Missouri River.

- Site 1: North Dakota: Slope county; Little Missouri River, 200 meter length of river in northeast corner of section T133N R105W S19; Collection date: 07/10/1993; Width: approx. 40 m, Depth: at least 1 m, Substrate: mud and gravel (in order of prevalence); strong hail and thunderstorm previous night, hail still on ground during sampling, river rose approx. 1 foot following storm; Vegetation: flooded young willows and cottonwoods near shore
- Site 2: North Dakota: Slope county; Little Missouri River, 200 meter length of river in northeast corner of section T133N R106W S1; Collection date: 07/10/1993; Width: approx. 50 m, Depth: approx. 1 m, Substrate: mud and gravel
- Site 3: North Dakota: Slope county; Little Missouri River, 200 meter length of river in northwest corner of section T134N R106W S24; Collection date: 07/10/1993; Width: approx. 55 m, Depth: approx. 0.8 m, Substrate: mud, some sand
- Site 4: North Dakota: Slope county; Little Missouri River, 200 meter length of river in southwest corner of section T134N R105W S7; Collection date: 07/11/1993; Width: main channel approx. 30 m, Depth: less than 1 m, Substrate: mud and gravel; Vegetation: flooded grass near shore
- Site 5: North Dakota: Slope county; Little Missouri River, 200 meter length of river in northwest corner of section T135N R105W S33; Collection date: 07/11/1993; Width: approx. 50 m, Depth: less than 1 m, Substrate: mud and gravel
- Site 6: North Dakota: Slope county; Little Missouri River, 200 meter length of river in northeast corner of section T135N R105W S29; Collection date: 07/11/1993; Width: approx. 35 m, Depth: less than 1 m, Substrate: mud and gravel
- Site 7: North Dakota: Slope county; Little Missouri River, 200 meter length of river in west-central part of section T135N R105W S14; Collection date: 07/12/1993; Width: approx. 40 m, Depth: less than 1 m, Substrate: mud, sand and gravel; Vegetation: dense flooded grass and rushes near shore
- Site 8: North Dakota: Slope county; Little Missouri River, 200 meter length of river near center of section T135N R105W S1; 07/12/1993; Collection date: 07/12/1993; Width: approx. 50 m (with mud bar), Depth: less than 1 m, Substrate: mud, sand and gravel; Vegetation: dense flooded grass along most of shoreline
- Site 9: North Dakota: Slope county; Little Missouri River, 200 meter length of river near center of section T136N R104W S31; Collection date: 07/12/1993; Width: approx. main channel 35 m, Depth: 0.5 m maximum, Substrate: sand, gravel and mud; Vegetation: flooded grasses, and flooded young willows and cottonwoods on bars

- Site 10: North Dakota: Slope county; Little Missouri River, 200 meter length of river in southwest corner of section T136N R104W S21; Collection date: 07/13/1993; Width: approx. 45 m (with sand bar), Depth: approx. 1 m, Substrate: sand, gravel and mud; Vegetation: grasses, and young willows and cottonwoods
- Site 11: North Dakota: Slope county; Little Missouri River, 200 meter length of river in northeast corner of section T136N R104W S16; Collection date: 07/13/1993; Width: approx. 35 m, Depth: over 2 m, Substrate: gravel, sand, mud, and sandstone
- Site 12: North Dakota: Golden Valley county; Little Missouri River, 200 meter length of river near center of section T137N R103W S32; Collection date: 07/13/1993; Width: approx. 50 m, Depth: approx. 1.5 m, Substrate: sand, gravel and mud; Vegetation: dense and flooded along shore
- Site 13: North Dakota: Slope county; Little Missouri River, 200 meter length of river near center of section T136N R103W S3; Collection date: 07/13/1993; Width: approx. 35 m (with bar), Depth: approx. 1 m, Substrate: sand and gravel
- Site 14: North Dakota: Slope county; Little Missouri River, 200 meter length of river in west-center of section T136N R102W S6; Collection date: 07/14/1993; Width: approx. 20 m (main channel), Depth: approx. 0.6 m, Substrate: sand, gravel and mud; Vegetation: bar with numerous seedling cottonwoods
- Site 15: North Dakota: Slope county; Little Missouri River, 200 meter length of river in southwest corner of section T136N R102W S8; Collection date: 07/14/1993; Width: approx. 30 m, Depth: approx. 1.2 m, Substrate: sand, gravel and mud; Vegetation: recently flooded cottonwood seedlings on exposed bar
- Site 16: North Dakota: Slope county; Little Missouri River, 200 meter length of river in northeast corner of section T136N R102W S3; Collection date: 07/16/1993; Width: approx. 55 m (including bar), Depth: 1 m maximum, Substrate: sand and gravel
- Site 17: North Dakota: Billings county; Little Missouri River, 200 meter length of river in east-center of section T137N R101W S19; Collection date: 07/16/1993; Width: approx. 40 m, Depth: 1 m, Substrate: sand and gravel
- Site 18: North Dakota: Billings county; Little Missouri River, 200 meter length of river in north-center of section T137N R102W S15; Collection date: 07/16/1993; Width: approx. 45 m, Depth: 0.6 m, Substrate: mud, cobbles and sand; Vegetation: willows and sedges extending into water
- Site 19: North Dakota: Billings county; Little Missouri River, 200 meter length of river in southeast corner of section T137N R102W S5,8; Collection date: 07/16/1993; Width: approx. 45 m (with bar), Depth: approx. 1 m, Substrate: gravel and sand

- Site 20: North Dakota: Billings county; Little Missouri River, 200 meter length of river in southwest corner of section T138N R102W S19; Collection date: 07/17/1993; Width: approx. 25 m (main channel), Depth: 1.3 m, Substrate: sand, gravel and mud; Vegetation: some in shallows
- Site 21: North Dakota: Billings county; Little Missouri River, 200 meter length of river near center of section T138N R102W S6; Collection date: 07/17/1993; Width: approx. 40 m, Depth: 1.1 m, Substrate: sand and gravel; Vegetation: flooded grasses near shore
- Site 22: North Dakota: Billings county; Little Missouri River, 200 meter length of river in northeast corner of section T139N R102W S21; Collection date: 07/17/1993; Width: approx. 45 m (main channel), Depth: 1.3 m, Substrate: sand, gravel and mud; Vegetation: flooded vegetation near shore
- Site 23: North Dakota: Billings county; Little Missouri River, 200 meter length of river in southwest corner of section T139N R102W S3; Collection date: 07/17/1993; Width: approx. 40 m, Depth: 1.1 m, Substrate: sand, mud and gravel
- Site 24: North Dakota: Billings county; Little Missouri River, 200 meter length of river about 150 m upstream from power line crossing river at Sully Creek Campground in section T140N R102W S34; Collection date: 07/17/1993; Width: approx. 55 m, Depth: 1.3 m, Substrate: mud; Vegetation: flooded seedling cottonwoods

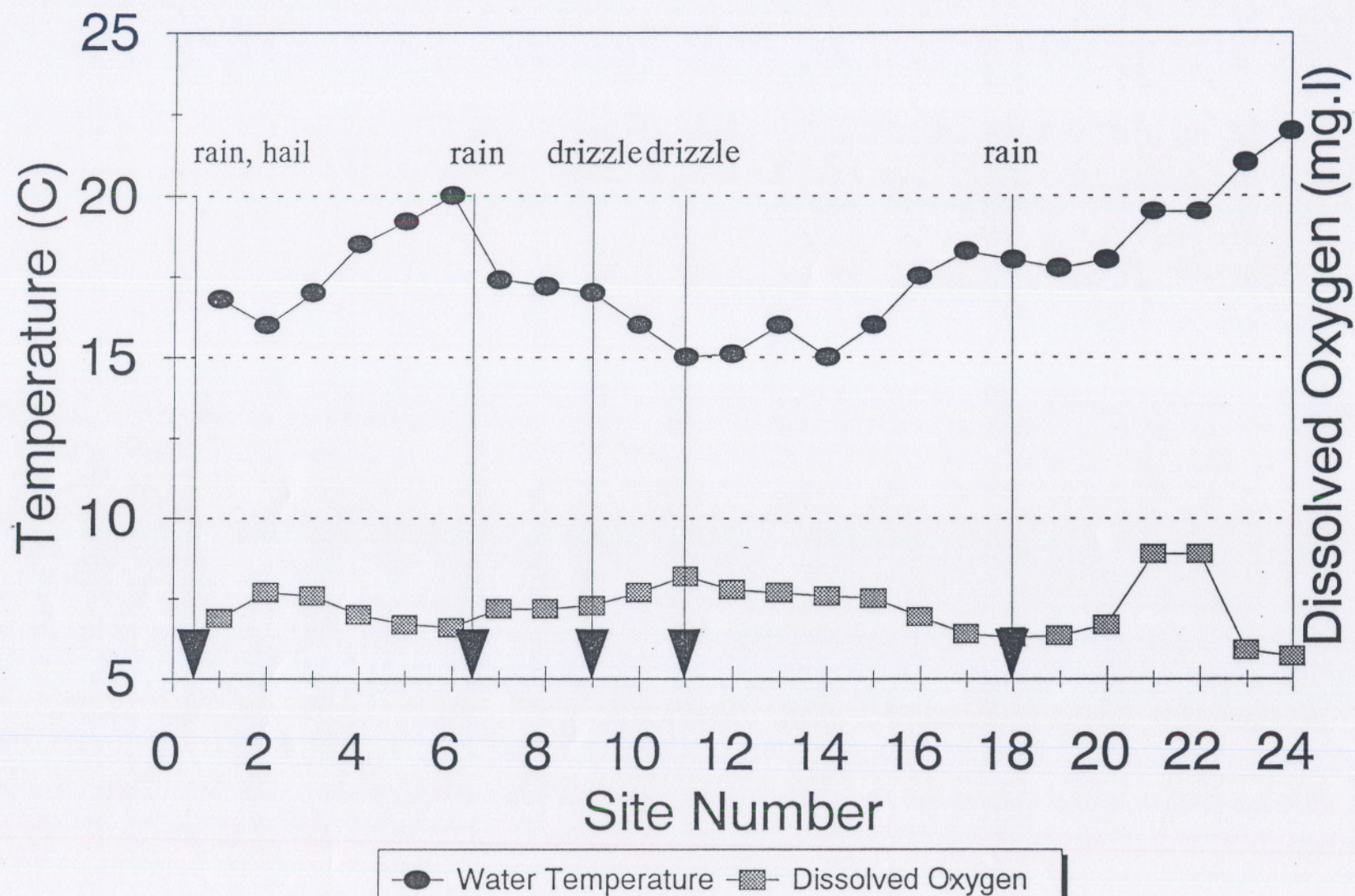


Fig. 4. Water temperature and dissolved oxygen concentrations at collecting sites on the Little Missouri River from Marmarth to Medora.

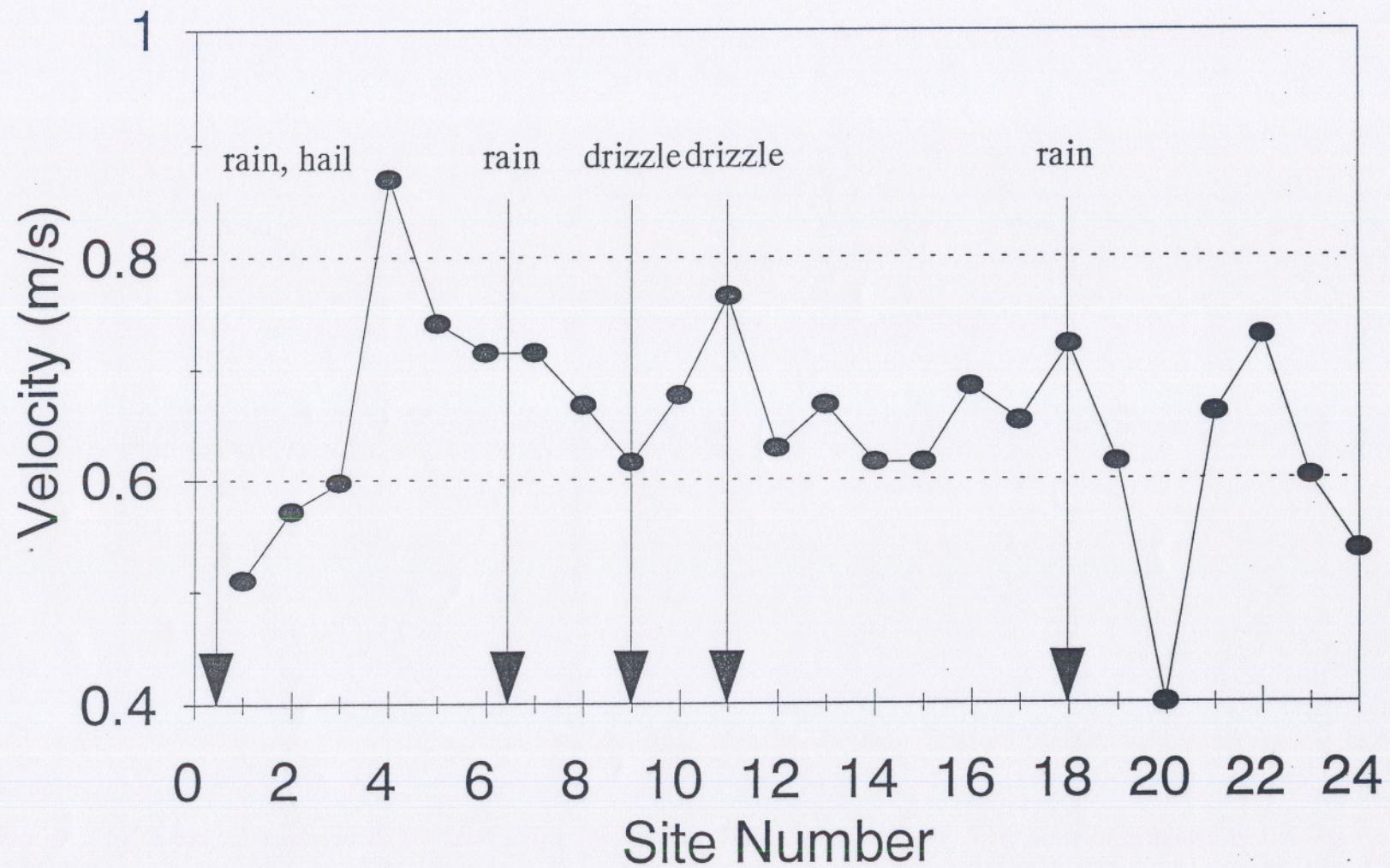


Fig. 5. Water velocity at collecting sites on the Little Missouri River from Marmarth to Medora.

(Fig. 6). Turbidity was extremely high throughout the whole survey area and tended to decrease slightly downstream. A Secchi disk became completely obscured at depths ranging from 0.5 to 2.0 m (Fig. 7). High turbidity is characteristic of the Little Missouri River even when water levels are low. The highly prevalent clay particles are small, negatively charged, and repel other particles causing them to stay in suspension even at low water velocities.

DISCUSSION

Considering the unusually high flow and current velocity during the study period, it is not surprising that certain species previously recorded from the Little Missouri River were not captured during this study. High flow across much of the River at all sites made collecting difficult at depths greater than 0.5 m. High water levels inundated vegetation at many sites making seining difficult and offering escape and cover for fishes. Receding water left mud that made collecting a challenge. At times mud depths exceeded 0.5 m with consistencies ranging from milk-shake-like to thick and clinging. Occasionally the mud was too thin to seine over and too thick to go through the seine.

Even considering the difficult seining conditions, it is unlikely that many species escaped detection. Non-flood adapted species did not persist in periods of high flow but survived in refugia or were eliminated from the river system (Minckley and Mefee 1987). In this study, all but the most flood-resistant species were reduced in number, found only in refugia, or absent from the Little Missouri River. The three most prevalent species (flathead chub, longnose dace, and plains minnow) are known to be well adapted to high flow and turbidity. The longnose dace, for example, held its position in a current of up to eight body-lengths-per-second without swimming by using the current to press it to the substrate (Facey and Grossman 1992). Not surprisingly, longnose dace were found in swifter velocities than all other species collected in this study.

Of the seven species considered to be of special concern in the region, only two were collected in the Little Missouri River from Marmarth to Medora--the lake chub and northern

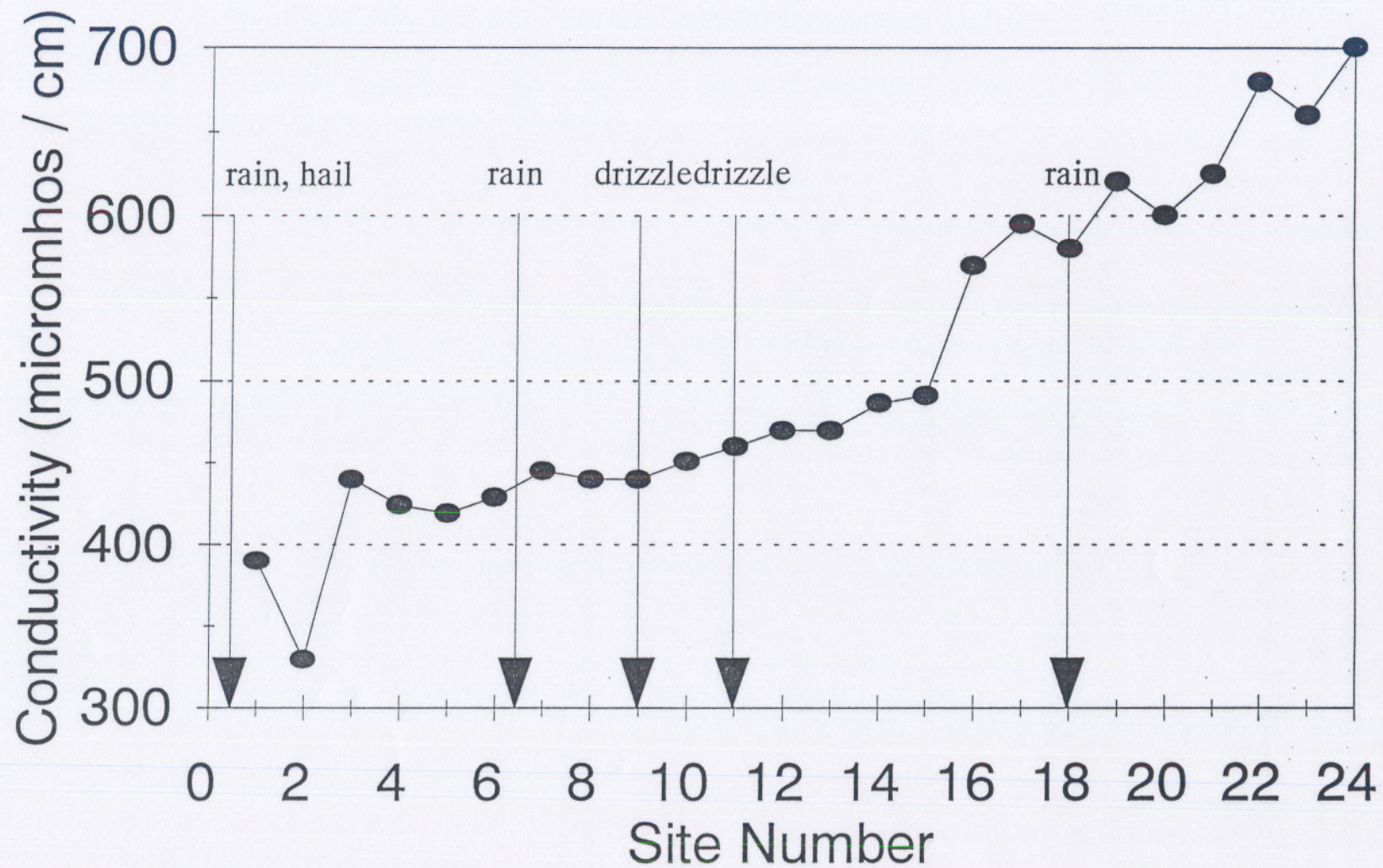


Fig. 6. Conductivity at collecting sites on the Little Missouri River from Marmarth to Medora.

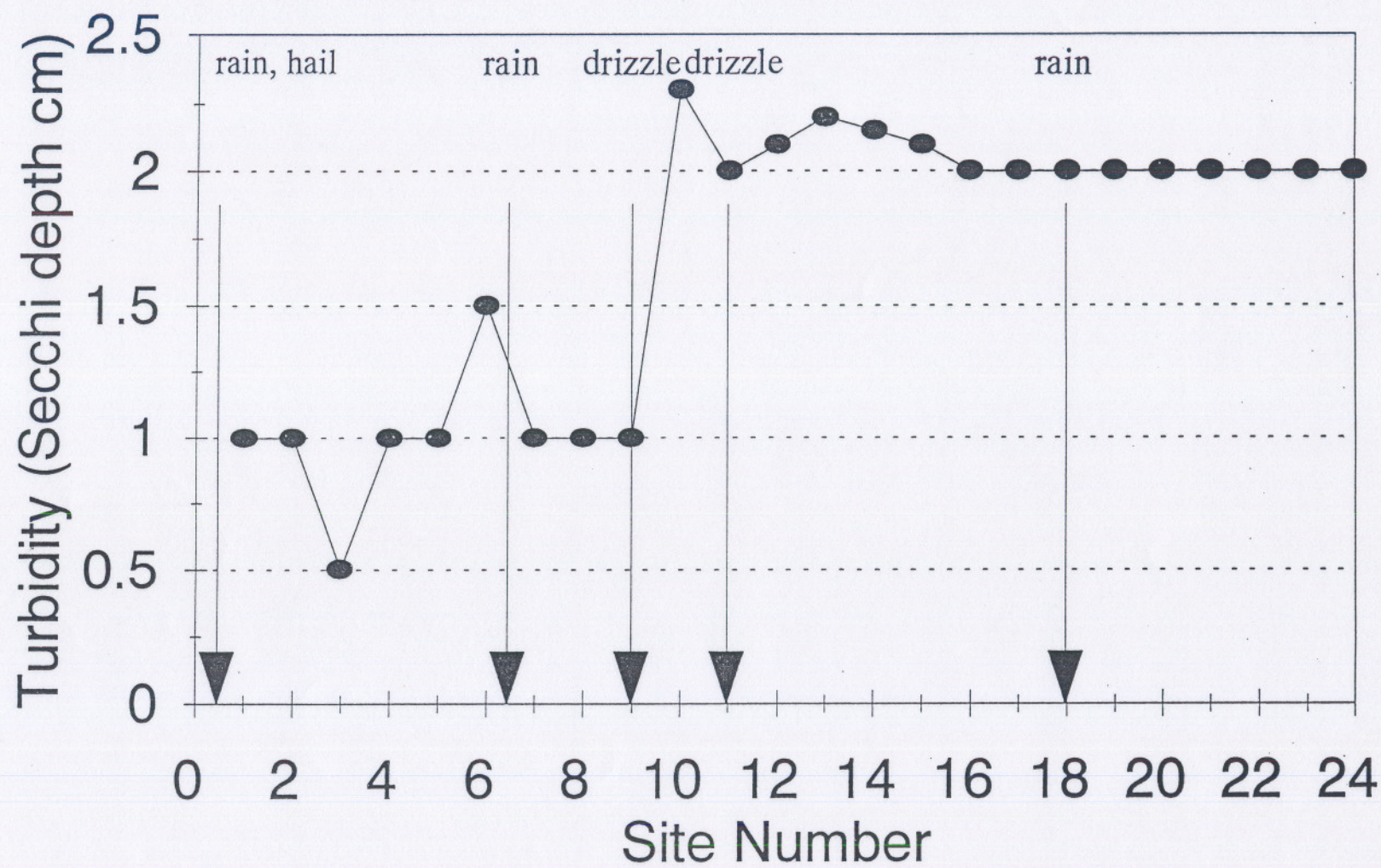


Fig. 7. Turbidity at collecting sites on the Little Missouri River from Marmarth to Medora.

redbelly dace. Neither species was common at any site nor found at numerous sites (Table 1). The northern redbelly dace apparently was not previously recorded from the Little Missouri River. Of the remaining five species of special concern, only the sturgeon chub is notable for its absence. The sicklefin chub was recorded from a single collection by Personius and Eddy (1955) in a portion of the River that has since been inundated by Lake Sakakawea. The sicklefin chub is highly specialized for life in turbid flowing streams and would not be expected to persist under lake conditions. None of the other three species (longnose sucker, quillback, and blue sucker) had been recorded from the Little Missouri River so it was not surprising that they were not found in the current study.

The absence of the sturgeon chub from the Little Missouri River is of great concern considering its abundance and prevalence in surveys as recent as the late 1970s (Reigh 1978). Not only was the sturgeon chub not found in the current study but it was not collected in other recent surveys (Peterka 1993, Werdon 1993). The sturgeon chub is currently a candidate endangered species (Werdon 1993).

What caused the apparent extirpation of the sturgeon chub from the Little Missouri River? Like the sicklefin chub, the sturgeon chub is highly specialized for life in turbid, flowing water but it tends to be found more frequently over gravel substrates rather than sand (Bailey and Allum 1962, Jenkins 1980). During this study, these conditions were common in the Little Missouri River so it did not appear that habitat alteration was responsible for their decline. Competition or predation by encroaching species did not appear to explain the extirpation of the sturgeon chub either, since the species composition had not drastically changed and no new species were present that were potential competitors or predators. The sturgeon chub also was apparently still present in the Yellowstone River (the next major western tributary to the Missouri River) as of 1993, so whatever caused the decline in the Little Missouri River must not have occurred in the Yellowstone River.

What happened to the sturgeon chub? I can only offer a hypothesis. The Little Missouri River itself has not undergone any significant modifications that would be likely causes of the

demise of the sturgeon chub; however, the closing of Garrison Dam in 1953 and the subsequent formation of Lake Sakakawea caused the inundation of the lower portion of the Little Missouri River. How could this have an effect on the sturgeon chub, particularly since it was still present in the river nearly 25 years afterward? Consider the possibility that extreme droughts made conditions in the Little Missouri River unsuitable for the sturgeon chub. It may have been unable to persist in the River during periods of intermittent flow, clearing water, and silty substrate--conditions known to periodically occur. During these periods of extreme drought the unimpounded Missouri River may have served as a refuge, continuously providing turbid, flowing conditions. The impounding of the Missouri River by Garrison Dam eliminated these riverine conditions and may have removed the last refuge for the sturgeon chub. The only additional requirement for the extirpation of the sturgeon chub from the Little Missouri River was an extended period of drought. This scenario is consistent with the survival of the sturgeon chub in the Yellowstone River which still has, at its confluence, the riverine conditions of the Missouri River as a refuge.

If the above scenario could have caused the demise of the sturgeon chub, why did other turbid-river species such as the flathead chub and the longnose dace survive? Evidence suggests that the sturgeon chub may be much more of a turbid-river specialist than these other species. It has reduced eyesight and extremely well developed facial sense organs. Davis and Miller (1967) reported that the widths of the various lobes of the brain correlate with habitat preferences. The sturgeon chub has both the most developed facial lobe (22.7 % of total brain length) and the most reduced optic lobe (12.3 % of total brain length) of 21 species of minnows examined. By contrast, the flathead chub has a facial lobe width of 14.9 % and an optic lobe width of 22.8 % of the total brain length (Davis and Miller 1967). Moore (1950) stated that the sturgeon chub may have the most well developed cutaneous sense organs of all the North American minnows. Reduced eyes, optic lobes, and well developed cutaneous sense organs are specializations for life in turbid waters.

Four other species (river carpsucker, channel catfish, stonecat, and sauger) were noted for their absence from the current survey. Since collecting conditions were difficult, and seines of the size and type used in this study are biased toward smaller, slower individuals; it is possible that these species were present but not sampled. However, none of these species is known to be flood tolerant and a reduction in numbers, or displacement would not have been unusual in response to the flood conditions of the summer of 1993. Minckley and Meece (1987) reported that carp, catfishes, centrarchids and many other species are depleted or removed by floods. They noted that in many western streams, floods actually play a role in preserving the native flood-adapted species. If these species were actually displaced by the high flow in the Little Missouri River, it is likely that they will become reestablished when conditions permit.

Periods of floods and droughts are certainly part of the ecology of the Little Missouri River so cycles in species diversity and abundance are expected over time. Ichthyological surveys by their nature give only a snap-shot view of the cycle and give no clue whether the system is stable or in flux. To really know the status of the fishes of the Little Missouri River would require additional surveys particularly at periods of normal and low flow.

The relatively unique and unaltered Little Missouri River offers an excellent opportunity to study stream ecology. For example, it appeared that the conditions of 1993 may even have given a start to a new riparian cottonwood forest to replace the existing, aging forest. Also, if the sturgeon chub had waited out the recent drought in some refugium, I would have expected that it would have begun to repopulate the River under the current flood conditions. Therefore, it appears that it may have been extirpated from the River, possibly due to construction of Garrison Dam and the subsequent removal of its drought refugium. If the sturgeon chub were reintroduced into the river, I predict that it would do well until another severe drought changed its habitat. To maintain this valuable ecosystem, care should be exercised to preserve habitats that may serve as refugia for native fishes as well as the Little Missouri River itself.

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