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An Evaluation of the Fishery Resource in a portion of the James River, South Dakota Scheduled for Channel Modification

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AN EVALUATION OF THE FISHERY RESOURCE IN A PORTION OF THE JAMES RIVER, SOUTH DAKOTA SCHEDULED FOR CHANNEL MODIFICATION

BY

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RESOURCE IN A PORTION OF THE JAMES
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This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable as meeting the thesis requirements for this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

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ABSTRACT

The fish populations of a 193 km (120 mi) section of the James River between Tacoma Park and Redfield, South Dakota, that is scheduled for stream modification under the Oahe Irrigation project, were evaluated from October 74 to July 76. Twenty-two species of fish were captured in the James River between Tacoma Park and Redfield, South Dakota. The fishes use the area primarily as a spawning ground and nursery for young-of-the-year. Evidence of spawning was found for 19 species of fish. Only a residual population of forage fishes, young-of-the-year of various species, and a few adult black bullheads attempt to overwinter in the area.

Dissolved oxygen was the only water quality factor limiting to the fishes. Conductance, alkalinity, calcium hardness, magnesium hardness, and total hardness increased under the ice in the James River, a condition that also occurs under the ice in prairie lakes and farm ponds. Turbidity was less in the flooded areas. The flooded areas acted as a natural buffer against downstream flooding.

During the 1975 summer the major food source for piscivorous and omnivorous fishes was young-of-the-year carp. The fishes showed good growth when compared with fishes from other areas, but were relatively short-lived. They displayed excellent condition, which may have been a result of good growing conditions during the sampling

period. Low yearly flow appeared to adversely affect fish growth. Of 8,065 fishes captured from the 1976 spring migration, 99% were carp, northern pike, and black bullheads.

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INTRODUCTION

The James River is an integral part of a proposed irrigation system designed to bring water from the Oahe Reservoir on the Missouri River in central South Dakota to irrigate farm lands on both sides of the James River in the Aberdeen, Redfield area, South Dakota. Channel modification was proposed to reduce 193 km (120 mi) of James River channel to 89 km (55 mi) thereby increasing flow capacity and providing flood protection. Channelization has been shown to reduce populations and alter the community structure of fishes and benthic organisms. Funk (1974) reported an 80% decrease in the commercial harvest of fishes after the lower Missouri River was channeled. Emerson (1971) reported that the standing crop of fishes in the Blackwater River, Missouri varied from 256 kg/acre in the unchanneled part to 51 kg/acre in the channeled part. Bayless and Smith (1965) compared 23 channeled streams to 36 natural streams in North Carolina and found a 90%/acre reduction of fishes over six inches in the channeled streams. Morris, et al. (1968) found the standing crop of drift invertebrates to be eight times greater in the unchanneled portion of the Missouri River. Hanson and Muncy (1971) reported an altered community structure of fishes and 31.2% higher turbidity in the channeled portion of the Little Sioux River, Iowa. The structure of the fish community in the James River and its relationships with the environment have not been documented. If channelization takes place there will be no way to evaluate its effects on the fish populations.

The objectives of the present study were to determine the physiochemical aspects, the food base available, and the fish community found in that portion of the James River scheduled for channel alteration.

STUDY AREA

The study area encompassed a 193 km (120 mi) section of the James River, a road distance of 89 km (55 mi), between Redfield and Tacoma Park, 24 km (15 mi) northeast of Aberdeen, South Dakota (Figure 1). It is a typical slow moving prairie river that has warm summer temperatures and is subject to periodic flooding and drying.

The limits of the study area coincided with the north and south boundaries of the Dakota Lake Plain. The plain is the dry bed of Lake Dakota, a prehistoric glacial lake. The river gradient is approximately 13 cm (5 in) per mile. The James River meanders extensively as it crosses the plain. The river current, due to the low gradient, is slow and sediments settle out. The channel bottom consisted of silt throughout the study area. Stream width varied with the volume of flow. The distance between the high water marks in the channel varied from 12 m (40 ft) to 30.5 m (100 ft) and the river was intermittent during dry periods. The discharge changed with the season and by manipulation of dams at Jamestown, North Dakota and Sandlake National Wildlife Refuge, about 16 km (10 mi) upstream from the northern end of the study area. Flooding is common in the study area during the spring. The present study was conducted during an extremely wet year, 1975, and parts of two fairly dry years, 1974 and 1976.

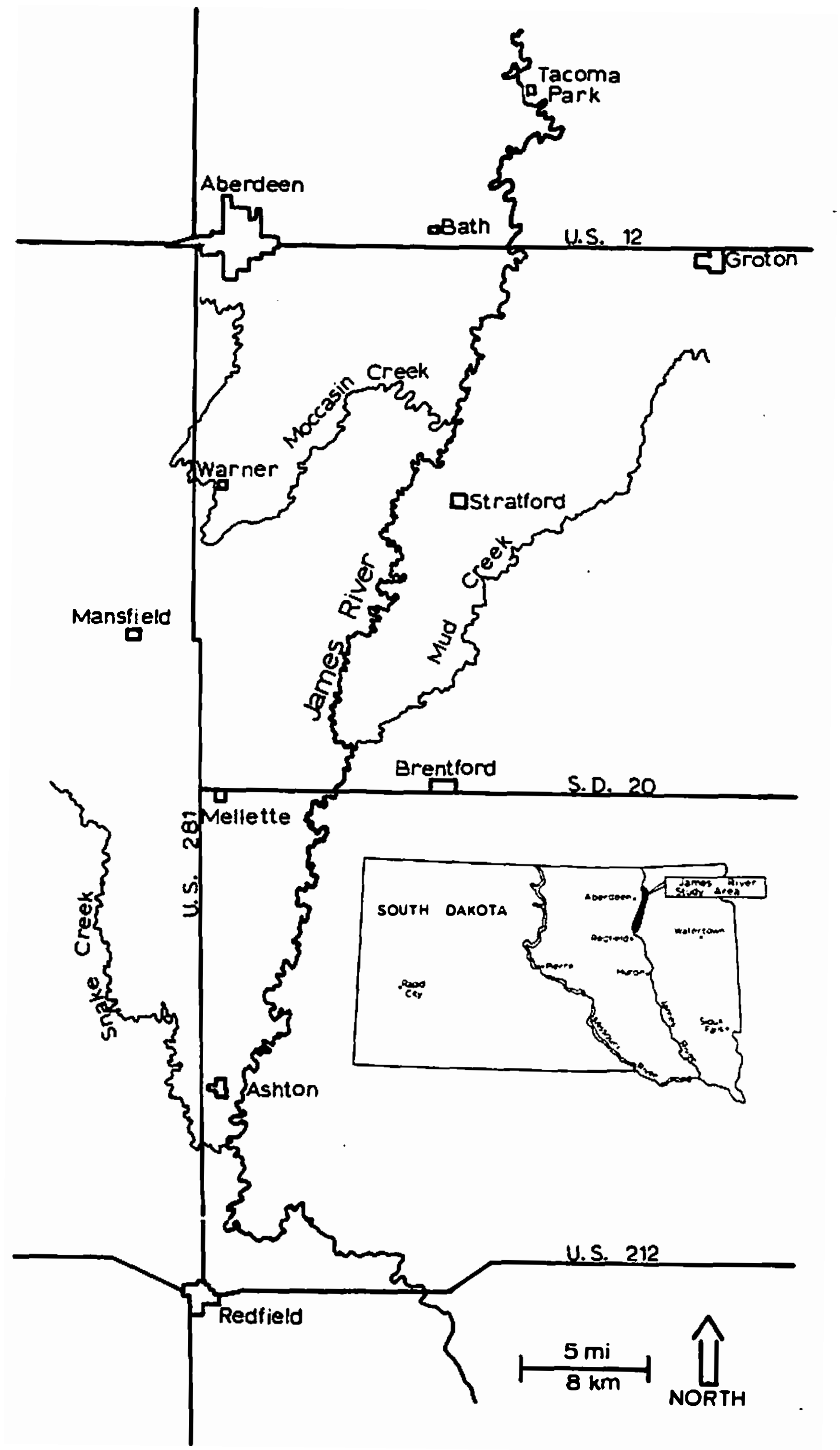

Figure 1. The James River study area and the geographical location of the James River in South Dakota.

Three tributaries, Moccasin Creek, Mud Creek, and Snake Creek, enter the James within the study area. These creeks, except for low-lying marsh-like areas, were dry or without flow during the latter part of each summer.

METHODS

Field work began in October 74 and was completed in July 76. Chemical and physical parameters were monitored monthly at four stations. Stations were located at Tacoma Park and at the first road bridge crossing the James River downstream from the junction of the three tributaries. Dissolved oxygen, turbidity, alkalinity, calcium hardness, magnesium hardness, total hardness were measured using a Hach[1] Field Engineers Laboratory. A Hellige Pocket Comparator[1] was used to measure pH. Specific conductance was measured with a Beckman RB-3 Solubridge[1] conductance meter. Surface water temperature was measured during midday with a hand held thermometer.

Benthose and zooplankton were sampled to describe the food base available to the fishes. Five benthose samples were taken at each of five stations with a Needham sampler, or hand dredge, in October 74. Zooplankton was collected monthly from 28 May 75 to 28 October 75. One site in each tributary and four in the river channel were sampled. Six liters of water from each site were poured through a Wisconsin vertical tow net to collect zooplankton. Aquatic insects were identified to family and the zooplankters were identified to genera.

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[1]Trade names.

Information about the common species of fishes were collected by seining, electrofishing, trapnetting, and gill netting. Adult fish distribution was determined by electrofishing in ten, two-hour periods in all types of flooded habitat and oxbows. A portable AC-DC generator was mounted in a ten-foot aluminum john boat which was easily rowed through the shallow flooded areas. Fry were sampled with a fine mesh dip net to establish spawning success by the various species of fish.

Seasonal relative abundance estimates were derived from data collected in October 74, June and July 75, October 75, and from March through July 76. Discharge was used as the criteria for choosing the type of fishing gear that would be least selective. When the river was at or near zero discharge during October 74, two block seines 30.5 m (100 ft) by 2.5 m (8 ft) of .65 cm (.25 in) mesh were used to block off areas of approximately 100 m (328 ft) in both shallow areas and deep holes. Deep holes were seined with a 30.5 by 2.5 m (100 by 8 ft) seined of 1.3 cm (0.5 in) mesh or a 23.0 by 1.8 m (75 by 6 ft) seined of 1.3 cm (0.5 in) mesh, depending on the width and depth of the channel. Shallow areas were seined with a 12.2 by 1.8 m (40 by 6 ft) minnow seine of 0.65 cm (0.3 in) mesh. Fishes were counted and total lengths were measured.

The river remained above flood stage through October 75 and seining as described above was not possible because of swift current and deep water. During flood conditions, standard three-hour experimental gill net sets were used. Each net was 38.0 by 1.8 m (125 by 6 ft) and consisted of five 7.6 m (25 ft) panels with mesh sizes of 1.27 cm (0.5 in), 2.6 cm (1.0 in), 3.8 cm (1.5 in), 4.1 cm (2.0 in), and 7.6 cm (3.0 in). Preliminary gill net sets indicated that the activity of the fishes increased at sundown. To maximize the catch rate, gill nets were set in 14 different areas between 10:00 p.m. and 1:00 a.m. during July and August 75. Ten areas were sampled in October 75.

Total length and weight of each fish were measured. Scales or spines were collected for age determination. Carlander (1949) indicated that samples of 15 or more fish should be used in age and growth calculations. As many fish as possible for each age group of the common species were sampled to reduce error from small sample size.

Age and growth data for all species except carp, northern pike, and walleye were collected in August and October 75. Carp were sampled in May and June 75. Northern pike and walleye were sampled in October 75 and March 76.

Scale impressions for aging were made on acetate slides and read independently by two people. Pectoral spines from black bullheads were decalcified, sectioned, and used for aging. Both scales and opercles were used to age carp. Length frequency tables were used to verify the accuracy of the aging process.

The body-scale relationship for each species was determined by plotting total fish length over total scale radius. The slope of the line and the Y intercept were calculated by fitting the line to the points using standard regression procedures. Each of the six species for which lengths were back-calculated displayed a straight line body-scale relationship with the Y intercept somewhere on the positive end of the Y axis. The Y intercept was used in the following formula for back calculation of total length (Tesch 1971).

$$l_n - c = \frac{S_n}{S}(l - c)$$

where

l_n = length of fish when annulus n was formed

l = length of fish when scale sample was obtained

S_n = radius of annulus n

S = total scale radius

c = Y intercept

The condition factor 'K' was calculated from (Tesch 1971):

$$K = \frac{W}{l^3}$$

where

K = condition factor

w = weight of the fish in gms

l^3 = the fishes total length to the nearest .5 cm cubed

Special trapnets were built and set in two bays of a nine-bay culvert bridge 4 km (2.5 mi) north of Stratford, South Dakota (Figure 2). The nets were set for 24 hour periods from 27 March 76 to 1 July 76, to monitor the spring migrations of the fishes. The nets were removed when they could not be checked daily. Numbers of fish of each species, total lengths, sex and sexual condition when possible were recorded. Weights were measured and scales were collected from selected species. The data are presented separately because of possible errors arising from differential use of the bays by the fishes and different mesh sizes of the two trapnets. A trapnet with mesh size of 1.9 cm (0.8 in) was used in the bay nearest the shore and a trapnet with mesh size of 1.27 cm (0.5 in) was used in the center bay.

Figure 2. Netting site of the spring migration study at the nine-bay culvert bridge, 4 km (2.5 mi) north of Stratford, S.D., James River, 24 April 76.

RESULTS AND DISCUSSION

PHYSIOCHEMICAL ASPECTS OF THE HABITAT

Dissolved oxygen was the only water quality parameter that occurred at levels which could be considered limiting to fish. Oxygen dupletions occurred in the stagnant water of flooded areas and oxbows during the summer and under the ice during the winter. Concentrations as low as 2.0 ppm dissolved oxygen occurred in the river channel on 30 July 76 (Table 1). Supplemental sampling in an oxbow near Ashton, South Dakota, on 12 July 76, indicated that no oxygen was present. A low of 1.0 ppm was measured under the ice in the river channel on 31 January 76; and numerous dead fishes were noted as the ice on the river went out in the spring 1976, an indication that fish kills had occurred in parts of the river during the previous winter.

The pH ranged from 7.2 under the ice to 8.8 in the spring and summer. The stability of the pH was possibly due to the buffering capacity of the relatively high calcium hardness (Greenbank 1945).

Specific conductance, alkalinity, calcium hardness, total hardness, and magnesium hardness increased under the ice cover. This condition, characteristic of prairie lakes, has been called the "freezing out" phenomenon. It

Table 1. Physiochemical characteristics, James River, S.D., 1975-76.

Date	pH		Diss. oxygen ppm		Temp. C		Turbidity JTU		Conductivity micromho		Alkalinity ppm		Calcium hardness ppm		Magnesium hardness ppm		Total hardness ppm	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
5-28-75	8.0	8.0-8.0	7.0	7.0- 7.0	17.3	16.5-18.5	20	10-30	631	585- 670	204	180-220	119	110-120	101	95-110	220	210-230
7-1-75	8.3	8.2-8.8	4.9	4.0- 6.0	27.3	26.5-29.0	28	10-50	634	575- 710	213	180-230	118	110-130	88	70-100	205	180-220
7-30-75	8.0	8.0-8.0	4.3	2.0- 5.0	24.4	23.0-25.5	30	20-40	553	460- 620	229	200-260	117	110-135	79	65- 90	195	175-225
8-28-75	8.0	8.0-8.0	4.8	3.2- 5.8	19.3	19.0-20.0	51	40-60	604	580- 625	250	245-255	128	120-135	95	90-100	223	220-225
9-27-75	8.0	8.0-8.0	8.6	7.4- 9.4	12.8	12.5-13.0	40	20-60	699	670- 745	258	240-275	136	125-140	104	85-115	240	225-250
10-25-75	8.0	8.0-8.0	9.0	7.6-10.4	6.6	6.0- 7.5	35	30-40	584	410- 650	238	230-250	141	135-155	103	85-115	244	240-250
1-31-76	7.3	7.2-7.4	3.1	1.0- 6.2	1.0	1.0- 1.0	15	10-30	1250	1100-1300	503	480-520	290	270-310	258	180-300	548	460-590
3-27-76	8.8	8.8-8.8	13.7	11.8-14.6	1.6	0.5- 4.0	18	10-20	690	450- 780	205	165-225	125	100-150	104	100-110	229	200-255
5-8-76	8.7	8.6-8.8	9.4	8.8-10.2	15.5	14.5-17.8	30	30-30	575	550- 600	180	175-190	121	110-140	76	70- 80	198	190-210

was observed under the ice in South Dakota farm ponds by Graham (1966) and in prairie lakes by Gloss (1969).

The mean turbidity increased from 20 JTU in May 75 to 51 JTU in August 75, then decreased to 18 JTU during spring runoff in April 76. The flooded areas served to decrease turbidity by slowing the current and allowing sediments to settle out. The average turbidity in Stratford Slough was 20 JTU. The average turbidity in the river channel was 33 JTU upstream and 38 JTU downstream from Stratford Slough.

Results from sampling directly below each tributary indicated that there were no major changes in water quality resulting from the three tributaries located in the study area.

Discharge of the James River at the Stratford check station, near Ashton, South Dakota, is shown in Figure 3 (U.S. Geological Survey Surface Water Records for South Dakota 1970-75). Approximately one-fourth of the river bottom on the Dakota Lake Plain is flood plain which is inundated nearly every year. During years of medium to low flow the flood waters recede back to the channel by late June or early July and the flood plain is used for pasture or hayland. Occasionally more severe flooding causes surrounding cultivated lands to be inundated. Some of the inundated grain fields drain quickly; others do not. Some

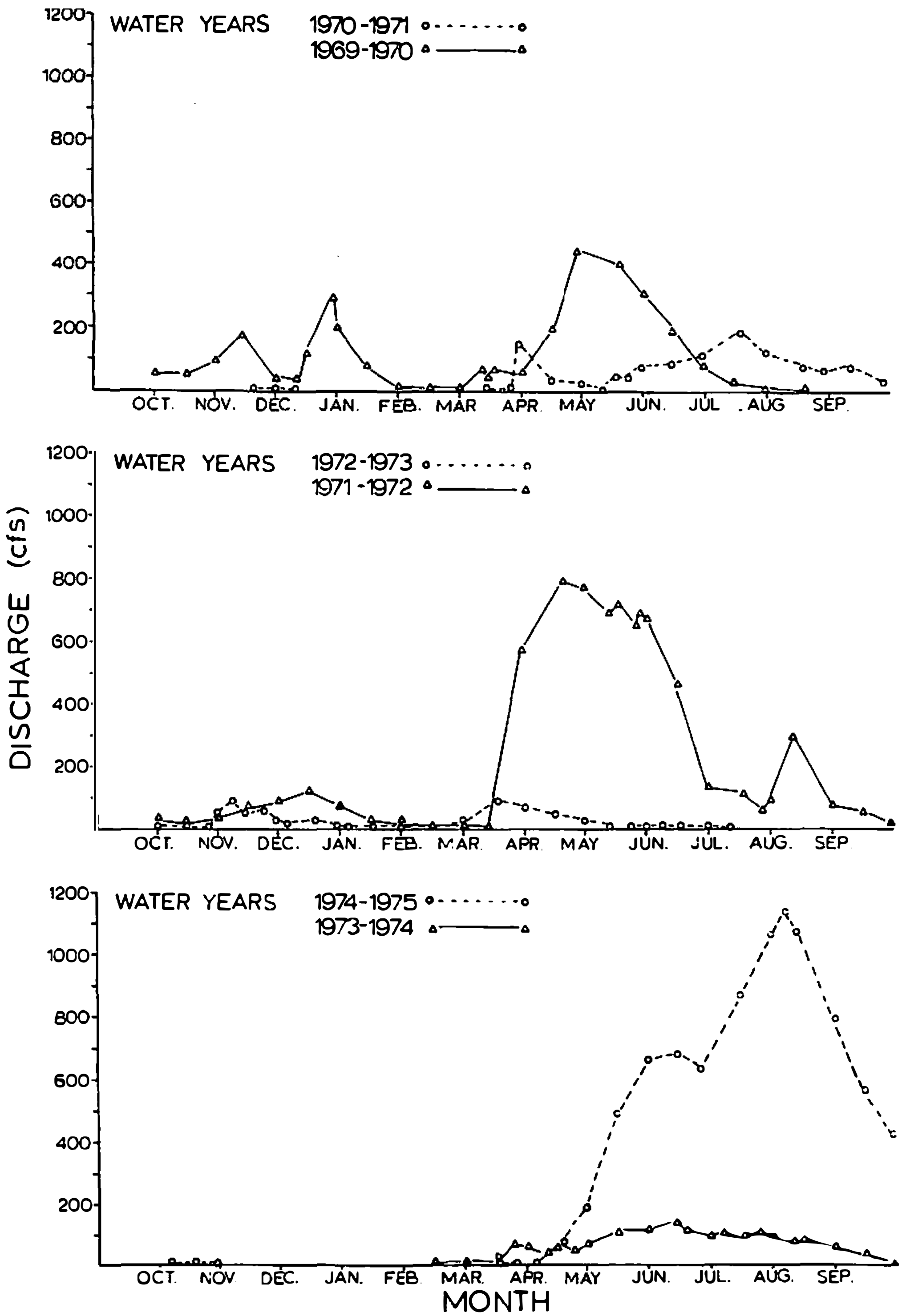

Figure 3. Discharge rates for water years 1969-1975, James River, S.D.

of the land along the James is diked to reduce damage from flooding.

Most of the flood plain is located in an area known as Stratford Slough which begins at South Dakota highway 12 and extends southward to a point 1.6 km (1 mi) west of Stratford, South Dakota (Figure 4). The shallow meandering channel, 0.6 to 0.9 m (2 to 3 ft) deep, and the low gradient cause the water to pool on the flood plain. The water, except under extreme conditions, is then naturally metered out at a rate the downstream channel can handle. Natural pooling areas, such as Stratford Slough, provide natural flood controls against downstream flooding. Emerson (1971) found that channeling on the Blackwater River, Missouri provided new agricultural land at the expense of damage to bridges, erosional loss of farmland, and frequent flooding downstream where little or none had previously occurred. Modifying the James River channel to increase its capacity and eliminate natural pooling would cause higher than normal peak flows at flow inhibitors downstream where flooding normally does not occur.

FISH FOOD BASE

The food base available to the fishes in the James River study area include zooplankton, benthic insects, and smaller fishes (Tables 2 and 3). Daphnia spp. comprised

Figure 4. The James River and the southern end of the flood plain known as Stratford Slough, 4 km (2.5 mi) north of Stratford, S.D., July 1976 (photo courtesy of Remote Sensing Institute, South Dakota State University).

Table 2. Invertebrates available to the fishes for food, James River, S.D., 1974-75.

Zooplankton	- Cladocera (Water fleas)	- *Daphnia*
		- *Ceriodaphnia*
		- *Bosmina*
		- *Diaphanosoma*
	- Copepoda (Copepods)	- *Cyclops*
		- *Diaptomus*
Aquatic insects	- Ephemeroptera (May-flies)	- Ephemeridae
		- Baetidae
		- Heptageniidae
	- Odonata (Damsel flies and dragon flies)	- Coenagrionidae
		- Libellulidae
	- Coleoptera (Beetles)	- Elmidae
		- Dytiscidae
		- Amphizoidae
		- Haliplidae
	- Diptera (True Flies)	- Chironomidae
		- Ceratopogonidae

Table 3. Relative abundance of young-of-the-year and adult forage fishes. James River, S.D., October 1974.

Black bullhead	18.00%
Carp	3.00%
White sucker	1.50%
Bigmouth buffalo	0.15%
Sand shiner	58.70%
Fathead minnow	12.60%
Black crappie	1.70%
White crappie	0.30%
Green sunfish	0.50%
Orangespotted sunfish	0.25%
Johnny darter	0.15%
Tadpole madtom	0.05%
Red shiner	3.80%

nearly 100% of the zooplankton until the end of May (Figure 5). Bosmina spp. and Cyclops spp. constituted the bulk of the zooplankton throughout the balance of the summer.

Chironomidae and Ceratopogonidae constituted 50% of the benthic insects found in the study area. High relative percentages of these organisms may indicate pollution or lack of habitat diversity in aquatic systems.

Eighty stomachs of piscivorous and omnivorous fishes were checked for contents. Eighty-two percent of the stomachs contained young-of-the-year fishes of various species, 59% contained carp, 24% bigmouth buffalo, 6% black bullheads and 6% white or black crappies. Fathead minnows occurred in only 18% of the stomachs. Twelve percent of the stomachs contained aquatic insects and mollusks. Midge larvae (chironomidae) and burrowing mayfly nymphs (ephemeridae) were the insects that occurred most frequently. The most important food source for adult piscivorous and omnivorous fishes during the summer 1975 were young-of-the-year fishes with young-of-the-year carp serving as the single most important food source.

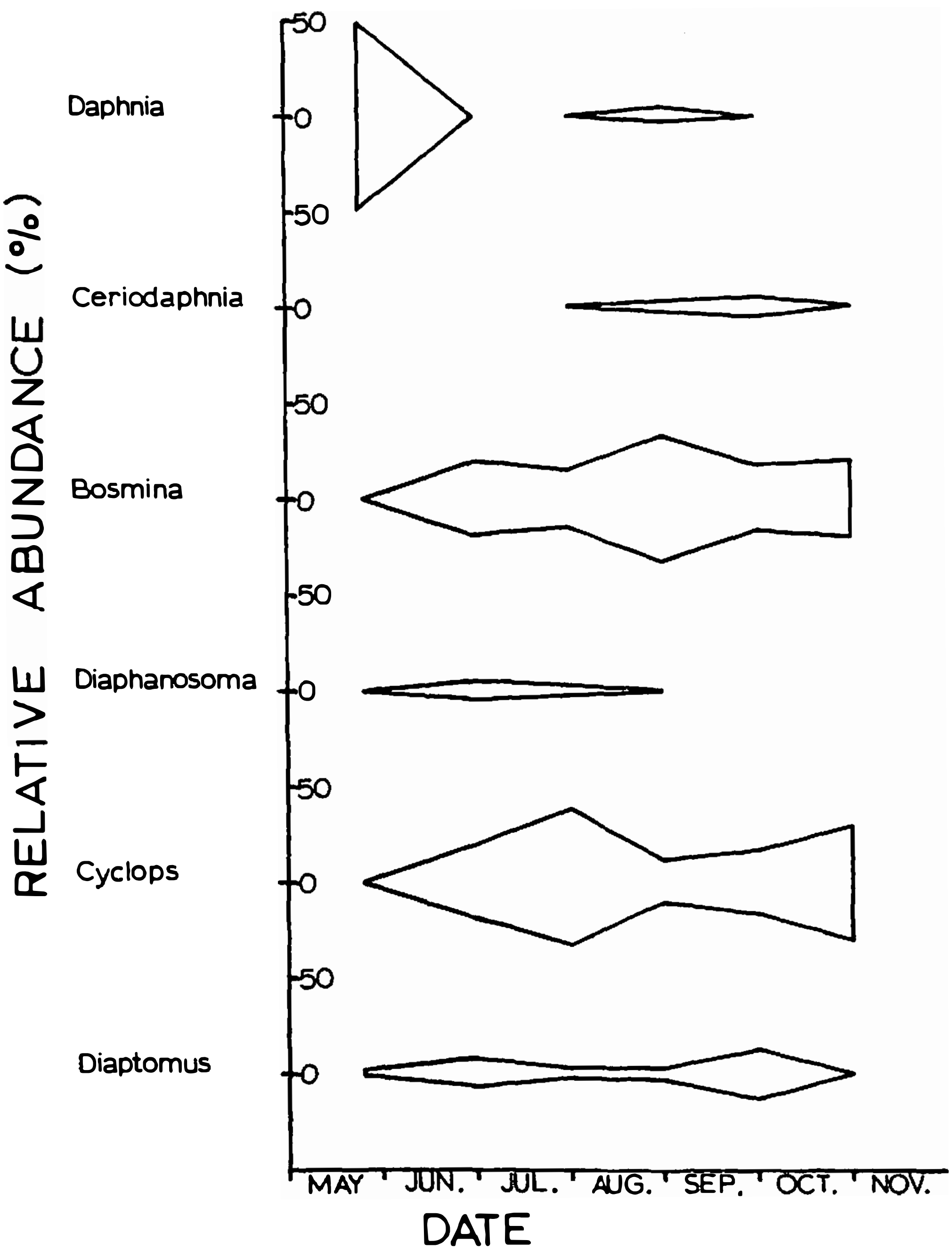

Figure 5. Relative abundance of zooplankton, James River, May-November 1976.

THE FISH COMMUNITY

Relative Abundance

Twenty-two species of fish were collected between Tacoma Park and Redfield from October 74 through July 76 (Table 4). Adult carp, black bullheads, and northern pike, the most abundant non-forage fishes at any one time constituted 92% of the catch in the fall 1974, 79% in the summer 1975, 89% in the fall 1975, and 99% in the spring 1976 (Table 5). Young-of-the-year non-forage fishes and forage fishes were sampled in October 74 (Table 3). Fifty-eight percent were sand shiners and 37.4% were black bullheads, fathead minnows, red shiners, and carp.

The fish community was comprised of those species most adaptable to the existing environmental conditions in the James; and the relative abundance of the fishes reflect their relative ability to adapt to the varied environment.

Age and Growth

Age and growth of six species of fish were examined. Total lengths and condition factors (K) for the fishes appear in Table 6. Total lengths and condition factors were averaged for all age groups and are presented in Table 7. Length frequency analysis for the fishes appear in Figures 6,7,8,9,10, and 11.

Table 4. Fishes collected in the James River, 1974-76.[1]

Class Osteichthyes - Bony Fishes

Order Semionotiformes
Fam. Lepisosteidae - Gars
Lepisosteus platostomus Rafinesque - Shortnose gar

Order Salmoniformes
Fam. Esosidae - Pike Family
Esox lucius Linnaeus - Northern pike

Order Cypriniformes
Fam. Cyprinidae - Minnows and carps
Notropis lutrensis (Baird and Girard) - Red shiner
Notropis stramineus (Cope) - Sand shiner
Pimephales promelas Rafinesque - Fathead minnow
Cyprinus carpio Linnaeus - Carp
Fam. Catostomidae - Suckers
Catostomus commersoni (Lacepede) - White sucker
Ictiobus cyprinellus (Valenciennes) - Bigmouth buffalo

Order Siluriformes
Fam. Ictaluridae - Fresh water catfishes
Ictalurus melas (Rafinesque) - Black bullhead
Ictalurus natalis (Lesueur) - Yellow bullhead
Ictalurus punctatus (Rafinesque) - Channel catfish
Noturus gyrinus - Tadpole madtom

Order Gasterosteiformes
Fam. Gasterosteidae - Sticklebacks
Culaea inconstans (Kirtland) - Brook stickleback

Order Perciformes
Fam. Centrarchidae - Sunfishes
Lepomis cyanellus Rafinesque - Green sunfish
Lepomis humilis (Girard) - Orangespotted sunfish
Pomoxis annularis Rafinesque - White crappie
Pomoxis nigromaculatus (Lesueur) - Black crappie
Fam. Percidae - Perch Family
Etheostoma exile (Girard) - Iowa darter
Etheostoma nigrum Rafinesque - Johnny darter
Perca flavescens (Mitchill) - Yellow perch
Stizostedion vitreum vitreum (Mitchill) - Walleye
Fam. Sciaenidae - Drums
Aplodinotus grunniens Rafinesque - Freshwater drum

[1]Common and scientific names are in accordance with the Trans. Amer. Fish. Soc., Spec. Publ. No. 6, a list of common and scientific names of fishes from the United States and Canada, 3rd edition, 1970.

Table 5. Relative abundance by season of fishes in the James River, S.D., 1974-76.

Species	Fall 1974	Summer 1975	Fall 1975	Spring 1976
Carp	58.00%	21.00%	17.10%	21.26%
Black bullhead	31.00%	33.00%	46.40%	61.30%
Northern pike	3.80%	15.00%	26.30%	16.42%
Walleye	0.20%	11.00%	19.10%	0.25%
Black crappie	2.50%	3.00%	0.00%	0.12%
White crappie	4.50%	5.00%	0.00%	0.00%
White sucker	0.00%	8.00%	1.10%	0.22%
Freshwater drum	0.00%	4.00%	0.00%	0.00%
Bigmouth buffalo	0.00%	0.00%	0.00%	0.37%
Shortnose gar	0.00%	0.00%	0.00%	0.04%
Yellow perch	0.00%	0.00%	0.00%	0.02%
Total catch	445	131	203	8065

Table 6. Back calculated total lengths and condition factors (K) of fishes from the James River, S.D., 1975-76.[2]

Species	Year class	Age group	No. of fish	Av. total length at end of each year (cm) 1	2	3	4	5	6	7	8	K factor
Walleye[1]	1975	0	11	22.5								
	1974	I	12	23.5	28.0							0.99
	1973	II	6	21.0	24.5	29.0						1.13
Northern pike	1975	0	86	38.5								0.69
	1974	I	35	33.5	55.5							0.69
	1973	II	4	24.5	36.5	56.0						0.81
White crappie	1974	I	20	9.0	16.0							1.39
	1973	II	14	8.5	13.5	20.0						1.63
	1972	III	4	9.5	14.5	19.0	24.0					1.54
Black crappie	1974	I	25	10.0	16.0							1.63
	1973	II	31	10.0	14.0	18.5						1.78
	1972	III	4	9.5	15.5	17.0	21.5					1.63
Black bullhead	1974	I	35	15.0	17.5							1.53
	1973	II	29	16.5	19.5	22.0						1.61
	1972	III	39	16.5	19.0	21.0	23.5					1.74
	1971	IV	4	15.5	17.5	19.0	20.5	22.0				1.58
Carp	1974	I	12	12.0	20.5							2.26
	1973	II	11	10.5	17.5	22.5						2.06
	1972	III	6	10.0	21.0	35.0	48.5					1.33
	1971	IV	5	11.0	23.0	27.5	37.5	43.0				1.36
	1970	V	3	11.5	21.5	29.0	38.0	44.5	47.5			1.24
	1969	VI	1	9.0	14.0	26.0	34.0	40.0	45.0	46.5		1.18
	1968	VII	1	23.0	30.0	36.0	46.0	55.0	61.5	64.0	69.0	1.16

[1]The walleyes in age group 0 were not weighed and a K factor was not calculated for them.

[2]The specimens for white crappie, black crappie, black bullhead and carp were collected in the spring or mid-summer of 1975 so the final total lengths for each age group does not represent the total growth to the end of 1975.

Table 7. Average condition factor (K) and total lengths of fishes from the James River, S.D., 1975-76.

Species	Mean K	Average calculated total length (cm)							
		1	2	3	4	5	6	7	8
Walleye	1.03	23.0	27.0	29.0					
Northern pike	.69	36.5	53.5	56.0					
Black crappie	1.65	10.0	15.0	18.5	21.5				
White crappie	1.47	9.0	15.0	19.5	24.0				
Black bullhead	1.66	16.0	18.5	21.5	23.0	22.0			
Carp	1.75	11.0	20.5	27.5	42.0	44.5	49.5	45.0	61.5

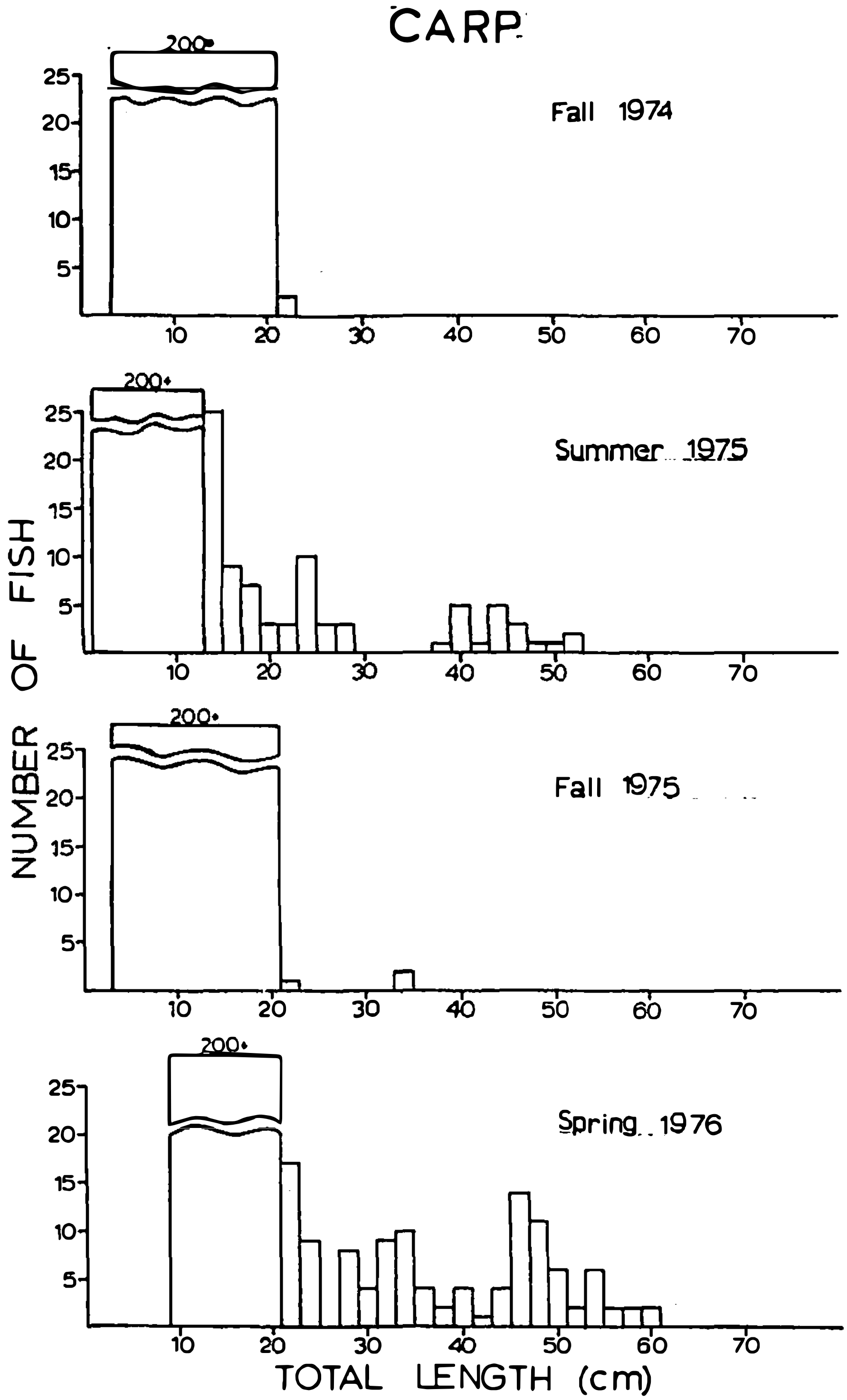

Figure 6. Seasonal length-frequency analysis for carp, James River, S.D., fall 1974-spring 1976.

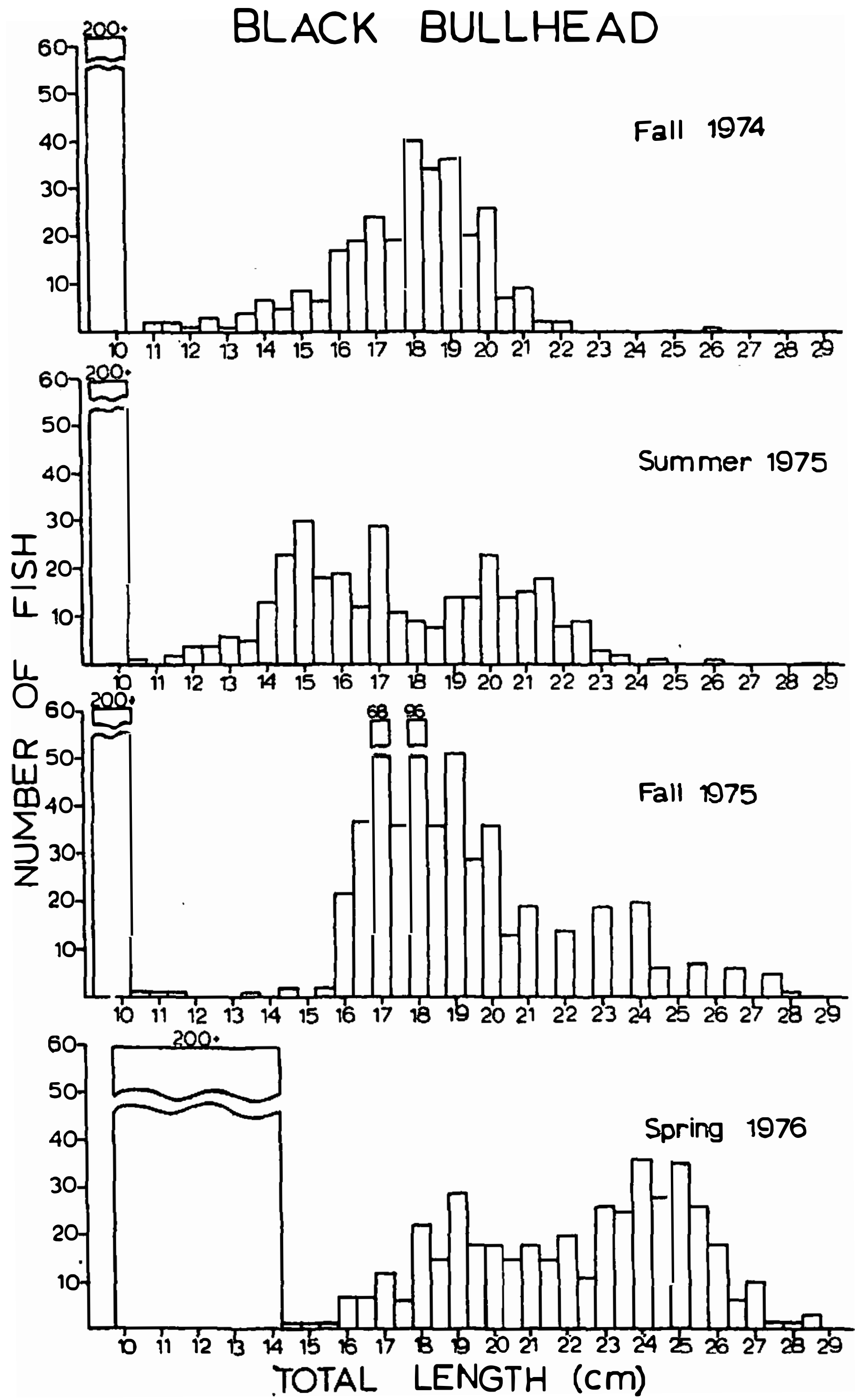

Figure 7. Seasonal length-frequency analysis for black bullhead, James River, S.D., fall 1974-spring 1976.

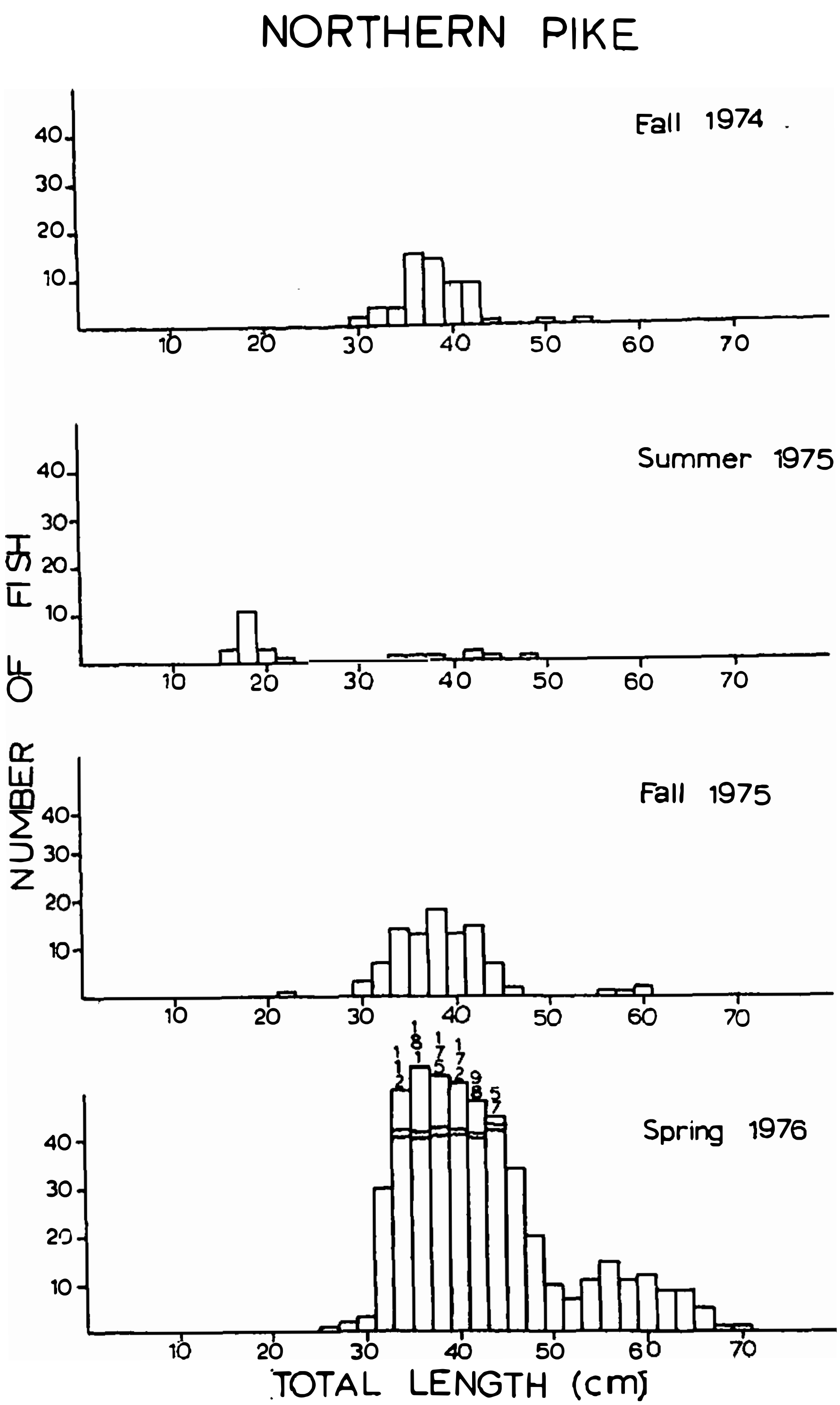

Figure 8. Seasonal length-frequency analysis for northern pike, James River, S.D., fall 1974-spring 1976.

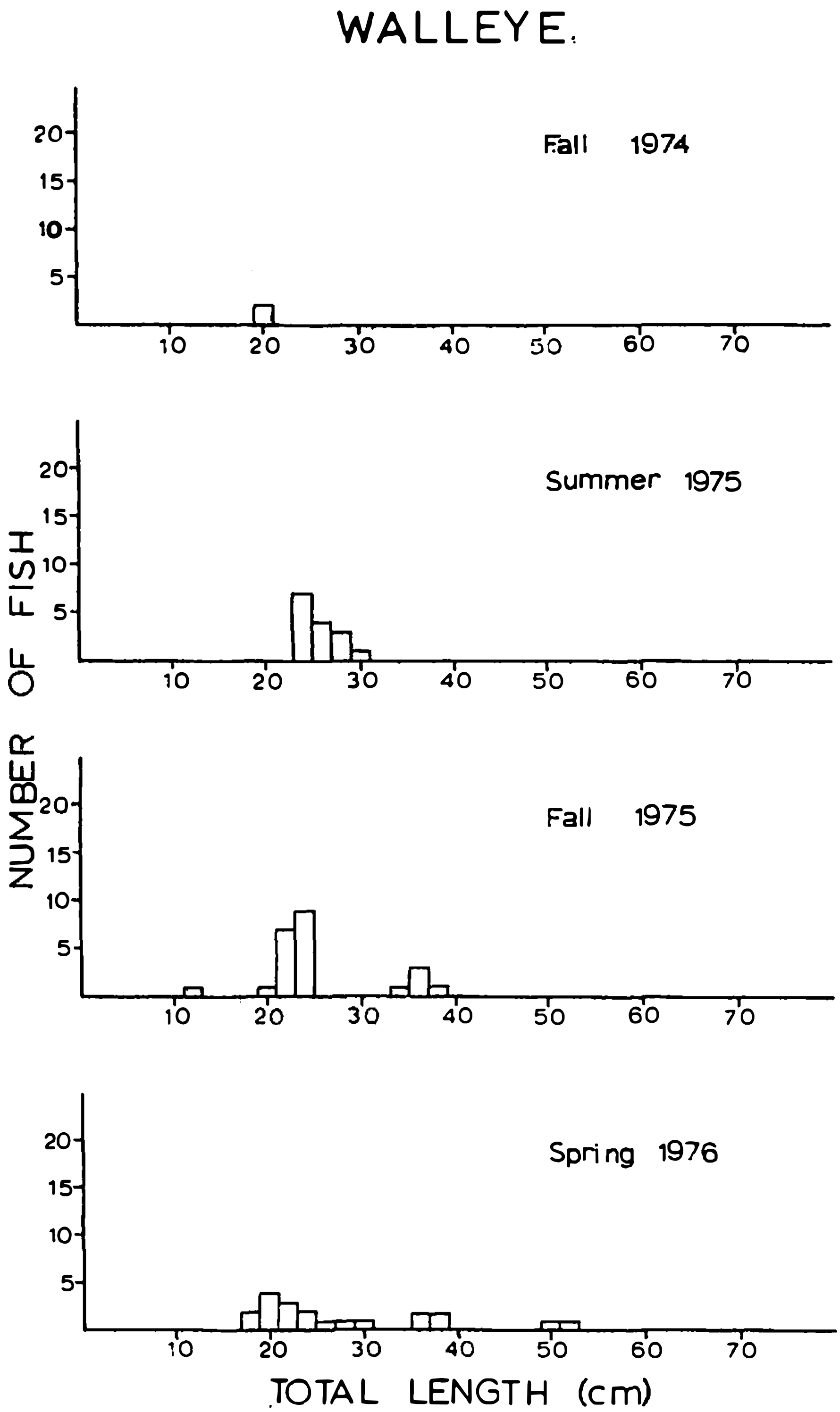

Figure 9. Seasonal length-frequency analysis for walleye, James River, S.D., fall 1974-spring 1976.

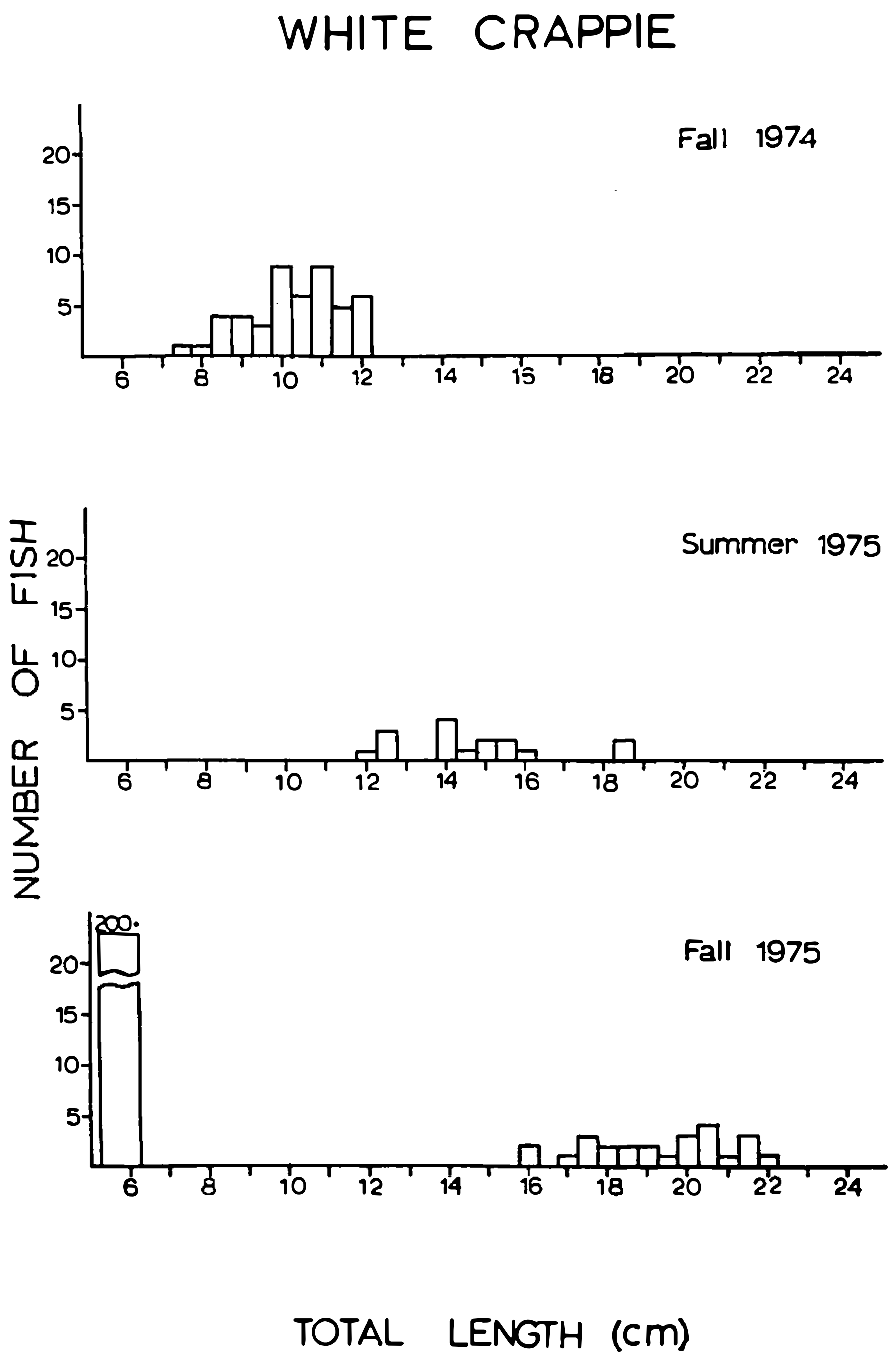

Figure 10. Seasonal length-frequency analysis for white crappie, James River, S.D., fall 1974-spring 1976.

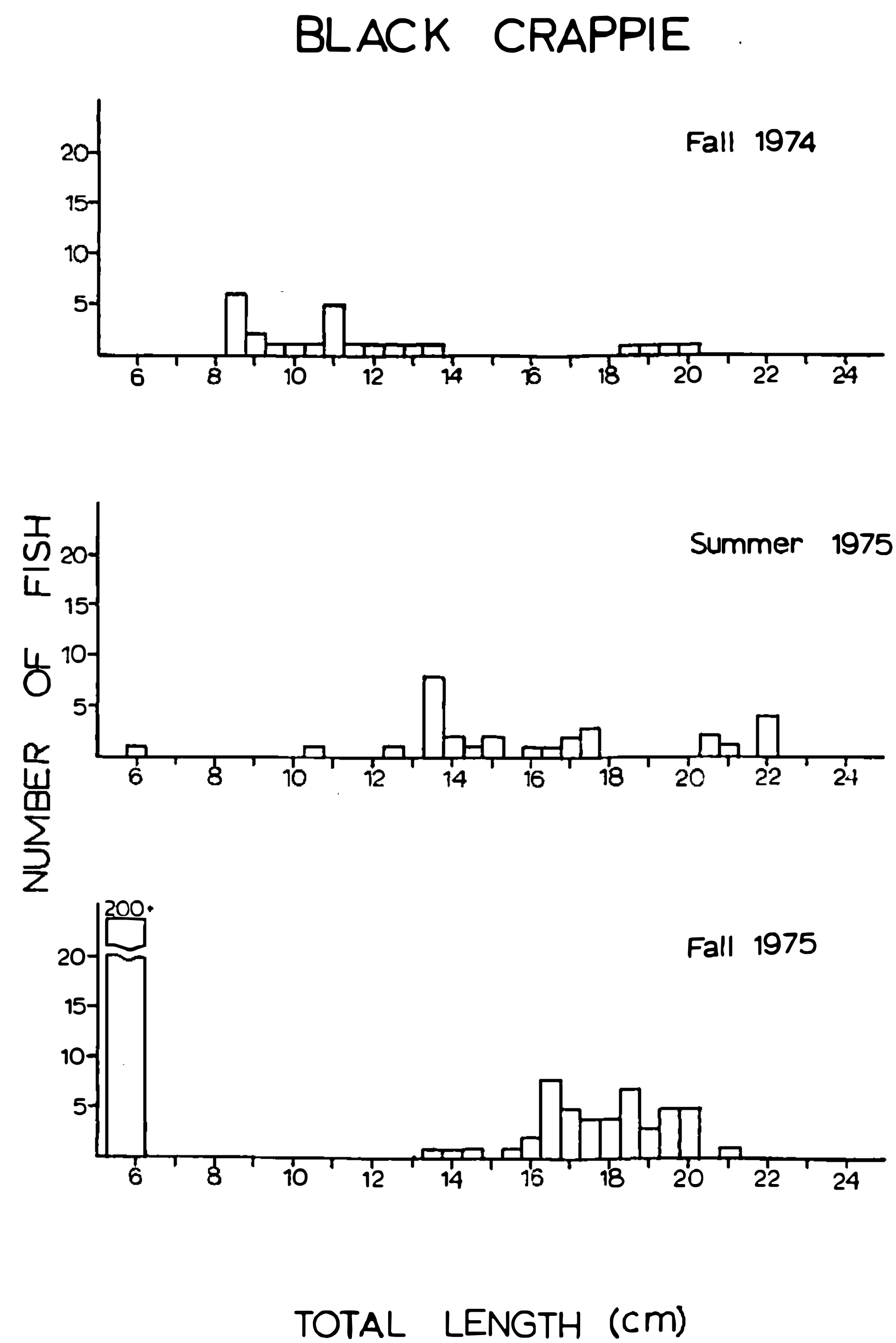

Figure 11. Seasonal length-frequency analysis for black crappie, James River, S.D., fall 1974-spring 1976.

Carp exhibited eight age groups (Table 6). These age groups did not appear distinctly in relative abundance analysis (Figure 6). Carp in age group I averaged 20.5 cm (8.1 in) in length (Table 7). Carp in age group I ranged in mean total length from 8.4 cm (3.3 in) in Big Blue River, Kansas to 30.0 cm (11.8 in) in Wisconsin (Carlander 1969). James River carp in age group IV averaged 44.5 cm (29.0 in). Carp in age group IV were reported to range from 18.5 cm (7.3 in) in Glen Canyon, Utah to 73.7 cm (8.1 in) in Clear Lake, Iowa. Carlander reported the condition factor for carp to range from 1.23 at Williams Point, Iowa to 1.66 in Oklahoma. The mean K for the James River carp is 1.75.

Carp appeared to be relatively fast growing in the James River. The high mean condition factor is probably a result of favorable living conditions for the fishes treated by the high rate of flow during the summer of 1975. Adult carp appeared to leave the study area during the falls of 1974 and 1975 (Figure 6). The tendency for carp to migrate seasonally and its ability to utilize the James and its tributaries for spawning make it successful in the James River.

Black bullheads were represented by five age-groups. The James River black bullheads averaged 18.5 cm (7.3 in) in age-group I. Lengths from black bullheads from other bodies of water ranged from 5.1 cm (2.0 in) in Kansas to 18.0 cm (7.1 in) in Missouri (Carlander 1969). In age-group III the James River black bullheads averaged 23.0 cm (9.1 in), and others ranged from 15.2 cm (6.0 in) in Iowa to 30.0 cm (11.8 in) in Oregon. Carlander reported the mean K to range from 1.11 in Iowa to 1.66 in Lake Oahe, South Dakota. The mean K was 1.66 for the James River black bullheads. Movement of black bullheads did occur, although unlike carp, not to the point of total desertion of the Lake Plain area by adult fish (Figure 7). They were the most abundant fish found in the study area (Table 5).

Northern pike were limited to 3 age-groups probably because of reoccurring low volume of flow and accompanying low dissolved oxygen levels. Yearling northern pike from the James River averaged 53.5 cm (21.2 in). Carlander (1969) reported their mean total lengths of age-group I ranged from 13.7 cm (5.4 in) in Saskatchewan, Canada to 62.7 cm (24.7 in) in Lake Oahe, South Dakota. James River northern pike in age group-II averaged 56.0 cm (22.0 in). At age-group II Carlander reported northern pike ranged from 23.9 cm (9.4 in) in Saskatechewan, Canada to 68.8 cm (27.1 in) in Lake Oahe, South Dakota.

White crappies, black crappies, and walleyes, low in abundance, lacked spawning habitat and the ability to cope with low flows. Three year-classes were present in the walleye population and separated distinctly in length-frequency analysis (Figure 9). James River walleyes averaged 21.0 cm (8.3 in) their first year and 29.0 cm (11.4 in) their third year. Minnesota walleyes averaged 12.9 cm (5.1 in) at the end of their first year of growth and 31.2 cm (12.3 in) at the end of the third (Moyle and Burrows 1975).

White crappies were represented by four year-classes. James River white crappies averaged 15.0 cm (5.9 in) when two-years-old and 24.0 cm (9.4 in) when four-years-old. The mean total length was 15.1 cm (5.9 in) for two-year-old fish from various parts of the world and it was 22.2 cm (8.7 in) for four-year-old fish (Carlander unpublished). The mean K for James River white crappies was 1.47. Carlander reported the mean K for white crappies to range from 1.10 in Alabama to 1.61 in Iowa and Oklahoma.

Black crappies were also represented by four year-classes. The James River black crappies averaged 15.0 cm (5.9 in) at two years and 21.0 cm (8.3 in) at four years. Black crappies from various parts of the United States averaged 14.3 cm (5.6 in) when two-years-old and 24.8 cm (9.8 in) when four-years-old (Carlander unpublished). The mean K for the James River black crappies was 1.65. The mean K for black crappies ranged from 0.97 in Iowa to 1.68 in Wisconsin and Oklahoma. Minnesota standard condition factors for black crappies designate fish with a K less than 1.05 as poor and greater than 1.88 as excellent (Carlander 1969).

The James River fishes appeared to have good growth when compared to fishes from other areas. The high condition factors might have been a result of favorable conditions during the sampling period. The fishes, especially walleyes and northern pike, are short-lived probably because of extreme environmental stress.

Growth increments were compared within age-groups of species examined for age and growth (Figure 12). Discharge rates from October 70 through September 75 are presented in Figure 3. The relationship between flows and fish growth was reflected most clearly by the faster growing fish species; carp, walleye, and northern pike. Only walleye and northern pike were sampled near the end of their growing season in 1975. Both walleye and northern pike had greater growth for water year 1974-75 than for water year 1973-74, when there was lower discharge. The growth increment for carp during water year 1971-72 was greater than that for other years when the flows were lower. Black bullheads also displayed an improved growth rate for 1972. Both black crappies and white crappies exhibited a growth rate for 1975 that was nearly equal to or greater than that for previous years, even though these fishes were collected in mid to late summer and had much of the 1975 growing season

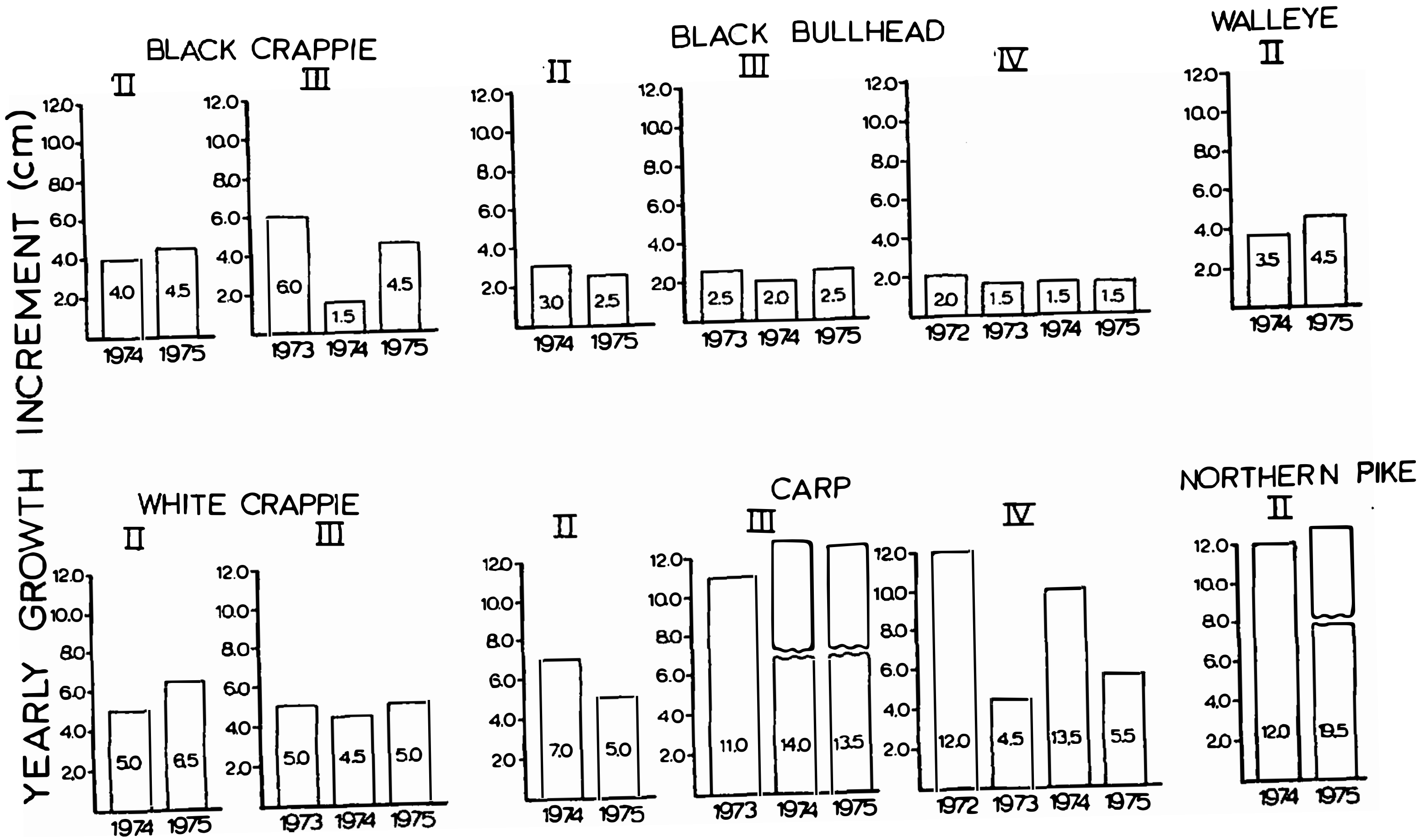

Figure 12. Yearly growth increments from James River, S.D. fishes, 1975.

remaining. Their growth rate also appeared to be related to the amount of yearly flow.

Near zero discharge in the late summer and fall months appeared to adversely affect the growth of the fishes. The best growth occurred during years when the volume of discharge was sufficient to inundate commonly flooded areas long enough to allow for spawning and the production of food organisms.

Distribution

Adult fishes were found in large numbers only during the spring spawning season and for as long as the flows remained stable or were increasing. During periods of strong current the fishes were found mainly in areas of quiet water. Netting results indicated that the adult fishes preferred the entrances to the tributaries and oxbows, log jams, and flooded areas near the main channel.

The flooded areas proved to be important habitat for young-of-the-year and adult forage fishes (Table 8). The adults of the larger species frequented weedy areas near the main current, and young-of-the-year were found throughout the flooded areas. In addition to the species listed in Table 8, brook sticklebacks, johnny darters, white suckers, green sunfish, and black crappies were occasionally observed and captured on the flooded areas.

Table 8. Relative abundance of adult fishes sampled by electrofishing and young-of-the-year and forage fishes sampled by seining from James River flooded areas, summer 1975.

Species	Adult fishes	Young-of-the-year and forage fishes
Carp	61%	24%
Black bullhead	11%	0%
Northern pike	8%	0%
White crappie	6%	14%
Bigmouth buffalo	0%	14%
Orangespot sunfish	14%	0%
Fathead minnow	0%	48%

Adult carp made up 61% of the fishes captured by electrofishing in 1975 (Table 8). Carp were present during most of the 1975 summer and were captured in spawning condition until 13 June 75. Other fishes that used the flooded areas appeared in the early spring, spawned, and returned to the channel leaving only their young as evidence of their past presence.

Large numbers of young-of-the-year carp, bigmouth buffalo, white and black crappies, fathead minnows, sticklebacks, johnny darters, and black bullheads were observed and collected in the shallows, below bridges, around snags, and any other place offering protection during the summer 1975. I did not observe them during the spring and summer 1976. By 1 July 76 the James River was nearly dry. Holes or pockets of deep water and the shallow water of the river channel were the only types of habitat remaining after the river was confined within its banks during the fall 1974 and the summer 1976. The shallow areas were inhabited primarily by forage species and young-of-the-year of slower growing species (Table 3). The deep holes were inhabited primarily by adult black bullheads and young of the faster growing species such as northern pike and carp (Table 5). Low discharge reduced habitat for spawning, food production, and protection.

Movement

The James Diversion Dam, north of Huron, South Dakota, can be bypassed by fishes moving upstream only during years of exceptionally high discharge such as 1972 and 1975 (Figure 3). Freshwater drum and channel catfish appeared in the nets only during the spring and summer 1975.

Gill netting in June and July 75 produced few fishes. Approximately 3000 adult fishes were captured in two trapnets set in an oxbow four miles north of Ashton during October 75. Trapnet sets captured two fishes at the same place on 2 August 75. There was a fall and winter northern pike sport fishery at Tacoma Park while gill net sets there produced two fishes on 21 June 75. General movement appeared to continue as long as current velocity was increasing or stable, even after spawning. Most of the adult populations moved completely through the area when flows increased throughout most of the summer 1975. The stimulus for a return migration appeared to be decreasing current velocity. Few adult fishes, other than black bullheads and forage fishes were found in the study areas during October 74 when the discharge was near zero. Hanson and Muncy (1971) and Welker (1967) reported that channel catfish migrated to areas offering better living conditions during low flow periods in the Little Sioux River, Iowa. The overwintering places on the Lake Plain are washouts around sharp bends, behind lowhead and rock dams, and dredged out places under bridges. Much of this type of habitat is marginal and the fishes often have difficulty overwintering due to low dissolved oxygen levels (Table 1).

No small stretch of the James River can satisfy all of the needs associated with the life cycle of a particular fish species. An area that may serve satisfactorily as a place to live, providing food and shelter from predation in June, may be dry in July. Fish populations must be highly mobile to succeed in such unstable environments.

1976 Spring Migrations

Spring migrations were monitored at a nine-bay culvert bridge 4 km (2.5 mi) north of Stratford from 26 March 76 to 1 July 76. Northern pike first appeared in the nets on 27 March. Spring northern pike migration probably began while the ice still covered the river. The major spawning activity was observed between 27 March and 17 April with the peak at 2 April (Figure 13 and Table 9). Water temperature was 10.6C (51.0F) at the peak. Ripe males were occasionally found until 8 May. Nearly all northern pike had spawned by the time the water temperature reached 15.0C (59.0F). General movement continued through the sampling site at a slow rate until sampling efforts were terminated on 1 July. Spawning female northern pike averaged 42.5 cm (16.7 in) total length. The males averaged 38.0 cm (15.0

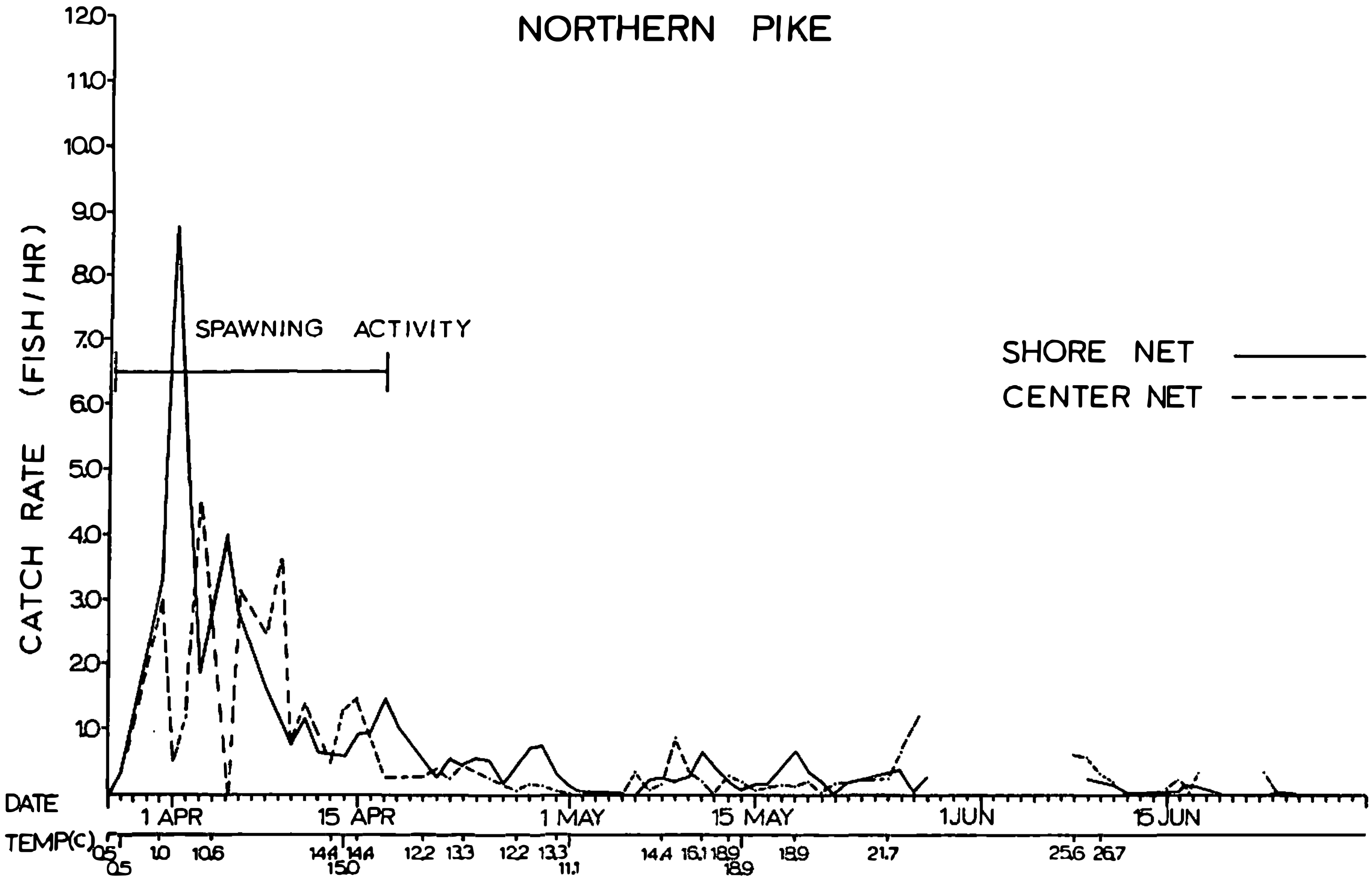

Figure 13. Variation in the catch rate of northern pike in two trapnets during the spring migration, James River, S.D., 1976.

Table 9. Northern pike catch in two trapnets (N_1 and N_2) during the spring migration, James River, S.D., 1976.

Date	Hrs.	Catch N_1	Catch N_2	Catch rate (fish/hr) N_1	Catch rate (fish/hr) N_2	Total length range (cm) N_1	Total length range (cm) N_2	Av. total length (cm) N_1	Av. total length (cm) N_2	Sex ratio (M/F) N_1	Sex ratio (M/F) N_2	% ripe N_1	% ripe N_2
3-27-76	3	0	0	0.0	0.0	-	-	-	-	-	-	-	-
3-28-76	3	1	1	0.3	0.3	39.0	38.0	39.0	38.0	1.0-0	1.0-0	100	100
3-31-76	3	10	9	3.3	3.0	35.5-43.5	34.0-38.0	38.5	36.0	10.0-0	9.0-0	100	100
4-01-76	15	131	8	8.7	0.5	33.0-59.0	32.5-41.0	38.5	35.5	5.0-1	4.0-1	100	100
4-02-76	4	21	5	5.0	1.2	31.0-62.0	33.0-37.0	30.0	35.5	5.2-1	4.0-1	100	100
4-03-76	15	28	67	1.9	4.5	33.5-59.5	31.0-59.0	38.0	41.5	9.4-1	5.6-1	100	100
4-05-76	3	12	0	4.0	0.0	30.5-45.5	-	37.5	-	11.0-1	-	100	-
4-06-76	15	42	47	2.8	3.1	30.5-61.5	31.5-60.0	37.5	40.0	5.3-1	6.7-1	95	74
4-08-76	24	39	60	1.6	2.5	32.0-63.0	33.0-66.0	40.0	40.5				
4-09-76	19	3	69	0.8	3.6	33.0-38.0	31.0-61.0	35.5	47.0	3.0-0	5.7-1	33	66
4-10-76	24	27	19	1.1	0.8	32.0-66.0	29.5-50.5	38.5	38.0	3.0-1	4.8-1	66	42
4-11-76	16	10	22	0.6	1.4	32.0-46.0	31.0-62.0	35.5	38.5	9.0-1	3.7-1	70	27
4-13-76	26	15	12	0.6	0.5	32.0-58.0	33.5-51.0	38.5	40.5	7.0-1	2.4-1	60	17
4-14-76	23	21	29	0.9	1.3	33.0-62.0	31.0-59.0	40.5	39.5	0.3-1	6.3-1	38	33
4-15-76	24	22	35	0.9	1.5	32.0-64.0	31.0-58.0	36.5	38.5	16.0-0		55	29
4-16-76	24	35	21	1.5	0.9	34.0-66.0	33.0-59.0	41.5	47.5				0
4-17-76	15	16	4	1.1	0.3	38.0-52.0	38.0-39.0	39.5	38.5			0	0
4-20-76	24	6	7	0.3	0.3	32.5-68.0	27.0-57.0	47.0	46.5				
4-21-76	24	14	8	0.6	0.3	31.0-58.0	34.0-42.0	41.5	36.0		3.1-1	14	0
4-22-76	25	11	6	0.4	0.2	34.0-43.0	34.0-54.0	38.0	40.0			0	0
4-23-76	23	13	10	0.6	0.4	38.0-63.0	33.0-43.0	49.0	38.5			0	0
4-24-76	24	13	0	0.5	0.0	35.0-67.0	-	46.0	-			0	0
4-25-76	24	4	7	0.2	0.3	37.0-57.0	32.0-56.0	44.5	40.5				
4-27-76	24	17	2	0.7	0.1	34.0-59.0	30.0-40.0	45.5	39.0				
4-28-76	24	18	4	0.8	0.2	36.0-47.0	34.0-59.0	40.0	42.0				
4-29-76	23	8	3	0.3	0.1	34.0-65.0	31.0-34.0	45.0	32.5				
4-30-76	24	4	2	0.2	0.1	36.0-66.0	34.0	49.0	34.0				
5-01-76	24	1	1	0.1	0.1	42.0	35.0	42.0	35.0				
5-05-76	19	0	0	0.0	0.0	-	-	-	-				
5-06-76	24	5	8	0.2	0.3	37.0-44.0	35.0-44.0	41.5	39.0				
5-07-76	24	6	2	0.3	0.1	35.0-45.0	39.0-41.0	40.5	40.0				
5-08-76	24	5	4	0.2	0.2	33.0-49.0	29.0-53.0	40.0	42.0				
5-09-76	24	7	21	0.3	0.9	39.0-70.0	37.0-65.0	48.5	45.0				
5-10-76	24	16	9	0.7	0.4	35.0-57.0	38.0-58.0	43.0	43.0				
5-11-76	24	10	5	0.4	0.2	32.0-45.0	36.0-49.0	41.0	40.0				
5-12-76	24	5	0	0.2	0.0	35.0-65.0	-	47.5	-				
5-13-76	24	2	7	0.1	0.3	36.0-39.0	36.0-45.0	37.5	39.5				

Table 9. Continued.

Date	Hrs.	Catch N1	Catch N2	Catch rate (fish/hr) N1	Catch rate (fish/hr) N2	Total length range (cm) N1	Total length range (cm) N2	Av. total length (cm) N1	Av. total length (cm) N2	Sex ratio (M/F) N1	Sex ratio (M/F) N2	% ripe N1	% ripe N2
5-14-76	24	4	5	0.2	0.2	36.0-45.0	35.0-45.0	40.0	41.5				
5-15-76	24	4	2	0.2	0.1	40.0	41.0	40.0	41.0				
5-17-76	24	16	4	0.7	0.2	38.0-51.0	39.0	40.5	39.0				
5-18-76	24	8	3	0.3	0.1	37.0-64.0	39.0-46.0	43.0	43.0				
5-19-76	24	5	5	0.2	0.2	38.0-65.0	41.0-52.0	47.5	45.5				
5-20-76	24	0	0	0.0	0.0	-	-	-	-				
5-21-76	24	4	4	0.2	0.2	36.0-60.0	37.0-39.0	44.5	38.0				
5-25-76	24	9	6	0.4	0.3	34.0-69.0	42.0-45.0	44.0	43.5				
5-26-76	24	1	16	0.1	0.7	41.0	34.0-59.0	41.0	43.5				
5-27-76	24	7	28	0.3	1.2	38.0-64.0	35.0-58.0	45.5	43.5				
6-08-76	24	6	15	0.3	0.6	32.0-65.0	30.0-57.0	41.0	42.5				
6-09-76	24	5	14	0.2	0.6	36.0-41.0	34.0-51.0	38.0	41.5				
6-10-76	24	4	8	0.2	0.3	38.0-40.0	36.0-48.0	39.0	43.5				
6-11-76	24	1	5	0.1	0.2	44.0	40.0	44.0	40.0				
6-15-76	24	1	2	0.1	0.1	66.0	45.0	66.0	45.0				
6-16-76	24	4	6	0.2	0.3	38.0-44.0	42.0-47.0	41.0	44.5				
6-17-76	24	3	1	0.1	0.1	38.0	43.0	38.0	43.0				
6-18-76	24	2	8	0.1	0.3	40.0	34.0-40.0	40.0	42.5				
6-23-76	24	1	0	0.1	0.0	31.0	-	31.0	-				
6-24-76	24	0	0	0.0	0.0	-	-	-	-				

in). The smallest female in spawning condition was 36.0 cm (14.2 in) and the smallest ripe male was 31.0 cm (12.2 in). Some northern pike in the James River began spawning as yearlings.

Carp appeared in the nets on 1 April (Table 10), and peaked between 19 April and 9 May. Carp were nearly all yearlings. The spawning period, as judged by the size, numbers, and spawning readiness of the fish in the catch, occurred between 1 April and 14 April (Table 10, Figures 14 and 15). Females averaged 48.0 cm (18.9 in) length, and males were 36.0 cm (14.2 in). The smallest ripe male was a yearling 26.0 cm (10.2 in) in length. Some James River carp appeared to begin spawning at one year of age. General movement continued through the bridge throughout the sampling period.

Netting at the bridge indicated that black bullheads were the most abundant fish in the 1976 spring migration (Table 11). Black bullheads first appeared in the nets on 6 April and the peak of the migration occurred between 18 April and 17 May (Table 12). Large fluctuations in catch rate indicated that the fish traveled in groups (Figure 16). Many females caught on 6 April contained developing eggs. By 17 June all of the females checked had either spawned or were reabsorbing their eggs. The spawning activity of black bullheads included movement to

Table 10. Carp catch in two trapnets (N_1 and N_2) during the spring migration, James River, S.D., 1976.

Date	Hrs.	Catch		Catch rate (fish/hr)		Total length range (cm)		Av. total length (cm)		Sex ratio (M/F)		% ripe	
		N_1	N_2	N_1	N_2	N_1	N_2	N_1	N_2	N_1	N_2	N_1	N_2
3-27-76	3	0	0	0.0	0.0	-	-	-	-				
3-28-76	3	0	0	0.0	0.0	-	-	-	-				
3-31-76	3	0	0	0.0	0.0	-	-	-	-				
4-01-76	15	1	1	0.1	0.1	53.5		53.5		1.0-0		100	
4-02-76	4	0	0	0.0	0.0	-	-	-	-				
4-03-76	15	1	7	0.1	0.4	48.5	46.0-59.0	48.5	51.5	1.0-0	0.8-1	100	100
4-05-76	3	0	0	0.0	0.0	-	-	-	-				
4-06-76	15	0	30	0.0	2.0	-	44.0-59.0	-	49.5		1.3-1		100
4-08-76	24	0	4	0.0	0.2	-	15.0-36.0	-	25.0				
4-09-76	19	0	16	0.0	0.8	-	16.0-44.0	-	26.5				
4-10-76	24	8	1	0.3	0.1	34.0-47.0	46.0	42.0	46.0	1.6-1		87	100
4-11-76	16	0	5	0.0	0.3	-	26.0-55.0	-	37.5		5.0-0		100
4-13-76	26	2	1	0.1	0.1	30.0-33.0	26.0	31.5	26.0	2.0-0	1.0-0	100	100
4-14-76	23	6	0	0.3	0.0	23.0-35.0	-	31.0	-	5.0-1	3.0-1	33	76
4-15-76	24	2	4	0.1	0.1	32.0-47.0	26.0-46.0	39.5	34.5	1.0-1		50	0
4-16-76	24	5	28	0.2	1.2	31.0-40.0	15.0-40.0	34.0	20.5				
4-17-76	15	0	0	0.0	0.0	-	-	-	-				
4-20-76	24	8	7	0.3	0.3		21.0-34.0		26.5				
4-21-76	24	45	102	1.9	4.3	16.0-32.0	15.0-31.0	29.5	17.5				
4-22-76	25	43	124	1.7	5.2	15.0-31.0	14.0-38.0	18.5	18.5				
4-23-76	23	35	123	1.5	5.6	14.0-38.0	15.0-39.0	19.0	18.0				
4-24-76	24	20	73	0.8	3.9	15.0-28.0	12.0-32.5	18.0	18.0				
4-25-76	24	32	29	1.3	1.2	15.0-35.0	14.0-30.0	20.0	17.5				
4-27-76	24	3	67	0.1	2.8	26.0-28.0	-	37.5	-				
4-28-76	24	9	28	0.4	1.2	14.0-31.0	11.0-31.0	22.0	17.0				
4-29-76	23	58	57	2.5	2.5	15.0-30.0	11.0-31.0	18.5	17.0				
4-30-76	24	23	50	1.0	2.1								
5-01-76	24	14	63	0.5	2.6	17.0-46.0	.	24.0					
5-05-76	19	3	15	0.2	0.8								
5-06-76	24	21	44	0.9	1.8	15.0-30.0	12.0-25.0	21.5	16.5				
5-07-76	24	37	94	1.5	3.9	15.0-29.0	12.0-38.0	18.5	17.0				
5-08-76	24	3	1	0.1	0.1	23.0-46.0	26.0	33.0	26.0				
5-09-76	24	0	11	0.0	0.5	-	25.0-50.0	-	35.0				
5-10-76	24	3	23	0.1	1.0	15.0-31.0	14.0-32.0	24.0	17.1				
5-11-76	24	2	31	0.1	1.3	24.0-28.0		26.0					
5-12-76	24	20	34	0.8	1.4	13.0-33.0	13.0-32.0	20.5	17.5				
5-13-76	24	9	1	0.4	0.1	19.0-31.0		27.0					

Table 10. Continued.

Date	Hrs.	Catch N1	Catch N2	Catch rate (fish/hr) N1	Catch rate (fish/hr) N2	Total length range (cm) N1	Total length range (cm) N2	Av. total length (cm) N1	Av. total length (cm) N2	Sex ratio (M/F) N1	Sex ratio (M/F) N2	% ripe N1	% ripe N2
5-14-76	24	5	3	0.2	0.1		20.0-30.0		26.0				
5-15-76	24	7	4	0.3	0.2								
5-17-76	24	2	40	0.1	1.7	29.0-51.0		40.0					
5-18-76	24	0	0	0.0	0.0	-	-	-	-				
5-19-76	24	5	6	0.2	0.3	26.0-31.0	26.0-42.0	28.5	30.0				
5-20-76	24	0	2	0.0	0.1	-	15.0-18.0	-	16.5				
5-21-76	24	0	0	0.0	0.0	-	-	-	-				
5-25-76	24	1	6	0.1	0.3	51.0	15.0-19.0	51.0	16.5				
5-26-76	24	3	5	0.1	0.2	29.0-40.0	32.0-36.0	34.0	34.0				
5-27-76	24	5	2	0.2	0.1	25.0-35.0	27.0-30.0	20.0	28.5				
6-08-76	24	0	13	0.0	0.5	-	26.0-32.0	-	29.15				
6-09-76	24	1	19	0.1	0.8	30.0	23.0-33.0	30.0	28.0				
6-10-76	24	1	9	0.1	0.4	29.0	25.0-30.0	29.0	28.5				
6-11-76	24	0	21	0.0	0.9	-		-					
6-15-76	24	1	4	0.1	0.2	33.0	27.0-28.0	33.0	27.5				
6-16-76	24	1	9	0.1	0.4	33.0	20.0-32.0	33.0	30.0				
6-17-76	24	0	18	0.0	0.8	-	26.0-36.0	-	28.0				
6-18-76	24	0	1	0.0	0.1	-		-					
6-23-76	24	0	0	0.0	0.0	-	-	-	-				
6-24-76	24	0	35	0.0	1.5	-	25.0-33.0	-	29.0				

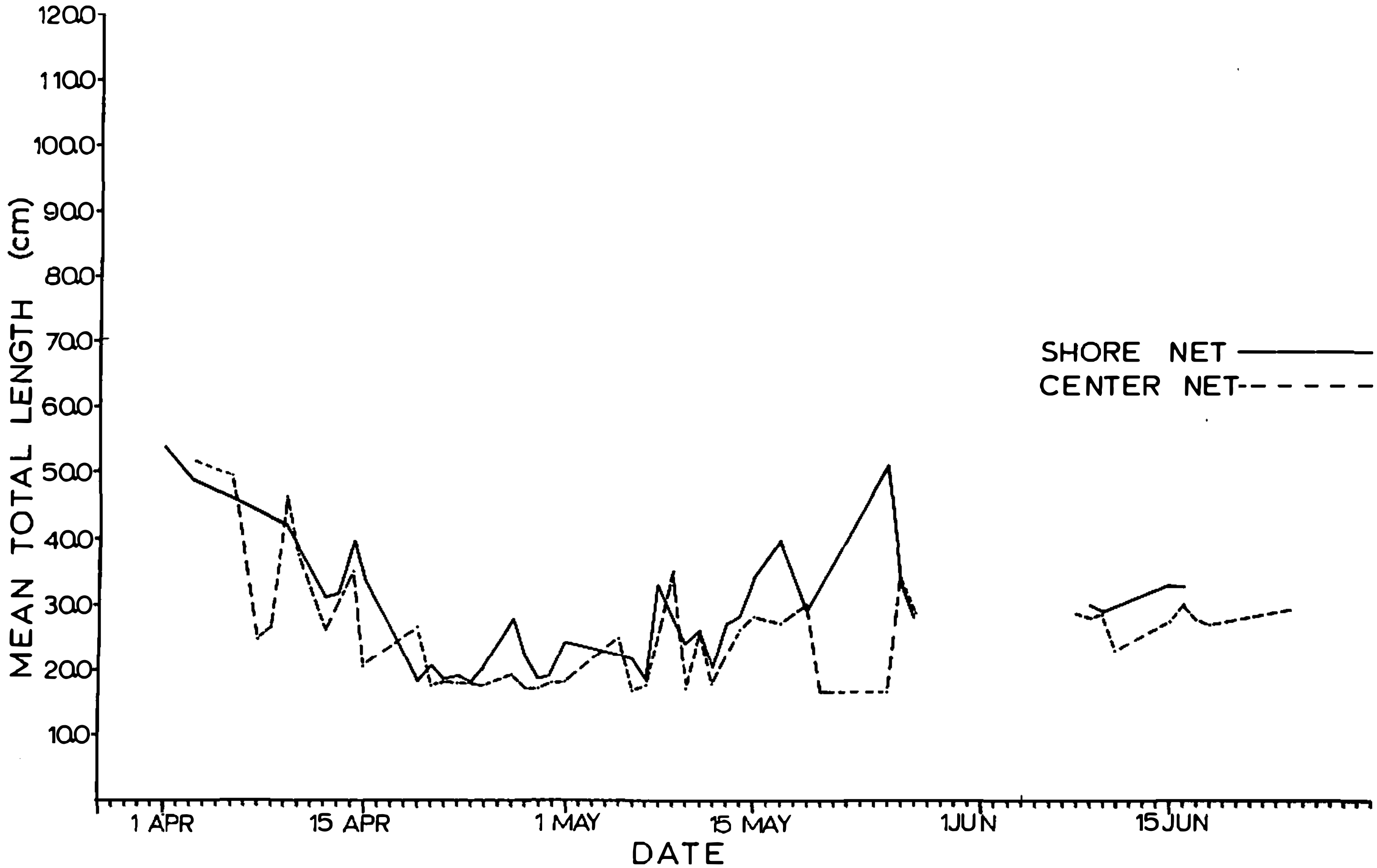

Figure 14. Variation in the catch rate of carp in two trapnets during the spring migration, James River, S.D., 1976.

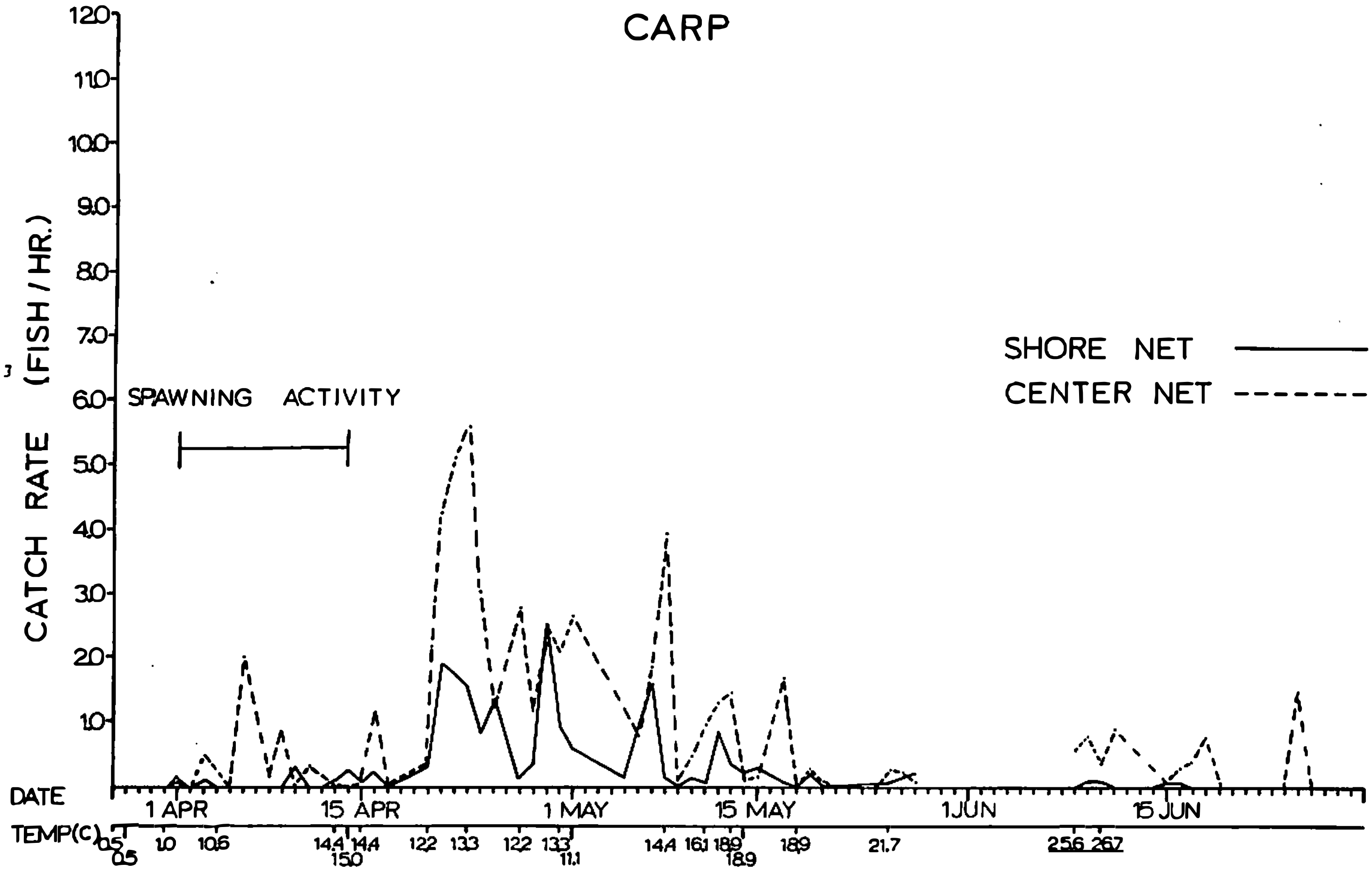

Figure 15. Variation in mean total lengths of carp captured in two trapnets during the spring migration, James River, S.D., 1976.

Table 11. Total number of the fishes captured in two trapnets during the spring migration, James River, S.D., 1976.

Date	Northern pike	Carp	Black bullhead	Walleye	White sucker	Bigmouth buffalo	Black crappie	Shortnose gar	Yellow perch	Total
3-27-76	-	-	-	-	-	-	-	-	-	0
3-28-76	1	-	-	-	-	-	-	-	-	1
3-31-76	19	-	-	-	-	-	-	-	-	19
4-01-76	139	2	-	1	-	-	-	-	-	142
4-02-76	26	-	-	2	-	-	-	-	-	28
4-03-76	95	8	-	-	-	1	-	-	-	104
4-05-76	12	-	-	-	-	-	-	-	-	12
4-06-76	89	30	4	2	1	-	-	-	1	127
4-08-76	99	4	-	-	-	-	-	-	-	103
4-09-76	72	16	2	1	1	1	-	-	-	93
4-10-76	46	9	8	1	1	1	-	-	-	66
4-11-76	32	5	18	3	1	-	-	-	-	59
4-13-76	27	3	54	2	1	2	-	-	-	89
4-14-76	50	6	84	1	-	-	-	-	-	141
4-15-76	57	6	86	1	-	-	-	-	-	150
4-16-76	56	33	204	-	1	-	-	-	-	294
4-17-76	20	-	75	-	-	-	-	-	-	95
4-20-76	13	15	75	-	-	-	-	-	-	103
4-21-76	22	147	205	1	-	1	-	-	-	376
4-22-76	17	167	258	-	1	2	-	-	-	445
4-23-76	23	158	73	1	1	1	1	-	-	258
4-24-76	13	93	150	-	1	3	-	-	-	260
4-25-76	11	61	308	-	-	5	1	-	-	386
4-27-76	19	70	127	-	-	-	-	-	-	216
4-28-76	22	37	119	-	-	-	-	-	-	178
4-29-76	11	15	285	2	1	1	1	-	-	416
4-30-76	6	73	158	-	-	1	-	-	-	238
5-01-76	2	77	216	-	-	-	-	-	-	295
5-05-76	-	18	17	-	-	-	-	-	-	35
5-06-76	13	65	80	-	-	-	-	-	-	158
5-07-76	8	131	148	-	-	-	-	-	-	287
5-08-76	9	4	70	-	-	-	-	1	-	84
5-09-76	28	11	45	-	-	2	-	-	-	86
5-10-76	25	26	61	-	-	2	1	1	-	116
5-11-76	15	33	345	-	-	2	-	-	-	395
5-12-76	5	54	208	-	1	4	-	-	-	272
5-13-76	9	10	340	-	-	-	1	1	-	361
5-14-76	9	8	139	-	-	-	-	-	-	156
5-15-76	6	11	122	-	-	1	-	-	-	140
5-17-76	20	42	509	-	2	-	-	-	-	573
5-18-76	11	-	29	-	-	-	-	-	-	40
5-19-76	10	11	54	-	-	-	-	-	-	75
5-20-76	-	2	-	-	-	-	-	-	-	2
5-21-76	4	-	1	-	-	-	-	-	-	5
5-15-76	15	7	18	-	-	-	1	-	-	41
5-26-76	17	8	104	1	1	-	-	-	-	131
5-27-76	35	7	14	-	1	-	-	-	-	57
6-08-76	21	13	2	-	1	-	-	-	-	37
6-09-76	19	20	25	-	-	-	-	-	-	64
6-10-76	12	9	8	1	-	-	1	-	-	31
6-11-76	6	21	11	-	-	-	-	-	-	38
6-15-76	3	5	5	-	-	-	2	-	-	15
6-16-76	10	10	10	-	-	-	-	-	-	30
6-17-76	4	18	22	-	1	-	1	-	-	46
6-18-76	10	1	14	-	-	-	-	-	-	25
6-23-76	1	-	6	-	-	-	-	-	-	7
6-24-76	-	35	28	-	1	-	-	-	-	64
Totals	1324	1715	4944	20	18	30	10	3	1	8065

Table 12. Black bullhead catch in two trapnets (N_1 and N_2) during the spring migration, James River, S.D., 1976.

Date	Hrs.	Catch		Catch rate (fish/hr)		Total length range (cm)		Av. total length (cm)	
		N_1	N_2	N_1	N_2	N_1	N_2	N_1	N_2
3-27-76	3	0	0	0.0	0.0	-	-	-	-
3-28-76	3	0	0	0.0	0.0	-	-	-	-
3-31-76	3	0	0	0.0	0.0	-	-	-	-
4-01-76	15	0	0	0.0	0.0	-	-	-	-
4-02-76	4	0	0	0.0	0.0	-	-	-	-
4-03-76	15	0	0	0.0	0.0	-	-	-	-
4-05-76	3	0	0	0.0	0.0	-	-	-	-
4-06-76	15	1	3	0.1	0.2	16.0	16.0-19.0	16.0	17.5
4-08-76	24	0	0	0.0	0.0	-	-	-	-
4-09-76	19	0	2	0.0	0.1	-	22.0-25.0	-	23.5
4-10-76	24	5	3	0.2	0.1	17.0-27.0	16.0-27.0	23.5	20.0
4-11-76	16	0	18	0.0	1.1	-	17.0-24.0	-	20.0
4-13-76	26	52	2	2.0	0.1	16.0-29.0	18.0-19.0	24.0	18.5
4-14-76	23	50	34	2.2	1.5	17.0-27.0	17.0-27.0	23.0	21.5
4-15-76	24	3	83	0.1	3.5	20.0-26.0	14.0-27.0	22.5	21.5
4-16-76	24	94	110	3.9	4.5	18.0-29.0	15.0-27.0	23.0	22.0
4-17-76	15	61	14	4.1	0.9	15.0-27.0	16.0-24.0	23.0	22.0
4-20-76	24	61	14	2.5	0.6	15.0-27.0		23.0	
4-21-76	24	171	34	7.1	1.4	17.0-28.0	16.0-27.0	22.5	21.0
4-22-76	25	222	36	8.9	1.4	15.0-29.0	16.0-27.0	21.5	21.0
4-23-76	23	35	38	1.5	1.7	17.0-28.0	16.0-27.0	23.7	22.5
4-24-76	24	91	15	3.79	2.5	17.0-27.0	17.0-25.0	22.0	21.0
4-25-76	24	284	24	11.8	1.0	18.0-26.0	16.0-24.0	21.0	20.0
4-27-76	24	19	108	0.8	4.5	17.0-28.0		22.0	
4-28-76	24	48	71	2.0	3.0	16.0-29.0	12.0-24.0	21.0	19.0
4-29-76	23	214	71	9.3	3.1	16.0-27.0	11.0-27.0	21.5	21.5
4-30-76	24	128	30	5.3	1.3	18.0-24.0		20.5	
5-01-76	24	50	166	2.1	6.9	18.0-26.0	17.0-22.0	21.0	18.5
5-05-76	19	1	16	0.1	0.7	-		-	
5-06-76	24	24	56	1.0	2.3	18.0-27.0	14.0-27.0	23.5	18.5
5-07-76	24	40	108	1.67	4.5	15.0-28.0	15.0-26.0	22.5	19.6
5-08-76	24	7	63	0.3	2.6	20.0-29.0	16.0-28.0	25.5	21.5
5-09-76	24	35	10	1.5	0.4		21.0-28.0		25.5
5-10-76	24	23	38	1.0	1.6				
5-11-76	24	27	318	1.1	13.3				
5-12-76	24	44	164	1.8	6.8	18.0-27.0	14.0-27.0	22.0	18.5
5-13-76	24	16	324	0.7	13.5	16.0-26.0	12.0-25.0	22.0	20.5
5-14-76	24	18	121	0.8	5.0				
5-15-76	24	15	107	0.6	4.5				
5-17-76	24	18	491	0.8	20.5				
5-18-76	24	0	29	0.0	1.2				
5-19-76	24	2	52	0.1	2.2				
5-20-76	24	0	0	0.0	0.0				
5-21-76	24	1	0	0.1	0.0				
5-25-76	24	2	16	0.1	0.7		14.0-26.0		18.5
5-26-76	24	5	99	0.2	4.1	19.0-26.0	15.0-21.0	24.0	17.5
5-27-76	24	1	13	0.1	0.5	27.0	15.0-25.0	27.0	20.0
6-08-76	24	0	2	0.0	0.1		16.0-18.0		17.0
6-09-76	24	6	19	0.3	0.8		16.0-18.0		17.0
6-10-76	24	0	8	0.0	0.3		15.0-24.0		18.5
6-11-76	24	1	10	0.1	0.4	24.0		24.0	
6-15-76	24	1	4	0.1	0.2	24.0	13.0-14.0	24.0	13.5
6-16-76	24	0	10	0.0	0.4		15.0-22.0		18.5
6-17-76	24	0	22	0.0	0.9		17.0-24.0		19.0
6-18-76	24	0	14	0.0	0.6		16.0-21.0		17.0
6-23-76	24	0	6	0.0	0.3		14.0-20.0		16.5
6-24-76	24	0	28	0.0	1.17		15.0-26.0		18.0

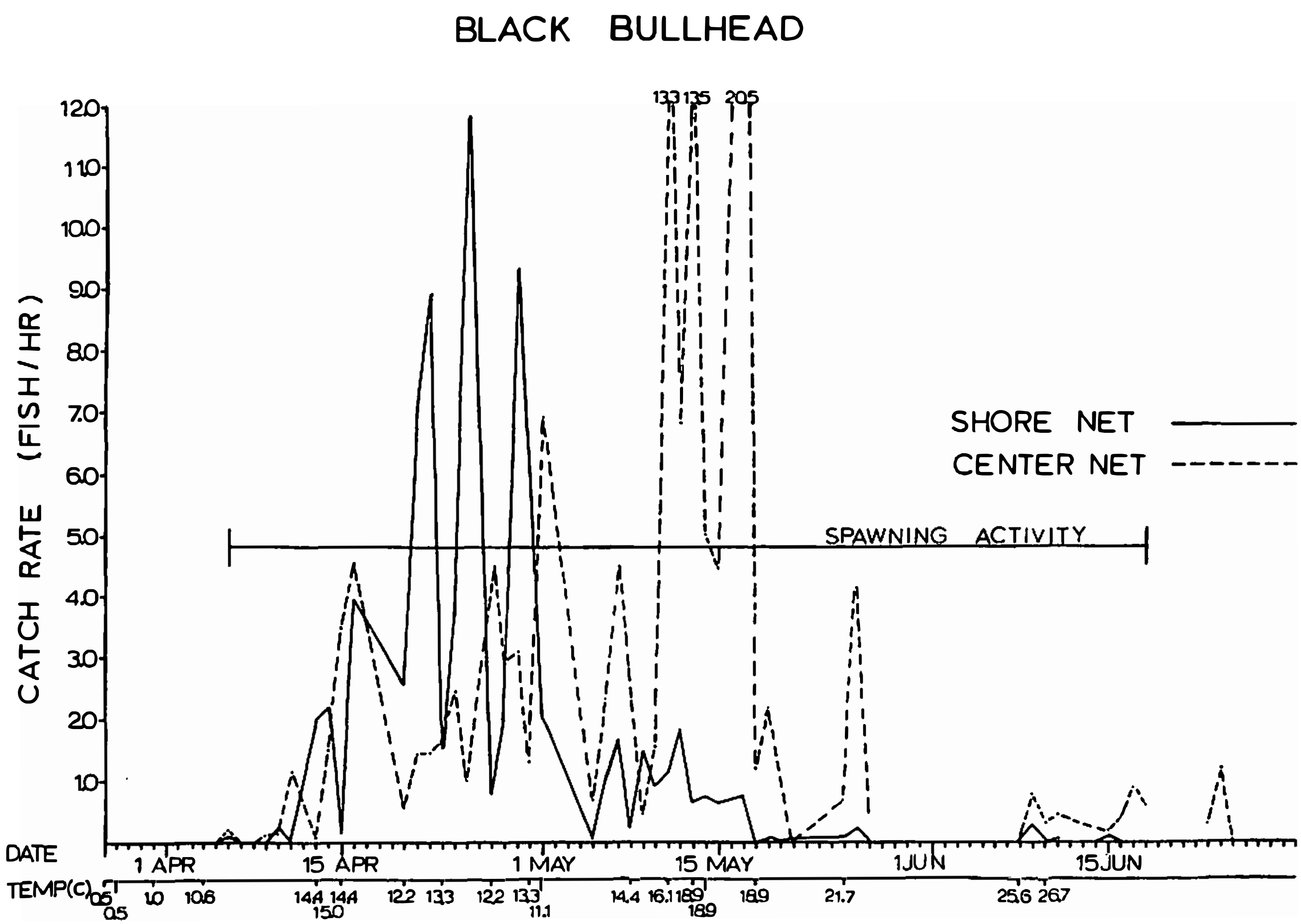

Figure 16. Variation in the catch rate of black bullheads in two trapnets during the spring migration, James River, S.D., 1976.

the spawning areas. Actual spawning probably occurred in a narrow time span and between 1 June and 15 June when the water temperature ranges from 21.0 C (70.0F) to 27.0C (81.0F).

Few walleye, white sucker, bigmouth buffalo, and black crappie were caught during the 1976 spring migration (Table 13, Figure 17).

Walleye apparently spawned from 1 April to 30 April. Water temperatures ranged from 1.0C (33.8F) to 13.3C (55.9F). Males were from 25.5 cm (9.5 in) to 35.0 cm (13.5 in) in length and females from 53.0 cm (21.0 in) to 48.0 cm (19.0 in) in length.

White suckers were active between 6 April and 17 May. Water temperature range was 10.6 C (51.0F) to 18.9C (66.0F). The males were from 20.0 cm (8.0 in) to 32.5 cm (13.0 in), and females ranged from 25.0 cm (10.0 in) to 27.0 cm (10.5 in) in total length.

Black crappies in spawning condition occasionally appeared in the nets from 23 April to 17 June. All but one were in spawning condition. Water temperatures ranged from 13.3C (55.9F) to 28.7C (83.7F). The females ranged in length from 19.0 cm (7.5 in) to 25.0 cm (10.0 in) and the males from 20.0 cm (8.0 in) to 25.0 cm (10.0 in).

Bigmouth buffalo were caught from 3 April to 15 May. The water temperature ranged from 10.6C (51.0F) to 18.9C

Table 13. The total catch of walleyes, white suckers, bigmouth buffalo, and black crappies, in two trapnets during the spring migration, James River, S.D., 1976.

Date	Hrs.	Walleye			Black crappie			Bigmouth buffalo			White sucker		
		No.	Av. total length (cm)	Sexual cond. [1]	No.	Av. total length (cm)	Sexual cond. [1]	No.	Av. total length (cm)	Sexual cond. [1]	No.	Av. total length (cm)	Sexual cond. [1]
3-27-76	3	0	-	-	0	-	-	0	-	-	0	-	-
3-28-76	3	0	-	-	0	-	-	0	-	-	0	-	-
3-31-76	3	0	-	-	0	-	-	0	-	-	0	-	-
4-01-76	15	1	22.5	J	0	-	-	0	-	-	0	-	-
4-02-76	4	2	51.0	F2	0	-	-	0	-	-	0	-	-
4-03-76	15	0	-	-	0	-	-	1	55.5	M	0	-	-
4-05-76	3	0	-	-	0	-	-	0	-	-	0	-	-
4-06-76	15	2	21.5	J	0	-	-	0	-	-	1	28.0	M
4-08-76	24	1	25.0	J	0	-	-	0	-	-	0	-	-
4-09-76	19	1	19.0	J	0	-	-	1	60.5	M	1	23.0	M
4-10-76	24	1	23.0	J	0	-	-	1	63.0	F	1	25.0	F
4-11-76	16	3	31.5	M2-J	0	-	-	0	-	-	1	27.0	F
4-13-76	26	2	19.0	J2	0	-	-	2	62.5	MF	1	25.0	F
4-14-76	23	1	53.0	F	0	-	-	0	-	-	0	-	-
4-15-76	24	1	23.0	J	0	-	-	0	-	-	0	-	-
4-16-76	24	0	-	-	0	-	-	0	-	-	1	25.0	M
4-17-76	15	0	-	-	0	-	-	0	-	-	0	-	-
4-20-76	24	0	-	-	0	-	-	0	-	-	0	-	-
4-21-76	24	1	22.0	J	0	-	-	1	57.0	M	0	-	-
4-22-76	25	0	-	-	0	-	-	2	13.5	J	1	25.0	M
4-23-76	23	1	23.0	J	1	19.0	F	1	13.0	J	1	25.0	F
4-24-76	24	0	-	-	0	-	-	3	14.0	J3	1	20.0	M
4-25-76	24	0	-	-	1	20.0	M	5	14.0	J5	0	-	-
4-27-76	24	0	-	-	0	-	-	0	-	-	0	-	-
4-28-76	24	0	-	-	0	-	-	1	13.0	J	0	-	-
4-29-76	23	2	23.5	M-J	1	22.0	F	1	10.0	J	1	26.0	F
4-30-76	24	0	-	-	0	-	-	0	-	-	0	-	-
5-01-76	24	0	-	-	0	-	-	0	-	-	0	-	-
5-05-76	19	0	-	-	0	-	-	0	-	-	0	-	-
5-06-76	24	0	-	-	0	-	-	0	-	-	0	-	-
5-07-76	24	0	-	-	0	-	-	0	-	-	0	-	-
5-08-76	24	0	-	-	0	-	-	0	-	-	0	-	-
5-09-76	24	0	-	-	0	-	-	2	59.0	MF	0	-	-
5-10-76	24	0	-	-	1	25.0	M	2	60.5	MF	0	-	-
5-11-76	24	0	-	-	0	-	-	2	50.5	M2	0	-	-
5-12-76	24	0	-	-	0	-	-	4	61.5	M1F3	1	27.0	
5-13-76	24	0	-	-	1	22.0		0	-	-	0	-	-
5-14-76	24	0	-	-	0	-	-	0	-	-	0	-	-
5-15-76	24	0	-	-	0	-	-	1	57.0	M	0	-	-
5-17-76	24	0	-	-	0	-	-	0	-	-	2	30.5	M2
5-18-76	24	0	-	-	0	-	-	0	-	-	0	-	-

[1] The sex is listed for ripe fishes only; M is male, F is female, J is juvenile and M2-J indicates two males and one juvenile.

Table 13. Continued.

Date	Hrs.	Walleye No.	Walleye Av. total length (cm)	Walleye Sexual cond.	Black crappie No.	Black crappie Av. total length (cm)	Black crappie Sexual cond.	Bigmouth buffalo No.	Bigmouth buffalo Av. total length (cm)	Bigmouth buffalo Sexual cond.	White sucker No.	White sucker Av. total length (cm)	White sucker Sexual cond.
5-19-76	24	0	-	-	0	-	-	0	-	-	0	-	-
5-20-76	24	0	-	-	0	-	-	0	-	-	0	-	-
5-21-76	24	0	-	-	0	-	-	0	-	-	0	-	-
5-25-76	24	0	-	-	1	25.0	F	0	-	-	0	-	-
5-26-76	24	1	38.0		0	-	-	0	-	-	1	25.0	
5-27-76	24	0	-	-	0	-	-	0	-	-	1	17.0	
6-08-76	24	0	-	-	0	-	-	0	-	-	1	24.0	
6-09-76	24	0	-	-	0	-	-	0	-	-	0	-	-
6-10-76	24	1	38.0		1	19.0		0	-	-	0	-	-
6-11-76	24	0	-	-	0	-	-	0	-	-	0	-	-
6-15-76	24	0	-	-	2	17.5		0	-	-	0	-	-
6-16-76	24	0	-	-	0	-	-	0	-	-	0	-	-
6-17-76	24	0	-	-	1	24.0	F	0	-	-	1	27.0	
6-18-76	24	0	-	-	0	-	-	0	-	-	0	-	-
6-23-76	24	0	-	-	0	-	-	0	-	-	0	-	-
6-24-76	24	0	-	-	0	-	-	0	-	-	1	25.0	

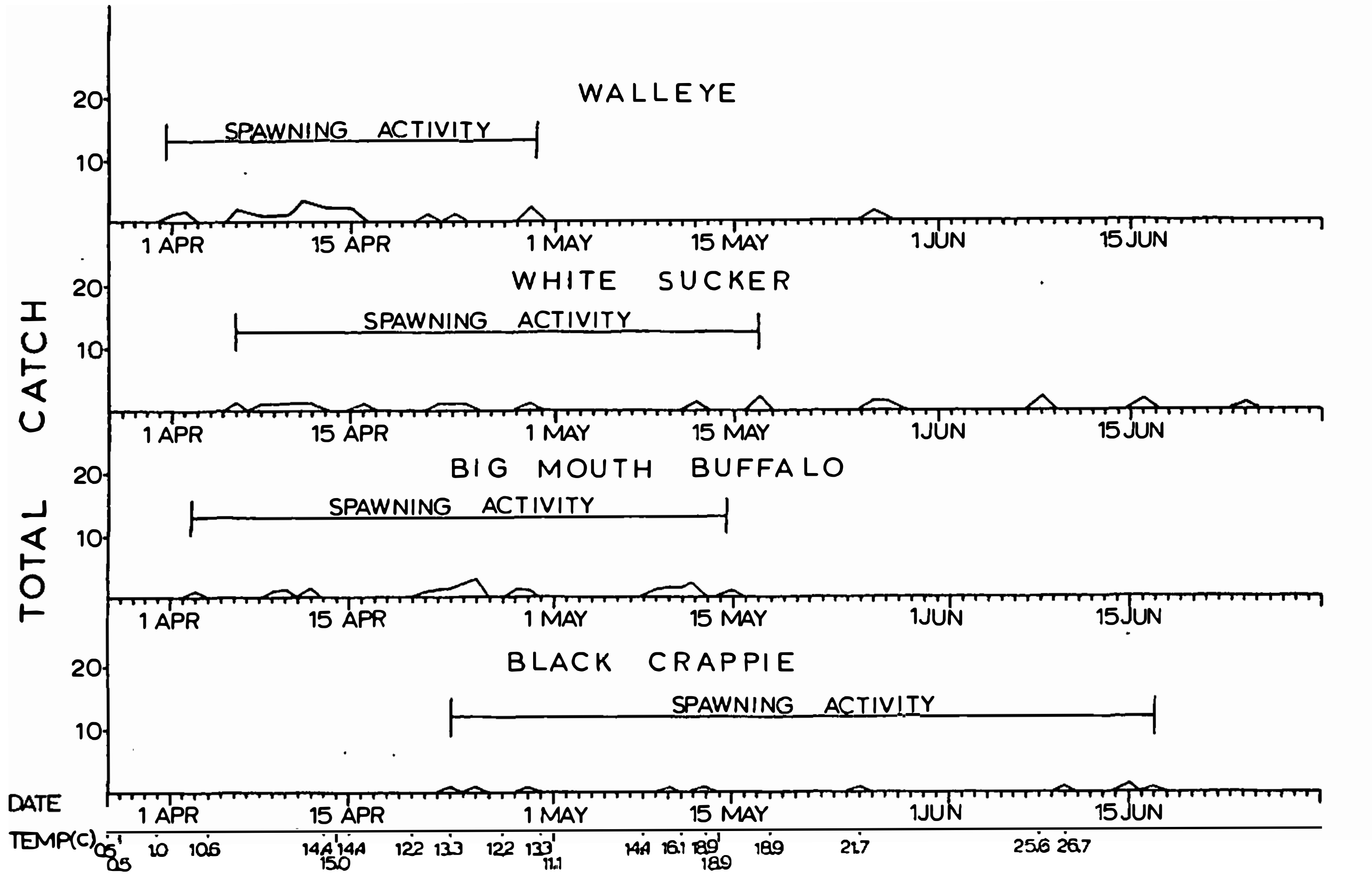

Figure 17. Variation in total catch of walleye, white sucker, bigmouth buffalo, and black crappie from trapnetting during the spring migration, James River, S.D., 1976.

(66.0F). The females ranged in total length from 61.0 cm (24.0 in) to 68.0 cm (26.5 in), and the males ranged from 60.5 cm (24.0 in) to 65.5 cm (26.0 in).

Spawning Habitat

Fry and small fingerlings from 19 species of fish were captured in the Lake Plain area providing evidence of their spawning success during the spring and summer 1975. Two more species were collected in spawning condition during the spring 1976. No evidence of spawning by freshwater drum was observed. Drum that were checked for spawning condition were reabsorbing their eggs.

The Lake Plain area is most important to those fishes spawning over grasses and other plant matter. Carp broadcast their eggs over any type of vegetable matter and achieve tremendous spawning success (Carlander 1969). Black bullheads prefer a pocket or crevice for spawning but will make nests in sand or mud (Carlander 1969). Franklin and Smith (1963) indicated that northern pike require fine vegetation or matted grasses for spawning. Habitat for the species of fish that spawn over gravel was limited but present.

Stratford Slough was inundated during 1975 and 1976 and I observed young-of-the-year fishes in its farthest reaches. Zooplankton and other food organisms necessary for the survival and growth of young fishes appeared to be abundant. Habitat offering protection from predators was also readily available.

McCarraher and Thomas (1972) found that in Nebraska northern pike deposited their eggs in greatest densities on flooded prairie grasses. Most of the land subject to flooding in Stratford Slough is used as pasture or hay land. When flooded it provided the requirements for those fishes needing vegetation for spawning (Figure 18).

The tributaries offer varied types of spawning habitat. The lower three miles of the Moccasin Creek was covered with river bullrush (Scirpus fluviatilis) an excellent spawning substrate for the carp (Carlander 1969) and, to a more limited extent, northern pike (Figure 19). The rest of Moccasin Creek had the appearance of a long cattail marsh because of standing water caused by the low gradient. Young-of-the-year carp, bigmouth buffalo, white suckers, black bullheads and fathead minnows were observed as far as 24 km (15 mi) upstream. Northern pike were observed only near the mouth and apparently did not spawn in Moccasin Creek upstream from the lower three miles. Franklin and Smith (1963) found that northern pike did not spawn over cattails (Typha latifiolia).

Water in Mud Creek flowed only during spring runoff and then dried up quickly. The creek bed was covered with river bullrush and other fine grasses and offered excellent

Figure 18. Flooded pasture land along the James River (Stratford Slough), S.D., May 75.

Figure 19. Flooded habitat along the banks of Moccasin Creek, S.D., June 75.

spawning habitat for northern pike (Figure 20). Large numbers of young-of-the-year northern pike were caught in fine mesh gill nets set at the mouth of Mud Creek. The other location where young northern pike occurred in heavy concentrations was in Stratford Slough. Carp were observed twelve miles upstream from the mouth of Mud Creek in the spring 1975.

Most of the limited gravel spawning habitat was found in Snake Creek. The largest concentrations of adult and young-of-the-year black and white crappies and some young-of-the-year walleyes were captured at the mouth of Snake Creek. Part of the stream bank on an oxbow, 6.7 km (4 mi) north of Ashton, consisted of gravel and rock. Many young-of-the-year crappies, a few young-of-the-year walleyes, and white suckers were captured there.

The lack of species diversity of minnows is probably a reflection of the lack of habitat diversity in the river channel. Fathead minnows, sand shiners and red shiners were abundant so the spawning habitat types available in the Lake Plain area apparently met their requirements. Fathead minnows spawn late in the spring or early summer at temperatures from 18C (65F) to 29C (85F) (Flickinger 1971). I noted that fathead minnows became increasingly abundant after 1 July 75. By 1 July 76 the James was nearly dry on the Lake Plain. The minnows were restricted to the river

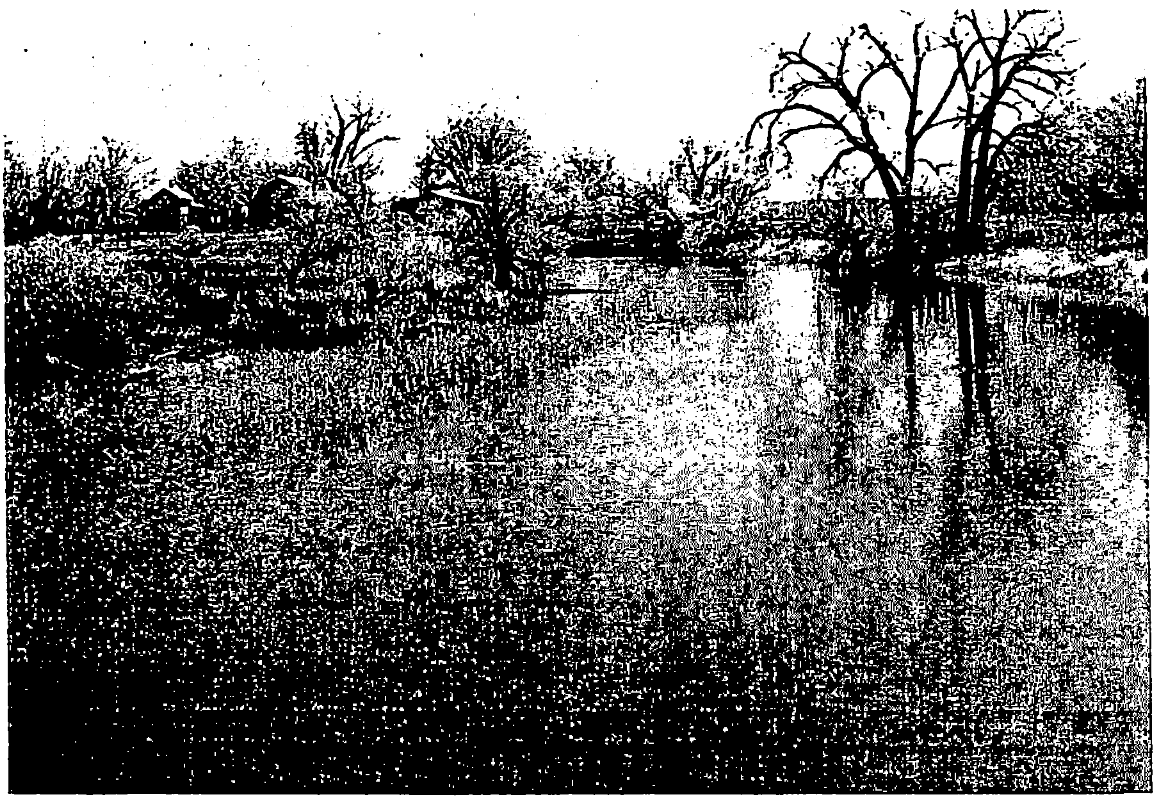

Figure 20. Flooded habitat at the mouth of Mud Creek, S.D., May 75.

Figure 20. Flooded habitat at the mouth of Mud Creek, S.D., May 75.

bed and lacked proper habitat for spawning. Starrett (1951) found that heavy silt load in flood waters adversely affected minnow populations in the Des Moines River, Iowa. He also found that spawning failure occurred when flows remained low throughout the year. The flooded areas on the Lake Plain offer habitat for forage fishes to spawn and areas for silt to settle out of the flood waters. The forage fishes in turn supply food for the larger species of fish using the flooded areas for spawning or as a feeding ground.

The substrata of the river channel on the Lake Plain is composed entirely of mud or silt and is nearly useless for spawning. Hynes (1970) reported that mud is an unpopular site for breeding fishes and most fishes which live over mud either move upstream to gravel, aquatic vegetation, or flooded terrestrial vegetation. The spawning habitat needed by the fishes in the James River is generally found away from the main river channel. Flooded areas, oxbows, and tributaries along the river are especially valuable to the spawning fish populations.

CONCLUSIONS

The James River from Tacoma Park to Redfield is used primarily as a spawning ground by adult fishes and as a nursery for young fishes. Fish populations apparently overwinter in the deep-water areas downstream. The flooded areas and the three tributaries provide valuable habitat for spawning and habitat for the rearing of fish-food organisms and young-of-the-year fishes. The commonly inundated flood plains, such as Stratford Slough, also provide a natural buffer against downstream flooding.

Duration of adequate flow volume appears to be the single most important limiting factor to the fishes in relation to growth, reproduction, and movement of fishes. Food, crowding, temperature, predation, and probably other factors are governed mainly by flow levels. Gunning and LaNasa (1973) determined that pollution and environmental disturbances were reflected by changing growth rates. The growth rates of James River fishes also appeared to be related to the annual discharge in the James. Extreme low flow and drying of the James River, even though relatively common, are rightly considered environmental catastrophies. High flows and flooding, generally detrimental to agricultural land use, are directly beneficial to the fishes by reducing stress factors related to low flow. The Oahe Irrigation Project could improve fish habitat in the James

River by increasing and stabilizing the flow volume providing water quality does not deteriorate. The beneficial influence would however be greatly limited if spawning and rearing habitat were eliminated by channeling the James River on the Dakota Lake Plain.

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