THE RELATIONSHIP OF PHYSICAL HABITAT TO THE DISTRIBUTION OF NORTHERN PIKE AND WALLEYE IN TWO MONTANA PRAIRIE STREAMS

by

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APPROVAL

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VITA

John William Guzevich was born August 28, 1956 in Elizabeth, New Jersey to Edward J. and Victoria B. Guzevich. After graduating high school he attended the University of Wyoming in Laramie, Wyoming earning a Bachelor of Science degree in Wildlife Management (Fisheries Curriculum) in December 1978. After being employed for seven years as a fisheries biologist technician for various state and federal agencies and for four years as an engineering technician with county government, in January 1990 he began a Master of Science Degree program with the Montana Cooperative Fishery Research Unit at Montana State University.

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ABSTRACT

Beaver Creek and Little Beaver Creek, located in eastern Montana, are tributaries to the Little Missouri River. These prairie streams were found to support small, reproducing, possibly non-migratory populations of northern pike (*Esox lucius*) and walleye (*Stizostedion vitreum vitreum*), two coolwater fish species more commonly associated with lacustrine and large riverine habitats. Both streams were sampled from April 1990 through August 1991 to assess their physicochemical attributes and gamefish distribution. Correlation and logistic regression models were employed to assess the variation in biomass of northern pike and walleye in relation to prairie stream habitats. In Beaver Creek, northern pike were distributed in the middle portion of the drainage, with their presence related to submerged aquatic vegetation, water transparency, gravel substrate, conductivity and a streamside cover of forbs and grasses. Walleye distribution was likewise confined to the middle portion of the drainage, overlapping that of the pike although extending slightly farther upstream. Walleye presence was related to various measures of pool dimension, moderate turbidity, sand substrate and a lack of instream cover. In Little Beaver Creek, northern pike ranged through the middle portion of the drainage and their abundance was related to pH, pool volume, organic debris and a sand substrate. Walleye were not found in Little Beaver Creek.

INTRODUCTION

Physical habitat characteristics are believed to interact to determine the occurrence and biomass of fishes within streams (Lobb and Orth 1991). These physicochemical attributes contribute to the delineation of an organism's niche (Layher and Maughan 1985). Because so many factors can influence this relationship, there can be much variation among streams, regions and years. Previous studies describing the influence of physical habitat on fish occurrence in warmwater streams have assessed fish species commonly associated with these habitats (Schlosser 1982; Layher and Maughan 1985; Lobb and Orth 1991). In this study, I examined habitat characteristics associated with the distribution of two fish species not commonly found in small, warmwater prairie streams.

Beaver Creek and Little Beaver Creek, two eastern Montana streams (Figure 1), were found to support small, reproducing populations of northern pike (*Esox lucius*) and walleye (*Stizostedion vitreum vitreum*). These intermittent prairie streams are characterized by a wide range of habitat conditions, sporadic flow regimes and high summer water temperatures.

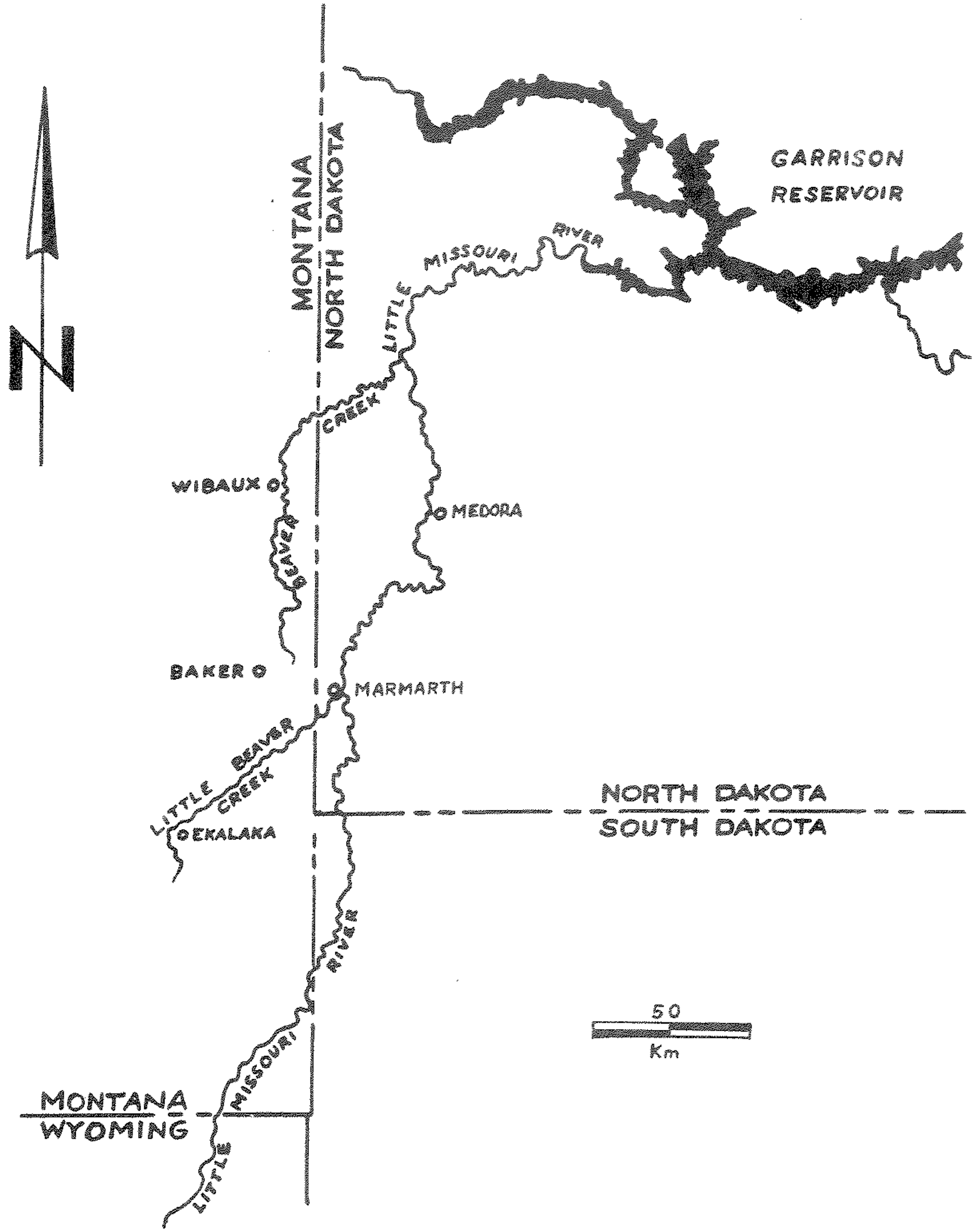

Figure 1. Location of Beaver Creek and Little Beaver Creek study areas within the Little Missouri River drainage.

Northern pike have a circumpolar distribution in the northern hemisphere (Scott and Crossman 1973). In North America, the natural historical range extends from Alaska across most of Canada, excluding the Maritime Provinces and portions of British Columbia. Northern pike occur southward to Missouri and Nebraska east of the Rocky Mountains and west of the Appalachian Mountains (Eddy and Underhill 1974; Scott and Crossman 1973). Of the five species in the family Esocidae, northern pike have the greatest tolerance for cold environments, with their range extending into the Arctic (Lee et al. 1980). The northern pike is classified as a coolwater species with maximum growth occurring at water temperatures near 20°C (Casselman 1978, cited in Inskip et al. 1982). They generally prefer clear, cool waters of ponds, large lakes and, to a lesser extent, low gradient rivers (Hubbs and Lagler 1964). In the Missouri River system, northern pike spawning migrations of several hundred kilometers have been documented (Moen and Henegar 1971, cited in Inskip et al. 1982). Northern pike are native to Montana in the Saskatchewan River drainage (Brown 1971) and they have been widely introduced as a sport fish. Northern pike are believed to have entered Beaver Creek and Little Beaver Creek during spawning migrations from the Little Missouri River (P.A. Stewart, MDFWP, personal communication) and by illegal introductions from private stock ponds.

Historical distribution of walleye ranges from the Northwest Territories near the Arctic coast across the Canadian Provinces east of the Rocky Mountains, the Saskatchewan River system and the Hudson Bay region into northern Labrador (Eddy and Underhill 1974; Hubbs and Lagler 1964). Walleye are common through the Great Lakes region, extending southward on the Atlantic slope to North Carolina, west to Nebraska and the Dakotas (Hubbs and Lagler 1964; Scott and Crossman 1973). Walleye prefer large, cold lakes (Eddy and Underhill 1974), or large riverine systems characterized by moderate turbidity and cool water temperatures with shallow to moderate depths (McMahon et al. 1984). Walleye are not native to Montana (Brown 1971) and are considered to be rare in the Little Missouri River. Walleye may have entered Beaver Creek during a spawning migration from the Little Missouri River or from an initial stocking of Lame Steer Reservoir during the 1950's (Elser et al. 1978) which empties into Beaver Creek in the middle zone of the drainage.

The purpose of this study was to explore the existence of northern pike and walleye occupying warmwater, prairie stream habitats and describe the physical factors affecting their distribution and abundance. The objectives of this study were to:

1. describe the extent to which northern pike and walleye were distributed in Beaver Creek and Little Beaver Creek.
2. relate this distribution and variation in biomass to the physical habitat variables of these streams.

In addition, information was gathered on the movement and well being of northern pike and walleye as indicated by tag returns, age and growth, condition factor and recruitment.

DESCRIPTION OF STUDY AREA

Beaver Creek and Little Beaver Creek are second order tributaries to the Little Missouri River. Originating in southeast Montana, they flow northeasterly through a semi-arid region of flatlands, rolling hills and badlands characterized by low annual precipitation and high evaporation. Most of the 37 cm of mean annual precipitation (NOAA 1990), occurs in late winter and spring. Air temperature extremes range from 43°C to -40°C (NOAA 1990). Flow regimes are typical of prairie streams with a bi-modal discharge (Figure 2). Stream gauge records for Beaver Creek near Trotters, North Dakota and Little Beaver Creek near Marmarth, North Dakota for the 53 year period of record (1938-1990), indicate peak flows occur in mid-March, with a smaller crest in early June. Precipitation and flow may vary greatly from year to year. Average annual flow of Beaver Creek and Little Beaver Creek is 0.60 m^3/s and 1.26 m^3/s, respectively (U.S. Geological Survey 1991). Extremes range from 850 m^3/s for Beaver Creek and 360m^3/s for Little Beaver Creek, to a complete cessation of flow at times during the year. The predominant land use in the region is livestock grazing with some bottom land cultivated for small grains and

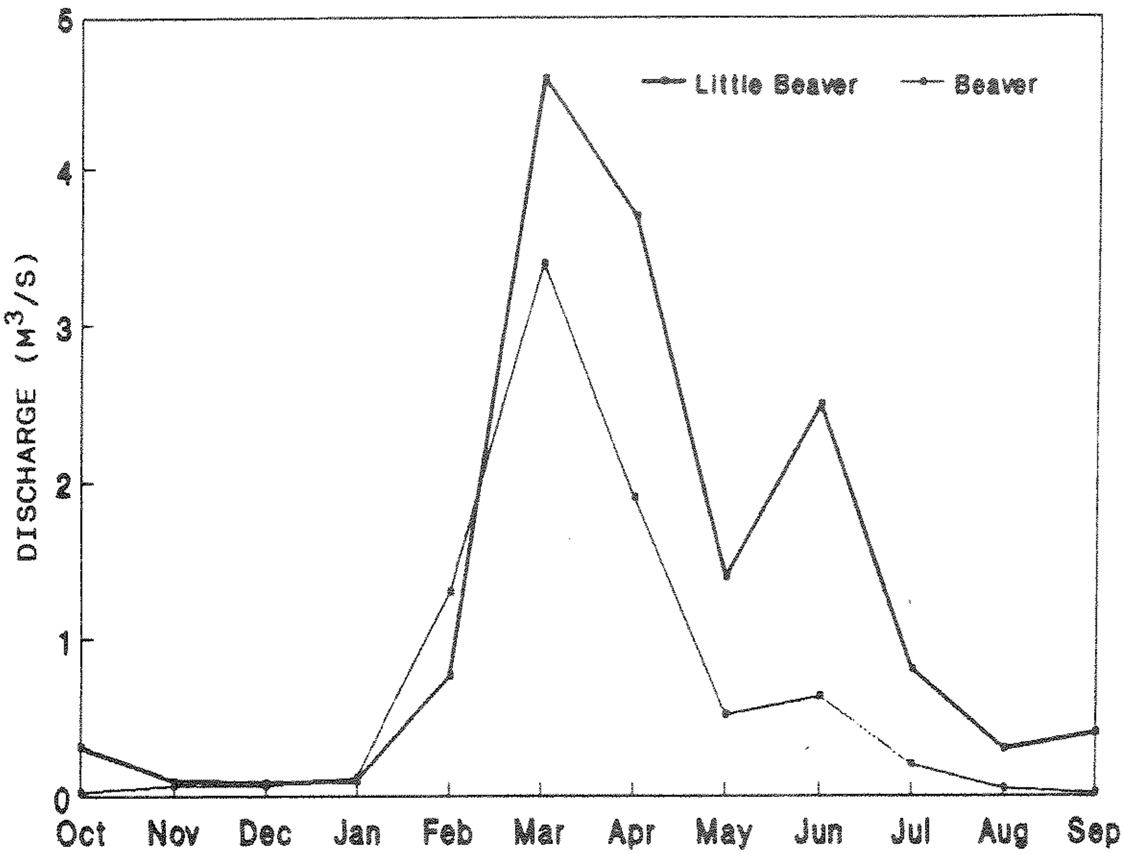

Figure 2. Mean monthly flows of Beaver Creek near Trotters, N.D. and Little Beaver Creek near Marmarth, N.D. for period of record (1938-1990) U.S. Geological Survey 1990.

forage crops (McConnell et al. 1943; U.S.D.A. Soil Conservation Service, unpublished data).

Beaver Creek arises at an elevation of about 930 m in the tablelands of northern Fallon County, Montana, near the town of Baker (Figure 1). The creek drains an area of nearly 2060 km^2 (U.S. Geological Survey 1991), and has an average gradient of 1.0 m/km. Beaver Creek meanders for approximately 299 km through Fallon and Wibaux counties in Montana and Golden Valley and McKenzie counties in North Dakota. Its confluence with the Little Missouri River is approximately 46 km north of Medora, North Dakota, at an elevation of 633 m.

Little Beaver Creek originates at an elevation of nearly 1022 m in the rolling prairie hills of northeast Carter County, Montana, near the town of Ekalaka (Figure 1). The drainage basin encompasses about 1554 km^2 (U.S. Geological Survey 1991). With an average gradient of 1.6 m/km, Little Beaver Creek flows for approximately 124 km across the counties of Carter, Fallon, Bowman and Slope. It empties into the Little Missouri River at Marmarth, North Dakota at an elevation of 822 m.

Both streams were divided into three zones based on channel morphology. The upper 50 km of Beaver Creek (Figure 3) and 32 km of Little Beaver Creek (Figure 4) were designated as the upper zones. The channel consists of a series of small, intermittent pools separated by riffles of

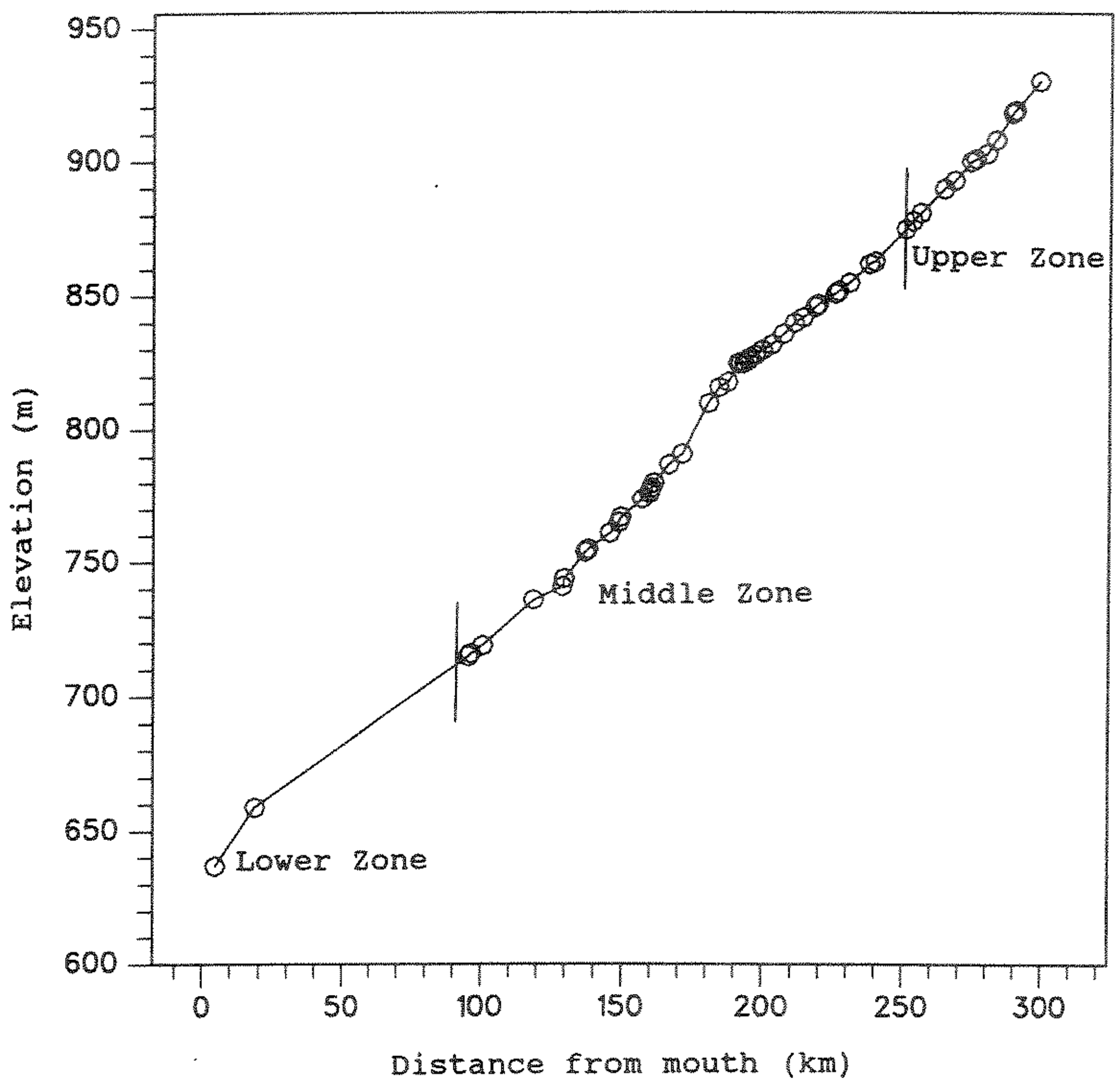

Figure 3. Location of sampling sites and delineation of the Upper, Middle and Lower Zones for Beaver Creek.

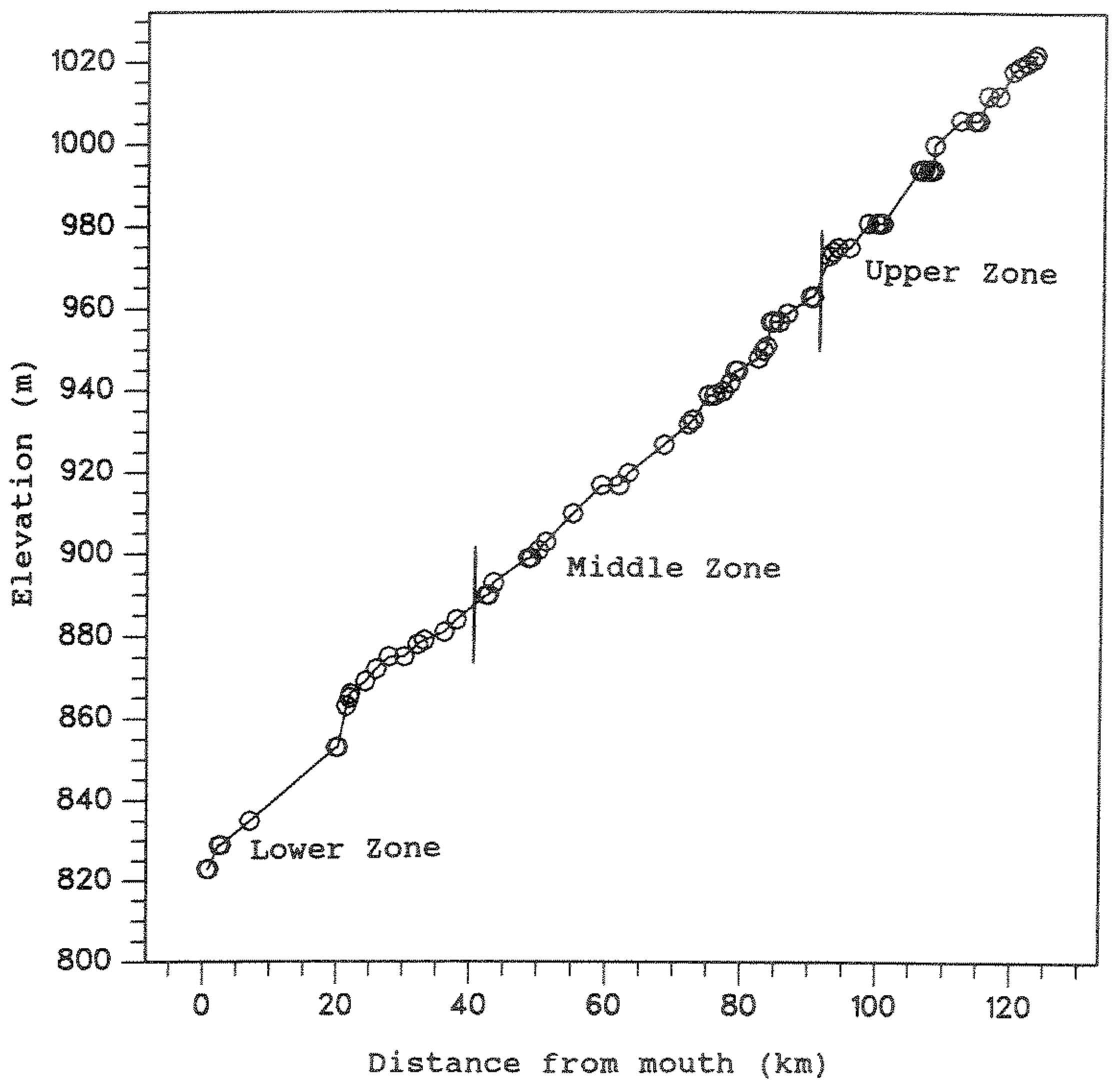

Figure 4. Location of sampling sites and delineation of the Upper, Middle and Lower Zones for Little Beaver Creek.

1 m or less in length. These spring-fed pools, usually less than 1 m deep, contain an abundant growth of coontail (*Ceratophyllum demersum*) and water milfoil (*Myriophyllum exalbescens*) (Fassett 1966) from late May through September. The streambanks are gently sloped, with a luxuriant growth of grasses (*Bouteloua* sp.), sedges (*Carex* spp.), horsetail (*Equisetum arvense*) and spike rush (*Eleocharis acicularis*) in the riparian zone. As pool margins recede with the advent of the hot summer temperatures, the channel resembles a sedge meadow.

The meandering middle zone is dominated by long, well-formed pools, some of which reach depths in excess of 2 m and as much as several hundred meters in length. This zone begins about 92 km upstream from the mouth of Beaver Creek (Figure 3), extending upstream for about 157 km. On Little Beaver Creek the middle zone is about 52 km in length and begins about 40 km above the mouth (Figure 4). The incised channel of the middle zone is bounded by higher, steeper banks covered with a mixture of serviceberry (*Amelanchier* sp.), snowberry (*Symphoricarpos* sp.) and buffaloberry (*Shepherdia* sp.). Vegetation at the pool margins consists mainly of western wheatgrass (*Agropyron smithii*), sweetclover (*Melilotus* spp.), curlycup gumweed (*Grindelia squarrosa*), sedges (*Carex* spp.) and bulrush (*Scirpus* spp.). The pools are separated by short, shallow riffles. In late spring, riffles often become dewatered and pools become, in effect, a series of small ponds which are thermally stratified, possessing more lentic than lotic characteristics. Submerged aquatic vegetation of the middle zone consists of water crowfoot (*Ranunculus* sp.), pond weed (*Potamogeton* spp.), coontail and water milfoil. Substrate in the pools consists primarily of sand and fine particulate organic material, while riffles are characterized by gravel and cobble substrate.

The lower 92 km of Beaver Creek and 40 km of Little Beaver Creek flow through a portion of the North Dakota Badlands. Vegetation on the adjacent, heavily eroded slopes consists of a mixture of silver sage brush (*Artemisia cana*), snowberry (*Symphoricarpos* sp.), wild rose (*Rosa* sp.), buffaloberry (*Shepherdia* sp.) and russian olive (*Elaeagnus* sp.). The channel increases in width and incision with vertical streambanks often rising to heights in excess of 5 m. These banks, devoid of vegetation, contribute a high sediment load during spring high flow and summer rain storms. The lower zone is characterized by high turbidity, a general absence of aquatic vegetation, and shorter pools (<1 m deep) with sand substrate. Riffles occur more frequently than upstream sections and have a gravel and cobble substrate.

METHODS

Field work was initiated in March 1990 and terminated in August 1991. Habitat and fish distribution data were collected on Beaver Creek and Little Beaver Creek from headwaters to mouth. Longitudinal sampling provided information on northern pike and walleye distribution and associated habitat conditions. Elevations, distances and estimation of gradient (m/km) were obtained from U.S. Geological Survey topographic maps. Land ownership adjacent to both study streams was predominantly private, but permission to access the stream was readily granted.

Habitat Measurements

Physical and chemical habitat variables (Table 1) were collected from 56 study sites on Beaver Creek and 81 study sites on Little Beaver Creek. A site consists of a pool and adjacent downstream riffle. Sample sites were selected as the third riffle-pool sequence downstream of the point of access. At locations where access was restricted due to a physical barrier such as rough topography, fencelines or cultivated crops, the first available site was chosen. During periods of zero flow, only pools were sampled.

Table 1. List of physical and chemical habitat variables measured at 137 sites on Beaver Creek and Little Beaver Creek, Montana in 1990 and 1991.

Stream name	Elevation (m)
Stream morphology (riffle/pool)	Month
Sampling site number	Day
Distance from mouth (km)	Time of day
Length (m)	Year
Volume (m^3)	Instream cover
Mean width (m)	Type
Surface area (m^2)	Quantity (m^2)
Mean x-sec area (m^2)	Shoreline cover
Depth	Type
Area > 25 cm (m^2)	Quantity (m^2)
Area > 50 cm (m^2)	Velocity (cm/s)
Area > 75 cm (m^2)	Secchi disk depth (cm)
Area > 100 cm (m^2)	pH
Substrate	Conductivity (umhos/cm)
Type	Water temperature (°C)
Quantity (m^2)	Dissolved oxygen (mg/L)

Lengths of pools and riffles were measured along the right streambank, looking downstream (Platts et al. 1983). Each pool or riffle was divided into 10 equally spaced transects. Where pool length exceeded 200 m, 20 equally spaced transects were established. Five transects were measured in riffles and in pools less than 10 m in length.

Transects were established perpendicular to the thalweg with seven equally spaced sampling points along each transect. Water depth measured to the nearest centimeter, substrate composition and instream cover were recorded at each sampling point. Substrate composition was determined by direct observation or, in deeper water, by probing with a wading rod. The dominant substrate type was classified according to Platts et al. (1983) (Table 2).

Instream cover was visually identified as organic debris, and submergent and emergent hydrophytes (Table 3) and expressed as a percentage of the area occupied from the previous sampling point on the transect (Platts et al. 1987). Flow velocity was measured to the nearest 0.01 cm/s at 0.6 depth with a Marsh-McBirney Model 201 electromagnetic portable current meter at three equally spaced points across each transect. Streamside cover measurements were recorded at both ends of each transect and consisted of the vegetation type covering the bank (Table 4).

Table 2. Definition of substrate type[a].

Classification	Particle Diameter (mm)
Bedrock	
Large boulder	610.0 or more
Small boulder	305.0 to 609.0
Cobble	76.1 to 304.0
Gravel	4.81 to 76.0
Sand	0.83 to 4.71
Fine sediment	0.83 or less

[a] From Platts et al. (1983).

Water Quality Variables

Water quality variables were measured at the same time as habitat. Water temperature, dissolved oxygen concentration, conductivity and pH were measured early in the day to minimize the influence of daily photosynthesis on the dissolved oxygen concentration. Water temperature and

Table 3. Instream cover identification and assessment[a].

Cover	Description
Aquatic vegetation	Submergent and emergent vegetation providing overhead cover.
Organic debris	Submerged sagebrush, tumbleweeds and tree branches providing overhead cover.
No cover	No physical objects providing overhead cover.

Rating

Units	*Percent*
4	75 - 100
3	50 - 74
2	25 - 49
1	0 - 24

[a] Modified from Platts et al. (1987).

Table 4. Streamside cover rating[a].

Rating	Description
4	Shrubs are the dominant streamside vegetation.
3	Trees are the dominant streamside vegetation.
2	Forbs and grasses are the dominant streamside vegetation.
1	Over 50 percent of streambank transect line has no vegetation, dominant bank material is earth.

[a] Modified after Platts et al. (1987).

dissolved oxygen concentration were measured using a Yellow Springs Instrument Company (YSI) Model 54A Temperature and Dissolved Oxygen Meter and an Otterbein-Barebo Sentry 3 Oxygen Meter. In deep pools, measurements were recorded at 0.5 m intervals from the bottom to the surface. Additional temperature information was collected using Taylor maximum-minimum thermometers placed in each of the three stream zones. The pH was measured with a VWR Scientific Incorporated Model 55 Digital Mini PH Meter. Conductivity was measured with a VWR Scientific Incorporated Digital Automatic Compensation Meter. Measurement of water transparency was expressed as a mean depth (cm) using a Secchi Disk.

Fish Sampling

Fish populations were sampled at each study site to determine the total weight in grams of northern pike and walleye present. I restricted my analysis to weight in grams of taxa since I was unable to obtain adequate relative or absolute biomass or density estimates at some sites. This was due to reduced efficiency in electrofishing from high water conductance and temperature and in seining from abundant submerged macrophytes and organic debris. Riffles and pools were sampled separately.

Fish were sampled by either electrofishing or seining. In wadable areas, I used a Coffelt Model BP 1-C backpack electrofishing unit. Pools or riffles were blocked at each end with a 6 mm mesh seine and two upstream passes were made. In large, deep pools, I used a boat-mounted DC electrofishing unit (Coffelt Model VVP-15). Complete passes through the pool were repeated until no northern pike and walleye were sampled. Effort was recorded as the time fished. Where local topography and dry streambed prohibited boat access, a 9.1 m x 1.2 m, 6 mm mesh bag seine was used. Seine hauls were always in an upstream direction.

Northern pike and walleye were measured for maximum total length (MTL) to the nearest 1.0 mm and live weight was measured to the nearest 1.0 g using a Morris Model OM-410/RS/CH scale. Fish were identified to species, and numbers and life-stage were recorded. Excluding young of the year, all northern pike and walleye were marked with a numbered Floy tag and released. Scales for age determination and back calculation of length were collected from northern pike and walleye in 1990 and 1991. Samples were taken from the left side of the fish above the lateral line near the dorsal fin following the method of Jearld (1983). Impressions of the scales were made on cellulose acetate and examined using a microfiche reader at 48X magnification. Scale radius and distances to annuli were measured following the method of Jearld (1983). An estimation of age was made from the scales by the method of Tesch (1968). Assuming the body length to scale radius relationship was nearly isometric, growth was estimated by back calculation. The formula used was:

$$l_n = (S_n/S)\ (l)$$

where ln is the length of the fish when annulus n was formed, l is the length of the fish when the scale was collected, S_n is the radius at annulus n and S is the total scale radius (Tesch 1968).

Condition factor was calculated using the formula from Anderson and Gutreuter (1983):

$$K = (10^5)\ (W)/l^3$$

Where K = condition factor

W = total weight (g)

l = maximum total length (mm)

The length-weight relationship was attained using the formula from Ricker (1975):

$$W = a\ l^b$$

Where W = weight (g)

a = y intercept

l = length (mm)

b = regression coefficient

Statistical Analysis

The data set contained measurements of physical and chemical habitat variables (Table 1) and presence/absence data for all fish species found at each location. All variables considered in the analyses were measured at each of the 137 sites. Habitat variables were assessed for their relationship with northern pike and walleye biomass by Spearman rank correlation (Press et al. 1986). A

Kruskal-Wallis rank test (Conover 1980) was used to compare recorded values of all 34 habitat variables among the three stream zones. The test assigned a rank to each variable for each of the three stream zones based on their observed values. Greater values for a particular variable received the higher rank. I also used stepwise logistic regression (SAS 1988) to identify habitat variables related to the distribution of northern pike and walleye biomass. Habitat variables used in the analysis were those that minimized redundancy due to significant correlations with other variables. The most commonly used measures of association for ordinal variables are those based on the number of concordant and discordant pairs of observations in the sample (Agresti 1984). In a data set such as the association of northern pike and walleye biomass with the habitat variables, the greater the relative number of concordant pairs, the more evidence there is of a positive association. In all analyses, a $P<0.05$ was considered statistically significant. Computations used the computer programs MSUSTAT (Lund 1987), SAS (1988) and programs developed by D. Gustafson (Biology Department, Montana State University).

RESULTS

Habitat Characteristics

Northern pike and walleye were collected only in pools with negligible velocity in both Beaver Creek and Little Beaver Creek. Although a greater range of values was observed for length, surface area, average cross-sectional area and volume in Little Beaver Creek (Table 5), overall the greater mean values occurred in Beaver Creek. This is consistent with Beaver Creek being the larger of the two streams. The two streams had similar pH, dissolved oxygen and temperature (Table 5). Monthly average maximum and minimum water temperatures from April to September, 1990 and 1991 (Table 6) indicate the annual peak occurred in July with temperatures declining through late August into September. Maximum temperatures recorded during this study were 30°C in Beaver Creek in 1990 and 31°C in Little Beaver Creek in 1991. All physical and chemical data are included in Appendix.

Fish Distribution

During 1990 and 1991, 51 northern pike with a total weight of 24.8 kg and 73 walleye with a total weight of

Table 5. Mean and range of values of habitat variables for pools of Beaver Creek and Little Beaver Creek, Montana in 1990 and 1991.

	Beaver Creek		Little Beaver Creek	
Habitat variable	mean	range	mean	range
Length (m)	192.5	20.1-672.0	82.8	7.6-960.0
Average width (m)	6.9	2.6-19.5	5.4	1.2-15.0
Surface area (m^2)	1598.9	58.3-8675.2	680.7	9.2-10629
Volume (m^3)	1090.4	22.7-8361.8	430.7	2.1-9027.5
Average depth (m)	0.57	0.19-1.1	0.48	0.11-0.81
Ave x-sec area (m^2)	3.8	0.85-12.5	2.1	0.21-14.1
pH	8.5	7.6-10.6	8.3	7.3-10.3
DO (mg/L)	8.96	5.1-20.0	8.26	3.5-16.0
Temperature (°C)	19.7	3.0-30.0	18.5	4.0-31.0
Secchi depth (cm)	59.3	4.5-130.0	43.6	2.8-135.0
Cond. (umhos/cm)	2508	942-3800	1352	744-2150
Velocity (cm/s)	0.01	0.0-2.5	0.01	0.0-3.1
Area depth				
> 25 cm (m^2)	1106.2	34.4-6651.0	451.1	1.3-8444.3
> 50 cm (m^2)	774.5	0.0-6024.4	293.5	0.0-6790.8
> 75 cm (m^2)	445.1	0.0-4964.1	171.7	0.0-5196.5
> 100 cm (m^2)	211.7	0.0-3325.5	72.8	0.0-2675.1
Substrate				
Fine (m^2)	1216.3	45.7-6692.3	440.3	0.0-5921.9
Sand (m^2)	229.3	0.0-1425.2	183.7	0.0-3644.3
Gravel (m^2)	118.4	0.0-1365.4	49.2	0.0-1062.9
Cobble (m^2)	30.5	0.0-579.2	0.9	0.0-56.2
Small boulder (m^2)	4.5	0.0-115.6	6.6	0.0-267.3
Instream cover				
No cover (m^2)	1096.8	0.0-7188.0	325.6	0.0-4938.7
Emer. veg. (m^2)	104.2	0.0-1487.2	44.4	0.0-987.1
Sub. aq. veg (m^2)	333.1	0.0-1743.0	231.9	0.0-4327.5
Organ. deb. (m^2)	64.7	0.0-549.4	78.9	0.0-2201.8
Streamside cover				
Bare gr. (m)	26.5	0.0-287.1	14.7	0.0-110.6
Forb & grass (m)	278.1	32.2-1344.0	148.0	7.7-1920.0
Trees (m)	5.0	0.0-74.8	1.0	0.0-42.1
Shrubs (m)	75.4	0.0-418.5	1.9	0.0-64.8

Table 6. Monthly average maximum-minimum water temperatures (°C) for Beaver Creek and Little Beaver Creek, Montana in 1990 and 1991.

		April	May	June	July	Aug	Sept
Beaver Creek							
1990	max	11	18	25	30	26	24
	min	8	12	23	16	16	15
1991	max	10	19	23	24	28	-
	min	3	3	12	17	18	
Little Beaver Creek							
1990	max	15	21	28	28	28	25
	min	8	15	21	23	15	15
1991	max	18	24	26	31	30	-
	min	4	5	13	20	20	

44.4 kg were collected in Beaver Creek. Northern pike were found at 19 of the 56 study sites. Distribution extended from stream kilometer (Skm) 97, upstream to Skm 187 (Figure 5). The largest number of northern pike was collected in a pool located in the middle stream zone, 160 km upstream from the mouth and consisted of 16 fish with a total weight of 9.74 kg representing 34% of all pike sampled. Walleye were collected at 28 sites located within the middle stream zone between Skm 137 and Skm 225 (Figure 5). For walleye, the largest sample size was 11 fish collected from a pool at Skm 225 with a total weight of 9.84 kg representing 22% of all walleye sampled.

Seventy northern pike with a total weight of 57.5 kg were collected in Little Beaver Creek but no walleye were

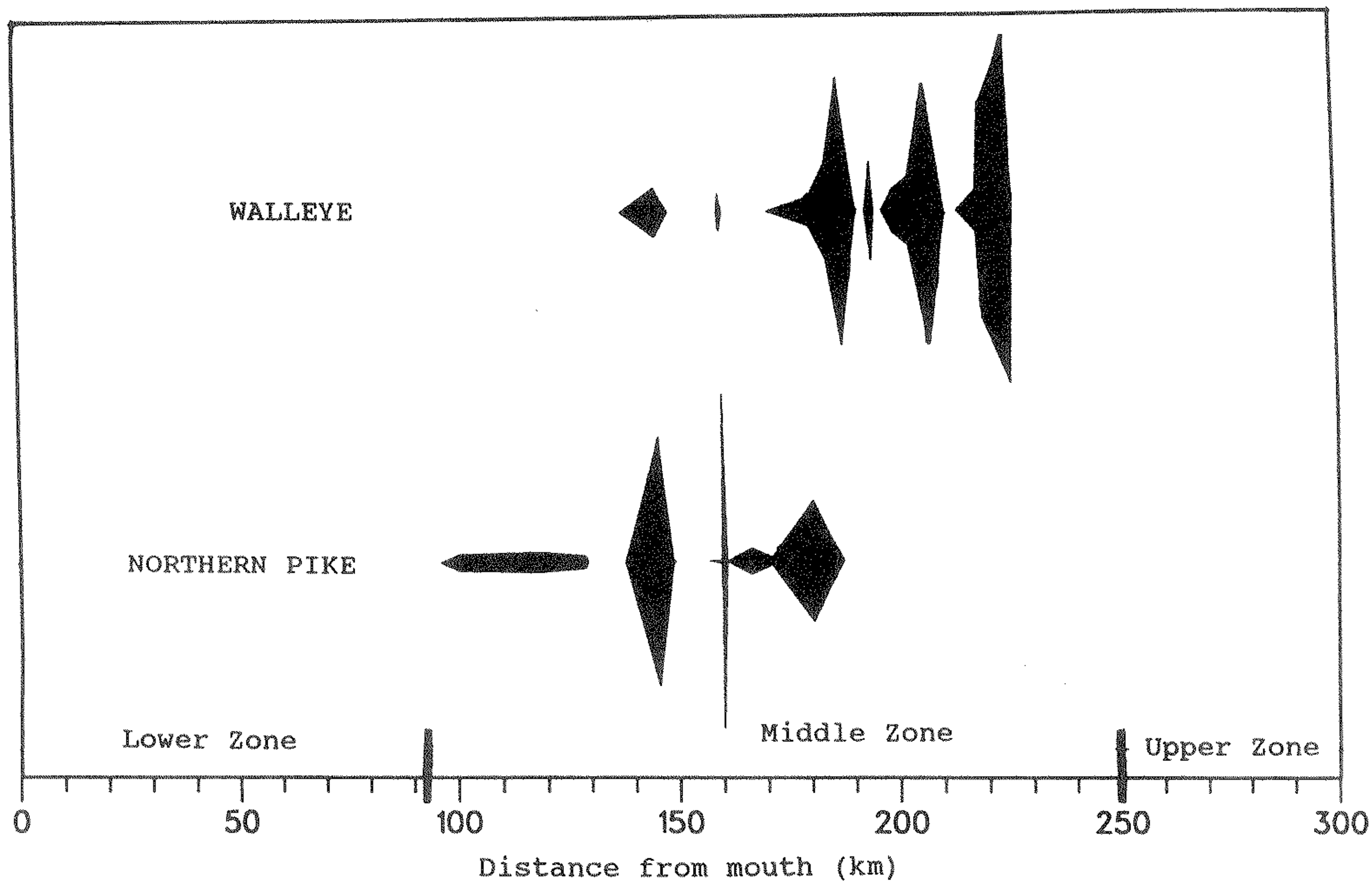

Figure 5. Distribution of northern pike and walleye in Beaver Creek 1990 and 1991. Width of kite at each site is proportional to fish weight (g).

sampled. Northern pike occurred at 31 of the 81 sample sites. With the exception of two isolated individuals captured in a headwater pool, northern pike were distributed along a 50 km stream segment within the middle stream zone located between Skm 42 and Skm 92 (Figure 6). The largest sample contained 30 fish collected from a pool at Skm 86 with a total weight of 29.3 kg representing 51% of all northern pike sampled.

Anglers returned tags from nine northern pike and two walleye caught in Beaver Creek and two northern pike caught in Little Beaver Creek in 1990 and 1991. Tagged fish were caught the same year they were marked and had not moved from the pools where they were initially tagged.

I collected 25 fish species representing eight families in Beaver Creek and Little Beaver Creek (Table 7). Five of these species were found only in Beaver Creek, and two only in Little Beaver Creek. Others were common to both streams (Figures 7 and 8).

Habitat Analysis

Among the 34 habitat variables measured, 16 were found to have significant relationships to the distribution of northern pike and walleye biomass. Five habitat variables were important in describing the distribution of northern pike in Beaver Creek (Table 8), compared to 10 in Little

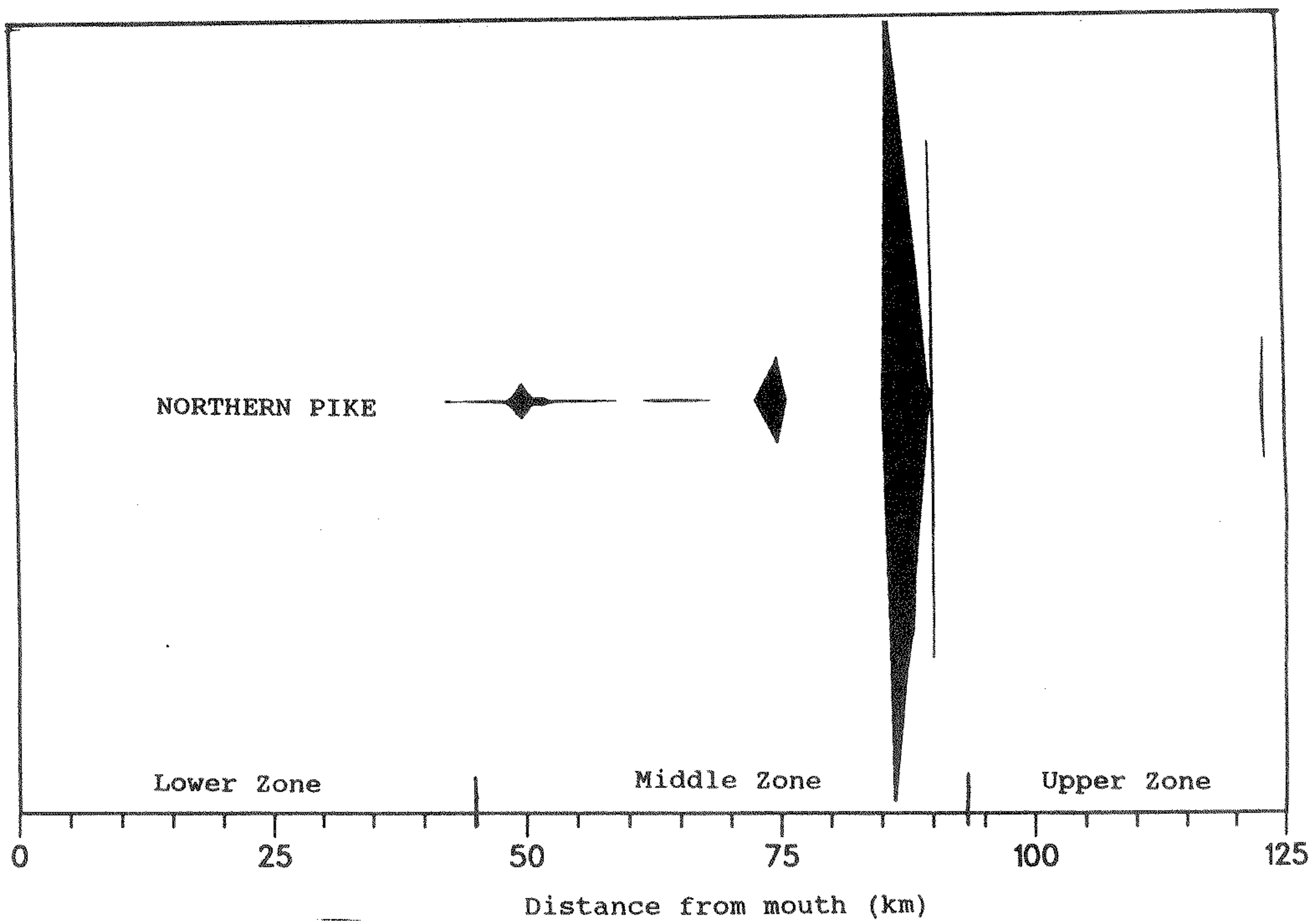

Figure 6. Distribution of northern pike in Little Beaver Creek 1990 and 1991. Width of kite is proportional to the weight (g) of pike.

Table 7. Families and species of fish collected in Beaver Creek and Little Beaver Creek in 1990 and 1991.

Common Name	Scientific Name
Mooneye	Hiodontidae
Goldeye	*Hiodon alosoides*
Pike	Esocidae
Northern Pike	*Esox lucius*
Minnow	Cyprinidae
Carp	*Cyprinus carpio*
Longnose Dace[b]	*Rhinichthys cataractae*
Creek Chub	*Semotilus atromaculatus*
Golden Shiner[a]	*Notemigonus crysoleucas*
Fathead Minnow	*Pimephales promelas*
Brassy Minnow	*Hybognathus hankinsoni*
Western Silvery Minnow	*Hybognathus argyritis*
Plains Minnow	*Hybognathus placitus*
Flathead Chub	*Hybopsis gracilis*
Sand Shiner	*Notropis stramineus*
Sucker	Catostomidae
River Carpsucker[b]	*Carpiodes carpio*
Shorthead Redhorse	*Moxostoma macrolepidotum*
White Sucker	*Catostomus commersoni*
Catfish	Ictaluridae
Yellow Bullhead[a]	*Ameiurus natalis*
Black Bullhead	*Ameiurus melas*
Stonecat	*Noturus flavus*
Stickleback	Gasterosteidae
Brook Stickleback	*Culaea inconstans*
Sunfish	Centrarchidae
Largemouth Bass[a]	*Micropterus salmoides*
Green Sunfish	*Lepomis cyanellus*
Pumpkinseed[a]	*Lepomis gibbosus*
Perch	Percidae
Yellow Perch	*Perca flavescens*
Walleye[a]	*Stizostedion v. vitreum*
Iowa Darter	*Etheostoma exile*

[a] Found only in Beaver Creek.
[b] Found only in Little Beaver Creek.

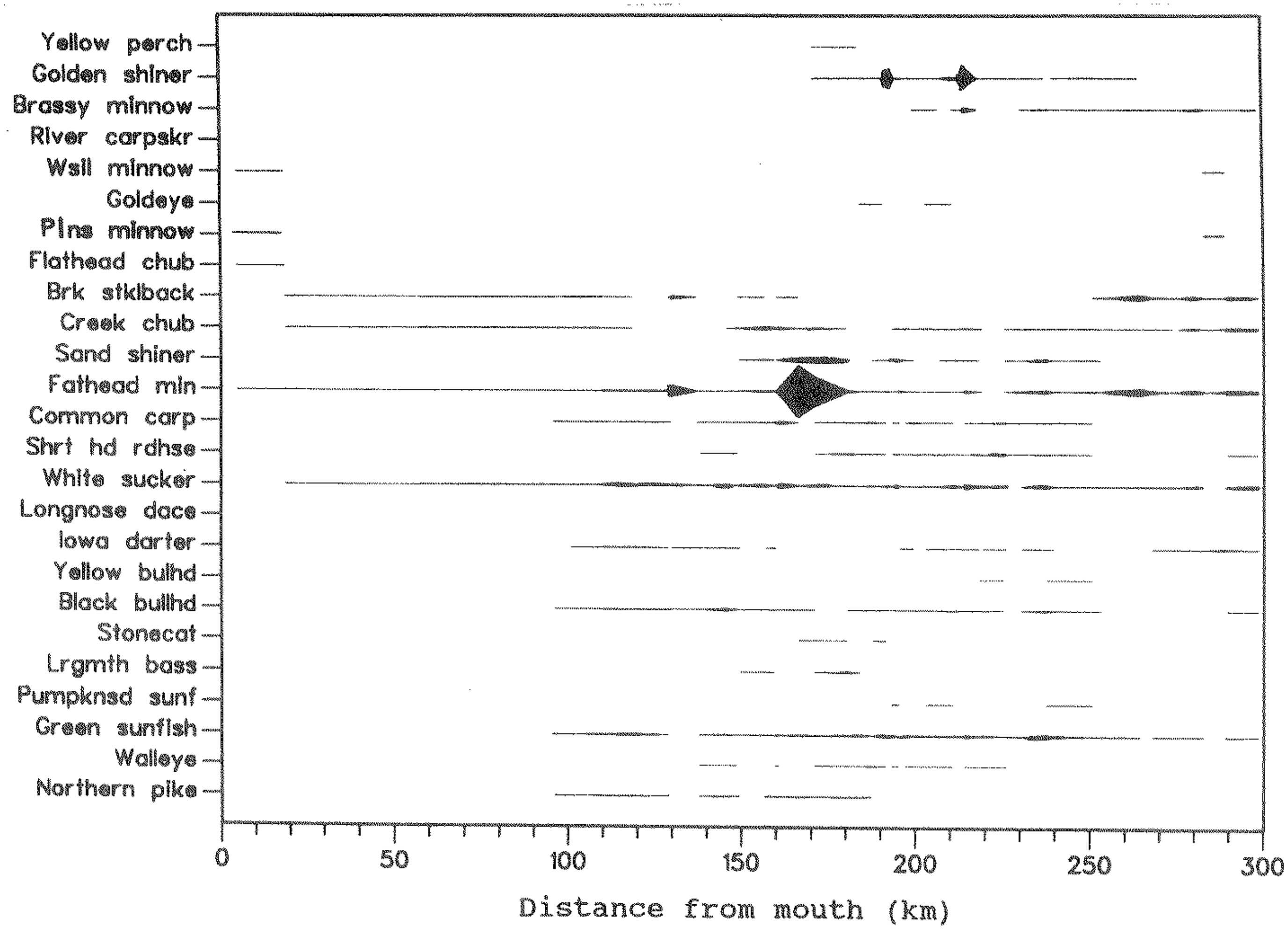

Figure 7. Distribution and relative abundance of fish species in Beaver Creek 1990 and 1991. Width of kite at each site is proportional to the number of that species captured.

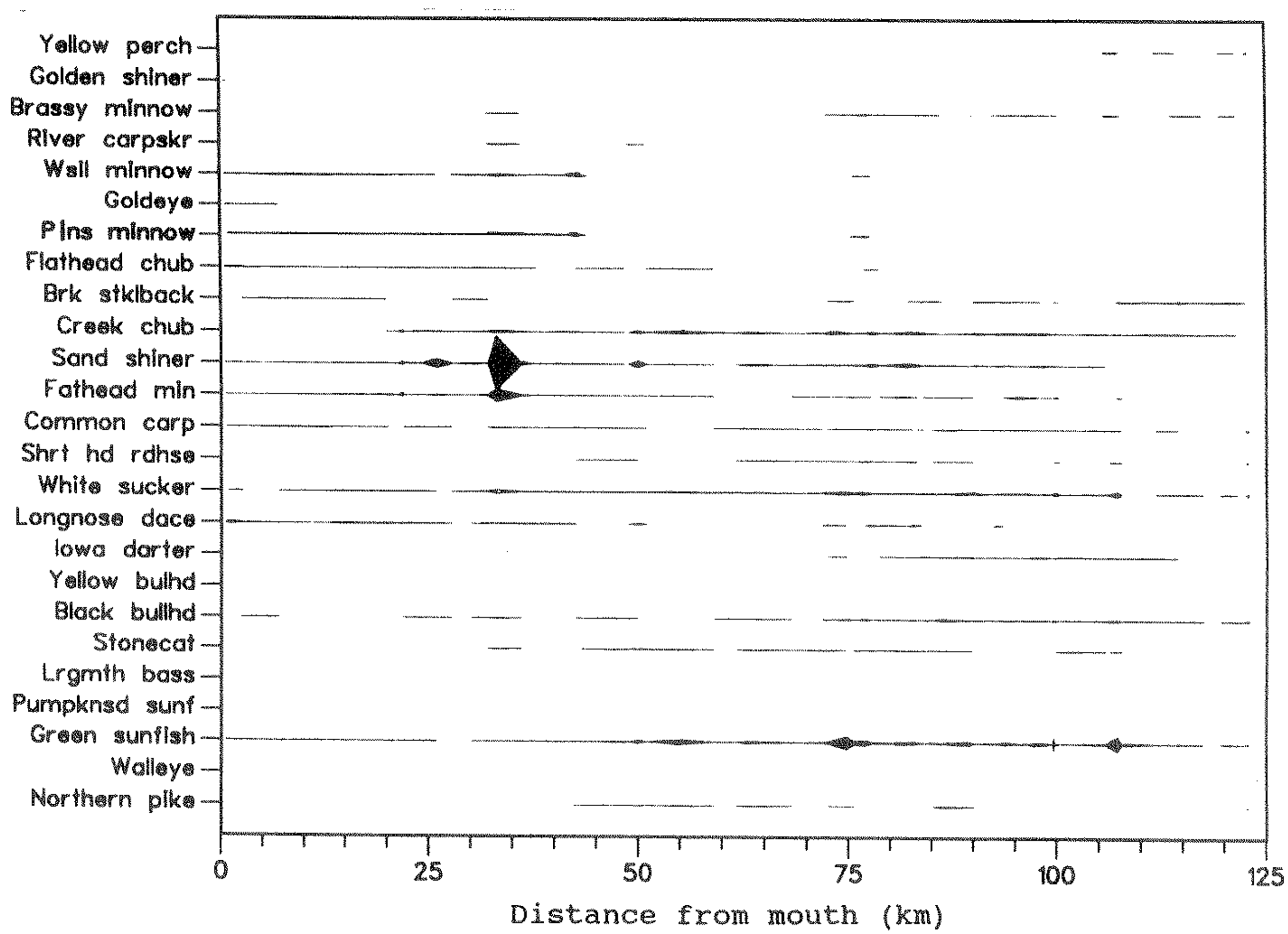

Figure 8. Distribution and relative abundance of fish species in Little Beaver Creek 1990 and 1991. Width of kite at each site is proportional to the number of that species captured.

Beaver Creek (Table 9). For walleye in Beaver Creek, 10 variables (Table 10) were important.

Table 8. Spearman's coefficient of rank correlation (r_s) and significance (*$P<0.05$) of habitat variables with northern pike biomass in Beaver Creek.

Habitat variable	r_s	P
Instream cover		
Submerged aquatic vegetation (m^2)	0.41	0.0017 *
Conductivity (umhos/cm)	0.33	0.0111 *
Streamside cover		
Forbs and grasses (m)	0.30	0.0245 *
Gravel substrate (m^2)	0.29	0.0307 *
Secchi disk depth (cm)	0.26	0.0499 *
Length (m)	0.20	0.1321
Average width (m)	0.01	0.9268
Surface area (m^2)	0.15	0.2444
Volume (m^3)	0.08	0.5221
Ave. x-sec area (m^2)	-0.12	0.3578
Fine substrate (m^2)	0.11	0.4348
Sand substrate (m^2)	0.21	0.1233
Cobble substrate (m^2)	0.21	0.1202
Small boulder (m^2)	0.26	0.5850
Area depth > 25 cm (m^2)	0.10	0.4254
Area depth > 50 cm (m^2)	0.01	0.9491
Area depth > 75 cm (m^2)	-0.07	0.5776
Area depth > 100 cm (m^2)	-0.10	0.4264
Velocity (cm/s)	0.03	0.6976
Sample site	0.09	0.5673
Elevation (m)	0.12	0.3968
Month	0.14	0.2745
Day	0.13	0.3176
Time of day	0.19	0.1564
Year	0.17	0.1875
Instream cover		
no cover (m^2)	0.02	0.9102
emergent vegetation (m^2)	-0.33	0.1140
organic debris (m^2)	-0.23	0.0916
Streamside cover		
bare ground (m)	0.01	0.9268
trees (m)	0.09	0.5122
shrubs (m)	-0.20	0.1335
pH	0.18	0.1697
Dissolved oxygen (mg/L)	-0.11	0.4417
Water temperature °C	0.10	0.4443

Table 9. Spearman's coefficient of rank correlation (r_s) and significance (*P<0.05) of habitat variables with northern pike biomass in Little Beaver Creek.

Habitat variable	r_s	P
Volume (m^3)	0.45	0.0001 *
Streamside cover		
Forbs and grasses (m)	0.44	0.0001 *
Surface area (m^2)	0.43	0.0001 *
Area depth > 75 cm (m^2)	0.43	0.0001 *
Sand substrate (m^2)	0.43	0.0001 *
Length (m)	0.42	0.0001 *
Ave x-sec area (m^2)	0.41	0.0002 *
Ave width (m)	0.39	0.0003 *
pH	0.33	0.0023 *
Instream cover		
Organic debris (m^2)	0.28	0.0113 *
Area depth > 25 cm (m^2)	0.20	0.0626
Area depth > 50 cm (m^2)	0.21	0.0607
Area depth > 100 cm (m^2)	0.19	0.0632
Fine substrate (m^2)	0.20	0.0530
Gravel (m^2)	0.21	0.0589
Cobble (m^2)	0.12	0.2796
Small boulder (m^2)	-0.07	0.5613
Velocity (cm/s)	0.06	0.6104
Sample site	0.05	0.6042
Elevation (m)	0.07	0.5806
Month	0.10	0.4417
Day	0.13	0.3176
Time of day	0.14	0.2747
Year	0.10	0.4443
Instream cover		
No cover (m^2)	0.12	0.2009
Emergent vegetation (m^2)	0.16	0.1521
Submerged aqua. veg. (m^2)	0.16	0.1420
Streamside cover		
Bare ground (m)	0.03	0.8073
Trees (m)	-0.12	0.2968
Shrubs (m)	-0.09	0.4106
Secchi disk depth (cm)	0.15	0.1751
Dissolved oxygen (mg/L)	0.16	0.1348
Conductivity (umhos/cm)	0.11	0.2879
Water temperature (°C)	0.06	0.5881

Table 10. Spearman's coefficient of rank correlation (r_s) and significance (*P<0.05) of habitat variables with walleye biomass in Beaver Creek.

Habitat variable	r_s	P
Sand substrate (m^2)	0.62	0.0001 *
Instream cover		
No cover (m^2)	0.62	0.0001 *
Surface area (m^2)	0.61	0.0001 *
Length (m)	0.60	0.0001 *
Volume (m^3)	0.59	0.0001 *
Area depth > 50 cm (m^2)	0.58	0.0001 *
Streamside cover		
Forbs and grasses (m)	0.56	0.0001 *
Average width (m)	0.54	0.0001 *
Ave x-sec area (m^2)	0.51	0.0001 *
Secchi disk depth (cm)	-0.29	0.0299 *
Area depth > 25 cm (m^2)	0.10	0.4254
Area depth > 75 cm (m^2)	0.21	0.0523
Area depth > 100 cm (m^2)	0.27	0.0517
Fine substrate (m^2)	0.21	0.0592
Gravel (m^2)	0.20	0.0601
Cobble (m^2)	0.24	0.0664
Small boulder (m^2)	0.15	0.2628
Velocity (cm/s)	0.08	0.4430
Sample site	0.11	0.3429
Elevation (m)	0.14	0.2110
Month	0.06	0.5664
Day	0.07	0.5280
Time of day	0.13	0.2342
Year	0.19	0.0977
Instream cover		
Emergent vegetation (m^2)	0.19	0.1404
Submerged aqua. veg. (m^2)	-0.03	0.8090
Organic debris (m^2)	0.20	0.0625
Streamside cover		
Bare ground (m)	0.19	0.1462
Trees (m)	-0.11	0.3896
Shrubs (m)	0.12	0.3626
pH	-0.06	0.6648
Dissolved oxygen (mg/L)	-0.15	0.2747
Conductivity (umhos/cm)	0.25	0.0600
Water temperature (°C)	-0.02	0.8683

The five habitat variables significantly correlated with the distribution of northern pike biomass in Beaver Creek were submerged aquatic vegetation, conductivity, streamside cover consisting of a mixture of forbs and grasses, gravel substrate and water transparency (Table 8). A Kruskal-Wallis rank test for comparison of the recorded values of the habitat variables among the three stream zones of Beaver Creek, resulted in the middle zone receiving the highest rank for four of the five variables significantly correlated to northern pike biomass (Table 11). The lower stream zone received the highest rank for conductivity. Differences between stream zones were statistically significant for recorded values of submerged aquatic vegetation and secchi depth.

Table 11. Kruskal-Wallis rank test of the five variables significantly correlated to northern pike biomass for the three stream zones of Beaver Creek.

Habitat variable	Kruskal-Wallis statistic		
	Upper zone	Middle zone	Lower zone
Submerged aquatic * vegetation (m^2)	22.03	41.53	20.00
Conductivity (umhos/cm)	24.56	33.18	38.75
Streamside cover forbs and grass (m)	27.58	34.36	19.75
Gravel substrate (m^2)	28.42	28.87	27.38
Secchi depth (cm) *	25.74	39.08	22.75

* Differences between zones were statistically significant.

Ten habitat variables were significantly correlated with the distribution of northern pike biomass in Little

Beaver Creek. Northern pike presence was related to volume, streamside cover of forbs and grasses, surface area, area with depth exceeding 75 cm, sand substrate, length, average cross-sectional area, average width, pH, and organic debris (Table 9). A Kruskal-Wallis rank test for the three stream zones of Little Beaver Creek resulted in the middle zone receiving the highest rankings for pH, average cross-sectional area, shoreline cover of forbs and grasses, area with depth exceeding 75 cm and organic debris (Table 12). Highest rankings for average width, surface area, volume, length and sand substrate occurred in the lower zone. Differences in the Kruskal-Wallis rankings for recorded values between stream zones were not statistically significant.

The 10 habitat variables significantly correlated with the distribution of walleye biomass in Beaver Creek were sand substrate, area of no cover, surface area, length, volume, area of pool with depth exceeding 50 cm, streamside cover of forbs and grasses, average width and average cross-sectional area (Table 10). Walleye biomass was negatively correlated with water transparency. A Kruskal-Wallis rank test of the habitat variables among the three stream zones of Beaver Creek resulted in all 10 variables important to the distribution of walleye receiving their greatest ranking in the middle zone (Table 13). In most cases, differences in the rankings for recorded values between stream zones were statistically significant.

Table 12. Kruskal-Wallis rank test of the 10 variables significantly correlated to northern pike biomass for three stream zones of Little Beaver Creek.

Habitat variable	Kruskal-Wallis statistic		
	Upper zone	Middle zone	Lower zone
pH	30.38	48.05	43.47
Organic debris (m^2)	40.05	42.63	37.85
Shoreline cover forbs and grass (m)	35.66	46.19	38.70
Average cross-sectional area (m^2)	35.74	43.71	42.42
Area depth > 75 cm (m^2)	36.59	44.74	39.60
Length (m)	32.29	44.97	45.47
Average width (m)	34.12	42.44	46.75
Surface area (m^2)	32.21	43.65	47.65
Volume (m^3)	32.38	44.13	46.65
Sand substrate (m^2)	25.59	46.42	52.95

In a stepwise logistic regression with all 34 variables, submerged aquatic vegetation was selected as the most important variable governing the distribution of northern pike biomass in Beaver Creek, pH for northern pike in Little Beaver Creek and average width for walleye in Beaver Creek (Table 14). The percentage of concordant pairs for northern pike in Little Beaver Creek was 71.4%;

in Beaver Creek 83.9%; for walleye in Beaver Creek it was 93.5%.

Table 13. Kruskal-Wallis rank test of the 10 variables significantly correlated to walleye biomass for the three stream zones of Beaver Creek.

Habitat variable	Kruskal-Wallis statistic		
	Upper zone	Middle zone	Lower zone
Average width (m) *	21.00	37.16	18.05
Surface area (m^2) *	20.71	35.46	22.82
Length (m) *	21.35	34.66	23.86
Volume (m^3) *	22.88	34.07	23.00
Average cross-sectional area (m^2)	24.74	33.63	21.27
Area depth > 50 cm (m^2)	22.65	33.93	23.73
Sand substrate (m^2) *	15.79	39.86	19.23
Instream cover no cover (m^2) *	23.59	34.89	19.82
Streamside cover forbs and grass (m) *	19.56	34.36	27.41
Secchi disk depth (cm) *	25.74	39.08	22.75

* Differences between zones were statistically significant.

Length-Frequency

Northern pike collected from Beaver Creek in 1990 and 1991 displayed a bi-modal size distribution (Figure 9). Northern pike ranged in length from 14.6 to 68.3 cm with the largest pike collected weighing 2.0 kg (Table 20 in

Appendix). Northern pike collected from Little Beaver Creek exhibited a similar bi-modal size distribution (Figure 10). They ranged in length from 8.6 to 83.5 cm, with the largest individual weighing 4.0 kg (Table 20 in Appendix). Walleye lengths (Figure 11) were more normally distributed. Walleye ranged in length from 9.5 to 64.3 cm; the largest specimen weighed 2.55 kg (Table 20 in Appendix).

Table 14. Statistics for each term passing the remove (P>0.05) and enter limits (P<0.05) in stepwise logistic regression models for comparison of habitat variables in Beaver Creek and Little Beaver Creek with the distribution of northern pike and walleye biomass.

Habitat variable	Parameter estimate	Standard error	Score Chi-square	P
		Beaver Creek		
Northern pike				
Submerged aquatic vegetation (m^2)	0.005	0.001	20.21	0.0001
Walleye				
Average width (m)	1.13	0.38	5.62	0.0177
		Little Beaver Creek		
Northern pike				
pH	1.06	0.54	4.30	0.0380

Length and Weight Relationship

Because of the relatively small sample sizes, northern pike length-weight data from Beaver Creek (n = 51) and Little Beaver Creek (n = 70) were combined. No sex

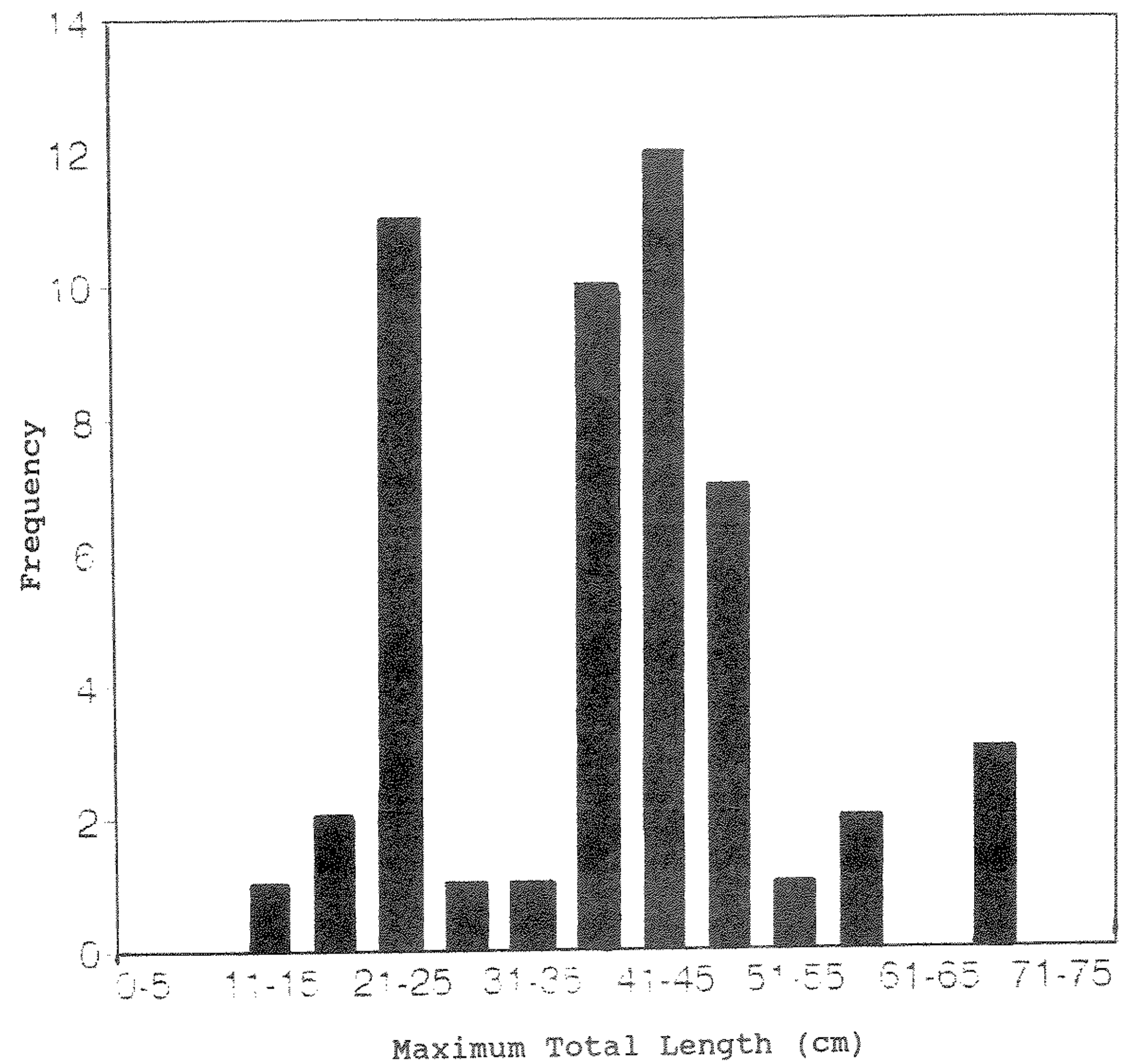

Figure 9. Length-frequency distribution of northern pike collected from Beaver Creek, Montana in 1990 and 1991.

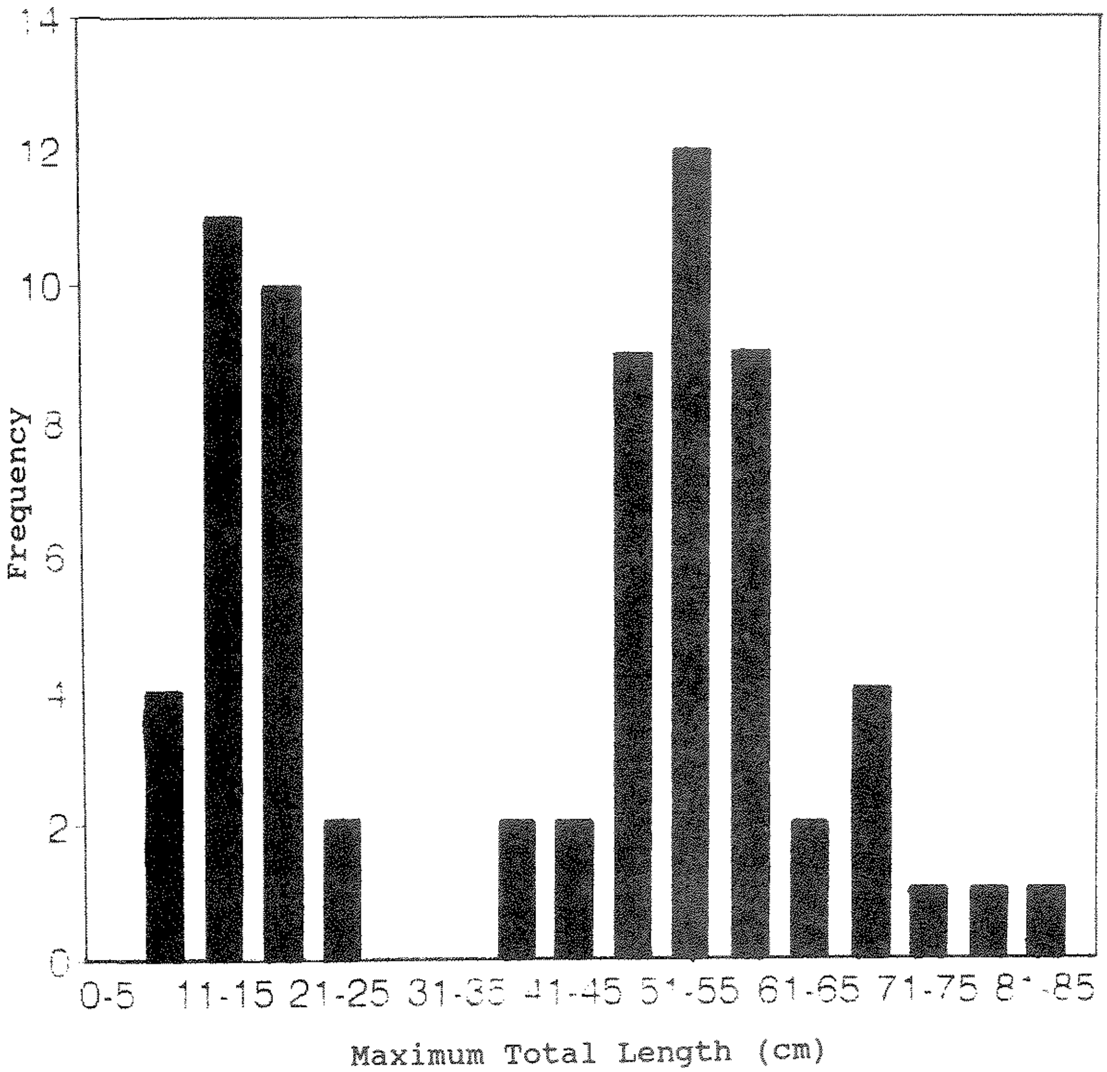

Figure 10. Length-frequency distribution of northern pike collected from Little Beaver Creek, Montana in 1990 and 1991.

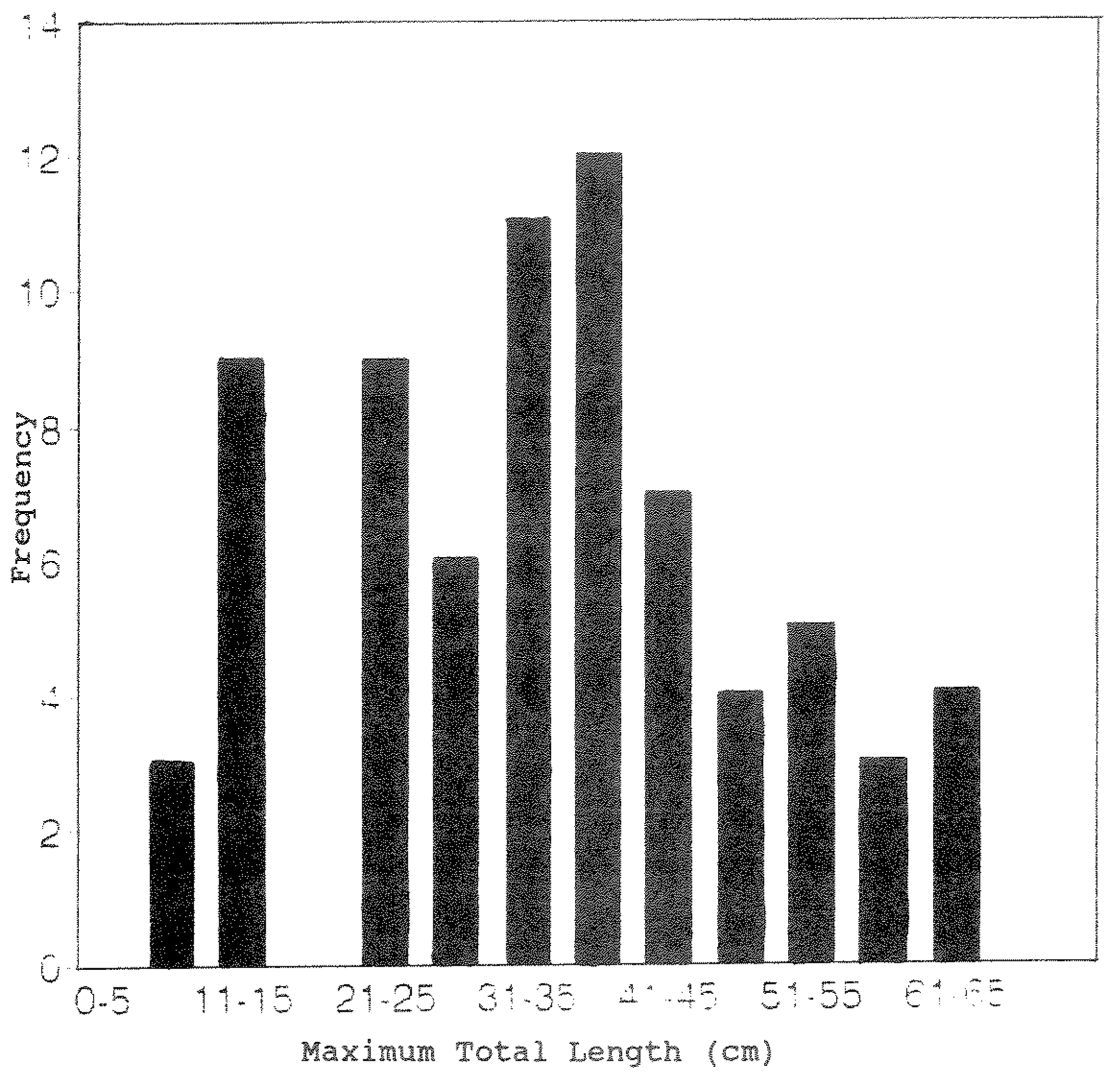

Figure 11. Length-frequency distribution of walleye collected from Beaver Creek, Montana in 1990 and 1991.

determination was made for northern pike or walleye. Therefore sexes were combined for length-weight and age and growth analyses. The equation for the northern pike length-weight relationship (Figure 12) is: Weight (g) = 0.0071819 Length $(mm)^{2.975}$. The correlation coefficient was 0.993, indicating a good fit. The overall exponent of the power function relationship between total body length and body weight for northern pike, b = 2.975, indicates growth was nearly isometric.

The length-weight relationship derived for 73 walleye (Figure 13) collected from Beaver Creek in 1990 and 1991 is: Weight (g) = 0.0019685 Length $(mm)^{3.40}$, r = 0.992. The value of the regression constant b for walleye is 3.40 indicating growth is allometric.

Condition Factor

Average condition factors were calculated for the various age classes of northern pike and walleye in Beaver Creek and Little Beaver Creek sampled in 1990 and 1991. Average condition of northern pike from Beaver Creek (Table 15) ranged from 0.591 (age 6) to 0.660 (age 5). In Little Beaver Creek (Table 15) condition factors ranged from 0.542 (age 1) to 0.727 (age 0). Condition of walleye collected from Beaver Creek (Table 16) gradually increased with age: 0.556 for age 0 to 0.950 for age 11. Walleye in age class 9 had the highest value at 1.083.

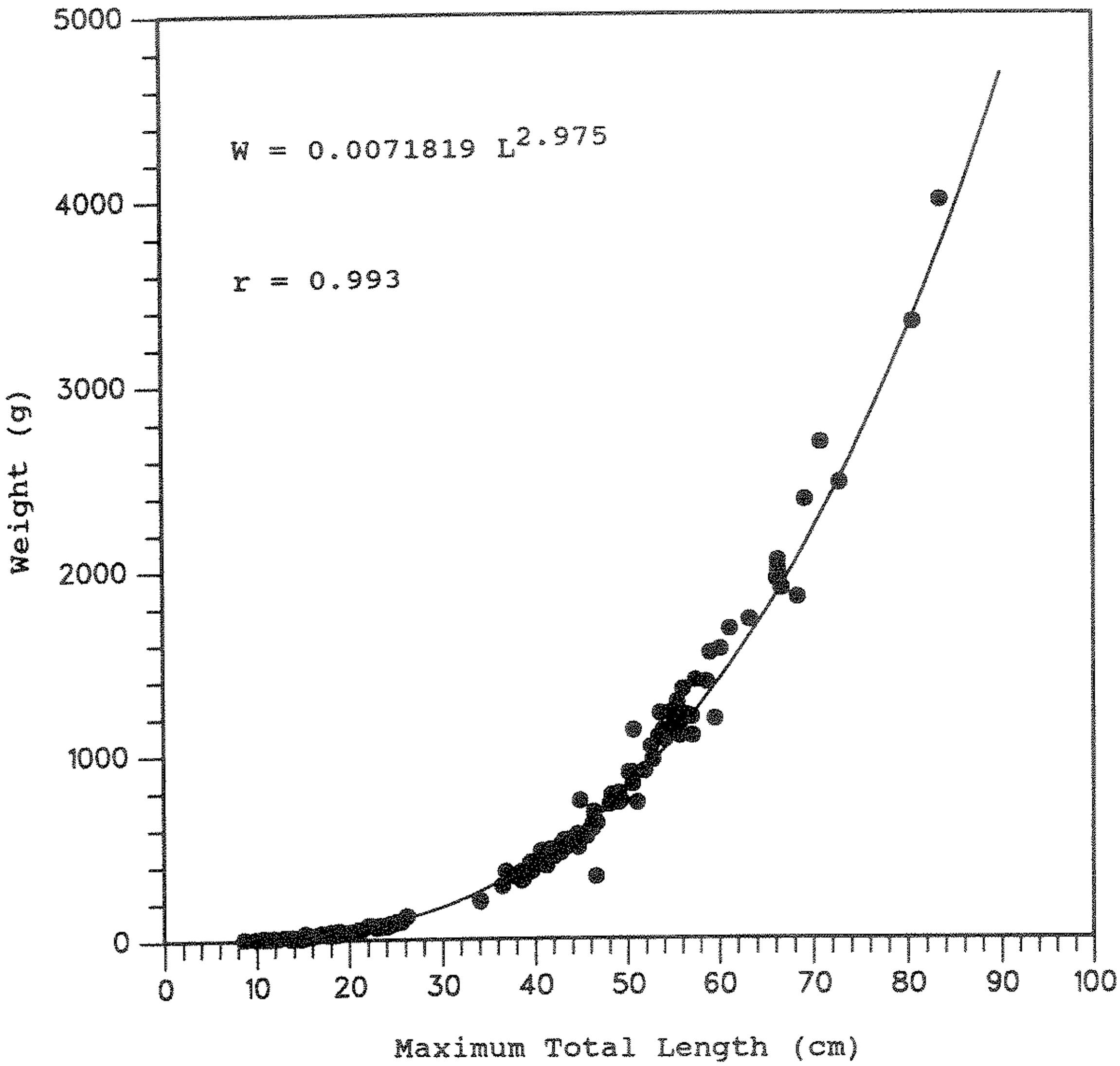

Figure 12. Length-weight relationship of 121 northern pike from Beaver Creek and Little Beaver Creek, Montana in 1990 and 1991.

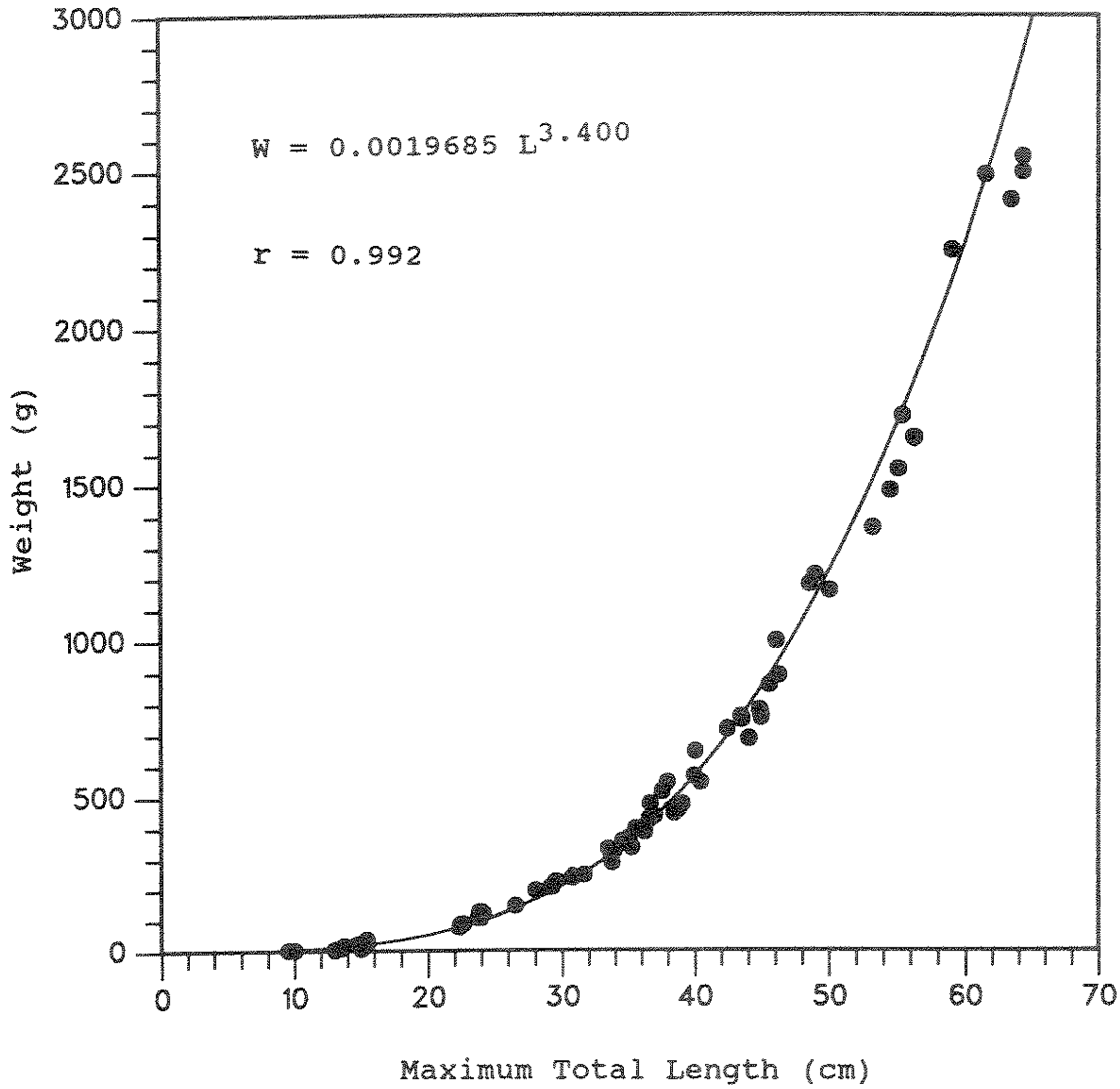

Figure 13. Length-weight relationship of 73 walleye from Beaver Creek, Montana in 1990 and 1991.

Table 15. Average condition factor (K) by age class for northern pike collected from Beaver Creek and Little Beaver Creek, Montana in 1990 and 1991.

Beaver Creek

Age class	0	1	2	3	4
Mean K	0.633	0.635	0.616	0.621	0.631
N	15	4	5	16	4
Std. dev.	0.079	0.048	0.017	0.044	0.050

Age class	5	6	7	8
Mean K	0.660	0.591		0.638
N	3	1	-	3
Std. dev.	0.111	0.000		0.057

Little Beaver Creek

Age class	0	1	2	3	4	5
Mean K	0.727	0.542	0.639	0.641	0.707	0.721
N	26	1	3	4	8	8
Std. dev.	0.266	0.000	0.067	0.221	0.083	0.024

Age class	6	7	8	9	10	11
Mean K	0.683		0.680	0.706		0.662
N	12	-	2	4	-	2
Std. dev.	0.057		0.028	0.081		0.072

Table 16. Average condition factor (K) by age class for walleye collected from Beaver Creek, Montana in 1990 and 1991.

Age class	0	1	2	3	4	5
Mean K	0.556	0.798	0.884	0.866	0.832	0.884
N	12	5	5	5	6	12
Std. dev.	0.256	0.069	0.101	0.052	0.051	0.076

Age class	6	7	8	9	10	11
Mean K	0.870	0.904	0.956	1.083	0.946	0.950
N	5	9	9	2	1	2
Std. dev.	0.082	0.050	0.051	0.024	0.000	0.070

Age and Growth

I back calculated lengths of northern pike and walleye at earlier ages from scale samples collected in 1990 and 1991 from populations in Beaver Creek and Little Beaver Creek.

Due to small sample sizes, age and growth data for northern pike from Beaver Creek and Little Beaver Creek were combined. Age 0 to age 11 northern pike were collected, but few individuals older than age 6 were sampled. Northern pike age 7 and 10 were absent from samples. Walleye collected from Beaver Creek ranged from age 0 to 11, although low numbers represented ages 9 to 11. The mean back calculated lengths at each age class for northern pike (Table 17) and walleye (Table 18) exhibit a tendency for computed lengths at a given age to be smaller with increasing age of fish from which they are computed.

Table 17. Back calculated mean lengths at annuli by age class for 80 northern pike sampled from Beaver Creek and Little Beaver Creek, Montana in 1990 and 1991.

		Mean length (mm) at annuli										
Age	N	1	2	3	4	5	6	7	8	9	10	11
1	4	225										
2	9	197	319									
3	20	197	291	384								
4	12	148	247	338	430							
5	11	107	190	277	384	480						
6	13	98	170	251	354	449	535					
8	5	106	172	230	322	427	514	573	634			
9	4	71	124	200	290	385	506	596	642	678		
11	2	58	108	174	268	352	421	509	602	706	758	799
Grand average calculated length		147	231	304	368	443	516	570	631	687	758	799
Grand average increment length		147	87.6	84.9	98.5	96.1	86.3	75.6	61.4	58.7	52.0	41.0
Sum of grand average increments		147	235	320	418	514	600	676	737	796	848	889

Table 18. Back calculated mean lengths at annuli by age class for 61 walleye sampled from Beaver Creek, Montana in 1990 and 1991.

		Mean length (mm) at annuli										
Age	N	1	2	3	4	5	6	7	8	9	10	11
1	5	170										
2	5	119	192									
3	5	67	161	242								
4	6	76	136	200	271							
5	12	64	119	190	260	321						
6	5	50	105	161	216	283	341					
7	9	60	111	159	218	284	346	400				
8	9	62	115	186	262	338	388	444	492			
9	2	47	109	178	243	314	380	438	509	569		
10	1	55	100	151	262	358	405	461	509	564	608	
11	2	54	103	153	210	248	316	377	442	500	559	605
Grand average calculated length		75.6	127	185	246	309	361	405	489	540	575	605
Grand average increment length		75.6	62.1	64.3	67.6	66.5	57.6	55.8	53.7	58.2	54.0	46.0
Sum of grand average increments		75.6	235	320	418	514	600	676	737	796	848	889

DISCUSSION

Habitat Characteristics

The physical and chemical properties of Beaver Creek and Little Beaver Creek are closely linked to geologic features and climate. Local geology influences gradient, substratum and water chemistry (Winger 1981); climate determines the quantity of moisture and vegetation types. Shifts in the geomorphology of Beaver Creek and Little Beaver Creek, resulted in changes from the large, physicochemically stable pools of the middle stream zones to the more variable conditions of the upper and lower zones.

The large permanent pools of the middle zones of Beaver Creek and Little Beaver Creek (Figures 3 and 4) provide more favorable environmental conditions during dry periods. By mid-summer, the desiccation of both Beaver Creek and Little Beaver Creek from near zero flow, evaporation, and transpiration exposes fish to extremes in environmental conditions. Pools in the middle zone of each stream have a clay substratum. In prairie streams with such a relatively impermeable layer, water has a long residence time (Matthews 1981) and water loss to deep sediments is minimized. The value of these large pools is directly related to their size and volume. Groundwater input to pools of the middle zone during periods of zero flow, would serve to moderate water temperature and influence the concentration of chemical constituents in the water (Winger 1981). Streams at base flow usually have higher solute concentrations (Hynes 1970); pools of the middle zone had lower values for conductivity than in the lower zone. By comparison, water has a shorter residence time in the smaller volume pools of the upper and lower stream zones. The combination of a lower water volume and higher rate of exchange with the more permeable sand and gravel substratum results in wider fluctuation of environmental conditions and less stability.

Habitat diversity in Beaver Creek and Little Beaver Creek increased from headwaters to the middle stream zone, but did not increase downstream in the lower zone as has been reported for other stream systems (Gorman and Karr 1978; Schlosser 1982) where habitat diversity and volume increased from upstream to downstream. In these studies, upstream reaches were shallow and structurally simple, changing to complex channels and large pools in the downstream reaches. This pattern holds true for Beaver Creek and Little Beaver Creek but only to the downstream end of the middle zone. In contrast, the lower zones did not display complex channels nor progressively deeper pools, but were instead dominated by shorter, shallower pools with a shifting sand and gravel substrate. In the lower stream zones, pool habitats and cover associated with aquatic macrophytes and organic debris were absent, displaying a decrease rather than increase in habitat diversity.

Fish Distribution and Movement

Northern pike were found in Beaver Creek and Little Beaver Creek but walleye were found only in Beaver Creek. Their distribution reflects the presence of the permanent pools which were most numerous in the middle zone of each drainage (Figures 5 and 6). Northern pike were rare and walleye were absent in fish samples collected from the upper and lower stream zones. A similar example of faunal zonation due to major changes in stream geomorphology was reported for a stream in Illinois (Schlosser 1982). The only instance of occurrence outside the middle stream zones, was two northern pike collected from a pool in the upper zone of Little Beaver Creek. This pool was non-typical of the small pools that characterize the upper stream zones and resembled the large pools located in the middle stream zones.

Large volume pools, like those of the middle stream zones tend to be more physicochemically stable (Schlosser 1987). Because of this inherent stability, large, deep, well developed pools of Beaver Creek and Little Beaver Creek enable coolwater species, northern pike and walleye (Inskip et al. 1982; Scott and Crossman 1973), to occupy prairie streams where surface water temperatures may reach 31°C. At the same time, large pools also contained forage species vital to the growth and survival of northern pike and walleye.

There are no records of walleye introductions into Little Beaver Creek, although they occur in the Little Missouri River (P.A. Stewart, MDFWP, personal communication). Walleye migrate into tributary streams in the spring to spawn (Scott and Crossman 1973) during periods of rapid warming soon after ice-out (Colby et al. 1979). The timing of the migration coincides with peak flows of Little Beaver Creek (Figure 2) and, to my knowledge, no instream barriers exist that would obstruct walleye passage from the Little Missouri River. The environmental conditions of Little Beaver Creek and Beaver Creek are similar (Table 6). Why walleye are absent from Little Beaver Creek is unknown.

With the exception of northern pike and walleye, the fish community of Beaver Creek and Little Beaver Creek (Table 7) is characteristic of intermittent prairie streams (Zale et al. 1989; McCoy and Hales 1974; Elser et al. 1978). Several patterns emerged (Figures 7 and 8) regarding the distribution of these species. The first group, consisting of cyprinids, a catostomid and a hiodontid, were confined to the lower stream zone and are believed to have originated from the Little Missouri River (Pflieger 1975; Brown 1971), inhabiting Beaver Creek and Little Beaver Creek temporarily for spawning and rearing. A second group, absent from the lower zone, was comprised of pool-associated ictalurids, centrarchids, percids, cyprinids, a catostomid and a gasterosteid which occur in permanent pools of the middle and upper zones. The third group, cyprinids, catostomids and centrarchids (Brown 1971), were habitat generalists and were found throughout each drainage.

This study was conducted during two drought years. Data reflect these conditions and conclusions must be somewhat conjectural. The absence of substantial runoff in 1990 and 1991, greatly restricted fish movement and the opportunity to gather information on such movement. During the summer, movement of riverine walleye is usually limited to less than 8 km (Paragamian 1989), but tagged walleye have been known to travel over 150 km (Scott and Crossman 1973). Northern pike are fairly sedentary (Scott and Crossman 1973; Diana 1980) but movements of up to 60 km for radio tagged northern pike in the Lower Flathead River, Montana were reported (Dos Santos 1991). Angler returns of tagged fish in 1990 and 1991 from Beaver Creek and Little Beaver Creek indicated no between-pool movement.

Habitat Relationships

Northern Pike

Submerged aquatic vegetation was the primary variable identified by logistic regression (Table 14) influencing the distribution of northern pike biomass in Beaver Creek. Northern pike are known to have a close association with aquatic macrophytes during several stages of their life history (Carlander 1969; Scott and Crossman 1973; Chapman and MacKay 1984). Spawning takes place over vegetation in areas of calm, shallow water (Franklin and Smith 1963; Eddy and Underhill 1974). Young-of-the-year and juvenile pike occupy vegetation (Holland and Huston 1984) for foraging and predator avoidance. In my study, northern pike were often encountered in and around clumps of submerged vegetation. Radio tagged adult pike preferred heavily vegetated habitats in the Lower Flathead River, Montana (Dos Santos 1991). Adults are day active, ambush predators (Craig and Babaluk 1989) positioning themselves at the macrophyte-open water interface (Chapman and MacKay 1984), utilizing vegetation for concealment without impairing vision. Although submerged aquatic vegetation was important to northern pike in Beaver Creek, it was not correlated to pike in Little Beaver Creek. Pools containing northern pike in Beaver Creek had a mean of 664 m^2 of submerged aquatic vegetation, while pools in Little

Beaver Creek had a mean of 393 m^2. This may account for the correlation of aquatic vegetation with northern pike in Beaver Creek and not in Little Beaver Creek. Organic debris is used for cover by northern pike in a similar manner to their use of submerged aquatic vegetation (Inskip et al. 1982) and was correlated to northern pike in Little Beaver Creek but not in Beaver Creek. Pools containing northern pike in Little Beaver Creek had a mean of 98 m^2 of organic debris, while pools in Beaver Creek had a mean of 53 m^2. This may account for the correlation of organic debris with northern pike in Little Beaver Creek and not in Beaver Creek. In the lower stream zone, shallow pools and a shifting stream bed prevent accumulation of debris and establishment of vascular plants resulting in habitat conditions apparently unsuitable for northern pike.

Logistic regression identified pH as the most important variable influencing the distribution of northern pike biomass in Little Beaver Creek (Table 14). Northern pike can survive and reproduce in a range of pH from 5.0 to 9.5 (McCarraher 1962), although reproduction is impaired at values below 5.0 (Inskip et al. 1982) and it is unclear if successful reproduction can occur above a pH of 9.5. Northern pike were found in pools of the middle zone of Little Beaver Creek where pH ranged from 7.8 to 10.3, with a mean of 8.5; in Beaver Creek northern pike were found where pH ranged from 7.9 to 9.5, with a mean of 8.4. A greater mean and upper pH range may explain the correlation of pH with northern pike in Little Beaver Creek and not in Beaver Creek. High pH values occur from a divergence from equilibrium of the free carbon dioxide-bicarbonate-carbonate system (Hutchinson 1957) as a result of photosynthetic removal of carbon dioxide. Pools within the middle zone had moderate water transparency and abundant submerged macrophytes. Although not selected by the model for pike in Little Beaver creek, these two variables enhance photosynthesis and may explain the relationship between northern pike and pH.

Streamside cover of forbs and grasses was positively correlated with northern pike distribution and was the only variable in common between models. Northern pike spawn by broadcasting gametes over vegetation in areas of calm shallow water (Eddy and Underhill 1974). Inundated terrestrial vegetation provides excellent substrate for embryo development (Franklin and Smith 1963) and cover during the fry stage (Holland and Huston 1984). Flooded prairie grasses and sedges (Hassler 1970) seem to be preferred and recruitment has been directly related to the amount of suitable spawning habitat. A Kruskal-Wallis rank test of the recorded values from the three stream zones of Beaver Creek and Little Beaver Creek (Tables 11 and 12), indicated the greatest linear meters of this shoreline coverage occurred in the middle stream zones.

Young-of-the-year northern pike were collected from the middle zones of both Beaver Creek and Little Beaver Creek in 1990 and 1991 where forbs and grasses were inundated along pool margins.

Positive correlations exist between various measures of pool dimension and the distribution of northern pike in Little Beaver Creek. Pools with a large volume and average cross sectional area provide concealment and a good forage base. Smaller pools do not afford pike the same protection. Large surface area and average width would suggest that large pools have a wider range of water depths and habitat diversity, along with higher invertebrate and vertebrate biomass levels than small pools (Chapman and MacKay 1984). Depths greater than 75 cm would provide refuge from extremes in environmental conditions. Large pike select deeper unvegetated water more often than small pike (Diana et al. 1977). Deep water holding habitat was preferred by pike during the day as overwintering sites in a study of a riverine pike population in Montana (Dos Santos 1991). Surface area and depth were found to be among the most important variables related to northern pike abundance in Ontario lakes (Johnson et al. 1977). Some pools in Little Beaver Creek were nearly 1 km in length. Long pools would allow greater movement of pike (Kipling and Frost 1970) for feeding since food resources are more limited in streams than in lakes (Diana et al. 1977).

Sand substrate was positively correlated with the distribution of northern pike biomass in Little Beaver Creek, while gravel substrate was positively correlated with northern pike in Beaver Creek. Northern pike have been reported to occur over shredded vegetation scattered on a substrate of sand and fine black muck (Inskip et al. 1982; Chapman and MacKay 1984). In pools containing pike in the middle stream zones of Beaver Creek and Little Beaver Creek, the substrate consists of sand and fine particulate organic material. The relationship of gravel substrate to northern pike is unclear. Pools inhabited by northern pike were separated by short, shallow riffles comprised of gravel with deposition often extending a meter or more into the pool. Although gravel was recorded where pike were found in Beaver Creek, it has not been reported as a variable characteristic of northern pike habitat (Inskip et al. 1982; Dos Santos 1991).

Conductivity was positively correlated with the distribution of northern pike biomass in Beaver Creek. Ionic concentrations appear to be directly limiting to northern pike in arid environments, but an upper limit has not been established (Inskip et al. 1982). Pools of the middle zone of Beaver Creek had a mean conductivity of 2716 umhos/cm compared to a mean of 1454 umhos/cm in the middle zone of Little Beaver Creek. In Beaver Creek, northern pike occurred over a range of conductivity from 2020 to as high as 3800 umhos/cm and may explain the significant correlation. Water salinity and conductance is greatly modified by runoff of the drainage basin (Wetzel 1975) and concentrated by evaporation and transpiration. The Kruskal-Wallis rank test of recorded conductivity values among the three stream zones of Beaver Creek (Table 11) indicates that the greatest observed values occurred in the lower stream zone where the smaller volume pools would be more susceptible to elevated conductance as a result of small groundwater input and greater evaporation.

The last variable significantly influencing northern pike biomass distribution in Beaver Creek was water transparency. The Kruskal-Wallis rank test for secchi disk depth for the three stream zones of Beaver Creek (Table 11) indicated higher mean secchi disk depths were recorded in the middle zone. Northern pike are primarily diurnal feeders (Scott and Crossman 1973) relying on keen vision and concealment in their ambush style of predation (Chapman and MacKay 1984).

Walleye

Similar to northern pike, the distribution of walleye biomass in Beaver Creek was also associated with large pools. The primary variable identified by logistic regression (Table 14) influencing this distribution in Beaver Creek is average pool width. This appears reasonable because the widest pools had the largest volume, providing habitat similar to the sublittoral environments inhabited by walleye in lakes (Kitchell et al. 1977). Kitchell et al. (1977) suggested that this daytime lacustrine sublittoral habitat used by walleyes was in many respects similar to the pool habitats of riverine walleyes. Average cross-sectional area and the area of the pool where water depth exceeded 50 cm was positively correlated with walleye biomass.

Light exerts a strong controlling influence on walleye behavior (Ali et al. 1977; Bulkowski and Meade 1983) and depth attenuates light intensity (Wetzel 1975). The Kruskal-Wallis rank test of recorded values of secchi disk depth (Table 13) indicates greater water transparency occurred in the middle stream zone. Greater pool depth and the presence of submerged aquatic vegetation in middle zone pools would allow walleye to avoid high light intensity (Ryder 1977). Walleye are known to occupy deeper water during daylight hours (Ryder 1977; Eddy and Underhill 1974) and riverine walleye populations selected the deepest pools available (Paragamian 1989; Stevens 1990).

Pool surface area and length were important to walleye presence. In a meandering stream, a pool several hundred meters in length coupled with a large surface area would suggest the presence of a diversity of water depths and inshore habitats. Juvenile and adult walleye exhibit distinct diel movement (Kelso and Ward 1977; Johnson and Hale 1977) from deeper water areas occupied in daytime to shallower shoreline areas at night to forage (Stevens 1990). Smaller sized pools located in the lower and upper stream zones of Beaver Creek would not present much opportunity for horizontal and vertical movement.

Sand substrate was positively correlated with the distribution of walleye biomass in Beaver Creek. Optimum substrate for spawning walleye is clean gravel or rubble (McMahon et al. 1984), although spawning will occur over sand and muck when preferred substrates are absent (Johnson 1961; Pitlo 1989). Walleye exhibit a great deal of adaptability in their reproductive habits, particularly in the Missouri River and its tributaries (Johnson and Hale 1977). Egg survival of a riverine population in Ontario was highest over sand (Corbett and Powles 1986). Age-0 walleye in an Ohio reservoir were found mostly over sand (Johnson et al. 1988) and adults of a riverine population in Wisconsin (Stevens 1990) were observed over a sand bottom 70% of the time. Pools of the middle stream zone of Beaver Creek received the highest Kruskal-Wallis rank for area of sand substrate (Table 13). Walleye successfully spawned in Beaver Creek as evidenced by young-of-the-year walleye collected there in 1990 and 1991.

The next significant variable related to the distribution of walleye biomass in Beaver Creek is area of no instream cover. Walleye are an open water shoaling fish (Ryder 1977; Kitchell et al. 1977) and habitat selection by adult walleye in streams in Wisconsin (Stevens 1990) and Iowa (Paragamian 1989) indicated a general lack of preference for overhead cover. In a Kruskal-Wallis rank test for area of no instream cover among the three stream zones of Beaver Creek, the middle stream zone received the highest rank indicating the least amount of instream cover was recorded there.

A streamside cover of forbs and grasses was positively correlated with walleye distribution. Demersal walleye fry are photosensitive (Bulkowski and Meade 1983), actively seeking shelter in the form of submerged terrestrial or aquatic vegetation (Ryder 1977). The middle stream zone of Beaver Creek received the highest Kruskal-Wallis ranking (Table 13) for this vegetation type indicating greater observed values were recorded there. I collected young-of-the-year walleye from inundated forbs and grasses along inshore habitats of stream meanders. Age-0 walleye may have been using this vegetation as a nursery area and as a form of intraspecific habitat segregation between themselves and older age classes as protection against the cannibalistic nature of percids (Chevalier 1973; Collette et al. 1977).

The last variable found to influence the distribution of walleye in Beaver Creek was water transparency. Light is considered to be the strongest stimulus influencing walleye behavior, even stronger than food (Ali et al. 1977; Ryder 1977). Walleye abundance was negatively correlated with secchi disk depth. Although the middle zone of Beaver Creek received the highest Kruskal-Wallis rank for secchi disk depth (Table 13), walleye were present in moderately turbid pools where secchi disk depths ranged from 10.0 to 125.0 cm, with a mean of 48.0 cm. Shelter from bright daylight in the form of greater water depth and turbidity is considered suitable walleye habitat (Scott and Crossman 1973) and the large pools of the middle zone of Beaver Creek provide such conditions. Walleye are able to forage efficiently at such light levels (Craig and Babaluk 1989) because of a specialized eye structure, the tapetum lucidum (Ali et al. 1977).

To my knowledge, self-sustaining populations of northern pike and walleye have not been previously reported in streams as small as Beaver Creek and Little Beaver Creek. Habitat relationships developed in this study were, in general, similar to those reported in the literature for northern pike and walleye in lacustrine and large riverine habitats.

Age, Growth and Condition of Northern Pike and Walleye

Back calculated lengths (Tables 17 and 18) of both northern pike and walleye in Beaver Creek and Little Beaver

Creek showed evidence of Lee's phenomenon. Calculated lengths of older fish in earlier years of life were smaller than those of younger fish of the same age (Carlander 1969). This may be due to sampling bias or to some naturally occurring factor (Hile 1970). Sampling by seining may have been biased toward smaller fish while electrofishing is biased towards larger fish resulting in samples not representative of the population. Such sampling bias would result in undue weighting of the recorded values of the habitat variables at a particular site during the statistical analyses. I felt the use of toxicants and explosives to overcome fish sampling difficulties were unnecessary and not in the best interest of safety and maintaining good public relations. The use of calcified structures such as otoliths and cleithra can provide accurate age results (Casselman 1990). The use of these structures however, necessitates sacrificing the fish being sampled and it was felt such measures may have adverse effects on the small populations of northern pike and walleye in these streams.

The occurrence of Lee's phenomenon in the back calculated lengths for walleye has also been attributed to missed annuli on older fish (Carlander and Whitney 1961). Similar difficulties for northern pike (Laine et al. 1991) stemmed from the naturally occurring factor of the crowding of annuli at the edge of the scale and the presence of false annuli.

The low numbers in the younger age classes of both northern pike and walleye (Tables 17 and 18) could result from poor spawning, low hatching success or high mortality of young fish. Cannibalism occurs frequently among percids (Chevalier 1973; Collette et al. 1977) and esocids (Chapman and MacKay 1984) and is believed to be one of the more important factors influencing year class strength (Kipling and Frost 1970; Scott and Crossman 1973). The amount of cannibalism, however, is dependent upon the availability of a forage base (Franklin and Smith 1963; Kitchell et al. 1977). I found cyprinids, centrarchids and catostomids to be plentiful throughout the middle stream zones and in sizes that would enable them to be used as prey (Figures 7 and 8). Thus cannibalism may not be responsible for the small representation of the younger age classes in samples. I was unable to detect irregular spacing of annuli on scales of the older aged northern pike and walleye that would suggest these fish had spent a portion of their life in the Little Missouri River or Lake Sakakawea under a different set of environmental conditions.

The average body condition of the various age classes of northern pike sampled in Beaver Creek and Little Beaver Creek was rated as poor when compared to other populations (Beckman 1948; Carlander 1969) while condition of walleye from Beaver Creek was good when compared to other populations (Colby et al. 1979). The observed differences in condition of two visual predators (Scott and Crossman 1973) could be the result of the differential effect of turbidity on their behavior, feeding and growth. Mean secchi disk depths for the middle stream zones of Beaver Creek and Little Beaver Creek were 82.0 cm and 48.0 cm respectively. These conditions are lower than the 2 to 4 m considered optimum for northern pike (Inskip et al. 1982), but are considerably closer to the 1 to 2 m considered optimum for walleye (Ryder 1977). Moderate turbidity, a characteristic of prairie streams (Matthews 1981), reduces the ability of northern pike to feed (Diana 1980) and feeding behavior changes from a relatively stationary, inshore existence to a pelagic lifestyle (Chapman and MacKay 1984). Under the same conditions, walleye increase their activity (Ryder 1977) and feed in the daytime. Visual adaptations enable walleye to effectively feed under the moderately turbid environment of Beaver Creek and may account for their higher relative condition than northern pike. For sympatric northern pike and walleye in Canadian prairie lakes, turbidity was reported to influence feeding, growth and condition of northern pike but not walleye (Craig and Babaluk 1989).

The exponent of the power function relationship between total body length and total body weight for northern pike in Beaver Creek and Little Beaver Creek was 2.97, representing nearly isometric growth. This is in agreement with exponents slightly less than 3 that were reported from more than 38 lacustrine and riverine populations of northern pike in Canada (Doyon et al. 1988). Walleye in Beaver Creek grew allometrically (b=3.4) (Tesch 1968) with weight increasing faster than length. Such a trend is in agreement with the average values of condition for various age classes of walleye in Beaver Creek being good (Colby et al. 1979). Fish living under marginal environmental conditions will theoretically weigh less at any particular body length than those living under more optimal conditions (Tesch 1968). From this I would surmise conditions in Beaver Creek favor the growth of walleye over northern pike.

Future of Northern Pike and Walleye

Young-of-the-year northern pike and walleye were collected from Beaver Creek and Little Beaver Creek in 1990 and 1991. However, based on the small numbers of adults collected, these streams are probably not important sources of recruitment to the Little Missouri River and Lake Sakakawea. Evidence suggests the populations of northern pike and walleye in these streams are self-sustaining and non-migratory.

Informal discussions with the few anglers encountered, indicated a genuine interest and enthusiasm for the recreational opportunity provided by northern pike and walleye in Beaver Creek and Little Beaver Creek. Although total numbers of anglers observed were relatively small, those that did fish, did so quite often. With the small populations of northern pike and walleye being isolated in the large pools, overfishing could be a concern. In any event, public interest coupled with the recreational potential of this resource, may be an impetus for future study and provide a direction for management.

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APPENDIX

Table 19. Mean values for all habitat variables measured at each study site for Beaver Creek and Little Beaver Creek, Montana in 1990 and 1991.

Beaver Creek Pools

St	El	Dist	L	Aw	Sa	Vol	Asa	A25	A50	A75	A100
1	930	298.8	86.8	4.2	368.0	185.9	1.9	217	131	25	12
2	919	289.8	40.0	3.3	133.6	52.9	1.2	59	28	3	0
3	918	289.0	65.0	6.2	399.5	141.4	1.9	244	0	0	0
4	908	283.0	20.1	2.9	58.3	22.7	1.0	34	10	0	0
5	908	282.9	38.7	6.4	249.1	130.4	3.0	136	69	30	0
6	903	279.8	34.3	2.6	89.7	32.8	0.9	45	12	2	0
7	901	275.6	480.0	10.6	5085.1	5454.8	10.5	4096	3390	3079	2486
8	900	274.0	62.0	3.7	228.9	133.5	1.8	140	71	33	8
9	893	268.1	122.5	5.0	609.8	406.3	2.7	454	332	142	0
10	890	264.5	139.1	7.9	1100.8	1074.8	6.4	868	648	477	355
11	881	256.0	192.0	6.4	1233.4	1025.1	4.4	973	740	480	137
12	878	253.3	73.0	3.3	239.7	104.6	1.2	165	43	0	0
13	875	250.8	122.1	6.0	731.6	392.4	2.8	496	276	33	0
14	863	239.6	215.6	6.7	1447.2	1594.3	6.9	1238	1053	933	667
15	862	237.6	141.3	5.1	723.7	410.7	2.5	507	322	8	0
16	855	230.5	303.2	7.4	2237.3	1551.8	4.8	1566	1231	708	236
17	852	226.6	68.5	7.6	520.9	279.8	3.5	341	191	52	0
18	851	225.6	520.0	8.3	4308.2	3051.6	5.4	3470	2274	1340	503
19	847	219.4	426.0	10.6	4524.8	4034.9	9.0	3494	3117	2036	1156
20	846	218.4	195.9	8.7	1709.4	936.6	4.3	1064	722	38	0
21	842	214.1	293.3	6.4	1871.0	933.3	3.0	1237	686	135	31
22	842	214.0	40.7	6.4	261.6	108.5	2.4	142	64	0	0
23	840	210.9	230.2	3.7	840.9	426.8	1.7	617	402	0	0
24	836	207.0	187.6	9.0	1696.3	1426.2	6.6	1263	848	452	132
25	832	203.0	400.0	6.6	2643.0	2089.3	4.7	2203	1821	1131	147
26	830	199.6	395.2	9.9	3931.3	2750.6	6.6	2796	1835	983	415
27	828	197.1	37.8	5.6	211.3	112.1	2.5	160	77	5	0
28	827	195.4	47.0	7.8	364.2	204.8	3.8	227	162	53	0
29	826	194.6	218.0	7.4	1619.0	997.2	4.3	1151	747	288	135
30	825	193.3	334.7	8.8	2928.1	1391.3	3.9	1871	1090	244	0
31	825	191.6	329.7	9.6	3165.8	1627.0	4.6	2339	1284	211	0
32	825	191.0	293.0	19.5	5709.7	3940.1	12.5	4377	3616	2347	254
33	818	187.5	672.0	12.9	8675.2	8361.8	11.4	6651	6024	4964	3325
34	816	184.3	337.7	9.6	3236.0	1345.8	3.7	1546	683	180	0
35	810	180.5	462.5	10.4	4794.5	3236.0	6.6	3223	2237	1092	479
36	791	171.1	87.7	5.9	519.0	191.7	1.9	265	75	0	0
37	787	166.4	335.0	9.1	3065.3	774.6	2.2	1192	85	0	0
38	780	161.0	187.1	12.7	2376.5	1191.6	5.1	1241	660	343	185
39	778	160.1	199.0	7.1	1411.5	533.5	2.2	659	298	47	0
40	777	159.8	147.7	5.7	846.2	221.4	1.3	254	85	19	0
41	776	159.5	105.0	6.3	663.6	321.9	2.6	420	236	29	0
42	774	157.0	34.5	6.0	207.1	100.8	2.5	104	62	25	0
43	767	149.5	78.5	8.1	638.0	404.0	4.4	425	326	135	43
44	765	148.8	56.9	5.0	286.2	123.3	1.9	134	51	22	6
45	761	145.6	286.0	7.4	2129.0	1273.2	4.1	1431	840	367	154

Table 19. *Continued*

Beaver Creek Pools											
St	El	Dist	L	Aw	Sa	Vol	Asa	A25	A50	A75	A100
46	755	137.9	333.4	8.4	2804.9	2111.8	5.7	2197	1714	1215	639
47	754	137.0	28.0	5.9	166.3	97.2	2.8	118	65	31	4
48	744	129.5	173.3	6.4	1106.3	704.8	3.5	750	504	209	86
49	744	129.4	98.2	5.7	561.3	467.4	3.8	437	387	243	44
50	741	128.9	293.0	5.6	1635.2	1249.1	3.9	1281	1045	672	209
51	736	118.5	186.0	3.6	673.1	305.5	1.4	374	194	15	0
52	719	100.5	133.2	4.5	599.4	299.4	1.8	400	186	13	0
53	716	96.3	128.5	4.7	602.3	256.9	1.6	308	141	0	0
54	715	95.5	32.1	4.6	148.7	81.2	2.2	79	40	23	8
55	659	18.8	47.1	6.3	299.0	110.9	1.9	156	40	10	0
56	637	4.8	182.5	4.7	853.7	275.0	1.2	313	104	0	0

Beaver Creek Pools											
St	S1	S2	S3	S4	S5	C0	C1	C2	C3	Sc1	Sc2	Sc3
1	233	53	82	0	0	53	68	247	0	0.5	0.3	---
2	60	27	47	0	0	46	13	74	0	0.7	0.3	---
3	361	27	5	5	0	6	51	342	0	0.9	0.3	---
4	46	13	0	0	0	14	13	26	6	0.6	0.5	0.9
5	228	21	0	0	0	36	25	185	4	0.8	0.4	2.0
6	46	37	5	1	0	0	18	56	15	0.6	0.3	1.0
7	4976	109	0	0	0	3923	218	726	218	1.6	0.4	1.7
8	219	10	0	0	0	118	56	10	46	0.7	1.0	0.7
9	584	26	0	0	0	470	52	0	87	1.0	---	0.6
10	1101	0	0	0	0	393	189	456	63	1.0	0.5	1.3
11	1143	91	0	0	0	687	141	405	0	1.8	0.4	---
12	240	0	0	0	0	34	21	175	10	1.2	0.3	1.3
13	617	94	21	0	0	554	73	105	0	0.8	0.8	---
14	1127	93	227	0	0	1178	0	269	0	---	0.6	---
15	724	0	0	0	0	548	10	124	41	1.0	0.8	1.5
16	2030	208	0	0	0	2046	96	64	32	0.7	1.1	1.0
17	298	82	134	7	0	491	22	0	7	1.0	---	2.0
18	3077	1139	92	0	0	4124	92	31	62	1.3	1.0	2.0
19	2911	836	721	58	0	3491	194	291	549	0.3	1.3	1.2
20	1478	231	0	0	0	1294	220	147	49	0.6	0.3	1.5
21	1607	264	0	0	0	1323	53	120	374	1.8	0.7	1.2
22	153	60	45	4	0	142	30	11	78	1.0	0.7	0.9
23	728	113	0	0	0	583	174	0	84	0.7	---	0.8
24	1236	460	0	0	0	1599	48	24	24	1.0	1.0	2.0
25	2360	132	151	0	0	2435	57	113	38	1.0	0.7	1.0
26	2387	1320	225	0	0	3117	112	421	281	1.0	1.1	1.4
27	166	45	0	0	0	151	36	3	21	1.2	1.0	1.0
28	241	123	0	0	0	229	109	5	21	1.2	2.0	1.0
29	1284	301	23	12	0	1353	58	162	46	1.1	0.8	1.0
30	2450	228	187	62	0	2489	63	356	21	1.2	0.6	2.0
31	1922	905	249	90	0	2759	68	68	271	0.4	1.3	0.7
32	3227	538	1365	579	0	5057	204	326	122	1.2	0.9	2.0

Table 19. *Continued*

Beaver Creek Pools

St	S1	S2	S3	S4	S5	C0	C1	C2	C3	C1a	C2a	C3a
33	6692	1425	186	372	0	7188	1487	0	0	1.0	---	---
34	1456	162	1133	370	116	3028	0	23	185	---	1.0	1.0
35	3664	308	685	34	103	3904	0	890	0	---	0.6	---
36	230	96	148	44	0	363	37	119	0	0.7	0.6	---
37	2036	591	394	44	0	2036	0	1029	0	---	0.6	---
38	1713	629	35	0	0	306	781	1154	136	1.3	0.5	2.6
39	1270	121	20	0	0	242	0	1170	0	---	0.4	---
40	326	508	12	0	0	24	157	665	0	1.2	0.4	---
41	542	122	0	0	0	104	57	502	0	1.1	0.3	---
42	183	6	0	3	15	44	12	151	0	1.4	0.4	---
43	529	109	0	0	0	18	36	538	46	2.5	0.4	1.2
44	176	110	0	0	0	8	12	266	0	1.7	0.3	---
45	1429	365	335	0	0	867	91	1049	122	1.3	0.5	1.5
46	2605	200	0	0	0	721	220	1743	120	1.0	0.4	2.3
47	138	29	0	0	0	38	29	76	24	0.8	0.4	1.7
48	1027	79	0	0	0	237	16	585	269	3.0	0.5	1.1
49	545	16	0	0	0	168	24	345	24	2.3	0.3	2.0
50	1483	128	23	0	0	117	128	1343	47	1.4	0.3	2.0
51	539	77	38	19	0	212	0	462	0	---	0.5	---
52	539	60	0	0	0	34	34	505	26	1.9	0.4	2.0
53	585	17	0	0	0	26	0	568	9	---	0.5	1.0
54	104	38	6	0	0	28	0	113	8	---	0.4	0.8
55	235	21	26	0	17	184	94	17	4	0.7	0.5	1.0
56	805	37	12	0	0	781	37	0	37	0.8	---	1.3

Beaver Creek Pools

St	Sc1	Sc2	Sc3	Sc4	Sec	pH	DO	Cond	T
1	0	174	0	0	105	7.6	7.5	1600	24
2	0	80	0	0	86	7.9	12.0	1800	19
3	7	124	0	0	33	10.6	20.0	2900	20
4	0	32	0	8	70	9.1	12.0	1958	23
5	8	70	0	0	96	8.6	8.1	1971	20
6	3	65	0	0	31	10.6	20.0	2900	21
7	0	542	0	418	105	8.1	9.6	1813	15
8	37	62	0	25	68	8.4	9.5	1920	15
9	0	52	0	193	78	8.3	12.0	1904	5
10	0	111	0	167	101	8.7	15.5	2410	19
11	0	115	0	269	5	8.0	5.1	955	18
12	0	102	0	44	72	9.4	10.0	2590	18
13	0	103	0	141	18	7.9	6.5	1683	18
14	0	334	0	97	56	8.7	7.0	3500	21
15	0	71	0	212	28	8.4	8.1	2560	21
16	61	334	15	197	30	8.5	8.0	2340	18
17	0	89	0	48	86	7.9	11.5	1420	5
18	52	676	0	312	39	8.2	7.6	1090	10
19	192	618	0	43	32	8.5	7.5	3000	24

Table 19. *Continued*

Beaver Creek Pools

St	Sc1	Sc2	Sc3	Sc4	Sec	pH	DO	Cond	T
20	39	274	20	59	20	8.5	7.8	2950	22
21	0	421	15	150	26	8.3	6.2	3240	21
22	4	61	4	12	30	7.9	6.1	3340	22
23	12	253	0	196	22	8.0	5.1	2460	22
24	19	206	0	150	36	8.3	6.3	2500	21
25	120	660	0	20	26	8.4	6.9	3500	20
26	59	454	0	277	38	8.1	6.5	2570	22
27	0	45	0	30	76	8.3	9.5	2570	23
28	15	64	0	15	30	8.3	6.1	2300	23
29	11	207	0	218	27	7.9	5.6	2580	20
30	0	485	17	167	18	8.4	7.6	2600	20
31	148	429	0	82	21	8.6	6.5	2370	21
32	59	469	0	59	16	8.6	7.0	3400	22
33	0	1344	0	0	10	8.1	8.4	942	12
34	287	388	0	0	30	8.6	8.8	3800	20
35	69	809	0	46	35	8.9	9.4	3200	21
36	0	158	0	18	55	8.3	8.5	2550	21
37	0	670	0	0	26	8.7	7.6	2900	27
38	19	281	75	0	47	8.2	9.7	2120	24
39	0	398	0	0	109	8.1	6.5	2800	22
40	30	251	0	15	88	7.9	9.5	2020	21
41	11	147	21	32	100	8.0	7.4	2770	24
42	21	41	0	7	48	8.1	10.6	2770	25
43	0	71	31	55	112	8.6	8.6	2410	22
44	23	74	0	17	125	7.9	6.6	2460	20
45	14	543	0	14	102	8.9	7.5	2900	20
46	0	600	0	67	81	8.0	5.5	2530	21
47	0	56	0	0	100	8.3	14.5	2720	3
48	0	277	0	69	130	8.6	9.8	2550	19
49	0	157	0	39	95	8.2	8.3	2620	20
50	15	469	44	59	103	8.4	8.6	3150	22
51	0	335	0	37	100	9.5	9.1	3000	19
52	0	133	27	107	78	8.7	7.6	2330	20
53	51	180	13	13	125	9.9	11.5	3100	23
54	16	48	0	0	60	9.6	12.0	2760	27
55	28	66	0	0	22	8.6	9.0	2730	22
56	55	292	0	18	21	8.6	12.0	2660	14

Beaver Creek Riffles

St	El	Dist	L	Aw	Sa	Vol	Asa	A25	A50	A75	A100
1	930	298.8	7.5	0.9	6.9	0.3	0.0	0	0	0	0
3	918	289.0	33.0	0.8	24.6	3.3	0.1	1	0	0	0
4	908	283.0	6.4	2.8	18.3	3.9	0.3	0	0	0	0
5	908	282.9	6.3	2.5	15.8	2.2	0.2	0	0	0	0
8	900	274.0	4.1	2.5	10.0	2.7	0.4	2	0	0	0
11	881	256.0	7.2	3.9	28.3	24.4	1.9	23	14	0	0

Table 19. *Continued*

Beaver Creek Riffles

St	El	Dist	L	Aw	Sa	Vol	Asa	A25	A50	A75	A100
13	875	250.8	3.9	1.7	6.7	0.9	0.1	0	0	0	0
16	855	230.5	16.2	1.6	26.8	2.7	0.1	0	0	0	0
17	852	226.6	4.3	1.9	8.1	1.2	0.2	0	0	0	0
19	847	219.4	5.8	1.4	8.1	0.3	0.0	0	0	0	0
20	846	218.4	1.3	0.7	0.9	0.1	0.0	0	0	0	0
23	840	210.9	3.9	3.7	14.5	6.7	1.0	7	0	0	0
24	836	207.0	7.0	1.7	11.8	1.5	0.1	0	0	0	0
26	830	199.6	1.9	2.0	3.8	0.6	0.2	0	0	0	0
27	828	197.1	4.0	2.1	8.4	2.8	0.3	2	0	0	0
28	827	195.4	4.0	3.7	14.8	2.3	0.3	0	0	0	0
29	826	194.6	4.9	1.6	8.0	0.8	0.1	0	0	0	0
33	818	187.5	7.2	6.7	48.4	22.0	1.7	20	1	0	0
35	810	180.5	7.6	0.6	4.6	0.2	0.0	0	0	0	0
36	791	171.1	2.2	1.3	2.9	0.2	0.0	0	0	0	0
40	777	159.8	8.2	2.7	21.8	2.1	0.1	0	0	0	0
44	765	148.8	2.1	2.2	4.5	0.4	0.1	0	0	0	0
46	755	137.9	5.4	9.1	49.2	15.6	1.7	10	0	0	0
49	744	129.4	8.9	6.1	54.7	32.9	2.1	40	10	0	0
50	741	128.9	7.6	3.6	27.1	12.2	0.9	12	1	0	0
52	719	100.5	7.7	3.5	26.6	5.7	0.4	1	0	0	0
55	659	18.8	16.2	7.8	126.3	24.9	1.1	8	0	0	0
56	637	4.8	22.0	2.6	57.9	9.0	0.3	3	0	0	0

Beaver Creek Riffles

St	S1	S2	S3	S4	S5	C0	C1	C2	C3	C1a	C2a	C3a
1	0	1	6	0	0	5	2	0	0	0.3	---	---
3	7	6	11	0	0	12	8	5	0	0.6	0.3	---
4	8	10	0	0	0	4	11	2	1	0.4	1.0	0.8
5	8	8	0	0	0	3	11	2	0	0.4	0.9	---
8	7	3	0	0	0	1	8	0	1	0.6	2.0	0.7
11	13	15	0	0	0	28	0	0	0	---	---	---
13	2	4	1	0	0	3	3	0	0	0.7	1.0	---
16	7	20	0	0	0	22	5	0	0	1.0	---	---
17	6	3	0	0	0	2	4	2	0	0.6	0.5	3.0
19	1	5	2	0	0	4	1	2	1	0.3	0.5	0.3
20	0	0	0	0	0	0	0	0	0	1.1	0.6	---
23	11	3	0	0	0	5	9	1	0	0.5	0.8	---
24	4	7	0	0	0	5	7	0	0	0.5	---	---
26	0	3	1	0	0	0	0	3	0	---	0.3	---
27	3	5	0	0	0	4	5	0	0	0.7	---	---
28	4	10	0	0	0	3	9	3	0	0.6	0.9	---
29	1	7	0	0	0	6	1	0	0	0.7	2.0	---
33	39	0	10	0	0	7	36	4	1	0.6	1.7	3.0
35	0	0	4	1	0	5	0	0	0	---	---	---
36	1	0	2	0	0	2	0	0	0	0.8	---	1.0
40	1	21	0	0	0	0	2	20	0	1.8	0.6	---

Table 19. *Continued*

Beaver Creek Riffles

St	S1	S2	S3	S4	S5	C0	C1	C2	C3	C1a	C2a	C3a
44	1	4	0	0	0	0	0	5	0	---	0.5	---
46	39	10	0	0	0	10	17	22	0	1.1	0.8	---
49	48	6	0	0	0	2	3	50	0	2.5	0.4	---
50	9	15	4	0	0	4	11	12	0	1.3	0.6	---
52	3	24	0	0	0	14	2	10	0	1.2	0.4	---
55	43	67	16	0	0	36	90	0	0	0.4	---	---
56	21	37	0	0	0	54	4	0	0	0.8	---	---

Beaver Creek Riffles

St	Sc1	Sc2	Sc3	Sc4	Sec	pH	DO	Cond	T
1	0	15	0	0	105	7.6	7.5	1600	24
3	0	66	0	0	33	10.6	20.0	2900	20
4	0	13	0	0	70	9.1	12.0	1958	23
5	1	11	0	0	96	8.6	8.1	1971	20
8	2	6	0	1	68	8.4	9.5	1920	15
11	0	4	0	10	5	8.0	5.1	955	18
13	0	6	0	2	18	7.9	6.5	1683	18
16	18	15	0	0	30	8.5	8.0	2340	18
17	5	3	0	0	86	7.9	11.5	1420	5
19	0	12	0	0	32	8.5	7.5	3000	24
20	2	1	0	0	20	8.5	7.8	2950	22
23	0	7	0	1	22	8.0	5.1	2460	22
24	6	8	0	0	36	8.3	6.3	2500	21
26	1	3	0	0	38	8.1	6.5	2570	22
27	1	6	0	1	76	8.3	9.5	2570	23
28	5	3	0	0	30	8.3	6.1	2300	23
29	5	5	0	0	27	7.9	5.6	2580	20
33	0	14	0	0	10	8.1	8.4	942	12
35	3	12	0	0	35	8.9	9.4	3200	21
36	0	4	0	0	55	8.3	8.5	2550	21
40	5	11	0	0	88	7.9	9.5	2020	21
44	3	1	0	0	125	7.9	6.6	2460	20
46	0	5	0	5	81	8.0	5.5	2530	21
49	0	16	0	2	95	8.2	8.3	2620	20
50	3	12	0	0	103	8.4	8.6	3150	22
52	5	9	0	2	78	8.7	7.6	2330	20
55	11	21	0	0	22	8.6	9.0	2730	22
56	29	15	0	0	21	8.6	12.0	2660	14

Little Beaver Creek Pools

St	El	Dist	L	Aw	Sa	Vol	Asa	A25	A50	A75	A100
1	1022	123.0	410.6	15.0	6173.4	6243.3	14.1	4664	4424	3567	2675
2	1021	122.6	15.1	3.3	49.5	30.9	1.8	27	20	13	5
3	1020	121.6	24.0	3.4	81.2	26.7	1.0	35	10	0	0
4	1019	120.4	27.2	2.0	55.8	12.3	0.4	9	5	0	0

Table 19. *Continued*

Little Beaver Creek Pools

St	El	Dist	L	Aw	Sa	Vol	Asa	A25	A50	A75	A100
5	1018	119.6	20.5	3.0	60.4	18.3	0.8	26	2	0	0
6	1012	117.6	8.4	2.4	20.0	4.0	0.4	1	0	0	0
7	1012	115.9	14.7	2.5	36.5	13.2	0.8	13	4	0	0
8	1006	114.6	54.0	7.7	413.1	103.5	1.6	142	0	0	0
9	1006	114.5	40.5	5.1	205.7	69.3	1.5	91	30	2	0
10	1006	114.4	37.4	5.8	216.7	140.2	3.3	125	91	41	10
11	1006	113.8	22.0	3.9	86.6	32.8	1.3	32	13	1	0
12	1006	111.8	13.9	2.9	40.3	13.8	0.9	19	5	0	0
13	1000	108.0	42.9	2.9	124.6	29.6	0.6	36	0	0	0
14	994	107.9	7.6	1.2	9.2	2.2	0.2	1	0	0	0
15	994	107.7	26.1	4.7	123.6	27.0	0.9	25	3	0	0
16	994	107.2	98.0	5.9	580.5	232.5	2.1	303	97	6	0
17	994	106.4	500.0	12.8	6384.5	4987.6	8.2	5179	3760	2235	603
18	994	105.9	16.7	2.9	48.8	26.5	1.3	31	15	5	1
19	981	100.4	26.7	3.7	98.9	27.4	0.8	42	0	0	0
20	981	100.0	191.0	11.5	2202.6	1079.2	5.0	1395	685	147	0
21	981	99.8	26.4	4.1	108.4	44.2	1.4	65	18	0	0
22	981	99.7	147.0	9.9	1454.6	687.5	4.1	808	420	81	0
23	981	99.6	12.7	3.0	37.9	12.4	0.8	18	5	0	0
24	981	99.5	13.6	2.9	39.9	12.9	0.8	17	1	0	0
25	981	98.3	41.4	5.2	216.1	73.5	1.5	108	12	0	0
26	975	95.5	105.2	3.8	401.5	240.9	1.9	308	161	54	4
27	975	93.7	76.7	5.4	410.7	121.1	1.4	192	23	0	0
28	974	93.0	31.8	3.6	114.3	31.3	0.9	47	6	0	0
29	973	92.5	53.6	6.8	363.6	73.5	1.2	48	0	0	0
30	963	90.2	32.5	6.7	216.4	70.7	1.8	89	7	0	0
31	963	90.1	320.0	11.0	3518.1	2205.0	6.3	2717	1896	704	98
32	963	90.0	15.3	2.9	44.6	10.7	0.6	9	1	0	0
33	963	89.7	89.7	6.1	544.4	314.1	3.0	369	200	60	12
34	959	86.3	960.0	11.1	10629.1	9027.5	8.1	8444	6791	5196	2303
35	957	85.2	21.9	3.0	64.7	28.5	1.1	40	12	1	0
36	957	84.3	23.5	4.6	107.1	29.0	1.0	38	4	0	0
37	957	83.9	37.9	4.4	168.4	54.2	1.2	69	7	0	0
38	951	83.3	31.8	2.3	72.7	16.3	0.4	13	0	0	0
39	950	82.8	28.4	6.0	170.7	50.7	1.5	74	2	0	0
40	948	82.1	71.2	7.7	548.2	232.1	2.7	311	140	6	0
41	945	79.1	11.5	4.7	53.8	19.0	1.4	20	6	0	0
42	945	78.8	26.0	4.2	108.3	30.5	1.0	39	8	0	0
43	942	78.0	15.0	3.0	44.4	12.3	0.7	19	1	0	0
44	940	77.0	350.2	10.9	3833.5	2321.3	6.1	2769	1938	1214	149
45	939	75.8	60.1	4.1	247.4	78.6	1.0	96	25	6	0
46	939	75.7	131.4	5.8	767.0	328.2	1.9	435	94	17	0
47	939	74.8	100.0	8.6	856.5	380.7	3.0	552	143	29	0
48	933	72.6	56.2	4.1	227.9	58.3	0.9	84	3	0	0
49	933	72.5	58.0	2.9	168.6	48.0	0.7	71	15	0	0
50	932	71.9	21.8	2.8	62.1	13.4	0.5	14	2	0	0
51	927	68.3	40.8	4.6	187.1	96.0	1.9	133	67	6	0

Table 19. *Continued*

Little Beaver Creek Pools

St	El	Dist	L	Aw	Sa	Vol	Asa	A25	A50	A75	A100
52	920	63.0	113.2	7.0	792.5	392.3	3.1	458	159	88	9
53	917	61.7	29.2	3.9	112.6	54.0	1.4	84	16	3	0
54	917	59.1	32.4	3.6	116.8	64.2	1.6	84	43	14	0
55	910	55.0	71.4	4.5	320.2	55.0	0.6	25	0	0	0
56	903	51.1	54.0	5.1	277.6	172.7	2.5	219	120	31	0
57	901	50.0	116.3	8.5	983.7	391.7	3.0	514	208	11	0
58	899	48.9	159.9	9.4	1510.1	839.5	4.5	1057	638	67	0
59	899	48.4	36.6	5.5	200.1	64.5	1.4	91	11	0	0
60	893	43.3	69.5	3.4	234.9	98.3	1.2	146	37	0	0
61	890	42.7	69.6	4.1	283.6	172.3	2.0	230	136	16	0
62	890	42.3	18.6	2.6	48.3	14.0	0.6	18	2	0	0
63	884	37.9	17.9	6.2	111.3	60.4	2.7	79	47	2	0
64	881	36.1	58.5	3.4	201.5	41.3	0.5	38	0	0	0
65	879	33.1	197.0	5.0	987.6	347.2	1.5	494	121	0	0
66	878	32.1	72.0	4.7	340.2	135.0	1.5	227	49	0	0
67	875	30.2	19.3	4.0	77.5	20.7	0.8	27	2	0	0
68	875	27.9	12.8	5.1	65.4	26.1	1.6	43	5	0	0
69	872	26.0	30.8	4.1	125.6	34.3	1.0	42	6	0	0
70	869	24.4	109.5	4.6	500.4	254.2	1.9	373	139	61	6
71	866	22.1	57.5	5.4	310.5	122.6	1.7	186	28	7	0
72	865	22.0	95.0	3.2	301.3	83.5	0.8	80	27	0	0
73	863	21.5	150.0	7.3	1098.8	293.0	1.7	391	85	0	0
74	853	20.3	38.8	5.3	203.5	63.2	1.2	63	11	0	0
75	853	20.0	41.4	7.7	316.7	144.0	2.9	148	88	49	18
76	835	7.0	50.0	12.3	613.8	397.8	6.8	457	361	109	0
77	829	2.7	100.5	4.0	405.1	108.4	1.0	117	18	5	0
78	829	2.4	105.6	4.3	453.8	131.8	1.1	131	30	15	5
79	823	0.9	39.6	7.0	278.5	146.2	3.0	173	115	28	0
80	823	0.9	90.9	6.4	584.8	121.3	1.1	91	0	0	0
81	823	0.6	39.2	12.3	480.8	192.5	3.8	240	102	11	0

Little Beaver Creek Pools

St	S1	S2	S3	S4	S5	C0	C1	C2	C3	C1a	C2a	C3a
1	4895	1279	0	0	0	4939	441	0	794	0.9	---	0.8
2	30	20	0	0	0	20	4	16	10	0.8	0.7	1.1
3	63	9	1	0	0	37	10	34	0	0.7	0.7	---
4	21	10	25	0	0	25	19	12	0	0.6	0.6	---
5	58	3	0	0	0	7	0	0	53	---	---	0.3
6	20	0	0	0	0	1	3	15	0	0.6	0.5	---
7	35	1	0	0	0	0	19	18	0	0.9	0.6	---
8	401	12	0	0	0	207	130	6	71	1.0	2.0	0.6
9	209	0	0	0	0	91	44	62	9	0.6	0.6	1.3
10	186	31	0	0	0	37	12	158	9	2.1	0.4	0.7
11	80	0	0	5	0	11	9	63	4	1.7	0.5	0.8
12	26	13	2	0	0	2	13	23	2	0.7	0.4	0.8
13	119	5	0	0	0	2	18	94	11	1.0	0.6	1.4

Table 19. *Continued*

Little Beaver Creek Pools												
St	S1	S2	S3	S4	S5	C0	C1	C2	C3	C1a	C2a	C3a
14	8	1	0	0	0	2	0	6	2	2.0	0.5	1.0
15	106	18	0	0	0	0	26	92	5	1.1	0.6	2.3
16	373	158	50	0	0	207	58	307	8	0.4	0.5	3.0
17	5244	1140	0	0	0	3238	0	1140	2007	---	0.5	0.6
18	40	9	0	0	0	0	10	39	0	1.6	0.4	---
19	33	65	1	0	0	40	33	14	13	0.8	0.7	1.2
20	1636	598	0	0	0	220	126	1856	0	0.9	0.4	---
21	93	15	0	0	0	3	14	90	2	1.6	0.4	4.0
22	997	312	145	0	0	644	42	707	62	0.8	0.4	2.0
23	22	14	2	0	0	1	2	34	1	1.5	0.4	3.0
24	10	30	0	0	0	3	5	31	1	2.1	0.4	2.5
25	161	56	0	0	0	6	12	195	3	1.5	0.4	1.0
26	275	115	11	0	0	57	52	270	23	1.1	0.4	1.9
27	370	35	0	0	0	6	41	340	23	1.5	0.5	1.1
28	0	44	70	0	0	47	16	42	8	0.9	0.6	1.5
29	343	16	5	0	0	10	0	353	0	---	0.4	---
30	170	46	0	0	0	145	19	12	40	0.6	1.0	0.6
31	2639	653	226	0	0	980	0	2412	126	---	0.4	1.5
32	22	20	3	0	0	6	3	36	0	1.4	0.3	---
33	288	249	8	0	0	226	0	319	0	---	0.6	---
34	5922	3644	1063	0	0	3113	987	4328	2202	0.9	0.6	0.9
35	60	5	0	0	0	18	3	37	6	2.0	0.5	0.9
36	76	31	0	0	0	5	3	99	0	2.0	0.4	---
37	135	34	0	0	0	5	7	156	0	3.0	0.4	---
38	57	13	2	0	0	4	29	39	0	1.0	0.4	---
39	29	88	51	2	0	46	7	112	5	1.3	0.4	2.0
40	352	196	8	0	0	345	8	94	102	2.0	0.7	1.3
41	23	25	7	0	0	4	2	47	2	2.0	0.4	3.0
42	67	31	8	2	2	15	12	77	3	1.2	0.4	3.0
43	9	14	22	0	0	24	4	16	1	0.8	0.6	2.0
44	2574	356	876	0	27	1424	192	2191	27	1.7	0.4	3.0
45	159	88	0	0	0	64	18	124	42	0.7	0.4	0.3
46	701	66	0	0	0	110	110	449	99	2.2	0.5	0.5
47	734	98	0	0	0	587	196	0	73	1.0	---	1.8
48	91	127	10	0	0	62	33	134	0	2.2	0.5	---
49	53	106	10	0	0	58	24	87	0	0.9	0.5	---
50	25	34	4	0	0	15	14	33	0	1.1	0.5	---
51	131	40	16	0	0	64	13	88	21	1.1	0.4	0.8
52	408	226	159	0	0	113	23	657	0	0.8	0.4	---
53	8	103	2	0	0	92	13	0	8	1.7	---	2.0
54	22	88	7	0	0	92	10	3	12	2.0	0.8	1.6
55	87	119	110	0	0	137	32	142	9	2.0	0.5	2.5
56	91	182	4	0	0	198	4	4	71	2.0	1.0	1.0
57	197	492	239	56	0	717	14	239	14	2.0	1.1	3.0
58	1208	108	194	0	0	1143	86	129	151	1.1	0.7	1.2
59	77	109	11	3	3	54	17	129	0	2.5	0.4	---
60	124	111	0	0	0	161	40	27	7	0.8	0.6	2.0

Table 19. *Continued*

Little Beaver Creek Pools

St	S1	S2	S3	S4	S5	C0	C1	C2	C3	C1a	C2a	C3a
61	170	105	8	0	0	211	16	0	57	1.3	---	0.8
62	15	29	0	0	4	30	3	15	1	0.9	0.4	1.0
63	49	62	0	0	0	57	48	5	2	0.6	0.8	1.0
64	35	161	3	0	0	132	6	63	0	1.5	0.6	---
65	818	99	71	0	0	720	0	254	14	---	0.8	2.0
66	292	44	10	0	0	287	15	0	39	0.9	---	1.4
67	17	50	0	1	10	54	7	0	17	1.3	---	0.8
68	16	49	0	0	0	63	3	0	0	1.5	---	---
69	31	70	25	0	0	95	2	25	4	2.0	1.2	3.5
70	0	450	50	0	0	429	57	0	14	0.9	---	1.5
71	106	160	44	0	0	208	89	13	0	0.6	1.5	---
72	43	116	138	0	0	220	82	0	0	0.9	---	---
73	455	565	16	0	63	1067	0	16	16	---	1.0	1.0
74	3	192	9	0	0	172	15	6	12	1.1	0.8	0.8
75	136	176	5	0	0	303	9	0	5	1.0	---	1.0
76	237	324	18	0	44	570	9	0	35	2.0	---	2.0
77	243	156	0	0	6	353	6	46	0	1.0	0.8	---
78	292	162	0	0	0	344	13	91	6	0.5	0.6	1.0
79	84	60	24	0	115	239	28	4	8	1.4	1.0	2.0
80	100	75	134	8	267	585	0	0	0	---	---	---
81	131	268	82	0	0	343	110	7	21	1.0	1.0	1.3

Little Beaver Creek Pools

St	Sc1	Sc2	Sc3	Sc4	Sec	pH	DO	Cond	T
1	21	801	0	0	64	8.2	8.9	783	20
2	0	30	0	0	10	7.5	6.0	750	10
3	0	48	0	0	65	7.5	6.2	745	13
4	0	54	0	0	59	7.3	6.5	850	15
5	0	41	0	0	22	7.7	6.5	1650	18
6	0	17	0	0	11	7.6	6.9	1430	19
7	0	29	0	0	24	8.0	6.3	1607	19
8	0	108	0	0	18	7.3	6.5	1500	17
9	0	77	0	4	31	7.5	14.0	750	19
10	15	60	0	0	72	8.3	6.2	1773	20
11	11	33	0	0	23	7.8	8.8	1727	19
12	0	26	0	1	61	8.6	8.9	1972	19
13	0	86	0	0	44	7.3	9.6	1694	19
14	0	15	0	0	40	7.7	5.1	1791	19
15	0	52	0	0	56	7.3	8.3	1577	19
16	0	196	0	0	17	7.5	6.5	860	15
17	50	950	0	0	135	8.2	9.6	1230	7
18	8	25	0	0	107	8.0	5.2	1908	22
19	8	35	0	11	47	8.2	8.0	1388	13
20	0	382	0	0	91	8.4	7.9	1579	21
21	3	50	0	0	74	8.6	11.0	1549	24
22	0	294	0	0	84	8.1	9.8	1546	18

Table 19. *Continued*

Little Beaver Creek Pools									
St	Sc1	Sc2	Sc3	Sc4	Sec	pH	DO	Cond	T
23	0	25	0	0	61	8.9	10.0	1619	21
24	5	22	0	0	24	8.9	10.0	1619	21
25	25	58	0	0	67	8.6	9.2	1583	20
26	0	168	42	0	52	8.6	6.9	1379	22
27	0	153	0	0	74	8.4	7.6	1616	20
28	0	64	0	0	57	9.1	13.2	1700	26
29	11	96	0	0	35	9.4	6.5	1600	31
30	0	65	0	0	53	8.3	8.5	1130	7
31	0	640	0	0	72	10.3	8.5	1575	20
32	3	28	0	0	52	8.5	8.0	1471	22
33	0	179	0	0	109	8.5	7.4	1460	18
34	0	1920	0	0	119	9.0	9.8	1300	22
35	9	35	0	0	84	8.1	13.5	1300	8
36	9	38	0	0	57	8.3	8.8	1299	18
37	0	68	0	8	69	8.1	9.0	1303	18
38	13	51	0	0	48	8.1	7.5	1275	12
39	0	57	0	0	54	8.2	7.6	1200	23
40	100	43	0	0	51	8.1	7.5	744	14
41	4	19	0	0	72	8.6	13.2	1331	21
42	8	44	0	0	45	8.7	16.0	1323	21
43	3	27	0	0	27	8.5	7.2	1400	19
44	0	700	0	0	48	8.9	6.1	1450	19
45	6	114	0	0	28	8.6	5.9	1234	20
46	0	263	0	0	28	8.6	5.9	1234	20
47	80	120	0	0	44	8.4	8.5	1050	12
48	6	107	0	0	51	8.5	6.7	1342	20
49	0	116	0	0	70	8.4	6.9	1345	20
50	0	44	0	0	43	8.3	6.7	1280	22
51	0	82	0	0	6	7.8	6.1	772	19
52	11	215	0	0	104	8.6	6.9	1650	22
53	9	50	0	0	9	8.1	8.6	891	17
54	13	49	3	0	35	8.4	8.0	1350	15
55	0	143	0	0	39	9.2	10.7	1700	24
56	38	65	0	5	12	8.1	11.0	1025	5
57	0	233	0	0	14	9.0	6.2	1750	21
58	16	304	0	0	37	8.7	8.3	2150	19
59	4	70	0	0	39	8.7	9.6	2030	21
60	0	118	0	21	16	8.6	7.8	1138	19
61	7	132	0	0	25	8.6	8.0	1163	18
62	0	37	0	0	22	8.9	8.2	1637	21
63	4	32	0	0	4	8.2	7.3	1121	21
64	6	105	0	6	28	9.2	10.2	1965	20
65	59	335	0	0	4	7.7	3.5	930	19
66	7	72	0	65	49	8.5	8.1	1375	10
67	27	12	0	0	5	7.6	7.6	951	19
68	6	18	1	0	10	8.3	16.0	1200	4
69	0	62	0	0	63	8.1	6.9	1115	28

Table 19. *Continued*

Little Beaver Creek Pools

St	Sc1	Sc2	Sc3	Sc4	Sec	pH	DO	Cond	T
70	88	120	0	11	15	8.4	6.6	1120	19
71	17	92	0	6	6	8.4	8.0	1059	19
72	19	152	19	0	7	8.2	6.0	1000	19
73	0	300	0	0	22	8.9	10.1	1485	23
74	62	8	4	4	26	8.7	7.9	1201	18
75	46	25	12	0	15	8.5	8.3	1314	24
76	45	55	0	0	14	8.3	8.5	1190	10
77	111	80	0	10	72	8.5	8.2	1571	23
78	63	148	0	0	55	8.5	7.9	1567	20
79	20	59	0	0	16	8.6	7.1	1124	21
80	91	91	0	0	18	8.6	7.8	1180	23
81	27	51	0	0	3	8.2	8.5	1018	16

Little Beaver Creek Riffles

St	El	Dist	L	Aw	Sa	Vol	Asa	A25	A50	A75	A100
2	1021	122.6	6.4	0.6	3.6	0.7	0.1	0	0	0	0
6	1012	117.6	3.3	0.5	1.8	0.2	0.0	0	0	0	0
12	1006	111.8	6.8	1.0	6.8	0.9	0.1	0	0	0	0
16	994	107.2	11.1	1.7	18.8	2.3	0.2	0	0	0	0
18	994	105.9	2.8	2.9	8.1	3.3	0.7	4	0	0	0
19	981	100.4	10.4	2.1	21.7	4.0	0.3	1	0	0	0
20	981	100.0	9.9	5.0	49.7	15.6	0.7	9	1	0	0
21	981	99.8	4.8	4.7	22.7	7.5	0.9	6	0	0	0
22	981	99.7	32.0	2.5	79.2	10.8	0.3	0	0	0	0
23	981	99.6	7.6	1.4	10.8	2.5	0.2	1	0	0	0
24	981	99.5	5.1	2.3	11.5	2.4	0.2	0	0	0	0
25	981	98.3	38.7	5.2	200.7	32.8	0.6	7	0	0	0
26	975	95.5	7.6	2.5	19.3	3.2	0.2	0	0	0	0
27	975	93.7	9.5	1.6	15.0	3.8	0.2	2	0	0	0
28	974	93.0	5.1	1.4	7.1	0.5	0.1	0	0	0	0
30	963	90.2	7.0	3.1	21.8	5.5	0.4	2	0	0	0
32	963	90.0	2.3	2.4	5.6	1.1	0.3	0	0	0	0
33	963	89.7	4.1	3.3	13.4	1.0	0.1	0	0	0	0
35	957	85.2	7.8	2.3	17.8	4.6	0.3	2	0	0	0
36	957	84.3	5.3	2.5	13.0	2.1	0.2	0	0	0	0
37	957	83.9	4.4	2.4	10.7	1.6	0.2	0	0	0	0
38	951	83.3	12.2	1.9	22.9	2.6	0.1	0	0	0	0
39	950	82.8	25.5	2.2	57.3	6.5	0.2	0	0	0	0
40	948	82.1	22.3	3.0	66.7	10.7	0.3	4	0	0	0
41	945	79.1	6.0	2.5	14.8	2.2	0.2	0	0	0	0
42	945	78.8	1.8	3.7	6.6	1.2	0.4	0	0	0	0
43	942	78.0	18.0	1.8	32.9	2.5	0.1	0	0	0	0
47	939	74.8	6.8	2.5	16.7	3.3	0.3	1	0	0	0
48	933	72.6	4.9	1.9	9.2	0.7	0.1	0	0	0	0
49	933	72.5	5.4	2.7	14.7	1.9	0.2	0	0	0	0
50	932	71.9	4.6	3.2	14.9	1.5	0.2	0	0	0	0

Table 19. *Continued*

Little Beaver Creek Riffles

St	El	Dist	L	Aw	Sa	Vol	Asa	A25	A50	A75	A100
51	927	68.3	5.2	3.5	18.4	10.7	1.2	12	4	0	0
52	920	63.0	14.4	2.7	38.8	2.1	0.1	0	0	0	0
53	917	61.7	5.8	4.8	28.0	10.9	1.0	9	0	0	0
54	917	59.1	29.6	3.7	108.9	26.0	0.6	15	0	0	0
55	910	55.0	8.0	2.6	21.0	1.8	0.1	0	0	0	0
56	903	51.1	5.3	2.9	15.6	10.2	1.1	13	2	0	0
57	901	50.0	14.0	4.1	58.0	2.6	0.1	0	0	0	0
58	899	48.9	8.2	5.0	40.7	9.8	0.7	3	0	0	0
59	899	48.4	10.4	3.8	39.0	7.6	0.5	2	0	0	0
60	893	43.3	13.6	2.5	33.8	5.5	0.3	2	0	0	0
61	890	42.7	26.1	3.3	86.4	24.5	0.7	23	0	0	0
62	890	42.3	8.2	1.6	13.0	1.0	0.1	0	0	0	0
63	884	37.9	7.5	3.0	22.2	19.6	1.4	16	12	0	0
66	878	32.1	10.1	6.0	60.9	3.8	0.3	1	0	0	0
67	875	30.2	19.6	3.1	60.2	12.8	0.5	12	0	0	0
68	875	27.9	12.2	3.1	37.3	10.1	0.6	15	0	0	0
69	872	26.0	13.3	2.1	28.5	2.8	0.1	0	0	0	0
70	869	24.4	38.8	4.3	166.2	30.0	0.6	28	0	0	0
71	866	22.1	19.9	4.0	79.3	21.8	0.8	26	0	0	0
72	865	22.0	3.4	0.8	2.8	0.2	0.0	0	0	0	0
73	863	21.5	8.7	0.7	6.3	0.1	0.0	0	0	0	0
74	853	20.3	8.2	5.3	43.8	7.5	0.5	0	0	0	0
75	853	20.0	19.4	3.9	74.8	12.9	0.5	10	0	0	0
76	835	7.0	8.3	7.3	60.8	20.1	1.4	12	4	0	0
77	829	2.7	19.4	1.4	26.4	1.4	0.1	0	0	0	0
78	829	2.4	13.4	2.5	32.9	0.7	0.0	0	0	0	0
79	823	0.9	27.4	3.8	103.3	20.1	0.5	5	0	0	0
80	823	0.9	12.2	3.3	40.8	3.5	0.2	0	0	0	0
81	823	0.6	15.2	11.2	170.1	55.3	2.7	89	0	0	0

Little Beaver Creek Riffles

St	S1	S2	S3	S4	S5	C0	C1	C2	C3	C1a	C2a	C3a
2	3	0	0	0	0	0	0	2	1	2.1	0.6	0.8
6	2	0	0	0	0	0	1	1	0	0.6	0.4	---
12	2	5	0	0	0	1	3	3	0	0.6	0.6	---
16	2	4	13	0	0	13	3	3	0	1.0	0.6	---
18	6	2	0	0	0	0	2	6	0	1.7	0.4	---
19	4	16	2	0	0	8	11	1	1	0.4	0.6	1.5
20	6	41	0	0	0	14	18	17	0	0.3	0.5	---
21	13	10	0	0	0	0	11	12	0	0.7	0.8	---
22	24	32	24	0	0	28	31	17	3	0.6	0.7	1.7
23	2	6	3	0	0	1	2	8	0	1.7	0.4	3.0
24	1	10	1	0	0	4	1	6	0	1.5	0.4	---
25	54	146	0	0	0	20	60	118	3	1.0	0.5	1.0
26	14	5	0	0	0	0	16	3	0	0.6	1.1	---
27	9	6	0	0	0	1	2	12	0	1.4	0.5	---

Table 19. *Continued*

Little Beaver Creek Riffles

St	S1	S2	S3	S4	S5	C0	C1	C2	C3	C1a	C2a	C3a
28	0	3	4	0	0	2	1	4	0	0.6	0.4	1.5
30	8	11	1	0	0	13	3	0	6	0.7	---	0.7
32	0	4	1	0	0	3	1	1	0	0.9	0.6	---
33	0	12	1	0	0	4	2	8	0	1.0	0.4	---
35	11	2	5	0	0	4	5	10	0	0.8	0.6	---
36	5	7	1	0	0	1	0	11	0	1.0	0.3	---
37	2	9	0	0	0	4	0	7	0	3.0	0.5	---
38	4	19	0	0	0	9	11	3	0	0.6	0.6	---
39	3	10	29	15	0	29	8	20	0	1.2	0.6	---
40	35	31	0	0	0	47	7	10	3	0.9	0.4	1.0
41	1	8	6	0	0	0	0	14	0	3.0	0.3	---
42	1	4	2	0	0	1	1	5	0	1.6	0.4	2.5
43	0	1	31	0	0	26	5	2	0	1.0	1.3	---
47	10	7	0	0	0	4	13	0	0	0.4	---	---
48	1	8	1	0	0	5	3	1	0	0.6	0.8	---
49	3	11	0	0	0	0	3	12	0	1.0	0.3	---
50	2	13	0	0	0	3	4	8	0	1.0	0.4	---
51	5	9	4	0	0	7	1	6	5	2.0	0.5	0.7
52	1	4	28	6	0	5	8	26	0	0.9	0.3	---
53	2	22	4	0	0	19	7	0	2	1.0	---	2.5
54	8	68	33	0	0	64	37	3	5	0.8	1.0	2.3
55	2	2	16	1	0	19	1	0	1	1.0	---	2.0
56	0	7	8	0	0	11	3	0	2	1.1	---	0.7
57	0	4	49	5	0	30	12	16	1	1.0	0.6	3.0
58	12	22	5	1	1	22	12	6	1	1.1	0.4	1.0
59	6	24	9	0	0	4	11	23	0	1.0	0.4	---
60	6	24	4	0	0	15	17	0	0	0.6	2.0	1.0
61	14	73	0	0	0	43	41	0	2	0.6	---	1.5
62	0	13	0	0	0	6	4	3	0	0.5	0.5	---
63	4	16	2	0	0	15	5	2	1	1.4	1.0	1.0
66	15	46	0	0	0	57	4	0	0	1.6	---	---
67	9	51	0	0	0	44	16	0	0	0.7	---	---
68	0	37	0	0	0	37	0	0	0	---	---	---
69	0	7	21	0	0	26	0	3	0	---	1.3	---
70	0	157	10	0	0	128	38	0	0	0.6	---	---
71	3	60	16	0	0	61	18	0	0	0.7	---	---
72	1	1	2	0	0	2	1	0	0	0.5	1.0	---
73	0	6	1	0	0	6	0	0	0	---	---	---
74	0	39	5	0	0	44	0	0	0	---	---	---
75	5	58	12	0	0	70	5	0	0	1.4	---	---
76	3	56	2	0	0	57	2	0	2	1.0	---	2.0
77	2	24	0	0	0	24	0	2	0	1.0	1.0	---
78	1	32	0	0	0	24	0	8	0	1.0	0.4	1.0
79	1	32	69	0	0	91	3	1	7	1.5	1.0	1.2
80	0	1	3	0	37	41	0	0	0	---	---	---
81	0	92	75	0	2	148	12	0	10	1.0	---	1.0

Table 19. *Continued*

Little Beaver Creek Riffles									
St	Sc1	Sc2	Sc3	Sc4	Sec	pH	DO	Cond	T
2	0	13	0	0	10	7.5	6.0	750	10
6	0	7	0	0	11	7.6	6.9	1430	19
12	0	14	0	0	61	8.6	8.9	1972	19
16	0	22	0	0	17	7.5	6.5	860	15
18	0	6	0	0	107	8.0	5.2	1908	22
19	8	12	0	0	47	8.2	8.0	1388	13
20	0	20	0	0	91	8.4	7.9	1579	21
21	0	10	0	0	74	8.6	11.0	1549	24
22	0	64	0	0	84	8.1	9.8	1546	18
23	0	15	0	0	61	8.9	10.0	1619	21
24	2	7	0	1	24	8.9	10.0	1619	21
25	15	62	0	0	67	8.6	9.2	1583	20
26	2	14	0	0	52	8.6	6.9	1379	22
27	0	19	0	0	74	8.4	7.6	1616	20
28	0	10	0	0	57	9.1	13.2	1700	26
30	0	14	0	0	53	8.3	8.5	1130	7
32	0	5	0	0	52	8.5	8.0	1471	22
33	0	8	0	0	109	8.5	7.4	1460	18
35	0	16	0	0	84	8.1	13.5	1300	8
36	4	6	0	0	57	8.3	8.8	1299	18
37	0	9	0	0	69	8.1	9.0	1303	18
38	9	16	0	0	48	8.1	7.5	1275	12
39	0	51	0	0	54	8.2	7.6	1200	23
40	40	4	0	0	51	8.1	7.5	744	14
41	2	10	0	0	72	8.6	13.2	1331	21
42	1	2	0	0	45	8.7	16.0	1323	21
43	6	30	0	0	27	8.5	7.2	1400	19
47	8	5	0	0	44	8.4	8.5	1050	12
48	1	9	0	0	51	8.5	6.7	1342	20
49	0	11	0	0	70	8.4	6.9	1345	20
50	0	9	0	0	43	8.3	6.7	1280	22
51	0	10	0	0	6	7.8	6.1	772	19
52	1	27	0	0	104	8.6	6.9	1650	22
53	2	9	0	0	9	8.1	8.6	891	17
54	12	44	0	3	35	8.4	8.0	1350	15
55	6	10	0	0	39	9.2	10.7	1700	24
56	0	11	0	0	12	8.1	11.0	1025	5
57	11	17	0	0	14	9.0	6.2	1750	21
58	8	8	0	0	37	8.7	8.3	2150	19
59	0	21	0	0	39	8.7	9.6	2030	21
60	0	27	0	0	16	8.6	7.8	1138	19
61	16	37	0	0	25	8.6	8.0	1163	18
62	0	16	0	0	22	8.9	8.2	1637	21
63	0	15	0	0	4	8.2	7.3	1121	21
66	0	10	0	10	49	8.5	8.1	1375	10
67	27	12	0	0	5	7.6	7.6	951	19
68	21	1	2	0	10	8.3	16.0	1200	4

Table 19. *Continued*

Little Beaver Creek Riffles									
St	Sc1	Sc2	Sc3	Sc4	Sec	pH	DO	Cond	T
69	5	21	0	0	63	8.1	6.9	1115	28
70	66	12	0	0	15	8.4	6.6	1120	19
71	14	26	0	0	6	8.4	8.0	1059	19
72	1	5	0	0	7	8.2	6.0	1000	19
73	2	16	0	0	22	8.9	10.1	1485	23
74	16	0	0	0	26	8.7	7.9	1201	18
75	29	8	2	0	15	8.5	8.3	1314	24
76	10	7	0	0	14	8.3	8.5	1190	10
77	33	6	0	0	72	8.5	8.2	1571	23
78	15	12	0	0	55	8.5	7.9	1567	20
79	30	25	0	0	16	8.6	7.1	1124	21
80	15	9	1	0	18	8.6	7.8	1180	23
81	15	15	0	0	3	8.2	8.5	1018	16

St	site number
El	elevation (m)
Dist	distance from mouth (km)
L	length (m)
Aw	average width (m)
Sa	surface area (m^2)
Vol	volume (m^3)
Asa	average cross-sectional area (m^2)
A25	area depth > 25 cm (m^2)
A50	area depth > 50 cm (m^2)
A75	area depth > 75 cm (m^2)
A100	area depth > 100 cm (m^2)
S1	fine sediment (m^2)
S2	sand substrate (m^2)
S3	gravel substrate (m^2)
S4	cobble substrate (m^2)
S5	small boulder (m^2)
C0	no cover (m^2)
C1	emergent vegetation (m^2)
C2	submerged aquatic vegetation (m^2)
C3	organic debris (m^2)
C1a	emergent vegetation average
C2a	submerged aquatic vegetation average
C3a	organic debris average
SC1	bare ground (m)
SC2	forbs and grasses (m)
SC3	trees (m)
SC4	shrubs (m)
Sec	secchi disk depth (cm)
pH	pH
DO	dissolved oxygen (mg/l)
Con	conductivity (umhos/cm)
T	temperature (°C)

Table 20. Length and weight of northern pike and walleye collected from Beaver Creek and Little Beaver Creek, Montana in 1990 and 1991.

Northern Pike in Beaver Creek Maximum total length (mm) Weight (g)					
Length	Weight	Length	Weight	Length	Weight
146	15	368	370	445	570
160	25	378	340	446	500
190	50	384	360	448	560
210	60	385	370	455	560
220	80	387	330	460	600
222	80	389	370	461	600
223	80	396	370	462	630
228	70	406	480	466	630
231	70	406	420	480	730
233	80	411	410	490	740
243	90	412	400	505	840
250	100	416	490	510	740
252	100	420	450	560	1350
255	100	427	470	571	1100
261	130	428	520	662	2000
340	210	432	500	666	1900
364	290	434	540	683	1850

Northern Pike in Little Beaver Creek Maximum total length (mm) Weight (g)					
Length	Weight	Length	Weight	Length	Weight
86	10	205	50	546	1220
98	10	211	50	550	1150
99	10	240	75	554	1280
108	10	385	320	557	1100
113	10	395	420	557	1170
113	12	431	540	561	1210
122	13	448	750	564	1210
130	20	463	690	565	1210
137	10	465	340	570	1200
138	20	482	780	574	1400
147	10	490	790	586	1390
148	15	492	750	590	1550
151	16	501	900	595	1190
152	40	504	900	601	1570
155	25	505	890	611	1680
165	30	506	1130	632	1730
170	40	518	910	661	1950
170	40	525	1040	662	2050
176	30	527	970	691	2380
181	35	535	1100	708	2690

Table 20. *Continued*

Northern Pike in Little Beaver Creek Maximum total length (mm) Weight (g)					
Length	Weight	Length	Weight	Length	Weight
185	30	535	1220	728	2470
187	50	539	1120	806	3340
198	40	541	1080	835	4000
199	45				

Walleye in Beaver Creek Maximum total length (mm) Weight (g)					
Length	Weight	Length	Weight	Length	Weight
95	5	295	230	404	550
100	5	307	240	424	720
100	5	316	250	434	760
130	5	334	335	435	750
130	7	336	310	440	690
134	10	337	290	448	780
137	20	339	330	449	760
147	25	345	360	455	860
150	9	346	360	460	1000
151	20	346	360	462	890
154	25	350	370	485	1180
154	40	352	340	489	1210
223	80	355	400	500	1160
224	90	362	390	532	1360
226	90	365	430	545	1480
237	110	366	480	551	1550
237	115	369	440	554	1720
238	130	375	520	562	1650
239	110	379	550	563	1650
239	130	384	450	590	2250
241	125	387	460	615	2490
265	150	390	480	634	2410
280	200	399	570	643	2500
291	210	400	650	643	2550
292	210				