ANNUAL FISH POPULATION SURVEYS ON SOUTH DAKOTA MISSOURI RIVER RESERVOIRS, 1993

by

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PREFACE

Information collected during 1993 is summarized in this report. Copies of this report and references to the data can be made with permission from the authors or Director of the Division of Wildlife, South Dakota Department of Game, Fish and Parks, 523 E. Capitol, Pierre, South Dakota 57501-3182.

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ABSTRACT

This report includes annual fish population survey data from 1989 through 1993 for South Dakota Missouri River reservoirs. Results and discussion pertain to changes in fish community and population characteristics and evaluation of management activities.

Twenty-three fish species were collected with gillnets in Lake Oahe during coolwater sampling in 1993. Rainbow trout were sampled for the first time from Lake Oahe during the coolwater portion of the fish population survey. Walleyes were the most abundant species in the catch followed by channel catfish, yellow perch and rainbow smelt. Mean CPUE for walleye (21/net night) was the highest recorded since re-initiation of the survey in 1982. Goldeye, shorthead redhorse and white bass mean CPUE were the lowest ever recorded on Oahe. In 1993, walleye abundance increased from lower to upper areas of Lake Oahe. Eleven species of age-0 fish or small littoral forage species (minnows and darters) were collected with seines in 1993. Spottail and emerald shiners CPUE declined again in 1993, while white bass, yellow perch and white crappie young of year (YOY) increased. White crappie YOY CPUE was the highest ever recorded in 1993. Abundance of age-0 walleyes in the gillnet catch was low in 1993. Walleye *Wr* increased in Lake Oahe in all three areas, for all length categories. Walleye length at each annulus gradually decreased from lower to upper areas of Lake Oahe. Nearly half of the walleyes caught in coolwater gillnets were from the 1991 year class. Mean age of walleye on Oahe increased to 2.7 years, the highest since 1988. Survival estimates for age-1 and older walleyes increased in 1993 to 52%. A total of 900 walleyes were tagged in 1993. Only 6.2% of the tags were returned in 1993. Proportional stock density and RSD values increased again on Lake Oahe.

The total 1993 chinook salmon CPUE of 2.35 was significantly greater than all previous years CPUE values, with the exceptions of 1984 and 1986. This is largely the result of a high 1993 age-0 chinook salmon CPUE. The 1993 rainbow smelt CPUE of 125.52 is the highest ever recorded since initiation of the suspended gillnet survey in 1984 and is 2.7 times greater that the 1992 CPUE. However, the mean length of rainbow smelt in the standard suspended survey decreased by 16 mm from 1992 to 1993. The lake herring CPUE for standard suspended gill nets was virtually unchanged from 1992. Six fish species were sampled by larval trawling in 1993. Sampling suggests measurable smelt reproduction in 1993. Rainbow smelt densities in 1993 were generally greater than in 1990 although not as great as in 1987. Lake herring were sampled at three stations suggesting the further establishment of this recently introduced species. Zooplankton sampling collected six different taxonomic groups. Previous sampling suggests that 1993 zooplankton densities were low.

Twenty-three species of fish were collected with gillnets from Lake Sharpe in 1993. Mean CPUE for blue sucker, goldeye, sauger and shovelnose sturgeon were the highest since re-initiation of the sampling program in 1982 and lowest recorded for yellow perch. Walleye CPUE increased in 1993 in spite of low recruitment in 1992 and 1993. Fourteen species of age-0 fish or small littoral species (minnows and darters) were collected with seines in 1993. Mean CPUE was the lowest yet recorded for gizzard shad and walleye since re-initiation of the survey. Mean length of walleyes and annual growth increments were lower for all ages in 1992 than previous years. Age-0 walleyes were not sampled in gillnets in 1993. Mean age of walleyes in gillnet samples increased to 2.8 years. Walleye survival estimates decreased in 1993 on Lake Sharpe to 39%. Walleye PSD increased to 36 in 1993. Sauger CPUE increased in 1993 for the fourth consecutive year The mean length of sauger at each annulus decreased in 1993 for age-1 through age-3. Age-3 saugers (1990 year class) were the largest year class sampled in the 1993

survey. The survival estimate for Lake Sharpe saugers was low, only 21%. Sauger PSD remained very high at 89 and the RSD-P stayed high at 30.

Twenty-one species of fish were collected with gill nets in Lake Francis Case in 1993. Walleye abundance increased in 1993 to the highest level in five years. The 1993 CPUE of 23.4 exceeds the five year average of 18.2. The individual sampling location with the highest CPUE occurred at the Pease Creek station in the greater than 80 ft deep sampling station. Sauger abundance in 1993 also increased to a five year high, reversing a previous declining trend. Eighteen species of YOY fish or small littoral forage species were collected by seine in 1993. Emerald and spottail shiners abundance showed the largest increase for 1993. Gizzard shad abundance was well below the 1992 observation. Young-of-the-year walleye, white bass, and smallmouth bass catches in 1993 all showed increases over 1992. Yellow perch YOY abundance was the highest of the five year reporting period. Growth of walleye during 1992 was generally in the range of previous years. Walleye mean age increased to 2.1 years. Annual survival for pooled 1992 and 1993 data increased to 49%, the highest since re-initiation of this survey in 1981. Walleye *Wr* for stock and quality length fish sampled in 1993 were in the range of previous years. Walleye PSD remained at 20. Sauger CPUE in gill nets was the highest observed since re-initiation of this survey in 1981. Sauger growth during 1993 was considerably less than previous years. Sauger sampled in 1993 had a mean age of 1.8 years. Annual survival of sauger for the 1992-1993 pooled data was 42%. Sauger PSD was 81. A total of 29 paddlefish were netted and 11 fish were taken to American Creek Station for spawning and tagging.

Gillnets sampled fifteen species of fish in Lewis and Clark Lake in 1993. Channel catfish, freshwater drum, gizzard shad, and sauger CPUE were the highest observed since reinitiation of the sampling program in 1983. Flathead catfish were absent from gillnet samples after being collected the past two years. Shoreline seining for YOY or small littoral fish collected eighteen species. Stoneroller were collected for the first time. Emerald shiner CPUE was the highest since 1987. White crappie CPUE was the highest since reinitiation of the current sampling program. Walleye growth during 1992 was similar to previous years. Walleye mean age decreased to 2.1 years, due to a large number of yearlings in the sample. Walleye annual survival, at 65% for 1992-93 pooled data, is the lowest since 1987-88. The walleye PSD of 37 is lower than previous years. Walleye *Wr* in 1993 were the highest of the five-year period for all length categories. Growth of sauger in 1992 for L&C was comparable to sauger in Lakes Sharpe and Francis Case. Average age decreased to 1.8 years. Relative weights for all length categories of sauger in 1993 were excellent. Annual survival of sauger in L&C declined slightly to 53% for 1992-93 pooled data. A sauger PSD of 57 in 1993 shows a decline over the past two years.

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INTRODUCTION

The four mainstem Missouri River reservoirs are an extremely valuable fisheries resource for the state of South Dakota. These reservoirs span 192,000 hectares and annually support over 400,000 angler trips (Fielder et al. 1992a, 1992b; Stone and Wickstrom 1992). This fishery has an economic value between $9.2 million and $17.2 million per year based on information provided by the United State Departments of Interior and Commerce (1993), Southwick and Hutchison (1989), and McPhillips (1989). Because of the importance of these reservoirs to the state fishery resource, they must be effectively managed to produce optimal recreational benefits. A prerequisite to the development of effective management strategies is the annual acquisition and analysis of data describing the fish community and population parameters. This report includes data collected on the four reservoirs from 1989 through 1993 and focuses on changes in fish populations for 1993.

South Dakota experienced an unusually cool summer in 1993. Weather conditions undoubtedly affected abundance, growth, distribution, and other parameters of some species.

OBJECTIVES

The objectives of the annual fisheries surveys are to provide information on:

(1) species composition
(2) relative abundance
(3) age, growth, and condition
(4) recruitment
(5) survival and mortality rates
(6) population size structure
(7) effects of regulations.
(8) effects of stocking and other management activities
(9) effects of sport fish harvest

Emphasis is given to selected species which may be important from a sport, commercial or prey perspective, or that are threatened or endangered. Common and scientific names of fishes collected during these surveys are listed in Appendix 1.

STUDY AREA

The Missouri River reservoirs in South Dakota extend from Lake Oahe in north-central South Dakota downstream to Lewis and Clark Lake in southeastern South Dakota. Historical, biological, chemical, and physical parameters have been discussed in previous North Central Reservoir Investigation reports (June 1974; Selgeby and Jones 1974) and South Dakota Game, Fish and Parks reports (Warnick 1987). Table 1 presents selected limnological and management statistics on the four Missouri River reservoirs in South Dakota (Michaletz et al. 1986).

Table 1. Physical characteristics at base of flood control and management information for the four Missouri River impoundments in South Dakota.

	Lake Oahe	Lake Sharpe	Lake Francis Case	Lake Lewis and Clark
Location	From Pierre, SD to Bismarck, ND	From Ft. Thompson to Pierre, SD	From Pickstown to Ft. Thompson, SD	From Yankton to Springfield, SD
Surface area (x 1,000 ha)	126.8	23.1	32.0	10.5
Depth (m) maximum	60.8	23.7	42.6	16.7
mean	19.2	9.5	15.2	5.0
Bottom	Sand, gravel, clay and shale	Sand, gravel, shale and silt	Sand, gravel, shale and silt	Mud, silt, sand and gravel
Water source	Missouri River and tributaries	Missouri River and tributaries	Missouri River and tributaries	Missouri River and tributaries
Management classification	Cold, cool, and warmwater permanent	Cold, cool, and warmwater permanent	Cool and warm water permanent	Cool and warm water permanent

SAMPLING METHODS AND SCHEDULE

Data Collection

Gill nets and seines were used to sample fish populations in the four reservoirs as shown in Figures 1-4. A standard gillnet of multifilament nylon was 91.4-m (300 ft) long x 1.8-m (6 ft) deep with 15.2-m (50 ft) panels of the following bar mesh sizes: 12.7 mm (1/2 in), 19.1 mm (3/4 in), 25.4 mm (1 in) 31.8 mm (1 1/4 in), 38.1 mm (1 1/2 in), and 50.8 mm (2 in). Standard gillnets were fished in 1993 in Lakes Oahe, Sharpe, Francis Case, and Lewis and Clark. Three standard gillnets were fished overnight (approximately 24 hr) on the bottom in each depth zone (where possible), at each station (Table 2). Sampling was conducted in August or September, depending on the reservoir.

Table 2. Sampling times and depths for annual fish population surveys on Missouri River reservoirs.

	Reservoir			
	Lake Oahe	Lake Sharpe	Lake Francis Case	Lewis and Clark Lake
Gill Net Depths:	9-18m(30-60 ft) 0-9m(0-30 ft) 18-27m(60-90 ft)*	0-9m(0-30 ft) 9-18m(30-60 ft)	0-12m(0-40 ft) 12-24m(40-80 ft) 24-37m(80-120 ft)	0-12m(0-40 ft) 12-24m(40-80 ft)
Number of Gillnets:	Coolwater 54 Suspended 30	24	27	9
Dates:	August	August	September	September
Seine Dates:	August	August	July	July

*Suspended nets

The Lake Oahe survey was comprised of two portions, coolwater fish collection and coldwater fish collection. Coolwater fish collection was conducted as described above. Coldwater fish collection targeted salmon, trout, rainbow smelt and lake herring and consisted of suspended sets of standard gillnets with a 15.2-m (50 ft) panel of 10.1 mm (3/8 in) mesh added.

Age-0 and age-1 salmon and smelt >100 mm (4 in) have been sampled effectively in nets set near the 13°C stratum (Warnick 1987). Depths of that stratum have been documented at 30 m some years. Fifteen standard gillnets were suspended at depths of about 20 m (65 ft) at each of two stations, Peoria and Little Bend (Figure 1) during 1993.

All fish collected during coolwater standard gillnet surveys were identified and counted. Walleyes, northern pike, sauger, smallmouth bass, yellow perch, white bass, channel catfish and recently introduced coldwater species were measured for total length and weight. Scale samples were collected from walleyes, saugers, and smallmouth bass. A representative sample of at least 50 individuals per sampling station was measured for all other species, where possible.

Lake Oahe

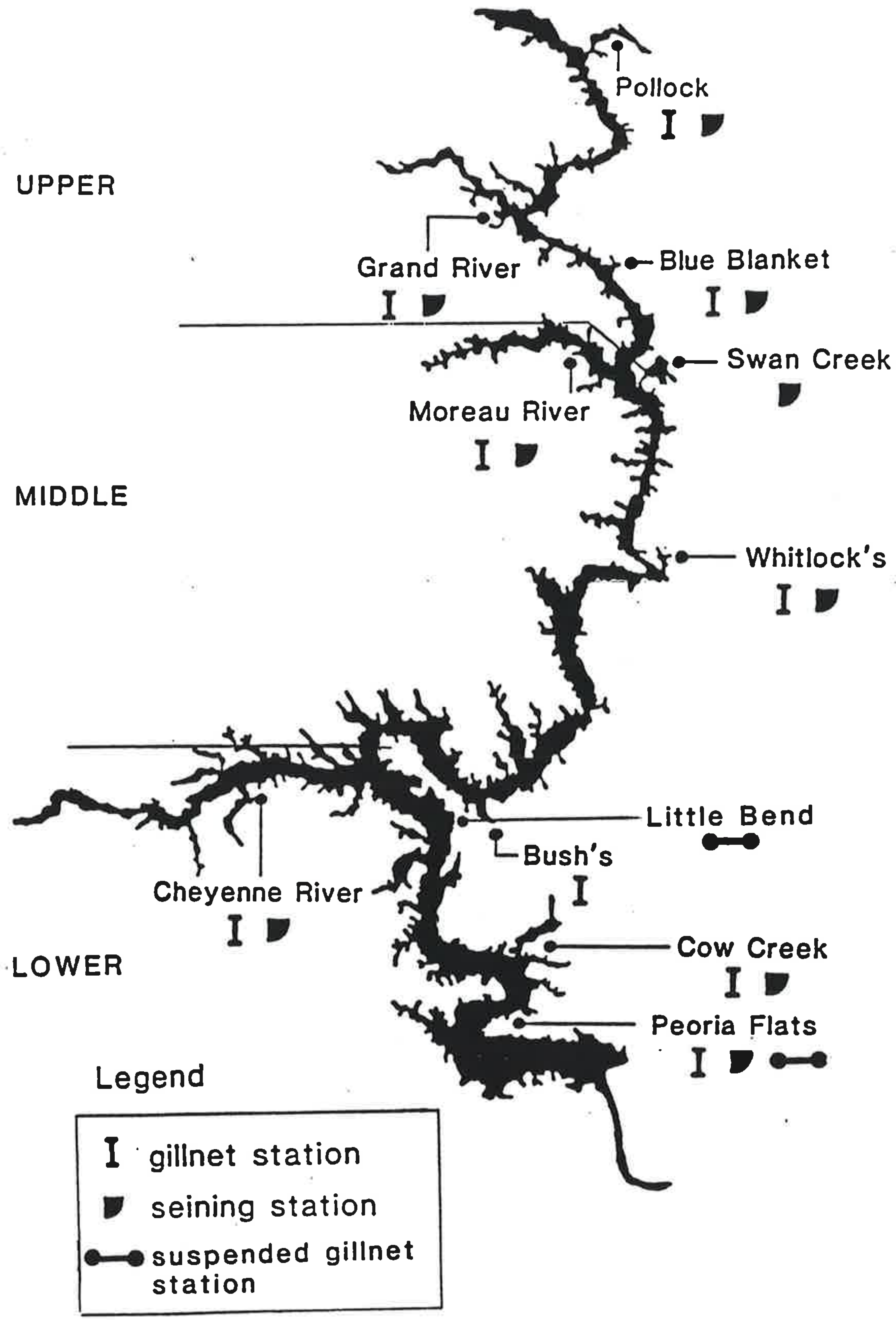

Figure 1. Lake Oahe study area

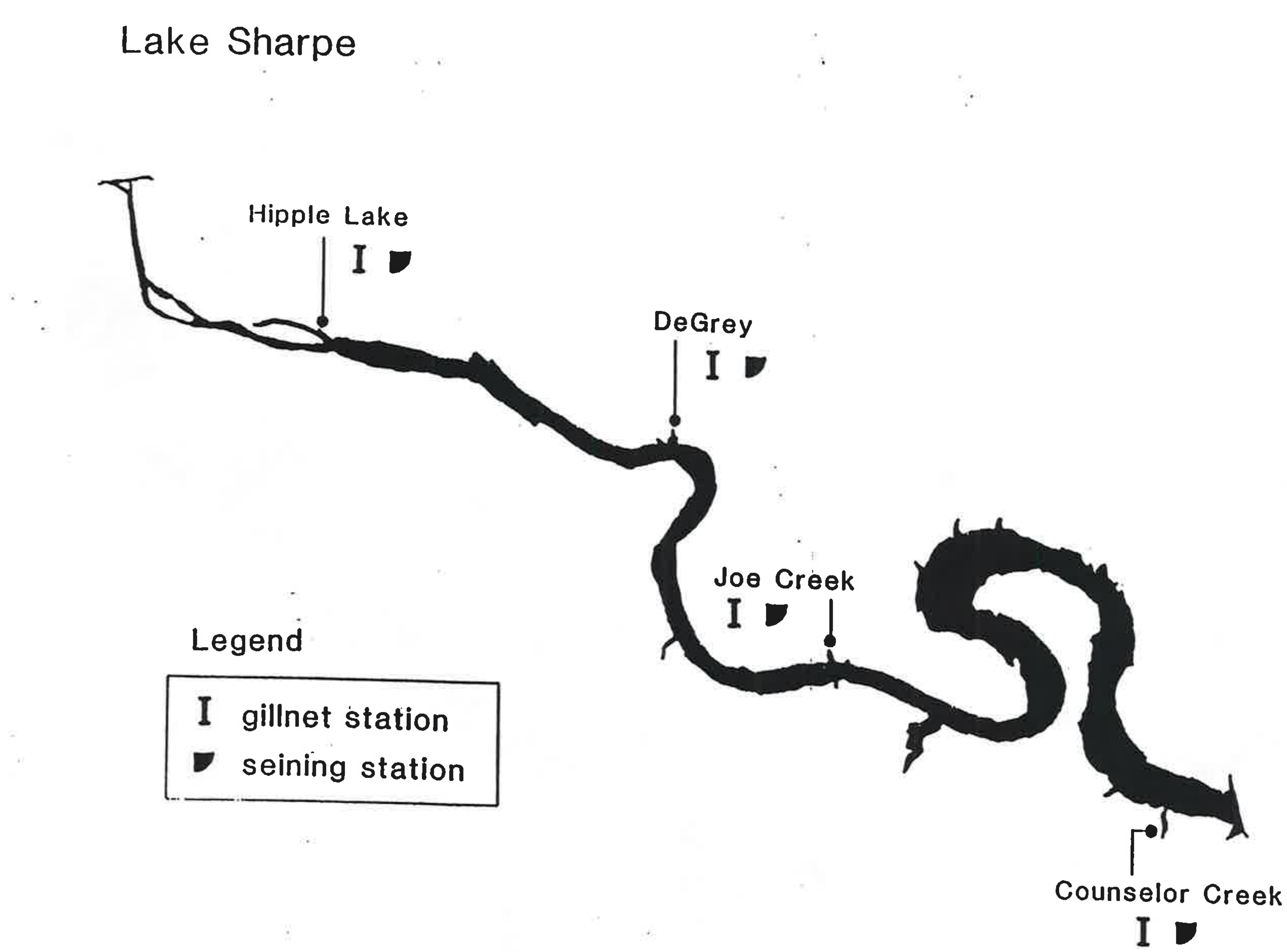

Figure 2. Lake Sharpe study area

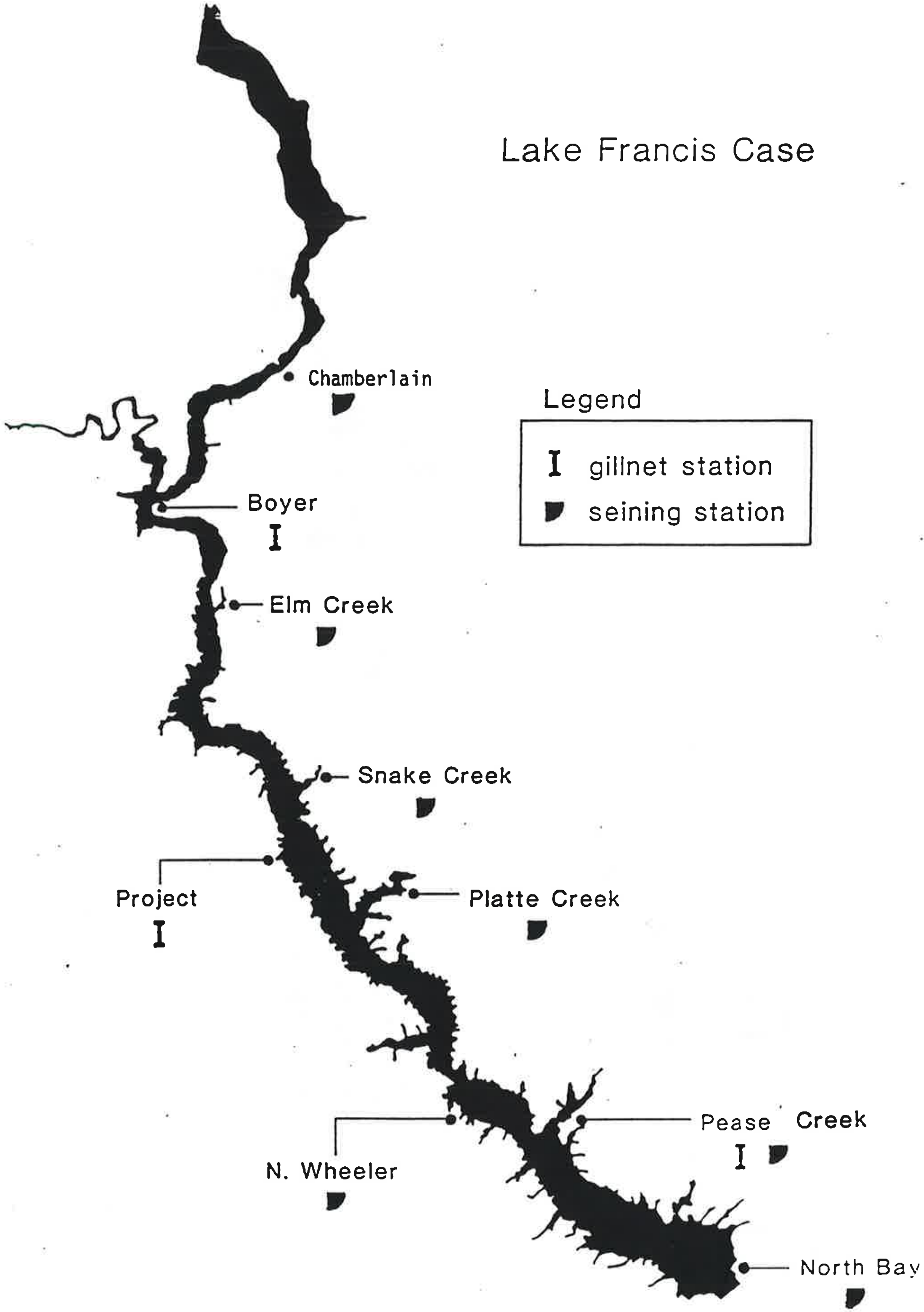

Figure 3. Lake Francis Case study area

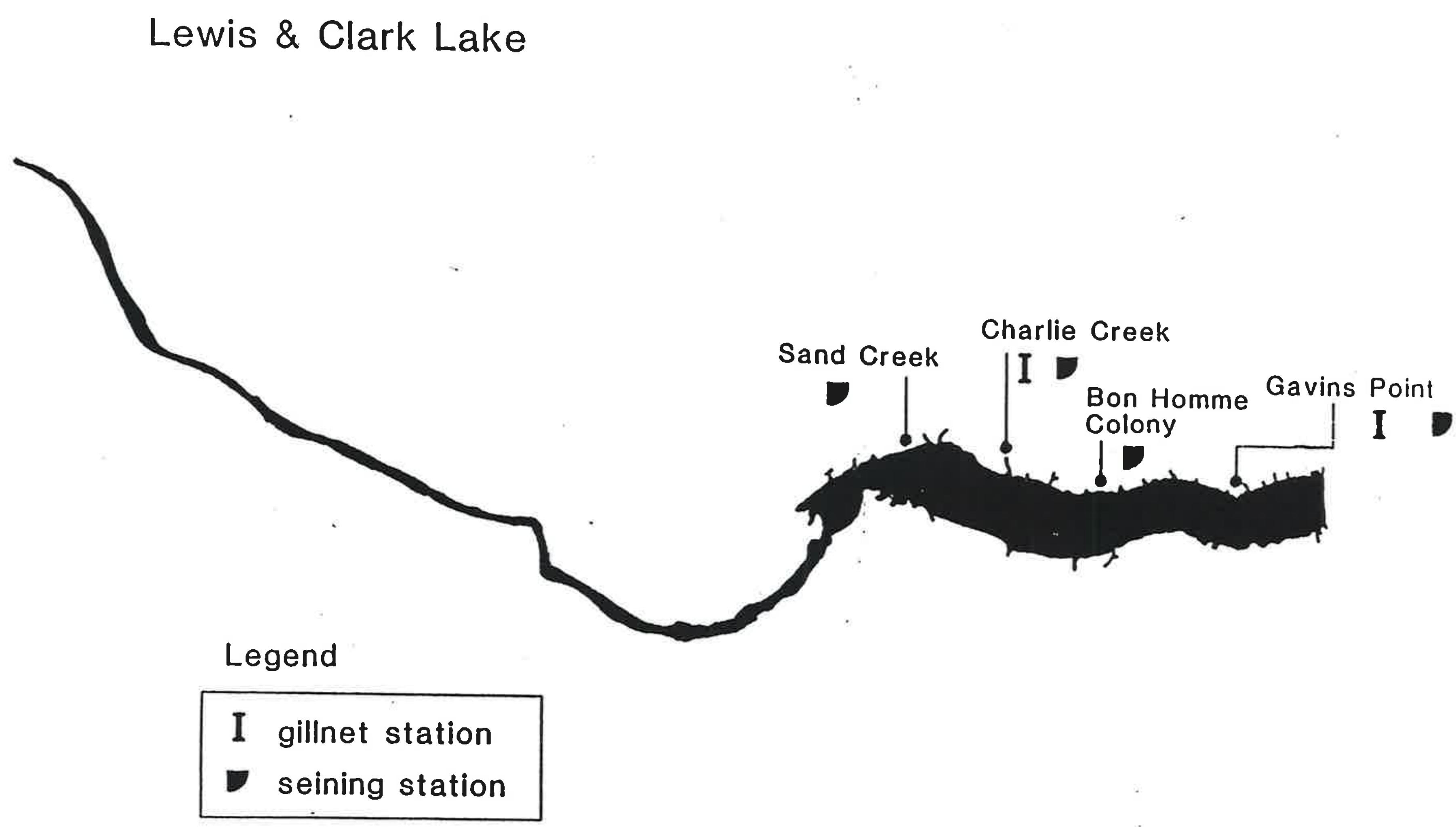

Figure 4. Lewis and Clark study area

All fish collected during coldwater suspended gillnetting operations were identified and counted. Chinook salmon, rainbow trout, lake herring and other sport fishes were measured for total length (mm) and weighed (g). A representative sample of 25 rainbow smelt from each suspended standard gillnet were measured for total length (mm) and weighed (g). Scale samples were taken from 10 rainbow smelt per 10-mm length group at each sampling station. Fish caught in the panel of 10.1-mm mesh, added to the standard suspended gillnets, were recorded separately from fish caught in standard suspended gillnets.

Midwater trawling was not conducted in 1993 because Lake Oahe did not stratify and because the 13°C water was at a depth greater than 30 m. There are many trees at that depth at most of the sampling stations making it impossible to trawl.

Larval fish densities were estimated for Lake Oahe by sampling with paired limnetic larval trawls. Each trawl had a mesh size of 0.5 mm (bar measure), a 2-m x 2-m opening and was equipped with a flow meter. Trawling was performed in the daytime and each trawl haul lasted about five minutes. Two paired trawl hauls were made at each sampling location. Ten locations were sampled throughout Lake Oahe in late May, 1993. All samples were preserved and later identified and enumerated.

Zooplankton were collected with triplicate oblique tows of an 80 um mesh Clarke-Bumpus sampler. Sampling occurred in late May and early June, 1993. All samples were preserved and later identified and enumerated.

Nylon 6.4 mm (1/4 in) mesh bag seines, measuring 30.5 m (100 ft) long x 2.4 m (8 ft) deep, with a 1.8-m x 1.8-m bag, were used to collect age-0 fishes and small littoral species. A quarter-arc seine haul was accomplished by methods described in Martin et al. (1981). Four seine hauls were made at each sampling station, except in Lewis and Clark Lake where two hauls were made at each station. All fish collected with seines were identified and counted.

Data Analysis

Relative abundance of fish species was expressed as mean catch per unit effort (CPUE) for standard gillnet and seine catches. Walleye CPUE for gillnets was tested for differences among areas within Lake Oahe (Figure 1) using single classification analysis of variance (ANOVA) procedures (SAS Institute 1985; Sokal and Rohlf 1981). Chinook salmon and rainbow smelt CPUE from the Lake Oahe coldwater survey were tested for differences among years using a single classification ANOVA and the Least Squared Means procedure (SAS Institute 1985). All statistical tests were performed using a significance level of 0.05 unless otherwise stated.

Age and growth analyses were conducted for walleyes, sauger, and smallmouth bass. Scales were aged according to standard techniques (Jearld 1983). Back-calculations were made with the computer program DISBCAL (Missouri DOC 1989). Standard y-intercept values suggested by Carlander (1982) were used for walleye (55 mm), sauger (55 mm), and smallmouth bass (35 mm). Age distributions for gillnet catches were developed by aging all walleyes caught in gillnet sets. Proportional stock density (PSD) and relative stock density (RSD) values were calculated for walleyes, sauger, and smallmouth bass (Anderson and Weithman 1978; Gabelhouse 1984). Length categories used to calculate PSD and RSD are listed in Table 3.

Table 3. Minimum lengths (mm) of length class designations.

	Stock	Quality	Preferred	Memorable	Trophy
Walleye	250	380	510	630	760
Sauger	200	300	380	510	630
Smallmouth bass	180	280	350	430	510
Channel catfish	280	410	610	710	910
White Bass	150	230	300	380	460
Yellow Perch	130	200	250	300	380

Relative weights (*Wr*) (Anderson 1980) were calculated using the standard weight (*Ws*) equations developed for walleye (Murphy et al. 1990), sauger (Guy et al. 1990), and smallmouth bass (Anderson 1980) for the length categories listed in Table 3. Standard weight equations used in this report are provided in Appendix 2. The computer program Fishmate (Mack 1989) was used to perform the calculations. Mean *Wr* values were tested for differences among length class designations using one-way ANOVA (SAS Institute 1985). Mean *Wr* for stock length fish is reported when no significant differences were detected ($P<0.05$).

Survival and mortality estimates for walleye, sauger, and smallmouth bass were calculated using catch curves (Ricker 1975). To reduce the effects of variable recruitment, two or more consecutive years of age-distribution data were combined for analysis. Catch curves were analyzed to determine the age at which walleyes were fully recruited to the sampling gear. To estimate instantaneous mortality rates (Z), the slope of the regression of the natural logarithm of the number of fish of each age on fish age was used.

RESULTS AND DISCUSSION
LAKE OAHE

Species Composition and Relative Abundance

Twenty-three fish species were collected with gillnets in Lake Oahe during coolwater sampling in 1993 (Table 4). Rainbow trout were sampled for the first time from Lake Oahe during the coolwater portion of the fish population survey. All other species had been previously sampled from Lake Oahe (Michaletz et al. 1986; Wickstrom et al. 1991; Johnson et al. 1992; Wickstrom et al. 1993). Walleyes were the most numerous species in the catch followed by channel catfish, yellow perch and rainbow smelt (Table 4). Mean CPUE for walleye was the highest recorded since re-initiation of the survey in 1982. Goldeye, shorthead redhorse and white bass mean CPUE was the lowest ever recorded on Oahe. Mean CPUE for other species was within ranges observed in previous years (Michaletz et al. 1986; Wickstrom et al. 1991; Johnson et al. 1992; Wickstrom et al. 1993). The walleye CPUE was statistically different between lower and upper areas, but not between the middle area and the other two areas (Table 5). In 1993, walleye abundance increased from lower to upper areas of Lake Oahe.

Eleven species of age-0 fish or small littoral forage species (minnows and darters) were collected with seines in 1993 (Table 6). Spottail and emerald shiners CPUE declined again in 1993, while white bass, yellow perch and white crappie young of year (YOY) abundance increased. White crappie YOY CPUE was the highest ever recorded. Mean CPUE for other species was within ranges observed in previous years (Michaletz et al. 1986; Wickstrom et al. 1991; Johnson et al. 1992; Wickstrom et al. 1993).

Population Parameters for Walleye

Walleyes from 120-630 mm were sampled in Lake Oahe in 1993 (Figure 5). Abundance of age-0 walleyes in the gillnet catch was low in 1993. There was flooded vegetation throughout the reservoir as water levels increased more than 6 m in 1993, providing cover for age-0 walleyes. As a result, the CPUE may not reflect the true abundance of age-0 walleye, due to sampling difficulties.

Walleye *Wr* increased in Lake Oahe in all three areas, for all length categories (Table 7). The observed increases are probably due to increased nutrient inflows, expanding habitat from higher water levels and an increasing forage base, primarily rainbow smelt. Average lengths of walleyes in Lake Oahe, at each annulus are indicated in Table 8. Length at each annulus gradually decreases from lower to upper areas of Lake Oahe.
Possible factors contributing to this decrease include climate, walleye density and prey density. Average annual growth increments of walleyes are presented in Table 9. Growth increments gradually decrease from lower to upper areas of Lake Oahe until age-4 when walleyes from the middle and upper areas have a larger growth increment. Since age-4 and older walleyes from the middle and upper areas of Lake Oahe are shorter than Lower Oahe walleyes they have more potential to increase in length. When compared to 1991 growth increments, growth decreased through age-3 in 1992 and increased in older walleyes.

Walleyes of ages 0 to 11 years were collected with gillnets in 1993 (Table 10). Nearly half of the walleyes caught were from the 1991 year class. Mean age of walleyes on Lake Oahe increased to 2.7 years, the highest since 1988.

Table 4. Mean catch per unit effort for fish species collected with standard coolwater gillnet sets in Lake Oahe. Trace (T) indicates values less than 0.05. Standard deviation (SD) is in parenthesis.

Species	1989	1990	1991	1992	1993
Bigmouth buffalo	0.2 (0.7)	T	0.1 (0.3)	0.1 (0.3)	0.1 (0.3)
Black bullhead	0.9 (3.3)	0.1 (0.4)	T	T	0.0
Black crappie	0.0	0.3 (0.4)	T	0.0	T
Blue catfish	0.0	T	0.0	0.0	0.0
Bluegill	0.0	0.0	0.0	0.1 (0.3)	0.0
Blue sucker	T	T	0.0	0.0	0.0
Channel catfish	13.5 (15.0)	15.8 (10.6)	17.1 (13.6)	17.7 (14.9)	14.0 (12.0)
Chinook salmon	0.0	0.0	0.1 (0.3)	0.1 (0.4)	0.1 (0.4)
Common carp	3.0 (3.3)	1.9 (1.1)	2.4 (2.6)	2.8 (2.5)	2.1 (2.6)
Emerald shiner	T	0.0	0.0	0.0	0.0
Freshwater drum	1.1 (2.2)	1.4 (1.8)	2.0 (3.0)	0.9 (1.6)	0.9 (1.3)
Goldeye	2.5 (7.0)	5.9 (12.1)	5.1 (7.3)	4.2 (8.0)	1.1 (2.0)
Lake herring	0.0	0.0	0.0	T	0.0
Lake whitefish	0.0	0.0	0.0	T	0.0
Northern pike	0.2 (0.4)	0.2 (0.4)	0.1 (0.3)	0.3 (0.6)	0.3 (0.7)
Rainbow smelt	0.0	0.0	0.3 (1.6)	0.7 (2.4)	2.8 (10.1)
Rainbow trout	0.0	0.0	0.0	0.0	0.1 (0.2)
River carpsucker	3.5 (6.2)	2.4 (3.3)	1.9 (3.4)	1.0 (1.6)	0.7 (1.2)
Sauger	0.7 (1.5)	0.7 (1.1)	0.8 (1.5)	0.6 (1.3)	0.8 (1.6)
Shorthead redhorse	0.7 (1.5)	1.2 (2.2)	0.6 (1.0)	0.8 (1.7)	0.4 (0.9)
Shortnose gar	T	0.1 (0.4)	0.1 (0.2)	T	T
Shovelnose sturgeon	0.1 (0.4)	T	0.1 (0.3)	T	T
Smallmouth bass	0.3 (0.7)	0.3 (1.1)	0.5 (1.1)	0.4 (0.8)	0.5 (1.0)
Smallmouth buffalo	0.1 (0.4)	0.2 (0.4)	0.2 (0.6)	0.1 (0.4)	0.1 (0.4)
Spottail shiner	0.6 (1.1)	0.4 (0.7)	1.5 (4.3)	0.9 (1.8)	1.0 (1.6)
Walleye	9.3 (6.2)	13.9 (8.4)	19.9 (11.3)	17.9 (12.5)	21.0 (16.4)
White bass	4.8 (5.1)	6.8 (7.3)	10.8 (19.1)	1.1 (2.0)	0.9 (1.5)
White crappie	0.1 (0.4)	0.2 (0.7)	17.6 (32.1)	2.3 (4.3)	1.5 (6.5)
White sucker	0.1 (0.4)	T	0.1 (0.3)	0.1 (0.4)	0.4 (0.9)
Yellow perch	1.8 (3.3)	4.5 (12.5)	12.7 (17.8)	15.1 (23.7)	11.7 (13.2)

Table 5. Mean walleye catch per unit effort for lower, middle, and upper portions of Lake Oahe, 1989-1993. Values within a year with no letters in common are significantly different at P<0.05. Comparisons are within years only.

Year	Lower	Middle	Upper
1989	7.2 b	6.3 b	14.3 a
1990	12.3 a	13.6 a	15.9 a
1991	18.8 a	19.6 a	21.4 a
1992	18.6 a	18.0 a	17.1 a
1993	13.9 a	20.0 ab	28.9 b

Table 6. Mean catch per seine haul for fish species in Lake Oahe, 1989-1993. Catches are for age-0 fishes except where noted. Trace (T) indicates values less than 0.05. Standard deviation is in parentheses.

Species	1989	1990	1991	1992	1993
Bigmouth buffalo	0.3 (1.0)	0.0	0.0	0.0	0.0
Black bullhead	0.0	0.0	0.4 (2.3)	0.0	0.0
Black crappie	0.0	0.0	2.6 (6.4)	T	0.0
Bluntnose minnow*	0.0	0.0	0.1 (0.8)	T	0.0
Brassy minnow*	0.0	0.0	0.0	0.0	0.7 (4.3)
Channel catfish	T	0.1 (0.6)	T	0.0	0.0
Common carp	0.0	1.4 (3.9)	0.9 (1.9)	0.1 (0.5)	0.5 (2.3)
Emerald shiner*	8.3 (19.0)	65.7 (142.5)	20.0 (32.1)	18.5 (39.0)	4.3 (9.8)
Fathead minnow*	0.0	0.0	T	T	0.0
Freshwater drum	9.4 (34.5)	0.7 (2.4)	0.9 (2.0)	1.0 (4.7)	0.0
Golden shiner*	0.0	T	0.0	0.0	0.0
Goldeye	0.0	0.0	T	0.0	0.0
Johnny darter*	0.2 (0.7)	T	0.0	0.0	0.0
Northern pike	0.0	T	0.0	0.1 (0.3)	0.2 (0.4)
Orangespotted sunfish	0.0	T	0.1 (0.4)	0.0	0.0
River carpsucker	0.9 (3.8)	0.4 (0.9)	0.0	0.0	0.0
Shortnose gar	0.0	0.0	T	0.0	0.0
Smallmouth bass	1.5 (3.5)	0.9 (1.8)	1.5 (3.9)	0.2 (0.5)	0.2 (0.4)
Smallmouth buffalo	0.0	0.0	2.5 (11.6)	0.0	0.0
Spottail shiner*	4.6 (9.8)	5.3 (7.0)	5.1 (17.9)	1.9 (5.4)	0.9 (1.7)
Walleye	0.5 (2.0)	0.1 (0.5)	0.5 (1.3)	0.1 (0.2)	0.3 (0.6)
White bass	17.3 (35.9)	42.6 (121.1)	27.3 (54.2)	16.6 (57.2)	22.1 (91.6)
White crappie	1.0 (4.6)	1.3 (7.2)	6.1 (25.1)	0.9 (3.1)	13.6 (62.2)
White sucker	0.0	1.7 (7.2)	0.4 (1.7)	0.0	0.0
Yellow perch	1.8 (7.6)	17.0 (46.2)	26.3 (84.3)	5.8 (12.0)	18.1 (80.7)

* Includes all ages.

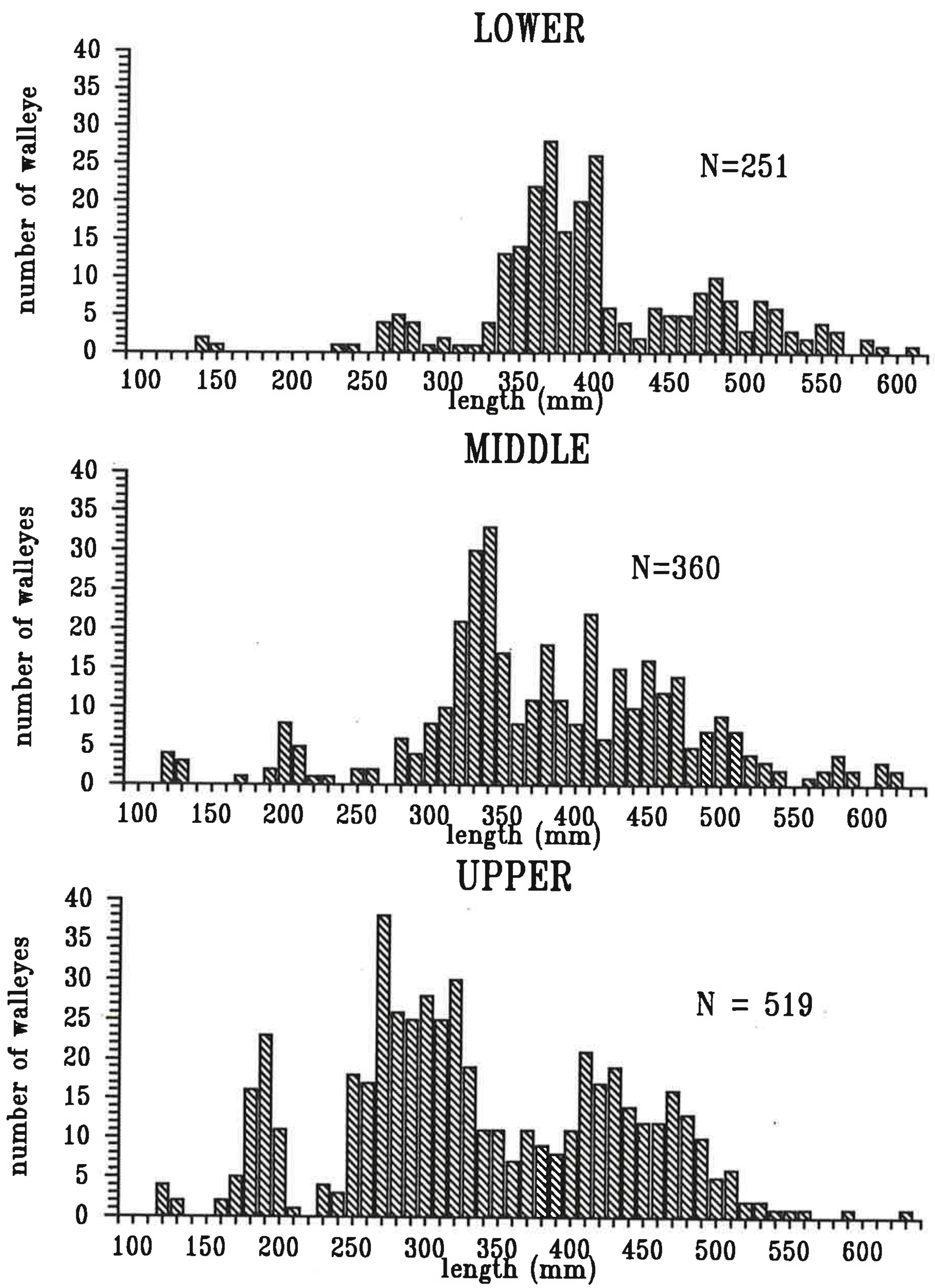

Figure 5. Length frequencies of walleye collected with gill nets from Lake Oahe, 1993.

Table 7. Mean Wr by length class for Lake Oahe walleyes, 1989-1993. N = sample size.

Year	S - Q	Q - P	Preferred	N
Lower Oahe				
1989	86	89	91	90
1990	84	91	96	152
1991	90	93	99	228
1992	90	94	99	282
1993	95	100	103	246
Middle Oahe				
1989	88	86	82	87
1990	82	87	89	129
1991	85	89	85	267
1992	90	93	86	237
1993	92	96	99	328
Upper Oahe				
1989	79	80	80	209
1990	87	82	85	167
1991	84	83	84	206
1992	83	86	93	203
1993	87	95	100	452

Table 8. Mean back-calculated total length (mm) at each annulus of walleye from Lake Oahe for 1993. Sample size is in parentheses.

	Annulus										
Area	1	2	3	4	5	6	7	8	9	10	11
Lower	172	298	398	460	492	526	546	524	551		
	(245)	(227)	(78)	(44)	(16)	(11)	(7)	(2)	(1)		
Middle	156	266	360	430	494	527	567	566	568	590	605
	(353)	(329)	(166)	(86)	(32)	(17)	(9)	(2)	(1)	(1)	(1)
Upper	141	240	331	397	434	461	518	516			
	(512)	(450)	(213)	(116)	(43)	(14)	(7)	(2)			
All	152	261	353	419	465	505	546	536	559	590	605
	(1110)	(1006)	(457)	(246)	(91)	(42)	(23)	(6)	(2)	(1)	(1)

Table 9. Average annual increments (mm) of back-calculated lengths for each year-class of walleye from Lake Oahe collected in 1993.

LOWER OAHE

Year Class	Age	N	Back-calculation Age 1	2	3	4	5	6	7	8	9
1992	1	18	177								
1991	2	149	173	127							
1990	3	34	170	139	103						
1989	4	28	165	125	109	71					
1988	5	5	155	114	110	68	44				
1987	6	4	168	114	87	86	47	31			
1986	7	5	170	115	85	66	59	40	25		
1985	8	1	142	78	132	66	33	25	18	17	
1984	9	1	145	65	99	98	66	27	21	16	13
All Classes			172	127	104	72	50	34	23	16	13
N		245	245	227	78	44	16	11	7	2	

MIDDLE OAHE

Year Class	Age	N	Back-calculation Age 1	2	3	4	5	6	7	8	9	10	11
1992	1	24	142										
1991	2	163	158	109									
1990	3	80	158	115	91								
1989	4	54	146	96	101	78							
1988	5	15	160	113	98	72	46						
1987	6	8	174	118	97	61	36	29					
1986	7	7	163	116	105	78	53	30	29				
1985	8	1	181	139	69	67	51	23	39	25			
1984	9	0	0	0	0	0	0	0	0	0	0		
1983	10	0	0	0	0	0	0	0	0	0	0	0	
1982	11	1	142	92	85	70	62	34	36	20	27	22	16
All Classes			156	109	96	74	46	29	31	23	27	22	16
N		353	353	329	166	86	32	17	9	2	1	1	1

UPPER OAHE

Year Class	Age	N	Back-calculation Age 1	2	3	4	5	6	7	8
1992	1	62	123							
1991	2	237	144	94						
1990	3	97	144	111	83					
1989	4	73	142	90	96	76				
1988	5	29	140	89	96	69	46			
1987	6	7	146	91	75	47	44	34		
1986	7	5	138	100	86	68	52	50	33	
1985	8	2	140	64	87	87	41	47	29	20
All Classes			141	97	89	72	46	41	32	20
N		512	512	450	213	116	43	14	7	2

Table 9. continued...

TOTAL LAKE OAHE

Year			Back-calculation Age										
Class	Age	N	1	2	3	4	5	6	7	8	9	10	11
1992	1	104	137										
1991	2	549	156	107									
1990	3	211	154	117	89								
1989	4	155	147	98	100	75							
1988	5	49	148	99	98	70	46						
1987	6	19	163	107	87	61	41	31					
1986	7	17	158	111	94	71	55	39	29				
1985	8	4	151	86	94	77	42	35	29	21			
1984	9	1	145	65	99	98	66	27	21	16	13		
1983	10	0	0	0	0	0	0	0	0	0	0	0	
1982	11	1	142	92	85	70	62	34	36	20	27	22	16
All Classes			152	107	94	72	47	35	29	20	20	22	16
N		1110	1110	1006	457	246	91	42	23	6	2	1	1

Table 10. Age distributions of walleyes collected from Lake Oahe, 1989-1993 with experimental gillnets. Mean age (x) excludes age-0 fish.

	Age												
Area	0	1	2	3	4	5	6	7	8	9	10	11	x
1989													
Lower	35	33	12	26	9	5	1	8	0	2	0	0	2.9
Middle	9	50	20	13	12	6	2	2	0	0	0	0	2.2
Upper	8	36	116	62	20	9	1	3	0	0	0	0	2.5
All	52	119	148	101	41	20	4	13	0	2	0	0	2.5
1990													
Lower	28	156	12	4	7	7	4	1	1	0	0	0	1.5
Middle	8	128	38	22	31	16	2	0	0	1	0	0	2.1
Upper	31	94	47	89	18	3	1	1	1	0	0	0	2.2
All	67	378	97	115	56	26	7	2	2	1	0	0	2.0
1991													
Lower	89	123	90	9	5	8	11	1	0	2	0	0	1.9
Middle	52	73	164	29	17	10	3	2	0	3	0	0	2.2
Upper	116	96	54	49	62	9	2	0	1	0	0	0	2.4
All	257	292	308	87	84	27	16	3	1	5	0	0	2.2
1992													
Lower	4	202	70	30	8	7	5	3	1	0	1	0	1.7
Middle	0	124	100	73	13	8	3	3	0	2	0	0	2.1
Upper	2	101	63	74	33	27	6	1	1	0	0	0	2.5
All	6	427	233	177	54	42	14	7	2	2	1	0	2.1
1993													
Lower	3	18	149	34	28	5	4	5	1	1	0	0	2.6
Middle	7	24	163	80	54	15	8	7	1	0	0	1	2.8
Upper	6	63	238	98	72	29	7	5	2	0	0	0	2.6
All	16	105	550	212	154	49	19	17	4	1	0	1	2.7

Survival estimates for age-1 and older walleyes increased in 1993 to 52% (Table 11). A total of 900 walleyes were tagged during the spring spawning run in 1993. Only 6.2% of the tags were returned in 1993. In comparison, first year return rates for walleye tagged in 1988, 1990 and 1991 were 8.3%, 16.1% and 10.8%, respectively (Riis et al. 1993).

Table 11. Estimates of annual survival (S), annual mortality (A), and instantaneous mortality rates (Z) for age 1 and older fish. Years indicate which annual survey data were combined for analysis.

Reservoir	Years	S	A	Z
Lake Oahe	1988-1989	0.54	0.46	0.613
(walleye)	1989-1990	0.49	0.51	0.706
	1990-1991	0.49	0.51	0.713
	1991-1992	0.50	0.50	0.685
	1992-1993	0.52	0.48	0.789
Lake Sharpe	1988-1989	0.51	0.49	0.682
(walleye)	1989-1990	0.44	0.56	0.811
	1990-1991	0.44	0.56	0.814
	1991-1992	0.54	0.46	0.624
	1992-1993	0.39	0.61	1.120
(sauger)	1992-1993	0.21	0.79	1.897
Lake Francis Case	1988-1989	0.40	0.60	0.910
(walleye)	1989-1990	0.43	0.57	0.839
	1990-1991	0.44	0.56	0.811
	1991-1992	0.43	0.57	0.851
	1992-1993	0.49	0.51	0.710
(sauger)	1988-1989	0.36	0.64	1.010
	1989-1990	0.38	0.62	0.966
	1990-1991	0.59	0.41	0.531
	1991-1992	0.79	0.21	0.242
	1992-1993	0.42	0.58	0.859
(smallmouth bass)	1989-1990	0.48	0.52	0.742
	1990-1991	0.20	0.80	1.631
	1991-1992	0.26	0.74	1.340
	1992-1993	0.71	0.29	0.348
Lewis and Clark	1988-1989	0.70	0.30	0.360
(walleye)	1989-1990	0.81	0.19	0.207
	1990-1991	0.87	0.13	0.144
	1991-1992	0.85	0.15	0.163
	1992-1993	0.65	0.35	0.436
(sauger)	1988-1989	0.72	0.28	0.330
	1989-1990	0.76	0.24	0.268
	1990-1991	0.50	0.50	0.686
	1991-1992	0.59	0.41	0.531
	1992-1993	0.53	0.47	0.634

Proportional stock density and RSD values increased again on Lake Oahe, especially lower Oahe where many of the numerous age-2 walleyes reached the quality length category (Table 12). The same year class only reached the stock length category in upper Oahe in 1993 which explains the decrease PSD and RSD values in that area of Oahe.

Table 12. Walleye, sauger, and smallmouth bass proportional stock density (PSD) and relative stock density (RSD-P and RSD-M) from gillnet data for 1989-1993.

Reservoir	1989	1990	1991	1992	1993
Oahe					
walleye					
Upper	31(3,1)	22(2,1)	24(0,0)	50(5,0)	42(3,0)
Middle	47(11,1)	55(11,1)	19(3,0)	49(6,1)	55(9,0)
Lower	64(20,5)	18(7,0)	33(8,0)	38(5,1)	60(11,0)
Total	42(9,2)	31(7,1)	25(4,0)	45(6,1)	50(7,0)
Sharpe					
walleye	43(2,1)	26(3,0)	20(2,0)	28(2,1)	36(0,0)
sauger	*	*	*	89(34,0)	89(30,0)
Francis Case					
walleye	8(2,0)	11(1,0)	23(1,0)	20(1,0)	20(1,0)
sauger	41(9,0)	82(14,0)	90(45,0)	*	81(36,1)
sm bass	25(0,0)	28(0,0)	14(0,0)	*	54(0,0)
Lewis & Clark					
walleye	74(27,0)	*	77(23,0)	*	57(23,4)
sauger	90(64,3)	42(29,2)	91(59,0)	74(65,0)	42(6,0)

* insufficient sample for analysis

Suspended Gillnet Results and Discussion

The total 1993 chinook salmon CPUE of 2.35 was significantly greater than all previous years CPUE values, with the exceptions of 1984 and 1986 (1.89 and 2.16 fish per net night, respectively). This is largely the result of a high 1993 age-0 chinook salmon CPUE (Table 13). If this netting method is a suitable index of recruitment into the chinook salmon population, the 1993 year class would be one of the largest yet observed. This year class was established from a stocking of 275,055 age-0 chinook salmon at average sizes of 66/kg to 110/kg. In comparison, year classes were established in 1984 and 1986 from stockings of 784,550 and 811,665 chinook salmon, respectively, at a rate of 154/kg. Attempts were made to relate numbers, pounds and sizes of chinook salmon at stocking with age-0 CPUE values using linear multiple regression analysis, however, no significant relationships were discovered. The wide range in size at stocking, in conjuction with environmental variables, has prevented any relationships between stocking and age-0 chinook salmon CPUE values from being evident. Therefore, no index of survival from stocking to August of age-0 exists.

Table 13. Mean Catch-per-unit-effort (CPUE; number/net night) values for coldwater fish species collected in suspended, standard gill nets in Lake Oahe, South Dakota from 1988 through 1993. Within each grouping, values with the same letter code are not significantly different from one another at the P=0.05 level. N denotes the number of units of effort for a given year.

	Year					
Species	1988	1989	1990	1991	1992	1993
N	29	32	30	30	30	31
Chinook salmon age 0	0.38 a	0.16 ab	0.00 a	0.37 *	0.50 b	1.42 c
Chinook salmon age 1 and older	0.55 de	0.53 de	0.30 d	0.43 *	1.00 f	0.94 ef
Chinook salmon total	0.93 gh	0.69 g	0.30 g	0.80 *	1.50 h	2.35 i
Rainbow smelt standard net	0.28 j	5.94 j	1.77 j	7.43 *	45.83 k	125.52 l
Rainbow smelt 3/8 inch mesh	----	----	----	----	----	191.15
Rainbow smelt total	----	----	----	----	----	318.13
Lake herring	0.00	0.00	0.00	0.00	0.37	0.42
Rainbow trout	0.07	0.00	0.03	0.00	0.03	0.06

* individual net catch information is not available for 1991 netting data.

Chinook salmon *Wr* values for age-0 fish show no discernable difference among years. However, the 1993 age-1 and older mean *Wr* of 100 is significantly greater than for previous years (Table 14). Growth rates are often inferred from *Wr* values. If this idea is followed, Lake Oahe chinook salmon growth is generally below average for inland populations (Halseth et al. 1990).

The 1993 rainbow smelt CPUE of 125.52 is the highest ever recorded (Table 13) since initiation of the suspended gillnet survey in 1984 and is 2.7 times greater than the 1992 CPUE. However, the mean length of rainbow smelt in the standard suspended survey decreased by 16 mm from 1992 to 1993 (Table 15). Possible reasons for the decline in average length of rainbow smelt include the recruitment of a strong year class of smaller-sized fish into the gear, weaker, older age classses, or a reduction in growth rates associated with increased abundance. Currently in Lake Oahe, predator populations are high. The high abundance of rainbow smelt in the system would support the theory that the rainbow smelt population of Lake Oahe is controlled more by physical factors (temperature, reservoir discharge; Walter Duffy, SDSU unpublished data) than by biological (predation) factors. The high abundance of rainbow smelt has occurred at a time when reservoir elevations and nutrient inflow into the reservoir are high. However, there is still concern that the rainbow smelt population may experience a rapid and significant decline in abundance after exceeding it's carrying capacity.

Table 14. Mean Wr values, by age group, for chinook salmon captured in suspended standard gill nets from 1986 to 1993 in lower Lake Oahe, South Dakota. Within groupings, values with the same letter code are not significantly different from one another at the alpha=0.05 level.

		Wr				
Year	N	Age 0	N	Age 1 and older	N	Overall
1986	54	84 ac	33	86 e	87	84 j
1987	0	--	28	84 e	28	84 j
1988	12	71 bd	21	78 f	33	77 k
1989	6	82 acd	13	77 f	19	79 k
1990	0	--	8	68 g	8	68 l
1991	9	75 b	13	94 h	22	86 jm
1992	15	84 acd	29	94 h	44	91 m
1993	45	80 bcd	27	100 i	72	87 jm

Table 15. Mean length of rainbow smelt captured in standard suspended gill nets in August, in lower Lake Oahe, South Dakota from 1986 through 1993. Values with the same letter code are not significantly different from one another at the alpha=0.05 level.

Year	N	Mean Length (mm)
1987	39	113 a
1988	54	101 a
1989	158	128 b
1990	37	129 b
1991	288	142 c
1992	212	147 d
1993	729	131 b

Lake herring CPUE for standard suspended gill nets was virtually unchanged from 1992 (Table 13). It has not been determined if the introduction of lake herring, to diversify the prey base and provide a larger size of prey for chinook salmon, has been successful. Rainbow trout CPUE continues to be low (Table 13), however, the use of night-time surface gillnet sets has shown promise as a possible standard survey technique (Sean Lynott, SDSU unpublished data).

Other Coldwater Survey Gears

Small-mesh and deepwater (bottom sets) gillnetting and midwater trawling were not conducted during 1993. The small-mesh gillnetting survey was discontinued and 10.1 mm mesh was added to the standard suspended netting survey nets to effectively sample all sizes of rainbow smelt susceptible to capture in gill nets. Deepwater netting was not effective at capturing chinook salmon or lake herring and was therefore discontinued (Wickstrom et al. 1993). A lack of thermal stratification in Lake Oahe during July of 1993 prevented collection of valid midwater trawling data.

Larval Fish Trawling

Six fish species were sampled by larval trawling in 1993. All species had previously been sampled in Oahe (Table 16). Larval trawling samples primarily those species whose larvae have an open water existence. Sampling occurs in mid to late May and therefore doesn't sample all reproducing species in Oahe. Larval trawling is primarily intended to provide early measurements of rainbow smelt reproduction.

Sampling suggests measurable smelt reproduction in 1993, with Chantier Creek, Minneconjou Creek and No Mouth Bay having the greatest densities of larval smelt. Comparisons among years is difficult because slight differences in timing of sampling each year can account for large variations in larval fish density. Rainbow smelt densities in 1993 were generally greater than in 1990 although not as great as in 1987.

Although walleye larvae generally have a limnetic existence, previous sampling has failed to collect many specimens despite known natural reproduction. Similarly, only one northern pike larvae was collected in 1993, despite considerable natural reproduction. Lake herring were sampled at three stations (Table 16) suggesting the further establishment of this recently introduced species.

Table 16. Average densities (No. per cubic meter) of larval fish sampled in spring 1993 in Lake Oahe. Densities of larval smelt from 1990 and 1987 are included for comparison.

Location	Yr	Smelt	Perch	Walleye	N. Pike	L. Herring	Unident
Chantier	93	.1332	.0004	-	.0004	-	.0004
	90	.0164					
	87	.4662					
Agency	93	.0654	.0012	-	-	-	-
	90	.0178					
	87	.8389					
Brush	93	.0476	.0030	-	-	-	-
Minneconjou	93	.2427	.1267	.0018	-	.0012	-
	90	.0020					
Bakers	93	.0014	.0253	-	-	-	-
Stove	93	.0088	.0626	-	-	-	-
	90	.7716					
Whitlock	93	.0125	.0964	-	-	-	-
	90	.0825					
Dodge	93	.0009	.0106	-	-	-	-
No Mouth	93	.3299	.2264	.0069	-	.0028	-
	90	.0175					
Grand R.	93	.0247	.0647	.0012	-	.0212	-

Zooplankton Sampling

Zooplankton sampling collected six different taxonomic groups (Table 17). Identification is not routinely performed to the species level. Those six groups were; *Daphnia*, *Leptodora*, *Diaphanosoma*, *Bosmina* cladocerans and Cyclopoid and Calanoid copepods. Copepod nauplii were also tallied separately for estimating zooplankton densities. Uniform data were not available for all sampling locations, however, some previous sampling suggests that 1993 zooplankton densities were low. Like larval fish densities, slight differences in timing of sampling can greatly influence density levels detected whereby making comparisons among years difficult.

Table 17. Average late May to early June zooplankton densities in Lake Oahe, 1993. Density is expressed as number of plankters per liter.

Location	Density
Chantier	76.03
Agency	36.59
Minneconjou	28.36
Stove	56.81
Whitlock	27.50
Dodge	65.12
No Mouth	50.16
Grand R.	88.38

LAKE SHARPE

Species Composition and Relative Abundance

Twenty-three species of fish were collected with gillnets from Lake Sharpe in 1993 (Table 18). Walleye, gizzard shad, channel catfish, shovelnose sturgeon and sauger were the most abundant species collected. Mean CPUE for blue sucker, goldeye, sauger and shovelnose sturgeon was the highest since re-initiation of the sampling program in 1982 and lowest recorded for yellow perch. Bluegill, flathead catfish and rainbow trout were sampled for the first time in 1993. Catch rates of other species were within previously observed ranges (Michaletz et al. 1986; Johnson et al. 1990; Wickstrom et al. 1993).

Fourteen species of age-0 fish or small littoral species (minnows and darters) were collected with seines in 1993 (Table 19). Gizzard shad, white bass and yellow perch were the most abundant age-0 fish species collected. Mean CPUE was the highest since re-initiation of the sampling program in 1982 for bluntnose minnow, largemouth bass and white bass and the lowest recorded CPUE for gizzard shad and walleye. Catch rates of other species were within previously observed ranges (Michaletz et al. 1986; Johnson et al. 1990; Wickstrom et al. 1993).

Table 18. Mean catch per unit effort for fish species collected with standard coolwater gillnet sets in Lake Sharpe. Trace (T) indicates values less than 0.05. Standard deviation (SD) is in parenthesis.

Species	1989	1990	1991	1992	1993
Bigmouth buffalo	0.0	T	T	0.1 (0.6)	0.2 (0.5)
Black bullhead	0.0	0.0	0.3 (0.5)	0.0	0.0
Bluegill	0.0	0.0	0.0	0.0	0.2 (0.5)
Blue sucker	0.0	T	0.0	0.0	0.1 (0.3)
Channel catfish	8.4 (7.3)	12.9 (15.2)	8.2 (7.8)	5.3 (4.6)	11.0 (7.1)
Common carp	4.6 (5.9)	2.5 (1.9)	3.1 (3.9)	2.8 (2.7)	3.5 (2.8)
Flathead catfish	0.0	0.0	0.0	0.0	T
Freshwater drum	0.5 (0.9)	1.9 (2.8)	0.8 (1.7)	0.6 (1.1)	1.2 (2.3)
Gizzard shad	24.6 (24.9)	14.7 (41.2)	7.9 (27.5)	2.9 (11.6)	18.5 (45.1)
Goldeye	0.5 (1.4)	1.1 (5.0)	0.6 (1.9)	1.0 (2.9)	2.3 (3.6)
Largemouth bass	T	0.0	0.0	0.0	0.0
Muskellunge	T	0.0	0.0	0.0	0.0
Northern pike	0.0	0.0	T	T	0.0
Rainbow smelt	0.0	0.0	0.0	0.1 (0.3)	0.7 (1.2)
Rainbow trout	0.0	0.0	0.0	0.0	0.2 (0.6)
River carpsucker	1.0 (1.7)	0.5 (0.9)	0.5 (1.4)	0.4 (0.6)	1.0 (1.8)
Sauger	1.0 (1.4)	1.6 (2.6)	2.8 (3.5)	3.8 (3.4)	4.7 (3.6)
Shorthead redhorse	0.5 (1.4)	0.3 (0.7)	0.2 (0.5)	0.5 (0.8)	0.4 (0.8)
Shortnose gar	0.5 (2.1)	0.2 (0.5)	0.0	0.1 (0.3)	0.1 (0.3)
Shovelnose sturgeon	0.9 (1.9)	1.5 (3.8)	0.3 (0.8)	0.7 (1.0)	6.1 (9.9)
Smallmouth bass	0.2 (0.7)	0.3 (0.9)	0.6 (2.1)	0.1 (0.3)	0.2 (0.4)
Smallmouth buffalo	T	0.2 (0.2)	0.1 (0.4)	T	T
Spottail shiner	1.9 (5.0)	0.2 (0.5)	0.1 (0.4)	T	0.1 (0.3)
Tiger musky	0.0	0.1 (0.2)	0.0	0.0	0.0
Walleye	15.6 (22.0)	33.3 (28.4)	26.5 (26.1)	17.2 (14.6)	30.6 (16.1)
White bass	1.4 (2.1)	5.9 (13.5)	1.8 (3.7)	1.3 (3.0)	2.8 (4.2)
White crappie	0.4 (0.9)	0.8 (2.1)	0.5 (1.2)	0.6 (1.8)	0.7 (1.9)
White sucker	0.0	T	T	T	0.0
Yellow perch	14.5 (29.6)	7.0 (10.2)	5.2 (8.8)	2.9 (6.4)	2.8 (4.0)

Table 19. Mean catch per seine haul for fish species in Lake Sharpe. Catches are for age-0 fishes except where noted. Standard deviation is in parenthesis.

Species	1989	1990	1991	1992	1993
Bluegill	0.0	0.8 (3.3)	0.0	0.0	0.0
Bluntnose minnow*	2.1 (6.0)	2.2 (2.9)	2.9 (5.2)	4.9 (17.9)	5.1 (10.1)
Channel catfish	0.0	0.0	0.1 (0.3)	0.0	0.0
Common carp	0.0	0.0	0.1 (0.3)	0.0	0.0
Common shiner*	0.0	0.0	0.1 (0.3)	0.0	0.0
Creek chub*	0.0	0.0	0.0	1.1 (4.2)	0.0
Emerald shiner*	11.1 (37.4)	36.7 (65.5)	44.9 (99.6)	34.3 (55.9)	41.3 (96.1)
Fathead minnow*	0.0	0.2 (0.4)	0.1 (0.3)	0.1 (0.3)	0.1 (0.3)
Freshwater drum	3.0 (3.5)	4.5 (10.0)	4.0 (4.9)	0.0	0.0
Gizzard shad	801.2 (2026.1)	579.7 (1298.3)	256.9 (232.7)	374.3 (646.3)	187.7 (380.1)
Golden shiner	0.0	0.0	0.0	0.0	0.3 (0.6)
Goldeye	0.0	0.0	4.3 (7.1)	0.0	1.1 (4.0)
Johnny darter*	1.4 (2.0)	0.0	0.0	0.4 (0.8)	1.0 (2.3)
Largemouth bass	0.4 (1.3)	0.5 (1.3)	0.3 (0.5)	0.3 (0.8)	0.7 (1.4)
Orangespotted sunfish	0.3 (1.0)	0.0	0.2 (0.5)	0.0	0.0
River carpsucker	0.1 (0.3)	6.3 (11.4)	7.0 (22.3)	0.2 (0.4)	0.0
Smallmouth bass	0.7 (1.4)	0.4 (0.9)	1.1 (1.5)	0.6 (0.9)	0.3 (0.7)
Spottail shiner*	5.8 (5.0)	12.0 (7.8)	18.4 (27.4)	12.5 (27.8)	5.3 (10.0)
Walleye	5.4 (10.4)	33.1 (89.9)	13.1 (24.1)	1.8 (3.3)	0.1 (0.3)
White bass	23.4 (45.9)	27.3 (53.4)	7.1 (18.8)	34.9 (77.1)	67.1 (198.1)
White crappie	3.0 (6.3)	1.5 (3.4)	0.4 (0.9)	5.9 (23.8)	1.2 (2.4)
White sucker	0.3 (1.0)	0.3 (0.8)	0.1 (0.3)	1.4 (4.7)	0.1 (0.3)
Yellow perch	9.1 (8.5)	11.4 (18.7)	18.9 (23.2)	22.4 (51.1)	15.0 (23.4)

* Includes all ages

Population Parameters for Walleye

Walleye lengths from gillnet catches on Lake Sharpe in 1993 ranged from 180 to 610 mm (Figure 6). Walleye CPUE increased in 1993 despite low recruitment in 1992 and 1993. Mean length of walleyes (Table 20) and annual growth increments (Table 21) were lower for ages 1 though 6 in 1992 than previous years. Relative weight values increased in all length categories and were similar to 1990 levels (Table 22).

Table 20. Mean back-calculated total lengths (mm) for each year-class of walleye from Lake Sharpe in 1993.

Year			Back-calculation Age							
Class	Age	N	1	2	3	4	5	6	7	8
1992	1	59	142							
1991	2	212	164	263						
1990	3	307	158	288	338					
1989	4	127	153	275	358	397				
1988	5	16	162	275	363	417	445			
1987	6	6	161	278	368	416	451	471		
1986	7	1	196	326	416	488	523	557	582	
1985	8	1	171	257	372	442	499	522	554	584
All Classes			158	277	345	400	452	488	568	584
N		729	729	670	458	151	24	8	2	1

Table 21. Average annual increments (mm) of back-calculated lengths for each year-class of walleye from Lake Sharpe in 1993.

Year			Back-calculation Age							
Class	Age	N	1	2	3	4	5	6	7	8
1992	1	59	142							
1991	2	212	164	99						
1990	3	307	158	130	50					
1989	4	127	153	123	83	39				
1988	5	16	162	113	88	53	28			
1987	6	6	161	116	90	49	34	21		
1986	7	1	196	130	90	72	35	33	25	
1985	8	1	171	87	115	70	57	23	32	30
			158	118	61	41	31	23	29	30
N		729	729	670	458	151	24	8	2	1

Walleyes collected with gillnets in 1993 ranged in age from 1 to 8 years (Table 23). Age-0 walleyes were not sampled in gillnets in 1993. Age-3 walleyes were the most numerous in the 1993 catch followed by age-2 and age-4 fish. Mean age of walleyes in gillnet samples increased to 2.8 years.

Survival estimates decreased in 1993 on Lake Sharpe to 39% (Table 11), although, harvest estimates from the 1993 creel survey were lower than usual on Lake Sharpe (Stone et al. 1994). The large 1990 year class affected the slope of the mortality estimate regression. Walleye PSD increased to 36 in 1993 (Table 12), but walleyes in the preferred length category are rare. Walleye PSD will probably increase in 1994 due to several strong year classes (1988 through 1991) being followed by two weak year classes (1992 and 1993).

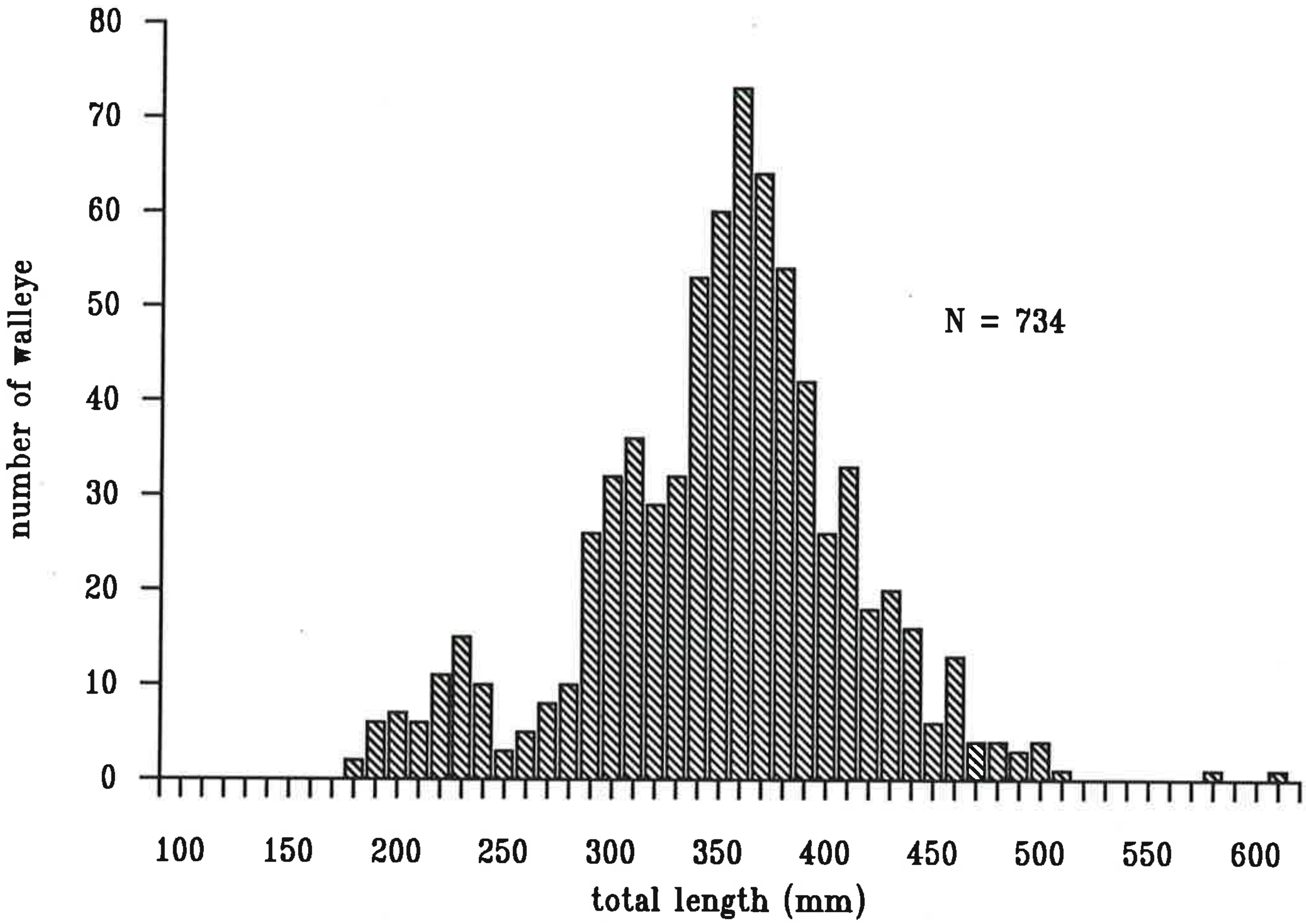

Figure 6. Length frequency of walleyes collected with gill nets from Lake Sharpe, 1993.

Table 22. Mean *Wr* by length class for Lake Sharpe walleyes and sauger 1989-1993. N = sample size.

Year	S-Q	Q-P	Preferred	N
Walleye				
1989	81	80	74	282
1990	86	84	77	498
1991	80	76	67	538
1992	81	79	72	313
1993	84	83	78	674
Sauger				
Year	S-Q	Q-P	Preferred	N
1992	86	80	79	82
1993	85	81	79	112

Table 23. Age distributions of walleyes collected from Lake Sharpe with experimental gillnets. Mean age (x) excludes age-0 fish.

	Age													
	0	1	2	3	4	5	6	7	8	9	10	11	12	x
1989	10	106	81	126	49	9	1	3	1	0	0	0	0	2.4
1990	94	283	257	43	71	25	10	2	1	1	0	0	0	2.1
1991	45	217	239	90	10	16	7	5	1	0	0	0	0	2.0
1992	1	65	150	126	27	8	4	1	1	0	1	0	1	2.5
1993	0	59	212	307	127	16	6	1	1	0	0	0	0	2.8

Population Parameters for Sauger

Sauger CPUE increased in 1993 for the fourth consecutive year (Table 18). Saugers ranged in length from 190 to 500mm in 1993 (Figure 7). The mean length at each annulus decreased in 1993 for age-1 through age-3 (Table 24). The average annual increments for 1992 growth decreased from the previous year in all ages sampled (Table 25). Relative weights did not change significantly in 1993 (Table 22). Saugers ranged in age from 1 to 4 years with a mean age of 2.6 years (Table 26). Age-3 saugers (1990 year class) were the largest year class sampled in the 1993 survey. The survival estimate for Lake Sharpe saugers is low, only 21%. No saugers over age 4 were sampled in 1993. Even with high mortality rates the sauger PSD remained very high at 89 and the RSD-P stayed high at 30 (Table 12). In South Dakota, saugers are included as a combination limit with walleye and therefore subjected to the same length limits and creel limits as walleye. Because of this, the Lake Sharpe sauger population structure resembles the walleye population structure.

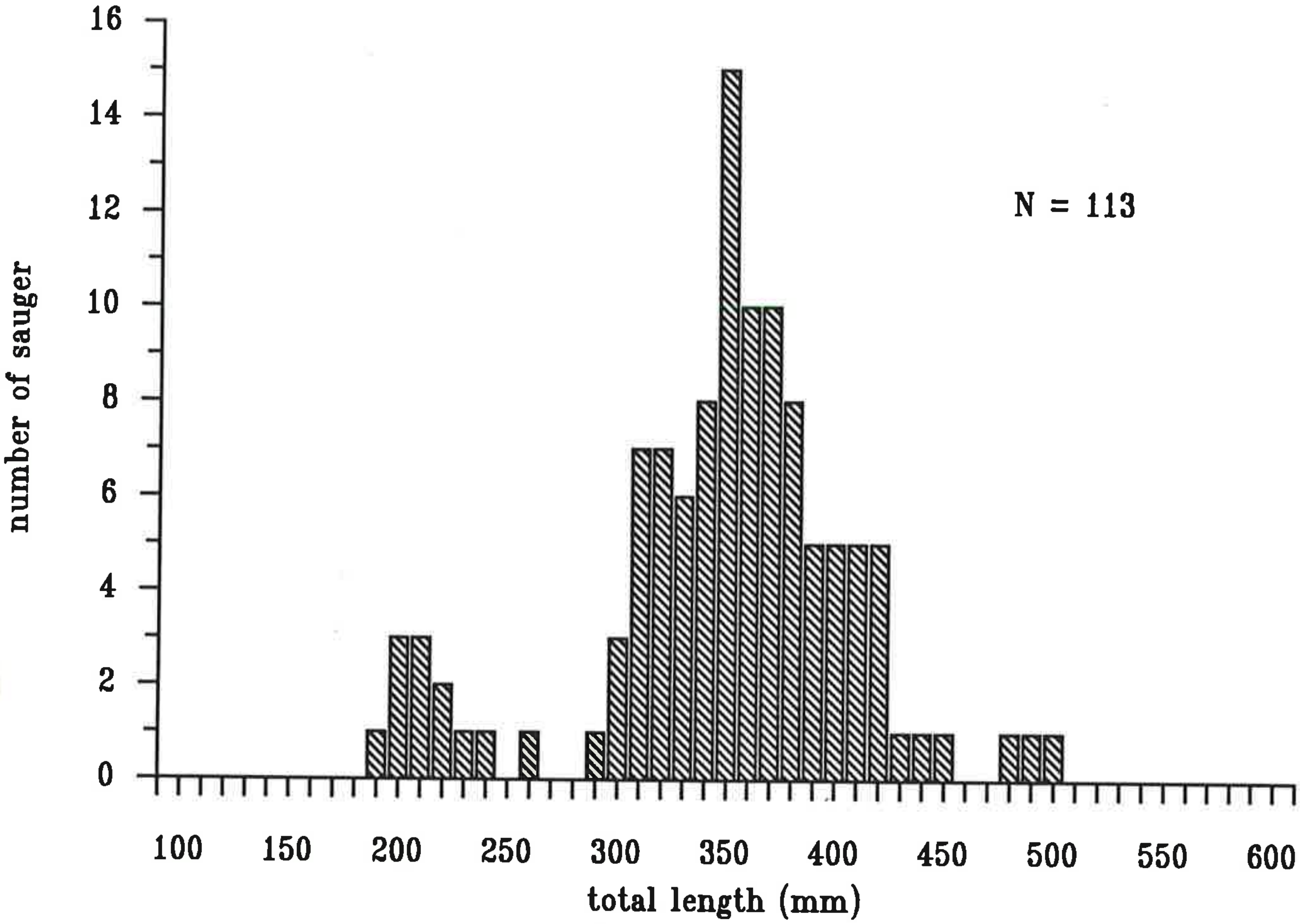

Figure 7. Length frequency of saugers collected with gill nets from Lake Sharpe, 1993.

Table 24. Mean back-calculated total lengths (mm) for each year-class of sauger from Lake Sharpe in 1993.

Year Class	Age	N	Back-calculation Age 1	2	3	4
1992	1	12	149			
1991	2	30	182	290		
1990	3	61	167	310	352	
1989	4	10	167	316	394	421
All Classes			169	304	358	421
N		113	113	101	71	10

Table 25. Average annual increments (mm) of back-calculated lengths for each year-class of sauger collected from Lake Sharpe in 1993.

Year Class	Age	N	Back-calculation Age 1	2	3	4
1992	1	12	149			
1991	2	30	182	107		
1990	3	61	167	143	43	
1989	4	10	167	149	78	27
All Classes			169	133	47	27
N		113	113	101	71	10

Table 26. Age distributions of saugers collected from Lake Sharpe with experimental gillnets. Mean age (x) excludes age-0 fish.

Year	Age 0	1	2	3	4	5	x
1992	0	7	35	39	6	2	2.6
1993	0	12	30	61	10	0	2.6

LAKE FRANCIS CASE

Species Composition and Relative Abundance

Twenty-one species of fish were collected with gill nets in Lake Francis Case (LFC) in 1993 (Table 27). All species have been previously reported (Riis et al. 1988). Walleye continue to dominate the catch of sport fish, as they have since re-initiation of this survey in 1981 (Michaletz et al. 1986; Wickstrom et al. 1993). Channel catfish, YOY gizzard shad, and sauger were common.

Walleye abundance increased in 1993 to the highest level in five years. The 1993 CPUE of 23.4 exceeds the five year average of 18.2. An unusual walleye distribution observation was made in 1993. The individual sampling location with the highest CPUE occurred at the Pease Creek transect, in the greater than 80 ft deep sampling station. Why these fish chose to inhabit this depth is unknown.

Sauger abundance in 1993 also increased to a five year high, reversing a previous declining trend (Wickstrom et al. 1993). The 1993 sauger CPUE of 2.7 is nearly double the five year average of 1.4. Smallmouth bass and white bass abundance in 1993 were similar to values observed in 1992 and near five year averages.

Eighteen species of YOY fish or small littoral forage species were collected by seine in 1993 (Table 28). All species have been previously reported for LFC (Riis et al. 1988). Sampling was hampered in 1993 by high reservoir elevation, which resulted in several sampling locations having to be relocated. Emerald and spottail shiners abundance showed the largest increase for 1993, highest of the five year period and well above five year averages. Gizzard shad abundance was well below the 1992 observation. Figure 8 shows a 10 year average of these three important forage species by sampling location. Generally, there is decreasing abundance as you move down the reservoir.

YOY walleye, white bass, and smallmouth bass catches in 1993 all showed increases over 1992. Yellow perch YOY abundance was the highest of the five year reporting period. Sauger YOY, collected in 1992 for the first time since 1985 (Michaletz et al. 1986), were also sampled in 1993.

Population Parameters for Walleye

Growth of walleye during 1992 was generally in the range of previous years (Table 29). Length at a given age, as determined by back-calculation, is provided in Table 30. Walleye age increased to 2.1 years, in part because of a large 1991 year-class which are now age 2 (Table 31). Improved survival of all age groups also played a role in the increase in mean age. Walleye collected in 1993 represented eight year-classes and ranged in total length from 120 to 650 mm (Figure 9).

Annual survival for pooled 1992 and 1993 data increased to 49% (Table 11), the highest since re-initiation of this survey in 1981 (Michaletz et al. 1986; Wickstrom et al. 1993). Relative weights for stock and quality length fish sampled in 1993 were in the range of previous years (Table 32). Preferred length walleyes had the lowest *Wr* of the five year period. A significant difference ($P<0.05$) was detected between S-Q, and Q-P versus preferred (P) length fish. Walleye PSD remained at 20 (Table 12), but is still a vast improvement over the values observed in the late 1980's. The restrictive walleye regulations, instituted in 1990 (Wickstrom et al. 1993), will be tested as to there ability to protect the 1991 year-class as it moves through the population.

Table 27. Mean gill net catch per lift, sampling stations combined, on Lake Francis Case, 1989-1993. Standard deviation is in parenthesis. Trace (T) indicates values less than 0.1.

Species	1989	1990	1991	1992	1993
Bigmouth Buffalo	0.0	0.0	0.0	0.0	0.1 (0.3)
Brown Trout	0.0	0.0	0.0	0.0	T
Black Crappie	0.0	0.1 (0.2)	0.0	0.0	0.0
Bluegill	0.0	T	T	0.0	0.0
Channel Catfish	5.1 (4.3)	5.5 (4.8)	3.9 (3.3)	4.5 (3.4)	3.9 (3.5)
Chinook Salmon	T	0.0	0.0	0.0	0.0
Common Carp	1.5 (1.7)	1.6 (1.4)	0.9 (1.1)	1.1 (1.2)	1.9 (2.5)
Emerald Shiner	T	0.0	T	T	0.0
Freshwater Drum	0.4 (0.7)	0.6 (1.0)	0.9 (1.2)	0.6 (0.8)	
Gizzard Shad	0.9 (2.3)	2.1 (4.7)	6.2 (10.7)	0.2 (0.6)	2.9 (5.5)
Goldeye	0.4 (0.9)	1.4 (1.8)	0.4 (0.6)	0.7 (2.7)	0.4 (1.5)
Green Sunfish	0.0	T	0.0	0.0	0.0
Largemouth Bass	0.0	0.0	0.0	0.0	0.2 (0.6)
Northern Pike	0.0	0.0	0.0	0.0	0.1 (0.4)
River Carpsucker	1.0 (2.1)	0.5 (1.3)	0.2 (0.4)	0.3 (0.6)	1.7 (0.9)
Sauger	1.5 (2.1)	1.6 (2.6)	1.0 (1.6)	0.4 (0.7)	2.7 (4.6)
Shorthead Redhorse	0.3	0.1 (0.4)	0.1 (0.5)	0.1 (0.5)	0.0
Shortnose Gar	0.4 (1.0)	0.3 (0.9)	T	0.1 (0.5)	0.3 (0.8)
Shovelnose Sturgeon	T	T	0.0	0.0	0.1 (0.3)
Smallmouth Bass	0.5 (0.8)	0.8 (1.5)	1.7 (2.6)	0.6 (1.6)	0.6 (1.4)
Smallmouth Buffalo	0.2 (0.4)	0.1 (0.4)	T	T	0.1 (0.5)
spottail Shiner	0.0	0.1 (0.5)	T	0.6 (1.6)	0.6 (1.4)
Walleye	12.4 (6.0)	17.7 (14.6)	15.0 (9.8)	22.7 (16.7)	23.4 (14.8)
White Bass	0.9 (1.7)	0.6 (0.9)	2.0 (4.8)	1.0 (1.9)	1.2 (1.8)
White Crappie	0.1 (0.3)	0.2 (0.8)	0.8 (1.9)	T	0.2 (0.6)
Yellow Perch	0.4 (0.9)	0.6 (0.9)	0.8 (1.9)	2.2 (2.9)	1.9 (2.3)

Table 28. Mean catch per seine haul, sampling stations combined, of young-of-year fishes from Lake Francis Case, 1989-1993. Standard deviation is in parenthesis. Trace (T) indicates values less than 0.1.

Species	1989	1990	1991	1992	1993
Bigmouth Buffalo	0.0	0.0	T	0.0	0.1 (0.3)
Black Crappie	0.0	0.0	0.4 (1.0)	0.0	0.0
Catostomidae	0.0	T	0.0	0.0	0.0
Channel Catfish	0.0	0.0	T	0.0	0.0
Common Carp	0.0	0.6 (2.7)	0.2 (0.7)	0.0	T
Common Shiner*	0.0	0.0	T	0.0	1.3 (6.4)
Creek Chub	0.0	0.0	0.0	0.0	T
Cyprinidae	0.0	0.0	0.0	0.1 (0.4)	0.0
Emerald Shiner*	12.2 (14.3)	32.7 (55.2)	18.8 (26.8)	6.4 (14.9)	89.7 (246.0)
Fathead Minnow*	T	0.0	0.0	T	1.0 (2.1)
Freshwater Drum	0.0	0.8 (3.1)	3.4 (10.2)	0.0	0.4 (0.9)
Gizzard Shad	15.8 (51.6)	44.5 (187.3)	109.1 (209.4)	321.9 (1487.6)	86.6 (404.0)
Goldeye	0.0	0.0	0.0	0.0	0.1 (0.4)
Johnny Darter*	0.3 (0.7)	2.1 (3.2)	0.4 (1.3)	0.8 (1.3)	0.8 (1.3)
Largemouth Bass	0.0	0.0	T	0.0	0.0
Ozark Minnow*	0.0	0.0	0.0	T	0.0
Red Shiner*	T	0.6 (1.5)	0.0	1.5 (7.7)	T
River Carpsucker	0.0	0.7 (1.3)	0.0	0.0	0.0
Sand Shiner*	0.0	0.0	0.5 (0.7)	0.0	0.0
Sauger	0.0	0.0	0.0	T	T
Shortnose Gar	0.0	0.0	T	0.0	0.0
Silvery Minnow*	0.0	0.0	0.4 (0.9)	0.0	0.0
Smallmouth Bass	0.2 (0.5)	0.6 (1.4)	1.5 (2.5)	0.2 (0.4)	0.7 (1.8)
Smallmouth Buffalo	0.0	0.0	4.8 (13.6)	0.0	0.0
Spottail Shiner*	1.6 (2.9)	3.6 (9.5)	3.8 (5.6)	2.4 (4.0)	23.0 (55.6)
Walleye	0.9 (2.0)	1.5 (3.9)	0.7 (1.5)	0.1 (0.3)	1.2 (2.7)
White Bass	17.4 (26.1)	56.2 (108.3)	256.4 (712.7)	12.3 (30.2)	39.0 (83.3)
White Crappie	0.0	0.0	0.5 (1.2)	0.0	0.4 (1.2)
Yellow Perch	3.9 (5.3)	18.4 (28.1)	1.5 (2.7)	2.4 (8.2)	21.1 (69.5)

* includes both young-of-year and adults

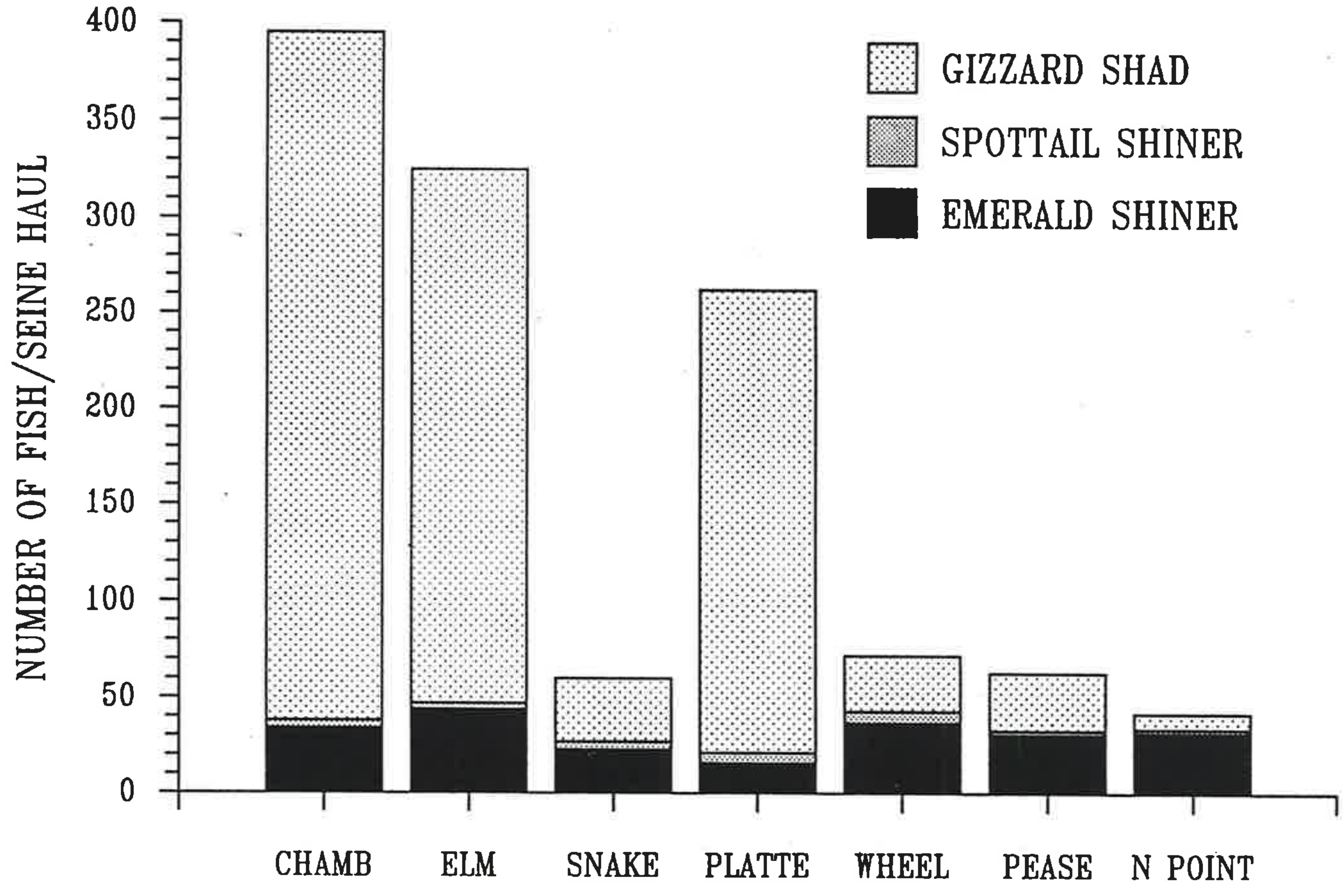

Figure 8. Ten year average trend of three primary Lake Francis Case forage fish species by sampling location.

Table 29. Average annual increments (mm) of back-calculated lengths for each year-class of walleye from Lake Francis Case collected in 1993.

Year Class	Age	N	Back-calculation age 1	2	3	4	5	6	7	8	9	10	11
1992	1	65	152										
1991	2	132	160	102									
1990	3	44	162	128	58								
1989	4	18	167	106	54	49							
1988	5	7	163	94	74	53	44						
1987	6	2	140	118	52	32	37	15					
1986	7	0	0	0	0	0	0	0	0				
1985	8	0	0	0	0	0	0	0	0	0			
1984	9	0	0	0	0	0	0	0	0	0	0		
1983	10	0	0	0	0	0	0	0	0	0	0	0	
1982	11	1	205	125	75	92	58	30	20	17	8	8	12
All classes			159	108	59	51	44	20	20	17	8	8	12
N		269	269	204	72	28	10	3	1	1	1	1	1

Table 30. Average back-calculated total lengths (mm) for each year-class of walleye from Lake Francis Case in 1993.

Year Class	Age	N	Back-calculation age 1	2	3	4	5	6	7	8	9	10	11
1992	1	65	153										
1991	2	132	160	262									
1990	3	44	162	289	347								
1989	4	18	167	273	327	377							
1988	5	7	163	257	331	384	428						
1987	6	2	140	258	311	342	379	394					
1986	7	0	0	0	0	0	0	0	0				
1985	8	0	0	0	0	0	0	0	0	0			
1984	9	0	0	0	0	0	0	0	0	0	0		
1983	10	0	0	0	0	0	0	0	0	0	0	0	
1982	11	1	205	405	497	497	555	585	605	622	630	638	650
All classes			159	269	341	380	431	458	605	622	630	638	650
N		269	269	204	72	28	10	3	1	1	1	1	1

Table 31. Age distribution of walleye collected from Lake Francis Case with experimental gill nets, 1989-1993. Mean age (X) excludes age-0 fish.

	Age												
Year	0	1	2	3	4	5	6	7	8	9	10	11	X
1989	30	193	82	13	2	3	2	2	0	0	0	0	1.5
1990	63	138	190	62	15	5	3	2	0	0	0	0	2.0
1991	120	91	81	84	20	6	1	2	0	0	0	0	2.2
1992	53	317	126	64	35	13	3	2	0	0	0	0	1.8
1993	67	139	297	78	29	18	2	0	0	0	0	1	2.1

Table 32. Mean Wr by length category for Lake Francis Case walleye, sauger, and smallmouth bass, 1989-1993 (N = sample size).

Walleye

Year	S-Q	Q-P	P	N
1989	85	78	78	167
1990	81	81	76	326
1991	83	83	76	263
1992	82	79	82	320
1993	83	84	69	269

Sauger

Year	S-Q	Q-P	P	N
1989	86	83	64	34
1990	78	77	82	44
1991	72	81	79	20
1992	78	86	78	10
1993	86	87	88	69

Smallmouth Bass

Year	S-Q	Q-P	P	N
1989	107	100	0	12
1990	118	121	0	18
1991	122	115	0	38
1992	107	103	0	14
1993	96	112	0	13

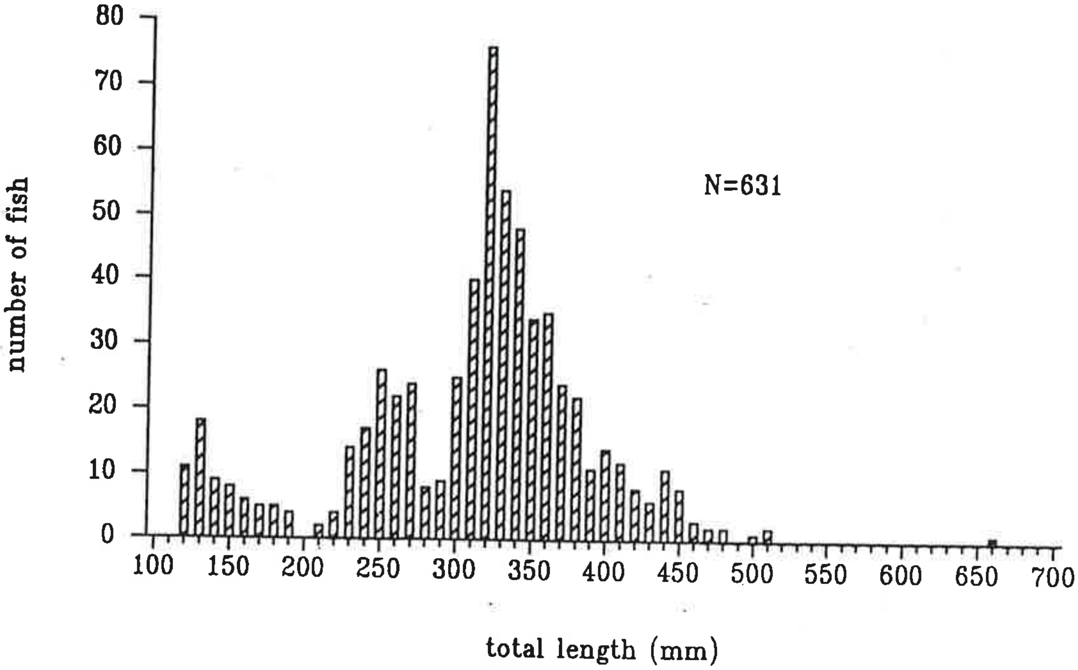

Figure 9. Length frequencies of walleye collected with gill nets from Lake Francis Case, 1993.

Population Parameters for Sauger

Sauger CPUE in gill nets was the highest observed since re-initiation of this survey in 1981 (Michaletz et al. 1986). The sample reflects an apparently strong 1991 year-class (Table 33). Lengths of fish sampled ranged from 170 to 510 mm (Figure 10).

Sauger growth during 1993 was considerably less than previous years (Table 33). Length at a given age, as determined by back-calculation, is provided in Table 34. Relative weights of the various length categories are all equal to or higher than previous years (Table 32).

Sauger sampled in 1993 represent five year-classes, with a mean age of 1.8 years (Table 35). The decrease in mean age over the 1992 value of 2.7 years is reflective of the large 1991 and 1992 year-classes. Annual survival for the 1992-1993 pooled data was 42% (Table 11). Sauger PSD was 81 in 1993, within the range of the five year period.

Population Parameters for Smallmouth Bass

Growth of smallmouth bass in LFC during 1992 is reported in Table 36. Condition remains good, as *Wr* for all length categories sampled were near or above 100 (Table 32). Length at a given age, from back-calculations, is presented in Table 37.

Three year-classes were represented in the sample in 1993, with a mean age of 1.8 years (Table 38). PSD was 54, highest of the five year period. Annual survival for pooled 1992-1993 data was 71% (Table 11). Lengths sampled ranged from 90 to 310 mm (Figure 11).

Paddlefish Monitoring

Paddlefish were collected with 89-127 mm, bar measure gill nets near the mouth of the White River in LFC. During May 10-18, a total of 29 paddlefish were netted (Table 39). Eleven fish taken to American Creek Station for spawning were tagged and released on May 18. Fish not selected for spawning were immediately tagged and released. Three fish captured had been collected during previous years sampling efforts (Table 39). As in previous years, no fish tagged in 1993 were recaptured in 1993 and therefore a population estimate could not be calculated.

Other LFC Comments and Concerns

As previously mentioned, reservoir elevation in 1993 was extremely high for much of the spring and summer, exceeding 1360 msl during the mid July to early August period. This high elevation did result in some terrestrial vegetation being flooded for the first time in many years. However, it was to late for many spring spawners, such as northern pike. There are two fisheries concerns that need to be evaluated and monitored in future surveys. First, the continued development of the White River delta and its role in movement and distribution of fish through out the reservoir, especially walleyes. Second, the apparent decline in overall productivity of the lower 10 miles of the reservoir.

Table 33. Average annual increments (mm) of back-calculated lengths for each year-class of sauger from Lake Francis Case collected in 1993.

Year Class	Age	N	Back-calculation age 1	2	3	4
1992	1	18	192			
1991	2	48	212	94		
1990	3	1	217	141	15	
1989	4	2	219	144	74	44
All classes			207	97	54	44
N		69	69	51	3	2

Table 34. Average back-calculated total lengths for each year-class of sauger from Lake Francis Case collected in 1993.

Year Class	Age	N	Back-calculation age 1	2	3	4
1992	1	18	192			
1991	2	48	212	307		
1990	3	1	217	358	372	
1989	4	2	219	363	437	481
All classes			207	310	415	481
N		69	69	51	3	2

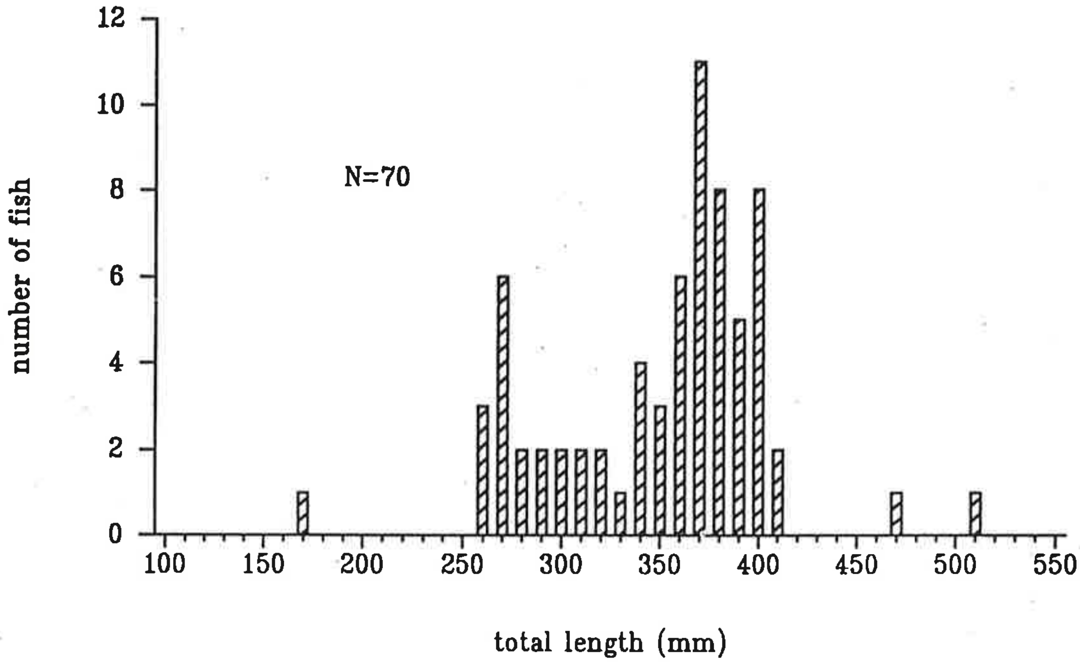

Figure 10. Length frequencies of sauger collected with gill nets from Lake Francis Case, 1993.

Table 35. Age distribution of sauger collected from Lake Francis Case with experimental gill nets, 1989-1993. Mean age (x) excludes age-0 fish.

	Age					
Year	0	1	2	3	4	x
1989	6	22	9	2	1	1.5
1990	0	5	34	3	1	2.6
1991	7	3	4	10	2	2.7
1992	0	3	1	3	2	2.7
1993	1	18	48	1	2	1.8

Table 36. Average annual increments (mm) of back-calculated lengths for each year-class of smallmouth bass from Lake Francis Case in 1993.

			Back-calculation age	
Year Class	Age	N	1	2
1992	1	3	86	
1991	2	10	101	99
All classes			98	99
N		13	13	10

Table 37. Average back-calculated total lengths (mm) for each year-class of smallmouth bass from Lake Francis Case in 1993.

Year Class	Age	N	Back-calculation age 1	2
1992	1	3	86	
1991	2	10	101	200
All classes			98	200
N		13	13	10

Table 38. Age distribution of smallmouth bass collected from Lake Francis Case with experimental gill nets, 1989-1993. Mean age (x) excludes age-0 fish.

Year	Age 0	1	2	x
1989	0	8	5	1.4
1990	3	13	5	1.3
1991	8	33	4	1.1
1992	0	9	7	1.4
1993	2	3	10	1.8

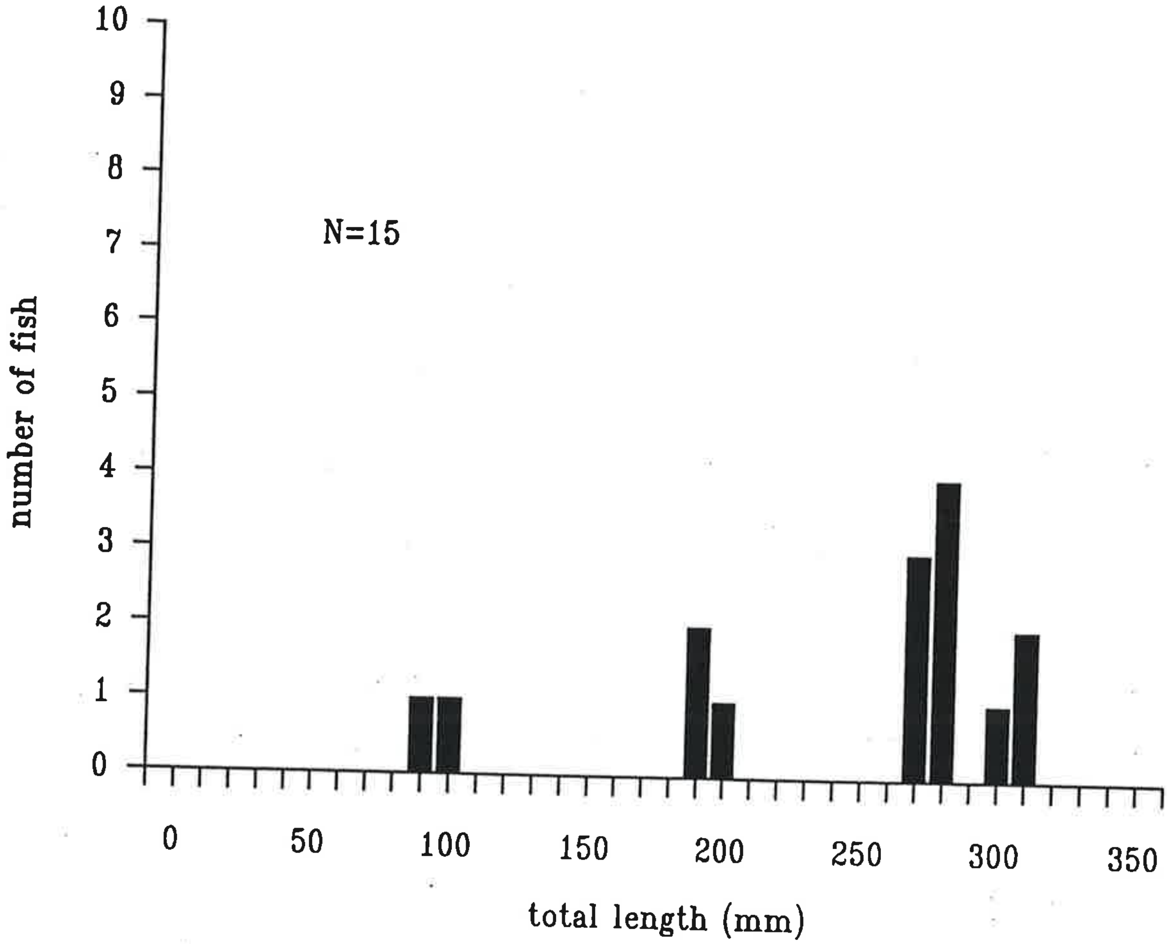

Figure 11. Length frequencies of smallmouth bass collected with gill nets from Lake Francis Case, 1993.

Table 39. Statistics on paddlefish caught, tagged, and released in Lake Francis Case, 1993.

Tag #	Date Tagged	Tagging Location	Eye to Fork Length (in)	Weight (lbs)	Sex	Comments
*	-	-	-	140	F	spawner
1936#	-	-	43.25	44	M	spawner
1992#	-	-	46	64	M	spawner
4047#	-	-	44.75	-	F	no eggs
4701	5/10	White River	43	-	F	no eggs
4703	5/11	White River	41	-	M	-
4704	5/11	White River	44.25	-	F	no eggs
4705	5/12	Am Crk Station	-	66	F	no eggs
4706	5/11	White River	44	-	F	no eggs
4707*	5/12	Am Crk Station	-	98	F	spawner
4708	5/11	White River	49	-	F	no eggs
4709*	5/12	Am Crk Station	-	106	F	spawner
4710	5/12	Am Crk Station	-	60	F	spawner
4711*	5/12	Am Crk Station	-	122	F	spawner
4712	5/12	Am Crk Station	-	81	F	eggs
4713	5/12	Am Crk Station	48	104	F	eggs
4714	5/12	Am Crk Station	44	58	M	spawner
4715	5/12	Am Crk Station	40.5	48	M	spawner
4716	5/12	Am Crk Station	42.5	55	M	spawner
4717	5/12	Am Crk Station	43	56	M	-
4718	5/12	Am Crk Station	41.5	46	M	spawner
4719	5/12	Am Crk Station	45.25	61	M	spawner
4720	5/12	Am Crk Station	44.5	66	M	-
4721	5/18	White River	45.5	-	M	-
4722	5/18	White River	49	-	F	eggs
4723*	5/14	Am Crk Station	-	140	F	spawner
4724	5/12	White River	51.5	-	F	eggs
4725	5/12	White River	52	-	F	eggs
4728	5/12	White River	45.25	-	M	-

* Died during the spawning process.

\# These fish had been tagged in previous yeras and were recaptured in 1992.

1936 was tagged on May 15, 1986 at White River, was 39.5 inches long and weighed 45 pounds.

1992 was tagged at American Creek Station on May 18, 1988 and was 67 pounds.

4047 was tagged at the White River mouth on May 13, 1991 and was 44.25 inches long.

LEWIS AND CLARK LAKE

Species Composition and Relative Abundance

Gillnets sampled fifteen species of fish in Lewis and Clark Lake (L&C) in 1993 (Table 40). All species have been previously reported (Walburg 1976). Gizzard shad was the most abundant species in the catch. Black bullhead were collected for the first time since 1974 (Walburg 1976). Channel catfish, freshwater drum, gizzard shad, and sauger CPUE were the highest observed since reinitiation of the sampling program in 1983 (Michaletz et al. 1986; Johnson et al. 1990; Wickstrom et al. 1993). Walleye abundance in 1993 was the highest since first measured in 1983. Flathead catfish were absent from gillnet samples after being collected the past two years.

Due to flooding during the summer of 1993 in the Mississippi and lower Missouri River basins, releases from Ft. Randall and Gavins Pt. Dams were substantially reduced (U.S. Army Corps of Engineers 1993). This caused much reduced flows and correspondingly low water in the Missouri River below Ft. Randall Dam. Conversely, increased local runoff and reduced releases out of Gavins Pt. Dam caused the L&C lake elevation to be higher than normal. The simultaneous occurrence of these events may have stimulated walleye, sauger and possibly catfish to migrate downstream from the river into L&C, which increased their abundance in L&C. Additionally, reduced releases from Gavin's Point Dam may have caused fewer fish to be flushed from L&C and lost through the dam in 1993 (Walburg 1964).

Shoreline seining for young-of-year or small littoral fish collected eighteen species (Table 41). Stoneroller were collected for the first time. All other species collected in 1993 were previously reported for L&C (Walburg 1964; Walburg 1976; Michaletz et al. 1986). Bigmouth buffalo were collected for the first time in the current sampling program, re-initiated in 1983. Shorthead redhorse and bluegill had not been collected with seines since 1986 and 1988 respectively (Michaletz et al. 1986; Stone et al. 1989). Emerald shiner CPUE was the highest since 1987 (Riis et al. 1988). White crappie CPUE was the highest since reinitiation of the current sampling program. However, a large portion of the white crappie catch occurred at an alternate seining site in the upper part of L&C. Due to high water, the traditional site was unusable. Gizzard shad seine haul CPUE was low compared to previous years, although gill net catches later in the season showed an abundance of YOY gizzard shad later in the season.

Population Parameters for Walleye

Walleye growth during 1992 was similar to previous years (Table 42). Length at a given age, as determined by back-calculation, is shown in Table 43. Growth of walleye in L&C is similar to that in the other Missouri River reservoirs in South Dakota, although first year growth is somewhat slower (Wickstrom et al. 1993).

Mean age decreased to 2.1 years, due to a large number of yearlings in the sample (Table 44). Annual survival, at 65% for 1992-93 pooled data, is the lowest since 1987-88 (Table 11). However, survival of walleye in L&C is consistently the highest of the Missouri River reservoirs in South Dakota.

A PSD of 37 is much lower than previous years (Table 12), but is still in the range considered balanced for coolwater fish populations (Anderson and Weithman 1978). The walleye population in 1993 was comprised of nine year-classes which ranged in length from 160-660 mm (Figure 11). Relative weights in 1993 were the highest of the five-year period for all length categories (Table 45). The increased sample size for 1993 provides a more reliable estimate of *Wr* than in previous years.

Table 40. Mean gill net catch per lift for Lewis and Clark Lake, sampling stations combined, 1989-1993. Standard deviation is in parenthesis.

Species	1989	1990	1991	1992	1993
Black bullhead	0.0	0.0	0.0	0.0	0.1(0.3)
Black crappie	0.0	0.0	0.1(0.3)	0.0	0.0
Channel catfish	2.3(2.0)	4.2(4.2)	2.8(4.8)	1.4(1.0)	5.9(2.5)
Common carp	0.8(1.2)	0.3(0.5)	0.2(0.4)	1.1(1.4)	0.6(0.9)
Emerald shiner	0.2(0.4)	0.0	0.0	0.0	0.0
Flathead catfish	0.0	0.0	0.1(0.3)	0.3(0.5)	0.0
Freshwater drum	3.3(2.8)	8.3(5.4)	8.2(4.1)	10.4(6.9)	12.3(9.5)
Gizzard shad	1.3(1.9)	10.6(16.9)	11.8(15.1)	4.2(6.9)	58.4(46.1)
Goldeye	0.0	0.0	0.0	0.0	0.1(0.3)
Northern pike	0.1(0.3	0.0	0.0	0.0	0.0
Paddlefish	0.0	0.0	0.1(0.3)	0.0	0.0
River carpsucker	1.7(2.4)	0.7(1.0)	2.1(4.2)	1.6(2.1)	1.8(3.0)
Sauger	6.2(3.3)	7.4(6.2)	2.9(2.2)	4.1(2.6)	15.2(14.1)
Shorthead redhorse	0.0	1.2(3.0)	0.3(0.7)	0.2(0.4)	0.0
Shortnose gar	0.1(0.3)	0.2(0.5)	0.8(1.4)	0.2(0.4)	0.4(1.0)
Shovelnose sturgeon	0.0	0.0	0.0	0.0	0.1(0.3)
Smallmouth buffalo	0.3(0.5)	0.0	0.4(0.9)	0.3(0.7)	0.1(0.3)
Spottail shiner	0.0	0.0	0.1(0.3)	0.0	0.0
Walleye	3.0(2.1)	0.6(0.9)	1.9(2.3)	1.1(1.3)	10.8(8.5)
White bass	0.2(0.7)	0.2(0.7)	0.3(1.0)	0.2(0.4)	0.7(1.0)
White crappie	3.6(5.3)	1.0(1.7)	0.3(0.7)	2.4(3.3)	0.3(0.5)
Yellow perch	0.0	0.2(0.5)	0.0	0.1(0.3)	0.4(0.7)

Table 41. Mean catch per seine haul, sampling stations combined, of young-of-year fishes from Lewis and Clark Lake, 1989-1993. Standard deviation is in parenthesis.

Species	**1989**	**1990**	**1991**	**1992**	**1993**
Bigmouth buffalo	0.0	0.0	0.0	0.0	3.4(5.3)
Black crappie	0.0	0.3(0.7)	0.5(0.9)	2.0(5.3)	0.0
Bluegill	0.0	0.0	0.0	0.0	0.4(0.7)
Bluntnose minnow*	0.1(0.4)	0.0	0.0	0.1(0.4)	0.0
Common carp	0.0	0.6(0.7)	0.1(0.4)	0.0	1.9(2.6)
Emerald shiner*	101.3(145.9)	172.9(197.2)	78.6(82.8)	161.9(177.9)	472.0(635.5)
Fathead minnow*	1.0(2.5)	0.0	0.0	0.0	0.0
Freshwater drum	0.0	5.5(15.6)	18.9(35.1)	0.0	15.0(11.6)
Gizzard shad	24.3(52.0)	16.0(44.4)	142.4(255.8)	49.3(120.0)	17.1(20.5)
Johnny darter*	0.3(0.7)	1.1(2.1)	0.4(0.5)	2.1(2.4)	1.6(1.5)
Largemouth bass	0.3(0.5)	8.5(17.9)	1.9(2.3)	0.8(1.4)	1.1(1.5)
Red shiner*	0.0	2.4(5.6)	0.5(1.4)	1.9(4.9)	0.3(0.7)
River carpsucker	0.3(0.5)	0.0	0.9(1.8)	0.0	4.8(7.7)
Sand shiner*	0.0	0.0	2.1(4.5)	0.5(1.4)	0.0
Sauger	0.4(0.5)	1.9(4.5)	0.8(1.8)	1.0(1.2)	0.0
Shorthead redhorse	0.0	0.0	0.0	0.0	0.1(0.4)
Silver chub*	0.0	0.3(0.5)	0.0	0.0	0.0
Smallmouth bass	0.6(0.9)	1.0(2.4)	0.8(0.7)	1.0(2.1)	0.1(0.4)
Smallmouth buffalo	0.0	0.0	0.6(1.8)	0.0	0.0
Spotfin shiner*	0.0	12.1(18.7)	7.8(18.1)	1.5(2.8)	0.0
Spottail shiner*	0.0	0.0	2.8(4.5)	1.0(2.1)	2.6(3.6)
Stoneroller	0.0	0.0	0.0	0.0	0.1(0.4)
Suckermouth minnow*	0.0	0.0	0.0	0.3(0.7)	0.0
Tiger musky	0.0	0.0	0.0	0.1(0.4)	0.0
Walleye	0.6(1.8)	2.6(5.0)	4.1(6.0)	8.0(8.6)	1.4(1.2)
White bass	19.8(40.0)	32.4(88.8)	19.1(27.5)	40.0(66.7)	19.6(19.6)
White crappie	0.4(0.7)	0.0	0.6(1.2)	2.8(7.8)	28.6(58.9)
Yellow perch	0.0	2.5(6.3)	0.6(1.1)	0.0	0.8(0.9)

* includes all ages

Table 42. Average annual increments (mm) of back-calculated lengths for each year-class of walleye from Lewis and Clark Lake collected in 1993.

			Back-calculation age							
Year	age	N	1	2	3	4	5	6	7	8
1992	1	42	122							
1991	2	7	124	159						
1990	3	8	155	154	78					
1989	4	4	129	154	58	58				
1988	5	4	133	160	109	63	38			
1987	6	2	135	157	92	62	36	31		
1986	7	2	108	65	72	81	86	44	34	
1985	8	1	151	191	88	80	40	53	19	1
All classes			127	152	81	66	48	40	29	11
N		70	70	28	21	13	9	5	3	1

Table 43. Average back-calculated total lengths (mm) for each year-class of walleye from Lewis and Clark Lake in 1993.

			Back-calculation age							
Year	age	N	1	2	3	4	5	6	7	8
1992	1	42	122							
1991	2	7	124	283						
1990	3	8	155	309	387					
1989	4	4	129	283	340	399				
1988	5	4	133	293	402	465	502			
1987	6	2	135	293	384	446	482	513		
1986	7	2	108	173	246	327	412	456	490	
1985	8	1	151	342	429	509	549	601	620	631
All classes			127	287	369	424	483	508	533	631
N		70	70	28	21	13	9	5	3	1

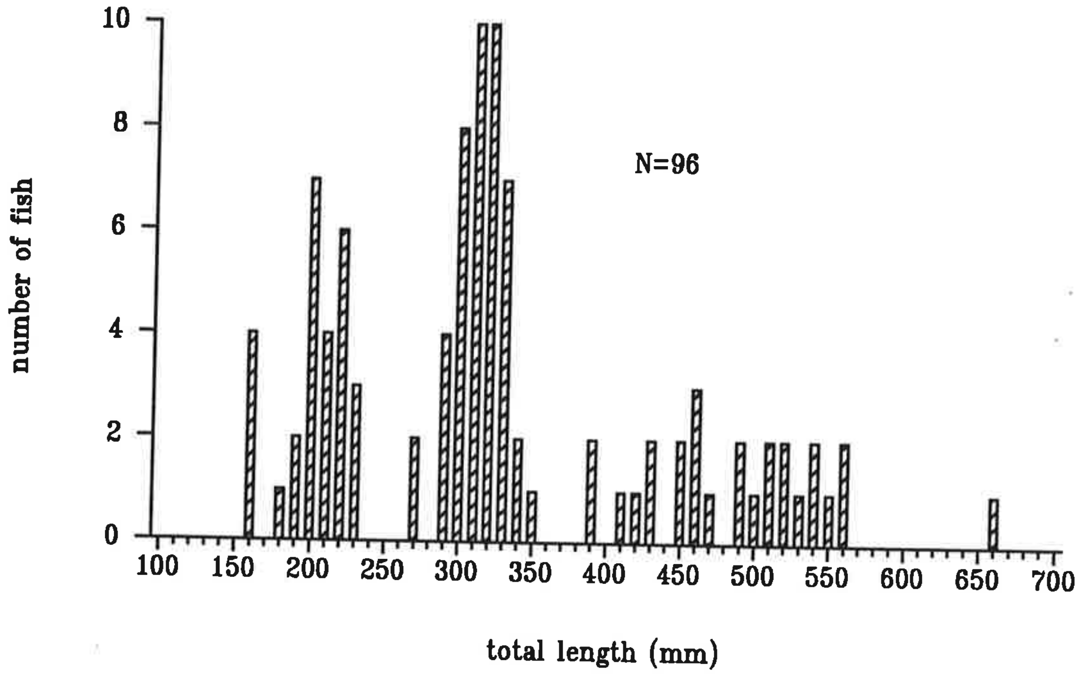

Figure 12. Length frequencies of walleye collected with gill nets from Lewis and Clark Lake, 1993.

Table 45. Age distribution of walleye collected from Lewis and Clark Lake with experimental gill nets, 1989-1993. Mean age (x) excludes age-0 fish.

Year	Age 0	1	2	3	4	5	6	7	8	x
1989	3	5	7	2	3	4	2	1	0	3.2
1990	1	1	0	0	1	0	2	0	0	4.2
1991	4	2	4	1	3	0	1	1	1	3.5
1992	6	0	1	1	1	0	1	0	0	3.8
1993	27	42	7	8	4	4	2	2	1	2.1

Table 45. Mean Wr by length category for Lewis and Clark Lake walleye and sauger, 1989-1993 (N = sample size).

Walleye

Year	S-Q	Q-P	P+	N
1989	83	83	84	22
1990*	-	-	-	4
1991	80	83	78	13
1992*	-	-	-	4
1993	96	97	98	70

Sauger

Year	S-Q	Q-P	P+	N
1989	98	84	82	39
1990	80	87	82	45
1991	83	83	82	22
1992	82	90	84	34
1993	99	103	101	79

* insufficient data for analysis

Population Parameters for Sauger

Growth of sauger in 1992 for L&C was slower for ages one and four than in previous years (Table 46), but still comparable to sauger in Lakes Sharpe and Francis Case (Wickstrom et al. 1993). Length at a given age is presented in Table 47. Average age decreased to 1.8 years (Table 48). Similar to walleye, the increased sample size resulted in an abundance of yearlings which contributed largely to the decline. Relative weights for all length categories of sauger in 1993 were excellent (Table 45).

The population was comprised of eight year classes which ranged in length from 150 to 560 mm (Figure 12). Annual survival of sauger in L&C declined slightly to 53% for 1992-93 pooled data (Table 11). Annual survival has continued to decline since the late 1980's. Sauger PSD, at 57 in 1993, shows a decline over the past two years (Table 12). However, the larger sample size in 1993 may provide a more accurate value than that of 1990 or 1991. Sauger PSD for 1993 is in the desirable 30-60 range for coolwater fishes (Anderson and Weithman 1978).

Table 46. Average annual increments (mm) of back-calculated lengths for each year-class of sauger from Lewis and Clark Lake collected in 1993.

			Back-calculation age							
Year Class	Age	N	1	2	3	4	5	6	7	8
1992	1	53	122							
1991	2	10	161	134						
1990	3	6	179	154	47					
1989	4	6	150	186	91	38				
1988	5	2	181	178	56	42	28			
1987	6	1	188	113	42	74	28	18		
1986	7	0	0	0	0	0	0	0	0	
1985	8	1	195	245	50	71	34	40	34	13
All classes			136	157	64	46	30	29	34	13
N		79	79	26	16	10	4	2	1	1

Table 47. Average back-calculated total lengths (mm) for each year-class of sauger from Lewis and Clark Lake in 1993.

Year Class	Age	N	Back-calculation age 1	2	3	4	5	6	7	8
1992	1	53	122							
1991	2	10	161	295						
1990	3	6	179	333	379					
1989	4	6	150	335	426	464				
1988	5	2	181	358	414	456	485			
1987	6	1	188	300	342	417	445	463		
1986	7	0	0	0	0	0	0	0	0	
1985	8	1	195	440	490	561	595	635	669	682
All classes			136	324	406	468	30	29	669	682
N		79	79	26	16	10	4	2	1	1

Table 48. Age distribution of sauger collected from Lewis and Clark Lake with experimental gill nets, 1989-1993. Mean age (x) excludes age-0 fish.

Year	Age 0	1	2	3	4	5	6	7	8	x
1989	17	4	12	5	2	9	7	0	0	3.5
1990	22	28	8	4	2	2	1	0	0	1.8
1991	4	7	11	2	1	1	0	0	0	2.0
1992	3	3	11	13	4	2	1	0	0	2.8
1993	51	57	11	8	6	2	1	0	1	1.8

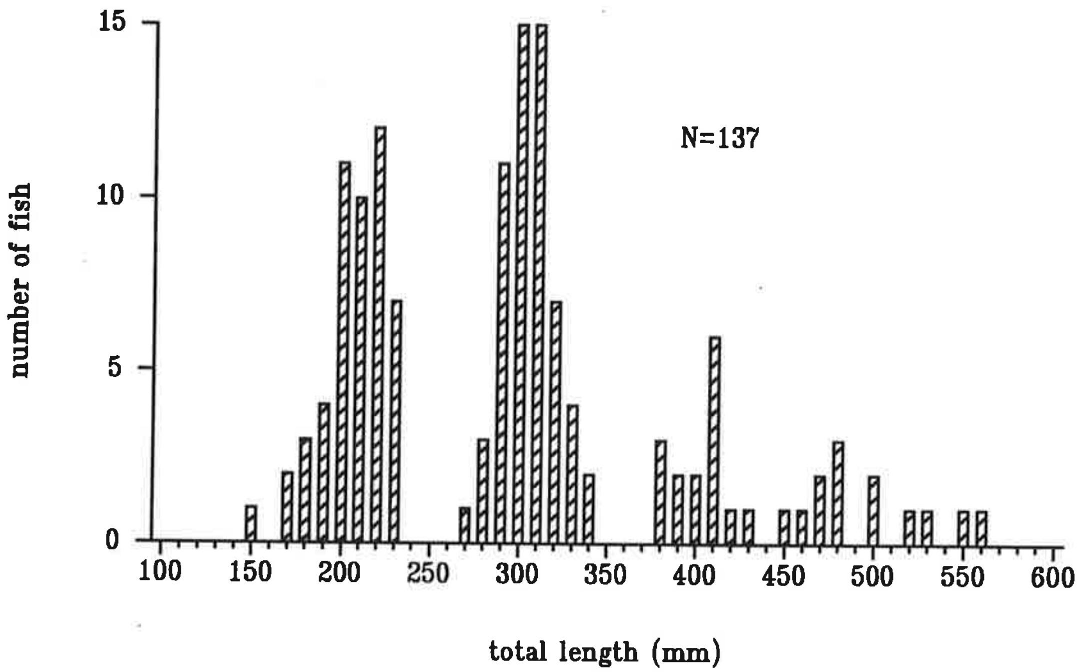

Figure 13. Length frequencies of sauger collected with gill nets from Lewis and Clark Lake, 1993.

RECOMMENDATIONS

1. Continue and modify reservoir fish population surveys, as described in this report, on an annual basis. These surveys are essential for providing basic information on abundance, reproduction, growth and condition, and survival and mortality.

2. Continue emphasis on threatened and endangered fish, record locations, and report observations.

3. Develop and implement standardized smallmouth bass population surveys on all reservoirs, following techniques outlined by Milewski and Willis (1990).

4. Continue the current walleye regulations (daily and possession limit, and 356 mm minimum size limit) unchanged.

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Appendix 1. Common and scientific names of fishes mentioned in this report.

Common Name	Scientific Name
Bigmouth buffalo	Ictiobus cyprinellus
Black bullhead	Ameiurus melas
Black crappie	Pomoxis nigromaculatus
Blue catfish	Ictalurus furcatus
Bluegill	Lepomis macrochirus
Blue sucker	Cycleptus elongatus
Bluntnose minnow	Pimephales notatus
Channel catfish	Ictalurus punctatus
Chinook salmon	Oncorhynchus tshawytscha
Common carp	Cyprinus carpio
Common shiner	Notropis cornutus
Creek chub	Semotilus atromaculatus
Emerald shiner	Notropis atherinoides
Fathead minnow	Pimephales promelas
Flathead catfish	Pylodictis olivaris
Freshwater drum	Aplodinotus grunniens
Gizzard shad	Dorosoma cepedianum
Golden shiner	Notemigonus crysoleucas
Goldeye	Hiodon alosoides
Green sunfish	Lepomis cyanellus
Johnny darter	Etheostoma nigrum
Lake herring	Coregonus artedi
Lake whitefish	Coregonus clupeaformis
Largemouth bass	Micropterus salmoides
Muskellunge	Esox masquinongy
Northern pike	Esox lucius
Paddlefish	Polyodon spathula
Pallid sturgeon	Scaphirhynchus albus
Rainbow smelt	Osmerus mordax
Rainbow trout	Oncorhynchus mykiss
Red shiner	Notropis lutrensis
River carpsucker	Carpiodes carpio
Sand shiner	Notropis stramineus
Sauger	Stizostedion canadense
Shorthead redhorse	Moxostoma macrolepidotum
Shortnose gar	Lepisosteus platostomus
Shovelnose sturgeon	Scaphirynchus platorynchus
Silver chub	Hybopsis storeriana
Silvery minnow	Hydognathus nuchalis
Smallmouth bass	Micropterus dolomieu
Smallmouth buffalo	Ictiobus bubalus
Spotfin shiner	Notropis spilopterus
Spottail shiner	Notropis hudsonius
Stoneroller	Campostoma anomalum
Suckermouth minnow	Phenacobius mirabilis
Tiger musky	E. masquinongy x E. lucius
Walleye	Stizostedion vitreum
White bass	Morone chrysops
White crappie	Pomoxis annularis
White sucker	Catostomus commersoni
Yellow perch	Perca flavescens

Appendix 2. Standard Weight Equations used for relative weight calculations. Length is in millimeters, weight is in grams, and logarithms are to the base 10.

Walleye	LogWS=3.180LogTL-5.453
Sauger	LogWS=3.157LogTL-5.446
Smallmouth bass	LogWS=3.055LogTL-4.983
Channel catfish	LogWS=3.243LogTL-5.649
Yellow perch	LogWS=3.114LogTL-5.138
White bass	LogWS=3.230LogTL-5.386

Appendix 3. Total length (TL) - weight (WT) regression equations for walleye, sauger, and smallmouth bass from Missouri River reservoirs, and mean lengths and weights. Length is in millimeters and weight in grams. Logarithms are to the base 10. Mean (x) lengths and weights do not include age-0 fish.

Year		N	Equation	R^2	x TL (mm)	x WT (gm)
			Lake Oahe Walleye			
1988	lower	144	LogWT=3.1490LogTL-5.3969	0.94	420	808
	middle	215	LogWT=3.2683LogTL-5.7180	0.98	432	890
	upper	202	LogWT=3.2100LogTL-5.5831	0.98	363	555
1989	lower	95	LogWT=3.2586LogTL-5.7153	0.99	415	872
	middle	105	LogWT=3.0777LogTL-5.2523	0.99	345	487
	upper	247	LogWT=3.2005LogTL-5.6082	0.97	332	360
1990	lower	100	LogWT=3.3319LogTL-5.8950	0.99	296	321
	middle	177	LogWT=3.3606LogTL-5.9920	0.98	349	505
	upper	253	LogWT=3.0021LogTL-5.0728	0.98	304	294
1991	lower	249	LogWT=3.3111LogTL-5.8266	0.99	340	469
	middle	301	LogWT=3.2642LogTL-5.7359	0.99	326	358
	upper	273	LogWT=3.1743LogTL-5.5167	0.99	314	303
	total	823	LogWT=3.2684LogTL-5.7394	0.99	326	373
1992	lower	327	LogWT=3.2910LogTL-5.7712	0.99	332	440
	middle	326	LogWT=3.2755LogTL-5.7406	0.95	334	443
	upper	306	LogWT=2.5530LogTL-3.9566	0.82	330	404
	total	959	LogWT=2.9773LogTL-4.9986	0.90	332	430
			Lake Sharpe			
1988	walleye	522	LogWT=2.7749LogTL-4.4412	0.86	366	523
1989	walleye	368	LogWT=3.0915LogTL-5.3232	0.99	337	382
1990	walleye	523	LogWT=3.0762LogTL-5.2600	0.94	316	390
1991	walleye	592	LogWT=2.9059LogTL-4.8656	0.95	330	324
1992	walleye	406	LogWT=3.1158LogTL-5.3886	0.99	334	323
	sauger	86	LogWT=2.9546LogTL-5.0275	0.95	353	345

Appendix 3 Continued...

Lake Francis Case

1988	walleye	551	LogWT=2.809LogTL-4.626	0.96		
1989	walleye	298	LogWT=2.780LogTL-5.020	0.94		
	sauger	37	LogWT=2.780LogTL-4.600	0.94		
	sm bass	12	LogWT=3.057LogTL-4.965	0.89		
1990	walleye	351	LogWT=3.177LogTL-5.536	0.98		
	sauger	44	LogWT=3.320LogTL-5.971	0.98		
	sm bass	18	LogWT=3.376LogTL-5.685	0.97		
1991	walleye	405	LogWT=3.167LogTL-5.506	0.99	328	341
	sauger	27	LogWT=3.055LogTL-5.283	1.00	381	417
	sm bass	45	LogWT=3.424LogTL-5.786	0.99	255	295
1992	walleye	469	LogWT=3.045LogTL-5.206	0.98	303	268
	sauger	10	LogWT=3.069LogTL-5.325	0.99	382	447
	sm bass	16	LogWT=3.054LogTL-5.952	0.97	224	107
1993	walleye	563	LogWT=3.218LogTL-5.623	0.97	333	349
	sauger	69	LogWT=3.177LogTL-5.556	0.97	355	375
	sm bass	13	LogWT=3.359LogTL-5.692	0.98	267	315

Lake Lewis and Clark

1988	walleye	45	LogWT=3.067LogTL-5.252	0.96		
	sauger	28	LogWT=2.991LogTL-5.104	0.93		
1989	walleye	26	LogWT=2.370LogTL-3.460	0.77		
	sauger	56	LogWT=2.880LogTL-4.800	0.95		
1990	walleye	4	LogWT=3.242LogTL-5.803	0.97		
	sauger	45	LogWT=3.221LogTL-5.695	0.98		
1991	walleye	17	LogWT=3.312LogTL-5.898	0.99	436	837
	sauger	26	LogWT=3.261LogTL-5.799	0.99	372	411
1992	walleye	10	LogWT=2.941LogTL-4.896	0.99	393	653
	sauger	37	LogWT=2.584LogTL-4.026	0.96	406	557
1993	walleye	70	LogWT=3.231LogTL-5.593	0.99	380	687
	sauger	79	LogWT=3.087LogTL-5.260	0.97	367	499

Appendix 4. Channel catfish, white bass, and yellow perch proportional stock density (PSD), relative stock density (RSD-P and RSD-M), and relative weight (Wr) for 1989-1993. N = sample size.

OAHE
PSD(RSD-P,M)-Wr

Species	1989	1990	1991	1992	1993
Channel catfish	13(0,0)-*	17(0,0)-*	24(1,0)-78 N = 123	19(0,0)-77 N=437	41(0,0)-83 N=201
White bass	100(49,3)-*	98(75,0)-*	100(100,0)-95 N = 20	28(26,2)-95 N=50	100(9,4)-98 N=46
Yellow perch	3(0,0)-*	16(0,0)-*	18(0,0)-92 N = 115	14(0,0)-96 N=288	29(0,0)-94 N=230

SHARPE
PSD(RSD-P,M)-Wr

Species	1989	1990	1991	1992	1993
Channel catfish	33(0,0)-*	24(0,0)-*	40(3,0)-79 N = 140	70(0,0)-82 N=115	76(3,0)-77 N=120
White bass	76(59,0)-*	90(44,0)-*	100(43,29)-95 N = 35	97(84,35)-91 N=31	93(88,34)-92 N=41
Yellow perch	16(0,0)-*	14(0,0)-*	47(1,0)-87 N = 92	43(3,0)-90 N=30	18(3,0)-85 N=38

FRANCIS CASE
PSD(RSD-P,M)-Wr

Species	1989	1990	1991	1992	1993
Channel catfish	12(0,0)-* N = 86	13(1,0)-* N = 115	14(0,0)-* N = 85	16(0,0)-77 N = 108	23(1,0)80 N= 95
White bass	100(95,27)-99 N = 22	*	100(95,59)-* N = 44	100(81,69)-83 N = 16	91(91,64)103 N= 11
Yellow perch	*	*	*	19(2,0)-85 N = 9	41(5,0)88 N= 44

LEWIS AND CLARK
PSD(RSD-P,M)-Wr

Species	1989	1990	1991	1992	1993
Channel catfish	70(20,0)-* N = 10	37(6,0)-* N = 35	50(0,0)-* N = 24	78(22,11)-* N = 9	42(6,0)85 N= 52

* not available