The status and distribution of the sicklefin chub in the middle Missouri River, Montana
by Grant Gerald Grisak

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Fish & Wildlife Management
Montana State University

Abstract:
This study examined the status and distribution of the sicklefin chub in the middle Missouri River in Montana. Seining in peripheral zones produced only four sicklefin chub. A trawling technique was developed to sample deep water zones of the river, which significantly increased the number of sicklefin chub sampled (n = 298). Sicklefin chub catch per trawl was as high as 1.28 in Section 3 of the study area. The distribution range above Fort Peck Reservoir was 83.7 km spanning from Cow Island to near CK Creek. Habitat variables in peripheral zones included mean depth of 0.50 m, mean velocity of 0.32 m/s and substrate composition of 34% sand, 16% silt and 50% rock. Habitat variables at successful sicklefin chub catch sites in deep-water zones included mean depth of 3.41 m, mean bottom velocity of 0.58 m/s and substrate composition of 70% sand, 2% silt, 13% rock and 15% mixed material. Sicklefin chub ages 1 through 4 were sampled. Backcalculation was used to validate ages determined by reading scales. Twenty-two gravid females and 11 ripe males were sampled between July 18 and August 16. Probable spawning habitat had water depth of 1.98 m, bottom velocity of 0.58 m/s and rock 2.54-5.05 cm diameter. The youngest fish exhibiting reproductive characteristics were age 2. Total body length ranged from 29 to 109 mm. Simple linear regression analysis indicated a positive relationship between total body length and weight. Condition factor ranged from 0.243 to 0.964. Head measurements were used as a means to differentiate small (< 50 mm) sicklefin chub from small sturgeon chub. Annual monitoring of this population should be conducted by trawling at Knox Bottoms (RM 146.5), Sand Creek (RM 158.9) and Sevenmile Creek (173.5). The findings of this study suggest that additional information should be gathered before listing the sicklefin chub as an endangered species in the. middle Missouri River in Montana.

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A thesis submitted in partial fulfillment
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APPROVAL

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Grant Gerald Grisak

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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ABSTRACT

This study examined the status and distribution of the sicklefin chub in the middle Missouri River in Montana. Seining in peripheral zones produced only four sicklefin chub. A trawling technique was developed to sample deep water zones of the river, which significantly increased the number of sicklefin chub sampled (n = 298). Sicklefin chub catch per trawl was as high as 1.28 in Section 3 of the study area. The distribution range above Fort Peck Reservoir was 83.7 km spanning from Cow Island to near CK Creek. Habitat variables in peripheral zones included mean depth of 0.50 m, mean velocity of 0.32 m/s and substrate composition of 34% sand, 16% silt and 50% rock. Habitat variables at successful sicklefin chub catch sites in deep-water zones included mean depth of 3.41 m, mean bottom velocity of 0.58 m/s and substrate composition of 70% sand, 2% silt, 13% rock and 15% mixed material. Sicklefin chub ages 1 through 4 were sampled. Backcalculation was used to validate ages determined by reading scales. Twenty-two gravid females and 11 ripe males were sampled between July 18 and August 16. Probable spawning habitat had water depth of 1.98 m, bottom velocity of 0.58 m/s and rock 2.54-5.05 cm diameter. The youngest fish exhibiting reproductive characteristics were age 2. Total body length ranged from 29 to 109 mm. Simple linear regression analysis indicated a positive relationship between total body length and weight. Condition factor ranged from 0.243 to 0.964. Head measurements were used as a means to differentiate small (< 50 mm) sicklefin chub from small sturgeon chub. Annual monitoring of this population should be conducted by trawling at Knox Bottoms (RM 146.5), Sand Creek (RM 158.9) and Sevenmile Creek (173.5). The findings of this study suggest that additional information should be gathered before listing the sicklefin chub as an endangered species in the middle Missouri River in Montana.

INTRODUCTION

Sicklefin chub (*Macrhybopsis meeki*) have rarely been encountered over the past decade, and are suspected of being in danger of extinction throughout their historic range (Werdon 1993_a). Most observations have been incidental to other research and management endeavors. Like other large river fishes, the decline of the species is thought to be due to channelization, irrigation diversion and mainstem impoundments (Reich and Elsen 1979, Pflieger and Grace 1987, Werdon 1993_a). These changes ultimately affect fish abundance by disrupting the natural hydrograph, reducing turbidity, and reducing organic matter availability (Hesse 1993).

The historic range of the sicklefin chub includes the Missouri River and select tributaries from central Montana to southern Illinois, and parts of the lower Mississippi River. The species is documented as currently being present in Missouri (Pfleiger and Grace 1987), Nebraska (very rare) (Hesse 1993, Larry Hesse, GPRRC Consultants, personal communication, 1994), North Dakota (Fred Rykman, North Dakota Game & Fish, personal communication, 1994) and Montana (Gardner and Stewart 1987, Tews 1994). There are seven additional states within the historic range of the sicklefin chub where the population status is not known (Werdon 1993_a).

Sicklefin chub were first reported in Montana in 1980 in the Missouri River above Fort Peck Reservoir (Gardner and Berg 1980) and subsequently sampled downstream of Fort Peck Dam (Gardner and Stewart 1987, Tews 1994). Prior to this the farthest known upstream distribution was the Little Missouri River in North Dakota (Reich and Elsen 1979).

The sicklefin chub is listed as a Species of Special Concern, class B, by the State of Montana indicating that it occurs in limited numbers and/or habitats, and elimination from this area would be at least a moderate loss to the gene pool (Hunter 1994). The United States Fish & Wildlife Service (USFWS) has designated it a Category 1 Species, meaning there are sufficient scientific data available to support a listing proposal (USFWS 1994). In 1993 the USFWS prepared a status report which recommended field studies in the Wild and Scenic section of the Missouri River in Montana to determine the abundance and distribution of the species. In May 1994 the organization American Rivers petitioned the USFWS for Federal protection of the sicklefin chub under the Endangered Species Act of 1973 (Great Falls Tribune, July 1994). Following the filing of the petition, this study was initiated in the Missouri River above Fort Peck Reservoir, which is the longest free flowing section of the Missouri River, to investigate the status and distribution of the sicklefin chub.

The objectives of the study were to: (1) determine the longitudinal distribution and abundance of sicklefin chub within a 160 km reach of the Wild and Scenic River section of the middle Missouri River above Fort Peck Reservoir , (2) determine habitat and species association of sicklefin chub and (3) describe their vital population statistics (length, weight and age).

STUDY AREA

The study area was located in north-central Montana on the middle section of the Missouri River (Figure 1). It consisted of a 160 km reach from the Judith River to the delta area of Fort Peck Reservoir near Beauchamp Creek. The river flows through rugged breaks which are well known for scenic vistas and unique fish and wildlife resources. Recreational use is predominantly canoeing, paddlefish snagging and hunting. The entire length of the study area is protected under Federal law. The first 98 km is classified as National Wild and Scenic River and is administered by the Bureau of Land Management. The lower 77.2 km runs through the Charles M. Russell National Wildlife Refuge and is administered by the U. S. Fish & Wildlife Service. There is a 9.8 km overlap in jurisdiction between the two agencies. The study area was selected because sicklefin chub were known to occur here but little was known about the population status or habitat use (Gardner and Berg 1982).

The middle Missouri River is influenced by nine upstream impoundments and by Fort Peck Reservoir in its downstream reach. This is the longest free flowing stretch of the Missouri River mainstem, and is the least modified throughout the drainage (Berg 1981). This section of the basin drains roughly

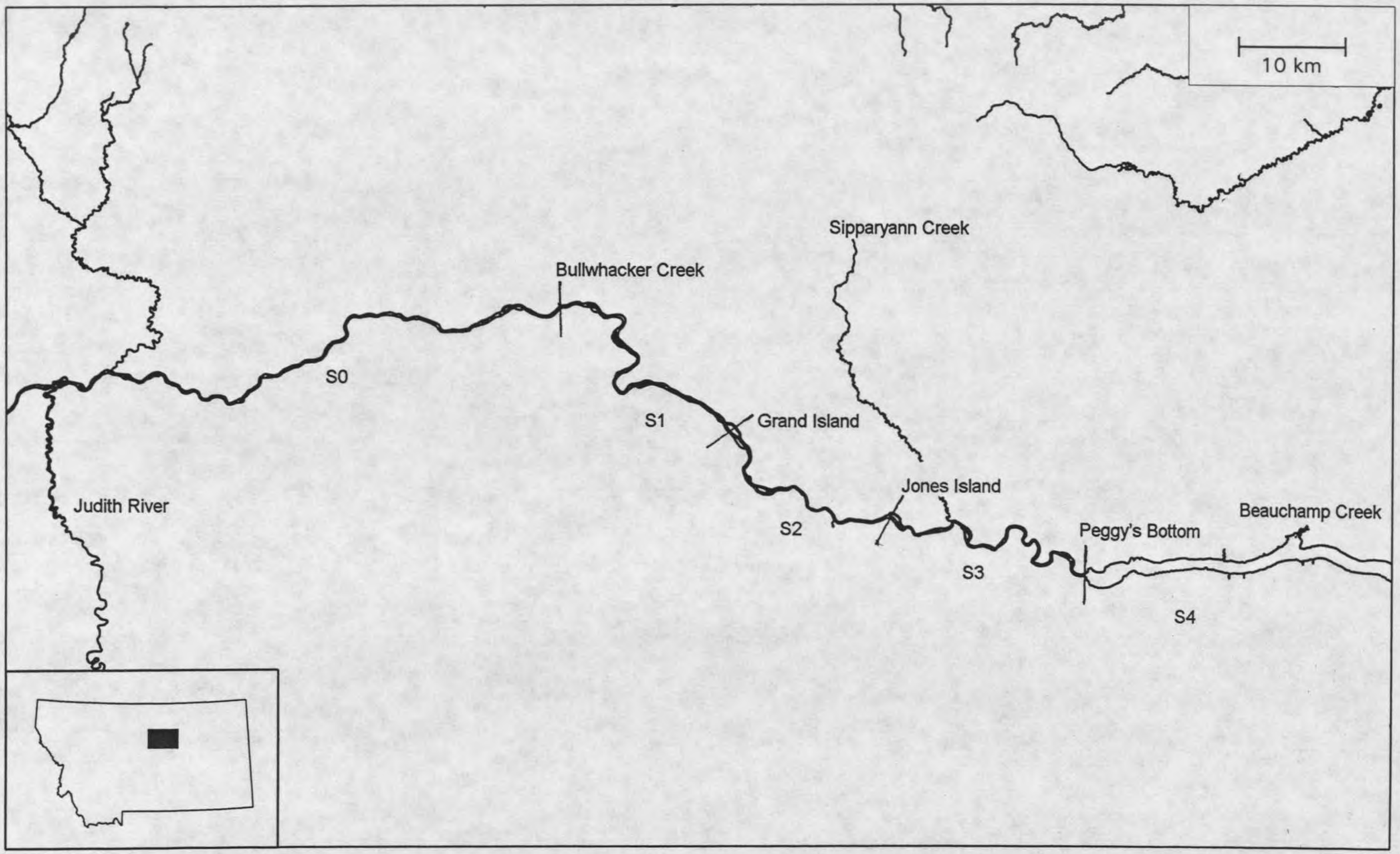

Figure 1. Map of the study area, middle Missouri River, Montana.

110, 000 km^2 . The stream gradient is approximately 0.7 m/km throughout the study area (Berg 1981).

The study area was divided into five longitudinal sections based on differences in channel morphology and associated physical characteristics (Figure 1). Section 0 spanned 54.7 km beginning near the Judith River confluence (RM 88) and continuing to near Bullwhacker Creek (RM 122). The channel is very stable, substrate is predominantly large rock with some areas of gravel, and depths are generally less than 2.4 m. Section 1 marked the uppermost known range of the sicklefin chub. It spanned 27.9 km between Bullwhacker Creek (RM 122.1) and Grand Island (RM 139.5). The channel is well defined and armored. Substrate is predominantly gravel with some areas of large rock. Depths are generally no greater than 2.4 m. One significant geologic feature is present near the middle of Section 1. A gradual transition of subterranean parent material occurs between the Eagle Creek sandstone and Bear Paw shale formations resulting in downstream decrease in gradient, finer channel substrate and widening of the floodplain. Section 2 spanned 21.6 km beginning at Grand Island (RM 139.6) and continued down to Jones Island (RM 153). The channel meanders and has point bars, cut banks and numerous shifting island complexes. Predominant substrata appear as intermittent areas of gravel and sand. Depths are generally no greater than 6.7 m. Section 3 spanned 18.8 km beginning at Jones Island (RM 153.1) and continued down to Peggy's

Bottom (RM 171.9). The channel is very dynamic and meanders throughout the entire floodplain. Cut banks and point bars are common throughout with some islands present. Substrate is predominantly sand with a few isolated areas of gravel. This section illustrates the impoundment effects of Fort Peck Reservoir and actually lies within its historic delta. Depths are as great as 11.6 m. Section 4 marks the farthest known downstream distribution of sicklefin chub above Fort Peck Reservoir. It spans 24.1 km beginning at Peggy's Bottom (RM 172) and continues downstream to Beauchamp Creek (RM 187). The channel is straight and water velocity is much lower than upstream sections. This section is considered to be the uppermost portion of Fort Peck Reservoir. Substrate is predominantly sand with areas of silt deposition. Depths are generally no greater than 5.5 m. In 1995 the study area was reduced to include only sections 1,2,3 and 4 in an effort to concentrate sampling within the known distribution range of the sicklefin chub. Mean channel width throughout the study area was 197 m (standard deviation (SD) 72.8) and ranged from 76 to 455 m.

METHODS

Fish and Habitat Sampling -1994

The entire study area was divided into 93 1-mile sampling units based on Bureau of Land Management river maps (Bureau of Land Management 1994) which have been used as the standard reference for management and research in the area. Twenty-four units were randomly selected for seining in the peripheral zone of the river in 1994. Ninety-two seine hauls were made throughout 23 of the 24 sites. One site was eliminated, and four others were partially eliminated due to poor seining conditions.

Fish were sampled with a common sense minnow seine (Little et al. 1984). It was 15.2 m long, 1.2 m high and had 6.35 mm mesh with a bottom lead line and a top float line. At each site two seine hauls were made along both banks, one directly above the boat landing, and one directly below. Seining near the boat landing site was not a concern as Paloumpis (1958) illustrated that increased activity in the vicinity of a seining site did not negatively influence catch rates. Two seiners were positioned near each other upstream of the site, each holding half of the net. The procedure began with the two briskly walking away from each other and slightly downstream while deploying the seine perpendicular to the flow as they parted. Seiners moved apart only about 10 m to ensure the seine was forming a bag and walked quickly downstream, slightly faster than the flow of the river. Near the end of the site, the seine was pivoted on the innermost axis and retrieved towards the shore. After each seine haul, length and width of the haul were measured with a 30.5 m tape. Habitat measurements were made at three points along two lateral transects established within the area seined, one at 25% and one at 75% of the distance seined. A Price current meter was used to measure velocity at the three points along each transect. Depth was measured with a top-setting rod to the nearest inch and subsequently converted to metric. Dominant substrate was determined by visual observation or feeling substrate diameter at each point along the transect and assigned a corresponding number code (Table 1).

Fish sampled were enumerated and identified to species with the exception of *Hybognathus spp.* (western silvery/plains minnow) and *Stizostedion spp.* (sauger/walleye) which were difficult to differentiate in the field. Sicklefin chub and sturgeon chub (*Macrhybopsis gelida*) were weighed to the nearest 0.1 g on an Ohaus portable electronic balance and total length was measured in millimeters on a small measuring board. Scale samples were collected from the left side of fish above the lateral line at the mid-point between the nape and dorsal fin and stored in scale envelopes. Pressure was applied to the abdomen of each specimen to document evidence of milt or eggs. Males that released milt were termed ripe and females that had visible signs of eggs in the vent were termed gravid. Following examination specimens were released.

Table 1. Substrate type codes, material description and particle diameter developed for substrate classification.

Code	Material description	Particle diameter (cm)
0	Silt	Silt
1	Sand	Sand
2	Small gravel	0.64-2.54
3	Medium gravel	2.54-5.08
4	Large gravel	5.08-7.62
5	cobble	7.62-15.24
6	boulder	> 15.24

Deep water zones were sampled with a beam trawl, similar to one used successfully to collect juvenile white sturgeon on the Columbia River (Beamesderfer and Nigro 1994). During 1994 trawling techniques were developed and no formal sampling protocol was followed. Rather, I conducted 148 trawls within a 128.72 km reach of river (RM 97 to RM 177) in an effort to describe longitudinal distribution of the sicklefin chub.

The trawl consisted of a metal sled frame measuring 2 m wide by 0.5 m high. The net was 5.5 m long with a 3.8 cm mesh outer chafing net and 3.2 mm mesh inner liner. The cod end was 16.5 cm in diameter. The trawl was equipped with a "rock hopper" lead line having 40 leads and 12 rubber discs to aid in trawling over rock. Three floats were attached to the top of the net to keep the gape open.

The trawl was deployed from a 5.5-m aluminum Wooldridge boat with a 150 horsepower Evinrude outboard jet unit. The boat had a standard electrofishing safety rack on the front. Trawling was conducted from the bow of the boat while traveling downstream in reverse. The trawl was secured to the boat with two, 12.2 m-long, 9.5 mm-diameter braided nylon ropes attached to the base of the shocking rack. A small float with 9.15 m of rope was attached to the crossbar of the trawl to mark its position when in the water.

When the trawl was deployed, a buoy marker was set to identify the upper boundary of the area sampled. The boat engine was accelerated in reverse to 2000 rpm and two technicians deployed the trawl net in the water allowing it to inflate. The entire trawl was then submerged and the ropes were let out evenly to prevent the trawl from turning sideways or flipping. The engine speed was maintained so the boat traveled slightly faster than the flow of the river to keep the net inflated, and generally did not exceed 2500 rpm. When the tow was completed, a second marker buoy was deployed to mark the lower sampling boundary. Boat speed was reduced and the two technicians began retrieving the ropes quickly and evenly to prevent the net from deflating or getting tangled on the sled frame. When the trawl reached the boat, the speed was increased in reverse to prevent the net from drifting under the boat and being drawn into the jet unit. The technicians retrieved the sled frame and net from the water and placed it on the shocking rack. Materials in the net were flushed to the cod end and emptied into a bucket of water.

All fish captured in the trawl were enumerated and identified. Length and weight were recorded, and scales were taken from sicklefin chub larger than 50 mm. Specimens were released with the exception of a few collected for museum purposes.

Depth, substrate and bottom velocity were measured at 25% and 75% of the distance trawled. A Ranging Rangomatic model 1200 range finder was used to measure the distance between the marker buoys. Depth was recorded using an Impulse electronic sonar device mounted to the hull of the boat. A Marsh-McBirney model 201 portable water current meter was used to measure velocity. Three velocity readings were taken from each side of the boat, one near the river bottom, one at 80% depth and a third at 20% depth. An aluminum tube 6.1 m in length was used to probe the river bottom to determine substrate composition (Table 1). This method was tested in areas of known substrate and found to provide accurate description of dominant substrate material.

Fish and Habitat Sampling -1995

Due to the low success of sampling the peripheral zone with a seine in 1994, sampling with a trawl in deep water zones was the primary method used in 1995. The study area for 1995 was reduced to concentrate sampling in areas where sicklefin chub were sampled in 1994. These areas were exclusively within sections 1,2,3 and 4 (RM 128.4 to RM 177.5) (Figure 1). A weighted average of sicklefin catch per trawl haul (CPUE, catch per unit effort), in each section, during 1994, was used to distribute sampling effort in 1995 (Table 2). Given the time allowed for sampling, it was determined that 150 trawls could be conducted, 3 at each of 50 sites. Sections 1,2,3 and 4 were divided into 649 sampling units that corresponded to 0.10 mile increments. A simple random sample without replacement design was used to select the 50 sites using a weighted number of units from each section based on the success in each section in 1994. Due to the low number of units allotted for sections 1 and 4, three units were taken from sections 2 and 3 and added to 1 and 4.

Average distance trawled during the 1994 season was 180 m (68 -366 m) and served as a standard for the procedure. Three 180 m trawls were conducted at each site, one at 25%, 50% and 75% of the channel width. A four sided die was used to randomize the order in which the three would be trawled.

Table 2. Sicklefin chub (SFC) catch per trawl haul (CPUE) by section from 1994 used to assign sampling effort in 1995, middle Missouri River, Montana.

	Distance in km	SFC catch / trawl haul in 1994	% of total catch (84)	# of stations as a % of 50 avail. in 1995	Adjusted # of stations
Section 1	27.9	2/22	2.4	2	5
Section 2	21.6	29/51	34.5	17	14
Section 3	18.8	51/39	60.7	30	27
Section 4	24.1	2/4	2.4	2	5

In 1995 I also sampled upstream of section 0 in an effort to expand the known distribution range of the species. The sites were chosen arbitrarily over 142 km beginning at Fort Benton (RM 1) and continuing downstream to the Judith River (RM 88). Portions of the Teton River were also seined to update historic records.

Temperature and Discharge

A Taylor continuous-recording 30 d thermograph was installed near the middle of the study area directly downstream from the Fred Robinson Bridge. The thermograph was monitored throughout the study by Fish, Wildlife & Parks field personnel. In 1995 the data were compromised when unusually high discharge in June deposited 0.61 m of sand over the probe. Daily "spot" temperature data collected by U.S. Geological Survey field personnel were used as a substitute (USGS 1995_b).

Discharge data were obtained from the United States Geological Survey - Landusky gauging station located at Fred Robinson Bridge (USGS 1994, USGS 1995_a). This station recorded daily minimum, maximum and mean discharge of the river in cubic feet per second. A 25 cm diameter Secchi disc was used daily to measure turbidity at 10:00 a.m.

Age

Sicklefin chub scale samples were processed at Montana Department of Fish, Wildlife & Parks fish aging lab in Bozeman, Montana. Imprints made on acetate sheets were viewed on a Northwest Microfilm model 90 projector at 72 power magnification to determine age. Scales were also used to backcalculate the average length at age.

Fish Identification

Due to similarity of sicklefin and sturgeon chub < 30 mm in total length, preserved specimens were observed under a Bausch & Lomb model ASZ30L2 binocular microscope at 300 power and dissected to remove pharyngeal teeth for species identification (sicklefin 0,4-4,0 sturgeon chub 1,4-4,1). Head length measurements were also used to differentiate small sicklefin and sturgeon chub (Pflieger 1975). For sturgeon chub, distance from snout to eye (a) and distance from eye to rear edge of operculum (b) are nearly equal, whereas with sicklefin chub, measurement (a) is "considerably less" than measurement (b) (Pflieger 1975, p. 102). A random sample of *Hybognathus spp.* was also collected for positive identification in the lab. Specimens were viewed under 40 power magnification with a Bausch & Lomb model ASZ30L2 binocular microscope to remove the head and view the configuration of the basioccipital process. The western silvery minnow (*Hybognathus argyritus*) has a configuration that broadens in a triangular fashion at the posterior end of the process, while the plains minnow (*Hybognathus placitus*) has a uniform rectangular configuration (Gould 1994_b). Positive identification of fathead minnow (*Pimephales promelas*) and lake chub (*Couesius plumbeus*) was made by examining the peritoneum and making scale counts, respectively (Gould 1994_b).

Data Analysis

Statistical analyses were conducted using the Statistical Analysis System (SAS 1991). A Wilcoxon-Mann-Whitney nonparametric rank sum test was used to compare depth and bottom velocity differences between successful sicklefin chub catch sites and unsuccessful catch sites (Conover 1980, Iman 1994). A Kruskal-Wallis non-parametric analysis of variance (ANOVA) test was used to determine if there were significant differences in catch rates of sicklefin chub among the five sections of the study area. Parametric ANOVA was considered in determining significant differences in catch rates with respect to the individual habitat features of depth, substrate and bottom velocity, but lack of homogeneity in variance precluded its use (Neter et al. 1990, Iman 1994). Simple linear regression analysis was used to determine if there was a significant relationship between length and weight of sicklefin chub. It was also used to determine the relationship between habitat variables and catch rates of sicklefin chub in each section. This was done by ordinally arranging the substrate, depth and bottom velocity measurements and regressing catch rates of sicklefin chub with each habitat variable. Backcalculation of growth was conducted using Weisberg's (1989) computer program for analyzing the growth of fish. The Fulton-type index of well being was used to assess condition (weight at length) of the sicklefin chub population (Anderson and Gutreuter 1992). Condition (K) was calculated as follows:

$$K = \frac{W}{L^3} \times 100{,}000$$

where W represents weight, L^3 is the length of the fish cubed and 100,000 is a standard scaling constant. Thirteen length groups having 5 mm intervals were established to provide a more detailed description of sicklefin chub condition.

RESULTS

Discharge and Temperature

During the study period in 1994 (July 6 - August 18) mean river discharge was unusually low at 143.5 m^3/s (5000 cfs) and ranged from 126.2 m^3/s (4460 cfs) to 163.6 m^3/s (5780 cfs). It remained fairly constant during both the seining and trawling surveys (Figure 2). In 1995 peak discharge was more than six times greater. Mean discharge during the sampling period (July 18 - August 31) was 342.2 m^3/s (12,000 cfs), ranging from 246.2 m^3/s (8,700 cfs) to 693.4 m^3/s (24,501 cfs)(Figure 3). On June 8, 1995 discharge reached 905.6 m^3/s (32,000 cfs) which was the greatest discharge experienced in the area for 13 years (Mel White, USGS, Helena, Montana, personal communication, 1996). The 1995 hydrograph had three major peaks over a 3 month period compared to only one major peak in 1994. The most dramatic change occurred in early May 1995 when discharge more than doubled in a 4 d period from 288.7 to 639.6 m^3/s (10,200 cfs to 22,600 cfs).

Mean daily temperature during the sampling period in 1994 was 18.5 °C ranging from 12 °C to 23.5 °C. Mean temperature in 1995 was 21.8 °C ranging from 18 to 28 °C (USGS 1995_b). Mean Secchi reading during 1995 was 27.7 cm

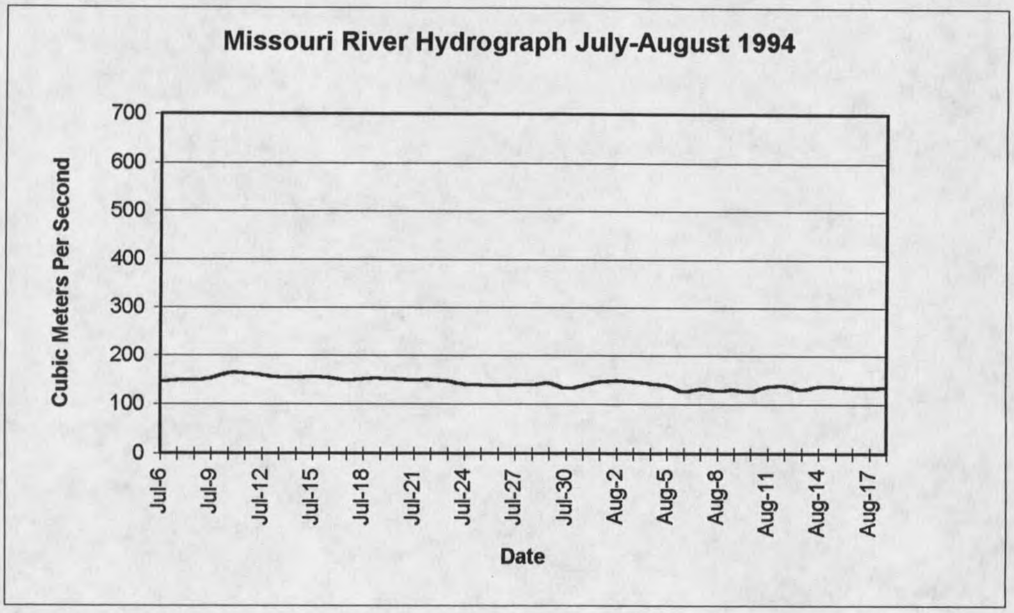

Figure 2. Average daily discharge of the Missouri River measured at the Landusky gauging station during the study period, July 6 -August 18, 1994. (U.S. Geological Survey 1994).

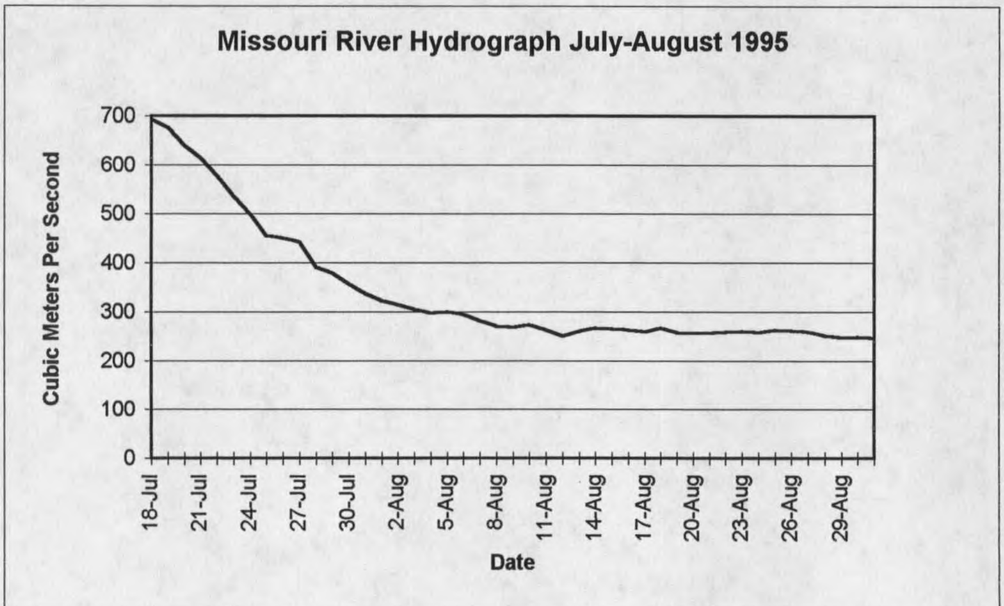

Figure 3. Average daily discharge of the Missouri River measured at the Landusky guaging station during the study period, July 18 -August 31, 1995. (U.S. Geological Survey 1995).

ranging from 10.2 on July 18 to 58.4 cm on August 23, 1995 (SD 13.8).

Fish Abundance and Distribution

I sampled 6,470 fish during the study, representing 30 species from 12 families (Appendix A, Table 14).

Peripheral Zone

I conducted 141 seine hauls throughout the study area during 1994. A total of 5,095 fish representing 23 species was sampled (Table 3). Flathead chub was the most abundant species comprising 45% of the total catch. Only four sicklefin chub (0.08% of total catch) were sampled by seining in 1994; all were in section 1 (Figure 1) at three different sites. Of the 23 species sampled, sicklefin chub ranked 15th in abundance. Average depth at the three capture sites was 0.55 m with a range of 0.41 to 0.75 m. Average velocity was 0.35 m/s ranging from 0.21 to 0.45 m/s. Substrate material consisted of silt, small gravel and medium gravel. Two of the specimens were sampled from a backwater. Mean depth at all seining sites in the peripheral zone was 0.50 m and ranged from 0.19 to 0.86 m (SD 0.15). Mean velocity was 0.32 m/s and ranged from 0 to 0.75 m/s (SD 0.15). Average distance seined was 35.2 m ranging from 10 to 65 m (SD 10.8). Average width was 9.9 m ranging from 7 to 14 m (SD 2.5). The average area covered per seine haul was 348.5 m^2.

Table 3. Fish species composition and abundance from seining both experimental and randomly chosen sites in the middle Missouri River, Montana 1994.

Species	Number	Relative abundance (%)
Flathead chub	2,296	45
Emerald shiner	806	16
Hybognathus spp. (western silvery/plains minnow)	727	14
Carp [a]	410	8
Longnose sucker	227	4
Stizostedion spp. (sauger/walleye) [a]	175	3
Lake chub	169	3
Shorthead redhorse sucker [a]	136	3
Goldeye [a]	41	0.70
Fathead minnow	32	0.63
River carpsucker [a]	23	0.45
Longnose dace	20	0.39
Channel catfish	11	0.22
Sturgeon chub	8	0.16
Sicklefin chub	4	0.08
Yellow perch	3	0.06
Stonecat [a]	3	0.06
Mountain whitefish	1	0.02
Shovelnose sturgeon	1	0.02
Northern pike	1	0.02
Spottail shiner	1	0.02

[a] young-of-the-year of this species sampled

Deep-water zone

There were 324 successful trawls conducted within sections 1,2,3 and 4 during 1994 and 1995. A total of 1,376 fish representing 26 species were sampled (Table 4). In contrast to seining, sicklefin chub was the most abundant species captured in the trawl in 1994 and second most abundant species for both years combined, representing 22% (n = 302) of the total catch. Channel catfish were the most abundant species sampled, making up 30% of the catch. They made up a small proportion of the catch in sections 1 and 2, but dominated the catch in sections 3 and 4. Sicklefin, sturgeon and flathead chubs were the second, third and fourth most abundant species captured with the trawl, respectively.

Sicklefin chub were sampled in 110 (36%) of the trawl sets. Of these, 50 sets had other fish species present (Table 5). Channel catfish were the most abundant species captured with sicklefin chub and comprised 44.9% of the total number of fish sampled. Sturgeon chub and flathead chub were the second and third most abundant species observed at sicklefin chub catch sites, respectively.

Longitudinal Distribution

I documented the longitudinal distribution of sicklefin chub to be 83.7 km beginning near Cow Island (RM 129) and continuing downstream to near CK

Creek (RM 181). I sampled 130 fish representing 10 species in Section 1 (Table 6). The overall CPUE was 3.02 ranging from 1 to 14 fish per trawl. Sturgeon chub was the most abundant species, making up 31% of the total catch with a CPUE of 0.93. Sicklefin chub and longnose dace each made up 24% of the catch with a CPUE of 0.72.

Table 4. Species composition and abundance from trawling in the middle Missouri River, Montana. 1994 & 1995.

Species	Number	Relative Abundance (%)
Channel catfish [a]	406	30.0
Sicklefin chub	302	22.0
Sturgeon chub	260	19.0
Flathead chub	125	9.0
Longnose dace	84	6.0
Stonecat [a]	60	3.0
Shovelnose sturgeon [a]	39	3.0
Carp [a]	19	1.4
Stizostedion spp. (sauger /walleye) [a]	18	1.3
Hybognathus spp. (western silvery/plains minnow)	13	0.9
Longnose sucker	11	0.8
Freshwater drum [a]	8	0.6
Goldeye [a]	5	0.4
Smallmouth buffalo [a]	5	0.4
Shorthead redhorse sucker [a]	5	0.4
White sucker	4	0.3
River carpsucker [a]	4	0.3
Burbot	2	0.2
Fathead minnow	1	0.1
White crappie	1	0.1
Emerald shiner	1	0.1
Mottled sculpin	1	0.1
Bigmouth buffalo	1	0.1
Spottail shiner	1	0.1

[a] young-of-the-year of this species sampled

Table 5. Relative abundance of fish species observed in 50 trawl catches having sicklefin chub present, middle Missouri River, Montana 1994 & 1995.

Species	Number observed	Relative abundance (%)
Channel catfish [a]	184	44.9
Sturgeon chub	78	19.0
Flathead chub	62	15.0
Stizostedion spp. (sauger/walleye) [a]	25	6.1
Shovelnose sturgeon [a]	14	3.3
Hybognathus spp. (western silvery/plains minnow)	11	2.6
Stonecat	10	2.4
Carp [a]	6	1.4
Stonecat [a]	5	1.2
Freshwater drum [a]	4	0.9
Longnose dace [a]	3	0.6
Longnose sucker	3	0.6
White sucker	2	0.4
Shorthead redhorse sucker	2	0.4
Mottled sculpin	1	0.2
Bigmouth buffalo	1	0.2
River carpsucker	1	0.2

[a] young-of-the-year of this species sampled

In Section 2, 209 fish were sampled representing 16 taxa (Table 7). Sturgeon chub was the most abundant species sampled comprising 38.7% of the total catch with a CPUE of 0.81. Sicklefin chub made up 28.2% of the catch with a CPUE of 0.59. Overall CPUE was 2.1 ranging from 1 to 28 fish per trawl.

There were 530 fish sampled in section 3. This section had the highest fish diversity with representatives from 20 species (Table 8). The most abundant was channel catfish, making up 32% of the total catch. Sicklefin chub made up 28.7% of the catch with a CPUE of 1.28. Overall CPUE was 4.49 ranging from 1 to 57 fish per trawl.

Table 6. Species composition, relative abundance and CPUE based on 43 trawls conducted in Section 1, middle Missouri River, Montana, 1994 & 1995.

Species	Number observed	Relative abundance (%)	CPUE (catch/43)
Sturgeon chub	40	31	0.93
Longnose dace	31	24	0.72
Sicklefin chub	31	24	0.72
Stonecat	13	10	0.30
Flathead chub	5	4	0.12
Stizostedion spp. [a]	4	3	0.09
Channel catfish [a]	3	2	0.07
Longnose sucker	2	2	0.04
Mottled sculpin	1	1	0.02

[a] young-of-the-year of this species sampled

In section 4 there were 461 fish sampled representing 19 species (Table 9). Channel catfish were the most abundant species sampled making up 49.2% of the total catch. Sicklefin chub made up only 10.3% of the catch with a CPUE of 0.75. Sturgeon chub were similar in abundance making up 10.5% of the total sample with a CPUE of 0.76. Overall CPUE was 7.2 ranging from 1 to 62 fish per trawl.

Table 7. Species composition, relative abundance and CPUE based on 99 trawls conducted in Section 2, middle Missouri River, Montana, 1994 & 1995.

Species	Number observed	Relative abundance (%)	CPUE (catch/99)
Sturgeon chub	81	38.7	0.81
Sicklefin chub	59	28.2	0.59
Longnose dace	17	7.1	0.17
Stonecat	15	7.1	0.15
Flathead chub	8	3.8	0.08
Channel catfish [a]	8	3.8	0.07
Stizostedion spp. [a]	7	3.3	0.07
Longnose sucker	4	1.9	0.04
Shovelnose sturgeon	3	1.4	0.03
Hybognathus spp.	2	0.9	0.02
White sucker	2	0.9	0.02
Smallmouth buffalo	1	0.4	0.01
Spottail shiner	1	0.4	0.01
Shorthead redhorse sucker [a]	1	0.4	0.01

[a] young-of-the-year of this species sampled

Table 8. Species composition, relative abundance and CPUE based on 118 trawls conducted in Section 3, middle Missouri River, Montana, 1994 & 1995.

Species	Number observed	Relative abundance (%)	CPUE (catch/118)
Channel catfish [a]	171	32.0	1.45
Sicklefin chub	152	28.7	1.28
Sturgeon chub	71	13.4	0.60
Flathead chub	70	13.0	0.59
Stonecat	22	4.1	0.19
Hybognathus spp.	8	1.5	0.07
Shovelnose sturgeon [a]	6	1.1	0.05
Carp [a]	6	1.1	0.05
Longnose dace	5	0.9	0.04
Longnose sucker	4	0.8	0.03
Stizostedion spp. [a]	3	0.6	0.03
Shorthead redhorse sucker	3	0.6	0.03
River carpsucker [a]	3	0.6	0.03
White sucker	2	0.3	0.02
Emerald shiner	1	0.2	0.01
White crappie	1	0.2	0.01
Fathead minnow	1	0.2	0.01
Smallmouth buffalo [a]	1	0.2	0.01

[a] young-of-the-year of this species sampled

Table 9. Species composition, relative abundance and CPUE based on 64 trawls conducted in Section 4, middle Missouri River, Montana, 1994 & 1995.

Species	Number observed	Relative abundance (%)	CPUE (catch/64)
Channel catfish [a]	228	49.2	3.56
Sturgeon chub	49	10.5	0.76
Sicklefin chub	48	10.3	0.75
Flathead chub	34	7.3	0.53
Shovelnose sturgeon [a]	30	6.4	0.47
Longnose dace	16	3.4	0.17
Carp [a]	13	2.8	0.20
Stonecat	10	2.1	0.16
Stizostedion spp.	9	1.9	0.10
Freshwater drum [a]	8	1.7	0.13
Goldeye [a]	5	1.0	0.08
Smallmouth buffalo [a]	3	0.6	0.05
Hybognathus spp.	3	0.6	0.05
Burbot	2	0.4	0.03
Longnose sucker	1	0.2	0.02
River carpsucker [a]	1	0.2	0.02
Bigmouth buffalo	1	0.2	0.02

[a] young-of-the-year of this species sampled

Habitat Associations

Microhabitat preference of sicklefin chub was not attainable due to the large spatial scale of the study and difficulties associated with sampling the large river environment. Seining and trawling did not provide instantaneous collections and sampled such a large area per unit effort that I was unable to determine precisely where fish were captured. Therefore, description of habitat use was general and based on macrohabitat features measured at sicklefin chub catch sites. These data were compared to the habitat features measured at all sample sites combined.

Interpreting substrate data was difficult because multiple substrate types were measured at some sampling sites (Table 10). In deep water zones, 14.1% of the measured substrate was a mixture of silt, sand, gravel, and cobble. An additional 4.5% consisted of varying sizes of rock. Because it was not known which substrate type sicklefin chub were sampled from, observations were consolidated and considered as "mixed substrate material".

Deep-water Zone

I recorded depth, velocity, and substrate composition at 176 trawl sites. Sand was the most abundant substrate at trawl sites making up 66.4%, silt represented 3.4%, 15.9% was rock including mixed size rock and 14.3 % was a mixture of silt, sand and rock. Sand was the predominant substrate at sicklefin chub catch sites (64.3%). If mixed substrate categories containing sand (10.8) are included (Table 10), 81.1% of sicklefin chub catches were associated with

Table 10. Substrate types (see Table 1) and their relative abundance compared to relative abundance and number of sicklefin chub (SFC) captured at trawl sites, middle Missouri River, Montana. 1995.

Substrate code	# of observations	Relative abundance (%)	# of SFC observed	Relative abundance (%) at SFC catch sites
0	6	3.4	2	1.8
1	117	66.4	72	64.3
2	2	1.7	2	1.8
3	11	5.7	4	3.6
4	4	2.3	1	0.9
5	1	0.6	0	0.0
6	2	1.1	0	0.0
0-1	9	5.1	2	1.8
0-3	2	1.1	13	11.6
1-2	5	2.8	2	1.8
1-3	4	2.3	1	0.9
1-4	2	1.1	3	2.7
1-5	2	1.7	4	3.6
2-3	5	1.7	2	1.8
2-4	1	1.1	3	2.7
4-5	1	0.6	0	0.0
5-6	2	1.1	1	0.9

sand. Comparison of substrate distribution and sicklefin chub catch, by study section, showed an increase in catch densities with increases in sand substrate between sections 1 and 3. This pattern did not hold true for section 4 (Figure 4).